New England Wind Project Biological Assessment

December 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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Acronyms and Abbreviations

°C	degrees Celsius
AC	alternating current
AIS	automatic identification system
AMAPPS	Atlantic Marine Assessment Program for Protected Species
applicant	Park City Wind, LLC
BA	Biological Assessment
BACI	before-after-control-impact
BAG	before-after-gradient
BHMP	Benthic Habitat Monitoring Plan
BIA	biologically important area
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
Call	Call for Information and Nominations
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
CWA	Clean Water Act
dB	decibel
dB re 1 µPa	decibels referenced to 1 micropascal
dB re 1 μPa^2	decibels referenced to 1 micropascal squared
dB re 1 μPa^2 s	decibels referenced to 1 micropascal squared second
DMA	dynamic management area
DP	dynamic positioning
DPS	distinct population segment
EA	environmental assessment
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EMF	electromagnetic fields
$ER_{95\%}$	95th percentile exposure range
ESA	Endangered Species Act
ESP	electrical service platform
FHWG	Fisheries Hydroacoustic Working Group
Fed. Reg.	Federal Register
ft	foot
GARFO	Greater Atlantic Regional Fisheries Office
HFC	high-frequency cetacean
HRG	high-resolution geophysical
Hz	hertz
ITA	incidental take authorization
IUCN	International Union for Conservation of Nature
JASMINE	JASCO Applied Sciences Animal Simulation Model Including Noise Exposure
kHz	kilohertz
kJ	kilojoule
km	kilometer
km^2	square kilometer
LAA	likely to adversely affect
LFC	low-frequency cetacean
Lpk	peak sound pressure level
m	meter
m^2	square meter
mi	mile
MFC	mid-frequency cetacean
mG	milligauss

MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
MW	megawatt
NA	not applicable
NARW	North Atlantic right whale
NLAA	not likely to adversely affect
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OECC	offshore export cable corridor
OECR	onshore export cable route
PAM	passive acoustic monitoring
PATON	private aids to navigation
PDC	Project Design Criteria
PDE	Project design envelope
PPW	phocid pinniped in water
Proposed Action	New England Wind Project
proposed Project	New England Wind Project
PSO	protected species observer
PTS	permanent threshold shift
RI/MA Lease Areas	Rhode Island and Massachusetts Lease Areas
RSLL	received sound level limit
ROW	right(s)-of-way
SAP	site assessment plan
SCV	South Coast Variant
SEL	sound exposure level
SEL_{24h}	sound exposure level over 24 hours
SMA	seasonal management area
SPL	root-mean-square sound pressure level
SPUE	sightings per unit effort
SWDA	Southern Wind Development Area
TSHD	trailing suction hopper dredge
TSS	total suspended solids
TTS	temporary threshold shift
µPa	micropascal
U.S. Navy	U.S. Department of the Navy
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
Vineyard Wind 1	Vineyard Wind 1 Project
WEA	wind energy area
WTG	wind turbine generator

1 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 (ROW) on the Outer Continental Shelf (OCS) for the purpose of renewable energy development (43 U.S. Code [USC] § 1337(p)(1)(C)). The Secretary of the Interior 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 in the Code of Federal Regulations, Title 30, Section 585 (30 CFR Part 585).

This Biological Assessment (BA) has been prepared pursuant to Section 7 of the Endangered Species Act (ESA) to evaluate potential effects of the New England Wind Project (proposed Project or Proposed Action) described herein on ESA-listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) (50 CFR § 402.14). 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).

This BA provides a comprehensive description of the Proposed Action, defines the Action Area, describes those species potentially affected by the Proposed Action, and provides an analysis and determination of how the Proposed Action may affect listed species, their habitats, or both. The activities being considered include approving the Construction and Operations Plan (COP) for the construction and installation (construction), operations and maintenance (operations), and conceptual decommissioning (decommissioning) of the proposed Project, which is an offshore wind energy facility on the OCS offshore Massachusetts. Effects on ESA-listed species under the oversight of the U.S. Fish and Wildlife Service (USFWS) are analyzed under a separate BA for consultation.

As detailed in the COP (Epsilon 2022), the Proposed Action would include construction, operations, and decommissioning of an at least 2,036 megawatt (MW) and up to 2,600 MW offshore wind energy facility, as well as associated submarine and upland cable interconnecting the wind facility to cable landfall sites in the Town of Barnstable on the southern shore of Cape Cod. The proposed Project would occupy all of BOEM's Renewable Energy Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501[1], collectively hereafter referenced as the Southern Wind Development Area (SWDA). The proposed Project would be developed in two phases with a maximum of 130 wind turbine generator (WTG) and electrical service platform (ESP) positions. Two positions may potentially have collocated ESPs (i.e., two foundations installed at one grid position), resulting in 132 foundations. Each WTG would have a minimum capacity of 16 MW. Four or five offshore export cables would transmit electricity generated by the WTGs to onshore transmission systems. Phase 1, also known as Park City Wind, would be developed immediately southwest of the Vineyard Wind 1 Project (Vineyard Wind 1) and include up to 62 WTGs and 1 or 2 ESPs. Phase 2, also known as Commonwealth Wind, would be immediately southwest of

[1] The developer of the Vineyard Wind 1 Project (Vineyard Wind 1, LLC) will assign spare or extra positions in the southwestern portion of OCS-A 0501 to Lease Area OCS-A 0534 for the New England Wind Project if those positions are not developed as part of the Vineyard Wind 1 Project.

Phase 1 and occupy the remainder of the SWDA. The final size of the SWDA depends on the construction of OCS-A 0501 (Figure 1-1).

This BA considers the potential effects of the Proposed Action on ESA-listed marine mammals, sea turtles, marine fish, and designated critical habitat in the Action Area. This BA describes the Proposed Action (Section 1.4); describes avoidance, minimization, and mitigation measures applicable to all phases of the Proposed Action (Section 1.4.5); defines the Action Area (Section 1.3); describes the federally listed species potentially affected by the Proposed Action (Section 2.4); and provides an analysis and determination of how the Proposed Action may affect listed species or their habitats (Section 3). The ESA Section 7 effects analysis determinations are summarized in Section 4.

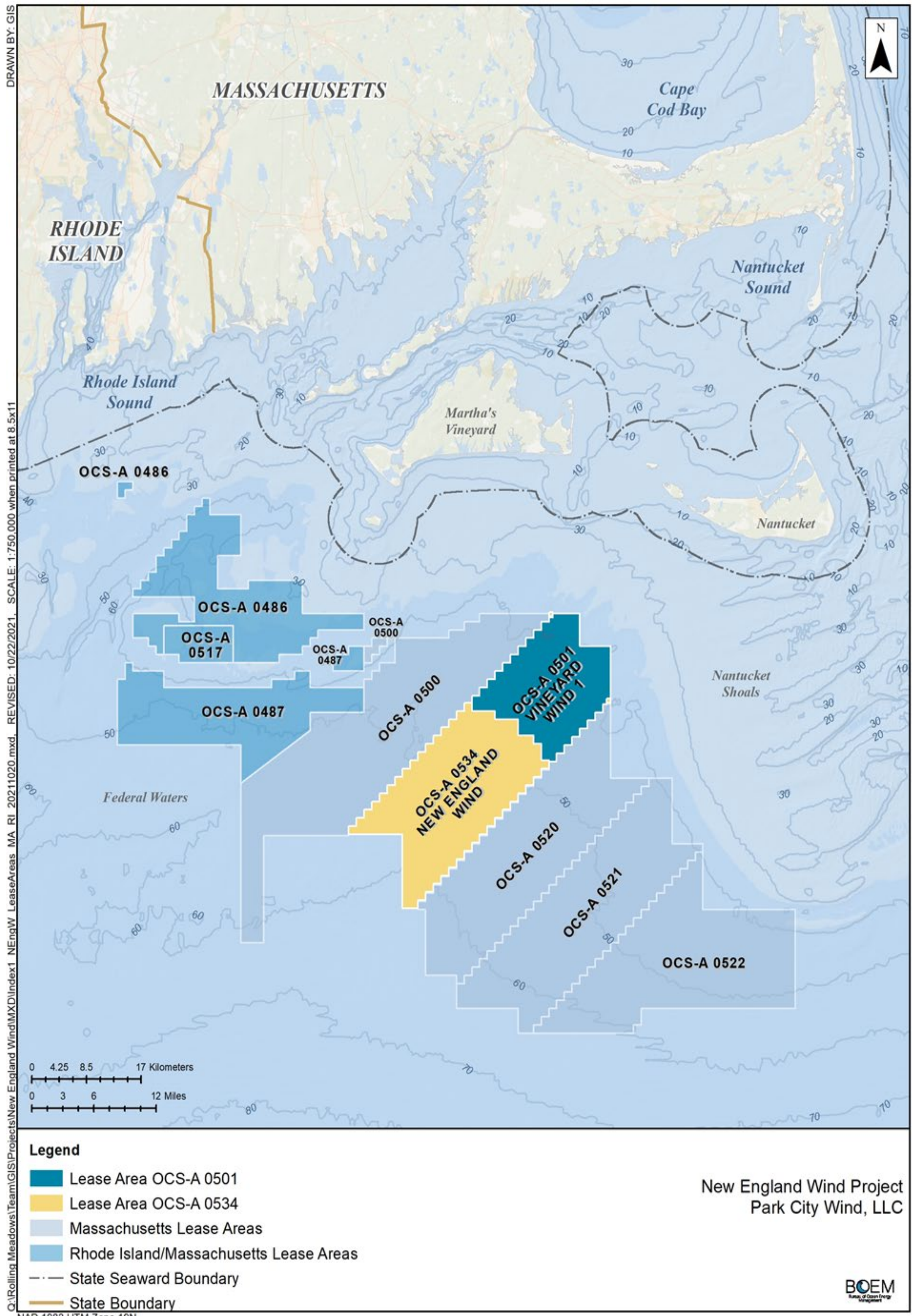


Figure 1-1: Southern Wind Development Area, which includes all of Renewable Energy Lease Area OCS-A 0534 and a Portion of Lease Area OCS-A 0501, Relative to Rhode Island and Massachusetts Lease Areas

1.1 Renewable Energy Process

Site assessment activities can be conducted on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's site assessment plan (SAP) (30 CFR § 585.613). As a condition of SAP approval, meteorological towers will be required to have visibility sensors to collect data on climatic conditions above and beyond wind speed, direction, and other associated metrics generally collected at meteorological towers. These data will assist BOEM and the USFWS with evaluating the impacts of future offshore wind facilities on Threatened and Endangered birds, migratory birds, and bats.

The fourth and final phase (Phase 4) of the process is the submission of a COP, a detailed plan for the construction and operations of a wind energy farm on the SWDA (30 CFR §§ 585.620–585.638). BOEM's approval of a COP is a precondition of 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 SWDA and offshore export cable corridor (OECC).

Phases 1 through 3 have already been completed for the SWDA and offshore export cables; the Proposed Action addressed in this consultation represents Phase 4 for the development.

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 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 (BOEM 2019a).

The Proposed Action addresses Phase 4 of the renewable energy process. The applicant has completed site characterization activities and developed a COP in accordance with BOEM regulations. BOEM is consulting on the proposed approval of the COP for the SWDA and offshore export cables, as well as other permits and approvals from other agencies associated with the approval of the COP. Pursuant to 50 CFR § 402.07, BOEM has accepted designation as the lead federal agency for the purposes of fulfilling interagency consultation under Section 7 of the ESA. The other action agencies are the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (USEPA), the U.S. Coast Guard (USCG), and the NMFS Office of Protected Resources given their role in the issuance of authorizations or permits associated with the Proposed Action.

BOEM began evaluating OCS wind energy offshore Massachusetts in 2009 by establishing an intergovernmental renewable energy task force comprised of elected officials from state, local, and tribal governments and affected federal agency representatives. After extensive consultation with the task force, BOEM removed some areas from further consideration for offshore wind leasing and conducted the following activities concerning planning and leasing:

- In December 2010, BOEM published a Request for Interest in the *Federal Register* (Fed. Reg.) to determine commercial interest in wind energy development in an area offshore Massachusetts (75 Fed. Reg. 82055 [December 29, 2010]). BOEM invited the public to provide information on environmental issues and data for consideration in the Request for Interest area and express interest in offshore wind energy development. BOEM re-opened the comment period in March 2011 in response to requests from the public and the Commonwealth of Massachusetts. BOEM received 260 public comments and 11 indications of interest from ten companies interested in obtaining a commercial lease. Subsequently, BOEM made the planning area 50 percent smaller than the original area in response to comments regarding navigational and commercial fishery concerns.

- In February 2012, BOEM published a Call for Information and Nominations (Call) in the Fed. Reg. to solicit industry interest in acquiring commercial leases for developing wind energy projects in the Call area (77 Fed. Reg. 5820 [February 6, 2012]). In the same month, BOEM published a Notice of Intent to prepare an environmental assessment (EA) for commercial wind leasing and site assessment activities offshore Massachusetts. The comment period for the Call yielded 32 comments and 10 nominations of commercial interest.
- In May 2012, BOEM publicly identified a wind energy area (WEA) offshore Massachusetts, excluding additional areas from commercial leasing addressed in comments from the Call, including an area of high sea duck concentration and an area of high-value fisheries. After conducting an EA, BOEM issued a Finding of No Significant Impact, which concluded that reasonably foreseeable environmental impacts associated with the activities that would likely be performed following lease issuance (e.g., site characterization surveys in the WEA, deployment of meteorological towers or buoys) would not significantly affect the environment. The Revised Massachusetts EA (BOEM 2014) more fully describes the development of the WEA.
- In June 2014, BOEM published a Proposed Sale Notice identifying that 742,974 acres (3,007 square kilometers [km^2]) offshore Massachusetts in federal waters would be available for commercial wind energy leasing.
- In January 2015, BOEM held a competitive lease sale pursuant to 30 CFR § 585.211 for the lease areas within the Massachusetts WEA. Offshore MW LLC (subsequently renamed to Vineyard Wind, LLC) won the competition for Lease Area OCS-A 0501 in the auction (Figure 1-1).
- On June 28, 2021, BOEM approved a partial assignment of the northernmost 65,296 acres (264 km^2) of Lease OCS-A 0501 from Vineyard Wind, LLC to Vineyard Wind 1, LLC. The assigned lease under Vineyard Wind 1, LLC continues to be designated Lease Area OCS-A 0501. Vineyard Wind, LLC retained the remaining 101,590 acres (411 km^2), which are designated Lease Area OCS-A 0534 for the Proposed Action. Except for the description of the leased area, which now reflects the two different lease areas, the terms, conditions, and stipulations of the two leases, including the lease effective date of April 1, 2015, remain the same.
- On December 14, 2021, BOEM approved the assignment of Lease Area OCS-A 0534 from Vineyard Wind, LLC to Park City Wind, LLC, a wholly owned subsidiary of Avangrid Renewables, LLC. The applicant, Park City Wind, LLC, has the exclusive right to submit a COP for activities within Lease Area OCS-A 0534. The majority of the Proposed Action would be constructed within Lease OCS-A 0534, although the portion of Lease Area OCS-A 0501 not used for Vineyard Wind 1 could also be used for the Proposed Action, pursuant to an additional (future) lease assignment.
- In July 2020, the applicant submitted an initial COP for the Proposed Action. COP revisions were submitted in December 2021, as well as April and May 2022 (Epsilon 2022). The May 2022 COP is available for viewing at BOEM's proposed Project-specific website[2]. BOEM has deemed the COP sufficient.

Section 7(a)(2) of the ESA of 1973, as amended (16 USC §1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat for those species. When the action of a federal agency may affect a listed species or its critical habitat, that agency is required to consult with either NMFS or the

[2] The Draft COP can be reviewed at https://www.boem.gov/renewable-energy/state-activities/new-england-wind-formerly-vineyard-wind-south.

USFWS, depending upon the jurisdiction of the services. This BA serves as the consultation document with NMFS for proposed activities considered in the COP that could affect listed species.

1.1.1 Bureau of Safety and Environmental Enforcement

In 2010, the creation of BOEM and BSEE focused on dividing regulatory responsibility for the offshore mineral development program and left regulatory responsibility for renewable energy entirely with BOEM. However, the Secretarial Order that created the two bureaus envisioned that there would be a future division of administrative responsibility for renewable energy. This division of responsibility for renewable energy would have BOEM continue to oversee the identification and leasing of offshore areas for renewable energy development and evaluation of proposed development plans, while BSEE's mission is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during construction and operations. The bureaus are working together to implement these changes. BOEM will retain authority to approve, approve with modification, or disapprove any SAPs, while BSEE will review 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 following proposed Project decommissioning and component removal. Under the renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a staged decision-making process.

1.1.2 U.S. Environmental Protection Agency

Section 328(a) of the Clean Air Act (42 USC § 7401 et seq.), as amended by Public Law 101-549 enacted on November 15, 1990, required the USEPA to establish air pollution control requirements for OCS sources subject to the OCSLA for all areas of the OCS, except those located in the Gulf of Mexico west of 87.5 degrees longitude (near the border of Florida and Alabama)[3] to attain and maintain federal and state ambient air quality standards and comply with the provisions of Part C of Title I of the OCSLA.[4] To comply with this statutory mandate, on September 4, 1992, the USEPA promulgated "Outer Continental Shelf Air Regulations" at 40 CFR Part 55 (57 Fed. Reg. 40791 [September 4, 1992]). This regulation also established procedures for implementation and enforcement of air pollution control requirements for OCS sources. 40 CFR § 55.2 states an OCS source means any equipment, activity, or facility, which:

1. Emits or has the potential to emit any air pollutant;
2. Is regulated or authorized under the OCSLA (43 USC § 1331 et seq.); and
3. Is located on the OCS or in or on waters above the OCS.

This definition includes vessels only when they are permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing, or producing resources there from, or physically attached to an OCS facility, in which case only the stationary sources aspects of the vessels will be regulated.

[3] Public Law 112-74, enacted on December 23, 2011, amended § 328(a) to add an additional exception from USEPA regulation for OCS sources "located offshore of the North Slope Borough of the State of Alaska."

[4] Part C of Title I contains the Prevention of Significant Deterioration of Air Quality requirements.

OCS sources, pursuant to this definition, can include wind energy development sources that are authorized under the OCSLA at 43 USC § 1337(p)(1)(C).[5] On April 22, 2009, BOEM announced final regulations for the OCS Renewable Energy Program. These regulations, codified at 30 CFR Part 585, provide a framework for issuing leases, easements, and ROW for OCS activities that support production and transmission of energy from sources other than oil and natural gas. BOEM issues commercial leases and approves COPs to construct, operate, and decommission offshore wind projects. Thus, where these projects emit or will have the potential to emit air pollutants and are located on the OCS or in or on waters above the OCS, the projects will be subject to the 40 CFR Part 55 requirements, including the 40 CFR § 55.6 permitting requirements.

The USEPA may also require, or delegate authority to Massachusetts state agencies, for a National Pollutant Discharge Elimination System (NPDES) General Permit if there is regulated discharge of pollutants into waters of the U.S. NPDES General Permits are issued under Section 402 of the Clean Water Act (CWA; 33 U.S.C. 1342 et seq.) to authorize routine discharges by multiple dischargers. Although the construction and operation of an offshore wind energy project would not likely create an ongoing source of water pollution, specific activities during construction may be considered a regulated discharge.

Permits would be issued no more than 90 days after issuance of the Record of Decision for the Final Environmental Impact Statement (EIS) being prepared for the Proposed Action. The applicant submitted their OCS air permit on October 7, 2022, and it is targeted to be completed by the applicant by February 13, 2023, with permit approval targeted for October 1, 2023. The applicant is still in the process of filing its NPDES permit application.

1.1.3 U.S. Army Corps of Engineers

The USACE has regulatory responsibilities under Section 10 of the Rivers and Harbors Act to approve, permit, or approve and permit any structures, work activities, or both, conducted below the ordinary high water elevation or of affecting navigable waters of the U.S. In tidal waters, this jurisdiction extends landward to the mean high water line. The USACE also has responsibilities under Section 404 of the CWA to regulate the discharge of dredged or fill material within waters of the U.S., prevent water pollution, obtain water discharge permits and water quality certifications, develop risk management plans, and maintain such records. A general condition of a Nationwide Permit for water quality stipulates that where states, authorized tribes, or the USEPA, where applicable, have not previously certified compliance of a Nationwide Permit with CWA Section 401, an individual 401 water quality certification must be obtained or waived (33 CFR § 330.4(c)). The USACE District Engineer, state, or tribe may require additional water quality management measures to ensure that the authorized activity, such as site characterization, does not result in more than minimal degradation to water quality. All proposed discharges of dredged or fill material must be evaluated for compliance with USEPA's guidelines on implementing CWA Section 404 (b)(1) guidelines (40 CFR Part 230). Because this Proposed Action requires an individual USACE permit, the applicant will also be required to obtain an individual CWA Section 401 water quality certification from the Massachusetts Department of Environmental Protection. Work for the Proposed Action that is regulated by the USACE would include construction of up to 130 offshore WTGs and ESPs, scour protection around the base of the WTGs and ESPs, inter-array cables connecting the WTGs to the ESPs, inter-link cables between ESPs, and up to five offshore export cables between the SWDA and Barnstable, Massachusetts. The applicant has not yet submitted a

[5] The Energy Policy Act of 2005 (Public Law Number 109-58) amended the OCSLA to add subsection (p)(1)(C), granting the Secretary of the Interior the authority to issue leases, easements, or ROW on the OCS for activities that "produce or support production, transportation, or transmission of energy from sources other than oil and gas," which includes renewable energy development, including wind energy development. The U.S. Department of the Interior delegated this authority to the Minerals Management Service (now BOEM).

Section 401 water quality certification application to the Massachusetts Department of Environmental Protection. The applicant submitted CWA Section 404/Rivers and Harbors Act Section 10 permit applications for Phases 1 and 2 to the USACE on August 1, 2022, which is currently under review and was published for public notice on December 23, 2022. No effects are proposed on special aquatic sites including non-tidal or tidal wetlands, or mudflats, eelgrass beds, coral reef complexes, etc., as part of the Proposed Action. The final decision is expected to be rendered by October 1, 2023.

1.1.4 U.S. Coast Guard

The USCG administers the permits for private aids to navigation (PATON) located on structures positioned in or near navigable waters of the U.S. PATON and federal aids to navigation, including radar transponders, lights, sound signals, buoys, and lighthouses, are located throughout the Action Area. It is anticipated that USCG approval of additional PATON during construction of the WTGs, ESPs, and along the OECC may be required. These aids serve as a visual reference to support safe maritime navigation. The applicant would establish marine coordination to control vessel movements throughout SWDA, as required. Federal regulations governing PATON are found within 33 CFR Part 66 and address the basic requirements and responsibilities.

1.1.5 National Marine Fisheries Service, Office of Protected Resources

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

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

The applicant submitted a request for a rulemaking and Incidental Take Authorization (ITA) pursuant to Section 101(a)(5) of the MMPA and 50 CFR Part 216 Subpart I to allow for the incidental harassment of marine mammals resulting from impact and vibratory pile setting and foundation drilling during the installation of WTGs and ESPs, potential detonations of unexploded ordnance (UXO), and performance of high-resolution geophysical (HRG) site characterization surveys operating at less than 180 kilohertz (kHz) (JASCO 2022). The applicant is including activities in the ITA request that could cause acoustic disturbance to marine mammals during construction of the proposed Project pursuant to 50 CFR § 216.104. The applicant's application to NMFS Office of Protected Resources for an ITA pursuant to Section 101(A)(5) of the MMPA was considered complete by NMFS on July 20, 2022. NMFS published a Notice of Receipt in the Fed. Reg. on August 22, 2022. The applicant is currently coordinating with NMFS Office of Protected Resources on any additional information necessary to consider the level of impacts and number of takes that may be subject to authorization under the MMPA. The applicant subsequently submitted an addendum to the ITA application to NMFS in January and December 2023 to document updates to the calculated and requested marine mammal takes. The addendum is currently under NMFS review.

1.2 Endangered Species Act Section 7 Consultation History

A similar ESA consultation was previously conducted for the construction, operations, and decommissioning of Vineyard Wind 1 (Lease OCS-A 0501) and the Biological Opinion published by NMFS in 2021 (NMFS 2021a). Lease OCS-A 0501 was originally awarded to Vineyard Wind, LLC on April 1, 2015, which was then split on June 28, 2021, such that the northernmost 65,296 acres (264 km^2) of Lease OCS-A 0501 was assigned to Vineyard Wind 1, LLC and continued to be designated Lease OCS-A 0501, while the remaining 101,590 acres (411 km^2) were designated as Lease OCS-A 0534 for the New England Wind Project. On December 14, 2021, Lease OCS-A 0534 was re-assigned from Vineyard Wind, LLC to Park City Wind LLC who now has exclusive rights to submit a COP for activities within this lease, which are described under the Proposed Action (Section 1.4). The initial version of the COP and Biological Opinion for Vineyard Wind 1 were prepared prior to the split of the lease area, so the activities assessed in that Biological Opinion partially cover the area of interest in this consultation, though current consultation for the New England Wind Project is treated as separate from that previously conducted for Vineyard Wind 1. However, since the Biological Opinion was published, the humpback whale (*Megaptera novaeangliae)* population in the northwestern Atlantic has been de-listed and is, therefore, not carried forward in this consultation (81 Fed. Reg. 62259 [September 8, 2016]).

1.3 Action Area

Under ESA Section 7 consultation regulations (50 CFR § 402.02), the Action Area refers to all areas affected directly and indirectly by the Proposed Action. This includes the area where all consequences to listed species or critical habitat caused by the Proposed Action would occur, including actions that would occur outside the immediate area involved in the action (50 CFR § 402.17). Therefore, the Action Area includes where all proposed Project activities would occur; including the SWDA and OECC; the surrounding areas ensonified by Project noise; all cable routes; the areas where pre- and post-construction surveys may take place; the vessel transit areas between any ports any Project vessel may use and the Project area; the potential routes used by vessels transporting manufactured components from all ports, inclusive of any ports outside the east coast of the United States; and the area inclusive of any proposed Project-related electromagnetic fields (EMF), turbidity and water quality effects, habitat disturbance effects, vessel and survey operations, and other effects associated with the Proposed Action that may affect listed species, critical habitat, or both. The Action Area, as defined, includes vessel transit routes between port locations, including ports outside of Massachusetts, necessary for completion of the Proposed Action. Potential ports located in Massachusetts (Brayton Point, Fall River, New Bedford, Salem, and Vineyard Haven), Rhode Island (Davisville, Providence, and South Quay Terminal), Connecticut (Bridgeport and New London), New York (Arthur Kill Terminal, GMD Shipyard, Greenport Harbor, Homeport Pier, Shoreham, South Brooklyn Marine Terminal, and Capitol Region ports on the Hudson River), New Jersey (Paulsboro Marine Terminal), and/or one or more ports in Atlantic Canada and Europe are considered as part of the Action Area. The exact ports to be used will not be known until final contracts are in place. Foreign ports are only anticipated to be used during construction; all operations vessels are expected to operate out of Bridgeport, Connecticut, and Vineyard Haven, Massachusetts, though other ports identified above in Rhode Island, New York, New Jersey, and Canada may also be used to support operations activities. The number of ports under consideration does not increase the number of vessel trips that are likely to occur but may affect the location and length of the transits. See Section 1.4 for a complete description of activities, including vessel transits, associated with the Proposed Action.

For the purposes of this BA, the Project area is considered the portion of the full Action Area where construction and operations of the Proposed Action would take place. The Project area, therefore, encompasses the SWDA, all inter-array cable routes, and the transmission cable ROW to the onshore cable landing location. Due to the difference in risk to ESA-listed species associated with proposed Project activities within the Project area compared to activities within the Action Area, this portion of the Action Area is treated separately, where applicable, in Section 3.

1.4 Description of the Proposed Action

As detailed in the New England Wind Project Draft EIS (BOEM 2022a), the Proposed Action would allow the applicant to construct, operate, and decommission a wind energy facility of at least 2,036 MW and up to 2,600 MW of electricity within the SWDA. The Proposed Action would be developed in two phases (804 MW as part of Phase 1 and 1,232 MW as part of Phase 2), each with an operational lifespan of approximately 30 years, and would include up to 130 WTGs and ESPs; inter-array and inter-link cables within the SWDA; an OECC through Muskeget Channel; landfall sites in Barnstable, Massachusetts; onshore export cables; and new or upgraded onshore substation sites. Each WTG would have a minimum capacity of 16 MW. The Proposed Action could also include a Western Muskeget Variant for the OECC, which would be the same as the proposed Phase 1 and Phase 2 OECC except for a western deviation through Muskeget Channel (Figure 1-2). The Proposed Action could also include the South Coast Variant (SCV), a separate OECC (instead of or in addition to the Phase 2 OECC) that would link the SWDA to a landfall site, onshore export cable route (OECR), and onshore substation facilities in Bristol County, Massachusetts (Figure 1-2). Further discussion of the Proposed Action components, construction methods, and schedule are provided in the COP (Volume I, Sections 3.0 and 4.0; Epsilon 2022) and summarized in the following subsections. Key components of the Project area are summarized in Table 1-1.

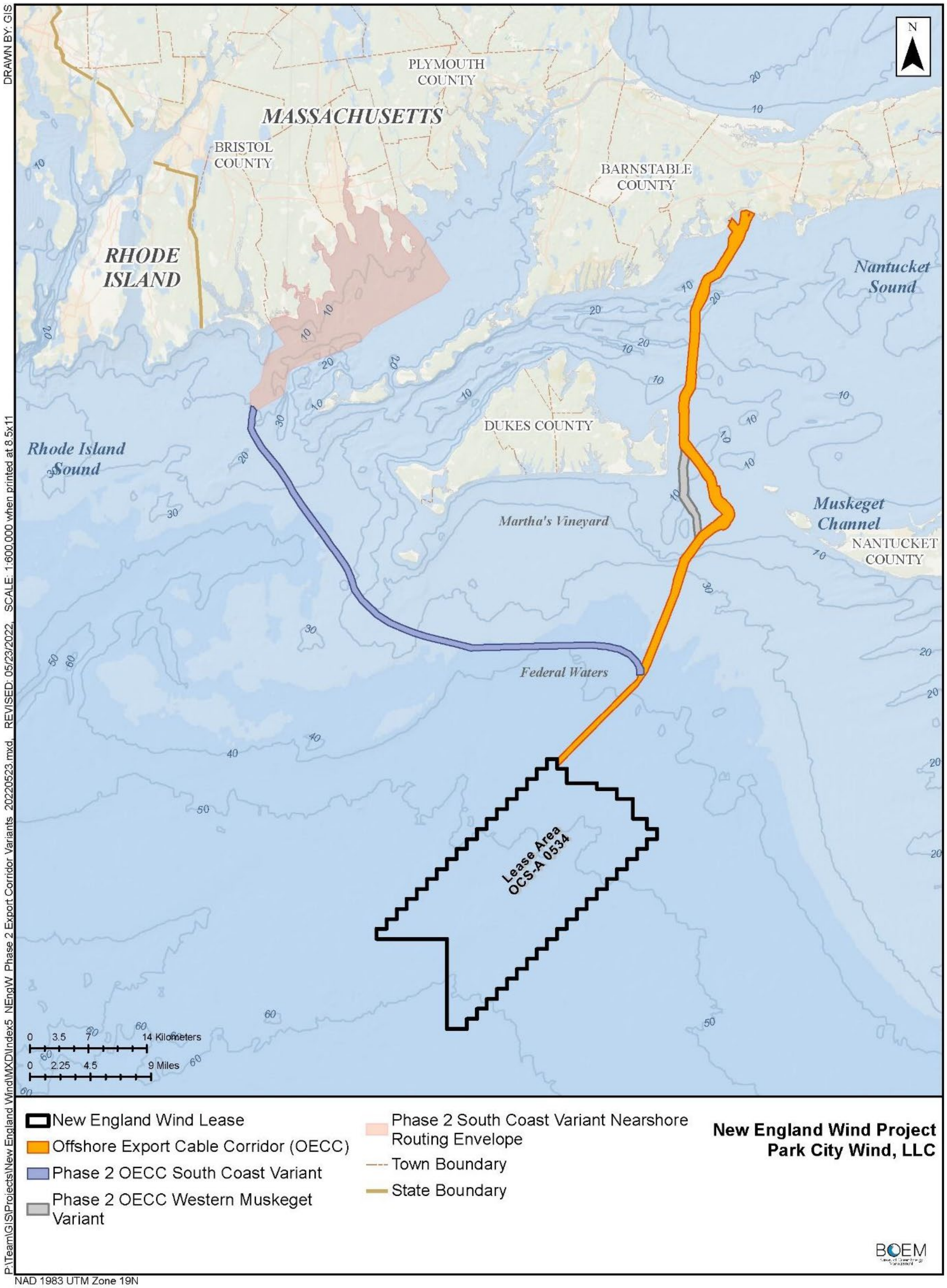


Figure 1-2: Offshore Export Cable Corridor and Variants for the Southern Wind Development Area

Table 1-1: Summary of Proposed Project Components

Proposed Project Component	Proposed Action
WTGs	41–62 WTG for Phase 1 and up to 88 WTG for Phase 2 generating at least 2,036 MW and up to 2,600 MW electricity; this equates to approximate minimum nameplate capacity of 16 MW per WTG
WTG layout	41–62 potential WTG foundation sites for Phase 1, 64–88 potential WTG foundation sites for Phase 2 Spacing = 1 nautical mile (1.9 kilometers, 1.15 miles) uniform layout
Foundations	12- and 13-meter monopiles (WTG and ESP), 4-meter jacket pin piles (WTG and ESP)
Inter-array cables	66–132 kilovolt inter-array cables
ESPs	One or two ESP installed during Phase 1, up to three ESP installed during Phase 2
Offshore export cables	Two 220–275 kilovolt offshore export cables buried at a target depth of 5 to 8 feet (1.5 to 2 meters) installed during Phase 1, two or three 220–345 kilovolt cables installed at a target depth of 5 to 8 feet (1.5 to 2 meters) during Phase 2
OECR	Cable landing location at either the Craigville Public Beach Landfall Site in the Town of Barnstable during Phase 1 Cable landing location at the Dowses Beach Landfall Site in Barnstable for Phase 2
Grid interconnection	Grid interconnection cables installed within an underground duct band along two potential grid interconnection routes Grid interconnection cables installed along one or two grid interconnection routes to connect to the onshore substation for Phase 2
Onshore substation	Eversource's existing West Barnstable Substation

Source: Epsilon 2022
ESP = electrical service platform; MW = megawatt; OECR = onshore export cable route; WTG = wind turbine generator

1.4.1 Construction and Installation

The activities included for construction of the components of the Proposed Action are provided in the following subsections. Figures 1-3 and 1-4 provide the indicative construction schedules for Phase 1 and Phase 2, respectively (COP Volume I, Sections 3.1.1.3 and 4.1.1.3; Epsilon 2022), with commercial operations anticipated to commence in 2026.

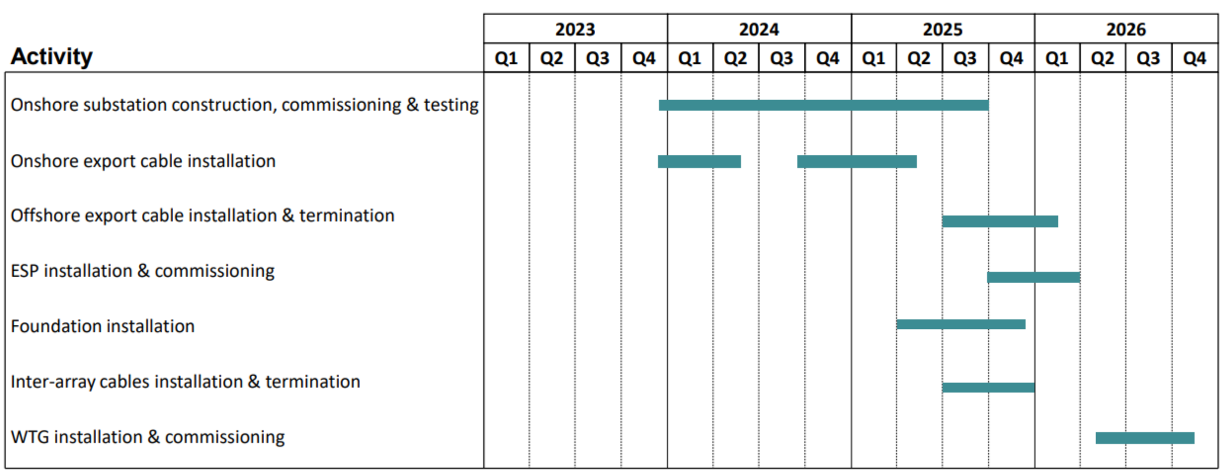
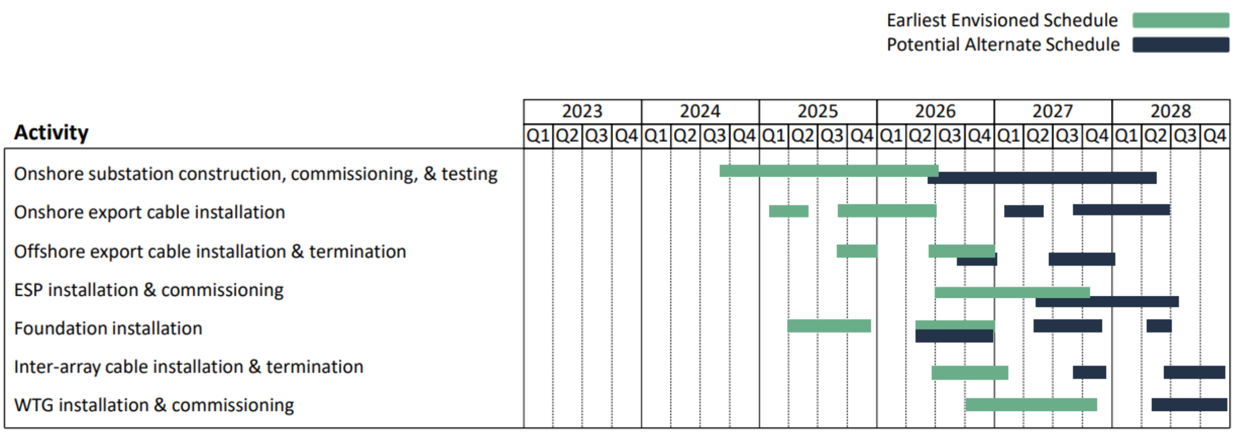


Figure 1-3: Tentative Draft Schedule for Phase 1 of the Proposed Action



Though the earliest envisioned schedule for Phase 2 foundation installation shows some potential overlap with the Phase 1 foundation installation schedule, no concurrent or simultaneous piling of Phase 1 and Phase 2 foundations would occur.

Figure 1-4: Tentative Draft Schedule for Phase 2 of the Proposed Action

1.4.1.1 Onshore Activities and Facilities

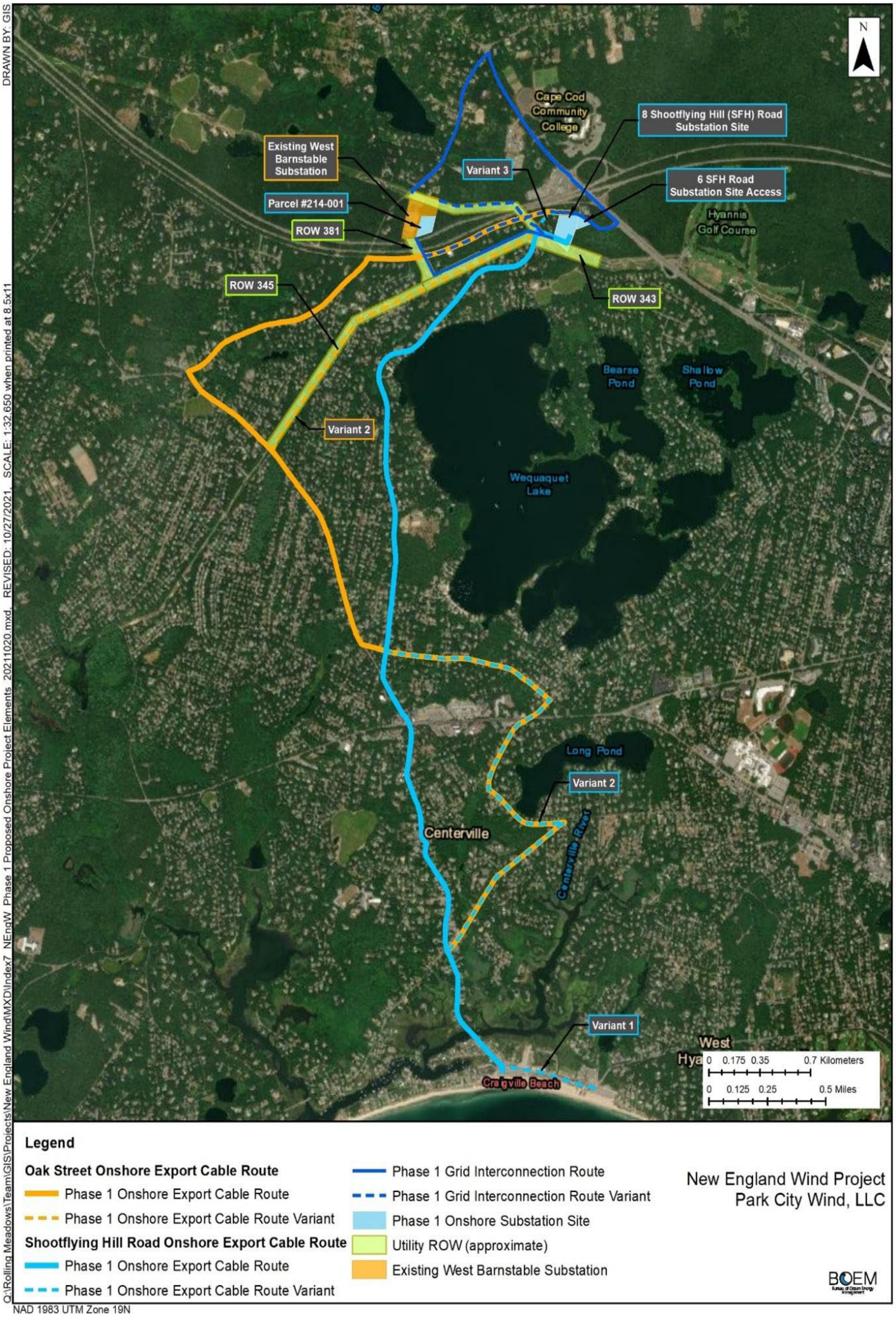
1.4.1.1.1 Landfall Site

The Proposed Action's Phase 1 offshore transmission cables would make landfall at Craigville Public Beach in Barnstable Massachusetts. The Phase 2 cables would make landfall at Dowses Beach. The transition of the export cable from offshore to onshore would be accomplished by horizontal directional drilling, which would bring the proposed cables beneath the nearshore area, the tidal zone, beach, and adjoining coastal areas to one of the two proposed landfall sites. Use of horizontal directional drilling would help to avoid impacts on the beach, intertidal zone, and nearshore areas within the OECC (COP Section 3.3.1.8; Epsilon 2022). One or more underground concrete transition vaults, also called splice vaults, would be constructed at the landfall site. These would be accessible after construction via a manhole. Inside the splice vault(s), the 220- to 345-kilovolt alternating current (AC) offshore export cables would be connected to the 220- to 345-kilovolt onshore export cables (with the size of the cables depending on the phase and final Project design envelope [PDE]).

COP Sections 3.2 and 4.2 provide additional details on the proposed landfall sites and their construction approaches for Phase 1 and 2, respectively (Volume I; Epsilon 2022).

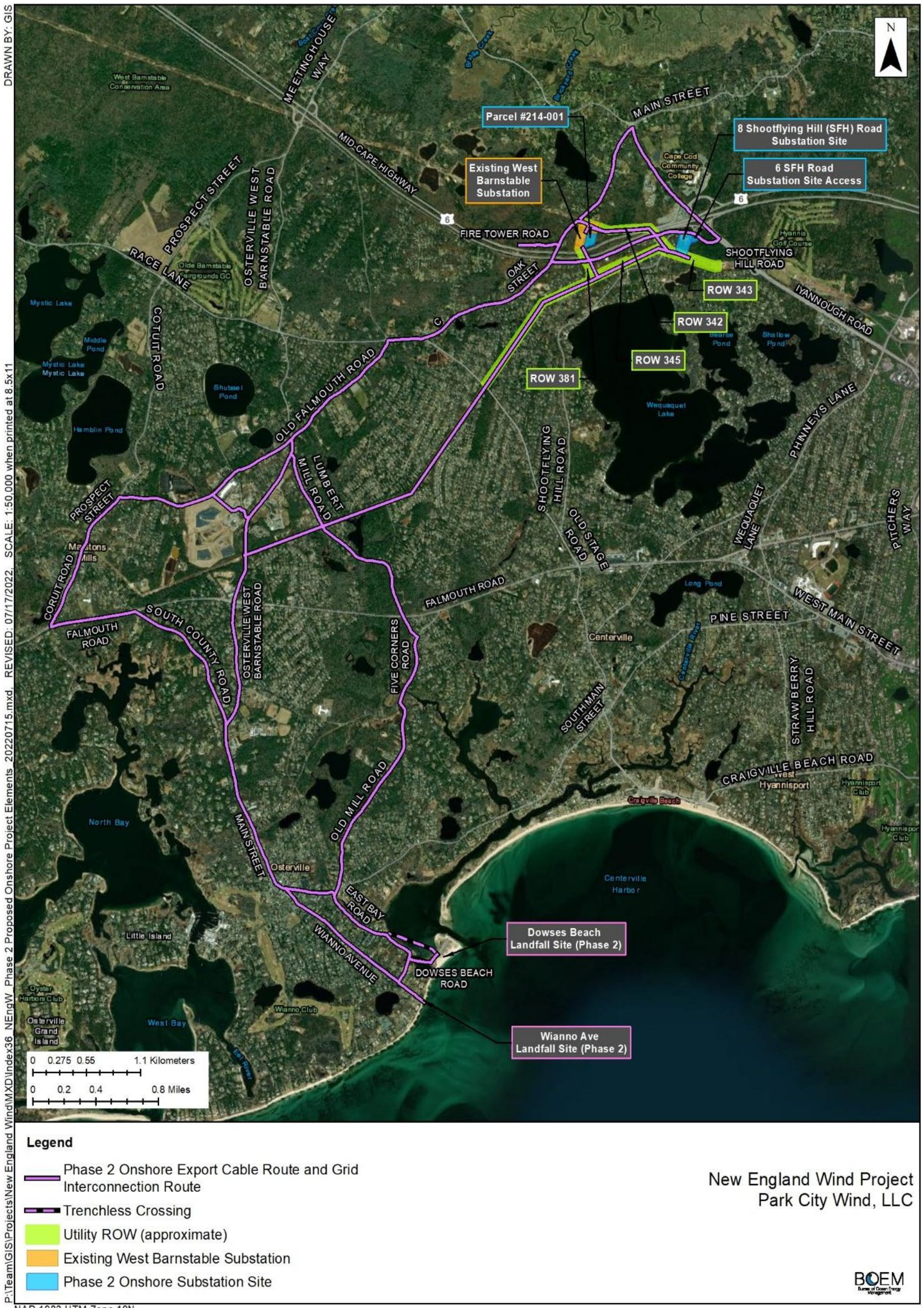
1.4.1.1.2 Onshore Export Cable and Substation

The Proposed Action includes one OECR for each phase, shown on Figure 1-5 for Phase 1 and Figure 1-6 for Phase 2. The OECRs for both phases would be installed entirely underground, and nearly all of the proposed OECRs for both phases would pass through already-developed areas, primarily paved roads, and existing utility ROW.



ROW = right-of-way

Figure 1-5: Phase 1 Onshore Export Cable Route Options



ROW = right-of-way

Only the Dowses Beach Landfall site is considered under the Proposed Action for this BA; the Wianno Ave Landfall site is an alternative addressed in the Final EIS, which would only be used if the Dowses Beach Landfall site is not available at the time of construction.

Figure 1-6: Phase 2 Onshore Export Cable Route Options

The applicant would install the onshore export cables in a single concrete duct bank buried along the entire offshore export cable route. The duct bank may vary in size along its length, and the planned duct bank could be arrayed four conduits wide by two conduits deep (flat layout) measuring up to 5 feet (1.5 meters) wide by 2.5 feet (0.8 meter) deep, or vice versa, with an upright layout with two conduits wide by four conduits deep. The top of the duct bank would typically have a minimum of 3 feet (1 meter) of cover comprised of properly compacted sand topped by pavement.

The proposed onshore export cables would terminate at the proposed substation site of the existing West Barnstable Substation for Phase 1 (COP Volume I, Section 3.2; Epsilon 2022). The connection location for the Phase 2 onshore cables has not yet been determined but could occur either at existing substations within the Town of Barnstable, including, but not limited to, the West Barnstable Substation, or new substation facilities (COP Volume I, Section 4.2; Epsilon 2022).

1.4.1.2 Offshore Activities and Facilities

Proposed Action components include WTGs and their foundations, ESPs and their foundations, scour protection for all foundations, inter-array cables that connect the WTGs to the ESPs, the inter-link cable that connects the ESPs, and the export cable to the landfall location. The Proposed Action offshore elements are located within federal waters, with the exception of a portion of the OECC located within state waters (Figures 1-7 through 1-10). The Proposed Action would comprise two phases each with their own associated construction parameters, for which additional detail can be found in COP Sections 3.3 and 4.3 for Phase 1 and 2, respectively (Volume I; Epsilon 2022), but are summarized in the following subsections.

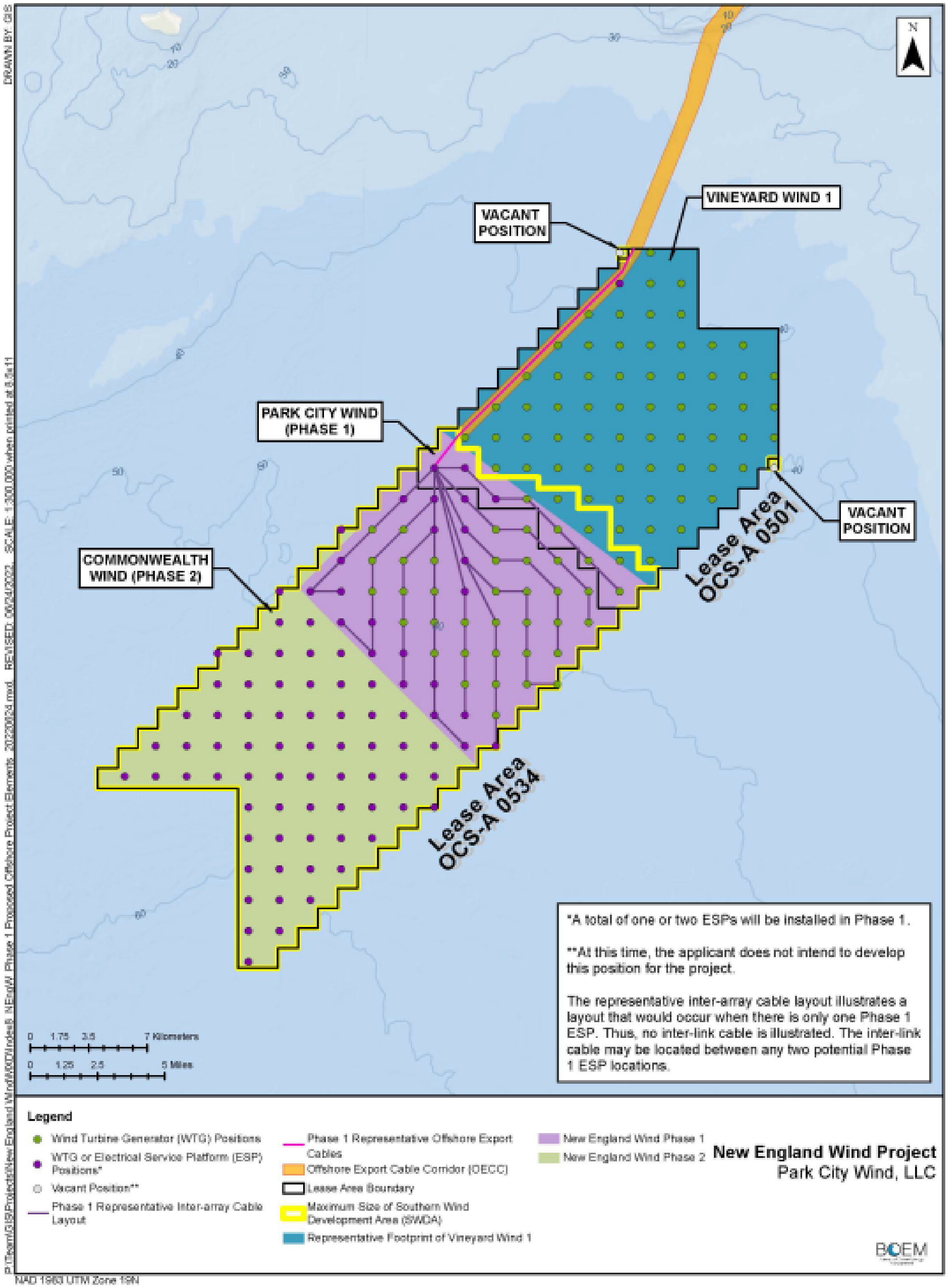


Figure 1-7: Proposed Phase 1 Offshore Project Components

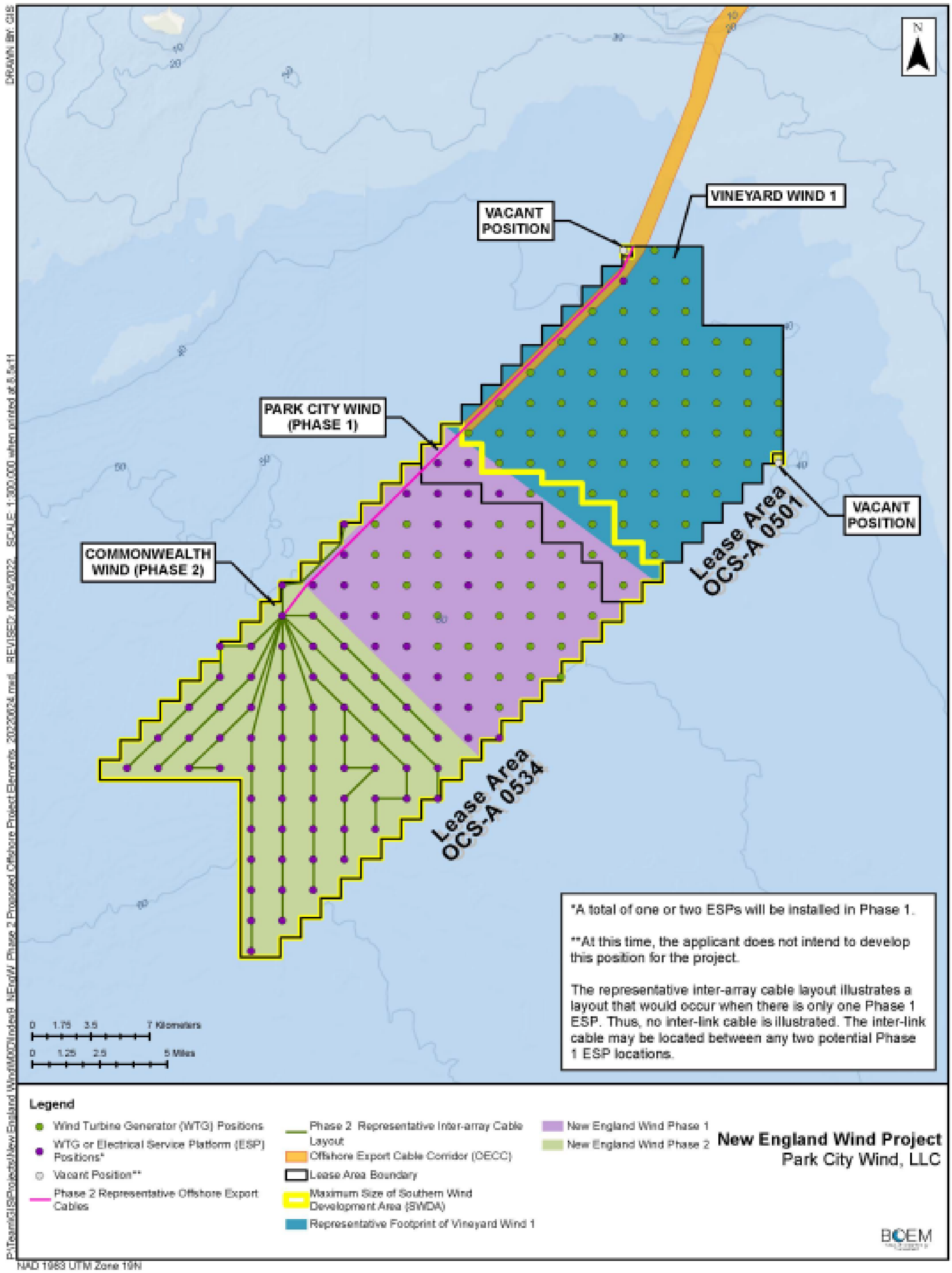
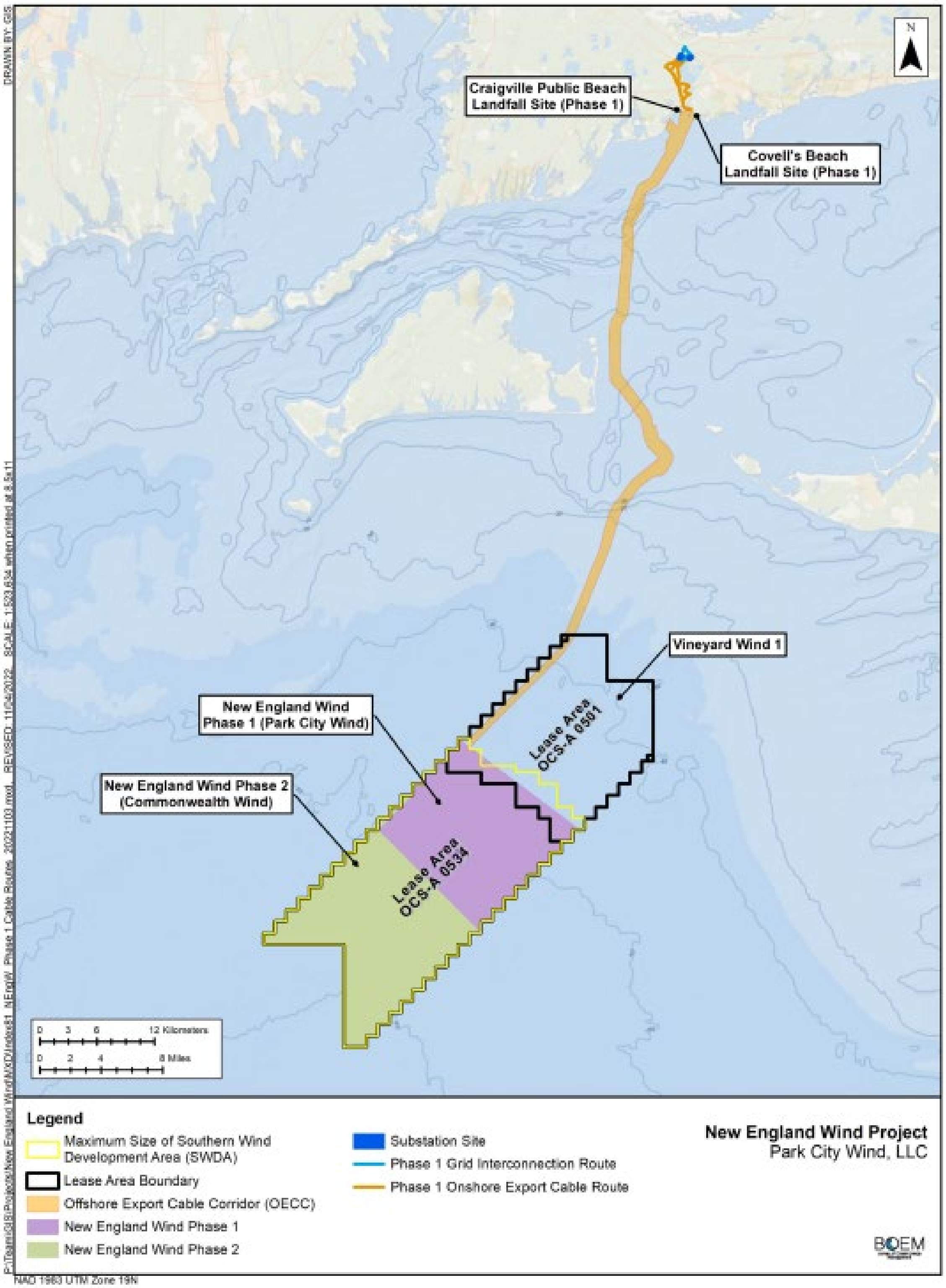
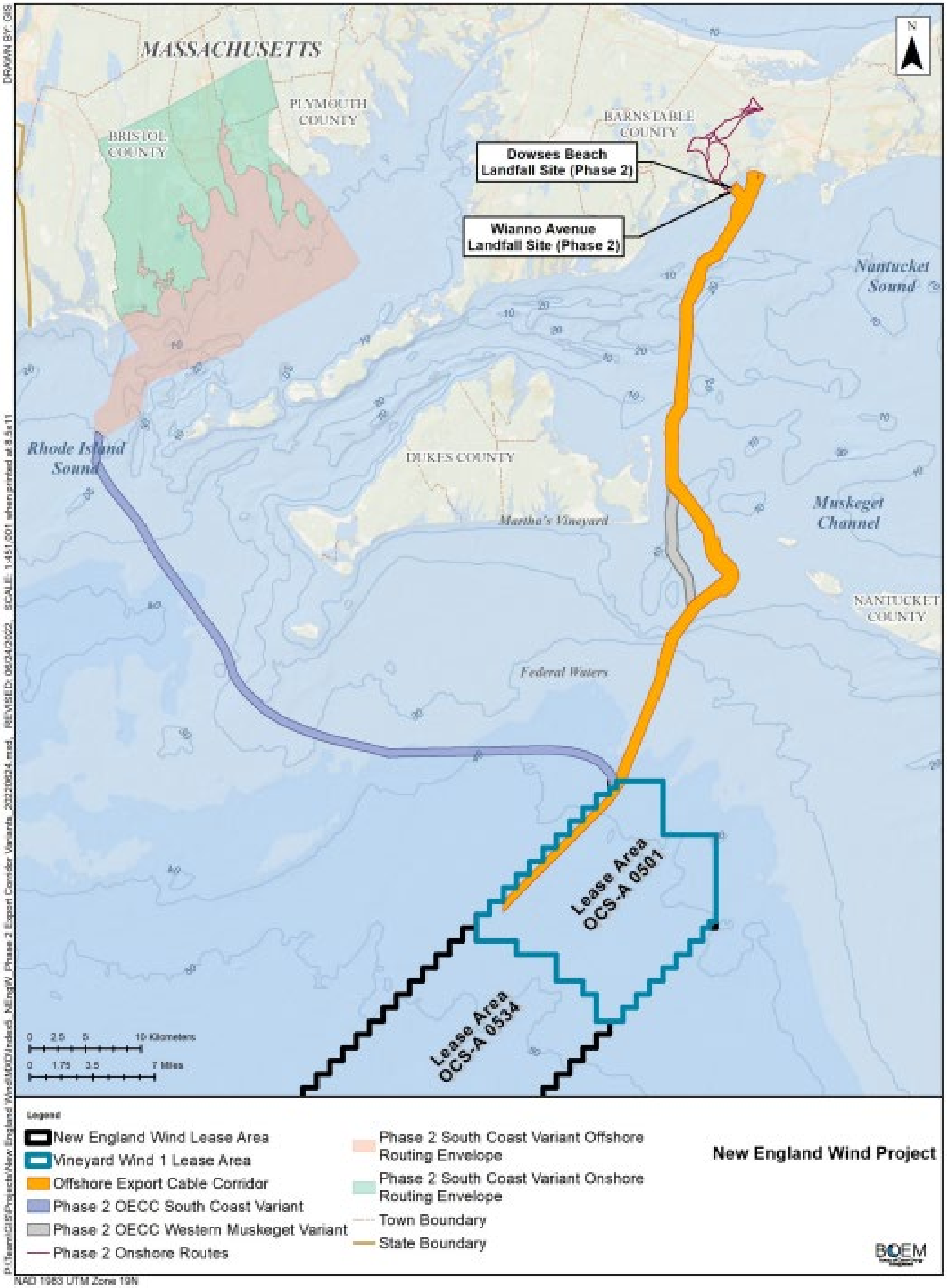


Figure 1-8: Proposed Phase 2 Offshore Project Components



Only the Craigville Public Beach Landfall site is considered under the Proposed Action of this BA; the Covell's Beach Landfall site is an alternative, which is assessed in the Final EIS and would only be used if the Craigville Public Beach Landfall site is not available at the time of construction.

Figure 1-9: Proposed Phase 1 Offshore Export Cables



OECC = offshore export cable corridor
Only the Dowses Beach Landfall site is considered under the Proposed Action of this BA; the Wianno Ave Landfall site is an alternative which is assessed in the Final EIS and would only be used if the Dowses Beach Landfall site is not available at the time of construction.

Figure 1-10: Proposed Phase 2 Offshore Export Cable Variants

1.4.1.2.1 Wind Turbine Generators

Table 1-2 summarizes the maximum parameters of WTGs that could be installed for both Phase 1 and Phase 2. The applicant is proposing to install 41 to 62 WTGs and 1 or 2 ESPs in Phase 1 of the SWDA and 64 to 88 WTG/ESP positions in Phase 2 of the SWDA. The Proposed Action WTGs would be installed in a uniform east-to-west, north-to-south grid pattern with 1-nautical-mile (1.9-kilometer, 1.15-mile) × 1-nautical-mile (1.9-kilometer, 1.15-mile) spacing between positions. As described further in Section 1.4.1.2.2, the WTG and ESPs would be collocated, so the Proposed Action includes a total of 133 foundations installed in 130 positions for both WTG and ESPs across both proposed Project phases, as shown on Figures 1-7 and 1-8.

Table 1-2: Proposed Action Wind Turbine Generator Specifications

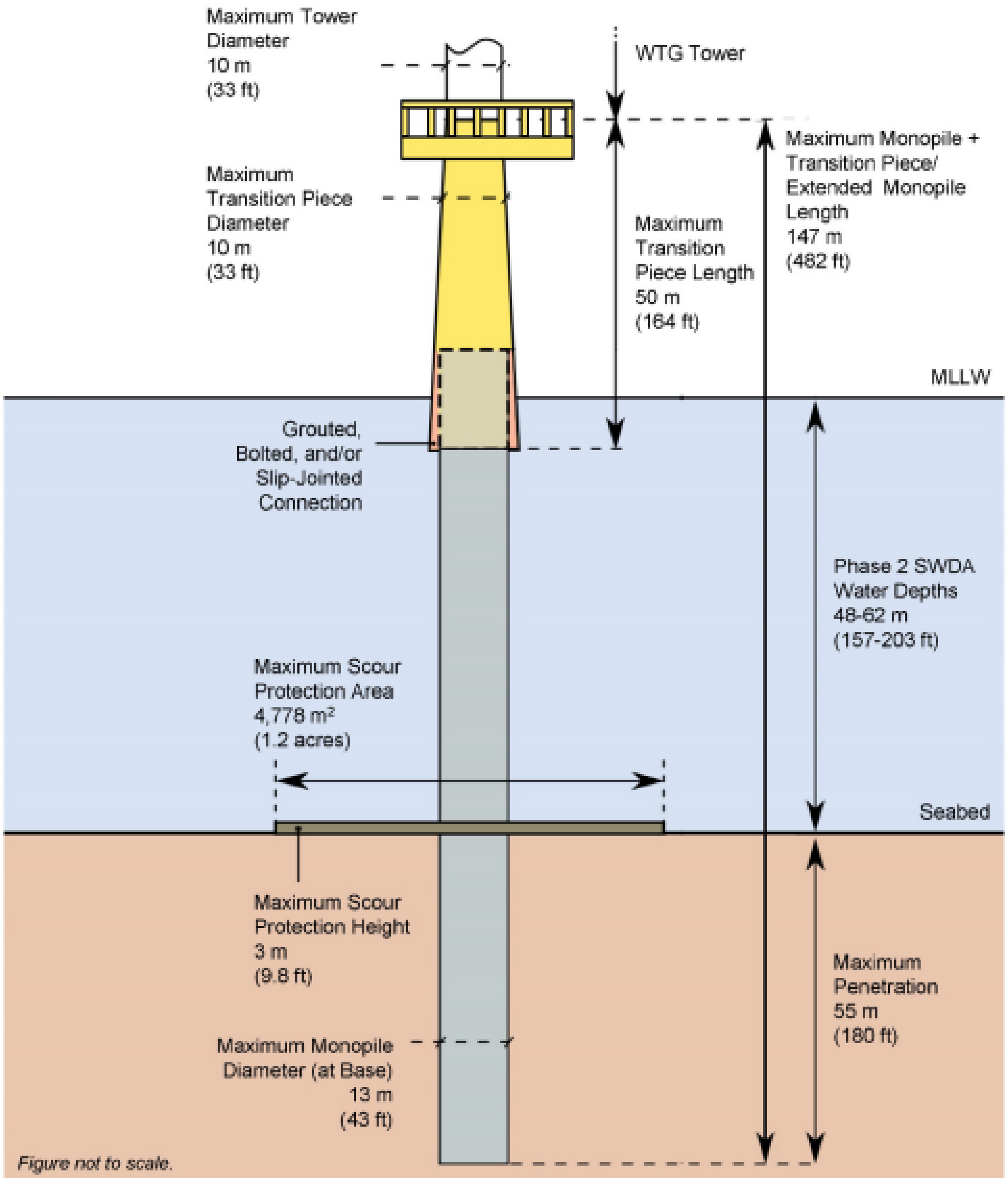
Component	Specification
WTG	
Maximum tip height	1,171 feet (357 meters) MLLW[a]
Maximum hub height	702 feet (214 meters) MLLW[a]
Maximum height to nacelle top	725 feet (221 meters) MLLW[a]
Maximum rotor diameter	937 feet (286 meters) MLLW[a]
Maximum tip clearance	89 feet (27 meters) MLLW[a]
Maximum tower diameter for WTG	30 feet (9 meters)
Monopile foundations[b]	
Maximum diameter	39 or 43 feet (12 or 13 meters)
Permanent pile footprint with scour protection (all piles, Phase 1 and Phase 2)	71.6 acres (0.29 km^2)
Height between seabed and MLLW (water depth)	157–203 feet (48–62 meters)
Maximum penetration	180 feet (55 meters)
Maximum transition piece tower diameter	33 feet (10 meters)
Maximum transition piece length	164 feet (50 meters)
Number of piles/foundation	1
Maximum number of piles driven/day within 24 hours	2
Typical foundation time to pile drive	Approximately 6 hours
Maximum hammer size	6,000 kJ
Jacket (pin piles) foundation	
Maximum diameter per pile	13 feet (4 meters)
Maximum jacket structure height	285 feet (87 meters)
Maximum pile penetration	279 feet (85 meters)
Permanent pile footprint with scour protection (all piles, Phase 1 and Phase 2)	17.3 acres (0.07 km^2)
Number of piles/foundation	3 to 4
Maximum number of piles driven/day within 24 hours	1 (up to 4 pin piles)
Typical foundation time to pile drive	Approximately 3 hours
Maximum hammer size	3,500 kJ

Component	Specification
Bottom-frame foundation (Phase 2 only)	
Maximum diameter per pin pile	13 feet (4 meter)
Maximum diameter per bucket pile	49 feet (25 meters)
Maximum bottom-frame structure height	302 feet (92 meters)
Maximum pile penetration (pin pile)	279 feet (85 meters)
Maximum pile penetration (bucket pile)	49 feet (15 meters)
Permanent bucket pile footprint with scour protection (all piles, Phase 2 only)	182.9 acres (0.74 km^2)
Number of piles/foundation	3
Maximum number of piles driven/day within 24 hours[c]	1 (up to 3 piles)
Typical foundation time to install pile (both types)	Approximately 3 hours
Maximum hammer size	6,000 kJ

Source: COP Volume I; Epsilon 2022
kJ = kilojoule; km^2 = square kilometer; MLLW = mean lower low water; WTG = wind turbine generator
[a] Elevations relative to mean higher high water are approximately 3 feet (1 meter) lower than those relative to MLLW.
[b] The foundation size is not connected to the turbine size/capacity. Foundations are individually designed based on seabed conditions, and the largest foundation size could be used with the smallest turbine.

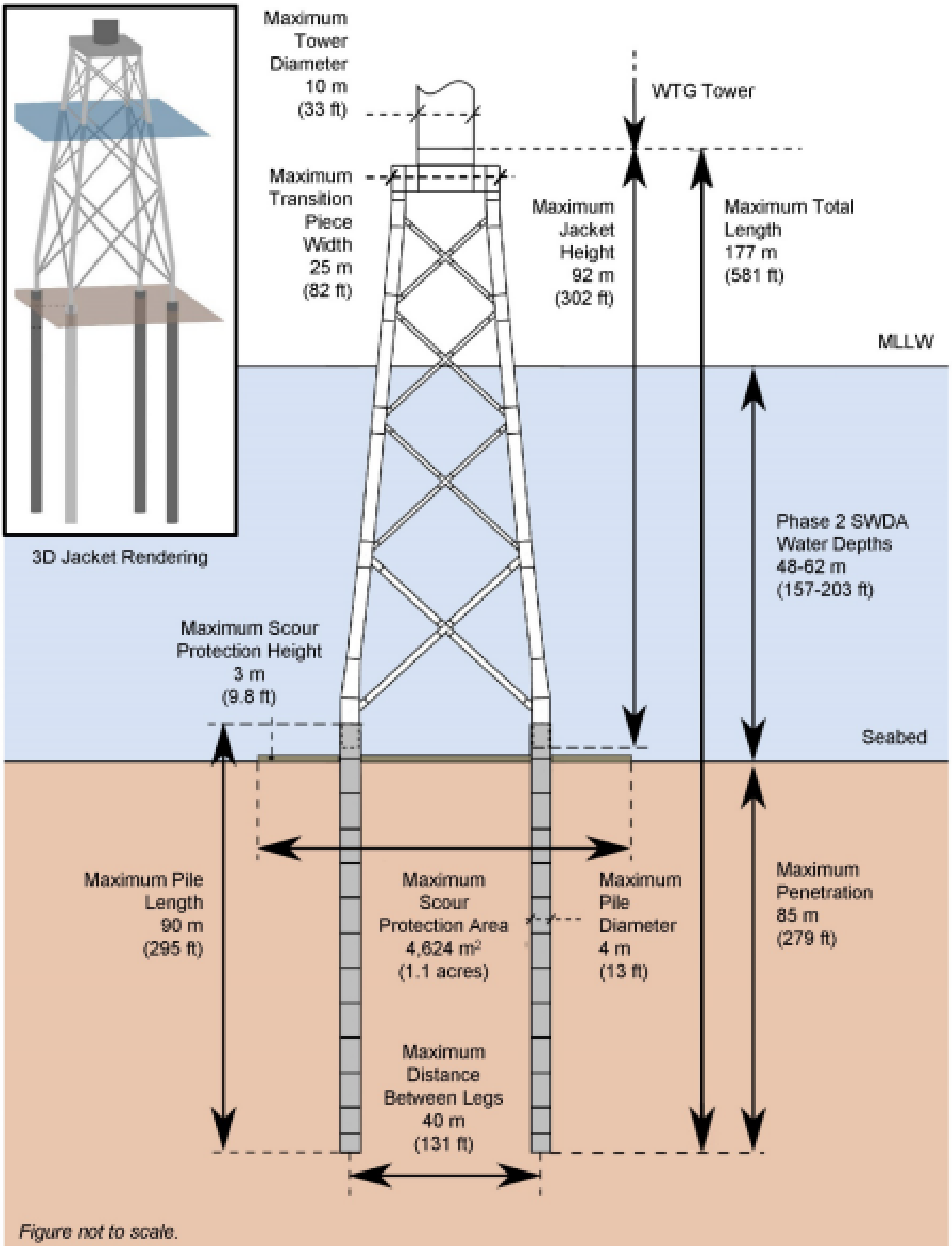
Phase 1 WTGs would be mounted on either 12-meter monopiles or 4-meter jacket foundations, and Phase 2 WTGs would be mounted on either 12- or 13-meter monopiles, 4-meter jacket, or 4-meter bottom-frame foundations. A monopile is a long steel tube driven up to 180 feet (55 meters) into the seabed using an impact hammer (Figure 1-11). A jacket foundation is a latticed steel frame with up to four supporting piles (pin piles) driven up to 279 feet (85 meters) into the seabed using an impact hammer (Figure 1-12). The ESPs proposed for both Phase 1 and Phase 2 would be installed on jackets, and some of the WTG may be installed on jackets during Phase 2.

A bottom-frame foundation, currently only being considered for Phase 2, is a triangular space frame with a vertical column supporting the WTG connected to three legs that radiate outward toward the feet of the foundation (Figure 1-13). The feet of the bottom-frame foundation may be secured either using pin piles or suction buckets, which would be pushed up to 49 feet (15 meters) into the seabed by pumping water out of the bucket. The applicant currently expects to use only monopile or piled jacket foundations for Phase 1; however, piled and suction bucket jacket and bottom-frame foundations are also considered under the Proposed Action for Phase 2 and are, therefore, assessed in this BA.



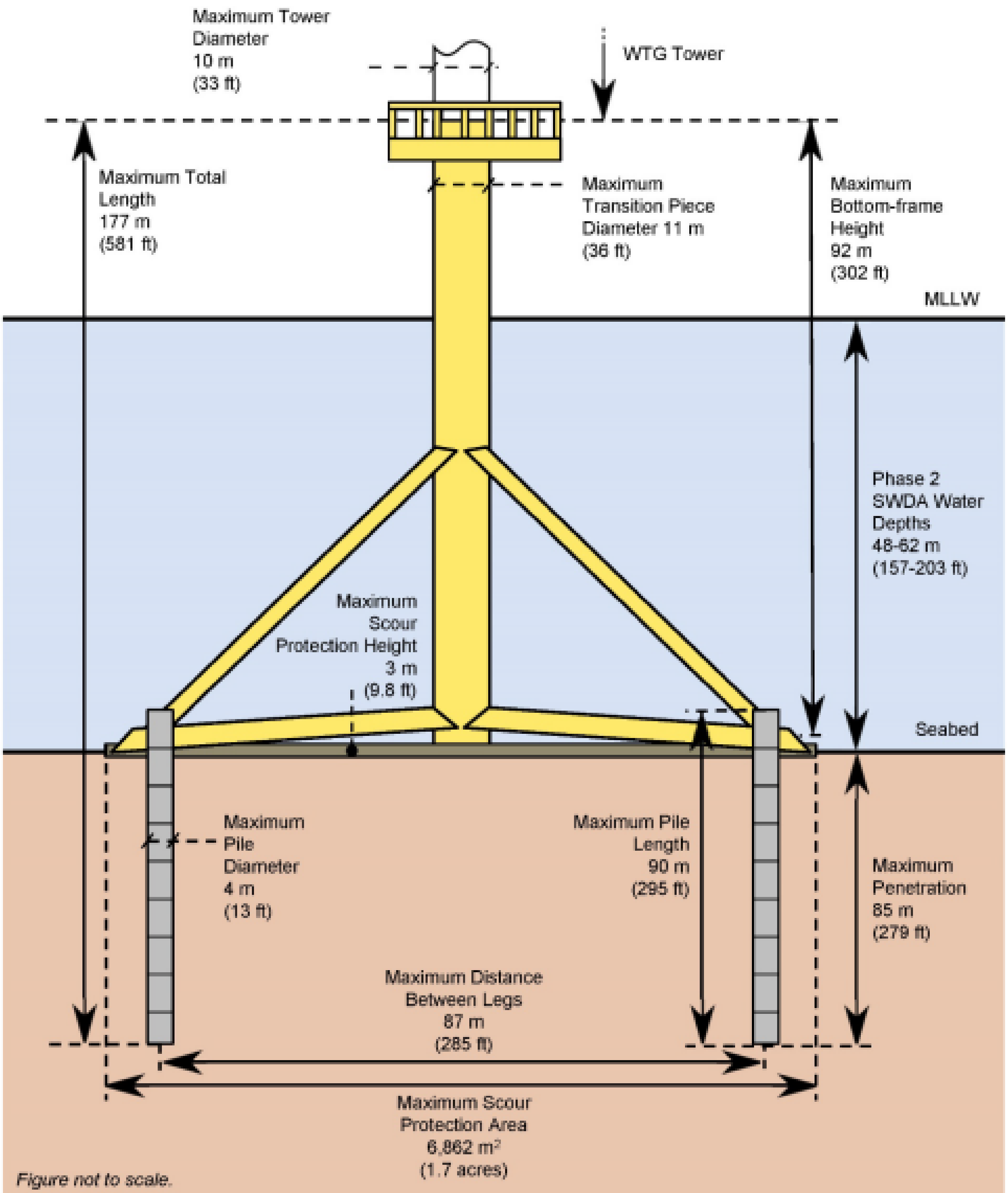
Source: Epsilon 2022
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 1-11: Monopile Foundation Conceptual Drawing



Source: Epsilon 2022
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 1-12: Jacket Foundation Conceptual Drawing



Source: Epsilon 2022
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 1-13: Bottom-Frame Foundation Conceptual Drawing

The proposed WTGs would have a maximum nacelle-top heights of 725 feet (221 meters) above mean lower low water (MLLW) and maximum vertical blade tip extension of 1,171 feet (357 meters) MLLW (COP Volume I; Epsilon 2022).

