Sunrise Wind Farm and Sunrise Wind Export Cable – Development and Operation

Biological Assessment

April 24, 2023

For the National Marine Fisheries Service

U.S. Department of the Interior

Bureau of Ocean Energy Management

Office of Renewable Energy Programs

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Abbreviations and Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
ac	acre(s)
AC	alternating current
AIF	average intake flow
AIS	automatic identification system
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMP	Alternative Mitigation Plan
ASV	autonomous surface vehicle
AUV	autonomous underwater vehicle
BA	Biological Assessment
BD	behavioral disturbance
BIA	biologically important area
BIWF	Block Island Wind Farm
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
C	construction
C&D	Chesapeake and Delaware
CFE	controlled flow excavation
CFR	Code of Federal Regulations
CH	critical habitat
CHIRP	compressed high-intensity radiated pulses
cm	centimeter(s)
cm/s	centimeter(s) per second
COP	Construction and Operations Plan
CPS	cable protection system
CTV	crew transfer vessel
CWIS	cooling water intake structure
D	decommissioning
dB	decibel(s)
dB re 1 μPa	decibel re 1 micropascal
dB re 1 $\mu Pa^2 s$	decibel re 1 micropascal squared second
dB rms	decibel(s) root mean square
DC	direct current

DIF	design intake flow
DMA	dynamic management area
DOI	Department of the Interior
DoN	Department of the Navy
DPS	distinct population segments
E	endangered
EEZ	Exclusive Economic Zone
EMF	electric and magnetic field
EPA	United States Environmental Protection Agency
EPM	environmental protection measure
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FDR	Facility Design Report
FIR	Fabrication and Installation Report
FMP	Fisheries and Benthic Research Monitoring Plan
FR	Federal Register
ft	foot(feet)
ft-lb	foot-pound(s)
ft^2	square foot(feet)
G&G	geophysical and geotechnical
gal	gallon(s)
GARFO	Greater Atlantic Regional Fisheries Office
GPS	global positioning system
ha	hectare(s)
HDD	horizontal directional drilling
HF	high frequency
HMS	highly migratory species
HRG	high-resolution geophysical
Hz	hertz
IAC	Inter-Array Cables
IHA	Incidental Harassment Authorization
in.	inch(es)
in./s	inch(es) per second
IPF	impact-producing factor
ITA	Incidental Take Authorization
ITR	Incidental Take Regulations
J	joule(s)

JASMINE	JASCO Animal Simulation Model Including Noise Exposure
JUV	jack-up installation vessel
kg	kilogram(s)
kHz	kilohertz
kJ	kilojoule(s)
km	kilometer(s)
km^2	square kilometers
kt	knot(s)
kV	kilovolt(s)
L	liter(s)
LAA	likely to adversely affect
lb	pound(s)
$L_{E,24hr}$	cumulative sound exposure level over a 24-hour period, synonymous with SEL_{24h}
LF	low frequency
LFC	low-frequency cetacean
LOA	Letter of Acknowledgement
L_p	sound pressure level, synonymous with SPL
L_{pk}	zero-to-peak sound pressure level, synonymous with SPL_{pk}
L_{rms}	root mean square sound pressure level, synonymous with SPL_{rms}
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
MA	Massachusetts
MEC	munitions and explosives of concern
MF	mid-frequency
MFC	mid-frequency cetacean
mG	milligauss
MGD	million gallon(s) per day
mi	mile(s)
mm	millimeter(s)
MMPA	Marine Mammal Protection Act of 1972
MONM	JASCO's Marine Operations Noise model
MSL	mean sea level
mV/m	millivolts/meter
MW	megawatt(s)
N/A	not applicable
NARW	North Atlantic right whale

NAS	noise abatement system
NEFOP	Northeast Fisheries Observer Program
NEPA	National Environmental Policy Act
NLAA	not likely to adversely affect
NLPSC	Northeast Large Pelagic Survey Collaborative
NM	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NYB	New York Bight
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
O&M	operations and maintenance
OCS	outer continental shelf
OCS–DC	Offshore Converter Station
OCSLA	Outer Continental Shelf Lands Act
OnCS–DC	Onshore Converter Station
OPR	Office of Protected Resources
OSS	Offshore Substation
PAM	passive acoustic monitoring
PATON	private aid to navigation
PBF	physical or biological feature
PDE	project design envelope
PF	physical feature
PIT	passive integrated transponder
PLGR	Pre-Lay Grapnel Run
ppt	part(s) per thousand
PRD	Protected Resources Division
PSMMP	Protected Species Mitigation and Monitoring Plan
PSO	Protected Species Observer
PTS	permanent threshold shift
PV	plan view imaging
RI	Rhode Island
ROV	remotely operated vehicle
SAP	Site Assessment Plan

SAV	submerged aquatic vegetation
SBP	subbottom profiler
SCADA	supervisory control and data acquisition
SEL	sound exposure level
SEL_{24h}	cumulative sound exposure level over a 24-hour period
SFVP	Sound Field Verification Plan
SMA	seasonal management area
SOV	service operating vessel
SPI	sediment profile imaging
SPL	root mean square sound pressure level, synonymous with L_p
SPL_{pk}	zero-to-peak sound pressure level, synonymous with L_{pk}
SRWEC	Sunrise Wind Export Cable
SRWF	Sunrise Wind Farm
SST	sea surface temperature
STDN	Sea Turtle Disentanglement Network
STSSN	Sea Turtle Stranding and Salvage Network
Sunrise Wind	Sunrise Wind LLC
SWLP	seawater lift pump
T	threatened
TBD	to be determined
TJB	transition joint bay
TSHD	trailing suction hopper dredger
TSS	total suspended solids
TTS	temporary threshold shift
UME	Unusual Mortality Event
μPa	micropascals
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VHF	very high frequency
WEA	Wind Energy Area
WFA	weighting factor adjustment
WTG	wind turbine generator
yd^3	cubic yard(s)

1.0 INTRODUCTION

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

Sunrise Wind, LLC (Sunrise Wind; Applicant) is a 50/50 joint venture between Ørsted North America, Inc. and Eversource Investment LLC. Sunrise Wind submitted the first draft of the Construction and Operations Plan (COP) to BOEM on September 1, 2020. After addressing several rounds of comments from BOEM, Sunrise Wind resubmitted the COP on August 23, 2021 (Sunrise Wind 2021c). BOEM deemed the COP sufficient and initiated this National Environmental Policy Act (NEPA) analysis on August 31, 2021, with the issuance of the notice of intent (NOI) to initiate scoping and prepare an Environmental Impact Statement (EIS). Sunrise Wind submitted a second updated COP for the Project in October 2021 (Sunrise Wind 2021d), a third updated COP in April 2022 (Sunrise Wind 2022h), and a fourth updated COP in August 2022 (Sunrise Wind 2022i). Consistent with the requirements of 30 CFR §§ 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Proposed Action and the Applicant completes all studies and surveys defined in their Site Assessment Plan (SAP). BOEM's renewable energy development process is described in the following section.

The Sunrise Wind Offshore Wind Farm Project includes up to 87 wind turbine generator (WTG) monopile foundations, an Offshore Converter Station (OCS–DC), Inter-Array Cables (IAC), an Onshore Converter Station (OnCS-DC), an offshore transmission cable making landfall on Long Island, New York, and an onshore interconnection cable to the Long Island Power Authority (LIPA) Holbrook Substation. The Project will generate up to approximately 1,034 megawatts (MW) of renewable energy.

This Biological Assessment (BA) has been prepared pursuant to Section 7 of the Endangered Species Act (ESA) to evaluate potential effects of the Sunrise Wind Offshore Wind Farm Project (Project, or Proposed Action) described herein on ESA-listed species and critical habitat under the jurisdiction of the National Marine Fisheries Service (NMFS) (50 CFR § 402.14). This BA provides a summary description of the Proposed Action, defines the Action Area, describes species potentially impacted by the Proposed Action, and provides an analysis and determination of how the Proposed Action may affect listed species and/or their habitats. The activities being considered include all proposed federal actions associated with the construction, operations and maintenance (O&M), and decommissioning of the proposed Project including approving the COP for the Sunrise Wind offshore wind energy facility on the OCS offshore of Massachusetts, Rhode Island, and New York. Effects on ESA-listed species and critical habitat under the oversight of the U.S. Fish and Wildlife Service (USFWS) are analyzed under a separate BA document for consultation.

This document contains BOEM's analysis of the potential effects to ESA-listed species and habitats managed by NMFS. Summaries of many of the required elements for the initiation package for formal consultation with NMFS are included in this document for convenience; however, below is a list of the primary source documents for this information that are being submitted in the initiation package.

- Project Description – Sunrise Wind Construction and Operations Plan (Sunrise Wind 2022i)
- Maps and description of the Project Area – Sunrise Wind Construction and Operations Plan (Sunrise Wind 2022i)
- Information on Species and Critical Habitat in the Action Area
  - This document
- Summary of Information Provided by the Applicant
  - Appendix H Sediment Transport

- Draft EIS Appendix H Monitoring and Mitigation
- Appendix I1, Underwater Acoustic Assessment
- Appendix J1 Offshore EMF Assessment
- Appendix M1, M2, M3 Benthic Characterization Reports
- Appendix N1 EFH Assessment
- Appendix N2 Ichthyoplankton Entrainment Assessment
- Appendix O1 Marine Mammal, Sea Turtle, and ESA-Listed Fish Assessment
- Appendix O2 Marine Mammal Protected Species Mitigation and Monitoring Plan (PSMMP)
- Appendix O3 Sea Turtle and ESA-Listed Fish PSMMP
- Appendix V Commercial and Recreational Fisheries Data Report
- COP Appendix H, Mitigation and Monitoring
- Sunrise Wind Marine Mammal Incidental Harassment Authorization (IHA) Application
- Sunrise Wind CWA Application
- Vessel and Construction Schedule

1.1 RENEWABLE ENERGY PROCESS

Under BOEM's renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a phased decision-making process. BOEM's wind energy program occurs in four distinct phases, defined below. Phases 1 through 3 have already been completed for the Sunrise Wind Farm (SRWF) and Sunrise Wind Export Cable (SRWEC); the Proposed Action addressed in this consultation represents phase 4 for the development:

1. Planning and Analysis (complete). The first phase of the renewable energy process is to identify suitable areas to be considered for wind energy leases through collaborative, consultative, and analytical processes using the state's task forces; public information meetings; and input from the states, Native American tribes, and other stakeholders.
2. Lease Issuance (complete). The second phase is the issuance of a commercial wind energy lease. The competitive lease process is set forth at 30 CFR §§ 585.210 to 585.225, and the noncompetitive process is set forth at 30 CFR §§ 585.230 to 585.232. A commercial lease gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold. The lease does not grant the lessee the right to construct any facilities; rather, the lease grants the right to use the leased area to develop its plans, which must be approved by BOEM before the lessee can move on to the next phase of the process (30 CFR §§ 585.600 and 585.601).
3. Approval of a SAP (complete). The third phase of the renewable energy development process is the submission of a SAP, which contains the lessee's detailed proposal for the construction of a meteorological tower and/or the installation of meteorological buoys on the leasehold (30 CFR §§ 585.605 to 585.618). The lessee's SAP must be approved by BOEM before it conducts these "site assessment" activities on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's SAP (30 CFR § 585.613). As a condition of SAP approval, meteorological towers will be required to have visibility sensors to collect data on climatic conditions above and beyond wind speed, direction, and other associated metrics generally collected at meteorological towers. These data will assist BOEM and USFWS with evaluating the impacts of future offshore wind facilities on threatened and endangered birds, migratory birds, and bats.
4. Approval of a COP (Proposed Action). The fourth and final phase of the process is the submission of a COP; a detailed plan for the construction and operation of a wind energy farm on the lease (30 CFR §§ 585.620 to 585.638). BOEM approval of a COP is a precondition to the construction of any wind energy facility on the OCS (30 CFR § 585.628). As with a SAP, BOEM may approve, approve with modification, or disapprove a lessee's COP (30 CFR § 585.628). This phase is the focus of the Proposed Action including the SRWF and SRWEC.

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

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

BOEM completed an environmental assessment and BA on the issuance of leases for wind resource data collection on the OCS within the Rhode Island (RI) – Massachusetts (MA) Wind Energy Area (WEA) and the MA WEA in 2013 and on associated site characterization and site assessment activities that could occur on those leases, including the Lease Area. The RI-MA WEA comprises 13 whole and 29 partial lease blocks (see the Lease Area on **Figure 1**). On April 10, 2013, NMFS issued a programmatic biological opinion for commercial wind lease issuance and site assessment activities on the Atlantic OCS in Massachusetts, Rhode Island, New York, and New Jersey WEAs.

1.2 DESIGN ENVELOPE

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

BOEM gives offshore renewable energy lessees the option to use a PDE approach when submitting a COP to evaluate a design envelope approach for the environmental review of COPs (DOE and DOI 2016). 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. Therefore, this BA and associated outcomes of the ESA consultation are anticipated to cover the menu of potential alternatives that may be authorized by BOEM in the Record of Decision and approval of the COP.

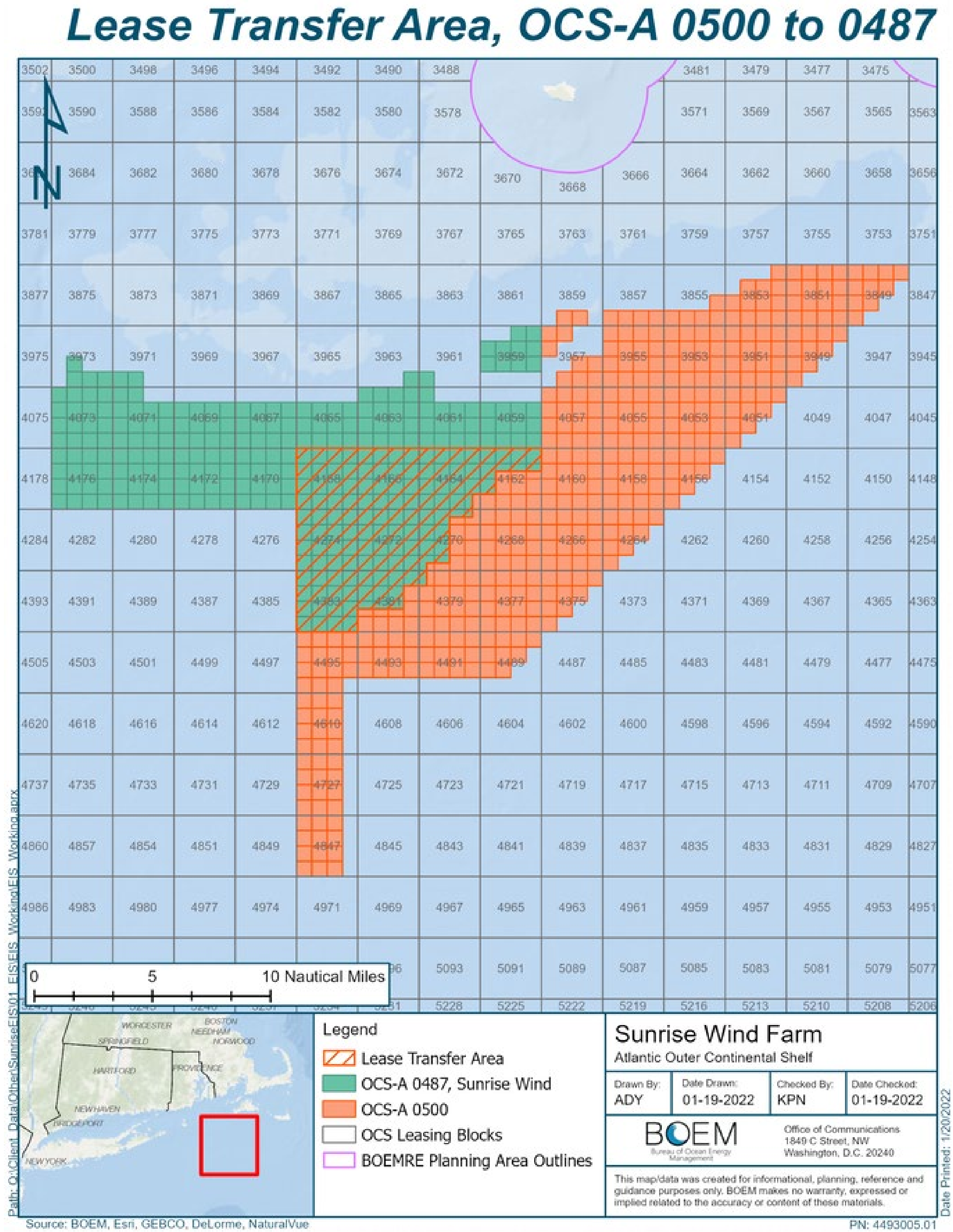

Figure 1. Sunrise Wind Lease Area OCS-A 0487 and OCS-A 0500 Transfer.

1.3 REGULATORY BACKGROUND AND CONSULTATION HISTORY

Under ESA Section 7 consultation regulations (50 CFR § 402.02), 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." The immediate area involved in the action (see 50 CFR § 402.17). The immediate Project Area includes the 11.25-by-20-nautical-mile (NM; 20.84-by-37.04-kilometer [km]) wind farm footprint within the Lease Area and all IAC routes and transmission cable right-of-way from the Offshore Substation (OSS) to shore. In addition to the immediate Project footprint, the O&M facility, port maintenance (no port modifications are proposed as part of this action; however, ports used during this project may incur repairs, additional maintenance activities, or undertake expansions in response to use by project vessels.), and vessel transits are considered as part of the Action Area. Additionally, the size of the Action Area includes the area affected by noise, electromagnetic field (EMF), water quality, benthic, vessel and survey operations, and other impacts associated with the Proposed Action that have the potential for consequences that may affect listed species or critical habitat.

1.4 ACTION AGENCIES AND REGULATORY AUTHORITIES

The Energy Policy Act of 2005 (Public Law 109-58) added the OCSLA. The new section authorized the Secretary of Interior to issue leases, easements, and rights-of-way in the OCS for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR Part 585) were promulgated on April 22, 2009. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove Sunrise Wind's COP.

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

USACE regulates work that is authorized or permitted through Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, which would include the construction of up to 87 WTG monopile foundations, scour protection around the base of the WTGs , one Offshore Converter Station-DC (OCS-DC), the IAC connecting the WTGs to the OCS, and two offshore export cables. The offshore export cables would originate from the OCS and would connect to the electric grid at Smith Point County Park in Town of Brookhaven, Suffolk County, New York. The "OCS Air Regulations," found at 40 CFR Part 55, establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement, for facilities subject to Section 328 of the Clean Air Act; the EPA issues OCS air permits. Sunrise Wind has submitted to EPA Region 1 an application requesting a Clean Air Act permit under Section 328 of the Clean Air Act for the construction and operation of an offshore wind farm, including the export cable, on the OCS with the potential to generate up to 1,034 MW of electricity (the wind farm).

The EPA may also issue a National Pollutant Discharge Elimination System (NPDES) General Permit for construction activities under the Clean Water Act. Sunrise Wind submitted a complete NPDES permit application to the EPA in December 2021. A Public Notice on the proposed permit and 30-day (minimum) public comment period is expected spring 2023. The estimated date of issuance of a Final NPDES Permit is January 2024. The EPA may also use general permits issued under Section 402 of the Clean Water Act (33 USC § 1342 et seq.) to authorize routine discharges by multiple dischargers. Once the NOI is submitted and any review period specified under the construction general permit has closed, the Applicant is authorized to discharge under the terms of the general permit. Coverage for discharges under a general permit is granted to applicants after they submit a NOI to discharge; however, no general permit applications under Section 402 of the Clean Water Act have been submitted that are associated with Sunrise Wind.

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

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

NMFS OPR received a petition from Sunrise Wind for an Incidental Take Authorization (ITA) under the MMPA for marine mammal takes incidental to construction of an offshore wind energy project in the RI-MA WEA and adjacent New York State (NYS) waters (Sunrise Wind 2022j). The application was deemed adequate and complete on May 10, 2022. A notice of the application for an ITA was published in the Federal Register (FR) on June 2, 2022 (87 FR 33470). The public comment period closed on July 5, 2022.

1.5 Action Area

Under ESA Section 7 consultation regulations (50 CFR § 402.02), the Action Area refers to the area affected by the Proposed Action and also includes the area where all consequences to listed species or critical habitat that are caused by the Proposed Action would occur, including actions that would occur outside the immediate area involved in the action (see 50 CFR § 402.17). The Project Area (**Figure 2**) refers to the footprint of the proposed facilities, including the SRWF, SRWEC, and the Onshore Facilities (OnCS-DC, Onshore Transmission Cable, and Onshore Interconnection Cable).

In addition to the immediate Project footprint, the vessel transits are considered part of the Action Area. Additionally, the Action Area includes the area affected by underwater noise, EMF, water quality impacts, benthic impacts, vessel and survey operations, and other impacts associated with the Proposed Action that have the potential for consequences that may affect listed species or critical habitat. Underwater noise associated with unexploded ordnance (UXO) detonations and construction-related impact pile driving is the most geographically extensive temporary noise effects that would result from the construction of the wind farm itself.

The Proposed Action's Action Area includes upland and coastal nearshore habitats on eastern Long Island and adjacent NYS waters, and ocean habitats in the RI-MA WEAs on the OCS offshore of New York, Rhode Island, and Massachusetts. The SRWF and SRWEC area and cable routes are shown on **Figures 2** and **3**. Although most activities would occur on the lease and along the proposed cable routes, vessels would travel locally between ports and the SRWF and possibly from ports in Europe and along the east coast of Canada. The Proposed Action will use existing port facilities located in Albany and/or Coeymans, New York; Davisville-Quonset Point, Rhode Island; and New London, Connecticut, for offshore construction, staging and fabrication, crew transfer, and logistics support (**Figure 4**). Other ports in Massachusetts, Maryland, New Jersey, and Virginia may be used as back-up or support facilities. These back-up options include the Port of New York-New Jersey, New York; the New Bedford Marine Commerce Terminal, Massachusetts; Sparrow's Point, Maryland; Paulsboro Marine Terminal, New Jersey; Port of Providence, Rhode Island; and Port of Norfolk, Virginia. Upgrades at these facilities are not required for the purposes of the Project and are not included as part of the Proposed Action. Additional vessel routes may include ports in Europe and Canada. Final port selection has not been determined at this time; Table 3.3.10-1 and Figure 3.3.10-1 in the COP (Sunrise Wind 2022i) provide a summary and depiction of potential ports that could be used to support construction of the Project.

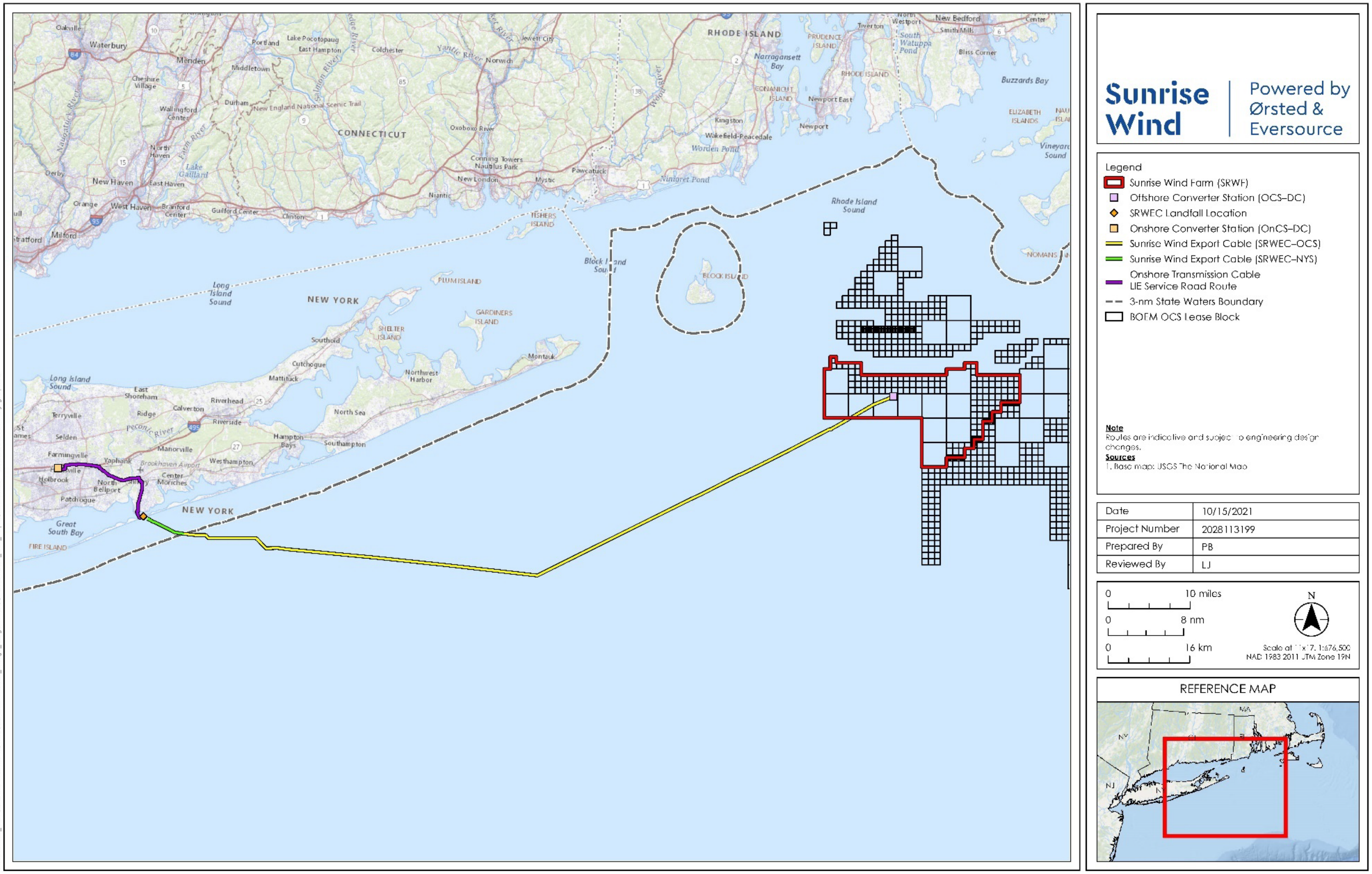

Figure 2. Sunrise Wind Project Area.

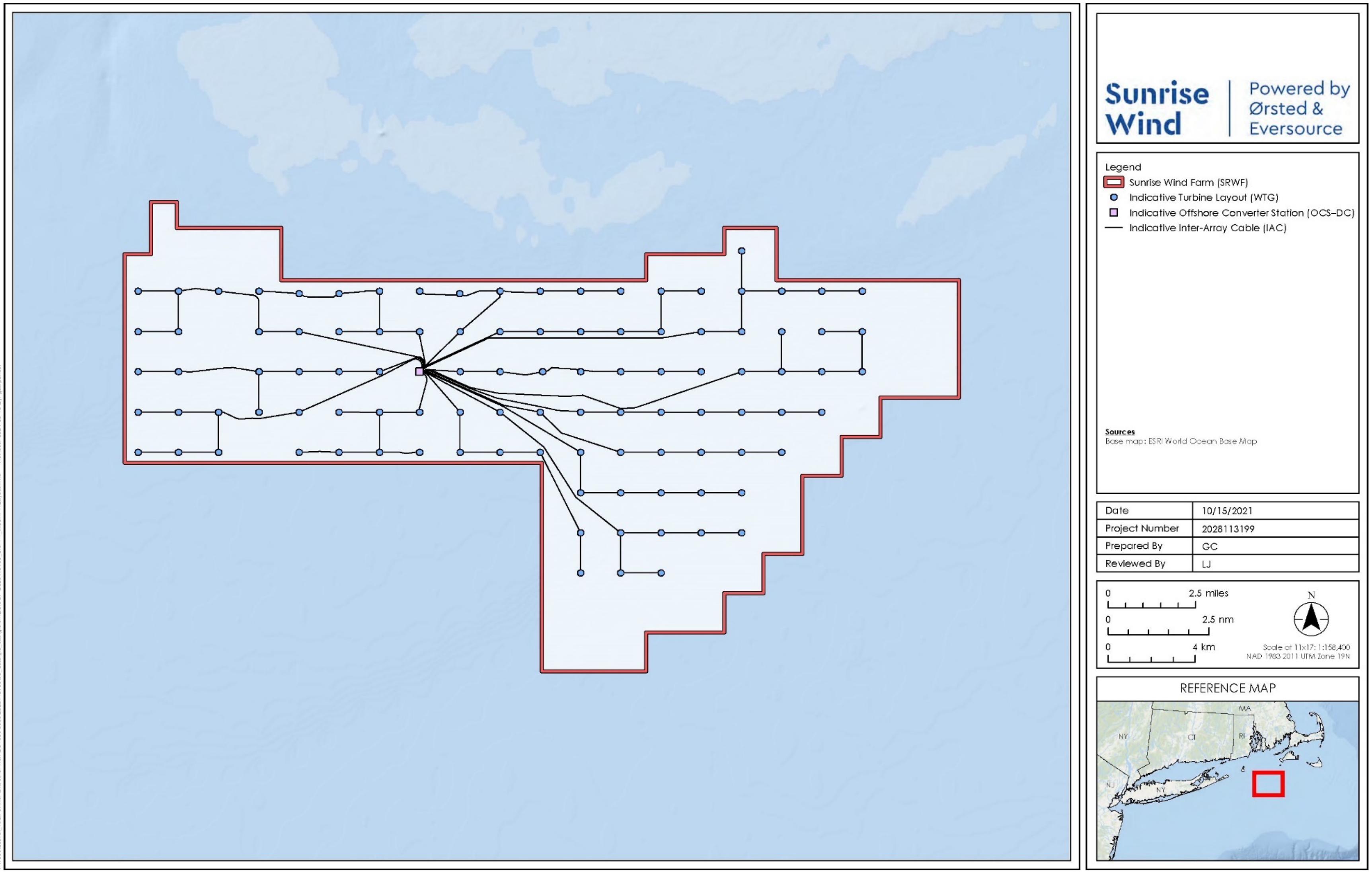

Figure 3. Sunrise Wind Farm Area.

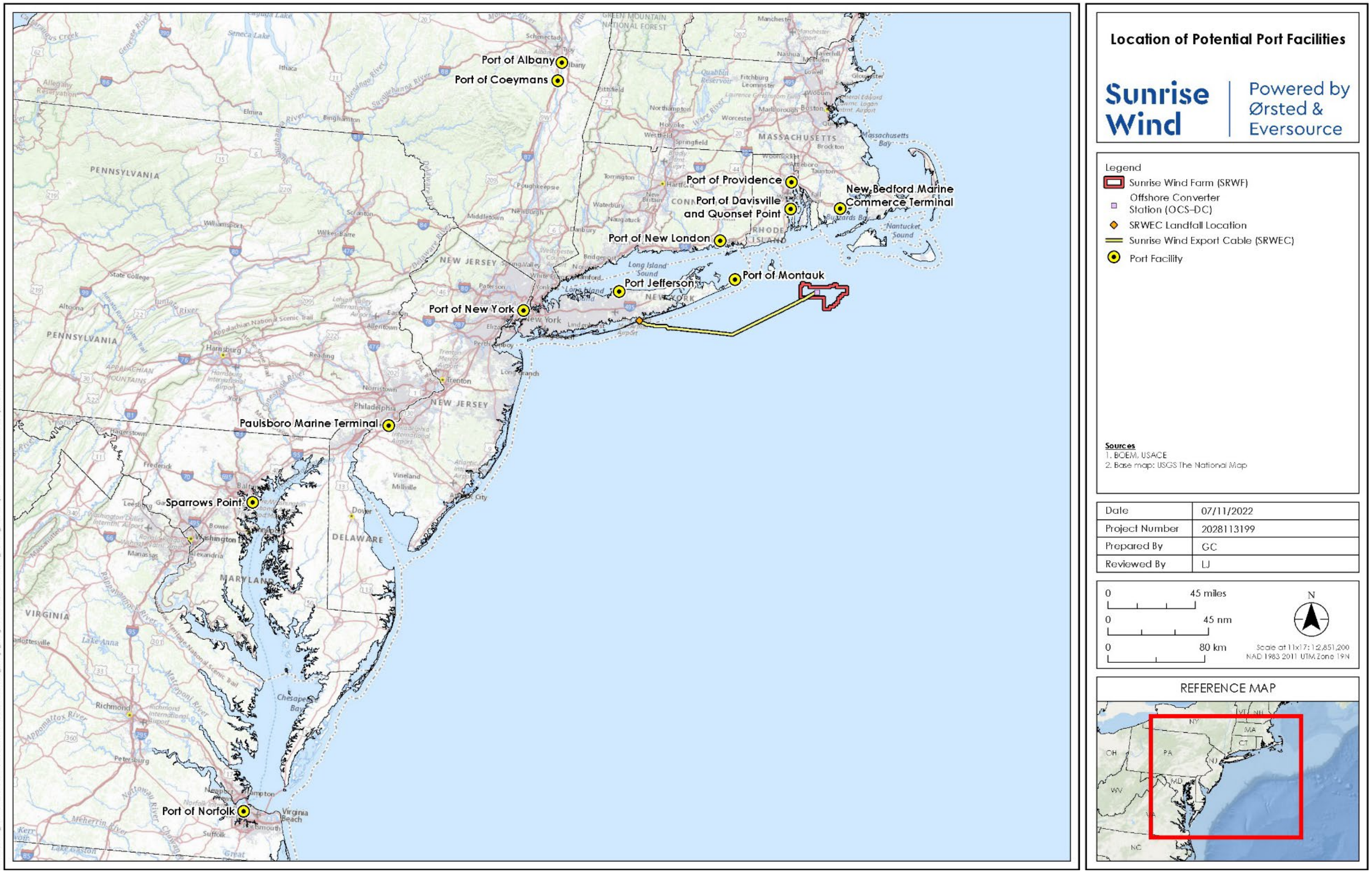

Figure 4. Potential port locations.

2.0 PROPOSED ACTION

On July 31, 2013, the BOEM conducted a competitive auction and awarded Lease OCS-A 0487, consisting of about 67,250 acres (ac; 27,215 hectares [ha]), to Deepwater Wind New England, LLC. On August 3, 2020, Deepwater Wind New England, LLC assigned Lease OCS-A 0487 to Sunrise Wind. On September 3, 2020, Bay State Wind, LLC assigned 100 percent of its record title interest in a portion of lease OCS-A 0500, which BOEM designated OCS-A 0530, to Sunrise Wind. On March 15, 2021, BOEM completed the consolidation of Lease OCS-A 0530 into Lease OCS-A 0487 through an amendment to Lease OCS-A 0487 (see **Figure 1**). The resulting Lease Area is 109,952 ac (44,496 ha). The effective date of Lease OCS-A 0487 remains October 1, 2013. The Lease Area is approximately 26.5 NM (30.5 miles [mi], 48.1 km) east of Montauk, New York, and approximately 14.5 NM (16.7 mi [26.8 km]) from Block Island, Rhode Island (see **Figure 2**).

The Proposed Action addressed in this BA includes all activities proposed for the construction, O&M, and decommissioning of the SRWF and SRWEC. The two major construction and operations components, the SRWF and the SRWEC, are described in this section. Decommissioning and site clearance surveys are anticipated at the end of the Project life. There would be a maximum of 87 monopiles driven for SRWF WTGs with a nameplate capacity of 11 MW per turbine. The project also includes OCS–DC on a piled jacket foundation using up to eight total driven pin piles, casing piles and sheet piles at the landfall connection. In addition to pile driving, submarine cables would be installed between the WTGs (IAC) and to shore (export cable) (see **Figure 2**). The SRWF would be located within federal waters on the OCS, specifically in the Lease Area (see **Figure 3**) approximately 16.4 NM (18.9 mi [30.4 km]) south of Martha's Vineyard, Massachusetts.

The SRWEC is an alternating current (AC) electric cable that would connect the SRWF to the existing mainland electric grid in the Town of Brookhaven, New York (see **Figure 2**). The SRWEC includes both offshore and onshore segments. Offshore, the SRWEC would be located in federal waters (SRWEC-OCS) and NYS territorial waters (SRWEC-NYS) and would be buried to a target depth of 3 to 7 feet (ft; 1 to 2 meters [m]) below the seabed. Onshore, the terrestrial underground segment of the export cable (SRWEC-Onshore) would be located in the Town of Brookhaven, New York. The SRWEC-NYS would be connected to the SRWEC-Onshore via the sea-to-shore transition where the offshore and onshore cables would be spliced together. The SRWEC would also include a new interconnection facility where the SRWEC would interconnect with the LIPA electric transmission and distribution system at the existing Holbrook Substation also located in the Town of Brookhaven, New York.

The Applicant has elected to use a PDE approach for describing the Proposed Action, consistent with BOEM's *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan* (BOEM 2018) (**Figure 5**).

SRWF

Foundations

- Monopile foundations for the WTGs and a piled jacket foundation for the OCS-DC
- Up to 88 foundations for the WTGs and OCS-DC within 88 potential positions
- Maximum embedment depth of up to 164 ft (50 m) for WTG monopile foundations, and 295 ft (90 m) for OCS-DC piled jacket foundation
- Maximum area of seafloor footprint per foundation, inclusive of scour protection and CPS stabilization: 1.06 ac (4,290 m^2) for WTG monopile foundations and 1.39 ac (5,625 m^2) for the OCS-DC foundation structure

WTGs

- Up to 87 WTGs within 87 potential positions
- Nameplate capacity of 11 MW
- Rotor diameter of 656 ft (200 m)
- Hub height of 459 ft (140 m) amsl
- Upper blade tip height of 787 ft (240 m) amsl

IAC

- Maximum 161 kilovolt AC cables buried up to a target depth of 3 to 7 ft (1 to 2 m)
- Maximum total length of up to 180 mi (290 km)
- Maximum cable diameter of 8 inches (in; 200 millimeters [mm])
- Maximum disturbance corridor width of 98 ft (30 m) per circuit

OCS-DC

- One OCS-DC
- Up to 295 ft (90 m) total structure height from lowest astronomical tide (LAT) (including lightning protection and ancillary structures)

SRWEC-OCS and SRWEC-NYS

SRWEC

- One 320-kV DC export cable bundle buried to a target depth of 3 to 7 ft (1 to 2 m)
- Maximum total corridor length of up to 104.6 mi (168.4 km)
- Maximum individual cable diameter of 7.8 in (200 mm)
- Maximum bundled cable diameter of 15.8 (400mm)
- Maximum disturbance corridor width of 98 ft (30 m)
- Maximum seafloor disturbance for horizontal directional drilling (HDD) exit pit of 61.8 ac (25 ha)
- Maximum disturbance for Landfall Work Area (onshore) of up to 6.5 ac (2.6 ha)

Onshore Facilities

Onshore Transmission Cable and Onshore Interconnection Cable

- Onshore Transmission Cable, including associated TJB and fiber optic cable, up to 17.5 mi (28.2 km) long, with a temporary disturbance corridor of 30 ft (9.1 m) and maximum duct bank target burial depth of 6 ft (1.8 m)
- Maximum cable diameter of 6 in (152 mm)
- Onshore Interconnection Cable to connect to Holbrook Substation

OnCS-DC

- An OnCS-DC with operational footprint of up to 6 ac (2.4 ha)

Figure 5. Proposed Action project design envelope parameters.

2.1 Construction

The following sections describe the proposed Project infrastructure and provide details on design and construction methodologies, organized in accordance with the standard construction sequence of an offshore wind farm as outlined in the following Project schedule with construction of the onshore components beginning first in 2023 and concluding with WTG construction by year-end 2025 (**Figure 6**):

- Onshore Facilities (OnCS–DC, Onshore Interconnection Cable, and Onshore Transmission Cable): approximately 2 years
- SRWEC: approximately 8 months (including 3 months of route clearance, and 5 months of installation)
- Offshore Foundations (WTG and OCS–DC): approximately 4 to 5 months
- IAC: approximately 7 months (including 3 months route clearance and 4 months installation and termination)
- WTGs: approximately 10 months
- OCS–DC: approximately 12 months

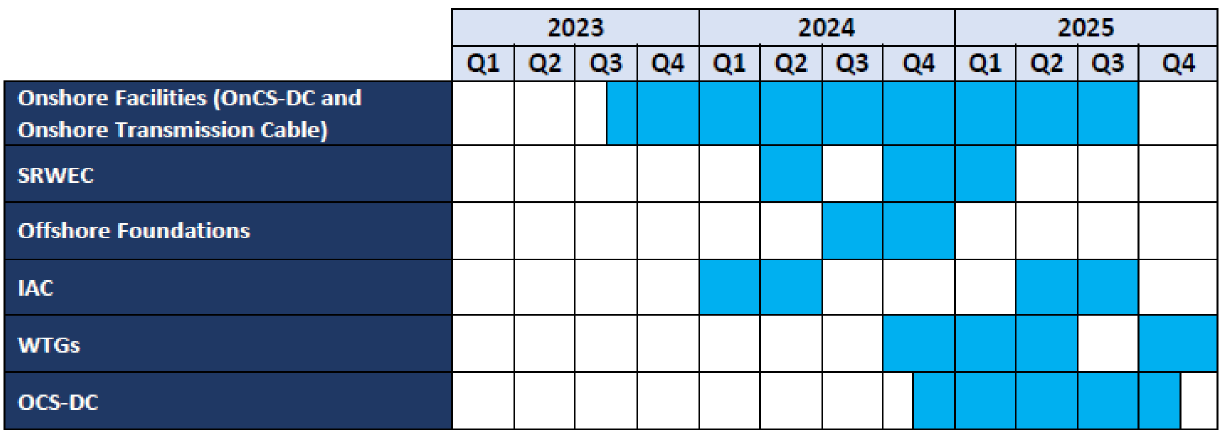

Figure 6. Proposed project schedule.

Construction activities are proposed to occur at night with enhanced monitoring measures including night vision equipment (see **Tables 14** and **15** and **Section 2.6**). Completing construction work at night is considered necessary to complete work within the project schedule and avoid unnecessary extensions in the duration of construction activities .

2.1.1 Offshore Sunrise Wind Farm

Proposed SRWF components to be constructed include WTGs, an OCS–DC, and their foundations; scour protection for all foundations; and the IAC that connects the WTGs to the OCS–DC. The proposed offshore Project elements are located within federal waters. COP Section 3.3.1.2 provides a detailed description of proposed construction and installation methods (Sunrise Wind 2022i).

As part of the PDE, Sunrise Wind would erect up to 87 WTG monopile foundations and one OCS–DC within the SRWF (see **Figure 1**) using 11-MW WTGs for a 924-MW project. The OCS–DC serves as the interconnection point between the WTGs and the SRWEC. Based on the PDE, Sunrise Wind would mount the WTGs upon 39-ft (12-m)-diameter monopile foundations and the OCS–DC on a piled jacket foundation using up to eight total driven pin piles. A monopile is a long steel tube driven up to 164 ft (50 m) into the seabed. A piled jacket foundation is a latticed steel frame with supporting hollow steel pin piles driven 295 ft (90 m) into the seabed. The WTGs would be sited in a uniform east-west/north-south grid with 1-by-1-NM (1.15-by-1.15-mi [1.85-by-1.85-km]) spacing (see **Figure 3**). The water depths where the WTGs would be located range from 135 to 184 ft (41 to 56 m) mean sea level based on National Oceanic and Atmospheric

Administration (NOAA) Coastal Relief Model data (127 to 181 ft [39 to 55 m] mean lower low water based on site-specific geophysical surveys). The maximum area of the seafloor footprint per foundation, inclusive of scour protection and cable protection system (CPS) stabilization, is 1.06 ac (4,290 square meters [m^2]) for WTG monopile foundations and 2.64 ac (10,684 m^2) for the OCS–DC foundation structure.

Up to 87 WTG monopile foundations and 1 OCS–DC foundation with four legs, each leg with two pin piles, would be installed. The typical SRWF WTG foundation pile installation would require approximately 1 to 4 hours of impact pile driving to a final embedment depth of 164 ft (50 m) below the seafloor, with some difficult installations potentially taking up to 12 hours to install due to more difficult substrate conditions. After installation, the WTG would be placed on top of the foundation pile and the vessels would be repositioned to the next site. Between one and three WTG monopile foundations may be installed per day. Sunrise Wind anticipates pile driving at night to be necessary to complete the project construction on schedule. Additional mitigation measures for nighttime pile driving are described in **Section 2.6** but include continuous monitoring of shutdown zones using passive acoustic monitoring (PAM), infrared camera systems, and night vision systems for Protected Species Observers (PSOs).

Monopile foundations for WTGs will be up to 12 m in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kilojoules (kJ) (**Table 1**). The pin piles used to secure the OCS–DC piled jacket foundation will be up to 13 ft (4 m) in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kJ (**Table 2**).

Table 1. Pile driving assumptions used in underwater acoustic modeling of the 7-12-meter-diameter monopiles.

Parameter	Value
Hammer	IHC S-4000 (impact)
Modeled maximum impact hammer energy	4,000 kJ
Pile length	129.68 m
Pile diameter	7 m at the top, widening to 12 m at the bottom (12 m)
Pile wall thickness	8.1–13.5 mm
Seabed penetration	50 m

Notes:
kJ = kilojoule(s); m = meter(s); mm = millimeter(s)

Table 2. Piling driving assumptions used in underwater acoustic modeling of the jacket foundation pin piles.

Parameter	Value
Hammer	IHC S-4000 (impact)
Modeled maximum impact hammer energy	4,000 kJ
Pile length	110 m
Pile diameter	4 m
Pile wall thickness	7.5 mm
Seabed penetration	90 m

Notes:
kJ = kilojoule(s); m = meter(s); mm = millimeter(s)

Because the exact location and number of piles to be installed each day may be variable, Sunrise Wind is considering multiple construction schedules/scenarios that could result from different installation timelines that describe reasonable situations that may be expected under the Proposed Action. The first two scenarios assume consecutive (non-simultaneous) pile installation while the third through fifth scenarios assume concurrent (simultaneous) pile installations. The five modeled scenarios are summarized in the following list:

1. Construction Schedule 6 assumes the installation of one OCS-DC jacket foundation (four pin piles per day for 2 days, for a total of eight pin piles per foundation) and then 56 of the WTG monopile foundations (two piles per day for 28 days) during the highest density month for each species, with the remaining 31 WTG monopile foundations installed in each species second highest density month (two piles per day for 14 days and three piles per day for 1 day).
2. Construction Schedule 7 assumes the installation of one OCS-DC jacket foundation (four pin piles per day for 2 days, for a total of eight pin piles per foundation) and then 84 of the WTG monopile foundations (three piles per day for 28 days) during the highest species density month for each species, with the remaining three WTG monopile foundations installed in the second highest species density month (three piles per day for 1 day).
3. Construction Schedule 8 assumes a mixture of concurrent operations involving two vessels each installing two monopile foundations per day, and sequential operations involving one vessel installing three monopile foundations per day. In Construction Schedule 8, the concurrent vessels are assumed to be in their closest likely position relative to each other (proximal), a separation distance of 3 NM (two foundation locations between vessels). The installation consists of the OCS-DC jacket foundation (four pin piles per day for 2 days, for a total of eight pin piles for the foundation) and then 84 WTG monopile foundations (two vessels installing two piles per day for 21 days). The remaining three monopile foundations are installed sequentially by one vessel (three piles per day for 1 day). All installation for Construction Schedule 8 is assumed during the highest species density month.
4. Construction Schedule 9 is the same as Construction Schedule 8, except that the two concurrently operating monopile installation vessels are assumed to be most distal from each other, installing foundations on opposite ends of the wind lease area.
5. Construction Schedule 10 assumes that the jacket foundation will be installed using one vessel at the same time as monopile foundations are installed using another vessel. In Construction Schedule 10, the vessels are assumed to be within the proximal separation distance, as was assumed for Construction Schedule 8 (a separation distance of 3 NM with two foundation locations between the vessels). The concurrent operations would occur for two days during the highest density month, in which time eight pin piles and four monopiles would be installed (four pin piles per day and two monopiles per day, for two days). Construction Schedule 10 then assumes sequential operations of one vessel installing two monopiles per day for 28 days, totaling 56 monopiles in the highest species density month. The remaining 27 monopile foundations would be installed by one vessel in second highest density month (two piles per day for 12 days, and three piles for day for 1 day).

For the OCS–DC foundation, the jacket foundation would be placed first, with the pin pile placed through the jacket and driven to its penetration depth (295 ft [90 m]). Pile driving of each pin pile may take up to 48 hours during a difficult installation. Because separate vessels are anticipated to be used for WTG and OCS–DC foundation installations, these activities may occur concurrently. Pile driving activities will occur on up to 51 days between May 1 and December 31; no pile driving activities will occur between January 1 and April 30 (**Table 3**).

Table 3 estimates of a potential foundation installation schedule assuming the maximum number of days of pile driving that could occur in a given month from all five construction scenarios; however, the installation schedule is subject to change based on several factors, including contractor selection, vessel availability, engineering and fabrication schedules, weather, protected species down-time, unforeseen circumstances during installation, etc. It is anticipated that a maximum of three monopile foundations can be driven into the seabed per day using one installation vessel, assuming 24-hour pile driving operation. Additionally, it is possible that two separate vessels may work simultaneously which would result in installation of up to four total monopiles per day (maximum two per day on each of the two vessels), assuming 24-hour pile driving operations. The piled jacket foundation for the OCS–DC may also be installed simultaneously with the WTG monopile foundations (up to four pin piles per day). At a maximum, the Project expects up to two vessels working simultaneously (i.e., two monopile vessels, or one monopile foundation vessel and one piled jacket foundation vessel). Therefore, it is possible that up to 4 monopile foundations, or up to six total piles (two monopiles and four pin piles), may be installed on any given day during any given month.

Table 3. Sunrise Wind monthly maximum estimated total days of pile driving activities that could occur in each month, independent of the final selected construction schedule.

Month	Days of Pile Driving	Maximum Number of Piles Per Day
May	10	4
June	12	4
July	14	4
August	14	4
September	14	4
October	12	4
November	10	6*
December	8	4

Note:
* Includes the OCS–DC jacket (four pin piles/day)

Because the exact location and number of piles to be installed each day is uncertain, to estimate the number of animals likely to be exposed above the regulatory thresholds, a conservative construction schedule that maximizes activity during the highest density months for each species was assumed in the COP Appendix I1 (Sunrise Wind 2022d) and analysis in **Section 4.2**. For the analysis of potential impacts, all five potential construction scenarios were modelled for each species, including two which assume consecutive (non-simultaneous) pile installation, and three which assume concurrent (simultaneous pile installations).

2.1.2 Inter-Array Cable Installation

The IAC will carry the electrical current produced by the WTGs to the OCS–DC. The IAC will consist of three bundled copper or aluminum conductor cores surrounded by layers of cross-linked polyethylene or ethylene propylene rubber insulation and various protective armoring and sheathing to protect the cable from external damage and keep it watertight. A fiber optic cable will also be included in the interstitial space between the three conductors and will be used to transmit data from each of the WTGs to the supervisory control and data acquisition (SCADA) system. The length of the entire network of IAC will be up to 180 mi (290 km). **Figure 3** presents the indicative IAC layout for the Project. The IAC will be installed within a 90-ft-(30-m)-wide corridor. Burial of the IAC will typically target a depth of 3 to 7 ft (1 to 2 m). The target burial depth for the IAC will be determined based on an assessment of seafloor conditions, seafloor mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific Cable Burial Risk Assessment. Cable laying may be conducted using a mechanical plow, jet plow, mechanical cutting, or the controlled flow excavation (CFE) method. These techniques are fully described in the COP (Sunrise Wind 2022i).

Seafloor preparation (specifically boulder clearance and sand wave leveling) would be required; boulder clearance trials (testing equipment and methods) may also be implemented prior to wide-scale seafloor preparation activities. Sunrise Wind assumes up to 5 percent of the SRWEC-OCS, up to 30 percent of the SRWEC-NYS, and up to 10 percent of the total IAC network would require boulder clearance. Boulder clearance would involve the use of a boulder grab to relocate boulders along the IAC network routes and near WTG foundations. Sunrise Wind will relocate boulders up to approximately 2.4 m (7.9 ft) in diameter, from the installation footprint by means of a boulder grab. When using a boulder grab, the maximum distance a boulder will be moved is approximately 15 m (49 ft) from its original location if the boulder is located on the centerline of the SRWEC-OCS (i.e., it will be moved perpendicular to the edge of the 30 m [98 ft] wide installation corridor). The maximum distance for a boulder would be moved at a foundation location is approximately 220 m (722 ft) from its original location if it is in the center of the planned WTG location.

The boulders will be removed by boulder grab utilizing a remotely operated grab tool (**Figure 7**). The grab is deployed from the system's self-contained Launch and Recovery System, an A-frame, or a crane and guided by a video link from a remotely operated vehicle (ROV). The grab is lowered to the seabed over the targeted boulder, "grabbed", and relocated away from the designated location.

Figure 7. Typical boulder grab device.

Sand wave leveling (inclusive of leveling of sand accumulation areas) may also be required during seafloor preparation activities prior to installation of the SRWEC. Sunrise Wind has assumed a maximum of 10 percent of the SRWEC–OCS will require sand wave leveling before the cable can be installed. Based on a review of the geophysical and geotechnical data, potential cable installation tools, and cable burial requirements, Sunrise Wind has preliminary identified four distinct segments of the SRWEC-OCS (KP8.8 to KP19.8, KP33.3 to KP36.5, KP48.4 to KP49.9, and KP66.6 to KP70.7) that total a length of 19.8 km where sand wave leveling may be required (Sunrise Wind 2022c). Along the SRWEC-OCS in these areas, sand wave leveling is anticipated to require the leveling of approximately 11,344 cubic meters (m^3) (14,837 cubic yards [yd^3]) of sediment (Sunrise Wind 2022c).

Sunrise Wind does not anticipate sand wave leveling along the SRWEC–NYS or IAC. Where required, Sunrise Wind has assumed the 98-ft (30-m) construction corridor would be cleared of sand waves.

Sandwave clearance areas are identified and calculated based on a cable installation tool capability of 2.2 m and a burial requirement of 1.5 m. On this basis, where bedform thickness exceeds 0.7 m, sandwave clearance is assumed to be required. (Tool capability of 2.2 m considers the dimensions of the bundled high voltage direct current cable). Further engineering is ongoing which will better define the burial depths required to ensure that the cable is buried to target depths, minimize the risk of anchor strikes or de-burial through windfarm operation, and as such, the above numbers should not be considered final and sand wave clearance remains in PDE for the SRWEC-OCS and IAC. Additionally, further route engineering by the installation contractor will aim to minimize the requirement to complete sandwave levelling by laying the cable in areas of lower bedform where their tool will achieve the required burial depth relative to stable seabed.

Available methodologies for sand wave leveling include trailing suction hopper dredger (TSHD) and CFE, which can be used as stand-alone or in combination. CFE is a non-contact dredging tool, providing a method of clearing loose sediment below submarine cables, enabling burial. The method utilizes thrust to direct waterflow into sediment, creating liquefaction and subsequent dispersal. The CFE tool draws in seawater from the sides and then jets this water out from a vertical down pipe at a specified pressure and volume. The down pipe is positioned over the cable alignment, enabling the stream of water to fluidize the sands around the cable. There is no “placement” or “sidecasting” of material.

As described in the COP Section 3.3.3.4, the TSHD involves the use of a drag arm which is pulled along the seafloor from the dredge and hopper vessel at the surface. The drag arm fluidizes sediment at the seafloor which is then hydraulically pumped to the hopper portion of the vessel where the sediment is able to settle out of suspension. During this operation, there is often a continuous overflow of water and any sediments remaining in suspension from the hopper at the water surface. Once the hopper is filled with sediment, disposal is made either hydraulically at the surface or the vessel transports to a disposal site at least 50 m within the surveyed corridor boundary and the sediment is released from the bottom of the hopper through a hatch in the vessel’s hull, or more carefully position material subsea via means of a downpipe. If necessary, THSD disposal would likely occur via downpipe disposal in the adjacent sand wave field, within the survey corridor. The survey corridor width varies between approximately 400 and 800 m wide, depending on water depth, so disposal would occur approximately 150 to 350 m from the corridor centerline.

Scour protection for the WTGs will have a radial extension of approximately five times the monopile radius and a height of approximately 6.5 ft (2 m) from original seabed level around selected monopile foundations. Additional CPS stabilization may be used where the IAC are pulled into the foundation, which would require additional rock cover on top of the scour protection. This additional rock cover would have a height of approximately 6.5 ft (2 m), for a total of up to 13.1 ft (4 m) height from the original seabed level, inclusive of the scour protection and CPS stabilization. Scour protection for the OCS–DC will cover the entire piled jacket footprint, extending an additional 33 to 66 ft (10 to 20 m) beyond the base of the structure and reaching a height of approximately 6.5 ft (2 m) from original seabed level. Additional CPS stabilization may be used where the IAC and SRWEC are pulled into the foundation, which would require additional rock cover on top of the scour protection. This additional rock cover would have a height of approximately 6.5 ft (2 m) for a total of up to 13.1 ft (4 m) height from the original seabed level, inclusive of the scour protection and CPS stabilization.

2.1.3 Offshore Sunrise Wind Export Cable

The SRWEC will consist of one cable bundle comprised of two cables and be spliced together with the Onshore Transmission Cable at the co-located transition joint bay (TJB) and link boxes located at the landfall location at Smith Point County Park, in the Town of Brookhaven, New York. A fiber optic cable will be bundled together with the two main conductors, which assists in cable fault detection, control and monitoring, and communication. The SRWEC would have portions in federal waters (SRWEC-OCS), state waters (SRWEC-NYS), and onshore (SRWEC-Onshore). In addition, a segment of the SRWEC (up to 1,339 ft [408 m]) will be located onshore (i.e., above the mean high-water line) and underground, up to the TJB. The export cable would have a transmission capacity of up to 320 kilovolts (kV). The PDE lengths for the SRWEC-OCS and SRWEC-NYS segments total 99.4 and 5.2 mi (159.6 and 8.4 km), respectively, for a potential total length of 104.6 mi. The SRWEC would be installed within a survey corridor ranging in width from 1,312 to 2,625 ft (400 to 800 m), depending on water depth. The total width of the disturbance corridor for installation of the SRWEC would be up to 98 ft (30 m) (if the cable bundle would separate prior to the horizontal directional drilling [HDD] exit pits, the disturbance corridor would be up to 98 ft [30 m] per individual cable), inclusive of any required sand wave leveling and boulder clearance. Dynamic Positioning vessels would generally be used for cable burial activities. If anchoring (or a pull ahead anchor) is necessary during cable installation, it would occur within the survey corridor. See Section 3.3.10 of the COP for additional information on vessel anchoring (Sunrise Wind 2022i).

The marine segments would be buried to a target depth of 3 to 7 ft (1 to 2 m) using the same trenching methods and construction vessels described above for the IAC. The target burial depth for the SRWEC will be determined based on an assessment of seabed conditions, seabed mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific Cable Burial Risk Assessment. The Cable Burial Risk Assessment would be prepared for the Facility Design Report (FDR) to be reviewed by the Certified Verification Agent and submitted to BOEM prior to construction. The Cable Burial Feasibility Assessment, which provides an assessment of cable burial based on review of site-specific survey data, is provided with the Marine Site Investigation Report as Appendix G4, under confidential cover. Where burial cannot occur, sufficient burial depth cannot be achieved, or protection is required due to cables crossing other existing cables, additional cable protection methods may be used (cable protection is discussed further below). Sunrise Wind assumes up to 5 percent of the SRWEC would require secondary cable protection, which includes cable protection needed for jointing. Secondary protection will be up to 39 ft (12 m) wide (SRWEC corridor length x 0.05 x 39 ft (12 m). Sunrise Wind assumes up to 15 percent of the entire IAC network may require secondary cable protection in areas where burial cannot occur, sufficient burial depth cannot be achieved due to seafloor conditions, or to avoid risk of interaction with external hazards. The location of the SRWEC and associated cable protection would be provided to NOAA's Office of Coast Survey after installation is completed so that they may be marked on nautical charts. Burial depths at specific locations would be formalized in the FDR/Fabrication and Installation Report (FIR).

Installation of the proposed SRWEC consists of a sequence of events, including pre-lay cable surveys, seafloor preparation, offshore cable installation, beginning with cable pull into the landfall, joint construction, cable installation surveys, cable protection, and connection to the OCS–DC, as summarized in Table 3.3.3-4 of the COP (Sunrise Wind 2022i). Additional details for seafloor preparation, cable installation methodologies and cable protection strategies are described in the COP, including information on UXO/munitions and explosives of concern (MEC) risk mitigation, boulder removal, sand wave leveling, and pre-lay grapnel run.

Based on the identified range of installation methods and requirements, Sunrise Wind has established a design envelope for installation of the proposed SRWEC that reflects the maximum seafloor disturbance associated with construction (see Table 3.3.3-5 of the COP; Sunrise Wind 2022i). Temporary seafloor disturbance during installation includes the construction disturbance corridor where seafloor preparation would occur prior to cable installation, as well as the installation of the cable. Vessel anchoring occurring within the surveyed corridor during cable installation would also result in temporary seafloor disturbance. Permanent seafloor disturbance includes areas where additional cable protection may be required post-installation.

2.1.4 Onshore Sunrise Wind Export Cable

Sunrise Wind will land the SRWEC at the landfall location via HDD methodology. Up to three HDDs will be installed to support the landfall of the SRWEC, including one for each of the transmission cables of the bundle, as well as one additional third borehole to be used if it is technically or physically infeasible for the fiber optic cable to be included with the transmission cables. Up to two ducts will be installed in each drilled hole, one for the transmission cable, and one for the fiber optic cable. The HDD methodology will require temporary use of a Landfall Work Area located onshore within which the transition joint bay will be installed, and HDD construction activities will occur, including cable pull in activities.

The HDD installation involves drilling a horizontal bore underneath the seafloor surface and the intertidal area using a drilling rig located onshore within the Landfall Work Area. The process uses drilling heads and reaming tools of various sizes controlled from the rig to create a passage that is wide enough to accommodate the cable duct. Drilling fluid, comprised of bentonite, drilling additives, and water is pumped to the drilling head during the drilling process to stabilize the hole preventing collapse, and to return the cuttings to the rig site where the cuttings will be separated from the drilling fluids and the fluid recycled for re-use. Sunrise Wind will use a casing pipe to support drilling operations. The casing pipe will contain and collect drilling fluid within the casing to minimize dispersal into the marine environment. The casing pipe solution will require a steel casing pipe and supporting steel sheet piles (goal posts) to be installed temporarily at the HDD exit pit locations during HDD installation and provide a closed system for the drilling fluids.

To support HDD installation, HDD exit pit will be excavated offshore within the surveyed corridor and outside of the Fire Island National Seashore boundary. The HDD exit pit (will be excavated where the HDD drill will reach the seafloor surface and to support subsequent burial of the HDD duct beneath the seabed. The HDD exit pit will be excavated using a mechanical dredge, such as a long-reach excavator or clamshell bucket dredge. Upon completion of the excavation of the offshore exit pit, it is anticipated that temporary rock bags may be lowered into the excavated exit pit from the marine support vessel. The rock bags will prevent the natural backfill of the excavation during the drilling process and therefore prevent a need to re-excavate later. Once the drilling has been completed, the rock bags will be removed to enable the lowering of the duct end and awaiting subsequent cable installation and final backfill of the excavation. The depth and actual length of the HDD will depend on the soil conditions and final cable specifications. The exit pit will be approximately 50 m x 15 m x 5 m (3,750 m3 [4,900 yd3]). A barge or jack-up vessel may be used at this location to assist the drilling process, excavate the exit pit, and handle the duct for pull in.