It is possible that monopiles would be transported to the SWDA by floating in the water while pulled by tugs. The foundation components could be picked up directly in a U.S. port (if Jones Act-compliant vessels are available) or Canadian port by the main installation vessel(s). The WTGs and their foundations would be installed using jack-up vessels, anchored vessels, or dynamic positioning (DP)[6] vessels, along with necessary support vessels and supply vessels. If suction bucket piles are used, they would be installed using suction pumps attached to the buckets, which would pump water and air out of the space between the suction buckets and seafloor, pushing the buckets down into the seafloor. Once full penetration is achieved, the suction pumps would be recovered to the vessel. Any remaining interstitial space between the bucket and seafloor may be filled with grout, sand, or concrete (COP Volume I, Section 4.3.1.4.3; Epsilon 2022).

It is estimated that a total of up to 55 acres (0.22 km^2) of seafloor would be temporarily disturbed during installation of the foundations during Phase 1 and up to 74 acres (0.30 km^2) would be temporarily disturbed during installation of the WTG topside during Phase 1 (COP Appendix III-T; Epsilon 2022). The temporary footprint of seafloor disturbance during installation of the foundations and WTG topside during Phase 2 was estimated to be 68 acres (0.28 km^2) and 91 acres (0.37 km^2), respectively (COP Appendix III-T; Epsilon 2022).

All monopile, jacket, and piled bottom-frame foundations would be installed using impact pile driving. However, vibratory pile setting could be used before impact pile driving begins to mitigate the risk of pile run, an effect where due to unstable soil conditions, the pile begins to move under its own self weight through the soil in an uncontrolled manner (JASCO 2022). The vibratory hammer mitigates this risk by forming a hard connection to the pile using hydraulic clamps, thereby acting as a lifting/handling tool, as well as a vibratory hammer. The tool is inserted into the pile on the construction vessel deck, and the connection is made. The pile is then lifted, upended, and lowered into position on the seabed using the vessel crane. After the pile is lowered into position, vibratory pile installation would commence. Vibratory pile installation is a technique where piles are driven into soil using a longitudinal vibration motion. The motion is produced by a vibratory hammer, which contains a system of rotating eccentric weights, powered by electric or hydraulic motors. The vibratory effect begins to push the pile through the soil strata by unsettling the soil locally surrounding the pile. The pile would be kept vertical through the vibratory installation, as it is still connected to the vessel crane. The crane would continue to slowly lower the pile, and once a certain depth of penetration has been achieved (the penetration depth will be pre-determined using pile drivability engineering studies to ascertain the pile stability in the soil without exposure to pile run risk), the vibratory motion would be stopped from the control cabin on the construction vessel, and the hard clamped connection between the vibratory hammer and the pile would be released. The vibratory hammer is then recovered to the vessel. At this point, the pile would be self-stable and standing vertically in the soil without any connection or support from the vessel crane and safe to lift the impact hammer onto the pile, and commence impact hammer driving. The use of vibratory hammering would decrease the amount of impact hammering required (JASCO 2022). Based on a seabed drivability analysis conducted by the applicant, up to 50 percent of the foundations (approximately 66 foundations) may require vibratory pile driving, with an additional 6 percent (approximately 4) of the foundations added to the modeling assessment for conservatism, resulting in a total of 70 foundations that may require vibratory pile driving (JASCO 2023).

[6] DP allows a vessel to maintain its position by using a computer-controlled system that operates the propellers and thrusters.

Drilling is another contingency measure that may be required in the event of pile refusal. A pile refusal can occur if the total frictional resistance of the soil becomes too much for the structural integrity of the pile and the capability of the impact hammer. Continuing to drive in a refused condition can lead to overstress in the pile and could potentially buckle (tear) the pile material. The use of an offshore drill can reduce the frictional resistance by removing the material from inside the pile and allowing the continuation of safe pile driving. An offshore drill is an equipment piece consisting of a motor and bottom hole assembly. The drill is placed on top of the refused pile using the construction vessel crane, and the bottom hole assembly is lowered down to the soil inside the pile. On the bottom face of the bottom hole, assembly is a traditional "drill bit," which slowly rotates (at 4 or 5 revolutions per minute or approximately 1.3 feet [0.4 meters] per hour) and begins to disturb the material inside the pile. As the disturbed material mixes with seawater, which is pumped into the pile, it begins to liquify. The liquified material is pumped out to a pre-designated location, leaving only muddy seawater inside the pile instead of a solid "soil plug" and largely reducing the frictional resistance generated by the material inside the pile. When enough material has been removed from inside the pile and the resistance has reduced sufficiently, the drill is then lifted off the pile and recovered to the vessel. The impact hammer is then docked onto the pile and impact pile driving commences (JASCO 2022). Based on the seabed drivability analysis conducted by the applicant, up to 30 percent of the foundations (approximately 40 foundations) may require foundation drilling with an additional 20 percent added for conservatism in the acoustic modeling, resulting in a total of 48 foundations that may require drilling (JASCO 2023).

The Proposed Action includes two potential construction schedules, which incorporate the maximum PDE and allows for some flexibility in the final construction plan. The first construction schedule (Construction Schedule A) assumes a 2-year construction scenario where 54 Phase 1 WTGs are installed on monopiles, 53 Phase 2 WTGs are installed on monopiles, 23 Phase 2 WTGs are installed on jackets, and 2 ESPs are installed on jackets (one during each phase). Construction Schedule A assumes that foundations for all of Phase 1 and a portion of Phase 2 are installed in Year 1 and that the remaining Phase 2 foundations are installed in Year 2. Construction Schedule B assumes a 3-year construction scenario where 55 Phase 1 WTGs are installed on monopiles, 75 Phase 2 WTGs are installed on jackets, and 2 ESPs are installed on jackets (one during each phase). Construction Schedule B assumes that all ESP foundations and Phase 1 12-meter monopile WTG foundations are installed in Year 1 and that the Phase 2 jacket WTG foundations are installed in Years 2 and 3. However, under both construction schedules two positions may potentially have co-located ESPs (i.e., two foundations installed at one grid position), resulting in 132 foundations, so though Table 1-3 includes 133 foundations installed in this schedule, only 132 would be installed under the Proposed Action (JASCO 2023).

Construction Schedule B has the longest duration (3 years) and the greatest number of piling days. Therefore, Construction Schedule B is carried forward in the effects analysis for the Proposed Action. A summary of the number of piling days under Construction Schedule B is provided in Table 1-3.

Table 1-3: Maximum Monthly Pile Driving Days, Construction Schedule B (All Years Summed)[a]

Month	Total Days of Impact Pile Driving	Total Days with Vibratory Setting Followed by Impact Pile Driving[b]	Total Days with Drilling[c]	Total Days of Foundation Installation
May	6	0	4	6
June	17	6	10	23
July	15	11	9	26
August	10	16	9	26
September	7	10	9	17

Month	Total Days of Impact Pile Driving	Total Days with Vibratory Setting Followed by Impact Pile Driving[b]	Total Days with Drilling[c]	Total Days of Foundation Installation
October	0	8	4	8
November	2	3	3	5
December	2	0	0	2
Total	59	54	48	113
Total days	113 days			
Total foundations	133 foundations			
Total piles	367 piles			

Source: JASCO 2023
dB = decibel; SPL = root-mean-square sound pressure level
[a] This schedule covers the 5-year construction period 2025–2029, during which pile installation is scheduled to begin in 2026. These dates reflect the currently projected construction start year and are subject to change because exact project start dates and construction schedules are not currently available. No concurrent/simultaneous pile driving of foundations is planned.
[b] The number of days with vibratory pile setting is based on a percentage of the number of days of pile installation and includes installation of a mix of monopiles at a rate of both 1 per day and 2 per day as well as installation of jacket foundations at a rate of four pin piles per day.
[c] As a conservative measure, it was assumed that vibratory pile setting and drilling would not occur on the same day, when possible. However, for months when the number of days with vibratory pile setting plus the number of days with drilling exceeded the total number of impact piling days that month, we assumed the minimum number of days of overlap possible for these two activities.

For each pile type, the modeling included a piling schedule that accounted for soft-start procedures (Tables 1-4 through 1-6), as well as noise attenuation of at least 10 decibels (dB). Noise attenuation may be achieved with a variety of systems such as HydroSound Damper, bubble curtains, IHC Hydrohammer noise mitigation systems, or similar. For this analysis, BOEM identified 10 dB as the most appropriate because the type and manufacturer of a sound attenuation system has not yet been identified (Bellmann et al. 2020).

Table 1-4: Soft-Start Procedure for Each Modeled Foundation Under the Proposed Action Installed using Only Impact Pile Driving

12-Meter Monopile, 5,000 kJ Hammer			13-Meter Monopile, 5,000 kJ Hammer			12-Meter Monopile, 6,000 kJ Hammer			4-Meter Pin Pile, 3,500 kJ Hammer			13-Meter Monopile, 6,000 kJ Hammer[a]		
Energy Level (kJ)	Strike Count	Pile Penetration (%)	Energy Level (kJ)	Strike Count	Pile Penetration (%)	Energy Level (kJ)	Strike Count	Pile Penetration (%)	Energy Level (kJ)	Strike Count	Pile Penetration (%)	Energy Level (kJ)	Strike Count	Pile Penetration (%)
1,000	690	25	1,000	745	25	1,000	750	25	525	875	25	1,000	850	25
1,000	1,930	25	1,000	2,095	25	2,000	1,250	25	525	1,925	25	2,000	1,375	25
2,000	1,910	20	2,000	2,100	20	3,000	1,000	20	1,000	2,165	14	3,000	1,100	20
3,000	1,502	20	3,000	1,475	20	4,500	1,000	20	3,500	3,445	26	4,500	1,100	20
5,000	398	10	5,000	555	10	6,000	500	10	3,500	1,395	10	6,000	550	10
Total	6,430	100	Total	6,970	100	Total	4,500	100	Total	9,805	100	Total	4,975	100
Strike rate	30.0 blows per minute		Strike rate	30.0 blows per minute		Strike rate	25.0 blows per minute		Strike rate	30.0 blows per minute		Strike rate	27.6 blows per minute	

Source: COP Appendix III-M; Epsilon 2023
kJ = kilojoule
[a] Although the Proposed Action may install the 13-meter monopile foundations at a maximum of 6,000 kJ, this is not modeled beyond acoustic source modeling in JASCO (2023) and is not considered in the proposed construction schedule.

Table 1-5: Soft-Start Procedure for Monopile Foundations Under the Proposed Action Installed using Vibratory Pile Setting Followied by Impact Pile Driving

12 m Monopile			13 m Monopile			12 m Monopile			13 m Monopile			All Monopiles
Vibratory Hammer	5,000 kJ Impact Hammer		Vibratory Hammer	5,000 kJ Impact Hammer		Vibratory Hammer	6,000 kJ Impact Hammer		Vibratory Hammer	6,000 kJ Impact Hammer		
Duration (min)	Energy Level (kJ)	Strike Count	Duration (min)	Energy Level (kJ)	Strike Count	Duration (min)	Energy Level (kJ)	Strike Count	Duration (min)	Energy Level (kJ)	Strike Count	Pile Penetration (%)
60	-	-	60	-	-	60	-	-	60	-	-	25
-	1,000	1,930	-	1,000	2,095	-	2,000	1,250	-	2,000	1,375	25
-	2,000	1,910	-	2,000	2,100	-	3,000	1,000	-	3,000	1,100	20
-	3,000	1,502	-	3,000	1,475	-	4,500	1,000	-	4,500	1,100	20
-	5,000	398	-	5,000	555	-	6,000	500	-	6,000	550	10
-	Total	5,740	-	Total	6,225	-	Total	3,750	-	Total	4,125	100
Frequency: 20 Hz	Strike rate: 30.0 bpm		Frequency: 20 Hz	Strike rate: 30.0 bpm		Frequency: 20 Hz	Strike rate: 30.0 bpm		Frequency: 20 Hz	Strike rate: 30.0 bpm		

Source: COP Appendix III-M; Epsilon 2023
kJ = kilojoule

Table 1-6: Soft-Start Procedure for Jacket Foundations Under the Proposed Action Installed using Vibratory Pile Setting Followied by Impact Pile Driving

4 m Pin Pile			
Vibratory Hammer	**3,500 kJ Impact Hammer**		
Duration (min)	**Energy Level (kJ)**	**Strike Count**	**Pile Penetration (%)**
60	-	-	25
-	525	1,925	25
-	1,000	2,165	14
-	3,500	3,445	26
-	3,500	1,395	10
-	Total	8,930	100
Frequency: 20 Hz	Strike rate: 30.0 bpm		

Source: COP Appendix III-M; Epsilon 2023
kJ = kilojoule

1.4.1.2.2 Electrical Service Platforms

Phase 1 would include one or two ESPs, while Phase 2 would include up to three ESPs. Both Phase 1 and Phase 1 ESPs would be installed on a monopile or jacket foundations with pin piles, as described for WTGs (Section 1.4.1.2.1). The ESPs would serve as the interconnection point between the WTGs and the export cable and include step-up transformers and other electrical equipment needed to connect inter-array cables for each phase to the corresponding offshore export cables. Table 1-7 summarizes the range of pertinent ESP characteristics provided in the PDE. Depending on the size of WTGs installed for Phase 2, the transformer and other electrical equipment necessary to connect inter-array cables to export cables could be installed on WTG platforms, rather than a dedicated ESP platform (COP Volume I, Section 4.2.1.3; Epsilon 2022). Installation of the ESP topside and foundations would result in a total estimated temporary disturbance footprint of 5 acres (0.02 km^2) during Phase 1 and 7 acres (0.03 km^2) during Phase 2 for all proposed ESPs (COP Appendix III-T; Epsilon 2022). The permanent footprint of all the proposed ESP foundations with scour protection during both Phase 1 and Phase 2 is 17.3 acres (0.07 km^2) (COP Volume III, Section 6.5.2.1; Appendix III-T; Epsilon 2022).

Each ESP would contain up to 189,149 gallons (716,007 liters) of oils, lubricants, coolants, and diesel fuel (COP Volume I, Sections 3.3 and 4.3; Epsilon 2022). ESP foundation installations would follow the methods described for the WTG in Section 1.4.1.2.1.

Table 1-7: Proposed Action Electrical Service Platform Specifications

Foundation Type	Monopile	Jacket
Dimensions	197 × 328 × 125 feet (60 × 100 × 38 meters)	197 × 328 × 125 feet (60 × 100 × 38 meters)
Number of transformers per ESP	1	1
Number of piles/foundation	1	3–12
Maximum height[a]	230 feet (70 meters)	230 feet (70 meters)

Source: COP Section 4.2.1.3, Volume I; Epsilon 2022
ESP = electrical service platform; MLLW = mean lower low water
[a] The elevations provided are relative to MLLW, defined as the average of all the lower low water heights of each tidal day observed over the National Tidal Datum Epoch.

1.4.1.2.3 Scour Protection

Scour protection would be placed around all foundations for both Proposed Action phases and would consist of rock or concrete material (i.e., hard substrate) up to 9.8 feet (3.0 meters) in height above the seabed. The scour protection would serve to stabilize the seabed near the foundations, as well as the foundations themselves. Table 1-8 provides scour protection information for foundations for both Proposed Action phases (additional information provided in COP Volume I, Sections 3.2.1.4 and 4.2.1.4; Epsilon 2022).

Table 1-8: Proposed Action Scour Protection Information

Maximum Scour Protection per Foundation[a]	Height	Dimensions	Area
Monopile (WTG and ESP)	9.8 feet (3 meters)	Radius 128 feet (39 meters)	1.2 acres (0.0049 km^2)
Piled jacket (WTG)	9.8 feet (3 meters)	Square/rectangle with sides of 68 meters (223 feet)	1.1 acres (0.0045 km^2)
Piled jacket (ESP)	9.8 feet (3 meters)	Rectangle with sides of 129 x 77 meters (423 x 253 feet)	2.5 acres (0.0100 km^2)
Suction bucket jacket (WTG)	9.8 feet (3 meters)	Triangle with sides of 121 meters (397 feet)	1.6 acres (0.0065 km^2)
Suction bucket jacket (ESP)	9.8 feet (3 meters)	Rectangle with sides of 146 meters (479 feet)	5.3 acres (0.0214 km^2)
Piled bottom-frame (WTG)	9.8 feet (3 meters)	Triangle with sides of 126 meters (413 feet)	1.7 acres (0.0069 km^2)
Suction bucket bottom frame (WTG)	9.8 feet (3 meters)	Triangle with sides of 150 meters (492 feet)	2.4 acres (0.0097 km^2)

Source: COP Sections 3.2.1.4 and 4.2.1.4, Volume I; Epsilon 2022
ESP = electrical service platform; km^2 = square kilometer; WTG = wind turbine generator
[a] The dimensions of the scour protection for the jacket and bottom-frame are per foundation, but the estimate includes the total number of pin piles or bucket piles included for each foundations.

1.4.1.2.4 Offshore Export Cables

Up to two offshore export cables for Phase 1 and two to three cables for Phase 2 in one cable corridor would connect the proposed wind facility to the onshore electrical grid. The proposed OECC for Phase 1 and Phase 2 are shown on Figures 1-9 and 1-10, respectively. Each offshore export cable would consist of three-core 220- to 275-kilovolt high voltage AC cables for Phase 1 and 220- to 345-kilovolt high voltage AC cables for Phase 2 that would deliver power from the ESPs to the onshore facilities. Cables for Phase 1 and 2 would be installed in the OECC, which would be largely collocated with the OECC for Vineyard Wind 1 and would travel from the northwest corner of the SWDA through the eastern part of Muskeget Channel to landfall sites in the Town of Barnstable on the southern shore of Cape Cod (COP Section 3.2.1 and COP Volume I, Figure 3.1-6; Epsilon 2022). The proposed Project's preferred OECC would be collocated with the permitted Vineyard Wind 1 OECC. Under Phase 2, two cable route variants (Western Muskeget Variant and SCV) would only be used if the preferred export cable route is found to be infeasible. Moreover, if the Western Muskeget Variant is used, the cable route would still be mostly collocated with the permitted Vineyard Wind 1 export cable corridor. The final route would be contingent on the choice of landfall site, where the offshore export cable approaches Cape Cod. The Phase 1 landfall site would occur at Craigville Public Beach, while the Phase 2 landfall would occur at Dowses Beach (Section 1.4.1.1.1).

Figure 1-14 shows the proposed OECC for both Phase 1 and Phase 2 of the Proposed Action in relation to the OECC identified for Vineyard Wind 1 (COP Volume I, Section 2.3; Epsilon 2022). The applicant has identified an OECC that is largely the same as OECC included in the approved Vineyard Wind 1 COP but will be widened by approximately 948 feet (300 meters) to the west along the entire corridor and by approximately 948 feet (300 meters) to the east in portions of Muskeget Channel, for a total width of approximately 3,100 to 5,500 feet (950 to 1,700 meters) (COP Volume I, Section 2.3.1; Epsilon 2022). The applicant is choosing to select a shared OECC with Vineyard Wind 1, as it provides for an efficient, technically feasible connection of the SWDA to the grid interconnection points in West Barnstable, Massachusetts; the geological conditions in the OECC are fairly well understood given the survey work completed for Vineyard Wind 1 and are suitable for cable installation. Using a shared OECC would help to minimize environmental impacts in addition to the commercial benefits, and this route has already been reviewed and approved by the Commonwealth of Massachusetts and BOEM (COP Volume I, Section 2.3.1; Epsilon 2022).

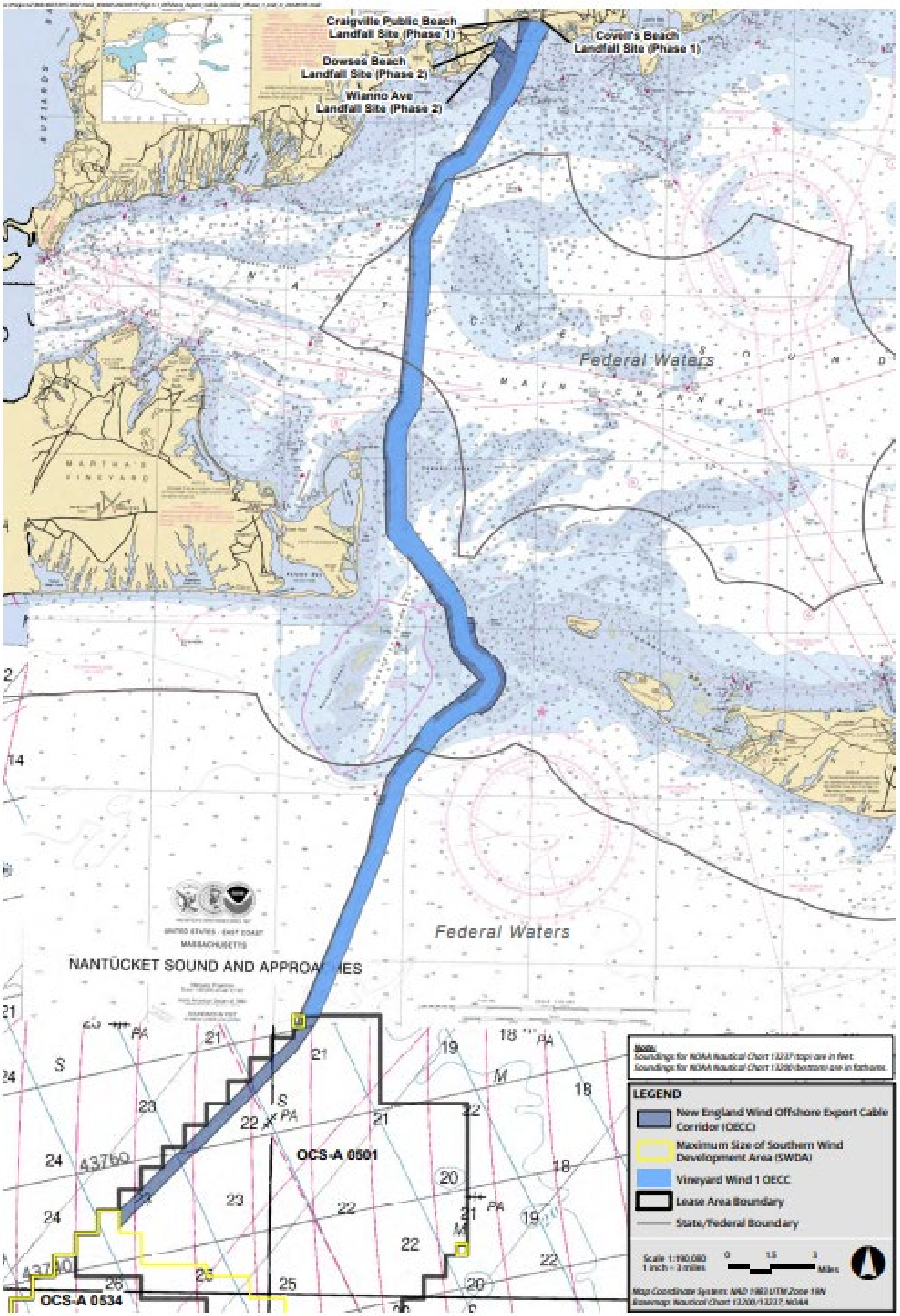


Figure 1-14: Proposed Offshore Export Cable Corridor for Phase 1 and Phase 2 of the Proposed Action in Relation to the Vineyard Wind 1 Offshore Export Cable Corridor

It is expected that the Vineyard Wind 1 offshore export cables will be located in the central or eastern portion of the OECC. To avoid cable crossings, the two Phase 1 cables of the Proposed Action are expected to be located west of the Vineyard Wind 1 cables and, subsequently, the two or three Phase 2 cables of the Proposed Action are expected to be installed to the west of the Phase 1 cables. The cables will typically be separated by a distance of 164 to 328 feet (50 to 100 meters) to provide appropriate flexibility for routing and installation and allow for maintenance or repairs, although this distance could be further adjusted pending ongoing routing evaluation. While the Phase 1 and Phase 2 cables of the Proposed Action are expected to be physically located west of the Vineyard Wind 1 cables, it was assumed temporary construction impacts (e.g., use of anchors) during installation of the Phase 1 or Phase 2 cables may occur anywhere within the OECC (COP Volume I, Section 2.3.1; Epsilon 2022).

If technical, logistical, grid interconnection, or other unforeseen issues prevent all Phase 2 export cables from interconnecting at the West Barnstable Substation, the applicant would develop and use the SCV in place of or in addition to the currently proposed Phase 2 OECC and OECR. The SCV could include up to three offshore electrical transmission cables for Phase 2 only (in lieu of or in addition to the proposed route through Muskeget Channel) with a cable landing site, onshore transmission cable, grid interconnection, and new or upgraded substations in Bristol County, Massachusetts. Because the SCV is a contingency, the applicant has not provided information on grid interconnection routes, onshore cable routes, landfall locations, and nearshore cable routes necessary to prepare a sufficient analysis of the SCV at the time of publication of this BA. Therefore, the analysis of the SCV in this BA includes available information but reflects some uncertainty.

If selected, the portion of the SCV within federal waters would be 78.3 miles (126 kilometers) long per export cable. Dredging for installation of two export cables in the SCV would affect 3.3 acres (0.013 km^2) and include up to 6,131 cubic yards (4,687 cubic meters) of dredged material for the federal waters portion of the two export cables (Epsilon 2022). These impacted areas would be in addition to or in place of some or all of the impacts described for the proposed OECC through Muskeget Channel, depending on the number of Phase 2 cables installed in the proposed OECC and SCV OECC. Installation of a third export cable within the SCV would require additional dredging. BOEM will provide additional information about the SCV, including any potential dredging within state waters, as part of a supplemental National Environmental Policy Act analysis once the applicant provides more detailed information. If the SCV is selected, a portion or all of the dredging impacts for the Muskeget Channel routes would not occur.

Inter-array cables would link groups (or strings) of WTGs to an ESP for each phase, including up to 139 miles (224 kilometers) of cable for Phase 1 and up to 201 miles (323 kilometers) of cable for Phase 2. Inter-link cables would connect multiple ESPs within each phase if more than one ESP is needed, including up to 13 miles (21 kilometers) for Phase 1 and up to and 37 miles (60 kilometers) of cable for Phase 2.

The applicant would install all cables by simultaneous laying and burying using jetting techniques or mechanical plow, depending on bottom type/conditions, water depth, and contractor preference. The total area of temporary disturbance estimated during installation of the inter-array cables during both Phase 1 and Phase 2 is 622.7 acres (2.52 km^2), and during the installation of the offshore export cables, this area was estimated to be 548.6 acres (2022 km^2) (COP Appendix III-T; Epsilon 2022). The total permanent footprint of anticipated cable protection during both phases is 88.9 acres (0.36 km^2) (COP Appendix III-T; Epsilon 2022).

Prior to installation of the cables, a pre-lay grapnel run would be performed in all instances to locate and clear obstructions such as abandoned fishing gear and other marine debris. Based on preliminary survey data for the SWDA, dredging and boulder clearance may not be necessary prior to inter-array or inter-link cable laying, but this will be confirmed through additional data analyses (COP Volume I, Section 3.3.1.6

and 4.3.1.6; Epsilon 2022). The estimated area and volume of material to be dredged from sand waves crossed by the offshore export cables prior to cable installation is 119 acres (0.48 km^2) and 411,700 cubic yards (314,800 cubic meters) for both Phase 1 and Phase 2, respectively (COP Appendix III-T; Epsilon 2022). Avoidance of surficial coarse deposits with boulders would occur where feasible. It is currently anticipated that boulders larger than approximately 0.7 to 1 feet (0.2 to 0.3 meters) would be avoided or relocated outside of the final installation corridor to create an installation corridor wide enough and allow the installation tool to proceed unobstructed along the seafloor. Tools for moving the boulders are available for boulders up to approximately 7 feet (2 meters) in size. Any large boulders along the final OECCS may need to be relocated prior to cable installation to facilitate installation without any obstructions to the burial tool and better ensure sufficient burial. Boulder relocation would be accomplished either by means of a grab tool suspended from a vessel's crane that lifts individual boulders clear of the route or by using a plow-like tool that is towed along the route to push boulders aside. Boulders would be shifted perpendicular to the cable route; no boulders would be removed from the site (COP Volume I, Sections 3.3.1.3.2 and 4.3.1.3.2; Epsilon 2022). Additionally, at least 90 days prior to inter-array cable corridor preparation and cable installation (e.g., boulder relocation, pre-cut trenching, cable crossing installation, cable lay and burial) and foundation site preparation (e.g., scour protection installation), the applicant will provide BOEM and BSEE with a boulder relocation plan, which will include the following:

- Identification of areas of active (within last 5 years) bottom-trawl fishing, areas where boulders greater than approximately 6 feet in diameter are anticipated to occur, and areas where boulders are expected to be relocated for proposed Project purposes;
- Methods to minimize the quantity of seafloor obstructions from relocated boulders in areas of active bottom-trawl fishing.

BOEM and BSEE will review the plan and provide comments, if any, on the plan within 45 calendar days, but no later than 90 days, of the plan's submittal. The applicant must resolve all comments to BOEM and BSEE's satisfaction before the plan is implemented.

Following the pre-grapnel run, some dredging of the upper portions of sand waves may be required within the OECC to allow for effective cable laying. The majority of dredging would occur on large sand waves, which are mobile features predominantly located along the OECC within Muskeget Channel (COP Volume II-A, Section 2.1.3; Epsilon 2022).

The applicant anticipates that dredging would occur within a corridor that is 50 feet (15 meters) wide and 1.6 feet (0.49 meters) deep, and potentially as deep as 17 feet (5.2 meters) in localized areas. The applicant is proposing to lay most of the inter-array cable and offshore export cable using simultaneous lay and bury via jet embedment. Cable burial would likely use a tool that slides along the seafloor on skids or tracks (up to 3.3 to 10 feet ([1.0 to 3.0 meters wide]), which would not dig into the seafloor but would still cause temporary disturbance. The installation methodologies for Phase 1 are described in detail in the COP (Volume I, Section 3.3.1.3; Epsilon 2022).

For the installation of the two cables during Phase 1, total dredging could temporarily disturb up to 52 acres (0.21 km^2) and could include up to 134,800 cubic yards (102,450 cubic meters) of dredged material (COP Appendix III-T; Epsilon 2022). For the installation of up to three cables during Phase 2, total dredging could affect up to 67 acres (0.27 km^2) and could include up to 235,400 cubic yards (179,976 cubic meters) of dredged material (COP Appendix III-T; Epsilon 2022). The applicant could use several techniques to accomplish the dredging: trailing suction hopper dredge (TSHD) or jetting (also known as mass flow excavation).[7] TSHD would discharge the sand removed from the vessel within the

[7] TSHD can be used in sand waves of most sizes, whereas the jetting technique is most likely to be used in areas where sand

2,657-foot-wide (809.9-meter-wide) cable corridor.[8] Jetting would use a pressurized stream of water to push sand to the side. The jetting 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, which allows the cable to settle into the trench. This process causes the top layer of sand to be ejected to either side of the trench; therefore, jetting would both remove the top of the sand wave and bury the cable. Typically, a number of passes are required to lower the cable to the minimum target burial depth. All dredged material during construction of the Proposed Action would be disposed of within the sand waves in the Project area (COP Volume I, Sections 3.3 and 4.3; Epsilon 2022).

Protection conduits installed at the approach to each WTG and ESP foundation would protect all offshore export cables and inter-array cables. In the event that cables cannot achieve proper burial depths or where the proposed offshore export cable crosses existing infrastructure, the applicant could use the following protection methods: rock placement, concrete mattresses, gabion rock bags, or half-shell pipes or similar. The applicant has conservatively estimated up to 6 percent of the inter-array and offshore export cables would require one of these protective measures. The applicant has conservatively estimated up to 6 percent of the inter-array and offshore export cables would require one of these protective measures.

Vessel types proposed for the cable installation could be DP vessels, anchored vessels, self-propelled vessels, and/or barges. Typical cable installation speeds are expected to range from 100 to 200 meters per hour (5.5 to 11 feet per minute), and it is expected that offshore export cable installation activities would occur 24 hours per day (COP Volume I, Section 3.3.1.3.6; Epsilon 2022).

1.4.1.2.5 Unexploded Ordnance Detonations

Initial geophysical survey results suggest there is a moderate risk of encountering UXOs within the SWDA and OECC. The preferred approach of under the Proposed Action if UXOs are encountered is avoidance in which the WTG and ESP foundations and associated cables would be relocated to avoid the UXOs. There may be instances where avoidance of the UXOs are not feasible, so in-situ detonation would be required during construction. For UXOs where avoidance is not possible, the Proposed Action would first pursue the less impactful options for disposal such as:

- Avoidance: Relocating the construction activity away from the UXO;
- Lift and shift: Moving the UXO away from the activity;
- Cut and capture: Cutting the UXO open to apportion large ammunition or deactivate fused munitions;
- Low-order disposal: Using shaped charges to reduce the net explosive yield of a UXO;
- Deflagration: Using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously; and
- High-order disposal: Using a bulk charge to execute a controlled disposal of the UXO.

In instances where these options are not feasible due to restrictions in the proposed Project layout or where considered unsafe for Project personnel, UXOs may need to be detonated in-situ to continue construction activities such as foundation installation and cable-laying activities. The selection of the

waves are less than 6.6 feet (2.0 meters) high. Therefore, the sand wave dredging could be accomplished entirely by the TSHD, or the dredging could be accomplished by a combination of jetting and TSHD, where jetting would be used in smaller sand waves, and the TSHD would be used to remove the larger sand waves.

[8] The applicant anticipates that the TSHD would dredge along the OECC until the hopper was filled to an appropriate capacity; then the TSHD would sail over 600 feet (183 meters) away (while remaining within the 2,657-foot (809.9-meter) corridor) and bottom dump the dredged material.

disposal method would be determined by the size, location, and condition of each individual UXO that the proposed Project may encounter (JASCO 2022). If detonation of UXOs is necessary, detonation noise has the potential to cause non-auditory injuries, potential mortal injuries, permanent threshold shift (PTS) or temporary threshold shift (TTS) in marine mammals, sea turtles, and marine fish. Therefore, this activity is assessed in this BA. It is currently assumed up to 10 UXOs may require in-situ detonation over 2 years of construction (6 in Year 1[2025] and 4 in Year 2 [2026]), as detailed further in Section 3.2.6.2.3.

1.4.1.2.6 Construction Ports and Vessel Traffic

The applicant has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used for major Phase 1 and Phase 2 construction staging activities. In addition, some components, materials, and vessels could come from Canadian and European ports (Table 1-9 and Table 1-10). Importantly, it is not expected that all the ports identified will be used; instead, it is more likely that only some ports would be used during construction depending upon final construction logistics planning. Additionally, estimates of vessels trips for each individual port presented in Table 1-9 and Table 1-10 are not additive among the ports under consideration, and it is not expected that all of these ports would be used simultaneously. New Bedford Harbor is expected to be the primary port used to support construction activities, though ports in Connecticut, Rhode Island, and Martha's Vineyard, Massachusetts, would also be used (Table 1-9).

Each port facility under consideration for Phase 1 and Phase 2 is either already located within an industrial waterfront area with sufficient existing infrastructure or is identified as an area where other entities intend to develop infrastructure with the capacity to host construction activities under the Phase 1 schedule. The applicant does not propose to direct or implement any potential port improvements specifically to support Phase 1 or Phase 2. In selecting the ports for Phase 1 and Phase 2 construction and operations, the applicant would consider the suitability of existing ports listed in Table 1-9, including upgrades planned or completed by the port owners. Therefore, no port upgrades would occur as a direct result of Phase 1 or Phase 2 (COP Volume I, Section 3.2.2.5; Epsilon 2022).

The applicant would use a wide variety of vessels during Proposed Action construction, ranging from tugboats (52 to 115 feet [16 to 35 meters] in length) to jack-up, heavy-lift, and heavy transport vessels (more than 700 feet [213 meters] in length) (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). During each phase, the applicant anticipates an average of approximately 30 vessels operating during a typical workday in the SWDA and along the OECC (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). Approximately 60 vessels could be present during the period of maximum construction activity at the start of WTG installation (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). Many construction vessels would remain at the SWDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning as needed (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). For example, during foundation and WTG installation, the main installation vessel(s) and any support vessels(s) would likely remain at the SWDA (or in the immediate vicinity) while supply vessels, jack-up vessels, barges, and/or tugs provide a continuous supply of components to the SWDA. Therefore, although an average of approximately 30 vessels would be present in the SWDA during construction of each phase, fewer vessels would transit to and from port each day. Construction activity would vary over the course of the construction period; the estimates provided in Table 1-10, therefore, are not the expected number of trips that would occur each day and month throughout the entire construction period but, instead, are maximum averages.

Approximately 3,200 total vessel round trips are expected to occur during offshore construction of Phase 1, which equates to an approximate average of 6 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 3.3.1.12.1; Epsilon 2022). Approximately 3,800 total vessel round trips are expected to occur during offshore construction of Phase 2, which equates to an approximate average of 7 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 4.3.1.12.1; Epsilon 2022). Due to the range of buildout scenarios for Phases 1 and 2, the applicant expects the total number of vessel trips from both phases of proposed Project combined (approximately 6,700 total round vessel trips) to be less than the sum of vessel trips estimated for each phase independently. During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). Peak construction vessel activity is expected to occur during pile-driving activities. Peak, average, and total vessel trips to port during proposed Project construction is presented in Table 1-10.

Estimates of vessel traffic associated with both phases of proposed Project construction (Table 1-10) assume that Phase 2 construction begins immediately following Phase 1 construction. In this scenario, each major construction activity would be sequential for the two phases (e.g., Phase 2 foundation installation would immediately follow Phase 1 foundation installation). However, there could be some overlap of different offshore activities between Phase 1 and Phase 2 (e.g., Phase 2 foundation installation could occur at the same time as Phase 1 WTG installation). As a result, although offshore construction of each individual phase could take approximately 18 months, for the purposes of estimating vessel trips, it was assumed that the total duration of offshore construction for both phases (combined) was 31 months. A total of approximately 6,700 vessel trips over a 31-month construction period results in an average of approximately 215 vessel trips per month. For the purposes of estimating vessel trips, tugboats and barges are considered one vessel.

There is uncertainty regarding which port may be used for any given activity. Table 1-10 provides the maximum scenario for all ports combined and each port individually. More specifically, for each port grouping, the “Expected Average Round Trips Per Day,” “Average Round Trips Per Month,” and “Approximate Total Round Trips” are the maximum number of vessel trips that could occur from each individual port listed in that grouping (not the maximum number of vessel trips for all ports in the grouping combined) and are not additive among the ports under consideration. For example, in a maximum-case scenario, Bridgeport could have up to approximately 5,500 vessel trips, or Vineyard Haven could have up to 5,500 vessel trips of the 6,700 total vessel trips from all ports estimated during construction (for both phases, combined), with the remaining 1,200 vessel trips occurring out of one or more other ports (including other ports within the Bridgeport-Vineyard Haven-Davisville-South Quay grouping) such that estimated maximum total number of vessel trips would still be approximately 6,700. To further illustrate this, consider the following hypothetical scenario: assume that vessel trips out of New Bedford Harbor are at the maximum expected for that port over the entire construction period, or 6,500 round trips. Given that the total for all ports throughout the entire duration of Phase 1 and Phase 2 construction is 6,700, only 200 vessel round trips would be expected to originate from other ports, combined. If Paulsboro and Salem Harbor are the only other ports considered in this hypothetical scenario, up to (and not exceeding) 100 round trips could originate from Paulsboro, which would leave the remaining 100 round trips originating from Salem Harbor. If only 50 round trips originated from Paulsboro, then the remaining 150 round trips would originate from Salem Harbor. As explained previously, the vessel data is presented in this manner due to the high degree of uncertainty at this stage regarding precisely which ports will be utilized for which identified activity. Given this, the analysis presented in this BA (Section 3) assumes the maximum case scenario for each potential port under consideration.

The applicant anticipates that WTG and ESP components, as well as offshore export cables, would be shipped from Canadian and European ports. Transport vessels originating from overseas would likely transport components either to an installation vessel or to a U.S. port; vessels would likely remain at the SWDA or port facility for several days at a time to offload the components. Representative vessels used for construction that may transit to and from Europe are presented in Table 1-11. Based on this information, it is estimated that up to approximately 27 vessels could transit to and from European ports during Project construction (Table 1-11). Therefore, during a period when several construction activities overlap (i.e., during the peak construction period), there could be as many as 31 total vessel trips to and from a European port (this includes trips partially completed during that month) (Table 1-10). Further, it is estimated that there could be up to 215 round vessel trips to and from European ports in any given year during the construction of both Phases, combined, and the estimated total number of vessel trips from European ports over the entire construction period is 400 round trips (Table 1-10). Specific European ports are not identified in the COP. During the peak construction period, up to 38 vessel round trips, maximum, per month would occur between the Project area and ports in Canada (Table 1-10). A maximum average of 21 round trips per month are anticipated over the entire construction period from Canada (Table 1-10). Vessels that transit to and from ports in Canada and Europe may include cable-laying vessels, cable/scour protection installation vessels (e.g., fall-pipe vessels), dredging vessels, heavy lift vessels, heavy transport vessels, jack-up vessels, service operations vessels, support vessels, and/or tugboats.

The maximum number of vessels at any one time is dependent on the proposed Project's final construction schedule for each phase, the number of WTGs and ESPs installed, the final design of the offshore facilities, the ports ultimately used, and logistics solutions used to achieve compliance with the Jones Act (COP Volume I, Section 3.3.1.12.1; Epsilon 2022). For these reasons, the estimates of vessel counts and vessel trips provided are likely conservative and subject to change. Representative vessels used during Phase 1 and Phase 2 construction activities, including approximate vessel speeds and estimated number of transits, are presented in Table 1-12. The size and displacement of the representative vessels used for proposed Project construction is presented in Table 1-13.

Table 1-9: Potential Ports Used for Construction, Operations, and Decommissioning of the Proposed Action

Geography	Ports
Massachusetts	New Bedford Marine Commerce Terminal, other areas in New Bedford Harbor, Brayton Point Commerce Center, Vineyard Haven, Fall River, Salem
Rhode Island	Port of Davisville, Port of Providence, South Quay Terminal
Connecticut	Bridgeport, New London State Pier
New York	Capital Region ports (Port of Albany, Coeymans, and New York State Offshore Wind Port), Staten Island Ports (Arthur Kill and Homeport Pier), South Brooklyn Marine Terminal, GMD Shipyard, Shoreham
New Jersey	Paulsboro
Atlantic Canada	Halifax, Nova Scotia; Sheet Harbor, Nova Scotia; Saint John, New Brunswick
Europe	Specific ports currently unknown

Table 1-10: Maximum Scenario of Vessel Trips to Ports Under Consideration During Project Construction[a]

	Peak Construction Period	Over Construction Period	
Ports	Average Round Trips Per Month[b]	Average Round Trips Per Month[b]	Approximate Total Round Trips[b]
All ports	443	215	6,700
New Bedford Harbor	443	209	6,500

Ports	Peak Construction Period	Over Construction Period	
	Average Round Trips Per Month[b]	Average Round Trips Per Month[b]	Approximate Total Round Trips[b]
Bridgeport	376	177	5,500
Vineyard Haven			
Port of Davisville			
South Quay Terminal			
Port of Providence	162	68	2,100
Brayton Point Commerce Center			
Fall River			
New London State Pier			
Staten Island ports			
South Brooklyn Marine Terminal GMD Shipyard			
Shoreham			
Salem Harbor	46	20	610
Canadian ports	38	21	620
European ports	31	13	400
Capital Region ports	6	3	100
Paulsboro			

Source: Derived from Table 7.8-3, COP Volume III; Epsilon 2022

[a] The numbers presented in this table are the maximum number of vessel trips that could occur from each individual port listed in that grouping (not the maximum number of vessel trips for all ports in the grouping combined) and are not additive among the ports under consideration. It is also not expected that all ports would be used simultaneously.

[b] All trips presented in this table are rounded to the nearest whole number.

Table 1-11: Representative Vessels Used for Proposed Project Construction that may Transit to and from Europe

Vessel Role	Expected Vessel Type	Number of Vessels
Foundation installation		
Scour protection installation	Scour protection installation vessel (e.g., fall-pipe vessel)	1
Overseas foundation transport	Heavy transport vessel	2–5
Foundation installation (possibly including grouting)	Jack-up vessel or heavy lift vessel	1–2
ESP installation		
ESP installation	Heavy lift vessel	1
Overseas ESP transport	Heavy transport vessel and/or tugboat	1–2
Offshore export cable installation		
Cable laying (and potentially burial)	Cable-laying vessel	1–2
Trenching	Cable-laying vessel or support vessel	1
Install cable protection	Cable protection installation vessel (e.g., fall-pipe vessel)	1
Inter-array cable installation		
Cable laying (and potentially burial)	Cable-laying vessel	1
Cable installation support	Support vessel	1
Trenching	Cable-laying vessel or support vessel	1
Install cable protection	Cable protection installation vessel (e.g., fall-pipe vessel)	1
WTG installation and commissioning		
Overseas WTG transport	Heavy transport vessel	1–5
Overseas transport of WTG installation vessel(s)	Heavy transport vessel	1
WTG installation	Jack-up vessel or heavy lift vessel	1–2
	Total Number of Vessels	**16–27**

Source: JASCO 2022

ESP = electrical service platform; OECC = offshore export cable corridor; SWDA = Southern Wind Development Area; UXO = unexploded ordnance; WTG = wind turbine generator

Table 1-12: Representative Vessels Used for Proposed Project Construction

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed: Typical Operational Speed (Knots)	Approximate Vessel Speed: Maximum Transit Speed (Knots)	Estimated Number of Round Trips: Both Phases	Estimated Number of Round Trips: Phase 1	Estimated Number of Round Trips: Phase 2
Foundation installation								
Scour protection installation	Scour protection installation vessel (e.g., fall-pipe vessel)	1	At most, vessel would likely make one round trip from port to the SWDA per foundation to deposit rock material.	10–14	14	130	64	79
Overseas foundation transport	Heavy transport vessel	2–5	Vessels would likely transport sets of foundations directly to the main foundation installation vessel or to a U.S. port. Vessels would likely remain at the SWDA or port facility for several days at a time to offload foundations.	12–18	12–18	51	26	32
Foundation installation (possibly including grouting)	Jack-up vessel or heavy lift vessel	1–2	Vessel(s) would likely remain at the SWDA for the duration of foundation installation, except to travel infrequently to a sheltered area to bunker fuel or seek shelter from weather (if needed).	0–10	6.5–14	4	2	2
Tugboat to support main foundation installation vessel(s)	Tugboat	1	Vessel would likely remain at the SWDA for the duration of foundation installation, except to make port calls approximately every 2 weeks.	10–14	10–14	21	10	13
	Barge	2–5		10–14	10–14			
Transport of foundations to SWDA	Tugboat	2–5	If foundations are staged from a U.S. port, pairs of tugboats would likely bring barges loaded with sets of foundation components to the SWDA. Vessels would likely remain at the SWDA for 1 or more days at a time to offload foundations.	8–10	10–14	48	24	30

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
Secondary work and possibly grouting	Support vessel or tugboat	1	Vessel would likely make one round trip from port to the SWDA per foundation, with each trip to the SWDA lasting approximately 1 day.	10–14	14	134	65	81
Crew transfer	Crew transfer vessel	1–3	Vessel(s) would likely make daily round trips to the SWDA throughout the duration of foundation installation.	10–25	25	266	129	161
Noise mitigation	Support vessel or anchor handling tug supply vessel	1	Vessel would likely remain at the SWDA for the duration of foundation installation, except to make port calls approximately every 2 weeks.	10	13	21	10	13
Acoustic monitoring	Support vessel or tugboat	1	Vessel would likely remain at the SWDA for the duration of foundation installation, except to make port calls approximately every 2 weeks.	10–14	14	21	10	13
Marine mammal observers and environmental monitors	Crew transfer vessel	2–6	Vessel(s) would likely make daily round trips to the SWDA throughout the duration of foundation installation.	10	25	798	387	483
ESP installation								
ESP installation	Heavy lift vessel	1	Vessels would remain at the SWDA for the duration of ESP installation, except to travel infrequently to a sheltered area to bunker fuel or seek shelter from weather (if needed).	0–12	6.5–14	2	1	1
Overseas ESP transport	Heavy transport vessel and/or tugboat	1–2	Vessel(s) would likely transport one ESP at a time to the main ESP installation vessel or to a U.S. port. Vessels would likely remain at the	10–18	13–18	24	10	14

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
			SWDA or port facility for several days at a time to offload ESPs.					
ESP transport to SWDA (if required)	Heavy transport vessel and/or tugboat	1–4	If ESPs are staged from a U.S. port, vessel(s) would likely transport one ESP at a time to the SWDA. Vessels would likely remain at the SWDA for 1 or more days at a time to offload the ESP.	0–14	14			
Crew transfer	Crew transfer vessel	1	Vessel would likely make daily round trips to the SWDA throughout the duration of ESP installation and commissioning.	10–25	25	602	301	301
Service boat	Crew transfer vessel or support vessel	1	Vessel would likely make one round trip per month lasting 1 day each to deliver supplies to the accommodation vessel.	10–25	25	22	11	11
Crew accommodation vessel during commissioning	Jack-up	1	Vessel would likely remain in the SWDA for the duration of ESP commissioning.	0–6	6	6	3	3
	Accommodation vessel	1		10	13.5			
Offshore export cable installation								
Pre-lay grapnel run	Support vessel	1	At most, vessel would make daily trips to the OECC to perform a pre-lay grapnel run along the offshore export cable alignments.	4–15	15	86	31	55
Pre-lay survey	Survey vessel or support vessel	1	At most, vessel would make daily trips to the OECC to perform a pre-lay survey along the offshore export cable alignments.	4–14	25–30	107	39	68

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
Boulder clearance	Support vessel	1	At most, vessel would make daily trips to the OECC to perform boulder clearance.	5–12	12	152	55	97
Dredging	Dredging vessel	1	If dredging is needed, vessel would likely perform dredging along the OECC in one or two continuous trips.	10–16	16	4	2	2
Cable laying (and potentially burial)	Cable-laying vessel	1–2	Vessel(s) would likely remain in the OECC for the duration of offshore export cable installation, except to re-load cables every several weeks (if needed).	5–8	14	12	4	8
Trenching (*moved from below*)	Cable-laying vessel or support vessel	1	If trenching is needed, vessel would likely remain at the OECC for the duration of offshore export cable installation, except to make infrequent port calls every several weeks (if needed).	10	15			
Support main vessel with anchor handling	Tugboat or anchor handling tug supply vessel	1–3	Vessel(s) would likely remain at the OECC for the duration of offshore export cable installation, except to make infrequent port calls every several weeks (if needed).	5–14	10–14	24	8	16
Cable landing	Tugboat, jack-up vessel, or anchor handling tug supply vessel	1	Vessel would likely make trips to the OECC once every 1 or 2 weeks, with each trip lasting approximately 1 day.	10–14	10–14	12	5	7
Shallow water cable burial	Cable-laying vessel	1	Vessel would likely make one round trip to the OECC per cable, with each trip lasting approximately 1 or 2 weeks.	0–10	10	7	3	4

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
Install cable protection	Cable protection installation vessel (e.g., fall-pipe vessel)	1	Vessel would likely remain at the OECC for several days at a time to install cable protection and return to port (as needed) to reload cable protection.	10–14	14	6	2	4
Crew transfer	Crew transfer vessel	1	Vessel would likely make daily round trips to the OECC throughout the duration of offshore export cable installation.	10–25	25	162	58	103
Safety vessel	Crew transfer vessel	1	Vessel would likely remain at the OECC for the duration of offshore export cable installation, except to make port calls approximately every 2 weeks.	10–25	25	88	35	53
Inter-array cable installation								
Pre-lay grapnel run	Support vessel	1	Vessel would likely perform the pre-lay grapnel run along the entire length of the inter-array cables in one continuous trip but may make port calls during the campaign.	4–15	15	18	9	12
Pre-lay survey	Survey vessel or support vessel	1	Vessel would likely survey the entire length of the inter-array cables in one continuous trip but may make port calls during the survey campaign.	4–14	25–30	18	9	12
Cable laying (and potentially burial)	Cable-laying vessel	1	Vessel would likely remain at the SWDA for the duration of inter-array cable installation, except to re-load cables every few weeks (if needed).	5–8	14	8	4	5
Cable installation support	Support vessel	1	Vessel would likely remain at the SWDA for the duration of inter-array cable installation but may make port calls every few weeks (if needed).	5–12	12	10	5	7

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
Crew transfer	Crew transfer vessel	2	Vessels would likely make daily round trips to the SWDA throughout the duration of inter-array cable installation.	10–25	25	604	286	412
Cable termination and commissioning	Support vessel	1	Vessel would likely remain at the SWDA for the duration of inter-array cable installation but may make port calls every few weeks (if needed).	10–12	12	18	9	12
Trenching	Cable-laying vessel or support vessel	1	Vessel would likely remain at the SWDA for the duration of inter-array cable installation but may make port calls every few weeks (if needed).	10–15	15	18	9	12
Install cable protection	Cable protection installation vessel (e.g., fall-pipe vessel)	1	Vessel would likely remain at the SWDA for 1 or more days at a time to install cable protection and return to port (as needed) to reload cable protection.	10–14	14	10	5	7
Safety vessel	Crew transfer vessel	1	Vessel would likely remain at the SWDA for the duration of inter-array cable installation, except to make port calls approximately every 2 weeks.	10–25	25	24	11	16
WTG installation and commissioning								
Overseas WTG transport	Heavy transport vessel	1–5	Vessel(s) would likely transport sets of WTG components to a U.S. port. Vessels would likely remain at the port facility for several days at a time to offload WTGs.	14–18	14–18	86	42	53

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
Overseas transport of WTG installation vessel(s)	Heavy transport vessel	1	Vessel would likely make a limited number of overseas trips to transport the WTG installation vessel(s), if needed. Vessels would likely remain at the SWDA or at a sheltered location nearby for several days at a time to offload the vessel.	10–11.5	11.5	4	2	2
WTG transport to SWDA	Jack-up vessels or tugboat	2–6	Vessels would likely take turns transporting one or more WTGs at a time to the main WTG installation vessel(s). Vessels would likely remain at the SWDA for 1 or more days at a time to offload WTG components.	0–10	13–14	137	65	84
WTG transport assistance	Tugboat	1–6	Vessel(s) would likely remain at the SWDA for the duration of WTG installation, except to make port calls approximately every 2 weeks.	0–10	13–14	60	28	36
WTG installation	Jack-up vessel or heavy lift vessel	1–2	Vessel(s) would likely remain at the SWDA for the duration of WTG installation, except to travel infrequently to a sheltered area to bunker fuel or seek shelter from weather (if needed).	0–10	8–13	34	17	21
Crew transfer	Crew transfer vessel	3	Vessels would likely remain at the SWDA for the duration of WTG installation and commissioning, making port calls approximately every 4 days.	10–25	25	341	166	210
WTG commissioning vessel	Service operations vessel	1	Vessel(s) would likely remain at the SWDA for the duration of WTG commissioning, except to make port calls approximately every 2 weeks.	10–12	13	36	17	22

Vessel Role	Expected Vessel Type	Number of Vessels	Description of Anticipated Activity (Subject to Change)	Approximate Vessel Speed		Estimated Number of Round Trips		
				Typical Operational Speed (Knots)	Maximum Transit Speed (Knots)	Both Phases	Phase 1	Phase 2
Miscellaneous construction activities								
Crew transfer	Crew transfer vessel or service operations vessel	1–4	Crew transfer vessel(s) would likely make daily round trips to the SWDA throughout the duration of construction (weather permitting) whereas the service operations vessel(s) would likely remain at the SWDA for the duration of construction, except to make port calls approximately every 2 weeks.	10–25	25	2,336	1,168	1,168
Refueling	Crew transfer vessel or support vessel	1	Vessel would travel to the SWDA or a nearby sheltered area (as needed) to refuel vessels.	10–25	25	46	21	28
Geophysical, geotechnical, and UXO survey operations	Survey vessel or support vessel	1–3	Vessel(s) would likely remain at the SWDA for the duration of survey works, except to make port calls approximately every 2 weeks.	4–14	25–30	34	16	21

Source: JASCO 2022
ESP = electrical service platform; OECC = offshore export cable corridor; SWDA = Southern Wind Development Area; UXO = unexploded ordnance; WTG = wind turbine generator

Table 1-13: Size and Displacement of Representative Vessels Used for Proposed Project Construction

Vessel Role	Vessel Type	Approximate Size		Displacement	
		Width	Length	Gross Tonnage	Deadweight
Foundation installation					
Scour protection installation	Scour protection installation vessel (e.g., Fall-pipe Vessel)	30–45 meters (98–148 feet)	130–170 meters (427–558 feet)	15,000–28,000 tons (16,535–30,865 U.S. tons)	25,000 tons (27,558 U.S. tons)
Overseas foundation transport	Heavy transport vessel	24–56 meters (79–184 feet)	120–223 meters (394–732 feet)	12,000–25,000 tons (13,228–27,558 U.S. tons)	10,000–62,000 tons (11,023–68,343 U.S. tons)
Foundation installation (possibly including grouting	Jack-up vessel or heavy lift vessel	40–106 meters (131–346 feet)	154–220 meters (505–722 feet)	20,000–50,000 tons (22,046–55,116 U.S. tons)	10,000–80,000 tons (11,023–88,185 U.S. tons)
Tugboat to support main foundation installation vessel(s)	Tugboat	6–10 meters (20–33 feet)	16–35 meters (52–115 feet)	75–500 tons (83–551 U.S. tons)	50–200 tons (55–220 U.S. tons)
Transport of foundations to SWDA	Barge	~25 meters (82 feet)	100 meters (328 feet)	NA	9,600 tons (10,582 U.S. tons)
Transport of foundations to SWDA	Tugboat	~10 meters (33 feet)	~35 meters (115 feet)	200–500 tons (220–551 U.S. tons)	200–300 tons (220–331 U.S. tons)
Secondary work and possibly grouting	Support vessel or tugboat	~10 meters (33 feet)	30–80 meters (98–262 feet)	500–900 tons (551–992 U.S. tons)	120 tons (132 U.S. tons)
Crew transfer	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Noise mitigation	Support vessel or anchor handling tug supply vessel	~15 meters (49 feet)	65–90 meters (213–295 feet)	1,900–3,000 tons (2,094–3,307 U.S. tons)	2,200–3,000 tons (2,425–3,307 U.S. tons)
Acoustic monitoring	Support vessel or tugboat	~10 meters (33 feet)	~30 meters (98 feet)	50–500 tons (55–551 U.S. tons)	20 tons (22 U.S. tons)
Marine mammal observers and environmental monitors	Crew transfer vessel	~7 meters (23 feet)	~20 meters (66 feet)	NA	NA
ESP installation					
ESP installation	Heavy lift vessel	40–106 meters (131–346 feet)	154–220 meters (505–722 feet)	NA	10,000–48,000 tons (11,023–52,911 U.S. tons)
Overseas ESP transport	Heavy transport vessel	24–40 meters (79–131 feet)	20–223 meters (66–732 feet)	12,000–50,000 tons (13,228–55,116 U.S. tons)	10,000–62,000 tons (11,023–68,343 U.S. tons)
ESP transport to SWDA (if required)	Tugboat	~10 meters (33 feet)	~35 meters (115 feet)	200–500 tons (220–551 U.S. tons)	200–300 tons (220–331 U.S. tons)

Vessel Role	Vessel Type	Approximate Size		Displacement	
		Width	Length	Gross Tonnage	Deadweight
Crew transfer	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Service boat	Crew transfer vessel or support vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Refueling operations to ESP	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Crew accommodation vessel during commissioning	Jack-up	~40 meters (131 feet)	~55 meters (180 feet)	500 tons (551 U.S. tons)	NA
	Accommodation vessel	10–12 meters (33–39 feet)	70–100 meters (230–328 feet)	800–9,000 tons (882–9,921 U.S. tons)	120–4,500 tons (132–4,960 U.S. tons)
Offshore export cable installation					
Pre-lay grapnel run	Support vessel	8–15 meters (26–49 feet)	30–70 meters (98–230 feet)	700–4,000 tons (772–4,409 U.S. tons)	2,200–2,500 tons (2,425–2,756 U.S. tons)
Pre-lay survey	Survey vessel or support vessel	6–26 meters (20–85 feet)	13–112 meters (43–367 feet)	1,500–15,000 tons (1,653–16,535 U.S. tons)	400–3,000 tons (441–3,307 U.S. tons)
Cable laying (and potentially burial)	Cable-laying vessel	22–35 meters (72–115 feet)	80–150 meters (262–492 feet)	7,000–16,500 tons (7,716–18,188 U.S. tons)	1,200–1,5000 tons (1,323–16,535 U.S. tons)
Boulder clearance	Support vessel	15–20 meters (49–66 feet)	75–120 meters (246–394 feet)	2500–8000 tons (2756–8818 U.S. tons)	2,000–7,000 tons (2,205–7,716 U.S. tons)
Support main vessel with anchor handling	Tugboat or anchor handling tug supply vessel	6–15 meters (20–49 feet)	16–65 meters (52–213 feet)	75–1,900 tons (83–2,094 U.S. tons)	50–2,200 tons (55–2,425 U.S. tons)
Trenching	Cable-laying vessel or support vessel	~25 meters (82 feet)	~128 meters (420 feet)	NA	~7,500 tons (8,267 U.S. tons)
Crew transfer	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Install cable protection	Cable protection installation vessel (e.g., fall-pipe vessel)	30–45 meters (98–148 feet)	130–170 meters (427–558 feet)	15,000–28,000 tons (16,535–30,865 U.S. tons)	25,000 tons (27,558 U.S. tons)
Dredging	Dredging vessel	~30 meters (98 feet)	~230 meters (755 feet)	33,423 tons (36,843 U.S. tons)	59,798 tons (65,916 U.S. tons)
Cable landing	Tugboat or jack-up vessel	6–15 meters (20–49 feet)	16–65 meters (52–213 feet)	75–1,900 tons (83–2,094 U.S. tons)	50–2,200 tons (55–2,425 U.S. tons)

Vessel Role	Vessel Type	Approximate Size		Displacement	
		Width	Length	Gross Tonnage	Deadweight
Shallow water cable burial	Cable-laying vessel	13 meters (43 feet)	34 meters (112 feet)	499 t (550 U.S. tons)	NA
Safety vessel	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Inter-array cable installation					
Pre-lay grapnel run	Support vessel	8–15 meters (26–49 feet)	30–70 meters (98–230 feet)	700–4,000 tons (772–4,409 U.S. tons)	2,200–2,500 tons (2,425–2,756 U.S. tons)
Pre-lay survey	Survey vessel or support vessel	6–26 meters (20–85 feet)	13–112 meters (43–367 feet)	1,500–15,000 tons (1,653–16,535 U.S. tons)	400–3,000 tons (441–3,307 U.S. tons)
Cable laying (and potentially burial)	Cable-laying vessel	22–35 meters (72–115 feet)	80–150 meters (262–492 feet)	7,000–16,500 tons (7,716–18,188 U.S. tons)	1,200–15,000 tons (1,323–16,535 U.S. tons)
Cable installation support	Support vessel	15–20 meters (49–66 feet)	75–120 meters (246–394 feet)	2,500–8,000 tons (2,756–8,818 U.S. tons)	2,000–7,000 tons (2,205–7,716 U.S. tons)
Crew transfer	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
Cable termination and commissioning	Support vessel	15–20 meters (49–66 feet)	75–120 meters (246–394 feet)	2,500–8,000 tons (2,756–8,818 U.S. tons)	2,000–7,000 tons (2,205–7,716 U.S. tons)
Trenching	Cable-laying vessel or support vessel	21–25 meters (69–82 feet)	95–128 meters (311–420 feet)	NA	4,700–7,500 t (5,180–8,267 U.S. tons)
Install cable protection	Cable protection installation vessel (e.g., fall-pipe vessel)	30–45 meters (98–148 feet)	130–170 meters (427–558 feet)	15,000–28,000 tons (16,535–30,865 U.S. tons)	25,000 tons (27,558 U.S. tons)
Safety vessel	Crew transfer vessel	7–12 meters (23–39 feet)	20–30 meters (66–98 feet)	100–150 tons (110–165 U.S. tons)	20–75 tons (22–83 U.S. tons)
WTG installation					
Overseas WTG transport	Heavy transport vessel	15–20 meters (49–66 feet)	130–150 meters (427–492 feet)	6,300–8,600 tons (6,945–9,480 U.S. tons)	8,000–9,400 tons (8,818–10,362 U.S. tons)
Overseas transport of WTG installation vessel(s)	Heavy transport vessel	~56 meters (184 feet)	~214 meters (702 feet)	NA	~64,900 tons (71,540 U.S. tons)
WTG transport to SWDA	Jack-up vessels or tugboat	6–50 meters (20–164 feet)	35–100 meters (115–328 feet)	4,000 tons (4,409 U.S. tons)	2,000–8,000 tons (2,205–8,818 U.S. tons)
WTG transport assistance	Tugboat	6–12 meters (20–40 feet)	15–38 meters (49–125 feet)	75–500 tons (83–551 U.S. tons)	50–200 tons (55–220 U.S. tons)

Vessel Role	Vessel Type	Approximate Size		Displacement	
		Width	Length	Gross Tonnage	Deadweight
WTG installation	Jack-up vessel or heavy lift vessel	35–55 meters (115–180 feet)	85–165 meters (279–541 feet)	15,000–25,000 tons (16,535–27,558 U.S. tons)	4,500–20,000 tons (4,960–22,046 U.S. tons)
Crew transfer	Crew transfer vessel	~7 meters (23 feet)	~20 meters (66 feet)	NA	NA
WTG commissioning					
WTG commissioning vessel	Service operations vessel	~18 meters (59 feet)	~80 meters (262 feet)	NA	~2,500 tons (2,756 U.S. tons)
Crew transfer	Crew transfer vessel	6–12 meters (20–39 feet)	15–30 meters (49–98 feet)	10–50 tons (11–55 U.S. tons)	6–20 tons (7–22 U.S. tons)
Miscellaneous Construction Activities					
Refueling	Crew transfer vessel or support vessel	~7 meters (23 feet)	~20 meters (66 feet)	NA	NA
Safety vessel	Crew transfer vessel	~7 meters (23 feet)	~20 meters (66 feet)	NA	NA
Geophysical and geotechnical survey operations	Survey vessel or support vessel	6–26 meters (20–85 feet)	13–112 meters (43–367 feet)	1,500–15,000 tons (1,653–16,535 U.S. tons)	400–3,000 tons (441–3,307 U.S. tons)

ESP = electrical service platform; NA = not applicable; SWDA = Southern Wind Development Area; WTG = wind turbine generator
Vessel descriptions/dimensions are based on the specification sheets of vessels that are representative of the type of vessels that will be used during Phase 1 construction; not all specification sheets provided information for each category. All values provided are subject to change.

1.4.2 Operations and Maintenance

1.4.2.1 Onshore Activities and Facilities

The onshore substation site, onshore export cables, and splice vaults for Phases 1 and Phase 2 would require minimal maintenance. The applicant would conduct inspections and repairs according to industry standards for land-based power transmission facilities.

1.4.2.2 Offshore Activities and Facilities

The Proposed Action would have a designed operating phase of approximately 30 years for each phase.[9]

The applicant will develop a preventive maintenance strategy that aligns with best industry practice. This preventive maintenance strategy will be regularly reviewed to ensure maintenance objectives are met and continuously improved. Ultimately, preventive maintenance aims to reduce or eliminate the need for corrective maintenance and contribute to the objective of maintaining good reliability and high availability (COP Volume I; Epsilon 2022). Scheduled inspections, surveys, and maintenance activities will generally include annual and statutory inspections of the WTGs, foundations, and ESP(s) (COP Volume I; Epsilon 2022).

In addition to the physical preventive maintenance, proactive inspections will be undertaken on a routine basis to ensure that the offshore facilities remain in a safe condition so that maintenance activities can be carried out. Geophysical survey work would likely be conducted to ensure adequate understanding of seabed conditions, particularly in areas of seabed change, and monitor components such as cables and scour protection. Geophysical instruments may include, but are not limited to, side scan sonar, single and multibeam echosounders, magnetometers/gradiometers, and sub-bottom/seismic profilers (COP Volume I; Epsilon 2022). It is expected that the cables would be surveyed within 6 months of commissioning, at Years 1 and 2, and every 3 years thereafter. This monitoring schedule may be adjusted over time based on results of the ongoing surveys (COP Volume I; Epsilon 2022).

The applicant would monitor operations continuously from the operations facilities and possibly other remote locations. Specifically, the applicant would use an operations facility in Bridgeport, Connecticut, Vineyard Haven or New Bedford, Massachusetts, or Greenport Harbor, New York. These operations facilities—which would include offices, control rooms, shop space, and pier space—have been or would be constructed by the port owners or operators to support the overall offshore wind industry. The applicant does not propose to direct or implement any port improvements; therefore, none of these activities would occur as a direct result of the Proposed Action (COP Volume I; Epsilon 2022).

Crew transfer vessels and helicopters would transport crews to the offshore Proposed Action components during operations. The Proposed Action would generate trips by crew transport vessels (about 75 feet [23 meters] in length), multipurpose vessels, and service operations vessels (260 to 300 feet [79 to 91 meters] in length). In addition to the service operations vessels, crew transfer vessels, and/or daughter craft, other larger support vessels (e.g., jack-up vessels) may be used infrequently to perform some routine maintenance activities, periodic corrective maintenance, and significant repairs (if needed). These vessels are similar to the vessels used during construction (see Table 1-12 and Table 1-13, with larger vessels based at the New Bedford Marine Commerce Terminal and smaller vessels based at the onshore operations facility located in Vineyard Haven, Massachusetts). However, other ports listed in Table 1-9 may be used to support operations activities. Although fewer details are known, it is anticipated that the

[9] The applicant's lease with BOEM (Lease OCS-A 0534) has an operations term of 25 years that commences on the date of COP approval. See https://www.boem.gov/Lease-OCS-A-0534/ at Addendum B; see also 30 CFR § 585.235(a)(3)). The applicant would need to request an extension of its operations term from BOEM to operate the Proposed Action for 30 years. For purposes of the maximum-impact scenario, this BA analyzes a 30-year operations term.

applicant would use the previously described port facilities in Bridgeport, Vineyard Haven, and/or New Bedford Harbor in support of operations activities during Phase 2. During Phase 1 and Phase 2 operations, there is no planned use of Canadian or European ports. While not anticipated, use of Canadian or other U.S. ports could occur to support an unplanned significant maintenance event, if such maintenance activity could not be accomplished using one of the U.S. ports identified.

For routine Phase 1 operations, an average of approximately 6 and up to 15 vessels could operate in the SWDA or along the OECC on any given day during operations, depending on the type of maintenance required; additional vessels may be required in other maintenance or repair scenarios. Approximately 250 vessel round trips are estimated to take place annually for Phase 1 operations. Vessel activity during Phase 2 operations would be similar to that of Phase 1. The proposed Project would likely share some vessels between Phases 1 and 2, thus consolidating trips while both phases are operating. Approximately 470 vessel round trips are estimated to take place annually during the simultaneous operations of both phases, which equates to an average of less than 2 vessel round trips per day. This number would reduce if trips were consolidated.

WTG gearbox oil would be changed after Years 5, 13, and 21 of service. Additional operations information can be found in COP Sections 3.3 and 4.3 (Volume I; Epsilon 2022).

1.4.3 Conceptual Decommissioning

According to 30 CFR Part 585 and other BOEM requirements, the applicant would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All foundations would need to be removed to a depth of 15 feet [4.6 meters] below the mudline (30 CFR § 585.910(a)). The applicant would be required to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all removed materials. The applicant has submitted a decommissioning plan as part of the COP (Volume 1, Section 3.3.3.4; Epsilon 2022), and the final plan would outline the applicant's process for managing waste and recycling proposed Project components (Volume I; Epsilon 2022). Although the proposed Project has a designed life span of 30 years, some installations and components could remain fit for continued service after this time. The applicant would need to apply for an extension to operate the proposed Project for more than the 30-year operations term stated in its lease.

BOEM requires the applicant to submit a decommissioning application upon the earliest of the following dates: 2 years before the expiration of the lease; 90 days after completion of the commercial activities on the commercial lease; or 90 days after cancellation, relinquishment, or other termination of the lease (30 CFR § 585.905). Upon completion of the technical and environmental reviews, BOEM can approve, approve with conditions, or disapprove the lessee's decommissioning application. This process includes an opportunity for public comment and consultation with municipal, state, and federal management agencies. The applicant would need to obtain separate and subsequent approval from BOEM to leave any portion of the proposed Project in place in compliance with all applicable law.

According to the decommissioning plan included in the COP (Volume I, Section 3.3.3.4; Epsilon 2022), the WTG and ESP fluids would be drained into vessels for disposal in onshore facilities before disassembling the structures and bringing them to port. Foundations would be temporarily emptied of sediment, cut 15 feet (4.6 meters) below the mudline in accordance with BOEM regulations (30 CFR § 585.910(a)), and removed. The portion of foundations buried below 15 feet (4.6 meters) would remain, and the depression refilled with the temporarily removed sediment. In consideration of mobile gear fisheries (i.e., dredge and bottom-trawl gear), the applicant would remove scour protection during decommissioning. Offshore cables could be retired in place or removed, subject to 30 CFR § 585.900 (COP Volume I, Section 3.3.3.4; Epsilon 2022).

Depending on the needs of the host locations, the applicant may leave onshore facilities in place for future use. Onshore cable removal, if required, would likely proceed using truck-mounted winches and handling equipment. There are no plans to disrupt streets or onshore public utility ROWs by excavating or deconstructing buried facilities. If the COP is approved or approved with modifications, the applicant would be required to submit a bond (or another form of financial assurance) held by the U.S. government to cover the cost of decommissioning the entire facility in the event that the applicant would not otherwise be able to decommission the facility.

Although exact details regarding vessel types, ports, and transit estimates are not known at this time, decommissioning vessel activities are expected to be similar to or slightly less than those anticipated for construction.

1.4.4 Monitoring Surveys

The monitoring surveys proposed to be implemented include HRG surveys (Section 1.4.4.1), benthic habitat monitoring (Section 1.4.4.2), and fisheries monitoring (Section 1.4.4.3). Currently, no submerged aquatic vegetation surveys are included under the Proposed Action, as the proposed OECC has been identified to avoid and minimize impacts on sensitive habitats where feasible. The preliminary routing of the Phase 1 and Phase 2 cables has avoided sensitive habitats including eelgrass, hard bottom, and complex bottom (i.e., sand waves) where feasible, but avoidance of all sensitive habitats is not always possible. The identified eelgrass resources along the south shore of Cape Cod in proximity to the landfall sites would be avoided. Additionally, the eelgrass resources in proximity to the potential Phase 2 landfall sites, located outside the OECC boundary, would be avoided. However, for each phase of the Proposed Action, prior to the start of construction, contractors would be provided with a map of sensitive habitats to allow them to plan their mooring positions accordingly. Vessel anchors and legs would be required to avoid known eelgrass beds and would also be required to avoid other sensitive seafloor habitats (hard/complex bottom) as long as such avoidance does not compromise the vessel's safety or the cable's installation.

1.4.4.1 High-Resolution Geophysical Surveys

Offshore and nearshore HRG surveys would be conducted just prior to construction, during construction, and post-construction for activities such as pre-lay surveys (Section 1.4.1.2.4), verifying site conditions, ensuring proper installation of proposed Project components, conducting as-built surveys, inspecting the depth of cable burial, and inspecting foundations. UXO surveys may also be conducted prior to the installation of the offshore facilities. HRG survey instruments may include side scan sonar, synthetic aperture sonar, single and multibeam echosounders, and magnetometers/gradiometers, which are all high frequency devices that operate above 180 kHz. Sub-bottom profilers and seismic reflection systems (i.e., single channel and multi-channel seismic profilers), which operate at frequencies below 180 kHz, may also be used to a lesser extent (JASCO 2023).

The applicant assumes that HRG surveys during construction would be conducted for 24 hours per day for 25 days each year (125 days total over the 5 years of construction for Phase 1 and Phase 2 covered under the draft ITA application [JASCO 2022, 2023]), beginning in the first year of foundation installation and extending 2 years beyond the estimated 3-year duration of foundation installation. It is currently assumed that HRG surveys under the Proposed Action would begin in January 2025. The HRG surveys would occur in four main areas of interest (Figures 1-7 through 1-10):

- Phase 2 South Coast Variant offshore routing envelope;
- Proposed Project OECC;
- Phase 2 OECC Western Muskeget Variant; and

- Maximum size of the SWDA.

The applicant proposes using multiple vessels to acquire the HRG survey data. Up to three HRG vessels are currently proposed to operate concurrently within the SWDA and OECC area. HRG survey activities would be conducted by nearshore and offshore vessels that can accomplish the survey goals in specific survey areas. Each vessel would maintain both the required course and a survey speed required to cover approximately 80 kilometers (43 nautical miles) per day during line acquisition, with consideration to weather delays, equipment maintenance, and crew availability. Vessel survey speed is anticipated to be approximately 4 knots (2.1 meters per second).

1.4.4.2 Benthic Habitat Monitoring Plan

The Benthic Habitat Monitoring Plan (BHMP) is based on the approved Vineyard Wind 1 BHMP and would replicate it to the greatest extent practicable, including sharing the same six habitat zones, sampling effort, sampling equipment types, sample station design, control sites, and timing. The BHMP focuses on seafloor habitat and benthic communities to measure potential impacts and the recovery of these resources compared to control sites located outside of the areas potentially impacted by construction activities. The BHMP includes grab sampling, multibeam bathymetric surveys, and underwater video pre- and post-construction.

The applicant would apply a combination before-after-gradient (BAG) and before-after-control-impact (BACI) sampling design, which places sample stations at regular distances from the impact source (either scour protection or OECC) along impact monitoring transects and sample stations placed outside impact monitoring areas to serve as controls. The proposed combination BAG/BACI design incorporates elements of each sampling design and would allow for a rigorous assessment of impacts and recovery.

Using a combination BAG/BACI design, sampling would occur at two randomly placed benthic monitoring transects within the one habitat zone of the lease area and within each of the five habitat zones in the OECC along the easternmost Phase 1 cable. The number of transects is based on the results of the power analysis (Appendix A), which suggests that two transects in each habitat zone (12 transects total), each with seven sampling stations, are required to detect a 25 percent difference in benthic community diversity pre- and post-construction (i.e., before and after impact), between impact and control monitoring areas, and between stations at different distances from the impact source, with sufficient statistical power.

The OECC transects would be placed along the easternmost Phase 1 cable to avoid confounding results from installation of other proposed Project offshore export cables, which would be installed to the west of the easternmost Phase 1 cable. At each site, video and multibeam echo sounder (i.e., bathymetry) surveys would be performed in a "t" pattern, with the long axis oriented perpendicular to the easternmost offshore export cable and the short axis oriented parallel to the cable alignment. The transects would extend 150 meters (492 feet)[10] to the east and 50 meters (164 feet) to the north, west, and south. Four grab stations, with three replicate grab samples collected at each station, would be sampled along a gradient extending east from the impact source (either scour protection or offshore export cable). Stations would be positioned within the impact area immediately adjacent to the impact source (0 meters) and at distances of 50 meters (164 feet), 100 meters (328 feet), and 150 meters (492 feet), with three replicate benthic grab samples collected at each sample station. Including three replicated grab samples at each station increases understanding of small-scale variability, improves the precision of the mean indices analyzed for each sample station in the analysis of variance, and increases capture of organisms that are

[10] In the unlikely event the South Coast Variant is used for Phase 2, sampling transects would extend up to 250 meters (820 feet) from the direct impact location (i.e., the cable trench). This distance is slightly longer than used for the OECC and is based on sediment transport modeling completed for the South Coast Variant, which predicted deposition above 1 millimeter thickness would occur at a maximum distance of 200 meters (656 feet) of the route centerline.

rare or patchily distributed while also reducing the effects of random variation at the station (Gotelli and Ellison 2004; Noble-James et al. 2017). Replicated grab samples would be processed separately to analyze variation within the station and then averaged for each sample station.

Video surveys would be captured along 300 meters (984 feet) of each impact monitoring transect, both perpendicular and parallel to the cable or WTG foundation. Three control stations, each comprising 100 meters (328 feet) of video footage and one benthic grab sample station (and three replicate grabs), would be placed some distance away from the nearest impact grab station. For OECC transects, a minimum of 1 kilometer (.62 mile) would be maintained between control and impact grab stations where geography allows within the bounds of a habitat zone, based on the distance at which differences in community indices observed in a gradient sampling design around an oil platform leveled off (Ellis and Schneider 1997). Control stations would be placed outside of the lease area boundary in the control survey area designated in the Fisheries Monitoring Plan (Section 1.4.4.3). Control areas would be selected to have similar physical and environmental characteristics to detect natural environmental shifts that may occur unrelated to proposed Project activities.

This sampling design of four sample stations along each of 12 impact monitoring transects (two transects in each of the six habitat types), with three replicate grab samples per station, yields 144 grab samples in monitoring areas. In the control areas, there would be an additional 108 grab samples (three control stations a distance away from each transect, with three replicate grab samples per station, for 12 impact monitoring areas), for a total of 252 grab samples for each annual survey (144 grabs in impact monitoring areas and 108 grabs in control areas). This configuration is designed to document the benthic variability in and around the zone of potential disturbance from cables or scour protection installation and allow for comparison between samples at different distances from the impact source. Additionally, 3,600 meters (11,811 feet) of video survey would be collected along the impact monitoring transects (300 meters [984 feet] of video per each of the 12 impact monitoring transects), and 3,600 meters (11,811 feet) of video survey would be collected along the control area transects (300 meters [984 feet] of video per the 12 control area monitoring transects), for a total of 7,200 meters (23,622 feet) of video collected per survey.

Collected grab sample and video data would be used to monitor the following parameters (as recommended by McCann 2012):

- Changes in the infaunal density, diversity, and community structure (benthic grabs);
- Changes to the seafloor morphology and structure (multibeam echo sounder);
- Changes in median grain size (benthic grab and underwater video); and
- Changes in abundance, diversity, and cover of epibenthic species, with focus on important species and those colonizing hard structures (i.e., reef effects; underwater video).

Vessels used for benthic habitat monitoring surveys would be research vessels ranging in size from 30 to 150 feet (9.1 to 46 meters). Transit speeds would be maintained as legally mandated (73 Fed. Reg. 60173 and 87 Fed. Reg. 46921 if adopted) and are not expected to be greater than 15 to 20 knots. The total number of vessels conducting benthic habitat monitoring surveys would likely include one to three vessels per survey, depending on the contractor selected for the works. Mobilization ports may vary but would likely consist of those in Rhode Island and Massachusetts. It is anticipated that benthic monitoring would occur pre-construction and Years 1, 3, and, if necessary, Year 5 after construction. The total duration of survey work is expected to last 30 to 60 days annually, including weather downtime. Additional detail regarding survey design, program schedule, and monitoring equipment and methods may be found in the Draft BHMP (Appendix A).

1.4.4.3 Fisheries Monitoring Plan

The applicant is proposing a comprehensive Fisheries Monitoring Plan to assess potential impacts of the proposed development on marine fish and invertebrate communities. The proposed monitoring plan incorporates multiple gear types using a range of survey methods to study different facets of the regional ecology and fisheries. The monitoring plan includes a demersal otter trawl survey, benthic optical drop camera survey, and ventless trap survey with integrated neuston net survey, lobster tagging study, and black sea bass (*Centropristis striata*) study. The implementation of the monitoring plan would provide a holistic assessment of the key fisheries resources in the lease area and assess the potential impact of offshore wind energy development with the use of a common control area. All fisheries monitoring surveys under the Proposed Action would be conducted in addition to existing and ongoing commercial fishing effort in the region.

Fisheries monitoring surveys have been developed for the proposed Project in accordance with the recommendations set forth in *Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf* (BOEM 2019b). Additional documents considered include Responsible Offshore Science Alliance's Offshore Wind Project Monitoring Framework and Guidelines (Responsible Offshore Science Alliance 2021), March 2022 Draft National Oceanic and Atmospheric Administration (NOAA) Fisheries and BOEM Federal Survey Mitigation Implementation Strategy-Northeast U.S. Region (Hare et al. 2022), and Recommended Regional Scale Studies Related to Fisheries in the Massachusetts and Rhode Island-Massachusetts Offshore WEAs (MA DMF 2018).

The purpose of fisheries monitoring surveys are to:

- Identify and confirm which dominant benthic, demersal, and pelagic species are using the Project area and when these species may be present;
- Establish a pre-construction baseline, which may be used to address whether detectable changes associated with the Proposed Action occurred in post-construction abundance and distribution of fisheries;
- Collect additional information aimed at reducing uncertainty associated with baseline estimates and 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 the Proposed Action.

The experimental design for all surveys would follow the BACI design. A control area would be designated with the goal of comparing catch rates, population structure, community composition, abundance, size distributions, vital biological statistics (sex ratio, condition factor, etc.), and environmental parameters (temperature, salinity, dissolved oxygen, substrate) over time to the SWDA. The monitoring plan is proposed to be 6 years in duration, including 2 years of pre-construction baseline monitoring, 1 year of monitoring during construction, and 3 years of post-construction monitoring. Additionally, it is assumed that all sampling under the Fisheries Monitoring Plan would be conducted in addition to existing fishing gear and levels of effort currently ongoing in the region. The surveys to be conducted under the Fisheries Monitoring Plan include:

- Demersal otter trawl: The demersal otter trawl, further referred to as a trawl, is a net that is towed behind a vessel along the seafloor expanded horizontally by a pair of otter boards or trawl doors. Trawls tend to be relatively indiscriminate in the fish and invertebrates they collect; hence trawls are a general tool for assessing fish communities along the seafloor and are widely used by institutions worldwide for fisheries and ecosystem monitoring. The trawl survey would be used to evaluate the impacts of development on demersal fish populations in the SWDA and control area. The trawl survey would be conducted four times per year to adequately capture the seasonal variation within the region, as recommended by BOEM (2019b): spring (April to June), summer (July to September), fall (October to December), and winter (January to March). Tow locations within the study areas would be selected using a spatially balanced sampling design. A total of 25 tows would be made in the SWDA (101,590 acres [411 km^2]) and another 25 tows in the control area each season for a total of 200 tows per year. The SWDA would be sub-divided into 25 sub-areas (approximately 4,052 acres [16.4 km^2]), and one tow would be made in each of the 25 sub-areas. This would ensure adequate spatial coverage throughout the survey area. The starting location of each tow in each sub-area would be randomly selected. During post construction surveys, the turbine footprint (including scour protection) plus a safe zone would be excluded. Two areas located to the southwest and west of the SWDA would be established as control regions (total area: approximately 100,325 acres [406 km^2]). The selected regions have similar depth contours, bottom types, and benthic habitats to the SWDA and are not currently leased for future development. A total of 25 tows would be completed in the control area (one tow every 16.2 km^2). Tow locations would be selected in the same manner as the SWDA. Each tow would be conducted for 20 minutes at 3.0 knots (1.5 meters per second). The survey trawl would be a 400 centimeter x 12 centimeter, three-bridle, four-seam bottom trawl. This net style allows for a high vertical opening, relative to the size of the net, with consistent trawl geometry. A commercial fishing vessel from the northeast region would be contracted to conduct the survey.

- Ventless trap survey: A ventless trap survey would focus on the American lobster (*Homarus americanus*), Jonah crab (*Cancer borealis*), and rock crab (*Cancer irroratus*). This work would be conducted in partnership with the Massachusetts Lobstermen's Association. This survey follows the same sampling design as the Massachusetts, Maine, and Rhode Island state ventless trap surveys, allowing broader scale comparisons. To expand research questions, the ventless trap survey would be paired with neuston tows for larval lobster and other organisms, as well as conventional tagging and black sea bass sample collection. Thirty strings split between the control area and SWDA would be deployed, with six traps per string alternating vented and ventless. A single fish pot would be added to each string of lobster traps to collect general information on black sea bass, as well as their predation rates on lobsters. A mark-recapture tagging study and neuston sampling would also occur in coordination with the ventless trap sampling. Trap deployment, maintenance, and hauling are contracted to commercial lobstermen from a commercial fishing vessel, but sampling would always be conducted by a University of Massachusetts Dartmouth School for Marine Science and Technology researcher onboard the fishing vessel. The survey would sample 30 random depth-stratified stations from May through December with stations distributed throughout the SWDA and control area in a BACI design; station locations would be reselected each year. To the degree possible, survey gear would be hauled on a 3-day soak time in the attempt to standardize catchability among trips. The proposed sampling periods may vary, but two hauling periods per month is the target intensity of this study with gear removed at the end of the survey period in December (i.e., no wet storage). The gear would follow federal rigging regulations; the downlines of each string would use weak link technology to help mitigate the risk of protected species entanglement in survey gear. The use of ropeless gear may be a consideration in surveys after discussions with fishing industry collaborators.
- Black sea bass study: This study would also aim to assess the local black sea bass population, with sampling that would occur simultaneously with lobster trap hauling. This would allow for collection of general information on black sea bass and collection of stomach contents to provide insight on relative predation rates on year-of-young lobster.
- Lobster tagging study: This includes a tagging study conducted twice per month from May to December in conjunction with the ventless trap survey to tag lobsters with a carapace size of 1.6 inches (40 millimeters) or greater. Each tagged lobster would be released at the capture location, allowing for accurate spatial assessment of lobster both within and outside the SWDA.

- Neuston (surface zooplankton) net sampling: This includes a zooplankton sampling of 30 stations across the SWDA and control areas in conjunction with the ventless trap survey. Each station would be sampled twice per month from May to December. The Neuston net frame is 2.4 meters by 0.6 meter by 6.0 meters (7.8 feet by 1.9 feet by 19.6 feet) in size, and the net is made of a 1,320-micrometer mesh. At the end of the net is a codend for collecting samples. This survey would consist of 10-minute tows at 4 knots in the top 1.6 feet (0.5 meter) of the water column at 30 stations.
- Drop camera: The benthic optical drop camera survey deploys three cameras (digital still and video) to identify the substrate, as well as invertebrate and fish species that associate with the seafloor (Bethoney and Stokesbury 2018). This survey methodology is used in the NOAA stock assessment of the sea scallop resource, the habitat omnibus developed by the New England Fishery Management Council, and in an environmental impact assessment of the scallop fishery (Stokesbury and Harris 2006). The survey would follow a systematic sampling design with four quadrats sampled at each station. Survey stations would be located on an approximately 1.5-kilometer (0.9-mile) grid throughout the SWDA and control area. This would result in 182 stations in the SWDA and 186 stations in the control area, for a total of 368 station in a single survey. The control area was selected to have similar depth and habitat characteristics as the SWDA. During the survey, a sampling pyramid, supporting cameras, and lights would be deployed from a commercial scallop fishing vessel. Surveys would be conducted twice annually between April and September at over 368 stations within the SWDA and control areas. Each survey would last approximately 6 days.

A trawl survey was selected because of its ability to capture a wide variety of species (including many of the species of interest for the proposed Project) and its broad use in fisheries surveys and stock assessments in the northeast United States. A drop camera survey was selected because of its ability to monitor a variety of benthic species without significant disturbance to organisms, including those that are not likely to be represented well by a trawl. Drop cameras are also used for the stock assessment of one of the most valuable fisheries in the region, sea scallops, and can provide additional information about habitat. A ventless trap survey with associated tagging, fish pot, and neuston studies was included to target structure-oriented species that are not well captured by the other selected survey gear and have high economic value and stakeholder interest, including lobster, cancer crabs, and black sea bass.

Vessels conducting fisheries monitoring surveys would be commercial fishing vessels, ranging in size from 30 to 100 feet (9.1 to 30 meters) (Table 1-14). Operational survey speeds are survey-type and vessel dependent. Demersal otter trawl surveys are conducted at 3 knots, while neuston net sampling is conducted at 4 knots (Appendix B); all other fisheries monitoring surveys (i.e., drop camera, ventless trap, fish pot, and lobster tagging) are expected to be conducted either stationary or at idle speeds during active gear deployment or recovery. Transit speeds for these vessels may exceed 10 knots but would be maintained as legally mandated (73 Fed. Reg. 60173 and 87 Fed. Reg. 46921 if adopted). Each sampling type (i.e., demersal otter trawl, drop camera, and ventless trap study) would use a single vessel per trip; the neuston net sampling would use the same vessel and trip as the ventless trap study and would require no additional vessel trips. Additionally, the exact ports that would be used by vessels conducting the fisheries monitoring surveys are currently unknown, though homeports for vessels would be in Rhode Island or Massachusetts.

Table 1-14 summarizes the different components of the fisheries monitoring surveys, including expected vessel information per survey type. Mitigation measures applicable to fisheries monitoring surveys are presented in Table 1-15. Additional details on the survey design, methodology, and data analysis for fisheries monitoring surveys considered under the Proposed Action may be found in the Fisheries Monitoring Plan (Appendix B).

Table 1-14: Summary of Fisheries Monitoring Plan Components and Vessel Information

Gear Type	Sampling Frequency	Samples per Sampling Event	Total Annual Number of Samples	Tow Duration	Tow Speed	Vessel Information
Demersal otter trawl	Once seasonally in winter, spring, summer, and fall	25 impact stations, 25 control stations	200	20 minutes	3 knots	• 1 vessel per season • Expected to occur from a commercial groundfish trawl vessel (~75 to 90 feet [(~ 22 to 27 meters]) • Homeport in Rhode Island or Massachusetts • Transit speeds maintained as legally mandated
Drop camera	Two times yearly between April and September	182 impact stations, 186 control stations	736	—	—	• 1 vessel per trip • Expected to occur from a commercial scallop fishing vessel (~75 to 100 feet [(~ 22 to 27 meters]) • Homeport in Rhode Island or Massachusetts • Transit speeds maintained as legally mandated
Ventless trap, fish pot, and lobster tagging study	Two times monthly from May through December	30 stations (string of six lobster traps and one fish pot)	480	—	—	• 1 vessel per trip • Expected to occur from a commercial fishing vessel (~30 to 50 feet [(~ 9 to 15 meters]) • Homeport in Rhode Island or Massachusetts • Transit speeds maintained as legally mandated
Neuston (surface zooplankton) net sampling	Two times monthly from May through December	30 stations	480	10 minutes	4 knots	• Same vessel/trip as ventless study (i.e., no additional vessel trips)

—= not applicable

1.4.5 Avoidance, Minimization, and Monitoring Measures that are Part of the Proposed Action

This section outlines the proposed mitigation, monitoring, and reporting measures that are intended to minimize or avoid potential impacts on ESA-listed species. Mitigation measures committed to by the applicant in the COP are considered as a part of the Proposed Action and are binding.

Effects of the Proposed Action are evaluated for the potential to result in harm to listed species and/or designated critical habitat. If a proposed Project-related activity may affect a listed species, the exposure level and duration of effects are evaluated further for the potential for those effects to harass or injure listed species. The following sections present the potential proposed Project-related effects on ESA-listed species of marine mammals, sea turtles, and marine fish, and critical habitat from construction, operations, and decommissioning of the Proposed Action.

The effects determinations in the resource sections are based on the mitigation and monitoring measures included under the Proposed Action in Table 1-15, which includes all draft and final BOEM best management practices (BMP), and the additional BOEM-proposed mitigation and monitoring measures.

The applicant has applied for an MMPA ITA. If issued, the MMPA permit will authorize the incidental harassment of marine mammals when adhering to the terms and conditions included in the authorization. The MMPA ITA application only covers mitigation and monitoring measures for marine mammals including Threatened and Endangered marine mammals considered in this BA. Additional measures for ESA-listed marine mammals may be required through ESA consultation that BOEM expects will also be required in the final ITA. The conditions, as they may be amended in the final ITA, will also be included as a condition in the final Record of Decision and will be required by BOEM in its final approval of the COP. With final approval of the COP, the applicant will also commit to meeting the requirements of BOEM BMPs that are designed to avoid, minimize, or monitor effects of the Proposed Action on ESA-listed species.

Table 1-15 presents the applicant-committed mitigation, monitoring, and reporting measures derived from the draft ITA and COP for construction, O&M, and decommissioning activities; these measures are included and analyzed as part of the Proposed Action. BOEM-proposed and draft BMP meausres are also included in Table 1-15 as applicable.

Table 1-15: Mitigation, Monitoring, and Reporting Measures Considered Part of the Proposed Action and Committed to by the Applicant and Proposed or Modified by the Bureau of Ocean Energy Management

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
All Activities – All Stages			
Mitigation measures align with ITA and other permit conditions	The applicant will adhere to any additional requirements for the Proposed Action set forth by MMPA and ESA consultations, as well as BOEM PDCs/BMPs, and Record of Decision conditions.	The measures required by the final MMPA ITA would be incorporated by reference where appropriate into COP approval, and BOEM and/or BSEE would monitor compliance with these measures. These conditions may include foundation installation, foundation drilling, UXO, survey activity, and vessel operation under the period of the ITAs that may be issued.	Measures will be developed that reduce effects analyzed under forthcoming and ongoing agency consultations. This measure ensures the PDE includes preventative mitigation measures to avoid potential effects on ESA-listed species, in addition to external mitigation implemented during proposed Project activities.
PSO/PAM training and qualifications	The applicant will use NMFS-approved PSOs to monitor clearance and shutdown zones during foundation installation and HRG survey activity, as well as any UXO detonation.	BOEM will require that the applicant comply with applicant-proposed measures, and • PSOs must meet these minimum qualifications: o Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance; use of binoculars may be necessary to correctly identify the target; o Ability to conduct field observations and collect data according to assigned protocols; o Experience or training in the field identification of marine mammals, including the identification of behaviors; o Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations; o Writing skills sufficient to document observations including, but not limited to: the number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates and times when in-water construction activities were suspended to avoid potential incidental injury of marine mammals from construction noise within a defined shutdown zone; and marine mammal behavior; and • Ability to communicate orally, by radio or in person, with project personnel to provide real-time information	Training of PSOs and PAM operators will minimize the potential for adverse effects on ESA-listed species from vessel interactions or pile driving by increasing knowledge and effectiveness of mitigation and monitoring personnel.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		on marine mammals observed in the area as necessary.	
General PSO measures	PSOs must not exceed 4 consecutive watch hours on duty at any time, must have a 2-hour (minimum) break between watches, and must not exceed a combined watch schedule of more than 12 hours in a 24-hour period.	BOEM and USACE would ensure that PSO coverage is sufficient to reliably detect marine mammals and sea turtles at the surface in the identified clearance and shutdown zones to execute any pile driving delays or shutdown requirements during foundation installation. This will include a PSO/PAM team on the construction vessel and two additional PSO vessels each with a visual monitoring team. The following equipment and personnel will be on each associated vessel. ***Construction Vessel:*** • 2—visual PSOs on watch. • 2—reticle binoculars (7x or 10x) calibrated for observer height off the water. • 2—mounted "big eye" binoculars (25x or similar) if vessel is deemed appropriate to provide a platform in which use of the big eye binoculars would be effective. • 1—PAM operator on duty. • 1—mounted thermal/infrared camera system. • 2— "big eye" binoculars (25x or similar) mounted 180° apart. • 1—monitoring station for real-time PAM system. • 2—handheld or wearable night vision devices with infrared spotlights. • 1—data collection software system. • 2—PSO-dedicated VHF radios. • 1—digital single-lens reflex camera equipped with a 300- millimeter lens. ***Each Additional PSO Vessel (2):*** • 2—visual PSOs on watch. • 2—reticle binoculars (7x or 10x) calibrated for observer	These measures, combined, minimize the potential for adverse effects on ESA-listed species by increasing awareness, maintaining effective and consistent monitoring, and using effective monitoring technology. The combined measures improve species detection and monitoring reaction times for implementing mitigation measures.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		height off the water. • 1—mounted "big eye" binoculars (25x or similar) if vessel is deemed appropriate to provide a platform in which use of the big eye binoculars would be effective.1—mounted thermal/IR camera system. • 1—handheld or wearable night vision device with infrared • spotlight. • 1—data collection software system. • 2—PSO-dedicated VHF radios. • 1—digital single lens reflex camera equipped with a 300-mm lens. If, at any point prior to or during construction, the PSO coverage that is included 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 and/or platforms would be deployed. Determinations prior to construction would be based on review of the *Pile Driving Monitoring Plan*. Determinations during construction would be based on review of the weekly pile driving reports and other information, as appropriate.	
	PSOs will use visual aids (e.g., range finders, binoculars, night vision devices, infrared/thermal camera) when necessary. PSOs will have no tasks other than to conduct observations, collect and report data, and communicate with and instruct relevant vessel crew regarding the presence of marine mammals and mitigation requirements.		
	For all activities, monitoring distances will be measured with range finders or reticle binoculars. Distances to marine mammals observed will be based on the best estimate of the PSO, relative to known distances to objects in the vicinity of the PSO. Bearings to animals must be		

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	determined using a compass.		
	PSOs must record all incidents of marine mammal and sea turtle occurrence, regardless of distance from the construction activity.		
	During all observation periods related to pile-driving activities, PSOs will use high-magnification (25X), standard handheld (7X) binoculars, and the naked eye to search continuously for marine mammals. During periods of low visibility (e.g., darkness, rain, fog, etc.), PSOs will use alternative technology (e.g., infrared/thermal camera) to monitor shutdown and clearance zones.		
Project training	All proposed Project personnel working offshore will receive standardized environmental awareness training, which will stress individual responsibility for marine mammal and marine debris awareness and reporting. Prior to commencing offshore activities associated with either construction or HRG surveys, team members will participate in induction meetings, where summary materials are presented in person and with video materials covering topics including the following: • Code of Business Conduct including environmental commitments; • Relevant regulatory statutes, laws, and permit requirements; • Specific conditions and procedures related to offshore activities (e.g., marine debris protocols, marine mammal monitoring and mitigation, spill reporting); • Protected species and trained crew observers' procedures for sighting, reporting, and protection of species	BOEM will require that the applicant comply with applicant-proposed measures and • Ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to a lease 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 at marinedebris@bsee.gov. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process must include the following elements: o Viewing of either a video or slide show by the personnel specified above; o An explanation from management personnel that emphasizes their commitment to the requirements; o Attendance measures (initial and annual); and	This measure minimizes the potential for adverse effects on ESA-listed species by increasing awareness of protected species, mitigation protocols, and applicant compliance expectations across the entire proposed Project, improving species detection and monitoring reaction times for implementing mitigation measures.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	including vessel strike avoidance and sound source management; • Protected species identification; and • Communication protocols. All personnel are required to register their participation in the induction training. These records are auditable. Additional refresher training related to the protected species monitoring and mitigation plan is provided offshore, and individuals joining the proposed Project who did not attend the initial induction training will be required to participate in a separate training session, with their participation recorded for the proposed Project. Environmental management plans will be created for construction operations and HRG surveys. The environmental management plan includes all of the induction training components, including full copies of relevant permits and permit-required plans, protected species identification materials, communication flow charts and contact information. These materials are all retained in accessible areas on all proposed Project vessels.	o Recordkeeping and the availability of records for inspection by the Department of the Interior (DOI). • By January 31 of each year, the Lessee must submit to DOI an annual report signed by the Lessee that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. Reports must be sent via email to renewable_reporting@boem.gov and to marinedebris@bsee.gov • All PSOs must have completed a training program with BOEM-approved PSO training materials. PSOs must also have received NMFS approval to act as a PSO for geophysical surveys. The Lessee must provide to BOEM upon request, documentation of NMFS approval as PSOs for geophysical activities in the Atlantic and copies of the most recent training certificates of individual PSOs' successful completion of a commercial PSO training course with an overall examination score of 80% or greater. Instructions and application requirements to become a NMFS- approved PSO can be found at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/protected-species-observers. • For situations where Trained Lookouts are used when PSOs are not required, training must include protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. • The Lessee must ensure a PSO or crew lookout is posted during all times to avoid interactions with ESA-listed species when a vessel is underway (transiting or surveying) by monitoring 180 degrees in the forward path of the vessel. o Visual observers monitoring the vessel separation distances from ESA listed species can be either PSOs or crew members (if PSOs are not required). If the trained lookout is a vessel crew member, this must be their designated role and primary responsibility on shift. Any designated crew lookouts must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. o Regardless of monitoring duties, all crew members	

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		responsible for navigation duties must receive site-specific training on ESA-listed species sighting/reporting and vessel strike avoidance measures. • Vessels underway must not divert their course to approach any ESA-listed species and marine mammals.	
Data Collection Programmatic BA BMPs	—	BOEM would ensure that all Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (June 2021; https://media.fisheries.noaa.gov/2021-12/OSW-surveys-NLAA-programmatic-rev-1-2021-09-30-508-.pdf) shall be applied to activities associated with the construction, maintenance and operations of the New England Wind project as applicable.	
Marine debris reduction and awareness training	—	The Lessee would 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 would continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Recordkeeping and the availability of records for inspection by DOI. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process	The measure decreases the loss of marine debris, which may represent entanglement and/or ingestions risk.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov).	
NARW monitoring and reporting	The applicant will report NARW (*Eubalaena glacialis*) observations to NMFS Office of Protected Resources within 24 hours. The applicant will monitor NMFS NARW reporting systems from November 1 through July 31and whenever a DMA is established within any areas vessels operate. During these times, personnel will check the NMFS' NARW reporting systems on a daily basis.	BOEM will require that the applicant comply with applicant-proposed measures and • The Lessee must ensure all vessel operators check for information regarding mandatory or voluntary ship strike avoidance (SMAs and DMAs, or Slow Zones that are also designated as DMAs) and daily information regarding North Atlantic right whale sighting locations. These media may include, but are not limited to: NOAA weather radio, U.S. Coast Guard NAVTEX and channel 16 broadcasts, Notices to Mariners, the Whale Alert app, or WhaleMap website. o North Atlantic right whale Sighting Advisory System info can be accessed at: https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html o Information about active SMAs, DMAs, and Slow Zones can be accessed at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales o Vessels operating in water depths with less than 4 ft. clearance between the vessel and the bottom should maintain speeds no greater than 4 knots to minimize vessel strike risk to sturgeon and sawfish.	The measures increase situational awareness of NARW activity across the entire proposed Project, which improves detection and avoidance ability and requires that the appropriate agencies are contacted in the event of a NARW sighting.
Vessel strike avoidance policy	The proposed Project will implement a vessel strike avoidance policy for all vessels under contract to the applicant to reduce the risk of vessel strikes, as well as the likelihood of death and/or serious injury to ESA-listed marine mammals, sea turtles, or marine fish that may result from collisions with vessels. As safe and practicable, the applicant will adhere to NOAA guidelines for vessel strike avoidance during all proposed Project activities, including vessel speed	BOEM will require that the applicant comply with applicant-proposed measures and New England Wind must implement vessel strike avoidance measures to include the identified vessel speed restrictions and minimum separation distances for crew transfer vessels agreed to in the Applicant-proposed measures (as determined in the MMPA ITR or RPMs of the biological opinion). BOEM will also require that a vessel plan be submitted for review by BOEM and NMFS Office of Protected Resources 120 days prior to start of construction. The vessel plan will detail all speed and vessel strike avoidance measures employed during all stages of the proposed Project for all vessel types,	These general measures increase awareness of marine mammals, sea turtles, and vessel interactions and ensure timely detection and mitigation.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	restrictions and separation distances, that are applicable at the time of construction and during HRG surveys. All NMFS speed restrictions with respect to NARW will be followed. Vessel operators and crew will maintain a vigilant watch for marine mammals and slow down or maneuver their vessels, as appropriate, to avoid a potential interaction with a marine mammal.	including any adaptive speed plans, NARW strike avoidance measures, and compliance monitoring methods. Additionally, any vessels transiting from ports outside the United States will be required to have a trained lookout on board who will start monitoring when the vessel enters U.S. waters.	
Vessel separation distances	Vessel separation distances are as follows: • NARW: 1,640 feet (500 meters) • All other whales (includes ESA-listed whales and unidentified whales): 328 feet (100 meters) • Dolphins, porpoises, seals, sea turtles: 164 feet (50 meters)	BOEM will require that the applicant comply with applicant-proposed measures and 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 1,640 feet (500 meters) of the forward path of a vessel, the vessel operator must steer a course away from the whale at <10 knots (18.5 km/hr) until the minimum separation distance has been established. Vessels may also shift to idle if feasible. If any ESA-listed marine mammal is sighted within 656 feet (200 meters) 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 1,640 feet (500 meters). If stationary, the vessel must not engage engines until the large whale has moved beyond 1,640 feet (500 meters).	The measure reduces the potential for adverse effects on marine mammals, sea turtles, and giant manta rays (*Manta birostris*) resulting from vessel interactions by maintaining distances between vessels and animals that allow avoidance by either the vessel or animal.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized

Vessel speed restrictions	The applicant will adhere to legally mandated vessel speeds, approach limits, and other vessel strike avoidance measures to reduce the risk of impact on NARWs as a result of proposed Project activities in the SWDA.
	
	During appropriate time periods and within certain areas, proposed Project-related vessels traveling to/from Salem Harbor will transit at 11.4 miles per hour (18.4 kilometers per hour; 10 knots) or less within NOAA-designated NARW critical habitat and outside critical habitat.
		BOEM will require that the applicant comply with applicant-proposed measures and
		• Vessel captain and crew must maintain a vigilant watch for all protected species and reduce speed, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any listed species. The presence of a single individual at the surface may indicate the presence of submerged animals in the vicinity; therefore, precautionary measures should always be exercised. If pinnipeds or small delphinids of the following genera: *Delphinus*, *Lagenorhynchus*, *Stenella*, and *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.
		• To monitor the minimum separation distance, a PSO (or Trained Lookout if PSOs are not required) must be posted during all times a vessel is underway (transiting or surveying) to monitor for listed species within a 180-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard).
		  o Visual observers monitoring the minimum separation distance can be either PSOs or Trained Lookouts (if PSOs are not required). If the Trained Lookout is a vessel crew member, this must be their designated role and primary responsibility on shift. Any crew designated as Trained Lookouts must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. All observations must be recorded per reporting requirements.
		  o Regardless of monitoring duties, all crew members responsible for navigation duties must receive site-specific training on ESA-listed species sighting/reporting and vessel strike avoidance measures.
		  o Vessels underway must not divert their course to approach any ESA-listed species and marine mammals.
		• Regardless of vessel size, vessel operators must reduce vessel speed to 10 knots (18.5 mph) or less while operating in any Seasonal Management Area (SMA) and Dynamic Management Area (DMA) or Slow Zone triggered by visual detections of North Atlantic right whales. An exception to
			The measure reduces the potential for ship strikes and effects on NARW by reducing vessel transit speeds when NARWs are documented in the area. Speed reduction for NARW will also serve as a speed reduction for other ESA-listed marine mammals, sea turtles, and marine fish.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		this requirement is for vessels operating in areas within portions of a visually designated DMA or Slow Zone where it is not reasonable to expect the presence of North Atlantic right whales (e.g., Long Island Sound, shallow harbors). • BOEM encourages increased vigilance through the required best management practices to minimize vessel interactions with protected species, by reducing speeds to 10 knots or less when operating within an acoustically triggered slow zone, and when feasible, avoid operating in or transiting through Slow Zones. • BOEM and the USACE will also ensure all vessels follow the most recent NOAA guidelines regarding vessel speed restrictions to minimize vessel interactions with protected species. Furthermore, the applicant must comply with the vessel strike avoidance and vessel speed restriction measures. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements.	
Lookout for sea turtles and reporting	—	BOEM will require that the applicant comply with the following sea turtle measures: • For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, New England Wind would 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. • For all vessels operating south of the Virginia/North Carolina border, year-round, New England Wind would 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. This requirement would be in place year-round for any vessels transiting south of Virginia, as sea turtles are present year-round in those waters. • The trained lookout would monitor https://seaturtlesightings.org/ prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day.	The measure minimizes risk of vessel strikes to sea turtles by requiring lookouts and speed adjustments in areas and time periods of expected higher density.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		• The trained lookout would maintain a vigilant watch and monitor a 500-m Vessel Strike Avoidance Zone at all times to avoid potential vessel strikes of ESA-listed sea turtle species. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) would be available to ensure effective watch at night and in any other low visibility conditions. If the trained lookout is a vessel crew member, this would be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts would receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. • If a sea turtle is sighted within 100 m or less of the operating vessel's forward path, the vessel operator would slow down to 4 knots (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 100 m 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 would shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots. The vessel may resume normal operations once it has passed the turtle. • Vessel captains/operators would avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. In the event that operational safety prevents avoidance of such areas, vessels would slow to 4 knots while transiting through such areas. • All vessel crew members would be briefed in the identification of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials would 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) would be clearly communicated and posted in highly visible locations aboard all Project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so. • The only exception is when the safety of the vessel or crew	

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		necessitates deviation from these requirements on an emergency basis. If any such incidents occur, they must be reported to NMFS within 24 hours. • If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for NARWs, an additional lookout is not required and this PSO or trained lookout must maintain watch for whales and sea turtles. • 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.	
Foundation Installation – Construction			
Pile driving monitoring plan	—	BOEM would ensure that New England Wind prepares and submits a *Pile Driving Monitoring Plan* to NMFS for review and concurrence at least 90 days before start of pile driving. The plan would 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 plan would also describe how BOEM and New England Wind would determine the number of whales exposed to noise above the Level B harassment threshold during pile driving with the vibratory hammer to install the cofferdam at the sea to shore transition. New England Wind would obtain NMFS' concurrence with this plan prior to starting any pile driving.	Measures will be developed that reduce effects analyzed under forthcoming and ongoing agency consultations and endsure adequate monitoring is in place during all pile driving activities.
Time of year restrictions	The applicant expects to establish a restriction on pile-driving activities (i.e., impact pile driving, vibratory driving, and drilling) between January 1 and April 30. There is no seasonal restriction applied to HRG surveys and potential detonation of UXO.	—	The measure reduces the potential for acoustic exposures to NARW and other large whales by piling during low abundance periods.
Time of day restrictions	For the ESP post-piled jackets, piling will be initiated during daylight hours (no later than 1.5 hours prior to civil sunset) and need to continue until all piles are installed to maintain asset integrity at the sea floor and to alleviate health and safety concerns. If up to three ESP jackets require nighttime piling, breaks between piles will be limited to the	BOEM will require additional measures for nighttime piling (to be described within the Alternative Monitoring Plan and PAM Plan), and BOEM will require noise abatement systems and PAM systems for all foundation installation. The applicant will also submit two monitoring plans for NMFS and BOEM review and approval 6 months prior to initiating impact pile-driving activities: • Low visibility pile driving monitoring plan	The measure reduces potential for exposure of ESA-listed species during nighttime piling by starting during daylight and minimizing breaks between piling, during which animals are more likely to encroach on the clearance zones. Requiring an alternative monitoring plan ensures that the methods and technologies

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	shortest duration possible, noise abatement systems will be used, and PAM systems will be deployed.	• Nighttime pile driving monitoring plan The purpose of these plans is to demonstrate that the applicant can meet the visual monitoring criteria for the Level A harassment zone(s)/mitigation and monitoring zones plus an agreed upon buffer zone (these combined zones are referred to henceforth as the nighttime and low visibility clearance and shutdown zones). Both monitoring plans will demonstrate effective use of technologies that the applicant is proposing to use for monitoring during nighttime and during daytime low visibility conditions for instances when lighting or weather (e.g., fog, rain, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones. "Daytime" is defined as one hour after civil sunrise to 1.5 hours before civil sunset. Visual monitoring criteria will be developed by NMFS and BOEM and detailed in the Final EIS. the low visibility pile driving monitoring plan will be applicable during pile-driving activities conducted in poor or low visibility conditions (i.e., instances where clearance and shutdown zones cannot be effectively visually monitored), hereafter termed low visibility pile driving. The low visibility pile driving monitoring plan will also be applicable during times when a pile was started during daylight, including all pre-start clearance and soft-start protocols, but for unforeseen reasons, piling had to continue after civil twilight. If any part of the pre-start clearance and/or soft-start protocols associated with pile driving are conducted after civil twilight, the nighttime pile driving monitoring measures will be required. If during low visibility pile driving, undetected animals are found in the clearance and/or shutdown zones, low visibility impact pile-driving activities will cease as soon as possible in consideration of human safety, and NMFS, BOEM, and BSEE will be notified immediately. The low visibility pile driving monitoring plan will need to contain the following components: • Identification of low visibility monitoring devices (e.g., vessel-mounted thermal infrared camera systems, handheld or wearable night vision devices, handheld infrared imagers) that will be used to detect marine mammal and sea turtle species relative to the established clearance and shutdown zones; • The buffer zone distance and total clearance and shutdown	proposed for monitoring are sufficient to detect and localize on species of concern such that PSOs can implement mitigation measures.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		zones; and • A description of the monitoring methods, detection reliability, communication protocols, reporting and decision-making protocols that will be used during low visibility conditions.	
PSO monitoring	PSOs must visually monitor to a minimum radius around monopile and jacket foundations equivalent to the calculated impact pile-driving exposure range to Level B harassment thresholds using NMFS' unweighted 160 dB SPL or as modified based on sound field verification.	BOEM will require that the applicant comply with a modified PSO monitoring measure: PSOs must visually monitor all waters within visual range, including waters beyond the 160 dB isopleth (Level B harassment thresholds using NMFS unweighted 160 dB SPL), around monopile and jacket foundations. The entire extent of the clearance zone (modeled or adjusted after measurements) must be visible for visual monitoring to begin.	The measure improves visual detection ability of the PSOs monitoring beyond the 160 isopleth and ensuring visibility of the pr clearance zone. This allows animals to be detected early; therefore, mitigation can be prompt when required.
Sound field verification measurement plan	A sound field verification measurement plan will be submitted to NMFS for review and approval at least 90 days prior to the planned start of pile driving. The plan will follow the framework laid out in Appendix C of the draft ITA application and include underwater sound measurements during foundation installation to confirm that the sound propagation predicted by hydroacoustic modeling is comparable to, or lower than, measured sound in the field. Such confirmation will help demonstrate that estimated exposures of marine mammals and sea turtles were appropriately predicted.	New England Wind must submit a Sound Field Verification Plan consistent with requirements of the NMFS Biological Opinion. The results of sound field verification must be compared to modeled injury and disturbance isopleths for marine mammals. BOEM and USACE would ensure that sound field monitoring occurs as deemed appropriate in consultation with NMFS. Clearance and/or shutdown zones may be required to be expanded due to the verification of sound fields from Project activities and PSO coverage expanded to ensure sufficient coverage to reliably monitor the expanded clearance and/or shutdown zones. Additional observers would be deployed on additional platforms for every 1,500 meters that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification.	The measure ensures that noise level data collected in the sound field verification is consistently collected at an accepted standard using updated methodology. In turn, this allows for implemented mitigation to be optimally effective.
RSLL	—	BOEM intends to develop a second RSLL aimed at reducing Level B Harassment (e.g., potential to disrupt important behaviors), especially for LFCs. Although the application of the Level A LFC RSLL also reduces Level B zones to some extent, more Level B reduction may be required to meet MMPA negligible impact determinations, especially in areas of higher presence of low population species like NARWs. BOEM will advise the applicant once a second RSLL is developed to consider implementation concerns, if any.	This measure ensures that any potential acoustic harassment of marine mammals will be limited to a smaller zone, which, under most circumstances, can be monitored more effectively by PSOs.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
Level A and B harassment distance verification for foundation installation	The applicant will conduct field verifications of actual impact and vibratory pile driving during installation of the WTG foundations for model validation purposes and to further determine the effectiveness of the mitigation measures employed. Measurements will be performed either by extrapolating from in-situ measurements conducted at several points from the pile being driven or by direct measurements to locate the distance where the received levels reach the relevant Level A harassment and Level B harassment thresholds.	—	The measurements can be used to accurately evaluate the actual Level A and B harassment levels produced during pile driving to confirm the predicted exposure zones and inform adjustment of mitigation and monitoring zones, as necessary.
Adaptive management of sound field verification measurements	If needed, based on the sound field verification-informed distances to Level A and Level B harassment thresholds, the adaptive refinement of clearance zones, shutdown zones, and monitoring and mitigation measures (either a decrease or an increase) will be agreed upon with the federal agencies.	BOEM and USACE may consider reductions in the shutdown zones for ESA-listed sei, fin, or sperm whales based upon sound field verification of a minimum of 3 piles. Sound field verification of additional piles may be required based on results of actual measurements. However, BOEM/USACE would ensure that the shutdown zone for sei, fin, and sperm whales is not reduced to less than 1,000 m, or no less than the PTS distance for ESA-listed sea turtles. No reductions in the clearance or shutdown zones for NARWs would be considered regardless of the results of sound field verification of a minimum of three piles.	The measures allow for the shutdown zones to be modified to better represent actual risks to marine wildlife from noise-generating activities once sufficient evidence is present to permit such a change.
	If the initial sound field verification measurements indicate distances to the isopleths corresponding to Level A harassment and Level B harassment thresholds are greater than the predicted distances (based on modeling assuming 10 dB attenuation), the applicant will implement additional sound attenuation measures prior to conducting additional pile driving (e.g., improving the efficacy of the implemented noise attenuation technology, adjusting the piling schedule to reduce the sound source).		

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	If these corrective actions do not result in achieving the predicted zones, the applicant will install an additional noise attenuation system to achieve the modeled ranges and/or deploy additional observation tools. Each sequential modification will be evaluated empirically by sound field verification.		
	If sound field verification measurements continue to indicate distances to isopleths corresponding to Level A and Level B harassment thresholds are consistently larger than those predicted by modeling, the applicant may request that NMFS expand the relevant clearance and shutdown zones and associated monitoring measures.		
Noise mitigation / abatement systems	The proposed Project will use a noise mitigation system for all impact piling events for foundation installation. The noise mitigation system methods have not been finalized at this stage; however, the applicant expects to implement noise attenuation mitigation to reduce sound levels by a target of approximately 12 dB or greater. The applicant will use two noise attenuation systems during pile driving (two bubble curtains: one bubble curtain and one AdBm encapsulated bubble sleeve, etc.) for monopile installation and up to two noise attenuation systems for jacket installation. The proposed Project will also use noise abatement systems for all UXO detonation events and is committed to achieving a minimum of 10 dB of attenuation.	BOEM will require that the applicant comply with applicant-proposed measures and • The lessee should implement the best-available sound attenuation technology that would be targeted at reducing foundation installation noise, to maximum extent practicable with a minimum target of 10 dB reduction from unattenuated pile driving noise. • The lessee should have a second back-up attenuation device (e.g., bubble curtain or similar) available, if needed, to achieve the targeted reduction in noise levels, pending results of sound field verification testing. • If the lessee uses a bubble curtain, the bubble curtain must distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column. The lowest bubble ring shall be in contact with the mudline for the full circumference of the ring, and the weights attached to the bottom ring shall ensure 100 percent mudline contact. No parts of the ring or other objects shall prevent full mudline contact. The lessee must require that construction contractors train personnel in the proper balancing of airflow to the bubblers and would require that construction contractors submit an inspection/performance report for approval by the lessee following the performance test. Corrections to the attenuation device to meet the performance standards would	The measure reduces the amount of sound energy propagated into the water and, thus, reduces the ranges at which underwater noise will affect ESA-listed whales, sea turtles, marine fish, and the prey they feed on during impact pile driving.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		occur prior to impact driving	
PAM plan and general PAM monitoring	PAM will occur during all foundation installation activities and supplement the visual monitoring program.	BOEM and USACE would ensure that New England Wind prepares a PAM Plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the proposed uses of PAM for mitigation and long-term monitoring. This plan would be submitted to NMFS and BOEM for review and concurrence at least 120 days prior to the planned start of activities requiring PAM.	The measure increases the monitoring ability for NARW and, therefore, increases the detection ability for NARW such that mitigation measures and awareness notification can be implemented. The PAM plan and review will ensure the efficacy of the PAM plan and ensure that the PAM system and methods will detect NARW calls with high reliability within the Level A and Level B harassment zones.
	A PAM plan will be submitted to NMFS and BOEM for review and approval at least 90 days prior to the planned start of pile driving. The plan must describe all proposed PAM equipment, procedures, and protocols.		
	The plan will include a description of the PAM hardware and software used for marine mammal monitoring, including software version used, calibration data, bandwidth capability and sensitivity of hydrophone(s), any filters used in hardware or software, and limitations of the equipment, and other information.		
	PAM PSOs will operate in shifts under the same conditions as visual PSOs. PAM will be conducted by at least one dedicated PAM PSO. The PAM PSO(s) will have completed specialized training for operating the PAM system.		
	The dedicated PAM PSO must acoustically monitor to a minimum radius of 39,370 feet (12,000 meters) around monopile foundations and jacket foundations during foundation		

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	installation and drilling activities. PAM will begin 60 minutes prior to the initiation of the soft start, throughout foundation installation, or installation, and for 30 minutes after pile driving has been completed. The dedicated PAM PSO will inform the lead PSO on duty of animal detections approaching or within applicable mitigation zones.		
Visual monitoring for foundation pile driving	During pile-driving activities (i.e., impact pile driving, vibratory pile setting, and drilling), a single, dedicated PSO vessel will be used for visual monitoring. A minimum of two PSOs will be on active duty from 60 minutes before, during, and for 30 minutes after all pile installation activity. The dedicated PSO vessel will be located at the best vantage point to observe and document ESA-listed species in proximity to the clearance and/or shutdown zones.	BOEM will require that the applicant comply with applicant-proposed measures and the following: • In order to commence pile driving at foundations, PSOs must be able to visually monitor the exclusion zone radius from their observation points for at least 60 minutes immediately prior to piling commencement. Acceptable visibility will be determined by the Lead PSO and documented in PSO reports. • During pile-driving activities (i.e., impact pile driving, vibratory pile setting, and drilling), visual monitoring will be conducted from the construction/installation platform and two additional dedicated PSO vessels. If clearance zones are reduced after sound field verification measurements and consultation, a reduction in the number of PSO vessels can be proposed. A 4,921-foot (1,500-meter) increase in any marine mammal clearance zone or 1,640-foot (500-meter) increase in the sea turtle clearance zone will require an additional dedicated PSO vessel or the applicant must demonstrate other methods for effective visual monitoring of marine mammals and sea turtles in the expanded zones. Demonstration of this coverage should be provided in pile driving monitoring plan for review.	The measure allows for visual detection of ESA-listed species by PSOs prior to and during pile driving such that the clearance and shutdown zones, along with the mitigation measures associated with those zones, are effectively implemented.
Clearance and shutdown zones for foundation installation and drilling	The clearance and shutdown zones for proposed Project foundation installation and drilling activities presented below for monopile and jacket foundations separately (summarized from JASCO	BOEM will require that the applicant comply with applicant-proposed measures and: BOEM and USACE would ensure that New England Wind monitors the distance where noise would exceed the 175 dB re 1 µPa behavioral disturbance threshold for ESA-listed sea	The measure minimizes the potential for adverse effects on marine mammals and sea turtles by establishing zones at which impacts may occur and requiring clearance

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	2023 and Appendix III-M; Epsilon 2023).	turtles for the full duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and record all observations in order to ensure that all take that occurs is documented.	of those zones.

Species Group	Visual Clearance Zone (meters)	Visual Shutdown Zone (meters)	PAM Clearance Zone (meters)	PAM Shutdown zone (meters) for 6,000 kJ hammer	PAM Monitoring Zone (meters)
Monopile Foundation – Impact Pile Driving					
NARW	Any distance	Any distance	4,600	2,700	12,000
Other baleen and sperm whales	2,700	2,700	2,700	2,700	12,000
Sea turtles	1,500	300	1,500	300	10,000
Monopile Foundation – Vibratory Pile Setting and Drilling					
NARW	Any distance	Any distance	4,500	2,700	12,000
Other baleen and sperm whales	2,700	2,700	2,700	2,700	12,000
Sea turtles	1,600	500	1,600	500	10,000
Jacket Foundation – Impact Pile Driving					
NARW	Any distance	Any distance	5,300	4,100	12,000
Other baleen and sperm whales	4,100	4,100	4,100	4,100	12,000
Sea turtles	1,300	1,300	1,300	1,300	10,000
Jacket Foundation – Vibratory Pile Setting and Drilling					
NARW	Any distance	Any distance	4,700	4,100	12,000
Other baleen and sperm whales	4,100	4,100	4,100	4,100	12,000
Sea turtles	1,400	1,300	1,400	1,300	10,000

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Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
Clearance for pile driving of foundations	The PSOs will implement a 60-minute clearance period of the clearance zones prior to impact pile driving for the foundations. If any marine mammal or sea turtle is detected within the applicable clearance zone during the soft start, activities will be delayed until the animal is observed leaving the clearance zone or until 30 minutes have passed without a detection of the animal within the clearance zone.	BOEM will require that the applicant comply with applicant-proposed measures and: The PSOs will implement a 60-minute clearance period of the clearance zones prior to any pile driving or pile drilling for the foundations.	The measure minimizes the potential acoustic exposures of marine mammals and sea turtles by requiring the area of potential impact to be clear of marine mammals and sea turtles before starting piling.
Species noise exposure reporting for vibratory pile driving of	Due to the size of the zones, visual monitoring of the Level B zones for drilling and vibratory setting is not planned. To account for the potential	—	The measure ensures that monitoring is conducted within the highest exposure risk area and, therefore, reduces the potential

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
foundations	presence of marine mammals within the Level B zone, the ensonified area between the mitigation zones and Level B harassment threshold will be multiplied by the density estimate appropriate for each species for each activity and rounded to the nearest integer to calculate assumed take for those species beyond the mitigation zones for purposes of reporting.		exposures at higher SPLs that are more likely to result in behavioral disturbance.
Visual monitoring during nighttime and periods of reduced visibility for pile driving of foundations	During periods of low visibility (e.g., darkness, rain, fog, etc.), PSOs will use alternative technology (e.g., infrared/thermal camera) to monitor shutdown and clearance zones. All PSOs on duty will be in contact with the on-duty PAM operator who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.	BOEM will require that the applicant comply with applicant-proposed measures and the Alternative Monitoring Plan conditions described below.	The measure increases visibility of ESA-listed species under periods of reduced visibility to help minimize and avoid potential adverse effects during impact pile driving.
Shutdowns for foundation pile driving	If a marine mammal or sea turtle is detected entering or within the respective shutdown zones after impact pile driving has commenced, an immediate shutdown of pile driving will be implemented when practicable as determined by the lead engineer on duty who will determine if a shutdown is safe and practicable. If shutdown is called for but determined that shutdown is not feasible due to risk of injury or loss of life, there will be a	BOEM will require that the applicant comply with applicant-proposed measures and: BOEM and the USACE may consider reductions in the shutdown zones for sei, fin, or sperm whales based upon sound field verification of a minimum of three piles; however, BOEM/the USACE will ensure that the shutdown zone for sei, fin, blue, and sperm whales is not reduced to less than 3,281 feet (1,000 meters), or 1,640 feet (500 meters) for sea turtles. No reductions in the clearance or shutdown zones for NARW will be considered regardless of the results of sound field verification of a minimum of three piles. If a NARW is detected within the modeled PTS $ER_{95\%}$ during piling, an immediate shutdown of all piling activities will be implemented and a review of the monitoring and mitigation procedures will be conducted for the proposed Project, in consultation with NMFS and BOEM, before piling may resume.	The measure minimizes the potential for adverse effects on marine mammals and sea turtles resulting from impact pile driving by stopping the pile driving and resulting sound input into the water when a marine mammal or sea turtle is within a potentially impactful auditory exposure range.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	reduction of hammer energy if feasible.		
	Following shutdown, pile driving will only be initiated once the animal has been observed exiting its respective shutdown zone within 30 minutes of the shutdown, or if an additional time period has elapsed with no further sightings (i.e., 15 minutes for small odontocetes, 30 minutes for all other marine mammal species, and 30 minutes for sea turtles).		
	The shutdown zone will be continually monitored by PSOs and PAM operators during any pauses in pile driving.		
	If pile driving shuts down for reasons other than mitigation (e.g., mechanical difficulty) for periods less than 30 minutes, pile driving may restart without ramp-up if PSOs have maintained constant observations and no detections of any marine mammal or sea turtle have occurred.		
Ramp-up (soft start) for impact pile driving	Each impact pile installation will begin with a minimum of 20-minute soft-start procedure.	BOEM will require that the applicant comply with applicant-proposed measures and • 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/min 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.	The measure minimizes the potential for animals that are not detected within the clearance zone, and outside the clearance zone, to be exposed to maximum-acoustic energy at their location and allows time for animals to move farther from noise that could potentially result in auditory injury or behavioral disturbance.
	Soft-start procedure will not begin until the clearance zone has been cleared by the visual PSOs and PAM operators, as applicable.		
	If a marine mammal is detected within or about to enter the applicable shutdown zone, prior to or during the soft-start		

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	procedure, pile driving will be delayed until the animal has been observed exiting the shutdown zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes, 30 minutes for all other marine mammal species, and 60 minutes for sea turtles).		
Alternative Monitoring Plan (AMP) for pile driving	—	The Lessee must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones. The Lessee must submit an AMP to BOEM and NMFS for review and approval at least 6 months 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, and use of PAM and must demonstrate the ability and effectiveness to maintain clearance and shutdown zones during daytime as outlined below in Part 1 and nighttime as outlined below in Part 2 to BOEM's and NMFS's satisfaction. The AMP must include two stand-alone components as described below: • Part 1 – Daytime when lighting or weather (e.g., fog, rain, sea state) conditions prevent visual monitoring of the full extent of the clearance and shutdown zones. Daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. • Part 2 – Nighttime inclusive of weather conditions (e.g., fog, rain, sea state). Nighttime being defined as 1.5 hours before civil sunset to one hour after civil sunrise. If a protected marine mammal or sea turtle is observed entering or found within the shutdown zones after impact pile-driving has commenced, the Lessee would follow the shutdown procedures outlined in Section 1.4.4 of the Protected Species Management and Equipment Specifications Plan. The Lessee would 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 should include, but is not limited to the following	This measure establishes a pathway for proposing nighttime piling. Night time piling may reduce the overall sound exposure to ESA-listed species.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		information: • Identification of night vision devices (e.g., mounted thermal/IR camera systems, hand-held or wearable NVDs, IR spotlights), if proposed for use to detect protected marine mammal and sea turtle species. • The AMP must demonstrate (through empirical evidence) the capability of the proposed monitoring methodology to detect marine mammals and sea turtles within the full extent of the established clearance and shutdown zones (i.e., species can be detected at the same distances and with similar confidence) with the same effectiveness as daytime visual monitoring (i.e., same detection probability). Only devices and methods demonstrated as being capable of detecting marine mammals and sea turtles to the maximum extent of the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility monitoring must include an assessment of the results of field studies (e.g., Thayer Mahan demonstration), as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available). • Procedures and timeframes for notifying NMFS and BOEM of New England Wind's intent to pursue nighttime pile driving. • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP.	
UXO Detonations – Construction, Operations			
Visual monitoring during UXO detonations (vessel based)	Two PSOs will visually survey the UXO clearance zone at least 60 minutes prior to a detonation event, during the event, and for 30 minutes after the event.	BOEM will require that the applicant comply with a modified visual monitoring measure for UXO detonations: Two PSO vessels, each with two PSOs on watch, will visually monitor the UXO clearance zone at least 60 minutes prior to a detonation event, during the event, and for 30 minutes after the event.	The measure minimizes the potential acoustic exposures of marine mammals and sea turtles by requiring the area of potential impact to be clear of marine mammals and sea turtles before starting piling.
Time of day restrictions	No UXO will be detonated during nighttime hours.	—	The measures reduces potential impacts on marine mammals and sea

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
			turtles by conducting activities when they are most visible to PSOs who can implement mitigation measures and eliminates the potential for behavioral disturbance from multiple detonations.
	Only one detonation may occur in a 24-hour period.		
PAM during UXO detonations	PAM will be conducted during UXO detonations.	BOEM will require that the applicant comply with applicant-proposed measures and for UXO detonations, the dedicated PAM PSO must acoustically monitor to a minimum radius of 8.8 miles (14,100 meters) around the detonation site.	The measures ensure that shutdown zones are free of vocalizing marine mammals before UXO detonation activities commence through PAM.
	PAM will begin at least 60 minutes prior to UXO detonation and extend at least 30 minutes after the event.		
Clearance for UXO detonations	A 60-minute clearance period will be implemented prior to any in-situ UXO detonation.	—	The measure ensures that shutdown zones are free of marine mammals before UXO detonation activities can commence and will minimize the potential for impacts on marine mammals and sea turtles during UXO detonations.
	The clearance zone must be fully visible for at least 30 minutes prior to commencing detonation.		
	All marine mammals must be confirmed to be out of the clearance zone prior to initiating detonation.		
	If a marine mammal is observed entering or within the relevant clearance zones prior to the initiation of detonation, the detonation must be delayed.		

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	The detonation may commence when either the marine mammal(s) has voluntarily left the respective clearance zone and been visually confirmed beyond that clearance zone, or when 30 minutes have elapsed without redetection for whales, including the NARW, or 15 minutes have elapsed without redetection of dolphins, porpoises, and seals.		
UXO clearance zones	The clearance zones for UXO detonation are provided below (JASCO 2023).	BOEM will require that the applicant comply with applicant-proposed measures and BOEM will require that a 5,249-foot (1,600-meter) sea turtle clearance zone will be established.	

Species	Visual clearance zone	PAM clearance zone	PAM monitoring zone
NARW	Any distance	Any distance	12,000
LFC	3,800	3,800	12,000

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
Noise attenuation for UXO detonations	The applicant will use a noise mitigation system for all detonation events and is committed to achieving the modeled ranges associated with 10 dB of noise attenuation.	—	The measure reduces the area of underwater noise effects on ESA-listed whales, sea turtles, marine fish, and the prey they feed upon during UXO detonations.
HRG Surveys – Construction, Operations			
PDC and BMP for HRG Survey Activities	—	BOEM will require New England Wind to comply with all the Project Design Criteria and Best Management Practices for Protected Species that implement the integrated requirements for threatened and endangered species in the June 29, 2021, programmatic consultation under the ESA, revised September 1, 2021 (https://media.fisheries.noaa.gov/2021-12/OSW-surveys-NLAA-programmatic-rev-1-2021-09-30-508-.pdf).	
Visual monitoring for HRG surveys	Visual monitoring of the established HRG clearance and shutdown zones will occur around regulated active acoustic sources (CHIRP sub-bottom profilers, boomer or sparker sources).	BOEM will require that the applicant comply with applicant-proposed measures and • For situational awareness of marine mammals and ESA-listed species that may be in the survey area, during times third-party protected species observers (PSOs) are on duty, they must monitor to the farthest extent practicable, with a	The measure allows for visual detection of ESA-listed species by PSOs prior to and during surveys such that the clearance and shutdown zones, along with the mitigation measures associated with

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		primary focus being 200 m around geophysical survey vessels (i.e., the Clearance Zone). At all times PSOs are on duty, any observed species must be recorded. • For all protected species, Clearance Zones of 200 m for all ESA-listed species of marine mammal must be clear of all animals for 30 minutes before ramp-up or any deployed survey equipment is activated. • PSOs deployed for mitigation, monitoring, and reporting of geophysical survey activities must be employed by a third-party observer provider. While the vessel is underway, they must have no other tasks other than to conduct observational effort, record data, communicate with and instruct relevant vessel crew to the presence of listed species and implement required PDCs and BMPs. PSOs on duty must be clearly listed on daily data logs for each shift. o Non-third-party observers may be approved by NMFS on a case-by-case basis for limited, specific duties in support of approved, third-party PSOs • A minimum of one PSO must be observing for listed species on each vessel at all times that noise-producing equipment is operating, or the survey vessel is actively transiting. The Lessee must include a PSO schedule showing that the number of PSOs used is sufficient to effectively monitor the affected area for the project (e.g., surveys) and record the required data. PSOs must not be on watch for more than 4 consecutive hours, with at least a 2-hour break after a 4-hour watch. PSOs must not work for more than 12 hours in any 24-hour period. • Visual monitoring must occur from the most appropriate vantage point on the associated operational platform that allows for maximum possible 360-degree field of view around the sound source and vessel. If 360-degree field of view is not possible from a single vantage point, multiple PSOs must be on watch to ensure such coverage to ensure both geophysical survey and vessel strike avoidance requirements for ESA-listed species can be implemented. • Visual observations must be conducted using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner. • Rangefinders (at least one per PSO, plus backups) or reticle binoculars (e.g., • 7 x 50) of appropriate quality (at least one per PSO, plus	those zone, are effectively implemented.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		backups) to estimate distances to listed species located in proximity to the Clearance and Shutdown Zone(s). • Digital cameras with a telephoto lens that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR). The camera or lens should also have an image stabilization system. Used to record sightings and verify species identification when possible. • A laptop or tablet to collect and record data electronically. • Global Positioning Units (GPS) if data collection/reporting software does not have built-in positioning functionality. • PSO data must be collected in accordance with standard data reporting, software tools, and electronic data submission standards approved by BOEM and NMFS for the particular activity. • Any other tools deemed necessary to adequately perform PSO tasks.	
	During daylight hours, one PSO will be on duty.		
	During periods of low visibility (e.g., darkness, rain, fog, etc.), PSOs will use alternative technology (e.g., infrared/thermal camera) to monitor shutdown and clearance zones.		
Clearance and shutdown zones for HRG surveys	The following clearance/ shutdown zones will be implemented during HRG surveys: • Clearance and shutdown zones will be implemented at any distance for detections of NARW • 12,467-foot (3,800-meter) clearance and shutdown zone for all ESA-listed marine mammal species (except NARW); • 3280-foot (1,000-meter) shutdown zone for all other marine mammals; except seals and delphinids from the genera Delphinus,and Lagenorhynchus, Stenella or Tursiops; and	--	The measure minimizes the potential for adverse effects on marine mammals and sea turtles by establishing zones in which impacts may occur and requiring clearance and, in some cases, shut down of equipment when animals enter those zones.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	• 656-foot (200-meter) clearance and shutdown zone for sea turtles.		
Clearance for HRG surveys	Clearance zones will be monitored for all marine mammal and sea turtle species for 30 minutes before any CHIRP sub-bottom profilers, boomer, or sparker sources are initiated. If any marine mammal or sea turtle is observed within the applicable clearance zone during the 30-minute clearance period, ramp-up will not begin until the animal(s) is/are observed exiting the clearance zones or until an additional time period has elapsed with no further sightings (i.e., 15 minutes for small odontocetes, seals and sea turtles; and 30 minutes for all other species).	--	The measure minimizes the potential acoustic exposures of sea turtles and marine mammals by requiring the area of potential impact to be clear of marine mammals and sea turtles before starting HRG sources that have the potential to result in behavioral disturbance.
Ramp-up for HRG surveys	Where technically feasible, HRG equipment will be activated starting with the lowest practical power output appropriate for the survey and then gradually turned up and other sources added in such a way that the source level increases gradually.	BOEM will require that the applicant comply with applicant-proposed measures and Ramp up of the boomer or sparker survey equipment must occur at the start or re-start of geophysical survey activities when technically feasible. A ramp up must begin with the power for the geophysical survey equipment ramped up half power for 5 minutes, and then to full power.	The measure minimizes the potential for animals to be exposed to maximum-acoustic energy at their location and allows time for animals to move farther from noise that could potentially result in behavioral disturbance.
Shutdowns for HRG surveys	An immediate shutdown of HRG survey equipment specified in the incidental harassment authorization permit will be required if a marine mammal or sea turtle is detected at or within its respective shutdown zone.	--	The measure minimizes the potential for adverse effects on ESA-listed marine mammals and sea turtles by stopping the sound input into the water when a marine mammal or sea turtle is within a range that could result in behavioral disturbance.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	If another marine mammal or sea turtle enters a shutdown zone during the shutdown period, the HRG equipment may not restart until that animal is confirmed outside the respective exclusion or until the appropriate time has passed from the last sighting of the marine mammal.		
Fisheries Surveys – All Stages			
General mitigation and monitoring measures during fisheries surveys	Vessel operators and crew will maintain a vigilant watch for marine mammals and adhere to legally mandated vessel speeds, approach limits, and other vessel strike avoidance measures to reduce the risk of impact on NARWs and other marine mammals. Vessel distances from a marine mammal will adhere to federal guidelines for species-specific separation distances. Vessels will maintain a separation distance and exclusion zone that are applicable at the time of the surveys (currently 1,640 feet [500 meters] for NARW, 328 feet [100 meters] for other whale species, and 164 feet [50 meters] for dolphins, porpoises, and seals from the vessel and associated fishing gear). In the event a marine mammal is sighted near a vessel in transit, the captain will remain parallel to the animal, slow down, or maneuver their vessel, as appropriate, to avoid a potential interaction with a marine mammal. Vessels will follow NMFS guidelines for vessel strike avoidance that are applicable at the time of the surveys by maintaining required separation distances from the animal, which will be monitored by trained vessel operators and crews. Vessel operators will check the NMFS'	BOEM will require that the applicant comply with applicant-proposed measures and • Ensure all sampling gear would be hauled at least once every 30 days, and all gear would be removed from the water and stored on land between survey seasons to minimize risk of entanglement. • If any survey gear is lost, all reasonable efforts that do not compromise human safety would be undertaken to recover the gear. All lost gear would be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) within 24 hours of the documented time of missing or lost gear. This report would include information on any markings on the gear and any efforts undertaken or planned to recover the gear. • At least one of the survey staff onboard the trawl surveys and ventless trap surveys would have completed NEFOP observer training (within the last 5 years) or other 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 would be available on board each survey vessel. BOEM would ensure that New England Wind prepares a training plan that addresses how this requirement would be met and that the plan is submitted to NMFS in advance of any trawl or trap surveys. This requirement is in place for any trips where gear is set or hauled. • Any sea turtles or Atlantic sturgeon caught and/or retrieved in any fisheries survey gear would first be identified to species or species group. Each ESA-listed species caught and/or retrieved would then be properly documented using appropriate equipment and data collection forms. Biological	The measures minimize the risk of marine mammal, sea turtle, and marine fish entanglement and vessel interactions. The measures also ensure the safe handling and resuscitation of sea turtles and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) following established protocols.

<table>
<tr><th>Measure</th><th>Applicant-Proposed Measure</th><th>BOEM-Proposed Measure</th><th>Expected Effects Avoided or Minimized</th></tr>
<tr><td></td><td>NARW reporting systems on a daily basis.

Additionally, it is expected that vessel captains will monitor USCG VHF Channel 16 throughout the day to receive notifications of any sightings. This information will be used to alert the team to the presence of a NARW in the area and implement mitigation measures as appropriate. Whenever multiple proposed Project vessels are operating, all sightings of listed species will be communicated between vessels.

Vessel operators and crew will monitor for marine mammals prior to deployment of fishing gear (e.g., trawl net) and continue to monitor until the gear is brought back on deck. If a marine mammal is sighted within 1 nautical mile (1.9 kilometers, 1.15 miles) of the survey vessel within 15 minutes prior to the deployment of the research gear and it is considered to be at risk of interaction with the gear, the sampling station will be suspended until there are no sightings of marine mammals for at least 15 minutes within 1 nautical mile (1.9 kilometers, 1.15 miles) of the sampling station. The vessel operator may also relocate the vessel away from the marine mammal to a different sampling location.</td><td>data, samples, and tagging would occur as outlined below. Live, uninjured animals should be returned to the water as quickly as possible after completing the required handling and documentation.
The Sturgeon and Sea Turtle Take Standard Operating Procedures would be followed (https://media.fisheries.noaa.gov/2021-11/Sturgeon%20%26%20Sea%20Turtle%20Take%20SOPs_external_11032021.pdf).
Survey vessels would have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader) and this reader be used to scan any captured sea turtles and sturgeon for tags. Any recorded tags would be recorded on the take reporting form (see below).
Genetic samples would 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 would 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).
Fin clips would be sent to a NMFS-approved laboratory capable of performing genetic analysis and assignment to DPS of origin. To the extent authorized by law, BOEM is responsible for the cost of the genetic analysis. Arrangements would be made for shipping and analysis in advance of submission of any samples; these arrangements would be confirmed in writing to NMFS within 60 days of the receipt of the Project BiOp with ITS. Results of genetic analysis, including assigned DPS of origin would be submitted to NMFS within 6 months of the sample collection.
Subsamples of all fin clips and accompanying metadata forms would 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:</td><td></td></tr>
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Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		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. o All captured sea turtles and Atlantic sturgeon would be documented with required measurements and photographs. The animal's condition and any marks or injuries would be described. This information would be entered as part of the record for each incidental take. A NMFS Take Report Form would 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. • Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys would be handled and resuscitated (if unresponsive) according to established protocols and whenever at-sea conditions are safe for those handling and resuscitating the animal(s) to do so. Specifically: o Priority would be given to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used, if conditions at sea are safe to do so. Handling times for these species should be minimized (i.e., kept to 15 minutes or less) to limit the amount of stress placed on the animals. o All survey vessels would have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) prior to the commencement of 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 would be carried out any time a sea turtle is incidentally captured and brought onboard the vessel during the Proposed Action. o If any sea turtles that appear injured, sick, or distressed, are caught and retrieved in fisheries survey gear, survey staff would immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for	

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		further instructions and guidance on handling the animal, and potential coordination of transfer to a rehabilitation facility. If unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG should 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 following handling instructions provided by the Hotline, prior to transfer to a rehabilitation facility. o Attempts would be made to 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). o Provided that appropriate cold storage facilities are available on the survey vessel, following the report of a dead sea turtle or sturgeon to NMFS, and if NMFS requests, any dead sea turtle or Atlantic sturgeon would be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore as safe to do so. o Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey would ultimately be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s) to do so	
Reporting and sampling for incidental take during fisheries surveys	If any protected species are captured, they should be immediately released, and the incident should be reported in accordance with protected species reporting requirements to NMFS and BOEM. All trawl survey activities will comply with relevant take reduction plan regulations.	BOEM will require that the applicant comply with applicant-proposed measures and • Should any interactions with ESA-listed species occur, the contracted scientists will follow the sampling protocols described for at-sea monitors (ASMs in Fisheries Sampling Branch Observer On-Deck Reference Guide 2016 (Northeast Fisheries Science Center [NEFSC] 2016). Protected species interactions will be reported immediately to NOAA’s stranding hotline via telephone (866-755-NOAA) or via the Whale Alert App, and a written report will be provided to the NMFS GARFO (incidental.take@noaa.gov) within 24 hours,	The measure requires standard data collection and documentation of any ESA species caught during surveys. Reporting and sampling does not directly reduce ESA-species risk; however, the data gathered can be used to inform mitigation measures and assess effectiveness.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		as detailed in the FRMP. The following protocol will also be followed: o Should lethal incidental take of a marine mammal occur, the entire animal will be retained if practicable and provided to NOAA. If the animal cannot be retained, the contract scientists will complete the minimum ASM sampling requirements. o Should incidental take of Atlantic sturgeon occur, the contracted scientists will follow the sampling protocols described for the Northeast Fisheries Observer Program in the reference guide (NEFSC 2016), as follows: ▪ Live sturgeon will be released after scanning the animal for a passive integrated transponder tag; ▪ All data and any biological samples resulting from sturgeon encounters will be provided to the NEFSC	
Demersal otter trawl survey	Marine mammal monitoring will be conducted by the captain and/or a survey crew member before deployment, during survey activities, and upon retrieval of fishing gear. Vessel operators and fisheries survey personnel working offshore will receive environmental training, including marine mammal species identification. At least one of the survey staff onboard will have completed training (within past 5 years) in protected species identification and safe handling. Trawl tows will be limited to a 20-minute trawl time at 3.0 knots. If marine mammals are sighted before the gear is fully removed from the water, the vessel will slow its speed and maneuver the vessel away from the animals to minimize potential interactions with the observed animal. If a marine mammal is observed within 1 nautical mile (1.9 kilometers, 1.15 miles) of the planned sampling station in the 15 minutes prior to gear deployment, the applicant will delay setting the trawl until the marine mammal has not been observed for 15	--	This measure reduces the risk of ESA-listed species bycatch by limiting trawl times and maintaining efficient gear operations.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
	minutes. The applicant may also relocate the vessel away from the marine mammal to a different sampling location. If marine mammals are still visible from the vessel after relocation, the applicant may decide to relocate again or move on to the next sampling station. If marine mammals are sighted before the gear is fully removed from the water, the vessel will slow its speed and maneuver the vessel away from the animals to minimize potential interactions with the observed animal. The vessel crew will open the cod end of the trawl net close to the deck to avoid injury to animals that may be caught in the gear. Gear will be emptied immediately after retrieval within the vicinity of the deck. Trawl nets will be fully cleared and repaired if damaged before redeployment. Unless human safety will be compromised, there will be reasonable efforts made to recover lost gear within 24 hours. If the gear cannot be retrieved in 24 hours, the gear will be retrieved as soon as it is safe. All lost gear will be reported to the U.S. Department of the Interior in compliance with BOEM and BSEE's incident reporting requirements and procedures. In addition to lost gear, all lost or discarded marine trash and debris will be reported to U.S. Department of the Interior in compliance with BOEM and BSEE's requirements and reporting procedures found in the applicant's lease or grant and/or the BOEM 2021 BMPs. BOEM will share this information with NMFS.		

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
Trap/pot/gillnet surveys	To avoid entanglement with vertical lines, buoy lines will be weighted and will not float at the surface of the water, and all groundlines will consist of sinking line. Downlines of each string will use weak link or ropeless technology to deter whale entanglements. All gear will be compliant with the Atlantic large whale take reduction plan. Adequate gear for disentanglement (i.e., knife and boathook) will be onboard all survey vessels. Buoy lines and linkages will be compliant with best practices. "Ropeless" gear may be tested and used. All buoys will be properly labeled with the scientific permit number and identification as research gear. All labels and markings on the buoys and buoy lines will be compliant with the applicable regulations, and all buoy markings will comply with instructions received by the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division. Any lost fishing gear will be immediately reported to the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division. In the event that any marine mammal or sea turtle is entangled in survey gear, the NMFS stranding hotline will be contacted immediately.	BOEM will require that the applicant comply with applicant-proposed measures and To facilitate identification of gear on any entangled animals, all trap/pot gear used in the surveys would be uniquely marked to distinguish it from other commercial or recreational gear. Using yellow and black striped duct tape, place a 3-foot-long mark within 2 fathoms of a buoy. In addition, using black and white paint or duct tape, place 3 additional marks on the top, middle and bottom of the line. These gear marking colors are proposed as they are not gear markings used in other fisheries and are therefore distinct. Any changes in marking would not be made without notification and approval from NMFS. Vessels deploying fixed gear (e.g., pots/traps) would have adequate disentanglement equipment (i.e., knife and boathook) onboard. Any disentanglement would 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/20283).	This measure reduces the risk of ESA-listed species bycatch and entanglement by limiting gear soak times and implementing vertical line reduction and standards.
Mooring Systems – All Stages			
Buoy deployment, operations, and retrieval	—	BOEM will require New England Wind to comply with all the Project Design Criteria and Best Management Practices for Protected Species that implement the integrated requirements for threatened and endangered species in the June 29, 2021, programmatic consultation under the ESA, revised September	This measure reduces potential impacts by ensuring any mooring systems used during survey activities is designed to prevent potential entanglement or

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		1, 2021 (https://media.fisheries.noaa.gov/2021-12/OSW-surveys-NLAA-programmatic-rev-1-2021-09-30-508-.pdf).	entrainment of listed species, and in the unlikely event that entanglement does occur, ensure proper reporting of entanglement events.
Dredging – Construction, Operations			
Dredging activities outside of cable installation operations	—	BOEM will require that the applicant: • Implement USACE standard PSO requirements for suction/hydraulic dredges if used in areas where ESA-listed marine fish or sea turtles may occur. • Use silt retainment curtains if feasible. • When applicable and practicable, apply time of year restrictions for nearshore dredging and silt-producing activities associated operations facility improvements that occur in areas where ESA-listed marine fish or sea turtles may occur.	The measure reduces entrainment risk for sea turtles and sturgeon and minimizes effects on sea turtle and sturgeon habitat.
Reporting – All Stages			
All activities	The applicant will submit annual reports as required under the MMPA ITA. The applicant will compile and submit weekly PSO and PAM reports to NMFS (at PR.ITP.monitoring reports@noaa.gov) that document the daily start and stop of all pile-driving activities, the start and stop of associated observation periods by PSOs, details on the deployment of PSOs, a record of all detections of marine mammals, any mitigation actions (or if mitigation actions could not be taken, provide reasons why), and details on the noise attenuation system(s) used and its performance. Weekly reports are due on Wednesday for the previous week (Sunday through Saturday).	BOEM will require that the applicant comply with applicant-proposed measures and BOEM will also ensure that the applicant implements the following reporting requirements necessary to document the amount or extent of take that occurs during all stages of the proposed Project: • All reports would be sent to: nmfs.gar.incidental-take@noaa.gov. • During the construction phase and for the first year of operations, New England Wind would compile and submit monthly reports that include a summary of all Project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), and piles installed, and all observations of ESA-listed species. Monthly reports are due on the 15th of the month for the previous month. • Beginning in Year 2 of operations, New England Wind would compile and submit annual reports that include a summary of 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	The measure does not directly reduce impacts on ESA-listed species; however, the data gathered confirm compliance with mitigation and could be used to evaluate effects and potentially lead to additional mitigation measures, if required.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		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.	
Injured protected species reporting	The applicant will report impacts on marine mammals to jurisdictional/interested agencies, including NOAA and BOEM, as required.	BOEM will require that the applicant comply with applicant-proposed measures and • Regardless of survey type or the need to provide a dedicated trained watch stander or PSO, any potential take, strikes, or dead/injured protected species caused by Project activities must be reported to the NMFS GARFO Protected Resources Division nmfs.gar.incidental-take@noaa.gov), NOAA Fisheries 24-hour Stranding Hotline – for marine mammals from Maine-Virginia, report to (866) 755-6622, and from North Carolina-Florida to (877) 942-5343 and for sea turtles from Maine-Virginia, report to (866) 755-6622, and from North Caroline-Florida to (844)732-8785.BOEM (at mailto: renewable_reporting@boem.gov), and BSEE (at mailto:) as soon as practicable, but no later than 24 hours from the time the incident took place (Protected Species Incident Report). The Protected Species Incident Report must include the following information:protectedspecies@bsee.gov) as soon as practicable, but no later than 24 hours from the time the incident took place (Protected Species Incident Report). The Protected Species Incident Report must include the following information:	The measure improves any potential response time to incidents (if required) and maintains information about potential impacts for which modifications need to be made.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		○ Contact info for the person providing the report; ○ Time, date, and location (latitude/longitude) of the incident; ○ Species identification (if known) or description of the animal(s) involved; ○ Condition of the animal(s) (e.g., live, injured, dead); ○ Observed behaviors of the animal(s), if alive; ○ If available, photographs or video footage of the animal(s); and ○ General circumstances (e.g. vessel speed/direction of travel, sound sources in use) under which the animal was impacted • All dead or injured protected species, must be reported regardless of whether they were observed during operations or directly due to Lessee activities. In the event that an injured or dead marine mammal or sea turtle is sighted, regardless of the cause, the Lessee must report the incident to the NMFS Protected Resources Division (nmfs.gar.incidental-take@noaa.gov), NMFS 24-hour Stranding Hotline number (866-755-6622), BOEM (at renewable_reporting@boem.gov), and BSEE (at protectedspecies@bsee.gov) as soon as practicable (taking into account crew and vessel safety), but no later than 24 hours from the sighting (Dead or Injured Protected Species Report). Staff responding to the hotline call will provide any instructions for the handling or disposing of any injured or dead protected species by individuals authorized to collect, possess, and transport sea turtles. The Protected Species Incident Report must include the following information: ○ Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable); ○ Species identification (if known) or description of the animal(s) involved; ○ Condition of the animal(s) (including carcass condition if the animal is dead); ○ Observed behaviors of the animal(s), if alive; ○ If available, photographs or video footage of the animal(s); and ○ General circumstances under which the animal was discovered • If a live or dead marine protected species becomes	

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
		entangled, operators must immediately contact the applicable stranding network coordinator using the reporting contact details and provide any on-water assistance requested.	
	If a NARW is involved in any incidents, the vessel captain or PSO onboard should also notify the Right Whale Sighting Advisory System hotline as soon as practicable, but no later than 24 hours after the event.		
Reporting observed impacts on species	PSOs/PAM operators will report any observations concerning impacts on ESA-listed marine mammals, sea turtles, and marine fish to NMFS within 48 hours.	BOEM will require that the applicant comply with applicant-proposed measures and the measures proposed previously under "Injured protected species reporting"	The measure improves any potential response time to incidents (if required) and maintains information about potential impacts for which modifications need to be made.
	BOEM and NMFS will be notified within 24 hours if any evidence of a fish kill during construction activity is observed.		
	For all pile-driving activities, PSOs will document any behavioral reactions in concert with distance from the pile being driven.		
BOEM/NMFS meeting requirements for sea turtle take documentation	—	To facilitate monitoring of the incidental take exemption for sea turtles, through the first year of operations, BOEM and NMFS would meet twice annually to review sea turtle observation records. These meetings/conference calls would be held in September (to review observations through August of that year) and December (to review observations from September to November) and would use the best available information on sea turtle presence, distribution, and abundance, Project vessel activity, and observations to estimate the total number of sea turtle vessel strikes in the action area that are attributable to Project operations. These meetings would continue on an annual basis following year 1 of operations. Upon mutual agreement of NMFS and BOEM, the frequency of these meetings can be changed.	This measure establishes process for monitoring of incidental take exemption for sea turtles. By incorporating collaborative meetings, a better assessment of risk and potential take can be formulated.