All of the sheet pile goal posts would be installed first, followed by installation of the casing pipe. The installation of these components would occur on separate days. Up to six goal posts may be installed to support the casing pipe between the barge and the penetration point on the seabed. Each goal post would be composed of two vertical sheet piles installed using a vibratory hammer such as an APE model 300 (or similar). A horizontal cross beam connecting the two sheet piles would then be installed to provide support to the casing pipe. Up to 10 additional sheet piles may be installed per borehole to help anchor the barge and support the construction activities. This results in a total of up to 22 sheet piles per borehole and two boreholes bringing the overall total to 44 sheet piles. Sheet piles used for the goal posts and supports would be up to 100 ft (30 m) long, 2 ft (0.6 m) wide, and 1 inch (in.; 2.5 centimeter [cm]) thick. Installation of the goal posts would require up to 6 days per borehole, or up to 12 days total for both boreholes. Up to four piles may be installed per day, with an estimated time of 2 hours to install each pile. Removal of the goal posts may also involve the use of a vibratory hammer and likely require approximately the same amount of time or less (12 days total for both boreholes) as installation. Thus, use of a vibratory pile driver to install and remove sheet piles may occur on up to 24 days at the landfall location.

The installation of a temporary casing pipe for each bore hole at the Landfall HDD will be conducted from a construction barge using a pneumatic pipe ramming tool (e.g., Grundoram Taurus or similar; Table 4). The casing pipes will be installed at a 11- to 12-degree angle from horizontal and will be used to collect drilling fluids from the HDD. The casing pipe is anticipated to have a 10-m penetration depth below sea level and may require up to 32,400 strikes during its installation. Installation of a single casing pipe may take up to 3 hours of pneumatic hammering on each of 2 days for installation. Installation time will be dependent on the number of pauses required to weld additional sections onto the casing pipe. For both casing pipes, this would mean a total of 4 days of installation. Once HDD is complete and cables have been drawn through the HDD area, the temporary casing pipes will be removed. Removal of the casing pipes is anticipated to require approximately the same amount of pneumatic hammering and overall time, or less, meaning the pneumatic pipe ramming tool may be used for up to 3 hours per day on up to 8 days.

A temporary pile-supported pier needs to be constructed on the inshore side of Fire Island to allow for the transportation of equipment and materials from Long Island to the construction site on Fire Island. Based on the available bathymetric data at the site, the pier will extend approximately 240 ft (73 m) offshore to reach deep enough water to ensure adequate clearance between the transfer barge and mudline at all tide levels (i.e., a minimum water depth of 4 ft at low tide). The pier will be approximately 16 ft (4.9 m) wide to accommodate the safe transfer of the equipment as well as provide an adequate walkway for the crew. The pier will be constructed out of a light aluminum deck system (or a similar alternative) supported on steel or aluminum girders framed into driven steel piles. The precise pier design and type of piles have not yet been determined. The anticipated piles will be either 14 x 14 in. (35.6 x 35.6 cm) H-shaped piles or 16 in. (40.6 cm) diameter round steel piles. The piles will be lifted and driven into the seafloor by a barge-based crane and the barge will require two to four temporary “spud” piles to hold it in place during construction.

Table 4. Piling driving assumptions used in underwater acoustic modeling of the casing pipe piles.

Parameter	Value
Hammer	Grundoram Taurus (impact)
Impact hammer energy	18 kJ
Pile length	Penetration + water depth
Pile diameter	1.2 m
Pile wall thickness	25.4 mm
Seabed penetration	10 m
Angle of installation (relative to horizontal)	11–12 degrees
Piles per day	0.5
Strikes per day	32,400

Notes:

kJ = kilojoule(s); m = meter(s); mm = millimeter(s)

Based on the preliminary designs, the temporary pier will require the installation of up to 24 total "production" piles that will remain the entire time the temporary pier is in place. These production piles will include up to 24 piles to create "bents" that support the pier deck. Each production pile will be either a 14 x 14 in. (35.6 x 35.6 cm) H-shaped pile or 16 in. (40.6 cm) diameter round steel pile, or similar. The 16 in. (40.6 cm) round steel pile would have a 3/8-in. wall thickness and a length of up to 100 ft. Temporary piles may be used to support a steel-framed template used to ensure installation of the bent production piles in the correct positions. The temporary piles may include up to 24 H-shaped or cylinder piles of the same size as the production piles. Therefore, a total of 48 piles (up to 24 production piles and up to 24 temporary piles) may be installed, and in some cases removed, during construction.

Installation and removal of up to 24 temporary piles would be completed using only vibratory pile driving equipment. The up to 24 production piles will first be driven using a vibratory hammer followed by an impact hammer. A vibratory hammer with a centrifugal force of approximately 160 tons (e.g., APE 200) would be used for both installation and removal of piles. An impact hammer with a rated energy of approximately 15,000 foot-pounds (ft-lb) (e.g., APE D8-42) would be used to complete installation of the production piles. Both production and temporary piles will be removed using vibratory pile driving.

The construction sequence will begin with installation of up to two temporary piles using a vibratory hammer to support the template at each grouping of production piles that form a bent. Installation of a single temporary pile will require up to 15 minutes of vibratory pile driving. Once the temporary piles and template are in place, the bent production piles will be driven into place using a vibratory hammer followed by an impact hammer. Up to 15 minutes of pile driving may be required for each production pile, with vibratory pile driving for approximately 90 percent of the installation time (~13.5 minutes) followed by impact pile driving for the remaining 10 percent of the installation time (~1.5 minutes). Following installation of the bent production piles, the temporary piles supporting the template will be removed using only vibratory pile driving (up to 15 minutes each), and the template will be moved to the next position and again secured in place using up to two temporary piles. This process will continue until all production piles are installed.

It is anticipated that installation of the pier will occur over approximately three to four weeks in and around January to February 2024 (upon receipt of all necessary permits). Installation of up to 24 production piles may result in a total of up to 324 minutes (5 hours 24 minutes) of vibratory pile driving (24 x 13.5 minutes) and 36 minutes of impact pile driving (24 x 1.5 minutes). Installation and removal of up to 24 temporary piles may require up to 720 minutes (16 hours) of vibratory pile driving only (2 x 24 x 15 minutes). The maximum total pile driving time for installation is therefore 1,044 minutes (17 hours 24 minutes) of vibratory pile driving and 36 minutes of impact pile driving.

Following completion of the landfall construction work on Fire Island, the temporary pier is expected to be removed in approximately April or May 2025 and all work areas will be backfilled and returned to pre-construction conditions. Removal of the temporary pier would involve the removal of all 24 production piles using a vibratory hammer. Thus, the total duration of vibratory pile driving during pier removal may be up to 360 minutes (6 hours; 24 x 15 minutes).

2.2 OPERATIONS AND MAINTENANCE

Per the Lease, the operations term of the proposed Project is 25 years but could be extended to a period of 35 years in total, and this document considers the impacts for the maximum period of time. The operations term would commence on the date of COP approval. It is anticipated that Sunrise Wind would request to extend the operations term in accordance with applicable regulations in 30 CFR § 585.235.

The O&M Plan for both the Project's onshore and offshore infrastructure would be finalized as a component of the FDR/FIR review process; however, a preliminary O&M plan for the onshore facilities, offshore transmission facilities (e.g., the SRWEC, IAC, and the OCS–DC electrical components) and WTGs is provided in the following sections. As noted previously, various existing ports are under consideration to support offshore construction, assembly and fabrication, crew transfer and logistics (including for O&M activities) (see **Section 1.5** for the Action Area).

To support O&M, the Project would be controlled 24/7 via a remote surveillance system (i.e., SCADA).

2.2.1 Offshore Sunrise Wind Farm

WTGs would be continuously remotely monitored via the SCADA systems from shore. Preventative maintenance activities would be planned for periods of low wind and good weather (typically corresponding to the spring and summer seasons). The WTGs would remain operational between work periods of the maintenance crews. Certain O&M activities may require presence of either a jack-up vessel or anchored barge vessel. These activities would result in a short-term disturbance of the seafloor similar to or less than what is anticipated during construction.

The WTGs would also be designed to minimize the effects of potential icing conditions in the SRWF. The SCADA monitoring system and turbine control management system would be designed to detect the buildup of ice and/or snow on the WTG and shut down operations, as necessary. The WTGs would be type certified according to IEC standards. The WTGs would comply with EC machinery directive (CE marked). Sunrise Wind would seek compliance with BOEM and BSEE regulations that directly govern operations and in-service inspections for offshore wind facilities in the United States.

Each of the WTGs would require various oils, fuels, and lubricants to support the operation of the WTGs (**Table 5**). The spill containment strategy for each WTG would be comprised of preventive, detective, and containment measures. These measures include 100 percent leakage-free joints to prevent leaks at the connectors, high pressure and oil level sensors that can detect both water and oil leakage, and appropriate integrated retention reservoirs capable of containing 110 percent of the volume of potential leakages at each WTG.

Each WTG would have its own control system to carry out functions like yaw control and ramp down in high wind speeds. Each turbine would also connect to a central SCADA system for control of the wind farm remotely. This would allow functions such as remote turbine shutdown if faults occur. The Project would be able to shut down a WTG within 2 minutes of initiating a shutdown signal. The SCADA system would communicate with the wind farm via fiber optic cable(s), microwave, or satellite links. Individual WTGs can also be controlled manually from within the nacelle or tower base to control and/or lock out the WTG during commissioning or maintenance activities. In case of a power outage or during commissioning, the turbine would be powered by a permanent battery back-up power solution with integrated energy harvest from the rotor or by a diesel generator located temporarily on each WTG.

Table 5. Summary of maximum potential volumes oils, fuels, gases, and lubricants per wind turbine generator.

WTG System/Component	Oil/Fuel/Gas Type	Oil/Fuel/Gas Volume
WTG Bearings and Yaw Pinions	Grease[a]	132 gal (500 L)
Hydraulic Pumping Unit, Hydraulic Pitch Actuators, Hydraulic Pitch Accumulators	Hydraulic Oil	159 gal (600 L)
Yaw Drives Gearbox	Gear Oil	79 gal (300 L)
Blades and Generator Accumulators	Nitrogen	104 yd^3 (80 m^3)
High-Voltage Transformer	Transformer Silicon/Ester Oil	1,850 gal (7,000 L)
Emergency Generator	Diesel Fuel	793 gal (3,000 L)
Tower Damper and Cooling System	Glycol/Coolants	3,434 gal (13,000 L)

Notes:
[a] Approximately 26 gal to 40 gal (100 L to 150 L) per large bearing.
gal = gallon(s); L = liter(s); m^3 = cubic meter(s); WTG = wind turbine generator; yd^3 = cubic yard(s)

The WTGs would also be protected both externally and internally by a lightning protection system. The external lightning protection system is comprised of lightning receptors located within both the nacelle and blade tips, which are designed to handle direct lightning strikes and would conduct the lightning's peak current through a conductive cabling system that leads through the tower into the WTG grounding/earthing system. To avoid and/or minimize internal damage from the secondary effects of lightning (e.g., power surges), the internal electrical systems would be protected by equipotential bonding, overvoltage protection, and electromagnetic coordination.

WTGs would be accessed either from a vessel via a boat landing or alternative means of safe access (e.g., Get Up Safe). The WTGs would be lit and marked in accordance with Federal Aviation Administration (FAA), BOEM, and USCG requirements for aviation and navigation obstruction lighting, respectively. The lights would be equipped with back-up battery power to maintain operation should a power outage occur on a WTG. Additional operational safety systems on each WTG would include fire suppression, first aid, and survival equipment.

2.2.2 Offshore Transmission Facilities

An OCS–DC would be required to support the Proposed Project's maximum design capacity; maximum parameters for the OCS–DC platform foundation are provided in **Table 6**. The water depth at the OCS–DC location would be approximately 164 ft (50 m) below mean sea level (MSL) based on NOAA Coastal Relief Model data (166 ft [51 m] mean lower low water based on site-specific geophysical surveys). The OCS–DC would convert the medium voltage AC generated by WTGs and transported to the OCS–DC via the IAC to direct current (DC) for transmission to the onshore electrical infrastructure to reduce the energy losses incurred while transmitting energy over a long distance. Onshore, the OnCS–DC would convert the DC power back to AC for interconnection to the electrical grid.

The DC equipment on the OCS–DC is expected to be rated up to ±320 kV DC. The OCS–DC would house equipment for high-voltage transmission and conversion of electric power from AC to DC. The main equipment would include medium voltage AC (66-kV) gas-insulated switchgear, one or more converter transformers, and converter reactors. The OCS–DC would also include AC and DC gas- or air-insulated switchgears at voltages to be defined during detailed design, converter valves based on state-of-art voltage-source converter technology, DC smoothing reactors, and SCADA and protection systems.

Table 6. Maximum parameters for the Offshore Converter Station platform foundation.

Offshore Converter Station Characteristics	Maximum Parameters
Number of Legs	4
Total Number of Pin Piles (up to two per leg)	8
Leg Diameter	15 ft (4.6 m)
Pin Pile Diameter	13 ft (4 m)
Embedment Depth (below seafloor)	295 ft (90 m)
Height of Platform Above Mean Higher High Water	88 ft (26.8 m)
Perimeter Area of Foundation at Mean Sea Level	220 ft x 220 ft (67 m x 67 m)
Perimeter Area of Foundation at Sea Floor	262 ft x 262 ft (80 m x 80 m)
Mud-Mat Area (each leg)	75 ft x 75 ft (23 m x 23 m)

Notes:
ft = foot(feet); m = meter(s)

In addition to the power transmission system above, the OCS–DC would be equipped with the necessary low voltage and utility systems. These systems include emergency power generation and uninterrupted power supply seawater cooling, offshore crane, fire and safety, small power and lighting, and communications, sanitary facilities, and lifesaving and rescue. A helideck may also be located on the OCS–DC.

The AC to DC conversion process at the OCS–DC requires a cooling water intake structure (CWIS). The CWIS for the OCS–DC is withdrawn through three individual vertical pipes in a single parallel cluster attached to the steel foundation jacket. The openings of each of the three intake pipes are located approximately 30 ft (10 m) above the pre-installation seafloor grade and have a total intake surface area of approximately 27 ft^2 (2.54 m^2). Three steel crash bars of 2.4 x 0.8 in. (60 x 20 millimeters) oriented with the narrow aspect facing the current will be fixed across the opening of each intake pipes to exclude large solids.

Each intake pipe has a dedicated seawater lift pump (SWLP) that is equipped with a variable frequency drive. Each SWLP has a design capacity of 4,245 gallons per minute (964 cubic meters per hour), or 6.1 million gallons per day (MGD). Depending on cooling water volume requirements, typical operation of the SWLPs will require either one or two SWLPs on duty with the other SWLP(s) on standby (i.e., not in service). The two duty SWLPs will have a combined maximum design intake flow (DIF) of 8.1 MGD through the intake openings. In this scenario, seawater will flow into the SWLPs at a maximum through-screen velocity of 0.43 ft per second (0.13 m per second) under DIF conditions.

The cooling water volume requirements for the OCS–DC will vary according to ambient water temperature, wind farm power production, and other factors. There is no scenario where all three pumps will be operating simultaneously. The DIF of 8.1 MGD for the OCS–DC involves the simultaneous operation of two SWLPs operating at 66 percent capacity (4.1 MGD each) and represents the maximum daily flow that will occur. The standard operating procedure for the SWLPs are expected to have a daily average intake flow (AIF) ranging from 4.0 MGD to 5.3 MGD. This AIF range is based on seasonal changes in water temperatures and electrical demand. The expected daily AIF and DIF for SWLP operation by month is provided in **Table 7**, below. Maximum daily AIF and DIF values presented in **Table 7** are rounded to the nearest tenth.

The three SWLPs would pump water into a single manifold that leads into a coarse filtering element designed to remove suspended particles larger than 500 microns. The filtered cooling water would then be exposed to heat exchange equipment and ultimately discharged to the receiving water through a dump caisson. No chemicals or anti-fouling treatments will be added to the cooling water. The dump caisson is a single vertical pipe whose terminus is located 40 ft (12 m) below MSL, and approximately 124 ft (38 m) above the seafloor. The maximum anticipated discharge temperature is expected to be 90°F (32°C). The thermal plume was modeled to show the area where adjacent waters would experience a DT of 1°C. The 40-ft (12-m) MSL discharge depth and single discharge point had the largest plume area 3.1 hours after slack tide with and area of 731 ft^2 (66.9 m^2) and the smallest plume size of 415 ft^2 (38.6 m^2) after slack in the fall. Additional design details are included in the NPDES permit application, which was submitted to EPA in December 2021. The maximum topside design scenario for the OCS–DC is provided in Table 3.3.6-1 of the COP (Sunrise Wind 2022i).

Table 7. Offshore Converter Station average and maximum daily flow per month.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily DIF (MGD)	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Daily AIF (MGD)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.3	4.6	5.3	4.9	4.1

Notes:
AIF= average intake flow; DIF = design intake flow; MGD = million(s) gallons per day

The OCS–DC would require various oils, fuels, and lubricants to support its operation (**Table 8**). The spill containment strategy for the OCS–DC would be comprised of preventive, detective, and containment measures. The OCS–DC would be designed with a minimum of 110 percent of secondary containment of all identified oils, grease, and lubricants. OCS–DC gas insulated switchgears containing SF6 would be equipped with gas density monitoring devices to detect SF6 gas leakages should they occur. Any chemicals used in the auxiliary systems would be brought onto and taken off the platform during O&M and are not anticipated to be stored on the platform.

Table 8. Summary of maximum potential volumes oils, fuels, gases, and lubricants for the Offshore Converter Station.

OCS–DC Equipment	Oil/Fuel/Gas Type	Oil/Fuel/Gas Volume
Transformers and Reactors	Transformer Oil	105,700 gal (400,000 L)
Generator fuel tank	Diesel Fuel	24,304 gal (92,000 L)
Medium and High-Voltage Gas-insulated Switchgears	Sulfur Hexafluoride (SF6)	3,960 lb (1,796 kg)
Crane	Hydraulic Oil	528 gal (2,000 L)
Crane[1]	Grease	TBD
Rotating Equipment[1]	Lube Oil	TBD
Auxiliary Diesel Generator	Lube Oil	53 gal (200 L)
Seawater Lift Pumps	Lube Oil	119 gal (450 L)
Auxiliary Inert Gas System	High Pressure Nitrogen	52,834 gal (200,000 L), at 300 bar
Auxiliary Diesel Generator Fire Suppression System[1]	Inert Gas	TBD
Auxiliary Transformers	Synthetic Ester Oil	3,170 gal (12,000 L)
Chiller units	Refrigerant HFO123I(E)	40 gal (150 L)
Compressed Air Foam System[1]	Foam Concentrate	TBD
Uninterruptible Power Supply Battery[1]	Battery Acid	TBD
Cooling Medium System	Glycol/Water Mix	7,925 gal (30,000 L)
Chilled Water Medium System	Glycol/Water Mix	5,283 gal (20,000 L)

Notes:

[1] The volumes listed as "TBD" are pending further engineering and will be provided when the design is further progressed.

gal = gallon(s); kg = kilogram(s); L = liter(s); lb = pound(s)

The SRWEC and IAC would typically have no maintenance requirements unless a fault or failure was to occur. To evaluate integrity of the assets, Sunrise Wind intends to conduct a bathymetry survey along the entirety of the cable routes immediately following installation (scope of installation contractor), and at 1 year after commissioning, 2 to 3 years after commissioning, and 5 to 8 years after commissioning. Survey frequency thereafter would depend on the findings of the initial surveys (i.e., site seabed dynamics and soil conditions). A survey may also be conducted after a major storm event (i.e., greater than 10-year event). Surveys of the cables may be conducted in coordination with scour surveys at the foundations.

Should the periodic bathymetry surveys completed during the operational lifetime of the Project indicate that the cables no longer meet an acceptable burial depth (as determined by the Cable Burial Risk Assessment), the following actions may be taken:

- Alert the necessary regulatory authorities, as appropriate.
- Undertake an updated Cable Burial Risk Assessment to establish whether cable is at risk from external threats (i.e., anchors, fishing, dredging).
- Survey monitoring campaign for the specific zone around the shallow buried cable.
- Assess the risk to cable integrity.

Based on the outcome of these assessments, several options may be undertaken, as feasible, permitted and practical, such as remedial burial, addition of secondary protection (rock protection, rock bags or mattresses), and increased frequency of bathymetric surveys to assess reburial.

It is possible submarine cables may need to be repaired or replaced due to fault or failure. Also, it is expected that a maximum of 10 percent of the cable protection placed during installation may require replacement/remediation over the lifetime of the Project. These maintenance activities are considered non-routine. If cable repair/replacement or remedial cable protection are required, the Project would complete any necessary surveys of the seafloor in areas where O&M activities would occur and obtain necessary approvals. These activities would result in a short-term disturbance of the seafloor similar to or less than what is anticipated during construction.

2.3 DECOMMISSIONING

In accordance with 30 CFR §§ 585.905 through 585.912, BOEM requires permitted operators to decommission offshore energy facilities at the end of their design life and restore environment to baseline conditions to the extent practicable. As detailed in 30 CFR §§ 585.902, the lessee must submit an application and receive approval from BOEM before commencing with the decommissioning process. Final approval of this application is a separate process from approval of the conceptual decommissioning methodology in the COP. In accordance with applicable regulations and a BOEM-approved conceptual decommissioning plan, Sunrise Wind would have up to 2 years to decommission the Project after the 25-year lease ends, unless the lease is extended, which would return the area to pre-construction conditions, as feasible.

Sunrise Wind would need to obtain separate and subsequent approval from BOEM to retire any portion of the Project in place. Sunrise Wind would submit a conceptual decommissioning application prior to any conceptual decommissioning activities. BOEM would conduct a NEPA review at that time, which could result in the preparation of a NEPA document. If the COP is approved or approved with modifications, Sunrise Wind would have to submit a bond that would be held by the U.S. government to cover the cost of conceptually decommissioning the entire facility.

Conceptual decommissioning may not occur for all Project components; however, for the purposes of this BA, all analyses assume that conceptual decommissioning would occur as described in this section.

2.3.1 Offshore Activities and Facilities

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

WTGs and foundations (along with their associated transition pieces) now have an expected operating life of at least 25 years and substantially longer with prudent inspection and maintenance practices. This timeframe is applicable to offshore wind facilities worldwide, including for SRWF. At the end of the proposed Project's operational life, it would be decommissioned in accordance with a detailed Project decommissioning plan that would be developed in compliance with applicable laws, regulations, and BMPs at that time. Care would be taken to handle waste in a hierarchy that prefers reuse or recycling and leaves waste disposal as the last option. Absent permission from BOEM, Sunrise Wind would complete decommissioning within 2 years of termination of the Lease.

Sunrise Wind would develop a final decommissioning and removal plan for the facility that complies with all relevant permitting requirements. This plan would account for changing circumstances during the operational phase of the Project and would reflect new discoveries particularly in the areas of marine environment, technological change, and any relevant amended legislation.

2.4 VESSEL AND AIRCRAFT TYPES

2.4.1 Construction and Installation

Construction of the Project will require the support of onshore construction equipment (see Table 3.3.10-2 of the COP; Sunrise Wind 2022i), as well as various vessels, helicopters, and unmanned systems (**Tables 9** through **11**) (see Table 3.3.10-3 of the COP; Sunrise Wind 2022i). For each vessel type, the route plan for the vessel operation area will be developed to meet industry guidelines and best practices in accordance with International Chamber of Shipping guidance.

The Port of New York-New Jersey, New York; New Bedford Marine Commerce Terminal, Massachusetts; Sparrows Point, Maryland; Port of Albany, New York; Paulsboro Marine Terminal, New Jersey; and/or Port of Norfolk, Virginia, are considered back up and/or support facilities and part of the COP envelope, and their potential use is considered in the analysis of potential vessel impacts (**Section 4.3**). The use of these ports will depend upon contract signing and vessel availability, home port locations of vessels, supply chain logistics, emergency or storm refuge, and/or additional unforeseen circumstances. At this time, of these back up ports listed, it has been identified that approximately one roundtrip may be needed to and from the Port Elizabeth in the Port of New-York-New Jersey, to mobilize the lift boat and equipment needed for the Landfall HDD works during construction.

Table 9. Vessels required for offshore construction and installation.

Type of Vessel	# of Vessels	Foundations	OSS	SRWEC	IAC	OSS-Link Cable	WTGs
Accommodation Jack-up Vessel	1	X					X
Boulder Clearance Vessel	2	X		X	X	X	
Bubble Curtain Vessel	1	X	X				X
CTV	6	X	X	X	X	X	X
Nearshore Barge	1			X			
Rock Installation Vessel	1	X					
Helicopter	1-2	X					
Foundation Supply Vessel	3	X	X				
Foundation Installation Vessel	1		X				
Array Installation (cable laying vessel)	1				X		
Array Cable Burial	1				X		
SOV	1			X	X	X	X
Pre-lay Grapnel Vessel	4			X	X	X	
Safety Vessel	2	X	X	X	X	X	X
Scout Vessel	6	X	X	X	X	X	X
Survey Vessel	1			X	X	X	
PSO Vessel	4	X					
Cable Lay Vessel (export)	1			X		X	
Walk to Work Vessel	1			X	X	X	

Notes:

CTV = crew transport vessel; IAC = Inter-Array Cables; OSS = Offshore Substation; PSO = Protected Species Observer; SOV = Service Operations Vessel; SRWEC = Sunrise Wind Export Cables; WTG = wind turbine generator

Table 10. Anticipated vessel traffic during construction with anticipated ports by vessel type. Total trips represent the total number of trips, which may travel to the listed 'Ports that may be Used' in any combination up to that total number of trips.

Vessel	Total Trips	Ports that may be Used*
Safety vessel (2)	114	Quonset Port Jefferson
CTV (6)	870	Quonset Port Jefferson Davisville Providence New London
SOV	52	Quonset Port Jefferson New London
Accommodation JUV	1	Quonset Port Jefferson
PSO Vessel (4)	80	Providence
DP2 Platform Supply Vessel (3)	65	Providence
DP Fall Pipe Vessel	6	Providence
Bubble curtain vessel	20	Providence
Survey Vessel	11	Providence Quonset Davisville New Bedford
Boulder Clearance Vessel (Grab)	13	Providence Quonset Davisville New Bedford
Boulder Clearance Vessel (Plough)	13	Providence Quonset Davisville New Bedford
PLGR Vessel	6	Providence Quonset Davisville New Bedford
Nearshore Barge	4	Providence Quonset Davisville New Bedford

Vessel	Total Trips	Ports that may be Used*
Tug (4)	16	Providence Quonset Davisville New Bedford
Cable Installation Vessel	18	Providence Quonset Davisville New Bedford
Scout Vessel (6)	100	Providence Quonset Davisville New Bedford
Walk to Work Vessel	52	Quonset Port Jefferson
WTG Installation Vessel	40	New London Quonset
Secondary Steel	94	Coeymans
Transport Freighter	74	Unknown European Ports

Notes:

See **Figure 6** for the duration of the construction period.

* The use of these ports will depend upon contract signing and vessel availability, home port locations of vessels, supply chain logistics, emergency or storm refuge, and/or additional unforeseen circumstances.

CTV = crew transport vessel; JUV = jack-up installation vessel; PLGR = Pre-Lay Grapnel Run; SOV = Service Operations Vessel; WTG = wind turbine generator

Table 11. Properties of anticipated project vessel and aircraft for Sunrise Wind Farm.

Vessel Type	Max Speed (knots)	Typical Operational Speed (knots)	Approximate Vessel Draft (meters)	Approximate Beam (meters)	Approximate Length (meters)
Anchor Handling Tug	14	4	6.5	16.4	73.5
Array Cable Burial Vessel	15	2.4	5	30	150
Array Installation (CLV)	15	2.4	5	30	150
Bunkering Vessel	25	8	7	10	40-50
Export Cable Lay Vessel (CLV)	15	2.4	5	30	150
Crew Transport Vessels	25	23	1.6 - 3	8	20
Export Cable Burial Vessel	15	2.4	5	30	150
Barge – Towing Tug	14	4	7	30	90
Barge – Cable Lay	15	12 (1) +/-	7	30	90
Barge – Feeder	15	4	7	30	90

Vessel Type	Max Speed (knots)	Typical Operational Speed (knots)	Approximate Vessel Draft (meters)	Approximate Beam (meters)	Approximate Length (meters)
Barge – Material	15	4	6 - 7	30.5	91.5
Boulder Clearance Vessels	15	2	3.8 – 6	15.9 – 22	77.8 – 106.7
Bubble Curtain Vessel	15	0 (Vessel will hold position when operating the bubble curtain)	6	70	15
Foundation Installation Vessels	16	7	13.5	40-50	215 - 230
Foundation Supply Vessel	15	10	7	10	140
Heavy Transport Vessels	15	12	9 - 11	42 - 45	217
Jack-up Accommodation	16	10	5	41.2	56.4
Jack-up Installation Vessel	16	7	6.5	40-50	215 - 230
Liftboat	16	0 (Vessel will jack up for operations)	11	20	33
Pre-lay Grapnel Run Vessel	14	11	3	7.9	27.6
Platform Supply Vessels	15	9	3.2	14.6	61.3
PSO Vessels	25	5	3-4	10	50
Rock Installation Vessel	14	6.5	8	40	130
Scout Vessels	30	5	3	7-8	20-25
Service Operations Vessel	25	22	7.5	17	80
Survey Vessels	30	12.5	3.1	13.4	49.7
Transport Freighter	15	12	6.5	30-40	200
Tug (primary)	14	11.5	5	10.5	29.3
Tug (support tugs)	14	11.5	4 – 5	5.5 – 10.4	28 – 35.4
Helicopter	160	160	-	3.2 12 (Rotor Diameter)	15

Albany and/or Coeymans, New York, are included in the COP as being utilized for fabrication and assembly of secondary steel foundation components for the foundation scope. Coeymans has been identified as the preferred location for these activities, so no trips are currently planned to Albany; however, Albany will remain as a backup in the case of unforeseen logistical changes.

Vessels traveling from Europe may travel to ports in Canada for foundation marshalling and/or for material loading for scour protection and secondary cable protection prior to traveling to the SRWF. Although unknown at this time, Sunrise Wind conservatively estimates a total of approximately 33 roundtrips needed for these activities.

The Project will install operational automatic identification system (AIS) on all vessels associated with the construction of the Project. AIS will be used to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements. All vessels will operate in accordance with applicable rules and regulations for maritime operation within the U.S. and federal waters. Similarly, all aviation operations, including flying routes and altitude, will be aligned with relevant stakeholders (e.g., the FAA). Additionally, the Project will adhere to current vessel speed restrictions as appropriate at the time of Project activities and in accordance with BOEM and NMFS requirements.

Project vessels will employ a variety of anchoring systems, which include a range of size, weight, mooring systems, and penetration depths. Anchors associated with cable laying vessels will have a maximum penetration depth of 15 ft (4.6 m). Jack-up will include up to four spudcans with a maximum penetration depth of 52 ft (15.8 m). Jack-up will occur within the 722-ft (220-m) radius cleared around foundation locations during seafloor preparation activities.

2.4.2 Operations and Maintenance

Sunrise Wind expects to use a variety of vessels to support O&M, including service operating vessels (SOVs) with deployable work boats (SOV support craft), crew transfer vessels (CTVs), jack-up vessels, and cable laying vessels (**Table 12**). A hoist-equipped helicopter and unmanned aircraft systems may also be used to support O&M reducing the number of SOV trips. Table 3.5.5-1 in the COP provides a summary of O&M support vessels that are currently being considered to support Project O&M (Sunrise Wind 2022i). The type and number of vessels and helicopters will vary over the operational lifetime of the Project. For each vessel type, the route plan for the vessel operation area will be developed to meet industry guidelines and best practices in accordance with the International Chamber of Shipping guidelines.

CTVs would make approximately 52 round trips to the SRWF each year, or one per week, over the life of the project. The service operations vessel (SOV) would make an estimated 24 trips per year to the SRWF on an as-needed basis. This would equate to an estimated 2,660 O&M vessel round trips over the 35-year life of the project (**Table 13**). As with construction and installation, all O&M vessels would operate in accordance with applicable rules and regulations for maritime operation within U.S. and federal waters.

Table 12. Vessels required for offshore operations and maintenance by project component.

Activity Type	Vessel Type	Foundations	OSS	SRWEC	IAC	OSS-Link Cable	WTGs
Routine (e.g., annual maintenance, troubleshooting, inspections)	Service Operations Vessel	X	X	X	X	X	X
	Daughter Craft	X	X	X	X	X	X
	Crew Transfer Vessel/Surface Effects Ship	X	X	X	X	X	X
	Helicopter		X				X
Non-Routine (e.g., major components exchange)	Jack-up Vessel		X				X
	Cable-lay/Cable Burial Vessel			X	X	X	
	Support Barge		X	X	X	X	X

Notes:
IAC = Inter-Array Cables; OSS = Offshore Substation; SRWEC = Sunrise Wind Export Cables; WTG = wind turbine generator

Table 13. Anticipated vessel traffic (crew transfer vehicles and service operating vessels) associated with the operations and maintenance phase of the proposed action. Total trips represent the total number of trips, which may travel to the listed 'Ports that may be Used' in any combination up to that total number of trips.

Total Trips	Ports that may be Used
2,500	Montauk Operations and Maintenance Facility
130	Port of New London
30	Poulsboro Sparrows Point Norfolk

During O&M, helicopters may be used to provide supplemental means of access when vessel access is not practical or desirable. Flights may be restricted to daylight operations when visibility is good. Helicopters and unmanned aircraft systems may be used to support O&M:

- **Helicopter Hoist Operations**. An integrated helicopter hoist platform located on the roof of each WTG nacelle will provide access for O&M. SOVs and the OCS–DC may also be fitted with helicopter hoist platforms. The purpose of this effort is primarily for transport/transfer of technical personnel and equipment on to/from the WTGs via hoist to the nacelle but can also be conducted for transport/transfer of personnel and equipment to offshore installations that do not have a helideck. This is the means of access in the O&M phase and is typically used to perform minor repairs and restarts. Hoist operations can be combined with transport helicopter operation (e.g., landing on a vessel with a helideck and hoisting technicians or goods afterwards to a WTG).
- **Transport/Transfer Operations**. Transport helicopter operations are flights from an onshore airport/heliport to an offshore installation or vessel with a helideck and back. Transfer helicopter operations are flights within the SRWF, from an offshore installation or vessel with a helideck to another, and back.
- **Unmanned Aircraft Systems**. Unmanned aircraft systems may be used for inspection of blades, structures, seabed inspections, and cargo delivery between the assets in the wind farm.

2.4.3 Decommissioning

Sunrise Wind Sunrise Wind (2022i) has indicated that the project would have an operational life of up to approximately 35 years. The decommissioning plan is described in more detail above. The number and type of vessels required for project decommissioning would be similar to those used during project construction, with the exception that impact pile driving would not be required. As such, while the same class of vessel used for foundation installation may be used for decommissioning, that vessel would not be equipped with an impact hammer. At minimum, BOEM would require Sunrise Wind to completely remove all WTG and OSS components and their support towers as described above. Monopile foundations would be removed or cut off 15 feet below the mudline using a cable saw or equivalent technology. All materials would be recovered to the extent practicable for recycling and reuse.

It is not possible to predict the exact amount of vessel traffic or even potential ports that may be used during decommissioning as ports may undertake expansion projects or close during the up to 35-year lifetime of the Proposed Action. Because of the inability to predict required vessel traffic, potential ports that may be used, and that decommissioning would require its own permitting process, including NEPA analysis and its own Section 7 consultation with NMFS, analysis is limited to only portions of decommissioning that are reasonably certain to occur. With the understanding that no realistic estimate can be provided for actions more than three decades in the future, because the level of effort is anticipated to be of a similar scale or smaller level of impacts, **Table 13** represents a best estimate of potential vessel traffic on port locations.

2.5 PHYSICAL SURVEYS

A number of operations will be completed prior to the foundation installation process, including

- geophysical surveys to identify seafloor debris and potential UXO/MEC;
- geotechnical surveys to identify the geological, archaeological, and cultural resource conditions; and
- UXO/MEC clearance surveys to identify and confirm UXO/MEC targets for removal/disposal.

High-resolution geophysical (HRG) surveys are required throughout construction. Survey activities would include multibeam echosounders, side-scan sonars, shallow penetration subbottom profilers (SBPs), medium penetration SBPs, and marine magnetometers within the SRWF and SRWEC route. Additional geotechnical surveys may occur for further sediment testing at specific WTG locations. The geotechnical surveys would include in situ testing, boring, and sampling at foundation locations. Although Sunrise Wind has completed all biological surveys required with submission of the COP, Sunrise Wind has committed to working with BOEM and NMFS to conduct additional biological surveys during construction and/or monitoring periods during post-construction.

Cable installation surveys will be required, including pre- and post-installation surveys, to determine the cable lay-down position and the cable burial depth. Surveys are carried out using a combination of multibeam echo sounder or side-scan sonar to confirm the mean seafloor and a cable detection system to confirm the target cable burial depth.

HRG surveys will be conducted intermittently during the construction period to identify seabed debris and inspect cable installations. These surveys may utilize equipment such as multi-beam echosounders, sidescan sonars, shallow penetration SBPs (e.g., “Chirp”, parametric, and non-parametric SBPs), medium penetration sub-bottom profilers (e.g., sparkers and boomers), ultra-short baseline positioning equipment, and marine magnetometers. An estimated 30,861 linear km may be surveyed during the construction and operations phases of the Project over the 5-year duration of the Incidental Take Regulations (ITR); further breakdown of this total is described in the following paragraphs.

During the construction phase, an estimated 24,550 survey line km, plus in-fill and re-surveys may be necessary to survey the inter-array cables and the SRWEC in water depths ranging from 6.5 ft (2 m) to 180 ft (55 m). A maximum of 4 total vessels may be used for surveying. While the final survey plans will not be completed until construction contracting commences, on average, 70 km will be surveyed each day at 4 knots (kt) (7.4 km/hour) on a 24-hour basis, although some vessels may only operate during daylight hours (~12-hour survey vessels). While the final survey plans will not be completed until construction contracting commences, HRG surveys are anticipated to operate at any time of year for a maximum of 351 active sound source days over the 2 years of construction.

During O&M, geophysical surveys of the seafloor would occur as part of routine maintenance of offshore cables and foundations using multibeam echosounders, side-scan sonars, and marine magnetometers. Surveys will monitor bathymetry, cable burial depth, cable protection, and scour. During the operations phase (a period of approximately 3 years following up to 2 years of construction anticipated to be covered by the requested incidental take regulations) an estimated 6,311 km per year may be surveyed in the SRWF and along the SRWEC. Using the same estimate of 70 km of survey completed each day per vessel, approximately 90 days of survey would occur each year for a total of up to 270 active sound source days over the 3-year operations period. The underwater and in-air noise generated from equipment and vessels during these seafloor surveys would be similar to that occurring during site assessment of the Project Area; however, some of the equipment with higher sound pressure levels (SPLs), such as the SBP, are not anticipated to be used to support the O&M seafloor surveys.

The survey equipment to be employed during construction and O&M will be equivalent to the equipment utilized during the HRG survey campaigns associated with Lease Area OCS-A 0500 conducted in 2016, 2017, 2018, 2019, and 2020 and with Lease Area OCS-A 0487 conducted in 2019 and 2020 (CSA 2020). Site-specific verification has been conducted of all geophysical equipment sound sources deployed within the marine portions of the Project Area that operate within the functional hearing range of marine mammals.

For UXOs/MECs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to detonating the UXO/MEC in place. These may include relocating the activity away from the UXO/MEC (avoidance), moving the UXO/MEC away from the activity (lift and shift), cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to detonate the UXO/MEC in place be made. To detonate a UXO/MEC, a small charge would be placed on the UXO/MEC (see **Table 25**) and detonated causing the UXO/MEC to then detonate.

2.6 PROPOSED MITIGATION, MONITORING, AND REPORTING MEASURES

2.6.1 Fisheries and Benthic Research Monitoring

The Fisheries and Benthic Research Monitoring Plan (FMP) for Sunrise Wind has been developed in accordance with recommendations set forth in *Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf* (BOEM 2019), which state that a fishery survey plan should aim to

- identify and confirm which dominant benthic, demersal, and pelagic species are using the project site, and when these species may be present where development is proposed;
- establish a pre-construction baseline which may be used to assess whether detectable changes associated with proposed operations occurred in post-construction abundance and distribution of fisheries;
- collect additional information aimed at reducing uncertainty associated with baseline estimates and/or to inform the interpretation of research results; and
- develop an approach to quantify any substantial changes in the distribution and abundance of fisheries associated with proposed operations.

BOEM guidelines stipulate that 2 years of pre-construction monitoring data are recommended, and that data should be collected across all four seasons. Consultations with BOEM and other agencies are encouraged during the development of fisheries monitoring plans. BOEM also encourages developers to review existing data, and to seek input from the local fishing industry to select survey equipment and sampling protocols that are appropriate for the area of interest.

The FMP may occur throughout any of the phases of the Proposed Action. The FMP will be revised through an iterative process, and survey protocols and methodologies have been and will continue to be refined and updated based on feedback received from stakeholder groups. Much of the research described in this plan will be performed on commercial fishing vessels that are contracted for this monitoring. Further, the field work described in the monitoring plan will be performed by an independent contractor (e.g., local university, research institution, or consulting firm). No gillnet surveys are proposed.

2.6.2 Trawl Surveys

The primary objective of the fisheries and benthic monitoring is to investigate the relative abundance (i.e., kilograms [kg]/tow) of fish and invertebrate resources in the SRWF Area ("Sunrise Wind impact") and reference areas ("control") over time. The original target was to complete two years of sampling (i.e., eight seasonal trawl surveys) prior to the commencement of offshore construction, with the intention to begin sampling in the winter of 2021/2022. SMAST applied to NMFS for a Letter of Acknowledgement (LOA) to execute the survey, and the LOA was granted in November 2021; however, when the LOA was received, SMAST was informed that additional ESA and MMPA consultations were required prior to the start of any in-water activities. Therefore, the trawl survey has not yet commenced, as we are currently working with NMFS and BOEM to obtain an Incidental Take Permit for the trawl survey. Sunrise Wind intends to begin the trawl survey as soon as practicable, once the Incidental Take Permit has been received. Sampling will continue during Project construction, and a minimum of 2 years of monitoring will be completed following offshore construction, with the duration of post-construction monitoring also informed by ongoing guidance for offshore wind monitoring that is being developed cooperatively through the Responsible Offshore Science Alliance (ROSA 2021).

In order to obtain sufficient analytical power to detect trends in species abundances, Sunrise Wind will work with its partners to conduct 15 trawls per sampling area each season (45 trawls per season). Trawls may occur during any month of the season, and the number of days required will be dependent on field conditions but will require a maximum of 45 days. Sampling areas include the western portion of the SRWF and two reference trawl areas (**Figure 8**). This will result in 180 trawl tows per year.

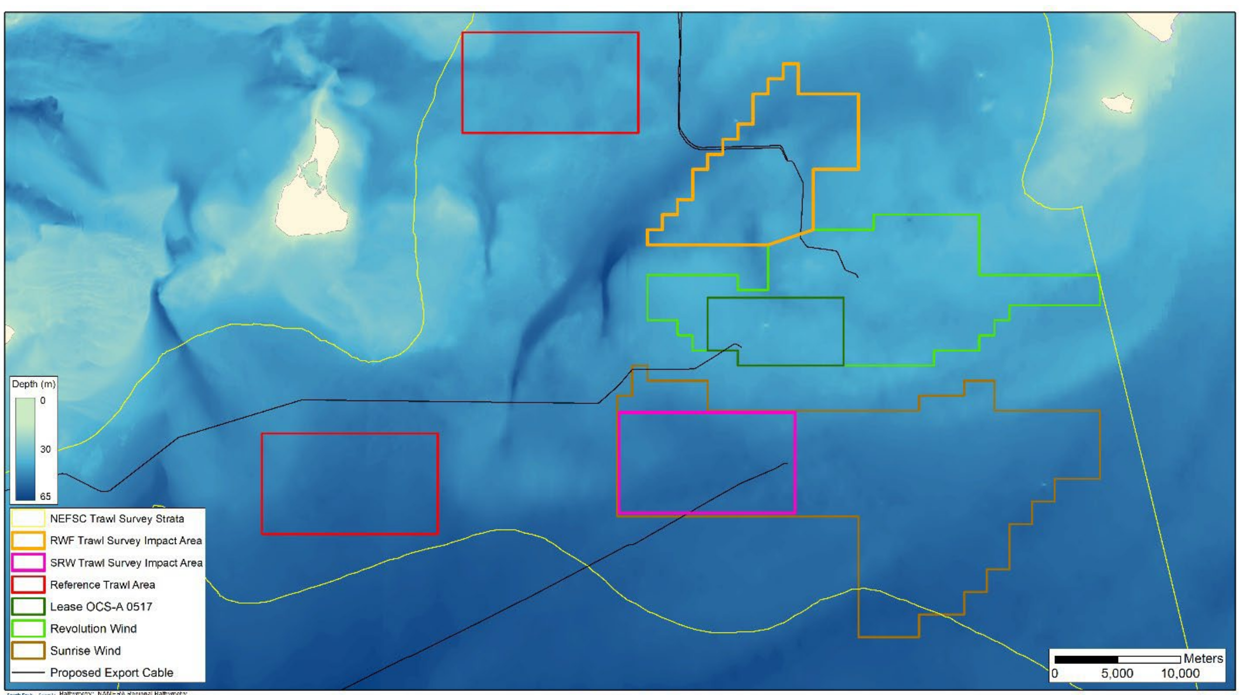

Figure 8. Bathymetric map of the Sunrise Wind Farm and Revolution Wind lease areas and the planned reference areas for the trawl survey.

2.6.3 Acoustic Telemetry

Ørsted, through the Sunrise Wind project, will provide additional support to ongoing highly migratory species (HMS) telemetry studies. The current HMS receiver array will be expanded from 17 to 36 receivers starting in the spring or summer of 2022 and will achieve monitoring across the Ørsted/Eversource lease sites (Sunrise Wind, Revolution Wind, and South Fork Wind) within the RI-MA WEA (see **Figure 9**). The array will be comprised of 13 Vemco VR2-AR (acoustic release) receivers that were purchased through the INSPIRE Environmental/ACCOL MassCEC project, four VR2-AR receivers previously purchased by Ørsted, and 19 additional VR2-AR receivers that will be purchased by Ørsted specifically for this monitoring activity. The full receiver array will be maintained year-round continuously through at least 2026. This will permit monitoring throughout the pre-construction, construction, and post-construction periods of the Sunrise Wind, Revolution Wind, and South Fork Wind projects. The receivers will also gather valuable pre-construction data at popular recreational fishing grounds within the OCS-A 0500 lease area.

The existing 17 HMS receiver stations established in 2020 (see **Figure 9**) will be retained for the duration of the project, with the Project Team responsible for maintaining the receiver array. An additional 19 receiver stations will be selected in collaboration with cod researchers to optimize monitoring for all species. The total receiver array will include 36 stations throughout the Ørsted/Eversource lease sites. BOEM funding for the cod study is expected to end in 2022; however, the HMS receiver array deployed during this monitoring study will continue to allow for detection of tagged cod, and all detections of tagged cod will be shared with that research team. The receivers will remain in the water year-round throughout the duration of the study.

Vemco model VR2-AR receivers will be rigged using standard procedures outlined by Vemco for benthic deployment5. Ropeless technology (AR Buoys) was selected to minimize risks to marine mammals and other protected species. VR2-ARs will be maintained using a Vemco VR-100 unit that communicates wirelessly to the receivers. Trips to download and maintain the acoustic receivers will be conducted in the spring and fall of each year of the project. During each trip, receivers will be summoned, downloaded, and cleaned of any biofouling. They will be rerigged and redeployed at sea. Receiver deployment and maintenance will be done primarily in collaboration with a local commercial fishing vessel.

2.6.4 Acoustic Telemetry – Sunrise Wind Export Cable

Sunrise Wind will work with researchers at Stony Brook University, Cornell Cooperative Extension, and the Shark Research and Education Program at the South Fork Natural History Museum to conduct a multiyear acoustic telemetry study to assess the potential impacts of the SRWEC on the behavior and migratory patterns of commercially and ecologically important species in coastal waters south of Long Island. The specific objectives associated with this monitoring study are as follows:

1. Implant or attach acoustic transmitters on lobsters, horseshoe crabs, winter skates, smooth dogfish, sandbar sharks, dusky sharks, and sand tiger sharks.
2. Deploy two arrays of acoustic receivers at the nearshore areas of the SRWEC landfall that extend outside of the existing receiver arrays deployed by Stony Brook University at Rockaway, Jones Beach, Fire Island, East Hampton, and Montauk, that are is designed to capture both broad-scale migratory behavior and fine-scale behaviors.
3. Evaluate effects of EMF on behavior and movement on targeted species before, during, and after construction.
4. Estimate movement metrics including depth, two-dimensional position, and residency for telemetered individuals.
5. Maintain the offshore and nearshore Sunrise Wind Receiver Arrays and collect data on the individuals tagged by Stony Brook University and partnering organizations along the east coast.

The study will commence in 2022, and continue through 2027, encompassing all three phases of cable installation (before, during, and after installation). The receiver array will be deployed in the spring or summer of 2022, and dedicated tagging trips would commence shortly after the receiver array has been deployed.

Capture and tagging of study animals will occur from a variety of vessels and projects. The expertise of the South Fork Natural History Museum Shark Group will assist in capturing and tagging elasmobranchs. For sampling methods associated with the export cable acoustic telemetry study, hook and line is used to tag sharks, smooth dogfish, and winter skate. Horseshoe crabs are being collected either on beaches during spawning, or by pound nets in shallow water embayments (e.g., Moriches, Great South Bay or Shinnecock Bays), and lobsters will be collected in coordination with local lobster fisherman from their existing traps. In addition, if necessary, hook and line will be used from Stony Brook University vessels to capture elasmobranchs for tagging. The Principal Investigators will attain all required research and scientific collection permits prior to commencing the tagging efforts. Because capture and tagging of animals will be permitted separately, they are not analyzed as part of the Proposed Action.

Positional monitoring of tagged individuals will be accomplished using two arrays of acoustic receivers to evaluate both broad-scale migratory behavior as well as fine-scale movements near the SRWEC The offshore receiver array will include three linear gates of receivers (offshore north approach, offshore south approach, and SRWEC gate). The nearshore fine-scale positional array will be used to evaluate movement around the SRWEC with high spatial resolution. Temperature (mean, min, max) will be recorded every three hours on all VR2AR-X receivers providing information to evaluate environmental drivers of the presence/absence of telemetered individuals in the study area. Sunrise Wind and Revolution Wind have funded the purchase of 19 VR2-AR telemetry receivers to complement the existing 13 receivers purchased through the INSPIRE/ACCOL MassCEC project, bringing the HMS receiver array to a total of 32 receivers in Lease Areas -0486, -0487, 0517, and -0500. All 32 receivers are deployed, as of May 2022. Sunrise Wind is also funding the deployment of 75 acoustic transmitters (in addition to the 75 transmitters funded by Revolution Wind) to be deployed from 2023 to 2025 (target of 50 total transmitter releases per year).

The offshore receiver array will provide the ability to track movement as telemetered individuals enter the approach field, pass over the cable area, and exit the approach region. The receiver array was designed to collect data that will provide for robust statistical analysis of the potential impacts of EMF on movement metrics. The north and south approach gates of receivers are designed to capture telemetered individual’s movement toward the SRWEC prior to any potential exposure to introduced EMF, while the gate of receivers along the SRWEC provides coverage near the cable and the ability to capture any alterations to movement behavior due to exposure to EMF. The design provides a quasi-controlled field-experiment system where the approach gates provide movement and behavior metrics independent of potential EMF impacts, while the SRWEC gate is adjacent to the cable and can capture local changes in behavior. In the offshore receiver array each linear gate will include 10 VR2AR-X acoustic release omnidirectional hydrophones (receivers) that can detect a telemetered individual from a radius of 500 to 1,000 m depending on sea conditions and transmitter strength. The receivers in the three linear gates will be placed approximately 1 km apart.

The near-shore fine-scale positioning array will provide high-resolution information on the two-dimensional or three-dimensional movements (depending on the type of transmitter) of individuals in the vicinity of the SRWEC. The receivers in the nearshore fine-scale positional array are planned to be spaced approximately 400 m apart, but the exact receiver spacing will be informed by range testing performed by the research team at a nearby location. The VR2AR-X receivers are equipped with built-in transmitters to sync with adjacent receivers (Vemco Positioning System), enabling the two-dimensional position of tagged individuals to be evaluated with high precision. Additionally, telemetered elasmobranchs tagged with V16TP transmitters can be positioned in three dimensions (latitude, longitude, and depth) within the fine-scale positioning array.

The VR2AR-X receivers are equipped with acoustic release mechanisms that allow instrument retrieval without the need for surface buoys and vertical lines in the water column. Ropeless technology (Acoustic Release Buoys) was selected to minimize risks to marine mammals and other protected species. The receivers will be deployed approximately 2 m from the benthos, and two small floats keep the receiver oriented vertically in the water column to maximize the detection radius. Retrieval is performed with wireless communication from a VR100 aboard the vessel that triggers the release, using a push-off titanium pin and an attached floatation buoy to bring the released receiver to the surface.

The entire receiver array will be downloaded twice per year, during which time the receivers will be cleaned of any biofouling, and the batteries will be replaced as needed. The receivers will be rigged inside a pop-up canister (Mooring Systems Inc.) to enable moorings to be retrieved during download trips. Downloading the receiver arrays twice per year will help to mitigate receiver loss and will also promote a greater probability of data integrity and allow any lost receivers to be replaced with no more than a 6-month gap in data at any one location. The potential for receiver losses will also be mitigated by deploying the receiver arrays strategically in areas with limited mobile gear fishing effort.

2.6.5 Benthic Monitoring/Video Surveys

High resolution video and still images will be acquired at targeted hard bottom areas and turbine foundations with a compact ROV comparable to a Seatronics Valor ROV (https://geo-matching.com/rovs-remotely-operated-underwater-vehicles/valor). The positioning components of the ROV would include a surface differential positioning system, an Ultra Short Baseline, as well as ROV-mounted motion and depth sensors. The Ultra Short Baseline transceiver will communicate with geophysical beacons mounted onto the ROV allowing for the vehicle's depth and angle in relation to the transceiver to be known. Adding in the motion and depth sensors on the ROV, all this information will be connected into the ROV navigation software simultaneously tracking both the vessel's position and the ROV's position accurately.

In addition to accurate ROV positioning components, the vehicle will be equipped with powerful thrusters in both horizontal and vertical directions, creating confidence for operating in areas with higher currents. The vehicle will also be equipped with several pilot aids including, auto heading, auto depth, and auto hover. Using these tools, the ROV cameras can focus on any specifically selected habitat features during the survey allowing for better visual observations by scientists.

The ROV will supply live video feed to the surface using high-definition video and ultra-high definition still cameras. One pair of cameras will be downward facing to observe and capture high resolution images of seafloor surface conditions while another pair will face forward to collect data on vertical surfaces and avoid collisions. High lumen light-emitting diode lights will be mounted onto the ROV frame to increase visibility and aid in species identification. With sufficient lighting the images transferred to the surface will be clear, allowing for real time observations and adaptive sampling. The recorded video will be transferred to the surface through the ROV's umbilical and recorded using a Digital SubSea Edge digital video recorder video inspection system (or equivalent). The system will provide simultaneous recording of both high-definition cameras as well as the ability to add specific transect data overlays during operations. The data overlay will include ROV position, heading, depth, date and time as well as field observations.

2.6.6 Passive Acoustic Monitoring

Moored PAM systems or mobile PAM platforms such as towed PAM, autonomous surface vehicles (ASVs), or autonomous underwater vehicles (AUVs) 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.

2.6.7 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. Measures are proposed for further consultation between BOEM and NMFS (**Tables 14** and **15**). 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 issued by NMFS may be addressed through mitigation proposed by BOEM. Mitigation measures to which the Applicant commits as part of the MMPA process, as may be amended through the NMFS LOA process, are anticipated to be required by NMFS in the ITS for listed marine mammals. 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.

Table 14. Mitigation and monitoring conditions during construction in the National Marine Fisheries Service proposed rule under the Marine Mammal Protection Act.