Measure	Applicant-Proposed Measure	BOEM-Proposed Measure	Expected Effects Avoided or Minimized
Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	—	The Lessee must monitor indirect impacts associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least ten of the WTGs annually. Survey design and effort (i.e., the number of WTGs and frequency of reporting) may be modified only upon concurrence by BOEM and BSEE and based upon review of annual reports. The Lessee must conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The Lessee must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at 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.	This measure establishes requirement for monitoring and reporting of lost monofilament and other fishing gear around WTGs. The data will provide better information regarding the risk of debris and monofilament line for ESA-listed species that can be used for future measures.

BMP = best management practice; BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; COP = Construction and Operations Plan; dB = decibel; dB re 1 µPa = decibels referenced to 1 micropascal; dB re 1 μPa^2 = decibels referenced to 1 micropascal squared; dB re 1 µPa2 s = decibels referenced to 1 micropascal squared second; DMA = dynamic management area; EIS = Environmental Impact Statement; $ER_{95\%}$ = 95th percentile exposure range; ESA = Endangered Species Act; ESP = electrical service platform; GARFO = Greater Atlantic Regional Fisheries Office; HRG = high-resolution geophysical; ITA = incidental take authorization; kJ = kilojoule; LFC = low-frequency cetacean; MFC = MFC = mid-frequency cetacean; MMPA = Marine Mammal Protection Act; NARW = North Atlantic right whale; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; PAM = passive acoustic monitoring; PDC = Project Design Criteria; PDE = Project design envelope; PPW = phocid pinniped in water; PSO = protected species observer; PTS = permanent threshold shift; RSLL = received sound level limit; SEL = sound exposure level; SMA = seasonal management area; SPL = root-mean-square sound pressure level; SWDA = Southern Wind Development Area; USACE = U.S. Army Corps of Engineers; USCG = U.S. Coast Guard; UXO = unexploded ordnance; WTG = wind turbine generator

[a] BOEM 2021 BMPs available at: https://www.boem.gov/pdcs-and-bmps-atlantic-data-collection-11222021.

1.5 Description of Stressors

The Proposed Action would result in various stressors that could affect ESA-listed species and critical habitat in the Action Area. The stressors cover all stages of the Proposed Action, including construction, operations, and decommissioning. Table 1-16 describes the stressors associated with the Proposed Action and identifies the listed species and critical habitat that may be exposed to each stressor. Each stressor is assessed in relation to the effects of the Proposed Action when added to the environmental baseline. Further details regarding effects determinations are provided in Section 3.

Table 1-16: Stressors Associated with the Proposed Action that Could Potentially Affect Listed Species and Critical Habitat

Stressor	Description	Sources and/or Activities	Project Stage	Listed Species and Critical Habitat Exposed to the Stressor
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, which typically consist of authorized operational effluents controlled through treatment and monitoring systems and permit limitations.	• Mobile sources (e.g., vessels) • Installation, operation, and maintenance of onshore or offshore stationary sources (e.g., renewable energy structures, transmission lines, cables)	All proposed Project stages	Blue whale (*Balaenoptera musculus*) Fin whale (*Balaenoptera physalus*) NARW (*Eubalaena glacialis*) Sei whale (*Balaenoptera borealis*) Sperm whale (*Physeter macrocephalus*) Green sea turtle (*Chelonia mydas*) Kemp's ridley sea turtle (*Lepidochelys kempii*) Leatherback sea turtle (*Dermochelys coriacea*) Loggerhead sea turtle (*Caretta caretta*) Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) NARW critical habitat Atlantic sturgeon critical habitat
Anchoring	Refers to an activity or action that attaches objects to the seafloor.	• 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)	Construction and decommissioning of the WTG and ESP foundations and Project cables Potentially during operations for non-routine maintenance activities	Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon
Cable emplacement and maintenance	Refers to an activity or action 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 • Mattress and rock placement	Construction and operations	Blue whale Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon
Discharges/intakes	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	• Vessels • Structures • Onshore point and non-point sources • Dredged material ocean disposal	All proposed Project stages	Blue whale Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle

Stressor	Description	Sources and/or Activities	Project Stage	Listed Species and Critical Habitat Exposed to the Stressor
	effluent, condensate, and seawater cooling system effluent, among others. These discharges are generally restricted to uncontaminated or properly treated effluents that may have BMP or numeric pollutant concentration limitations imposed through USEPA NPDES permits or USCG regulations. The discharge of dredged material refers to the deposition of sediment at approved offshore disposal sites.	• Installation, operation, and maintenance of submarine transmission lines, cables, and infrastructure		Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon NARW critical habitat Atlantic sturgeon critical habitat
EMF	Power generation facilities and cables produce electric fields (proportional to the voltage) and magnetic fields (proportional to flow of electric current) in the air/water around the power line. For undersea power cables, the voltage on the wire conductors within the cable does not produce an electric field in the seafloor or ocean because it is locked (shielded) by the outer grounded metallic sheath encircling the conductors. However, the metal sheath magnetic around the undersea power cable do not shield the environment from the magnetic field; therefore, a 60 Hz magnetic field surrounds each cable. This oscillating AC 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 generated or carried by the cable, 2) the design of the generator or cable, and 3) the distance of organisms from the generator or cable.	• Substations • Power transmission cables • Inter-array cables • Electricity generation	Operations	Fin whale NARW Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon

Stressor	Description	Sources and/or Activities	Project Stage	Listed Species and Critical Habitat Exposed to the Stressor
Noise	Refers to noise from various sources and commonly associated with construction activities, geophysical and geotechnical surveys, and vessel traffic. May be impulsive (e.g., pile driving) or broad spectrum and continuous (e.g., from proposed Project-associated marine transportation vessels). May also be noise generated from turbines themselves or interactions of the turbines with wind and waves.	• Aircraft • Vessels • Turbines • Geophysical and geotechnical surveys • Operations and maintenance • Onshore and offshore construction and installation • Pile driving • Vibratory pile setting • Foundation drilling • Dredging and trenching	All proposed Project stages	Blue whale Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon NARW critical habitat Atlantic sturgeon critical habitat
Presence of structures	Refers to an activity or action associated with onshore or offshore structures other than construction-related impacts, including the following: • Fish aggregation and/or dispersion • Marine mammal attraction and/or displacement • Sea turtle attraction and/or displacement • Scour protection • Allisions • Entanglement and/or gear ingestion • Gear loss and/or damage • Fishing effort displacement • Habitat alteration (creation or destruction) • Behavioral disruption (migration or breeding) • Seabed alterations • Microclimate and circulation effects (above and below water)	• Offshores structures including foundations, towers, and transmission cable infrastructure	Operations	Blue whale Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon
Monitoring surveys and gear utilization	Monitoring surveys refer to effects from biological surveys conducted pre-, post-, and during construction, including the following: • Bottom habitat disturbance • Removal of biological samples	• HRG surveys • Aerial and vessel-based surveys • Fishery surveys • Benthic surveys	Pre-, during, and post-construction Operations	Blue whale Fin whale NARW Sei whale Sperm whale

Stressor	Description	Sources and/or Activities	Project Stage	Listed Species and Critical Habitat Exposed to the Stressor
	• Entanglement/entrapment from lost fishing gear Gear utilization refers to entanglement and bycatch from gear utilization during fisheries and benthic monitoring surveys.			Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon
Traffic	Refers to marine vessel traffic, including vessel strikes of marine mammals, sea turtles, and marine fish; collisions; and allisions.	• Vessels	All proposed Project stages	Blue whale Fin whale NARW Sei whale Sperm whale Green sea turtle Kemp's ridley sea turtle Leatherback sea turtle Loggerhead sea turtle Atlantic sturgeon Atlantic sturgeon critical habitat NARW critical habitat
Turbidity	Refers to effects from turbidity associated with construction activities, port modifications, vessel traffic, and presence of structures during operations.	• Installation of offshore infrastructure • Port modifications (e.g., dredging) • Vessel activity • Presence of structures during operations	Construction and decommissioning	Fin whale NARW Sei whale Sperm whale Blue whale Green sea turtle Kemp's ridley sea turtle Loggerhead sea turtle Atlantic sturgeon

AC = alternating current; BA = Biological Assessment; EMF = electromagnetic fields; ESA = Endangered Species Act; ESP = electrical service platform; HRG = high-resolution geophysical; Hz = hertz; NARW = North Atlantic right whale; NPDES = National Pollutant Discharge Elimination System; USCG = U.S. Coast Guard; USEPA = U.S. Environmental Protection Agency; UXO = unexploded ordnance; WTG = wind turbine generator

[a] The following stressors have been discounted from the assessment in the BA for the ESA-listed resources analyzed because they are not expected to have any discernable effects on these species:

- Air emissions, land disturbance, lighting, port utilization, and unexpected events

2 Environmental Baseline

2.1 Physical Environment

2.1.1 Seabed and Physical Oceanographic Conditions

2.1.1.1 Seabed Conditions

The seafloor in the OECC and SWDA is predominantly composed of unconsolidated sediments ranging from silt and fine-grained sands to gravel. Local hydrodynamic conditions largely determine sediment types, with finer materials in low-current areas and coarser materials in high-current areas. Coarser materials on the seafloor include gravel, cobble, and boulders, which are typically mixed with a matrix of finer sediments and usually found among discontinuous patches of sand (COP Volume II; Epsilon 2022). This patchy distribution of coarse material (representative of coarse glacial till or end moraine deposits) is most common in high current areas, such as in the Muskeget Channel region and northwest of Horseshoe Shoal in the North Channel (COP Volume II, Table 2.1-1; Epsilon 2022).

No hard-bottom habitat was identified in the SWDA, but it was documented within the OECC where it has significant coverage through Muskeget Channel's shallow water passage (COP Volume II, Section 5.2.1; Epsilon 2022). Complex habitat, which is considered hard-bottom substrates, hard bottom with epifauna or macroalgae cover, and vegetated habitats (NMFS 2021b) are present mainly in the Muskeget Channel section of the OECC; no complex habitat was identified in the SWDA (COP Volume II, Section 5.2.2.1; Epsilon 2022). Soft-bottom habitat, consisting mainly of sand but also mud mainly in the southern portion of the OECC and within the SWDA, was the most common habitat type throughout the OECC and the only habitat type in the SWDA (COP Volume II, Section 5.2.2.4; Epsilon 2022). Additionally, a sparse to moderate distribution of living eelgrass was identified in one area of the OECC along the south shore of Cape Cod (COP Volume II, Section 5.2.3; Epsilon 2022).

2.1.1.2 Physical Oceanographic Conditions

Sea surface temperatures in the SWDA reported by the Northeast Fisheries Science Center Multispecies Bottom Trawl Survey ranged from 5.4 degrees Celsius (°C) in the winter to 17.5°C in the fall (COP Volume III, Section 5.2.1; Epsilon 2022). Along the OECC, data for Nantucket Sound and Cape Cod Bay from the Center for Coastal Studies showed average sea surface temperatures from 17.95°C to 20.36°C, varying due to the sampling locations within these areas (COP Volume III, Section 5.2.1; Epsilon 2022). Sea surface salinity in the SWDA is estimated to be 32.9 practical salinity units across all seasons, and along the OECC salinity values ranged from 31.60 to 31.75 practical salinity units (COP Volume III, Section 5.2.1; Epsilon 2022). Water depths in the SWDA range from 141 to 203 feet (43 to 62 meters) (COP Section 2.2; Epsilon 2022).

2.1.1.3 Water Quality

For the purpose of the Section 7 consultation, the total suspended solids (TSS) metric is the pertinent water quality parameter likely to be measurably affected by the proposed Project activities. Turbidity levels for the northeastern coastal waters were rated as fair to good condition by the USEPA Freshwater Quality Index (USEPA 2015). Data from the Center for Coastal Studies show TSS in the Project area range from 0.58 to 0.66 nephelometric turbidity units (COP Volume III, Section 5.2.1; Epsilon 2022).

2.1.2 Electromagnetic Fields

The marine environment continuously generates additional ambient EMF effects. The motion of electrically conductive seawater through the earth's magnetic field induces voltage potential, thereby creating electrical currents. Surface and internal waves, tides, and coastal ocean currents all create weak induced EMF effects. Their magnitude at a given time and location depends on the strength of the prevailing magnetic field, site, and time-specific ocean conditions. Other external factors like electrical storms and solar events can also generate variable EMF effects. The strength of the earth's direct current magnetic field is approximately 516 milligauss (mG) along the southern New England coast (CSA Ocean Sciences Inc. and Exponent 2019). The electric field generated by the movement of the ocean currents through the earth's magnetic field is reported to be 0.075 millivolts per meter or less (CSA Ocean Sciences Inc. and Exponent 2019). Other external factors like electrical storms and solar events can also generate variable EMF effects. Following the methods described by Slater et al. (2010), a uniform current of 3.3 feet per second (1 meter per second) flowing at right angles to the natural magnetic field in the Action Area could induce a steady-state electrical field on the order of 51.5 microvolts per meter. Wave action would also induce EMF at the water surface on the order of 10 to 100 microvolt per meter and 1 to 10 mG, respectively, depending on wave height, period, and other factors. Although these effects dissipate with depth, wave action would likely produce detectable EMF effects up to 185 feet (56 meters) below the surface (Slater et al. 2010).

Submarine transmission or communication cables can also contribute to EMF levels in an area. Electrical telecommunications cables are likely to induce a weak EMF in the immediate area along the cable path. Gill et al. (2005) observed electrical fields on the order of 1 to 6.3 microvolts per meter within 3.3 feet (1 meter) of a typical cable of this type. The heat effects of communication and transmission cables on surrounding sediments are likely to be negligible given the limited transmission power levels involved (Taormina et al. 2018). Fiber-optic cables with optical repeaters would not produce EMF or significant heat effects. The following subsea transmission and communication cables have been identified within or near the Project area (BOEM 2022a):

- A submarine power cable connecting Block Island to the mainland electrical grid at Narragansett, Rhode Island;
- Four electric cables located in three corridors present through Vineyard Sound providing electric service to Martha's Vineyard from Falmouth;
- Two electric cables present through Nantucket Sound providing service to Nantucket from Dennis and Hyannis Port; and
- Fiber-optic and trans-Atlantic cables originating near Charlestown, Rhode Island; New York City, New York; Long Island, New York; and Wall, New Jersey.

The only cables that have reported EMF measurements are the Block Island Wind Farm cables, which were measured by a crew from University of Rhode Island's School of Oceanography hired by National Grid in 2017 (Shuman 2017). The measurements showed a maximum reading of 8 mG, which was lower than the modeled EMF level of 22 mG (Shuman 2017).

2.1.3 Anthropogenic Conditions

2.1.3.1 Artificial Light

Vessel traffic and navigational safety lights on buoys, meteorological towers, and other existing infrastructure (i.e., Block Island Wind Farm WTGs) are the only artificial lighting sources in the open-water portion of the Action Area. Land-based artificial light sources become more predominant in proximity to the coastline throughout the Action Area.

2.1.3.2 Vessel Traffic

A Navigation Safety Risk Assessment was conducted as part of the COP (COP Appendix III-I; Epsilon 2022). According to its analysis of automatic identification system (AIS) data from 2016 through 2019, vessel traffic levels within the SWDA are low. The highest density of vessel traffic in the region occurs outside the Project area and primarily within traffic separation scheme, fairways, precautionary areas, and recommended routes. The relative traffic density within the SWDA is lower than the surrounding region, with the highest transiting density through the northeast section of SWDA with the vessel traffic along a northwest-to-southeast line of orientation. Vessel traffic is primarily seasonal, with approximately 87 percent of all annual SWDA area traffic occurring between Memorial Day and Labor Day; July, August and September had the highest vessel traffic each year. Vessel traffic in the SWDA ranged from a low of 0.5 vessel tracks per day on average during the winter to 5.5 vessel tracks per day on average during the summer; a peak of 6.4 vessel tracks per day on average occurred during the month of August. Overall, annual vessel traffic is relatively low, averaging 2.4 vessel tracks per day in the SWDA for AIS-equipped vessels, though vessel traffic was also variable by year. An evaluation of vessel proximity revealed that two or more vessels are present within the SWDA simultaneously for only 124 hours per year on average (1.4 percent of the year). There was one short period (a few hours) in September 2016 in which up to 14 vessels were in the SWDA with most of these vessels sailing at speeds less than 4 knots (2 meters per second) while trawling.

Based on the analysis conducted in the Navigation Safety Risk Assessment, the majority of the vessels in the SWDA were either fishing or recreational, though cargo, tanker, passenger, tug-tow, military, and other vessels were also recorded (COP Appendix III-I; Epsilon 2022). Commercial fishing vessels and recreational vessels comprised more than 75 percent of the AIS tracks recorded in 2016 and 2019. It was found that fishing vessels (transiting and trawling) represented the majority (59 percent) of total vessel traffic based on unique transits through the SWDA. Fishing vessels have a wide range of tracks through the SWDA with the most frequent transit directions along east-to-west and east/northeast-to-west/southwest tracks. Based on AIS data, fishing vessels typically have a length overall of 60 to 80 feet (18 to 24 meters); however, there are likely a number of fishing vessels less than 65 feet (19.8 meters), which transit through the SWDA but that do not transmit AIS data. It is estimated that 40 to 60 percent of the commercial fishing fleet is represented in the AIS data. Overall, available data indicate relatively low levels of fishing effort in the SWDA.

Recreational vessels transit the SWDA with an average of 174 unique transits per year through the SWDA over the 4-year AIS data period (approximately 20 percent of the unique vessel tracks). Most recreational vessels have a length of 30 to 60 feet (15 to 20 meters), but there are a small number of large motor and sailing recreational vessels greater than 200 feet (61 meters) that transit through the SWDA.

There is existing use of the SWDA waterway by larger commercial vessels including passenger, dry cargo, and tanker vessels. Over a 4-year period, on average, 103 larger commercial vessels transited through the SWDA each year. The typical size of these vessels was 600 feet (182 meters) or greater. It is anticipated that larger commercial vessel (e.g., cargo, tanker, passenger, military, and tug-tow) traffic may, instead of transiting through the SWDA, navigate to the south toward existing shipping routes, including the Nantucket to Ambrose Safety Fairway (westbound) and Ambrose to Nantucket Safety Fairway (eastbound), which are approximately 20 nautical miles (23 miles) south of the SWDA.

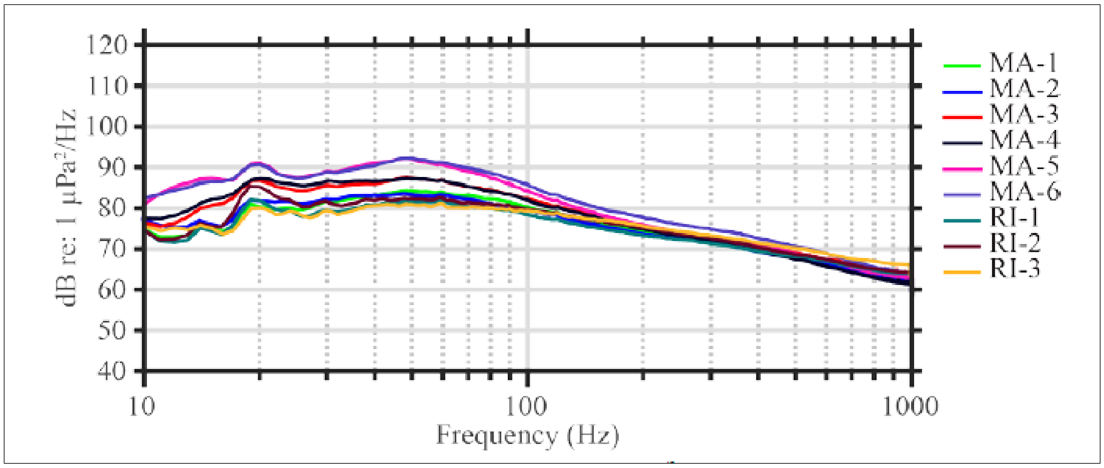
Traffic along the OECC was also analyzed in the Navigation Safety Risk Assessment (COP Appendix III-I; Epsilon 2022). Most of the vessel crossing traffic occurred between Martha's Vineyard and the mainland of Cape Cod. Overall, vessel traffic density along the OECC, including the Phase 2 OECC Western Muskeget Variant, was relatively low, with the highest concentration of traffic midway through Nantucket Sound. In 2019, a daily average of 71 vessels crossed the OECC. The majority of these vessels were either fishing or recreational, though passenger, tug-tow, military, and other vessels were also recorded.

Importantly, recreational vessels and commercial fishing vessels less than 65 feet (19.8 meters) in length are not required to broadcast via AIS; activity of these vessel classes in the Navigation Safety Risk Assessment study area is, therefore, likely underrepresented in the data. Given these limitations of the data, the baseline vessel activity described in this BA is considered an underestimate of total vessel activity for the region.

2.1.4 Underwater Noise

An ambient noise analysis for the Rhode Island and Massachusetts Lease Areas (RI/MA Lease Areas) was provided by Kraus et al. (2016a) through the deployment of passive acoustic recorders from 2011 through 2015, with dedicated recorders deployed specifically within the RI/MA Lease Areas between 2013 and 2015. The acoustic data were analyzed for both ambient noise levels and biological signals. In the analyses, Kraus et al. (2016a) built power spectral densities, which provided the received root-mean-square sound pressure level (SPL) within selected frequency bands, as well as the cumulative distribution, which provided the percentage of time that noise within a selected frequency band reached specific SPL. The cumulative distribution enables analysis of the acoustic habitat available within a species' specific vocal range. Kraus et al. (2016a) used a frequency band of 20 to 447 hertz (Hz) to capture the acoustic habitat of low-frequency cetaceans (LFC). By correlating the ambient SPL within this band with the average SPL of the LFC calls, some predictions can be made regarding acoustic habitat availability and potential masking.

As shown on Figure 2-1, Kraus et al. (2016a) found that the power spectrum levels above 200 Hz did not differ greatly among the nine recording sites; however, sites that were closest to shipping lanes showed an increase in power spectrum levels for spectral content below 100 Hz. The site labeled RI-3, centrally located within the Project area, had one of the lowest overall ambient noise levels with an increase around the 20 Hz frequency band, which was attributed to persistent fin whale (*Balaenoptera physalus*) vocal pulses. For frequencies between 70.8 and 224 Hz, the RI-3 site recorded SPL of 95 decibels referenced to 1 micropascal (dB re 1 μPa) or less for 40 percent of the recoding time and SPL of 104 dB re 1 μPa or greater for only 10 percent of the recording time.

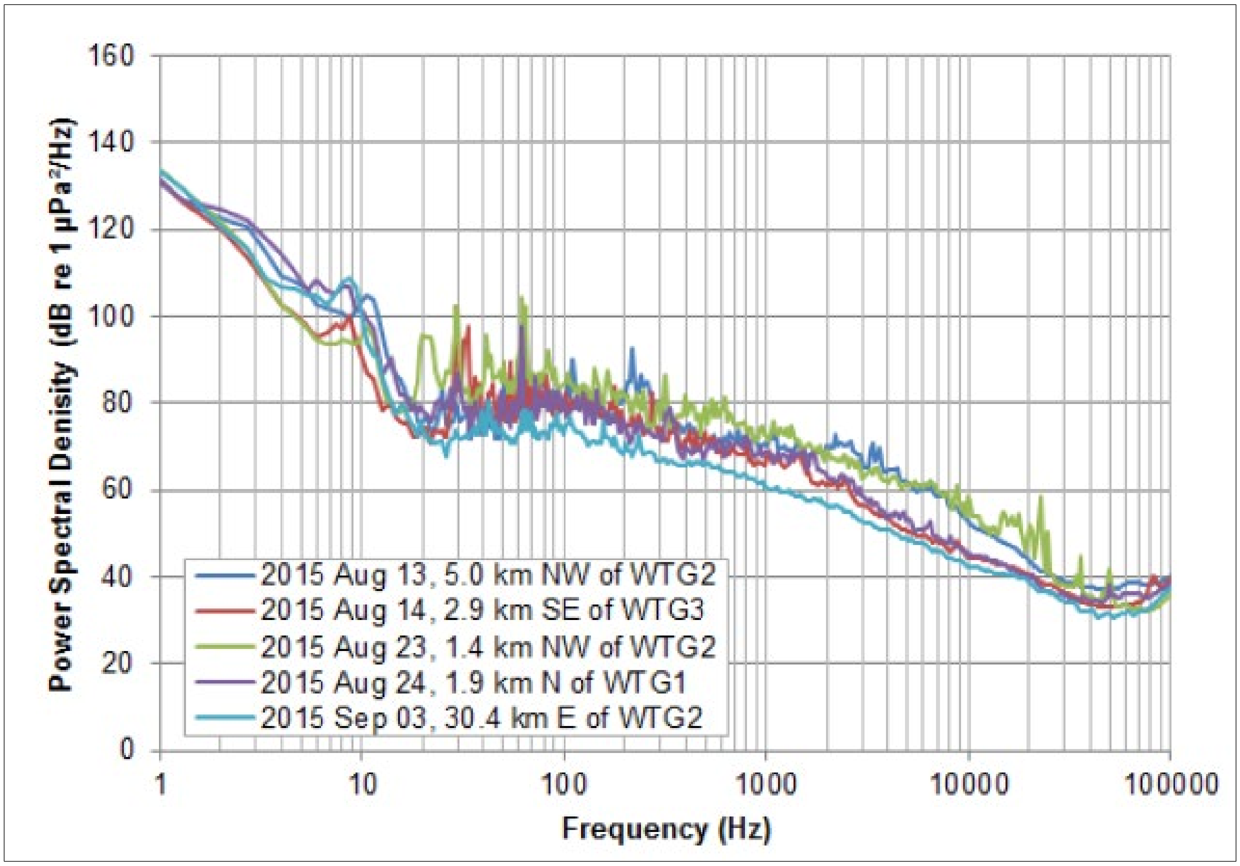


Source: Kraus et al. 2016a
dB re 1 µPa^2 = decibels referenced to 1 micropascal squared; Hz = hertz
The yellow line labeled RI-3 represents the hydrophone located centrally within the Project area.

Figure 2-1: Power Spectral Density Plot Showing the 50th percentile Power Spectrum Levels For Each Recording Site within the Rhode Island and Massachusetts Lease Areas between November 2011 and March 2015

In Lease Area OCS-A 0501, which is within the SWDA, Alpine Ocean Seismic Surveying, Inc. (2017) measured ambient noise as a part of a field verification exercise for HRG surveys conducted by Vineyard Wind 1. Average reported levels in this report were between 76.4 and 78.3 decibels referenced to 1 micropascal squared per hertz (dB re 1 µPa^2/Hz).

Amaral et al. (2018) collected ambient noise measurements during non-piling periods in between pile strikes and foundation installation activities for the Block Island Wind Farm offshore Rhode Island. Results show SPL range from 107.4 dB re 1 µPa 30 kilometers east of the Block Island Wind Farm site to 118.7 dB re 1 µPa within 1 kilometer of the site (Amaral et al. 2018). Power spectral density plots (Figure 2-2) showed higher noise levels in frequencies between 30 and 300 Hz attributed to vessel and equipment noise from Block Island Wind Farm construction activities (Amaral et al. 2018).



Source: Amaral et al. 2018
dB re 1 μPa^2 = decibels referenced to 1 micropascal squared; Hz = hertz; km= kilometer; WTG = wind turbine generator

Figure 2-2: Power Spectral Density Plot of Ambient Noise Measurements Collected within the Vicinity of the Block Island Wind Farm

2.2 Climate Change

NMFS and the USFWS list the long-term changes in climate change as a threat for almost all marine species (Hayes et al. 2020, 2022; NMFS 2022a, 2022b, 2022c, 2022d, 2022e, 2022f; USFWS 2022a, 2022b, 2022c, 2022d). Climate change is known to increase temperatures; alter ocean acidity; raise sea levels; alter precipitation patterns; increase the frequency and intensity of storms; and increase freshwater runoff, erosion, and sediment deposition. These effects can alter habitat, modify species' use of existing habitats, affect migration and movement patterns, and affect an organisms' physiological condition (Love et al. 2013; USEPA 2016; Gulland et al. 2022; NASA 2023).

An increase in ocean acidity has numerous effects on ecosystems, which fundamentally results in a reduction in available calcium carbonate that many marine organisms use to build shells (Doney et al. 2009). This can affect marine mammal and sea turtle prey items and result in feeding shifts within food webs (Love et al. 2013; USEPA 2022; NASA 2023). These effects have the potential to alter the distribution and abundance of marine mammal and sea turtle prey. For example, between 1982 and 2018, the average center of biomass for 140 marine fish and invertebrate species along U.S. coasts shifted approximately 20 miles (32 kilometers) north (USEPA 2022). These species also migrated an average of 21 feet (6.4 meters) deeper (USEPA 2022). This effect is especially profound off the northeast U.S., where American lobster, red hake (*Urophycis chuss*), and black sea bass have shifted, on average, 113 miles (182 kilometers) northward since 1973 (USEPA 2022).

Climate change could potentially affect the incidence or prevalence of infection and the frequency, severity, and/or magnitude of epizootics (Burge et al. 2014). Of the 72 established unusual mortality events identified for marine mammals between 1991 and 2022 in U.S. waters, 14 percent are attributed to infectious disease, though this has not been directly correlated with climate change (NMFS 2023a). However, infectious disease outbreaks are predicted to increase as a result of climate change (Burek et al. 2008).

Over time, climate change and coastal development will alter existing habitats, rendering some areas unsuitable for certain species and more suitable for others. For example, shifts in North Atlantic right whale (NARW; *Eubalaena glacialis*) distribution patterns are likely in response to changes in prey densities driven in part by climate change (O'Brien et al. 2022a; Reygondeau and Beaugrand 2011; Meyer-Gutbrod et al. 2015, 2021). These long-term, high-consequence impacts could include increased energetic costs associated with altered migration routes, reduction of suitable breeding, foraging habitat, and reduced individual fitness.

Available data also suggest that changing ocean temperatures and sea level rise may lead to changes in the sex ratio of sea turtle populations (e.g., green sea turtle [*Chelonia mydas*] population feminization predicted due to increases in global temperature; Booth et al. 2020); loss of nesting area; and a decline in population growth due to incubation temperature reaching lethal levels (Patrício et al. 2019; Varela et al. 2019). In addition to affecting nesting activity, increased sea surface temperatures could have physiological effects on sea turtles during migration (Marn et al. 2017). Higher temperatures in migratory corridors would be especially risky for metabolic rates of female sea turtles post-nesting, as they do not generally forage during breeding periods, and their body condition would not be expected to be optimal to withstand unexpected changes in water temperature in their migratory habitat (Hays et al. 2014).

Finfish and invertebrate migration patterns can be influenced by warmer waters, as can the frequency or magnitude of disease (Hare et al. 2016). Regional water temperatures that increasingly exceed the thermal stress threshold may affect the recovery of the American lobster fishery off the east coast of the United States (Rheuban et al. 2017). Ocean acidification driven by climate change is contributing to reduced growth, and, in some cases, decline of invertebrate species with calcareous shells. Increased freshwater input into nearshore estuarine habitats can result in water quality changes and subsequent effects on invertebrate species (Hare et al. 2016). Based on a recent study, marine, estuarine, and riverine habitat types were found to be moderately to highly vulnerable to stressors resulting from climate change (Farr et al. 2021). In general, rocky and mud bottom, intertidal, special areas of conservation, kelp, coral, and sponge habitats were considered the most vulnerable habitats to climate change in marine ecosystems (Farr et al. 2021). Similarly, estuarine habitats considered most vulnerable to climate change include intertidal mud and rocky bottom, shellfish, kelp, submerged aquatic vegetation, and native wetland habitats (Farr et al. 2021). Riverine habitats found to be most vulnerable to climate change include native wetland, sandy bottom, water column, and submerged aquatic vegetation habitats (Farr et al. 2021). As invertebrate habitat, finfish habitat, and essential fish habitat may overlap with these habitat types, the Farr et al. (2021) environmental study suggests that marine life and habitats could experience dramatic changes and decline over time as impacts from climate change continue.

The extent of these effects is unknown; however, it is likely that ESA-listed populations already stressed by other factors would likely be the most affected by the repercussions of climate change. The current effects from climate change are likely to result in long-term consequences to individuals or populations that are detectable and measurable and have the potential to result in population-level effects that could compromise the viability of some species.

2.3 Listed Species Considered but Discounted from Additional Analysis

Several species have broad ranges, which may include the Action Area, but are not likely to be affected by the Proposed Action. These species were excluded from further analysis because the potential for adverse effects from the Proposed Action were determined to be extremely unlikely to occur and, therefore, **discountable**.

2.3.1 Humpback Whale Cape Verde/Northwest Africa Distinct Population Segment – Endangered

The humpback whale can be found worldwide in all major oceans from the equator to sub-polar latitudes. In the summer, humpbacks are found in high-latitude feeding grounds, while during the winter months, individuals migrate to tropical or subtropical breeding grounds to mate and give birth (Hayes et al. 2020). North Atlantic humpback whales feed during the summer in various locations in cooler, temperate regions, including the Gulf of Maine, Newfoundland/Labrador, the Gulf of St. Lawrence, Greenland, Iceland, and Norway, including Svalbard (Wenzel et al. 2020). Available photo-identification and genotyping data indicate humpbacks from all these feeding grounds migrate to the primary winter breeding ground in the Dominican Republic (Wenzel et al. 2020). However, smaller numbers have been observed wintering around the Cape Verde Islands (Wenzel et al. 2020; Cooke 2018). The designation of the Cape Verde/Northwest Africa distinct population segment (DPS) was based on genetic evidence indicating a second breeding ground occupied by humpback whales feeding primarily off Norway and Iceland (Bettridge et al. 2015; Wenzel et al. 2020). Surveys conducted between 2010 and 2018 estimated 272 non-calf whales in the Cape Verde/Northwest Africa DPS using photo-identification survey methods (Wenzel et al. 2020). Although the population abundance for this DPS remains unknown, resighting rates suggest a small population size (Wenzel et al. 2020). Humpback whales were subject to significant removals by pre-modern whalers especially in their wintering grounds in the West Indies and Cape Verde Islands (Smith and Reeves 2003). Whaling in the Cape Verde Islands occurred primarily during 1850 to 1912 with a total estimated kill of about 3,000 animals (Reeves et al. 2002). Humpback whales from the Cape Verde/Northwest Africa DPS potentially occurring in the Action Area would be limited to those individuals located within or around the summer feeding grounds off Norway and Iceland where they may encounter proposed Project vessels originating from ports in Europe. However, interactions with proposed Project vessels in Europe would be uncommon and limited to the whales' migration to and from feeding/breeding grounds. Given the small size of this DPS and their limited presence in European waters, potential for adverse effects from the Proposed Action is **discountable.**

2.3.2 Hawksbill Sea Turtle – Endangered

Hawksbill sea turtles (*Eretmochelys imbricata*) are rare in Massachusetts and are not expected to occur in the Action Area. They have a circumtropical distribution and usually occur between latitudes 30°N and 30°S in the Atlantic Ocean. Hawksbills are widely distributed throughout the Caribbean Sea and off the coasts of Florida and Texas in the continental United States. Hawksbill nesting occurs on insular and mainland sandy beaches throughout the tropics and subtropics, and no nesting beaches are found in the northeast United States near the Action Area. Two sightings of one individual each occurred during the Atlantic Marine Assessment Program for Protected Species (AMAPPS) study in 2019 off central Florida, but no other sightings were recorded prior to 2019 or in 2020 (Palka et al. 2017; Northeast Fisheries Science Center and Southeast Fisheries Science Center 2020, 2021). Additionally, stranding data do not indicate any hawksbills occurring in the area. The presence of hawksbills would be considered extralimital and outside their normal range. Therefore, given the definition of the Action Area (Section 1.3) being limited to the northeastern U.S., eastern Canada, and Europe, as well as available distribution data, hawksbill sea turtles are not expected to occur in the Action Area, and the potential for adverse effects from the Proposed Action is **discountable**.

2.3.3 Shortnose Sturgeon – Endangered

The shortnose sturgeon (*Acipenser brevirostrum*) is anadromous, spawning and growing in freshwater and foraging in both the estuary of its natal river and shallow marine habitats close to the estuary (Bain 1997; Fernandes et al. 2010). Shortnose sturgeon occur in the Northwest Atlantic but are typically found in freshwater or estuarine environments. Historically, the species was found in coastal rivers along the entire east coast of North America. Because of threats such as habitat degradation, water pollution, dredging, water withdrawals, fishery bycatch, and habitat impediments (e.g., dams), the species is now listed as Endangered throughout the entire population range. Within the Action Area, shortnose sturgeon are found in the Saint John, Housatonic, Connecticut, Hudson, and Delaware rivers (Shortnose Sturgeon Status Review Team 2010). However, the only proposed Project activities that overlap with these areas would be vessels transits, so the primary risk to shortnose sturgeon from the Proposed Action would be vessel strikes and discharges. The only vessel ports under the Proposed Action that are on rivers with shortnose sturgeon are Saint John, New Brunswick, Canada on the Saint John River, Capital Region ports on the Hudson River, and Paulsboro on the Delaware River (Table 1-9). Bridgeport is located in close proximity to, but not on, the Housatonic River. Generally, spawning occurs far upstream in their natal rivers, with individuals moving downriver to the estuaries to feed, rest, and spend most of their time. They are a primarily benthic species that are rarely known to leave their natal freshwater rivers (Kieffer and Kynard 1993; NMFS 2015); therefore, their presence in the marine environment is uncommon (Baker and Howsen 2021). Movement of shortnose sturgeon between rivers is rare, though there have been some reported migrations between the Connecticut and Hudson rivers (Shortnose Sturgeon Status Review Team 2010). Acoustic tagging studies conducted in the Delaware River indicate the existence of an overwintering area in the lower portion of the river, below Wilmington, Delaware (Shortnose Sturgeon Status Review Team 2010).

As indicated above, proposed Project vessels may use Saint John, New Brunswick, Capitol Region, New York, and Paulsboro, New Jersey ports during construction, which overlap with known shortnose sturgeon presence (Shortnose Sturgeon Status Review Team 2010; Pendleton et al. 2018). As a result, there is some risk of proposed Project vessels encountering shortnose sturgeon in the Action Area. No transits from ports on the Delaware, Hudson, or Saint John rivers are anticipated to occur during operations.

An average of up to three round trips per month are expected for proposed Project vessels transiting on the Delaware and Hudson rivers from the Paulsboro and Capitol Region ports, respectively; an average of up to 100 transits in total may occur throughout the duration of construction (Table 1-10). Therefore, this analysis proceeds with a maximum case of 100 total vessel transits on the Delaware River and 100 total transits on the Hudson River over the Phase 1 and Phase 2, 36-month construction period.

Over an 8-year span from 2008 to 2016, 21 percent of the 53 total salvaged shortnose sturgeon carcasses reported in the Delaware Bay and River were detected in the Delaware River itself (NMFS 2021a). However, only 6 of 11 (55 percent) recovered from the Delaware River had indications of interaction with a vessel. Only two salvaged shortnose sturgeon were recovered in the Delaware Bay and River areas from 2019 to 2020, none of which were recovered in the Delaware River itself (NMFS 2021a). 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, or tugboats assisting other larger vessels or any Department of Defense vessels (e.g., Navy, USCG). Given the amount of traffic in the Delaware River and the relatively small number of reported vessel interactions with shortnose sturgeon from the Delaware River, the small increase in traffic due to the proposed Project presents an extremely low likelihood of vessel strikes to shortnose sturgeon.

Based on data presented in the BA for shortnose sturgeon (Shortnose Sturgeon Status Review Team 2010), there is no evidence of ship strikes with shortnose sturgeon on the Hudson River. Additionally, proposed Project vessel traffic on the Hudson River would represent a small increase in vessel traffic relative to existing traffic, especially in the lower Hudson River. Given these factors, the likelihood of a proposed Project vessel strike of a shortnose sturgeon is extremely low.

It is unknown how many vessel transits are expected to originate from Saint John, New Brunswick, as multiple Canadian ports are currently considered under the Proposed Action (Table 1-9). For the purposes of this assessment, a maximum case of up to 620 trips over the Phase 1 and Phase 2, 36-month construction period, or an average of one vessel transit per day, is used (Table 1-10). Saint John, New Brunswick is located at the mouth of the river, where the Saint John River meets the Bay of Fundy. Although the exact port facility in Saint John is not currently known, vessel transits are expected to be limited to Saint John Harbor along a 2-mile (3.2-kilometer) portion of the mouth of the river; no up-river transits are anticipated. Additionally, no vessel strikes have been reported for shortnose sturgeon on the Saint John River (Shortnose Sturgeon Status Review Team 2010). Given the expected low number of Project-related vessel transits relative to existing traffic, the limited overlap of vessels in riverine habitat, and that their presence in the marine habitat is uncommon, the likelihood of a proposed Project vessel strike of a shortnose sturgeon on the Saint John River is extremely low.

Likewise, given the brief transit encounter periods and marine debris and pollution abatement measures, effects from proposed Project vessel discharges would also be extremely low. Based on the above analyses, potential impacts on shortnose sturgeon from the Proposed Action is **discountable**.

2.3.4 Atlantic Salmon Gulf of Maine Distinct Population Segment – Endangered

The Gulf of Maine DPS of Atlantic salmon (*Salmo salar*) is the only DPS listed under the ESA, which may occur within the Action Area. They were originally listed in December 2000 (65 Fed. Reg. 69459 [November 17, 2000]), and the listing was updated in June 2009 to expand the range of the Gulf of Maine DPS listed under the ESA (74 Fed. Reg. 29343 [June 19, 2009]). The geographic range of the Gulf of Maine DPS is the Dennys River watershed to the Androscoggin River (74 Fed. Reg. 29343 [June 19, 2009]). Freshwater habitats in the Gulf of Maine provide spawning habitat and thermal refuge for adults; overwintering and rearing areas for eggs, fry, and parr; and migration corridors for smolts and adults (Bardonnet and Bagliniere 2000). Atlantic salmon in the Gulf of Maine are known to migrate far distances in the open ocean to feeding areas in the Davis Strait between Labrador and Greenland, which is approximately 2,486 miles (4,000 kilometers) from their natal rivers (Danie et al. 1984; Meister 1984). Most Atlantic salmon (about 90 percent) from the Gulf of Maine return after spending two winters at sea; usually less than 10 percent return after spending one winter at sea and approximately 1 percent of returning salmon are either repeat spawners or have spent three winters at sea (Baum 1997). Atlantic salmon in the Action Area would only be encountered during vessel transits from ports in Atlantic Canada and potentially Europe; therefore, the only risks to Atlantic salmon would be vessel strikes or discharges. A maximum total of 400 and 620 round trips are estimated for the entire 36-month construction period from Europe and Canada, respectively, equating to approximately 1 round trip per day on average for Canadian ports and European ports each (Table 1-10). However, the likelihood of proposed Project vessels encountering Atlantic salmon during transits is low, as vessel strikes are not often reported for this species, and vessel transits would not disturb any freshwater habitats where spawning occurs. Additionally, given the brief transit encounter periods and marine debris and pollution abatement measures, effects from proposed Project vessel discharges would also be extremely low. Therefore, the potential for adverse effects from the Proposed Action is **discountable**.

2.3.5 Giant Manta Ray – Threatened

The giant manta ray (*Manta birostris*) is the world's largest ray and can be found worldwide in tropical, subtropical, and temperate waters between 35°N and 35°S latitudes. In the western Atlantic Ocean, this includes South Carolina south to Brazil and Bermuda. However, the giant manta ray is known to follow warm Gulf Stream water intrusions into areas north of 35°N, typically in late summer and early fall when sea surface temperatures are the highest (Farmer et al. 2022). Sighting records of giant manta rays in the Mid-Atlantic and New England are, therefore, rare, but individuals have been observed as far north as New Jersey (Miller and Klimovich 2017) and Block Island (Gudger 1922). Additionally, these rays frequently feed in waters at depths of 656 to 1,312 feet (200 to 400 meters) (NMFS 2022a), depths much greater than waters found within the Project area. 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 from Europe could traverse some upwelling areas. Additionally, vessels transiting between the Project area and Paulsboro could potentially encounter giant manta ray off New Jersey.

Giant manta ray in the Action Area would only be encountered during proposed Project vessel transits, so the only risk considered in this BA for this species are vessel strikes and discharges. However, the co-occurrence of proposed Project vessels and individual giant manta rays within the Acton Area is expected to be very unlikely based on the low potential for occurrence in waters north of 35°N and the expected low number of vessel transits that may pass through suitable manta ray habitat. At-sea vessels transiting from foreign ports are not anticipated to employ protected species observers (PSO) or travel at reduced speeds. However, given the low density of giant manta rays and the low number of Project-related vessel transits from Canadian or European ports (Table 1-10) compared to the existing high level of commercial vessel traffic in the North Atlantic, the likelihood of an encounter resulting in a ship strike is very low. Additionally, the mitigation and monitoring measures proposed for all proposed Project vessels that include dedicated watch personnel to monitor for species and active vessel avoidance for all protected species, including giant manta rays, would further reduce the chance of any adverse effects on the species from the Proposed Action during vessel transits from domestic ports. Additionally, given the brief transit encounter periods and marine debris and pollution abatement measures, effects from proposed Project vessel discharges would also be extremely low. Therefore, the likelihood of any potential adverse effects resulting from the Proposed Action is, therefore, **discountable**.

2.3.6 Scalloped Hammerhead Shark – Endangered

Scalloped hammerhead sharks (*Sphyrna lewini*) are moderately large sharks with a global distribution. Animals from the Eastern Atlantic DPS, which occur in the Eastern Atlantic and Mediterranean Sea (79 Fed. Reg. 38213 [July 3, 2014]), may occur in the Action Area but are not expected within the Project area. The primary factors responsible for the decline of the listed scalloped hammerhead shark DPSs are overutilization, due to both catch and bycatch of these sharks in fisheries, and inadequate regulatory mechanisms for protecting these sharks, with illegal fishing identified as a significant problem (79 Fed. Reg. 38213 [July 3, 2014]). ESA-listed scalloped hammerhead sharks in the Action Area would only be encountered by proposed Project vessels transiting from ports in Europe; therefore, the only risks to the scalloped hammerhead shark would be vessel strikes or discharges. Because only a limited number of proposed Project vessels would transit from Europe to the Project area (Table 1-10), and reported vessel strikes for this species are low, the potential for vessel strikes occurring that result in serious injury or mortality is low. Likewise, given the brief transit encounter periods and marine debris and pollution abatement measures, the likelihood of any potential adverse effects from the Proposed Action is **discountable**.

2.3.7 Oceanic Whitetip Shark – Threatened

The oceanic whitetip shark (*Carcharhinus longimanus*), listed as threatened in 2018 (83 Fed. Reg. 4153 [January 30, 2018]), is usually found offshore in the open ocean, on the OCS, or around oceanic islands in deep water greater than 184 meters. As noted in the status review for whitetip shark (Young et al. 2017), the species has a clear preference for open ocean waters between 10°N and 10°S but can be found in decreasing numbers out to latitudes of 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves. In the Western Atlantic, oceanic whitetips occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. Oceanic whitetip sharks are not known to occur in waters less than 328 feet (100 meters) in the Action Area. There is no information to suggest that the data collection, construction, operations, or decommissioning activities associated with the Proposed Action would have any effect on this species. The likelihood of any potential adverse effects from the Proposed Action is, therefore, **discountable**.

2.4 Threatened and Endangered Species and Critical Habitat Considered for Further Analysis

Ten ESA-listed species under NMFS jurisdiction are considered for further analysis; these include five large whale species, four sea turtle species, and one fish species. Designated critical habitat for the NARW and Atlantic sturgeon (*Acipenser oxyrhynchus oxyrinchus*) are also considered further analysis. These species, their potential occurrence in the Action Area, and critical habitat are summarized in Table 2-1. General information about these species, current status and threats, use of the Action Area and Project area, and additional information about habitat use that is pertinent to this consultation are described in Section 3.

Information about species occurrence was drawn from several available sources, which includes the following: Previous assessments conducted by BOEM (Waring et al. 2012; BOEM 2012; Baker and Howsen 2021); the AMAPPS, which coordinates data collection and analysis to assess the abundance, distribution, ecology, and behavior of marine mammals in the U.S. Atlantic (Palka et al. 2017, 2021; Palka 2020); habitat-based cetacean density models for the U.S. east coast developed by the Duke University Marine Geospatial Ecology Lab in 2016 (Roberts et al. 2022); the most current marine mammal stock assessments (Hayes et al. 2020, 2021, 2022; NMFS 2023b); Section 7 mappers available online (GARFO 2022a); and other applicable research available for this region or these species (Davis et al. 2020; Farmer et al. 2022).

Table 2-1: Endangered Species Act-Listed Species Considered for Further Analysis

Common Name (Scientific Name)	Stock (NMFS) or DPS	ESA Status	Occurrence within Action Area[a]	Critical Habitat Occurs in Action Area	Critical Habitat Occurs in Project Area	Recovery Plan
Marine Mammals						
Blue whale (*Balaenoptera musculus*)	Western North Atlantic	Endangered (35 Fed. Reg. 18319)	Rare	No designated habitat	No designated habitat	Fed. Reg. not available[b] 07/1998 11/2020
Fin whale (*Balaenoptera physalus*)	Western North Atlantic	Endangered (35 Fed. Reg. 18319)	Regular	No designated habitat	No designated habitat	75 Fed. Reg. 47538 07/2010
NARW (*Eubalaena glacialis*)	Western North Atlantic	Endangered (73 Fed. Reg. 12024)	Regular	Yes (Northeastern U.S. Foraging Area Unit 1; 81 Fed. Reg. 4837)	No; Nearest critical habitat is approximately 74 kilometers northeast of the Project area (81 Fed. Reg. 4837)	70 Fed. Reg. 32293 08/2004
Sei whale (*Balaenoptera borealis*)	Nova Scotia	Endangered (35 Fed. Reg. 18319)	Rare	No designated habitat	No designated habitat	Fed. Reg. not available[c] 12/2011
Sperm whale (*Physeter macrocephalus*)	North Atlantic	Endangered (35 Fed. Reg. 18319)	Uncommon	No designated habitat	No designated habitat	75 Fed. Reg. 81584 12/2010
Sea Turtles						
Green sea turtle (*Chelonia mydas)*	North Atlantic	Threatened (81 Fed. Reg. 20057)	Regular	No (63 Fed. Reg. 46693)	No; Nearest critical habitat is approximately 2,536 kilometers southeast of the Project area (63 Fed. Reg. 46693)	Fed. Reg. not available[d] 10/1991 – U.S. Atlantic

Common Name (Scientific Name)	Stock (NMFS) or DPS	ESA Status	Occurrence within Action Area[a]	Critical Habitat Occurs in Action Area	Critical Habitat Occurs in Project Area	Recovery Plan
Leatherback sea turtle (*Dermochelys coriacea)*	NA	Endangered (35 Fed. Reg. 8491)	Regular	No (44 Fed. Reg. 17710 and 77 Fed. Reg. 4170)	No; Nearest critical habitat is approximately 2,606 kilometers southeast of the Project area (44 Fed. Reg. 17710 and 77 Fed. Reg. 4170)	Fed. Reg. not available[e] 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Loggerhead sea turtle (*Caretta caretta)*	Northwest Atlantic	Threatened (76 Fed. Reg. 58868)	Common	No (79 Fed. Reg. 39856)	No; Nearest critical habitat is approximately 328 kilometers southeast of the Project area (79 Fed. Reg. 39856)	74 Fed. Reg. 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic
Kemp's ridley sea turtle (*Lepidochelys kempii)*	NA	Endangered (35 Fed. Reg. 18319)	Common	No designated habitat	No designated habitat	Fed. Reg. not available[f] 09/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011

Common Name (Scientific Name)	Stock (NMFS) or DPS	ESA Status	Occurrence within Action Area[a]	Critical Habitat Occurs in Action Area	Critical Habitat Occurs in Project Area	Recovery Plan
Marine Fish						
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	All DPSs	Endangered (77 Fed. Reg. 5913)	Regular	Yes (New York Bight DPS Delaware River and Hudson River critical habitat; 82 Fed. Reg. 39160)	No; Nearest critical habitat is approximately 85 kilometers northwest of the Project area in the Connecticut River (82 Fed. Reg. 39160)	None[g]

DPS = distinct population segment; ESA = Endangered Species Act; Fed. Reg. = Federal Register; NA = not applicable; NARW = North Atlantic right whale; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration

[a] Potential occurrence of species evaluated based on five categories:

Common – Occurring consistently in moderate to large numbers;

Regular – Occurring in low to moderate numbers on a regular basis or seasonally;

Uncommon – Occurring in low numbers or on an irregular basis;

Rare – Records for some years but limited; and

Not expected – Range includes the Action Area, but due to habitat preferences and distribution information, species are not expected to occur in the Action Area, although records may exist for adjacent waters.

[b] NMFS 2020a

[c] NMFS 2011

[d] NMFS and USFWS 1991

[e] NMFS and USFWS 1992

[f] NMFS et al. 2011

[g] A recovery plan is not available for this species. However, NMFS has developed a recovery outline (NMFS 2018a) to serve as interim guidance until a full recovery plan is developed.

3 Effects of the Proposed Action

Effects of the Proposed Action are evaluated for the potential to result in harm to listed species and/or designated critical habitat. If a proposed Project-related activity may affect a listed species, the exposure level and duration of effects are evaluated further for the potential for those effects to harass or injure listed species. These effects determinations are based on the description of the Proposed Action (Section 1.4); the mitigation and monitoring measures included under the Proposed Action in Table 1-15, (Section 1.4.5); and the additional BOEM-proposed mitigation and monitoring measures. The following sections present the potential proposed Project-related effects on ESA-listed species of marine mammals, sea turtles, and marine fish and critical habitat from construction, operations, and decommissioning of the Proposed Action.

3.1 Determination of Effects

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

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

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

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

A determination for each species and designated critical habitat was made based on an analysis of potential consequences from each identified stressor. One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the proposed 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 effects, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the proposed Project and its environmental consequences.

A **may affect, not likely to adversely affect** determination would be given if the proposed Project's effects are wholly beneficial, insignificant, or discountable, as detailed below:

1. *Beneficial* effects have an immediate positive effect without any adverse effects on the species or habitat.
2. *Insignificant* effects relate to the size or severity of the effect and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
3. *Discountable*[11] effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did affect a listed species), but it is extremely unlikely to occur (NMFS and USFWS 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 proposed 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 3-1 depicts the effects determinations for each ESA-listed species analyzed in this assessment by stressor that were not already discounted in Section 2.3. The subsections below provide a description of existing conditions for each species of ESA-listed marine mammal, sea turtle, and marine fish in the Action Area, accompanied by the detailed effects assessment for each stressor on these ESA-listed species.

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

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Table 3-1: Effects Determination by Stressor

Stressor	Marine Mammals					Sea Turtles				Marine Fish	Critical Habitat	
	Fin Whale (*Balaenoptera physalus*)	NARW (*Eubalaena glacialis*)	Sei Whale (*Balaenoptera borealis*)	Sperm Whale (*Physeter macrocephalus*)	Blue Whale (*Balaenoptera musculus*)	Green Sea Turtle (*Chelonia mydas*; North Atlantic DPS)	Leatherback Sea Turtle (*Dermochelys coriacea*)	Loggerhead Sea Turtle (*Caretta caretta*; Northwest Atlantic DPS)	Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	NARW Critical Habitat	Atlantic Sturgeon Critical Habitat
Foundation Installation	LAA for PTS LAA for behavioral disturbance	NLAA for PTS LAA for behavioral disturbance	LAA for PTS LAA for behavioral disturbance	NE for PTS LAA for behavioral disturbance	LAA for PTS NLAA for behavioral disturbance	LAA for PTS LAA for behavioral disturbance	LAA for PTS LAA for behavioral disturbance	LAA for PTS LAA for behavioral disturbance	LAA for PTS LAA for behavioral disturbance	NLAA for Injury NLAA for behavioral disturbance	–	–
Foundation drilling	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for Injury NLAA for behavioral disturbance	–	–
Vessel and aircraft noise	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for Injury NLAA for behavioral disturbance	NLAA	NLAA
HRG survey noise	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for Injury NLAA for behavioral disturbance	–	–
UXO detonations	NLAA for injury LAA for PTS NLAA for TTS	NLAA for injury LAA for PTS NLAA for TTS	NLAA for injury LAA for PTS NLAA for TTS	NLAA for injury LAA for PTS NLAA for TTS	NLAA for injury LAA for PTS NLAA for TTS	NLAA for injury NLAA for PTS NLAA for TTS	NLAA for injury NLAA for PTS NLAA for TTS	NLAA for injury NLAA for PTS NLAA for TTS	NLAA for injury NLAA for PTS NLAA for TTS	NLAA for Injury NLAA for behavioral disturbance	–	–
WTG operational noise	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for PTS NLAA for behavioral disturbance	NLAA for Injury NLAA for behavioral disturbance	–	–
Physical disturbance of sediment	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	–	–
Structure presence	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	–	–
Changes in oceanographic and hydrological conditions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	–	–
Changes in prey	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	–	–
Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Oil spills/chemical release	NLAA	NLAA	NLAA	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	LAA	LAA	NLAA	NLAA	–	–
Vessel traffic	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	NLAA	NLAA	NLAA
EMF	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	–	–
Monitoring surveys	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	LAA	–	–
Overall effects determination	LAA	LAA	LAA	LAA	LAA	LAA	LAA	LAA	LAA	LAA	NLAA	NLAA

– = not applicable; DPS = distinct population segment; EMF = electromagnetic fields; HRG = high-resolution geophysical; LAA = likely to adversely affect; NLAA = not likely to adversely affect; PTS = permanent threshold shift; TTS = temporary threshold shift; WTG = wind turbine; UXO = unexploded ordnance; WTG = wind turbine generator

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3.2 Marine Mammals

Five marine mammal species listed under the ESA may occur in the Project area, all of which are large whales: fin whale, NARW, sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), and blue whale (*Balaenoptera musculus*). Species descriptions, status, likelihood, and timing of occurrence in the Action Area, as well as information about feeding habits, critical habitat, and hearing ability relevant to this effects analysis, are provided in the following sections.

3.2.1 North Atlantic Right Whale

The NARW is known to inhabit the continental shelf and coastal waters in the northeast United States, ranging from calving grounds in the southeastern United States to feeding grounds in New England waters and the Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence in Canadian waters (NMFS 2023b). There are two critical habitat areas for NARWs in Canadian waters (Brown et al. 2009) and two in U.S. waters: all U.S. waters within the Gulf of Maine are designated as a foraging area critical habitat, while waters off the Southeastern United States are designated as a calving area critical habitat (81 Fed. Reg. 4837 [February 26, 2016]; NMFS 2023b). The Mid-Atlantic OCS between the two critical habitat areas has been identified as a principal migratory corridor and, thus, an important habitat for NARWs as they travel between breeding and feeding grounds (NMFS 2023b; CETAP 1982). This migratory pathway is considered a biologically important area (BIA) for the species (LaBrecque et al. 2015). While some individuals undergo yearly migrations between summer months at their northern feeding grounds and winter months at their southern breeding grounds, the location of most individuals throughout much of the year is poorly understood. Year-round presence in all habitat areas has been recorded, including off the Mid-Atlantic (Bailey et al. 2018; Davis et al. 2017). In addition, long-range movements are also apparent, with some individuals being identified in the eastern North Atlantic and others covering long distances over short time periods (NMFS 2023b).

The NARW is a large, relatively stock whale that can range in length from 55.8 to 59 feet (17 to 18 meters). One of the most distinguishing features of the right whale is their prominently curved jawline and whitish callosities, or areas of roughened skin, covering the top of their rostrum and head, which can be up to one-third of their body length (Jefferson et al. 1993). The callosities form a unique pattern on the animal's head, enabling individual identification similar to a fingerprint and fundamental to demographic and movement studies. Foraging habits of NARWs show a clear preference for the zooplanktonic copepod, *Calanus finmarchicus* (Mayo et al. 2001). The NARW distribution and movement patterns within their foraging grounds is highly correlated with concentrations and distributions of their prey, which exhibit high variability within and between years (Pendleton et al. 2012). Due to the heightened energetic requirements of pregnant and nursing females, yearly reproductive success of the population is directly related to foraging success and the abundance of *C. finmarchicus* (Meyer-Gutbrod et al. 2015), which in turn is correlated with decadal-scale variability in climate and ocean patterns (Greene and Pershing 2000).

Skim feeding is an important activity identified in effects assessments because it demonstrates a critical behavior (feeding) that could be disrupted by introduced noise. Similarly, NARWs spend extended periods of time at the water's surface actively socializing in what are known as surface active groups; surface active groups have been documented in all habitat regions; during all seasons; involve all age classes; and include mating behaviors, play, and the maintenance of social bonds (Parks et al. 2007). The extensive and biologically critical surface behaviors of NARWs, such as surface skim feeding and surface active groups, represent a vulnerable time for NARW as they are exposed to an increased risk for ship strike when active at or near the surface.

NARW vocalizations most frequently observed during passive acoustic monitoring (PAM) studies include upsweeps rising from 30 to 450 Hz, often referred to as “upcalls,” and broadband (30 to 8,400 Hz) pulses, or “gunshots,” with sound levels between 172 and 187 dB re 1 µPa m (Erbe et al. 2017). However, recent studies have shown that mother-calf pairs reduce the amplitude of their calls in the calving grounds, possibly to avoid detection by predators (Parks et al. 2019). Modeling conducted using NARW ear morphology suggest that the best hearing sensitivity for this species is between 16 Hz and 25 kHz (Ketten et al. 2014; Southall et al. 2019).

3.2.1.1 North Atlantic Right Whale Foraging

New England waters are important feeding habitats for NARW that must locate and exploit dense patches of zooplankton to feed efficiently and meet biological and energetic requirements (Fortune et al. 2013). These dense zooplankton patches are a primary driver in NARW distribution and habitat use within their northern latitude foraging grounds (Kenney and Winn 1986; Kenney et al. 2001; Pendleton et al. 2012; Pershing et al. 2009). Notably, mean total density for the copepod *C. finmarchicus*, the NARW’s preferred zooplankton prey species, along the Northeast U.S. shelf can vary greatly from year to year (Grieve et al. 2017). These dense patches of zooplankton can be found throughout the water column depending on time of day and season. They are known to undergo daily vertical migration where they are found within the surface waters at night and at depth during daytime to avoid visual predators. The NARWs’ diving behavior is strongly correlated to the vertical distribution of *C. finmarchicus*. Baumgartner et al. (2017) investigated NARW foraging ecology by tagging 55 whales in six regions of the Gulf of Maine and southwestern Scotian Shelf Right in late winter to late fall from 2000 to 2010. Results indicated that, on average, NARWs spent 72 percent of their time in the upper 33 feet (10 meters) of water, and 15 of 55 whales (27 percent) dove to within 16.5 feet (5 meters) of the seafloor, spending as much as 45 percent of the total tagged time at this depth. While NARWs are always at risk of ship strike due to the time spent at the surface to breathe, they are particularly vulnerable to ship strike when spending time within springtime habitats (including the SWDA) due to their foraging and diving behaviors (Baumgartner et al. 2017).

In 2016, the Northeastern U.S. foraging critical habitat for NARWs was expanded to include all U.S. waters of the Gulf of Maine. Recent surveys (2012 to 2015) have detected fewer individuals in traditional feeding habitats such as the Great South Channel and the Bay of Fundy, and additional sighting records indicate that other habitats may exist, suggesting that existing habitat use patterns may be changing (Weinrich et al. 2000; Cole et al. 2013; Whitt et al. 2013; Khan et al. 2014). Baumgartner et al. (2017) discuss how ongoing and future environmental and ecosystem changes may displace *C. finmarchicus* from the Gulf of Maine and Scotian Shelf. The authors also suggest that NARWs are dependent on the high lipid content of calanoid copepods from the Family Calanidae (i.e., *C. finmarchicus, C. glacialis, C. hyperboreus*) and would not likely survive year-round only on the ingestion of small, less nutritious copepods in the area (i.e., *Pseudocalanus* spp., *Centropages* spp., *Acartia* spp., *Metridia* spp.). It is also possible that even if *C. finmarchicus* remained in the Gulf of Maine, changes to the water column structure from climate change may disrupt the mechanism that causes the very dense vertically compressed patches that NARWs depend on (Baumgartner et al. 2017).

NARW distribution and pattern of habitat use have also shifted both spatially and temporally beginning in 2010 (Davis et al. 2017). Meyer-Gutbrod et al. (2018) recorded NARW sightings in several traditional feeding habitats beginning to decline in 2012, causing speculation that a shift in NARW habitat usage was occurring (Pettis et al. 2022). An increased presence of NARWs in the Gulf of St. Lawrence beginning in 2015 further supports a shift in habitat use, potentially in response to shifting prey resources as a result of climate change (Crowe et al. 2021; Meyer-Gutbrod et al. 2015, 2021). Additionally, a recent increase in habitat use and year-round presence in the southern New England region, including Nantucket Shoals adjacent to the Project area, indicates that the area is an increasingly important NARW habitat (O’Brien et al. 2022a; Hayes 2022). These data and literature, therefore, collectively suggest that NARW habitat use, including changes in their distribution patterns linked to prey resources, is dynamic and likely related to climate change processes. Nantucket Shoals, which supports dense aggregations of preferred prey, is identified as the only known winter foraging area for NARW (Quintana-Rizzo et al. 2021; O'Brien et al. 2022a). The tidal front along the western edge of Nantucket Shoals, generally associated with the 30-meter (98-foot) isobath, is a well-mixed, productive region that is associated with NARW foraging aggregations (Quintana-Rizzo et al. 2021). As noted by Hayes (2022), additional stressors in this area; such as increased vessel traffic, habitat modifications, and underwater noise; can exacerbate NARW foraging disturbances, which may lead to energetic and population-level effects.

The diversity of zooplankton across the Northeast U.S. Continental Shelf is relatively high (greater than 100 species), although seasonal and interannual trends in abundance differ among species (NEFSC and SEFSC 2018; Johnson et al. 2014; DFO 2017). Seasonal trends in overall zooplankton abundance have been detected over the shelf waters of southern New England, ranging from relatively low densities (0.73 to 1.4 cubic inches per 2.4 cubic mile) in January through February to relatively high densities (greater than 3.36 cubic inches per 2.4 cubic mile) in May through August (NEFSC and SEFSC 2018). These trends are also present for *C. finmarchicus*, an important food source for many fish species, including NARWs. On average, *C. finmarchicus* has been the most abundant during the spring and summer (March through August), with a peak density in May through June along the Northeast U.S. Shelf (NEFSC and SEFSC 2018). Overall, average zooplankton densities have been remarkably consistent over the past 20 years, though interannual variability is present. Mean total density for *C. finmarchicus* along the Northeast U.S. Shelf varied greatly from year to year, commonly halving or doubling from 1 year to the next (NEFSC and SEFSC 2018). Results from Runge et al. (2015) and Ji et al. (2017) specify that predicting fluctuations in abundance or circumstances for disappearance of *C. finmarchicus* in the northwest Atlantic would require models that address the roles of local production and advection.

3.2.1.2 Current Status of the North Atlantic Right Whale Population

NARWs in U.S. waters belong to the Western Atlantic stock. "Stock" is defined by the MMPA as a group of individuals "of the same species or smaller taxa in a common spatial arrangement that interbreed when mature" (16 USC § 1362.11). The NARW is listed as Endangered under the ESA and Critically Endangered by the International Union for Conservation of Nature (IUCN) Red List (Cooke 2020; NMFS 2023b). NARW are considered to be one of the most critically endangered large whale species in the world (NMFS 2023b). The Western North Atlantic population size was estimated to be 338 individuals in the most recent draft 2022 stock assessment report, which used a hierarchical, state-space Bayesian open population model of sighting histories from the photo-identification recapture database through November 2022 (NMFS 2023b). Between 2011 and 2020, the population has declined in overall abundance by 29.7 percent, further evidenced by the decrease in the abundance estimate from 451 in 2018 (NMFS 2023b) to the current 2021 estimate of 338 individuals (NMFS 2023b). This decline in abundance follows a previous positive population trend from 1990 to 2011 that saw an increase of 2.8 percent per year from an initial abundance estimate of 270 individuals in 1998 (NMFS 2023b). Over time, there have been periodic swings of per capita birth rates (NMFS 2023b), although current birth rates continue to remain below expectations (Pettis et al. 2022), with an approximately 40 percent decline in reproductive output for the species since 2010 (Kraus et al. 2016b). Eighteen new calves were sighted during the 2021 calving season (Pettis et al. 2022), an increase from 10 calves observed in 2020, and 15 new calves have been sighted so far for the 2022 calving season (NMFS 2023b); and as of February 2023, 12 calves had been documented for the 2023 calving season (NMFS 2023b). Although the increasing birth rate is a beneficial sign, it is still significantly below what is expected, and the rate of mortality is still higher than what is sustainable (Pettis et al. 2022; NMFS 2023b). A reduction in adult female survival rates relative to male survival rates has caused a divergence between male and female abundance. In 1990, there were an estimated 1.15 males per female, and by 2015, estimates indicated 1.46 males per female (Pace et al. 2017).

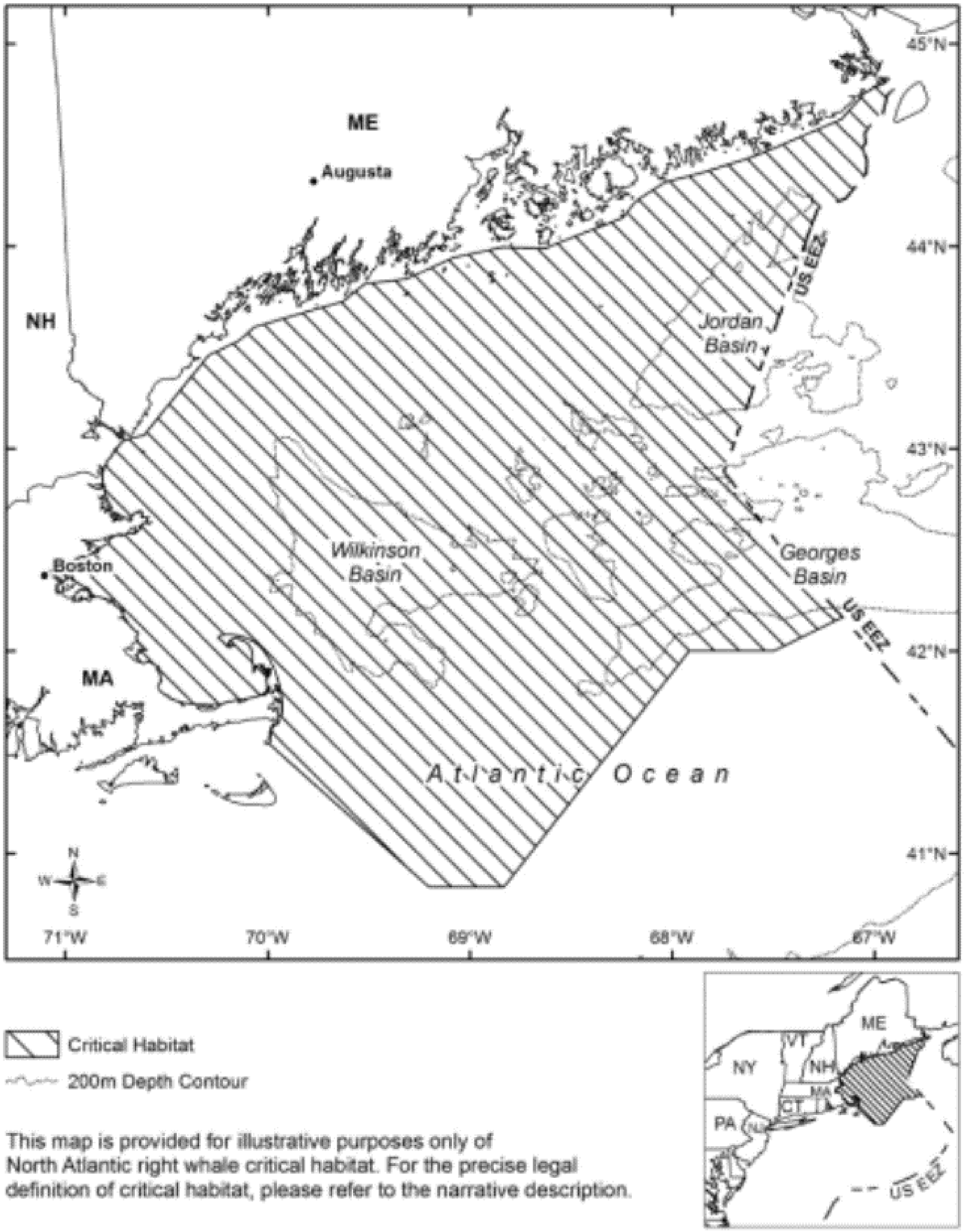
Net productivity rates do not exist, as the Western North Atlantic stock lacks any definitive population trend (NMFS 2023b). The average annual human-related mortality/injury rate exceeds that of the calculated potential biological removal of 0.7, and due to its listing as Endangered under the ESA, this population is classified as strategic and depleted under the MMPA (NMFS 2023b). Estimated human-caused mortality and serious injury between 2016 and 2020 was 8.1 whales per year, of which 5.7 whales per year are attributed to fisheries interactions and the remainder 2.4 whales per year cause by vessel strike (NMFS 2023b). However, it is likely that not all mortalities are documented, and modeling suggests that the mortality rate for the period from 2014 to 2018 may be up to 27.4 animals (NMFS 2023b; Pace 2021). There have been elevated numbers of mortalities reported since 2017, which prompted NMFS to designate an unusual mortality event for NARWs (NMFS 2023c). These elevated mortalities have continued into 2023, totaling 35 mortalities, 22 serious injuries, and 37 sublethal injuries or illness (NMFS 2023c). Based on the mortalities for which the carcasses could be examined, preliminary analyses indicate that all mortalities are likely to be humancaused, predominantly from entanglement in fishing gear or vessel collisions (NMFS 2023c). Although the majority of the mortalities occurred in Canadian waters, the U.S. population is not separated from those in Canada; therefore, the effects of mortality affect the population considered in the assessment process. While vessel strikes and entanglements in fishing gear represent the most significant threat to NARWs, other risks to the population include acoustic disturbance and masking, climate change, and climate-driven shifts in prey species (NMFS 2023b).

Kraus et al. (2016b) suggests that threats to the population are still pervasive and may be getting worse. Indicators of this trend include declining overall body condition (Rolland et al. 2016) and very high and increasing rates of entanglement in fishing gear (Knowlton et al. 2012, 2016), suggesting previous management interventions have not measurably reduced entanglement or entanglement-related mortality (Pace et al. 2015). Research has revealed the substantial energy drain on individual whales from drag related to ongoing entanglements, which likely results in reduced health and fitness (van der Hoop et al. 2015, 2017). Other studies indicate noise from shipping increases stress hormone levels (Rolland et al. 2012), and modeling suggests that their communication space can be reduced substantially by vessel noise in busy traffic lanes (Hatch et al. 2012). In addition to anthropogenic threats, NARWs also face environmental stressors including algal toxins, oceanographic changes from climate change, and, as discussed above, reduced prey availability (Rolland et al. 2007; Doucette et al. 2012; Fortune et al. 2013). These combinations of factors threaten the survival of this species (Pettis et al. 2017, 2022). If reduced *C. finmarchicus* abundance results in a decrease in reproduction similar to that observed in the late 1990s, which authors hypothesize has occurred during the past 5 years, extinction of the NARW could take place in as little as 27 years (Meyer-Gutbrod et al. 2018).

3.2.1.3 Critical Habitat Designated for the North Atlantic Right Whale

In 1994, NMFS designated critical habitat for the NARW population in the North Atlantic Ocean (59 Fed. Reg. 28805 [June 23, 1983]). This critical habitat designation included portions of Cape Cod Bay and Stellwagen Bank, the Great South Channel, and waters adjacent to the coasts of South Carolina, Georgia, and the east coast of Florida. These areas were determined to provide critical feeding, nursery, and calving habitat for the North Atlantic population of NARWs. In 2016, NMFS revised the NARW critical habitat by expanding the previously designated areas. The areas designated as critical habitat currently contain approximately 29,763 square nautical miles (102,084.2 km^2) of marine habitat, located in the Gulf of Maine and Georges Bank region (Unit 1) (Figure 3-1) and off the Southeast U.S. coast (Unit 2). Units 1 and 2 are both outside of the Project area, though Unit 1 is located within the Action Area. Proposed Project vessels may transit through Unit 1 depending on the ports selected and the routes that may be taken by vessels transiting to/from Canada and Europe. Unit 2, which contains the physical and biological features essential to NARW calving habitat, occurs outside of the Action Area, and no proposed Project vessels are expected to transit through the coastal habitat of Unit 2; therefore, it is not discussed further.

The physical and biological features essential to the conservation of NARW foraging habitat in Unit 1 are (1) the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate the zooplankton, *C. finmarchicus*, for NARW foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; (2) low flow velocities in Jordan, Wilkinson, and Georges basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; (3) late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and (4) diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region. When these features are available, they provide the combined features of foraging habitat essential to the conservation of NARW (81 Fed. Reg. 4837 [January 27. 2016]).



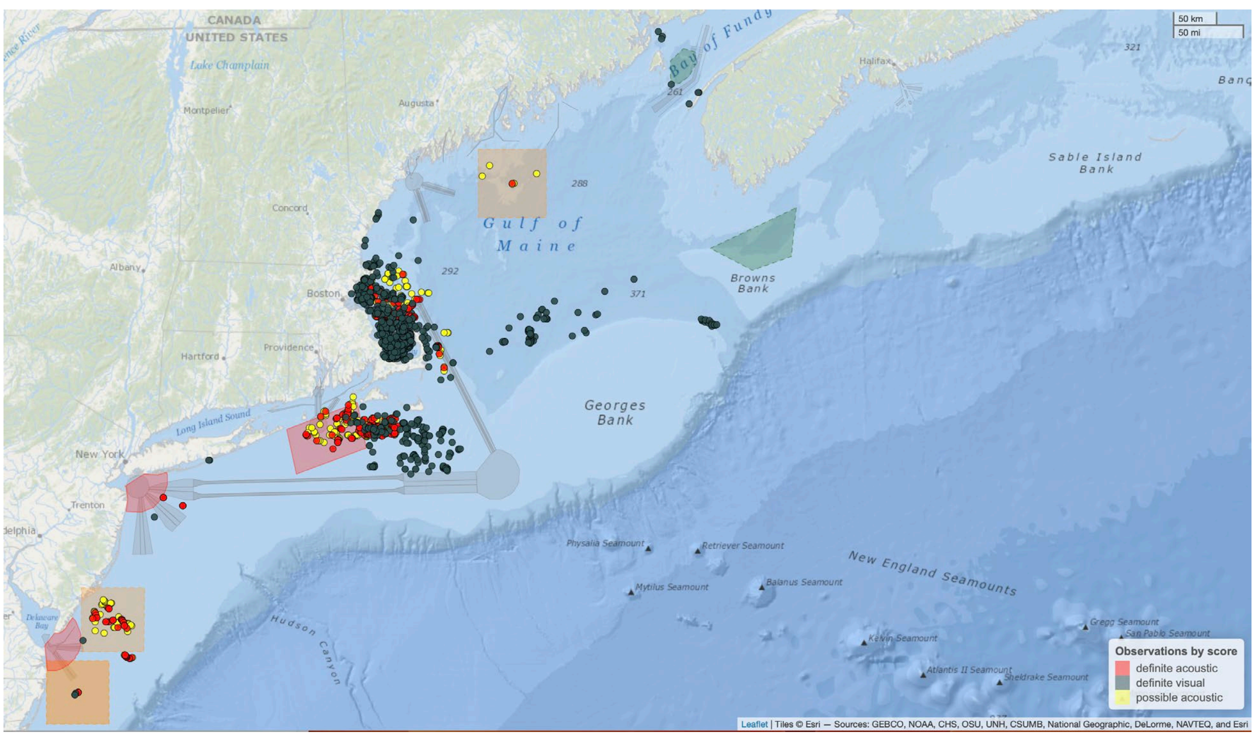
Source: 81 Fed. Reg. 4837 [January 27. 2016]
m = meter

Figure 3-1: **Map Identifying Designated Critical Habitat in the Northeastern Foraging Area for the Endangered North Atlantic Right Whale**

3.2.1.4 Presence and Abundance in the Action Area

Surveys indicate that there are several areas where NARWs congregate seasonally, which include waters adjacent and northeast of the geographic analysis area. The most recent density data from Roberts et al. (2022) indicate that NARWs are expected to occur in the Action Area in relatively moderate to high densities from December through May and in low densities in June through October (COP Appendix III-M; Epsilon 2022; Roberts et al. 2022). Although NARWs have been detected acoustically in all seasons, these are brief, transitory events by individuals, and the species is not expected to occur for any significant periods or regularity in the Action Area between July and November (Roberts et al. 2022).

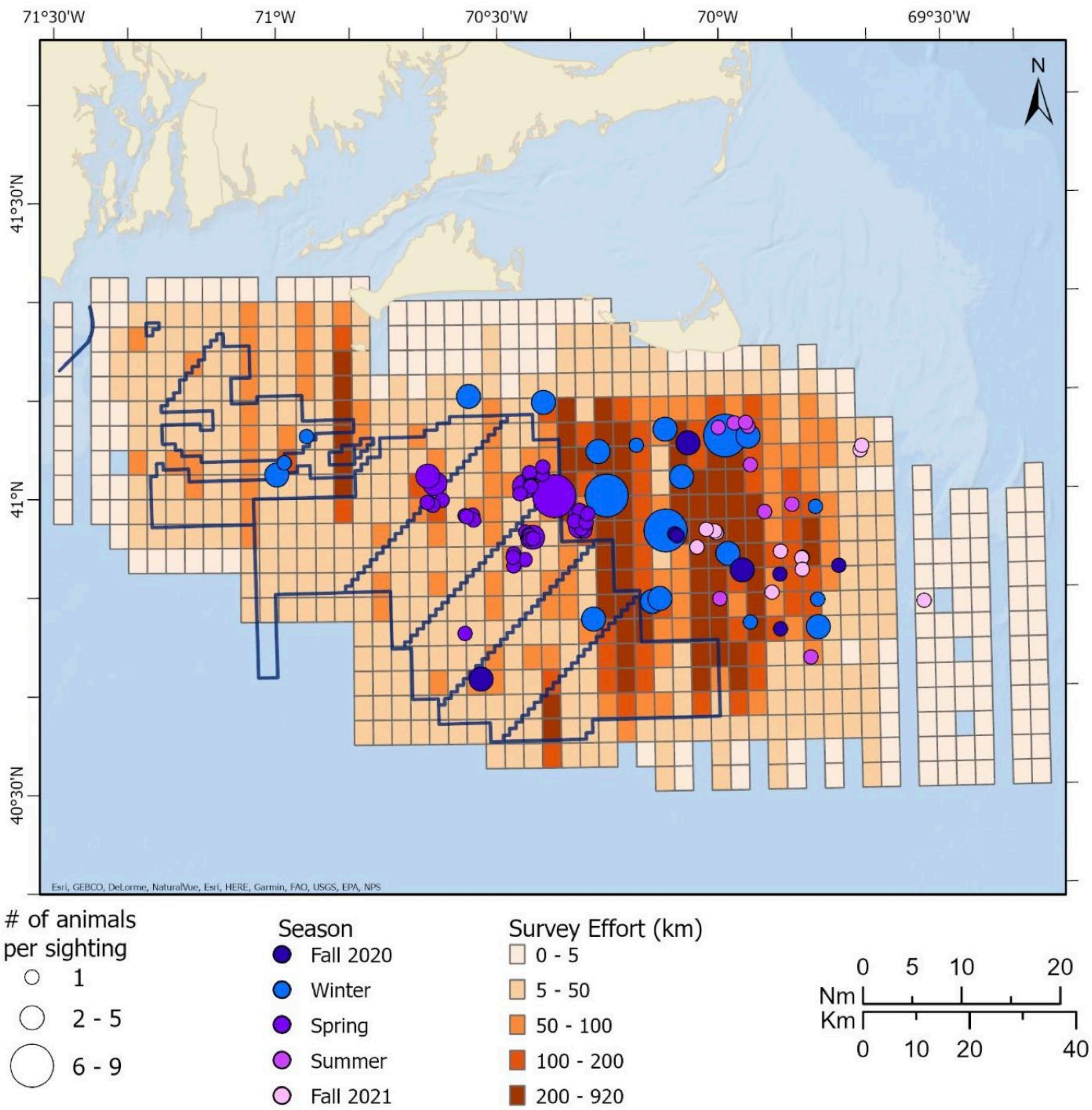
NARWs are consistently observed from aerial survey efforts that include the Project area and other portions of the Action Area (Kraus et al. 2016a; Leiter et al. 2017; Stone et al. 2017; O’Brien et al. 2021a, 2021b, 2022b). Sighting rates for the Project area generally show similar patterns between the various survey efforts: NARW occurrence is the highest in the winter, followed by spring; summer and fall months typically have the lowest sightings rates (Kraus et al. 2016a; Leiter et al. 2017; Stone et al. 2017; O’Brien et al. 2021a, 2021b, 2022b). The most recent report of the Right Whale Sighting Advisory System within the Northeast region additionally indicates the presence of NARWs in the Action Area (Johnson et al. 2021). As shown in these data, though unweighted for effort, southern New England and Cape Cod Bay represent important habitat for the NARW (Figure 3-2).



Source: Johnson et al. 2021
km = kilometer; mi = mile

Figure 3-2: North Atlantic Right Whales Sighting Reports, December 2021 through December 2022

To identify areas with statistically higher animal clustering than surrounding regions, a hot spot analysis was performed for the Action Area (Kraus et al. 2016a). Hot spot analysis provides a relative measure of presence in the survey area per unit effort, not actual numbers of whales in an area. The main persistent hot spot was primarily concentrated in the area immediately east of the SWDA over Nantucket Shoals (90 to 99 percent confidence level; Kraus et al. 2016a). In addition, the area just west of the Project area was an identified hot spot, especially during spring (90 to 99 percent confidence level; Kraus et al. 2016a). The area offshore of Muskeget Channel, overlapping the proposed OECC, also appears in the hot spot analysis during the winter (90 to 99 percent confidence level; Kraus et al. 2016a). Although O'Brien et al. (2021a, 2021b, 2022b; Figure 3-3) did not conduct a hot spot analysis and presents unweighted detection data, sightings of NARW during these surveys indicate a similar distribution around the RI/MA Lease Areas.



Source: O'Brien et al. 2022b
km = kilometer; nm = nautical mile

Figure 3-3: Sightings of North Atlantic Right Whales during the Massachusetts Clean Energy Center and New England Aquarium Surveys in the Rhode Island and Massachusetts Lease Areas

NARWs have been observed engaging in social behaviors and foraging, as well as with calves during survey efforts within the Action Area (Leiter et al. 2017; Stone et al. 2017). Behavioral data associated with sightings within the RI/MA Lease Areas and surrounding waters during surveys include surface active groups (defined as two or more whales rolling and touching at the surface) and feeding, with both behaviors observed during the spring from March through May within the RI/MA Lease Areas (Leiter et al. 2017).

NARW occurrence in the SWDA is likely underestimated using only aerial survey results. A more comprehensive picture of NARW presence is gained by a combination of visual and acoustic surveys. Comparisons between detections from passive acoustic recorders and observations from aerial surveys in Cape Cod Bay between 2001 and 2005 demonstrated that aerial surveys found whales on approximately two-thirds of the days during which acoustic monitoring detected whales (Clark et al. 2010). These data suggest that the current understanding of the distribution and movements of NARWs is likely incomplete.

Davis et al. (2017) presents results from a long-term passive acoustic survey of the western North Atlantic from the western Scotian Shelf to the waters off Jacksonville, Florida, from 2004 through 2014. From these acoustic detection results, NARWs were present along the entire eastern seaboard of North America for most of the year. These data also indicate that NARW distribution appears to have started to shift in 2010 from previously prevalent northern grounds, such as the Bay of Fundy and greater Gulf of Maine, to more time spent in mid-Atlantic regions year-round, including the waters south of Cape Cod (Region 7 in the study, which includes the SWDA). Past visual surveys led to the assumption that a majority of NARWs migrated between winter calving grounds in the south and summer feeding grounds in the north. The location of the remaining members of the population was not known. Davis et al. (2017) indicates that NARWs are present nearly year-round across their entire habitat range, particularly north of Cape Hatteras, suggesting that not all of the population undergoes the annual north-to-south migration. The authors suggest that non-migrating whales could be mobile individuals occupying a broader, more diffused geographic area through the year, but these potential cohort-specific behaviors require additional study.

Palka et al. (2021) also deployed bottom-mounted recorders from 2015 through 2019 as a part of the AMAPPS II data collection to detect the presence of baleen whales (including NARW) along the U.S. east coast. Several recorders were deployed along Nantucket, just east of the Project area, which showed NARW vocalizations were present in all months of the year, with the highest presence in the winter (Palka et al. 2021). Additionally, vocalizations showed their daily presence in the winter was greatest at the recorders inshore, closer to Martha's Vineyard and Nantucket, Massachusetts (Palka et al. 2021).

In summary, the relative abundance and density of NARWs in the Project area and surrounding waters is highest in the winter and spring within the RI/MA Lease Areas, with individuals typically arriving in December and departing in May (Kenney and Vigness-Raposa 2010; Kraus et al. 2016a; Leiter et al. 2017; Quintana-Rizzo et al. 2021). The highest densities in the Project area are expected during February, March, and April, though year-round presence is possible. The species is less commonly observed in the Project area during July, August, and September when they are more likely to be in northern feeding grounds such as the Gulf of Maine/Bay of Fundy and Gulf of St. Lawrence (Pendleton et al. 2012; Kraus et al. 2016a; Leiter et al. 2017; Crowe et al. 2021). Kraus et al. (2016a) and O'Brien et al. (2021a, 2021b) suggest that the areas of lowest NARW use appear to be the southern and furthest offshore portion of the RI/MA Lease Areas, whereas the highest rates of occurrence were over the Nantucket Shoals. Vessels transiting to and from foreign ports (i.e., Atlantic Canada, Europe) may encounter NARWs within the Action Area. However, given the overall low density of NARWs in the North Atlantic beyond the OCS and the low expected number of vessel transits from non-local ports, the likelihood of an encounter is very low.

3.2.2 Fin Whale

Fin whales are very common over the continental shelf waters from Cape Hatteras, North Carolina, northwards (Hayes et al. 2022) and are present in every season throughout the U.S. Exclusive Economic Zone (EEZ) north of Cape Hatteras (Edwards et al. 2015). They are typically found along the 328-foot (100-meter) isobath but may also occur in shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1986). Fin whales are migratory, moving seasonally into and out of feeding areas, but their overall migration pattern is complex, and specific routes are not known (Hayes et al. 2022). The species occurs year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Thus, their movements overall are patterned and consistent, but distribution of individuals in a given year may vary according to their energetic and reproductive condition and climatic factors (NMFS 2019).

Fin whales are fast swimmers and are often found in social or feeding groups of two to seven individuals (NMFS 2022b). These whales feed during summer and are known to have site fidelity to feeding grounds in New England during this period (Seipt et al. 1990). Fin whales in the North Atlantic feed on pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin (*Mallotus villosus*), Atlantic herring (*Clupea harengus*), and sand lance (Borobia et al. 1995) by skimming the water or lunge feeding. Several studies suggest that distribution and movements of fin whales along the east coast of the United States is influenced by the availability of sand lance (Kenney and Winn 1986; Payne et al. 1990). A BIA for feeding has been delineated for the area east of Montauk Point, New York, to the west boundary of the RI/MA Lease Areas between the 49-foot (15-meter) and 164-foot (50-meter) depth contour from March to October (LaBrecque et al. 2015).

Fin whales belong to the low-frequency hearing group of marine mammals (NMFS 2018b), with the predicted best hearing sensitivity ranging from 20 Hz to 20 kHz (Erbe 2002; Southall et al. 2019).

3.2.2.1 Current Status of the Fin Whale Western North Atlantic Population

Fin whales have been listed as Endangered under the ESA since the act's passage in 1973 (35 Fed. Reg. 8491 [June 2, 1970]). Fin whales in Atlantic U.S. waters belong to the Western North Atlantic stock. The best available abundance estimate for the western North Atlantic stock is 6,802, with a minimum population estimate of 5,573 based on shipboard and aerial surveys conducted in 2016 and the 2016 Northeast Fisheries Science Center and Department of Fisheries and Oceans Canada surveys (Hayes et al. 2022). The extents of these two surveys do not overlap; therefore, the survey estimates were added together. NMFS has not conducted a population trend analysis due to insufficient data and irregular survey design (Hayes et al. 2022). The best available information indicates that the gross annual reproduction rate is 8 percent, with a mean calving interval of 2.7 years (Hayes et al. 2022). For 2015 through 2019, the minimum annual rate of human-caused (i.e., vessel strike and entanglement in fishery gear) mortality and serious injury was 1.85 per year (Hayes et al. 2022).

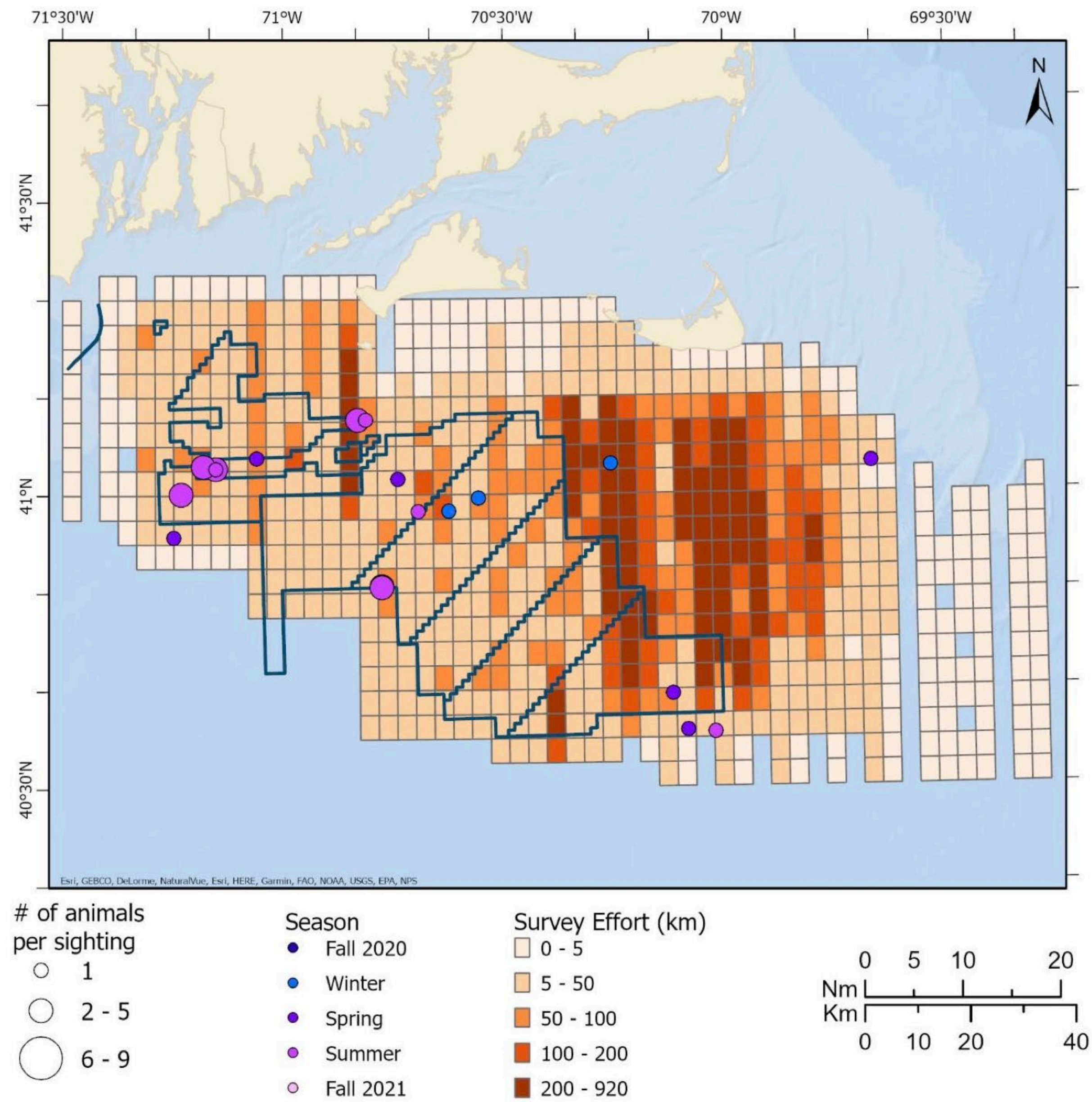
No critical habitat has been designated for fin whales in the Action Area.

3.2.2.2 Presence and Abundance in the Action Area

Visual surveys of the RI/MA Lease Areas from October 2011 through June 2015 resulted in more fin whale encounters compared to any other large whale species, with 87 sightings of fin whales out of a total of 154 animals observed over the study period (Stone et al. 2017). Summer 2015 had the highest density of fin whales (0.0076 individuals per 0.38 mile), which yielded the highest abundance (59) of any large whale for any season (Stone et al. 2017). The effort-weighted average sighting rate for fin whales in the RI/MA Lease Areas during the study period was highest in summer (4.75 animals per 621.4 survey miles [1,000 kilometers]) and second highest in spring (2.70 animals per 621.4 survey miles [1,000 survey kilometers]; Table 4-2; Kraus et al. 2016a). Fin whales were visually observed in the RI/MA Lease Areas every year from October 2011 through June 2015, and sightings occurred in every season, with peaks between April and August (Stone et al. 2017; Kraus et al. 2016a). Three cow/calf pairs were observed in the RI/MA Lease Areas (Kraus et al. 2016a).

Over the same time period, fin whales were visually detected in the northern portion of the SWDA during the summer in relatively high numbers, with sightings per unit effort (SPUE) ranging from 1 to 30 animals per 621.4 miles (1,000 kilometers) and in the southern portion in the spring in relatively low numbers (Kraus et al. 2016a). Fin whales were not observed in the SWDA during fall or winter. Summer sightings in the SWDA and surrounding waters suggest that fin whales may use this area each summer for feeding (Kraus et al. 2016a).

A similar trend was observed during surveys in the RI/MA Lease Areas conducted in 2020 and 2021, with the greatest sighting rate in the summer (4.0 animals per 0.38 survey mile [0.6 kilometers]) and spring (0.8 animals per 0.38 survey mile [0.6 kilometers]), a lower sighting rate in the winter (0.3 animals per 0.38 survey mile [0.6 kilometers]), and no whales detected in the fall (Figure 3-4; O’Brien et al. 2022b).



Source: O'Brien et al. 2022b
km = kilometer; nm = nautical mile

Figure 3-4: Sightings of Fin Whales during the Massachusetts Clean Energy Center and New England Aquarium Surveys in the Rhode Island and Massachusetts Lease Areas

Acoustic detections from recorders deployed off Nantucket indicate a year-round presence for fin whales in the vicinity of the Project area, with the highest occurrence in the winter (Palka et al. 2021). Acoustic detections were reported for all the recorders, regardless of depth, showing fin whales may make use of the entire continental shelf in this region (Palka et al. 2021).

Fin whales are also present throughout the North Atlantic (NMFS 2022b), including within the Action Area in vessel transit lanes from ports in Europe and Atlantic Canada (Table 1-9); however, given the number of Project-related vessels transits that may originate from these ports (Table 1-10) is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic, encounters along these transit routes would be uncommon.

3.2.3 Sei Whale

The Nova Scotia stock of sei whales is distributed across the continental shelf waters from the northeast U.S. coast northward to south of Newfoundland (Hayes et al. 2022). This species is highly mobile, and there is no indication that any population remains in a particular area year-round (NMFS 2011). Sei whale occurrence in a particular feeding ground is considered unpredictable or irregular (Schilling et al. 1992) but may be correlated to incursions of relatively warm waters of the Irminger Current off West Greenland (Hayes et al. 2022). Olsen et al. (2009) also indicated that sei whales' movements appear to be associated with oceanic fronts, thermal boundaries, and specific bathymetric features. NMFS (2011) indicated that climate change may affect sei whale habitat availability and food availability, as migration, feeding, and breeding locations may be affected by ocean currents and water temperature.

This species is typically sighted on the U.S. Atlantic mid-shelf and the shelf edge and slope (Olsen et al. 2009). Sei whales are usually observed alone or in small groups of two to five animals. Groups of up to ten sei whales in the inshore waters of the southern Gulf of Maine were reported on 30 of 67 days during the summer of 1986. Previously, sei whales were believed to occasionally occur in the inshore waters of the Gulf of Maine (Schilling et al. 1992); However, Baumgartner et al. (2011) reported sei whale observations during springtime in the Great South Channel from 2004 to 2010, suggesting that these whales are relatively common in the area.

Sei whales dive 5 to 20 minutes and feed on zooplankton (primarily on calanoid copepods), with a secondary preference for euphausiids (Christensen et al. 1992), krill, small schooling fish, and cephalopods (including squid) by both gulping, skimming, and lunging. They prefer to feed at dawn and may exhibit unpredictable behavior while foraging and feeding on prey (NMFS 2023d).

Sei whales belong to the low-frequency hearing group of marine mammals, which have a generalized hearing range of 7 Hz to 3.5 kHz (NMFS 2018b). Peak hearing sensitivity of sei whales is believed to range from 1.5 to 3.5 kHz (Erbe 2002).

3.2.3.1 Current Status of the Sei Whale Nova Scotia Population

Sei whales occurring in the U.S. Atlantic EEZ belong to the Nova Scotia stock. The current best abundance estimate for this stock is 6,292 individuals (Hayes et al. 2022). Between 2015 and 2019, the average annual minimum human-caused mortality and serious injury was 0.8 sei whales per year (Hayes et al. 2022). Threats to sei whales include vessel strike and entanglement in fisheries gear. No population trend is available for this stock.

No critical habitat has been designated for sei whales in the Action Area.

3.2.3.2 Presence and Abundance in the Action Area

Sei whales were observed in the RI/MA Lease Areas from October 2011 through June 2015 every year with enough sightings to estimate their abundance in this area (Stone et al. 2017); most frequently, they were sighted from March through June, with peaks in May and June, with mean abundances ranging from 0 to 26 animals (Stone et al. 2017). The effort-weighted average sighting rate in the RI/MA Lease Areas during the study period was highest in summer (0.78 animals per 621.4 miles [1,000 kilometers]) and second highest in spring (0.10 animals per 621.4 miles [1,000 kilometers]; Table 4-2; Kraus et al. 2016a).

Over the same time period, sei whales were observed in the northern portion of the SWDA during summer, with estimated SPUE ranging from 5 to 10 animals per 621.4 miles (1,000 kilometers) (Kraus et al. 2016a). Cow/calf pairs were observed in the vicinity of the Project area on three occasions throughout the study period. Due to the uncertainty associated with sei whale vocalization, this species was not included in the acoustic surveys.

During surveys conducted in the RI/MA Lease Areas in 2018 and 2019, most sei whale sightings occurred in May with the highest sighting rate in the spring (5.41 animals per 0.38 mile [0.6 kilometers]) with a lower sighting rate in the summer (0.56 animals per 0.38 mile [0.6 kilometers]) and no sei whales sighted in the winter or fall (O'Brien et al. 2021a). No sei whales were observed in the RI/MA Lease Areas during surveys conducted between March and October 2020 (O'Brien et al. 2021b). During surveys conducted between November 2020 and August 2021, only one sei whale was sighted in the spring of 2021 (O'Brien et al. 2022b).

Acoustic detections from recorders deployed off Nantucket show a similar pattern in sei whale presence, with vocalizations detected year-round but a higher number of detections in the spring (Palka et al. 2021). The number of daily detections on the recorders also showed sei whales prefer deeper waters along the shelf edge, although vocalizations were also present at the shallower recorders (Palka et al. 2021).

Sei whales are also present throughout the North Atlantic (NMFS 2023d), including within the Action Area in vessel transit lanes from ports in Europe and Atlantic Canada (Table 1-9). The majority of sei whale sightings in the Action Area are most likely concentrated in offshore waters between 328 and 3,280 feet (100 and 1,000 meters) deep. Given the number of Project-related vessel transits that may originate from foreign ports (Table 1-10) is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic, encounters along these transit routes would be uncommon.

3.2.4 Sperm Whale

Sperm whales are widely distributed throughout the deep waters of the North Atlantic. Distribution along the U.S. east coast is centered along the shelf break and over the slope (CETAP 1982; Hayes et al. 2020). An exception to this distribution pattern is found in the shallow continental shelf waters of southern New England, where relatively high numbers of sightings have been reported, particularly between late spring and autumn (Scott and Sadove 1997).

Geographic distribution of sperm whales appears to be linked to social structure. Most females form lasting bonds with other related females and their young and form social units of usually 12 females (NMFS 2023e). While females generally stay with the same unit all their lives in and around tropical waters, young males will leave when they are between 4 and 21 years old to form "bachelor schools" with other males of about the same age and size. As males get older and larger, they leave their bachelor schools and begin to migrate toward the poles; the largest males are usually solitary and often found alone (NMFS 2023e). Sperm whales hunt for food during deep dives, with feeding occurring at depths of 1,640 to 3281 feet (500 to 1,000 meters) (NMFS 2010). Deepwater squid make up the majority of their diet; other prey types include sharks, skates, and fish that occupy deep ocean waters (NMFS 2023e).

Sperm whales belong to the mid-frequency hearing group of marine mammals (NMFS 2018b). Members of this group have a presumed total frequency range of 150 Hz to 160 kHz (NMFS 2018b). However, sperm whales are most sensitive to sound in the 5 to 20 kHz hearing range based on data from a stranded neonate (Ridgway and Carder 2001).

3.2.4.1 Current Status of the Sperm Whale Western North Atlantic Population

The stock structure of the Atlantic population of sperm whales is poorly understood. It is not clear whether the western North Atlantic population is discrete from the eastern North Atlantic population (Hayes et al. 2020). However, the portion of the population found within the U.S. EEZ likely belongs to a larger stock in the western North Atlantic. Sperm whales are listed as Endangered under the ESA as a single, global population, but the best available estimate for the North Atlantic stock, which is expected to occur in the Action Area, is 4,349 individuals (Hayes et al. 2020). There were no reports of fishery-related mortality or serious injury between 2013 and 2017, and while there were 12 strandings documented during this period, none showed any indications of human interaction (Hayes et al. 2020).

No critical habitat has been designated for sperm whales in the Action Area.

3.2.4.2 Presence and Abundance in the Action Area

Sperm whale sightings in the RI/MA Lease Areas from October 2011 through June 2015 only occurred during the summer and fall, with three of the four sightings within a single year (2012) (Kraus et al. 2016a). There were two sightings on August 7, 2012 (one with four whales and one with a single whale), and one sighting of a single whale on September 17, 2012. The last sperm whale sighting was a group of three individuals observed on June 20, 2015. The sightings in summer occurred just southwest of Martha's Vineyard, in the RI/MA Lease Areas, and just north of the SWDA, south of the Muskeget Channel (Stone et al. 2017). The sighting in the fall occurred immediately west of the SWDA (Stone et al. 2017). Sperm whale acoustic presence was not reported in Kraus et al. (2016a) because their high -frequency clicks exceeded the maximum frequency of recording equipment settings used.

Two groups of sperm whales were spotted near the RI/MA Lease Areas during surveys in June and July 2019, and they occurred closer to shore in relatively shallower water than expected for this species (O'Brien et al. 2021a). These whales were observed milling and diving, and one individual was observed sleeping (O'Brien et al. 2021a). No sperm whale sightings were reported for surveys conducted in the RI/MA Lease Areas between March and October 2020 or between November 2020 and August 2021 (O'Brien et al. 2021b, 2022b).

Sperm whales are also present throughout the North Atlantic (NMFS 2023e), including within the Action Area in vessel transit lanes from ports in Europe and Atlantic Canada (Table 1-9); however, given the number of Project-related vessel transits that may originate from these ports (Table 1-10) is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic, encounters along these transit routes would be uncommon.

3.2.5 Blue Whale

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. 2020). Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence River, Newfoundland; Nova Scotia; New England; and Greenland all belong to the same stock, whereas blue whales photographed off Iceland and the Azores appear to be part of a separate population (CETAP 1982; Sears and Calambokidis 2002; Sears and Larsen 2002; Wenzel et al. 1988). The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (Comtois et al. 2010; Lesage et al. 2007), which is outside of the Action Area. Blue whales do not regularly occur within the U.S. EEZ and typically occur farther offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011). Sightings and strandings data indicate that blue whales occur along the U.S. east coast only rarely because their primary habitat is offshore eastern Canada (Reeves et al. 1998; Kraus et al. 2016a; Hayes et al. 2020). Blue whales primarily feed on pelagic crustaceans (mainly krill), but fish and copepods may also be a part of their diet (NMFS 2023f).

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).

3.2.5.1 Current Status of the Blue Whale Western North Atlantic Population

Blue whales have been listed as Endangered under the ESA, with a recovery plan published under 63 Fed. Reg. 56911 (October 12, 2018) and revised in 2020 (NMFS 2020a). Blue whales are separated into two major populations (the north Pacific and north Atlantic population) and further subdivided in stocks. The North Atlantic stock includes mid-latitude (North Carolina coastal and open ocean) to Arctic waters (Newfoundland and Labrador). The population size of blue whales off the eastern coast of the United States is not known; however, a catalogue count of 402 individuals from the Gulf of St. Lawrence is the minimum population estimate (Hayes et al. 2020). There are no recent confirmed records of anthropogenic mortality or serious injury to blue whales in the U.S. Atlantic EEZ or in Atlantic Canadian waters (Henry et al. 2020). As a result, the total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching zero (Hayes et al. 2020).

No critical habitat has been designated for blue whales in the Action Area.

3.2.5.2 Presence and Abundance in the Action Area

Historical observations indicate that the blue whale has a wide range of distribution throughout the North Atlantic, from warm temperate latitudes typically in the winter months and northerly distribution in the summer months. Blue whales are known to be an occasional visitor to U.S. Atlantic EEZ waters, with limited sightings. Blue whales in the North Atlantic appear to target high-latitude feeding areas and may also use deep-ocean features such as sea mounts outside the feeding season (Pike et al. 2009; Lesage et al. 2017, 2018). Given their reported occurrence and habitat preferences, their presence in the Project area is uncommon (Hayes et al. 2020). Additionally, sightings and strandings data indicate that blue whales occur along the U.S. east coast continental shelf rarely, typically exhibiting a more pelagic distribution (Kraus et al. 2016b; Lesage et al. 2017). As such, blue whales are expected to be rare in the Project area.

Given their pelagic distribution, it is possible that the species would be encountered along vessel transit paths in the Action Area between ports in Europe and the SWDA. However, given the low number of proposed Project vessels originating from Europe (Table 1-10) and the low relative densities of blue whales in the North Atlantic, these encounters are expected to be uncommon.

3.2.6 Effects Analysis for Marine Mammals

3.2.6.1 Definition of Take, Harm, and Harass

Section 3 of the ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. For the purposes of this effects analysis, two forms of take were considered: lethal and sublethal take. Lethal take is expected to result in immediate, imminent, or delayed but likely mortality. Sublethal take is when effects of the action are below the level expected to cause death but are still expected to cause injury, harm, or harassment. Harm, as defined by regulation (50 CFR §222.102), includes acts that actually kill or injure wildlife and acts that may cause significant habitat modification or degradation that actually kill or injure fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering. Thus, for sublethal take, NMFS is concerned with harm that does not result in mortality but is still likely to injure an animal.

NMFS has not defined "harass" under the ESA by regulation. However, on October 21, 2016, NMFS issued interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering." (NMFS 2016a). For this consultation, this definition of "harass" will be relied on when assessing effects on all ESA-listed species except marine mammals.

For marine mammal species, prior to the issuance of the October 21, 2016, guidance, consultations that involved NMFS Permits and Conservation Division's authorization under the MMPA relied on the MMPA definition of harassment. Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance that:

1. Has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or
2. Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). Under NMFS regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.

NMFS October 21, 2016, guidance states that the "interim ESA harass interpretation does not specifically equate to MMPA Level A or Level B harassment but shares some similarities with both levels in the use of the terms 'injury/injure' and a focus on a disruption of behavior patterns." NMFS has not defined 'injure' for purposes of interpreting Level A and Level B harassment but in practice has applied a physical test for Level A harassment (NMFS 2016a). However, the modeling used to estimate ESA-level take numbers for marine mammals, specifically regarding underwater noise stressors, correspond to MMPA definitions of Level A and B harassment. Therefore, any Level A harassment has been considered for this analysis to be instances of potential harm via PTS/auditory injury under the ESA. Level B harassment as applied in this consultation may involve a wide range of behavioral responses, including, but not limited to, avoidance, changes in vocalizations or dive patterns, or disruption of feeding, migrating, or reproductive behaviors. Level B harassment may or may not constitute harm under the ESA definition of "significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering," depending on the nature of the effects.

3.2.6.2 Underwater Noise

BOEM recognizes that underwater noise can result in take by harassment for ESA-listed marine mammal species. The Proposed Action would produce temporary construction-related underwater noise and long-term operational underwater noise above levels that may affect listed species. Activities that would generate underwater noise during proposed Project construction and operations include impact pile driving, vibratory pile setting, and foundation drilling for the installation of monopiles and pin piles for both jacket and bottom-frame foundations; installation of the suction buckets for the jackets and bottom-frame foundations proposed for Phase 2; potential UXO detonations; HRG surveys; vessel activity; WTG operations; and dredging. These activities would temporarily increase sound levels in the marine environment and may result in adverse effects on ESA-listed marine mammals in the Action Area. Potential adverse effects include PTS, behavioral disturbance, or both. No harm as defined by the ESA (Section 3.2.6.1) is expected to result from any underwater noise generated by the Proposed Action.

Potential auditory injury (i.e., PTS) and harassment (behavioral disturbance) takes of ESA-listed species from proposed Project activities would be restricted to the Project area as defined in Section 1.3, with the extent and severity of effects dependent on the timing of activities relative to species occurrence, the type of noise generated, and species-specific sensitivity. The applicant conducted Project-specific modeling to characterize the area affected by underwater noise from installation of the WTG and ESP foundations using impact and vibratory pile setting methods and foundation drilling and UXO detonations (JASCO 2022, 2023). Full details of these activities were provided in Section 1.4 and are summarized in the following subsections. For these sources, modeling was also completed to estimate the number of each ESA-listed species likely to be exposed to underwater noise levels above auditory injury (i.e., PTS) and behavioral thresholds. The results of this modeling effort were used to develop the effects analysis presented in this BA. Exposure modeling was conducted for installation of up to 132 foundations, including both monopile and jacket pin pile, following the schedule provided in Table 1-3. For sound sources where no Project-specific modeling was completed, information available in the literature was used to develop the effects analysis.

3.2.6.2.1 Overview of Underwater Noise

Two primary components of underwater noise important for effects assessment include pressure and particle motion. Pressure can be characterized as the compression and rarefaction of the water as the noise wave propagates through it. Particle motion is the displacement, or back and forth motion, of the water molecules that create the compression and rarefaction. Both factors contribute to the potential for effects from underwater noise on affected resources. Marine mammal and sea turtle hearing is based on the detection of sound pressure, and there is no evidence to suggest either group is able to detect particle motion for the purposes of hearing and noise detection (Bartol and Bartol 2012; Nedelec et al. 2016). All discussions of particle motion in this BA are, therefore, focused on fish and invertebrate species.

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

The efficiency of underwater sound propagation allows marine mammals to use underwater sound as a method of communication, navigation, prey detection and predator avoidance (Richardson et al. 1995; Southall et al. 2007). Anthropogenic (i.e., human-introduced) noise is a potential stressor for marine mammals because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995; Ketten 1998). Underwater noise generated by human activities can often be detected by marine animals many kilometers from the source; however, the potential for negative effects generally decreases with increasing distance from a noise source. Potential acoustic effects can include physiological injury, permanent or temporary hearing loss, behavioral changes, and acoustic masking (i.e., sound perception interference). All the above effects have the potential to induce stress on marine animals in their receiving environment (OSPAR Commission 2009; Erbe 2013).

Anthropogenic noise sources can be categorized generally as impulsive (e.g., impact pile driving, sparkers/boomers) or non-impulsive (e.g., vibratory pile setting, foundation drilling, vessel noise). Non-impulsive sources can be further characterized as continuous or intermittent. Sounds from moving sources such as ships are continuous noise sources, although temporary relative to the receivers. Impulsive sound is characterized by a distinct energy pulse that has a rapid rise time and high zero-to-peak sound pressure level (Lpk). Most impulsive sounds are broadband and are generated by sources such as impact pile driving, commercial and recreational echosounders, and sub-bottom profilers. Non-impulsive sounds tend to be tonal, narrowband, and do not have the rapid rise times seen in impulsive sources (Southall et al. 2007). Some non-impulsive sources can be broadband and, like impulsive sounds, may be generated from stationary or moving sources over a specified period, duty cycle, or both.

Marine mammals show varying levels of disturbance in response to underwater noise sources. Underwater noise is less likely to disturb or injure an animal if it occurs at frequencies outside of an animals generalized hearing sensitivity. Observed behavioral responses include displacement and avoidance, decreases in vocal activity, and habituation. Behavioral responses can consist of disruption in foraging patterns, increases in physiological stress, and reduced breeding opportunities, among other responses. To better understand and categorize the potential effects of behavioral responses, Southall et al. (2007) developed a behavioral response severity scale of low, moderate, or high (Southall et al. 2007; Finneran et al. 2017). This scale was recently updated in Southall et al. (2021). The revised report updated the single severity response criteria defined in Southall et al. (2007) into three parallel severity tracks that score behavioral responses from 0 to 9. The three severity tracks are (1) survival, (2) reproduction, and (3) foraging. This approach is acknowledged as being relevant to vital rates, defining behaviors that may affect individual fitness, which may ultimately affect population parameters. It is noted that not all the responses within a given category need to be observed, but a score is assigned for a severity category if any of the responses in that category are displayed. To be conservative, the highest (or most severe) score is to be assigned for instances when several responses are observed from different categories. In addition, the authors acknowledge that it is no longer appropriate to relate "simple all-or-nothing thresholds" to specific received sound levels and behavioral responses across broad taxonomic groupings and sound types due to the high degree of variability within and between species and noise types. The new criteria also move away from distinguishing noise effects from impulsive vs. non-impulsive sound types into considering the specific type of noise (e.g., pile driving, seismic, vessels).

Auditory masking occurs when sound signals used by marine mammal overlap in time, space, and frequency with another sound source (Richardson et al. 1995). Masking can reduce communication space, limit the detection of relevant biological cues, and reduce echolocation effectiveness. A growing body of literature is focused on improving the framework for assessing the potential for masking of animal communication by anthropogenic noise and understand the resulting effects. More research is needed to understand the process of masking, the risk of masking by anthropogenic activities, the ecological significance of masking, and what anti-masking strategies are used by marine animals and their degree of effectiveness before masking can be incorporated into regulation strategies or mitigation approaches (Erbe et al. 2016). For the current assessment, masking was considered possible if the frequency of the sound source overlaps with the hearing range of the marine mammal (Table 3-2).

3.2.6.2.2 Auditory Criteria for Marine Mammals

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. Auditory thresholds from underwater noise are expressed using two common metrics: SPL, measured in dB reference to (re) 1 µPa, and sound exposure level (SEL), a measure of energy in dB re 1 μPa^2 s. SPL is an instantaneous value represented as either SPL or Lpk, whereas SEL is the total noise energy to which an organism is exposed over a given time period, typically 1 second for pulse sources and up to 24-hours for assessing effects using NMFS threshold criteria. The importance of sound components at particular frequencies can be scaled by frequency weighting relative to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007; Finneran 2016). The sound exposure level over 24 hours (SEL_{24h}) NMFS threshold criteria for PTS are frequency-weighted metrics, which account for the susceptibility of a hearing group to noise-induced hearing loss (NMFS 2018b).

Thresholds used for the purpose of predicting the extent of potential noise effects on marine mammals and subsequent management of these effects account for the duration of exposure and the differences in hearing acuity in various marine mammal species (Finneran 2016; NMFS 2018b). For marine mammals, recommended acoustic criteria for hearing injury (i.e., PTS) and behavioral disturbance are recognized by NMFS and have recently been updated in terms of PTS thresholds (NMFS 2018b). The revised PTS thresholds apply dual criteria based on an unweighted Lpk and a SEL_{24h} based on updated frequency weighting functions for five functional marine mammal hearing groups described by Finneran and Jenkins (2012). Behavioral disturbance thresholds for marine mammals are based on an SPL of 160 dB re 1 µPa for impulsive and non-impulsive, intermittent sounds and 120 dB re 1 µPa for non-impulsive, continuous sounds for all marine mammal species (70 Fed. Reg. 1871 [January 11, 2005]). Although these disturbance thresholds remain current (in the sense that they have not been formally superseded by newer directives), they are not frequency weighted to account for different hearing abilities by the five marine mammal hearing groups. Current weighting for PTS (and TTS) relies on an animal's hearing sensitivities and an animal's susceptibility to noise-induced hearing loss based on empirical, modeled TTS data, or both. Because behavior is not grounded in the potential for hearing loss, these weighting criteria are not applied for behavioral disturbance thresholds. There has been some work conducted to group animals into categories based on their susceptibility to, or severity of reaction to, acoustic disturbance, which has resulted in step or dose response functions (Southall et al. 2019; Harris et al. 2017; Moretti et al. 2014; Wood et al. 2012); however, effects analysis in this document was based on the current SPL behavioral disturbance criteria of 120 dB re 1 µPa and 160 dB re 1 µPa applied equally to all species. Southall et al. (2019) conducted a broad, structured assessment of the audiometric and physiological basis for the categorization of marine mammal hearing groups. Southall et al. (2019) kept the same frequency responses (i.e., hearing sensitivities) but re-categorized the LFC, mid-frequency cetacean (MFC), and high-frequency cetacean (HFC) hearing groups to LFC, HFC (previously MFC), and very high-frequency (previously HFC) hearing groups, and distinguished between phocid carnivores (i.e., pinnipeds) in water and in air. Thus, Southall et al. (2019) proposed retaining the thresholds and functions developed by Finneran (2016) and adopted by NMFS (2018a). The results of Southall et al. (2019) remain congruent with the current existing regulatory guidance (NMFS 2018b); therefore, this BA maintains the nomenclature from NMFS (2018a) for this analysis. In addition, the species of marine mammals listed under the ESA that are likely to occur in the Project area (Sections 3.2.1 through 3.2.5) belong to the LFC and MFC hearing groups, so only these will be carried forward in this assessment as shown in Table 3-2.

Table 3-2: Marine Mammal Functional Hearing Groups

Functional Hearing Groups	Taxonomic Group	Hearing Range
LFC	Baleen whales (e.g., humpback whale [*Megaptera novaeangliae]*, blue whale [*Balaenoptera musculus*])	7 Hz to 35 kHz
MFC	Most dolphin species, beaked whales, sperm whale (*Physeter macrocephalus)*	150 Hz to 160 kHz

Source: NMFS 2018b
Hz = hertz; kHz = kilohertz; LFC = low-frequency cetacean; MFC = mid-frequency cetacean

The potential for underwater noise exposures to result in adverse effects on marine mammals depends on the received sound level, the frequency content of the sound relative to the hearing ability of the animal, an animal's susceptibility to noise-induced hearing loss, and the level of natural background noise. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or potential injury, mortality, or both at high received levels.

Sound reaching the receiver with ample duration and noise level can result in a loss of hearing sensitivity in marine animals termed a noise-induced threshold shift (i.e., TTS or PTS). TTS is a relatively short-term, reversible loss of hearing following exposure (Southall et al. 2007; Le Prell 2012), often resulting from cellular fatigue and metabolic changes (Saunders et al. 1985; Yost 2000). While experiencing TTS, the hearing threshold rises, and subsequent sounds must be louder to be detected. PTS is an irreversible loss of hearing (permanent damage) following exposure that commonly results from inner ear hair cell loss or structural damage to auditory tissues (Saunders et al. 1985; Henderson et al. 2008). While the only direct evidence of PTS occurring in marine mammals has been observed for harbor seals in a laboratory setting to a 4.1 kHz tone (Reichmuth et al. 2019), TTS demonstrated in captive settings has been used to estimate PTS onset for multiple species exposed to impulsive and non-impulsive noise sources (a full review is provided in Southall et al. 2007, 2019; Finneran 2016; Finneran et al. 2017). Prolonged or repeated exposures to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007, 2019).

Table 3-3 outlines the acoustic thresholds for onset of auditory effects (PTS and behavioral disruption) for marine mammals for both impulsive and non-impulsive noise sources. Acoustic thresholds are only provided for LFC and MFC hearing groups as these are the only ESA-listed marine mammal species likely to occur in the Project area. Impulsive noise sources for the proposed Project includes impact pile driving and certain HRG equipment (i.e., boomers and sparkers). Non-impulsive noise sources associated with the proposed Project include vibratory pile setting associated with installation of the WTG and ESP foundations, foundation drilling, vessel activities, and WTG operational noise.

Table 3-3: Acoustic Thresholds for Onset of Acoustic Impacts (Permanent Threshold Shift and Behavioral Disturbance) for Endangered Species Act-Listed Cetaceans

Marine Mammal Functional Hearing Group	Impulsive Sources			Non-Impulsive Sources	
	PTS	Behavioral Disturbance		PTS	Behavioral Disturbance
	Lpk	SEL_{24h}[a]	SPL	SEL_{24h}[a]	SPL
LFC (NARW [*Eubalaena glacialis*], fin whale [*Balaenoptera physalus*], sei whale [*Balaenoptera borealis*], blue whale [*Balaenoptera musculus*])	219	183	160	199	120–continuous 160–intermittent
MFC (sperm whale [*Physeter macrocephalus*])	230	185	160	198	120–continuous 160–intermittent

Source: NMFS 2018b; 70 Fed. Reg. 1871 (January 11, 2005)

dB = decibel; LFC = low-frequency cetacean; Lpk = peak sound pressure level in units of dB referenced to 1 micropascal; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal.

[a] SEL_{24h} thresholds including frequency weighting for each hearing group.

For UXO detonations, there is potential for non-auditory injury, such as lung or gastrointestinal tract compression injuries, in addition to auditory injuries such as PTS described previously in Section 3.2.6.2. TTS is used to estimate the onset for behavioral disturbances during explosive events when they occur as single detonations. Non-TTS behavioral responses are not expected to occur for Proposed Action because multiple, sequential detonations would not occur. The marine mammal threshold criteria used in this assessment comprises NMFS (2018a) technical guidance criteria for PTS (Table 3-3), the NMFS (2018a) TTS thresholds shown in Table 3-4, and the Finneran et al. (2017) thresholds for non-auditory injury shown in Table 3-5.

Table 3-4: Temporary Threshold Shift Onset Acoustic Threshold Levels

Hearing Group	TTS Onset Thresholds to Evaluate Level B Harassment for UXO Detonations (Received Level)
LFC (all the large whales except sperm whales [*Physeter macrocephalus*])	SEL_{24h} 168 dB re 1 μPa^2 s
MFC (all dolphins, pilot whales, and sperm whales [*Physeter macrocephalus]*)	SEL_{24h} 170 dB re 1 μPa^2 s

Sources: JASCO 2022; NMFS 2018b
LFC = low-frequency cetacean; MFC = mid-frequency cetacean
dB re 1 μPa^2 s = decibels referenced to 1 micropascal squared second; SEL_{24h} = sound exposure over 24 hours and has a reference value of 1 μPa^2 s; TTS = temporary threshold shift; UXO = unexploded ordnance

Table 3-5: Threshold Criteria for Non-Auditory Injury During Potential Deonation of Unexploded Ordnance

Impact Criterion	Threshold
Onset mortality – impulse	$103M^{1/3}(1+\frac{D}{10.1})^{1/6}\ Pa-s$
Onset injury – impulse (non-auditory)	$47.5M^{1/3}(1+\frac{D}{10.1})^{1/6}\ Pa-s$
Onset injury – peak pressure (non-auditory) for marine mammals	Lpk 237 dB re 1 μPa

Source: JASCO 2022; Finneran et al. 2017
dB re 1 μPa = decibels referenced to 1 micropascal; D = animal depth; M = animal mass in kilograms; Pa = pascal; Lpk = peak sound pressure level

3.2.6.2.3 Assessment of Underwater Noise Effects

The proposed Project-generated underwater noise considered in the assessment includes installation of the WTG and ESP foundations using a combination of vibratory pile setting and impact pile driving; drilling of the WTG and ESP foundations; vessel and aircraft noise; HRG survey equipment; UXO detonations;; and WTG operations. Acoustic propagation and exposure modeling was conducted for piling,, foundation drilling, UXOs, and HRG survey equipment to determine ranges to the regulatory PTS and behavioral disturbance thresholds for marine mammals and the number of individuals potentially exposed to above-threshold noise (JASCO 2023; COP Appendix III-M; Epsilon 2023).

Foundation Installation

As described in Section 1.4.1.2, foundations will be installed using a combination of vibratory pile setting and impact pile driving. Sixty-three of the total 132 foundations, which includes all pile types (i.e., 12-m monopile, 13-m monopile, and 4-m pin pile for the jacket foundations), will be installed using impact pile driving; the remaining 70 foundations will be installed first using vibratory pile setting followed by impact pile driving. The applicant has determined it may be necessary to start pile installation using a vibratory hammer rather than using an impact hammer, a technique known as vibratory setting of piles. The vibratory method is particularly useful when seabed sediments are not sufficiently stiff to support the weight of the pile during the initial installation, increasing the risk of 'pile run' where a pile sinks rapidly through seabed sediments. Based on a seabed drivability analysis conducted by the applicant to estimate the number of foundation positions that could potentially require vibratory setting of piles. The analysis suggested that up to 50% of foundations (~66 foundations) could require vibratory setting. An additional 6% conservatism is assumed (6% of 66 is ~4 additional foundations), resulting in approximately 70 total foundations (53% of all proposed foundations) that may require vibratory setting (JASCO 2023; COP Appendix III-M; Epsilon 2023).

The piling soft start schedule for impact pile driving only and vibratory pile setting followed by impact pile driving are provided in Tables 1-4 through 1-6 for all foundation types. These piling schedules were used in the acoustic propagation and exposure modeling to estimate the threshold ranges and exposure estimates. The piling schedules determine the overall duration of piling activities for each foundation. For consecutive piles, a delay in the pile schedule is included between foundation installation events; for foundations requiring vibratory pile setting, 15 minutes were also included in between the vibratory and impact hammering to account for the time needed to switch equipment (JASCO 2023; COP Appendix III-M; Epsilon 2023).

The JASCO Applied Sciences Animal Simulation Model Including Noise Exposure (JASMINE) was used to predict the probability of exposure of animals to sound above thresholds arising from the Proposed Action's impact pile-driving activities. Sound exposure models like JASMINE use simulated animals (animats) to sample the predicted 3D sound fields with movement rules derived from animal observations (JASCO 2022). Modeled sound fields are generated from representative pile locations, and animats are programmed to behave like the marine animals that may be present in the Project area. The parameters used for forecasting realistic behaviors (e.g., diving, foraging, aversion, surface times) are determined and interpreted from marine species studies (e.g., tagging studies), where available or reasonably extrapolated from related species as referenced in the model (JASCO 2023; COP Appendix III-M; Epsilon 2023).

The acoustic modeling to SEL thresholds, without considering animal movement, produces the 95th percentile acoustic ranges at which a marine mammal would have to remain stationary for the entire duration of the activity to be exposed to levels above the stated threshold. To provide a realistic estimate of distances at which acoustic thresholds for marine mammals may be met, the COP (Appendix III-M; Epsilon 2023) modeled exposure ranges to PTS and behavioral thresholds for impulsive sources (Table 3-3). To determine exposure ranges, pile strikes are propagated to create an ensonified environment while simulated animals (i.e., animats) are moved about the ensonified area following expected species-specific behaviors. Modeled animats that have received sound energy that exceeds the acoustic threshold criteria are registered, and the closest point of approach recorded at any point in that animal's movement is then reported as its exposure range. This process is repeated multiple times for each animat. The exposure-based ranges comprise 95 percent of the closest points of approaches for animats that exceeded the threshold (i.e., 95th percentile exposure range [$ER_{95\%}$]). The potential for noise from vibratory pile setting to induce PTS is low relative to impact pile driving; however due to. the relatively short (15-minute) period between vibratory and impact piling for each foundation, vibratory setting and impact pile driving must be considered together as part of the total received acoustic energy for the entire pile installation (JASCO 2023; COP Appendix III-M; Epsilon 2023).

While the PDE includes either one or two monopile foundations installed per day, this BA assesses the impacts for two piles driven per day because this indicates the activity which would present the highest risk to marine mammals. However, as discussed further in this section, the exposure estimates account for the full construction schedule in Table 1-3 which accounts for both scenarios (i.e., days where 1 pile is driven and days where 2 piles are driven). All pin piles will be installed at a rate of 4 piles per day. $ER_{95\%}$ values for two piles per day represent the closest the animats got to either of the two piles installed. Results of the modeling with 10 dB noise attenuation for all pile types installed using impact pile driving only are summarized in Table 3-6, and piles installed using vibratory pile setting followed by impact pile driving are summarized in Table 3-7. Blue whales were not modeled for the Project's exposure modeling analysis (JASCO 2023) because they are considered a rare species whose preferred ranges largely fall outside the Project area but were included as a conservative measure. As described in Section 1.4.1.2.1, BOEM determined 10 dB to be the appropriate level of attenuation for the Proposed Action.

Table 3-6: Summary of Proposed Action 95th Percentile Exposure Ranges (Meters) for Marine Mammals Acoustic Thresholds for Impact Pile Driving of Two Monopile or Four Pin Piles per Day and 10 Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, 6,000 kJ Hammer			13-Meter Monopile, 6,000 kJ Hammer			4-Meter Pin Pile,| 3,500 kJ Hammer[a]		
	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)
NARW (*Eubalaena glacialis*)	0	1,340	4,830	0	1,620	5,180	0	2,350	4,540
Fin whale (*Balaenoptera physalus*)	0	2,160	5,290	0	2,580	5,400	< 10	3,730	4,660
Sei whale (*Balaenoptera borealis*)	0	1,270	5,170	0	1,310	5,340	< 10	2,100	4,520
Sperm whale (*Physeter macrocephalus*)	0	0	5,160	0	0	5,270	0	0	4,520

Source: COP Appendix III-M; Epsilon 2023; JASCO 2023
< = less than; dB = decibel; kJ = kilojoule; NARW = North Atlantic right whale; Lpk = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second, weighted by hearing group; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal
[a] Modeling of the 4-meter pin piles includes both the jacket foundations and the bottom-frame foundations proposed for Phase 2 of the Proposed Action given the similarity in the acoustic characteristics for construction expected for both foundation types.

Table 3-7: Summary of Proposed Action 95th Percentile Exposure Ranges (Meters) for Marine Mammals Acoustic Thresholds for Two Monopile or Four Pin Piles per Day Installed using Vibratory Setting of Piles Followed by Impact Pile Driving and 10 Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, 6,000 kJ Hammer			13-Meter Monopile, 6,000 kJ Hammer			4-Meter Pin Pile,| 3,500 kJ Hammer[a]		
	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL) [b]	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL) [b]	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL) [b]
NARW (*Eubalaena glacialis*)	0	1,440	21,100	0	1,590	27,450	0	2,440	25,660
Fin whale (*Balaenoptera physalus*)	0	2,240	22,140	0	2,690	29,410	<10	4,020	27,740
Sei whale (*Balaenoptera borealis*)	0	1,260	22,080	0	1,330	29,020	<10	2,160	28,050
Sperm whale (*Physeter macrocephalus*)	0	0	21,950	0	0	28,870	0	0	27,110

Source: COP Appendix III-M; Epsilon 2023; JASCO 2023
< = less than; dB = decibel; kJ = kilojoule; NARW = North Atlantic right whale; Lpk = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second, weighted by hearing group; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal
[a] Modeling of the 4-meter pin piles includes both the jacket foundations and the bottom-frame foundations proposed for Phase 2 of the Proposed Action given the similarity in the acoustic characteristics for construction expected for both foundation types
[b] For behavior, the SPL threshold does not account for duration and instead assumes exposure if an animal is exposed to above-threshold noise in that instant an exposure could occur. Conversely, the SEL24h thresholds for PTS account for the entire exposure duration required to meet the threshold level. Therefore, the SEL24h threshold accounts for the vibratory pile setting followed by impact pile driving to reach the PTS threshold, whereas the behavior threshold only accounts for the second over which vibratory pile setting may exceed the threshold, and these ranges are based only on vibratory pile setting activities.

A bottom-frame foundation may also be used during Phase 2, which would have the same 4-meter maximum pile diameter as the jacket foundation, but with shallower penetration. Although the bottom-frame foundation was not modeled separately, it is assumed that the potential acoustic impact would be equivalent to or less than that predicted for the jacket foundation (JASCO 2022). Suction bucket piles proposed for the jacket and bottom-frame foundations under Phase 2 were not modeled because they are not expected to produce noise sufficient to cause auditory or behavioral effects for any marine species assessed in this BA (JASCO 2022). Noise produced by this activity would largely result from the suction pumps used during installation, which would be expected to be similar in acoustic signature to vessel noise, and any effects would be comparable to those discussed under that section.

To estimate marine mammal densities (animals per km^2) for the modeling, JASCO (2023) used the most recent models available for each species from the Duke University Marine Geospatial Ecological Laboratory (Roberts et al. 2022). This is considered the best available information to be used for modeling in this assessment. The mean density for each month was calculated using the mean of all (5 × 5 kilometers [3.1 × 3.1 miles]) grid cells partially or fully within a 6.2-kilometer (3.9-mile) buffer polygon around the SWDA for impact pile driving only, and within a 10-kilometer (6-mile) buffer around the SWDA for vibratory pile setting followed by impact pile driving, which were determined based on the longest $ER_{95\%}$ estimated by JASCO (2023) for impact pile driving only, and the smallest acoustic range from COP Appendix III-M (Epsilon 2023). Density values from the data are given in units of animals per 100 km^2 (38.6 square miles). The mean density between May to December were also calculated to coincide with planned impact pile-driving activities. Table 3-8 and 3-9 provide the mean monthly and May to December averages for marine mammals included in the modeling for each area. Blue whale densities from Roberts et al. (2022) were not applied to the modeling as they are considered a rare species within the Project area (JASCO 2023).

Table 3-8: Mean Density Estimates for Marine Mammal Species Modeled in a 6.2-Kilometer Perimeter[a] around the Southern Wind Development Area for all Months

Common Name (Scientific Name)	Monthly Density (animals per 100 km²)												May to December Mean[b]
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Fin whale (*Balaenoptera physalus*)	0.212	0.168	0.106	0.163	0.270	0.249	0.443	0.370	0.234	0.057	0.050	0.138	0.226
NARW (*Eubalaena glacialis*)	0.356	0.427	0.431	0.459	0.289	0.048	0.021	0.018	0.027	0.050	0.062	0.174	0.086
Sei whale *(Balaenoptera borealis*)	0.039	0.021	0.044	0.111	0.194	0.053	0.013	0.011	0.019	0.037	0.079	0.063	0.059
Sperm whale (*Physeter macrocephalus*)	0.031	0.012	0.013	0.003	0.013	0.029	0.039	0.109	0.066	0.063	0.031	0.021	0.046

Source: JASCO 2023

km^2 = square kilometer; SWDA = Southern Wind Development Area

[a] The perimeter around the SWDA was determined based on the longest exposure range to the thresholds for impact pile driving from the modeling (Appendix III-M; Epsilon 2023).

[b] Pile-driving activities would only occur from May to December.

Table 3-9: Mean Density Estimates for Marine Mammal Species Modeled in a 10-kilometer Perimeter[a] around the Southern Wind Development Area for all Months

Common Name (Scientific Name)	Monthly Density (animals per 100 km²)												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	May to December Mean[b]
Fin whale (*Balaenoptera physalus*)	0.215	0.166	0.107	0.164	0.272	0.256	0.438	0.366	0.227	0.057	0.051	0.141	0.226
NARW (*Eubalaena glacialis*)	0.387	0.461	0.456	0.478	0.295	0.050	0.022	0.018	0.028	0.052	0.068	0.197	0.091
Sei whale (*Balaenoptera borealis*)	0.039	0.021	0.044	0.112	0.192	0.052	0.013	0.011	0.019	0.036	0.079	0.065	0.058
Sperm whale (*Physeter macrocephalus*)	0.031	0.011	0.013	0.003	0.014	0.028	0.038	0.107	0.070	0.057	0.031	0.020	0.046

Source: JASCO 2023

km^2 = square kilometer; SWDA = Southern Wind Development Area

[a] The perimeter around the SWDA was determined based on the longest exposure range to the thresholds for vibratory pile setting from the modeling (JASCO 2023).

[b] Pile-driving activities would only occur from May to December.

Table 3-10 summarizes the number of animals estimated to be exposed to sound levels above PTS and behavioral disturbance thresholds during installation of all piles as summarized in the construction schedule in Table 1-3. This construction schedule includes a combination of foundations installed with vibratory setting of piles followed by impact pile driving and foundations installed with impact pile driving alone for all foundation types (JASCO 2023).

Table 3-10: Number of Animals Exposed to Noise at or Above Thresholds for All Foundation Types[a] over All 3 Years of Construction under the Proposed Action with 10 Decibel Noise Attenuation

Common Name (Scientific Name)	PTS	Behavior Disturbance
Fin whale (*Balaenoptera physalus*)	33	349
NARW (*Eubalaena glacialis*)	0[b]	74
Sei whale (*Balaenoptera borealis*)	6	50
Sperm whale (*Physeter macrocephalus*)	0	97
Blue whale (*Balaenoptera musculus*)[c]	2	4

Source: JASCO 2023
NARW = North Atlantic right whale; PTS = permanent threshold shift
[a] The exposure estimates in this table include all foundations under the Proposed Action as a combination of foundations installed with vibratory setting of piles followed by impact pile driving and foundations installed with impact pile driving alone using the construction schedule in Table 1-3 of this BA.
[b] Five PTS exposures were estimated for NARW, but due to mitigation measures proposed, no PTS (Level A takes) exposures are expected, and no Level A takes have been requested for this species. PTS and behavioral exposures are based on the number of Level A and Level B takes requested in the draft ITA application addendum (JASCO 2023).
[b] Blue whales were not modeled for the proposed Project's exposure analysis (JASCO 2023) because they are considered a rare species whose preferred ranges largely fall outside the Project area but were included as a conservative measure. Therefore, the exposures represent the 5-year total for all noise-producing activities modeled for the Proposed Action and not just impact pile-driving activities.

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

Modeling indicates that up to 33 fin whales, 6 sei whales, and 2 blue whales may be exposed to underwater noise levels above PTS thresholds during foundation installation. No PTS exposures were modeled for sperm whales, and no PTS exposures are anticipated to occur for NARW (discussed further in the following subsection). The blue whale was not modeled with the other species by JASCO (2023) because they are considered rare in the Project area; rather they were included based on the estimated group size. To allow for maximum flexibility and uncertainty in construction schedules, a 3-year construction schedule was assumed for potential exposures of rare species, assuming one group of each rare species could be exposed above PTS thresholds in any 2 years of the 3-year construction schedule. However, For all other species, the estimated number of exposures above PTS thresholds is based on animal movement, sound propagation, and 10 dB noise mitigation applied to the source (JASCO 2023). Mitigation actions such as soft starts, while considered in the propagation model, are not considered in the animal movement model. Similarly, shutdowns resulting from the detection of an animal in their respective shutdown zone (Table 1-15) are not part of the exposure modeling.

Modeled Ranges and Mitigation Zones

The $ER_{95\%}$ in Tables 3-6 and 3-7 were used as the basis for the mitigation zones included under the Proposed Action. The potential for auditory injury is minimized by the implementation of clearance and shutdown zones. The largest PTS $ER_{95\%}$ during jacket foundation installation for an ESA-listed marine mammal was 13,189 feet (4,020 meters) for the fin whale, and the largest PTS $ER_{95\%}$ during monopile foundation installation for an ESA-listed marine mammal was 8,825 feet (2,690 meters) for the fin whale, both using vibratory pile setting followed by impact pile driving (Tables 3-6 and 3-7).

Although individual species' $ER_{95\%}$ were modeled to estimate the number of individuals of each species potential exposed to noise above PTS thresholds, clearance and shutdown zones were grouped for certain species, so one set of mitigation zones are applied specifically for NARW, and then another set are applied for all other baleen whales and sperm whales (JASCO 2023). For all baleen whales, except NARW, and sperm whales, a clearance and shutdown zone of 13,451 feet (4,100 meters) would be implemented for the jacket foundations (inclusive of all installation methods), and a clearance and shutdown zone of 8,858 feet (2,700 meters) would be implemented for monopile foundations (inclusive of all installation methods) (Table 1-15).

The 13,451-foot (4,100-meter) and 8,858-foot (2,700-meter) clearance and shutdown zones represent the area that must be effectively monitored by visual observers on the piling platform and from two PSO vessels (Table 1-15). This range can be monitored by visual PSOs; however, due to the size of area being monitored the risk of Level A take to ESA-species, excluding NARWs, cannot be fully eliminated. In addition to the clearance and shutdown measures that facilitate delay or shutdown of impact pile driving, soft-start procedures (Tables 1-4 through 1-6) would be implemented and could be effective in deterring marine mammals from entering the ensonified area prior to exposures resulting in PTS. However, few empirical studies have been conducted that test how effective soft-start procedures are for moving marine mammals, particularly baleen whales, out of acoustic injury ranges. Studies on soft starts of deep penetration seismic surveys (i.e., airgun arrays) have shown mixed results for efficacy and seem to be highly contextual (Dunlop et al. 2016; Barkaszi et al. 2012; Barkaszi and Kelly 2019). A recent study by Graham et al. (2023) showed that the combined use of acoustic deterrent devices and soft-start procedures resulted in a strong directional response by harbor porpoise (*Phocoena phocoena*) away from the sound source. For impact pile driving, soft-start procedures are assumed to be reasonably effective in reducing high-level exposures (exposures that meet PTS thresholds in a short accumulation period) but are not considered to be fully effective at eliminating PTS exposure risk. The potential for PTS is largely minimized through clearance zones and use of a noise mitigation system during all impact pile-driving operations. Additionally, the requirement that impact pile driving can only commence when the clearance zones (Table 1-15) are fully visible to PSOs increases marine mammal detection capabilities and enables a high rate of success in implementing these zones to avoid PTS. However, exposures leading to PTS are still possible for some species due to the relatively large size of the PTS threshold ranges for LFC. Therefore, the effects of noise exposure above PTS thresholds resulting from impact pile driving during WTG and ESP installation **may affect, likely to adversely affect** fin, sei, and blue whales.

A total of five PTS exposures were modeled for NARWs for the construction schedule.(JASCO 2023). However, no Level A take is being requested for NARWs because the potential for PTS exposures to NARW is expected to be reduced to zero given the mitigation measures outlined in Table 1-15. Specifically, the following measures will be used to eliminate NARW PTS exposures:

- Piling will occur between May and December, in order to avoid the winter and spring seasons when NARW presence is greatest (Section 3.2.1);
- Clearance delays and shutdowns at any distance during foundation installation will occur for NARWs allowing mitigation to be implemented at maximum ranges that will stop or significantly reduce the accumulation of acoustic energy that could lead to PTS onset;
- A real-time PAM monitoring program will be implemented to help detect NARWs from greater distances and in more conditions to initiate timely mitigation measures and reduce the accumulation of acoustic energy;
- A NARW acoustic detection that is localized and confirmed within 5,000 meters of the source will be considered equivalent to a visual detection and a delay or shutdown will be implemented. That represents a 58 percent increase in the PTS $ER_{95\%}$ range, thus providing significant buffer between the maximum acoustic detection range and the PTS range;

- The PAM clearance zone will be adjusted relative to the PTS risk for larger piles. The PAM clearance zone will extend to 15,092 feet (4,600 meters) for monopile foundations, and the PAM clearance zone will extend to 17,389 feet (5,300 meters) for jacket foundations;
- PSO coverage is adequate for visually monitoring for large whale species. PSOs will visually monitor from the foundation construction vessel and a minimum of two PSO monitoring vessels will be required to fully monitor the maximum PTS range estimated for LFC;
- The applicant will complete an aerial or a boat survey prior to piling across an extended 6-mile (10-kilometer) monitoring zone for NARW. Aerial surveys will not begin until the lead PSO determines adequate visibility and at least 1 hour after sunrise (on days with sun glare as determined by the lead PSO on duty). Boat surveys will not begin until the lead PSO determines there is adequate visibility;
- A soft-start procedure will be implemented so that maximum sound levels are not produced at the beginning of piling event;
- In order to reduce the amount of accumulation in acoustic energy, a NARW visually detected at any range or acoustically detected within 5,000 meters (16,404 feet) during a time when a shutdown could not occur, reduced hammer energy and strike rate, as practicable to maintain safety, will be employed and the NARW monitored until it exists the clearance zone, at which time a soft-start procedure will be initiated to resume piling;
- If a NARW is detected within its modeled PTS $ER_{95\%}$ during piling, an immediate shutdown of all piling activities will be implemented, and a review of the monitoring and mitigation procedures will be conducted for the proposed Project, in consultation with NMFS and BOEM, before piling may resume; and
- Nighttime pile driving may be required for up to three ESP jacket foundations and some of the WTG foundations. If nighttime pile driving is required during proposed Project construction, additional measures, which will be developed in the nighttime pile driving monitoring plan through consultation with BOEM and NMFS, will be implemented such that no PTS exposures would be realized for NARW. The nighttime pile driving monitoring plan will include defining the technologies and methodologies effective for nighttime monitoring of marine mammals and the environmental conditions affecting efficacy of these technologies and methodologies such as sea state, precipitation, temperature, and atmospheric condition. If the nighttime pile driving monitoring plan is not in place and approved by the relevant agencies, it is assumed that no nighttime pile driving will occur under the Proposed Action.

These combined measures optimize the opportunity for visual and acoustic PSOs to detect NARWs around the foundation installation activities. These measures would help reduce the amount of time an animal is receiving acoustic energy above the PTS onset thresholds, which lower the risk of PTS being realized. With full implementation of these measures, the potential for PTS exposure to NARW is considered unlikely to occur and **discountable**. Therefore, the effects of noise exposure above PTS thresholds resulting from pile driving during foundation installation **may affect, not likely to adversely affect** NARWs.

The $ER_{95\%}$ for sperm whales was estimated to be 0 feet (0 meters) to the PTS threshold for all pile types and installation methods (Tables 3-6 and 3-7). Given these ranges, no sperm whales are likely to be exposed to noise above the PTS threshold, and **no effect** from PTS is expected for this species.

Effects of Exposure to Noise Above the Behavioral Thresholds

Modeling indicates up to 349 fin whales, 74 NARWs, 50 sei whales, 97 sperm whales, and 4 blue whales could be exposed to noise that meets or exceeds the behavioral thresholds during foundation installation (Table 3-10). To allow for maximum flexibility and uncertainty in construction schedules, a 3-year construction schedule was assumed for potential exposures of rare species, assuming one blue whale group could be exposed above behavioral thresholds in any 2 years of the 3-year construction schedule.

Although behavioral thresholds may be reached, how species react and the consequences of these reactions are highly contextual and largely unknown; therefore, a behavior exposure may not in and of itself result in an adverse effect. Changes in vocal behavior (Di lorio and Clark 2009; Cerchio et al. 2014) and some avoidance and displacement of LFCs has been documented during other impulsive noise activities (seismic exploration) (Malme et al. 1988; McDonald et al. 1995; McCauley et al. 1998), which may be used as a proxy to determine the potential behavioral reactions of LFC to other impulsive noise such as impact pile driving. However, recent reports assessing the severity of behavioral reactions to underwater noise sources indicate that applying behavioral responses across broad sound categories (e.g., impact pile driving and seismic exploration are both impulsive) can lead to significant errors in predicting effects (Southall et al. 2021). Therefore, hearing group-specific analyses are presented in the following subsections.

<u>Low-Frequency Cetaceans</u>

Behavioral and masking effects are more difficult to mitigate and are, therefore, still considered likely for activities with large acoustic disturbance areas such as impact pile driving. The most commonly reported behavioral effect of pile-driving activity on marine mammals has been short-term avoidance or displacement from the pile-driving site, although studies that examine the behavioral responses of baleen whales to pile driving are absent from the literature. Since there are no studies that have directly examined the behavioral responses of baleen whales to pile-driving, studies using other impulsive sound sources such as seismic airguns serve as the best available proxies. With seismic airguns, the distance at which responses occur depends on many factors, including the volume of the airgun (and consequently source level), as well as the hearing sensitivity, behavioral state, and even life stage of the animal (Southall et al. 2021). Malme et al. (1986) observed that gray whales (*Eschrichtius robustus*) exposed to received levels of about 173 dB re 1 μPa, had a 50 percent probability of stopping feeding and leaving the area. Some whales ceased to feed but remained in the area at received levels of 163 dB re 1 μPa. Individual gray whale responses were highly variable. Other studies have documented baleen whales initiating avoidance behaviors to full-scale seismic surveys at distances as short as 1.8 miles (3 kilometers) away (McCauley et al. 1998, Johnson 2002, Richardson et al. 1986) and as far away as 12 miles (20 kilometers) (Richardson et al. 1999). Bowhead whales (*Balaena mysticetus*) have exhibited other behavioral changes, including reduced surface intervals and dive durations, at received SPL between 125 to 133 dB re 1 μPa (Malme et al. 1988). A more recent study by Dunlop et al. (2017a) compared the migratory behavior of humpback whales exposed to a 3,130-cubic-inch-airgun array with those that were not. There was no gross change in behavior observed (including respiration rates), although whales exposed to the seismic survey made a slower progression southward along their migratory route compared to the control group. This was largely seen in female-calf groups, suggesting there may be differences in vulnerability to underwater sound based on life stage (Dunlop et al. 2017a). The researchers produced a dose-response model that suggested behavioral change was most likely to occur within 2 miles (4 kilometers) of the seismic survey vessel at SELs greater than 135 dB re 1 μPa^2 s (Dunlop et al. 2017a).

Behavioral effects that could occur during vibratory pile setting of the WTG and ESP foundations would likely be similar to those described for impact pile driving of the foundations, primarily short-term avoidance or displacement from the pile-driving site. The noise produced would have the greatest acoustic energy in the lower frequency bands (less than 1 kHz), which overlaps best with the hearing range of the LFC species present in the Project area. The primary difference between noise produced during vibratory pile setting versus impact pile driving are the levels of noise produced.

Though the SWDA, where impact pile driving would occur, does not overlap with any critical habitat (Section 2.4), it overlaps with BIA for migrating NARWs and feeding fin whales (NOAA 2023). Timing of NARW migrations includes a northward migration during March to April and a southward migration during October and November between summer feeding and winter calving grounds. During this migration period, adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2022). Additionally, as discussed in Section 3.2.1.1, recent information suggests NARWs may be present in the southern New England region around the Project area year-round, with an important foraging area identified within Nantucket Shoals (Quintana-Rizzo et al. 2021; Hayes 2022; O'Brien et al. 2022a). In addition to the potential changes in NARW foraging behavior discussed previously in this section, impact pile-driving noise may also affect copepod species, the preferred prey type of NARWs. Available data suggest that zooplankton may be affected by impact pile-driving activities (Section 3.2.6.2.6). Studies have documented mortalities of individuals following exposure to impulsive sound sources like impact pile driving; however, given the mitigation measures that will be in place, such as soft starts and the noise attenuation system, zooplankton mortalities would only be expected to occur in a limited area around each pile. The potential effects on zooplankton aggregations due to impact pile-driving activities would not affect NARW foraging capabilities in and near Nantucket Shoals, which concentrate in greatest densities near the 98-foot (30-meter) isobath located over 12 miles (20 kilometers) northeast of the proposed Project lease area (Section 3.2.1.1). Therefore, given the short duration of pile-driving activity expected per day, the mitigation included under the Proposed Action, and the location of this activity outside the Nantucket Shoals foraging area, no long-term effects on NARW prey species would be likely to occur during impact pile driving. Fin whales have been detected year-round in the Project area, but the highest occurrence is in the summer and spring. Sei and blue whales (Sections 3.2.3 and 3.2.5) are less abundant in the Project area relative to NARW (Section 3.2.1) and fin whales (Section 3.2.2) but are likely to occur in the spring, summer, and fall within and around the SWDA.

Based on the literature previously identified, behavioral responses of LFCs to impact pile driving could include ceasing feeding and avoiding the ensonified area. To limit potential effects on NARWs, impact pile driving would not occur January 1 through April 30, avoiding the times of year when NARWs are present in higher densities. In addition, both the visual and PAM clearance and shutdown zones will extend to any distance from the pile at which a NARW is detected (Table 1-15), which will limit the potential for behavioral disturbance to NARWs and any other species present when the NARW detection occurs by reducing the amount of time an animal is receiving acoustic energy above the behavioral threshold. If animals are exposed to underwater noise above behavioral thresholds, it could result in displacement of individuals from a localized area around a pile (maximum 17,717 feet [5,400] for fin whales during installation of the 12-meter monopile; Table 3-6). However, this displacement would be temporary for the duration of activity, which would be a maximum of 6 hours per 24-hour period for foundation installation. NARWs (and other LFCs in the Project area) would be expected to resume their previous behavior after an unknown period of time following the cessation of active pile driving. In addition, BOEM intends to develop a received sound level limit (RSLL) aimed at reducing the potential for proposed Project construction noise to disrupt important behaviors, especially for LFCs (Table 1-15). This measure aims to reduce the size of area around each pile ensonified above the marine mammal behavioral threshold to reduce the risk of animals being exposed. This measure has not been fully developed at the time of preparing this BA, and BOEM anticipates that, if implemented, BOEM would work with the applicant to potentially develop a Project-specific RSLL such that a smaller behavioral disturbance impact area may be realized during proposed Project construction. However, because this RSLL is not in place for the analysis, the modeled PTS, TTS, and behavioral ranges were considered part of the Proposed Action as provided in the applicant's Incidental Take Request application only. Any reduction in the zones given any future RSLLs would only serve to reduce take risk to marine mammals.

Behavioral disturbances would also be likely to occur for LFC during vibratory pile setting, but, as discussed previously for impact pile driving, effects on zooplankton would only be expected within a limited area around each pile and would not affect the major aggregations of this prey item know to concentrate in and near Nantucket Shoals (Section 3.2.1.1). Additionally, the duration of this activity would only be up to 30 minutes per pile, substantially less than that expected for impact pile-driving activities. Therefore, the likelihood of an ESA-listed LFC species being exposed to sound energy above the behavioral threshold is low, and no long-term avoidance of the area or auditory masking is expected during vibratory pile setting activities.

Acoustic masking can occur if the frequencies of the activity overlap with the communication frequencies used by marine mammals. Modeling results indicate that dominant frequencies of impact pile-driving activities for the Proposed Action were concentrated below 1 kHz (COP Appendix III-M; Epsilon 2023), which overlaps with the hearing sensitivity of LFC species (Sections 3.2.1, 3.2.2, 3.2.3, and 3.2.5). Additionally, low frequency sound can propagate greater distances than higher frequencies, meaning masking may occur over larger distances than masking related to higher frequency noise. There is evidence that some marine mammals can compensate for the effects of acoustic masking by changing their vocalization rates (Blackwell et al. 2013; Di Iorio and Clark 2010; Cerchio et al. 2014), increasing call amplitude (Scheifele et al. 2004; Holt et al. 2009), or shifting the dominant frequencies of their calls (Lesage et al. 1999; Parks et al. 2007). When effects of masking cannot be compensated for, increasing noise could affect the ability to locate and communicate with other individuals. NARWs appear to be particularly sensitive to the effects of masking as a result of underwater noise and have faced significant reductions in their communication space due to anthropogenic noise. For example, vocalizing NARWs in the Stellwagen Bank National Marine Sanctuary were exposed to noise levels greater than 120 dB for 20 percent of their peak feeding month and were estimated to have lost 63 to 67 percent of their communication space (Hatch et al. 2012). Reduced communication space caused by anthropogenic noise could potentially contribute to the population fragmentation and dispersal of the critically endangered NARW (Hatch et al. 2012; Brakes and Dall 2016). However, given that impact pile driving occurs intermittently and would only occur up to 5 hours per day under the Proposed Action, it is unlikely that complete auditory masking would occur.