Measure	Purpose
Noise attenuation through use of a noise mitigation system (Impact Pile Driving)	Reduce the area affected by noise and minimize or avoid impacts to marine mammals.
PSO training and equipment requirements	Increase the effectiveness of PSOs to implement certain mitigations and minimize or avoid impacts to marine mammals.
Visual monitoring; including low visibility monitoring tools during pile driving (Impact Pile Driving)	Increase the effectiveness of PSOs to implement certain mitigations and minimize or avoid impacts to marine mammals.
Passive acoustic monitoring during pile driving (Impact Pile Driving)	Increase the effectiveness of PSOs to implement certain mitigations and minimize or avoid impacts to marine mammals.
Establishment and monitoring of shutdown zones (Impact Pile Driving)	Increase the effectiveness of PSOs to implement certain mitigations and minimize or avoid impacts to marine mammals.
Shutdown Procedures (Impact Pile Driving)	Implement mitigations to minimize or avoid impacts to marine mammals when they are detected.
Pre-start clearance and post-activity monitoring (Impact Pile Driving)	Implement mitigations to minimize or avoid impacts to marine mammals when they are detected.
Acoustic Monitoring (Impact Pile Driving)	Implement mitigations to minimize or avoid impacts to marine mammals when they are detected.
Pre-Start Clearance (Impact Pile Driving)	Implement mitigations to minimize or avoid impacts to marine mammals when they are detected.
Pile Driving Shutdown Zones (Impact Pile Driving)	Implement mitigations to minimize or avoid impacts to marine mammals when they are detected within specified Shutdown Zones.
Soft Start (Impact Pile Driving)	Slowly increase noise levels to provide an opportunity for animals to leave the area before full pile driver power is achieved. Implement mitigations to minimize or avoid impacts to marine mammals when they are detected during soft starts.
Sound source measurements	Monitoring of the effectiveness of the predicted shutdown zones to minimize or avoid impacts to marine mammals
Marine Mammal Separation Distances and SMA Compliance	Avoid striking marine mammals
North Atlantic Right Whale Situational Awareness	Avoid striking marine mammals
Vessel Strike Avoidance	Avoid striking marine mammals
Adaptive Vessel Speed Plan	Avoid striking marine mammals by implementing speed restrictions when whales are detected.
Passive Acoustic Monitoring Network to Support Speed Restrictions Outside of SMAs.	Avoid striking marine mammals by implementing speed restrictions when whales are detected.
Data recording	Information collected to report on the effectiveness of mitigation to avoid or minimize effects to marine mammals.
Reporting	Reporting on the effectiveness of mitigation to avoid or minimize effects to marine

Measure	Purpose
Monitoring Equipment	Minimize impact pile driving effects
Visual Monitoring	Minimize impact pile driving effects
Daytime Visual Monitoring	Minimize impact pile driving effects
Daytime Visual Monitoring During Periods of Low Visibility	Minimize impact pile driving effects
Nighttime Pile Driving	Minimize impact pile driving effects
Acoustic Monitoring	Minimize impact pile driving effects
Shutdown Zones	Minimize impact pile driving effects
Pre-Start Clearance	Minimize impact pile driving effects
Soft Start	Minimize impact pile driving effects
Shutdowns	Ensure that modeled isopleths used to establish clearance and shutdown zones and estimate marine mammal take are accurate
Sound Measurements	Minimize vibratory pile driving effects
Unexploded Ordnance/Munitions and Explosives of Concern Disposal	Minimize pile driving effects
Monitoring and Reporting	Minimize pile driving effects

Notes:

PSO = Protected Species Observer; SMA = Seasonal Management Area

See the full description of the proposed mitigation measures from the National Marine Fisheries Service in the proposed rule letter of authorization under the Marine Mammal Protection Act (February 10, 2023, 88 Federal Register 8996)

Table 15. Bureau of Ocean Energy Management–proposed mitigation, monitoring, and reporting measures for Endangered Species Act–listed species in the Action Area

Measure	Description	Project Phase	Purpose
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
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 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. Sunrise 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 Biological Opinion 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

Measure	Description	Project Phase	Purpose
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	Purpose
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
Pile Driving Monitoring Plan	Pile driving mitigation, monitoring, and reporting condition for sea turtles will be required, such as soft starts, pre-clearance and shutdown zones, and reporting requirements. BOEM will require Sunrise 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. The pile driving plan will include pe-clearance procedures, clearance and shutdown zone distances based on acoustic modeling and ESA consultation requirements, shutdown and restart protocols when sea turtles are sighted, and reporting requirements. Sunrise must obtain BOEM, BSEE, USACE (for pile driving in State waters), and NMFS's 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 Sunrise can execute any pile driving delays or shutdown requirements. If, at any point before or during construction, the PSO coverage that is included by Sunrise 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	Purpose
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 SFVP for review and comment to the 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, 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
Soft Starts for Sea Turtles and Sturgeon	The lessee must implement soft start techniques for pile driving. For impact pile driving, the soft start must include a minimum of 20 minutes of 4-6 strikes/minute at 10-20 percent of the maximum hammer energy. Soft start is required at the beginning of driving a new pile and at any time following the cessation of impact pile driving for 30 minutes or longer.	C	Minimize the risk of adverse noise exposure from pile driving.
Sea Turtle Clearance Zones	The visual clearance zone must be clear of sea turtles for 30 minutes before the activity (e.g., pile driving) can begin. Monitoring must begin 60 minutes before the start of the activity (at least 30 minutes prior to clearance requirements). Any visual detection of sea turtles within the clearance zone during the 30 minutes prior to activity will trigger a delay or repeated in the monitoring of the Clearance Zone. If there is a visual detection of a sea turtle entering or within the clearance zone the lessee must delay the pile driving activities from the time of the observation, until: 1) The lead PSO verifies that the animal(s) voluntarily left and headed away from the clearance zone; or 2) 30 minutes have elapsed without re-detection of the animal(s) by the lead PSO. For ESA-listed whales: refer to Proponent's ITA application, as may be modified by BOEM.	C	Minimize the risk of adverse noise exposure from pile driving

Measure	Description	Project Phase	Purpose
Sea Turtle Shutdown zones	For sea turtles: To ensure that impact pile driving operations are carried out in a way that minimizes the exposure of listed sea turtles to noise that may result in injury, based on the modeling results for each pile type and reasonableness at detection sea turtles. For sea turtles: To ensure that pile driving operations are carried out in a way that minimizes the exposure of listed sea turtles to noise that may result in injury, PSOs will monitor the established 500-m shutdown zone for all pile driving activities (500 m has been used previously required by NMFS). Adherence to this shutdown zone must be reflected in the PSO reports. Upon a visual detection of a sea turtles entering or within the shutdown zone during pile driving, the lessee must shut down the pile driving hammer (unless activities must proceed for human safety or for concerns of structural failure) from when the PSO observes, until: 1) The lead PSO verifies that the animal(s) voluntarily left and headed away from the clearance area; or 2) 30 minutes have elapsed without re-detection of the sea turtle(s) by the lead PSO.	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 Sunrise 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 during any pile driving activities and for 30 minutes following the cessation of pile driving activities.	C	Ensures accurate monitoring of sea turtle take
Nighttime Monitoring Plan for impact pile driving	Sunrise 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. Sunrise 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, Sunrise must follow the shutdown procedures outlined in the Protected Species Mitigation Monitoring Plan. Sunrise must notify BOEM and NMFS of any shutdown occurrence during pile driving operations within 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 in 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	Purpose
Pile Driving PAM Plan	BOEM, BSEE, and USACE will require Sunrise 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); and 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. Sunrise 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, Sunrise may conclude that BOEM has concurred with the PAM Plan.	C, O&M	Ensure the efficacy of PAM placement for appropriate monitoring
Modification of clearance and exclusion zones	BOEM, BSEE, and USACE may reduce, upon request, shutdown zones for ESA-listed sei, fin, or sperm whales based upon sound field verification of a minimum of three 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	Ensure the efficacy of distance in which to implement mitigation for PSO, clearance, and shutdown requirements.
Monthly/annual reporting requirements[a]	Sunrise 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, Sunrise 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, Sunrise 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	Sunrise 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	Purpose
Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	Sunrise must monitor potential loss of fishing gear in the vicinity of WTG foundations by surveying at least ten different WTGs in the project area annually. Survey design and effort may be modified based upon previous survey results after review and concurrence by BOEM. Sunrise must conduct surveys by remotely operated vehicles, divers, or other means to determine the locations and amounts of marine debris. Sunrise 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
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
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	Purpose
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	Purpose
Marine debris awareness and elimination	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 ft (0.5 m), or a sub-bottom anomaly of greater than 1.6 ft (0.5 m) 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).	Pre-C, C, O&M, D	Decrease the loss of marine debris which may represent entanglement and/ or ingestions risk

Measure	Description	Project Phase	Purpose
Marine debris awareness and elimination	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. 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

Measure	Description	Project Phase	Purpose
Look out for sea turtles during vessel operations	a. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, Sunrise 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), Sunrise 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 kt (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 kt 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 kt. 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 kt 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	Purpose
Data Collection BA BMPs	BOEM will ensure that all Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (June 2021) shall be applied to activities associated with the construction, maintenance, and operations of the Sunrise 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.
Minimize vessel interactions with listed species (consistent with 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 kt (18.5 km/hour) 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 m. 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 kt 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
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. Sunrise 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

Measure	Description	Project Phase	Purpose
Vessel Crew and Visual Observer Training Requirements	The Lessee must provide Project-specific training to all vessel crew members, Visual Observers, and Trained Lookouts on the identification of sea turtles and marine mammals, vessel strike avoidance and reporting protocols, and the associated regulations for avoiding vessel collisions with protected species. Reference materials for identifying sea turtles and marine mammals must be available aboard all Project vessels. Confirmation of the training and understanding of the requirements must be documented on a training course log sheet, and the Lessee must provide the log sheets to DOI upon request. The Lessee must communicate to all crew members its expectation for them to report sightings of sea turtles and marine mammals to the designated vessel contacts. The Lessee must communicate the process for reporting sea turtles and marine mammals (including live, entangled, and dead individuals) to the designated vessel contact and all crew members. The Lessee must post the reporting instructions, including communication channels, in highly visible locations aboard all Project vessels.	C, O&M, D	Minimize risk of vessel strike to sea turtles and marine mammals
Vessel Observer Requirements	The Lessee must ensure that vessel operators and crew members maintain a vigilant watch for marine mammals and sea turtles, and reduce vessel speed, alter the vessel's course, or stop the vessel as necessary to avoid striking marine mammals or sea turtles. All vessels transiting to and from the SRWF must have a trained lookout for NARWs on duty at all times, during which the trained lookout must monitor a vessel strike avoidance zone around the vessel. The trained lookout must maintain a vigilant watch at all times a vessel is underway and, when technically feasible, monitor the 500-m Vessel Strike Avoidance Zone for ESA-listed species to maintain minimum separation distances. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) must be available to maintain a vigilant watch at night and in any other low visibility conditions. If a vessel is carrying a trained lookout for the purposes of maintaining watch for NARWs, an additional trained lookout for sea turtles is not required, provided that the trained lookout maintains watch for marine mammals and sea turtles. If the trained lookout is a vessel crew member, the lookout obligations as noted above must be that person's designated role and primary responsibility while the vessel is transiting. Vessel personnel must be provided an Atlantic reference guide to help identify marine mammals and sea turtles that may be encountered. Vessel personnel must also be provided material regarding NARW SMAs, DMAs, visually triggered Slow Zones, sightings information, and reporting. All observations must be recorded per reporting requirements. Outside of active watch duty, members of the monitoring team must check NMFS's NARW sightings for the presence of NARWs in the SRWF. The trained lookout must check the Sea Turtle Sighting Hotline30 before each trip and report any detections of sea turtles in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty that day. For all vessels operating north of the Virginia/North Carolina border, the Lessee must have a trained lookout posted between June 1 and November 30 on all vessel transits during all phases of the Project to observe for sea turtles. For all vessels operating south of the Virginia/North Carolina border, the Lessee must have a trained lookout posted year-round on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout must communicate any sightings in real time to the captain to implement required avoidance measures.	C, O&M, D	Minimize risk of vessel strike to sea turtles and marine mammals
Vessel Communication of Threatened and Endangered Species Sightings	The Lessee must ensure that whenever multiple Project vessels are operating, any visual detections of ESA-listed species (marine mammals and sea turtles) are communicated in near real time to these personnel on the other Project vessels: a third-party PSO, vessel captains, or both.	Pre-C, C, O&M, D	Minimize risk of harm to sea turtles and marine mammals by communicating with other Project Vessels

Measure	Description	Project Phase	Purpose
Vessel Speed Requirements	During construction, vessels of all sizes must operate at 10 kt or less between November 1 and April 30 and while operating port to port and operating in the lease area, along the export cable route, or in the transit area to and from ports in New York, Connecticut, Rhode Island, and Massachusetts. Regardless of vessel size, vessel operators must reduce vessel speed to 10 kt (11.5 miles per hour) or less while operating in any SMA (https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales) or DMA/visually detected Slow Zones. This requirement does not apply when necessary for the safety of the vessel or crew. Any such events must be reported. These speed limits do not apply in areas of Narragansett Bay or Long Island Sound, where the presence of NARWs is not expected. All vessel operators must check for information regarding mandatory or voluntary ship strike avoidance and daily information regarding NARW sighting locations. These media may include, but are not limited to, the following: NOAA weather radio, Coast Guard NAVTEX and Channel 16 broadcasts, Notices to Mariners, Whale Alert app (http://www.whalealert.org/), WhaleMap website (https://whalemap.ocean.dal.ca/), NARW Sighting Advisory System (https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html), or information on active SMAs and Slow Zones. (https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales) The Lessee may only request a waiver from any visually triggered Slow Zone or DMA vessel speed reduction requirements during operations and maintenance by submitting a vessel strike risk reduction plan that details revised measures and an analysis demonstrating that the measure(s) will provide a level of risk reduction at least equivalent to the vessel speed reduction measure(s) proposed for replacement. The plan included with the request must be provided to NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division and BOEM at least 90 days prior to the date scheduled for the activities for which the waiver is requested. The plan must not be implemented unless NMFS and BOEM reach consensus on the appropriateness of the plan. BOEM encourages increased vigilance through voluntary implementation of best management practices to minimize vessel interactions with NARWs, by voluntarily reducing speeds to 10 kt or less when operating within an acoustically triggered slow zone, and, when feasible, by avoiding Slow Zones. Regardless of vessel size, the vessel captain and crew must maintain a vigilant watch for all protected species and slow down, stop their vessel, or alter course, as appropriate, to avoid striking any listed species. The presence of a single individual at the surface may indicate the presence of submerged animals in the vicinity; therefore, precautionary measures should always be exercised upon the sighting of a single individual. If pinnipeds or small delphinids of the genera *Delphinus*, *Lagenorhynchus*, *Stenella*, or *Tursiops* are visually detected approaching the vessel (i.e., to bow ride) or towed equipment, vessel speed reduction, course alteration, and shutdown are not required.	C, O&M, D	Establishes requirement for vessel strike avoidance measures

Measure	Description	Project Phase	Purpose
Vessel Speed Requirements	Vessels underway must not divert their course to approach any protected species. If an ESA-listed whale or large unidentified whale is identified within 1,640 ft (500 m) of the forward path of any vessel (90 degrees port to 90 degrees starboard), the vessel operator must immediately implement strike avoidance measures and steer a course away from the whale at 10 kt (18.5 km/hour) or less until the vessel reaches a 1,640-ft (500-m) separation distance from the whale. If a whale is observed but cannot be confirmed as a species other than a NARW, the vessel operator must assume that it is an NARW and execute the required vessel strike avoidance measures to avoid the animal. Trained lookouts, visual observers, vessel crew, or PSOs must notify the vessel captain of any whale observed or detected within 1,640 ft (500 m) of the survey vessel. Upon notification, the vessel captain must immediately implement vessel strike avoidance procedures to maintain a separation distance of 1,640 ft (500 m) or reduce vessel speed to allow the animal to travel away from the vessel. If an ESA-listed large whale is sighted within 656 ft (200 m) of the forward path of a vessel, the vessel operator must initiate a full stop by reducing speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 1,640 ft (500 m). If stationary, the vessel must not engage engines until the ESA-listed large whale has moved beyond 1,640 ft (500 m).	C, O&M, D	Establishes requirement for vessel strike avoidance measures
Vessel Strike Avoidance of Small Cetaceans and Seals	For small cetaceans and seals, all vessels must maintain a minimum separation distance of 164 ft (50 m) to the maximum extent practicable, except when those animals voluntarily approach the vessel. When marine mammals are sighted while a vessel is underway, the vessel operator must endeavor to avoid violating the 164-ft (50-m) separation distance by attempting to remain parallel to the animal's course and avoiding excessive speed or abrupt changes in vessel direction until the animal has left the area, except when taking such measures would threaten the safety of the vessel or crew. If marine mammals are sighted within the 164-ft separation distance, the vessel operator must reduce vessel speed and shift the engine to neutral, not engaging the engines until animals are beyond 164 ft (50 m) from the vessel.	C, O&M, D	Minimize risk of vessel strike to marine mammals

Measure	Description	Project Phase	Purpose
Vessel Strike Avoidance of Sea Turtles	The Lessee must slow down to 4 kt if a sea turtle is sighted within 328 ft (100 m) of the operating vessel's forward path. The vessel operator must then proceed away from the turtle at a speed of 4 kt or less until there is a separation distance of at least 328 ft (100 m), at which time the vessel may resume normal operations. If a sea turtle is sighted within 164 ft (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 individual at a speed of 4 kt or less until there is a separation distance of at least 328 ft (100 m), at which time normal vessel operations may be resumed. Between June 1 and November 30, all vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., sargassum lines or mats). In the event that operational safety prevents avoidance of such areas, vessels must slow to 4 kt while transiting through such areas. Year-round, vessels operating south of the Virginia/North Carolina border must avoid transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., sargassum lines or mats). In the event that operational safety prevents avoidance of such areas, vessels must slow to 4 kt while transiting through such areas. The only exception to all the above requirements is when the safety of the vessel or crew necessitates deviation from these requirements. If any such incidents occur, they must be reported (see reporting requirements). All vessel crew members must be briefed on the identification of sea turtles and on regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all Project vessels for identification of sea turtles. The expectation and process for reporting of sea turtles (including live, entangled, and dead individuals) must be clearly communicated and posted in highly visible locations aboard all Project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to so report.	C, O&M, D	Minimize risk of vessel strike to sea turtles
Reporting of All NARW Sightings	The Lessee must immediately report all NARWs observed at any time by PSOs or vessel personnel on any Project vessels during any Project-related activity or during vessel transit. Reports must be submitted to BOEM (at renewable_reporting@boem.gov) and BSEE (at OSWSubmittals@bsee.gov); the NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622); the Coast Guard (via telephone at (617) 223-5757 or via Channel 16); and WhaleAlert (http://www.whalealert.org/). The report must include the time, location, and number of animals sighted.		Promotes reporting of NARW

Measure	Description	Project Phase	Purpose
Detected or Impacted Protected Species Reporting	The Lessee is responsible for reporting dead or injured protected species, regardless of whether they were observed during operations or due to Project activities. The Lessee must report any potential take, strikes, dead, or injured protected species caused by Project vessels or sighting of an injured or dead marine mammal or sea turtle, regardless of the cause, to the NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (at nmfs.gar.incidental-take@noaa.gov), NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622), BOEM (at renewable_reporting@boem.gov), and BSEE (at OSWSubmittals@bsee.gov). The Detected or Impacted Protected Species Report must be submitted as soon as practicable but no later than 24 hours from the time the incident took place. Staff responding to the hotline call will provide any instructions for the handling or disposing of any injured or dead protected species by individuals authorized to collect, possess, and transport sea turtles. The Detected or Impacted Protected Species Report must include the following information: • Time, date, and location (latitude and longitude) of the first discovery of the animal or animals and updated location information (if known) and applicable • Species identification (if known) or a description of the animals involved • Condition of the animals (including carcass condition if the animal is dead) • Observed behaviors of the animals, if alive • If available, photographs or video footage of the animals • General circumstances under which the animal or animals were discovered In the event of a vessel strike of a protected species by any survey vessel, the Lessee must immediately report the incident to BOEM (at renewable_reporting@boem.gov) and NMFS (at nmfs.gar.incidental-take@noaa.gov), and the NOAA stranding hotline (866-755-6622). The Protected Species Incident Report must include the following information: • Time, date, and location (latitude and longitude) of the incident Species identification (if known) or description of the animals involved • Lessee and vessel information • Vessel's speed during and leading up to the incident • Vessel's course or heading and what operations were being conducted (if applicable) • Status of all sound sources in use (if applicable) • Description of avoidance measures or requirements in place at the time of the strike and what additional measures were taken, if any, to avoid the strike • Environmental conditions (e.g., wind speed and direction, Beaufort scale, cloud cover, visibility) immediately preceding the strike • Estimated size and length of animal or animals struck • Description of the behavior of the animals immediately preceding and following the strike • Estimated fate of the animal or animals (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared) • To the extent practicable, photographs or video footage of the animals	Pre-C, C, O&M, D	Promotes reporting of impacts to ESA species.
Detected or Impacted Dead Non-ESA-Listed Fish	Any occurrence of at least 10 dead non-ESA-listed fish within established shutdown or monitoring zones must also be reported to BOEM (at renewable_reporting@boem.gov) as soon as practicable (taking into account crew and vessel safety), but no later than 24 hours after the sighting.	Pre-C, C, O&M, D	Promotes proper reporting of impacted non-ESA listed fishes

Notes:

[a] See the South Fork Wind COP approval for the data fields BOEM proposes to require for PSO reports.

AMP = Alternative Mitigation Plan; BA = Biological Assessment; BMP = Best Management Practice; BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; C = construction; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; D = decommissioning; dB re 1 μPa = decibel re 1 micropascal; dB rms = decibel(s) root mean square; DMA = dynamic management area; DOI = Department of the Interior; DPS = distinct population segment; ESA = Endangered Species Act; ft = foot(feet); GARFO = Greater Atlantic Regional Fisheries Office; GPS = global positioning system; HRG = high-resolution geophysical; kHz = kilohertz; km = kilometer(s); kt = knot(s); m = meter(s); NARW = North Atlantic right whale; NEFOP = Northeast Fisheries Observer Program; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; O&M = operations and maintenance; OCS = outer continental shelf; PAM = passive acoustic monitoring; PIT = passive integrated transponder; PRD = Protected Resources Division; PSO = Protected Species Observer; PTS = permanent threshold shift; SFVP = Sound Field Verification Plan; SMA = Seasonal Management Area; SRWF = Sunrise Wind Farm; STDN = Sea Turtle Disentanglement Network; USACE = United States Army Corps of Engineers; USCG = United States Coast Guard; VHF = very high frequency; WTG = wind turbine generator

During the development of the draft BA, and in coordination with cooperating agencies, BOEM considered additional mitigation measures that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this document. These potential additional mitigation measures are described below. Some or all of these BOEM-proposed mitigation measures may be required as a result of consultation completed under Section 7 of the ESA. 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) and may be amended for consistency for all listed species in the final approval. Mitigation imposed through consultations will be included in the final record of decision. The additional mitigation measures presented in **Table 15** 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 description of all proposed mitigation measures evaluated as part of the Proposed Action, including BOEM-proposed measures and measures included in the petition for a Letter of Authorization under the MMPA (87 FR 33470). The conditions for marine mammals proposed in the MMPA application are subject to change according to the requirements of the final LOA issued by NMFS. As they pertain to endangered and threatened marine mammals, the final measures are expected to replace those described below and will be detailed in Appendix H of the Sunrise Wind EIS. The following activities associated with wind farm construction and operation are being considered in the MMPA application: Impact installation of up to 87 WTG monopole foundations at 87 potential locations; impact installation of one OCS–DC jacket foundation; installation and removal of temporary cofferdams or casing pipes with support sheet piles at the cable landfall location using a pneumatic pipe rammer, impact hammer, and vibratory hammer; detonation of UXOs; HRG site characterization surveys; fisheries monitoring surveys; and export cable and IAC trenching, laying, and burial. Vessels will be used to transport crew, supplies, and materials within the Project area to support construction and operation. Sunrise Wind has determined that a subset of these activities (i.e., WTG and OCS–DC foundation installation, installing and removing piles and casing pipes at the cable landfall location, HRG surveys, and UXO detonation) may result in the taking, by permanent threshold shift (PTS) or behavioral harassment of marine mammals, and have requested the authorization of such takings from NMFS under the MMPA.

3.0 ENVIRONMENTAL BASELINE

3.1 PHYSICAL ENVIRONMENT

3.1.1 Seabed and Physical Oceanographic Conditions

3.1.1.1 Seabed Conditions

The seabed in and around the Project Area is defined by the glacial history of the Atlantic continental shelf near Rhode Island and Massachusetts (Sunrise Wind 2022i). It is a transitional region, bordering the northern continental shelf which is more heavily glaciated than the non-glaciated southern regions. This glacial history has resulted in the formation of glacial moraines, which are material deposited by the glacial formation and movement (Sunrise Wind 2022i). There are glacial drift deposits in the northern areas of the Project Area, deposited by the Laurentide continental ice sheet which terminated north of the Project Area, while in the south, below the terminal points of the moraines, drift sediments are deposited with layers of sand, gravel, and mud (Sunrise Wind 2022i).

The barrier islands of Long Island were formed in part by the shifts in these deposits due to rising sea levels and changes in shorelines (Sunrise Wind 2022i). These sand drifts have a thickness between 6.5 to 16.4 ft (2 to 6 m) with finer grained sediments below (Sunrise Wind 2022i). The Project Area is located south of a terminal glacial moraine, which results in the likely presence of boulders due to glacial transport (Sunrise Wind 2022i).

In a sediment profile and plan view imaging survey (SPI/PV) conducted in 2019, the primary sediment in the region was mud and sand with minimal rippling in the seabed and fine grain sizes in the southeast, west central, and eastern portions of the Project Area (Sunrise Wind 2022i). Pebbles and boulders were found in the northwest and north-central borders of the Project Area (Sunrise Wind 2022i). The seabed morphology in the Project Area is comprised of a gentle slope, angled north to south, with an average gradient of < 0.1 degrees (0.15%) (Sunrise Wind 2022i). This angle increases in the boulder fields with a gradient that can exceed 5 degrees (Sunrise Wind 2022i).

Regarding the export cable route, a sediment profile and plan view imaging study found that route is primarily comprised of fine to coarse sand with small gravels; however, it also found two distinct sedimentary regions: the western area, beginning from the NYS waters boundary to where the planned cable corridor bends northeast, and the eastern portion which is the remaining area along the planned export cable route (Sunrise Wind 2022i). The western area was comprised of sand and mud with the presence of ripples and fine sand grains, while the eastern area showed sand and mud without ripples and a limited presence of bedforms (Sunrise Wind 2022i). Areas with ripples are subject to a higher degree of energy and movement and result in variation of benthic communities, which was evidenced by the western portion of the planned export cable route showing high densities of sand dollars and presence of mobile epifauna while sea stars, cerianthids (burrowing anemone), mobile crustaceans, tube-building amphipods and polychaetes, and deep-burrowing polychaetes were present in the eastern portion of the planned export cable route (Sunrise Wind 2022i).

At the proposed landfall area, Fire Island is a 31-mi- (50-km-) long barrier island which is part of the greater system of barrier islands that runs along Long Island's nearshore areas (Sunrise Wind 2022i). While the offshore portions of the Project Area are defined by shore-face attached sand ridges that migrate in a southwestward direction, the proposed landfall area has smaller sorted bedforms that show active erosion of the glacial drift units (Sunrise Wind 2022i). The system of Long Island's barrier islands is nourished by sediment from the erosion of Montauk Point, but their shoreward sides shift often, influenced by seasonal weather, waves, and tidal action (Sunrise Wind 2022i). For the export cable route, the maximum water depth is 223 ft (68 m) in federal waters and 95 ft (29 m) in state waters (Sunrise Wind 2022i).

Benthic habitats with a combination of hard and softbottom substrate, such those found within the Project Area, are associated invertebrate communities that are important sources of refuge, food, and spawning sites for fish and shellfish and aid in nutrient and carbon cycling while improving water quality (Sunrise Wind 2022i). There is little seasonal variation within the benthic communities of the Atlantic OCS; however, some studies have observed a peak in biomass in the spring and summer though this observation is disputed by studies that do not show seasonal variation (Sunrise Wind 2022i). Benthic invertebrate assemblages in the Northwest Atlantic OCS found in soft sediment environments include emergent infauna (e.g., burrowing anemones (cerianthids), tube-building polychaetes, and tube-building amphipods) and are suitable for shellfish, such as the Atlantic sea scallop (*Placopecten magellanicus*), Jonah crab (*Cancer borealis*), Atlantic rock crab (*Cancer irroratus*), channeled whelk (*Busycotypus canaliculatus)*, ocean quahog clam (*Arctica islandica*), Atlantic surf clam (*Spisula soliddissima)*, and horseshoe crab (*Limulus polyphemus*) (Sunrise Wind 2022i). In comparison, areas with hard bottom substrates have a large presence of "encrusting" epifauna such as bryozoa, hydroids, tunicates, and sponges forming a complex habitat that supports species such as Atlantic cod (*Gadus morhua*), longfin squid (*Doryteuthis pealeii*), and American lobster (*Homarus americanus*) (Sunrise Wind 2022i). Additionally, the rocky substrate can provide sheltered nursery habitat as well as feeding grounds for a variety of species.

Submerged aquatic vegetation (SAV) is present in the shallow areas of the bays north of Fire Island where the landfall region is planned (Sunrise Wind 2022i). The beds of SAV include both eel grass (*Zostera marina*) and Widgeon grass (*Ruppia maritima*). The depth of the greater Project Area precludes the presence of SAV offshore.

3.1.1.2 Oceanographic Conditions

Based on an assessment of ocean current information from 2001 to 2010, the average surface current speeds were estimated at 8 inches per second (in./s; 20 centimeters per second [cm/s]) though the strongest currents were 20 in./s (50 cm/s) in late fall and early spring (Sunrise Wind 2022i). At depths of 147.6 ft (45 m), the current speeds were found to average 2.6 in./s (6.6 cm/s), showing strongest currents occurring near or at the water surface while currents weaken with depth. Additionally, the directionality of currents also changed with depth with eastern and western directed currents at the surface and western directed currents between 66 and 131 ft (20 and 40 m) (Sunrise Wind 2022i). The depths of the Project Area range from between 115 and 203 ft (35 and 62 m) at mean lower low water (Sunrise Wind 2022i).

The salinity in the water of the Project Area shows seasonal variance, increasing in summer and fall and causing a seasonal stratification of the water column which is disrupted by mixing in the later fall due to upwelling, storms, and increased wind speeds (Sunrise Wind 2022i). Water temperatures align with the salinity measures, with surface water temperatures fluctuating between 68°F (15°C) during the summer and 39°F (4°C) in the winter, while bottom water temperatures have a narrower fluctuation between 41°F (5°C) and 50°F (10°C) (Sunrise Wind 2022i). This seasonal stratification is part of a broader seasonal function within the Mid-Atlantic known as the “cold pool” where a large body of cold water is beneath a mass of warm water with a seasonal stratification that is strongest in summer and weakest in winter (Chen et al. 2018). This stratification, paired with seasonal upwelling, is a key source of nutrients that supports the region’s primary productivity (Lentz 2017).

Wave movement in the area is generally directed from the south and has an average height between 3.3 to 9.8 ft (1 to 3 m) while storm waves can reach as high as 30 ft (9 m). This wave action causes little disturbance to the bottom waters and sediments and experiences tidal floods twice daily from the southeast. The average tidal amplitude is 3.2 ft (1.0 m); however, due to sea level rise resulting from climate change, the water levels are projected to rise by 3.3 to 4.6 in. (84.25 to 117.95 millimeters) (Sunrise Wind 2022i). In the Project Area, the water depth can vary between 115 to 203 ft (35 to 62 m) mean lower low water, while the average depth of currents is 147.6 ft (45 m) (Sunrise Wind 2022i).

3.1.1.3 Water Quality

There is limited water quality data for the Project Area and planned offshore export cable routes; however, there is water quality data from the adjacent offshore waters of Rhode Island as well as federal surveys of the water quality within the broader Mid-Atlantic Bight (Sunrise Wind 2022i). Due to the distance from shore and lack of direct point sources for pollution within the area, the greatest degradation of water quality is likely to be from nonpoint sources including pollution from agricultural and urban runoff, construction, and airborne pollutants (Sunrise Wind 2022i). Turbidity (i.e., the amount of suspended particulates in the water leading to a cloudy or hazy appearance) is likely to be the water quality variable most influenced by the Proposed Action and is measured as total suspended sediment and is known to decrease in deeper waters. Regional surveys in the Rhode Island Sound found a total suspended sediment range of 01 to 7.4 milligrams per liter (Sunrise Wind 2022i).

3.1.2 Electromagnetic Fields

EMFs are generated by and propagated within the ambient environment and driven by the movement of saltwater, which is naturally conductive. Magnetic fields are naturally created by the earth. These are relatively weak currents though they can be increased or diminished based on ocean conditions, solar events, electrical storms, and variables in the magnetic field. For the buried export cables, it is estimated that the change in EMF currents would peak at 4.6 milligauss (mG) and 0.09 millivolts/meter (mV/m) when positioned right above them with a rapid decrease to 0.1 milligrams and <0.01 mV/m at approximately 10 ft (3 m) away from the cables horizontally and an overall change in the Earth’s geomagnetic field of +104 mG (based on an ocean current of 2 ft/sec [0.6 m/s] of 0.37 mV/m) with induced electric fields (Sunrise Wind 2022i).

Within the region, there are existing submarine cables that are laid on or buried within the seafloor and run through the area, transmitting communications or power with most concentrated along Long Island, New York and Green Hill, Rhode Island (Sunrise Wind 2022i).

3.1.3 Anthropogenic Conditions

3.1.3.1 Artificial Light

While there are more substantive land- and water-based sources of artificial light directly off the shoreline of Long Island, New York, the open waters of the Project Area are unlikely to currently have artificial light sources aside from transiting vessels, buoys, and their associated safety lights.

3.1.3.2 Vessel Traffic

There are two traffic separation schemes present within the Project Area: the Narragansett Bay Traffic Separation Scheme and the Buzzard Bay Traffic Separation Scheme (Sunrise Wind 2022i). They move in opposite directions, with the Buzzard Bay Traffic allowing for traffic to transit from the southwest to the northeast while the Narragansett Bay Traffic Separation Scheme moves from north to south with a precautionary region of 5.4 NM (10 km) that joins them located to the east of Block Island (Sunrise Wind 2022i). Both are typically comprised of differing vessels, with tugs and other service vessels following the coastal Buzzard Bay Traffic Separation Scheme, and only a few crossing into the borders of the Wind Farm Assessment Area, while passenger vessels follow the Narragansett Bay Traffic Separation Scheme (and comprise the majority of the vessel traffic in the area), and fishing vessels are most densely congregated near the coastline (Sunrise Wind 2022i). By examining cross sections of these major marine routes, it was estimated that most cross sections have less than 10 transits per day (3,650 transits per year). The cross sections near the entrance of Narragansett Bay through East Passage and Point Judith have higher transit counts of 36 per day (totaling 13,000 transits per year); however, these are both more than 20 NM (37 km) away from the Project Area (Sunrise Wind 2022i).

3.1.3.3 Underwater Noise

Current sources of underwater noise within the general noise ambient environment are wave action, wind, vocalizing cetaceans, and other organisms, while anthropogenic noise can be caused by vessel traffic. Current ambient noise levels have not been collected within the Project Area, and previous acoustic surveys have been directed towards species identification. Surveys conducted at water depths between 98 to 197 ft (30 to 60 m) in the adjacent RI-MA WEAs resulted in ambient noise in the frequency band between 70.8 to 224 hertz (Hz) with decibel levels primarily between 96 dB and 103 dB for the majority of the time (Kraus et al. 2016b).

3.2 CLIMATE CHANGE CONSIDERATIONS

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer. The impacts of these changes have wide ranging implications for the natural and human environment and can vary greatly around along the Atlantic coast. CEQ guidance describes how federal agencies should consider the effects of greenhouse gas emissions and climate change in their NEPA reviews. CEQ recommends that

- agencies consider both the potential effects of a Proposed Action on climate change, as indicated by estimated greenhouse gas emissions, and the implications of climate change for the environmental effects of the Proposed Action;
- extent of the analyses should be proportional to the projected greenhouse gas emissions and climate impacts; and
- analyses employ appropriate quantitative or qualitative analytical methods to ensure useful information is available to inform the public and the decision-making process in distinguishing between alternatives and mitigation.

BOEM addresses climate change in the description of the affected environment. The current and expected future state of the environment without the Proposed Action represents the reasonably foreseeable affected environment that should be described based on available climate change information, including observations, interpretative assessments, predictive modeling, scenarios, traditional ecological knowledge, and other empirical evidence. The descriptions of the affected environment for each resource in Chapter 3 provide the basis for comparing the current and future state of the environment should the Proposed Action or any of its reasonable alternatives proceed.

BOEM’s impact analysis acknowledges the potential net benefit renewable energy development actions could have on climate change. For example, as renewable energy expands, it has the potential to reduce and/or replace traditional electricity sources, such as coal-fired power plants, that emit greenhouse gases.

Climate change can increase the vulnerability of a resource, ecosystem, or human community, which could then be more susceptible to climate change effects and other effects, and result in a Proposed Action’s effects being more environmentally damaging. BOEM considers these factors in the cumulative analysis. This is especially important for Proposed Actions that are long-term or located in areas that are considered vulnerable to specific effects of climate change, such as ecological change.

Climate change can also affect the operating environment in such ways as to change the requirements for the proposed activities. For example, one potential effect of climate change may be increased intensity of hurricanes along the Atlantic coast and proposed WTGs would need to be designed to withstand these greater wind strengths.

Global climate change is an ongoing risk to marine mammals although the associated impact mechanisms are complex, not fully understood, and difficult to predict with certainty. Possible impacts to marine mammals include increased storm severity and frequency, increased erosion and sediment deposition, disease frequency, ocean acidification, and altered habitat, ecology, and migration patterns (Albouy et al. 2020; Record 2019). Over time, climate change and coastal development would alter existing habitats, rendering some areas unsuitable for certain species and more suitable for others. The extent of these impacts is unknown; however, it is likely that marine mammal populations will be affected by the repercussions of climate change. The current impacts from climate change are likely to result in long-term consequences that are detectable and measurable.

Global climate change is an ongoing potential risk to sea turtles, although the associated impact mechanisms are complex, not fully understood, and difficult to predict with certainty, especially considering potential interactions with other impact-producing factors (IPFs). Possible impacts to sea turtles due to climate change include increased storm severity and frequency; increased erosion and sediment deposition; disease frequency; ocean acidification; and altered habitat, prey availability, ecology, and migration patterns (Hawkes et al. 2009). The potential implications of these factors and other related environmental changes for sea turtles, and the ways in which they are likely to interact with the effects of regional offshore wind development, are complex and uncertain. Increasing ocean temperatures are already having a quantifiable impact on ecological processes that affect sea turtles (NEFSC and SEFSC 2021). Evidence shows a northward shift in the distribution of certain species based on water temperature (McMahon and Hays 2006; NEFSC and SEFSC 2021), and future warming could result in a higher interaction between sea turtles and offshore wind farms, potentially magnifying the impacts and benefits. Over time, climate change, in combination with coastal and offshore development, would alter existing habitats, potentially rendering some areas unsuitable for certain species and more suitable for others. All sea turtle populations likely to be impacted by future offshore wind projects are stable or increasing.

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

Future trends for climate change predict that fish, invertebrates, and EFH may experience adverse effects going forward. Several factors of climate change impact the world's oceans including increasing water temperatures, ocean acidification, and changing weather patterns. These factors are causing a shift in the distribution of many important fish species toward cooler or deeper waters. These changes can and would have significant impacts on not only the commercial and recreational fishing industry, but on the health of fish stocks in the North Atlantic (Sumaila et al. 2020). Ocean acidification is another process being accelerated by climate change that is causing the oceans to become more acidic as more Carbon Dioxide enters the atmosphere. This increased acidity can have adverse effects on invertebrate groups that rely on calcareous shells to thrive, as well as fish that utilize reef systems for protection and habitat (Espinel-Velasco et al. 2018). The trends surrounding climate change are anticipated to continue and intensify in the future.

3.3 Description of Critical Habitat in the Action Area

There is no critical habitat designated for ESA-listed marine mammals, sea turtles, or fish that overlaps the proposed Project Area. In this section, we describe the reasoning for determining that the Proposed Action will have no effect on critical habitats designated outside of the proposed Project Area but within the Action Area.

3.3.1 Critical Habitat Designated for the North Atlantic Right Whale

Critical habitat is designated in North Atlantic right whale foraging areas (Unit 1) in the Gulf of Maine and Georges Bank region and calving areas (Unit 2) in nearshore and offshore waters of the southeastern United States from Cape Fear, North Carolina, south to approximately 27 NM below Cape Canaveral, Florida (NMFS 2016a). Right whale occurrence is concentrated in these areas in February through June and November through March, respectively (Hamilton and Mayo 1990; Kenney et al. 1995; Nichols et al. 2008; Winn et al. 1986). The closest potential port facilities supporting the Project are in New Bedford, Massachusetts, and Norfolk, Virginia (Table 3.3.10, Sunrise Wind 2022i). Both of these locations are outside of critical habitat units 1 and 2, and the proposed vessel routes between all potential ports and the Project Area do not overlap with or come close to these critical habitat units (Figures 1 and 2, Section 4.1.5, Sunrise Wind 2021b). Therefore, we determine that the Proposed Action would not affect North Atlantic right whale critical habitat.

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

Critical habitat was designated for the Northwest Atlantic Ocean Distinct Population Segment (DPS) of loggerhead sea turtle in 79 FR 39856 on July 10, 2014. Designated marine critical habitat for the DPS consists of 38 occupied marine areas, including some nearshore reproductive areas directly offshore of nesting beaches from North Carolina through Mississippi, winter habitat in North Carolina, breeding habitat in Florida, constricted migratory corridors in North Carolina and Florida, and *Sargassum* habitat in the western Gulf of Mexico and in U.S. waters within the Gulf Stream in the Atlantic Ocean (NMFS 2014a). The proposed vessel routes between all potential ports and the Project Area do not overlap with or come close to these critical habitat units (Figures 1 and 2, Section 4.1.5, Sunrise Wind 2021b). Therefore, we determine that the Proposed Action would not affect critical habitat for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle.

3.3.3 Critical Habitat Designated for the New York Bight Distinct Population Segment of Atlantic Sturgeon

Five DPSs of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are listed under the ESA: Chesapeake Bay (endangered), Carolina (endangered), New York Bight (NYB) (endangered), South Atlantic (endangered), and Gulf of Maine (threatened) (NMFS 2012a; NMFS 2012b). Critical habitat has been designated for all five DPSs of Atlantic sturgeon and includes 31 units within rivers from Maine to Florida (NMFS 2017a). None of the critical habitat units extend into the marine environment. The Action Area includes the transit routes for project vessels moving between the Project Area and ports. In relation to the critical habitat units, port facilities supporting this project that overlap with critical habitat include the Paulsboro Marine Terminal in Paulsboro, New Jersey, on the Delaware River (New York Bight DPS Unit 4 Delaware River) and the Port of Albany-Rensselaer on the Hudson River (New York Bight DPS Unit 3 Hudson River) (Table 3.3.10, Sunrise Wind 2022i). No other proposed ports overlap with Atlantic sturgeon critical habitat, and only critical habitat designated for the NYB DPS falls within the Action Area (NMFS 2017a).

The physical features (PFs) essential for the conservation of Atlantic sturgeon belonging to the New York Bight DPS are those habitat components that support successful reproduction and recruitment. Those are

- PF 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, refuge, growth, and development of early life stages;
- PF 2. Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
- PF 3. Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear) between the river mouth and spawning sites necessary to support: Unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river; and
- PF 4. Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: Spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment (e.g., 13°C to 26°C for spawning habitat and no more than 30°C for juvenile rearing habitat, and 6 milligrams per liter or greater dissolved oxygen for juvenile rearing habitat).

The only project activity that may affect the designated habitat for the NYB DPS is the transit of project vessels between the Paulsboro Marine Terminal, Port of New York, Port of Coeymans, and the Port of Albany and the Project Area. The essential features of this critical habitat either do not occur in the Action Area or would not be affected by Project vessels:

- Physical or Biological Feature (PBF) 1. Hard bottom substrate suitable for spawning generally occurs upstream of the fall line within a river, and both ports occur downstream of the fall line and along routinely dredged shipping channels. Project vessels will not have any effect on hard bottom substrates because no anchoring or spudding in riverine habitat is anticipated and therefore will have no effect on PBF 1.
- PBF 2. Vessels will transit portions of both critical habitat units where the salinity gradient changes from saline/brackish to freshwater. Project vessels will not have any effect on temperature, salinity, or dissolved oxygen and therefore will have no effect on PBF 2.

- PBF 3. Vessels will transit portions of both critical habitat units that provide migratory passage between the river mouth and spawning areas; however, vessels will have no effect on bottom depth and will not create any physical barrier to passage through these areas for any life stage of Atlantic sturgeon and will have no effect on PBF 3.
- PBF 4. Vessels will transit portions of both critical habitat units that provide dissolved oxygen and salinity values and appropriate water temperatures that support all life stages of Atlantic sturgeon that may be present. Vessel traffic will not have any effect on dissolved oxygen, salinity, or water temperature and will have no effect on PBF 4.

Based on this information, the Proposed Action would not affect the PBFs and would have no effect on the critical habitat units designated for the NYB DPS.

3.4 Description of Endangered Species Act–Listed Species in the Action Area

3.4.1 Species Considered but Discounted from Further Analysis

3.4.1.1 Hawksbill Sea Turtle

Although occasional occurrences are possible, hawksbill sea turtles (*Eretmochelys imbricata*), which are endangered under the ESA, are not expected to occur in the Action Area and are not considered further in this BA. This species primarily occurs in warmer southern waters associated with coral reef habitats (NMFS and USFWS Diez et al. 2003; 1993) and is exceedingly rare north of Florida (GARFO 2021; Keinath et al. 1991; Lee and Palmer 1981; Parker 1995; Plotkin 1995; USFWS 2001). In Kenney and Vigness-Raposa (2010) assessment of sea turtles present in southern New England, the hawksbill turtle is considered a hypothetical species in this region based on the relatively few stranding records in Massachusetts and New York (Lazell 1980; Morreale et al. 1992; Prescott 2000; Zarriello and Steadman 1987). In addition, no hawksbill turtles have been sighted off the northeastern United States during recent AMAPPS surveys (e.g., NEFSC and SEFSC 2018; NEFSC and SEFSC 2020; NEFSC and SEFSC 2021), RI-MA WEA surveys (Kraus et al. 2016b; O'Brien et al. 2021a; Quintana et al. 2019; Stone et al. 2017), or Project-specific geophysical surveys (Gardline 2021a; 2021b; Smultea Sciences 2020a; 2020b).

3.4.1.2 Fish

Five ESA-listed fish species may occur in the Action Area: Atlantic salmon (*Salmo salar*), shortnose sturgeon (*Acipenser brevirostrum*), giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus longimanus*), and Atlantic sturgeon.

Atlantic Salmon

The endangered Gulf of Maine DPS of Atlantic salmon does not occur in the Action Area. Smolts leave Maine rivers in the spring and migrate to Newfoundland and Labrador where they spend their first winter at sea (NMFS and USFWS 2005). Some then return to Maine, but the majority spend a second year at sea, feeding off Greenland. After this second winter in the Labrador Sea, most Maine salmon return to rivers in Maine to spawn (NMFS and USFWS 2005). The project vessel transit routes are anticipated to occur between the project area and ports from Virginia to southern Massachusetts and do not overlap with these areas. It is noted that even if Atlantic salmon presence overlapped with vessel transit routes, vessel strikes are not an identified threat to the species (74 FR 29344) or their recovery (USFWS and NMFS 2019). Therefore, Atlantic salmon are not expected to be exposed to impacts of the Project and are not considered further in this BA.

Shortnose Sturgeon

The endangered shortnose sturgeon inhabits river systems from Saint John River, New Brunswick, Canada to St. Johns River, Florida (NMFS 1998). Populations are mostly confined to natal rivers and estuarine habitats with occasional movement short distances to the mouths of estuaries and the nearby coastal waters (NMFS 1998). Inter-riverine movements may be relatively common in some areas, such as rivers in

Maine or the Southeast United States (SSSRT 2010). Within the Mid-Atlantic region, shortnose sturgeon are found in the Delaware River, Hudson River, their estuaries, and Chesapeake Bay (NMFS 2022b). Project vessels may transit to or from the Port of Albany-Rensselaer (Hudson River, river kilometer 230), the Port of Norfolk (Virginia) and Sparrows Point (Maryland) on Chesapeake Bay, and Paulsboro Marine Terminal in Paulsboro, New Jersey (Delaware River, approximately river kilometer 139). Movement of shortnose sturgeon between rivers is rare, and their presence in the marine environment is uncommon (BOEM 2021a); therefore, the species is not expected to be found in the offshore portion of the Project Area and is unlikely to be found in the estuaries of the offshore export cable corridors (NMFS 2022b). No coastal migrations in this region are documented, and if they did occur, we assume that the sturgeon would remain in coastal waters inshore of the Project Area. The Action Area overlaps with the distribution of shortnose sturgeons in the Hudson and Delaware Rivers and Chesapeake Bay. The only activity that will occur in the Project Area where it overlaps with shortnose sturgeon distribution will be vessel traffic.

The range of shortnose sturgeon extends upstream in the Hudson River to the Federal Dam at Troy. This species occurs in the navigation channel upstream to Albany, and their distribution overlaps with the route of the steel transport vessels that transit upstream to Coeymans. A total of 94 round trips are currently anticipated between the project and Coeymans over the 2-year construction period (188 one-way trips). No additional vessel trips to Coeymans are anticipated during the O&M or decommissioning phases. The USACE recorded an annual vessel traffic flow of 7,356 one-way trips per year in this reach of the river (USACE (U.S. Army Corps of Engineers) 2020). Assuming that project trips are spread equally over time during the 2-year construction period, this increased vessel traffic represents an increase of approximately 1.3 percent in vessel traffic each year (i.e., 94 one-way trips per year/7,356 average baseline vessel one-way trips per year).

Assuming that the risk of strike rises proportionally to an increase in vessel traffic and results in a corresponding increase in the number of strikes, we calculate that this increase in vessel traffic would result in an increase in the risk of strike (and a corresponding increase in the number of sturgeon struck) of up to 1.3 percent per year over the 2-year period. The worst-case year for sturgeon strikes in the area upstream of the vessel impact area to Albany in the NYSDEC database (Croton Point to Albany) recorded nine dead sturgeon (Atlantic and shortnose) with injuries consistent with vessel strike (NMFS (National Marine Fisheries Service) 2017b). An increase in strikes of 1.3 percent would be calculated as an additional 0.117 sturgeon struck per year. Over the remaining 2 years of the project, this would be calculated as an additional 0.234 sturgeon being struck. This is significantly less than one fish, and only a proportion of struck sturgeon is shortnose sturgeon. Therefore, we expect that the likelihood of a shortnose sturgeon being struck is less than 0.234 during construction of the project by a project vessel traveling between the project area and Coeymans or Albany.

Several major ports are present along the Delaware River. In 2014, there were 42,398 one-way trips reported for commercial vessels in the Delaware River Federal navigation channel (USACE 2014). In 2020, 2,195 cargo ships visited Delaware River ports. Neither of these numbers includes any recreational or other non-commercial vessels, ferries, tugboats assisting other larger vessels or any Department of Defense vessels (e.g., Navy, USCG). Vessels transiting to Baltimore, Sparrows Point would also transit through Delaware Bay to the Chesapeake and Delaware (C&D) Canal. From the canal, these vessels would transit through the upper Chesapeake Bay to the Sparrows Point facility, located near the mouth of the Patapsco River.

The 14-mi long C&D Canal is a fabricated waterway first excavated in 1824 to improve navigation time between ports in the Chesapeake Bay and the Delaware River; over time, it has been expanded and is currently maintained at a depth of 35 ft and width of 450 ft. We identified a number of estimates of vessel traffic in the C&D Canal included 25,000 total vessels annually and a reported 5,853 commercial one-way trips in 2014 (USACE 2014).

Shortnose sturgeon are not known to occur in the lower Chesapeake Bay where vessels would transit to the Port of Norfolk, and we do not anticipate any co-occurrence between shortnose sturgeon and project vessels in this portion of the Project Area. Up to 12 trips may occur between the Project Area and the Paulsboro, Sparrows Point, or Norfolk ports during the construction phase and up to 30 trips during O&M.

Assuming the highest number of trips that could potentially occur during a single year (12 during construction), this still represents only a 0.048 percent (12 transits compared to 25,000 vessel trips) in increased traffic when considering the increase in vessel traffic to the vessel path with the least traffic (C and D canal). Ship strikes have been documented for Atlantic sturgeon, particularly on the Delaware, James, and Cape Fear Rivers (ASSRT 2007) and seem to occur most frequently in rivers that support large ports and have relatively narrow waterways. Although a few boat strikes have been documented in other non-project rivers, these are rare and perhaps due to their smaller size (NOAA 2010). There is no evidence of ship strikes within the Hudson River (NOAA 2010), and therefore we expect that strikes from increased vessel traffic within the Hudson River are extremely unlikely to occur.

Given the amount of vessel traffic for each of these active ports, vessel traffic from the project is anticipated to result only in a very small increase in overall vessel traffic. Given the small number of project vessels that may access these ports, the very small relative change in vessel traffic, and correspondingly low risk of vessel strike, we conclude that vessel strikes to shortnose sturgeon are extremely unlikely to occur. Therefore, the Proposed Action may affect, but is not likely to adversely affect shortnose sturgeon.

Giant Manta Ray

The threatened giant manta ray is globally found in tropical, subtropical, and temperate waters and common in offshore waters and near productive coastlines (Miller and Klimovich 2017) generally between 35°N and 35°S latitudes. In the western North Atlantic, this species has been documented as far north as New Jersey and Long Island, New York (Gudger 1922; Miller and Klimovich 2017; NOAA 2019). Off the east coast of the United States, high concentrations of sightings are recorded in nearshore to shelf-edge waters between Florida and Georgia and between Cape Hatteras and New York (Farmer et al. 2022). During recent surveys in the NYB, giant manta rays were primarily sighted offshore of the shelf break (Tetra Tech and LGL 2020; Willmott et al. 2021). The species is unlikely to occur within the Project Area as water temperatures are likely at the lower range of its tolerance. Additionally, these rays frequently feed in waters at depths of 656 to 1,312 ft (200 to 400 m) (NMFS 2022a), depths much greater than waters found within the Project Area; however, giant manta rays travel long distances during seasonal migrations and may be found in upwelling waters at the shelf break south or east of the Project Area. There is a small chance that the transport of foundation and WTG components could traverse some upwelling areas. The species could also be encountered in the Action Area associated with Project vessels moving between the WDA and ports in the Mid-Atlantic. It is possible that vessels transiting between the Project Area and ports in Europe could encounter giant manta rays, but this is considered unlikely due to these ports and transit routes occurring at latitudes north of 35°N and in waters at the low range, or below its tolerance range. In the Action Area, co-occurrence of Project vessels and individual giant manta rays is expected to be extremely unlikely based on the low potential for occurrence and the probable low encounter rate by vessels in the Action Area. At-sea vessels transiting from non-local ports are not anticipated to employ PSOs or travel at reduced speeds. Given the low density of giant manta rays and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Additionally, the general mitigation and monitoring measures proposed for all Project vessels to watch out for and avoid all giant manta rays would further reduce the chance of any adverse effects to the species from the Proposed Action. The likelihood of any potential impacts resulting from the Project would be discountable; therefore, giant manta rays are not considered further in this BA.

Oceanic Whitetip Shark

The threatened oceanic whitetip shark is found in tropical and subtropical seas worldwide and ranges as far north as Maine in the western North Atlantic. This species occurs in the open ocean, on the OCS, or around oceanic islands in water depths greater than 604 ft (184 m) (Young et al. 2018). The species has a clear preference for open ocean waters between latitudes of 10°N and 10°S but can be found in decreasing numbers out to 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves (Young et al. 2018). In the western Atlantic Ocean, oceanic whitetip sharks occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. In the central and eastern Atlantic Ocean, the species occurs from Madeira, Portugal, south to the Gulf of Guinea, and possibly in the Mediterranean Sea. There is a small chance that the transport of foundation and WTG components from Europe would interact with oceanic whitetip sharks. At-sea vessels transiting from non-local ports are not anticipated to travel at reduced speeds; however, given the low density of oceanic whitetip sharks and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Vessel strikes are not identified as a threat in the status review (Young et al. 2018), listing determination (83 FR 4153), or the recovery outline (NMFS 2018b). There is no information to suggest that vessels in the ocean have any effects on oceanic whitetip sharks. Therefore, effects on the oceanic whitetip shark are not expected even if migrating individuals co-occur with Project vessels, and this species is not expected to occur in the Action Area and is not considered further in this BA.

3.4.2 Species Included in the Analysis

Table 16. Species included in the analysis.

Marine Mammals – Cetaceans	ESA Status	Critical Habitat	Recovery Plan
Blue whale (Balaenoptera musculus)	E – 35 FR 12222	-- --	11/2020
Fin whale (Balaenoptera physalus)	E – 35 FR 18319	-- --	75 FR 47538 07/2010
North Atlantic right whale (Eubalaena glacialis)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004
Sei whale (Balaenoptera borealis)	E – 35 FR 18319	-- --	12/2011
Sperm whale (Physeter macrocephalus)	E – 35 FR 18319	-- --	75 FR 81584 12/2010

Marine Reptiles	ESA Status	Critical Habitat	Recovery Plan
Green turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	FR Not Available 10/1991 – U.S. Atlantic
Kemp's ridley turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	09/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Loggerhead turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39856	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic

Fishes	ESA Status	Critical Habitat	Recovery Plan
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* – Carolina, Chesapeake, Gulf of Maine, New York Bight, South Atlantic DPSs	E – 77 FR 5913	82 FR 39160	-- --

Notes:

DPS = distinct population segment; E = endangered; ESA = Endangered Species Act; FR = Federal register; T = threatened

3.4.2.1 Marine Mammal Species Included in the Analysis

Of the 40 marine mammal species with occurrence records off the northeastern coast of the United States (DoN 2005), four ESA-listed species are expected to occur in the Action Area and Project Area: three endangered mysticetes – the North Atlantic right whale (*Eubalaena glacialis*), fin whale (*Balaenoptera physalus*), and sei whale (*B. borealis*) – and one endangered odontocete – the sperm whale (*Physeter macrocephalus*). Additionally, blue whales (*Balaenoptera musculus*) are included for consistency with the determinations made NOAA's proposed Letter of Authorization under the Marine Mammal Protection Act for the Sunrise Wind Offshore Wind Farm Project (88 FR 8997).Of these ESA species, critical habitat has only been designated for the North Atlantic right whale (see **Section 3.3.1**). Expected occurrence in these areas is based on known habitat associations, habitat modeling, confirmed sightings and acoustic detections regardless of how frequent that occurrence may be. Ongoing threats to these species in this region include vessel strikes, entanglement in fishing gear, fisheries bycatch, contaminants, disease, climate change, and noise (i.e., marine construction activities, vessel traffic, seismic surveys, sonar, and other military training activities) (Grieve et al. 2017; Hayes et al. 2021; MacLeod 2009; Record 2019).

Brief descriptions of the status, habitat associations, distribution, feeding and hearing information, and known occurrence of these species in the Action Area are provided in this section. Seasonal and annual abundance estimates are provided for the Project Area (SRWF) (**Table 17**). These estimates are average absolute estimates corrected for perception and availability bias. Seasons are defined as follows: spring (March through May), summer (June through August), fall (September through November), and winter (December through February). The estimates were derived from Duke University's Habitat-based Marine Mammal Density Models for the United States Atlantic (Roberts et al. 2016; Roberts et al. 2017; Roberts et al. 2018) and include OCS Lease Area 0487 with a 6-mi (10-km) buffer. These models were updated in 2022 and include data from 1992-2020 and the version 12 model for the North Atlantic right whale.

Table 17. Abundance estimates of Endangered Species Act–listed marine mammals expected to occur in the Project Area.

Species	Annual	Winter	Spring	Summer	Fall
Blue Whale*	0	0	0	0	0
North Atlantic right whale	2.71	4.64	5.29	0.33	0.59
Sei whale	0.74	0.58	1.55	0.26	0.59
Fin whale	3.08	2.69	2.71	5.42	1.48
Sperm whale	0.32	0.20	0.11	0.49	0.47

Note:

* Blue whale densities are not repeated in table through the rest of the document because the densities are so low they appear as zero. Subsequent analysis is based on the assumption in the National Marine Fisheries Service proposed rule that blue whales may potentially occur in the Action Area, albeit at extremely low numbers.

Blue Whale

Status

Blue whales have been listed as endangered under the ESA Endangered Species Conservation Act of 1969, with a recovery plan published under 63 FR 56911. No critical habitat has been designated for the blue whale. Blue whales are separated into two major populations (the North Pacific and North Atlantic populations) and further subdivided in stocks. The North Atlantic Stock includes mid-latitude (North Carolina coastal and open ocean) to Arctic waters (Newfoundland and Labrador); however, historical observations indicate that the blue whale has a wide range of distribution from warm temperate latitudes typically in the winter months and northerly distribution in the summer months. Blue whales are known to be an occasional visitor to U.S. Atlantic waters, with limited sightings.

Distribution and Habitat

In the North Atlantic Ocean, the range of blue whales extends from the subtropics to the Greenland Sea. As described in the most recent stock assessment report, blue whales have been detected and tracked acoustically in much of the North Atlantic, with most of the acoustic detections around the Grand Banks area of Newfoundland and west of the British Isles (Hayes et al. 2021). Photoidentification in eastern Canadian waters indicates that blue whales from the St. Lawrence River, Newfoundland; Nova Scotia; New England; and Greenland all belong to the same stock, whereas blue whales photographed off Iceland and the Azores appear to be part of a separate population (CETAP 1982; Sears and Calambokidis 2002). The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (Comtois et al. 2010; Lesage et al. 2017), which is outside of the Project area. Blue whales do not regularly occur in the U.S Atlantic water near the coast and typically occur farther offshore in areas with depths of 328 ft (100 m) or more (Waring et al. 2012).

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

Occurrence in the Action Area

The Western North Atlantic stock of blue whale is primarily distributed in the pelagic waters seaward of the continental shelf off the Grand Banks and Newfoundland, and in the Gulf of St. Lawrence. Individuals from this stock have only occasionally been observed in the U.S. Exclusive Economic Zone, and only to the north of Massachusetts (Hayes et al. 2021; Waring et al. 2012). The species was not observed during an intensive, multi-year aerial and shipboard survey of the RI/MA WEA (Kraus et al. 2016b). Based on known distribution and lack of observations in the vicinity, this species could potentially occur in the marine component of the Action Area during the operational life of the Proposed Action but the probability of occurrence during project construction and installation is very low.

Blue whales are thought to occur seasonally within the vessel transit component of the Action Area in the spring and summer but, because of their rarity, overlap with vessel transits within the Project area is not anticipated. Furthermore, the use of speed restrictions and lookouts during transit reduces the potential for impacts on blue whales. Given the low density of blue whales and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is extremely low.

North Atlantic Right Whale

Status

The North Atlantic right whale (hereafter referred to as “right whale”) is one of the world’s most endangered large whale species (Clapham et al. 1999; IWC 2001; Perry et al. 1999) and is classified as endangered under the ESA (NMFS 2008a). The most recent estimate of population size is 336 whales based on data through September 7, 2021 (Pettis et al. 2022). The current NMFS Stock Assessment Report lists the best estimate as 368 whales based on data through 30 November 2019 (NMFS 2022a). Despite decades of protection under the ESA, a combination of anthropogenic impacts, primarily from commercial fisheries and vessel strikes, and low calving rates continue to impede recovery of this species. Since 2010, calving rates have declined by approximately 40% (Kraus et al. 2016a). The exact cause of this decline is unknown but most likely is due to climate change-related alterations in food resources and anthropogenic impacts (Kenney 2018; Meyer-Gutbrod et al. 2015).

Currently, the most significant threats to right whale survival include entanglement in fishing gear and collisions with vessels (Knowlton and Kraus 2001). Between 2003 and 2018, 43 mortalities documented between Florida and the Gulf of St. Lawrence were due to entanglement and vessel strikes (Sharp et al.

2019). NOAA declared an Unusual Mortality Event (UME) for this species in 2017 (NOAA Fisheries 2022). The UME is ongoing, and the current total confirmed mortalities are 34 right whales. The primary cause appears to be human interactions, specifically vessel strikes or rope entanglements (NOAA Fisheries 2022).

As mentioned previously, critical habitat is designated in right whale foraging areas in the Gulf of Maine, Cape Cod Bay, and Georges Bank region and calving areas off the southeastern coast of the United States (NMFS 2016a). Ten SMAs are designated along the East Coast of the United States to protect right whales from vessel strikes. Most vessels equal to or greater than 65 ft (20 m) in length are required to transit at speeds of 10 kt or less in these SMAs during certain times of the year (NMFS 2008b). The SMA in Block Island Sound overlaps with the proposed Project Area; the mandatory speed restriction for this area is in effect from November 1 through April 30. In addition, speed restrictions are encouraged in Dynamic Management Areas and Right Whale Slow Zones which are triggered by right whale visual and acoustic detections.

Distribution and Habitat

This species ranges widely across the Northwest Atlantic Ocean mostly along the United States and Canadian coasts. Generally, right whales travel along the coast annually moving between the northern portions of the range where they feed and the southern portions, which support calving and breeding (Brown 1986; Jefferson et al. 2015; Winn et al. 1986); however, not all individuals in the population complete this migration (Gowan et al. 2019), and the distribution of many whales is unknown during much of the year (Hayes et al. 2022). Right whales are often detected in these well-known habitat areas outside of the ‘typical’ time periods (Kenney 2001; Patrician et al. 2009; Winn et al. 1986). Right whales have been recorded in the mid-Atlantic year-round (e.g., Estabrook 2021; Hayes et al. 2022; O’Brien et al. 2021a; Quintana et al. 2019; Whitt et al. 2013). Some individuals have been sighted throughout the fall and winter on the northern feeding grounds, and a large portion of the population may spend the winter in several northern areas, such as the Gulf of Maine and Cape Cod Bay (Clark et al. 2010; Cole et al. 2013; Mussoline et al. 2012). Cape Cod Bay provides foraging, socializing, and nursery habitat for right whales, and there has been an increase in the number of right whales visiting the Bay since 2003, particularly between 2010 and 2013 due in part to a change in habitat preference (Mayo et al. 2018). Results from a recent study using long-term acoustics data (2004-2014) confirmed the year-round presence of right whales across their entire range, an increase in right whale presence in the mid-Atlantic region since 2010, and a simultaneous decrease in presence in the northern Gulf of Maine (Davis et al. 2017).

Occurrence in the Action Area

Although some trans-Atlantic movement of individuals has been documented (e.g., Jacobsen et al. 2004), North Atlantic right whales are found primarily in continental shelf waters between Florida and Nova Scotia (Winn et al. 1986). In addition to coastal calving areas and relatively nearshore known feeding areas, migration habitat for this species is thought to be close to shore. A review of sightings data collected in the mid-Atlantic found that 94 percent of all right whale sightings were within 56 km from shore (Knowlton et al. 2002). Therefore, North Atlantic right whale occurrence is most likely to overlap the more nearshore portions of the Action Area and not the offshore routes between the Project Area and Europe. The Action Area is part of the NMFS-designated migratory corridor biologically important area (BIA) for the right whale (LaBrecque et al. 2015). Right whale high-use areas have recently been identified in the Gulf of St. Lawrence and south of Cape Cod in southern New England (Hamilton et al. 2022), which includes the Project Area. Southern New England shelf waters were a historically important area for right whales, and abundance has been increasing in this area probably due to climate-driven habitat changes (O’Brien et al. 2022). Based on survey and acoustics data collected during the NLPSC study in the RI-MA WEAs between 2011 and 2021, right whales were recorded in the WEAs year-round, and hot spots of right whale occurrence were identified within the WEAs and nearby on Nantucket Shoals (Kraus et al. 2016b; O’Brien et al. 2021a; O’Brien et al. 2021b; Quintana-Rizzo et al. 2021; Quintana et al. 2019; Stone et al. 2017). The NLPSC study confirmed the use of this area by adults, juveniles, and mom-calf pairs with multiple whales resighted across months and years (Kraus et al. 2016b; O’Brien et al. 2021a; Stone et al. 2017). As many as 196 individual whales since 2010 have been identified based on photo-identification analyses (Leiter et al. 2017). Both feeding and courtship behaviors (Surface Active Groups) were observed (Kraus et al. 2016b;

Quintana-Rizzo et al. 2021; Stone et al. 2017). Oceanographic survey results indicate that the zooplankton community composition in the MA WEA is similar to that of Cape Cod Bay (Quintana et al. 2019), a well-known feeding, socializing, and nursery area for right whales (Mayo et al. 2018). Based on survey data, higher abundances are expected in the Project Area during winter and spring compared to the other seasons (O'Brien et al. 2022) (see **Table 17**). This estimated abundance is consistent with mean monthly acoustic detections in this region which have been higher during January through March and lower during July through September (Kraus et al. 2016b; Stone et al. 2017) and the peak abundance recorded in the NYB during April and December (Zoidis et al. 2021).