Mid-Frequency Cetaceans

MFCs also show varying levels of sensitivity to mid-frequency impulsive noise sources (i.e., impact pile driving), with observed responses ranging from displacement (Maybaum 1993) to avoidance behavior (animals moving rapidly away from the source) (Watkins et al. 1993; Hatakeyama et al. 1995), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013). Würsig et al. (2000) studied the response of Indo-Pacific humpbacked dolphins (*Sousa chinensis*) to impact pile driving in the seabed in water depths of 20 to 26 feet (6 to 8 meters). No overt behavioral changes were observed in response to the pile-driving activities, but the animals' speed of travel increased, and some dolphins remained in the vicinity, while others temporarily abandoned the area. Once pile driving ceased, dolphin abundance and behavioral activities returned to pre-pile-driving levels. The effect of impact and vibratory pile-driving on the vocal presence of both bottlenose dolphins and harbor porpoises was compared both in and outside the construction area based on a study conducted during wind farm construction in Cromarty Firth, Scotland (Graham et al. 2017). The researchers found a similar level of response of both species to both impact and vibratory piling, likely due to the similarly low received SELs from the two approaches, which were measured at 129 decibels referenced to 1 micropascal squared second (dB re 1 μPa^2 s) for vibratory and 133 dB re 1 μPa^2 s for impact, both at 2,664 feet (812 meters) from the pile. There were no statistically significant responses attributable to either type of pile-driving activity in the presence/absence of a species or the duration over which individuals were encountered, except for bottlenose dolphins on days with impact pile driving. The duration of bottlenose dolphin acoustic encounters decreased by an average of approximately 4 minutes at sites within the Cromarty Firth (closest to pile-driving activity) in comparison to areas outside the Cromarty Firth (Graham et al. 2017). The authors hypothesized that the lack of a strong response was because the received levels were very low in this particularly shallow environment, despite similar size piles and hammer energy to other studies. In another playback study, trained dolphins were asked to perform a target detection exercise during increasing levels of vibratory pile driver playback SPL up to 140 dB re 1 µPa (Branstetter et al. 2018). Three of the five dolphins exhibited either a decrease in their ability to detect targets in the water, or a near complete secession of echolocation activity, suggesting the animals became distracted from the task by the vibratory pile-driving sound (Branstetter et al. 2018).

Similar to impact pile driving, noise during vibratory pile setting of the WTG and ESP foundations would partially overlap with the hearing sensitivity for sperm whales, though it is not within their peak sensitivity range (Section 3.2.4). Previous studies of common bottlenose dolphin responses to vibratory pile setting noise indicate behavioral responses such as decreases or ceased echolocation activity may occur (Bransetter et al., 2018; Graham et al., 2017)

Sperm whales in the Project area occur primarily in the summer and fall, though some detections may also occur during the spring (Section 3.2.4). Around the SWDA, the density of sperm whales is expected to be low relative to other species present (Tables 3-8 and 3-9). Based on the available literature, behavioral responses of sperm whales to impact pile driving could include ceasing feeding and avoiding the ensonified area. However, due to the expected low density of sperm whales in the wind farm area (Tables 3-8 and 3-9) and the low number of behavioral exposures estimated (Table 3-10), the potential for exposure to underwater noises above behavioral thresholds is considered unlikely. Additionally, the clearance and shutdown zones for sperm whales extend to a maximum of 13,451-foot (4,100-meter) for jacket foundations and 8,858-foot (2,700-meter) for monopile foundations. While this would help limit exposures to the higher noise isopleths for sperm whales, it would not eliminate all exposure an individual is receiving to acoustic energy above the behavioral threshold, which extends out to 19,160 feet (5,270 meters) (Table 3-6). If animals are exposed to underwater noise above behavioral thresholds, it would likely result temporary displacement out to maximum 17,290 feet (5,270 meters) for impact pile driving only noise (Tabe 3-6), and 94,718 feet (28,870 meters) for vibratory pile setting noise (Table 3-7). This displacement would be temporary for the duration of activity, which would be a maximum of 6 hours a day for pile installation. MFCs (specifically sperm whales) would be expected to resume pre-construction behaviors following the approximate 6-hour installation period or once they move out of the disturbance zone.

As previously outlined for LFCs, modeling results indicate that dominant frequencies of impact pile-driving activities for the Proposed Action would be concentrated below 1 kHz (COP Appendix III-M, Epsilon 2023; JASCO 2023). Though this does overlap with the frequency range of sperm whale hearing and vocalizations (Section 3.2.4), it is not within their peak sensitivity range, so the effects of masking would be less severe for MFC as they are better attuned to noise outside the range of pile driving. Therefore, piling noise would not impede their ability to echolocate prey or navigate. Additionally, given that pile-driving occurs intermittently, and would only occur up to 6 hours a day under the Proposed Action, it is unlikely that complete auditory masking would occur. Similarly, the limited duration of vibratory pile-driving activities (30 minutes per pile) would reduce the risk of long-term behavioral changes or auditory masking for sperm whales.

Impact Pile Driving – Behavioral Effect Summary

The combination of monitoring and mitigation measures (Table 1-15), the intermittent nature of impact pile driving noise, and the limited duration of vibratory pile setting noise under the Proposed Action would reduce the potential for behavioral exposures of ESA-listed marine mammals to the level of the individual animal and would not be expected to have population-level effects. As described in Section 1.4.1.2.1, the soft-start procedure was modeled to account for the sound field and ranges to thresholds, but animal aversion (i.e., moving away from the source), which is the anticipated reaction to the soft-start procedures, was not modeled. Therefore, the behavioral exposure estimates should be considered a conservative estimate. Due to the large behavioral disturbance range, behavioral exposures cannot be completely avoided with mitigation.

Although no critical habitat exists in the Project area, NARWs and fin whales are expected to use the Project area year-round with seasonal peaks during which foraging activities are consistent and predictable. Sei, sperm, and blue whales show a more seasonal presence, occurring in the summer and fall. All groups demonstrate feeding site fidelity that may include the Project area. Sperm whales would also be expected to be exploiting key feeding opportunities when present in the Project area. Nantucket Shoals, adjacent to the Project area, is an increasingly important NARW foraging habitat (O'Brien et al. 2022a), and there is a BIA identified for fin whales east of Montauk Point, which overlaps with the SWDA (NOAA 2023). Given that disturbance could potentially disrupt feeding behavior, the behavioral disturbance resulting from foundation installation cannot be discounted for NARW, fin, sei, and sperm whales.

As detailed in Section 3.2.5, blue whales are most likely to occur in deeper waters offshore of the SWDA. Although these species may occur year-round in the Project area, their predictability and use of the Project area is likely ancillary to deeper water habitats. Additionally, this species was not modeled in JASCO (2023) because it is considered rare in the Project area, and the four behavioral exposures estimated are based on all noise-producing activities assessed under the Proposed Action. It is unlikely that any behavioral reactions to noise exposures above the behavioral thresholds would interrupt critical functions for blue whales, and any effects would be unlikely and would be **discountable.**

Therefore, the effects of exposure to noise above behavioral thresholds resulting from impact pile driving for WTG and ESP foundation installation **may affect, likely to adversely affect** NARW, fin, sei, and sperm whales; and **may affect, not likely to adversely affect** blue whales.

Foundation Drilling

As discussed in Section 1.4.1.2.1, drilling for the foundations is a contingency measure that may be required to remove boulders or soil from inside the pile in cases of pile refusal during foundation installation. The use of the offshore drill would reduce frictional resistance by removing this material from inside the pile and allow impact pile-driving activities to commence safely (JASCO 2023). Based on the seabed drivability analysis conducted by the applicant, up to 48 foundations could require drilling to help reduce the risk of pile run (JASCO 2023). It was assumed that foundation drilling activities, if required, would occur for approximately 12 hours per pile, which adds up to a maximum of 24 hours of foundation drilling per day if two piles are installed per day (JASCO 2023).

Foundation drilling noise was modeled by JASCO (2023) using representative source levels from Amaral et al. (2018) at a representative location near the proposed drilling sites. Exposures were calculated for one day of drilling, modeled at three site locations. Exposures were calculated for each of these locations individually and for the maximum potential exposures using the maximum ensonified area for each threshold. The PTS ranges have been calculated under a conservative assumption that drilling occurs 24 hours a day, regardless of foundation or pile type. Exposures were estimated using the monthly animal densities from May to December (Table 3-12). The same 10 dB noise mitigation that was applied for foundation installation was also assumed to apply for foundation drilling activities.

Modeling of the drilling activities did not account for animal movement in the range estimation as described previously for foundation installation, and these represent acoustic ranges rather than the exposure ranges calculated for foundation installation. The acoustic ranges estimated by JASCO (2023) are provided in Table 3-11 for the species of concern in this BA.

Table 3-11: Estimated Ranges to Permanent Threshold Shift Thresholds during Drilling Activities[a]

Hearing Group	Range to PTS Threshold (meters)	Range to Behavior Threshold (meters)
LFC	65	7,054
MFC	<50	7,054

Source: JASCO 2023

kHz = kilohertz; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift

[a] This assumes 15 log (range) transmission loss, single weighting (weighting factor adjustment of 2.5 kHz), 12 hours of drilling per pile, and two monopiles installed per day.

Similar to methods described for vibratory pile setting, this range was used to denote an area around the SWDA within which marine mammal densities were estimated, as provided in Table 3-12.

Table 3-12: Mean Density Estimates for Marine Mammal Species Modeled in a 6-mile (10-kilometer) Perimeter[a] around the Southern Wind Development Area for all Months

Common Name (Scientific Name)	Monthly Density (animals per 100 km²)												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	May to December Mean[b]
Fin whale (*Balaenoptera physalus*)	0.215	0.166	0.107	0.164	0.272	0.256	0.438	0.366	0.227	0.057	0.051	0.141	0.226
NARW (*Eubalaena glacialis*)	0.387	0.461	0.456	0.478	0.295	0.050	0.022	0.018	0.028	0.052	0.068	0.197	0.091
Sei whale (*Balaenoptera borealis*)	0.039	0.021	0.044	0.112	0.192	0.052	0.013	0.011	0.019	0.036	0.079	0.065	0.058
Sperm whale (*Physeter macrocephalus*)	0.031	0.011	0.013	0.003	0.014	0.028	0.038	0.107	0.070	0.057	0.031	0.020	0.046

Source: JASCO 2023

NARW = North Atlantic right whale; SWDA = Southern Wind Development Area

[a] The perimeter around the SWDA was determined based on the longest exposure range to the thresholds for foundation drilling from the modeling (JASCO 2023).

[b] Pile-driving activities would only occur from May to December.

Due to the small size of the PTS ranges (Table 3-11) and the proposed mitigation measures (Table 1-15), PTS is not expected for any ESA-listed marine mammals during drilling activities, and were not requested by the applicant in their draft ITA application (JASCO 2023). The exposure estimates provided in Table 3-13 represent the total number of individuals that may be exposed to noise above the behavioral disturbance threshold for all foundations which may required drilling under the construction schedule (Table 1-3).

Table 3-13: Estimated Number of Endangered Species Act-Listed Marine Mammals Exposed Above Behavioral Disturbance Thresholds during Foundation Drilling for the Proposed Action for All Years Combined

Common Name (Scientific Name)	Number of Exposures
Fin whale (*Balaenoptera physalus*)	23
NARW (*Eubalaena glacialis*)	5
Sei whale (*Balaenoptera borealis*)	5
Sperm whale (*Physeter macrocephalus*)	5
Blue whale (*Balaenoptera musculus*)[a]	4

Source: JASCO 2023
NARW = North Atlantic right whale
[a] Blue whales were not modeled for the proposed Project's exposure analysis (JASCO 2023) because they are considered a rare species whose preferred ranges largely fall outside the Project area but were included as a conservative measure. Therefore, the exposures represent the 5-year total for all noise-producing activities modeled for the Proposed Action and not just foundation drilling activities.

Effects of Exposure to Noise Above Permanent Threshold Shift Thresholds

As discussed previously, the small ranges to the PTS thresholds and the proposed measures the applicant will employ (Table 1-15) indicate no marine mammals would be exposed to noise above these thresholds. First, both the clearance and shutdown zones for NARW will extend to any distance from the foundations (Table 1-15), which fully covers the extent of the 213-foot (65-meter) PTS range for LFC (Table 3-11). All other species, both LFC and sperm whales, will have a clearance and shutdown zone that extends out to 8,858 feet (2,700 meters) for monopile foundations, and 13,451 feet (4,100 meters) for jacket foundations (Table 1-15) which covers the PTS ranges for all other species. Additionally, foundation drilling driving would only occur between May 1 and October 31 to avoid the NARW migration season. As a result, the potential for PTS exposures resulting from vibratory pile setting are highly unlikely and, therefore, are **discountable.** Therefore, effects of noise exposure above PTS thresholds **may affect, not likely to adversely affect** any ESA-listed marine mammals.

Effects of Exposure to Noise Above Behavioral Thresholds

As shown in Table 3-13, up to 23 fin whales, 5 NARW, 5 sei whales, 5 sperm whales, and 4 blue whales may be exposed to noise above the behavioral disturbance threshold. However, these exposures were calculated using the SPL 120 dB re 1 µPa threshold, which does not account for the duration of exposure or animal movement that contribute to the potential for biologically notable behavioral effects. Additionally, as discussed for foundation installation, the exposures for blue whales are based on the estimated group size and consider all construction noise, not just foundation drilling activities.

Low-Frequency Cetaceans

Drilling activities used prior to pile-driving activities to remove soil, boulders, or both from inside the piles in cases of pile refusal may produce SPL of 140 dB re µPa at 3,280 feet (1,000 meters) (Austin et al. 2018). This would exceed the continuous noise threshold of 120 dB re 1 µPa beyond 13.4 miles

(21.5 kilometers), but these events are expected to be short term and irregular (only a maximum of 48 foundations out of 132), which limits the marine mammals potentially present during construction. The noise produced would have the greatest acoustic energy in the lower frequency bands (less than 1 kHz), which overlaps best with the hearing range of the LFC species present in the Project area. While behavioral responses may occur from drilling, they are not expected to be long lasting or biologically significant to LFC populations or their prey items, as discussed in Section 3.2.6.2.6.

Mid-Frequency Cetaceans

Noise during foundation drilling would partially overlap with the hearing sensitivity for sperm whales, though it is not within their peak sensitivity range (Section 3.2.4). Like with LFC, the spatial extent of the above-threshold noise would be less than that for impact and vibratory pile setting of the WTG and ESP foundations. This would reduce the likelihood of sperm whales being exposed to sound energy above the behavioral disturbance threshold. Additionally, only 50 of the 132 total foundations would be expected to require drilling, which further limits the potential for exposure that are long lasting or biologically significant for sperm whales.

Foundation Drilling – Behavioral Effects Summary

The Proposed Action includes a clearance and shutdown zone that extends to any distance from the foundations for drilling for NARWs and out to 8,858 feet (2,700 meters) for monopile foundations, and 13,451 feet (4,100 meters) for jacket foundations for all other species (Table 1-15). Additionally, while the seasonal restriction of foundation installation activities only occurring between May and December to avoid peak NARW presence was accounted for in the densities, other mitigation such as soft-start procedures were not, which would help further reduce the risk of behavioral effects on these species. The SPL 120 dB µPa threshold represents the minimum sound level at which an animal may exhibit a behavioral response to a noise and does not equate to biologically relevant behaviors. The assessment from Southall et al. (2021) showed that in response to continuous noise sources (which includes foundation drilling), sperm whales and NARW showed changes in both foraging and reproductive behaviors that, though they were detectable, were categorized as brief and minor. They would not be expected to be long term, and the individuals that alter their behavior in response to foundation drilling noise would be expected to return to normal once the activity has ceased. Therefore, no behavioral effects that would jeopardize the continued existence of any populations are expected, and any behavioral effects that do occur would be so minor they cannot be meaningfully evaluated and would be considered **insignificant**. Thus, exposure to noise above behavioral thresholds during foundation drilling **may affect, not likely to adversely affect** ESA-listed marine mammals.

Vessel and Aircraft Noise

As discussed in Section 1.4.1.2.6, during each proposed Project phase, the applicant anticipates an average of approximately 30 vessels operating during a typical workday in the SWDA and along the OECC. Up to 60 vessels could be present during the period of maximum construction activity at the start of WTG installation. Many construction vessels would remain at the SWDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning as needed (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). This volume of traffic would vary monthly depending on weather and Proposed Action activities. Approximately 3,200 total vessel round trips are expected to occur during offshore construction of Phase 1, which equates to an approximate average of 6 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 3.3.1.12.1; Epsilon 2022). Approximately 3,800 total vessel round trips are expected to occur during offshore construction of Phase 2, which equates to an approximate average of 7 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 4.3.1.12.1; Epsilon 2022). During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur during both phases (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). Peak construction vessel activity is expected to occur during pile-driving activities. The applicant has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used during construction, with some vessels with additional components or materials coming from Canadian and European ports (COP Volume I; Epsilon 2022). Any vessels transiting from Canada and Europe would follow the major navigation routes.

Current vessel traffic in the Action Area and surrounding waters is relatively high; vessel traffic within the RI/MA Lease Areas and SWDA is relatively moderate (COP Appendix III-I; Epsilon 2022) and includes commercial fishing vessels, recreational vessels, and other commercial vessels (merchant and passenger ships) (COP Appendix III-I; Epsilon 2022). The Action Area experiences increased vessel traffic during the summer months (COP Appendix III-I; Epsilon 2022); however, BOEM finds that the Proposed Action would not significantly disrupt normal vessel traffic patterns.

Vessel sound is characterized as low frequency, typically below 1,000 Hz with peak frequencies between 10 and 50 Hz, non-impulsive rather than impulsive like impact pile driving, and continuous, meaning there are no substantial pauses in the sounds that vessels produce. The acoustic signature produced by a vessel varies based on the type of vessel (e.g., tanker, bulk carrier, tug, container ship) and vessel characteristics (e.g., engine specifications, propeller dimensions and number, length, draft, hull shape, gross tonnage, speed). Larger barges and commissioning vessels would produce lower frequency noise with a primary energy near 40 Hz and underwater source levels that can range from 177 to 200 dB re 1 μPa m (McKenna et al. 2012; Erbe et al. 2019). Smaller crew transfer vessels would typically produce higher frequency noise (1,000 to 5,000 Hz) at source levels between 150 and 180 dB re 1 μPa m (Kipple and Gabriele 2003, 2004). Vessels using DP thrusters (such as platform or cable-laying vessels) are known to generate substantial underwater noise with source levels ranging from 150 to 180 dB re 1 μPa m depending on operations and thruster use (BOEM 2013; McPherson et al. 2016). While vessel noise was not modeled for the proposed Project, qualitative information about vessel noise, which may be produced during Project activities and how it may affect marine mammals, was obtained from available literature. Parsons et al. (2021) reviewed literature for the source levels and spectral content of vessels less than 82 feet (25 meters) in length, a category often not addressed in vessel noise assessment measurements. Parsons et al. (2021) found reported source levels in these smaller vessels to be highly variable (up to 20 dB difference); however, an increase in speed was consistently shown to increase source levels while vessels at slower speeds were shown to emit low frequency acoustic energy (less than 100 Hz) that is often not characterized in broadband analyses of small vessel sources.

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

No PTS exposures are expected as a result of vessel noise due to the non-impulsive nature of the sources and relatively low source levels produced (BOEM 2013; McPherson et al. 2016). Therefore, potential PTS exposures resulting from vessel noise are **discountable**. Thus, the effects of noise exposure above PTS thresholds **may affect, not likely to adversely affect** ESA-listed marine mammals.

Effects of Exposure to Noise Above Behavioral Thresholds

Based on the source levels presented in the literature for vessels similar to those that would be used for the proposed Project (outlined previously), behavioral disturbance thresholds could be exceeded. A comprehensive review of the literature (Richardson et al. 1995; Erbe et al. 2019) revealed that most of the reported adverse effects of vessel noise and presence are changes in behavior, though the specific behavioral changes vary widely across species. Physical behavioral responses include changes to dive patterns (Finley et al. 1990), disruption to resting behavior (Mikkelsen et al. 2019), increases in swim velocities (Finley et al. 1990; Sprogis et al. 2020; Williams et al. 2022), and changes in respiration patterns (Nowacek et al. 2006; Hastie et al. 2006; Sprogis et al. 2020). These responses have, in certain cases, been correlated with numbers of vessels and their proximity, speed, and directional changes. Responses have been shown to vary by gender and by individual. Hearing group-specific analyses are presented in the following subsections.

Low-Frequency Cetaceans

A playback study of humpback whale mother-calf pairs exposed to varying levels of vessel noise revealed that the mother's respiration rates doubled and swim speeds increased by 37 percent in the high noise conditions (low frequency-weighted received SPL at 328 feet [100 meters] was 133 dB re 1 µPa) compared to control and low-noise conditions (104 dB re 1 µPa and 112 dB re 1 µPa, respectively) (Sprogis et al. 2020). Rolland et al. (2012) showed that fecal cortisol levels in NARWs decreased following the September 11, 2001, terrorist attacks, when vessel activity was significantly reduced. Interestingly, NARWs do not seem to avoid vessel noise nor vessel presence (Nowacek et al. 2004), yet they may incur physiological effects as demonstrated by Rolland et al. (2012). This lack of observable response, despite a physiological response, makes it challenging to assess the biological consequences of exposure. In addition, there is evidence that individuals of the same species may have differing responses if the animal has been previously exposed to the sound versus if it is completely novel interaction (Finley et al. 1990). Reactions may also be correlated with other contextual features, such as the number of vessels present, their proximity, speed, direction or pattern of transit, or vessel type (Erbe et al. 2019).

Some marine mammals may change their acoustic behaviors in response to vessel noise, either due to a sense of alarm or in an attempt to avoid masking. For example, fin whales (Castellote et al. 2012) have altered frequency characteristics of their calls in the presence of vessel noise. When vessels are present, humpback whales and beluga whales (*Delphinapterus leucas*) have been seen to completely stop vocal activity (Tsujii et al. 2018; Finley et al. 1990). Fin whales have been documented shortening their calls to avoid acoustic masking from vessel noise (Castellote et al. 2012).

Understanding the scope of acoustic masking is difficult to observe directly, but several studies have modeled the potential decrease in "communication space" when vessels are present (Clark et al. 2009; Erbe et al. 2016; Putland et al. 2017). For example, Putland et al. (2017) showed that during the closest point of approach (less than 10 kilometers) of a large commercial vessel, the potential communication space of Bryde's whale was reduced by 99 percent compared to ambient conditions. Large vessels generally emit underwater noises in the low frequency bands below 1 kHz (McKenna et al. 2012; Erbe et al. 2019) that have the potential to overlap with LFC communications. Smaller vessels typically produce higher-frequency sound concentrated in the 1,000 Hz to 5,000 Hz range (Erbe et al. 2019). Masking of LFC communications is considered possible across large and small vessel frequency spectrums. However, as the effects of masking would be temporary in nature (moving with the vessel) the potential for communications to be masked is also considered temporary.

Although there have been many documented behavioral changes in response to vessel noise (Erbe et al. 2019), it is necessary to consider what the biological consequences of those changes may be. One of the first attempts to understand the energetic cost of a change in vocal behavior found that metabolic rates in bottlenose dolphins increased by 20 to 50 percent in comparison to resting metabolic rates (Holt et al. 2015). Although this study was not tied directly to exposure to vessel noise, it provides insight about the potential energetic cost of this type of behavioral change documented in other works (i.e., increases in vocal effort such as louder, longer, or increased number of calls). In another study, the energetic cost of high-speed escape responses in dolphins was modeled, and the researchers found that the cost per swimming stroke was doubled during such a flight response (Williams et al. 2017). When this sort of behavioral response was also coupled with reduced glide time for beaked whales, the researchers estimated that metabolic rates would increase by 30.5 percent (Williams et al. 2017). Differences in response have been reported both within and among species groups (Finley et al. 1990; Tsujii et al. 2018). Despite demonstrable examples of biological consequences to individuals, there is still a lack of understanding about the strength of the relationship between many of these acute responses and the potential for long-term or population-level effects. The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Additionally, as discussed further in Section 3.2.6.2.6, zooplankton species such as copepods may also experience behavioral disturbances due to non-impulsive sources such as vessel noise, which could have implications for prey availability within the Project area. However, the major aggregations of zooplankton, including the preferred prey of NARWs, concentrate in greatest densities near the 98-foot (30-meter) isobath of Nantucket Shoals, located over 12 miles (20 kilometers) northeast of the proposed Project lease area. Due to the nature of vessel noise as discussed previously, no large-scale mortalities would occur for any prey species (Section 3.2.6.2.6). Therefore, proposed Project vessel noise is not expected to have any long-term effects on zooplankton biomass within the Project area or larger Action Area.

Mid-Frequency Cetaceans

Changes to foraging behavior, which can have a direct effect on an animal's fitness, have been observed in porpoises (Wisniewska et al. 2018) and killer whales (*Orcinus orca*) (Holt et al. 2021) in response to vessel noise. Other MFC species have been observed altering their acoustic behavior in response to vessel noise. When vessels are present, bottlenose dolphins have been observed increasing the number of whistles (Buckstaff 2006; Guerra et al. 2014), while sperm whales decrease the number of clicks (Azzara et al. 2013). Killer whales have been observed increasing their call amplitude (Holt et al. 2009) to avoid acoustic masking from vessel noise.

Masking of echolocation clicks used by sperm whales is not anticipated given the low frequencies of noise produced by vessel (McKenna et al. 2012; Erbe et al. 2019); however, some masking of other communications used by this species is possible. Observed changes in acoustic vocalizations from Gordon et al. (1992) demonstrate that in response to whale watching vessel exposures, sperm whales produce brief or minor changes in vocal rates and signal characteristics. These effects would be transient in nature (moving with the vessel) the potential for communications to be masked for all is considered reduced.

Vessel Noise – Behavioral Effects Summary

ESA-listed marine mammals may be exposed to noise above the behavioral thresholds and may experience masking effects depending on the type and speed of the vessel. The Proposed Action does not include any vessel noise quieting measures; however, some of the vessel strike avoidance measures (Table 1-15; Section 3.2.6.6) will contribute to reducing sound exposures from vessel traffic. Some of the measures that will reduce vessel noise impacts include minimum separation distances, which would reduce the risk of an animal being close enough to receive sound energy above the behavioral threshold, and vessel speed restrictions, which would help reduce the level of noise produced by proposed Project vessels (ZoBell et al. 2021). Construction vessels have the highest likelihood of producing noise levels that could interrupt key behaviors; however, vessel noise from construction would be temporary. Noise produced by operations vessels is expected to be long term but lower intensity and spatially and temporally intermittent. Therefore, elevated sound levels that pose a risk of prolonged exposures that would affect biologically important behaviors such as foraging or reproduction is low. With the consideration of the vessel strike measures that will reduce noise, exposures of ESA-listed LFC and MFC to vessel noise that results in behavioral disturbances is **insignificant**. Vessel noise as a result of the Proposed Action, therefore, **may affect, not likely to adversely affect** ESA-listed marine mammals in the Action Area.

Effects of Vessel Noise on Critical Habitat

Vessel transits originating from Salem, Massachusetts would traverse designated NARW critical habitat (Section 3.2.1.2). Additionally, vessels transiting to/from Canada may, but not necessarily, traverse the farthest offshore portion of the NARW Gulf of Maine foraging habitat Unit 1. Vessels transiting from Europe may, but are unlikely to, enter NARW critical habitat given established shipping lanes, and the most direct route from Europe to the U.S. would not intersect this critical habitat. Based on the best available data, a maximum total of 610 round trips are estimated for the entire 36-month construction period from Salem Harbor, Massachusetts, equating to approximately 1 round trip per day on average for each (Table 1-10). The frequency of any transits through NARW critical habitat would be minimal when compared to the number of transits from the primary ports identified in Sections 1.4.1.2.6 and 1.4.2.2. Additionally, the number of proposed Project-related vessels that may transit any portion of NARW critical habitat is considered relatively low when compared to the existing high levels of commercial and recreational vessel traffic in the region.

Vessel noise is not expected to result in PTS for any marine mammal species, and the risk of prolonged exposures that would affect biologically important behaviors such as foraging or reproduction is low. There is minimal information on zooplankton responses to underwater noise, but available data show Antarctic krill (*Euphausia superba*) exhibited small-scale avoidance of a single beam echosounder (Guihen et al. 2022), so some localized, temporary behavioral disruptions of copepod in the NARW critical habitat may occur in response to vessel noise, but this would not cause any significant loss of availability of prey for NARW. Therefore, the addition of noise from proposed Project vessels would not affect behaviors important to NARW foraging or any prey resources within the established critical habitat. Any effects on the acoustic environment within NARW critical habitat from this brief exposure would be so small that they could not be measured, detected, or meaningfully evaluated and are, therefore, **insignificant**. Therefore, the effects from increased noise levels resulting from vessel operations **may affect, not likely to adversely affect** critical habitat for NARW.

High-Resolution Geophysical Survey Noise

Offshore and nearshore HRG surveys will be conducted just prior to construction, during, and post-construction for various activities including cable and foundation installation (JASCO 2022). Equipment that operates under 180 kHz included in the Proposed Action includes the Applied Acoustics AA251 boomer and GeoMarine's Geo Spark 2000 (400 tip) sparker system. It was assumed that HRG surveys would be conducted for 24 hours per day for up to 25 days each year (totaling 125 days over the 5-year ITA period) beginning in the first year of foundation installation and extending 2 years beyond the 3-year foundation installation schedule (JASCO 2022). JASCO conducted acoustic modeling for the HRG survey equipment included in the Proposed Action, and the ranges to the PTS and behavioral thresholds are provided in Table 3-14.

Table 3-14: Estimated Ranges to Permanent Threshold Shift Thresholds during High-Resolution Geophysical Survey Activities[a]

Equipment	Range to PTS Threshold (Meters)				Range to Behavioral Threshold (meters)
	Lpk		SEL_{24h}		
Hearing Group	LFC	MFC	LFC	MFC	All
Applied Acoustics AA251 boomer	NA	NA	<1	<1	178
GeoMarine Geo Spark 2000 (400 tip) sparker	NA	NA	<1	<1	141

Source: JASCO 2022
< = less than; LFC = low-frequency cetacean; Lpk = peak sound pressure level; MFC = mid-frequency cetacean; NA = not applicable; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours

To assess the potential for effects on marine mammals, the duration of the surveys needs to be considered. For this assessment, it was assumed the HRG equipment would cover up to 50 miles (80 kilometers) per day and would take place intermittently between 2025 and 2030 (JASCO 2022). Exposures were estimated by multiplying the behavioral threshold range, but the number of days of surveying expected by the highest monthly density was estimated for each species. The highest density month was used as a conservative measure because the exact dates of HRG surveys are unknown within each year that surveys may occur. The monthly density estimates are provided in Table 3-15, and subsequent exposure estimates are provided in Table 3-16.

Table 3-15: Maximum Monthly Density used to Estimate Exposures Above Acoustic Thresholds during High-Resolution Geophysical Surveys under the Proposed Action

Species	Maximum Monthly Density (animals per 100 km^2)
Fin whale (*Balaenoptera physalus*)	0.436
NARW (*Eubalaena glacialis*)	0.567
Sei whale (*Balaenoptera borealis*)	0.193
Sperm whale (*Physeter macrocephalus*)	0.111

Source: JASCO 2023
km^2 = square kilometer; NARW = North Atlantic right whale

Table 3-16: Estimated Number of Endangered Species Act-Listed Marine Mammals Exposed Annually and for All Years of Construction Above Behavioral Disturbance Thresholds during High-Resolution Geophysical Survey Activities

Species	Annual Maximum Exposures	5-Year Construction Total Exposures
Fin whale (*Balaenoptera physalus*)	4	20
NARW (*Eubalaena glacialis*)	5	25
Sei whale (*Balaenoptera borealis*)	2	10
Sperm whale (*Physeter macrocephalus*)	2	10
Blue whale (*Balaenoptera musculus*)	6[a]	

Source: JASCO 2023
HRG = high-resolution geophysical; NARW = North Atlantic right whale
[a] Blue whales were not modeled for the proposed Project's exposure analysis (JASCO 2023) because they are considered a rare species whose preferred ranges largely fall outside the Project area but were included as a conservative measure. Therefore, the exposures represent the 5-year total for all noise-producing activities modeled for the Proposed Action and not just HRG survey activities.

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

No PTS exposures are expected to occur due to the small threshold ranges (Table 3-14) and relatively low densities of ESA-listed marine mammals likely to be present during HRG surveys (Table 3-15). The range to the PTS threshold for both sources modeled was estimated to be less than 3.3 feet (1 meter) for both boomers and sparkers (Table 3-14), which would not be realized given the mitigation measures and adherence to BOEM-proposed mitigation measures that are included under the Proposed Action. Both the clearance and shutdown ranges for all ESA-listed species would extend out to 1,640 feet (500 meters) (Table 1-15) during operation of boomers and sparkers, which will encompass the largest LFC PTS threshold range. Additionally, the maximum range is only applicable during operations of boomer equipment, which would not occur during the entire survey period, further limiting the risk of exposure to sound energy above the PTS threshold. Therefore, potential for PTS exposures during HRG surveys are **discountable**. Therefore, the effects of noise exposure above PTS thresholds **may affect, not likely to adversely affect** any ESA-listed marine mammals.

Effects of Exposure to Noise Above the Behavioral Thresholds

Though HRG surveys would occur irregularly between 2025 and 2030, only 25 surveys days are expected per year under the Proposed Action, and the maximum range to behavioral thresholds was estimated to be 584 feet (178 meters) during operations of boomer equipment and 463 feet (141 meters) during sparker operations (Table 3-14). As discussed in the draft ITA application, the exact amount of time each of these equipment may be used during the proposed HRG surveys is not currently known, so the exposures in Table 3-16 assumed the maximum monthly density estimate for each marine mammal species. Using this assumption, the modeling predicted four fin whales, five NARWs, two sei whales, two sperm whales, and six blue whales would be exposed to noise above the behavioral threshold per year during the 25-day HRG surveys expected under the Proposed Action (Table 3-16).

Low-Frequency Cetaceans

Although the HRG sources assessed in this BA can be detected by marine mammals, given several key physical characteristics of the sound sources (e.g., source level, frequency range, duty cycle, beamwidth), most HRG sources are unlikely to result in behavioral disturbance of marine mammals, even without mitigation (Ruppel et al. 2022). The areas where HRG surveys will occur overlaps with a BIA for migrating NARWs. Timing of migrations includes a northward migration during March and April and a southward migration during October and November between summer feeding and winter calving grounds. During this migration period, adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round; however, fin and sei whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2022). There is limited information regarding the potential behavioral reactions of LFCs to HRG surveys. For some of the higher-amplitude sources such as some boomers and the highest-power sparkers, behavioral disturbance is possible within an immediate area around the vessel (up to 584 feet [178 meters]) from the source (Table 3-14). The behavioral disturbance area (maximum 584 feet [178 meters] from the vessel) would not be expected impede the migration of NARWs to critical habitats located north and south of the survey area as animals would still be able to move outside of the behavioral disturbance zone easily or wait until the vessel passes. However, as discussed in Section 3.2.1.1, NARWs in the vicinity of the Project area may also be foraging; important and potentially year-round foraging habitat has been identified in and near Nantucket Shoals, located over 12 miles (20 kilometers) northeast of the proposed Project lease area. There may be short-term, localized effects on zooplankton (discussed further in Section 3.2.6.2.6), the primary prey for NARW, in the area directly associated with the survey vessel and equipment (Guihen et al. 2022); however, as discussed previously for other proposed Project activities, HRG surveys are not expected to affect biomass of zooplankton in the region or affect the concentrations of zooplankton available for NARW in Nantucket Shoals (Section 3.2.1.1). Foraging activities of other species within the Project area would similarly be not expected to be disrupted for extended periods of time given the relatively short duration of the surveys. Additionally, a 1,640-foot (500-meter) clearance and shutdown zone included in the Proposed Action (Table 1-15) for the selected HRG surveys covers the entire behavioral zone for NARWs and part of the behavioral zones for fin and sei whales (Table 3-14), which would limit the potential for behavioral effects. Due to the range of frequencies emitted during the equipment assessed in this BA, masking of all hearing groups is considered possible. Masking of LFC communications is considered more likely due to the overlap of these surveys with lower-frequency signals produced by these species. However, as the effects of masking would be transient in nature (moving with the vessel), the potential for communications to be masked is reduced.

Mid-Frequency Cetaceans

Available studies suggest MFCs have a low likelihood of responding to HRG survey noise. Kates Varghese et al. (2020) found no change in three of four beaked whale foraging behavior metrics (i.e., number of foraging clicks, foraging event duration, click rate) during two deep-water mapping surveys using a 12 kHz multibeam echosounder. There was an increase in the number of foraging events during one of the mapping surveys, but this trend continued after the survey ended, suggesting that the change was more likely in response to another factor, such as the prey field of the beaked whales, than to the mapping survey. During both multibeam mapping surveys, foraging continued in the survey area, and the animals did not leave the area (Kates Varghese et al. 2020, 2021). Vires (2011) also found no change in Blainville's beaked whale (*Mesoplodon densirostris*) click durations before, during, and after a scientific survey with a 38 kHz EK-60 echosounder, while Cholewiak et al. (2017) found a decrease in beaked whale echolocation click detections during use of an EK-60. Quick et al. (2017) found that short-finned pilot whales did not change foraging behavior but did increase their heading variance during use of an EK-60. For some of the higher-amplitude sources such as some boomers and the highest-power sparkers, behavioral disturbance is possible but unlikely given the mitigation included in the Proposed Action (Table 1-15). A 1,640-foot (500-meter) clearance and shutdown zone will be applied for all ESA-listed marine mammals during HRG surveys, which fully covers the maximum 584-foot (178-meter) behavioral threshold range predicted by the modeling (Table 3-14) and would reduce the likelihood to animals being exposed to sound energy above the behavioral threshold for extended periods of time. These sounds could result in acoustic masking in MFC but are unlikely to result in behavioral disturbance given their low source levels and intermittent use.

HRG Surveys – Behavioral Effects Summary

The Proposed Action includes a clearance and shutdown zone, which extends to 1,640 feet (500 meters) for all ESA-listed species (Table 1-15) and effectively covers the maximum range to behavioral thresholds that were modeled were estimated to be a maximum of 584 feet (178 meters) during operations of sparker equipment (Table 3-14). These exposure estimates do not account for mitigation measures applied during the survey, the variability in survey operations, the presence and noise of the vessel, or the usage of specific equipment that would change the ranges to behavioral thresholds for ESA-listed species and are considered conservative. Exposures, if they were to occur, would be **insignificant** because are not expected to rise to the level of ESA take (as defined by the interim definition of harassment under the ESA) because any changes in biologically important activities would be at the lower limits of the threshold ranges, temporary, and unlikely to produce any measurable behavioral changes. Therefore, effects of exposures above behavioral thresholds from proposed Project HRG surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

Unexploded Ordinance Detonation

The acoustic modeling assessment for UXO detonations followed the study recently conducted for the Revolution Wind Project (Hannay and Zykov 2022), which modeled UXO detonations in multiple locations to account for water depth and employed the use of U.S. Department of the Navy (U.S. Navy) bins. Hannay and Zykov (2022) grouped potential UXOs into five bins based on the maximum UXO charge weights as shown in Table 41 of the draft ITA application (JASCO 2023). Though there may be some slight bathymetric differences between the Revolution Wind Project area and the proposed Action Area, the results from the study would be approximately transferrable and were, therefore, used for the modeling and exposure assessment (JASCO 2023). It was assumed that up to ten UXOs may be encountered within the Project area during construction, and any detonations would use a noise mitigation system to achieve at least 10 dB noise attenuation. The estimated affected areas for species of concern in this BA to the PTS and TTS thresholds are provided in Table 3-17, and the impulse exceedance ranges to the non-auditory injury thresholds are provided in Table 3-18.

Table 3-17: Acoustic Ranges and Areas of Effect on the Permanent Threshold Shift- and Temporary Threshold Shift-Onset Thresholds for Potential Unexploded Ordnance Detonations for Various Water Column Depths with 10 Decibel Noise Attenuation

Hearing Group	PTS-Onset (depth in meters)				TTS-Onset (depth in meters)			
	12	20	30	45	12	20	30	45
Acoustic Ranges (meters)								
LFC	3,220	3,780	3,610	3,610	11,000	11,900	11,500	11,800
MFC	461	386	412	412	2,550	2,430	2,480	2,480
Area of Effect (km^2)								
LFC	32.57	44.89	40.94	40.94	380.13	444.88	415.48	437.44
MFC	0.67	0.47	0.53	0.53	20.43	18.55	19.32	19.32

Source: JASCO 2023
km^2 = square kilometer; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; TTS = temporary threshold shift

Table 3-18: Impulse Exceedance Ranges (Meters) to the Non-Auditory Injury Thresholds for Potential Unexploded Ordinance Detonations for Various Water Column Depths with 10 Decibel Noise Attenuation

Marine Mammal Group	Onset of Lung Injury (depth in meters)				Onset of Mortality (depth in meters)			
	12	20	30	45	12	20	30	45
Baleen and sperm whales (*Physeter macrocephalus;* calf)	151	204	226	237	90	105	109	108
Baleen and sperm whales (adult)	73	80	81	78	34	34	31	29

Source: JASCO 2023

Exposures for potential UXO detonations were estimated by multiplying the areas of effect in Table 3-17 by the maximum monthly species density in the deep water OECC segment and the SWDA for the 66- to 203-foot (20- to 62-meter) depths and by the highest monthly species density in the shallow water OECC segment for the 12-meter depth (JASCO 2023). To capture all density data within the potential area of effect, the largest area for either PTS-onset or TTS-onset ranges was used as the area for the density estimates provided in Table 3-19.

Table 3-19: Maximum Monthly Density (Animals per 386 Square Miles [100 Square Kilometers]) used to Estimate Exposures Above Acoustic Thresholds during Potential Unexploded Ordnance Detonations under the Proposed Action

Species	Shallow OECC Segment	Deep OECC Segment and SWDA
Fin whale (*Balaenoptera physalus*)	0.007	0.425
NARW (*Eubalaena glacialis*)	0.116	0.707
Sei whale (*Balaenoptera borealis*)	0.034	0.191
Sperm whale (*Physeter macrocephalus*)	0.002	0.112

Source: JASCO 2023
NARW = North Atlantic right whale; OECC = offshore export cable corridor; SWDA = Southern Wind Development Area

To estimate the total number of potential individuals exposed to above threshold noise, the modeling assumed that UXO detonations could occur within both 2025 and 2026 due to the indicative construction schedule, and that up to 10 detonations could occur in total throughout proposed Project construction. The potential UXO detonation schedule used to estimate the potential for exposures is provided in Table 3-20. This schedule with the densities in Table 3-19 was used to model the exposures provided in Table 3-21.

Table 3-20: Potential Unexploded Ordnance Detonation Schedule

Year 1 (2025)	Year 2 (2026)
2 UXO at 39 feet (12 meters) water depth	0 UXO at 39 feet (12 meters) water depth
3 UXO at 39 feet (12 meters) water depth	0 UXO at 39 feet (12 meters) water depth
1 UXO at 39 feet (12 meters) water depth	2 UXO at 39 feet (12 meters) water depth
0 UXO at 39 feet (12 meters) water depth	2 UXO at 39 feet (12 meters) water depth

Source: JASCO 2023
UXO = unexploded ordnance

Table 3-21: Maximum Potential Number of Endangered Species Act-Listed Marine Mammals Estimated to be Exposed above Permanent Threshold Shift and Behavioral Disturbance Thresholds Resulting from Possible Detonations of up to 10 Unexploded Ordnances over 2 Years of Construction with 10 Decibel Noise Attenuation

Species	PTS SEL_{24h}	Behavioral Disturbance (TTS SEL_{24h})
Fin whale (*Balaenoptera physalus*)	2	14
NARW (*Eubalaena glacialis*)	0[a]	27
Sei whale (*Balaenoptera borealis*)	2	7
Sperm whale (*Physeter macrocephalus*)	2	2
Blue whale (*Balaenoptera musculus*)[b]	2	4

Source: JASCO 2023
NARW = North Atlantic right whale; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; TTS = temporary threshold shift; UXO = unexploded ordnance
[a] Two PTS exposure were estimated for NARW, but due to mitigation measures proposed by the applicant, no PTS (Level A takes) exposures are expected, and no Level A takes have been requested for these species. PTS and behavioral exposures are based on the number of Level A and Level B takes requested in the draft ITA application addendum (JASCO 2023).
[b] Blue whales were not modeled for the proposed Project's exposure analysis (JASCO 2023) because they are considered a rare species whose preferred ranges largely fall outside the Project area but were included as a conservative measure. Therefore, the exposures represent the 5-year total for all noise-producing activities modeled for the Proposed Action and not just UXO detonation activities.

Effects of Exposure to Acoustic Impulses Above Non-Auditory Injury Thresholds

No mortality or non-auditory injury is expected to occur for any ESA-listed marine mammal species as a result of UXO detonations. The ranges to these thresholds were estimated to be relatively small (up to 237 for the onset of lung injuries and 358 feet (109 meters) for the onset of morality; Table 3-18) and can, therefore, be effectively monitored prior to and during detonations. The applicant will implement a visual clearance zone for NARW at any distance, a 12,467-foot (3,800-meter) visual and PAM clearance zone for LFC, and a 3,281-foot (1,000-meter) visual and PAM clearance zone for MFC (Table 1-15). The PAM system will enable monitoring out to 39,370 feet (12,000 meters) for NARW and LFCs, and 8,530 feet (2,600 meters) for MFCs (Table 1-15). These measures, in addition to the limited number of potential detonations that would occur in the Project area (Table 3-20), make the risk of non-auditory injuries or moralities **discountable**. Therefore, the effects of exposure to an acoustic impulse above non-auditory injury thresholds is **likely to affect, not likely to adversely affect** ESA-listed marine mammals.

Effects of Exposure to Noise Above Permanent Threshold Shift Thresholds

PTS threshold ranges, with 10 dB attenuation, averaged 11,663 feet (3,555 meters) across all four water column depths for LFC and 1,371 feet (418 meters) for MFC (Table 3-17). Modeled PTS exposures differed from the requested number of Level A takes in the draft ITA application (JASCO 2023); therefore, this assessment is based on the requested number of takes. The range to the MFC PTS threshold was small (1,371 feet [418 meters]), and no PTS exposures were modeled for sperm whales; however, two PTS takes were requested for sperm whales in the draft ITA application (JASCO 2023). Given the larger PTS range with 10 dB attenuation, there is potential for PTS exposures during UXO detonations to LFCs. Results of the modeling indicate up to two fin whales and two sei whales could be exposed to noise levels above PTS thresholds resulting from UXO detonations. The blue whale was not modeled with the other species by JASCO (2023) because they are considered rare in the Project area. Additionally, up to two PTS exposures were estimated for NARW, but with mitigation, no Level A take is being requested for NARW by the applicant in the draft ITA application (JASCO 2023). However, Level A take is being requested for all other species, and proposed mitigation measures are equivalent for all LFC species. The applicant has agreed to consult with BOEM and NMFS to identify the appropriate noise mitigation system(s) to prohibit Level A take of NARW. This noise mitigation system would serve to minimize and potentially eliminate PTS exposure risk to other marine mammal species. In addition to the bespoke noise mitigation system, mitigation measures to reduce the risk of PTS include:

- Two PSO vessels each with two PSOs on active watch will visually survey the UXO clearance zone at least 60 minutes prior to a detonation event;
- No UXOs will be detonated during nighttime;
- Only one detonation may occur in a 24-hour period;
- PAM will be conducted during all UXO detonations;
- A noise mitigation system will be used for all detonation events to achieve a minimum of 10 dB noise attenuation; and
- If an animal is observed entering the relevant clearance zones (Table 1-15) prior to the detonation, the detonation must be delayed until the clearance zone has been free of marine mammal species for 30 minutes without a re-sighting inside the clearance zone.

Because UXO threshold ranges were modeled for hearing groups and are not species-specific like for impact pile driving, and mitigation measures for UXO detonations are designated for all groups and not individual species, the potential for PTS is considered to be the same for all LFC species. Exposure to noise above the PTS thresholds was estimated for all LFC species by JASCO (2023); therefore, the potential for PTS exposure to these ESA-listed species cannot be discounted for any species within this hearing group. Although sperm whales had no modeled PTS exposures, Level A take is being requested; therefore, the risk to sperm whales also cannot be discounted. The applicant will apply a noise mitigation system such that no NARW are exposed to PTS thresholds; however, because the system has not yet been identified, the current analysis indicates there is still a risk of PTS exposure to NARW. Therefore, the effects of exposure to noise above PTS thresholds during potential UXO detonations **may affect, likely to adversely affect** ESA-listed marine mammals.

Effects of Exposure to Noise Above Temporary Threshold Shift Thresholds

Results of the acoustic and exposure modeling show up to 14 TTS exposures for fin whales, 27 exposures for NARW, 7 exposures for sei whales, 2 exposures for sperm whales, and 4 exposures for blue whales (Table 3-21). These are based on the TTS SEL_{24h} threshold recommended by Finneran et al. (2017), as only a single detonation event would occur within a 24-hour period. The Proposed Action includes up to 10 UXO detonations over a 2-year period (Table 3-20).

TTS may be characterized as auditory fatigue or impairment which, if not reversed, may result in PTS and, thus, may be a precursor to auditory injury. TTS onset is often described as a 6 dB shift in the normal hearing threshold for a given individual (Southall et al. 2019). Although PTS onset thresholds are derived from marine mammal TTS measurements, there is little empirical data that illustrate the relationship between TTS and PTS. Marine mammals are more susceptible to TTS from long-duration noise than from short or intermittent noise sources because of the interim recovery periods. In the absence of behavioral effects resulting from multiple concurrent explosions, TTS is considered Level B harassment under the MMPA, though there are some arguments to support TTS as an auditory injury, at least in some species (Tougaard et al. 2015, 2016).

Low-Frequency Cetaceans

There are no available TTS measurement data for LFCs, and there is little direct evidence of the effects of TTS on LFCs. The durations of exposure during explosions are short and, therefore, would need to be of sufficient amplitude within the LFC frequency range to cause TTS. Todd et al. (1996) observed humpback whales near underwater explosions and did not note any overt behavioral changes (e.g., changing course, abrupt dive behavior) within 1.83 kilometers from the blast, with received Lpk of 123 dB re 1 µPa. They saw no overall trend in humpback whale movements during the course of the month when intermittent blasting was taking place.

Given the range in sizes of UXO that may be encountered in the Project area, if TTS were to occur in LFC species, rapid recovery would be expected with minimal effects on the individuals exposed. There could be some reduction in communication ability with conspecifics, but this also would be temporary. Sensitive communication periods include migration or when adults may be accompanied by calves, so the significance of reduced communication ability would be greater during these periods. As discussed in Section 3.2.1.1, NARW may be present in southern New England waters year-round and foraging in Nantucket Shoals, adjacent to the Project area. UXO detonations may also affect zooplankton species, the preferred prey of NARW. Studies have documented mortalities of individuals following exposure to impulsive sound sources like UXO detonations (Section 3.2.6.2.6); however, given the mitigation measures that will be in place, such as the noise attenuation system and the limited number of detonations that would occur under the Proposed Action, zooplankton mortality would only be expected to occur in a limited area over a limited duration. The potential effects on zooplankton aggregations around UXO removal activities would not affect NARW foraging capabilities given that the major concentrations of zooplankton in the region occur on Nantucket Shoals, especially along the well mixed tidal front generally located over 12 miles (20 kilometers) from the proposed Project lease area. Therefore, given the limited number of UXO detonations under the Proposed Action, the spatial distance between important prey aggregations and where detonations would occur, and the mitigation included under the Proposed Action, no long-term effects on NARW prey species would be likely to occur during UXO detonations. Fin whales have been detected year-round in the Project area, but the highest occurrence is in the summer and spring (Section 3.2.2.2). Fin whales in the Project area would largely be foraging, but some individuals may be migrating from the summer feeding habitats in the northeast to winter breeding habitats in the Caribbean, and it would be during these migrations that individuals would be most likely to be accompanied by calves (Section 3.2.2). Sei and blue whales are less abundant in the Project area relative to NARW and fin whales but are likely to occur in the spring, summer, and fall within and around the SWDA (Sections 3.2.3 and 3.2.5). Sei whales would follow a similar migratory pattern as described for fin whales (Section 3.2.3), but the migratory behavior of blue whales is not well known (Section 3.2.5).

LFCs would be expected to resume pre-detonation activities shortly after an explosive event. The applicant would limit the number of detonations to one in a 24-hour period, so no concurrent blasting would occur, and the duration of exposure under the Proposed Action UXO detonations would be short and would not result in any long-term alterations in migration or foraging behavior for LFC in the Project area.

Mid-Frequency Cetaceans

TTS has been demonstrated in captive odontocetes exposed to high amplitude sounds (Finneran 2015; Southall et al. 2007), but there is no documented evidence of TTS resulting from explosions in free-ranging marine mammals. Similar effects on sperm whales are likely to occur and are expected for LFC species during potential UXO detonations. However, sperm whales are relatively less abundant in the Project area (Section 3.2.4) and primarily present in the summer and fall as evidenced by the less than 1 exposure estimated (JASCO 2023) and the total of two exposures being requested for this species (Table 3-21). Similar to LFCs, sperm whales would be expected to recover from TTS shortly after an explosive event. The applicant would limit the number of detonations to one in a 24-hour period, so no concurrent blasting would occur, and the duration of exposure under the Proposed Action UXO detonations would be short, no long-term alterations in migration or foraging behavior are likely to occur for sperm whales in the Project area.

Unexploded Ordnance Detonations—Temporary Threshold Shift Effects Summary

The combination of monitoring and mitigation measures (Table 1-15) and the short duration of potential UXO detonations under the Proposed Action will reduce the potential for TTS-level exposures of ESA-listed marine mammals to the level of the individual animal and would not be expected to have population-level effects. As discussed above, up to 14 fin whales, 27 NARWs, 7 sei whales, 2 sperm whales, and 4 blue whales may be exposed to noise above the TTS threshold (Table 3-21), but these species are expected to recover occur shortly after the detonation events. Due to the large TTS-onset area (172 and 8 square miles [445 and 21 km^2] for LFC and MFC, respectively), TTS exposures cannot be completely avoided even with mitigation.

Although no critical habitat exists in the Project area, NARWs and fin whales are expected to use the Project area year-round with seasonal peaks during which foraging activities are consistent and predictable. Sei, sperm, and blue whales show a more seasonal presence, occurring in the summer and fall. All groups demonstrate feeding site fidelity that may include the Project area. Sperm whales would also be expected to be exploiting key feeding opportunities when present in the Project area. Nantucket Shoals, adjacent to the Project area, is an increasingly important NARW foraging habitat (O'Brien et al. 2022a), and there is a BIA identified for fin whales east of Montauk Point, which overlaps with the SWDA (NMFS 2023g). Furthermore, explosive detonation is not the preferred removal of UXO (Section 1.4.1.2.5), so the occurrence of in-situ UXO detonations is likely to be low during construction. Although the ranges to TTS thresholds can be large (Table 3-17), which increases the risk of exposure, the instantaneous nature of UXO detonations make them unlikely to disrupt critical behaviors. Additionally, since there would only be a single detonation event within any 24-hour period, marine mammals experiencing TTS are expected to recover quickly and would not likely be re-exposed to noise above TTS thresholds resulting from any other proposed Project activities including UXO detonations; therefore, the effect of being exposed to noise above TTS thresholds during UXO detonations would be considered so minor it cannot be meaningfully measured and **insignificant**. The effects of exposure to noise above TTS thresholds resulting from UXO detonations, therefore, **may affect, not likely to adversely affect** ESA-listed marine mammals.

Wind Turbine Generator Noise

Reported sound levels of operational wind turbines is generally low (Madsen et al. 2006; Tougaard et al. 2020; Stöber and Thomsen 2021) with a source SPL of about 151 dB re 1 µPa m and a frequency range of 60 to 300 Hz (Wahlberg and Westerberg 2005; Tougaard et al. 2020). At the Block Island Wind Farm, low-frequency noise generated by turbines reach ambient levels at 164 feet (50 meters) (Miller and Potty 2017). SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 66 feet (14 to 20 meters) from the WTGs (Tougaard and Henriksen 2009). Thomsen et al. (2016) indicated SPL ranging from 122 to 137 dB re 1 µPa at 492 feet (150 meters) and 131 feet (40 meters), respectively with peak frequencies at 50 Hz and secondary peaks at 150 Hz, 400 Hz, 500 Hz, and 1,200 Hz from a jacket foundation turbine and from 133 to 135 dB re 1 µPa at 492 and 131 feet (150 and 40 meters), respectively, with peak frequencies at 50 and 140 Hz from a steel monopile foundation turbine. The measurements within 131 feet (40 meters) of the monopile were similar to those observed at the jacket foundation wind turbine. However, at the greater distance of 492 feet (150 meters), the jacketed turbine was quieter.

Tougaard et al. (2020) reviewed the literature sources previously cited, along with others, to attempt some standardization in reporting and assessment. The resulting analyses showed that sound levels produced by individual WTG were low in all literature and comparable to or lower than sound levels within 0.6 mile (1 kilometer) of commercial ships. The complied data also showed an increase in noise levels with increasing WTG power and wind speed; however, Tougaard et al. (2020) noted that the noise produced from a WTG is stationary and persistent, which differs from the transitory nature of sound produced by vessel traffic, and the cumulative contribution of multiple WTG within a region must be critically assessed and planned. Stöber and Thomsen (2021) reviewed published literature and also identified an increase in underwater source levels (up to 177 dB re 1 µPa) with increasing power size with a nominal 10 MW WTG. They also estimate a sound decrease of roughly 10 dB from WTG using gear boxes (which is what has been used on the majority of WTG measured in Europe) compared to WTG using direct drive technology in which the gear box, which connects the generator to the turbine blades, is removed and instead the turbine rotor is connected directly to the generator (Osmanbasic 2020).

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

Based on the currently available sound field data for turbines smaller than 6.2 MW (Tougaard et al. 2020) and comparisons to acoustic impact thresholds (NMFS 2018b), underwater sound from offshore wind turbine operations is not likely to cause PTS for any ESA-listed species assessed in this BA. Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise, including both older-generation, geared turbine designs and quieter, modern, direct-drive systems like those proposed for the Project. They determined that operating WTGs produce underwater noise on the order of 110 to 125 dB re 1 µPa SPL at a reference distance of 164 feet (50 meters), occasionally reaching as high as 128 dB re 1 µPa SPL, in the 10 Hz to 8 kHz range. This is consistent with the noise levels observed at the Block Island Wind Farm (Elliot et al. 2019) and the range of values observed at European wind farms. More recently, Stöber and Thomsen (2021) used monitoring data and modeling to estimate operational noise from larger (10 MW), current-generation, direct-drive WTGs and concluded that these designs could generate higher operational noise levels than those reported in earlier research. This suggests that operational noise effects on ESA-listed marine mammals could be more intense and extensive than those considered herein; however, due to the relatively low source levels referenced in the available data, injury-level effects are not considered likely and are **discountable**. Therefore, the effects of noise exposure above PTS thresholds resulting from WTG operations **may affect**, **not likely to adversely affect** ESA-listed marine mammals.

Effects of Exposure to Noise Above Behavioral Thresholds

Based on the available source level and modeling information previously presented, underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. Estimated ranges to behavioral thresholds for marine mammals from gear box versus direct drive WTG extended to 3.9 miles (6.3 kilometers) versus 0.87 mile (1.4 kilometers), respectively (Stöber and Thomsen (2021). Given the relatively low sound levels that would be produced during WTG operations, only temporary changes in marine mammal behavior would be expected at close distances from the proposed Project turbines. Hearing group-specific analyses are presented in the following subsections.

Some studies have shown an increase in acoustic occurrences of harbor porpoises within a wind farm during the operational phase of wind farms (Russell et al. 2016; Scheidat et al. 2011), while another study showed a decrease in the abundance of harbor porpoises 1 year after operations began in comparison with the pre-construction period (Tougaard et al. 2005). However, no change in acoustic behavior was detected in the animals that were present (Tougaard et al. 2005). In these field monitoring studies, it is not always clear if the behavioral responses have anything to do with operational noise, or merely the presences of turbine structures. Regardless, these findings suggests that turbine operational noise did not have any severe adverse effect on the acoustic behavior of the animals.

Low-Frequency Cetaceans

Very few empirical studies have looked at the effect of operational wind turbine noise on wild marine mammals, in particular LFCs mainly because wind farm operations monitoring has largely been conducted in Europe where the LFC species content is not comparable to that expected at U.S. wind farms. Modeling conducted on 6 MW WTGs estimated that minke whales (*Balaenoptera acutorostrata*) would detect wind farms at distances of 18 kilometers. Although there were no predictions of behavioral alterations at these distances, the of anticipated minimum 16 MW WTG nameplate power planned for the applicant has the potential to produce higher source levels at lower frequencies (Stöber and Thomsen 2021); however, data supporting this potential effect is lacking.

Based on the modeling conducted by Tougaard et al. (2020), the noise from a single, 1 MW turbine dropped below ambient conditions within a few kilometers for an array of 81 turbines. For high ambient noise conditions, the distance at which the turbine could be heard above ambient noise was even less. It is important to note that just because a sound is audible, that does not mean that it would be disturbing or be at a sufficient level to mask important acoustic cues. There are many natural sources of underwater sound that vary over space and time and would affect an animal's ability to hear turbine operational noise over ambient conditions.

WTG operational noise would be considered a chronic effect, such as vessel noise, in which the effect of noise contributes to an overall degradation of the acoustic space and may result in long-term, sub-acute effects on marine mammals. These chronic effects may result in lowered health and behavioral changes over the operational term of the wind farm. The chronic presence of this low-frequency noise source could also have non-lethal physiological effects on zooplankton species, the primary prey of NARW (discussed further in Section 3.2.6.2.6). Sources of chronic noise typically fall within the low frequency bands that are problematic for LFCs due to masking risk. Masking of LFC communications is considered likely but, as with behavioral disturbances, the extent of these effects is unknown. There is no published literature assessing long-term movement or acoustic exposure of LFC in or around offshore wind farms. Rather than sound levels produced by individual WTGs, cumulative noise from individual wind farms, as well as combined regional wind farms, are likely to produce more widespread sound fields, which, in the absence of other similar ambient noise (e.g., ships), could produce a pronounced change to the regional soundscape and could affect marine mammals (and other species) acoustic acuity (Tougaard et al. 2020).

Mid-Frequency Cetaceans

Similar to LFC, there are limited data regarding responses of MFC species to WTG operational noise. Some studies have indicated no change in the acoustic presence of marine mammals during wind farm operations (Russell et al. 2016; Scheidat et al. 2011), while some indicate temporary avoidance of the wind farm (Tougaard et al. 2005). Masking of high-frequency echolocation clicks used by sperm whales is not anticipated because WTG operational noise is not expected to overlap with the broad-band sperm whale click frequencies at sufficient sound levels to propagate into sperm whale habitat. Lucke et al. (2007) explored the potential for acoustic masking from operational noise by conducting hearing tests on trained harbor porpoises while they were exposed to sounds resembling operational wind turbines (less than 1 kHz). They saw masking effects at 128 dB re 1 µPa at frequencies of 700, 1,000, and 2,000 Hz, but found no masking at SPLs of 115 dB re 1 µPa. Based on propagation loss in a shallow water environment, the sound would attenuate to 115 dB re 1 µPa within 66 feet (20 meters) of the operating turbine (Lucke et al. 2007), suggesting the range for masking for HFCs is very small, and would likely be similarly small for sperm whales given the low overlap between the frequencies of WTG operational noise and the peak hearing sensitivity of sperm whales (Section 3.2.4). If any behavioral or masking effects would occur due to an animal's proximity to the WTG, the effects would be temporary and would not be expected to affect an individual's ability to successfully obtain food to maintain their health, make seasonal migrations, or participate in breeding or calving.

Wind Turbine Generator Operations – Behavioral Effects Summary

The potential for exposure of ESA-listed LFC and MFC to noise levels that meet or exceed the behavioral disturbance threshold during WTG operations would be reduced to the level of the individual animal and would not be expected to have population-level effects. NARWs, fin whales, sei whales, and sperm whales may be exposed to noise above the behavioral thresholds during WTG operations, particularly during high wind events when WTG noise levels are likely to be elevated (Tougaard et al. 2020). However, available studies suggest WTG turbine operational noise would not have any severe adverse effect on the behavior of the animals, and potential behavioral effects of ESA-listed cetaceans from WTG operations is currently considered **insignificant**. Therefore, the effects of exposures to noise above behavioral threshold levels from proposed Project WTG operations **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.2.6.2.4 Sound Field Verification

Sound field verification measurements would be conducted during portions of foundation piling, foundation pile drilling, and UXO detonations during proposed Project construction. To assess the efficacy of mitigation measures and compare the in-situ distance to pre-defined acoustic thresholds with modeled distances, a sound field verification study would be completed. Sound levels are expected to be recorded for a minimum of three monopiles and two jackets for foundation installation techniques (i.e., drilling, vibratory hammering, impact hammering) that are used. Additional sound field verification measurements may be taken if the applicant obtains technical information that suggests a subsequent foundation, or foundations, may produce larger sound fields. Acoustic measurements would also be made during any potential UXO detonation. Measurements would provide verification of modeled ranges to the modeled harassment threshold isopleths and provide acoustic measurement data collected using International Organization for Standardization-standard methodology for comparison among projects and to inform future projects. Such confirmation will help demonstrate that estimated exposures of marine mammals and sea turtles were appropriately predicted.

3.2.6.2.5 Summary of Effects of Underwater Noise

Noise generated from proposed Project activities include impulsive (e.g., impact pile driving, some HRG surveys), non-impulsive (e.g., vibratory pile setting, foundation drilling, vessels, WTG operations), and explosive sources (i.e., UXO detonations). Of those activities, only impact pile driving and UXO detonations could cause PTS effects on ESA-listed marine mammals. All noise sources, except UXO detonations, have the potential to cause behavioral disturbance effects through behavioral modification, masking, and other non-lethal effects in certain species. UXO detonation are not expected to result in any non-auditory injuries to marine mammals due to the small impulse ranges and planned mitigation measures. The mitigation measures outlined in Table 1-15 are expected to be effective in limiting the potential for PTS effects in most marine mammal species; however, the potential for some PTS, TTS, behavioral effects, and masking remain for some proposed Project activities. Table 3-22 summarizes the number of ESA-listed marine mammals potentially exposed to underwater noises above PTS, TTS and behavioral thresholds for all underwater noise sources.

Table 3-22: Estimated Number of Endangered Species Act-Listed Marine Mammals Exposed to Sound Levels Above Permanent Threshold Shift and Level B (Behavioral and Temporary Threshold Shift) Thresholds

Marine Mammal Species		PTS Exposures	Level B Exposures[a]
Foundation Installation (10 dB Noise Mitigation)			
LFC	NARW (*Eubalaena glacialis*)	0[b]	74
	Fin whale (*Balaenoptera physalus*)	33	349
	Sei whale (*Balaenoptera borealis*)	6	50
	Blue whale (*Balaenoptera musculus*)[c]	2	4
MFC	Sperm whale (*Physeter macrocephalus*)	0	97
Foundation Drilling (10 dB Noise Mitigation)			
LFC	NARW	0	5
	Fin whale	0	23
	Sei whale	0	5
	Blue whale[a]	0	4
MFC	Sperm whale	0	5
HRG Surveys (5-Year Total) (0 dB Noise Mitigation)			
LFC	NARW	0	25
	Fin whale	0	20
	Sei whale	0	10
	Blue whale[c]	0	4
MFC	Sperm whale	0	10
UXO Detonations (10 dB Noise Mitigation)			
LFC	NARW	0[b]	27
	Fin whale	2	14
	Sei whale	2	7

Marine Mammal Species		PTS Exposures	Level B Exposures[a]
	Blue whale[c]	2	4
MFC	Sperm whale	2	2

Source: JASCO 2022, 2023
dB = decibel; HRG = high-resolution geophysical; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PTS = permanent threshold shift; TTS = temporary threshold shift; UXO = unexploded ordnance
[a] Level B exposures include exposures above behavioral thresholds for all activities except UXO detonations that applies TTS thresholds.
[b] PTS exposure were estimated for NARW for certain Project activities, but due to mitigation measures proposed by the applicant, no PTS (Level A takes) exposures are expected, and no Level A takes have been requested for these species.
[c] Blue whales were not modeled for the proposed Project's exposure analysis (JASCO 2023) because they are considered a rare species whose preferred ranges largely fall outside the Project area but were included as a conservative measure. Therefore, the exposures represent the 5-year total for all noise-producing activities modeled for the Proposed Action and are not provided for individual proposed Project activities

3.2.6.2.6 Effects on Prey Organisms

Reduction of prey availability could affect marine mammals if rising sound levels alter prey abundance, behavior, distribution, or both (McCauley et al. 2000a, 2000b; Popper and Hastings 2009; Slabbekoorn et al. 2010). Prey species may show responses to noise; however, there are limited data on hearing mechanisms and potential effects of noise on common prey species (i.e., crustaceans, cephalopods, fish) that would result loss of availability to marine mammals. These species have been increasingly researched as concern has grown related to noise effects on the food web. Invertebrates appear to be able to detect sounds and particle motion (André et al. 2016; Budelmann 1992; Solé et al. 2016, 2017) and are most sensitive to low-frequency sounds (Packard et al. 1990; Budelmann and Williamson 1994; Lovell et al. 2005a, 2005b; Mooney et al. 2010).

Squid and other cephalopods are an extremely important food chain component for many higher order marine predators, including fin and sperm whales. Cephalopods (i.e., octopus, squid) and decapods (i.e., lobsters, shrimps, crabs) are capable of sensing low-frequency sound. Packard et al. (1990) showed that three species of cephalopod were sensitive to particle motion, not sound pressure, with the lowest particle acceleration thresholds reported as 0.002 to 0.003 meter per second squared at 1 to 2 Hz. Solé et al. (2017) showed that SPL ranging from 139 to 142 dB re 1 µPa at one-third octave bands centered at 315 Hz and 400 Hz may be suitable threshold values for trauma onset in cephalopods. Cephalopods have exhibited behavioral responses to low frequency sounds under 1,000 Hz, including inking, locomotor responses, body pattern changes, and changes in respiratory rates (Kaifu et al. 2008; Hu et al. 2009). In squid, Mooney et al. (2010) measured acceleration thresholds of -26 dB re 1 meter per second squared between 100 and 300 Hz and an SPL threshold of 110 dB re 1 µPa at 200 Hz. Lovell et al. (2005a) found a similar sensitivity for common prawn (*Palaemon serratus*), SPL of 106 dB re 1 µPa at 100 Hz, noting that this was the lowest frequency at which they tested and that the prawns might be more sensitive at frequencies below this. Hearing thresholds at higher frequencies have been reported, such as 134 and 139 dB re 1 µPa at 1,000 Hz for the oval squid (*Sepioteuthis lessoniana*) and the common octopus (*Octopus vulgaris*), respectively (Hu et al. 2009). McCauley et al. (2000a) reported that of caged squid exposed to seismic airguns showed behavioral responses such as inking. Wilson et al. (2007) exposed two groups of longfin inshore squid (*Loligo pealeii*) in a tank to killer whale echolocation clicks at SPL from 199 to 226 dB re 1 µPa, which resulted in no apparent behavioral effects or any auditory debilitation. However, both the McCauley et al. (2000a) and Wilson et al. (2007) experiments used caged squid, so it is unclear how unconfined animals would react. André et al. (2011) exposed four cephalopod species (European squid [*Loligo vulgaris*], cuttlefish [*Sepia officinalis*], octopus, and southern shortfin squid [*Ilex coindetii*]) to 2 hours of continuous noise from 50 to 400 Hz at received SPL of 157 dB re 1 µPa ± 5 dB, and reported lesions occurring on the statocyst's sensory hair cells of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound.

Similar to André et al. (2011), Solé et al. (2013) conducted a low-frequency (50 to 400 Hz) controlled exposure experiment on two deep-diving squid species (southern shortfin squid and European squid), which resulted in lesions on the statocyst epithelia. Sóle et al. (2013) described their findings as "morphological and ultrastructural evidence of a massive acoustic trauma induced by low-frequency sound exposure." In experiments conducted by Samson et al. (2014), cuttlefish exhibited escape responses (i.e., inking, jetting) when exposed to sound frequencies between 80 and 300 Hz with SPL above 140 dB re 1 μPa and particle acceleration of 0.01 meter per second squared; the cuttlefish habituated to repeated 200 Hz sounds. The intensity of the cuttlefish response with the amplitude and frequency of the sound stimulus suggest that cuttlefish possess loudness perception with a maximum sensitivity of approximately 150 Hz (Samson et al. 2014).

Several species of aquatic decapod crustaceans are also known to produce sounds. Popper et al. (2001) concluded that many are able to detect substratum vibrations at sensitivities sufficient to tell the proximity of mates, competitors, or predators. Popper et al. (2001) reviewed behavioral, physiological, anatomical, and ecological aspects of sound and vibration detection by decapod crustaceans and noted that many decapods also have an array of hair-like receptors within and upon the body surface that potentially respond to water- or substrate-borne displacements, as well as proprioceptive organs that could serve secondarily to perceive vibrations. However, the acoustic sensory system of decapod crustaceans remains poorly studied (Popper et al. 2001). Lovell et al. (2005a, 2005b, 2006) reported potential auditory-evoked responses from prawns showing auditory sensitivity of sounds from 100 to 3,000 Hz, and Filiciotto et al. (2016) reported behavioral responses to vessel noise within this frequency range.

Marine mammal prey species of fish are typically sensitive to the 100 to 500 Hz range, which is below most HRG survey sources, but does overlap with many of the proposed Project activities described previously. Several studies have demonstrated that seismic airguns and impulsive sources might affect the behavior of at least some species of fish. For example, field studies by Engås et al. (1996) and Løkkeborg et al. (2012b) showed that the catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) significantly declined over the 5 days immediately following seismic surveys, after which the catch rate returned to normal. Other studies found only minor responses by fish to noise created during or following seismic surveys, such as a small decline in lesser sand eel (*Ammodytes marinus*) abundance that quickly returned to pre-seismic levels (Hassel et al. 2004) or no permanent changes in the behavior of marine reef fishes (Wardle et al. 2001). However, both Hassel et al. (2004) and Wardle et al. (2001) noted that when fish sensed the airgun firing, they performed a startle response and sometimes fled. Squid (*Sepioteuthis australis*) are an extremely important food chain component for many higher order marine predators, including fin and sperm whales. McCauley et al. (2000a) recorded caged squid responding to airgun signals. Given the generally low sound levels produced by HRG sources in comparison to airgun sources, no short-term effects on potential prey items (fishes, cephalopods, crustaceans) are expected from the proposed survey activities.

Minimal data are available for zooplankton (the primary prey for NARW) responses to anthropogenic sound. Guihen et al. (2022) found a noted avoidance of Antarctic krill species to the presence of an autonomous glider carrying a single beam echosounder. However, these disturbances had small ranges (approximately 131 feet [40 meters]) and did not show a large-scale movement in krill. A recent review from Solé et al. (2023) indicated that zooplankton mortalities can occur during airgun survey operations, and there is a differential mortality risk based on the size of the individuals; smaller species (e.g., Cladocera and krill larvae) had higher mortalities during airgun operations, while larger species (e.g., *C. finmarchicus*) had lower risk of mortalities. However, Nantucket Shoals, which supports dense aggregations of the NARW's preferred prey, is located over 12 miles (20 kilometers) from the proposed Project lease area; the effects of acoustic pulses on individual zooplankton species is not likely to affect overall prey quality or quantity for the NARW, particularly during short-term pile driving. Tremblay et al. (2020) assessed the joint effect of noise and increased temperature on the pelagic copepod *Acartia tonsa* to help determine potential effects of long-term noise produced by operating WTG generators on zooplankton species. The noise source in this study was a 110 Hz vibrational motor applied in different temperature scenarios. Results showed no significant changes in oxygen consumption rates linked to just the noise exposures; but there was a stronger relationship between oxygen consumption and temperature, and exposure to the low-frequency noise altered enzyme activities linked to antioxidant defense systems (Tremblay et al. 2020). This suggests that potentially less metabolic energy could be available in these individuals for development, growth, reproduction, immune response, or predator avoidance behavior (Tremblay et al. 2020), though the authors note that more research is needed to assess the full energetic consequences. Based on available studies it is expected that although some mortalities or reactionary behavioral responses by zooplankton from noise produced under the Proposed Action is likely, these would not result in population-level effects localized and temporary nature of the movement would not cause significant loss in the availability of the species to marine mammals.

The effects on ESA-listed marine mammals due to reduction in prey items from underwater noise generated by the proposed Project would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Therefore, effects from underwater noise sources due to the Proposed Action **may affect, not likely to adversely affect** prey organisms of ESA-listed marine mammals.

3.2.6.3 Habitat Disturbance Effects on Marine Mammals (Construction, Operations, Decommissioning)

Habitat disturbance related to the proposed Project would occur during construction, operations, and decommissioning. Individual stressors under habitat disturbance encompass displacement of marine mammal species, prey items, or both from physical disturbance of sediment; behavioral changes due to the presence of structures; changes in oceanographic and hydrological conditions due to presence of structures; conversion of soft-bottom habitat to hard-bottom habitat; and the changes in or concentration of prey species due to the reef effect.

3.2.6.3.1 Displacement from Physical Disturbance of Sediment (Construction, Decommissioning)

In general, effects from disturbance and alteration of the seabed resulting from the Proposed Action would be limited to short-term, localized displacement of some ESA-listed marine mammal species in the Project area. Displacement as the result of physical disturbance of sediment would result from temporary displacement of prey species due to disturbance of the seabed or temporary increases in turbidity (addressed in Section 3.2.6.4). Physical disturbances of the seabed during construction could result from pre-lay grapnel runs for the inter-array and offshore export cables; proposed Project vessel anchoring; installation of the WTG and ESP foundations; installation of the inter-array and export cables; and potential UXOs clearance and mitigation in the event that UXOs that are unable to be avoided through micrositing. Based on the information provided in the COP, the total area of temporary and permanent seabed disturbance resulting from the proposed Project components during construction is provided in Table 3-23.

Table 3-23: Estimated Areas of Seafloor Disturbance during Construction of the Proposed Action

Construction	Total Disturbance Area (km^2)	Total Disturbance Area (acres)
Temporary Disturbance		
Inter-array cable installation (Phase 1 and Phase 2)	2.52	622.7
Offshore export cable installation (Phase 1 and Phase 2)	2.22	548.6
Dredging prior to offshore export cable installation (Phase 1 and Phase 2)	0.48	118.6
Jack-up and anchored vessels (Phase 1 and Phase 2, full Project area)	1.71	421.0
Total	6.93	1,710.9
Permanent Proposed Project Footprint		
WTG foundations and scour protection (Phase 1 and Phase 2)[a]	1.03	254.5
ESP foundations and scour protection (Phase 1 and Phase 2)	0.07	17.3
Cable protection (Phase 1 and Phase 2)	0.36	88.9
Total	1.46	360.7

Source: COP Volume III, Section 6.5.2.1 and Appendix III-T; Epsilon 2022
ESP = electrical service platforms; km^2 = square kilometer; WTG = wind turbine generator
[a] The permanent footprint for the WTG foundations includes monopile, jacket, and the bottom-frame foundations proposed for Phase 2; Phase 1 only includes monopile and jacket foundations. This estimate also includes the maximum total area of seafloor disturbance, which could be caused by the suction bucket piles for the jacket and bottom-frame foundations during Phase 2.

Based on information in the COP (Appendix III-T; Epsilon 2022), an estimated 1,710.9 acres (6.93 km^2) would be temporarily disturbed during the proposed Project construction (Table 3-23). Habitat disturbance effects on marine mammals during decommissioning would likely be similar to or less than those experienced during construction. Given that decommissioning techniques are expected to advance over the life of the proposed Project, potential impacts would need to be evaluated at that time; however, effects on ESA-listed marine mammals are not expected to not be greater than those experienced during construction. No hard-bottom habitat was identified in the SWDA, but hard-bottom habitat has been documented within the OECC where it has significant coverage through Muskeget Channel's shallow water passage (COP Volume II, Section 5.2.1; Epsilon 2022). Complex habitat is present mainly in the Muskeget Channel section of the OECC; no complex habitat was identified in the SWDA (COP Volume II, Section 5.2.2.1; Epsilon 2022). Soft-bottom habitat, consisting mainly of sand but also mud mainly in the southern portion of the OECC and within the SWDA, was the most common habitat type throughout the OECC and the only habitat type in the SWDA (COP Volume II, Section 5.2.2.4; Epsilon 2022). Additionally, a sparse to moderate distribution of living eelgrass was identified in one area of the OECC along the south shore of Cape Cod (COP Volume II, Section 5.2.3; Epsilon 2022).