Feeding

North Atlantic right whales feed on zooplankton, particularly large calanoid copepods such as *Calanus* spp. (Baumgartner et al. 2007; Beardsley et al. 1996; Kenney et al. 1985). The historic food resource in the Great South Channel and the Bay of Fundy is believed to be composed almost exclusively of *Calanus finmarchicus*, while in Cape Cod Bay and southern New England, their food resource is more diverse, consisting of *Centropages typicus* and *Pseudocalanus* spp. As well as *Calanus finmarchicus* (Jaquet et al. 2005; Mayo and Marx 1990; Quintana et al. 2019). In the Gulf of St Lawrence, right whales may also target different prey species, including *C. hyperboreus* and *C. glaciali*s (Meyer-Gutbrod et al. 2022). Right whales feed by skimming prey from the water's surface (Baumgartner et al. 2007; Mayo and Marx 1990; Pivorunas 1979), but they also feed throughout the water column (Baumgartner et al. 2017; Goodyear 1993; Watkins and Schevill 1976; 1979; Winn et al. 1995). Based on a tagging study conducted in core feeding areas, the average right whale spends 72 percent of its time within 10 m (33 ft) of the surface. Of the total time the whales were tagged, they spent as much as 45 percent of that time within 5 m (16 ft) of the seafloor. The high incidence of near-surface and near-bottom diving poses great risk from the draft of large commercial vessels and floating ground lines in pot and trap gear (Baumgartner et al. 2017). Feeding behavior has been observed in all of the northern high-use areas, as well as along the migration route and on the calving grounds (Kraus et al. 1993; Naessig 2012; Quintana-Rizzo et al. 2021; Whitt et al. 2013).

Hearing

Right whales and other baleen whales belong to the low-frequency cetacean hearing group which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). This range represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), whereas individual species' hearing ranges are typically not as broad. Based on morphometric analyses of right whale inner ears, the hearing range of this species is estimated to be between 10 Hz and 22 kHz (Parks et al. 2007).

<u>Sei Whale</u>

Status

Sei whales are listed as endangered under the ESA (NMFS 2011a). There is no designated critical habitat for this species. The stock structure of sei whales in the North Atlantic is uncertain. The International Whaling Commission currently recognizes three stocks: the Nova Scotian, Iceland-Denmark Strait and Eastern North Atlantic stocks (Huijser et al. 2018). The Nova Scotia stock occurs in U.S. Atlantic waters (NMFS 2022a). The best estimate of abundance for this stock is 6,292 individuals based on survey data recorded between Nova Scotia and Florida during the spring when they are most prevalent in U.S. waters (NMFS 2022a); however, this estimate may not be accurate due to uncertainties in population structure and movements between surveyed and unsurveyed areas and known issues in the data collection and analysis processes (NMFS 2022a). Vessel strikes and fishing gear entanglement pose the greatest current risk to sei whales. The total annual observed average human-caused mortality and serious injury for the Nova Scotia stock is 0.8 sei whales which is biased low and, therefore, represents a minimum estimate of human-caused mortality (NMFS 2022a).

Distribution and Habitat

Sei whales are primarily found in oceanic waters but do occur on the continental shelf (Horwood 1987; NMFS 2022a). They move into nearshore waters in response to prey concentration and may occur regularly in some nearshore areas (Baumgartner et al. 2011; Jonsgård and Darling 1977; Payne et al. 1990). On feeding grounds, sei whales are associated with oceanic frontal systems (Horwood 1987; Skov et al. 2008). Characteristics of preferred breeding and calving grounds are unknown. In the western North Atlantic Ocean, sei whales range primarily from Georges Bank north to Davis Strait (northeast Canada, between Greenland and Baffin Island) (Perry et al. 1999). During the spring, sei whale abundance in the waters of the Northwest Atlantic Ocean increases, and sightings are concentrated along the eastern margin of Georges Bank, into the Northeast Channel area, south of Nantucket, and along the Southwestern edge of Georges Bank (CETAP 1982; Palka et al. 2021b; Roberts et al. 2016). Sei whale feeding activity in the U.S. Atlantic waters is concentrated from May through November with a peak in July and August (LaBrecque et al. 2015).

Occurrence in the Action Area

Given their known occurrence in continental shelf and deep waters, sei whales may be found year-round throughout the Action Area, including the Project Area and the potential vessel routes along the U.S. and Canada East Coast and to/from Europe. Vessel routes may overlap with the NMFS-designated sei whale feeding BIA which extends from the 25-m (82-ft) contour off coastal Maine and Massachusetts west to the 200-m (656-ft) contour in central Gulf of Maine and includes the northern shelf break area of Georges Bank and the southern shelf break area of Georges Bank from 100 to 2,000 m (328 to 6,562 ft) and the Great South Channel (LaBrecque et al. 2015). Peak abundance in the Project Area is estimated to be during spring (see **Table 17**) although sei whales may occur in this region throughout the year. AMAPPS 2010-2017 surveys recorded sei whales in or near the RI-MA WEAs during spring and summer (Palka et al. 2021a). The sei whale was the least common baleen whale species recorded during the NYSDEC and NLPSC studies. In the NYB, this species was sighted during spring (Tetra Tech and LGL 2020) and acoustically detected primarily during March, April, and May (Estabrook 2021). The NYSERDA surveys recorded sei whales during August, February/March, and April/May; individuals were seen as close as 10 to 20 NM from Long Island (NYSERDA 2020). In the RI-MA WEAs, sei whales, including calves, were sighted in spring and summer (March through June) (Kraus et al. 2016b; O’Brien et al. 2021a; Quintana et al. 2019; Stone et al. 2017), and feeding behavior was observed (Kraus et al. 2016b; Stone et al. 2017).

Feeding

Sei whales have been shown to adjust the timing of their feeding with the vertical migration of prey in the water column, feeding preferentially when the prey concentration is higher at the surface (Baumgartner et al. 2011; Horwood 1987). In the North Atlantic, the major prey species are copepods and euphausiids (Horwood 1987; Kenney et al. 1985; Sigurjónsson 1995). Jonsgård and Darling (1977) noted that *Calanus finmarchicus* seems to predominate in the diet of eastern North Atlantic individuals.

Hearing

While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing. Sei whales and other baleen whales belong to the low-frequency cetacean hearing group which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). This range represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), whereas individual species’ hearing ranges are typically not as broad. Best hearing sensitivity may range from 1.5 to 3.5 kHz (Erbe 2002).

Fin Whale

Status

Fin whales are listed as endangered under the ESA (NMFS 2010a). There is no designated critical habitat for this species. Fin whales in the North Atlantic are considered a separate subspecies (Archer et al. 2019), and those off the eastern coast of the United States, Nova Scotia, and the southeastern coast of Newfoundland constitute the Western North Atlantic Stock (NMFS 2022a). The best available current abundance estimate for this stock is 6,802 fin whales. The total annual observed average human-caused mortality and serious injury from incidental fishery interactions and vessel collisions is 1.8 fin whales in this stock which is a biased, low estimate and, therefore, represents a minimum estimate of human-caused mortality (NMFS 2022a).

Distribution and Habitat

Fin whales are common year-round in U.S. Atlantic EEZ waters, particularly north of Cape Hatteras (Davis et al. 2020; Edwards 2015). Although fin whales are globally found in continental shelf, slope, and oceanic waters, fin whale occurrence off the eastern United States appears to be scarce in slope and Gulf Stream waters (CETAP 1982; Waring et al. 1992). This species is the most commonly sighted large whale in continental shelf waters from the mid-Atlantic coast of the United States to eastern Canada (CETAP 1982; Hain et al. 1992). Relatively consistent sighting locations for fin whales off the northeastern U.S. and Canadian coasts include the banks on the Nova Scotian Shelf, Georges Bank, Jeffreys Ledge, Cashes Ledge, Stellwagen Bank, Grand Manan Bank, Newfoundland Grand Banks, the Great South Channel, the Gulf of St. Lawrence, off Long Island and Block Island, and along the shelf break of the northeastern United States (CETAP 1982; Hain et al. 1992). Waters off New England and in the Gulf of St. Lawrence waters represent major feeding grounds for fin whales (NMFS 2022a).

Occurrence in the Action Area

Fin whales may occur in shelf and offshore waters of the Action Area during any time of the year. Peak abundance is estimated to be during summer (see **Table 16**) which coincides with the peak abundance of this species in the NYB (Zoidis et al. 2021). AMAPPS 2010-2017 surveys recorded fin whales in or near the RI-MA WEAs during spring and summer (Palka et al. 2021a). Fin whales were commonly detected year-round during recent NYB studies (Estabrook 2021; NYSERDA 2020; Tetra Tech and LGL 2020). Although visual surveys recorded some seasonal variations in occurrence, acoustic detections were nearly continuous throughout the year (Estabrook 2021). Fin whales are known to feed in this region. The Action Area is within a fin whale feeding BIA which is designated March to October east of Montauk Point between the 15-m (49-ft) and 50-m (164-ft) depth contours (LaBrecque et al. 2015). Feeding behavior has been observed in/near the Project Area (Kraus et al. 2016b; Stone et al. 2017). During the RI-MA WEA studies, fin whales were sighted and acoustically detected year-round with peak sightings recorded between April and August (Kraus et al. 2016b; O'Brien et al. 2021a; O'Brien et al. 2021b; Quintana et al. 2019; Stone et al. 2017). At least three sightings of fin whale calves have been recorded in this region (Kraus et al. 2016b; Stone et al. 2017).

Feeding

Fin whales feed by "gulping" where up to 50 percent of the animal's body volume in seawater enters the mouth and distends pleats along the throat (Lambertsen et al. 1995; Orton and Brodie 1987; Pivorunas 1979). They prey upon a wide variety of small, schooling prey (especially herring, capelin, and sand lance) including squid and crustaceans (krill and copepods) (see review in Kenney et al. 1985; NMFS 2006). Fin whale dives are typically 5 to 15 min long and separated by sequences of four to five blows at 10- to 20-second intervals (CETAP 1982; Lafortuna et al. 2003; Stone et al. 1992). Kopelman and Sadove (1995) found significant differences in blow intervals, dive times, and blows per hour between surface-feeding and non-surface-feeding fin whales.

Hearing

Fin whales and other baleen whales belong to the low-frequency cetacean hearing group which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). This range represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), whereas individual species' hearing ranges are typically not as broad. Best hearing sensitivity may range from 20 to 150 Hz (Erbe 2002) to 20 Hz to 12 kHz (Cranford and Krysl 2015).

Sperm Whale

Status

The sperm whale is classified as endangered under the ESA (NMFS 2010b). No critical habitat is designated for this species. Stock structure for sperm whales in the North Atlantic is unknown (Dufault et al. 1999). Currently, one stock is recognized for the entire North Atlantic. This North Atlantic stock includes sperm whales in the eastern U.S. Atlantic EEZ (NMFS 2022a). The current best estimate of sperm whale abundance in the western North Atlantic is 4,349 individuals based on 2016 surveys conducted from Central Florida to the lower Bay of Fundy (NMFS 2022a). There were no documented reports of fishery-related mortality or serious injury to this stock in the U.S. EEZ during 2013–2017 (NMFS 2022a). Primary threats to sperm whale populations include collisions with vessels, direct harvest, and possibly competition for resources, loss of prey base due to climate change, and disturbance from anthropogenic noise (NMFS 2010b).

Distribution and Habitat

Sperm whale distribution can be variable but is generally associated with waters over the continental shelf edge, continental slope, and offshore waters (CETAP 1982; Davis et al. 2002; Hain et al. 1985; Smith et al. 1996; Waring et al. 2001). Sperm whales are frequently sighted seaward of the continental shelf off the eastern United States (CETAP 1982; Kenney and Winn 1987; Waring et al. 1993). Although females are rarely sighted in shallow waters over the continental shelf (Whitehead 2003), adult males are known to inhabit shallow waters of 328 ft (100 m) or less in portions of their range (Croll et al. 1999; Garrigue and Greaves 2001; Scott and Sadove 1997; Whitehead et al. 1992).

Sperm whales have a year-round occurrence throughout the U.S. Atlantic EEZ (Cohen et al. 2022; Stanistreet et al. 2018); concentrations are known to shift latitudinally, particularly north of Cape Hatteras, depending on the season (CETAP 1982; Cohen et al. 2022; Scott and Sadove 1997; Stanistreet et al. 2018). In winter, sperm whales are primarily concentrated east and northeast of Cape Hatteras. During spring, the concentration of sperm whales shifts northward to waters off Virginia and Delaware, and distribution is generally widespread throughout the central mid-Atlantic Bight and southern Georges Bank. Summer distribution is similar to spring but also includes the area northeast of Georges Bank and into the Northeast Channel region as well as shelf waters south of New England. Fall sperm whale occurrence is generally on the continental shelf south of New England but also extends along the shelf break in the mid-Atlantic Bight. Despite these seasonal shifts in concentration, no movement patterns affect the entire stock (CETAP 1982).

Occurrence in the Action Area

Sperm whales have often been described as primarily a deep-water species where they forage on their preferred prey items. Recent survey data, however, indicates that sperm whales are more common within the Action Area than has been previously thought. Sperm whales may occur in the Action Area during any time of the year; peak abundance in the Project Area is estimated to be during summer (see **Table 17**). This coincides with the known year-round occurrence and peak summer abundance of sperm whales in the nearby NYB (Estabrook 2021; NYSERDA 2020; Tetra Tech and LGL 2020; Zoidis et al. 2021). Regular sightings of sperm whales are well documented in shallow shelf waters (average water depth of 180 ft [55 m]) southeast of Montauk Point during spring, summer, and fall (Scott and Sadove 1997). It is thought that sperm whales may use this area as foraging habitat since sightings are concentrated in the channel between Block Island Sound and Block Canyon where there is a localized abundance of squid (Scott and Sadove 1997). During the AMAPPS 2010-2017 and NLPSC surveys, sperm whales were sighted in or near the RI-MA WEAs during summer and fall (Kraus et al. 2016b; O'Brien et al. 2021a; Palka et al. 2021a; Stone et al. 2017). Sleeping behaviors were observed in relatively shallow waters during the NLPSC studies (O'Brien et al. 2021a).

Feeding

Sperm whales prey on large mesopelagic squids and other cephalopods, as well as demersal fishes and benthic invertebrates (Clarke 1996; Fiscus and Rice 1974; Rice 1989). Foraging dives routinely exceed a depth of 1,312 ft (400 m) and a duration of 30 minutes (Watkins et al. 2002). Sperm whales are capable of diving to depths of over 6,561 ft (2,000 m) for over 60 minutes (Watkins et al. 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Amano and Yoshioka 2003; Jaquet et al. 2000). Males do not spend extensive periods of time at the surface (Jaquet et al. 2000). In contrast, females spend prolonged periods of time at the surface (1 to 5 hours daily) without foraging (Amano and Yoshioka 2003; Whitehead and Weilgart 1991). An average dive cycle consists of about a 45-minute dive with a 9-minute surface interval (Watwood et al. 2006); however, presence in the Action Area may indicate that sperm whales are opportunistic feeders that will take advantage of local abundance of prey items in relatively shallow locations on the OCS.

Hearing

Sperm whales belong to the mid-frequency cetacean (MFC) hearing group which has a generalized hearing range of 150 Hz to 160 kHz (NMFS 2018a). This range represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), whereas individual species' hearing ranges are typically not as broad. The anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency (HF) to ultrasonic-frequency sounds (Ketten 1992). They may also possess better low-frequency hearing than other odontocetes although not as low as many baleen whales (Ketten 1992). Best hearing sensitivity may range from 5 to 20 kHz based on an auditory brainstem response of a stranded neonatal sperm whale (Ridgway and Carder 2001).

3.4.2.2 Sea Turtle Species Included in the Analysis

Of the five ESA-listed sea turtle species with occurrence records off the northeastern coast of the United States (DoN 2005), four species are expected to occur in the Action Area (**Table 18**): the green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), and Kemp's ridley sea turtle (*Lepidochelys kempii*). There is no designated critical habitat in or near the Action Area (see **Section 3.3**). These species may occur near the onshore facilities (SRWEC landfall location at Smith Point on Long Island, New York) and the in-water areas which range from state waters (SRWEC-NYS from the shoreline to a maximum depth of 29 m) to federal waters (SRWEC-OCS with maximum depth of 68 m and SRWF which ranges from 35 to 62 m in depth) (Appendix G1, COP; Sunrise Wind 2021a). Expected occurrence in these areas is summarized in **Table 18** and is based on known habitat associations, confirmed sightings and strandings, and the potential for occurrence based on these factors regardless of how frequent that occurrence may be. Ongoing threats to these species in this region include, but are not limited to, entanglement in fishing gear, fisheries bycatch, marine debris ingestion or entanglement, vessel strike, nesting beach impacts, climate change, noise pollution, marine and coastal construction activities, vessel traffic, seismic surveys, sonar and other military activities, beach cleaning, beach nourishment, shoreline armoring, recreational beach equipment, beach driving, artificial lighting, and nest relocation (Hamann et al. 2010; Lutcavage et al. 1997; NMFS et al. 2011b; NMFS and USFWS 2008; NMFS and USFWS 2013a; NMFS and USFWS 2013b; Osgood 2008; TEWG 2007; Witherington and Martin 2003).

Brief descriptions of the status, habitat associations, distribution, feeding and hearing information, and known occurrence of these species in the Action Area are provided in this section. Stranding data reflect reports from 2017 to 2021 from New York to Massachusetts (NMFS STSSN 2022) (**Table 18**). Abundance estimates of nesting females are provided (**Table 18**). No absolute density/abundance estimates specific to the Project Area are available yet. Duke University Marine Geospatial Ecology Laboratory's density models do not yet include turtle data, and the Navy's turtle density models are outdated (used NMFS Summer 1998 aerial survey data) and not spatially or seasonally stratified (DoN 2007).

Table 18. Endangered Species Act–listed sea turtles expected to occur in the Action Area.

Species[1]	DPS	ESA Status	Regional Nester Abundance[2]	Strandings[3]	Expected to Occur in SRWF	Expected to Occur in SRWEC-OCS	Expected to Occur in SRWEC-NYS	Expected to Occur in Onshore Facilities[4]
Leatherback sea turtle (*Dermochelys coriacea*)	N/A	E	20,659 (Northwest Atlantic) (NMFS and USFWS 2020)	231	Yes	Yes	Yes	No
Loggerhead sea turtle (*Caretta caretta*)	Northwest Atlantic Ocean	T	38,334 (Northwest Atlantic) (Richards et al. 2011)	250	Yes	Yes	Yes	Yes
Kemp's ridley sea turtle (*Lepidochelys kempii*)	N/A	E	4,395 (Gulf of Mexico) (NMFS and USFWS 2015)	174	Yes	Yes	Yes	Yes
Green sea turtle (*Chelonia mydas*)	North Atlantic	T	167,424 (North Atlantic DPS) (NMFS and USFWS 2016)	72	Yes	Yes	Yes	Yes

Notes:

1 Taxonomy follows Pritchard (1997).

2 Abundance estimates of nesting females are provided. No absolute density/abundance estimates specific to the Project Area or Action Area are available yet. [Duke University Marine Geospatial Ecology Laboratory's density models do not yet include turtle data, and the Navy's turtle density models are outdated (used NMFS Summer 1998 aerial survey data) and not spatially or seasonally stratified (DoN 2007).

3 A stranding is defined as "a sea turtle that is either found dead or is alive but is unable to go about its normal behavior due to any injury, illness, or other problem" and is "found washed ashore or floating in the water". Data reflects reports from 2017 to 2021 from NY to MA (NMFS STSSN 2022).

4 Occurrence in onshore facilities is based on nesting potential on Long Island. Leatherback nesting in the United States is mainly on the Atlantic coast of Florida (Stewart and Johnson 2006) with sporadic nesting in Georgia, South Carolina, and North Carolina (Rabon et al. 2003). Although hardshell turtle nesting beaches are primarily south of New York, loggerhead, green, and Kemp's ridley turtles are known to nest in the mid-Atlantic, and a Kemp's ridley recently nested on Long Island (Rafferty et al. 2019). A sea turtle nesting response plan is being developed for New York (Bonacci-Sullivan 2018).

DPS = distinct population segment; E = endangered; N/A = not applicable; T = threatened

Leatherback Sea Turtle

Status

Leatherback turtles are listed as endangered under the ESA throughout their range (NMFS and USFWS 1992). The leatherbacks found in the U.S. Atlantic EEZ are part of the global population. The total index of 20,659 nesting females is based on the most recent and relevant information and represents the best available data for this population (NMFS and USFWS 2020). This estimate is comparable to previous estimates: 18,700 adult females based on extrapolations from 2004–2005 nesting data (estimated range of 34,000 to 94,000 total adults) (TEWG 2007) and 20,000 mature individuals based on the most recently published International Union for Conservation of Nature Red List assessment for this subpopulation (Northwest Atlantic Leatherback Working Group 2019). The Northwest Atlantic DPS is experiencing an overall decreasing trend in annual nesting activity (Northwest Atlantic Leatherback Working Group 2018). Threats to this DPS include habitat loss and modification, overutilization, predation, inadequate regulatory mechanisms, fisheries bycatch, pollution, vessel strikes, oil and gas activities, and climate change (NMFS and USFWS 2020).

Distribution and Habitat

The leatherback turtle is distributed circumglobally in tropical, subtropical, and warm-temperate waters throughout the year and in cooler temperate waters during warmer months (NMFS and USFWS James et al. 2005a; 1992). Nesting occurs on isolated mainland beaches in tropical and temperate oceans (NMFS and USFWS 1992) and to a lesser degree on some islands, such as the Greater and Lesser Antilles. In the United States, the densest nesting is on the Atlantic coast of Florida (Stewart and Johnson 2006). Sporadic nesting occurs in Georgia, South Carolina, and North Carolina (Rabon et al. 2003). Leatherbacks are pelagic but also commonly observed in coastal waters along the U.S. continental shelf (NMFS and USFWS 1992). In the northeastern United States, leatherbacks have a regular, seasonal occurrence. In the late winter and early spring, they are distributed primarily in tropical latitudes (Stewart and Johnson 2006); survey data confirm that around this time of year, individuals begin to move north along the North American Atlantic coast. By February and March, the majority of leatherbacks found in Atlantic waters of the United States are distributed off northeastern Florida. This movement continues through April and May when leatherbacks begin to occur in large numbers off the coasts of Georgia, North Carolina, and South Carolina (NMFS 1995; NMFS 2000). Leatherbacks become more numerous off the mid-Atlantic and southern New England coasts in late spring and early summer, and by late summer and early fall, they may be found in the waters off eastern Canada (CETAP 1982; Dodge et al. 2014; Shoop and Kenney 1992; Thompson et al. 2001).

Occurrence in the Action Area

Leatherback turtles may occur in shelf and offshore waters of the Action Area throughout the year. Peak leatherback occurrence in the Project Area is expected during the summer and fall although this species may occur in the region year-round. During recent aerial surveys in the NYB, leatherbacks were sighted during all seasons except winter, and most sightings were during summer and fall and were in nearshore and offshore waters (NYSERDA 2020; Tetra Tech and LGL 2019; 2020). AMAPPS surveys conducted from 2010 through 2013 routinely documented leatherbacks in New England waters, including the RI-MA WEAs (Palka 2017b). The Sea Turtle Stranding and Salvage Network (STSSN) reported 89 offshore and 142 inshore leatherback sea turtle strandings between 2017 and 2021 from New York to Massachusetts (NMFS STSSN 2022). During the NLPSC surveys in the RI-MA WEAs, leatherbacks were recorded during spring, summer, and fall with a strong peak in August (Kraus et al. 2016b; O'Brien et al. 2021a; O'Brien et al. 2021b; Quintana et al. 2019; Stone et al. 2017). Sightings were documented close to shore (within 10 NM) (O'Brien et al. 2021a). Sightings were concentrated just south of Nantucket on Nantucket Shoals during summer and fall (Kraus et al. 2016b; O'Brien et al. 2021a; O'Brien et al. 2021b; Quintana et al. 2019). During Project-specific geophysical surveys, leatherbacks were sighted in or near the Project Area during June, July, August, and October (Gardline 2021a; Smultea Sciences 2020a).

Feeding

Leatherbacks foraging in the western North Atlantic prefer waters from 16 to 18°C (James et al. 2006; Thompson et al. 2001); their lower thermal limit is in sea surface temperature (SSTs) between 10 to 12°C (Witt et al. 2007). Juvenile and adult foraging habitats include both coastal feeding areas in temperate waters and offshore feeding areas in tropical waters (Eckert and Abreu-Grobois 2001; Frazier 2001). Adults may also feed in cold waters at high latitudes (James et al. 2006). The movements of adult leatherbacks appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycle (Collard 1990; Davenport and Balazs 1991; Luschi et al. 2006). Leatherbacks feed throughout the epipelagic and into the mesopelagic zones of the water column (Davenport 1988; Eckert et al. 1989; Eisenberg and Frazier 1983; Grant and Ferrell 1993; James et al. 2005b; Salmon et al. 2004). Prey is predominantly gelatinous zooplankton such as cnidarians (jellyfish and siphonophores) and tunicates (salps and pyrosomas) (NMFS and USFWS Bjorndal 1997; Grant and Ferrell 1993; James and Herman 2001; 1992; Salmon et al. 2004).

Hearing

Sea turtles have low frequency hearing. Hearing frequencies range from 30 Hz to 2 kHz with a range of maximum sensitivity between 100 to 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994; Ridgway et al. 1969). The in-water hearing range of leatherback hatchlings has been recorded from approximately 50 to 1,200 Hz with maximum hearing sensitivity between 100 and 400 Hz (Dow Piniak et al. 2012).

Loggerhead Sea Turtle

Status

The loggerhead turtles found in the U.S. Atlantic EEZ are part of the Northwest Atlantic Ocean DPS which is designated as threatened under the ESA (USFWS and NMFS 2011). The recent best abundance estimate for the western North Atlantic adult female loggerhead population is 38,334 nesters based on 2001-2010 nest counts (Richards et al. 2011). Although some progress has been made since publication of the 2008 recovery plan for the Northwest Atlantic population (NMFS and USFWS 2008), the Recovery Units have not met most of the critical benchmarks, and dedicated large-scale aerial surveys designed specifically for sea turtles are still needed (Bolten et al. 2019). Primary threats include barriers to nesting (e.g., beach armoring, shoreline stabilizations structures), light pollution, bycatch, vessel strikes, and marine debris ingestion and entanglement as well as emerging issues including climate change, aquaculture, power generation in the marine environment, and harmful algal blooms (Bolten et al. 2019).

Distribution and Habitat

Loggerheads occur worldwide in habitats ranging from coastal estuaries, bays, and lagoons to pelagic waters (Dodd 1988). Foraging loggerhead sea turtles range widely and have been observed along the entire Atlantic coast as far north as Canada (Brazner and McMillan 2008; Ceriani et al. 2014; Shoop and Kenney 1992). Southeastern Florida represents the principal nesting site for loggerheads along the U.S. Atlantic coast (NMFS and USFWS 1991b). While the rare nest may occur north of Virginia, Virginia is the northernmost nesting area regularly used by loggerheads along the east coast of the United States (Musick 1988). In southern New England, loggerhead sea turtles can be found seasonally, primarily during the summer and fall but are typically absent during the winter (Kenney and Vigness-Raposa 2010; Shoop and Kenney 1992) as distribution is dictated primarily by SSTs. Loggerheads are associated with SSTs between 13 and 28°C (55.5 and 82.4°F) (Mrosovsky 1980); they tend to become lethargic in SSTs below 15°C (59°F) and may become incapacitated ("cold-stunned") at temperatures below 10°C (50°F) (Mrosovsky 1980; Schwartz 1978). Loggerheads occur north of Cape Hatteras primarily in late spring through early fall (May and October) with a peak occurrence in June; however, sightings are recorded in mid-Atlantic and northeast waters throughout the year (CETAP 1982; DoN 2008a; DoN 2008b; Lutcavage and Musick 1985; Shoop and Kenney 1992). During the summer, loggerheads may be found regularly in shelf waters from Delaware Bay to Hudson Canyon, including Long Island Sound and Cape Cod Bay (Burke et al. 1991; Prescott 2000;

Shoop and Kenney 1992; UDSG 2000). As SSTs decrease in the winter, most individuals move south of Cape Hatteras to overwinter (Epperly et al. 1995; Hawkes et al. 2011; Mitchell et al. 2002). From November to April, loggerheads are primarily found off the coast of southern North Carolina in the South Atlantic Bight (Griffin et al. 2013); however, stranding and sighting data indicate that not all loggerheads leave mid-Atlantic and New England waters during the winter (Burke et al. 1991).

Occurrence in the Action Area

Loggerhead turtles may occur year-round in the Action Area; peak occurrence in the Project Area is expected to be during summer and fall. Loggerheads are the most commonly sighted sea turtles on the shelf waters from New Jersey to Nova Scotia, Canada. During AMAPPS surveys between December 2014 and March 2015, 280 individuals were recorded in this region (Palka 2017a). Throughout the NYB, loggerheads are sighted year-round with fewer sightings recorded during the winter (NYSERDA 2020; Tetra Tech and LGL 2020). Large concentrations of loggerheads are regularly observed south and east of Long Island near the RI-MA WEAs (NEFSC and SEFSC 2018). During the NLPSC surveys, loggerhead turtles were sighted within the RI-MA WEAs during spring, summer, and fall with the greatest number of observations in summer and fall (Kraus et al. 2016b; O'Brien et al. 2021a; O'Brien et al. 2021b; Quintana et al. 2019). During Project-specific geophysical surveys, loggerheads were sighted in or near the Project Area during June, July, August, and September (Smultea Sciences 2020a). The STSSN reported 78 offshore and 172 inshore loggerhead sea turtle strandings between 2017 and 2021 from New York to Massachusetts, the highest number among all turtle species reported (NMFS STSSN 2022). In NYS waters, the New York Marine Rescue Center (NYMRC) documented 816 strandings of loggerhead sea turtles from 1980 to 2018 (New York Marine Rescue Center 2022). Winton et al. (2018) estimated densities of tagged turtles using data from 271 satellite tags deployed on loggerhead sea turtles between 2004 and 2016 and found that tagged loggerheads primarily occupied the continental shelf from Long Island, New York, south to Florida, but relative densities in the RI-MA WEAs increased between July and September. Collectively, available information indicates that loggerhead sea turtles are expected to occur commonly as adults, subadults, and juveniles from the late spring through fall, with the highest probability of occurrence from July through September (Winton et al. 2018).

Feeding

The diet of the loggerhead turtles progressively changes with age and size (e.g., Godley et al. 1998). Post-hatchlings are known to feed on zooplankton, jellyfish, larval shrimp and crabs, and gastropods (Richardson and McGillivary 1991; Witherington 1994). Juvenile and subadult loggerhead turtles are omnivorous, foraging on pelagic crabs, mollusks, jellyfish, and vegetation captured at or near the surface (Dodd 1988; Frick et al. 1999). Adult loggerheads are generally carnivorous, often choosing to forage on benthic invertebrates (mollusks, crustaceans, and coelenterates) and sometimes fish in nearshore waters (Dodd 1988). In the mid-Atlantic Shelf region, loggerheads have a high diversity of foraging approaches and exhibit both pelagic and benthic foraging behaviors (Smolowitz et al. 2015). Pelagic prey includes Lion's mane jellies (*Cyanea capillata*), comb jellies (*Ctenophora*) and salps (*Salpidae*), while benthic prey includes hermit crabs (*Paguroidea*), rock crabs (*Cancer irroratus*), and Atlantic sea scallops (*Placopecten magellanicus*) (Smolowitz et al. 2015). They generally forage on gelatinous prey near the surface or within 1-16 m of the water column (Patel et al. 2016).

Hearing

Sea turtles have low frequency hearing. Hearing frequencies range from 30 Hz to 2 kHz with a range of maximum sensitivity between 100 to 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994; Ridgway et al. 1969). The hearing range of post-hatchling and juvenile loggerhead turtles has been recorded from 50 Hz to 1.1 kHz with highest sensitivity between 100 and 400 Hz (Lavender et al. 2014).

Kemp's Ridley Sea Turtle

Status

The Kemp's ridley turtle is classified as endangered under the ESA and is considered the world's most endangered sea turtle (USFWS and NMFS 1992). The worldwide population declined from tens of thousands of nesting females in the late 1940s to approximately 300 nesting females in 1985 (TEWG 2000). The only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo on the eastern coast of Mexico (USFWS and NMFS 1992). The most recent abundance estimate is 4,395 nesters based on 2.5 nests per female per nesting season and the total number of nests in Mexico in 2014 (NMFS and USFWS 2015). There are an estimated 3,900 to 8,100 juvenile Kemp's ridleys that utilize developmental habitats annually along the western North Atlantic coast (Seney and Musick 2005). Current threats to this species include bycatch, oil spills, ingestion and entanglement in marine debris, vessel strikes, and climate change (NMFS and USFWS 2015).

Distribution and Habitat

Kemp's ridley sea turtles occur primarily in the Gulf of Mexico and along the Atlantic coast of the U.S. Atlantic but also make trans-Atlantic crossings (e.g., Fontaine et al. 1985; Wibbels 1983). They inhabit open-ocean and Sargassum habitats of the North Atlantic Ocean as post-hatchlings and small juveniles (Manzella et al. 1991; Witherington et al. 2012). The species is primarily associated with habitats on the continental shelf with preferred habitats consisting of sheltered areas along the coastline, including estuaries, lagoons, and bays (Burke et al. 1994; Landry and Costa 1999; Lutcavage and Musick 1985; Seney and Musick 2005) and nearshore waters less than 120 ft (37 m) deep although they can be found in deeper offshore waters (Shaver and Rubio 2008; Shaver et al. 2005). Their most suitable habitats are less than 33 ft (10 m) deep with SSTs between 22 and 32°C (72 and 90°F) (Coyne et al. 2000). Seagrass beds, mud bottom, and live bottom are important developmental habitats (Schmid and Barichivich 2006). Large juveniles and adults move to benthic, nearshore feeding grounds along the Atlantic and Gulf coasts of the United States (Morreale and Standora 2005). Some juveniles may migrate as far north as New York and New England, arriving in these areas around June and leaving to travel south in early October (Morreale and Standora 2005). Nesting occurs primarily on a single beach at Rancho Nuevo on the eastern coast of Mexico (USFWS and NMFS 1992) with a few additional nests in Texas, Florida, South Carolina, and North Carolina (Foote and Mueller 2002; Godfrey 1996; Meylan et al. 1990; Weber 1995) and an occasional nest in Virginia (Boettcher 2015) and New York (Rafferty et al. 2019).

Occurrence in the Action Area

Kemp's ridley turtles may occur year-round in the Action Area; occurrence in the Project Area is expected to be lowest during winter. Despite the amount of aerial survey effort conducted in the NYB and southern New England, this small turtle species is extremely difficult to observe via high-altitude surveys, so sightings may often go undetected. During the recent NYB surveys, relatively few Kemp's ridley turtles were sighted compared to other turtle species; sightings were recorded during spring, summer, and fall (NYSERDA 2020; Tetra Tech and LGL 2020). During NLPSC surveys in the RI-MA WEAs, Kemp's ridley sightings were during August and September 2012 (Kraus et al. 2016b). During Project-specific geophysical surveys, one Kemp's ridley was sighted in the Project Area during July 2020 (Gardline 2021a). The STSSN reported 17 offshore and 157 inshore Kemp's ridley sea turtle strandings between 2017 and 2021 from New York to Massachusetts (NMFS STSSN 2022), and the NYMRC documented strandings of 620 Kemp's ridley sea turtles within NYS waters between 1980 and 2018 (New York Marine Rescue Center 2022). Cold-stunned Kemp's ridley sea turtles are often found stranded on the beaches of Cape Cod (Liu et al. 2019; Wellfleet Bay Wildlife Sanctuary 2018). The first confirmed Kemp's ridley nesting event on Long Island was in July 2018 (Rafferty et al. 2019).

Feeding

Kemp's ridley turtles feed primarily on portunids and other types of crabs, but are also known to prey on mollusks, shrimp, fish, jellyfish, and plant material (Frick et al. 1999; Marquez-M. 1994). Blue crabs and spider crabs (*Libinia* spp.) are also important prey species for the Kemp's ridley (Keinath et al. 1987; Lutcavage and Musick 1985; Seney and Musick 2005). Kemp's ridleys may also feed on shrimp fishery bycatch (Landry and Costa 1999).

Hearing

Sea turtles have low frequency hearing. Hearing frequencies range from 30 Hz to 2 kHz with a range of maximum sensitivity between 100 to 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994; Ridgway et al. 1969). Juvenile Kemp's ridleys are known to respond to stimuli between 100 and 500 Hz with maximum sensitivity between 100 and 200 Hz (Bartol and Ketten 2006).

<u>Green Sea Turtle</u>

Status

Of the 11 DPSs of green turtles, the North Atlantic DPS is found in the North Atlantic Ocean and Gulf of Mexico and is listed as threatened (NMFS and USFWS 2016). Nesting concentrations of particular interest in the North Atlantic DPS are found in Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), United States (Florida), and Cuba (Seminoff et al. 2015). The most recent abundance estimate is 167,424 nesters in this DPS based on nest monitoring conducted through 2012 (Seminoff et al. 2015). Current threats include nesting habitat degradation and artificial lighting effects resulting from coastal development, degradation and loss of seagrass and marine algae foraging resources, illegal harvest of eggs and mature adults, bycatch, vessel strikes, and climate change (Seminoff et al. 2015).

Distribution and Habitat

The green turtle has a circumglobal distribution throughout tropical and subtropical waters (Seminoff and MTSG (Marine Turtle Specialist Group) Green Turtle Task Force 2004). The most important nesting and feeding grounds lie within the tropics (Pritchard 1997; Seminoff et al. 2015; Sternberg 1981). Most nesting in North America occurs in southern Florida and Mexico (Seminoff et al. 2015). Along the east coast of the United States, adult green sea turtles are only occasionally found north of Florida, which is near the northern extent of the green turtle's Atlantic nesting range, although some nests have been documented in Georgia, North Carolina, South Carolina, and Virginia (Boettcher 2015; NMFS and USFWS 1991a; Peterson et al. 1985; Schwartz 1989; USFWS 2005). Juveniles and subadults range as far north as Massachusetts (NMFS and USFWS 1991a) and are occasionally observed in Long Island Sound, Nantucket Sound, and Cape Cod Bay (CETAP 1982; Lazell 1980; Morreale et al. 1992). The STSSN reported four offshore and 68 inshore green sea turtle strandings between 2017 and 2021 from New York to Massachusetts, and green sea turtles are found each year stranded on Cape Cod beaches (NMFS STSSN 2022; Wellfleet Bay Wildlife Sanctuary 2018).

Occurrence in the Action Area

Green turtles may occur year-round in the Action Area. Sightings in or near the Project Area are limited. This species may occur in the Project Area in small numbers throughout the year. During the recent NYB surveys, one green sea turtle was sighted during spring 2016 (NYSERDA 2020). Kenney and Vigness-Raposa (2010) recorded one confirmed sighting within the RI-MA WEAs in 2005. Five green sea turtle sightings were recorded off the Long Island shoreline 10 to 30 mi (16 to 48 km) southwest of the WEAs during AMAPPS aerial surveys conducted from 2010 to 2013 (NEFSC and SEFSC 2018), but none were positively identified during the NLPSC aerial surveys of the RI-MA WEAs from October 2011 to October 2020 (Kraus et al. 2013; O'Brien et al. 2021a; O'Brien et al. 2021b; Quintana et al. 2019).

Feeding

Very young green turtles are omnivorous, leaning to carnivorous (Bjorndal 1997; Bjorndal 1985). Adult green turtles feed primarily on seagrasses (e.g., turtle grass [*Thalassia testudinum*], manatee grass [*Syringodium filliforme*], shoal grass [*Halodule wrightii*], and eelgrass [*Zostera marina*]), macroalgae, and reef-associated organisms (Bjorndal 1997; Burke et al. 1992). They also consume jellyfish, salps, and sponges (Bjorndal 1997; Mortimer 1995).

Hearing

Sea turtles have low frequency hearing. Hearing frequencies range from 30 Hz to 2 kHz with a range of maximum sensitivity between 100 to 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994; Ridgway et al. 1969). Sub-adult green turtles are known to respond to underwater stimuli between 100 and 500 Hz with maximum sensitivity between 200 and 400 Hz (Bartol and Ketten 2006), while juvenile green turtles have responded to stimuli between 50 and 1.6 kHz with maximum sensitivity between 200 and 400 Hz (Piniak et al. 2016).

3.4.2.3 Fish Species Included in the Analysis

The only ESA-listed fish species considered for analysis in this BA is the Atlantic sturgeon. There are five DPSs of Atlantic sturgeon present or likely to be present in the Action Area. A brief description of the status, distribution and habitat associations, feeding and hearing information, and known occurrence of Atlantic sturgeon in the Action Area are provided in this section.

Atlantic Sturgeon

Status

Five DPSs of Atlantic sturgeon are listed under the ESA: Chesapeake Bay (endangered), Carolina (endangered), NYB (endangered), South Atlantic (endangered), and Gulf of Maine (threatened) (NMFS 2012a; NMFS 2012b). The best estimate of abundance of Atlantic sturgeon in oceanic waters off the northeastern coast of the U.S. is 417,934 fish (67,776 fish when assuming a 50 percent catchability) based on 2006-2011 data from the Northeast Area Monitoring and Assessment Program inshore surveys (Kocik et al. 2013). Threats to these DPSs include degraded water quality, habitat impacts from dredging, continued bycatch in state and federally managed fisheries, and vessel strikes (ASSRT 2007; NMFS 2012b). The Atlantic sturgeon's DPS located within the New York Bight has been given a "high demographic risk" by the National Marine Fisheries Service (NMFS) due to low breeding productivity and limited distribution; however, NMFS believes that New York Bight's DPS of Atlantic sturgeon has a high potential to recover with management of anthropogenic threats (NMFS 2022c).

Distribution and Habitat

Atlantic sturgeon spawn in freshwater but spend most of their adult life in the marine environment. Subadult and adult Atlantic sturgeons emigrate from rivers into coastal waters where they may undertake long range migrations. The marine range of Atlantic sturgeon extends from St. Lawrence, Canada, to Cape Canaveral, Florida (NMFS 2012b). Results from genetic analyses indicate that adults intermix with populations from other rivers. For example, Atlantic sturgeon found in the NYB have been matched to not only the NYB DPS but also the Chesapeake Bay and Gulf of Maine DPSs (NMFS 2012b).

Juvenile habitat and migrations are limited to narrow corridors in shallow waters less than 20 m (Dunton et al. 2010). Migratory subadult and adult sturgeon are typically found in shallow (10 to 50 m) nearshore waters with gravel and sand substrates (Collins and Smith 1997; Erickson et al. 2011; Ingram et al. 2019; Stein et al. 2004b). Depth distribution is known to be seasonal with fish inhabiting deepest waters during winter and shallowest waters during summer and early fall (Erickson et al. 2011). Although extensive mixing occurs in coastal waters, Atlantic sturgeons return to their natal river to spawn (ASSRT 2007). Spawning adults generally migrate upriver in the spring/early summer (Smith and Clugston 1997). Spawning is believed to occur in flowing water between the salt front and fall line of large rivers. Male Atlantic sturgeon have been observing spawning more frequently than females, though females can spawn annually, and they have a greater level of variation in their spawning timings (NMFS 2022c). Post-larval juvenile sturgeon move downstream into brackish waters and eventually move to estuarine waters where they reside for a period of months or years (Moser and Ross 1995). Examination of young fish in the Connecticut River showed evidence that it was recolonized by Atlantic sturgeon from the Hudson River, and once they were post-larval, they remained in the low salinity water of their natal river for one year before transiting into more brackish water; this was supported by a genetic analysis which showed a high number of siblings, which indicated that there was a low number of breeding adults contributing to this cohort (NMFS 2022c).

Occurrence in the Action Area

Atlantic sturgeon may occur in the riverine, estuarine, and nearshore portions of the Action Area; however, there are not abundance estimates for the various DPSs (NMFS 2022c). In the Hudson and Delaware River and their associated estuaries, Atlantic sturgeon are likely to be present throughout the year as juveniles, and from spring to fall as subadults, adults, and when migrating to spawning areas in those watersheds. Atlantic sturgeon are known to aggregate off southwest Long Island (Erickson et al. 2011) which is part of the known overwintering habitat for juvenile Atlantic sturgeon between the NYB and Virginia (Dunton et al. 2010). Given their anticipated distribution in depths primarily 50 m and less (Stein et al. 2004b), Atlantic sturgeon may occur in the Project Area and the coastal nearshore and river vessel transit routes in the Action Area. Adult and subadult Atlantic sturgeon are expected to occur in the Project Area throughout the year based on tagging and capture data (Dunton et al. 2010; Ingram et al. 2019; Stein et al. 2004a; 2004b). Peak occurrence is expected during the fall and winter based on tagging data which detected a peak in occurrence in Atlantic sturgeon in the New York WEA from November through January and lower numbers of sturgeon in the area during July through September (Ingram et al. 2019).

Feeding

Atlantic sturgeon are benthic predators (ASSRT 2007). They feed on a variety of prey, including polychaete worms, crustaceans, mollusks, and fish such as sand lance (Johnson et al. 1997; Novak et al. 2017).

Hearing

While no studies have been conducted on Atlantic sturgeon hearing abilities, there are a few studies that document hearing abilities of other species of sturgeon (Hastings and Popper 2005; Lovell et al. 2005; Popper et al. 2014). The primary hearing range of sturgeons is generally described as a lower frequency (under approximately 1 kHz), and swim bladders are not utilized for hearing as with some other fish species (Popper et al. 2014). Atlantic sturgeon hearing may range from 100 to 500 Hz based on data collected from lake sturgeon (Lovell et al. 2005).

4.0 EFFECTS OF ACTION ORGANIZED BY STRESSOR (IMPACT-PRODUCING FACTOR)

In this section, we examine the activities associated with the Proposed Action and determine what the consequences of the Proposed Action are to listed species and/or critical habitat. The term “consequences,” was introduced to the ESA to replace “direct” and “indirect” effects in 2019. Consequences are a result or effect of an action on ESA species. Consequences are a result or effect of an action on ESA species. A consequence is caused by the Proposed Action if it would not occur but for the Proposed Action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR § 402.02).

The effects of the issuance of an MMPA LOA and other permits/authorizations, such as the USACE and EPA permits, are considered effects of the action as they would not occur but for the Proposed Action (e.g., the proposed construction of the Sunrise Wind project causes the need for an MMPA LOA); however, they are also federal actions that trigger consultation in their own right. This project will require an LOA, as well as permits from other federal agencies aside from BOEM, and we have analyzed the effects of those actions along with the effects of BOEM's Proposed Action.

NMFS uses two criteria to identify the ESA-listed species and designated critical habitat that are **not likely to be adversely affected** by the Proposed Action. A consequence is caused by the Proposed Action if it would not occur but for the Proposed Action and it is reasonably certain to occur. In analyzing effects, we evaluate whether a source of impacts is “likely to adversely affect” listed species/critical habitat or “not likely to adversely affect” listed species/critical habitat. A “not likely to adversely affect” determination is appropriate when an effect is expected to be discountable, insignificant, or completely beneficial.

A consequence is considered **likely to adversely affect** if the effects of the Proposed Action are not extremely unlikely to occur, insignificant, or beneficial, and may result in “take”. “Take” means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct” (ESA § 3[19]). If a Proposed Action has consequences that are likely to result in “take” or adversely affect ESA species, then Section 7(a)(2) of the ESA requires federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

“Jeopardize the continued existence of” means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR § 402.02).

“Destruction or adverse modification” means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of an ESA-listed species as a whole (50 CFR § 402.02).

Based on an analysis of potential consequences, we provide a determination for each species and designated critical habitat (**Table 19**). One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the Project: No effect; may affect, not likely to adversely affect; may affect, likely to adversely affect.

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

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

A **may affect, not likely to adversely affect** determination would be given if the Project’s effects are wholly beneficial, insignificant, or discountable.

1. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat.
2. *Insignificant* effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. *Insignificant* is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
3. *Discountable* effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is extremely unlikely to occur (USFWS and NMFS 1998).

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

Table 19. Determination for each species and designated critical habitat in and around the Project Area by each impact-producing factor.

	Marine Mammals				Sea Turtles				Marine Fish
IPF	Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon
Impact Pile-Driving Noise	LAA for PTS and TTS/BD	LAA for PTS and TTS/BD	LAA for PTS and TTS/BD	NLAA for PTS LAA for TTS/BD	NLAA for PTS and TTS/BD	LAA for PTS, NLAA for TTS/BD	NLAA for PTS and TTS/BD	NLAA for PTS and TTS/BD	NLAA
Vibratory Pile-Driving Noise	NLAA for PTS LAA for TTS/BD	NLAA for PTS LAA for TTS/BD	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
HRG Survey Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
WTG Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Aircraft Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Cable Laying or Trenching Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Dredging Noise	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA

	Marine Mammals				Sea Turtles				Marine Fish
IPF	Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon
UXO	NLAA for mortality/slight lung injury/ gastrointestinal injury LAA for PTS and TTS/BD	NLAA for PTS/mortality/ slight lung injury/ gastrointestinal injury LAA for TTS/BD	NLAA	NLAA	NLAA	NLAA	NLAA for PTS/mortality/ slight lung/ gastrointestinal injury LAA for TTS/BD	NLAA	LAA
Habitat Disturbance	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Secondary Entanglement from Increased Recreational Fishing Due to Reef Effect	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Traffic	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	NLAA

	Marine Mammals				Sea Turtles				Marine Fish
IPF	Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Kemp's Ridley Sea Turtle	Atlantic Sturgeon
Monitoring Surveys	NLAA	NLAA	NLAA	NLAA	NLAA for all except for trawl surveys which are LAA for capture/ potential injury	NLAA	NLAA for all except for trawl surveys which are LAA for capture/ potential injury	NLAA for all except for trawl surveys which are LAA for capture/ potential injury	NLAA for all except for trawl surveys which are LAA for capture/ potential injury
EMF	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Air Emissions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Dredging	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Lighting/ Marking of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Oil Spills/ Chemical Release	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unanticipated Events	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Overall Effects Determination	**LAA**	**LAA**	**LAA**	**LAA**	**NLAA**	**LAA**	**LAA**	**LAA**	**LAA**

Notes:

BD = behavioral disturbance; DPS = distinct population segment; EMF = electromagnetic field; HRG = high-resolution geophysical; LAA = likely to adversely affect; NLAA = not likely to adversely affect; TTS = temporary threshold shift; PTS = permanent threshold shift; TBD = to be determined following additional analysis; UXO = unexploded ordinance; WTG = wind turbine generator

4.1 Description of Impact-Producing Factors

Based on the methods described in the COP, potential effects from the proposed Project have been broken down and described by the various impact producing elements.

IPF	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to IPF	NLAA or LAA
Accidental releases	Refers to unanticipated release or spills into receiving waters of a fluid or other substance such as fuel, hazardous materials, suspended sediment, trash, or debris. Accidental releases are distinct from routine discharges, the latter typically consisting of authorized operational effluents controlled through treatment and monitoring systems and permit limitations.	Onshore or offshore stationary sources (e.g., renewable energy structures, transmission lines, cables) or mobile sources (e.g., vessels) Dredged material ocean disposal	Blue whale Fin whale NARW Rice's whale Sei whale Sperm whale Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray Oceanic whitetip shark Shortnose sturgeon NARW CH Loggerhead sea turtle CH	NLAA
Intakes and Discharges	Generally, refers to routine permitted operational effluent discharges to receiving waters. There can be numerous types of vessel and structure discharges, such as bilge water, ballast water, deck drainage, gray water, fire suppression system test water, chain locker water, exhaust gas scrubber effluent, condensate, and seawater cooling system effluent, among others. These discharges are generally restricted to uncontaminated or properly treated effluents that may have best management practice or numeric pollutant concentration limitations imposed through U.S. Environmental Protection Agency National Pollutant Discharge Elimination System permits or U.S. Coast Guard regulations.	Onshore point and non-point sources Dredged material ocean disposal Vessels Structures Submarine transmission lines, cables, and infrastructure	Blue whale Fin whale NARW Rice's whale Sei whale Sperm whale Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray Oceanic whitetip shark Shortnose sturgeon NARW CH Loggerhead sea turtle CH	NLAA

IPF	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to IPF	NLAA or LAA
Air emissions	Refers to the release of gaseous or particulate pollutants into the atmosphere. Can occur onshore and offshore.	Internal combustion engines (such as generators) aboard stationary sources or structures. Internal combustion engines within mobile sources such as vessels, vehicles, or aircraft.	Blue whale Fin whale NARW Rice's whale Sei whale Sperm whale Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle	NLAA
Anchors/Mats	Anchors, anchor chain sweep, mooring, and the installation of bottom-founded structures can alter the seafloor. Does not refer to designated anchorage areas for marine transportation, all of which are far from wind energy lease or planning areas.	Anchoring of vessels Attachment of a structure to the sea bottom by use of an anchor, mooring, or gravity-based weighted structure (i.e., bottom-founded structure)	Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA

IPF	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to IPF	NLAA or LAA
Electromagnetic fields and heat	Power lines produce electric fields (proportional to the voltage of the lines) and magnetic fields (proportional to flow of electric current) in the air around the power line. For undersea power cables, the voltage on the wire conductors within the cable does not produce an electric field in the seafloor or ocean because it is locked (shielded) by the outer grounded metallic sheath encircling the conductors; however, the metal sheath magnetic around the undersea power cable do not shield the environment from the magnetic field; therefore, a 60-hertz magnetic field surrounds each cable. This oscillating alternating current magnetic field, in turn, induces a weak electric field in the surrounding ocean that is unrelated to the voltage of the cable. This means when the current flow on the undersea power cable increases or decreases, both the magnetic field and the induced electric field increase or decrease. Three major factors determine levels of the magnetic and induced electric fields from offshore wind energy projects: 1) the amount of electrical current being carried by the cable, 2) the design of the cable, and 3) the distance of marine organisms from the cable.	Electricity generation Substations Power transmission cables Inter-array cables	Fin whale NARW Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA
Land disturbance	Refers to land disturbances for any onshore construction activities.	Onshore construction Onshore land use changes Erosion and sedimentation	Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA

IPF	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to IPF	NLAA or LAA
Lighting	Refers to the presence of light above the water onshore and offshore as well as underwater associated with offshore wind development and activities that utilize offshore vessels.	Vessels or offshore structures above or under water Onshore infrastructure	Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray Oceanic whitetip shark Shortnose sturgeon NARW CH Loggerhead sea turtle CH	NLAA
New cable emplacement/ maintenance	Refers to disturbances associated with installing new offshore submarine cables on the seafloor, commonly associated with offshore wind energy.	Dredging or trenching Cable placement Seabed profile alterations Sediment deposition and burial	Fin whale NARW Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA
Noise: In-Air	Refers to noise from various sources. Commonly associated with construction activities including vessel traffic, turbine-generated noise, wind and waves.	Aircraft Operation and maintenance Turbines Vessels Wind Waves	Blue whale Fin whale NARW Rice's whale Sei whale Sperm whale Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle NARW CH Loggerhead sea turtle CH	NLAA
Noise: Underwater	Refers to noise from various sources. Commonly associated with construction activities, geophysical and geotechnical surveys, and vessel traffic. May be impulsive (e.g., pile driving), or may be broad spectrum and continuous (e.g., from project-associated marine transportation vessels). May also include noise generated from turbines themselves or interactions of the turbines with wind and waves.	Aircraft Geological and geophysical Operation and maintenance Pile driving / Foundation Installation Turbines Vessels	Blue whale Fin whale NARW Rice's whale Sei whale Sperm whale Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Giant manta ray Oceanic whitetip shark Shortnose sturgeon NARW CH Loggerhead sea turtle CH	LAA

IPF	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to IPF	NLAA or LAA
Port utilization	Refers to effects associated with port activity, upgrades, or maintenance that occur only as a result of the project. Includes activities related to port expansion and construction from increased economic activity and maintenance dredging or dredging to deepen channels for larger vessels.	Expansion / Rehabilitation Near-shore pile driving Cofferdams	Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA
Presence of structures	Refers to effects associated with onshore or offshore structures other than construction-related effects, including the following: Fish aggregation/dispersion Scour protection Allisions Entanglement/entrapment from lost fishing gear Gear loss/damage Fishing effort displacement Habitat alteration (creation and destruction) Migration disturbances Seabed alterations	Onshore and offshores structures including towers and transmission cable infrastructure	Fin whale NARW Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA
Biological surveys	Refers to effects from biological surveys conducted pre-, post-, and during construction Bottom habitat disturbance Removal of biological samples Entanglement/entrapment from lost fishing gear	Aerial- and vessel-based surveys Fish surveys Benthic surveys	Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon	NLAA

IPF	Description	Sources and/or Activities	Listed Species and Critical Habitat Exposed to IPF	NLAA or LAA
Traffic	Refers to marine and onshore vessel and vehicle congestion, including vessel strikes of sea turtles and marine mammals, collisions, and allisions.	Aircraft Vessels Onshore vehicles	Blue whale Fin whale NARW Rice's whale Sei whale Sperm whale Green sea turtle Hawksbill sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic salmon Atlantic sturgeon Giant manta ray Oceanic whitetip shark Shortnose sturgeon Atlantic sturgeon CH NARW CH Loggerhead sea turtle CH	LAA
Unexpected/ unanticipated events	Effects associated with unexpected and unanticipated events, such vessel collision with foundation, failure of turbines due to weather events, oil spills, and unexploded ordinance encounters.	Offshore structures Vessels Unexploded ordnance encounters/response	Fin whale NARW Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon Shortnose sturgeon	NLAA

Notes:

CH = critical habitat; IPF = impact-producing factor; LAA = likely to adversely affect; NARW = North Atlantic right whale; NLAA = not likely to adversely affect

Each of these sources of potential impacts is described below.

4.2 Underwater Noise

Anthropogenic sounds, such as those associated with the Proposed Action, can impact marine mammals, sea turtles, and fish in a variety of ways. The intensity of those impacts depends on the type or source of sound and the hearing physiology of the animal.

The noise associated with offshore wind project construction and operation generally falls into two categories: (1) impulsive noise sources, such as impact pile driving, which generate sharp instantaneous changes in sound pressure and (2) intermittent or continuous non-impulsive noise sources, such as vessel engine noise, vibratory pile driving, and WTG operation, which remain relatively constant and stable over a given time period. NMFS recognizes high underwater SPLs as a possible source of take for ESA-listed aquatic species, including large whales, sea turtles, and fish occurring in the Action Area. The Proposed Action would produce temporary construction-related and long-term operational underwater noise above levels that may impact ESA-listed species.

Preconstruction noise impacts may occur from vessel operation and geophysical and geotechnical (G&G) survey activities. During the construction phase of the project, sources of increased underwater noise include pile driving (impact and vibratory), vessel operations, UXO/MEC detonations and other underwater construction activities (cable laying, placement of scour protection, dredging). During the O&M phase of the project, sources of increased underwater noise are limited to WTG operations, vessel and aircraft operations, and maintenance activities. During decommissioning, sources of increased underwater noise include removal of project components and associated surveys, as well as vessel and aircraft operations.

Impulsive and non-impulsive noise sources associated with offshore wind projects and other activities likely to occur as a result of this Project are discussed below.

4.2.1 Impact Pile Driving – C

4.2.1.1 Modeling Methods

The analysis of potential effects of pile driving appears in the subsections for each species. The followjng section describes the modeling and basis required to understand the effects analysis. Underwater noise generated by impact pile driving could result in physiological and behavioral effects that could result in potential adverse effects impacts to ESA-listed species of marine mammals, sea turtles, and Atlantic sturgeon. Impact pile driving may produce relatively high source levels that ensonify large distances that may exposure animals to different levels of noise. Up to 87 WTG foundations and 1 OCS–DC foundation with four legs, each leg with two pin piles, would be installed. The typical SRWF WTG foundation pile installation would require approximately 1 to 4 hours of impact pile driving to a final embedment depth of 164 ft (50 m) below the seafloor, with some difficult installations potentially taking up to 12 hours to install due to more difficult substrate conditions. After installation, the WTG would be placed on top of the foundation pile and the vessels would be repositioned to the next site. Between one and three WTG monopile foundations may be installed per day.

Monopile foundations for WTGs will be 12 m in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kJ. The pin piles used to secure the OCS–DC piled jacket foundation will be up to 13 ft (4 m) in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kJ.

Impact pile driving noise effects on ESA-listed animals are evaluated based on the intensity of the noise source, distance from the source, the duration of sound exposure, and species-specific sound sensitivity. Underwater noise impacts on ESA-listed animals were evaluated using behavioral and injury-level thresholds for different species groups developed by NMFS (2018a) (**Table 20**). Specific injury thresholds are defined for different species and hearing groups based on hearing sensitivity. Dual injury criteria have been defined for each group for instantaneous exposure to a single impulsive pile strike, and cumulative exposure to multiple pile strikes or extended non-impulsive sources (NMFS 2018a). NMFS behavioral thresholds are based on noise levels known to alter behavior and/or interfere with communication.

Table 20. Permanent threshold shift onset acoustic thresholds for marine mammal hearing groups.

Faunal Group	Impulsive Signals[1]		Non-Impulsive Signals
	Unweighted L_{pk} (dB re 1 μPa)	**Frequency-weighted $L_{E,24h}$ (dB re 1 μPa²·s)**	**Frequency-weighted $L_{E,24h}$ (dB re 1 μPa²·s)**
Low Frequency Cetaceans	219	183	199
Mid Frequency Cetaceans (sperm whales)	230	185	198

Notes:

Source: NMFS (2018a) included in COP, Appendix I1 (Underwater Acoustic Assessment) (Sunrise Wind 2022d)

[1] Dual-metric acoustic thresholds for impulsive sounds: The largest isopleth result of the two criteria is used for calculating permanent threshold shift onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds have also been considered.

μPa = micropascal; μPa² s = micropascal squared second; dB = decibel(s); $L_{E,24hr}$ = decibel re 1 micropascal squared second cumulative sound exposure level; L_{pk} = peak sound pressure level; m = meter

As part of the COP, Appendix I1 (underwater acoustic assessment) (Sunrise Wind 2022d), impacts to marine mammals, sea turtles, and fish were assessed. The acoustic propagation model predicts sound fields for a 24-hour period, or a specific scenario, which includes consideration of the hammer energies required to drive the pile from start to finish, as well as the silent periods between two consecutive piles (if applicable in the impact pile driving scenario), and any proposed noise mitigation measures. The highest estimates of impacts across all modeled scenarios were used to assess potential impacts. Within this assessment, the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was utilized to predict the probability of exposure of marine mammals and sea turtles (fish species were not modeled using JASMINE) to sound arising from pile driving operations during construction activities. Simulated animals (animats) were used to sample predicted three-dimensional sound fields derived from animal movement observations. Predicted sound fields were sampled so that animats were programmed to behave like marine species are expected to under normal circumstances, and the output provided an exposure history for each animat included within the simulation. Both peak sound pressure level (L_{pk}) and cumulative sound exposure level ($L_{E,24hr}$) were calculated for each species based on corresponding acoustic criteria.

Appendix I1 (Sunrise Wind 2022d), additionally provides modeled sound propagation distances based on expected construction scenarios associated with the PDE such as hammer type, pile type, pile schedule (hammer energy, number of strikes, piling duration), season, geographic location, and implementation of noise mitigation (i.e., sound attenuation) measures. The acoustic ranges to the sound exposure level (SEL) physiological threshold assume an animal is stationary within the propagated sound field and thus that it accumulates noise levels for the full 24-hour period. When modeled animal behavior and movement are considered, the predicted risk of exposure to accumulated noise levels with the potential to cause a physiological impact is lower (exposure range). As evidenced by the variable monthly densities of marine mammals in the SRWF, seasonality is an important parameter when estimating exposures and impacts from potential sources of underwater noise.

Sounds produced by installation of the 12-m WTG monopiles were modeled at two representative locations: one in the northwestern section of the SRWF area and one in the southeast section (**Figure 9**). The installation of pin piles to secure the OCS–DC jacket foundation were modeled at one location in the central portion of the SRWF area (**Figure 9**). All piles were assumed to be vertical and driven to a maximum expected penetration depth of 50 m for the WTG monopiles and 90 m for the OCS–DC jacket foundation pin piles. For the 12-m WTG monopiles, 10,398 total hammer strikes were assumed, with hammer energy varying from 1,000 to 3,200 kJ. A single strike at 4,000 kJ on a 12-m WTG monopile was also modeled in case the use of the maximum hammer energy is required during some installations. The smaller 4-m pin piles for the OCS–DC jacket foundation were assumed to require 17,088 total strikes with hammer energy ranging from 300 to 4,000 kJ during the installation.

Forcing functions for impact pile driving were computed for each pile type using GRLWEAP (Pile Dynamics Inc. 2020). The resulting forcing functions were used as inputs to JASCO's impact pile driving source model to characterize the sounds generated by the piles. Acoustic sound fields were estimated using JASCO's Marine Operations Noise model (MONM) and Full Wave Range Dependent Acoustic Model. To account for the likely minimum sound reduction resulting from noise abatement systems (NASs) such as bubble curtains, the modeling study included hypothetical broadband attenuation levels of 0, 6, 10, and 15 dB for all impact pile driving acoustic modeling results.

Due to seasonal changes in the water column, sound propagation is likely to differ at different times of the year. To capture this variability, acoustic modeling was conducted using an average sound speed profile for a "summer" period including the months of May through November, and a "winter" period including December through April. Additional details on modeling inputs and assumptions are described in Appendix A of the ITR Application (Sunrise Wind 2022j).

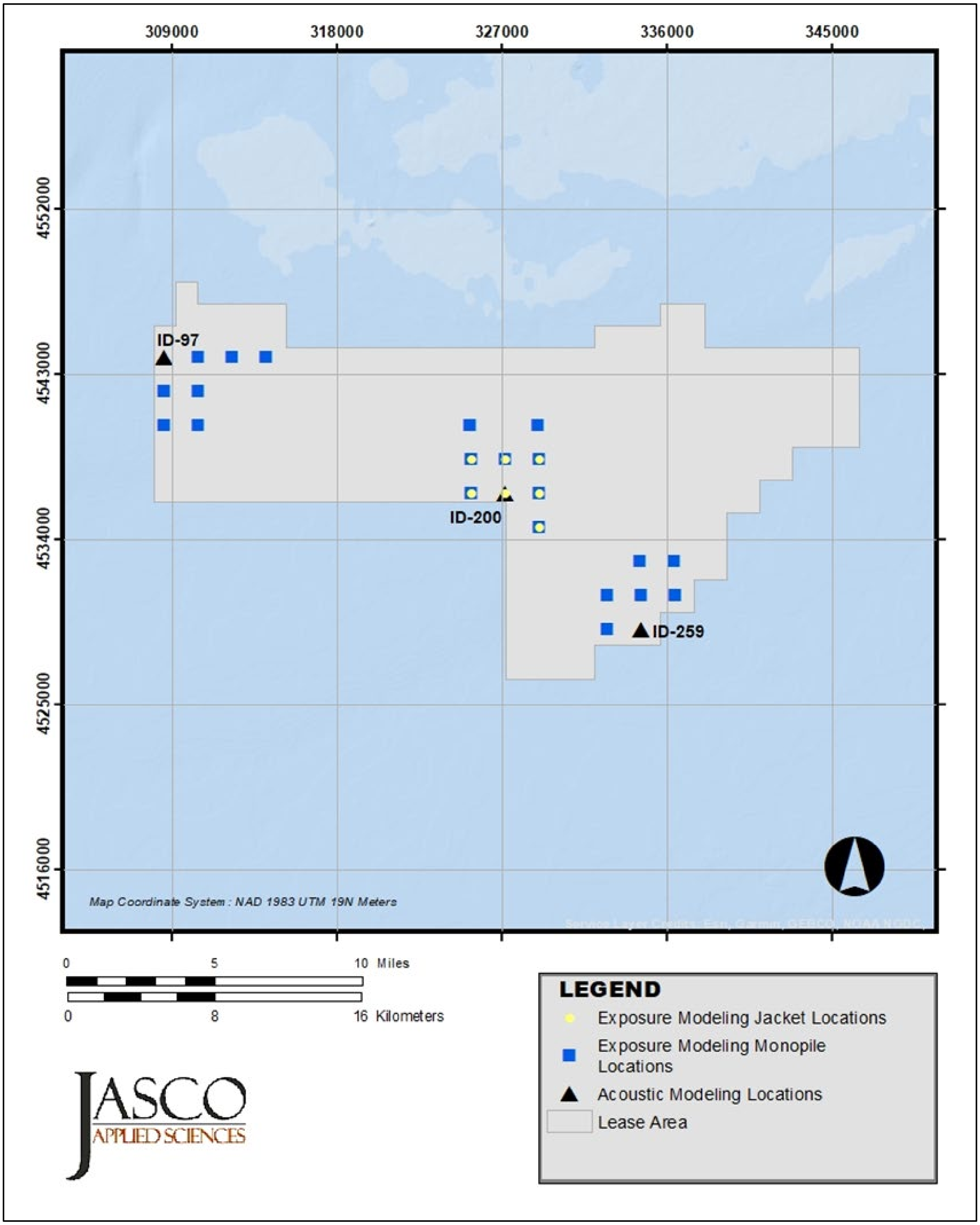

Figure 9. Location of acoustic propagation and animal exposure modeling for wind turbine generator monopile and Offshore Converter Station piled jacket foundations (from Sunrise Wind 2022d).

The acoustic modeling included assumptions about the potential effectiveness of one or more NAS, such as bubble curtains, evacuated sleeve systems, encapsulated bubble systems (HydroSound Dampers), and Helmholtz resonators (AdBm) in reducing sounds propagated into the surrounding marine environment. Several recent studies summarizing the effectiveness of NAS have shown that broadband sound levels are likely to be reduced by anywhere from 7 to 17 dB, depending on the environment, pile size, and the size, configuration and number of systems used (Bellmann et al. 2020; Buehler et al. 2015). The single bubble curtain applied in shallow water environments regularly achieves 7- to 8-dB broadband attenuation (Bellmann 2014; Lucke et al. 2011; Rustemeier et al. 2012). More recent in situ measurements during installation of large monopiles (~8 m) for WTGs in comparable water depths and conditions indicate that attenuation levels of 10 dB are readily achieved for a single bubble curtain (Bellmann et al. 2020). Large bubble curtains tend to perform better and more reliably, particularly when deployed with two rings (Bellmann 2014; Bellmann et al. 2020; Koschinski and Ludemann 2013; Nehls et al. 2016). A California Department of Transportation study tested several small, single, bubble curtain systems and found that the best attenuation systems resulted in 10 to 15 dB of attenuation (Buehler et al. 2015). Buehler et al. (2015) concluded that attenuation greater than 10 dB could not be reliably predicted from small, single, bubble curtains because sound transmitted through the seabed and reradiated into the water column is the dominant sound in the water for bubble curtains deployed immediately around the pile. Combinations of systems (e.g., double big bubble curtain, HydroSound damper plus single big bubble curtain) potentially achieve much higher attenuation. The type and number of NAS to be used during construction have not yet been determined but will consist of at a minimum a single bubble curtain paired with an additional sound attenuation device or a double big bubble curtain. Based on prior measurements, this combination of NAS is reasonably expected to achieve far greater than 10-dB broadband attenuation of impact pile driving sounds.

The ranges to threshold levels resulting from the acoustic modeling are reported using two different terminologies to reflect the underlying assumptions of the modeling. The term “acoustic range” is used to refer to acoustic modeling results that are based only on sound propagation modeling and not animal movement modeling. Acoustic ranges assume receivers of the sound energy are stationary throughout the duration of the exposure. These are most applicable to thresholds where any single instantaneous exposure above the threshold is considered to cause a take, such as the PTS L_{pk} thresholds and the behavioral disturbance root mean square sound pressure level (L_{rms}) thresholds. For $L_{E,24hr}$-based thresholds, acoustic ranges represent the maximum distance at which a receiver would be exposed above the threshold level if it remained present during the entire sound producing event or 24 hours, whichever is less. Because of the instantaneous or single event nature of these thresholds, acoustic ranges will not differ between installation scenarios that assume consecutive piling and concurrent piling.

Pile driving will only occur during the construction and installation portion of the project. Project mitigation measures include an in-water construction window of May 1 to December 31 to minimize potential noise impacts on North Atlantic right whales. No pile driving would occur at the SRWF and OCS–DC facility outside of the construction window. This would effectively reduce the potential for North Atlantic right whale exposure to pile-driving noise; however, other ESA-listed species may be present in the vicinity during this construction window and could be exposed to behavioral and injury-level noise effects. In addition, underwater noise could indirectly affect ESA-listed animals by killing, injuring, or altering the behavior of fish prey species. As described in Appendix H, additional protection measures include noise attenuation technologies, soft starts for pile driving, timing restrictions, the use of 6 to 8 trained PSOs for monopile installation, exclusion and monitoring zones, passive acoustic monitoring systems, reduced visibility monitoring tools, adaptive vessel speed reductions, and utilization of software to share visual and acoustic detection data between platforms in real time. PSOs will perform pre-clearance monitoring of the area surrounding the construction site for 60 minutes prior to beginning pile driving. PSOs will also enforce shutdown zones when marine mammals are observed within the shutdown zones. Pile driving will not resume until individuals leave the shutdown zone of their own volition, and no animals are observed within the shutdown zone for at least 30 minutes. Pre-clearance monitoring and shutdown zones are detailed in **Table 21**. Additional monitoring and mitigation measures are described in **Tables 14** and **15**.

Table 21. Mitigation and monitoring zones during impact pile driving assuming 10 decibels of broadband sound attenuation.

Species	Summer (May through November)	Winter (December only)
	Pre-start Clearance and Shutdown Zone (m)[1]	Pre-start Clearance Zone and Shutdown Zone (m)[1]
North Atlantic right whale (WTG monopiles and OCS–DC pin piles)	At any distance	At any distance
All other listed whales (WTG monopiles)	3,700	4,300
All other listed whales (OCS–DC pin piles)	5,600	6,500

Notes:

Source: Adapted from the draft Protected Species Mitigation and Monitoring Plan dated April 2022 (Sunrise Wind 2022k)

[1] Dual-metric acoustic thresholds for impulsive sounds: The largest isopleth result of the two criteria is used for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds have also been considered.

μPa = micropascal(s); dB = decibel(s); $L_{E,24hr}$ = decibel re 1 micropascal squared second cumulative sound exposure level; L_{pk} = peak sound pressure level; m = meter(s); OCS–DC = Offshore Converter Station; s = micropascal squared second(s) ; WTG = wind turbine generator

4.2.2 Vibratory Pile Driving – C

4.2.2.1 Modeling Methods

The analysis of potential effects of pile driving appears in the subsections for each species. The following section describes the modeling and basis required to understand the effects analysis. Vibratory pile driving is anticipated to occur during the construction and installation phase for the export cable landfall and temporary equipment trestle. This portion of the construction will include the installation of a temporary casing pile and 'goal posts' steel sheet piles. Because of the lower thresholds to behavioral disturbance for marine mammals (120 dB, root mean square) as compared to impact pile driving, vibratory pile driving can result in behavioral disturbance for marine mammals at distances much greater than for impact pile driving, often reaching 10,000 m or more.

Acoustic modeling for vibratory pile driving at the HDD exit pit location was also performed to determine threshold distances from installation of sheet piles to create the casing pipe support "goal posts" and support the construction barge. The modeling assumed the use of an APE model 300 vibratory hammer to drive the sheet piles vertically to 10 m below the seabed. For modeling purposes, it was assumed that each pile would require 2 hours to install and up to four piles would be installed per day (**Table 22**).

Results of the sheet pile installation acoustic modeling are shown in **Table 23**. The estimated distance to the Level B threshold, 9.74 km, is much greater than the approximate 805-m (0.5-mi) distance to shore from the construction site. The shoreline adjacent to this location is quite linear and effectively splits a circle of 9.74 km in half. Thus, the area of a circle with 9.74-km radius (pi × r^2 where r is 9.74 km) was calculated and divided in half resulting in a Level B ensonified area of 149 square kilometers (km^2) from sheet pile installation.

The distances to PTS $L_{E,24hr}$ thresholds are relatively short and assume animals would remain within those distances for the entire 8-hour duration of pile driving in a day. This, in addition to the planned monitoring and mitigation around the landfall construction activities, means PTS exposures are not anticipated.

Table 22. Sheet pile installation acoustic modeling assumptions.

Parameter	Model Input
Vibratory Hammer	APE 300
Pile Type	Sheet Pile
Pile Length	30 m
Pile Width	0.6 m
Pile Wall Thickness	2.54 cm
Seabed Penetration	10 m
Time to Install 1 Pile	2 hrs
Number of Piles per Day	4

Notes:
cm = centimeter(s); hrs = hours; m = meter

Table 23. Acoustic ranges ($R_{95\%}$) in meters to permanent threshold shift and Level B disturbance thresholds from vibratory pile driving during sheet pile installation for marine mammal functional hearing groups assuming a winter sound speed profile.

	Range (m)	
Marine Mammal Hearing Group	Level A SEL_{cum} Thresholds (dB re 1 $\mu Pa^2 \cdot s$)	Level B SPL_{rms} Threshold (120 dB re 1 μPa)
Low-frequency	5	9,740
Mid-frequency	-	9,740
High-frequency	190	9,740
Phocid pinniped	10	9,740

Notes:
μPa = micropascal; μPa^2 s = micropascal squared second; dB = decibel(s); m = meter; SEL_{cum} = decibel re 1 micropascal squared second cumulative sound exposure level; SPL_{rms} = sound pressure level, root mean square

The Proposed Action includes a range of measures to avoid and minimize marine mammal exposure to injurious pile-driving noise. The Project would adhere to timing restrictions to avoid periods of peak North Atlantic right whale occurrence to the greatest extent practicable. The project will maintain clearance and exclusion zones of 0.8 NM (1,500 m) around vibrator pile driving for all ESA-listed species. Clearance zones must be clear of target species for at least 60 minutes before pile driving can begin. The exclusion zone is the area in which shutdown or other mitigation measures must be implemented if a whale enters that zone while a noise source is active.

4.2.3 Temporary Equipment Trestle – C

The potential effects from underwater noise associated with the installation of the Temporary Equipment Trestle will be contained entirely within Narrow Bay and a portion of Bellport Bay. Because of this, no ESA-listed marine mammals will be exposed to these effects.

Installation and removal of up to 24 temporary piles would be completed using only vibratory pile driving equipment. The up to 24 production piles will first be driven using a vibratory hammer followed by an impact hammer. A vibratory hammer with a centrifugal force of approximately 160 tons (e.g., APE 200) would be used for both installation and removal of piles. An impact hammer with a rated energy of approximately 15,000 ft-lb (e.g., APE D8-42) would be used to complete installation of the production piles. Both production and temporary piles will be removed using vibratory pile driving.

The construction sequence will begin with installation of up to two temporary piles using a vibratory hammer to support the template at each grouping of production piles that form a bent. Installation of a single temporary pile will require up to 15 minutes of vibratory pile driving. Once the temporary piles and template are in place, the bent production piles will be driven into place using a vibratory hammer followed by an impact hammer. Up to 15 minutes of pile driving may be required for each production pile, with vibratory pile driving for approximately 90% of the installation time (~13.5 min) followed by impact pile driving for the remaining 10 percent of the installation time (~1.5 min). Following installation of the bent production piles, the temporary piles supporting the template will be removed using only vibratory pile driving (up to 15 minutes each), and the template will be moved to the next position and again secured in place using up to two temporary piles. This process will continue until all production piles are installed.

It is anticipated that installation of the pier will occur over approximately three to four weeks in and around January to February 2024 (upon receipt of all necessary permits). Installation of up to 24 production piles may result in a total of up to 324 minutes (5 hours 24 min) of vibratory pile driving (24 x 13.5 min) and 36 minutes of impact pile driving (24 x 1.5 min). Installation and removal of up to 24 temporary piles may require up to 720 minutes (16 hours) of vibratory pile driving only (2 x 24 x 15 min). The maximum total pile driving time for installation is therefore 1,044 min (17 hours 24 min) of vibratory pile driving and 36 minutes of impact pile driving.

Following completion of the landfall construction work on Fire Island, the temporary pier is expected to be removed in approximately April or May of 2025. Removal of the temporary pier would involve the removal of all 24 production piles using a vibratory hammer. Thus, the total duration of vibratory pile driving during pier removal may be up to 360 min (6 hours; 24 x 15 min).

A total of 12 piles may be installed or removed per day, therefore the installation of the temporary equipment trestle could result in up to 3 hours of vibratory pile driving, and up to 18 minutes of impact pile driving. Based on the anticipated duration of impact pile driving to finalize the installation of the production piles, we are assuming up to 100 impact strikes per pile. In selecting proxies for sound source levels, we use the most conservative value between the 14-in H-type pile and 16-in steel pipe piles of the available source levels using NMFS Multi-species Pile Driving Tool (NMFS 2022b). A direct proxy was not available for the 16-in. steel pipe pile for vibratory installation, so we used the next size up (18-in.) to provide a conservative estimate. The steel pipe pile proxy had higher source SEL than the H-type pile for vibratory installation, while the H-type pile proxy source levels had higher values for impact pile driving.

When multiple pile-types and/or installation methods are proposed, the noise analysis will evaluate the worst-case scenario. That is, we will present the pile-type and/or installation method with the largest effect radius and assume all other pile driving noise effects will fall within that radius. In this case, the potential for effects to fish and sea turtles is much greater for impact pile driving than from vibratory installation, therefore those results are presented here.

According to the Multi-species Pile Driving Tool (NMFS 2022b), the installation of up to 12 H-type steel piles per day using up to 100 strikes per pile could result in a single strike injury to fish to a distance of 13.6 m, and to sea turtles to a distance of 0.8 m. The installation could result in cumulative SEL injury to fish at a radius of 243.3 m, and to sea turtles to a radius of 17.9 m. We believe that the potential for injury to sea turtles and fish is discountable. PSOs will observe the area prior to and during pile driving, and pile driving will not occur when ESA-listed species have been observed. If an individual approaches within 150 yards, pile driving activity will cease until that individual has level the area of their own volition, or until 20 minutes have passed since they were observed. Further, for an individual to experience PTS, they must remain in the area for the installation of multiple piles. Individuals are expected to move away from sound levels above the behavioral threshold, making it extremely unlikely that an individual would be exposed to cumulative sound levels that would result in injury.

According to the Multi-species Pile Driving Tool (NMFS 2022b), the installation of 14-in H-type steel piles could result in behavioral effects to fish to a radius of 1,585 m and to sea turtles to a radius of 34.1 m. We believe this effect will be insignificant due to the mobility of these species project. Although we generally expect individuals to move away from sound disturbances, fish could be caught within the area of behavioral effects from impact pile driving. However, this would only occur for 1.5 minutes at a time, and no more than 12 times per day. Since the pile installations will occur intermittently, all listed species will be able to resume normal activities between pile installations.

Based on the above information, and because the potential for effects from the installation of the Temporary Equipment Trestle is discountable or insignificant. Therefore, installation of the temporary equipment trestle **may affect, but is not likely adversely affect** all ESA-listed species.

4.2.4 Geotechnical and Geophysical Surveys – P, C, O&M

HRG surveys will take place within the SRWF as well as along the SRWEC. For some species, marine mammal densities may differ between the more nearshore areas along the SRWEC and the more offshore location of the SRWF. For that reason, separate densities were calculated for the two areas and the total anticipated survey effort was similarly split between the two locations as described below.

HRG surveys will be carried out on a routine basis during the 3 years of operations expected under the requested incidental take regulations. Potential takes for these HRG surveys during the operations phase were calculated using the same approach as described for the construction phase but assume a reduced level of survey effort on an annual basis as described below.

HRG surveys will be carried out on a routine basis during the 3 years of operations expected under the requested incidental take regulations. Potential exposures under the MMPA application for HRG surveys were calculated using the same approach as described for the construction phase but assume a reduced level of survey effort on an annual basis. Short-term, localized HRG surveys during the construction period may include the use of multi-beam echosounders, side-scan sonars, shallow penetration SBPs, medium penetration SBPs, and marine magnetometers. The survey equipment to be employed would be equivalent to the equipment utilized during the HRG survey campaigns associated with Lease Area OCS-A 0500 conducted in 2016, 2017, 2018, 2019, and 2020 and with Lease Area OCS-A 0487 conducted in 2018, 2019, and 2020 (Gardline 2021a; 2021b; Smultea Sciences 2020a; 2020b). Site-specific verification was conducted of all geophysical equipment sound sources deployed within the marine portions of the proposed Project Area that operate within the functional hearing range of marine mammals. Without mitigation, certain types of G&G surveys could result in short-term, behavioral impacts on marine mammals. Typically, the distances at which temporary loss of hearing sensitivity; and permanent auditory injury do not exist or are so small that hearing impacts are not expected to occur.

Several different types of equipment may be used during HRG surveys, including single-beam echosounders, multibeam echosounders, side scan sonars, nonparametric SBPs, parametric SBPs, boomers, and sparkers. Only the sounds produced by SBPs, boomers, and sparkers have the potential to cause incidental take so representative instruments were modeled and distances to threshold levels determined (**Table 24**).

Table 24. Summary of representative high-resolution geophysical survey equipment and operating parameters used to calculate distances to incidental take threshold levels.

Equipment Type	Representative Model	Operating Frequency (kHz)	Source Level SPL_{rms} (dB)	Source Level 0-pk (dB)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)	Information Source
Sub-bottom Profiler	EdgeTech 216	2 – 16	195	-	20	6	24	MAN
	EdgeTech 424	4 – 24	176	-	3.4	2	71	CF
	Edgetech 512	0.7 – 12	179	-	9	8	80	CF
	GeoPulse 5430A	2 – 17	196	-	50	10	55	MAN
	Teledyn Benthos Chirp III - TTV 170	2 – 17	197	-	60	15	100	MAN
Sparker	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	0.3 – 1.2	203	211	1.1	4	Omni	CF
Boomer	Applied Acoustics triple plate S-Boom (700-1,000 J)	0.1 – 5	205	211	0.6	4	80	CF

Notes:

Source Levels are given in dB re 1 micropascal @ 1 meter

- = not applicable; dB = decibel(s); CF = Crocker and Fratantonio Crocker and Fratantonio (2016); Hz = hertz; kHz = kilohertz; MAN = Manufactures Specifications; ms = millisecond(s); SPL_{rms} = sound pressure level, root mean square

In general, G&G noise resulting from offshore wind site characterization surveys is of less intensity than the acoustic energy characterized by seismic air guns and affects a much smaller area than G&G noise from seismic air gun surveys typically associated with oil and gas exploration. Although seismic air guns are not used for offshore wind site characterization surveys, SBP technologies that are hull-mounted on survey vessels may incidentally harass marine mammals and would be required to follow mitigation and monitoring measures. Typically, mitigation and monitoring measures are required by BOEM through requirements of lease stipulations and required by ITAs from NMFS pursuant to Section 101(a)(5) of the MMPA. Mitigation and monitoring measures would lower the stock-level effects of the take of any marine mammals to negligible levels, as required by the MMPA, including potential for adverse behavioral responses and auditory injury (PTS/temporary threshold shift [TTS]). Similarly, the requirement to comply with avoidance and minimization measures for these surveys would avoid any effects on individuals that could result in population-level effects to threatened and endangered populations listed under the ESA. These measures may include PSOs, passive acoustic monitoring, pre-survey monitoring, and the establishment of exclusion zones in which sound sources would be shut down when marine mammals are present. The project will maintain clearance and exclusion zones of 0.3 NM (500 m) for North Atlantic right whales and 0.05 NM (100 m) for all other ESA-listed species. Clearance zones must be clear of target species for at least 60 minutes before surveys can begin. Exclusion zones are the area in which shutdown or other mitigation measures must be implemented if a whale enters that zone while a noise source is active. The Project will also comply with all PDCs from the June 29, 2021, programmatic consultation on data collection activities (NMFS 2021), with the COP acting as the required survey plan.

Impacts from future offshore wind G&G surveys would be discountable for ESA-listed species due to the inclusion of PSOs, pre-clearance and shutdown zones, minimum separation distances, and other conditions as described in the June 29, 2021, programmatic consultation on data collection activities, that will reduce any potential for adverse effects to discountable levels.

4.2.5 Unexploded Ordnance/Munitions and Explosives of Concern Detonations – C

For UXOs/MECs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to detonating the UXO/MEC in place. These may include relocating the activity away from the UXO/MEC (avoidance), moving the UXO/MEC away from the activity (lift and shift), cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to detonate the UXO/MEC in place be made. To detonate a UXO/MEC, a small charge would be placed on the UXO/MEC (**Table 25**) and detonated causing the UXO/MEC to then detonate.

Table 25. Navy 'bins' and corresponding maximum charge weights (equivalent TNT).

Navy Bin Designation	Maximum Equivalent Weight (TNT)	
	kilograms	pounds
E4	2.3	5
E6	9.1	20
E8	45.5	100
E10	227	500
E12	454	1,000

The exact number and type of UXOs/MECs in the Project Area are not yet known. As a conservative approach, it is currently assumed that up to three UXOs/MECs in the SRWF may have to be detonated in place and none along the SRWEC route based on the ITR application (Sunrise Wind 2022j). If necessary, these detonations would occur on three different days. To avoid times when sensitive marine mammal species are more likely to be present, UXO/MEC detonations are only planned to occur during the months from May through November (Sunrise Wind 2022j). The Applicant-proposed mitigation for UXO detonations include pre-clearance zones, restricting detonations to daylight hours and the use of a dual noise mitigation system for all detonations to achieve a 10-dB attenuation. Sunrise Wind has committed that enough vessels would be deployed to provide 100 percent temporal and spatial coverage of the pre-clearance zones and, if necessary, aerial surveys would be used to provide coverage.

4.2.6 Vessels and Cable Laying – C, O&M, D

The majority of anthropogenic underwater noise in the marine environment is continuous noise from large vessel engines, specifically ocean-going cargo, tanker, and container vessels. Vessel noise is likely the most significant source of non-impulsive noise associated with offshore wind projects. The frequency range for vessel noise falls within the known range of hearing for marine mammals and would be audible. Although vessel noise may have some effect on behavior of ESA-listed species, it would be limited to temporary startle responses, masking of biologically relevant sounds, physiological stress, and behavioral changes (Erbe et al. 2018; Erbe et al. 2019; Nowacek et al. 2007). Studies indicate noise from shipping increases stress hormone levels in North Atlantic right whales (Rolland et al. 2012), and modeling suggests that their communication space was reduced substantially by anthropogenic noise (Hatch et al. 2012). The authors suggest that physiological stress may contribute to suppressed immunity and reduced reproductive rates and fecundity in North Atlantic right whales (Hatch et al. 2012; Rolland et al. 2012). Similar impacts could occur for other marine mammal species. Other behavioral responses to vessel noise could include animals avoiding the ensonified area, which may have been used as a forage, migratory, or socializing area. Results from studies on acoustic impacts from vessel noise on odontocetes indicate that small vessels at a speed of 5 kt in shallow coastal water can reduce the communication range for bottlenose dolphins within 164 ft (50 m) of the vessel by 26 percent (Jensen et al. 2009). In a quieter, deepwater habitat, model results suggest that there could be a 58 percent reduction in the communication range of pilot whales from a similar-sized boat and speed (Jensen et al. 2009).

Denes et al. (2020) modeled the distance required for construction vessel for the South Fork Wind farm noise to drop below marine mammal behavioral thresholds. This project is using a similar assortment of construction vessels within the same wind lease area, and adjacent to the Sunrise Wind Project Area with very similar oceanographic and geophysical conditions. Denes determined that marine mammals would have to remain within 115 to 367 ft (35 to 112 m) of a stationary vessel using its dynamic positioning thrusters for 24 hours to experience cumulative injury. Construction vessel noise would exceed marine mammal behavioral thresholds over a larger area, extending from 42,362 to 48,077 ft (12,911 to 14,654 m) from the source. The likelihood of any marine mammal species remaining close enough to a construction vessel for long enough to experience hearing injury is remote because marine mammals are mobile and unlikely to stay so close to noise exceeding behavioral thresholds for extended periods. Vessels under way produce lower noise levels and are moving, so the likelihood of injury level exposure for any marine mammal species is similarly remote.

While behavioral avoidance of anthropogenic noise sources has not been definitively proven, available data (e.g., Dunlop et al. 2017; Ellison et al. 2012; Southall et al. 2007) suggest that mobile marine mammals would avoid behavioral disturbances like those resulting from vessel noise. This means that the duration of any exposure to noise from slow-moving or closely clustered and stationary construction and installation vessels would be limited. It is also important to recognize that a substantial portion of construction and installation vessel activity would occur in areas with high existing levels of vessel traffic. As such, construction and installation vessels would contribute to, but may not substantially alter, ambient noise conditions generated by existing large vessel traffic. While some individual marine mammals could experience short-term behavioral and auditory effects from vessel noise exposure, these effects would be short term in duration and unlikely to cause measurable effects at the broader stock or population-level. For sea turtles and Atlantic sturgeon, the threshold to behavioral disturbance is higher than it is for marine mammals, making the potential area of affects smaller for effects even less likely for these species.

Noise associated with cable laying would be produced by vessels and equipment during route identification, trenching, jet plow embedment, backfilling, dredging, and cable protection installation. Noise intensity and propagation would depend upon bathymetry, local seafloor characteristics, vessels, and equipment used (Taormina et al. 2018). Modeling estimates that underwater noise would remain above 120 dB re 1 micropascals (µPa) in an area of 98,842 ac (400 km²) around the source (Bald et al. 2015; Nedwell and Howell 2004; Taormina et al. 2018). Assuming cable laying activities occur 24 hours per day and vessels continually move along the cable route, then estimated ensonified areas would not remain in the same location for more than a few hours (developed using Kirkpatrick et al. (2017). Although this suggests a large area of effect, it is important to place construction vessel noise in context with the existing underwater noise environment. Although anthropogenic noise effects, particularly from vessel noise, would continue to adversely ESA-listed species into the future, construction vessel noise from the Proposed Action is unlikely to substantially alter this baseline condition and, therefore, would not substantially change existing levels of adverse effects on marine mammals.

Throughout the construction and operational life of the SRWF, Sunrise Wind expects to use a variety of vessels to support O&M including SOVs with deployable work boats (daughter craft), CTVs, jack-up vessels, and cable laying vessels. Project vessels would undergo routine maintenance trips between the SRWF and potential ports in New York and Rhode Island. The types of impacts from vessel use during O&M would be similar to those described for construction, but the vessel traffic from O&M would be distributed over a much longer time period and result in fewer behavioral disruptions in any given year. Marine mammal individuals may experience direct, short-term, reversible behavioral disruptions due to the incremental contribution of O&M vessels at levels comparable to existing ambient vessel noise in the region.

Although construction vessel traffic and cable laying activity can produce noise levels sufficient to cause behavioral effects in marine mammals, BOEM anticipates that adverse impacts are unlikely given the localized nature of the area disturbed and patchy distribution of species in the area of effects. Any potential for effects would be very low and limited to minor, short-term avoidance of the immediate project area. A substantial portion of construction vessel activity would occur in an area having high levels of existing levels of vessel traffic. Construction vessel noise would be similar to baseline noise levels produced by existing large vessel traffic in the vicinity. Although some individual marine mammals, sea turtles, and Atlantic sturgeon may experience short-term behavioral effects from vessel noise exposure, the short-term nature of individual exposures, limited area of potential impact from these effects, and the small number of individuals expected in the area of work, any potential for affected would not be significant at stock or population levels. While ESA-listed species may be exposed to noise above the behavioral thresholds and masking effects depending on the type and speed of the vessel. However, given the interim definition for ESA harassment, the animals ability to avoid harmful noises, and the established mitigation and monitoring measures being proposed (including reduced vessel speeds), the exposure of ESA-listed cetaceans to vessel noise that results in TTS/behavioral disturbance or masking would not rise to the level of take under the ESA is, therefore, insignificant. Therefore, noise exposure from Project vessel operations leading to TTS/behavioral disturbance may affect, not likely to adversely affect ESA-listed species.

4.2.7 Aircraft – P, C, O&M, D

Project construction and installation, O&M, and decommissioning would involve the periodic use of helicopters for crew transport, inspection, and monitoring activities, and fixed wing aircraft for PSO monitoring during construction and installation and decommissioning. Fixed-wing aircraft may be used during construction for marine mammal monitoring, and helicopters may be used for crew transport to and from construction vessels. Monitoring aircraft would operate at an altitude of 1,000 ft (300 m) consistent with established guidance.

In general, marine mammal behavioral responses to aircraft most commonly occur at distances of less than 1,000 feet and those responses are typically limited (Patenaude et al. 2002). BOEM would require all aircraft operations to comply with current approach regulations for any sighted North Atlantic right whales or unidentified large whale. Current regulations (50 CFR § 222.32) prohibit aircraft from approaching within 1,500 feet of North Atlantic right whales. BOEM expects that most aircraft operations would occur above this altitude limit except under specific circumstances (e.g., helicopter landings on service operations vessels). Aircraft operations could result in short-term behavioral responses, including short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002), but BOEM does not expect that these exposures would result in measurable effects on marine mammals. With the implementation of altitude minimums, exposure of noises above PTS, TTS, and behavioral thresholds for all ESA-listed marine mammal species is considered extremely unlikely to occur and discountable. On this basis, noise and disturbance effects on marine mammals from aircraft operations are expected to be discountable due to protective regulations and short-term nature of the impact.

Currently, no published studies describe the impacts of aircraft overflights on sea turtles although anecdotal reports indicate that sea turtles respond to aircraft at low altitude by diving. While helicopter traffic may cause some short-term behavioral reactions, including startle responses (diving or swimming away), altered submergence patterns, and a short-term stress response (NSF and USGS 2011; Samuel et al. 2005), responses would be temporary and behavior would be expected to return to normal once the aircraft has left the area. The potential effects of aircraft noise and disturbance on sea turtles are therefore expected to be short-term and discountable.

Helicopter operations are not anticipated to have any measurable effect ("no effect") on Atlantic sturgeon or manta rays, particularly considering aircraft operations would adhere to protective regulations intended to avoid and minimize impacts to marine mammals.

4.2.8 Wind Turbine Generators – O&M

Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Sound generated by the airfoils, like aircraft, is produced in the air and enters the water through the air-water interface. Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment. Operational noise increases concurrently with ambient noise (from wind and waves), meaning that noise levels usually remain indistinguishable from background within a short distance from the source under typical operating conditions.

Measured underwater sound levels in the literature are limited to geared smaller wind turbines (less than 6.15 MW), as summarized by Tougaard et al. (2020). Available data on large direct-drive turbines are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliot et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 μPa at 164.0 ft (50 m) for a 6 MW direct-drive turbine.

Elliot et al. (2019) summarized findings from hydroacoustic monitoring of operational noise from the Block Island Wind Farm (BIWF). The BIWF is composed of five GE Haliade 150 6-MW direct-drive WTGs on jacketed foundations located approximately 30 km west of the proposed SFWF. We note that Tougaard et al. (2020) reported that in situ assessments have not revealed any systematic differences between noise from turbines with different foundation types (Madsen et al. 2006). Underwater noise monitoring took place from December 20, 2016, to January 7, 2017, and July 15 to November 3, 2017. Elliot et al. (2019) also presents comparing measurements of underwater noise associated with operations of the direct-drive at the BIWF to underwater noise reported at wind farms in Europe using older WTGs with gearboxes and conclude that absent the noise from the gears, the direct-drive models are quieter.

The SRWF will use the same, newer, direct-drive technology as the BIWF. Therefore, given the similarities in location and the use of direct-drive technology, we expect that the data from the BIWF is a reasonable predictor of noise associated with the operations of the SFWF turbines. Operational noise from the direct-drive WTGs at the BIWF were generally lower than those observed for older generation WTGs, particularly when weighted by the hearing sensitivity of different marine mammal species. Elliot et al. (2019) presented a representative high operational noise scenario at an observed wind speed of 15 m/s (approximately 54 km/h), which is summarized in **Table 26**. As shown, the BIWF WTGs produced frequency weighted instantaneous noise levels of 103 and 79 dB SEL for the LFC and MFC marine mammal hearing groups in the 10-Hz to 8-kHz frequency band, respectively. Frequency weighted noise levels for the LFC and MFC hearing groups were higher for the 10-Hz to 20-kHz frequency band at 122.5-and 123.3 dB SEL, respectively.

Table 26. Frequency weighted underwater noise levels, (weighting based on NMFS (2018a), at 50 meters from an operational 6-megawatt wind turbine generator at the Block Island Wind Farm as a proxy for Sunrise Wind Farm operational generator noise.

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

Source: Elliot et al. (2019)

* 1-second SEL re 1 μPa^{2}S for a 15 m/s (33 mph) wind speed.

† Cumulative SEL re 1 μPa^{2}S assuming continuous 24 exposure at 50 meter from a wind turbine generator foundation operating at 15 m/s (33 mph).

μPa^{2}s = micropascal squared second; dB = decibel(s); Hz = hertz; kHz = kilohertz; LFC = low-frequency cetacean; m/s = meter(s) per second; MFC = mid-frequency cetacean; mph = mile(s) per hour; SEL = sound exposure level

Elliot et al. (2019) also summarizes sound levels sampled over the full survey duration. These averages used data sampled between 10 PM and 10 AM each day to reduce the risk of sound contamination from passing vessels. The loudest noise recorded was 126 dB re 1 μPa at 50 m from the turbine when wind speeds exceeded 56 km/h; at wind speeds of 43.2 km/h and less, measured noise did not exceed 120 dB re 1 μPa at 50 m from the turbine. At no point is operational noise expected to exceed behavioral thresholds for sea turtles (175 dB re 1 μPa) or Atlantic sturgeon (150 dB re 1 μPa). Responses would be temporary and behavior would be expected to return to normal once the aircraft has left the area. The potential effects of aircraft noise and disturbance on sea turtles are therefore expected to be short-term and discountable.

4.2.9 Noise Effects from Decommissioning – D

Project conceptual decommissioning of offshore components would require the use of construction vessels of similar number and class as used during construction. Decommissioning activities would produce similar short-term effects on marine mammals to those described above for proposed Project construction, including short-term displacement, behavioral alteration, and elevated total suspended solids (TSS) exposure. Underwater noise and disturbance levels generated during conceptual decommissioning would be similar to those described for construction, with the exception that pile driving would not be required. The monopiles would be cut below the bed surface for removal using a cable saw or abrasive waterjet. Noise levels produced by this type of cutting equipment are generally indistinguishable from engine noise generated by the associated construction vessel (Pangerc et al. 2016). Therefore, this decommissioning equipment would have potential for insignificant effects to marine mammals, sea turtles, and Atlantic sturgeon.

4.2.10 Effects of Project Noise on Marine Mammals

Marine mammals are particularly sensitive to potential impacts from underwater anthropogenic noise sources. Marine mammals use sound for communication and hunting/foraging. Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. Noise from underwater anthropogenic sound sources can have one or more of the following effects: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Gordon et al. 2003; Götz et al. 2009; Richardson 1995; Southall et al. 2007). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high-level sounds can cause hearing loss, as can longer exposures to lower-level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range.

Marine mammal behavior can be affected even by relatively low sound levels (as low as 120 dB) from continuous noise sources which can cause masking, increased call rates, decreased foraging, or avoidance behavior. Higher sound source levels can cause temporary or permanent hearing loss, while very high source levels can cause barotrauma, injury to gas-filled organs, tissue damage, and mortality. Further, long-duration exposure to continuous sound sources or repeated impulse events can cause PTS or TTS through accumulated SEL.

Richardson (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking may occur. Masking is when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold. The masking zone may be highly variable in size.

The expected responses to pile driving noise may include threshold shift, behavioral effects, stress response, and auditory masking. Threshold shift is the loss of hearing sensitivity at certain frequency ranges (Finneran 2015). It can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal’s hearing threshold would recover over time (Southall et al. 2019). PTS is an auditory injury, which may vary in degree from minor to significant. Behavioral disturbance may include a variety of effects, including subtle changes in behavior (e.g., minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (e.g., Moberg 2000; Seyle 1950). In many cases, an animal's first and sometimes most economical response in terms of energetic costs is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness. Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity and may occur whether the sound is natural (e.g., snapping shrimp, wind, waves, precipitation) or anthropogenic (e.g., shipping, sonar, seismic exploration) in origin.

The following sections describe underwater noise sources that have the highest potential to affect marine mammals.

4.2.10.1 Pile Driving – C

Area Potentially Exposed to Sounds Above the Threshold Levels from Wind Turbine Generators Monopile Installation and Jacket Foundation Pin Piles

Since marine mammals are unlikely to remain stationary during the entire installation of a pile, $L_{E,24hr}$ acoustic ranges are difficult to interpret and tend to be overly conservative. To address this, results from animal movement modeling are used to estimate an "exposure range". This involves analyzing the movements and resulting accumulated sound energy during the exposure modeling and identifying the ranges within which most animals (95 percent) were exposed above the threshold level if they occurred within that range at any point in time. Therefore, the exposure ranges provide a more realistic assessment of the distances within which animals would need to occur in order to accumulate enough sound energy to cross the applicable $L_{E,24hr}$ threshold. Because these are calculated using simulated animal movements over time that can also allow for multiple sound fields in different positions to be encountered, exposure ranges allow evaluation of impacts from scenarios that assume consecutive and concurrent pile installations.

The acoustic ranges to the L_{pk} and $R_{95\%}$ $L_{E,24hr}$ thresholds for WTG and OCS–DC foundations assuming various reductions in sound levels through use of a NAS are shown in **Tables 27** through **30**. The L_{pk} ranges in **Table 27** are from modeling performed using a summer season sound speed profile that provides the most conservative assumption for marine mammals (Appendix A of the ITR Application (Sunrise Wind 2022j)). For the 12WTG monopiles, both the 3,200-kJ hammer energy assumed in the per-pile installation schedule used to calculate potential exposures and the maximum 4,000-kJ hammer energy are shown. If the maximum 4,000-kJ hammer energy were used during an installation it is expected that fewer total strikes would be necessary, thus the total sound energy introduced to the water would not increase and the modeled ranges to $L_{E,24hr}$ thresholds, exposures, and exposure ranges would not change; however, the behavioral threshold disturbance distances may increase with increasing hammer power overall the duration (**Table 28**). Acoustic ranges ($R_{95\%}$) in kilometers to PTS from peak sound pressure level (L_{pk}) thresholds for marine mammals from 12 wind turbine generator monopile and 4-m Offshore Converter Station jacket foundation pin pile installation using an IHC-4000 hammer and the summer sound speed profile. The values shown here do not assume 10 dB of broadband noise attenuation.

Table 27. The acoustic ranges to the L_{pk} and R95% $L_{E,24hr}$ thresholds for wind turbine generator and Offshore Converter Station foundations assuming various reductions in sound levels through use of a noise abatement system.

Hearing Group	SPL_{pk} Threshold (dB re 1 μPa)	Range (km) WTG Monopile Foundation (3,200 kJ)	WTG Monopile Foundation (4,000 kJ)	OCS-DC Jacket Foundation (4,000 kJ)
Low-frequency	219	0.11	0.13	0.06
Mid-frequency	230	<0.01	<0.01	<0.01
High-frequency	202	0.9	1.00	0.57
Phocid pinniped	218	0.13	0.14	0.07

Notes:

Only low- and mid-frequency cetaceans in the Action Area are listed under the Endangered Species Act.

dB re 1 μPa = decibel(s) re 1 micropascal; kJ = kilojoule(s); km = kilometer(s); OCS–DC = Offshore Converter Station; SPL_{pk} = peak sound pressure level (L_{pk}); WTG = wind turbine generator

Table 28. Acoustic ranges ($R_{95\%}$) in kilometers to permanent threshold shift from cumulative sound exposure level ($L_{E,24hr}$) thresholds for marine mammals from installation of a single 12-meter wind turbine generator monopile (10,398 strikes) and four 4-meter Offshore Converter Station jacket foundation pin piles (17,088 strikes each) in the summer (May – November) using an IHC S-4000 hammer and assuming increasing levels of broadband noise attenuation.

		Range (km)							
	SEL_{cum} Threshold	WTG Monopile Foundation				OCS-DC Jacket Foundation			
Hearing Group	(dB re 1 μPa^2)	0	6	10	15	0	6	10	15
Low-frequency	183	10.15	7.32	5.7	4	13.52	8.68	6.6	4.77
Mid-frequency	185	-	-	-	-	0.25	0.07	0.04	-
High-frequency	155	0.67	0.19	0.09	0.03	3.53	2.17	1.46	0.88
Phocid pinniped	185	2.63	1.32	0.73	0.34	3.78	2.21	1.42	0.72

Notes:

Only low- and mid-frequency cetaceans in the Action Area are listed under the Endangered Species Act.

dB re 1 μPa^2 = decibel(s) re 1 micropascal squared; km = kilometer(s); OCS–DC = Offshore Converter Station; SEL_{cum} = cumulative sound exposure level ($L_{E,24hr}$); WTG = wind turbine generator

Table 29. Acoustic ranges ($R_{95\%}$) in kilometers to permanent threshold shift from cumulative sound exposure level ($L_{E,24hr}$) thresholds for marine mammals from installation of a single 12-meter wind turbine generator monopile (10,398 strikes) and four 4-meter Offshore Converter Station jacket foundation pin piles (17,088 strikes each) in the winter (December – April) using an IHC S-4000 hammer and assuming increasing levels of broadband noise attenuation.

		Range (km)							
	SEL_{cum} Threshold	WTG Monopile Foundation				OCS-DC Jacket Foundation			
Hearing Group	(dB re 1 μPa^2)	0	6	10	15	0	6	10	15
Low-frequency	183	11.91	8.04	6.14	4.26	18.98	10.44	7.22	4.95
Mid-frequency	185	-	-	-	-	0.13	0.07	0.04	-
High-frequency	155	0.48	0.32	0.09	0.03	3.3	1.98	1.36	0.76
Phocid pinniped	185	2.77	1.37	0.74	0.34	3.91	2.28	1.48	0.75

Notes:

Only low- and mid-frequency cetaceans in the Action Area are listed under the ESA.

dB re 1 μPa^2 = decibel(s) re 1 micropascal squared; km = kilometer(s); OCS–DC = Offshore Converter Station; SEL_{cum} = cumulative sound exposure level ($L_{E,24hr}$); WTG = wind turbine generator

Table 30. Acoustic ranges ($R_{95\%}$) in kilometers to the behavioral impact, 160 decibels re 1 micropascal sound pressure level threshold from impact pile driving during 12-meter wind turbine generator monopile and Offshore Converter Station jacket foundation pin pile (4-meter) installation using an IHC S-4000 hammer and assuming 10 decibels of broadband noise attenuation. Frequency-weighting functions from Southall et al. (2007).

	Range (km)					
	WTG Monopile Foundation (3,200 kJ)		WTG Monopile Foundation (4,000 kJ)		OCS-DC Jacket Foundation (4,000 kJ)	
Hearing Group	Summer	Winter	Summer	Winter	Summer	Winter
Unweighted	6.07	6.5	6.49	6.97	6.47	6.63
Low-frequency	6.03	6.44	N.A.	N.A.	6.45	6.59
Mid-frequency	2.85	3.01	N.A.	N.A.	2.94	2.77
High-frequency	2.19	2.33	N.A.	N.A.	2.28	2.21
Phocid pinnipeds	4.38	4.64	N.A.	N.A.	4.81	4.62

Notes:

N.A. = Not Available, frequency-weighted modeling of a 4,000-kilojoule hammer energy on wind turbine generator monopiles was not conducted.

kJ = kilojoule(s); km = kilometer(s); OCS–DC = Offshore Converter Station; WTG = wind turbine generator

Only low- and mid-frequency cetaceans in the Action Area are listed under the ESA Exposure ranges ($ER_{95\%}$) to PTS $L_{E,24hr}$ thresholds resulting from animal exposure modeling assuming various consecutive pile installation scenarios and 10 dB of attenuation by a NAS are summarized in **Table 31**. By incorporating animal movement into the calculation of ranges to time-dependent thresholds (SEL metrics), these provide a more realistic assessment of the distances within which acoustic thresholds may be exceeded. This also means that different species within the same hearing group can have different exposure ranges as a result of differences in movement patterns for each species. Meaningful differences (greater than 500 m) between species within the same hearing group occurred for low-frequency cetacean (LFC), so exposure ranges are shown separately for those species (**Table 31**). For MFC and pinnipeds, the largest value from any single species was selected (**Table 31**). In the event two installation vessels are able to work simultaneously, exposure ranges ($ER_{95\%}$) to PTS $L_{E,24hr}$ thresholds from the three concurrent pile installation scenarios and 10 dB of attenuation by a NAS are summarized in **Table 32**. Comparison of the results in **Tables 31** and **32** show that the scenario assuming consecutive installation of two WTG monopiles per day (which assumes the piles are located close to each other) and concurrent installation of four WTG monopiles per day at distant locations yield very similar results. This makes logical sense because the close proximity of the two piles installed at each location in the concurrent scenario is very similar to the two piles installed in the consecutive installation scenario and animals are unlikely to occur in both locations in the concurrent scenarios when they are far apart. Exposure ranges from the "Proximal" concurrent installation scenario (assuming close distances between concurrent pile installations) are slightly greater than from the "Distal" concurrent installation scenario (assuming long distances between concurrent pile installations) reflecting the fact that animals may be exposed to slightly higher cumulative sound levels when concurrent pile installations occur close to each other; however, the differences are not large which suggests there is relatively little additional risk to marine mammals from concurrent piling occurring in close proximity (~3 NM).

Table 31. Exposure ranges[1] ($ER_{95\%}$) to permanent threshold shift from cumulative sound exposure level ($L_{E,24hr}$) thresholds for marine mammals from consecutive installation of two and three 12-meter wind turbine generator monopiles (10,398 strikes each) and four 4-meter Offshore Converter Station jacket foundation pin piles (17,088 strikes each) in one day during the summer and winter seasons using a IHC S-4000 hammer and assuming 10 decibels of broadband noise attenuation.

		Range (km)					
	SEL_{cum} Threshold	WTG Monopile 2-Piles/Day		WTG Monopile 3-Piles/Day		OCS-DC Jacket 4 piles/Day	
Hearing Group	(dB re 1 µPa^2·s)	Summer	Winter	Summer	Winter	Summer	Winter
Low-frequency	183						
Fin Whale*		3.91	4.19	3.68	4.24	5.55	6.42
Humpback Whale		3.63	3.8	3.4	3.82	5.13	3.2
Minke Whale		1.98	2.12	1.86	2.02	2.88	6.03
NA Right Whale*		2.66	2.81	2.51	2.9	3.62	4.06
Sei Whale*		2.69	3.09	2.67	3.01	4.22	4.73
Mid-frequency	185	0	0	0	0	0	0
High-frequency	155	0	0	0	0	0.81	0.59
Phocid pinnipeds	185	<0.01	<0.01	0.03	0.03	1.72	1.73

Notes:

* Denotes species listed under the Endangered Species Act

1 Exposure ranges are a result of animal movement modeling.

dB re 1 µPa^2 = decibel(s) re 1 micropascal squared; km = kilometer(s); OCS–DC = Offshore Converter Station; SEL_{cum} = cumulative sound exposure level ($L_{E,24hr}$); WTG = wind turbine generator

Exposure ranges ($ER_{95\%}$) to PTS ($L_{E,24hr}$) thresholds and behavioral (L_{rms}) resulting from animal exposure modeling assuming three WTG monopiles installed in one day and various levels of attenuation from 0 to 20 dB in the summer are shown in **Table 33** and in the winter are shown in **Table 34**. Any activities conducted in the winter season (December) will utilize monitoring and mitigation measures based on the exposure ranges ($ER_{95\%}$) calculated using winter sound speed profiles as shown in **Table 34**. Exposure ranges assuming various levels of attenuation from 0 to 20 dB are available for the other modeled installation scenarios in Appendix A of the ITR Application (Sunrise Wind 2022j).

Table 32. Exposure ranges[1] ($ER_{95\%}$) to permanent threshold shift from cumulative sound exposure level ($L_{E,24hr}$) thresholds for marine mammals from concurrent installation scenarios including up to four 12-meter wind turbine generator monopiles (10,398 strikes each) per day in close proximity to each other ("Proximal") and distant from each other ("Distal") or two 12-meter wind turbine generator monopiles and four 4-meter Offshore Converter Station jacket foundation pin piles (17,088 strikes each) in one day during the summer and winter seasons using a IHC S-4000 hammer and assuming 10 decibels of broadband noise attenuation.

		Range (km)					
	SEL$_{cum}$ Threshold	Proximal WTG Monopiles 4-Piles/Day		Distal WTG Monopiles 4-Piles/Day		2 WTG Monopiles and 4 OCS-DC Jacket	
Hearing Group	(dB re 1 μPa^2·s)	Summer	Winter	Summer	Winter	Summer	Winter
Low-frequency	183						
Fin Whale*		4.23	4.83	3.8	3.8	5.25	6.21
Humpback Whale		4.02	4.32	3.66	3.66	4.83	5.68
Minke Whale		2.17	2.37	1.96	1.96	2.71	3.07
NA Right Whale*		2.94	3.31	2.61	2.61	3.49	3.85
Sei Whale*		3.18	3.37	2.74	2.74	3.97	4.65
Mid-frequency	185	0	0	0	0	0	0
High-frequency	155	0	0	0	0	0.61	0.57
Phocid pinnipeds	185	0.22	0.16	0.22	0.22	1.62	1.74

Notes:

* Denotes species listed under the Endangered Species Act

1 Exposure ranges are a result of animal movement modeling

dB re 1 μPa^2 = decibel(s) re 1 micropascal squared; km = kilometer(s); OCS–DC = Offshore Converter Station; SEL$_{cum}$ = cumulative sound exposure level ($L_{E,24hr}$); WTG = wind turbine generator

Table 33. Exposure ranges[1] ($ER_{95\%}$) to permanent threshold shift from cumulative sound exposure levels ($L_{E,24hr}$) and behavioral impact sound pressure level (L_{rms}) thresholds for marine mammals from installation of three 12-meter wind turbine generator monopiles (10,398 strikes each) in one day during the summer season using an IHC S-4000 hammer and assuming various levels of broadband noise attenuation.

	Injury										Behavior				
	SEL_{cum}					SPL_{pk}					SPL_{rms}				
	Attenuation (dB)					Attenuation (dB)					Attenuation (dB)				
Hearing Group	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**
Low-frequency															
Fin Whale*	7.8	5.36	3.68	2.21	1.23	0.05	0.02	<0.01	<0.01	0	11	7.49	5.73	3.89	2.59
Humpback Whale	7.31	4.88	3.4	2.07	1.07	0.06	<0.01	<0.01	<0.01	0	10.8	7.32	5.52	3.86	2.51
Minke Whale	5.04	3.03	1.86	0.91	0.45	0.08	0	0	0	0	10.3	6.93	5.3	3.53	2.18
NA Right Whale*	6	3.79	2.51	1.4	0.52	0.07	0.01	0	0	0	10.4	6.97	5.26	3.65	2.37
Sei Whale*	6.33	4.01	2.67	1.41	0.48	0.09	<0.01	<0.01	<0.01	0	10.8	7.33	5.46	3.76	2.43
Mid-frequency	0	0	0	0	0	<0.01	0	0	0	0	10.6	7.42	5.47	3.76	2.54
High-frequency	0.02	0	0	0	0	0.64	0.32	0.18	0.03	0.01	10.3	6.89	5.22	3.52	2.23
Phocid pinnipeds	1.27	0.45	0.03	0	0	0.04	<0.01	<0.01	<0.01	0	11.2	7.74	5.84	4.06	2.97

Notes:

* Denotes species listed under the Endangered Species Act

Exposure ranges are a result of animal movement modeling

dB = decibel(s); SEL_{cum} = cumulative sound exposure level; SPL_{pk} = peak sound pressure level; SPL_{rms} = sound pressure level, root mean square

Table 34. Exposure ranges[1] ($ER_{95\%}$) to permanent threshold shift from cumulative sound exposure levels ($L_{E,24hr}$) and behavioral impact sound pressure level (L_{rms}) thresholds for marine mammals from installation of three 12-meter wind turbine generator monopiles (10,398 strikes each) in one day during the winter season using an IHC S-4000 hammer and assuming various levels of broadband noise attenuation.

	Injury										Behavior				
	SEL_{cum}					SPL_{pk}					SPL_{rms}				
	Attenuation (dB)					Attenuation (dB)					Attenuation (dB)				
Hearing Group	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**
Low-frequency															
Fin Whale*	9.4	5.98	4.24	2.46	1.35	0.05	0.02	<0.01	<0.01	0	13.2	8.44	6.16	4.13	2.55
Humpback Whale	8.96	5.52	3.82	2.29	1.06	0.06	<0.01	<0.01	<0.01	0	13.1	8.28	5.97	4.06	2.57
Minke Whale	5.77	3.39	2.02	0.98	0.47	0.07	0	0	0	0	12.3	7.87	5.66	3.73	2.24
NA Right Whale*	7.01	4.2	2.9	1.43	0.55	0.07	0.01	0	0	0	12.8	7.98	5.78	3.87	2.44
Sei Whale*	7.52	4.55	3.01	1.45	0.5	0.09	<0.01	<0.01	<0.01	0	12.9	8.24	5.93	4.08	2.46
Mid-frequency	0	0	0	0	0	<0.01	0	0	0	0	12.8	8.47	5.98	3.98	2.58
High-frequency	0.02	0	0	0	0	0.57	0.32	0.18	0.03	0.01	12.8	7.96	5.72	3.78	2.36
Phocid pinnipeds	1.34	0.45	0.03	0	0	0.04	<0.01	<0.01	<0.01	0	13.3	8.77	6.46	4.31	2.82

Notes:

* Denotes species listed under the Endangered Species Act

[1] Exposure ranges are a result of animal movement modeling.

dB = decibel(s); SEL_{cum} = cumulative sound exposure level; SPL_{pk} = peak sound pressure level; SPL_{rms} = sound pressure level, root mean square

Estimated Effects to Endangered Species Act–Listed Marine Mammals from Wind Turbine Generators Monopile and Offshore Converter Station Piled Jacket Foundation Installation

Exposure modeling for the number of marine mammals that could experience PTS or behavioral disturbance from all five construction scenarios was conducted using two modeling locations (see **Figure 9**) assuming 87 WTG monopile sites and one OCS–DC jacket foundation site (JASCO Applied Sciences 2022). Results from the construction schedule that produced the highest exposure estimates for WTG and OCS–DC were selected and used in the following way to estimate the total potential take from the installations. The density from the highest month for each species was used to calculate exposures from installing 87 WTG monopiles (three per day for 28 days) and the OCS–DC jacket foundation pin piles (four per day for 2 days). The highest potential PTS and behavioral exposure estimates from across the five installation scenarios were selected and summarized in **Table 35** along with the static behavioral and PSO-based exposure estimates. Sound exposure modeling results showing potential PTS and behavioral effects from installation of 87 WTG monopiles and one OCS–DC piled jacket foundations are shown in **Table 35**.

The PTS estimates shown are only from the $L_{E,24hr}$ threshold as the very short distances to the L_{pk} thresholds (**Table 35**) resulted in no meaningful likelihood of take from exposure to those sound levels. Behavioral impact estimates are shown from sound exposure modeling using the unweighted 160 dB L_{rms} criterion, not the frequency weighted Wood (2012) criteria. For comparison, behavioral impact estimates were also calculated using the unweighted 160-dB distances shown in (**Table 35**) (assuming 4,000-kJ hammer energy for both the WTG Monopile and OCS–DC jacket pin pile installations) to calculate the ensonified area around each foundation. This total area was then multiplied by the densities shown in **Table 36** to estimate take without the use of animal movement modeling.

Table 35. Estimated number of individuals that could be exposed to permanent threshold shift (or Level A under the Marine Mammal Protection Act) and behavioral impact (or Level B under the Marine Mammal Protection Act) annually from installation of 87, 12-meter wind turbine generator monopile foundations and one Offshore Converter Station piled jacket foundation using an IHC S-4000 hammer assuming 10 decibels of noise attenuation (88 FR 8996).

Species[1]	Injury		Behavior
	L_E	L_{pk}	L_p[1]
Fin whale	16.324	0.08	33.7078
Blue whale	0.00	0.00	0.00
North Atlantic right whale	7.260	0.00	18.7935
Sei whale	5.752	0.03	15.2731
Sperm Whale	0.00	0.00	6.43

Notes:

[1] NMFS (2005)

L_E = cumulative sound exposure level; L_p = root mean square sound pressure level; L_{pk} = peak sound pressure level

Potential impacts from pile driving are anticipated to be reduced by the use of a noise attenuation system capable of achieving at least a 10-dB reduction in sound source level, timing restrictions to protect North Atlantic right whales, clearance zone monitoring using PSOs and PAM, night vision equipment and infrared/thermal technology during nighttime pile driving, soft starts, and shutdown procedures. The project will establish pre-start clearance zones and shutdown zones. Pre-start clearance zones are defined as the area that must be visually and/or acoustically clear of protected species of marine mammal prior to starting an activity. Clearance zones may also be implemented after a shutdown in sound-producing activities prior to restarting. The size of the clearance zone will be specific to activity and species or hearing group and dependent on permit conditions. The shutdown zone is defined as the area in which a noise source must be shut down or other active mitigation measures must be implemented if a target species enters the zone. The size of the shutdown zone will be activity-specific and dependent on permit conditions. The shutdown zone will be specific to species and/or faunal groups.

Based on the modeling and proposed mitigation, impact pile driving is extremely unlikely to result in PTS or injury to blue whales, sperm whales, and North Atlantic right whales NMFS has proposed has committed to ensuring that the final monitoring and mitigation plan for all pile driving activities will ensure that North Atlantic right whales will not be at risk for PTS or significant behavioral impacts. This includes maintaining minimum pre-clearance and shutdown zone of 1 km for all pile driving, and a maximum of up to 6.59 km for the most impactful daily pile driving scenario (**Table 30**). Because of the monitoring and mitigation plan that will be implemented to meet this standard, impact pile driving is not likely to result in injury or PTS and therefore **may affect, but is not likely to adversely affect** North Atlantic right whales, fin, sei, and sperm whales.