Given the diversity of benthic habitat present in the Project area, some displacement of benthic prey resources for marine mammals may occur, but this is expected to be temporary. Restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). Disturbed areas not replaced with hardened structures (i.e., scour or cable protection) would be resettled, and the benthic community would be expected to approach normal conditions within approximately 1 to 2 years (Dernie et al. 2003; Department for Business, Enterprise and Regulatory Reform 2008; Collie et al. 2000; Gerdes et al. 2008). However, the actual mechanisms of recovery are highly complex and site-specific; recovery to baseline conditions may take much longer in some areas and for some benthic species. Generally, soft-bottom habitats are more rapidly restored following a disturbance compared to complex or hard-bottom habitats (Collie et al. 2000).

The only forage fish species that is expected to be impacted by the physical disturbance of sediment and permanent habitat alterations (i.e., conversion from soft substrate to hard substrate) would be the sand lance. Permanent hard structure would cover up to 360.7 acres (1.46 km^2; Table 3-23) for the Proposed Action, which represents a very small portion of overall habitat available offshore of Massachusetts (Figure 1-1). Sand lance are strongly associated with sandy substrate, and the proposed Project may result in a loss of such soft bottom that theoretically could result in a localized reduction in the abundance of sand lance in the Project area. The only marine mammal species that may feed on benthic prey species are fin whales, which may feed on sand lance in the Project area (Section 3.2.2). Though there is a BIA identified for fin whale foraging that is adjacent to the Project area (LaBrecque et al. 2015), the majority of this foraging area extends west toward Montauk, New York, which would be outside the proposed Project construction disturbance footprint. Even in a worst-case scenario assuming that the reduction in the abundance of sand lance in the Project area is directly proportional to the amount of soft substrate lost, it would be expected to be an unmeasurable reduction in the sand lance available as forage for fin whales in the Project area since the baseline densities are not known.

Given the limited overlap with important benthic feeding habitats for ESA-listed marine mammals and the temporary nature of the disturbance, effects from seabed disturbance during construction and decommissioning would be so small that they could not be meaningfully measured, detected, or evaluated and are **insignificant**.

As discussed in Section 3.2.1.2, the only designated critical habitat that overlaps with the Action Area is the NARW foraging habitat Unit 1 in the Gulf of Maine. The Project vessel ports in Massachusetts, Atlantic Canada, and potentially Europe may result in vessels entering NARW critical habitat. However, vessels potentially present in critical habitat would only be transiting, so no anchoring or other bottom-disturbing activities would result from proposed Project vessels; therefore, effects on NARW critical habitat from sediment disturbance is **discountable**.

3.2.6.3.2 Effects of the Structure Presence on Marine Mammals (Operations)

The estimated permanent footprint of the Proposed Action is up to 360.7 acres (1.46 km^2), which represents a very small portion of overall habitat available offshore of Massachusetts (Figure 1-1). The permanent proposed Project footprint includes the WTG and ESP foundations and their associated scour protection, as well as the cable protection (Table 3-23). As discussed in Section 2.1.1.1, there is no existing hard-bottom habitat in the SWDA, but there is hard-bottom habitat with in the OECC through Muskeget Channel's shallow water passage (COP Volume II, Section 5.2.1; Epsilon 2022). The WTG and ESP foundations are vertical structures that constitute obstacles in the water column that could alter the normal behavior of marine mammals in the Project area during operations, whereas the cable protection would predominantly affect benthic prey species through the introduction of new hard-bottom habitat, as discussed in Section 3.2.6.3.4. There are limited data on the potential effects directly associated with the presence of physical structures in the water column. Five turbines constituting Block Island Wind Farm and two pilot turbines for the Coastal Virginia Offshore Wind Pilot Project have not presented data with observable changes in marine mammal movement (NMFS 2021b). Long (2017) compiled several years of observer data for marine mammal and bird interactions with tidal and wave energy testing facilities in Scotland. The study 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. Marine mammals, including baleen whales, have been regularly sighted around offshore oil and gas platforms (Barkaszi and Kelly 2019; Delefosse et al. 2018; Todd et al. 2020), suggesting that the physical presence of a structure in OCS waters did not deter individuals from using the same area of habitat. Increased localize biomass, including clupeids, have been documented for oil and gas installations operating at less than 100 feet (30 meters) in the North Sea (Delefosse et al. 2018), which indicates a key prey item for fin and sei whales would not be negatively affected.

WTGs would be installed in a uniform east-to-west, north-to-south grid pattern with 1-nautical-mile × 1-nautical-mile spacing between positions. The upper range of whale lengths are as follows: NARW (59 feet [18 meters]), fin whale (79 feet [24 meters]), sei whale (59 feet [18 meters]), and sperm whales (59 feet [18 meters]). As noted in this BA, for reference, about 103, 59-foot (18-meter) long NARWs (large females) would fit end-to-end between two foundations spaced at 1 nautical mile (1.15 mile). Based on a simple assessment of spacing, it does not appear that the WTGs would be a barrier to the movement of any ESA-listed marine mammal species through the area.

Insufficient empirical information is available to characterize precisely how the presence of WTG foundations in the water column would affect the behavior of whales, fish, and other organisms (Long 2017; Thompson et al. 2015). Operational noise from WTG structures is recognized as a potential stressor; however, it is difficult to separate out any behavioral reactions of marine mammal to the presence of WTGs during operations versus reactions to the underwater noise the structures may emit. Operational noise from WTGs is not discussed further in this section.

The spacing and size of the offshore wind structures are not expected to pose barriers to movement of ESA-listed marine mammals. Further, cetaceans are documented around similar offshore structures in other parts of the world. Based on the limited information available regarding whale activity, or changes in activity, resulting from the physical presence of offshore structures any effects would be considered **insignificant**.

3.2.6.3.3 Effects of Changes in Oceanographic and Hydrological Conditions due to the Presence of Structures (Operations)

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

The general understanding of offshore wind-related impacts on hydrodynamics is derived primarily from European based studies. A synthesis of European studies by van Berkel et al. (2020) summarized the potential effects of wind turbines on hydrodynamics, the wind field, and fisheries. Local to a wind facility, the range of potential impacts include increased turbulence downstream, remobilization of sediments, reduced flow inside wind farms, downstream changes in stratification, redistribution of water temperature, and changes in nutrient upwelling and primary productivity.

Human-made structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale by potentially reducing wind-driven mixing of surface waters or increasing vertical mixing as water flows around the structure (Carpenter et al. 2016; Cazenave et al. 2016; Segtnan and Christakos 2015). When water flows around the structure, turbulence is introduced that influences local current speed and direction. Turbulent wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). While impacts on current speed and direction decrease rapidly around monopiles and are mainly driven by interactions at the air-sea interface, there is also the potential for tidal driven wakes out to a kilometer from a monopile (Li et al. 2014). Direct observations of the influence of a monopile extended to at least 984 feet (300 meters), however, was indistinguishable from natural variability in a subsequent year (Schultze et al. 2020). The range of observed changes in current speed and direction 984 to 3,281 feet (300 to 1,000 meters) from a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis.

Several hydrodynamic processes have been identified to exhibit changes resulting from vertical structures:

1. Advection and Ekman transport are directly correlated with shear wind stress at the sea surface boundary. Vertical profiles from Christiansen et al. (2022) exhibit reduced mixing rates over the entire water column. As for the horizontal velocity, the deficits in mixing are more pronounced in deep waters than in well-mixed, shallow waters, which is likely favored by the influence of the bottom mixed layer in shallow depths. In both cases, the strongest deficits occur near the pycnocline depth.
2. Additional mixing downstream has been documented from Kármán vortices and turbulent wakes due to the pile structures of wind turbines (Carpenter et al. 2016; Grashorn and Stanev 2016; Schultze et al. 2020).
3. Up-dwelling and down-dwelling dipoles under contact of constant wind directions affecting average surface elevation of waters have been documented as the result of offshore wind farms (Broström 2008; Paskyabi and Fer 2012; Ludewig 2015). Mean surface variability is between 1 percent and 10 percent.
4. With sufficient salinity stratification, vertical flow of colder/saltier water to the surface occurs in lower sea surface level dipoles and warmer/less saline water travels to deeper waters in elevated sea surface heights (Ludewig 2015; Christiansen et al. 2022). This observation also suggested impacts on seasonal stratification, as documented in Christiansen et al. (2022). However, the magnitude of salinity and temperature changes with respect to vertical structures is small compared to the long-term and interannual variability of temperature and salinity.

The potential hydrodynamic effects identified above from the presence of vertical structures in the water column affect nutrient cycling and could influence the distribution and abundance of fish and planktonic prey resources (van Berkel et al. 2020). Daewel et al. (2022) modeled the effects of offshore wind farm projects in the North Sea on primary productivity and found that there were areas with both increased and decreased productivity within and around the wind farms. There was a decrease in productivity in the center of large wind farm clusters but an increase around these clusters in the shallow, near-coastal areas of the inner German Bight and Dogger Bank (Daewel et al. 2022). However, the authors noted that when integrated over a larger area, the local decreases and increases averaged to a nominal (0.2 percent) increase across the entire North Sea. Several other studies have modeled and theorized potential impacts, but overall science is limited as to what effects would accompany the hydrologic changes brought about by a large turbine installation at the proposed spacing in an environment such as the U.S. OCS. The anticipated hydrodynamic effects of structures are expected to be localized and not extend beyond a few hundred meters from the foundation (Miles et al. 2017; Schultze et al. 2020).

In general, the discussion above describes varying scales of impacts on the oceanographic processes as a resultant effect of the presence of proposed Project structures. These impacts, mainly resulting from the extraction of kinetic wind energy by turbine operations and reduction in wind stress at the air-sea interface, can lead to changes in horizontal and vertical water column mixing patterns (Miles et al. 2021). These effects are likely to occur over a range of temporal and spatial scales, but the current information makes it difficult to discern proposed Project-related effects from the natural variability of oceanographic conditions in the Project area. However, the primary anticipated effect relevant to marine mammals is the change in stratification and vertical mixing that would influence lower-trophic level prey species. As aggregations of plankton are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and may decrease efficient foraging opportunities. Potential effects of hydrodynamic changes in prey aggregations would primarily affect the NARW that feeds on plankton whose movement is largely controlled by water flow, as opposed to the sperm, fin, and sei whale that feed predominately on fish and cephalopods. Available studies suggest these changes would be limited to the localized area around the proposed Project and water down-current of the foundations, extending a few hundred meters to tens of kilometers from proposed Project foundations (Christiansen et al. 2022; Floeter et al. 2017; Miles et al. 2017; Schultze et al. 2020). Proposed Project foundations would be located over 20 kilometers (12 miles) from the 30-meter (98-foot) isobath along the western edge of Nantucket Shoals. The 30-meter (98-foot) isobath generally corresponds with the well-mixed tidal front that supports prey aggregations and, therefore, represents important feeding habitat for the NARW (Quintana-Rizzo et al. 2021). The distance that proposed Project infrastructure would be located from the Nantucket Shoals western edge tidal front (i.e., greater than or equal to 20 kilometers [12 miles]) likely exceeds the extent of greatest oceanographic and hydrological impacts resulting from proposed Project infrastructure (Christiansen et al. 2022; Hayes 2022). As a result, measurable changes in zooplankton aggregations and NARW foraging success due to the Proposed Action are not anticipated. Therefore, the effects on ESA-listed species' prey availability resulting from changes in oceanographic and hydrological conditions due to presence of structures would be so small that they could not be meaningfully evaluated and are, therefore, **insignificant.**

3.2.6.3.4 Effects of Changes in and Concentration of Prey Species due to the Reef Effect of Structures (Operations, Decommissioning)

The reef effect is another habitat-related result of in-water structures that may have long-term effects on marine mammal prey species during operations and potentially after decommissioning. Russell et al. (2016) found clear evidence that seals were attracted to a European wind farm, apparently attracted by the abundant concentrations of prey created by the artificial reef effect. The artificial reef effect created by these structures forms biological hotspots that could support species range shifts and expansions and changes in the biological community structure resulting from a changing climate (Raoux et al. 2017; Methratta and Dardick 2019; Degraer et al. 2020). There is no example of an existing, large-scale offshore renewable energy project, or combination of projects, within the Action Area to evaluate this potential. However, it is not expected that any reef effect from the Proposed Action would result in an increased abundance or aggregations of species preyed on by NARWs or sperm whales but may increase prey abundance or aggregations of fish preyed upon by fin whales or sei whales. Fisheries studies conducted over 7 years at the Block Island Wind Farm showed a marked increase in black sea bass and Atlantic cod over the maturity of the foundation installation (Wilber et al. 2022). During the Block Island study, catches of schooling fishes such as herring, which would be more indicative of fin and sei whale prey effects, declined throughout the survey period; however, these declines were also reflected regionally (outside of the wind farm) and, thus, not attributable to foundation effects (Wilber et al. 2022). Further, fish that prey heavily upon herring (e.g., spiny dogfish) showed large peaks in abundance during some survey trawls indicating periodic, high prey availability (Wilber et al. 2022). Therefore, similar periodic peaks in the abundance of fin and sei whale prey could be expected.

The NARW is primarily a pelagic filter feeder that would not be impacted by the reef effect. Sperm whales are deep diving species feeding primarily on cephalopods in the water column and are also not expected to be affected by the reef effect as associated with the Proposed Action. Fin and sei whales commonly depredate on sand lance, as well as schooling fish species on feeding grounds in the Gulf of Maine; primary feeding activity is the mid-Atlantic OCS is expected to be on pelagic schooling fishes such as clupeids (i.e., herrings, menhaden) (Engelhaupt et al. 2019; Zoidis et al. 2021).

Although the reef effect may aggregate fish species and potentially attract an increased number of opportunistic predators, the reef effect from structures is not anticipated to have any measurable effect on

ESA-listed marine mammals. Based on the available information, it is expected that there may be an increase in abundance of schooling fish that sei or fin whales may prey on, but this increase would likely be small and does not represent a measurable increase in prey abundance throughout the Project area. Therefore, the impact, if any, would be considered **insignificant** on ESA-listed marine mammals.

Any **beneficial**, yet not measurable, increase in aggregation of prey species of the fin and sei whale due to the reef effect would be removed following decommissioning.

3.2.6.3.5 Summary of Habitat Disturbance Effects

As described in the previous subsections, any effects from habitat disturbance on marine mammals is expected to be **insignificant**. Therefore, the effects of habitat disturbance from proposed Project structures in the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.2.6.4 Water Quality Effects on Marine Mammals (Construction, Operations, Decommissioning)

The seabed within the proposed Project comprises primarily soft-bottom sediments composed of unconsolidated sediments ranging from silt and fine-grained sands to gravel (Section 2.1.1.1), so it is likely that increases in turbidity during construction and decommissioning may occur. Physical or lethal effects in increased turbidity during proposed Project construction and decommissioning are unlikely to occur because marine mammals are air-breathing and highly mobile and, therefore, do not share the physiological sensitivities of susceptible organisms like fish and invertebrates. These effects on water quality for finer sediments are anticipated to be localized adjacent to the disturbance and temporary in nature.

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). The agency concluded that elevated TSS could result in effects on listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging operations), but insufficient information is available to make ESA effect determinations. In general, marine mammals are not subject to effects mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae), so injury-level effects are unlikely. Behavioral effects, 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 effects could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors. Small-scale changes from one-time, localized activities are not likely to have significant effects.

Data are not available regarding whales' avoidance of localized turbidity plumes; however, Todd et al. (2015) suggest that since marine mammals often live in turbid waters, significant effects from turbidity are not likely. If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any negative effects would likewise be short-term and temporary. Cronin et al. (2017) suggest that NARWs may use vision to find copepod aggregations, particularly if they locate prey concentrations by looking upwards. However, Fasick et al. (2017) indicate that NARWs must rely on other sensory systems (e.g., vibrissae on the snout) to detect dense patches of prey in very dim light (at depths greater than 525 feet [160 meters] or at night). These studies indicate that whales, including NARWs, are likely able to forage in low-visibility conditions and, thus, could continue to feed in the elevated turbidity. If turbidity from cable installation caused foraging whales to leave the area, there would be an energetic cost of swimming out of the turbid area. However, whales could resume foraging behavior once they were outside of the turbidity zone or once the suspended sediment settled out of the water column. The Sediment Transport Modeling Study (COP Appendix III-A; Epsilon 2022) predicts that suspended sediments from cable installation activities in the SWDA and along the OECC (including the Western Muskeget Variant) would settle out within approximately 6 hours or less at any given location. Any associated small-scale behavioral changes are expected to be temporary in nature and not likely to have significant biological effects.

Increased turbidity effects could affect the prey species of marine mammals, both in offshore and inshore environments. Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clark 2001). However, as mentioned previously, sedimentation effects would be temporary and localized with regions returning to previous levels soon after the activity. In addition, there would be increased vessel anchoring during the construction of offshore components of the proposed Project. Anchoring would cause increased turbidity levels, but it is expected to have discountable effects because the affected areas would be localized and would have short-term, minor effects on turbidity levels during construction.

NARW feed almost exclusively on copepods (Section 3.2.1.1). Copepods exhibit diel vertical migration; that is, they migrate downward out of the euphotic zone at dawn, presumably to avoid being eaten by visual predators, and they migrate upward into surface waters at dusk to graze on phytoplankton at night (Baumgartner and Fratantoni 2008; Baumgartner et al. 2011). Baugmartner et al. (2011) conclude that there is considerable variability in this behavior and that it may be related to stratification and presence of phytoplankton prey with some copepods in the Gulf of Maine remaining at the surface and some remaining at depth. Because copepods even at depth are not in contact with the substrate, no burial or loss of copepods is anticipated during installation of the cable. No scientific literature could be identified that evaluated the effects on marine copepods resulting from exposure to TSS. Based on what is known about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that 1) the expected TSS levels are below those that are expected to result in effects on even the most sensitive species evaluated; 2) the sediment plume would be transient and temporary (i.e., persisting in any one area for no more than 6 hours); and 3) elevated TSS plumes would occupy only a small portion of the Project area at any given time; any effects on copepod availability, distribution, or abundance on foraging whales would be so small that they could not be meaningfully evaluated, measured, or detected.

Sperm and blue whales (Sections 3.2.4 and 3.2.5, respectively) predominantly feed in offshore, deep waters on pelagic prey. Given the shallow depths of the Project area (less than 203 feet [62 meters]) where elevated TSS would occur, it is extremely unlikely that any sperm or blue whales would be foraging in the area affected by sedimentation and unlikely that any potential sperm or blue whale prey would be affected by sedimentation.

Anticipated TSS levels are below the levels expected to result in the mortality of fish that are preyed upon by fin or sei whales. In general, fish can tolerate at least short-term exposure to high levels of TSS (Wilber and Clarke 2001). In an assessment of available information on sublethal effects on non-salmonids, the lowest observed concentration-duration combination eliciting a sublethal response in white perch (*Morone americana*) was 650 milligrams per liter for 5 days, which increased blood hematocrit (Sherk et al. 1974, in Wilber and Clarke 2001). Regarding lethal effects, Atlantic silversides (*Menidia menidia*) and white perch were among the estuarine fish with the most sensitive lethal responses to suspended sediment exposures, exhibiting 10 percent mortality at sediment concentrations less than 1,000 milligrams per liter for durations of 1 and 2 days, respectively (Wilber and Clarke 2001). Forage fish in the Action Area would be exposed to maximum TSS concentration-duration combinations far less than those demonstrated to result in sublethal or lethal effects of the most sensitive non-salmonids for which information is available. Based on this, no mortality of any forage fish is expected; therefore, no reduction in fish as prey for fin or sei whales is anticipated.

Based on the above analyses, any changes to marine mammals or their prey resulting from increases turbidity during proposed Project construction and decommissioning would be so small they could not be meaningfully measured and, therefore, **insignificant**.

The COP (Volume I, Appendix I-F; Epsilon 2022) presents results from a spill model assessing the trajectory and weathering of spilled material following a catastrophic release of all oil contents from an offshore ESP located at the closest potential position to shore from the SWDA. Each WTG would contain up to 17,413 gallons (65,915 liters) of oils, lubricants, coolant, and diesel fuel, while each ESP could contain up to 189,149 gallons (716,007 liters) of these fluids. Oils and lubricants would comprise the largest share of these stored materials. The maximum most probable discharge volume is 189,149 gallons (716,007 liters) (COP Volume I, Appendix 1-F; Epsilon 2022). According to Bejarano et al. (2013), the probability of occurrence of this type of catastrophic release, such as the topple of an ESP, is extremely small.

Proposed Project vessels generate exhaust and could be a source of potential accidental spills of petroleum-based toxics. Marine mammals that occur in the geographic 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). Additionally, accidental releases may result in impacts on marine mammals due to effects on prey species. However, the likely number of additional releases associated with future offshore wind would fall within the range of accidental releases that already occur on an ongoing basis from non-offshore wind activities. Although these effects are acknowledged, the likelihood of adverse population-level impacts on marine mammals from accidental releases of debris or contaminants from planned actions on the OCS is low.

As required under federal law, all proposed Project vessels would comply with USCG requirements for the prevention and control of oil and fuel spills and implement proposed BMP for waste management and mitigation, as well as marine debris awareness training for proposed Project personnel, reducing the likelihood of an accidental release. The applicant will have an oil spill response plan (Volume I, Appendix I-F; Epsilon 2022) in place that would decrease potential effects in the unlikely event of a spill by establishing response, containment, and removal procedures. Therefore, releases of contaminants from proposed Project vessels at levels that could affect marine mammals are unlikely to occur and are **discountable**.

Similarly, proposed Project vessels transiting within NARW critical habitat (Section 3.2.1.2) may present a risk of accidental releases or spills. However, only a limited number of proposed Project vessels would be present in this critical habitat throughout Project construction (Table 1-10), and they would be expected to follow all applicable guidelines such as those recommended by the International Convention for the Prevention of Pollution from Ships to minimize releases. Therefore, the likelihood of releases from proposed Project vessels that would alter the quality of NARW critical habitat is **discountable**.

Water quality effects resulting from activities under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals and NARW critical habitat.

3.2.6.5 Secondary Entanglement in Marine Mammals due to Increased and Altered Fishing Activity Caused by the Presence of Structures (Operations)

Offshore structures and the anticipated reef effect have the potential to lead to increased recreational fishing activity within the SWDA. This may result in an increased risk of interaction with fishing gear and may lead to entanglement, ingestion, injury, and death (Moore and van der Hoop 2012). The reef effect may result in drawing in recreational fishing effort from inshore areas, and overall interaction between marine mammals and fisheries could increase if marine mammals are also drawn to the SWDA due to increased prey abundance. Larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear may be more likely to be displaced from the SWDA compared to smaller fishing vessels with similar gear types that may be easier to maneuver. In addition, some potential exists for a shift in gear types from fixed to mobile, or from mobile to fixed gear, due to displacement from the SWDA. The potential impact on marine mammals from these changes is uncertain. However, if a shift from mobile gear to fixed gear occurs due to inability of the fisherfolk to maneuver mobile gear, there would be a potential increase in the number of vertical lines in the water column, resulting in an increased risk of marine mammal interactions with fishing gear. Additionally, abandoned or lost fishing gear (commercial and recreational) may become entwined within foundation structures and pose a hazard to marine mammals.

Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARWs and may be a limiting factor in the species' recovery (Knowlton et al. 2012). Over 80 percent of individual NARWs show evidence of at least one entanglement in fishing gear (Knowlton et al. 2012). Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species, including fin whales (Henry et al. 2020; Read et al. 2006).

The following monitoring and mitigation measure (Table 1-15) will act to reduce potential impacts on marine mammals resulting from lost or discarded fishing gear that accumulates around WTG foundations:

- The applicant must monitor indirect effects associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the SWDA annually. Survey design and effort may be modified with review and concurrence by Department of Interior. The applicant may conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The applicant must report the results of the surveys to BOEM and BSEE in an annual report for the preceding calendar year. Annual reports must include survey reports that include: the survey date; contact information of the operator; the location and pile identification number; photographic, video documentation, or both of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Annual reports must also include claim data attributable to the Project from the applicant corporate gear loss compensation policy and procedures. Required data and reports may be archived, analyzed, published, and disseminated by BOEM.

The implementation of the BOEM-proposed monitoring surveys would provide data regarding the presence of gear on structures that will help assess the secondary entanglement risk. Through this monitoring, removal actions could be taken if entanglement risk appears high, thus, reducing likelihood of any marine mammals becoming entangled. Currently, published data do not exist on the amount or type of debris that accumulates on offshore wind foundations in the U.S. Atlantic; therefore, the scale of entanglement risk is not known. The monitoring and disposition requirement provides BOEM with the ability to require removal of entanglement hazards should they occur.

Secondary entanglement of ESA-listed whale species would be unlikely, as contact with or presence in close proximity to the foundations are not expected. Unlike other marine mammals such as porpoise, dolphins, and seals, the ESA-listed whales are not expected to opportunistically forage on the foundations where contact with fishing gear caught on foundations would occur. The likelihood of ESA-listed whale entanglement occurring specifically with gear entrained on foundations is so low as to be **discountable**. Therefore, the effects of secondary entanglement due to altered fishing activity caused by the presence of structures **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.2.6.6 Vessel Traffic Effects on Marine Mammals (Construction, Operations, Decommissioning)

Proposed Project vessels working during all stages of the Proposed Action pose a potential collision risk to marine mammals. Additionally, the noise and disturbance generated by vessel presence may temporarily displace individual marine mammals from preferred habitats. HRG survey vessels would be limited to siting surveys and biological survey vessels with periodic activity on the wind farm and export cable routes. Vessel activity is anticipated to be highest during proposed Project construction, followed by decommissioning. The number of vessels operating during operations would be comparatively lower than during construction but would be long-term throughout the operational lifespan of the proposed Project.

Vessel-animal collisions are a measurable source of mortality and injury for many marine mammal species (Laist et al. 2001; Vanderlaan and Taggart 2007; Martin et al. 2016; Hayes et al. 2022), indicating the importance of protective measures to minimize risks to vulnerable species. Vessel strikes are of particular concern for mysticetes due to their size, relatively slow maneuverability, proportion of time spent at the surface between dives, lack of clear and consistent avoidance behavior, and their relatively low detectability by vessels without focused observation efforts (Garrison et al. 2022; Gende et al. 2011; Rockwood et al, 2017; Martin et al. 2016). Vessel strikes are a known or suspected contributor to three active unusual mortality events in the Atlantic Ocean for cetaceans (humpback whale, minke whale, and NARW) (NMFS 2023h).

If a vessel strike does occur, the impact on marine mammals would range from minor injury to mortality of an individual, depending on the species and severity of the strike. Injuries are typically the result of one of two mechanisms: either blunt force trauma from impact with the vessel or lacerations from contact with the propellers (Wiley et al. 2016). Depending on the severity of the strike and the injuries inflicted, the animal may or may not recover (Wiley et al. 2016). The size of the vessel and animal, speed of the vessel, and the orientation of the marine mammal with respect to vessel trajectory would all affect the severity of the injury (Vanderlaan and Taggart 2007; Martin et al. 2016).

The ability for vessel operators to detect a marine mammal within the path of the moving vessel can reduce vessel strike risk and is dependent on a variety of factors, including atmospheric/visibility conditions, observer training and experience, and vessel size and speed. Vessel speed is inversely correlated with detection rates, such that slower transit speeds, especially those below 9.7 knots (5.0 meters per second), generally lead to a higher in-time detection rates for most vessel sizes provided adequate (3,281 feet [greater than 1,000 meters]) reliable detection ranges (Baille and Zitterbart 2022).

Almost all sizes and classes of vessels have been involved in collisions with marine mammals around the world, including large container ships, ferries, cruise ships, military vessels, recreational vessels, commercial fishing boats, whale-watch vessels, research vessels, and even jet skis (Dolman et al. 2006; Winkler et al. 2020).

Primary factors that affect the probability of a marine mammal-vessel strike include:

- Density, distribution, species, age, size, speed, health, and behavior of animal(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Number, speed, and size of vessel(s) (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Vessel path (Vanderlaan and Taggart 2007; Martin et al. 2016);
- Operator's ability to detect and avoid collisions (Martin et al. 2016; Williams et al. 2016); and
- Animal's ability to detect an approaching vessel and propensity to avoid collisions (Gende et al. 2019; McKenna et al. 2015; Nowacek et al. 2004).

A marine mammal's ability to detect and actively avoid a vessel collision is poorly understood. An individual's aversion to an approaching vessel is likely dependent on the age and behavioral state of the animal and will differ among species (Gende et al. 2019; McKenna et al. 2015; Nowacek et al. 2004). Auditory recognition of a vessel by a marine mammal such that timely avoidance is triggered is likely highly variable and highly contextual. The following factors can impair the ability of a marine mammal to detect and locate the sound of an approaching vessel:

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

Vessel speed and size are two of the most important factors for determining the probability and severity of vessel strikes. The size and bulk of the large vessels inhibits the ability for crew to detect and react to marine mammals along the vessel's transit route. In 93 percent of marine mammal collisions with large vessels reported in Laist et al. (2001), whales were either not seen beforehand or were seen too late to be avoided. Laist et al. (2001) reported that the most lethal or severe injuries are caused by ships 262 feet (80 meters) or longer traveling at speeds greater than 13 knots (6.7 meters per second). An analysis conducted by Conn and Silber (2013) built upon collision data collected by Vanderlaan and Taggart (2007) and Pace and Silber (2005) and included new observations of serious injury to marine mammals as a result of vessel strikes at lower speeds (e.g., 2 and 5.5 knots [1.0 and 2.8 meters per second]). The relationship between lethality and strike speed was still evident; however, the speeds at which 50 percent probability of lethality occurred was approximately 9 knots (4.6 meters per second). Smaller vessels have also been involved in marine mammal collisions. Minke, humpback, and fin whales have been killed or fatally wounded by whale-watching vessels around the world (Jensen and Silber 2003). Strikes have occurred when whale watching boats were actively watching whales, as well as when they were transiting through an area, with the majority of reported incidences occurring during active whale watching activities (Laist et al. 2001; Jensen and Silber 2003).

The construction vessels that would be used for proposed Project construction are described in Section 1.4.1.2.6 and Table 1-9. As discussed, a wide variety of vessels would be used during construction, ranging from tugboats (52 to 115 feet [16 to 35 meters] in length) to jack-up, heavy-lift, and heavy transport vessels (more than 700 feet [213 meters] in length) (COP Volume I, Table 3.3-1; Epsilon 2022). Based on information provided in the COP, construction activities (including offshore installation of WTGs, ESPs, array cables, interconnection cable, and export cable) would require a daily average of approximately six and seven vessel round trips per day under an 18-month offshore construction schedule for Phase 1 and Phase 2, respectively. An average of up to 15 vessel round trips could occur during the most active month of construction, which is expected to be during pile-driving activities only during each phase. The maximum transit speed of these vessels varies from 6 to 30 knots (3 to 15 meters per second), though operational speeds are typically lower, ranging from 0 to 25 knots (0 to 13 meters per second). Proposed Project vessels within the SWDA would usually be stationary during construction or traveling at slow speeds, although transits between ports and the SWDA may result in speeds greater than or equal to 10 knots (5 meters per second). New Bedford Harbor is expected to be the primary port used to support construction activities, followed by ports in Connecticut, Rhode Island, and Martha's Vineyard, Massachusetts. Although Canadian and European ports may be used during construction, transits from these would comprise a small percent of overall vessel transits during Proposed Action construction (Table 1-10).

The daily average of six Phase 1 and seven Phase 2 Project vessel round trips per day would represent a 580 percent increase over the current number of daily average vessel transits in the SWDA. However, there are several limitations to the baseline vessel traffic data as analyzed by the Navigation Safety Risk Assessment (COP Appendix III-I; Epsilon 2022) that preclude a direct comparison between the proposed Project and ongoing vessel activity. First, as discussed in Section 2.1.3.2, AIS data does not capture all vessel activity in a region, so it is likely to underestimate actual vessel transits, particularly for smaller vessels. Secondly, vessel activity in the SWDA is highly seasonal, with a 16-fold difference in vessel transits between the low in February (0.4 transits per day, average) and high in August (6.4 transits per day, average). Additionally, baseline vessel activity is much higher along some portions of the OECC than in the SWDA; a daily average of 71 vessels cross the OECC (COP Appendix III-I; Epsilon 2022), though this number cannot necessarily be used to represent the actual number of transits in the region and, therefore, is incompatible with proposed Project vessel transit projections. Finally, the baseline vessel traffic data for the SWDA and OECC do not include regional traffic levels, which is higher in the shipping lanes south of the Project area and coastal regions north and west of the Project area (COP Appendix III-I; Epsilon 2022). As a result of these data limitations, it can be assumed that Proposed Action construction would increase vessel traffic in the SWDA and OECC, though the significance of the increase is poorly quantifiable based on available data. Decommissioning vessel activities are expected to be comparable or less than those anticipated for construction.

During operations, the Proposed Action would generate trips by crew transport vessels (about 75 feet [23 meters] in length) and service operations vessels (260 to 300 feet [79 to 91 meters] in length); other vessels may be used for routine and non-routine maintenance activities, as discussed in Section 1.4.2.2. Approximately 250 vessel round trips are estimated to take place annually for Phase 1 operations, equating to less than one round-trip transit per day. While vessel activity during Phase 2 operations would be similar to that of Phase 1, some vessels may be shared between Phases 1 and 2, thus consolidating trips while both phases are operating. Approximately 470 vessel round trips are estimated to take place annually during the simultaneous operations of both phases, which equates to an average of less than two vessel round trips per day. The majority of vessel transits during Phase 1 and Phase 2 operations would originate from Bridgeport, Connecticut and Vineyard Haven, Massachusetts. Crew transfer vessels have typical operational speeds of 10 to 25 knots (5 to 13 meters per second), whereas service operations vessels are slower, operating at 10 to 12 knots (5 to 6 meters per second) (Table 1-12). During Phase 1 and Phase 2 operations, there is no planned use of Canadian or European ports, though use of Canadian or other U.S. ports could occur to support an unplanned event. While the same limitations as discussed above for construction activities also exist for comparing proposed Project operations vessel activity to current baseline levels, an increase in vessel activity over baseline is expected as a result of the Proposed Action operations, potentially up to 107 percent above current daily averages.

In general, NARW and fin whale densities are relatively high in the Project area, whereas densities for sei, sperm, and blue whales are comparatively lower (JASCO 2023). The highest regional densities of NARWs occur in the waters north of the SWDA during winter and west of the SWDA during spring, though year-round presence in the region, including the SWDA, is possible (Section 3.2.1). Their heightened abundance during the winter and spring coincides with the seasonal pile driving restrictions. The highest densities of fin (Section 3.2.2) and sei (Section 3.2.3) whales in the Project area are expected during the summer and spring, respectively, which coincides with the peak construction period. Sperm whales (Section 3.2.4) may occur in the Project area in low numbers during summer and fall. Blue whales (Section 3.2.5) are considered rare in the Project area, and the likelihood of occurrence is very low. Table 3-8 provides the monthly and May to December average densities for marine mammals included in the modeling; blue whale densities were not calculated but, for comparison, are considered much lower than the sei whale (JASCO 2023). These densities, and corresponding abundances expected for the SWDA, are summarized below:

- Fin whale density estimates have a high of 0.0044 animals per km^2 in July and a low of 0.0005 animals per km^2 in November. This equates to less than one fin whale within the 175-square-mile (453-km^2) SWDA during their period of expected maximum abundance in the summer;
- NARW whale density estimates have a high of 0.0046 animals per km^2 in April and a low of 0.0002 animal per km^2 in August. This equates to up to two NARWs within the 175-square-mile (453-km^2) SWDA during their period of expected maximum abundance in the spring;
- Sei whale density estimates have a high of 0.0019 animals per km^2 in May and a low of 0.0001 animals per km^2 in August. This equates to less than one sei whale within the 175-square-mile (453-km^2) SWDA during their period of expected maximum abundance in the spring; and
- Sperm whale density estimates have a high of 0.0011 animals per km^2 in August and a low of 0.0000 animals per km^2 in April. This equates to less than one sperm whale within the 175-square-mile (453-km^2) SWDA during their period of expected maximum abundance in the summer.

The Proposed Action includes a range of mitigation and monitoring measures to minimize the potential for vessel collisions and impacts on marine mammals (Section 1.4.5; Table 1-15). A final vessel plan, which will include all vessel strike avoidance measures, will be submitted to NMFS and BOEM at least 120 days prior to commencement of vessels used for any proposed Project construction activities. Standard measures that will be included in the vessel plan, as presented in Table 1-15, are:

- Vessel strike avoidance policy – general measures:
  - The Project will implement a vessel strike avoidance policy for all vessels under contract to the applicant to reduce the risk of vessel strikes and the likelihood of death and/or serious injury to marine mammals, sea turtles, or ESA-listed fish that may result from collisions with vessels.
  - Provide Project-specific training for all vessel crew prior to the start of construction activities to ensure they are able to identify marine mammals and sea turtles and are fully aware of best practices for avoiding vessel collisions.
  - Require trained vessel operators and crew members or third-party observers, whichever is selected, to maintain a vigilant watch for marine mammals and sea turtles during all vessel operations.
  - All attempts will be made to remain parallel to the animal's course when a travelling marine mammal is sighted in proximity to the vessel in transit. All attempts will be made to reduce any abrupt changes in vessel direction until the marine mammal has moved beyond its associated separation distance (as described below).
  - If an animal or group of animals is sighted in the vessel's path or in proximity to it, or if the animals are behaving in an unpredictable manner, all attempts will be made to divert away from the animals or, if unable due to restricted movements, reduce speed and shift gears into neutral until the animal(s) has moved beyond the associated separation distance (except for voluntary bow riding dolphin species).
  - All vessels will employ a dedicated lookout during all operations.
  - All vessels will check NARW sightings information daily.
  - All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW.

  - Require use of AIS on each Project vessel.
  - Employ and use year-round an observer that has undergone marine mammal training, to be stationed on vessels transiting to and from the SWDA if traveling over 10 knots (5 meters per second).
- Vessel separation distances:
  - Vessels will maintain, to the extent practicable, separation distances of:
    - Greater than 1,640 feet (500 meters) distance from any sighted ESA-listed whale, including the NARW or unidentified large whale;
    - Greater than 328 feet (100 meters) from sperm whales and non-ESA listed baleen whales; and
    - Greater than 164 feet (50 meters) for dolphins, porpoises, seals, and sea turtles.
- Vessel speed restrictions:
  - All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW, including updates to the NARW Speed Rule if the Proposed Rule (87 Fed. Reg. 46921) is adopted.
  - All proposed Project-related vessels will comply with 10 knot speed restrictions in any seasonal management area (SMA), dynamic management area (DMA), or slow zone. In addition, all vessels 65 feet (20 meters) or larger operating from November 1 through April 30 will operate at speeds of 10 knots (5 meters per second) or less.
  - Reduce speeds within a voluntary DMA to less than 10 knots (5 meters per second) unless visual surveys or PAM are conducted that demonstrate that NARW are not present in the transit corridor.
  - All proposed Project-related vessels will reduce vessel speed to 10 knots (5 meters per second) or less when mother/calf pairs, pods, or larger assemblages of whales are observed near an underway vessel.
  - If an animal is sighted within their respective separation distance (described above), vessels must steer a course away from the animal at 10 knots (5 meters per second) or less until the minimum separate distance is established.
  - Implement vessel speed restrictions from November 1 to May 14, limiting vessel speed to less than 10 knots (5 meters per second) within the SWDA. When transiting to or from the SWDA (except while in Nantucket Sound, which has been demonstrated by best available science to not provide consistent habitat for NARW), vessels must travel at less than 10 knots (5 meters per second) or implement visual surveys or PAM to ensure the transit corridor is clear of NARW.

The contribution of the number of vessel trips under the proposed Project compared to current baseline levels would be moderate to high during construction. As a result, there is a moderate risk of interaction between marine mammals and proposed Project vessel traffic during construction based on the density of marine mammals in the Action Area and the estimated vessel activity over the total construction period. The highest levels of proposed Project-related vessel activity would occur during peak construction, which is expected to occur during pile-driving activities. With the implementation of seasonal restrictions for pile driving (Section 1.4.5), these highest levels of projected vessel activity would not occur during the months when NARW presence is predicted to be the highest (January through April), thereby lowering NARW encounter potential. There is an overall lower risk of vessel interaction with marine mammals in the Action Area during operations based on the density of marine mammals in the Action Area and the estimated activity over the operational life of the proposed Project. However, this risk would be present throughout operations and is, therefore, considered long term.

While the baseline encounter rate for vessels and animals to be within a strike risk with one another is already low, several factors are expected to further reduce the probability of a Proposed Action-related vessel strike. The communication and reporting procedures outlined in Table 1-15 are designed to increase awareness to the presence of marine mammals, and NARWs in particular. All proposed Project-related vessels operating in the U.S. EEZ are required to post trained and dedicated lookouts onboard that would use the best available tools and/or technology to continuously monitor the vessel strike zone. All protected species sightings would be shared among all proposed Project vessels to increase situational awareness to the presence of marine mammals. Although the Proposed Action would result in temporary, high levels of vessels operating in the Action Area during peak construction, data sharing amongst all vessels would be beneficial to each trained lookout. When combined with the effective implementation of vessel strike avoidance mitigation measures (Table 1-15; COP approval conditions), encounters that have a high risk of resulting in collision, or injury would be minimized by reducing both the encounter potential (e.g., separation distances, seasonal restrictions, avoidance of aggregations) and severity potential (e.g., speed reduction, vessel positioning parallel to animals). Slower operational speeds of less than or equal to 10 knots (5 meters per second) would allow whales to avoid vessels, vessels to avoid whales, or both to take evasive actions. Additionally, slower vessel speeds are generally correlated with a reduction in injury extent and reduced instances of mortality when compared to faster vessel speeds (Vanderlaan and Taggart 2007). All vessels, including those traveling faster than 10 knots (5 meters per second), are required to maintain minimum separation distances of 1,640 feet (500 meters) from all observed ESA-listed whales (Section 1.4.5). While this measure cannot entirely eliminate an undetected marine mammal from entering this zone, a reduction in strike/injury risk ultimately relies on the ability for a responsive action to be taken if there is an encounter with a marine mammal. The deployment of trained lookouts on all vessels along with operable and effective monitoring equipment, including equipment specialized for low-light conditions (i.e., thermal imaging, night vision devices) to effectively monitor at night, would serve to minimize the collision and injury risk of any encounters that may occur.

The Action Area also includes potential transit routes of vessels transporting offshore WTG components from Canada and Europe during proposed Project construction, with operational speeds of up to 18 knots (9 meters per second) (Table 1-12). Based on the best available data, a maximum total of 400 and 620 round trips are estimated for the entire 36-month construction period from Europe and Canada, respectively, equating to approximately 1 round trip per day on average for each (Table 1-10). This maximum-case scenario estimate is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic. At-sea vessels on cross-ocean transits are not anticipated to employ PSOs or travel at reduced speeds. Given the low density of ESA-listed marine mammals throughout the North Atlantic 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, no foreign vessel transits are anticipated during proposed Project operations; in the rare case in which a foreign transit is needed during operations, the risk to ESA-listed marine mammal populations would be exceedingly small given the rarity of such transits over the 30-year operations stage and the implementation of the above-described monitoring and mitigation measures. The likelihood of an encounter due to the temporary increase in vessel traffic to and from Canada and Europe would, therefore, be a rare event. Therefore, proposed Project-related vessel traffic to and from Canada and Europe would result in **discountable** effects on ESA-listed marine mammals.

Vessel transits originating from Salem, Massachusetts, would traverse designated NARW critical habitat (Section 3.2.1.2). Additionally, vessels transiting to/from Canada may, but not necessarily, traverse the farthest offshore portion of the NARW Gulf of Maine foraging habitat Unit 1. Vessels transiting from Europe may, but are unlikely to, enter NARW critical habitat given established shipping lanes, and the most direct route from Europe to the U.S. would not intersect this critical habitat. Based on the best available data, a maximum total of 610 round trips are estimated for the entire 36-month construction period from Salem Harbor, Massachusetts, equating to approximately 1 round trip per day on average for each (Table 1-10). The number of proposed Project-related vessels that may transit any portion of NARW critical habitat is considered relatively low when compared to the existing high levels of commercial and recreational vessel traffic in the region. Vessel transits through Unit 1 as a result of the Proposed Action would not affect or modify the biological or physical oceanographic conditions associated with foraging area functions (i.e., the distribution and aggregations of *C. finmarchicus*). If any proposed Project-related transits enter NARW critical habitat, all aforementioned monitoring and vessel strike avoidance measures would continue to be implemented. It is not anticipated that any proposed Project-related vessel transits would disrupt NARW feeding behaviors or foraging resources to any appreciable or measurable level given the low frequency of these transits. Therefore, proposed Project-related vessel transits would have an **insignificant** effect on NARW critical habitat.

The risk of vessel strike cannot be fully eliminated due to the unpredictable nature of animal-vessel interactions, even with dedicated observers. However, vessel strike risk, and importantly, injury resulting from vessel strikes, can be significantly reduced to a negligible level by strict adherence to the guidelines and proposed mitigation measures outlined in the vessel strike avoidance measures in Section 1.4.5. Therefore, vessel strike risk is low, but not eliminated, when monitoring and mitigation activities are effectively implemented, as outlined, and trained, dedicated lookouts are used on all vessels. With full implementation of mitigation measures, the potential for injury-causing vessel strikes to ESA-listed marine mammals is unlikely and **discountable**.

An additional potential effect of vessel traffic on marine mammals or their prey is spills from refueling or vessel-to-vessel/vessel-to-structure collisions. Effects on individual marine mammals, including decreased fitness, health effects, and mortality, may occur if individuals are present in the vicinity of a spill, but accidental releases are expected to be rare, and injury or mortality are not expected to occur. Proposed Project vessels would comply with USCG requirements for the prevention and control of oil and fuel spills and implement proposed BMPs for waste management and mitigation, as well as marine debris awareness training for proposed Project personnel, reducing the likelihood of an accidental release. The applicant will have an oil spill response plan (COP Appendix I-F; Epsilon 2022) in place that would decrease potential effects in the unlikely event of a spill. Therefore, vessel spills are not anticipated, and distribution of spills into the surrounding environment where damage may occur to animals or habitat is not anticipated when monitoring and mitigation activities are effectively implemented, as outlined. Thus, vessel accidents and spills would have an **insignificant** effect on ESA-listed marine mammals and critical habitat.

The effects of vessel traffic during proposed Project activities **may affect, not likely to adversely affect** ESA-listed marine mammals and NARW critical habitat.

3.2.6.7 Monitoring Survey Effects on Marine Mammals

The components of the HRG, fisheries, and benthic habitat monitoring surveys during pre- and post-construction, as well as during construction, are described in Section 1.4.4. The stressors associated with survey activities that may affect ESA-listed marine mammals include vessel strike, entanglement or entrapment, and impacts on prey resources.

3.2.6.7.1 Vessel Strike

As discussed in Section 3.2.6.6, vessel strikes are a known source of injury and mortality for ESA-listed marine mammals. Increased vessel activity in the Project area associated with the Proposed Action, including vessel traffic associated with HRG, fisheries, and habitat monitoring surveys, would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species. In general, large vessels traveling at high speeds pose the greatest risk of mortality to ESA-listed marine mammals.

Vessels conducting fisheries monitoring surveys would be commercial fishing vessels, ranging in size from 30 to 100 feet (9.1 to 30 meters) (Table 1-14). Operational survey speeds are survey-type and vessel dependent. Demersal otter trawl surveys are conducted at 3 knots, while neuston net sampling is conducted at 4 knots (Appendix B); all other fisheries monitoring surveys (i.e., drop camera, ventless trap, fish pot, and lobster tagging) are expected to be conducted either stationary or at idle speeds during active gear deployment or recovery. Transit speeds for these vessels may exceed 10 knots but will be maintained as legally mandated (73 Fed. Reg. 60173 and 87 Fed. Reg. 46921, if adopted). Each sampling type (i.e., demersal otter trawl, drop camera, and ventless trap study) would use a single vessel per trip; the neuston net sampling would use the same vessel and trip as the ventless trap study and require no additional vessel trips. Additionally, the exact ports that would be used by vessels conducting the fisheries monitoring surveys are currently unknown, though homeports for vessels will be in Rhode Island or Massachusetts.

The total number of vessels conducting HRG, fisheries, and benthic habitat monitoring surveys is expected to be a small proportion of the number of vessels and transits analyzed for construction, operations, and decommissioning activities, given the limited extent and duration of the proposed surveys relative to ongoing proposed Project activities (Section 1.4.4). The same mechanisms and stressors associated with vessel strike risk analyzed for proposed Project construction, operations, and decommissioning activities would apply to vessel activity associated with fisheries and habitat monitoring surveys under the Proposed Action. In addition, the monitoring and mitigation measures for vessel strike avoidance during all fisheries monitoring surveys as presented in Table 1-15 would be implemented during monitoring surveys. This analysis is not repeated here.

The monitoring surveys under the Proposed Action; inclusive of HRG surveys, benthic habitat monitoring surveys, and fisheries monitoring surveys; would not significantly increase vessel traffic in the Project area compared to other proposed Project-related vessel activities and regional vessel traffic already occurring in the Project area. In consideration of proposed Project-related monitoring survey design, vessel strike risk, and the implementation of mitigation and monitoring measures, the potential for vessel strike would be **discountable**. Therefore, vessel traffic during proposed Project-related monitoring surveys **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.2.6.7.2 Gear Utilization

As described in Section 1.4.4, the applicant is planning to conduct demersal otter trawl, drop camera, ventless trap, fish pot, lobster tagging, and Neuston net sampling surveys. The monitoring plan is proposed to be 6 years in duration, including 2 years of pre-construction baseline monitoring, 1 year of monitoring during construction, and 3 years of post-construction monitoring. Survey design, frequency, and extent are discussed in Section 1.4.4.2. Additionally, multibeam echo sounder, video, and benthic grab sampling would be conducted under the BHMP during pre-construction and Years 1, 3, and, if necessary, Year 5 after construction (Section 1.4.4.1). Each component of the monitoring plan presents differential entanglement risk and impacts on prey species to ESA-listed marine mammals, as discussed below.

Theoretically, any line in the water column, including line resting on or floating above the seafloor set in areas where whales occur, could entangle a marine mammal (Johnson et al. 2005). Entanglements may involve the head, flippers, or fluke; effects range from no apparent injury to death. Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and may be a limiting factor in the species recovery (NMFS 2023e; Knowlton et al. 2012). Current estimates indicate that 83 percent of NARWs show evidence of at least one past entanglement and 60 percent with evidence of multiple fishing gear entanglements, with rates increasing over the past 30 years (King et al. 2021; Knowlton et al. 2012). Of documented NARW entanglements in which gear was recovered, 80 percent was attributed to non-mobile fishing gear (i.e., lobster and gillnet gear) (Knowlton et al. 2012). Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species, including fin whales (Henry et al. 2020; Read et al. 2006).

Neuston sampling is conducted with a plankton net towed and slow speeds (4 knots) for short periods (10 minutes) in the top 1.6 feet (0.5 meter) of the water column. The Neuston net frame is 2.4 meters by 0.6 meter by 6.0 meters (7.8 feet by 1.9 feet by 19.6 feet) in size, and the net is made of a 1,320-micrometer mesh; given the size of the net relative to the body size of ESA-listed marine mammals, no marine mammal entanglement is expected to occur from Neuston net sampling. Drop camera sampling is conducted directly from the stern of vessel and includes continuous monitoring of the seabed. Similarly, HRG and benthic habitat monitoring surveys would not use gear that pose an entanglement risk to marine mammals. Therefore, entanglement risk due to the methodology presented for Neuston net, drop camera, and benthic habitat monitoring surveys is extremely unlikely and, therefore, **discountable** for ESA-listed marine mammals.

Demersal otter trawls and ventless traps, which are also used for the lobster tagging study, pose an entanglement risk to marine mammals. NMFS' 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 concluded that impacts on NARW, humpback, fin, sei, and blue whales, if any, as a result of trawl gear use would be expected to be extremely unlikely to occur. The slow speed of mobile trawl 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 (NMFS 2016b). Under the Proposed Action, the vessel operating the trawl (a commercial fishing vessel) would tow at 3 knots; the total effort of trawl surveys for the proposed Project is 50, 20-minute tows four times per year or 66.6 hours per year and 400 hours over a 6-year period. Although the trawl methods analyzed in commercial fisheries are comparable to the fishery monitoring methods proposed, the proposed trawl effort and tow durations (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 ESA-listed marine mammals is lower than commercial fishing activities.

Large whales are vulnerable to entanglement in stationary vertical and ground lines associated with trap/pot gear, including ventless trap surveys. The Final Environmental Impact Statement, Regulatory Impact Review, and Initial Regulatory Flexibility Analysis for Amending the Atlantic Large Whale Take Reduction Plan: Risk Reduction Rule (NOAA 2021) provides an analysis of data that show entanglement in commercial fisheries gear represents the highest proportion of all documented serious and non-serious incidents reported for humpback, NARW, fin, and minke whales. Entanglement was the leading cause of serious injury and mortality for NARW, humpback, fin, and minke whales from 2010 to 2018 for cases where the cause of death could be identified (NOAA 2021). As discussed in the Atlantic Large Whale Take Reduction Plan, it is believed that the weak links allow the buoy to break away and the rope to pull though the baleen if an entanglement occurs, although it is difficult to assess how well the weak link reduces serious injury and mortality (NOAA 2021). Another recommended risk reduction measure proposed is the use of weak rope or weak insertions. Based up Knowlton et al. (2016), it is assumed that weak rope (engineered to break at 1,700 pounds or less) would allow whales to break free from the ropes and avoid a life-threatening entanglement (NOAA 2021). Consistent with the best available information on gear configurations to reduce entanglement risk, sinking groundlines, weak links and line with 1,700-pound (771-kilogram) breaking strength or less is incorporated into the survey plan under the Proposed Action and would be implemented in all equipment used in the fisheries monitoring surveys. Additionally, the soak time for the ventless trap study is limited to 3 days (as feasible), and all trap and pot gear would be removed from the water between survey periods. Ventless trap surveys will be conducted seasonally, with sampling conducted at 30 stations twice monthly from May through December. The May to December mean monthly density of NARWs in the vicinity of the SWDA is 0.00086 individuals per square kilometer, which equates to less than one individual present within the SWDA per month during this time period. This seasonality, therefore, would avoid the time of year when NARW are predicted to be in the Action Area in high densities, which will lower the likelihood of interaction between the species and proposed Project-related trap gear and overall entanglement risk. Additional monitoring and mitigation measures (described below and in Section 1.4.5) would be employed to further minimize entanglement risk to NARW and other ESA-listed marine mammals.

The applicant has proposed mitigation measures to reduce bycatch and entanglement risk (Table 1-15), including mitigation measures that will be employed for each gear type. The mitigation measures, combined with the seasonal deployments of traps (Section 1.4.4.1) makes marine mammal entanglement and entrapment highly unlikely during fisheries monitoring surveys using otter trawls and ventless traps, and the risk is considered **discountable**.

Demersal trawl gear is designed to operate on or very near the bottom. NARWs feed on copepods and blue whales on krill exclusively, which are expected to pass through trawl gear used for the proposed Project and not be affected by turbidity created by the gear. Sperm whales feed on deep water species that do not occur in the area to be surveyed. Fin and sei whales consume prey species that have potential to be removed by trawl gear. However, the biological opinion for the Northeast Fisheries Science Center surveys are estimated to remove a negligible few hundred tons of prey fish per year total compared to the overall fish consumption of blue, humpback, and fin whales (NMFS 2016b). The proposed trap survey activities would not have any effects on the availability of prey for NARWs, blue whales, fin whales, sei whales, and sperm whales. NARW, blue, fin, and sei whale prey are small and would be able to pass through trap gear rather than being captured in it. Sperm whales feed on deep water species that do not overlap with the study area where trap activities would occur. Neuston net sampling is designed to collect planktonic organisms at the ocean's surface, which may include capture of prey for NARW and blue whales. However, blue whales typically feed in deep waters that generally do not overlap with the study area where sampling would occur. The feeding habitat of NARW does overlap with the Project area. However, given the short tow lengths (10 minutes) and small net volume, no measurable effect on NARW prey availability is expected. Similarly, fin and sei whale prey are not expected to be captured in volumes that could affect overall prey availability during Neuston net surveys. Under the BHMP, a benthic/sediment grab sampler (e.g., Van Veen, Day, Ponar) would be employed to retrieve sediments from the upper 10 to 20 centimeters (3.9 to 7.8 inches) of the seabed for analysis; a total of 252 grab samples would be collected for each annual survey. The only marine mammal prey resource that would potentially be captured during the BHMP surveys are sand lance. However, given the limited extent of the benthic grab surveys, any removal of fin and sei whale prey species would be non-measurable and negligible compared to the overall fish consumption of ESA-listed marine mammals. Impacts on NARW, sperm, and blue whale prey are not anticipated as a result of benthic grab sampling. In summary, effects from the proposed trawl, trap, Neuston net and benthic grab sampling surveys on the availability of prey for ESA-listed marine mammals are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

In summary, any effects from monitoring surveys (e.g., entanglement, reductions in prey) on marine mammals are considered extremely unlikely to occur and **discountable** or are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of gear utilization during monitoring surveys under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.2.6.8 Electromagnetic Field and Cable Heat Transfer Effects on Marine Mammals (Operations)

Normandeau Associates, Inc. (Normandeau et al. 2011) reviewed available evidence on marine mammal sensitivity to human-created EMF in the scientific literature. Although the scientific evidence is generally limited, available studies suggest that baleen and toothed whales, including the ESA-listed species known or likely to occur in the Project area, are likely sensitive to magnetic fields based on the presence of magnetosensitive anatomical features and observed behavioral and physiological responses. Marine mammals are likely to orient to the earth's magnetic field for navigation, suggesting they may have the ability to detect induced magnetic fields from underwater electrical cables. There is a potential for animals to react to local variations of the geomagnetic field caused by power cable EMF. Depending on the magnitude and persistence of the confounding magnetic field, such an effect could cause a trivial temporary change in swim direction or a longer detour during the animal's migration (Gill et al. 2005). Such an effect on marine mammals is more likely to occur with direct current cables than with AC cables (Normandeau et al. 2011). Assuming a 50-mG sensitivity threshold (Normandeau et al. 2011), marine mammals could theoretically be able to detect EMF effects from other, similar, inter-array and export cables but only in close proximity to cable segments lying on the bed surface. Individual marine mammals would have to be within 3 feet (0.9 meters) or less of those cable segments to encounter EMF above the 50-mG detection threshold. This, however, is unlikely to occur for durations of time that may affect an individual's ability to navigate or orient during migrations or other biologically necessary movements given the proportion of time ESA-listed marine mammals spend at the ocean's bottom in comparison to where they spend the majority of their time (i.e., at the surface, near-surface, and mid water column). Modeled magnetic field levels specific to the proposed Project's cables are not available on the New England Wind Project COP webpage following the June 2022 update (BOEM 2022b). However, both OECC and inter-array cable arrays are AC, and the applicant would bury these cables to a target depth of 5 to 8 feet (1.5 to 2.5 meters). Given the low field intensities expected and the limited extent of detectable effects relative to body size, swimming speed, dive durations, and overall movement patterns, effects of EMF on marine mammals that could disrupt biologically relevant behaviors are unlikely to occur and would be **discountable**.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. As a result, heat from submarine high-voltage cables is not likely to affect marine mammals and would be **discountable**.

Therefore, effects of EMF exposure and heat transfer from proposed Project cables operating under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.2.6.9 Dredging Effects on Marine Mammals (Construction, Decommissioning)

As described in Section 1.4.1.2.4, dredging of sand waves along portions of the OECC may occur under the Proposed Action; however, it would be limited to only the extent required to achieve the desired cable burial depth during installation of the offshore export cable for both proposed Project phases. It is conservatively estimated the dredge corridor would be 15 meters wide, but the depth would vary based on local site conditions during cable installation. Dredging may be accomplished through the use of a TSHD or through jetting by controlled flow excavation (Section 1.4.1.2.4). The geographic extent over which dredging would occur under the Proposed Action is site-specific, not extensive, and estimated to be approximately 119 acres (0.48 km^2) during Phase 1 and Phase 2 combined (COP Appendix III-T; Epsilon 2022). This limited extent minimizes the risk for marine mammals in the Project area. Impacts on marine mammals due to increased turbidity resulting from dredging activities is discussed in Section 3.2.6.4. ESA-listed marine mammals in the Project area are not expected to face a risk of entrainment, impingement, or capture in dredging equipment associated with the Proposed Action due to their relatively large body size and through the implementation of standard vessel strike avoidance mitigation measures that require minimum separation distances form all ESA-listed marine mammals (Section 1.4.5). The physical presence of dredging vessels and equipment could potentially displace marine mammals. However, given the limited spatial extent predicted for dredging under Phase 1 and Phase 2 combined, any effect on marine mammals would be so small that it could not be meaningfully evaluated.

Indirect effects from dredging may include impacts on prey species. Invertebrates, eggs, and larvae are most vulnerable to the effects of dredging, whereas pelagic prey items are extremely unlikely to be affected due to the operation of dredges on the seafloor (Todd et al. 2015). Therefore, species that predominantly feed on pelagic prey items are unlikely to be affected by dredging under the Proposed Action. Sand lance would be the most likely prey item to become entrained in a hydraulic dredge due to their bottom orientation and burrowing within sandy sediments that require clearing by the proposed Project. Fin whales prey on sand lance (Section 3.2.2). However, Reine and Clarke (1998) found that not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6 percent for entrained fish. It is expected that dredging in sand waves to allow for cable installation would result in the entrainment and mortality of some sand lance. However, given the limited spatial extent of the area where dredging would occur, the short duration of dredging, the expectation that most entrained sand lance will survive, and that sand lance are only one of several species available for fin whales to forage on while in the Action Area, it is expected any impact of the loss of sand lance on this species to be so small that it cannot be meaningfully measured, evaluated, or detected. Based on their foraging preferences, prey availability for the NARW, sei whale, sperm whale, and blue whale are not likely to be affected by seabed disturbance from dredging activities under the Proposed Action.

Based on the above analyses, the potential effects of dredging on marine mammals, including entrainment, displacement, and impacts on prey species, would be so small that they cannot be meaningfully measured, evaluated, or detected and would be **insignificant**. Therefore, effects from dredging under the Proposed Action **may affect, not likely to adversely affect** ESA-listed marine mammals.

3.3 Sea Turtles

Four ESA-listed species of sea turtles may occur in the Project area: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), Kemp’s ridley (*Lepidochelys kempii*), and green (Table 2-1). All these sea turtle species are migratory and enter New England waters primarily in the summer and fall. These species may use the Project area for travel, foraging, diving at depth for extended periods, and possibly for extended rest periods on the seafloor. Targeted surveys have been conducted for sea turtles near the Project area, and the results are summarized in the following subsections.

3.3.1 Loggerhead Sea Turtle

Loggerhead sea turtles have a worldwide distribution and inhabit temperate and tropical waters, including estuaries and continental shelves of both hemispheres. Globally, loggerhead sea turtles are divided into nine DPSs with varying federal (ESA) statuses. Individuals found in Virginia are members of the Northwest Atlantic DPS.

Female loggerhead sea turtles in the western north Atlantic nest from late April through early September. Individual females might nest several times within one season and usually nest at intervals of every 2 to 3 years. For their first 7 to 12 years of life, loggerhead sea turtles inhabit pelagic waters near the North Atlantic Gyre and are called pelagic immatures. When loggerhead sea turtles reach 16 to 24 inches (40 to

60 centimeters) straight-line carapace length, they begin recruiting to coastal inshore and nearshore waters of the OCS through the U.S. Atlantic and Gulf of Mexico and are referred to as benthic immatures. Benthic immature loggerheads have been found in waters from Cape Cod, Massachusetts, to southern Texas. Most recent estimates indicate that the benthic immature stage ranges from ages 14 to 32 years; they reach sexual maturity at approximately 20 to 38 years of age. Loggerhead sea turtles are largely present year-round in waters south of North Carolina but will forage during summer and fall as far north as the Northeastern U.S. and Canada and migrate south as water temperatures drop. Prey species for omnivorous juveniles include crab, mollusks, jellyfish, and vegetation at or near the surface. Coastal subadults and adults feed on benthic invertebrates, including mollusks and decapod crustaceans (TEWG 2009).

Based on Bartol et al. (1999), juvenile loggerhead sea turtles respond to auditory stimuli from tone bursts of 250 to 750 Hz. Martin et al. (2012) recorded the auditory evoked potentials of one adult loggerhead sea turtle, which responded to frequencies between 100 and 1,131 Hz, with greatest sensitivity between 200 and 400 Hz.

3.3.1.1 Current Status of the Loggerhead Sea Turtle Northwest Atlantic Population

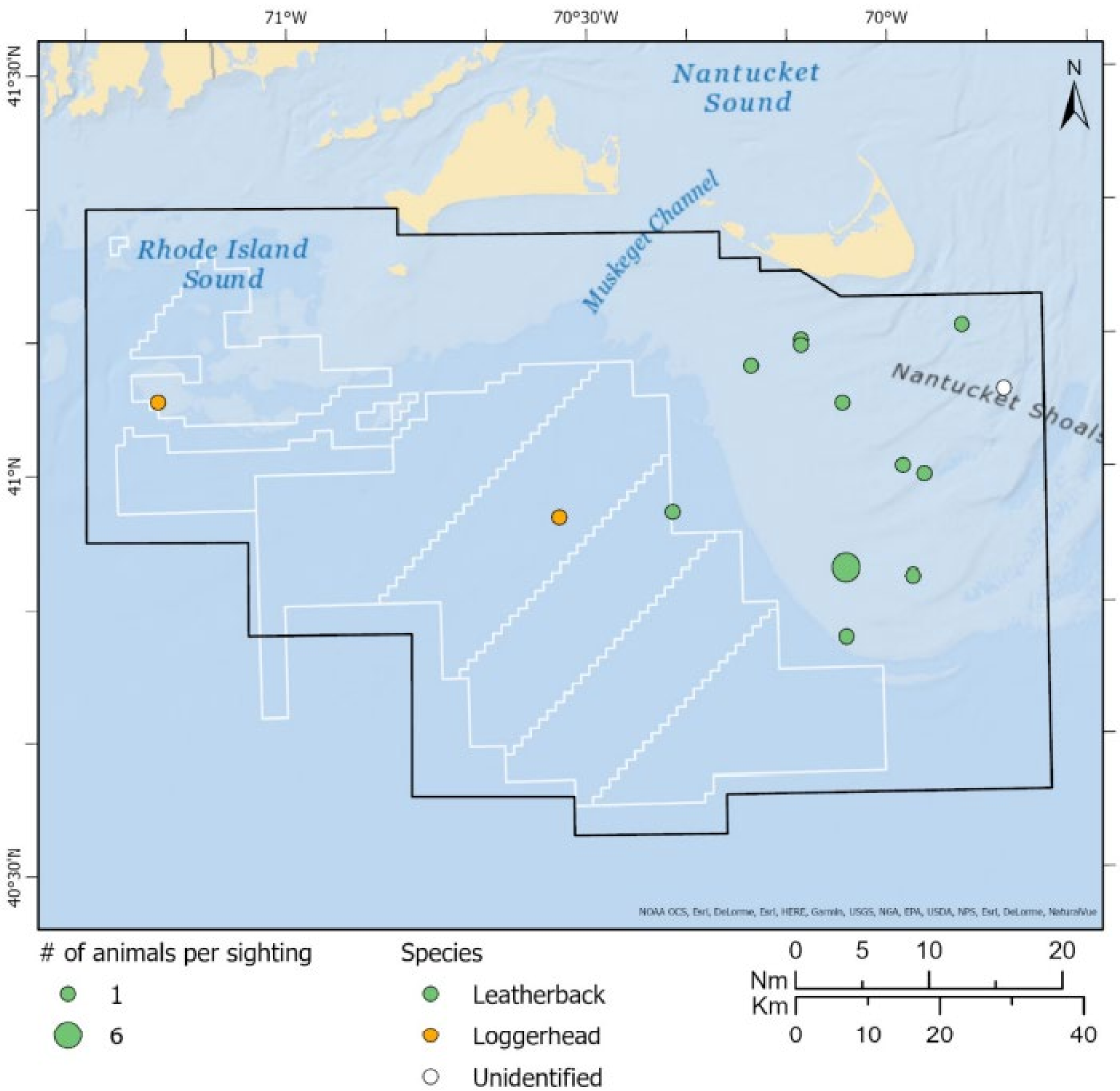
The most recent (2010) regional abundance estimate for loggerhead sea turtles in the Northwest Atlantic Continental Shelf water was approximately 588,000 individuals (NEFSC and SEFSC 2011). The three largest nesting subpopulations responsible for most of the production in the western North Atlantic (Peninsular Florida, Northern United States, and Quintana Roo, Mexico) have all been declining since at least the late 1990s, indicating a downward trend for this population (TEWG 2009).

Critical habitat for Northwest Atlantic Ocean DPS of loggerhead sea turtles was designated in 2014 (79 Fed. Reg. 39755 [July 10, 2014]; 79 Fed. Reg. 51264 [August 28, 2014]). The four designated critical habitat units are nesting beaches in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. Additionally, the sargassum habitat only extends as far north as New Jersey, and this area is located beyond the OCS edge offshore New Jersey (NMFS 2022c). No designated critical habitat occurs within the Project area. Factors affecting the conservation and recovery of this species include beach development, related human activities that damage nesting habitat, and light pollution (NMFS and USFWS 2008). In-water threats include bycatch in commercial fisheries, vessel strikes, anthropogenic noise, marine debris, legal and illegal harvest, oil pollution, and predation by native and exotic species (NMFS and USFWS 2008).

3.3.1.2 Presence and Abundance in the Action Area

Loggerhead sea turtles are frequently seen in waters off the coast of Rhode Island, Massachusetts, and New York. AMAPPS surveys reported loggerhead sea turtles as the most commonly sighted sea turtles on OCS waters from New Jersey to Nova Scotia. During the December 2014 to March 2015 aerial abundance surveys, 280 individuals were recorded (Palka et al. 2017). Kraus et al. 2016a reported 52 individuals in the RI/MA Lease Areas in the fall, 3 in the spring, and 32 in the summer.

Only two loggerhead sea turtles were observed in the RI/MA Lease Areas during aerial surveys conducted in 2018 and 2019: one in the northern portion of the RI/MA Lease Areas and the other in the southern portion of the RI/MA Lease Areas in Lease Area OCS-A 0522, both outside the SWDA (O’Brien et al. 2021a). Two loggerhead sea turtles were also detected during surveys conducted between March and October 2020: one within the SWDA and one within Lease Area OCS-A 0486 (O’Brien et al. 2021b; Figure 3-5). All sightings occurred in the summer and fall (O’Brien et al. 2021a, 2021b). However, the sightings shown on Figure 3-4 are not weighted by sighting effort (O’Brien et al. 2021b). Sightings data from AMAPPS also show loggerhead sea turtles are predominantly present in the Project area in the summer and fall, with few sightings in the winter (Palka et al. 2021).



Source: O'Brien et al. 2021b
km = kilometer; nm = nautical mile

Figure 3-5: Sightings of Sea Turtles during the Massachusetts Clean Energy Center and New England Aquarium Surveys in the Rhode Island and Massachusetts Lease Areas

Stranding data from the NMFS Sea Turtle Stranding and Salvage Network (NMFS 2023i) reported 326 loggerhead sea turtle strandings between January 2018 and January 12, 2023. Of these, 308 were reported in Barnstable, Massachusetts, which overlaps with the proposed Project landing sites. However, onshore stranding locations are only a minimal indication of animal occurrence in an area and are not reflective of onshore use. Of the strandings reported in Barnstable, 268 were documented as cold stunning, and the remaining 40 were documented as traditional strandings, defined by NMFS Sea Turtle Stranding and Salvage Network as "when a dead, sick, or injured sea turtle is found washed ashore, floating, or underwater, and when it is not an incidental capture, a posthatchling, or a cold-stunning" (NMFS 2023i). The stranded sea turtle was reported to be alive for 206 of these incidents (NMFS 2023i). NMFS bycatch data for the Northeast Fisheries Observer Program statistical area 537, which encompasses the waters from the southern shores of Martha's Vineyard and Nantucket south (including the Project area) to the OCS waters off New York, indicated 21 loggerhead sea turtles were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2021 (NMFS 2018c, 2022c). In area 538, which includes the waters from the south shore of Cape Cod to the southern shores of Martha's Vineyard and Nantucket (and the Proposed Action OECC area), one loggerhead turtle was incidentally caught in August of 2014 (NMFS 2018c).

Loggerhead sea turtles have been documented crossing the North Atlantic Ocean basin, as they are thought to passively follow oceanic currents or travel to find food resources (McCarthy et al. 2010; Lohmann et al. 1997). Loggerhead sea turtles may, therefore, be present in vessel transit lanes in the Action Area for transits between ports in Europe and Atlantic Canada; however, given the number of Project-related vessel transits that may originate from these ports (Table 1-9) is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic, encounters along these transit routes would be uncommon.

3.3.2 Leatherback Sea Turtle

The leatherback sea turtle is primarily a pelagic species and is distributed in temperate and tropical waters worldwide. The leatherback is the largest, deepest diving, most migratory, widest ranging, and most pelagic of the sea turtles (NMFS 2022d). Adult leatherback sea turtles forage in temperate and subpolar regions in all oceans. Satellite tagged adults reveal migratory patterns in the North Atlantic that can include a circumnavigation of the North Atlantic Ocean basin, following ocean currents that make up the North Atlantic gyre and preferentially targeting warm-water mesoscale ocean features such as eddies and rings as favored foraging habitats (Hays et al. 2006). Soft-bodied animals such as jellyfish and salps are the major component of the leatherback diet; they are also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed (NMFS 2022d; USFWS 2022b).

Historically, the most important nesting ground for the leatherback was the Pacific coast of Mexico. However, because of exponential declines in leatherback nesting, French Guiana in the Western Atlantic now has the largest nesting population. Other important nesting sites for the leatherback include Papua New Guinea, Papua-Indonesia, and the Solomon Islands in the Western Pacific. In the U.S., nesting sites include the Florida east coast; Sandy Point, U.S. Virgin Islands; and Puerto Rico. U.S. nesting occurs from March through July. On average, individual females nest every 2 to 3 years, laying an average of 5 to 7 nests per season with an average clutch size of 70 to 80 eggs (USFWS 2022b).

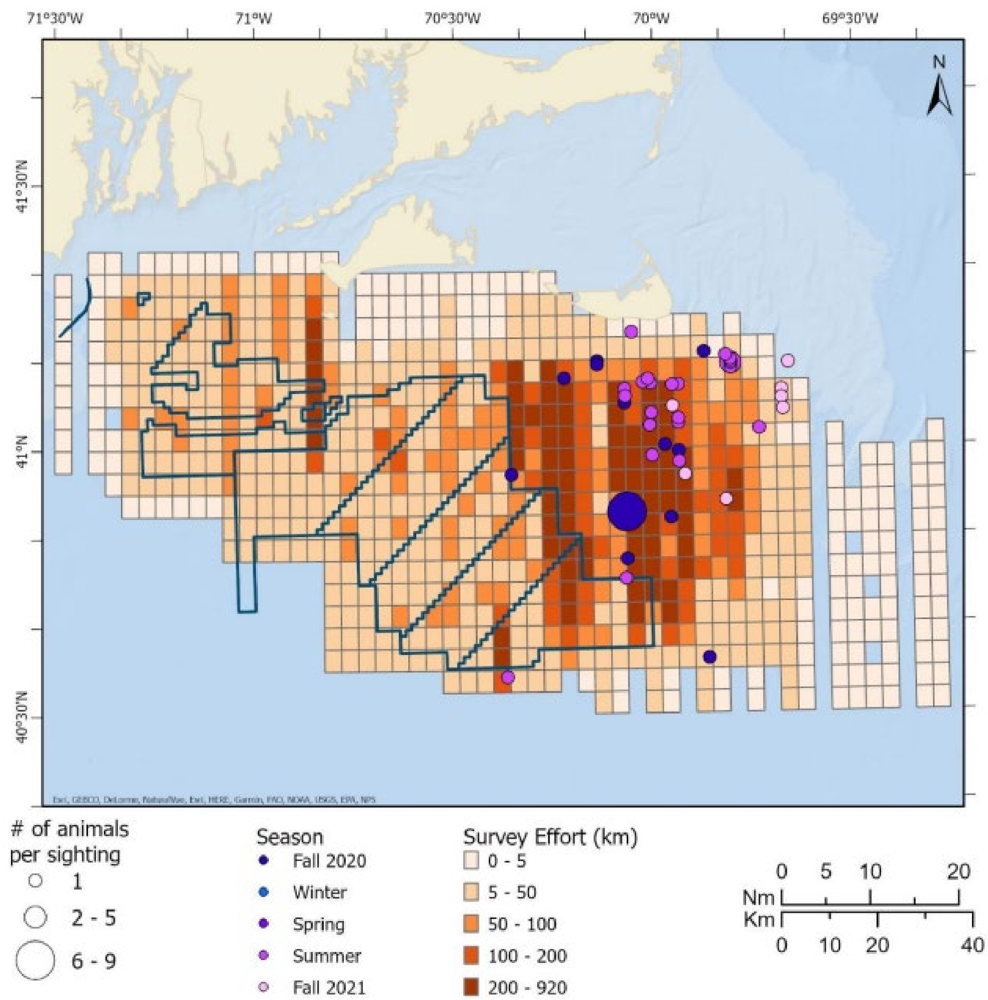
Piniak et al. (2012) found that hatchling leatherback sea turtles responded to auditory stimuli between 50 and 1,200 Hz in water and 50 and 1,600 Hz in air. The maximum sensitivity was between 100 and 400 Hz in water and 50 and 400 Hz in air.

3.3.2.1 Current Status of the Leatherback Sea Turtle

The leatherback sea turtle has been federally listed as Endangered under the ESA since 1970 and is considered Vulnerable by the IUCN Red List (IUCN 2022; NMFS 2022d). In 2017, NMFS received a petition to identify the Northwest Atlantic subpopulation as a DPS and list it as Threatened under the ESA. In response to this petition, NMFS initiated a status review for the leatherback sea turtle to include new data made available since the original listing (82 Fed. Reg. 57565 [December 6, 2017]). The status review was completed, and NMFS concluded there was not sufficient evidence to designate any DPS for leatherback sea turtles. Threats to this population include fisheries bycatch, habitat loss, nest predation, and marine pollution (USFWS 2022b). While critical habitat for this species was designated in waters adjacent to Sandy Point Beach, U.S. Virgin Islands in 1979 (44 Fed. Reg. 17710 [March 23,1979]), there is no designated critical habitat within the Project area.

3.3.2.2 Presence and Abundance in the Action Area

Leatherback sea turtles were the most commonly sighted sea turtle species in the RI/MA Lease Areas from 2011 through 2015 (161 animals over 4 years), occurring primarily during summer and fall, with a few sightings in the spring (Kraus et al. 2016a). The highest number of leatherback turtles occurred in August (71 turtles), and the second highest number was recorded in September (33 turtles). More recent surveys in the RI/MA Lease Areas also reported a higher number of leatherback sightings relative to other species, as 6 leatherback sea turtles were detected south of Nantucket during surveys conducted in June and August 2019, and 17 leatherback turtles were detected predominantly over Nantucket Shoals in the summer and fall of 2020 (O'Brien et al. 2021a, 2021b). Surveys conducted between November 2020 and August 2021 detected 51 individual leatherback sea turtles, and they were similarly seen over Nantucket Shoals (Figure 3-6; O'Brien et al. 2022b). However, these sightings are not weighted by survey effort, though survey effort is shown on Figure 3-6.



Source: O'Brien et al. 2022b
km = kilometer; nm = nautical mile

Figure 3-6: Sightings of Leatherback Sea Turtles during the Massachusetts Clean Energy Center and New England Aquarium Surveys in the Rhode Island and Massachusetts Lease Areas

Stranding data from the NMFS Sea Turtle Stranding and Salvage Network reported 138 leatherback sea turtle strandings between January 2018 and January 12, 2023. Of these, 85 were reported in Barnstable, Massachusetts, which overlaps with the proposed Project landing sites. However, onshore stranding locations are only a minimal indication of animal occurrence in an area and are not reflective of onshore use. Of the strandings reported in Barnstable, 38 were documented as incidental capture, and the remaining 47 were documented as traditional strandings. The stranded sea turtle was reported to be alive for 40 of these incidents (NMFS 2023i). NMFS bycatch data for the Northeast Fisheries Observer Program statistical area 537 indicated four leatherback sea turtles were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2021 (NMFS 2018c, 2022d).

Leatherback sea turtles are a pelagic species known for making large-scale movements, which can sometimes cross the Atlantic Ocean basin (Dodge et al. 2014; Lalire and Gaspar 2019). Given this distribution, leatherback sea turtles may also be present in vessel transit lanes in the Action Area for transits between ports in Europe and Atlantic Canada; however, given the number of Project-related vessel transits that may originate from these ports (Table 1-9) is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic, encounters along these transit routes would be uncommon.