Based on the modeling, impact pile driving of the OCS–DC and WTG foundations is likely to result in TTS/behavioral disturbance for North Atlantic right whales, fin, sei, and sperm whales. Even with included mitigation and exclusion zones, the potential for TTS/behavioral disturbance cannot be discounted. Therefore, impact pile driving of the OCS–DC and WTG foundations **may affect, and is likely to adversely affect** North Atlantic right whales, blue, fin, sei, and sperm whales.

Table 36. Maximum average monthly marine mammal densities in the Sunrise Wind Farm from only May through November and the month in which the maximum density occurs.

Species	Maximum Monthly Density (Ind./km^2)	Maximum Density Month
Mysticetes		
Blue Whale*	0.0000	Annual
Fin Whale*	0.0035	July
Humpback Whale	0.0042	September
Minke Whale	0.0023	May
North Atlantic Right Whale*	0.0029	May
Sei Whale*	0.0003	May
Odontocetes		
Atlantic Spotted Dolphin	0.0010	October
Atlantic White-Sided Dolphin	0.0608	May
Bottlenose Dolphin	0.0254	September
Common Dolphin	0.2565	December
Harbor Porpoise	0.0464	May
Pilot Whales	0.0086	Annual
Risso's Dolphin	0.0004	August
Sperm Whale*	0.0003	July
Pinnipeds		
Seals (Harbor and Gray)	0.0342	May

Note:

* Denotes species listed under the Endangered Species Act.

Ind./km^2 = individuals per square kilometer

Export Cable Landfall Construction – Temporary Casing Piles

The use of a Grundoram (or similar) pneumatic hammer to install and remove temporary casing pipe will produce impulsive sounds. To estimate distances to PTS injury and behavioral effect thresholds acoustic modeling was performed at the anticipated HDD exit pit location approximately 0.5 mi (800 m) offshore of the landfall site. The modeling used a winter sound speed profile and assumed up to 3 hours of pneumatic hammer use per day for 2 days to install each casing pipe. Assuming 180 strikes per minute over 3 hours of operations results in up to 32,400 total strikes per day (**Table 37**).

Results of the casing pipe installation acoustic modeling are shown in **Table 37**. The estimated distance to the behavioral impact threshold, 920 m, is only slightly greater than the approximate 0.5-mi (805-m) distance to shore from the construction site. For simplicity, the entire area of a circle with 0.6-mi (920-m) radius (pi × r^2 where r is 0.6 mi [920 m]) was calculated (1.03 mi^2 [2.66 km^2]) and used as the area ensonified above the behavioral threshold from casing pipe installation.

For low-frequency cetaceans, HF cetaceans, and seals, the estimated distances to PTS $L_{E,24hr}$ thresholds are larger than the behavioral impact SPL thresholds (**Table 38**). This is due to the high strike rate of the pneumatic hammer resulting in a high number of strikes per day; however, low-frequency cetaceans are unlikely to occur close to this nearshore site and individuals of any species are not expected to remain within the estimated $L_{E,24hr}$ threshold distances for the entire duration of piling. With the implementation of planned monitoring and mitigation (see Section 11 and Appendix A of the ITR Application (Sunrise Wind 2022j)), no risk of injury to ESA-listed species is anticipated.

Table 37. Casing pipe installation acoustic modeling assumptions.

Parameter	Model Input
Hammer Energy	18 kJ
Pile Length	30 m
Pile Diameter	1.2 m
Pile Wall Thickness	2.54 cm
Seabed Penetration	10 m
Angle of Installation	11-12 degrees
Time to Install 1 Casing Pipe	6 hrs
Number of Casing Pipes per Day	0.5
Duration of Hammering per Day	3 hrs
Strikes per Minute	180
Number of Hammer Strikes per Day	32,400

Notes:
cm = centimeter(s); hrs = hours; kJ = kilojoule(s); m = meter(s)

Table 38. Acoustic ranges ($R_{95\%}$) in meters to permanent threshold shift and behavioral disturbance thresholds from impact pile driving during casing pipe installation for marine mammal functional hearing groups assuming a winter sound speed profile.

Marine Mammal Hearing Group	Range (m)	
	Level A SEL_{cum} Thresholds (dB re 1 μPa^2·s)	Level B SPL_{rms} Threshold (160 dB re 1 μPa)
Low-frequency	3,870	920
Mid-frequency	230	920
High-frequency	3,950	920
Phocid pinniped	1,290	920

Notes:
dB re 1 μPa = decibel(s) re 1 micropascal; dB re 1 μPa^2 = decibel(s) re 1 micropascal squared; m = meter(s); SEL_{cum} = cumulative sound exposure level ($L_{E,24hr}$); SPLrms = SPLrms = sound pressure level, root mean square

Based on the modeling and included mitigation measures, impact pile driving of the casing piles is extremely unlikely to result in PTS or injury to ESA-listed marine mammals. Based on the modeling, impact pile driving of the casing piles is likely to result in TTS/behavioral disturbance for North Atlantic right whales, fin, sei, and sperm whales. Even with included mitigation and exclusion zones, the potential for TTS/behavioral disturbance cannot be discounted. Therefore, impact pile driving of the casing piles **may affect, and is likely to adversely affec**t North Atlantic right whales, blue, fin, sei, and sperm whales.

Estimated Effects to Endangered Species Act–Listed Marine Mammals from Export Cable Landfall Construction

Installation and removal of sheet piles may require vibratory pile driving on up to 12 days per cable borehole and 24 days in total for the two cables. Assuming a daily ensonified area of 149 km^2, the total area ensonified by vibratory pile driving would be 3,576 km^2. This value was multiplied by the densities in **Table 36** to calculate the density based-takes shown in the Sheet Pile column of **Table 39**. Casing pipe installation and removal may require a total of 8 days, 4 days for each casing pipe. Assuming a daily ensonified area of 0.92 km^2, the total ensonified area would be 21.3 km^2. This value was multiplied by the densities in **Table 36** to calculate the estimated behavioral exposures shown in the Casing Pipe column of **Table 39**.

Based on the modeling and included mitigation measures, vibratory pile driving of the steel sheet piles is extremely unlikely to result in PTS or injury to ESA-listed marine mammals.

Based on the modeling, vibratory pile driving of the steel sheet piles is likely to result in TTS/behavioral disturbance for North Atlantic right whales and fin whales. Even with included mitigation and exclusion zones, the potential for TTS/behavioral disturbance cannot be discounted. Therefore, vibratory pile driving of the steel sheet piles **may affect, and is likely to adversely affect** North Atlantic right whales, fin, sei, and sperm whales; however, modeling indicates that TTS/behavioral harassment is unlikely to occur for blue, sei, and sperm whales, and vibratory pile driving may affect, but is not likely to adversely affect these species.

Table 39. Estimated behavioral exposures from export cable landfall construction.

Species	Density-based Take by Landfall Installation Activity		Total Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
	Sheet Pile	Casing Pipe				
Mysticetes						
Blue Whale*	0.0	0.0	0.0	-	1.0	1
Fin Whale*	5.3	0.0	5.3	7.8	1.8	8
Humpback Whale	3.0	0.0	3.0	23.5	2.0	24
Minke Whale	2.2	0.0	2.2	4.8	1.2	5
North Atlantic Right Whale*	5.2	0.0	5.2	1.2	2.4	6
Sei Whale*	0.2	0.0	0.2	0.3	1.6	2
Odontocetes						
Atlantic Spotted Dolphin	1.3	0.0	1.3	-	29.0	29
Atlantic White-Sided Dolphin	19.5	0.1	19.6	3.0	27.9	28
Bottlenose Dolphin	386.4	2.3	388.7	33.8	7.8	389
Common Dolphin	267.5	1.6	269.1	952.3	34.9	953
Harbor Porpoise	196.9	1.2	198.0	0.8	2.7	199
Pilot Whales	1.4	0.0	1.4	-	8.4	9
Risso's Dolphin	0.1	0.0	0.1	2.4	5.4	6
Sperm Whale*	0.9	0.0	0.9	-	1.5	2
Pinnipeds						
Gray Seal	107.0	0.6	107.7	2.3	1.4	108
Harbor Seal	240.4	1.4	241.9	2.8	1.4	242

Note:

PSO = Protected Species Observer

4.2.10.2 Other Noise Sources – P, C, O&M, D

Area Potentially Exposed to Sounds Above Threshold Levels from High-Resolution Geophysical Surveys During the Construction Phase – P, C, O&M

Several different types of equipment may be used during HRG surveys, including single-beam echosounders, multi-beam echosounders, side scan sonars, non-parametric SBPs, parametric SBPs, boomers, and sparkers. Only the sounds produced by SBPs, boomers, and sparkers have the potential to cause incidental take so representative instruments were modeled and distances to threshold levels determined as described below and in **Table 40**.

Table 40. Summary of representative high-resolution geophysical survey equipment and operating parameters used to calculate distances to incidental take threshold levels.

Equipment Type	Representative Model	Operating Frequency (kHz)	Source Level SPL_{rms} (dB)	Source Level 0-pk (dB)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)	Information Source
Sub-bottom Profiler	EdgeTech 216	2 – 16	195	-	20	6	24	MAN
	EdgeTech 424	4 – 24	176	-	3.4	2	71	CF
	Edgetech 512	0.7 – 12	179	-	9	8	80	CF
	GeoPulse 5430A	2 – 17	196	-	50	10	55	MAN
	Teledyn Benthos Chirp III - TTV 170	2 – 17	197	-	60	15	100	MAN
Sparker	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	0.3 – 1.2	203	211	1.1	4	Omni	CF
Boomer	Applied Acoustics triple plate S-Boom (700-1,000 J)	0.1 – 5	205	211	0.6	4	80	CF

Notes:

Source Levels are given in dB re 1 µPa @ 1 m

- = not applicable; dB = decibel(s); CF = Crocker and Fratantonio Crocker and Fratantonio (2016); kHz = kilohertz; MAN = Manufactures Specifications; ms = millisecond(s); SPL_{rms} = sound pressure level, root mean square

Shallow-penetration, non-impulsive, non-parametric SBPs (compressed high-intensity radiated pulses [CHIRP SBPs]) are used to map the near-surface stratigraphy (top 0 to 16 ft [0 to 5 m] of sediment below the seabed). A CHIRP SBP system emits “swept” sound pulses that increase in frequency from approximately 2 to 20 kHz over the duration of the pulse. The pulse length and frequency range can be adjusted to meet Project variables. These shallow-penetration SPBs are typically mounted on a pole, rather than towed, either over the side of the vessel or through a moon pool in the bottom of the hull, reducing the likelihood that an animal would be exposed to the signal.

Medium-penetration, impulsive boomers are used to map deeper subsurface stratigraphy as needed. A boomer is a broad-band sound source operating in the 3.5 Hz to 10 kHz frequency range. This system is commonly mounted on a sled and towed behind the vessel.

Medium-penetration, impulsive sparkers are used to map deeper subsurface stratigraphy as needed. Sparkers create acoustic pulses from 50 Hz to 4 kHz omnidirectionally from the source that can penetrate several hundred meters into the seafloor. Sparkers are typically towed behind the vessel with adjacent hydrophone arrays to receive the return signals.

Although the final equipment choices will vary depending on the final survey design, vessel availability, make and model updates, and survey contractor selection, all sources that are representative of those that could be employed during the HRG surveys and have the expected potential to result in exposure of marine mammals and potentially result in take, are provided in **Table 40** along with details of the parameters used in acoustic analyses.

The Dura-spark measurements and specifications provided in Crocker and Fratantonio (2016) were used for all sparker systems proposed for the survey. These include variants of the Dura-spark sparker system and various configurations of the GeoMarine Geo-Source sparker system. The data provided in Crocker and Fratantonio (2016) represent the most applicable data for similar sparker systems with comparable operating methods and settings when manufacturer or other reliable measurements are not available. Crocker and Fratantonio (2016) provide S-Boom measurements using two different power sources (CSP–D700 and CSP–N). The CSP–D700 power source was used in the 700-joule (J) measurements but not in the 1,000-J measurements. The CSP–N source was measured for both 700-J and 1,000-J operations but resulted in a lower sound level; therefore, the single maximum sound level value was used for both operational levels of the S-Boom.

To estimate the potential for PTS exposures from the HRG survey sources, the $L_{E,24hr}$ metric was applied to non-impulsive sources to estimate the range to acoustic thresholds. Because impulsive sources use dual metrics ($L_{E,24hr}$ and L_{pk}) for PTS exposure criteria, the metric resulting in the largest isopleth distance was used for exposure estimation. Weighting factor adjustments (WFAs) for PTS isopleths used to account for differences in marine mammal hearing were determined by examining the frequency range and spectral densities for each source. The selected WFAs were then compared to the Applicable Frequencies Table located in the WFA tab of the NMFS User Spreadsheet Tool (NMFS 2018a). If the determined frequency was lower than the applicable frequency for all hearing groups, it was entered as the WFA. When the frequency of a source exceeded the applicable frequency for a certain hearing group, an additional worksheet was created that applied the “use” frequency of the exceeded hearing group as indicated by NMFS (2018a).

The User Spreadsheet does not calculate distances to behavioral impact thresholds; the range to the behavioral impact thresholds was determined by applying spherical spreading loss to the sound level for that equipment. The operational depth and directionality can greatly influence how the sound propagates and can influence the resulting isopleth distance, so these parameters were considered for sources that had reported beamwidths. Surface-towed omnidirectional sources (e.g., sparkers, boomers) and equipment with wide (more than 180 degrees) reported beamwidths are expected to propagate farther in the horizontal direction and produce larger ensonified fields. For these sources, the rate of TL was estimated using spherical spreading loss to calculate the distance to the behavioral impact threshold.

Sources that project a narrow beam, often in frequencies above 10 kHz directed at the seabed, are expected to have smaller isopleths and less horizontal propagation due to the directionality of the source and faster attenuation rate of higher frequencies. Narrow beamwidths allow geophysical equipment to be highly directional, focusing its energy on the vertical direction and minimizing horizontal propagation, which greatly reduces the possibility of direct path exposure to receivers (i.e., marine mammals) from sounds emitted by these sources. Therefore, for sources with beamwidths less than 180 degrees, isopleth distances were calculated following NMFS OPR interim guidance (NMFS 2020) to account for the influence of beamwidth and frequency on the horizontal propagation of these sources. The estimated distances to PTS and behavioral impact HRG survey isopleths calculated for each marine mammal hearing group are given in **Table 41**.

Table 41. Distances to weighted permanent threshold shift and unweighted behavioral impact thresholds for each high-resolution geophysical sound source or comparable sound source category for each marine mammal hearing group.

Equipment Type	Representative Model	Distance to Level A Threshold (m) LF (SEL_{cum})	MF (SEL_{cum})	HF (SEL_{cum})	HF (SPL_{0-pk})	PW (SEL_{cum})	Level B (m) All (SPL_{rms})
Sub-bottom Profiler	EdgeTech 216	<1	<1	2.9	NA	0	9
	EdgeTech 424	0	0	0	NA	0	4
	Edgetech 512	0	0	<1	NA	0	6
	GeoPulse 5430A	<1	<1	36.5	NA	<1	21
	Teledyn Benthos Chirp III - TTV 170	1-Jan	<1	16.9	NA	<1	48
Sparker	Applied Acoustics Dura-Spark UHD (700 tips, 1,000 J)	<1	0	0	4.7	<1	34
	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	<1	0	0	2.8	<1	141
	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	<1	0	0	2.8	<1	141
Boomer	Applied Acoustics triple plate S-Boom (700–1,000 J)	<1	0	0	2.8	<1	141

Notes:

LF = low-frequency cetaceans; m = meter(s); MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = phocid pinnipeds in water; SEL_{cum} = cumulative sound exposure level; SPL_{0-pk} = zero to peak sound pressure level; SPL_{rms} = sound pressure level, root mean square

Estimated Effects to Endangered Species Act–Listed Marine Mammals from High-Resolution Geophysical Surveys – Construction Phase

To calculate potential exposure from HRG surveys within the SRWF during year 1 of the construction phase, the annual average marine mammal densities in **Table 36** were multiplied by half of the total ensonified area expected within the SRWF and the results are shown in the SRWF column in **Table 42**. The same calculation was performed for the SRWEC using marine mammal densities in **Table 36** and the results are shown in the SRWEC column of **Table 42**. The same method was used to calculated potential takes from HRG surveys during year 2 of the construction phase as shown in **Table 43**.

The largest PTS threshold distances was 36.5 m across all representative instruments. No PTS is expected to occur for any HRG surveys due to the very small distance in which PTS could occur and implementation of the project design criteria from the June 29, 2021, programmatic consultation on these activities.

The largest modeled distance to the behavioral impact threshold from HRG survey equipment was 141 m from a sparker. Although a sparker may not be used at all times during HRG surveys, this distance was used in calculating the area exposed to sounds above 160 dB SPL for all HRG survey activity. This was done by assuming an average of 70 km of survey activity would be completed daily by each survey vessel when active. The 70 km of survey line was then buffered on all sides by the 141 m distance to estimate a daily ensonified area of 19.8 km^2.

Table 42. Estimated exposure to National Marine Fisheries Service behavioral thresholds from high-resolution geophysical surveys during year 1 of the construction phase of the Project.

Species	Year 1 Construction Phase Exposure by Survey		Total Density-based Exposure Estimate	PSO Data Exposure Estimate	Mean Group Size	High Level B Exposure
	SRWF	SRWEC				
Mysticetes						
Fin Whale	4.0	3.9	7.9	43.0	1.8	44.0
North Atlantic Right Whale	5.2	3.2	8.4	6.6	2.4	9.0
Sei Whale	0.1	0.1	0.2	1.7	1.6	2.0
Odontocetes						
Sperm Whale	0.1	0.2	0.3	-	1.5	2.0

Notes:

* Denotes species listed under the Endangered Species Act

PSO = Protected Species Observer; SRWEC = Sunrise Wind Export Cable; SRWF = Sunrise Wind Farm

Table 43. Estimated behavioral impacts from high-resolution geophysical surveys during year 2 of the construction phase of the Project.

Species	Year 2 Construction Phase Exposure by Survey		Total Density-based Exposure Estimate	PSO Data Exposure Estimate	Mean Group Size	High Level B Exposure
	SRWF	SRWEC				
Mysticetes						
Fin Whale	4.0	3.9	7.9	43.0	1.8	44.0
North Atlantic Right Whale	5.2	3.2	8.4	6.6	2.4	9.0
Sei Whale	0.1	0.1	0.2	1.7	1.6	2.0
Odontocetes						
Sperm Whale	0.1	0.2	0.3	-	1.5	2.0

Notes:

* Denotes species listed under the Endangered Species Act

PSO = Protected Species Observer; SRWEC = Sunrise Wind Export Cable; SRWF = Sunrise Wind Farm

During construction, it is estimated that 12,604 km of HRG surveys will occur within the SRWF and 11,946 km will occur along the SRWEC. Assuming 70 km is surveyed per day, that results in 180 days of survey activity in the SRWF and 171 days of survey activity along the SRWEC. Multiplying the daily ensonified area by the number of days of survey activity within each area results in a total ensonified area of 3,566 km^2 in the SRWF and 3,380 km^2 along the SRWEC. The construction phase HRG surveys are expected to occur over approximately 2 years, so the total survey activity and associated ensonified area have been split evenly across 2 years.

The noise levels produced by HRG survey equipment are relatively low, meaning that an individual marine mammal would have to remain close to the sound source for extended periods of time to experience injury. This type of exposure is unlikely as the sound sources are continuously mobile and directional (i.e., pointed at the bottom). Moreover, consistent with BOEM requirements Sunrise Wind has developed a protected species monitoring and mitigation plan that includes PSO monitoring of species-specific clearance zones around HRG survey activities and mandatory shutdown procedures to further minimize exposure risk. These measures would effectively avoid the risk of PTS or TTS effects on marine mammals from HRG survey activities. Based on the modeling and included mitigation measures, HRG surveys during construction and installation are extremely unlikely to result in PTS or injury to ESA-listed marine mammals.

Based on the modeling, HRG surveys are likely to result in behavioral disturbance for North Atlantic right whales and fin whales. Even with included mitigation and exclusion zones, the potential for behavioral disturbance cannot be discounted. While individual marine mammals may be exposed to HRG survey noise sufficient to cause behavioral effects, those effects would be short-term and unlikely to cause any perceptible long-term consequences to individuals or populations. Therefore, HRG surveys **may affect, but are not likely to adversely affect** North Atlantic right whales, blue, fin, sei, and sperm whales.

Area Potentially Exposed to Sounds Above Threshold Levels from High-Resolution Geophysical Surveys – Operations and Maintenance Phase

On an annual basis during operations, it is estimated that 2,898 km of HRG surveys will occur within the SRWF and 3,413 km will occur along the SRWEC. Assuming 70 km is surveyed per day results in 41.4 days of survey activity in the SRWF and 48.8 days of survey activity along the SRWEC each year. Multiplying the daily ensonified area by the number of days of survey activity within each area results in an annual ensonified area of 820 km^2 in the SRWF and 966 km^2 along the SRWEC. Over the three years of operations that would occur during the five-year period covered by the requested regulations, the total ensonified area in the SRWF would be 2,460 km^2 and along the SRWEC would be 2,897 km^2.

Estimated Effects to Endangered Species Act–Listed Marine Mammals from High-Resolution Geophysical Surveys – Operations and Maintenance Phase

The density-based take estimate for one year during the operations phase was calculated for the SRWEC and the SRWF in the same manner as described above in the section describing estimated effects to Endangered Species Act–listed marine mammals from high-resolution geophysical surveys – construction phase. This value was then compared against the PSO data take estimate and the mean group size of each species and the largest value was selected as the annual estimated take during the 3 years of operations (**Table 44**). The annual estimated take was then multiplied by three to calculate the total take over the three years of operations. PTS for this activity is not expected.

Table 44. Estimated behavioral impacts from high-resolution geophysical surveys during operations.

Species	Annual Operations Phase Exposure by Survey Area		Annual Total Density-based Exposure Estimate	Annual PSO Data Exposure Estimate	Mean Group Size	Highest Annual Level B Exposure	3-Year Level B Exposure
	SRWF	SRWEC					
Mysticetes							
Fin Whale	1.9	2.2	4.1	22.1	1.8	23.0	69.0
North Atlantic Right Whale	2.4	1.8	4.2	3.4	2.4	5.0	15.0
Sei Whale	0.1	0.1	0.1	0.9	1.6	2.0	6.0
Odontocetes							
Sperm Whale	0.1	0.1	0.2	-	1.5	2.0	6.0

Notes:

PSO = Protected Species Observer; SRWF = Sunrise Wind Farm; SRWEC = Sunrise Wind Export Cable

The noise levels produced by HRG survey equipment are relatively low, meaning that an individual marine mammal would have to remain close to the sound source for extended periods of time to experience injury. This type of exposure is unlikely as the sound sources are continuously mobile and directional (i.e., pointed at the bottom). Moreover, consistent with BOEM requirements Sunrise Wind has developed a protected species monitoring and mitigation plan that includes PSO monitoring of species-specific clearance zones around HRG survey activities and mandatory shutdown procedures to further minimize exposure risk. These measures would effectively avoid the risk of PTS or TTS effects on marine mammals from HRG survey activities. Any potential behavioral effects would be very short-term based on the isopleth distances modeled. Considering the implementation of the project design criteria from the June 29, 2021, programmatic consultation on these activities, the potential for adverse effects from any HRG survey-related activities will be reduced to discountable levels.

Based on the modeling, HRG surveys are likely to result in behavioral disturbance for North Atlantic right whales and fin whales should they occur in the area of pile driving. Even with included mitigation and exclusion zones, the potential for TTS/behavioral disturbance cannot be discounted. While individual marine mammals may be exposed to HRG survey noise sufficient to cause behavioral effects, those effects would be short-term and unlikely to cause any perceptible long-term consequences to individuals or populations. Therefore, HRG surveys may affect, and but are not likely to adversely affect North Atlantic right whales, blue, fin, sei, and sperm whales.

Area Potentially Exposed to Sounds Above Threshold Levels from Unexploded Ordnance/ Munitions and Explosives of Concern Detonation

The type and net explosive weight of UXOs/MECs that may be detonated are not known at this time, but it is estimated up to three UXOs/MECs may require detonation within the Project Area (Sunrise Wind 2022i). To capture a range of potential UXOs/MECs, five categories or “bins” of net explosive weight established by the U.S. Navy (DoN 2017) were selected for acoustic modeling (**Table 45**). Sound propagation away from detonations is affected by acoustic reflections from the sea surface and seabed. Water depth and seabed properties will influence the sound exposure levels and sound pressure levels at distance from detonations. Their influence is complex but can be predicted accurately by acoustic models. Two sites (S3 and S4 in Appendix B of the ITR Application (Sunrise Wind 2022j)) were chosen within the nearby Revolution Wind Farm for this modeling assessment. The geo-acoustic properties of the seabed within the Revolution Wind Farm where the acoustic modeling was performed and the SRWF are very similar and the water depths in the SRWF are the same or only slightly deeper (maximum depth of 55 m in the SRWF versus the deepest modeled site in the Revolution Wind Farm of 45 m). Exact locations for the modeling sites are shown in Figure 1 of Appendix B of the ITR Application (Sunrise Wind 2022j).

Table 45. Navy “bins” and corresponding maximum charge weights (equivalent TNT) modeled.

Navy Bin Designation	Maximum Equivalent Weight (TNT)	
	kg	lbs
E4	2.3	5
E6	9.1	20
E8	45.5	100
E10	227	500
E12	454	1000

Notes:
kg = kilogram(s); lb = pound(s)

Modeling of acoustic fields generated by UXO/MEC detonations was performed using a combination of semi-empirical and physics-based computational models. The source pressure function used for estimating PK and impulse (J_p) metrics was calculated with an empirical model that approximates the rapid conversion (within approximately 1 microsecond for high explosive) of solid explosive to gaseous form in a small gas bubble under high pressure, followed by an exponential pressure decay as that bubble expands. The shape and amplitude of the pressure versus time signature of the shock pulse changes with distance from the detonation location due to non-linear propagation effects caused by its high peak pressure. This initial empirical model is only valid close to the source (within tens of meters), so alternative formulae were used beyond those distances to a point where the sound pressure decay with range transitions to the spherical spreading model.

The calculation of SEL and SPL levels is dependent on the entire pressure waveform, including the initial shock pulse (described above) and the subsequent oscillation of the gas bubble. The negative phase pressure troughs and bubble pulse peaks following the shock pulse are responsible for most of the low frequency energy of the overall waveform. The SEL and SPL thresholds for injury and disturbance occur at distances of many water depths in the relatively shallow waters of the Project. As a result, the sound field becomes increasingly influenced by the contributions of sound energy reflected from the sea surface and sea bottom multiples times. To account for this, the modeling was carried out in decidecade frequency bands using the marine operation noise model (JASCO Applied Sciences). This model applied a parabolic equation approach for frequencies below 4 kHz and a Gaussian beam ray trace model at higher frequencies. In this location, sound speed profiles change little with depth, so these environments do not have strong seasonal dependence. The propagation modeling was performed using a sound speed profile representative of September, which is slightly downward refracting and therefore conservative, and also represents the most likely time of year for UXO removal activities. Additional technical details of the modeling methods, assumptions, and environmental parameters used as inputs can be found in Appendix B of the ITR Application (Sunrise Wind 2022j).

A NAS similar to those described for monopile foundation installations is planned to be used during any UXO/MEC detonations. The reasons a NAS may not be used would be limited to instances where boulders or other obstructions on the seafloor prevented the effective deployment of a NAS or posed a risk to successful retrieval of the NAS after completion of the UXO/MEC detonation. Use of a NAS is expected to achieve at least the same 10 dB of attenuation assumed for monopile installation. This is based on an assessment of UXO/MEC-clearance activity in European waters summarized by Bellmann and Betke (2021). As a contingency in case a NAS cannot be placed properly around a UXO because of the presence of boulders or other obstructions on the seafloor, acoustic modeling was also conducted assuming no use of a NAS (unmitigated).

Table 46. United States Navy impulse and peak pressure threshold equations for estimate at what levels marine mammals have a 1% probability of experiencing mortality or non-auditory injury due to underwater explosions (DoN 2017). M is animal mass (kilograms) and D is animal depth (meters).

Onset Effect	Threshold
Onset Mortality – Impulse	$103M^{1/3}(1+\frac{D}{10.1})^{1/6} Pa-s$
Onset Injury – Impulse (non-auditory lung)	$47.5M^{1/3}(1+\frac{D}{10.1})^{1/6} Pa-s$
Onset Injury – Peak Pressure (gastrointestinal)	$237\ dB\ re\ 1\ \mu Pa\ peak$

Potential impacts to marine mammals from underwater explosions are assessed using separate criteria for mortality, non-auditory injury, gastrointestinal injury, auditory injury, and behavioral responses. Since marine mammal densities representative of the SRWF include water depths similar to UXO/MEC acoustic modeling Sites 3 and 4 and there is relatively little difference between the results from those two sites, the largest range to the thresholds from either Site 3 or 4, both with and without 10 dB of mitigation, was selected for each UXO/MEC size class and marine mammal size class or hearing group and summarized here. In all cases, distances to mortality (**Table 47**), non-auditory lung injury (**Table 48**), and gastrointestinal injury (**Table 49**) thresholds were shorter than to auditory injury thresholds (**Table 50**). Since the mitigation and monitoring measures described in the Sunrise Wind Monitoring and Mitigation Plan (Sunrise Wind 2022k) and the ITR Application Appendix C (Sunrise Wind 2022k) are designed to avoid as well as potential auditory injury for most species, only the auditory injury (PTS) threshold distances are used here for the calculation of potential PTS injury.

In the case of a single UXO/MEC detonation per day, as is planned here, TTS onset serves as the Level B take threshold. As was done for the PTS threshold above, the largest modeled ranges to the TTS onset threshold assuming 10 dB of mitigation for each UXO/MEC size class was selected from modeling results at Sites 3 and 4 to represent the behavioral impact range within the SRWF (**Table 51**).

Table 47. Maximum ranges (in meters) over depth to the onset of mortality thresholds in the Sunrise Wind Farm for five unexploded ordnance/munitions and explosives of concern size classes with and without 10-decibel mitigation. Thresholds are based on animal mass and submersion depth (see Table 46 above and Section 6.2 and Appendix B of the Incidental Take Regulations Application).

Hearing Group	R95% Distance (meters)									
	E4		E6		E8		E10		E12	
	Calf/Pup	Adult	Calf/Pup	Adult	Calf/Pup	Adult	Calf/Pup	Adult	Calf/Pup	Adult
Assuming 10-decibel reduction from mitigation										
Baleen and Sperm Whales	5	5	6	5	20	6	68	19	109	31
Assuming no reduction from mitigation										
Baleen and Sperm Whales	8	5	23	7	80	22	227	77	334	121

Table 48. Maximum ranges (in meters) over depth to the onset of non-auditory lung injury impulse thresholds in the Sunrise Wind Farm for five unexploded ordnance/munitions and explosives of concern size classes with and without 10-decibel mitigation. Thresholds are based on animal mass and submersion depth (see Table 46 above and Section 6.2 and Appendix B of the Incidental Take Regulations Application).

Hearing Group	R95% Distance (meters)									
	E4		E6		E8		E10		E12	
	Calf/Pup	Adult	Calf/Pup	Adult	Calf/Pup	Adult	Calf/Pup	Adult	Calf/Pup	Adult
Assuming 10-decibel reduction from mitigation										
Baleen and Sperm Whales	5	5	15	5	51	14	156	49	237	81
Assuming no reduction from mitigation										
Baleen and Sperm Whales	21	6	60	17	181	58	463	172	648	262

Table 49. Ranges (in meters) to the onset of gastrointestinal injury impulse thresholds in the Sunrise Wind Farm for five unexploded ordnance/munitions and explosives of concern size classes with and without 10-decibel mitigation. Thresholds are based on animal mass and submersion depth (see Table 46 above and Section 6.2 and Appendix B of the Incidental Take Regulations Application).

Hearing Group	L_{pk} Threshold (dB re 1 μPa)	R_{max} Distance (m)				
		E4	E6	E8	E10	E12
		Assuming 10 dB reduction from mitigation				
Onset Gastrointestinal Injury	237	21	34	58	99	125
		Assuming no reduction from mitigation				
Onset Gastrointestinal Injury	237	61	97	167	285	359

Notes:
dB re 1 μPa = decibel(s) re 1 micropascal; L_{pk} = peak sound pressure level; m = meter(s)

Since the size and type of UXOs/MECs that may be detonated is currently unknown, all area calculations were made using the largest UXO/MEC size class (E12). The E12 ranges to PTS and behavioral impact thresholds within the SRWF, **Tables 50** and **51**, respectively, were used as radii to calculate the area of a circle (pi × r^2 where r is the range to the threshold level) for each marine mammal hearing group. The results represent the largest area potentially ensonified above threshold levels from a single detonation within the SRWF and are shown in the final column of **Tables 50** and **51**.

Table 50. Ranges to $L_{E,24hr}$ permanent threshold shift-onset thresholds in the Sunrise Wind Farm for five unexploded ordnance/munitions and explosives of concern charge sizes with and without 10-decibel mitigation and the maximum area exposed.

Hearing Group	SEL Threshold (dB re 1 μPa²s)	$R_{95\%}$ Distance (km)					Single Detonation Maximum Area (km²)
		E4	E6	E8	E10	E12	
		Assuming 10 dB reduction from mitigation					
Low-frequency	183	0.39	0.76	1.58	2.9	3.6	40.9
Mid-frequency	185	<0.050	<0.050	0.09	0.32	0.41	0.5
High-frequency	155	1.75	2.59	3.9	5.4	6.2	120.4
Phocid pinnipeds	185	0.09	0.20	0.54	1.02	1.48	6.9
		Assuming no reduction from mitigation					
Low-frequency	183	1.5	2.72	4.8	7.3	8.5	229.1
Mid-frequency	185	0.16	0.36	0.68	1.14	1.48	6.9
High-frequency	155	4.3	5.8	7.7	9.9	10.9	373.3
Phocid pinnipeds	185	0.61	1.12	2.17	3.7	4.5	64.2

Notes:
dB re 1 μPa²s = decibel re 1 micropascal squared second; km² = square kilometer(s)

Table 51. Ranges to SEL_{cum} temporary threshold shift-onset thresholds in the Sunrise Wind Farm for five unexploded ordnance/munitions and explosives of concern charge sizes with and without 10-decibel mitigation and the maximum area exposed.

Hearing Group	SEL Threshold (dB re 1 μPa²s)	$R_{95\%}$ Distance (km)					Single Detonation Maximum Area (km²)
		E4	E6	E8	E10	E12	
		Assuming 10 dB reduction from mitigation					
Low-frequency	168	2.74	4.45	7.21	10.3	11.8	437.4
Mid-frequency	170	0.41	0.707	1.23	2.03	2.48	19.3
High-frequency	140	6.14	7.84	10.1	12.6	13.7	589.6
Phocid pinnipeds	170	1.21	2.18	3.81	5.97	7.02	154.8
		Assuming no reduction from mitigation					
Low-frequency	168	7.0	9.85	13.6	17.4	19.3	1170.2
Mid-frequency	170	1.45	2.21	3.49	5.04	5.84	107.1
High-frequency	140	10.7	13.0	15.8	18.7	20.2	1281.9
Phocid pinnipeds	170	4.07	6.07	8.85	12.0	13.3	555.7

Notes:
dB re 1 μPa²s = decibel re 1 micropascal squared second; km² = square kilometer(s)

Estimated Effects to Endangered Species Act–Listed Species from Unexploded Ordnance/ Munitions and Explosives of Concern Detonation

Based on the available information, up to three (3) UXO/MEC detonations may be necessary within the SRWF, and none are expected along the SRWEC route. The maximum areas to PTS and behavioral impact thresholds from a single detonation in the SRWF assuming 10 dB of noise reduction shown in **Table 50** and **51**, respectively, were therefore multiplied by 3 and then multiplied by the marine mammal densities shown in **Table 36** to calculate the potential exposures from UXO/MEC detonations in the SRWF shown in **Table 52**. In the unlikely event that a NAS cannot be used during a UXO/MEC detonation, exposures were also calculated using the unmitigated threshold distances in **Table 50** and **51** and the results are shown in **Table 53**, but this situation is considered to be unlikely to occur.

Monitoring and mitigation measures described in the Sunrise Wind Monitoring and Mitigation Plan (**Tables 14** and **15**) are designed to prevent all serious injury, as well as PTS for most species. PTS is not expected for low-frequency cetaceans, and the potential for permanent injury to ESA-listed mammals from UXO/MEC detonations is expected to be extremely unlikely to occur due to included mitigation measures.

Based on the modeling and included mitigation, potential effects from UXO/MEC detonations using 10 dB of sound attenuation are extremely unlikely to occur and **discountable** for sei whales and sperm whales. Therefore, UXO/MEC detonations **may affect, but are not likely to adversely affect** blue, sei whales, and sperm whales.

Modeling suggests that fin whales and North Atlantic Right whales could be exposed to noise impacts above the TTS/behavioral thresholds from UXO exposure resulting in the potential for TTS and behavioral disturbance. If a detonation is required, these species may be exposed to noise resulting in TTS/behavioral disturbance even with the application of mitigation measures and cannot be discounted, however , those effects would be short-term and unlikely to cause any perceptible long-term consequences to individuals or populations. Therefore, the effects of noise exposure from Project UXO detonations leading to

TTS/behavioral disturbance **may affect, but are not likely to adversely affect** fin whales and North Atlantic right whales.

Table 52. Permanent threshold shift and behavioral impact estimates from potential unexploded ordnance/munitions and explosives of concern detonations in Sunrise Wind Farm assuming 10 decibels of mitigation.

Species	Level A Density - based Exposure Estimate	Level B Density - based Exposure Estimate	Protected Species Observer Exposure Estimate	Mean Group Size	Highest Level B Exposure
Mysticetes					
Fin Whale	0.4	4.6	0.7	1.8	5.0
North Atlantic Right Whale	0.4	3.9	0.1	2.4	4.0
Sei Whale	0.0	0.3	0.0	1.6	2.0
Odontocetes					
Sperm Whale	0.0	0.0	-	1.5	2.0

Table 53. Permanent threshold shift and behavioral impact estimates from potential unexploded ordnance/munitions and explosives of concern detonations in the Sunrise Wind Farm assuming no mitigation.

Species	Level A Density - based Exposure Estimate	Level B Density - based Exposure Estimate	Protected Species Observer Exposure Estimate	Mean Group Size	Highest Level B Exposure
Mysticetes					
Fin Whale	2.4	12.2	0.7	1.8	13.0
North Atlantic Right Whale	2.0	10.3	0.1	2.4	11.0
Sei Whale	0.2	0.9	0.0	1.6	2.0
Odontocetes					
Sperm Whale	0.0	0.1	-	1.5	2.0

Operation of Wind Turbine Generators – O&M

Many of the published measurements of underwater noise levels produced by operating WTGs range are from older geared WTGs and may not be representative of newer direct-drive WTGs, like those that will be installed for the Vineyard Wind project. Elliot et al. (2019) reports underwater noise monitoring at the BIWF, which has direct-drive GE Haliade 150-6 MW turbines expected to be comparable to the ones proposed for SRWF. The loudest noise recorded was 126 dB re 1 μPa at 50 m from the turbine when wind speeds exceeded 56 km/h; at wind speeds of 43.2 km/h and less, measured noise did not exceed 120 dB re 1 μPa at 50 m from the turbine.

Elliot et al. (2019) conclude that based on monitoring of underwater noise at the Block Island site, under worst-case assumptions, no risk of temporary or permanent hearing damage (PTS or TTS) could be projected even if a marine mammal remained in the water at 50 m (164 ft) from the turbine for a full 24-hour period. As such, we do not expect any PTS, TTS, or other potential injury to result from even extended exposure to the operating WTGs.

Under certain windy conditions (winds over 43.2 km/h), underwater noise associated with the operating WTG could exceed 120 dB re 1 μPa at a distance of 50 m from the WTG foundation (Elliot et al. 2019); however, ambient noise in the lease area as high as 125 dB re 1 μPa has been recorded (Kraus et al. 2016b). Elliot et al. (2019) notes that the direct-drive turbines measured at BIWF are above the background sound levels at the measurement location of 50 m (164 ft) from the foundation during quiet conditions. The authors also conclude that even in quiet conditions (i.e., minimal wind or weather noise, no transiting vessels nearby), operational noise at any frequency would be below background levels within 1 km (0.6 mi) of the foundation. However, given the required windy conditions to result in operational noise above 120 dB re 1 μPa, we would expect the potential for operational noise to be above 120 dB re 1 μPa during quiet conditions where it would exceed ambient noise levels to be extremely unlikely. Further, based on data from the Nantucket Sound Buoy[1], the average wind speed is less than 20 mph and exceeds 40 km/h from 0 to 3 percent of the time depending on the month. Given the conditions necessary to result in noise above 120 dB re 1 μPa only occur 0 to 3 percent of the time per month and even less on an annual basis, and that in such windy conditions ambient noise is also increased, we do not anticipate the underwater noise associated with the operations noise of the direct-drive WTGs to exceed ambient noise at a distance of more than 50 m from the WTG foundation. As such, even if ESA-listed marine mammals avoided the area with noise above ambient, any effects would be so small that they could not be meaningfully measured, detected, or evaluated, and are therefore insignificant.

4.2.11 Effects of Project Noise on Sea Turtles

The potential significance of impulsive underwater noise is unclear because sea turtle sensitivity and behavioral responses to underwater noise are a subject of ongoing study. Potential behavioral impacts may include altered submergence patterns, short-term disturbance, startle response (diving or swimming away), and short-term displacement of feeding/migrating and a temporary stress response, if present within the ensonified area (**Table 54**) (NSF and USGS 2011; Samuel et al. 2005). The accumulated stress and energetic costs of avoiding repeated exposure to pile-driving noise over a season or a life stage could have long-term impacts on survival and fitness (DoN 2018). Conversely, sea turtles could become habituated to repeated noise exposure over time and not suffer long-term consequences (O'Hara and Wilcox 1990). This type of noise habituation was demonstrated even when repeated exposures were separated by several days (Bartol and Bartol 2011; DoN 2018).

Underwater noise sources that have the potential to adversely affect sea turtles are analyzed below.

Table 54. Impacts of noise levels on sea turtles.

Response	Threshold Level
Behavioral	175 dB re 1 μPa SPL
Single Strike Injury	232 dB re 1 μPa L_{pk}
$L_{E,24hr}$ Injury (impulsive)	204 dB re 1 μPa2s $L_{E,24hr}$
$L_{E,24hr}$ Injury (continuous)	220 dB re 1 μPa2s $L_{E,24hr}$

Notes:

dB re 1 μPa L_{pk} = decibel re 1 micropascal peak sound pressure level; dB re 1 μPa L_{RMS} = decibels re 1 micropascal root mean square sound pressure level; dB re 1 μPa^2s $L_{E,24hr}$ = decibel re 1 micropascal squared second cumulative sound exposure level

[1] Windfinder. 2022. Wind & weather statistics: Nantucket Sound Buoy. https://www.windfinder.com/windstatistics/nantucket_sound_buoy. Accessed 20 November 2022.

Table 55. Sea turtle density estimates for all modeled species within a 10-kilometer buffer around the lease area.

Species	Spring	Summer	Fall	Winter
Kemp's ridley sea turtle[2]	0.018	0.018	0.018	0.018
Leatherback sea turtle[2]	0.021	0.630[3]	0.873[3]	0.021
Loggerhead sea turtle	0.141	0.206[4]	0.755[4]	0.141
Green sea turtle[5]	0.018	0.018	0.018	0.018

Notes:

1 Density estimates are extracted from SERDP-SDSS NODE database within a 10-kilometer buffer of the OCS-A 0487 lease area, unless otherwise noted.

2 Listed as Endangered under the ESA.

3 Densities calculated as averaged seasonal densities from 2011 to 2015 (Kraus et al. 2016b).

4 Densities calculated as the averaged seasonal leatherback sea turtle densities scaled by the relative, seasonal sighting rates of loggerhead and leatherback sea turtles (Kraus et al. 2016b).

5 Kraus et al. (2016b) did not observe any green sea turtles in the RI/MA WEA. Densities of Kemp's ridley sea turtles are used as conservative estimates.

4.2.11.1 Impact Pile Driving – C

Potential for sound impacts were modeled in Sunrise Wind (2022d). Mitigation measures including sound attenuation and ramp up procedures will reduce the potential for injury. Assuming 10 dB of attenuation for all impact pile driving from included sound reduction methods, sea turtles would not be at risk for single strike injury. Sea turtles may experience PTS injury at a radius of up to 323 m from pile-driving activities (**Table 56**). Further, sea turtles will likely exhibit behavioral responses to sounds elevated above 175 dB associated with ramp up procedures that will cause them to move away from the sound source, and outside of the area of potential injury. With the inclusion of PSOs and exclusion zone, single strike injury is extremely unlikely to occur for sea turtles.

Table 56. Sea turtles: Maximum exposure ranges, $ER_{95\%}$, in kilometers from all modeled scenarios for monopile and pin pile installation to permanent threshold shift injury (L_E and L_{PK}) and behavioral disturbance (L_p) sound exposure acoustic thresholds for the 10-decibal sound attenuation level. Results based on animat modeling as described in Sunrise Wind (2022d).

Species	L_E (204 dB)	PL_{pk} (232 dB)	L_p (175 dB)
Kemp's ridley turtle	0.70	0	1.59
Leatherback turtle	2.31	0	1.83
Loggerhead turtle	0.30	0	1.40
Green turtle	1.14	0	1.54

Notes:

dB = decibel(s); L_E = cumulative sound exposure level; L_p = root mean square sound pressure level; L_{pk} = peak sound pressure level

Sea turtles may experience PTS injury at a radius of up to 5.59 km from pile driving activities (**Table 57**); however, sea turtles migrating through the area when pile driving occurs are expected to adjust their course to avoid the area where noise is elevated above 175 dB re 1 µPa L_p. Depending on how close the individual is to the pile being driven, this could involve swimming up to 1.02 mi (1.65 km). Such behavioral alterations could cause turtles to cease foraging or expend additional effort and energy avoiding the area. Presumably, turtles could continue foraging activities outside the area of elevated noise levels as adjacent habitat provides similar foraging opportunities. The turtle may experience physiological stress during this avoidance behavior, but this stressed state would be anticipated to dissipate over time once the sea turtle is outside the ensonified area. There have been no documented sea turtle mortalities associated with pile driving. Either a temporary or permanent reduction in hearing sensitivity could be harmful for sea turtles, but the potential significance is unclear because the role that hearing plays in sea turtle survival (e.g., for predator avoidance, prey capture, and navigation) is poorly understood (NSF and USGS 2011). The use of PSOs, pre-clearance and exclusion zones of a minimum of 500 m, monitoring zones to the range of potential PTS effects, and pile-driving soft start measures (see Table H-1 in Appendix H of the 2022 Sunrise Wind EIS) would minimize the risk of sea turtle exposure to elevated underwater noise levels. Because behavioral effects would only last for the duration of active pile driving these effects are expected to last a short time, and sea turtles would return to normal behavior once outside of the harassment area or when pile driving stops (BOEM 2021b).

Sea turtles that are close to impact pile driving could experience a temporary or permanent loss of hearing sensitivity. In theory, reduced hearing sensitivity could limit the ability to detect predators and prey or find potential mates, reducing the survival and fitness of affected individuals. Less than one individual of Kemp’s ridley, loggerhead, and green sea turtles are anticipated to be exposed to PTS from cumulative sound exposure, and there is no risk of PTS from single strike impacts associated with the installation of the WTG monopiles and the OCS–DC foundation pin piles; however, an estimated 3.7 leatherback sea turtles may experience PTS injury from cumulative sound impacts (JASCO Applied Sciences 2022).

Table 57. Maximum estimated number of individuals exposed to sound levels above exposure criteria among all modeled construction schedules (JASCO Applied Sciences 2022).

Species			
	L_E	L_{pk}	L_p
Kemp’s ridley turtle	0.03	0.00	0.15
Leatherback turtle	3.69	0.00	8.19
Loggerhead turtle	0.37	0.00	6.75
Green turtle	0.05	0.00	0.14

Notes:

L_E = cumulative sound exposure level; L_p = root mean square sound pressure level; L_{pk} = peak sound pressure level

Very low density for presence of Kemp’s ridley, loggerhead, and green sea turtles, along with the included project mitigation, exclusion zones, and soft start methods make it extremely unlikely that these species will be exposed to potential injury from impact pile driving and therefore **discountable**. Impact pile driving **may affect, but is not likely to adversely affect** Kemp’s ridley, loggerhead, and green sea turtles.

Based on the to the sound modeling, up to five leatherback sea turtles may be exposed to PTS injury from impact pile driving, and therefore impact pile driving **may affect, and** is **likely to adversely affect** leatherback, sea turtles.

Less than one green and Kemp’s ridley sea turtles are anticipated to be exposed to behavioral effects from pile driving; however, up to 10 each of leatherback and loggerhead sea turtles could be exposed to behavioral effects from impact pile driving. While individual sea turtles may be exposed to impact pile driving noise sufficient to cause behavioral effects, those effects would be short-term and unlikely to cause any perceptible long-term consequences to individuals or populations and would be insignificant. Therefore, behavioral impacts from impact pile driving may affect, but are not likely to adversely affect green, Kemp’s ridley, loggerhead, or leatherback sea turtles.

4.2.11.2 Export Cable Landfall Construction – C

The use of a Grundoram (or similar) pneumatic hammer to install and remove temporary casing pipe will produce impulsive sounds. To estimate distances to PTS injury and behavioral effect thresholds acoustic modeling was performed at the anticipated HDD exit pit location approximately 0.5 mi (800 m) offshore of the landfall site. The modeling used a winter sound speed profile and assumed up to 3 hours of pneumatic hammer use per day for 2 days to install each casing pipe. Assuming 180 strikes per minute over 3 hours of operations results in up to 32,400 total strikes per day.

Results of the casing pipe installation acoustic modeling are shown in **Table 58**. The estimated distance to the PTS is 500 m, and behavioral impact threshold, 340 m. The estimated distances to PTS $L_{E,24hr}$ thresholds are larger than the behavioral impact SPL thresholds due to the high strike high number of strikes per day from casing pipe installation; however, both of the distances to potential impacts fall within the 500-m required minimum pre-clearance and shutdown zone for sea turtles.

No individuals of any species are expected to remain within the estimated L_{E24} hr threshold distances for the entire duration of piling. With the implementation of planned monitoring and the implementation of a minimum 500-m pre-clearance and shutdown zone for pile driving, no risk of injury to ESA-listed species is anticipated. Based on the modeling and included mitigation measures, impact pile driving of the casing piles is extremely unlikely to result in PTS, injury, or behavioral impacts to ESA-listed sea turtles and is discountable.

Table 58. Acoustic ranges ($R_{95\%}$) in meters to PTS and behavioral impacts for sea turtles for impact pile driving associated with temporary casing pipes.

Metric	Threshold	R_{max}	$R_{95\%}$
L_E[1]	204	500	420
L_{pk}[1]	232	-	-
L_p[2]	175	340	290

Notes:

Dashes indicate that the acoustic threshold was not reached.

[1] Blackstock (2018).

[2] DoN (2017).

L_E = cumulative sound exposure level; L_p = root mean square sound pressure level; L_{pk} = peak sound pressure level

Impacts to sea turtles from vibratory pile driving associated with the goal post sheet piles to support the temporary casing pipe installation are to be extremely unlikely to occur because of the combination of minimization measures used and the low densities of sea turtles in the SRWF and SRWEC. Vibratory pile-driving noise would not exceed recommended sea turtle injury thresholds (220 dB_{Lp}) or behavioral thresholds (175 dB_{Le}) (NMFS 2022b; Sunrise Wind 2022d), as source levels for the installation of sheet piles are below behavioral thresholds for sea turtles. Potential impacts from vibratory pile driving would be limited to visual disturbance from movement associated with pile driving activities. Given the limited spatial extent of these potential effects and short duration of pile driving activities, the impacts from vibratory pile driving to sea turtles would be extremely unlikely to occur and **discountable**, and **insignificant** if experienced. Therefore, vibratory pile driving **may affect, but is not likely to adversely affect** sea turtles.

4.2.11.3 Unexploded Ordnance/Munitions and Explosives of Concern Clearance Detonations – C

Sunrise Wind may encounter UXOs on the seabed in the Lease Area and along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb sea turtles. Modeling of acoustic fields for UXO detonations performed for the WEA was performed and is described in detail in Hannay and Zykov (2022). Ranges to auditory injury (PTS), non-auditory injury (mortality, slight lung injury and gastrointestinal injury) and the behavioral threshold were calculated based on the representative body mass of harbor seal pups as surrogates for sea turtles and used to determine the number of individuals potentially exposed. **Table 59** summarizes the maximum ranges to PTS and behavioral thresholds per charge weight bin for sea turtles. Ranges to PTS thresholds were larger than ranges to mortality, slight lung injury and gastrointestinal injury criteria per charge eight bin. See **Table 45** for charge size E12 (1,000 pounds [lb; 454 kilograms (kg)]) (Hannay and Zykov 2022). Therefore, the pre-clearance zones for sea turtles were based on the ranges to PTS threshold.

NMFS has adopted criteria used by the U.S. Navy to assess the potential for non-auditory injury from underwater explosive sources as presented in U.S. Navy (2017). (**Table 41** in the marine mammals section). The criteria include thresholds for the following non-auditory effects: mortality, lung injury and gastrointestinal injury. Unlike auditory thresholds, these depend upon an animal's mass and depth. Hannay and Zykov (2022) provide mass estimates used in the assessment. For sea turtles, a harbor seal (*Phoca vitulina*) pup (8 kg) and adult (60 kg) masses are used as conservative surrogate values as outlined in U.S. Navy (2017) and (Hannay and Zykov 2022). For the BA, the more conservative 1 percent thresholds have been applied when determining the consequence of the effects and the number of sea turtles potentially exposed.

Single blast events within a 24-hour period are not presently considered by NMFS to produce behavioral effects if they are below the onset of TTS thresholds for frequency-weighted SEL ($L_{E,24h}$) and peak pressure levels. As only one charge detonation per day is planned for the Project, the effective disturbance threshold for single events in each 24-hour period is the TTS onset (behavioral zone, **Table 59**).

Table 59. Maximum permanent threshold shift zones and applicable pre-clearance zones (meters) to be applied during unexploded ordnance detonations for sea turtles using a minimum of 10 decibels of attenuation.

Charge Size									
E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone
<50	203	54	448	159	870	348	1,780	472	2,250

Notes:

Source: (Hannay and Zykov 2022)

UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). Four Project sites (S1-S4) were chosen and modeled for the detonation of each charge weight bin.

PTS zone represent maximum/largest $R_{95\%}$ values in meters calculated per charge size bin (e.g., E/kg). Pre-start clearance zones were calculated by selecting the largest distance to the PTS threshold. The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

kg = kilograms; E = equivalent; TNT = trinitrotoluene; m = meters; PTS = permanent threshold shift; $R_{95\%}$ = 95th percentile exposure range; UXO = unexploded ordinance

Table 60. Maximum unexploded ordnance ranges (meters) to non-auditory injury thresholds for sea turtles using a minimum of 10 decibels of attenuation.

Injury Type	Adult	Juvenile
Mortality (severe lung injury)	224	332
Injury (slight lung injury)	429	607
Gastrointestinal Injury	125	125

Notes:

Maximum ranges are based on worst-case scenario modeling results: charge size E12 (454 kilograms), deepest water depth (45 meters).

A Based on 1% of animals exposed (mortality/lung injury) (Hannay and Zykov 2022).

dB = decibels; UXO = unexploded ordnance

The Applicant-proposed mitigation for UXO detonations include pre-clearance zones, restricting detonations to daylight hours and the use of a dual noise mitigation system for all detonations to achieve a 10-dB attenuation. Sunrise Wind has committed that enough vessels would be deployed to provide 100 percent temporal and spatial coverage of the pre-clearance zones and, if necessary, aerial surveys would be used to provide coverage. **Table 61** outlines the number of ESA-listed turtles potentially exposed to sound sources above PTS, behavioral thresholds and non-auditory thresholds associated with UXO detonations. Calculations were conducted separate from the modeling exercise presented in Hannay and Zykov (2022). The calculations used the largest ranges to thresholds for the maximum charge weight (E12; 1,000 lb [454 kg]) scenario presented in Hannay and Zykov (2022) and the highest density months for each species outlined in Appendix A of COP Appendix I1 (summer for all species except leatherback turtle where fall densities were highest) (Sunrise Wind 2022d). As Sunrise Wind is committing to a 10-dB attenuation for all detonations, the number of exposed sea turtles outlined in **Table 55** is based on the mitigated ranges presented in **Tables 59** and **60**.

Table 61. Total number of Endangered Species Act-listed sea turtles exposed to sound levels above permanent threshold shift, non-auditory mortality/injury, and behavioral thresholds for detonation of up to 10 unexploded ordnances using a minimum of 10 decibels of sound attenuation.

Species	PTS	Mortality (severe lung injury)	Injury (slight lung injury)	Gastrointestinal Injury	Behavior
Kemp's Ridley	0	0	0	0	<1 (0.47)
Leatherback turtle	0	0	0	0	<1 (0.39)
Loggerhead turtle	<1 (0.59)	<1 (0.29)	1 (0.97)	0	13 (13.38)
Green turtle	0	0	0	0	0

Notes:

Source: Distances to thresholds taken from Hannay and Zykov (2022); densities compiled from various sources outlined in Appendix A.

Calculation used the largest ranges which were for sea turtle masses (using harbor seals pup as a surrogate as outlined in U.S. Navy (2017)) for the maximum charge weight (E12 [454 kg]) presented in Hannay and Zykov (2022) and the highest density months for each species outlined in Appendix A.

dB = decibels; ESA = Endangered Species Act; kg = kilograms; PTS = permanent threshold shift; UXO = unexploded ordnance

4.2.11.4 Effects of Exposure to Noise Above the Permanent Threshold Shift and Mortality/Slight Lung Injury/Gastrointestinal Injury Thresholds

Because direct studies of explosive impacts on sea turtles have not been conducted, the below discussion of injurious effects is based on studies of other animals, generally marine mammals, or from postmortem examination of sea turtle carcasses found after explosive events. The generalizations that can be made about in-water explosive injuries to other species should be applicable to turtles, with consideration of the unique anatomy of turtles. For example, it is unknown if the sea turtle shells may afford it some protection from internal injury.

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

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

Data on observed injuries to sea turtles from explosives is generally limited to animals found following explosive removal of offshore structures (Viada et al. 2008), which can attract sea turtles for feeding opportunities or shelter. Klima et al. (1988) observed a turtle mortality subsequent to an oil platform removal blast although sufficient information was not available to determine the animal's exposure. Klima et al. (1988) also placed small sea turtles (less than 15.4 lb [7 kg]) at varying distances from piling detonations. Some of the turtles were immediately knocked unconscious or exhibited vasodilation over the following weeks, but others at the same exposure distance exhibited no effects. Incidental impacts on sea turtles were documented for exposure to a single 1,200-lb (540 kg) underwater charge off Panama City, Florida, in 1981. The charge was detonated at mid-depth in water 120 ft (37 m) deep. Although details are limited, the following were recorded: at a distance of 500 to 700 ft (150 to 200 m), a 400-lb (180 kg) sea turtle was killed; at 1,200 ft (370 m), a 200- to 300-lb (90 to 140 kg) sea turtle experienced "minor" injury; and at 2,000 ft (600 m) a 200- to 300-lb (90 to 140 kg) sea turtle was not injured' (O'Keeffe and Young 1984).

In the event that UXO detonations are required, modeling indicates that less than one Kemp's ridley sea turtles, leatherback sea turtles, or green sea turtles will be exposed to noises/blasts above PTS/mortality/slight lung injury/gastrointestinal injury thresholds. The potential for serious injury is minimized by the implementation of pre-clearance and shutdown zones that would facilitate a delay in detonations if sea turtles were observed approaching or within areas that could be ensonified above sound levels that could result in auditory and non-auditory injury. These measures also make it unlikely that any sea turtles will be exposed to UXO detonations that would result in mortality and slight lung injury as well as severe hearing impairment or serious injury and—if exposed —would more likely have the potential to result in slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds). Furthermore, Sunrise Wind has committed to the use of aircraft to monitor the clearance zone if needed. The potential for PTS/non-auditory injury is further minimized by the use of a dual noise-mitigation system during all UXO detonations. The proposed requirement that UXO detonations can only commence when the pre-clearance zones (**Table**

59) are fully visible to PSOs allows the potential for high turtle detection capability and enables a high rate of success in implementation of these zones to avoid serious injury. As the maximum zones for the mortality – impulse (severe lung injury) are relatively small (e.g., 1,056 ft [332 m] for the largest charge weight) the ability for PSOs to detect sea turtles within this zone is considered high, thus the potential for PTS exposure to these sea turtle species is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project UXO detonations leading to PTS/mortality/slight lung injury/ gastrointestinal injury **may affect, not likely to adversely affect** green, Kemp's ridley, and leatherback sea turtles.

Modeling indicates that less than one individual loggerhead sea turtle may be exposed to underwater noise levels above PTS thresholds, less than one individual loggerhead sea turtle may be exposed–above mortality-impulse (severe lung injury) thresholds, and one individual loggerhead sea turtle may be exposed above injury-impulse (slight lung injury) thresholds from UXO detonations. As stated above, the modeling used to estimate potential exposures are based on a conservative approach under the assumption that the UXO could not be removed and had to be blown in place. While the scenario cannot be discounted, the likelihood of this scenario occurring is highly unlikely for the size charge that was modeled. Furthermore, the potential for serious injury would be minimized by the implementation of the mitigation and monitoring measures proposed (Appendix H) that are expected to reduce the potential for serious injury to loggerhead sea turtles. Thus, the potential for exposure of sea turtles to UXO detonations leading to PTS and non-auditory injury (mortality and internal trauma) is extremely unlikely to occur and **discountable**. Therefore, the effects of blast exposure from Project UXO detonations leading to PTS and non-auditory injury (mortality and internal trauma) **may affect, not likely to adversely affect** loggerhead sea turtles.

4.2.11.5 Effects of Exposure to Noise Above the Temporary Threshold Shift and Behavioral Thresholds and Masking

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

Considering UXO detonations activities that modeled the largest explosive charge, estimates indicated that less than one Kemp's ridley, less than one leatherback, and 13 loggerhead sea turtles may be exposed to noise levels that exceed TTS and behavioral thresholds (**Table 57**). No green turtle exposures are expected. As discussed, the highly unlikely occurrence of the event, and the mitigation measures in place to limit sea turtle exposures to UXO detonations are expected to reduce the potential effects on sea turtle behavior. Furthermore, the low number of potential UXOs identified in the Project Area and Sunrise Wind's commitment to using a dual noise-mitigation system for all detonations would further reduce all potential underwater noise effects associated with UXO detonations.

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

Modeling suggests that 13 loggerhead sea turtles could be exposed to noise impacts from UXO exposure resulting in the potential for TTS and behavioral disturbance. If a detonation is required loggerhead sea turtles may be exposed to noise resulting in TTS/behavioral disturbance even with the application of mitigation measures and cannot be discounted. Therefore, the effects of noise exposure from Project UXO detonations leading to TTS/behavioral disturbance **may affect, likely to adversely affect** loggerhead sea turtles.

4.2.11.6 Vessel Noise – P, C, O&M, D

The relatively low frequency range of turtle hearing (100 to 1,200 Hz) (Ketten and Moein Bartol 2006; Lavender et al. 2014) overlaps the broad frequency spectrum of intermittent non-impulsive noise produced by vessels (10 to 1,000 Hz). Sea turtles could respond to vessel approach and/or noise with a startle response and a temporary stress response (NSF and USGS 2011); however, Hazel et al. (2007) suggested that turtles could habituate to vessel sounds in marine areas that experience regular vessel traffic. This could reduce the behavioral impacts of vessel noise but may increase the potential for vessel collision (refer to subsection on vessel traffic below). Underwater noise generated by construction vessels would not exceed injury thresholds for turtles, as noise levels produced by vessels in general are below levels that could cause potential auditory threshold shifts. Behavioral responses to vessels have been reported but are thought to be more associated with visual cues, as opposed to auditory cues (Hazel et al. 2007), although both senses likely play a role in avoidance. A conservative assumption is that construction and support vessels could elicit behavioral changes in individual sea turtles near the vessels. It is assumed that these behavioral changes would be limited to evasive maneuvers such as diving, changes in swimming direction, or changes in swimming speed to distance themselves from vessels. Overall, impacts from vessel noise would be **insignificant** and therefore **may affect, but not likely to adversely** affect sea turtles.

4.2.12 Effects of Project Noise on Atlantic Sturgeon

Pile driving activity is likely to produce the most intense underwater noise levels and have the potential to initiate a response from finfish. Typical responses may include temporary displacement, or disruption of common activities during feeding and movement, with less likely and more severe responses including physiological reactions that could lead to mortality (Popper et al. 2014). The Fisheries Hydroacoustic Working Group (2008) established conservative thresholds for the impacts from sound on fish (**Table 62**).

Table 62. Thresholds for onset of acoustic impacts for fish.

Response	Threshold Level
Behavioral (All fish)[1]	150 dB re 1 μPa L_p
Single Strike Injury (All fish)[2]	206 dB re 1 μPa L_{pk}
$L_{E,24hr}$ Injury (Fish over 2 grams)[2]	187 dB re 1 μPa^{2}s $L_{E,24h}$

Notes:

[1] Andersson et al. (2007), Wysocki et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011)

[2] FHWG (2008)

dB re 1 μPa L_{pk}= decibel re 1 micropascal peak sound pressure level; dB re 1 μPa L_p = decibels re 1 micropascal root mean square sound pressure level; dB re 1 μPa^{2}s L_E = decibel re 1 micropascal squared second root mean square sound pressure level

Offshore construction activities associated with the Proposed Action primarily from pile-driving activities could cause fish to suffer behavioral and/or physiological responses based on distance from the sound source, equipment used, substrate and environmental conditions (Popper et al. 2014). Monopile and pin pile installation during construction are likely the only construction activity to produce underwater sound levels exceeding 180 to 200 dB re 1 μPa L_{pk} and likely to produce a response in fishes (Popper et al. 2019); however, many of the behavioral sound response studies conducted on fish have been on captive species within confined spaces, and there are significant gaps in understanding the true impacts of these noises in the wild (Hawkins et al. 2015; Popper et al. 2019). Fish and invertebrate response to construction noises is dependent on distance from the source and duration of the activity (**Table 63**), therefore the impacts are likely to be temporary as the sounds produced from pile driving activities would be intermittent and fish would need to be in the immediate area of disturbance to be susceptible to the impacts.

4.2.12.1 Impact Pile Driving – C

Single strike injury to Atlantic sturgeon from installation of monopiles and the jacket foundation pin piles with attenuation may occur to a range of 505 ft (154 m). Using FHWG (2008) for risk of injury from L_E, Atlantic sturgeon may experience cumulative sound exposure injury to a distance of 9.34 mi (15.03 km); however, with applicant-included soft start procedures for impact pile driving, Atlantic sturgeon will likely exhibit behavioral responses to sounds elevated above 150 dB associated with soft start procedures that will cause them to move away from the sound source, reducing the potential for injury.

The installation of a casing pipe at the exit pit for the Landfall HDD will be conducted with an impact hammer. The casing pipe will be installed at an 11- to 12-degree angle from horizontal and will be used to collect drilling fluids from the HDD. The casing pipe is anticipated to have a 10m penetration depth below sea level and may require up to 32,400 strikes during its installation. As shown in **Table 63**, the casing pipe installation may result in LE injury at a radius of up to 2.82 km and may create behavioral impacts to a radius of 2.51 km (Sunrise Wind 2022d).

Steel sheet piles (referred to as goal posts) are expected to be used to support casing pipe installation at the HDD exit pit for guidance, support, or mooring of the installation barge. They will be installed using an APE Model 300 vibratory hammer and installed to a penetration depth of 10 m. Up to four piles may be installed per day, with an estimated time of 2 hours to install each pile. As shown in **Table 63**, sheet piles may result in behavioral disturbance to Atlantic sturgeon to a distance of 100 m but are not expected to pose a risk of L_E or L_{pk} injury (Sunrise Wind 2022d).

Table 63. Maximum modeled acoustic radial distances ($R_{95\%}$ in kilometers) to thresholds for Atlantic sturgeon for project pile driving activities.

Activity	Single Strike (206 dB L_{pk})	Cumulative Exposure (187 dB L_E)	Behavioral Impacts (150 dB L_p)
Jacket foundation pin piles (4 per day max, with 10-dB attenuation, 90-m penetration depth, hammer energy of 4,000 kJ)	0.13	15.03	19.36
Monopile foundation (4 per day max, with 10-dB attenuation, 48-m penetration depth, hammer energy of 3,200 kJ)	0.15	7.82	14.57
Casing Pipe (1.2-m diameter, 10-m penetration depth, APE Model 300 steel sheet pile, 10-m penetration depth, hammer energy of 18 kJ)	0	2.82	2.51
Vibratory	0	0	0.1

Notes:

* (Popper et al. 2014)

dB = decibel(s); kJ = kilojoule(s); L_E = cumulative sound exposure level; L_{pk} = peak sound pressure level; L_p = root mean square sound pressure level; m = meter(s)

4.2.12.2 Unexploded Ordnance/Munitions and Explosives of Concern Clearance Detonations – C

Atlantic sturgeon may be present within the radius of potential injury for UXO/MEC detonations. Underwater explosions of this type generate high pressure levels that could kill, injure, or disturb Atlantic Sturgeon. Hannay and Zykov (2022) conducted modeling of acoustic fields for UXO detonations. Mitigated (10 dB) ranges to physiological injury and behavioral thresholds were calculated, and injury and behavioral isopleths were estimated based on those results and assuming a TL of 20 (**Table 64**).

Table 64. Modeled distances (in kilometers) and areas (in square kilometers) for mortality and injury isopleths with 10 decibels of attenuation for various explosive categories used for unexploded ordnance detonations for Atlantic sturgeon (Hannay and Zykov 2022).

Explosive Type	Mortality – 229 dB L_{pk}		Injury – 206 dB L_{pk}	
	Radial Distance (km)	Area (km^2)	Radial Distance (km)	Area (km^2)
E4 (2.3 kg)	0.05	0.008	0.69	1.496
E6 (9.1 kg)	0.08	0.020	1.13	4.011
E8 (45.5 kg)	0.14	0.062	1.91	11.46
E10 (227 kg)	0.23	0.166	3.25	33.183
E12 (454 kg)	0.29	0.264	4.10	52.910

Notes:

*Injury and behavioral impacts modeled based on results of mortality modeling from (Hannay and Zykov 2022), assuming a TL of 20.

dB = decibel(s); kg = kilogram(s); km = kilometer(s); km^2 = square kilometer(s); L_E = cumulative sound exposure level; L_{pk} = peak sound pressure level; L_p = root mean square sound pressure level

Modeling indicates that the distance for a UXO detonation to result in physiological injury resulting in mortality for Atlantic sturgeon ranges between 160 ft (49 m) and 951 ft (290 m) (depending on the charge weight) (Hannay and Zykov 2022). As described in **Section 3.4.2.3**, Atlantic sturgeon could occur in the Offshore Wind Area, where they could be exposed to UXO detonations. Individuals present in the area will likely occur intermittently, moving through the Offshore Wind Area throughout their spring and fall migrations and may forage opportunistically in areas where benthic invertebrates are present.

Lacking specific density estimates for the Project Area or region, we use NEAMAP trawl survey data reported by NMFS (2016c). NEAMAP trawl surveys in the northern region which overlaps the project area operates their trawls at up to 2.5 kt, using nets with a 70 ft footrope. Using the maximum estimates for trawl speed of 2.5 kt and trawl width, we can estimate the density of Atlantic sturgeon using the NEAMAP reported catch per trawl value (0.01038 Atlantic sturgeon per trawl). With the standard trawl operating for 20 minutes (1,200 seconds) at 2.5 kt (4.22 ft/s) with a trawl width of 70 ft, each trawl covers approximately 354,480 ft^2 (0.0329 km^2). Assuming a 50 percent trawl efficiency for catching Atlantic sturgeon, we multiply the sturgeon per trawl by 2 to estimate sturgeon present in the trawl area (0.02076).

$$Density\ estimate = \frac{0.02076\ sturgeon\ per\ trawl}{0.0329\ km^2\ per\ trawl} = 0.63\ sturgeon/km^2$$

We believe this estimate represents a conservative approach as trawls do not operate at the full width of the footrope due to the curving of the line due to drag. To estimate the potential for take from mortality and injury, we apply our conservative derived density estimate by the area of impacts (**Table 65**).

Assuming the maximum impact scenario of three events using an E12 explosive, the estimated potential take is 100 Atlantic sturgeon injured, inclusive of one possible direct mortality. Injured individuals may experience reduced survival and reproductive fitness and increased risk of predation. Actual take is likely to be less as the number of UXO events is anticipated to be fewer than three, and it is unlikely that each event requires the highest explosive type.

Table 65. Estimated mortality and injury by explosive category.

Explosive Type	Mortality – 229 dB L_{pk}		Injury – 206 dB L_{pk}	
	Area of impact (km^2)	Estimated Mortality	Area of Impact (km^2)	Estimated # of Injured
E4 (2.3 kg)	0.008	0.0	1.496	0.9
E6 (9.1 kg)	0.02	0.0	4.011	2.5
E8 (45.5 kg)	0.062	0.0	11.46	7.2
E10 (227 kg)	0.166	0.1	33.183	20.9
E12 (454 kg)	0.264	0.2	52.91	33.3

Notes:

dB = decibel(s); kg = kilogram(s); km^2 = square kilometer(s); L_E = cumulative sound exposure level; L_{pk} = peak sound pressure level; L_p = root mean square sound pressure level

While the distance at which Atlantic sturgeon could experience behavioral disturbance is extremely large (up to 2,584.63 km), the UXO events will be a single pulse event. Single pulse events are not considered to have behavioral effects that have the potential for take under the ESA. Should a sturgeon be exposed to noises above behavioral thresholds the effects would likely be brief (e.g., Atlantic sturgeon may be startled and divert away from the area), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Project UXO detonations leading to behavioral disturbance will be insignificant.

Overall, noise associated with the Proposed Action is likely to result in temporary and short-term impacts that may cause a range of responses from Atlantic sturgeon. The effects may include the potential to cause direct injury and mortality if fish are in the immediate area of the sound source. Based on the area of potential injury for Atlantic sturgeon and the estimated density of this species in the region, the Proposed Action **may affect, is likely to adversely affect** Atlantic sturgeon.

4.3 Effects of Vessel Traffic – P, C, O&M, D

Construction of the Project will require the support of various vessels and unmanned systems (**Table 66**). For each vessel type, the route plan for the vessel operation area will be developed to meet industry guidelines and best practices in accordance with International Chamber of Shipping guidance. The Project will install operational AIS on all vessels associated with the construction, O&M, and deconstruction phases of the Project. AIS will be used to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements. All vessels will operate in accordance with applicable rules and regulations for maritime operation within U.S. and federal waters. Similarly, all aviation operations, including flying routes and altitude, will be aligned with relevant stakeholders (e.g., the FAA). Additionally, the Project will adhere to current vessel speed restrictions as appropriate at the time of Project activities and in accordance with BOEM and NMFS requirements.

Construction and operation vessels pose a potential collision risk and generate noise and artificial light. Vessels also pose a theoretical risk of accidental spills, trash, and debris. Noise and artificial light effects on ESA-listed species are addressed in their respective sections. This portion of the effects analysis addresses potential risks from vessel collisions, oil spills, and release of trash and debris.

Table 66. Vessels and unmanned systems proposed for the Sunrise Wind Farm.

Vessel Type	# of Vessels	Foundations	OCS–DC	SRWEC	IAC	WTGs
Heavy Lift Installation Vessel	2	X	X			
Multi-Purpose Supply Vessel	3	X	X			
Heavy Transport Vessel	5		X			
Rock Dumping Vessel	2	X	X			
Bubble Curtain Vessel	2	X	X			
Fuel Bunkering Vessel	2	X	X			
Transportation Barge	3	X	X			
Escort Tug for Barge	3		X			
Towing Tug	6	X	X			X
Anchor Handling Tug	2	X	X	X		
Assisting Tug	2					X
Platform Supply Vessel	1					X
Jack-Up Vessel/Jack-up Accommodation Vessel	2	X	X	X	X	X
Transport Freighter	3			X		
Support Barge	1			X		
Boulder Clearance Vessel	2			X	X	
Sand Wave Leveling Vessel	2			X	X	
Pre-lay Grapnel Run Vessel	2			X	X	
Cable Laying Vessel	3			X	X	
Cable Burial Vessel	2			X	X	
Cable Remedial Protection Vessel	2			X	X	
Array Walk-2-Work Vessel	1				X	
Survey Vessel	5			X	X	
Crew Transfer Vessel	5	X	X	X	X	X
Guard / Safety Vessel	5	X	X	X	X	X
Service Operating Vessel	1	X	X		X	X

Notes:

IAC = Inter-array Cable; OCS–DC = Offshore Converter Station; SRWEC = Sunrise Wind Export Cables; WTG = wind turbine generator

Construction would involve vessels of various classes ranging from small inflatables to construction vessels and barges. Construction vessels would operate in the Action Area over a period of approximately 2 years. Regular maintenance typically consists of routine inspections and preventative maintenance activities. It is anticipated that these activities would require the use of CTVs but would not require the use of other specialized vessels. The number of visits to the WTGs and OCS–DC during a typical year may vary but is estimated to be approximately 5 to 10 visits per year per WTG and approximately 20 to 30 visits per year to the OCS–DC. The use of specialized vessels (e.g., crane barge, feeder barge) would only be necessary for major repairs, which are assumed to be a few times over the life of the wind farm. Maintenance activities can occur year-round but are anticipated to be more active during summer months when weather conditions are more favorable. During decommissioning, vessel operations would be similar in scope and duration to the construction and installation phase.

4.3.1 Risk of Vessel Strike – P, C, O&M, D

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

Risk of collision injury is commensurate with vessel speed. The probability of a vessel strike increases significantly as speeds increase above 10 kt (Conn and Silber 2013; Kite-Powell et al. 2007; Laist et al. 2001; Vanderlaan and Taggart 2007). Vessels operating at speeds exceeding 10 kt under poor visibility conditions have been associated with the highest risk for vessel strikes of North Atlantic right whales (Vanderlaan and Taggart 2007). Collision risk decreases significantly at speeds below 10 kt (Conn and Silber 2013); however, collisions at lower speeds are still capable of causing serious injury even when smaller vessels (<20 m length) are involved (Kelley et al. 2021). Vessel strikes are also implicated in sea turtle mortality, with collision risk similarly commensurate with vessel speed although at much lower speeds (Hazel et al. 2007; Shimada et al. 2017). Hazel et al. (2007) found that green sea turtles were unlikely to actively avoid vessels traveling faster than 2.1 kt (4 km/hour), indicating that voluntary speed restrictions below 10 kt may not be fully protective for this and potentially other sea turtle species.

In general, large vessels travelling at high speeds pose the greatest risk of serious injury or mortality to ESA-listed marine mammals, whereas sea turtles and sturgeon are vulnerable to a range of vessel types depending on the environment. Large vessels used during Proposed Action construction would likely include a cable-laying vessel (1), a rock-dumping vessel (1), jack-up barge (1), material and feeder barges (6) and tow tugs (4), a work vessel (1), and a fuel bunkering vessel (1). Similar vessels would be used during decommissioning. These vessels would largely remain on station or travel at speeds well below 10 kt during construction and decommissioning of the SRWF and SRWEC.

Other vessels used during construction and decommissioning would include crew transports and inflatable support vessels used for PSO monitoring. Two crew transport vessels would be used during operation. These vessels would adhere to speed restrictions and other mitigation measures outlined elsewhere in this document, and in general are smaller and more maneuverable and better able to avoid collisions with protected species when combined with observers. For this reason, these vessels would pose a minimal risk of collision with ESA-listed species.

Based on information provided by Sunrise Wind, Project construction would require an estimated total of 1,575 vessel trips between SRWF and ports in Rhode Island, Massachusetts, Connecticut, and New York over the 2-year construction period, with an estimated maximum of nine trips in any given month from U.S. ports outside of the RI-MA WEAs. Port traffic within the RI-MA WEAs would add an additional 127 one-way trips during WTG installation and 146 one-way trips during cable installation to the SRWF. The construction vessels used for Project construction are described in **Table 66** above. Typical large construction vessels used in this type of project range from 325 to 350 ft (99 to 107 m) in length, 60 to 100 ft (18 to 30 m) in beam, and draft from 16 to 20 ft (5 to 6 m) (Sunrise Wind 2022i). All project vessels operating between local ports and the Project Area would be required to comply with the mitigation described in **Section 2.6.7** as well as the final PSMMPs.

During construction, an estimated 924 vessel trips per year would cross transects 24 through 27 when transiting to and from SRWF (**Figure 10**). This would equate to a 64 percent increase in vessel traffic within the SRWF area; however, the AIS data used in transect analysis do not include many recreational vessels that lack AIS transponders and commercial fishing vessels that deactivate their transponders when actively fishing. These two vessel classes account for the vast majority of vessel activity. For example, Sunrise Wind (2022f) estimated 19,611 one-way trips per year by commercial fishing vessels between the SRWF and area ports. When commercial fishing vessel trips are included, Project construction and installation would result in a 4.4 percent increase in vessel transits per year across transects 24 through 27 during the construction and installation phase. In summary, this assessment indicates that construction and installation vessels would likely increase vessel traffic to some degree over baseline conditions. This indicates the potential for increased risk of marine mammal collisions, but that risk is mitigated in part by typical vessel speeds during construction and installation, low relative increase in vessel traffic, and by proposed risk avoidance and minimization measures.

Sunrise Wind expects to use a variety of vessels to support O&M, including SOVs with deployable work boats (daughter craft), CTVs, jack-up vessels, and cable laying vessels. **Table 12** in **Section 2.4** provides a summary of O&M vessels currently being considered for support of O&M activities (Sunrise Wind 2022i). Although the type and number of vessels would vary over the operational lifetime of the Project, five vessel types are currently being considered for O&M of the SRWF (three for routine activities and two for non-routine activities). There would be fewer vessels used for routine maintenance trips than for construction or non-routine maintenance, but they would occur over a longer period considering the 25- to 35-year operational life of the proposed Project. During SRWF O&M activities, the SOV would remain within the SRWF for up to 28 days and would therefore not make daily trips to port; crew changes would occur every 14 days via CTVs. Potential ports expected to be utilized during O&M of the SRWF are detailed in COP, Sections 3.3.10 and 3.5.5 (Sunrise Wind 2022i).

Sunrise Wind has estimated that proposed Project O&M would involve an estimated 76 trips per year, or 2,660 vessel trips over the lifetime of the Project. The majority of vessel trips (2,500) would originate from the Montauk O&M facility, with rare vessel trips (less than one per month) originating from New London, Connecticut, or potentially other unspecified ports (**Table 13**). The increase in vessel traffic of 76 vessel trips per year represents a 0.4 percent increase of vessel traffic within the project area. The negligible increase in vessel traffic due to unplanned maintenance is not expected to lead a significant increase in risk of collision with ESA-listed species due to the low number of vessel transits and the low density of these species in the SRWF and SRWEC.

During decommissioning, the applicant anticipates using a similar assortment and number of vessels as during construction and installation. The potential for impacts is expected to be substantially similar to construction and installation, though based on existing trends in vessel traffic within the region, baseline vessel traffic levels are expected to be higher.

It is anticipated that the risk of vessel strike on ESA-listed species is negligible because of the nature of construction and planned mitigation measures which include vessel strike avoidance measures. The applicant has committed to a range of environmental protection measures (EPMs) to avoid vessel collisions with marine mammals (**Section 2.6**). BOEM would also require additional mitigation measures to avoid and minimize impacts to ESA-listed species. These include strict adherence to NOAA guidance for collision avoidance and a combination of additional measures, speed restrictions to 10 kt or less for all vessels at all times between November 1 and April 30 and in all dynamic management areas (DMAs), and use of a PAM system to alert vessels to potential marine mammal presence in real time. All vessel crews would receive training to ensure that these EPMs are fully implemented for vessels in transit. Once on station, construction vessels either remain stationary when installing the monopiles and WTG/OSS equipment or move slowly (i.e., at less than 10 kt) when travelling between foundation locations. Cable laying vessels move very slowly at approximately 1 mi per day. Planned mitigation measures, including voluntary speed restrictions and use of PSOs, would effectively limit collision risk when travelling to and from area ports.

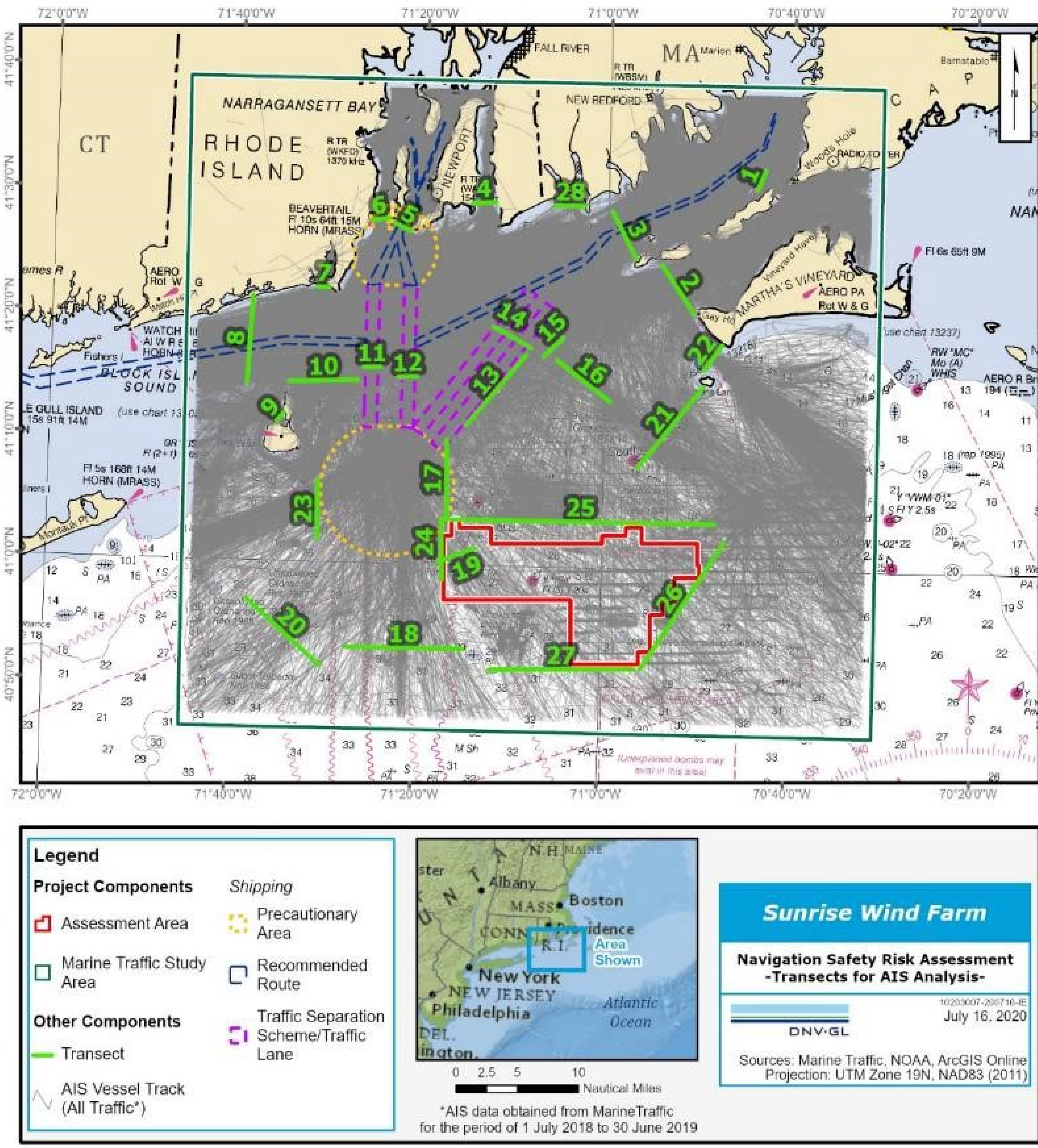

Figure 10. Transects used for analysis of vessel traffic (Sunrise Wind 2022f).

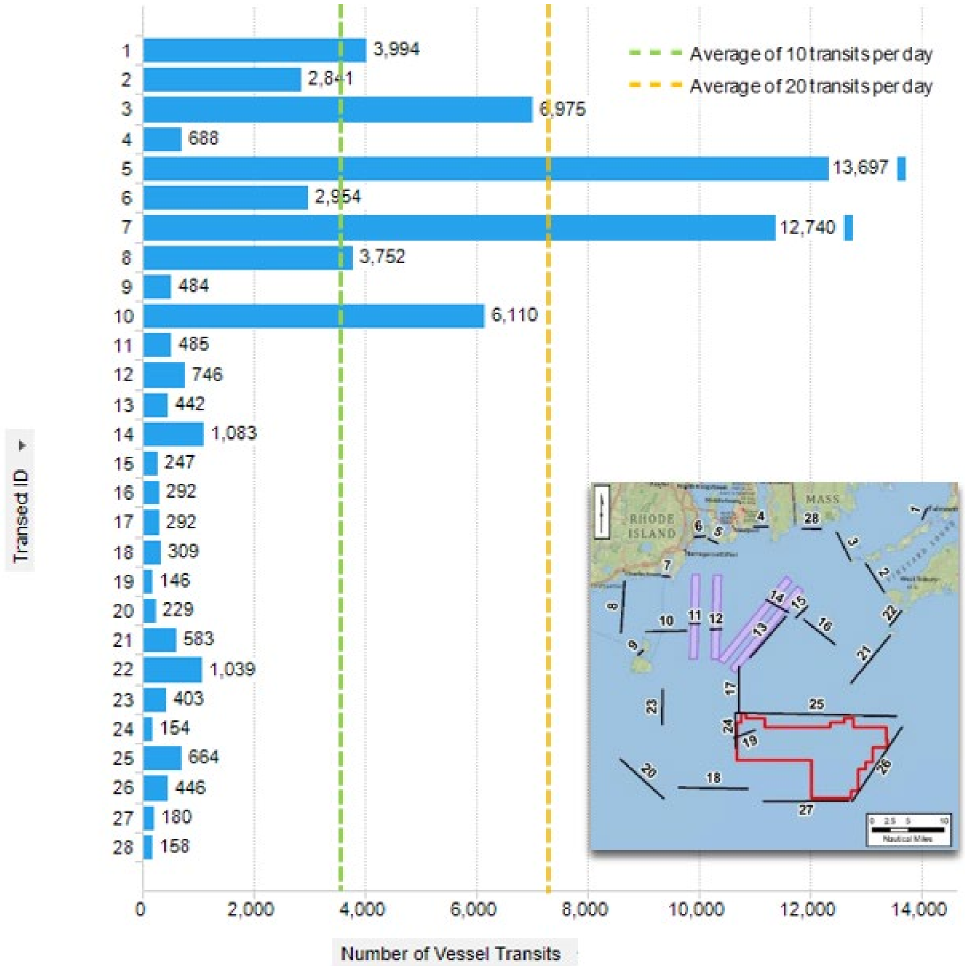

Figure 11. Annual number of transects based on Automatic Identification System from July 2018 through June 2019 (Sunrise Wind 2022f).

To monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements, all vessels associated with the proposed Project would be required to have operational AIS. All vessels would operate in accordance with applicable rules and regulations for maritime operation within U.S. and federal waters. Additionally, the Project would adhere to vessel speed restrictions as appropriate in accordance with BOEM and NOAA requirements. Vessel activity during O&M would be localized and occur for short periods of time. Similar to impacts described for the construction phase, in the unlikely event a strike was to occur during Project O&M that resulted in mortality or serious injury impacts to the most vulnerable ESA-listed species (e.g., North Atlantic right whale), the impact could result in population-level effects. Impacts to less vulnerable ESA-listed species and non-ESA-listed species from vessel strikes may result in injury or mortality of individuals; however, mortality impacts are expected to be less likely to result in population-level effects; however, based on the included mitigation and monitoring plan, including vessel speed restrictions and the use of PSOs for the vast majority of vessel traffic associated with this project, vessel strikes are extremely unlikely to occur. The Proposed Action construction will potentially increase risk of injury and mortality from vessel collisions in the wind development area; however, this risk is believed to be small for any ESA-listed species when considering the baseline level of vessel activity in the Action Area.

Fishing vessels may be displaced during construction of WTGs and installation of the SRWEC. Up to 300 fishing vessels use the SRWF annually (see Section 3.6.1 of the COP [Commercial Fisheries and For-Hire Recreation] (Sunrise Wind 2022i)) and might decide to avoid the SRWF once it is fully constructed. Potential for displacement of fishing vessels during SRWF operations is discussed further in Section 3.4.6.2.3 (Operations and Maintenance and Conceptual Decommissioning). The increased collision risk in some areas is anticipated to be commensurate with the decreased risk within the SRWF, so changes in collision risk from relocated commercial and for-hire fishing vessels during construction of the SRWF would not be measurable from baseline. The potential for effects from the relocation of fishing vessels during construction and installation would be considered **insignificant** and **may affect, but is not likely to adversely affect** ESA-listed species.

4.3.1.1 Marine Mammals

Vessel strike is one of the primary causes of anthropogenic mortality in large whale species (Hill et al. 2017; Laist et al. 2001). North Atlantic right whales are particularly vulnerable to vessel strikes based on the distribution of preferred habitats near major shipping lanes and feeding and diving habits (Baumgartner et al. 2017). As many as 75 percent of known anthropogenic mortalities of North Atlantic right whales likely resulting from collisions with large ships along the U.S. and Canadian eastern seaboard (Kite-Powell et al. 2007). Risk of injury resulting from a vessel strike is commensurate with vessel speed. The probability of a vessel strike increases as speeds increase above 10 kt (Conn and Silber 2013; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Vessels operating at speeds exceeding 10 kt under poor visibility conditions have been associated with the highest risk for vessel strikes of North Atlantic right whales (Vanderlaan and Taggart 2007). Collision risk decreases at speeds below 10 kt (Conn and Silber 2013), and when collisions do occur at these lower speeds, they are far less likely to result in serious injuries (Laist et al. 2001).

The densities of most common species of marine mammals likely to occur in the SRWF Lease Area and export cable route are low based on monthly mean density estimates developed by Roberts et al. (2016; 2017; 2018; Sunrise Wind 2022l). Project construction and installation would require an estimated maximum of 1,575 round trips for all vessel classes combined over the 2-year construction and installation period. Due to the low relative densities of those species vulnerable to collisions compared to where the majority of the population is, there is a low risk of a marine mammal vessel encounter. Although this would likely be an increase in vessel traffic in and around the SRWF lease area of approximately 4.4 percent a year during construction, the operational conditions combined with planned EPMs, including vessel speed restrictions and the use of PSOs for the vast majority of vessel traffic associated with this project, and additional mitigation measures agreed upon through agency consultation would minimize collision risk. Because vessel strikes are not an anticipated outcome given the relatively low number of vessel trips relative to the environmental baseline, and EPMs and mitigation measures implemented to avoid encountering marine mammals, BOEM concludes vessel strikes are extremely unlikely to occur and therefore **may affect, but is not likely to adversely affect** ESA-listed marine mammals.

4.3.1.2 Sea Turtles

Changes in vessel traffic resulting from the Proposed Action are a potential source of adverse effects on sea turtles. Propeller and collision injuries from boats and ships are common in sea turtles and an identified source of mortality (Hazel et al. 2007; Shimada et al. 2017). Hazel et al. (2007) also reported that individuals may become habituated to repeated exposures over time, when not accompanied by an overt threat. Project construction and installation vessels could collide with sea turtles, posing an increased risk of injury or death to individual sea turtles.

Sea turtles are likely to be most susceptible to vessel collision in coastal foraging areas crossed by construction and installation vessels traveling between the RWF and offshore RWEC and area ports. Hazel et al. (2007) indicated that sea turtles may not be able to avoid being struck by vessels at speeds exceeding 2 kt, and collision risk increases with increasing vessel speed. Habituation to noise may also increase the risk of vessel collision; however, avoidance behaviors observed suggest that a turtle's ability to detect an approaching vessel is more dependent on vision than sound, although both may play a role in eliciting behavioral responses. Construction and installation vessel speeds could periodically exceed 10 kt during transits to and from area ports, posing an incremental increase in collision risk relative to baseline levels of vessel traffic. During construction and installation, vessels generally either remain stationary when installing the monopiles and WTG/OSS equipment or move slowly (i.e., at less than 10 kt) when traveling between foundation locations.

Implementation of a range of EPMs and Mitigation, Monitoring and Reporting Measures to avoid vessel collisions (see **Tables 14** and **15**) are expected to minimize the risk of collisions with sea turtles. These include strict adherence to NOAA guidance for collision avoidance and a combination of additional measures, including speed restrictions to 10 kt or less for all vessels at all times between November 1 and April 30 and speed restrictions to 10 kt or less in DMAs. All vessel crews would receive training to ensure these EPMs are fully implemented for vessels in transit. Once on station, the construction and installation vessels either remain stationary when installing the monopiles and WTG/OSS equipment or move slowly (i.e., at less than 10 kt) when traveling between foundation locations. Cable laying and HRG survey vessels also move slowly, with typical operational speeds of less than 1 and approximately 4 kt, respectively.

Project EPMs and mitigation measures include the implementation of NOAA vessel guidelines for marine mammal and sea turtle strike avoidance measures, including vessel speed restrictions. These measures are intended to minimize the risk of vessel strikes; however, the likelihood of sea turtle injury or mortality resulting from project-related vessel strikes over the 2-year construction and installation period may be potentially significant. Because the potential for vessel strikes to green, Kemp's ridley, loggerhead, and leatherback turtles cannot be discounted, the Proposed Action **may affect, is likely to adversely affect** these species.

4.3.1.3 Fish

The most recent 5-year status review for the New York Bight DPS of Atlantic sturgeon indicates that in general, the potential for Atlantic sturgeon to be struck by a vessel is high and vessel strikes are a relatively common occurrence, and likely much more common than originally anticipated during the listing of Atlantic sturgeon (NMFS 2022c). Between 2005 and 2008, surveys in the Delaware estuary reported a total of 28 Atlantic sturgeon mortalities, of which 50 percent were the result of an apparent vessel strike (Brown and Murphy 2010). Similarly, five Atlantic sturgeon were reported to have been struck by commercial vessels within the James River, Virginia, in 2005, and one strike per 5 years is reported for the Cape Fear River, North Carolina. Most strikes occurred near busy ports where entrance channels narrow, or a significant portion of estuary and river habitat is transited by commercial vessels entering a port (Brown and Murphy 2010). In the Hudson River, the New York DEC reported finding 17 dead Atlantic sturgeon that had been struck by vessels. Further, based on available information, NMFS considers speed vessel restrictions in commercialized, navigable rivers is unlikely to reduce vessel strikes for Atlantic sturgeon because Atlantic sturgeon are unlikely to move away from vessels (2022c).

Vessel traffic during construction and installation of the SRWF would result in a temporary increase vessel traffic, representing a very small contribution in overall vessel traffic in the already heavily trafficked region. Larger construction and installation vessels will generally transit to the work location and remain in the area until installation is complete. These large vessels will move slowly and over short distances between work locations (Sunrise Wind 2022i). Transport vessels will travel between several ports and the SRWF over the course of Project construction and installation. These vessels will range in size from smaller crew transport boats to tug and barge vessels. Smaller vessels will also be used for routine maintenance related trips during the O&M phase (Sunrise Wind 2022i).

The Project-related increase in vessel traffic during construction and installation is not expected to be significant when compared to all other vessel traffic within the region, and most construction and installation vessels will be slow moving. In the unlikely event that an Atlantic sturgeon is struck, and injury or mortality occurs, the risk of population-level impacts would be greater given the Endangered status of this population. Impacts from vessel strikes are considered direct and short-term for Atlantic sturgeon during the construction and installation and decommissioning phases, given the relatively short, 18-month duration anticipated for each. Vessels used during the O&M phase will be generally smaller but will require more trips between port and the SRWF throughout the 20- to 35-year operational life of the project, so impacts during O&M would be direct and long-term (Sunrise Wind 2022i). While EPMs and Mitigation, Monitoring and Reporting Measures will be implemented to avoid and minimize the risk of vessel strikes on Atlantic sturgeon, the risk cannot be discounted and may be potentially significant over the life of the project.

4.3.2 Vessel Discharges – P, C, O&M, D

Vessels associated with offshore activities could generate exhaust and could be a source of potential accidental spills of petroleum-based toxics. Marine mammals that occur in the analysis area could be exposed to these contaminants. Inhalation of fumes from oil spills can result in mortality or sublethal effects on individual fitness, including adrenal effects, hematological effects, liver effects, lung disease, poor body condition, skin lesions, and several other health 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). Although these effects are acknowledged, the likelihood of adverse population-level impacts on marine mammals from accidental releases of debris or contaminants from activities on the OCS is low. Current regulations and requirements imposed on federally approved activities prohibit vessels from dumping potentially harmful debris, require measures to avoid and minimize spills of toxic materials, and provide mechanisms for spill reporting and response. Sunrise Wind will require all construction and O&M vessels to comply with applicable International Convention for the Prevention of Pollution from Ships (IMO MARPOL), federal (USCG and EPA), and state regulations and standards for the management, treatment, discharge, and disposal of onboard solid and liquid wastes and the prevention and control of spills and discharges. Based on these factors, accidental releases and discharges from federally approved activities on the OCS are not expected to appreciably contribute to adverse impacts for ESA-listed species and, therefore, the effects would be insignificant, and **may affect, but is not likely to adversely affect** ESA-listed species.

4.3.2.1 Spill Risk – P, C, O&M, D

Proposed Action vessels also pose a potential risk of accidental spills during fuel transfers or collisions with other vessels or structures during construction and operation. As stated in the water quality section, chronic low-level oil pollution associated with marine vessel traffic is likely to be present in and near the Action Area based on proximity to major shipping lanes and regular vessel traffic. Pursuant to 30 CFR § 585.627(c), an Oil Spill Response Plan must be submitted to the BSEE. In accordance with 30 CFR Part 254, Sunrise Wind has developed and presented Appendix E1 – Emergency Response Plan/Oil Spill Response Plan, which is provided under a confidential cover. Based on the impact avoidance and minimization measures in place, the Proposed Action is unlikely to result in significant accidental spills of toxic substances in the marine environment over the lifetime of the Project. For this reason, the Proposed Action is not likely to measurably alter the baseline levels of oil pollution from existing vessel traffic in and near the Action Area. With adherence to vessel regulations, the potential for a spill to occur is considered extremely unlikely to occur and **discountable**. Therefore, the effects of spills from Project vessel activities **may affect, not likely to adversely affect** ESA-listed species.

4.3.2.2 Marine Debris and Pollution Risk – P, C, O&M, D

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

4.4 Fisheries and Habitat Surveys and Monitoring – P, C, O&M

The FMP for Sunrise Wind has been developed in accordance with recommendations set forth in *Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf* (BOEM 2019), which state that a fishery survey plan should aim to

- identify and confirm which dominant benthic, demersal, and pelagic species are using the project site, and when these species may be present where development is proposed;
- establish a pre-construction baseline which may be used to assess whether detectable changes associated with proposed operations occurred in post-construction abundance and distribution of fisheries;
- collect additional information aimed at reducing uncertainty associated with baseline estimates and/or to inform the interpretation of research results; and
- develop an approach to quantify any substantial changes in the distribution and abundance of fisheries associated with proposed operations.

BOEM guidelines stipulate that 2 years of pre-construction monitoring data are recommended, and that data should be collected across all four seasons. Consultations with BOEM and other agencies are encouraged during the development of fisheries monitoring plans. BOEM also encourages developers to review existing data, and to seek input from the local fishing industry to select survey equipment and sampling protocols that are appropriate for the area of interest.

The FMP may occur throughout any of the phases of the Proposed Action. The FMP will be revised through an iterative process, and survey protocols and methodologies have been and will continue to be refined and updated based on feedback received from stakeholder groups. Much of the research described in this plan will be performed on commercial fishing vessels that are contracted for this monitoring. Further, the field work described in the monitoring plan will be performed by an independent contractor (e.g., local university, research institution, or consulting firm). **Chapter 2** describes the proposed activities in detail and is not repeated here. Effects of Project vessels, including the ones that will be used for survey and monitoring activities are considered in **Section 4.3**, above, and are not repeated here.

4.4.1 Risk of Capture/Entanglement – P, C, O&M

Any sampling that utilizes in-water gear that may pose a risk to fish species could be potentially hazardous to some vulnerable species. All sampling efforts will follow included BMPs to limit capture and entanglement risk.

The lessee must ensure that any buoys attached to the seafloor use buoys, lines (chains, cables, or coated rope systems), swivels, shackles, and anchor designs that prevent any potential entanglement of listed species while ensuring the safety and integrity of the structure or device. All mooring lines and ancillary attachment lines must use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak links, chains, cables, or similar equipment types that prevent lines from looping, wrapping, or entrapping protected species. Any equipment must be attached by a line within a rubber sleeve for rigidity. The length of the line must be as short as necessary to meet its intended purpose. All buoys must be properly labeled with lessee and contact information.

Potential effects from vessel noise and the risk of ship strike associated with fisheries surveys are considered in **Sections 4.2** and **4.3**.

4.4.1.1 Trawl Surveys – P, C, O&M

NMFS's opinion on the Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals pursuant to those Research Activities (dated June 23, 2016), concluded that impacts to North Atlantic right, humpback, fin, sei, and blue whales, if any, as a result of trawl gear use would be expected to be extremely unlikely to occur. These large whale species have the speed and maneuverability to avoid oncoming mobile gear (NMFS 2016b). The slow speed of mobile gear and the short tow times further reduce the potential for entanglements or other interactions. Observations during mobile gear use have shown that entanglement or capture of large whale species is extremely rare and (NMFS 2016b). Although the trawl methods analyzed in commercial fisheries are comparable to the fishery monitoring methods proposed, the proposed trawl effort and tow times (20 minutes) for the proposed fisheries monitoring surveys are less than that previously considered by NMFS for commercial trawling activities. Consequently, the likelihood of interactions with listed species of marine mammals is lower than commercial fishing activities. The eDNA sampling surveys would be conducted coincidentally with the trawl surveys and subject to the same mitigation measures. Based on the above analysis, the likelihood of any potential impacts to is extremely unlikely to occur and **discountable**, and the trawl and eDNA surveys **may affect, but not likely to adversely affect** ESA-listed species of marine mammals.

The capture and mortality of sea turtles in bottom trawl fisheries is well documented (Henwood and Stuntz 1987; NMFS and USFWS 1991a; NMFS and USFWS 1992; NMFS and USFWS 2008; NRC 1990). NOAA has prioritized reduction of sea turtle interactions with fisheries where these species occur. Finkbeiner et al. (2011) compiled sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, of which 4,500 were lethal, occurred annually since the implementation of bycatch mitigation measures; however, a vast majority of the interactions (98 percent) and mortalities (80 percent) occurred in the Southeast/Gulf of Mexico shrimp trawl fishery, although sampling inconsistencies and limitations should be considered when interpreting this data (NMFS 2014b).

While sea turtles are capable of remaining submerged for long periods of time, they appear to rapidly consume oxygen stores when entangled and forcibly submerged in fishing gear (Lutcavage and Lutz 1997); however, the preponderance of available research (Epperly et al. 2002; Sasso and Epperly 2006) and anecdotal information from past trawl surveys indicates that limiting tow times to less than 30 minutes will likely eliminate the risk of death for incidentally captured sea turtles. The proposed trawls would be limited to 20 minutes of tow time. The tow begins when winches are locked, and an acceptable net geometry is established. The relatively short tow duration is expected to minimize the potential for interactions with sea turtles and pose a negligible risk of mortality. The proposed mitigation measures would be expected to eliminate the risk of serious injury and mortality from forced submergence for sea turtles caught in the bottom otter trawl survey gear. While no mortality is expected from either proposed otter trawl surveys, incidentally captured individuals would suffer stress and potential injury. Where possible, turtles are disentangled and if injured, may be brought back to rehabilitation facilities for treatment and recovery. This helps to reduce the rate of death from entanglement. We expect that incidental capture and entanglement of sea turtles will continue in the Action Area at a similar rate over the life of the Proposed Action. Safe release, disentanglement protocols, and rehabilitation will help to reduce the severity of impacts of these interactions and these efforts are also expected to continue over the life of the project.

As described in **Section 2.6.1**, SRWF intends to conduct 180 surveys per year using the same methods and gear as the NEAMAP surveys, with 20 minutes per tow. Surveys may be conducted during the 2 years of construction and up to 6 additional years. We then apply the capture rates to the planned surveys to estimate the number of sea turtles that are likely to be captured during trawl surveys (**Table 68**).

Table 67. Sea turtle capture data and capture rates in Northeast Fisheries Science Center-affiliated research from 2004 through 2013 reported in turtles per tow hour (t/t-h) and per tow (NMFS 2016c).

Survey	Loggerhead capture rate	Kemp's ridley capture rate	Green capture rate	Leatherback capture rate
NEAMAP – Spring (150 tows/year @ 20 minutes/ tow x 10 year = 500 t-h)	0.014 t/t-h (0.0047/tow)	0	0	0
NEAMAP – Fall (150 tows/year @ 20 minutes/ tow x 10 year = 500 t-h)	0.01 t/t-h (0.0033/tow)	0.016 t/t-h (0.0053 per tow)	0.002 t/t-h (0.0007/tow)	0

Table 68. Estimated trawl captures from surveys associated with the Sunrise Wind Farm.

	Estimated loggerhead captures	Estimated Kemp's ridley captures	Estimated green captures	Estimated leatherback captures
Per Year	6.72	7.68	0.96	0
Total (8 Years)	53.76	61.44	7.68	0

Extensive trawl surveys in the region have indicated that leatherback sea turtles are extremely unlikely to be captured during trawl surveys and therefore **discountable**. Trawl surveys **may affect, but is not likely to adversely affect** leatherback sea turtles.

Because green, loggerhead, and Kemp's ridley sea turtles may be captured during trawl surveys, and capture will cause stress and may result in injury, and in rare cases, post capture mortality, trawl surveys **may affect, and are likely to adversely affect** these species.

Capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations (Collins et al. 2000; Moser et al. 2000; Moser and Ross 1995); however, the use of trawl gear has been employed as a safe and reliable method to capture sturgeon, provided that the tow time is limited (NMFS 2014b). Negative impacts to sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). Northeast Fisheries Observer Program data from Miller and Shepard (2011) indicate that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5 percent. Short tow durations and careful handling of individuals once on deck are likely to result in a very low risk of mortality to captured individuals (NMFS 2014b; NMFS 2016b). Historic NEFSC and NEAMAP surveys have captured 110 and 102 Atlantic sturgeon, respectively, with no recorded injury or mortality. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s. To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys.

NEAMAP has reported a capture rate of Atlantic sturgeon in the northern portion of that survey region where SRWF is of 0.01083 sturgeon per trawl (NMFS (National Marine Fisheries Service) 2016b). The trawl surveys associated with the Proposed Action will follow the same protocols, methods, and equipment as the NEAMAP surveys. With 180 trawls occurring per year, this results in an estimated two Atlantic sturgeon captures via trawl per year. Assuming 2 years of sampling during project construction, and up to 6 years of post-construction monitoring, it is estimated that trawl sampling could result in the capture of 16 Atlantic sturgeon.

The short tow times of 20 minutes and established sampling and animal handling practices that will be used for this Project indicate that an estimated 16 Atlantic sturgeon may be captured and potentially receive minor injuries in Project trawl surveys; however, based on extensive surveys and recorded interactions with this species, no mortality of Atlantic sturgeon as a result of Project trawl surveys is expected. Because Atlantic sturgeon may be captured during trawl surveys, and capture will cause stress and may result in injury, and in rare cases, post-capture mortality, trawl surveys **may affect, and are likely to adversely affect** Atlantic sturgeon.

4.4.1.2 Passive Acoustic Monitoring Surveys – P, C, O&M

The use of PAM buoys or autonomous PAM devices to monitor noise, marine mammals, passive acoustic telemetry tags, and the use of sound attenuation devices placed on the seafloor for mitigation during pile driving have been proposed by Sunrise Wind (Sunrise Wind 2022i).

Based on previous consultations, BOEM anticipates requiring that moored and autonomous PAM systems that may be used for monitoring would either be stationary (e.g., moored) or mobile (e.g., towed, ASVs, or AUVs), respectively. Moored PAM systems would use the best available technology to reduce any potential risks of entanglement. PAM system deployment would follow the same procedures as those described in the previous section to avoid and minimize impacts on ESA-listed species, as detailed in Appendices AA1 (Sunrise Wind 2022a) and AA2 (Sunrise Wind 2022b) of the COP. The use of buoys for moored PAM systems, or any other intended purposes, would pose a discountable risk of entanglement to listed marine mammals and sea turtles.

Autonomous PAM systems could have hydrophone equipment attached that operates autonomously in a defined area. ASVs and AUVs in very shallow water can be operated remotely from a vessel or by line of sight from shore by an operator and in an unmanned mode. These autonomous systems are typically very small, lightweight vessels and travel at slow speeds. ASVs and AUVs produce virtually no self-generated noise and pose a negligible risk of injury to marine mammals from collisions due to their low mass, small size, and slow operational speeds. ASVs and AUVs are not expected to pose any reasonable risk of harm to listed species; therefore, the effects of this type of survey equipment on marine mammals, sea turtles, and Atlantic sturgeon are **insignificant** and/or **discountable**. PAM surveys **may affect, but are not likely to adversely affect** ESA-listed species.

While the use of PAM technologies would not have any direct impacts on sea turtles, impacts arising from vessel noise and the potential for vessel strike could occur during system deployment and are discussed in **Sections 4.2** and **4.3**.

4.4.2 Effects to Prey and/or Habitat – P, C, O&M

4.4.2.1 Trawl Surveys – P, C, O&M

The proposed bottom trawl survey activities would have **no effect** on the availability of prey for North Atlantic right, blue, fin, sei, or sperm whales. Right whales and sei whales feed on copepods (Perry et al. 1999). Copepods are very small organisms that will pass through trawl gear rather than being captured in it. In addition, copepods will not be affected by turbidity created by the gear moving through the water. Fin whales feed on krill and small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002). The trawl gear used in the Sunrise Wind monitoring survey activities operates on or very near the bottom, while schooling fish such as herring and mackerel occur higher in the water column. Sand lance inhabit both benthic and pelagic habitats; however, they typically bury into the benthos and would not be caught in the trawl. Trawls are not expected to have a measurable impact on prey species for sperm whales, therefore prey impacts will be **insignificant** and **may affect, but is not likely to adversely affect** sperm whales.

Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish are removed from the marine environment as bycatch in bottom trawls. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the SR trawl surveys would not affect the availability of prey for leatherback and green sea turtles in the Action Area. Juveniles and adults of both loggerhead and Kemp's ridley sea turtles are known to feed on these species that may be caught as bycatch in the bottom trawls; however, all bycatch is expected to be returned to the water alive, dead, or injured to the extent that the organisms would shortly die. Injured or deceased bycatch would still be available as prey for sea turtles, particularly loggerhead sea turtles, which are known to eat a variety of live prey as well as scavenge dead organisms. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trawl gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are **insignificant** and **may affect, but are not likely to adversely affect** sea turtles or Atlantic sturgeon.

4.4.2.2 Structure-Associated Fishes Surveys – P, C, O&M

The proposed trap survey activities would have **no effect** on the availability of prey for North Atlantic right, blue, fin, sei, and sperm whales. Right whales and sei whales feed on copepods (Perry et al. 1999). Copepods are very small organisms that will pass through trap gear rather than being captured in it. Similarly, fin whales feed on krill and small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002). The size of the trap gear is too large to capture any fish that may be prey for listed whales. Trap surveys are not expected to have a measurable impact on prey species for sperm whales, therefore prey impacts will be **insignificant** and **may affect, but is not likely to adversely affect** sperm whales.

Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish may be removed from the marine environment as bycatch in trap gear. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the Sunrise Wind structure-associated fishes surveys will not affect the availability of prey for leatherback and green sea turtles in the Action Area. Neritic juveniles and adults of both loggerhead and Kemp's ridley sea turtles are known to feed on these species that may be caught as bycatch in the trap/pot gear; however, all bycatch is expected to be returned to the water alive, dead, or injured to the extent that the organisms will shortly die. Injured or deceased bycatch would still be available as prey for sea turtles, particularly loggerhead sea turtles, which are known to eat a variety of live prey as well as scavenge dead organisms. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trap gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are **insignificant** and **may affect, but is not likely to adversely affect** sea turtles.

4.4.2.3 Clam, Oceanography, and Pelagic Fish Surveys – P, C, O&M

The equipment used in the clam, oceanography, and pelagic fish surveys pose minimal risk to marine mammals. Tows for the clam survey have a very short duration of 120 seconds, and the vessel is subject to similar mitigation measures as the trawl survey. Both the oceanography and pelagic fish surveys are non-extractive and also subject to the mitigation measures as the structure-associated fish surveys. These surveys are anticipated a non-measurable and **insignificant** effect on prey base for marine mammals, sea turtles, or Atlantic sturgeon. Therefore, the effects of the equipment used in clam, oceanography, and pelagic fish surveys **may affect, but are not likely to adversely affect** ESA-listed.

4.4.2.4 Benthic Habitat Disturbance – P, C, O&M

Benthic sampling, trawl surveys, and ventless trap surveys would not result in measurable impacts. Impacts to Atlantic sturgeon from the placement of PAM equipment would also be insignificant, resulting in the temporary disturbance of a few square feet per receiver. Trawling, placement of fixed gear and PAM mooring equipment, and the use of benthic grabs and sediment profile and plan view imaging equipment from the benthic monitoring plan may impact epibenthic and infaunal prey species associated with soft-bottom benthic habitat. This could, in theory, reduce the amount of prey available to sea turtles and Atlantic sturgeon within the Action Area; however, given the limited extent and duration of bottom-disturbing survey activities relative to the amount of habitat available to Atlantic sturgeon on the mid-Atlantic OCS, these activities are anticipated to have a non-measurable and **insignificant** effect on the availability of prey for ESA-listed species. Therefore, this BA anticipates that the effects of bottom-disturbing survey activities **may affect, but are not likely to adversely affect** sea turtles and Atlantic sturgeon.

4.5 SEA FLOOR PREPARATION – C

Seafloor preparation (specifically boulder clearance, dredging of the HDD Landfall exit, and sand wave leveling) would be required; boulder clearance trials (testing equipment and methods) may also be implemented prior to wide-scale seafloor preparation activities. Sunrise Wind assumes up to 5 percent of the SRWEC-OCS, up to 30 percent of the SRWEC-NYS, and up to 10 percent of the total IAC network would require boulder clearance. Boulder clearance would involve the use of a boulder grab to relocate boulders along the IAC network routes and near WTG foundations. Sunrise Wind will relocate boulders up to approximately 2.4 m (7.9 ft) in diameter, from the installation footprint by means of a boulder grab. When using a boulder grab, the maximum distance a boulder will be moved is approximately 15 m (49 ft) from its original location if the boulder is located on the centerline of the SRWEC-OCS (i.e., it will be moved perpendicular to the edge of the 30 m [98 ft] wide installation corridor). The maximum distance for a boulder would be moved at a foundation location is approximately 220 m (722 ft) from its original location if it is in the center of the planned.

Boulder clearance associated with seafloor preparation is expected to have direct impacts on benthic and shellfish resources in the limited areas it may be required along the IAC corridor and around individual foundations. Loss of attached fauna is expected during boulder relocation. Boulders will be placed in new locations, creating new physical configurations in relation to nearby boulders; however, these relocated boulders are expected to return to their pre-Project habitat function with relatively rapid (<1 year) recolonization expected (Guarinello and Carey 2022). Mobile organisms, including all ESA-listed species in the project area, are not expected to experience direct impacts from boulder clearance and relocation activities. Boulder clearance equipment moves slowly, and mobile organisms are expected to move away from moving equipment and boulders. Boulders will be placed on the substrate at speeds that allow mobile organisms to avoid them during placement. Overall, only a very small proportion of boulders in the project area are anticipated to require relocation, and boulder clearance activities are expected to have an insignificant impact on prey availability and habitat function for ESA-listed species. Because boulder relocation will use slow moving equipment, potential injuries to ESA-listed speices from the relocation of boulders is extremely unlikely to occur.

Sand wave leveling (inclusive of leveling of sand accumulation areas) may also be required during seafloor preparation activities prior to installation of the SRWEC. Sunrise Wind has assumed a maximum of 10 percent of the SRWEC–OCS will require sand wave leveling before the cable can be installed. Based on a review of the geophysical and geotechnical data, potential cable installation tools, and cable burial requirements, Sunrise Wind has preliminary identified four distinct segments of the SRWEC-OCS (KP8.8 to KP19.8, KP33.3 to KP36.5, KP48.4 to KP49.9, and KP66.6 to KP70.7) that total a length of 19.8 km where sand wave leveling may be required. Along the SRWEC-OCS in these areas, sand wave leveling is anticipated to require the leveling of approximately 11,344 m^3 (14,837 yd^3) of sediment.

Available methodologies for sand wave leveling include TSHD and CFE, which can be used as stand-alone or in combination. CFE is a non-contact dredging tool, providing a method of clearing loose sediment below submarine cables, enabling burial. The method utilizes thrust to direct waterflow into sediment, creating liquefaction and subsequent dispersal. The CFE tool draws in seawater from the sides and then jets this water out from a vertical down pipe at a specified pressure and volume. Because intakes will be screened to prevent potential entrainment, the use of CFE for sand wave leveling is extremely unlikely to result in take of ESA-listed species.

As described in the COP Section 3.3.3.4, the TSHD involves the use of a drag arm which is pulled along the seafloor from the dredge and hopper vessel at the surface. The drag arm fluidizes sediment at the seafloor which is then hydraulically pumped to the hopper portion of the vessel where the sediment is able to settle out of suspension. During this operation, there is often a continuous overflow of water and any sediments remaining in suspension from the hopper at the water surface. Once the hopper is filled with sediment, disposal is made either hydraulically at the surface or the vessel transports to a designated disposal site and the sediment is released from the bottom of the hopper through a hatch in the vessel's hull, or more carefully position material subsea via means of a downpipe. If necessary, THSD disposal would likely occur via downpipe disposal in the adjacent sand wave field, within the survey corridor. The survey corridor width varies between approximately 400 and 800 m wide, depending on water depth, so disposal would occur approximately 150 to 350 m from the corridor centerline.

Hopper dredges are known to lethally entrain sea turtles and Atlantic sturgeon but are not known to pose a risk to marine mammals. While the total material anticipated to be dredged for sandwave leveling is relatively small, (14,837 yd^3), the potential for injury or mortality to sea turtles or Atlantic sturgeon cannot be discounted; however, due to the small amount of material that is expected to be moved, the number of potential individuals injured or killed are expected to be very small if take does occur.

The area around the landfall HDD exit will require dredging. The HDD exit pit will be excavated using a mechanical dredge, such as a long-reach excavator, clamshell bucket dredge, or similar. We believe the risk of physical injury from dredging activities is extremely unlikely to occur due to the species' ability to move away from the project site and into adjacent suitable habitat, if disturbed. NMFS has previously determined in dredging Biological Opinions that, while oceangoing hopper-type dredges may lethally entrain protected species, including sea turtles, non-hopper-type dredging methods, such as the mechanical dredge proposed in this project for the HDD exit pit, are slower and extremely unlikely to overtake or adversely affect them (NMFS 2007).

Because marine mammals are highly mobile and are not known to be at risk of entrainment for hopper type dredges, and other potential effects associated with seafloor preparation are insignificant or extremely unlikely to occur, seafloor preparation **may affect, but is not likely to adversely affect** ESA-listed marine mammals.

The potential use of hopper-type dredges poses a risk of entrainment for Atlantic sturgeon and sea turtles; however, based on the very low densities of green and Kemp’s ridley sea turtles and the relatively low volume of sediment that will be dredged for sandwave leveling, we believe the potential for entrainment of these species is extremely unlikely to occur, and therefore, seafloor preparation **may affect, but is not likely to adversely affect** green sea turtles or Kemp’s ridley sea turtles.

Because hopper-type dredges pose a risk, and will occur in areas where Atlantic sturgeon, leatherback turtles, and loggerhead turtles are likely to be present, the risk of entrainment cannot be discounted. Therefore, seafloor preparation **may affect, and is likely to adversely affect** Atlantic sturgeon, and leatherback and loggerhead sea turtles.

4.6 HABITAT DISTURBANCE/MODIFICATIONS – P, C, O&M

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

Seafloor-disturbing activities would include seafloor preparation, impact and/or vibratory pile driving/ foundation installation, IAC installation, UXO/MEC detonation, and vessel anchoring (including spuds from jack-up vessels). These activities could cause injury or mortality to benthic species and negatively affect their habitats. The impacts associated with these activities would be local and would cease after the construction is complete in a given area. Seafloor disturbance and habitat alteration would encompass a small portion of similar available benthic habitat in the area.

The total width of the disturbance corridor for installation of the SRWEC would be up to 98 ft (30 m), inclusive of any required sand wave leveling and boulder clearance, and trenching is expected to be as deep at 7 ft (2.1 m). Boulder clearance associated with seafloor preparation is expected to have minor impacts to habitat in the limited areas it may be required along the IAC corridor and around individual foundations. Loss of attached fauna is expected during boulder relocation. Relocated boulders may be recolonized, but microhabitats on the boulder would be shifted and attached fauna may not survive relocation or be able to adapt to a different positioning; however, these relocated boulders are expected to return to their pre-Project habitat function with relatively rapid (less than 1 year) recolonization expected (Guarinello and Carey 2022). Additionally, boulder relocation may result in aggregations of boulders, creating new features that may serve as high value habitat. For example, this increased complex structured habitat may benefit juvenile lobsters and fish by providing an opportunity for refuge compared to surrounding patchy habitat.

If necessary, CFE or suction hopper dredging may be used for sand wave leveling during installation of the IAC. This method utilizes thrust to direct waterflow into sediment, creating liquefaction and subsequent dispersal. The CFE tool draws in seawater from the sides and then jets this water out from a vertical down pipe at a specified pressure and volume. The water withdrawal volumes are expected to be approximately 250 to 650 million gallons (946 to 2,460 million liters) for the jet-plow and approximately 191 to 516 million gallons (724 to 1,953 million liters) for CFE equipment. The down pipe is positioned over the cable alignment, enabling the stream of water to fluidize the sands around the cable, which allows the cable to settle into the trench under its own weight. During the process, the fluidized sand gets deposited within the local sand wave field.

Other seafloor preparation activities, IAC installation, and installation of cable protection would occur along the IAC corridor and around individual foundations and would be expected to have similar direct short-term impacts on benthic and shellfish resources as boulder clearance in these areas, but habitat function is expected to rapidly recover.

UXO/MEC detonations would result in short-term disturbance of nearby habitats but are not expected to alter the physical character of impacted habitats. Benthic and infaunal communities would experience mortality and injury in areas near the blast relative to the size of the blast. A review of studies testing the impacts of underwater explosions (Keevin and Hempen 1997) shows that invertebrates are somewhat insensitive to pressure waves, likely related to the lack of gas-filled organs. Rates of mortality decrease rapidly with distance, with mortality ranges less than 100 m even for explosives as large as 800 lbs (1997). Based on the relatively small area impacted for each potential UXO/MEC event and low mortality rates, these areas are expected to experience short-term impacts with rapid recovery.

The installation of the WTG and OCS–DC foundations and associated scour protection could crush and/or displace benthic species, particularly sessile species and eggs and larvae within the impact area of the foundations and scour protection. Vessel anchoring (including spuds from jack-up vessels) could cause mortality or injury to slow-moving or sessile benthic species within the impact areas of the spuds, anchors, and anchor chain sweep. The extent of vessel anchoring impacts would vary, depending on the vessel type, number of vessels, and duration onsite, but would be smaller in spatial extent than other seafloor-disturbing construction activities.

In areas of seafloor disturbance, benthic habitat recovery and mobile and sessile benthic infaunal and epifaunal species abundances may take 1 to 3 years to recover to preimpact levels, based on the results of a number of studies on benthic recovery (e.g., AKRF et al. 2012; Carey et al. 2020; Germano et al. 1994; Guarinello and Carey 2022; Hirsch et al. 1978; Kenny and Rees 1994). Based on a review of impacts of sand mining in the U.S. Atlantic and Gulf of Mexico, softbottom communities within the cable corridors would recover within 3 months to 2.5 years (Brooks et al. 2006; Kraus and Carter 2018; Normandeau Associates 2014). A separate review of case studies from cable installations in Atlantic and Pacific temperate zones concludes that recovery of benthic communities on the OCS (less than a 262-ft [80-m] depth) occurs within a few weeks to 2 years after plowing, depending on the available supply of sediment (Brooks et al. 2006). Recovery time varies somewhat with the method of installation, with more rapid recovery after plowing than jetting (Kraus and Carter 2018).

Benthic habitat recolonization rates depend on the benthic communities in the area surrounding the affected region. Sand sheet and mobile sand with gravel habitats as found within and near the SRWF are often more dynamic in nature; therefore, they are quicker to recover than more stable environments, such as fine-grained (e.g., silt) habitats and rocky reefs (Dernie et al. 2003). Species inhabiting these dynamic habitats are adapted to deal with physical disturbances, for example, frequent sedimentation associated with strong bottom currents and ground swell. As such, these communities are expected to recolonize more quickly after a disturbance than communities not well-adapted to frequent disturbance (e.g., cobble and boulder habitats). Mobile species may be indirectly affected by the temporary reduction of benthic forage species; however, given the prevalence of similar habitat in the area, this is likely to be a minor impact.

Over the life of the project, the installation of cable armoring and scour protection would replace soft bottom habitat with hard bottom habitat. Removing soft bottom habitat may result in both negative and beneficial direct long-term impacts on benthic species and associated habitat function for ESA-listed species. Species that have life stages associated with soft bottom habitats, such as ocean quahog, waved and chestnut Astarte clam, Atlantic surf clam, sand shrimp, amphipods, channeled whelk, and horseshoe crab, may experience long-term effects as their available habitat would be slightly reduced; however, the completed SWREC alignment and the WTG foundations and OCS–DC within the SRWF would create new benthic habitat structure within the lease area. The IAC would likely require targeted surface protection in areas of consolidated glacial moraine that are already hard bottom, which would not result in long-term habitat conversion. The COP (Sunrise Wind 2022i) estimates that 110.76 ac (44.82 ha) of hard surface foundation and associated scour protection and 139.36 ac (56.40 ha) of cable associated structures and protections would remain on the seafloor for the life of the Project. When added together, the total acreage that would be converted from soft bottom to hard bottom represents a negligible fraction of the total soft bottom on the southern New England continental shelf, but the dispersed nature of the areas may have less predictable effects.

Each WTG would be spaced approximately 1 NM away from the adjacent WTGs in the array, so these hard bottom analogous habitat areas would create a regular, patchy, higher complexity habitat where epifaunal organisms could attach. The riprap materials surrounding the foundations for scour protection would provide shelter and hiding areas for more mobile organisms such as crabs, squid, and fish. Colonization of the new seafloor features would take approximately the same time as is estimated for recovery of disturbed habitat, or from several months up to 3 years. The Project is expected to operate for 25 years or more, so this habitat would be a long-term feature. Once colonized these complex habitat patches would be likely to attract other species as a food source, spawning area, or shelter site. As these foundations extend from below the seafloor to above the surface of the water, the development of attached benthic fauna and flora zonation with depth is expected (De Backer and Hostens 2017; De Mesel et al. 2015). Macroalgal zonation may occur ranging from deeper growing red foliose algae and calcareous algae to kelps and other species more common in shallow environments. Other species that may benefit from the increased hard substrate, which would exhibit zonation with depth, include sea anemones and other anthozoans, bivalves such as horse mussel (*Modiolus modiolus*) and blue mussel (*Mytilus edulis*), green sea urchin (*Strongylocentrotus droebachiensis*), barnacles, hydrozoans, sponges, and other fouling organisms. Similar effects have been seen at offshore oil rigs where ocean communities develop and resemble those found at natural and artificial reef structures. Hutchison et al. (2020)found that attached fauna including mussels colonized the five turbine foundations and jacket structures at the BIWF within 3 years of construction to the extent that the structures became areas of high biotic diversity and began to proceed through habitat and community successional stages. Although the SRWF is farther offshore and would use a monopole structure different from the BIWF, it is reasonable to expect that similar habitat and community development would occur once construction is completed. The spacing of the SRWF WTGs is close enough to allow for dispersal of gametes and larval forms of attached organisms which may facilitate the progressive colonization of the structures farther offshore.

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

Leatherback sea turtles are dietary specialists, feeding almost exclusively on pelagic jellyfish, salps, and siphonophores, rather than prey species affected by benthic habitat alteration. Green, Kemp's ridley, and loggerhead sea turtles all feed on benthic organisms; however, benthic habitat disturbances are anticipated to be temporary and localized and unlikely to affect the availability of prey resources for these species. Although the Proposed Action would temporarily impact benthic prey resources, those effects would be temporary and limited to less than 0.0001 percent of the Action Area and an even smaller percentage of suitable foraging habitat in nearshore and offshore areas of the Atlantic OCS. Given that the Action Area is naturally dynamic and exposed to anthropogenic disturbance, the species that occur in this region already adjust their foraging behavior based on prey availability. Kemp's ridley and green sea turtles are omnivorous species with flexible diets, and loggerhead sea turtles readily target new prey species to adapt to changing conditions. Given the limited amount of foraging habitat exposed to construction disturbance, the temporary and localized nature of these effects, and the ability of these species to adjust their diet in response to resource availability, the resulting effects of benthic disturbance on these species would be **insignificant** and **may affect, but are not likely to adversely affect** sea turtles.

A similar rationale applies to Atlantic sturgeon. Although Proposed Action construction would kill or displace preferential prey organisms (invertebrates, such as crustaceans, worms, and mollusks, and bottom-dwelling fish, such as sand lance) within the footprint defined by placement of the monopiles, scour protection, the IAC and SRWEC corridors, and the sea-to-shore transition cofferdam and sidecast, these effects would be temporary in duration and limited to an insignificant (less than 0.0001 percent) percentage of available foraging habitat in the Action Area. Given the limited extent of effects and the likelihood of rapid recovery to baseline benthic community conditions, the effects of Proposed Action construction on seabed and water column habitat conditions are likely to be **insignificant** and **may affect, but are not likely to adversely affect** Atlantic sturgeon.

The WTG and SRWEC OSS foundations constitute obstacles in the water column that could alter the normal behavior of aquatic organisms in the SRWF. Although operational noise is recognized as a potential effect mechanism, insufficient information is available to characterize how the presence of WTG foundations in the water column would affect the behavior of whales, fish, and other organisms (Long 2017; Thompson et al. 2013). Long (2017) compiled several years of observer data for marine mammal and bird interactions with tidal and wave energy testing facilities in Scotland. He was unable to identify any changes in behavior or distribution associated with the presence of ocean energy structures once construction was complete, concluding that the available data were insufficient to determine the presence or absence of significant effects.

Other research on the behavioral and displacement effects of offshore structures is equivocal. Delefosse et al. (2018) reviewed marine mammal sighting data around oil and gas structures in the North Sea and found no clear evidence of species attraction or displacement. In contrast, Russell et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently exploiting the abundant concentrations of prey produced by artificial reef effects, while Teilmann and Carstensen (2012)documented the apparent long-term displacement of harbor porpoises from previously occupied habitats within and around a wind farm in the Baltic Sea.

The WTGs are proposed to be laid out in a grid-like pattern with spacing of 0.76 to 1.0 NM (1.4 to 1.85 km) between turbines. The minimum distance between nearest turbines is no less than 0.65 NM (1.2 km) and the maximum distance between nearest turbines is no more than 1.1 NM (2 km). The average spacing between turbines is 0.86 NM (1.59 km). Based on a simple assessment of spacing relative to animal size, it does not appear that the WTGs would be a barrier to the movement of any listed species through the area. Based on this, the presence of the SRWF would not pose a barrier to the movement of ESA-listed marine mammals, sea turtles, or fish.

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

4.6.1 Habitat Conversion and Loss – C, O&M, D

4.6.1.1 Wind Turbine Generators/Substations

The operational effects of the Project include the physical presence of the SRWF turbine and OCS–DC foundations, and alteration of benthic habitat by rock armoring and scour protection. Structural elements of the SRWF would be present throughout the 25- to 35-year operational life of the Project. Once WTG and OCS–DC foundations, scour protection, and IAC protection would alter the existing habitat. The completed SWREC alignment and the WTG foundations and OCS–DC within the SRWF would create new benthic habitat structure within the lease area. The IAC would likely require targeted surface protection in areas of consolidated glacial moraine that are already hard bottom, which would not result in long-term habitat conversion. The COP (Sunrise Wind 2022i) estimates that 110.76 ac (44.82 ha) of hard surface foundation and associated scour protection and 139.36 ac (56.40 ha) of cable associated structures and protections would remain on the seafloor for the life of the Project. The new hard bottom structures are likely to result in a reef effect that encourages colonization by assemblages of both sessile and mobile animals (Bergström et al. 2014; Coates et al. 2014; Wilhelmsson et al. 2006). Studies have shown that artificial structures could create increased habitat heterogeneity that is important for species diversity and density (Langhamer 2012). This change in the visible infrastructure (i.e., presence of the SRWF) would provide a long-term primarily beneficial impact to marine mammals by increasing prey species attracted to the proposed Project infrastructure (Langhamer 2012; Wilson and Elliott 2009).

During construction of the SRWF, seafloor disturbances would be associated with seafloor preparation, placement of scour protection/cable protection, foundation installation, vessel anchoring and jack-up, and IAC installation. These seafloor disturbances could directly impact benthic species such as mollusks and crabs which are prey for sea turtles. As foundations, anchors, and/or jack-ups are placed on the seafloor, direct injury or mortality could occur to benthic species residing within the footprint of the foundations. It may take up to 5 years before stable communities are established following construction activities (Petersen and Malm 2006); however, the footprint of direct benthic impacts within the SRWF would be **insignificant** when compared to the ample available bottom habitat surrounding the SRWF and prey base alternations **may affect, but are not likely to adversely affect** ESA-listed species.

Impacts to ESA-listed species from seafloor disturbance during O&M of the proposed Project would be limited to the impacts expected on their benthic prey. Seafloor disturbing activities during O&M of the SRWEC–OCS and NYS are only expected during non-routine maintenance that may require uncovering and reburying the cables and/or the maintenance of the cable protection. These O&M activities are expected to result in similar impacts on benthic resources as those discussed for construction and could therefore temporarily displace listed species due to decreased available forage; however, the extent of disturbance would be limited to specific areas along the SRWEC cable corridor centerline and the footprint of the SRWEC is relatively small when compared to the ample surrounding available benthic/prey habitat. Overall impacts of O&M activities would be **insignificant** for marine mammals, sea turtles, and Atlantic sturgeon. Therefore, seafloor disturbance **may affect, but is unlikely to adversely affect** ESA-listed species.

Structural elements of the SRWF would be present for the 25- to 35-year operational life of the proposed Project. Once WTGs and OCS–DC have foundations have been installed within the seafloor, the presence of the operating SRWF would have converted the existing open water habitat to one with increased hard bottom, making it comparable to an artificial reef-like habitat. The presence of the SRWF foundations, scour protection, and IAC protection would create three-dimensional hard bottom habitats resulting in a reef effect that is expected to attract numerous species of algae, shellfish, finfish, and sea turtles (Langhamer 2012; Reubens et al. 213; Wilhelmsson et al. 2006). Sea turtles have been observed within the vicinity of offshore structures, such as oil platforms, foraging and resting under the platforms (Gitschlag and Herczeg 1994; NRC 1996). High concentrations of sea turtles have been reported around these oil platforms (NRC Gitschlag and Herczeg 1994; 1996).

Project conceptual decommissioning would have similar impacts on invertebrates and fish species to those anticipated for the Proposed Action, but the degree and magnitude of these effects are likely to be different.

The newly introduced surfaces are expected to develop a complex community of benthic invertebrates. The removal of these surfaces would likely injure or cause mortality to invertebrates attached to the hard surfaces or inhabiting the interstitial spaces and permanently alter benthic habitats within the decommissioning area. Any invertebrates that are living among these habitats may or may not survive, depending on whether they are able to find other suitable habitats. The invertebrates associated with softer bottom benthic habitats may be able to recover within a faster time period after conceptual decommissioning is completed. Whereas the invertebrate species associated with complex benthic habitat within the conceptual decommissioning area may take much longer to recover.

Loss or conversion of benthic habitats due to displacement of sand, sediment, boulders and other materials would likely cause unavoidable damage and potential mortality of prey species, but the impacts would be temporary and short-term. Benthic habitat surveys, mapping, and evaluation of geological conditions prior to exact route selection would minimize any serious impacts to vulnerable benthic habitats. In context of reasonably foreseeable environmental trends, the activities associated with the Proposed Action to combined impacts on fish and prey resources would range from insignificant to minorly beneficial. In general, fish and invertebrate impacts due to longer term habitat alteration are likely to be beneficial to some species and cause alteration and loss of habitat for others. The amount of overall habitat that is small in comparison to the abundant habitat available in the area and therefore the impacts are expected to be **insignificant**, and conversion of benthic habitats **may affect, but is not likely to adversely affect** ESA-listed species.

4.6.1.2 Mats/Anchors

The short-term impacts of vessel anchoring would cause increased turbidity in the immediate, localized areas with the potential to temporarily disturb Atlantic sturgeon. Anchor chains may drag or scour the substrate, potentially injuring or killing benthic invertebrates. Sensitive habitat areas such as eelgrass beds, or hard bottom substrates would be more susceptible to anchoring with the potential for longer term or permanent impacts. Habitat characterization and mapping, along with the required development of an anchoring plan would minimize any anchoring in sensitive habitats and reduce the area of sensitive habitats to be affected. The area of potential anchoring impacts is miniscule in comparison to the overall project area. If degradation of sensitive habitat were to occur, the impacts could be longer term, but the impacts from anchoring during construction are no greater than the impacts of anchoring proposed from ongoing and planned future activities in the future and will be **insignificant**. The combined impacts of anchoring on prey base and habitat **may affect, but are unlikely to adversely affect** ESA-listed species.

4.6.1.3 Scour Protection

The footprint of the SRWF WTGs and OCS–DC foundation and associated scour protection in the form of boulders and concrete mats would modify approximately 110.76 ac of seabed. Although these effects would be long term, the placement of additional rock on existing mixed-boulder substrate would not substantially alter the character of the current habitat.

4.6.1.4 Cable Presence/Protection

Cable presence and associated protection will result in 1,250.6 ac of long-term impacts to the seabed (468.9 ac [189.8 ha] from SRWEC cable and 781.7 ac [316.3 ha] from the IAC). Although these effects would be long term, the placement of additional rock on existing mixed-boulder substrate would not substantially alter the character of the current habitat.

Installation methods and anticipated maximum disturbance corridors during construction are detailed in **Section 2.1**. Construction activities could temporarily disturb marine mammals or their prey species in the area of activity. Mobile species are expected to temporarily relocate from the area immediately surrounding seafloor-disturbing activities, and marine mammals foraging in the vicinity may encounter a localized reduction in foraging opportunities; however, because prey would still be available within the overall region surrounding the SRWEC, impacts would be limited to short-term avoidance of small areas of available habitat and would not adversely impact annual rates of recruitment or survival. Therefore, the effects of seafloor disturbance would be **insignificant** and **may affect, but is not likely to adversely affect** ESA-listed species.

4.6.2 Turbidity – C, D

Construction of the SRWF and SRWEC is likely to result in elevated levels of turbidity in the immediate proximity of bed-disturbing activities like pile driving, placement of scour protection, vessel anchoring, and burial of the SRWEC and IAC. Decommissioning may result in similar levels of turbidity due to removal of the turbine foundations and cables. Elliott (2017) monitored TSS levels during construction of the BIWF. The observed TSS levels were far lower than levels predicted using the same modeling methods, dissipating to baseline levels less than 50-ft (15.2-m) from the disturbance. Both the modeled TSS effects, which are conservatively high, and the observed TSS effects were short term and within the range of baseline variability; however, these effects would be short term (lasting only a few tide cycles) due to the low mobility of sediments (primarily sand) in the proposed cable installation areas and HDD exit location (Stantec 2020). Seals and dolphins have evolved in and are able to forage and move effectively in low-visibility conditions. This suggests that temporary reduction in visibility would not significantly impair behavior in response to elevated TSS. Even if marine mammals were to temporarily alter their behavior (e.g., by avoiding the disturbance and/or interrupting foraging), the disturbance would be localized in extent, limited in magnitude, and short-term. Therefore, the anticipated effects of construction-related seabed disturbance on marine mammals would be insignificant.

The COP, Appendix H (Sunrise Wind 2022c), provides further information on suspended sediments from installation of the IAC in federal waters. Only short-term, limited impacts to fish and invertebrates are expected from suspended sediments; therefore, secondary effects on sea turtle prey availability are not expected. Furthermore, Appendix H of the COP (Sunrise Wind 2022c) concluded that TSS concentrations are predicted to return to ambient levels (less than 10 milligrams per liter) within 0.5 hours following completion of IAC installation. The TSS plume is predicted to be contained within the lower portion of the water column, approximately 12.8-ft (3.9-m) above the seafloor. This limited temporal effect over a relatively small area are not expected to interfere with ESA-listed species foraging success. Given that both the modeled and observed TSS effects would be short term and within the range of baseline variability, the Proposed Actioned effects on ESA-listed marine mammal, sea turtles, and Atlantic sturgeon in the Action Area are likely to be insignificant. Supporting rationale for this conclusion is provided in the following sections.

4.6.2.1 Marine Mammal Total Suspended Sediment Exposure

The NMFS Atlantic Region has developed a policy statement on turbidity and TSS effects on ESA-listed species for the purpose of Section 7 consultation Johnson (2018), NMFS has determined that elevated TSS could result in effects on listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging operations), but insufficient information is available to make ESA effect determinations. In general, marine mammals are not subject to impact mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae) so injury-level effects are unlikely. Behavioral impacts, including avoidance or changes in behavior, increased stress, and temporary loss of foraging opportunity, could occur but only at excessive TSS levels (Johnson 2018). Todd et al. (2015) postulated that dredging and related turbidity impacts could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors. As discussed above, increases in suspended sediments due to project actions are anticipated to be small scall and of short duration, with a return to ambient conditions within 30 minutes. Small-scale changes from one-time, localized activities are not likely to have significant effects.

As stated, anticipated TSS levels are limited in magnitude, short term in duration, and likely to be within the range of baseline variability in the Action Area, and therefore **insignificant**. the resulting effects on ESA-listed marine mammals would be insignificant. Increased turbidity associated with the Proposed Action **may affect, but is not likely to adversely affect** marine mammals.

4.6.2.2 Sea Turtle Total Suspended Sediment Exposure

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

4.6.2.3 Marine Fish Total Suspended Sediment Exposure

Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clarke 2001). Directed studies of sturgeon TSS tolerance are currently lacking, but sturgeons, as a whole, are adapted to living in naturally turbid environments like large rivers and estuaries (Johnson 2018). Although it is difficult to generalize across species, many estuarine-oriented fish species can tolerate turbidity levels in excess of 1,000 milligrams per liter for short periods without injury or noticeable sublethal effects (Wilber and Clarke 2001). This suggests that sturgeon could tolerate TSS levels produced by the Proposed Action without injury. Given that Atlantic sturgeon are adapted to naturally turbid environments and the projected effects are within the range of baseline variability and therefore **insignificant**. Increased turbidity associated with the Proposed Action **may affect, but is not likely to adversely affect Atlantic sturgeon**.

4.6.3 Physical Presence of Wind Turbine Generators on Atmospheric/Oceanographic Conditions – O&M

The addition of up to 95 new offshore structures in the Project Area could increase marine mammal prey availability through creating new hard-bottom habitat, increasing pelagic productivity in local areas, or promoting fish aggregations at foundations (Bailey et al. 2014; English et al. 2017). The presence of WTGs could alter circulation and stratification down current from the structures, potentially altering oceanographic conditions at the local scale; however, the presence of an estimated 95 structures could have broader effects on oceanographic conditions with the potential to influence the distribution of ESA-listed species prey at broader spatial scales.

Monopile foundations that are affixed to the bottom and their associated scour protection have the potential to impact the local hydrodynamics. As currents flow by the structures, there would be some turbulence occurring that can leave wakes in the immediate area depending on the conditions. These wake changes can increase the potential mixing of the bottom and surface layers of the water column with the potential to impact stratification, nutrient circulation, and possible larval dispersal (Schultze et al. 2020; van Berkel et al. 2020).

The area of the SRWF is seasonally stratified due to warmer waters late summer and early fall months causing higher salinity and strong stratification. A cold band of water near the bottom extending through the Middle Atlantic Bight from spring through fall contributes to a stratification effect is known as the Cold Pool in the area (Lentz 2017). Any mixing impacts around foundation piles is typically minimal in environments that are strongly stratified such as the Cold Pool region and would likely limit any measurable hydrodynamic impacts to fish, invertebrates, and EFH (van Berkel et al. 2020). Localized impacts would bring some nutrients to the surface and likely enhance primary productivity and phytoplankton growth in the immediate area (Floeter 2017); however, the impacts this may have on fish and invertebrates is still largely unknown and needs to be researched further to understand if any distinction from natural variability of the system exists (van Berkel et al. 2020). Localized impacts are likely to be **insignificant** on fish and invertebrates and may support increased biological productivity surrounding the potential increase in invertebrate communities that form around the monopile structures and therefore **may affect, but is not likely to adversely affect** ESA-listed species.

4.6.4 Physical Presence of Wind Turbine Generators on Listed Species – O&M

Current data suggest seals (Russell et al. 2014) and harbor porpoises (Scheidat et al. 2011) may be attracted to future offshore wind development infrastructure, likely because of the foraging opportunities and shelter provided. These species are expected to use habitat between the WTGs, as well as around offshore wind infrastructure, for feeding, resting, and migrating; however, the presence of structures may indirectly concentrate recreational fishing around foundations. In addition, ghost gear or lost commercial fishing nets may tangle around WTG foundations. Both could indirectly increase the potential for marine mammal and sea turtle entanglement leading to injury and mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). Entanglement in commercial fishing gear was identified as one of the leading causes of mortality in North Atlantic right whales and may be a limiting factor in the species recovery, with more than 80 percent of observed individuals showing evidence of at least one entanglement and 60 percent showing evidence of multiple entanglements (Knowlton et al. 2012). Abandoned or lost fishing gear may become tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, although debris tangled with WTG foundations may still pose a hazard to marine mammals. Wind farm mitigation measures include annual inspections of WTG foundations and surroundings to find and remove derelict fishing gear and debris. This would reduce entanglement risk for ESA-listed species foraging around the foundations. Importantly these mitigation measures would provide a new mechanism for removing derelict gear from the environment, incrementally reducing entanglement risk for all species in the analysis area. As a result, any effects from the secondary entanglement due to an increased presence of recreational fishing in response to reef effect would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of secondary entanglement due to an increased presence of recreational fishing in response to the reef effect from Project structures **may affect, not likely to adversely affect** ESA-listed cetaceans.

The long-term presence of WTG structures could displace ESA-listed species from preferred habitats or alter movement patterns, potentially changing exposure to commercial and recreational fishing activity. The evidence for long-term displacement is unclear and varies by species. For example, Long (2017) studied marine mammal habitat use around two commercial wind farm facilities before and after construction and found that habitat use appeared to return to normal after construction. Long cautioned that these findings were not definitive and additional research was needed. In contrast, Teilmann and Carstensen (2012) observed clear long-term (greater than 10 years) displacement of harbor porpoises from commercial wind farm areas in Denmark. Displacement effects remain a focus of ongoing study (Kraus et al. 2019).

The combined effects of the presence of wind farm structures on marine mammals are variable, ranging from incrementally adverse to incrementally beneficial, and difficult to predict with certainty. Broadly speaking, any effects on marine mammal prey species are expected to be localized and seasonal. Potential long-term, intermittent impacts would persist until conceptual decommissioning is complete and structures are removed. On balance, the presence of wind farm structures could alter marine mammal behavior at local scales. While derelict fishing gear associated with shifts in recreational fishing could indirectly expose individuals to injury, overall fishing effort in the region is not expected to increase, and included gear removal efforts make entanglement extremely unlikely to occur and **discountable** for marine mammals. Therefore, the risk of secondary entanglement due to fishing gear **may affect, but is not likely to adversely affect** listed mammals.

As a result of the increased habitat and foraging opportunities at the now artificial reef-like habitat, sea turtles could potentially remain in areas longer than they normally would and could become susceptible to cold stunning or death; however, artificial habitat created by these offshore structures can provide multiple benefits for sea turtles, including foraging habitats, shelter from predation and strong currents, and methods of removing biological build-up from their carapaces (Barnette 2017; NRC 1996). It is estimated that offshore petroleum platforms in the Gulf of Mexico, provided an additional 2,000 mi^2 (5,180 km^2) of hard bottom habitat (Gallaway 1981). Wakes created by the presence of the foundations may influence distributions of drifting jellyfish aggregations; however, since other prey species available to sea turtles would not be affected by these wakes, impacts on sea turtle foraging are not expected to be substantial (Kraus et al. 2019).

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of sea turtle entanglement in both vertical and horizontal fishing lines and increasing the risk of injury and mortality due to infection, starvation, or drowning. If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area and/or an increase in overall effort. These structures could also result in fishing vessel displacement or gear shift. The potential impact on sea turtles from these changes is uncertain; however, if a shift from mobile gear (trolling) to fixed gear (hook and line) occurs due to inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of sea turtle interactions with fishing gear. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low. Due to foraging strategies, leatherback and loggerhead sea turtles are more likely to be exposed to recreational fishing lines in the pelagic WTG area. Conversely, Kemp's ridley and green sea turtles are less likely to be exposed to recreational fishing lines in the pelagic WTG area and are in the Project Area at much lower densities than loggerhead and leatherback sea turtles.

Because of their much lower densities and in the Project Area and their foraging strategies that would not cause aggregation or attraction to WTGs, exposure of Kemp's ridley and green sea turtles to entanglement in fishing gear around WTGs is **discountable**. Therefore, potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations **may affect, not likely to adversely affect** Kemp's ridley and green sea turtles.

Based on available information, secondary entanglement due to an increased presence of recreational fishing around the WTGs is possible and cannot be discounted for leatherback or loggerhead sea turtles. Therefore, the potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations **may affect, likely to adversely affect** leatherback and loggerhead sea turtles.

On this basis, BOEM concludes that the presence of visible structures from O&M would have insignificant direct effects on sea turtle movement and migration, and insignificant to minor beneficial effects on the distribution, abundance, and availability of sea turtle prey and forage resources.

As primarily demersal species, Atlantic sturgeon may be displaced by WTGs and their scour protection; however, the area occupied by the WTGs and their scour protection is an extremely small portion of their available habitat. Further, Atlantic sturgeon are not limited by prey or marine habitat availability. The presence of WTGs will have an **insignificant** impact on Atlantic sturgeon, their available habitat, and prey resources. Therefore, the presence of WTGs **may affect, but is not likely to adversely affect** Atlantic sturgeon.

4.6.5 Electromagnetic Fields and Heat from Cables – O&M

Because EMFs are generated by power production when WTGs are operating, no effects to ESA-listed animals from this IPF are expected during construction or decommissioning of the offshore facilities.

The proposed Project would consist of two offshore electric transmission systems: 180 mi (290 km) of 161 kV alternating current IAC and up to 106 mi (170 km) of 320 kV DC SRWEC. These effects would be most intense at locations where the SRWEC cannot be buried and is laid on the bed surface covered by a stone or concrete armoring blanket. Approximately 2.97 mi (4.8 km) of the SRWEC cable and 2.1 mi (3.4 km) of the IAC could be unburied and would require surface armoring. Exponent Engineering, P.C. (2018) modeled anticipated EMF levels generated by the SRWEC and IAC. It estimated induced magnetic field levels ranging from 13.7 to 76.6 mG on the bed surface above the buried and exposed SRWEC cable and 9.1 to

65.3 mG above the IAC. Induced field strength would effectively decrease to 0 mG within 25 ft (7.6 m) of each cable. By comparison, the earth's natural magnetic field is more than five times the maximum potential EMF effect from the Project (Figure C-1, Appendix J1, COP; Sunrise Wind 2022e).

A modeling analysis of the magnetic and electric fields anticipated to be produced from Sunrise Wind's operational AC (i.e., IAC) and DC (i.e., SRWEC) cables was performed (Appendix J1, COP; Sunrise Wind 2022e). Assuming a conservative minimum target burial depth and no shielding effect of cable sheathing or armoring, produced magnetic and electric fields would be low and attenuate rapidly with increasing distance. For the IAC, at a height of 3.3 ft (1 m) above seabed, directly over the IAC at peak loading, AC magnetic and electric field levels were calculated to be 4.5 mG and less than 0.09 mV/m, decreasing to 1.1 mG and less than 0.1 mV/m or less at a horizontal distance of ±10 ft (3 m) from the cables; however, previous literature (e.g., Hutchinson et al. 2018) suggest the magnetic fields and electric fields would generally be lower than the Sunrise Wind modeling suggests. For the SRWEC, DC magnetic fields over the majority of the route (where cables are bundled together) were calculated at a height of 3.3 ft (1 m) above the seabed at peak loading (assessed for permutations of four geographic directions and four cable configurations). The calculated change to Earth's ambient geomagnetic field is a maximum of ±129 mG, over the cables. The magnetic field from the cables decreases to ±41 mG at a horizontal distance of 10 ft (3 m) from the cables, contributing less than 10 percent of the ambient geomagnetic field level (approximately 506 mG). The flow of seawater within the ambient geomagnetic field from an ocean current of 2 feet per second (ft/s; 60 cm/s) induces a static DC electric field of 0.033 mV/m at a distance of ±10 ft (3 m) from the cables. At landfall, the DC magnetic field level evaluated at a height of 3.3 ft (1 m) above the seabed at peak loading was 1,730 mG above the 506 mG contributed by the geomagnetic field of the Earth. The corresponding induced DC electric field over the SRWEC in a 2 ft/sec (60 cm/s) ocean current is 0.14 mV/m. The EMF present during operations would cease once the Project is decommissioned.

To minimize potential effects from EMF, both the IAC and SRWEC are proposed to be buried between 3 to 7 ft (0.9 to 2.1 m) deep below the seafloor, to the extent feasible, and feature various protective armoring and sheathing. Still, the magnetic fields measured at the seafloor may be slightly higher than the naturally occurring geomagnetic field of the earth.

As marine mammals in the area would be transiting and/or foraging and would not spend significant time on the seafloor in proximity to the proposed cables, no species- or population-level impacts to marine mammals are expected. The mobile nature and surfacing behavior in marine mammals likely limit time spent near the IAC and SRWEC, reducing potential for EMF exposure. Data are limited but only minor responses, such as lingering near or attraction to cables, have been noted in electrosensitive species (e.g., elasmobranchs, benthic species) and no interactions with anthropogenic EMF from submarine cables have been recorded for marine mammals. Therefore, potential effects to marine mammals from EMF exposure associated with the Sunrise Wind cable project, if present, are expected to be transient and **insignificant**. EMF exposure **may affect, but is not likely to adversely affect** marine mammals.

Normandeau Associates Inc. et al. (2011) indicate that sea turtles are magnetosensitive and orient to the earth's magnetic field for navigation, but they are unlikely to detect magnetic fields below 50 mG. The majority of SRWEC and IAC would be buried 6 ft below the bed surface, reducing the magnetic field in the water column below levels detectable to turtles. The transmission cables could produce magnetic field effects above the 50-mG threshold at selected locations where full burial is not possible; these areas would be localized and limited in extent. Magnetic field strength at these locations would decrease rapidly with distance from the cable and drop to 0 mG within 25 ft (7.6 m). Peak magnetic field strength is below the theoretical 50-mG detection limit along the majority of cable length, only exceeding this threshold above the short-cable segments laid on the bed surface. Those EMF effects would dissipate below the 50-mG threshold within 1 to 2 ft (0.3 to 0.6 m) of the cable surface. This indicates that turtles would only be able to detect induced magnetic fields within 1 to 2 ft (0.3 to 0.6 m) of cable segments lying on the bed surface. These cable segments would be relatively short (less than 100 ft [30 m]) and widely dispersed. Exponent Engineering, P.C. (Appendix J1, COP; Sunrise Wind 2022e) concluded that the shielding provided by burial and the grounded metallic sheaths around the cables would effectively eliminate any induced electrical field effects detectable to turtles. Given the limited extent of measurable magnetic field levels and limited potential for mobile species like sea turtles to encounter field levels above detectable thresholds, the effects of Project-related EMF exposure on sea turtles would be **insignificant**, and therefore **may affect, but is not likely to adversely affect** sea turtles.

Atlantic sturgeon are electrosensitive but appear to have relatively low sensitivity to magnetic fields based on studies of other sturgeon species. Bevelhimer (2013) studied behavioral responses of lake sturgeon, a species closely related to Atlantic sturgeon, to artificial EMF fields and identified a detection threshold between 10,000 and 20,000 mG, well above the levels likely to result from the Proposed Action (i.e., 9.1–76.6 mG). This indicates that Atlantic sturgeon are likely insensitive to magnetic field effects resulting from the Proposed Action; however, sturgeon may be sensitive to the induced electrical field generated by the cable. BOEM performed an evaluation commercially and recreationally important fish and invertebrate species regarding their susceptibility to EMF levels generated by commercial wind farm transmission cables on the OCS (CSA Ocean Sciences Inc. and Exponent 2019). It was determined that many fish species would likely not show quantifiable impacts from transmission cable EMFs, and species could potentially detect EMFs would not experience significant physiological or behavioral effects. It is likely that the impacts of EMF on Atlantic sturgeon would be **insignificant** due to the small areas of altered EMF and limited effect of EMF on the species. EMF **may affect, but is not likely to adversely affect** Atlantic sturgeon.

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

Although cable heat could theoretically affect benthic community structure, potentially affecting the composition and availability of invertebrate prey resources for species like Atlantic sturgeon, the physical extent of these effects would be limited relative to the amount of unaffected foraging habitat available in and near the Action Area. Therefore, although cable heat effects remain a data gap, the available evidence suggests that any associated effects on ESA-listed species and their prey base would be **insignificant**. Waste heat generation from transmission cables **may affect, but are not likely to adversely affect** ESA-listed species.

4.6.6 Lighting and Marking of Structures – O&M

Artificial lighting during SRWF construction would be associated with navigational and deck lighting on vessels from dusk to dawn. It is likely that reaction of marine mammals to this artificial light is species-dependent and may include attraction or avoidance of an area. Artificial lighting may disrupt the diel migration of some prey species, which may secondarily influence marine mammal distribution patterns. Observations at offshore oil rigs showed dolphin species foraging near the surface and staying for longer periods of time around platforms that were lit (Cremer et al. 2009). Only a limited area around Project-related vessels would be lit, relative to the surrounding unlit open ocean areas, therefore impacts to marine mammals are considered negligible and short-term during construction.

The Proposed Action includes the use of red flashing aviation obstruction lights on WTGs and ESPs in accordance with FAA and BOEM requirements (Sunrise Wind 2022i). The lights would consist of two L-864 medium-intensity red lights mounted on the nacelle and up to three L-810 low-intensity red lights mounted on the midsection of the WTG tower, and all lights will have a synchronous flash rate of 30 flashes per minute (Sunrise Wind 2022i). ADLS may also be installed so that obstruction lights will only be activated when an aircraft are near the turbines. The use of ADLS will dramatically reduce the amount of time the obstruction lights are on. In the Sunrise Wind ADLS efficacy analysis (Appendix Y2 of the COP; Sunrise Wind 2022g), the total obstruction light system for historical air traffic data had an activated duration of 35 minutes and 14 seconds over a 1-year period for 636-ft WTGs. Total obstruction light system activated duration increases slightly to 1 hour 21 minutes and 29 seconds over a 1-year period for 968-ft WTGs. Since the Sunrise Wind WTGs would have a height of 787 ft above MSL, the activated duration of ADLS-controlled obstruction lights could fall around the middle of this range.

Navigational lights associated with WTGs would consist of two L-864 medium intensity red lights mounted on the nacelle and up to three L-810 low intensity red lights mounted on the midsection of the WTG tower, and all lights will have a synchronous flash rate of 30 flashes per minute. Per the IALA guidance, navigation lighting will have the following characteristics: corner structures with flashing yellow lights with a visible range of 5 NM (moderate intensity) and a special mark characteristic (special flash pattern) and external border towers with flashing yellow lights with a nominal range of 2 NM (low intensity). Significant peripheral structures would be up to 3 NM apart, and the border/periphery lighted structures would be up to 2 NM apart. All other towers could have flashing yellow lights visible for 2 NM.

Additionally, BOEM anticipates that any additional work lights on support vessels or Project structures will be hooded downward, directed when possible, to reduce illumination of adjacent waters and upward illumination, and will be used only when required to complete a project task (Sunrise Wind 2022i).

The SRWF would introduce stationary artificial light sources to the Project Area. Orr et al. (2013) summarized available research on potential operational lighting effects to marine mammals from offshore windenergy facilities. Orr et al. (2013) concluded that the operational lighting effects to marine mammal distribution, behavior, and habitat use were negligible if recommended design and operating practices are implemented. Lighting is expected to have **insignificant** impacts and **may affect, but is not likely to adversely affect** marine mammals.

Lights would be required on vessels and heavy equipment during construction. Most scientific studies on lighting effects on sea turtles were conducted at nesting sites, which do not occur in the SRWF and SRWEC. Gless et al. (2008) reported that previous studies showed that loggerhead turtles were attracted to lights from longline fishing vessels. Gless et al. (2008) conducted a laboratory study to see if juvenile leatherbacks responded to lights in the same way as loggerheads. Their study showed that leatherbacks either failed to orient or oriented at an angle away from the lights and concluded that there is no convincing evidence that marine turtles are attracted to vessel lights. Limpus (2006) indicates that navigation/anchor lights on top of vessel masts are not impactful but that bright deck lights should be shielded, if possible, to reduce impacts to sea turtles. Project EPMs (see Table H-1 in Appendix H of the Sunrise Wind Draft EIS (BOEM 2022) include construction vessel light shielding and operational restrictions to limit light use to required periods and minimize artificial lighting effects on the environment. Considering the EPMs and the fact that construction vessel activity is unlikely to measurably alter baseline vessel light levels, construction lighting effects on sea turtles would be negligible.

The SRWF would include a variety of operational lighting, including navigational lighting for mariners, obstruction lighting for aviators, and vessel/work lighting for maintenance and operations. Orr et al. (2013) indicate that lights on wind generators flash intermittently for navigation or safety purposes and do not present a continuous light source. Limpus (2006) suggests that intermittent flashing lights with a very short “on” pulse and long “off” interval are non-disruptive to marine turtle behavior, irrespective of the color. Limpus (2006) also indicates that navigation/anchor lights on top of vessel masts are unlikely to adversely affect sea turtles but that bright deck lights should be shielded, if possible, to reduce impacts to sea turtles.

Sea turtles’ typical behavior of remaining predominantly submerged would additionally limit the exposure of individuals to operational lighting. Operational lighting would be limited to the minimum required by regulation and for safety (see Table H-1 in Appendix H of the 2022 Sunrise Wind EIS), further minimizing the potential for exposure. Based on the available information, it is expected that the impact of operational lighting on sea turtles would be **insignificant**. Therefore, lighting from the Proposed Action **may affect, but is not likely to adversely affect** sea turtles.

Any artificial lighting from construction activities would be attributed to deck lighting and navigation purposes of vessels from dusk to dawn. Vessels would be required to comply with guidance from BOEM to minimize or reduce lighting that affects the aquatic environment. Finfish impacts due to artificial light are highly species dependent and can either cause attraction or avoidance (Orr et al. 2013). Most impacts are associated with more permanent light sources associated with nearshore or overwater permanent structures; however, Atlantic sturgeon is a demersal species, and are unlikely to encounter the minimal lighting used during construction and decommissioning. Any lighting effects on Atlantic sturgeon during construction and decommissioning activities would be minimal, temporary in nature and have **insignificant** impacts. Lighting from the Proposed Action **may affect, but is not likely to adversely affect** Atlantic sturgeon.

4.6.7 Operation of Offshore Converter Station – O&M

4.6.7.1 Water Withdrawal/Risk of Impingement and/or Entrainment

Seawater cooling would be needed for the OCS–DC (Section 3.3.6.1, COP; Sunrise Wind 2022i). During operation, the OCS–DC would require continuous cooling water withdrawals and subsequent discharge of heated effluent back to the receiving waters. The maximum DIF and discharge volume is 8.1 MGD with AIF and discharge volumes that are dependent on ambient source water temperature and facility output. Preliminary hydrodynamic modeling indicates that there would be some highly localized increases in water temperature in the immediate vicinity of the discharge location of the OCS–DC. The design, configuration, and operation of the CWIS for the OCS–DC would be permitted as part of an individual NPDES permit and additional details would be included in the permit application submitted to the EPA. This would include final results of the hydrodynamic modeling.

The OCS–DC would include three openings for intake pipes located approximately 30 ft (10 m) above the pre-installation seafloor grade. The water depth of the intake pipe openings was selected to minimize the potential of biofouling and entrainment of ichthyoplankton and to take advantage of the cooler water temperatures found at depth to maximize cooling potential of water withdrawn. The design intake velocity at the intake screens is <0.5 ft/s (<15.25 cm/s). This intake velocity estimate is below the threshold required for new facilities defined at 40 CFR § 125.84I and is therefore protective against the impingement of juvenile and adult life stages of finfish. Therefore, it is anticipated that only egg and larval life stages of all species are at risk of entrainment.

The three SWLPs would pump water Into a single manifold that leads into a coarse filtering element designed to remove suspended particles larger than 500 microns. The filtered cooling water would then be exposed to heat exchange equipment and ultimately discharged to the receiving water through a dump caisson. No chemicals or anti-fouling treatments will be added to the cooling water. The dump caisson is a single vertical pipe whose terminus is located 40 ft (12 m) below MSL, and approximately 124 ft (38 m) above the seafloor. The maximum anticipated discharge temperature is expected to be 90°F (32°C). The thermal plume was modeled to show the area where adjacent waters would experience a DT of 1°C. The 40-ft (12-m) MSL discharge depth and single discharge point had the largest plume area 3.1 hours after slack tide with an area of 731 ft^2 (66.9 m^2) and the smallest plume size of 415 ft^2 (38.6 m^2) after slack in the fall.

Because of the included intake screens and relatively low intake velocities, marine mammals, sea turtles, and Atlantic sturgeon are not expected to be at risk for entrainment. Further, none of these species have planktonic or juvenile life history stages that are expected to occur in the area and be at risk of entrainment. Due to the extremely localized nature of temperature effects from cooling water discharge, the potential for impacts to ESA-listed species will be **insignificant**. Because ESA-listed species at the sizes and life stages that may be present in the Action Area are not expected to be at risk for entrainment, we believe that this effect is extremely unlikely to occur and **discountable**. Therefore, the operation of the cooling water system for the OCS–DC **may affect, but is not likely to adversely affect** ESA-listed species.

4.6.7.2 Impacts to Prey

To analyze potential prey impacts that may be affected by OCS–DC operations, one representative species of zooplankton was considered. *Calanus finmarchicus* is a heavy-bodied, planktonic copepod that is an important prey species for several organisms in the region, including the North Atlantic right whale. Although additional species of zooplankton within the vicinity of the OCS–DC may also be susceptible to entrainment, C*. finmarchicus* was selected as representative due to its trophic importance in the ecosystem. Using the approach described in COP Appendix N2 (Sunrise Wind 2022i), the entrainment of *C. finmarchicus* from the National Centers for Environmental Information density data was estimated to be 1.1 billion organisms annually. For context, assuming an even distribution of this species and an average depth of 148 ft (45 m), the total abundance of *C. Finmarchicus* within Lease Area OCS–A 0487 (109,252 ac) would be close to 2 trillion, and the annual entrainment losses would represent less than 0.1 percent of the local population for this zooplankton species.

It is important to note that these potential estimates assume 100 percent mortality of entrained organisms. There is potential that entrained individuals would survive passage through the CWIS due to short residence time in the system and a maximum water temperature exposure of only 90°F (32°C). Entrainment survival studies at existing power plants do not include directly comparable facilities or environments, but Review of Entrainment Survival Studies: 1970–2000 (EPRI 2020) identifies 91.4°F (33°C) as an upper threshold discharge temperature for many organisms to survive entrainment in existing power plants located along the Hudson River in New York. These potential mechanisms for entrainment survival (i.e., assuming less than 100% mortality) have not yet been applied to this analysis but could be considered when evaluating overall biological impacts of the OCS–DC operation.

Because the total entrained portion of the population of prey is less than 0.1 percent, and survival rates are likely higher than the assumed 100 percent mortality associated with entrainment in the cooling water system, the proportion of prey base that may be affected by the operation of the cooling water system is **insignificant**, and therefore **may affect, but is not likely to adversely affect** ESA-listed species.

4.7 AIR EMISSIONS

Once the Sunrise Wind Project is operational, the WTGs, OCS–DC, and offshore and onshore cable corridors would not generate any measurable air pollutant emissions; however, vessels and equipment used in the construction and installation, O&M, and decommissioning phases of the Project would generate emissions that could affect air quality within the marine component of the Action Area. Most emissions would occur during Project construction within and near the SRWF and SRWEC route and would be temporary in duration. Additional emissions related to the Project could also occur at nearby ports used to transport material and personnel to and from the Project site.

To satisfy the requirements of 40 CFR Part 55, the Project will obtain an OCS Air Permit from the USEPA for Project-related emissions occurring within 25 mi of the center of the SRWF. The OCS Air Permit/PSD/NNSR emissions include emissions from OCS sources, vessels meeting the definition of OCS Source (40 CFR § 55.2), and vessels traveling to and from the Project when within 25 mi of the SRWFs centroid (Sunrise Wind 2021b). Sunrise Wind prepared an assessment of project emissions to support the application for this permit, and related air quality permits for state environmental protection agencies for construction and installation and operations and maintenance (Sunrise Wind 2021b).

At this time, there is no information on the effects of air quality on listed marine mammal and sea turtle species that may occur in the marine component of the Action Area. Marine mammal and sea turtle exposures to air pollutant emissions during Project construction and installation and O&M are anticipated to be temporary and short-term in duration; however, the OCS air quality permit is expected to include conditions designed to ensure that offshore air quality does not significantly deteriorate from baseline levels. Given the fact that vessel exhausts are located high above the water surface, and most vessel activity will occur in the open ocean where exhaust will be readily dispersed by steady winds, the likelihood of individual animals being repeatedly exposed to high concentrations of airborne pollutants from Project vessels and equipment is extremely low, and changes in concentration at the water surface level are expected to be so small that they cannot be meaningfully measured. Given the types of activities and vessels needed for construction and installation and decommissioning (e.g., driving and removing piles, and laying and removing cable) are similar, it is assumed the effects to air quality from decommissioning are similar to those of construction and installation, such that the air quality effects from the Proposed Action as a whole are still likely to be so small that they cannot be meaningfully measured.

On this basis, it is reasonable to conclude that any effects to listed marine mammals and sea turtles from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are insignificant and air emissions may affect, but are not likely to adversely affect marine mammals or sea turtles. ESA-listed fish species would not be exposed to airborne emissions, therefore this IPF would have no effect on Atlantic sturgeon Port Modifications (e.g., Operations and Maintenance facilities).

No port modifications are proposed as part of this action; however, ports used during this project may incur repairs, additional maintenance activities, or undertake expansions in response to use by project vessels.

4.8 INDIRECT EFFECTS

4.8.1 Potential Shifts or Displacement of Ocean Users (Vessel Traffic, Recreational and Commercial Fishing Activity) – C, O&M

Passenger vessels as well as O&M related vessels may increase if the proposed Project is operational as the WTGs may increase public interest and the presence of recreational boaters in the area. Within the SRWF, potential impacts to marine mammals during O&M include direct effects from vessel strike and behavioral disturbance, and indirect effects from increased fishing vessel presence. As potential effects of vessel traffic on ESA-listed species is a region-wide concern, BOEM is currently evaluating risk to whales from offshore vessel activities that support wind development. Results of this study are expected to contribute to existing knowledge and to inform decision-making on potential mitigation needs for vessel risks to whales and sea turtles in the U.S. North, Mid-, and South Atlantic WEAs.

Overall, as discussed in **Section 4.3**, increased vessel traffic from O&M activities and potentially increased commercial and recreational fishing activity may result in vessel strikes to marine mammals and sea turtles resulting in injury or mortality due to rare collisions with vessels.

Indirectly, there may be an increased number of commercial and recreational fishing vessels that operate around the SRWF, which could increase the occurrence of trash and debris from these vessels being released in the SRWF. This could increase the potential entanglement risk from netted fishing gear, longlines, ropes, traps, or buoy lines. Although unlikely, there would be potential for entanglement or ingestion of line by marine mammals in the vicinity. Adverse impacts incurred from increased fishing activity in the SRWF are not anticipated, but in the event that a line or cable is lost, it could then present a higher risk to species entanglement including for the North Atlantic right whale. While such entanglements have the potential for a prolonged impact on the individual and may result in mortality, O&M of the SRWF is not expected to directly increase this risk. Therefore, Project impacts from trash and debris during O&M would be insignificant.

Indirectly, there may be an increased number of commercial and recreational fishing vessels that operate around the SRWF, which could increase the occurrence of trash and debris from these vessels being released in the SRWF. This could also increase the potential entanglement risk from netted fishing gear, longlines, ropes, traps, or buoy lines. Although unlikely, there would be potential for entanglement or ingestion of line by sea turtles in the vicinity. Adverse impacts incurred from increased fishing activity in the SRWF are not anticipated, but in the event that a line or cable is lost, it could then present a higher risk of sea turtle entanglement. While such entanglements have the potential for a prolonged impact on the individual and may result in mortality, O&M of the SRWF is not expected to directly increase this risk. Therefore, the proposed project impacts from trash and debris during O&M would be **insignificant** and **may affect, but is not likely to adversely affect** ESA-listed species of sturgeon, sea turtles, or marine mammals.

4.9 Unexpected/Unanticipated Events

4.9.1 Vessel Collision/Allision with Foundation – O&M

Shipping traffic is increasing worldwide, as is the development of offshore wind energy. A collision between a vessel and a WTG or the OCS–DC could result in failure or destruction of the structure with the potential for release of chemicals and debris. Additionally, the vessel involved in the collision could be damaged or destroyed, also posing a risk of release of contaminants and debris that could pose a risk to ESA-listed species; however, there are no documented collisions between vessels and structures associated with offshore wind farms, and these events are anticipated to be extremely rare. Based on this, impacts to ESA-listed species are extremely unlikely to occur and **discountable**. Therefore, vessel collision with foundations **may affect, but is not likely to adversely affect** ESA-listed species of sturgeon, sea turtles, or marine mammals.

4.9.2 Failure of Wind Turbine Generators due to Weather Event – O&M

In rare cases, WTGs experience failure due to mechanical issues or weather events. WTGs are designed with safeguards to reduce the potential for failures related to wind events; however, occasional failures do occur. In the event of a catastrophic failure, turbine blades or other components of the structure come apart. This poses a potential risk of injury from flying debris; however, the area of impact is extremely small relative to available habitat, and injury to an ESA-listed species from flying debris is extremely unlikely to occur and **discountable** and therefore, **may affect, but is not likely to adversely affect** ESA-listed species of sturgeon, sea turtles, or marine mammals. Catastrophic failure of a WTG may also result in the release of contaminants, which is considered in the next section.

4.9.3 Oil Spill/Chemical Release – P, C, O&M, D

Accidental discharges and releases represent a risk factor to ESA-listed species because marine mammals could potentially ingest or inhale contaminants. ESA-listed species exposure to aquatic contaminants or inhalation of fumes from oil spills can result in mortality or sublethal effects on the individual fitness, including adrenal effects, hematological effects, liver effects, lung disease, poor body condition, skin lesions, and several other health affects attributed to oil exposure (Mohr et al. 2008; Sullivan et al. 2019; Takeshita et al. 2017); however, catastrophic failure of wind turbines is rare, and failure resulting in the release of contaminants is even more rare. The maintenance for WTGs is expected to further reduce the risk of accidental spills to such low levels that risk of any spill affecting a listed species is considered discountable. In the unexpected event of such a failure, the applicant will implement their spill response plan to contain the spill and mitigate any potential impacts. Based on the above analysis, impacts to ESA-listed impacts from contaminant releases due to unexpected events is **discountable** and therefore, **may affect, but is not likely to adversely affect** ESA-listed species.

5.0 CONCLUSION

Based on an analysis of potential direct and indirect effects, a determination for each species and designated critical habitat is provided. One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the Project:

- *No effect* – the determination that the proposed Project would have no impacts, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the proposed Project and its environmental consequences.
- *May affect, not likely to adversely affect* – the determination that all the effects of the proposed Project would be discountable, insignificant, or completely beneficial on the species and/or its designated critical habitat. Discountable effects are those that are extremely unlikely to occur. Insignificant effects relate to the size of the impact and would not reach the scale where take of a listed species occurs. Beneficial effects are contemporaneous positive effects without any adverse effects on the species. Based on best judgment, a person would not (1) be able to meaningfully measure, detect, or evaluate insignificant effects, or (2) expect discountable effects to occur.

- *May affect, likely to adversely affect* – the determination that the proposed Project may result in any adverse effect on a species or its designated critical habitat. In the event that the proposed Project would have beneficial effects on listed species or critical habitat, but is also likely to cause some adverse effects, then the proposed Project may affect, and is likely to adversely affect, the listed species.
- BOEM has concluded that the construction, operation, and future decommissioning of the proposed SRWF and SRWEC Proposed Action **may affect, and is likely to adversely affect** fin whales, north Atlantic right whales, blue whales, sei whales, sperm whales, the North and South Atlantic DPSs of green sea turtles, Kemp's ridley sea turtles, leatherback sea turtles, the Northwest Atlantic DPS of loggerhead sea turtles, and Atlantic sturgeon. The supporting rationale for these effect determinations are summarized by species and described further below. No designated critical habitat for NMFS ESA-listed species occurs in the Action Area; therefore, the Proposed Action would have no effect on critical habitat.

Based on the analysis in this assessment, the construction, O&M, and eventual decommissioning of the Proposed Action **may affect, and is likely to adversely affect** NMFS ESA-listed species known or potentially occurring in the Action Area (**Table 69**). This conclusion is based on the following rationale:

- The Proposed Action **may affect** ESA-listed fin whale, blue whale, sei whale, North Atlantic right whale, sperm whale, Kemp's ridley sea turtle, leatherback sea turtle, Northwest Atlantic DPS of loggerhead sea turtle, and the South Atlantic, Carolina, Chesapeake Bay, New York Bight, and Gulf of Maine DPSs of Atlantic sturgeon because these species are known to occur in the Action Area and would be exposed to the effects of Proposed Action construction, operation, and decommissioning.
- The Proposed Action is **likely to adversely affect** fin whale, North Atlantic right whale, blue whale, sei whale, and sperm whale <u>because of</u> <u>the following</u>:
  - Individual animals could occur in the Action Area during construction-related pile driving (May to November).
  - Impact pile driving would generate underwater noise above LFC injury and behavioral-level thresholds up to 3.8 mi (6.1 km) and 4.3 mi (6.9 km) from the source, respectively.
  - Vibratory pile driving would produce underwater noise above the LFC injury and behavioral-level thresholds up to 0.1 mi (0.2 km) and 6.1 mi (9.8 km) from the source, respectively.
  - PSO monitoring may not prevent incidental exposure of individual whales to pile driving noise above injury and behavioral thresholds.
- The Proposed Action is **not likely to adversely affect** green sea turtle <u>because of the following</u>
  - The likelihood of occurrence in the Action Area during construction and exposure to construction-related impacts on the environment is extremely unlikely to occur.
  - The operational effects of the SRWF on green sea turtles would be insignificant and extremely unlikely to occur.
  - The operational effects of the SRWEC on green sea turtles would be insignificant.
- The Proposed Action is **likely to adversely affect** North Atlantic green, South Atlantic green, Kemp's ridley, leatherback, and Northwest Atlantic loggerhead sea turtles <u>because of the following</u>:
  - These species are likely to occur in the Action Area when construction-related pile driving occurs.
    - Impact pile driving would produce underwater noise above sea turtle injury and behavioral-level thresholds up to 3.47 mi (cumulative sound exposure) and 1.13 mi from the source, respectively.
    - PSO monitoring may not be able to prevent incidental exposure of individual turtles to pile driving noise above injury and behavioral thresholds.
  - Increased vessel traffic from construction, O&M, decommissioning activities, and commercial and recreational fisheries poses additional risk of vessel strike for these species.

- Trawl surveys may result in small numbers of these species being captured, experience increased stress, with the potential for injury and, in rare cases, mortality.
- The use of hopper-type dredges for sand wave leveling may lethally entrain these species.

- The Proposed Action is **likely to adversely affect** the South Atlantic, Carolina, Chesapeake Bay, New York Bight, and Gulf of Maine DPSs of Atlantic sturgeon because of the following:
  - Trawl surveys may result in small numbers of Atlantic sturgeon that are captured and may experience minor injury; however, no mortality is expected.
  - Individual animals are likely to be present within the potential injury radius for UXO events.
  - The use of hopper-type dredges for sand wave leveling may lethally entrain these species.

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

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

Table 69. Bureau of Ocean Energy Management conclusions by stressor and species.

Stressor	Project Development Phase	Potential Effect	ESA-Listed Marine Mammals	ESA-Listed Sea Turtles	Atlantic Sturgeon
Impact Pile-Driving	C	PTS or Injury	LAA for fin whales and North Atlantic right whales NLAA for others	LAA for Loggerhead NLAA for others	NLAA
Impact Pile-Driving	C	TTS/BD	LAA	NLAA for Green Sea Turtle, LAA for others	NLAA
Vibratory Pile-Driving	C,D	PTS or Injury	NLAA	NLAA	NLAA
Vibratory Pile-Driving	C,D	TTS/BD	LAA for fin whales and North Atlantic Right Whales, NLAA for blue, sei, and sperm whales	NLAA	NLAA
HRG Surveys	Pre-C, C, O&M	PTS or Injury	NLAA	NLAA	NLAA
HRG Surveys	Pre-C, C, O&M	BD	LAA	NLAA	NLAA
Vessel Noise		TTS/BD	NLAA	NLAA	NLAA
WTG Noise		TTS/BD	NLAA	NLAA	NLAA

Stressor	Project Development Phase	Potential Effect	ESA-Listed Marine Mammals	ESA-Listed Sea Turtles	Atlantic Sturgeon
UXO	Pre-C, C	PTS or Injury	NLAA	NLAA	NLAA
UXO	Pre-C, C	TTS/BD	LAA for fin and North Atlantic right whales, NLAA for blue, sei, and sperm whales	LAA for Loggerhead NLAA for others	NLAA
Aircraft Noise	pre-C, C, O&M, D	BD	NLAA	NLAA	NLAA
Cable Laying or Trenching Noise	C	BD	NLAA	NLAA	NLAA
Dredging Noise	C	BD	NLAA	NLAA	NLAA
Habitat Disturbance	C, O&M, D	Foraging/Prey availability	NLAA	NLAA	NLAA
Secondary Entanglement Risk from Increased Recreational Fishing	O&M	Secondary entanglement	NLAA	LAA for Loggerhead and Leatherback, NLAA for Kemp's and Green	NLAA
Turbidity	C, D	Foraging/Prey availability	NLAA	NLAA	NLAA
Vessel Traffic	pre-C, C, O&M, D	Injury, mortality	NLAA	LAA for loggerhead and Kemp's ridley, NLAA for Green and Leatherback	NLAA
Monitoring Surveys	Pre-C, C, O&M	Injury, mortality	NLAA	LAA for loggerhead and Kemp's ridley, NLAA for Green and Leatherback	LAA
EMF	O&M	Effects on orientation/ navigation	NLAA	NLAA	NLAA
Air Emissions	C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Sea Floor Preparation	C	Injury, mortality	NLAA	LAA for Loggerhead and Leatherback, NLAA for Kemp's and Green	LAA
Dredging	C	Injury, mortality	NLAA	NLAA	NLAA
Lighting/Marking	C, O&M, D	Photoperiod disruption/ Attraction	NLAA	NLAA	NLAA
Unanticipated Events	C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Oil Spills/ Chemical Release	pre-C, C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Overall Effects Determination	pre-C, C, O&M, D	PTS/TTS/BD, Injury/ Mortality	LAA	NLAA for Green Sea Turtle, LAA for others	LAA

Notes:

BD = behavioral disturbance; C = construction; D = decommissioning; EMF = electric and magnetic field; ESA = Endangered Species Act; HRG = high-resolution geophysical; LAA = likely to adversely affect; NLAA = not likely to adversely affect; O&M = operations and maintenance; PTS = permanent threshold shift; TTS = temporary threshold shift; WTG = wind turbine generator; UXO = unexploded ordnance

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