3.3.3 Kemp's Ridley Sea Turtle

Kemp's ridley sea turtles occur off the coast of the Gulf of Mexico and along the U.S. Atlantic Coast (TEWG 2000). Juveniles inhabit the U.S. Atlantic Coast from Florida to the Canadian Maritime Provinces. In late fall, Atlantic juveniles/sub adults travel northward to forage in the coastal waters off Georgia through New England, then return southward for the winter (Stacy et al. 2013; New York State Department of Environmental Conservation 2022). Preferred habitats include sheltered areas along the coastline, such as estuaries, lagoons, and bays (NMFS 2022e). Kemp's ridley sea turtles are opportunistic foragers, feeding on decapod crustaceans, shellfish, and fish (NMFS 2022e). Sixty percent of Kemp's ridley nesting occurs on beaches near Rancho Nuevo, Tamaulipas, Mexico. The nesting season spans from April through July (NMFS and USFWS 2007). On average, individual females nest every 1 to 2 years, with an average of 1 to 3 clutches every season and an average clutch size of 110 eggs per nest (NMFS and USFWS 2007).

Data are limited on Kemp's ridley hearing capability; however, available studies show that this species can likely detect lower frequency noises below approximately 1 to 2 kHz (Bartol and Ketten 2006; Martin et al. 2012; Popper et al. 2014; Piniak et al. 2016).

3.3.3.1 Current Status of the Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle population was severely decimated in 1985 due to intensive egg collection and fishery bycatch, with only 702 nests counted during the entire year (NMFS and USFWS 2015; Bevan et al. 2016). After initiation of conservation measures, the population increased through 2009; however, since 2009, there has been a noted decline in nests (NMFS and USFWS 2015). Evaluations of hypothesized causes of the nesting setback, including the Deepwater Horizon oil spill in 2010, have been inconclusive, and experts suggest that various natural and anthropogenic causes could have contributed to the nesting setback either separately or synergistically (Caillouet et al. 2018). Despite the increased number of local strandings in 2014, recent models indicate a persistent reduction in survival and/or recruitment to the nesting population, suggesting that the population is not recovering. Current threats include bycatch from some fisheries, marine debris, and boat strikes (NMFS and USFWS 2015). There is no designated critical habitat for Kemp's ridley sea turtles, and though they typically only nest in the Southeast and Mid-Atlantic U.S. states, there has been on report of Kemp's ridley sea turtle nesting in the Gateway National Recreation Area in Long Island, New York, in 2018 (Yun 2018).

3.3.3.2 Presence and Abundance in the Action Area

From October 2011 through June 2015, six Kemp's ridley sea turtles were sighted in the RI/MA Lease Areas: one in August and five in September (Kraus et al. 2016a). There were insufficient data for sighting rate, SPUE, or density/abundance analyses (Kraus et al. 2016a). From 1998 through 2017, Kemp's ridley sea turtles were observed during the fall (September through November in the waters surrounding the SWDA) in relatively moderate numbers (10 to 40 turtles per 1,000 survey kilometers [621.4 miles]; North Atlantic Right Whale Consortium 2018). AMAPPS surveys documented five Kemp's ridley sea turtles during aerial surveys conducted from August through September 2010 in waters from Cape May, New Jersey, to the Gulf of St. Lawrence. No confirmed sightings were reported from 2011 through 2014 (Palka et al. 2017, 2021). No Kemp's ridley sea turtles were detected during surveys conducted in the RI/MA Lease Areas between 2018 and 2021 (O'Brien et al. 2021a, 2021b, 2022b).

Stranding data from the NMFS Sea Turtle Stranding and Salvage Network reported 3,046 Kemp's ridley sea turtle strandings between January 2018 and January 12, 2023. Of these, 3,029 were reported in Barnstable, Massachusetts, which overlaps with the proposed Project landing sites. However, onshore stranding locations are only a minimal indication of animal occurrence in an area and are not reflective of onshore use. Of the strandings reported in Barnstable, 3,015 were documented as cold stunning, and the remaining 14 were documented as traditional strandings. The stranded sea turtle was reported to be alive for 2,024 of these incidents (NMFS 2023i). No Kemp's ridley turtles were incidentally caught in either Northeast Fisheries Observer Program statistical area from 2008 through 2021 despite the relatively high number of strandings in the area for this species (NMFS 2018c, 2022e, 2023i).

Though Kemp's ridley sea turtles may be found as far north as Nova Scotia, the prefer warmer, shallower waters (TEWG 2000) and would, therefore, be uncommon in the potential proposed Project vessel transit routes within the Action Area. They are not likely to be encountered by proposed Project vessel originating from Europe or Atlantic Canada. Vessels traveling from areas south of the Project area (i.e., from Paulsboro, New Jersey) could encounter green sea turtles in marine waters in densities similar to or higher than that described for the Project area.

3.3.4 Green Sea Turtle

Green sea turtles have a worldwide distribution and can be found in both tropical and subtropical waters (NMFS and USFWS 1991; NatureServe 2022). In the Western North Atlantic Ocean, they can be found from Massachusetts to Texas, as well as in waters off Puerto Rico and the U.S. Virgin Islands (NMFS and USFWS 1991). Green sea turtles are divided into 11 DPSs with varying ESA statuses. Individuals found in Virginia are members of the North Atlantic DPS. Depending on the life stage, green sea turtles inhabit high-energy oceanic beaches, convergence zones in pelagic habitats, and benthic feeding grounds in shallow protected waters (NMFS and USFWS 1991). Green sea turtles are known to make long-distance migrations between their nesting and feeding grounds. Hatchlings occupy pelagic habitats and are omnivorous. Juvenile foraging habitats include coral reefs, emergent rocky bottoms, sargassum spp. mats, lagoons, and bays (USFWS 2022a). Once mature, green sea turtles leave pelagic habitats and enter benthic foraging grounds, primarily feeding on seagrasses and algae (Bjorndal 1997), although they will occasionally feed on sponges and invertebrates (NMFS 2022f).

Major green sea turtle nesting beaches occur on Ascension Island, Aves Island, Costa Rica, and Suriname. In the U.S., green sea turtles nest in North Carolina, South Carolina, Georgia, Florida, the U.S. Virgin Islands, and Puerto Rico (USFWS 2022a). Nesting seasons vary by region. On average, individual females nest every 2 to 4 years, laying an average of 3.3 nests per season at approximately 13-day intervals. The average clutch size is approximately 136 eggs, and incubation ranges from 45 to 75 days (USFWS 2022a).

Bartol and Ketten (2006) measured the auditory evoked potentials of two Atlantic green sea turtles and six sub adult Pacific green sea turtles. Sub-adults were found to respond to stimuli between 100 and 500 Hz, with a maximum sensitivity of 200 and 400 Hz. Juveniles responded to stimuli between 100 and 800 Hz, with a maximum sensitivity between 600 and 700 Hz. Piniak et al. (2016) found that the auditory evoked potentials of juvenile green sea turtles were between 50 and 1,600 Hz in water and 50 and 800 Hz in air, with ranges of maximum sensitivity between 50 and 400 Hz in water and 300 and 400 Hz in air.

3.3.4.1 Current Status of the Green Sea Turtle North Atlantic Distinct Population Segment

The primary nesting beaches for the North Atlantic DPS of green sea turtles are Costa Rica, Mexico, United States (Florida), and Cuba. According to Seminoff et al. (2015), nesting trends are generally increasing for this DPS. The only critical habitat for green sea turtles has been designated in Puerto Rico around Culebra Island (NMFS 2022f), which is outside both the Action Area and Project area.

3.3.4.2 Presence and Abundance in the Action Area

There are few records of green sea turtle sightings in the RI/MA Lease Areas. Green sea turtles were not observed in the Kraus et al. (2016a) surveys from October 2011 through June 2015, the O’Brien et al. (2021a, 2021b, 2022b) surveys from 2018 to 2021, or identified in the North Atlantic Right Whale Consortium (2018) sightings data from 1998 through 2017. However, sightings data from AMAPPS show they have potential to occur in the Project area in the summer (Palka et al. 2021).

Stranding data from the NMFS Sea Turtle Stranding and Salvage Network reported 126 green sea turtle strandings between January 2018 and January 12, 2023. Of these, 111 were reported in Barnstable, Massachusetts, which overlaps with the proposed Project landing sites. However, onshore stranding locations are only a minimal indication of animal occurrence in an area and are not reflective of onshore use. Of the strandings reported in Barnstable, all 111 were documented as cold stunning. The stranded sea turtle was reported to be alive for 79 of these incidents (NMFS 2023j). NMFS bycatch data for the Northeast Fisheries Observer Program statistical area 537 indicated two green sea turtles were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2021 (NMFS 2018c, 2022d).

Though green sea turtles may be found as far north as Nova Scotia, they prefer warmer, shallower waters (NMFS and USFWS 1991) and would, therefore, be uncommon in the potential proposed Project vessel transit routes within the Action Area. They are not likely to be encountered by proposed Project vessel originating from Europe or Atlantic Canada. Vessels traveling from areas south of the Project area (i.e., from Paulsboro, New Jersey) could encounter green sea turtles in marine waters in densities similar to or higher than that described for the Project area.

3.3.5 Effects Analysis for Sea Turtles

3.3.5.1 Underwater Noise

3.3.5.1.1 Effects of Underwater Noise on Sea Turtles

Underwater noise generated by impact pile driving during installation of WTG and ESP foundations; vibratory pile setting during installation of WTG and ESP foundations; foundation drilling during installation of the WTG and ESP foundations; potential UXO detonations; HRG surveys; vessel activity; and WTG operation would increase sound levels in the marine receiving environment and may result in potential adverse effects on sea turtles in the Project area including PTS and behavioral disturbances. Exposure modeling was conducted for up to 132 foundations using 12-meter monopiles, 13-meter monopiles, and 4-meter pin piles. Sections 3.3.5.1.2 and 3.3.5.1.3 provides a review of the available information on sea turtles hearing, the thresholds applied to this assessment and the results of the underwater noise modeling conducted for the COP (Appendix III-M; Epsilon 2022), and effects assessment of applicable underwater noise sources for this BA.

3.3.5.1.2 Auditory Criteria for Sea Turtles

Sea turtle auditory perception is thought to occur in air and in water through bone conduction, which is the vibration of the skull and other bones in response to underwater sound pressure (Lenhardt 1982; Lenhardt and Harkins 1983). Detailed descriptions of sea turtle ear anatomy are found in Ridgway et al. (1969), Lenhardt et al. (1985), and Bartol and Musick (2003). Sea turtles do not have external ears, but the middle ear is well adapted as a peripheral component of a bone conduction system. The thick tympanum is disadvantageous as an aerial receptor but enhances low-frequency bone conduction hearing (Lenhardt et al. 1985; Bartol et al. 1999; Bartol and Musick 2003). A layer of subtympanal fat emerging from the middle ear is fused to the tympanum (Ketten et al. 2006; Bartol 2004, 2008). This arrangement enables sea turtles to hear low-frequency sounds, while underwater and makes them relatively insensitive to sound above water. Vibrations can also be conducted through the bones of the carapace to reach the middle ear.

The limited data available on sea turtle hearing abilities are summarized in Table 3-24. The frequency range of best hearing sensitivity of sea turtles ranges from approximately 100 to 700 Hz; however, there is some sensitivity to frequencies as low as 60 Hz, and possibly as low as 30 Hz (Ridgway et al. 1969). Thus, there is substantial overlap in the frequencies that sea turtles detect, and the dominant frequencies produced by pile-driving activities. Given the high energy levels of pile driving, it is likely that sea turtles hear pile-driving noise. However, there are no available measurements of the absolute hearing thresholds of any sea turtle to waterborne sounds to the exact sources being analyzed. Most available data on sea turtle behavioral responses to underwater noise involve seismic airgun surveys that are impulsive like impact pile driving, but differ in terms of spectral content, mobility, and duration. In addition, recent reports assessing the severity of behavioral reactions to underwater noise sources indicate that applying behavioral responses across broad sound categories (e.g., impact pile driving and seismic both considered impulsive sources) can lead to significant errors in predicting effects (Southall et al. 2021). As a result, assessment of potential effects relies primarily on applicable sources and the results of the propagation and exposure modeling, rather than attempting to extrapolate from non-pile driving sources.

Table 3-24: Hearing Capabilities of Sea Turtles

Sea Turtle Species	Hearing Range (Hz)	Hearing Highest Sensitivity (Hz)	Source
Green sea turtle (*Chelonia mydas*)	60–1,000	300–500	Ridgway et al. 1969
	100–800	600–700 (juveniles) 200–400 (subadults)	Bartol and Ketten 2006; Ketten and Bartol 2005
	50–1,600	50–400	Piniak et al. 2016
Loggerhead (*Caretta caretta*)	250–1,000	250	Bartol et al. 1999
	50–1,100	100–400	Martin et al. 2012; Lavender et al. 2014
Kemp's Ridley (*Lepidochelys kempii*)	100–500	100–200	Bartol and Ketten 2006; Ketten and Bartol 2005
Leatherback (*Dermochelys coriacea*)	50–1,200 (underwater)	100–400	Piniak et al. 2012

Hz = hertz

Table 3-25 outlines the acoustic thresholds for the onset of PTS and behavioral disruptions for sea turtles for impulsive and non-impulsive noise sources. TTS thresholds, though not applied for this assessment, are available for sea turtles. Also known as auditory fatigue, TTS is the milder form of hearing impairment that is non-permanent and reversible, and results from exposure to high intensity sounds for short durations or lower intensity sounds for longer durations. TTS is species-specific, and results from sufficient noise exposure that leads to an elevation in the hearing threshold, meaning it is more difficult for an animal to hear sounds. TTS can last for minutes, hours, or days; the magnitude of the TTS depends on the level (frequency and intensity), energy distribution, and duration of the noise exposure among other considerations.

TTS is typically applied when assessing regulatory impacts of a number of specific activities (e.g., military operations, explosions). For marine mammals, data indicate that TTS onset in marine mammals is more closely correlated with the received SEL_{24h} than with the Lpk and that received sound energy over time, not just the single strongest pulse, should be considered a primary measure of potential impact (Southall et al. 2007; Finneran et al. 2017; NMFS 2018). For sea turtles, however, less is known about the onset of TTS, but some studies indicate threshold shifts up to 40 dB re 1 μPa may be experienced in freshwater turtle experiments; however, turtle hearing returned initial sensitivities following a recovery period of 20 minutes to several days (Woods Hole Oceanographic Institute 2022). It is reasonable to assume that the thresholds for TTS onset are lower than those for PTS onset but higher than behavioral disturbance onset. Preliminary analyses from the Woods Hole Oceanographic Institute (2022) freshwater turtle study showed TTS onset occurring lower than the 200 dB re 1 μPa^2 s criteria currently used to predict TTS in sea turtles, which could be a function of species and other conditions. Until more studies improve the understanding of TTS in sea turtles, ranges to TTS thresholds and TTS exposures should be considered qualitative, and mitigation measures designed to reduce PTS exposures should also contribute to reducing the risk of the TTS exposures.

For behavioral thresholds, no distinction is made between impulsive and non-impulsive sources. Behavioral criteria were developed by the U.S. Navy in consultation with NMFS and was derived from measurements conducted during exposure to airgun noise presented in McCauley et al. (2000b) (Finneran et al. 2017). The received SPL at which sea turtles have been observed exhibiting behavioral responses to airgun pulses, 175 dB re 1 μPa, is also expected to be the received sound level at which sea turtles would exhibit behavioral responses when exposed to impact pile driving (impulsive) and vibratory pile setting (non-impulsive) activities (Finneran et al. 2017).

Table 3-25: Acoustic Thresholds for Onset of Acoustic Effects (Permanent Threshold Shift, Temporary Threshold Shift, or Behavioral Disturbance) for Endangered Species Act-Listed Sea Turtles

Impulsive Sources					Non-Impulsive Sources	
PTS		TTS		Behavioral Disturbance	PTS	Behavioral Disturbance
Lpk	SEL_{24h}[a]	Lpk	SEL_{24h}[a]	SPL	SEL_{24h}[a]	SPL
232	204	226	189	175	220	175

Source: Finneran et al. 2017
Lpk = peak sound pressure level in units of decibels referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of decibels referenced to 1 micropascal; TTS = temporary threshold shift
[a] SEL_{24h} thresholds include frequency weighting for sea turtles as described by Finneran et al. (2017).

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 Finneran et al. (2017). 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. Table 3-26 provides mass estimates used in the assessment. For sea turtles, seal species (e.g., harbor seal [*Phoca vitulina*]) pup and adult masses can used as conservative surrogate values as outlined in Finneran et al. (2017). Table 3-5 provides the equations used to estimate these thresholds based on animal mass and depth in the water column.

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_{24h} and unweighted Lpk. As only one charge detonation per day is planned for the Proposed Action, the effective disturbance threshold for single events in each 24-hour period is the TTS onset (Table 3-25).

Table 3-26: Representative Pup and Adult Mass Estimates[a] Used for Assessing Impulse-based Onset of Lung Injury and Mortality Threshold Exceedance Distances

Impulse Animal Group	Representative Species	Pup Mass (kilograms)	Adult Mass (kilograms)
Sea turtles	Phocid pinnipeds in water	8	60

Source: Hannay and Zykov 2022
[a] These values are based on the smallest expected animals for the species that might be present within the Project area. Masses listed here are used for assessing impulse-based onset of lung injury and mortality threshold exceedance distances.

As with marine mammals, the potential for underwater noise to result in adverse effects on a sea turtle depends on the received sound level, the frequency content of the sound relative to the hearing ability of the animal, the duration of the exposure, and the context of the exposure. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or PTS at high received levels. Auditory masking may also occur when sound signals used by sea turtles (e.g., predator vocalizations and environmental cues) overlap in time and frequency with another sound source (e.g., pile driving). Popper et al. (2014) determined that continuous noise produced at frequencies and sound levels detectable by sea turtles can mask signal detection. As with behavioral effects, the consequences of masking to sea turtle fitness are unknown. The frequency range of best hearing sensitivity estimated for sea turtles is estimated at 100 to 700 Hz (Table 3-24). Masking is, therefore, more likely to occur with sound sources that have dominant low frequency spectrums such as vessel activities, vibratory pile setting, and WTG operations. These sound sources are also considered continuous, meaning they are present within the water column for longer durations and, therefore, have a higher chance of affecting sea turtle auditory perception.

3.3.5.1.3 Assessment of Underwater Noise Effects

Foundation Installation

The COP (Appendix III-M; Epsilon 2023) includes acoustic modeling of underwater sound generated and potential effects on sea turtle species during foundation installation for the Proposed Action using the same methods as described previously in Section 3.2.6.2.3.

Data regarding acoustic thresholds for effects on sea turtles from sound exposure during pile driving are limited and follow recommendations from the U.S. Navy (Finneran et al. 2017) as provided in Table 3-25. Table 3-27 shows the modeled exposure ranges to PTS and behavioral thresholds for all foundation types that could be installed as part of the Proposed Action using impact pile driving methods only, and Table 3-28 shows the modeled exposure ranges to PTS and behavioral thresholds for all foundation types that could be installed as part of the Proposed Action using vibratory pile setting followed by impact pile driving.

Table 3-27: Summary of Proposed Action 95th Percentile Exposure Ranges (Meters) for Sea Turtle Acoustic Thresholds for Impact Pile Driving of Two Monopile or Four Pin Piles per Day and 10 Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			13-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			4-Meter Pin Pile, Four Piles per Day 3,500 kJ Hammer		
	PTS (Lpk.)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk.)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk.)	PTS (SEL_{24h})	Behavior (SPL)
Kemp's ridley sea turtle (*Lepidochelys kempii)*	0	0	940	0	0	990	0	420	1,120
Leatherback sea turtle (*Dermochelys coriacea*)	0	260	1,470	0	290	1,500	0	1,280	1,280
Loggerhead sea turtle (*Caretta caretta*)	0	0	1,410	0	0	1,320	0	480	1,290
Green sea turtle (*Chelonia mydas*)	0	0	1,250	0	10	1,470	0	240	1,200

Source: COP Appendix III-M; Epsilon 2023
< = less than; Db = decibel; $ER_{95\%}$ = 95th percentile exposure range; kJ = kilojoule; Lpk. = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 3-28: Summary of Proposed Action 95th Percentile Exposure Ranges (Meters) for Sea Turtle Acoustic Thresholds for Two Monopile or Four Pin Piles per Day Installed using Vibratory Setting of Piles Followed by Impact Pile Driving and 10 Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			13-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			4-Meter Pin Pile, Four Piles per Day 3,500 kJ Hammer		
	PTS (Lpk.)	PTS (SEL_{24h})	Behavior (SPL)[a]	PTS (Lpk.)	PTS (SEL_{24h})	Behavior (SPL)[a]	PTS (Lpk.)	PTS (SEL_{24h})	Behavior (SPL)[a]
Kemp's ridley sea turtle (*Lepidochelys kempii)*	0	0	930	0	270	1,200	0	280	1,090
Leatherback sea turtle (*Dermochelys coriacea*)	0	390	1,520	0	410	1,510	0	1,480	1,280

Common Name (Scientific Name)	12-Meter Monopile, Two Piles per Day 6,000 kJ Hammer PTS ($L_{pk.}$)	PTS (SEL_{24h})	Behavior (SPL)[a]	13-Meter Monopile, Two Piles per Day 6,000 kJ Hammer PTS ($L_{pk.}$)	PTS (SEL_{24h})	Behavior (SPL)[a]	4-Meter Pin Pile, Four Piles per Day 3,500 kJ Hammer PTS ($L_{pk.}$)	PTS (SEL_{24h})	Behavior (SPL)[a]
Loggerhead sea turtle (*Caretta caretta*)	0	210	1,170	0	310	1,430	0	580	1,300
Green sea turtle (*Chelonia mydas*)	0	0	1,230	0	10	1,450	0	380	1,240

Source: COP Appendix III-M; Epsilon 2023
< = less than; Db = decibel; $ER_{95\%}$ = 95[th] percentile exposure range; kJ = kilojoule; Lpk. = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal
[a] For behavior, the SPL threshold does not account for duration and instead assumes exposure if an animal is exposed to above-threshold noise in that instant an exposure could occur. Conversely, the SEL24h thresholds for PTS account for the entire exposure duration required to meet the threshold level. Therefore, the SEL24h threshold accounts for the vibratory pile setting followed by impact pile driving to reach the PTS threshold, whereas the behavior threshold only accounts for the second over which vibratory pile setting may exceed the threshold, and these ranges are based only on vibratory pile setting activities

There are limited density estimates for sea turtles in the SWDA. For this analysis, sea turtle densities were obtained from the U.S. Navy Operating Area Density Estimate database on the Strategic Environmental Research and Development Program Spatial Decision Support System portal (U.S. Navy 2012, 2017) and the Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles (Kraus et al. 2016a). These data are summarized seasonally (winter, spring, summer, and fall). Because the results from Kraus et al. (2016a) use more recent data, those were used preferentially where possible. The COP (Appendix III-M; Epsilon 2023) notes that the winter densities of sea turtles in the SWDA were likely overestimated because these estimates are provided as a range of potential densities within each grid square, and the maximum density always exceeds zero. Thus, winter densities were reported, even though turtles are unlikely to be present in winter because the COP (Appendix III-M; Epsilon 2023) assumed maximum densities for all seasons. Details on data handling to develop these estimates are available in the COP (Appendix III-M; Epsilon 2023). These estimates suggest that leatherback sea turtles are the most likely species of sea turtle to be found in the Action Area followed by loggerhead sea turtles, and their densities would be highest during the summer and fall. Densities were estimated using a 6.2-kilometer perimeter around the SWDA for impact pile driving only (Tables 3-29), and a 10-kilometer perimeter around the SWDA for vibratory pile driving followed by impact pile driving (Table 3-30).

Table 3-29: Mean Density Estimates for Sea Turtle Species Modeled in a 6.2-Kilometer Perimeter[a] around the Southern Wind Development Area for all Seasons

Common Name (Scientific Name)	Density[b] Spring	Summer	Fall	Winter
Leatherback sea turtle (*Dermochelys coriacea)*	0.022	0.630	0.873	0.022
Loggerhead sea turtle (*Caretta caretta)*	0.103	0.206	0.633	0.103
Kemp’s ridley sea turtle (*Lepidochelys kempii)*	0.019	0.019	0.019	0.019
Green sea turtle (*Chelonia Mydas*)	0.019	0.019	0.019	0.019

Source: COP Appendix III-M; Epsilon 2023
[a] The perimeter around the SWDA was determined based on the longest exposure range to the thresholds for impact pile driving from the modeling (Appendix III-M; Epsilon 2023)
[b] This is animals per 38.6 square miles (100 square kilometers).

Table 3-30: Mean Density Estimates for Sea Turtle Species Modeled in a 10-Kilometer Perimeter[a] around the Southern Wind Development Area for all Seasons

Common Name (Scientific Name)	Seasonal Density[a]				Annual Mean
	Spring	Summer	Fall	Winter	
Leatherback sea turtle (*Dermochelys coriacea)*	0.023	0.630	0.873	0.023	0.387
Loggerhead sea turtle (*Caretta caretta)*	0.108	0.206	0.633	0.108	0.263
Kemp's ridley sea turtle (*Lepidochelys kempii)*	0.015	0.015	0.015	0.015	0.015
Green sea turtle (*Chelonia Mydas*)	0.015	0.015	0.015	0.015	0.015

Source: COP Appendix III-M; Epsilon 2023
[a] Based on the smallest acoustic range modled by COP Appendix III-M (Epsilon 2023).
[b] This is animals per 38.6 square miles (100 square kilometers).

Table 3-31 summarizes the number of animals estimated to be exposed to sound levels above PTS and behavioral disturbance thresholds during installation of all piles as summarized in the construction schedule in Table 1-3. This construction schedule includes a combination of foundations installed with vibratory setting of piles followed by impact pile driving and foundations installed with impact pile driving alone for all foundation types (COP Appendix III-M; Epsilon 2023).

Table 3-31: Number of Animals Exposed to Noise at or Above Thresholds for All Foundation Types[a] over All 3 Years of Construction under the Proposed Action with 10 Decibel Noise Attenuation

Common Name (Scientific Name)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)
Kemp's ridley sea turtle (*Lepidochelys kempii)*	0	20	270
Leatherback sea turtle (*Dermochelys coriacea*)	0	4,170	5,400
Loggerhead sea turtle (*Caretta caretta*)	0	1,110	9,850
Green sea turtle (*Chelonia mydas*)	0	110	660

Source: COP Appendix III-M; Epsilon 2023
< = less than; dB = decibel; Lpk. = peak sound pressure level in units of dB referenced to 1 micropascal; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal
[a] The exposure estimates in this table include all foundations under the Proposed Action as a combination of foundations installed with vibratory setting of piles followed by impact pile driving and foundations installed with impact pile driving alone

Effects of Exposure to Noise Above Permanent Threshold Shift Thresholds

Modeled sea turtle PTS threshold $ER_{95\%}$ range from 0 to 4,199 feet (0 to 1,280 meters) for foundation installation using impact pile driving only (Table 3-27) and from 0 to 4,856 feet (0 to 1,480 meters) for foundation installation using vibratory pile setting followed by impact pile driving (Table 3-28). PTS exposures for all foundations in the construction schedule in Table 1-3 using a combination of impact pile driving methods and vibratory pile setting followed by impact pile driving methods were calculated to be 20 for kemp's ridley sea turtles, 4,170 for leatherback sea turtles, 1,110 for loggerhead sea turtles, and 110 for green sea turtles (Table 3-31).

The proposed clearance and shutdown zones for sea turtles during all pile driving are 5,249 feet (1,600 meters) and 4,921 feet (1,500 meters), respectively (Table 1-15). The effective range for reliable and consistent visual detection of sea turtles from vessels is often less than 1,640 feet (500 meters) in good visibility conditions (Barkaszi and Kelly 2019; Smultea Environmental Sciences 2020; Vandeperre et al. 2019). Therefore, even with observers using Big Eye binoculars on the raised construction vessel and up to two PSO vessels circling the pile location, the ability to effectively clear the entire PTS isopleth area for sea turtles is unlikely and thus there is a moderate risk of PTS exposure even with the dedicated observer teams. Mitigation and monitoring measures (clearance, ramp up, shutdowns; Table 1-15) will reduce risk of PTS in sea turtles but will not eliminate the risk. Therefore, the effects of noise exposure above PTS thresholds during foundation installation **may affect, likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above Behavioral Thresholds

The modeled behavioral threshold isopleth for sea turtles, with 10 dB noise mitigation, for sea turtles resulting from impact pile driving was 4,921 feet (1,500 meters); and the maximum modeled isopleth for vibratory pile setting followed by impact pile driving of the foundation was 4,987 feet (1,520 meters) (Tables 3-27 and 3-28). Though not modeled, it is also likely that a portion of the sea turtles within the area ensonified above the behavioral disturbance threshold could also experience TTS effects, as discussed in Section 3.3.5.1.2. TTS is a form of auditory fatigue that, unlike PTS, is non-permanent and reversible. Additionally, onset of TTS does not equate to an individual being removed from a population or facing any long-term restrictions on critical behaviors, as TTS is recoverable.

Much of the knowledge of the behavioral reactions of sea turtles to underwater sounds has been derived from few studies, most of which have been conducted in a laboratory or caged setting. Potential behavioral effects may include altered submergence patterns, startle responses (e.g., diving, swimming away), short-term displacement of feeding or migrating activity, and a temporary stress response if present within the ensonified area (NSF and USGS 2011; Samuel et al. 2005). The accumulated stress and energetic costs of avoiding repeated exposures to pile-driving noise over a season or life stage could have long-term effects on survival and fitness (U.S. Navy 2018), though the consequences of potential behavioral changes to sea turtle fitness are unknown.

The frequency range of best hearing sensitivity estimated for sea turtles has been to be within the range of approximately 100 to 700 Hz; therefore, acoustic effects on sea turtles would be most likely to occur from activities producing noise within that bandwidth. Lenhardt (1994) demonstrated that avoidance reactions of sea turtles in captivity were elicited when the animals were exposed to low frequency tones. Moein et al. (1995) also conducted experiments on caged loggerhead sea turtles and monitored the behavior of the animals when exposed to seismic activities with source levels ranging from 175 to 179 dB re 1 μPa m. Avoidance was also demonstrated by O'Hara and Wilcox (1990) who found that sea turtles in a canal would avoid the area where seismic work was being conducted, although the received levels were not measured. McCauley et al. (2000b) estimated an airgun array operating in 328 to 394 feet (100 to 120 meters) water depth could elicit behavioral changes in sea turtles out to 1 mile (2 kilometers), whereas avoidance responses would occur out to 0.6 mile (1 kilometer). A monitoring assessment conducted by DeRuiter and Doukara (2012) estimated 51 percent of loggerhead sea turtles observed dove at or before the closest point of approach to the airgun array. Conversely, Weir (2007) reported no obvious avoidance by sea turtles at the sea surface as recorded by ship-based observers to seismic sounds, although the observers noted that fewer turtles were observed at the surface when the airgun array was active versus when it was inactive.

Auditory masking occurs when acoustic cues used by sea turtles (e.g., physical sounds of prey activity, acoustic signature of key habitats such as hard-bottom structures, environmental cues) overlap in time and frequency with another sound source, such as seismic sound. Popper et al. (2014) concluded that continuous noise of any level that is detectable by sea turtles can mask signal detection. The consequences of potential masking and associated behavioral changes to sea turtle fitness are unknown.

Masking is more likely to occur from sound sources with dominant frequencies in the low frequency spectrum such as vessel activities, vibratory pile setting and WTG operations. These activities also have high-duty cycles (i.e., are continuous) and, therefore, while the activity is occurring, have a higher chance of affecting sea turtles ability to detect biologically important acoustic cues compared to intermittent sources. Given the short duration of vibratory pile setting activities (up to 30 minutes per pile), the likelihood of behavioral disturbances that would affect foraging, migrating, or mating behaviors is considered extremely unlikely.

Modeling of foundation installation for all pile types and methods indicated up to 5,400 individuals leatherback sea turtles, 9,850 loggerhead sea turtles, 270 Kemp's ridley sea turtles, and 660 green sea turtles may be exposed to noise exceeding the behavioral thresholds levels over the 3 years of construction (Table 3-31). There is potential for exposure above the behavioral disturbance threshold given that the foundation installation would occur between May and October, which overlaps with the peak occurrence for sea turtle species in the Project area (Sections 3.3.1, 3.3.2, 3.3.3, and 3.3.4). While the mitigation and monitoring measures (Table 1-15) are expected to decrease the severity of behavioral disturbances that do occur, predominantly by limiting the duration of the exposure through clearance and shutdown procedures, the possibility for behavioral disturbances of relatively cannot be discounted. Therefore, the effects of noise exposures above behavioral thresholds resulting from impact pile driving during foundation installation **may affect, likely to adversely affect** ESA-listed sea turtles.

Foundation Drilling

Foundation drilling may be used on a limited basis to avoid the risk of pile run and ensure the pile can be installed to the target depth. While foundation drilling was not modeled for sea turtles, the information provided in the draft ITA addendum (JASCO 2023) enables a qualitative assessment of vibratory pile setting using published data of potential received noise levels that may be produced during proposed Project vibratory pile setting. Assuming the unweighted SPL levels at 2,461 feet (750 meters) were approximately 136 dB re 1 µPa during the summer (JASCO 2023), it was estimated that the SPL source level back-calculated to 3.3 feet (1 meter) using spherical spreading loss was 193 dB re 1 µPa m.

Effects of Exposure to Permanent Threshold Shift Thresholds

JASCO (2023) estimated a broadband SEL source level for drilling activities of 192 dB re 1 μPa^2 s m^2, which is lower than the PTS-onset SEL_{24h} threshold of 220 dB re μPa^2 s for sea turtles in response to non-impulsive sources (Table 3-25). Therefore, PTS in sea turtles in responses to foundation drilling is not likely to occur and is **discountable**. Therefore, exposure to noise above PTS thresholds during foundation drilling **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Behavioral Thresholds

Based on the estimated SPL source level of 193 dB 1 µPa m, the SPL 175 dB re 1 µPa sea turtle behavioral threshold may be met or exceeded only within approximately 26 feet (8 meters) using the same practical spreading loss equation used to estimate the behavioral disturbance range for marine mammals. Given this small threshold range and the low number of foundations requiring drilling (up to 48 foundations out of a total of 132), the likelihood of behavioral disturbances that would affect foraging, migrating, or mating behaviors is considered unlikely to occur and is **discountable**. Therefore, the effects of noise exposures above behavioral thresholds resulting from foundation drilling **may affect, not likely to adversely affect** ESA-listed sea turtles.

Vessel and Aircraft Noise

As discussed in Section 1.4.1.2.6, during each proposed Project phase, the applicant anticipates an average of approximately 30 vessels operating during a typical workday in the SWDA and along the

OECC. Approximately 60 vessels could be present during the period of maximum construction activity at the start of WTG installation. Many construction vessels would remain at the SWDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning as needed (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). This volume of traffic would vary monthly depending on weather and Proposed Action activities. Approximately 3,200 total vessel round trips are expected to occur during offshore construction of Phase 1, which equates to an approximate average of 6 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 3.3.1.12.1; Epsilon 2022). Approximately 3,800 total vessel round trips are expected to occur during offshore construction of Phase 2, which equates to an approximate average of 7 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 4.3.1.12.1; Epsilon 2022). During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur during both phases (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). Peak construction vessel activity is expected to occur during pile-driving activities. The applicant has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used during construction, with some vessels with additional components or materials coming from Canadian and European ports (COP Volume I; Epsilon 2022). Any vessels transiting from Canada and Europe would follow the major navigation routes.

Current vessel traffic in the Action Area and surrounding waters is relatively high, and vessel traffic within the RI/MA Lease Areas and SWDA is relatively moderate (COP Appendix III-I; Epsilon 2022) and includes commercial fishing vessels, recreational vessels, and other commercial vessels (merchant and passenger ships) in order of frequency (COP Appendix III-I; Epsilon 2022). The Action Area experiences increased vessel traffic during the summer months (COP Appendix III-I; Epsilon 2022); however, BOEM finds that the Proposed Action would not significantly disrupt normal vessel traffic patterns.

The frequency and sound levels produced by vessels are determined by a variety of parameters including vessel shape, speed, size, prop structure and condition, power plant, onboard equipment such as generators, and operating environment. In general, larger vessels and faster operating speeds produce higher sound levels than smaller vessels or slower operating speeds. Large shipping vessels and tankers produce low frequency noise with a primary energy near 40 Hz with underwater source levels that can range from 177 to 200 dB re 1 µPa m (McKenna et al. 2012; Erbe et al. 2019), while smaller vessels typically produce higher frequency noise (1,000 to 5,000 Hz) at source levels between 150 and 180 dB re 1 µPa m (Kipple and Gabriele 2003, 2004). Vessels using DP thrusters are known to generate substantial underwater noise with sound levels ranging from 150 to 180 dB re 1 µPa m depending on operations and thruster use (BOEM 2013; McPherson et al. 2016).

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

It is unlikely that received levels of underwater noise from vessel activities would exceed PTS thresholds for sea turtles, as the PTS threshold for non-impulsive sources is an SEL_{24h} of 200 dB re 1 μPa^2 s, which is comparable to the maximum source level reported for large shipping vessels (McKenna et al. 2012; Erbe et al. 2019). This means beyond 1 meter, the sound level produced by the loudest proposed Project vessel would likely be below the sea turtle PTS threshold, and the potential for ESA-listed sea turtles to be exposed to Project vessel noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposure above PTS thresholds during proposed Project vessel operations **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

The most likely effects of vessel noise on sea turtles would include behavioral disturbances. There is very little information regarding the behavioral responses of sea turtles to underwater noise. A recent study suggests that sea turtles may exhibit TTS effects even before they show any behavioral response (Woods Hole Oceanographic Institution 2022). Hazel et al. (2007) demonstrated that sea turtles appear to respond behaviorally to vessels at approximately 33 feet (10 meters) or closer. Based on the source levels outlined previously, the behavioral threshold for sea turtles is likely to be exceeded by proposed Project vessels. Popper et al. (2014) suggest that in response to continuous shipping sounds, sea turtles have a high risk for behavioral disturbance in the closer to the source (e.g., tens of meters), moderate risk at hundreds of meters from the source, and low risk at thousands of meters from the source.

Behavioral effects are considered possible but would be temporary with effects dissipating once the vessel or individual has left the area. A greater volume of vessel traffic is anticipated for construction and decommissioning, which could result in a detectable increase in background noise levels in the Action Area; however, this would be temporary and would cease once construction and decommissioning are completed. Operational vessels would constitute a longer-term source of noise throughout the 30-year operational life of the proposed Project, but the overall volume of vessels and frequency of trips proposed is lower than construction and would not be expected to result in an appreciable increase in noise levels. The Proposed Action includes the implementation of minimum vessel separation distance of 164 feet (50 meters) for sea turtles, which, though geared toward vessel strike avoidance, would help to reduce the level of noise a turtle is exposed to and reducing the likelihood of sea turtles receiving sound energy above the behavioral threshold. The additional BOEM-proposed measures to reduce vessel strikes on sea turtles, which includes slowing to 4 knots (2 meters per second) when sea turtle sighted within 328 feet (100 meters) of the forward path of the vessel and avoiding transiting through areas of visible jellyfish aggregations or floating sargassum, will also reduce the potential for behavioral disturbance effects by reducing the sound level received by sea turtles in the Action Area during vessel activities. Though these mitigation measures would not eliminate the potential for sea turtles to be exposed to above-threshold noise, the potential effects if exposure were to occur would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects on 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 exposures above behavioral disturbance thresholds during proposed Project vessel operations **may affect, not likely to adversely affect** ESA-listed sea turtles in the Action Area.

Geophysical Survey Noise

Acoustic modeling for HRG surveys was not conducted for sea turtles. However, HRG survey activities indicate a maximum modeled range to the marine mammal PTS thresholds of less than 1 meter for LFC and MFC for both boomers and sparkers (Table 3-14). The ranges to the SPL 160 dB re 1 µPa behavioral threshold for marine mammals ranged from 463 feet (141 meters) for the sparker to 584 feet (178 meters) for the boomer (Table 3-15). Therefore, these values allow inference that the PTS and behavioral threshold ranges for sea turtles would be smaller than those noted for marine mammals. This is because that even within their best hearing range, sea turtles have a lower sensitivity to underwater noise than marine mammals, with their lowest thresholds being almost 40 dB higher than those for MFCs and audiograms with no specialized auditory adaptations for higher-frequency hearing (Popper et al. 2014; Finneran et al. 2017). This position is further validated by the assessment conducted by Baker and Howsen (2021), which estimated the PTS thresholds for sea turtles would not be met or exceeded at any distance for any HRG source type, and the maximum behavioral disturbance threshold range would extend out to 295 feet (90 meters) for sparkers. However, this assessment assumed the maximum power and source settings were used for each type of equipment, which is not applicable to the HRG surveys proposed by the applicant (JASCO 2022, 2023), so it is expected that with the source and power settings included in the Proposed Action the maximum range to the sea turtle behavioral disturbance threshold would be even lower. HRG survey activities affecting sea turtles would follow the same approximate number of survey days described previously.

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

The Proposed Action includes shutdowns of HRG sources when sea turtles are sighted within 200 meters of the source (Table 1-15), which meets the maximum threshold ranges estimated for marine mammals and would, therefore, be expected to fully cover the area over which both the PTS and behavioral threshold ranges for sea turtles are met or exceeded. Additionally, based on the modeling conducted for marine mammals presented previously and the assessment conducted by Baker and Howsen (2021), PTS thresholds for sea turtles would only be met or exceeded within a few meters (less than 16 feet [5 meters]) of the source. The potential for ESA-listed sea turtles to be exposed to HRG survey noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposures above PTS thresholds resulting from HRG surveys **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

As discussed previously, modeling conducted for marine mammals, as well as the assessment conducted by Baker and Howsen (2021), indicates that the behavioral threshold for sea turtles would extend out less than 328 feet (100 meters) from the source. The clearance zone and shutdown zone included in the Proposed Action (Table 1-15) would be expected to fully cover the area exceeding the behavioral disturbance threshold, reducing the likelihood of sea turtles experiencing changes in behavior that affect their long-term fitness. Additionally, the effects are temporary and would dissipate as the vessel moves away from the turtle. The potential for behavioral exposure to ESA-listed turtles is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposures above behavioral thresholds during HRG surveys **may affect, not likely to adversely affect** ESA-listed sea turtles.

Unexploded Ordinance Detonations

Acoustic modeling was not conducted for potential UXO detonation effects on sea turtles; however, modeling results are available for sea turtles for the Revolution Wind Project, which is also located offshore Rhode Island and Massachusetts and would, therefore, have comparable seafloor and oceanographic conditions applicable for underwater acoustic modeling. Preliminary survey data for the Action Area indicate there is a risk of UXOs that cannot be avoided or removed through non-explosive methods. The analysis in the draft ITA application (JASCO 2023) estimated up to 10 UXO may be detonated over a 2-year period during construction. Underwater detonations of UXO present the risk of non-auditory injury for sea turtles such as lung or gastrointestinal injuries, PTS, and behavioral disturbances represented by TTS (Finneran et al. 2017). A quantitative analysis of ranges to non-auditory injury, PTS, and TTS ranges was not included for sea turtles (JASCO 2022); however, based on the thresholds modeled for the Revolution Wind Project (Hannay and Zykov 2022), a qualitative assessment of potential effects can be conducted for sea turtles.

Effects of Exposure to Acoustic Impulses Noise Above Non-Auditory Injury Thresholds

The maximum modeled ranges to the non-auditory injury threshold for sea turtles for the Revolution Wind Project were 1,155 feet (352 meters) for 454-kilogram (1,000-pound) charges detonated in 148-foot (45-meter) water depths (Hannay and Zykov 2022). The Proposed Action includes the implementation of a 60-minute clearance period before any detonations, limitation of the number of detonations to one within a 24-hour period, and implementation of a 1,600-meter clearance zone for sea turtles (Table 1-15), making the risk of non-auditory injuries or mortalities unlike to occur and **discountable**. Therefore, the effects of exposure to an acoustic impulse above non-auditory injury thresholds is **likely to affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above Permanent Threshold Shift Thresholds

Based on the modeled ranges for the Revolution Wind Project (Hannay and Zykov 2022), the PTS threshold for sea turtles may be exceeded out to 945 feet (288 meters) during detonation of a 454-kilogram (1,000-pound) charge in 148-foot (45-meter) water depths. With the mitigation and monitoring measures described previously (Table 1-15), the likelihood of PTS being realized for sea turtles is low. Additionally, Kemp's ridley and green sea turtles are less abundant in the Project area (Sections 3.3.3 and 3.3.4) and given the mitigation measures that will be implemented with the low presence of Kemp's ridley and green sea turtles, the likelihood of PTS occurring is **discountable**. Loggerhead and leatherback sea turtles, however, are more abundant in the Project area occurring predominantly in the summer and fall (Sections 3.3.1 and 3.3.2), so they are more likely to be present during potential UXO detonations, but with the implementation of a 1,600 meter clearance zone (Table 1-15), the likelihood of PTS occurring would also be **discountable** for these species. Therefore, the effects of noise exposures above PTS thresholds resulting from UXO detonations **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above Temporary Threshold Shift Thresholds

The modeled areas of affect for TTS thresholds for sea turtles were estimated to be a maximum of 6,562 feet (2,000 meters) during detonation of a 454-kilogram (1,000-pound) charge in 148-foot (45-meter) water depths in the Revolution Wind Project area (Hannay and Zykov 2022). As discussed previously for PTS, the mitigation measures that will be implemented by the applicant will help to reduce the likelihood of TTS occurring but may not completely eliminate the risk. However, exposures to noise that could exceed the TTS threshold would be brief, intermittent, and limited to only one detonation within a 24-hour period over a maximum of 10 detonations. Sea turtles, like marine mammals, would be expected to recover quickly after a detonation and are not expected to receive repeated or prolonged exposure that might initiate the onset of PTS. Given the temporary nature of TTS effects and rapid recovery such that substantial changes in hearing acuity or behavior, UXO detonation TTS effects on sea turtles are **discountable**. Therefore, the effects of exposure to noise above TTS thresholds resulting from UXO detonations **may affect, not likely to adversely affect** ESA-listed sea turtles.

Wind Turbine Generator Noise

Reported sound levels of operational wind turbines is generally low (Madsen et al. 2006; Tougaard et al. 2020; Stöber and Thomsen 2021) with a source SPL of about 151 dB re 1 µPa m and a frequency range of 60 to 300 Hz (Wahlberg and Westerberg 2005; Tougaard et al. 2020). At the Block Island Wind Farm, low-frequency noise generated by turbines reach ambient levels at 164 feet (50 meters) (Miller and Potty 2017). SPL from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 66 feet (14 and 20 meters) from measurements the WTGs (Tougaard and Henriksen 2009). Thomsen et al. (2006) indicated SPL ranging from 122 to 137 dB re 1 µPa at 492 feet (150 meters) and 131 feet (40 meters), respectively with peak frequencies at 50 Hz and secondary peaks at 150 Hz, 400 Hz, 500 Hz, and 1,200 Hz from a jacket foundation turbine and from 133 to 135 dB re 1 µPa at 492 and 131 feet (150 and 40 meters), respectively, with peak frequencies at 50 and 140 Hz from a steel monopile foundation turbine. The measurements within 131 feet (40 meters) of the monopile were similar to those observed at the jacket foundation WTG. However, at the greater distance of 492 feet (150 meters), the jacketed turbine was quieter.

Tougaard et al. (2020) reviewed the literature sources previously cited, along with others, to attempt some standardization in reporting and assessment. The resulting analyses showed that sound levels produced by individual WTG were low in all literature and comparable to or lower than sound levels within 0.6 mile (1 kilometer) of commercial ships. The complied data also showed an increase in noise levels with increasing WTG power and wind speed; however, Tougaard et al. (2020) noted that the noise produced from a WTG is stationary and persistent, which differs from the transitory nature of sound produced by vessel traffic, and the cumulative contribution of multiple WTG within a region must be critically assessed and planned. Stöber and Thomsen (2021) reviewed published literature and also identified an increase in underwater source levels (up to 177 dB re 1 µPa) with increasing power size with a nominal 10 MW WTG. They also estimate a sound decrease of roughly 10 dB from WTG using gear boxes compared to WTG using direct drive technology.

Sea turtle hearing (frequencies less than 1,200 Hz) is within the frequency range for operational WTG (less than 500 Hz; Popper et al. 2014; Thomsen et al. 2006; Tougaard and Henriksen 2009). Thus, it is possible that WTG noise is perceptible to sea turtles and may influence sea turtle behavior. Potential responses to WTG noise generated during normal operations may include avoidance of the noise source, disorientation, and disturbance of normal behaviors such as feeding (MMS 2007). In the discussion on reef effects from foundation structures (Section 3.3.5.2.4), sea turtles may be attracted to prey concentrations at foundation structures. This attraction may override avoidance of low level noise sources; in these cases, the acclimation of sea turtles to WTG noise may introduce low-level, long-term effects of noise exposures or masking.

Effects of Exposure to Noise Above the Permanent Threshold Shift Thresholds

Based on the source levels presented previously, it is unlikely that received levels of underwater noise from WTG operations would exceed the SEL_{24h} 200 dB re 1 μPa^2 s PTS thresholds for sea turtles for non-impulsive sources. As a result, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is **discountable**. Therefore, effects of noise exposure above PTS thresholds during proposed Project WTG operations **may affect, not likely to adversely affect** ESA-listed sea turtles.

Effects of Exposure to Noise Above the Behavioral Thresholds

Behavioral responses to noise, particularly long-term increases in ambient noise levels due to ocean development activities, are not well studied. Similar to increases in vessel noise, WTG operations have the potential to increase sound levels within the hearing range of sea turtles throughout the habitat used in the Project area. While avoidance of WTG structures due to increased noise levels is possible, there is no evidence of abandonment of habitats due to an increase in sound levels. Many species of sea turtles occupy coastal and heavily industrialized areas such as ports and harbors that have high ambient noise levels. However, the lack of a behavioral reaction may not fully capture potential effects of smaller noise increases that are expected during WTG operations. Samuel et al. (2005) recorded seasonal increases in vessel noise within coastal sea turtle habitat in the Peconic Bay Estuary, New York, and noted that such increases highlight that the spatial overlap between increased sound levels and sea turtles poses a potential acoustic exposure risk even though the “activity” is already part of the acoustic environment within which the sea turtles congregate. While the WTG sound level contributions may be small, the long-term change in acoustic habitat has the potential to cause some behavioral changes. Sea turtles are known to be attracted to offshore energy structures (Lohoefener et al. 1990; Valverde and Holzwart 2017; Viada et al. 2008), and sea turtles would likely be attracted to the WTG and ESP foundations due to beneficial foraging and sheltering opportunities (Barnette 2017; NRC 1996). Oil and gas platforms used by sea turtles are expected to produce higher SPLs than WTG operations. Further, satellite telemetered sea turtles in the Gulf of Mexico showed that platforms were part of home range core areas, and home range sizes for turtles captures at platforms were comparable to the home range sizes for telemetered turtles captured at Flower Garden Banks National Marine Sanctuary (Valverde and Holzwart 2017). In a comprehensive noise control study conducted by Spence et al. (2007), underwater noise sources were ranked based on the approximate overall source level for the source type, the affected or detectable range from the source, and duration or prominence of sounds. All types of oil and gas platforms ranked in the lowest significance category, which is indicative of a low likelihood of acoustic impacts (e.g., seismic surveys were ranked as highest significance). Because WTG operations are expected to produce even lower sound levels, the acoustic impact on sea turtles is expected to be low even for turtles that frequent the foundations or remain at the foundations for long periods. Therefore, the potential effects of operational WTG noise could not be measurable or meaningfully evaluated and would be **insignificant.** Therefore, effects of noise exposures above behavioral thresholds during WTG operations **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.3.5.1.4 Effects on Prey Organisms

Sea turtles assessed in this BA feed on a variety of prey items including invertebrates like crabs, jellyfish, and mollusks, and fish (Carr and Caldwell 1956; Byles 1988; Ruckdeschel and Shoop 1988; Burke et al. 1993; Plotkin et al. 1993; Schmid 1998; Heithaus et al. 2002; NMFS and USFWS 2008; NMFS 2011; Eckert et al. 2012; Seminoff et al. 2015; NMFS and USFWS 2020). A discussion of sea turtle life history traits is provided in Sections 3.3.1 through 3.3.4.

Green sea turtles primarily feed on seagrasses and algae (Bjorndal 1997); leatherbacks primarily feed on soft-bodied animals such as jellyfish and salps (NMFS 2022d; USFWS 2022b); juvenile loggerheads feed on crabs, mollusks, jellyfish, and vegetation at or near the surface, while subadults and adults are known to feed on benthic invertebrates such as mollusks and decapod crustaceans (TEWG 2009); and Kemp's ridley sea turtles are opportunistic foragers, feeding on decapod crustaceans, shellfish, and fish (NMFS 2022e).

Invertebrate sound sensitivity is restricted primarily to particle motion (André et al. 2016; Budelmann 1992; Solé et al. 2016, 2017), and effects are expected to dissipate rapidly such that any effects are highly localized from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for turtles is unlikely to be measurably affected by underwater noise resulting from any of the proposed Project activities. However, Solé et al. (2021) also show that seagrasses may be sensitive to anthropogenic noise. In their study, they exposed Neptune grass (*Posidoniaceae oceanica)* to noise sweeping through 50 to 400 Hz frequencies at received SPL of 157 dB re 1 µPa within a few meters (16 feet [less than 5 meters]) from the source to the grasses. Neptune grass is a slow-growing seagrass, endemic to the Mediterranean Sea; though is not the same species as the common eelgrass (*Zostera marina*) found in the Project area (BOEM 2022a), they both come from same order (Alismatales) and have similar physiological traits (Biodiversity of the Central Coast 2022). Results show deformed structure of starch grains in the plants studies after 48 hours of noise exposure, and damage to starch grains present after 96 to 120 hours of exposures (Solé et al. 2021). Damage to the starch grains in seagrasses could affect successful growth, and though the sound source used in the study is different from many of the noise-producing activities included under the Proposed Action, this shows seagrasses may be affected by low-frequency noise. However, as discussed in Section 2.1.1.1, only a sparse to moderate distribution of living eelgrass was identified in one area of the OECC along the south shore of Cape Cod (COP Volume II, Section 5.2.3; Epsilon 2022), so the likelihood of this food resource being exposed to proposed Project-related noise is low.

Marine fish, particularly those with swim bladders, are also sensitive to underwater sound pressure, and are typically sensitive to the 100 to 500 Hz range, which overlaps with many of the proposed Project activities described previously. Several studies have demonstrated that seismic airguns and other impulsive sources might affect the behavior of at least some species of fish; however, while these studies lend some information regarding behavior, it should be noted that the high energy, impulsive nature of seismic surveys are most comparable to but do not fully equate to the source levels and spectra produced by impact pile driving of foundations. Other activities (e.g., vibratory pile setting, foundation drilling) do not lend themselves to comparisons with seismic surveys. Field studies by Engås et al. (1996) and Løkkeborg et al. (2012) showed that the catch rate of haddock and Atlantic cod significantly declined over 5 days immediately following seismic surveys, after which the catch rate returned to normal. Other studies found only minor responses by fish to noise created during or following seismic surveys, such as a small decline in lesser sand eel abundance that quickly returned to pre-seismic levels (Hassel et al. 2004) or no permanent changes in the behavior of marine reef fishes (Wardle et al. 2001). However, both Hassel et al. (2004) and Wardle et al. (2001) noted that when fish sensed the airgun firing, they performed a startle response and sometimes fled.

Based on available data, only temporary behavioral responses to noise-producing proposed Project activities would be expected to occur to prey species resulting from underwater noise produced in the Proposed Action. No long-term or population-level effects are expected for any prey species during proposed Project construction, operations, or decommissioning, and, therefore, no long-term reduction in prey availability is expected for sea turtles. The potential for WTG construction/operations/decommissioning noise to reduce prey items for sea turtles is extremely unlikely and is **discountable**. Therefore, effects from noise exposures due to activities conducted in the Proposed Action **may affect, not likely to adversely affect** prey organisms for ESA-listed sea turtles.

3.3.5.2 Habitat Disturbance Effects on Sea Turtles (Construction, Operations, Decommissioning)

Effects from habitat disturbance to sea turtles are expected to be similar to the effects described for this stressor in marine mammals (Section 3.2.6.3). Habitat disturbance related to the proposed Project would occur through construction, operations, and decommissioning. Potential effects on ESA-listed sea turtles and their prey from habitat disturbance are analyzed in the following subsections and range from short- to long-term impacts. Individual stressors under habitat disturbance encompass displacement from physical disturbance of sediment; changes in oceanographic and hydrological conditions due to presence of structures, conversion of soft-bottom to hard-bottom habitat, and concentration of prey species due to the reef effect. These are discussed separately and organized by proposed Project stage in the following subsections.

3.3.5.2.1 Displacement from Physical Disturbance of Sediment (Construction, Decommissioning)

Construction of the Proposed Action would result in temporary disturbances of the seabed within the Project area as provided in Table 3-23. As discussed in Section 2.1.1.1, there are no sensitive resources, hard-bottom, or biogenic (sea grass beds, corals, shellfish reefs and beds, etc.) substrates identified within the SWDA, but there was hard-bottom habitat identified in the Muskeget Channel section of the OECC. Additionally, a sparse to moderate distribution of eelgrass was identified within the OECC along the south shore of Cape Cod (BOEM 2022a).

Significant displacement of ESA-listed sea turtles or their prey items due to seabed disturbance is not expected to occur during construction or decommissioning. As discussed previously, Kemp's ridley and green sea turtles are less common in the Project area compared to loggerhead and leatherback sea turtles (Section 3.3.1, 3.3.2, 3.3.3, and 3.3.4). Leatherback sea turtles forage primarily on pelagic soft-bodied animals such as jellyfish and salps and are, therefore, not expected to be affected by the physical disturbance of sediment. Kemp's ridley and green sea turtle diets include benthic invertebrates; however, their low occurrence and the limited complex or hard-bottom features in the Project area suggests that the region is not a critical feeding habitat. Adult loggerhead sea turtles also feed on benthic invertebrates and occur in the Project area in higher numbers, especially in the late summer and fall. However, based on observations of loggerhead sea turtles from aerial surveys of the RI/MA Lease Areas, there are expected to be foraging opportunities for the species outside the construction footprint (Dodge et al. 2014; O'Brien et al. 2021a, 2021b). Additionally, the natural restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes (Dernie et al. 2003). Disturbed areas not replaced with hardened structures (i.e., scour or cable protection) would be resettled, and the benthic community would be expected to approach normal conditions within approximately 1 to 2 years (Dernie et al. 2003; Department for Business, Enterprise and Regulatory

Reform 2008; Collie et al. 2000; Gerdes et al. 2008). However, the actual mechanisms of recovery are highly complex and site-specific; recovery to baseline conditions may take much longer in some areas and for some benthic species. Generally, soft-bottom habitats are more rapidly restored following a disturbance compared to complex or hard-bottom habitats (Collie et al. 2000).

Given the limited area affected and the lack of overlap with important benthic feeding habitats for ESA-listed sea turtles and the temporary nature of the disturbance, effects from seabed disturbance during construction and decommissioning would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**.

3.3.5.2.2 Effects of the Structure Presence on Sea Turtles (Operations)

The estimated permanent footprint of the Proposed Action throughout operations is provided in Table 3-23. The WTG and ESP foundations are vertical structures that constitute obstacles in the water column that could alter the normal behavior of sea turtles in the Project area during operations, whereas the cable protection would predominantly affect benthic prey species. The Proposed Action includes WTGs installed in a uniform east-to-west, north-to-south grid pattern with 1-nautical-mile × 1-nautical-mile (1.15-mile) spacing between positions. In total, 360.7 acres (1.46 km^2) of new permanent hard structure would be installed within the wind farm, including foundation and cable scour protection. ESA-listed sea turtles present in the immediate Project area would not be obstructed from transiting through the wind farm, and the structures would not be a barrier to the movement of any listed sea turtle species through the area.

Sea turtles are known to be attracted to offshore energy structures (Lohoefener et al. 1990; Valverde and Holzwart 2017; Viada et al. 2008). Studies have shown that sea turtles incorporate oil and gas platforms in core areas within their home ranges (Valverde and Holzwart 2017) and use offshore structures for foraging, resting, and other behaviors (Klima et al. 1988). The presence of the proposed Project structures would create an artificial habitat that could provide multiple benefits for sea turtles, including foraging habitats, shelter from predation and strong currents, and methods of removing biological build-up from their carapace (Barnette 2017; NRC 1996). High concentrations of sea turtles have been reported around these oil platforms (NRC 1996), and during a surface survey at a platform off the coast of Galveston, Texas, approximately 170 sightings were reported (Gitschlag 1990). Multiple species like green, hawksbill, and loggerhead sea turtles have also been observed using anthropogenic structures and submerged rocks to remove biological buildup and clean their flippers and carapace (Barnette 2017). In the Gulf of Mexico, both loggerhead and leatherback sea turtles were often observed resting at oil and gas platforms, making it possible that these species may behave similarly at wind farm structures (Gitschlag and Herczeg 1994; NRC 1996). These studies suggest that anthropogenic structures on the OCS may provide a beneficial habitat resource for sea turtles in the region.

The spacing and size of the offshore wind structures are not expected to pose barriers to movement of ESA-listed sea turtles. Further, sea turtles are well-documented around similar offshore structures in the Gulf of Mexico, California, and other parts of the world. Based upon the ability to move among structures and documented use of offshore structures, the effects from the physical presence of offshore structures, if any, would be considered **insignificant**.

3.3.5.2.3 Effects of Changes in Oceanographic and Hydrological Conditions due to the Presence of Structures (Operations)

Hydrodynamic processes resulting from the presence of structures is described in Section 3.2.6.3.3. The potential hydrodynamic effects identified from the presence of vertical structures in the water column may influence nutrient cycling and could influence the distribution and abundance of fish and planktonic prey resources throughout operations (van Berkel et al. 2020); however, these hydrodynamic effects are not expected to extend beyond a few hundred meters from the foundation (Miles et al. 2017; Schultze et al. 2020).

Hydrodynamic changes in prey aggregations would primarily affect the leatherback sea turtle that feed on planktonic prey that have limited independent movement beyond the ocean currents (Section 3.3.2), as opposed to green sea turtles, loggerhead sea turtles, and Kemp's ridley sea turtles whose diets include organisms that are sessile or can actively swim against ocean currents. The abundance and distribution of jellyfish are influenced by a number of factors rather than just currents, including sea surface temperature and prey (zooplankton) availability (Gibbons and Richardson 2008). Leatherback turtle prey such as jellyfish may be affected by changes in nutrient cycling and currents as a result of changes in oceanographic and hydrological changes due to the presence of proposed Project structures. However, as discussed in Section 3.2.6.3.3, these changes would be highly localized (Floeter et al. 2017; Miles et al. 2017; Schultze et al. 2020), and no localized or large-scale changes in jellyfish biomass are expected due to the Proposed Action. As indicated in Section 3.3.5.2.1, foraging resources for leatherback sea turtles would be available outside of the Project area if any alterations to jellyfish abundances were to occur as a result of the Proposed Action. The effects on ESA-listed sea turtle prey availability resulting from changes in oceanographic and hydrological conditions due to presence of structures, if any, would be so small that they could not be meaningfully evaluated and are, therefore, **insignificant.**

3.3.5.2.4 Effects of Changes in and Concentration of Prey Species due to the Reef Effect of Structures (Operations)

Another long-term operations effect created by the presence of wind farm structures is the reef effect. Foundations and cable protection may form biological hotspots that support species range shifts and expansions and changes in biological community structure resulting from a changing climate (Raoux et al. 2017; Methratta and Dardick 2019; Degraer et al. 2020). Colonizing organisms on the surface of the pile, namely blue mussels (*Mytilus edulis*), likely enhance food availability and food web complexity to the base of the structure and laterally away from the foundation through an accumulation of organic matter (Degraer et al. 2020; Mavraki et al. 2020). The accumulation could lead to an increased importance of the detritus-based food web, which could increase the availability of some sea turtle prey such as mollusks and crustaceans (Degraer et al. 2020). However, although the reef effect increases the total amount of biomass at each foundation, thereby increasing food resources and attraction by predators, significant broad scale changes to the regional trophic structure are considered unlikely (Raoux et al. 2017).

Leatherback sea turtles primarily feed on pelagic soft-bodied animals such as jellyfish and salps (Section 3.3.2). The primary effect that could alter leatherback prey distribution would be the presence of the structures and any changes in the hydrodynamic processes within the SWDA, as described in Section 3.3.5.2.3. The reef effect due to presence of structures is not expected to disrupt prey species for the leatherback sea turtle. Therefore, effects, if any, would be so small that they could not be meaningfully evaluated and are **insignificant** for leatherback sea turtle prey.

Adult green sea turtles primarily forage on seagrass and marine algae but occasionally will consume marine invertebrates (Section 3.3.4). As discussed in Section 2.1.1.1, the only seagrass identified in the Project area is within the OECC along the south shore of Cape Cod (COP Volume II, Section 5.2.3; Epsilon 2022). As described in Section 1.4.1.1.1, The applicant proposes to use horizontal directional drilling to avoid or minimize impact on the beach, intertidal zone, and nearshore areas within the OECC, thereby minimizing impact on nearshore habitats where seagrasses may be present (COP Section 3.3.1.8; Epsilon 2022). Additionally, as discussed in Section 3.3.4, adult green sea turtles may also forage on benthic invertebrates, which would beneficially be impacted by the reef effect due to the presence of structures. However, green sea turtles are relatively uncommon in the Project area and have not been reported in recent surveys in the RI/MA Lease Areas (Section 3.3.4.2). Given the low densities of seagrass detected and low occurrence of green sea turtles in the Project area, any effects on green sea turtles and their forage sources are expected to be **discountable**.

Loggerhead and Kemp's ridley sea turtles are the only species whose diet consists predominantly of benthic species such as mollusks and crustaceans (Sections 3.3.1 and 3.3.3, respectively) Therefore, physical displacement of benthic prey items within the Project area has greater potential to affect the loggerhead and Kemp's ridley sea turtles. Available information suggests that the predominant prey base for Kemp's ridley and loggerhead sea turtles may increase in the Project area due to the reef effect of the WTGs and associated scour protection following the temporary disturbances during construction activities; an increase in crustaceans and other forage species would be **beneficial** to those species. Loggerhead sea turtles are likely to benefit more than Kemp's ridley due to the nature of their distribution with Kemp's ridleys being less common in the Project area relative to loggerheads (Sections 3.3.1 and 3.3.3). Although both may benefit, the effect would be greatest for the loggerhead sea turtle. Sea turtles with increased habitat and foraging opportunities could potentially remain in the area longer than they typically would and become susceptible to cold stunning or death, although there is no quantitative evidence of this.

3.3.5.2.5 Summary of Habitat Disturbance Effects

As discussed above, all effects of habitat disturbance types resulting from WTG and ESP structures are either **discountable**, **insignificant**, or **beneficial**. Therefore, effects resulting from habitat disturbance due to activities conducted in the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.3.5.3 Water Quality Effects on Sea Turtles (Construction, Decommissioning)

The seabed within the Action Area is comprised of soft-bottom sediments characterized by fine sand punctuated by gravel and silt/sand mixes (Section 2.1.1.1), so it is likely that increases in turbidity during construction and decommissioning may occur. Physical or lethal effects in increased turbidity during proposed Project construction and decommissioning are unlikely because sea turtles are air-breathing and land-brooding, and, therefore, do not share the physiological sensitivities of susceptible organisms like fish and invertebrates. Elevated suspended sediments may cause individuals to alter normal movements and behaviors. However, these changes are expected to be limited in extent, short term in duration, and likely too small to be detected (NOAA 2021). Moreover, many sea turtle species routinely forage in nearshore and estuarine environments with periodically high natural turbidity levels. Therefore, short-term exposure to elevated suspended sediment levels is unlikely to measurably inhibit foraging (Michel et al. 2013). However, elevated levels of turbidity may negatively affect sea turtle prey items, including benthic mollusks, crustaceans, sponges, and sea pens by clogging respiratory apparatuses. The more mobile prey items like crabs may also be negatively affected by turbidity by clogging their gills but likely to a lesser extent due to their ability to leave the turbid area (BOEM 2021). Any effects from increased turbidity levels from construction activities on turtles, their habitat, or their prey would be isolated and temporary and are so small that they could not be measured and are, therefore, **insignificant.**

The COP (Volume I, Appendix I-F; Epsilon 2022) presents results from a spill model assessing the trajectory and weathering of spilled material following a catastrophic release of all oil contents from an offshore ESP located at the closest potential position to shore from the SWDA. Each WTG would contain up to 17,413 gallons (65,915 liters) of oils, lubricants, coolant, and diesel fuel, while each ESP could contain up to 189,149 gallons (716,007 liters) of these fluids. Oils and lubricants would comprise the largest share of these stored materials. The maximum most probable discharge volume is 189,149 gallons (716,007 liters) (COP Volume I, Appendix 1-F; Epsilon 2022). According to Bejarano et al. (2013), the probability of occurrence of this type of catastrophic release, such as the topple of an ESP, is extremely small.

Etkin et al. (2018) indicated that the risk of mortality for sea turtles would occur at a thickness of 100 grams per square meter (or 0.1 millimeter). In the unlikely event of an accidental oil spill, oil may affect sea turtles within 50 miles (80 kilometers) of the spill (COP Appendix 1-F; Epsilon 2022). Based on information obtained from oil spills and related studies, sea turtles are exposed to petroleum through contact with their skin and by ingestion and inhalation. The effects of such exposure generally fall into two categories: physical effects and chemical or toxicological effects (Wallace et al. 2020). Due to the thickness of the predicted slick from a potential spill, effects are expected to be sublethal. Execution of the applicant's required oil spill response plan would decrease potential effects by establishing response, containment, and removal procedures. Therefore, potential effects from accidental spills are unlikely to occur and would be **discountable**.

Therefore, effects from changes in water quality due to activities conducted under the Proposed Action **may affect, not likely to adversely affect** ESA-listed turtles.

3.3.5.4 Secondary Entanglement due to Increased and Altered Fishing Activity Caused by the Presence of Structures (Operations)

Another long-term impact of the presence of structures during operations is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of sea turtle entanglement in both lines and nets and increasing the risk of injury and mortality due to ingestion, infection, starvation, or drowning (Nelms et al. 2016; Gall and Thompson 2015; Shigenaka et al. 2010; Barnette 2017). These structures could also result in commercial fishing vessel displacement or gear shift. The potential impact on sea turtles from these changes is uncertain. However, if a shift from mobile gear to fixed gear occurs due to inability of fisherfolk to maneuver mobile gear, there could be an increase in the number of vertical lines in the water column, potentially resulting in an increased risk of sea turtle interactions with fishing gear. Greater fishing efforts around the wind farm area would increase the amount of fishing gear in the water, particularly monofilament line, which has been identified as a major hazard for all sea turtle species. As discussed in Section 3.2.6.5, this is expected to be low in intensity and persist until decommissioning is complete and structures are removed. Additionally, abandoned or lost fishing gear (commercial and recreational) may become entwined within foundation structures and pose a hazard to sea turtles. The following monitoring and mitigation measure (Table 1-15) will act to reduce potential impacts on sea turtles resulting from lost or discarded fishing gear that accumulates around WTG foundations:

- The applicant must monitor indirect effects associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the SWDA annually. Survey design and effort may be modified with review and concurrence by the Department of Interior. The applicant may conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The applicant must report the results of the surveys to BOEM and BSEE in an annual report for the preceding calendar year. Annual reports must include survey reports that include: the survey date; contact information of the operator; the location and pile identification number; photographic, video documentation, or both of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Annual reports must also include claim data attributable to the Project from the applicant corporate gear loss compensation policy and procedures. Required data and reports may be archived, analyzed, published, and disseminated by BOEM.

The implementation of the BOEM-proposed monitoring surveys would provide data regarding the presence of gear on structures that will help assess the secondary entanglement risk. Through this monitoring, removal actions could be taken if entanglement risk appears high, thus reducing likelihood of any sea turtles becoming entangled. Currently, published data do not exist on the amount or type of debris that accumulates on offshore wind foundations in the U.S. Atlantic; therefore, the scale of entanglement risk is not known.

The monitoring and disposition requirement provides BOEM with the ability to require removal of entanglement hazards should they occur. Secondary entanglement would pose a risk to the loggerhead sea turtles who have the greatest propensity for occupying the Project area and foraging in the vicinity of the foundations. Although leatherback sea turtles would not be expected to feed off the foundations, their pelagic nature and high degree of fisheries interactions indicate that they would be at risk of secondary entanglement. It is uncertain how much Kemp's ridleys will use offshore structures; however, their low occurrence in the Project area (Section 3.3.3) would result in a low likelihood of entanglement such that the effects are **discountable**. Similarly, green sea turtles that have a low occurrence in the Project area and primarily forage on seagrasses (Section 3.3.4), thus posing a low likelihood of entanglement resulting in a **discountable** effect.

Given the foraging strategies and expected presence of sea turtle species in Project area, effects of secondary entanglement in fishing gear within the proposed wind farm foundations **may affect, likely to adversely affect** loggerhead and leatherback sea turtles, but **may affect**, **not likely to adversely affect** green and Kemp's ridley sea turtles.

3.3.5.5 Vessel Traffic Effects on Sea Turtles (Construction, Operations, Decommissioning)

Proposed Project vessels operating during all phases of the Proposed Action pose a potential collision risk to sea turtles. HRG survey vessels would be limited to site investigation survey and biological survey vessels with periodic activity on the wind farm and export cable routes. Vessel activity is anticipated to be highest during proposed Project construction, followed by decommissioning. The number of vessels operating during operations would be comparatively lower than during construction but would be long-term throughout the operational lifespan of the proposed Project.

Vessel-animal collisions are a measurable and increasing source of mortality and injury for sea turtles; the percentage of stranded loggerhead sea turtles with injuries that were apparently caused by vessel strikes increased from approximately 10 percent in the 1980s to over 20 percent in 2004, although some stranded turtles may have been struck post-mortem (NMFS and USFWS 2008). Sea turtles are expected to be most vulnerable to vessel strikes in coastal foraging areas and may not be able to avoid collisions when vessel speeds exceed 2 knots (1 meter per second) (Hazel et al. 2007). The recovery plan for loggerhead sea turtles (NMFS and USFWS 2008) notes that, from 1997 to 2005, 14.9 percent of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having some type of propeller or collision injuries, although it is not known what proportion of these injuries occurred before or after the turtle died. Similar data are not available for Massachusetts; however, the Action Area does not contain high densities of sea turtles (compared to other studied areas), and there are no nearby nesting beaches. There are also no foraging hotspots, except for an area of relatively high density of leatherback sea turtles in the summer just south of the eastern shore of Martha's Vineyard (Kraus et al. 2016a). Regardless, increased vessel traffic associated with the Proposed Action may increase the potential for impacts from vessel strikes.

Vessels traveling at higher speeds pose a higher risk to sea turtles. Relative to marine mammals, as discussed in Section 3.2.6.6, sea turtles require more stringent speed reductions before lethal injury probabilities are reduced. To reduce the risk of lethal injury to loggerhead sea turtles from vessel strikes by 50 percent, Sapp (2010) found that small vessels (10 to 30 feet [3 to 6 meters] in length) had to slow down to 7.5 knots (3.9 meters per second); the probability of lethal injury decreased by 60 percent for vessels idling at 4 knots (2.1 meters per second). Foley et al. (2008) further indicated that vessel speed greater than 4 knots (2.1 meters per second) may cause serious injury or mortality to sea turtles. The most informative study of the relationship between ship speed and collision risk was conducted on green sea turtles (Hazel et al. 2007). Green sea turtles often failed to flee approaching vessels. Hazel et al. (2007) concluded that green sea turtles rarely fled when encountering fast vessels (greater than 10 knots [5 meters per second]), infrequently fled when encountering vessels at moderate speeds of around 6 knots (3.1 meters per second), and frequently fled when encountering vessels at slow speeds of approximately 2 knots (1 meter per second). Based on the observed responses of green sea turtles to approaching boats, Hazel et al. (2007) further concluded that sea turtles rely primarily on vision rather than hearing to avoid vessels; although both may play a role in eliciting responses, sea turtles may habituate to vessel sound and be more likely to respond to the sight of a vessel rather than the sound of a vessel. The potential for collisions between vessels and sea turtles, thus, increases at night and during inclement weather. Based on these findings, vessel speed restrictions may be inconsequential to reducing strike risk at anything but the slowest speeds (less than 2 knots [1 meter per second]) due to the relatively low rate of flee responses of sea turtles.

The construction vessels and ports that would be used for proposed Project construction are described in Section 1.4.1.2.6 and Table 1-9. As discussed, a wide variety of vessels would be used during construction, ranging from tugboats (52 to 115 feet [16 to 35 meters] in length) to jack-up, heavy-lift, and heavy transport vessels (more than 700 feet [213 meters] in length) (COP Volume I, Table 3.3-1; Epsilon 2022). Based on information provided in the COP, construction activities (including offshore installation of WTGs, ESPs, array cables, interconnection cable, and export cable) would require a daily average of approximately six and seven vessel round trips per day under an 18-month offshore construction schedule for Phase 1 and Phase 2, respectively. An average of up to 15 vessel round trips could occur during the most active month of construction, which is expected to be during pile-driving activities only during each phase. The maximum transit speed of these vessels varies from 6 to 30 knots (3 to 15 meters per second), though operational speeds are typically lower, ranging from 0 to 25 knots (0 to 13 meters per second). Proposed Project vessels within the SWDA would usually be stationary during construction or traveling at slow speeds, although transits between ports and the SWDA may result in speeds greater than or equal to 10 knots (5 meters per second). New Bedford Harbor is expected to be the primary port used to support construction activities, followed by ports in Connecticut, Rhode Island, and Martha's Vineyard, Massachusetts. Although Canadian and European ports may be used, transits from these would comprise a small percent of overall vessel transits during Proposed Action construction (Table 1-10).

The Action Area also includes potential transit routes of vessels transporting offshore WTG components from Europe or Canada during proposed Project construction, with operational speeds of up to 18 knots (9 meters per second) (Table 1-12). The number of proposed Project-related vessels transiting from Canada or Europe is considered relatively minor compared to the existing high level of commercial vessel traffic in the North Atlantic. Further, the likelihood of an encounter due to the temporary increase in vessel traffic to and from Canada and Europe would be a rare event given the low sea turtle densities in waters north and east of the SWDA (Sections 3.3.1, 3.3.2, 3.3.3, and 3.3.4).

During operations, the Proposed Action would generate trips by crew transport vessels (about 75 feet [23 meters] in length) and service operations vessels (260 to 300 feet [79 to 91 meters] in length); other vessels may be used for routine and non-routine maintenance activities as discussed in Section 1.4.2.2. Approximately 250 vessel round trips are estimated to take place annually for Phase 1 operations, equating to less than 1 round-trip transit per day. While vessel activity during Phase 2 operations would be similar to that of Phase 1, some vessels may be shared between Phases 1 and 2, thus consolidating trips while both phases are operating. Approximately 470 vessel round trips are estimated to take place annually during the simultaneous operations of both phases, which equates to an average of less than 2 vessel round trips per day. The majority of vessel transits during Phase 1 and Phase 2 operations would originate from Bridgeport, Connecticut, and Vineyard Haven, Massachusetts. Crew transfer vessels have typical operational speeds of 10 to 25 knots (5 to 13 meters per second), whereas service operations vessels are slower, operating at 10 to 12 knots (5 to 6 meters per second) (Table 1-12).

During Phase 1 and Phase 2 operations, there is no planned use of Canadian or European ports, though use of Canadian or other U.S. ports could occur to support an unplanned event.

Average daily Proposed Action construction activities would represent a 580 percent increase over the current number of daily average vessel transits in the SWDA, whereas proposed Project operations would represent up to 107 percent above current daily averages. However, there are several limitations to the comparison of proposed Project and baseline vessel activity; see Section 3.2.6.6 for a complete discussion.

The following ESA-listed sea turtle densities (Table 3-29) range from relatively moderate for leatherback and loggerhead sea turtles to low for Kemp's ridley and green sea turtles for the SWDA and export cable route from spring through fall (COP Appendix III-M; Epsilon 2023):

- Leatherback sea turtle density estimates have a high of 0.0087 animals per km^2 in the fall and a low of 0.0002 animal per km^2 in winter and spring. This equates to up to four leatherback sea turtles within the 175-square-mile (453-km^2) SWDA during their period of expected maximum abundance in the fall.
- Kemp's ridley sea turtle density estimates are 0.00017 animal per km^2 for spring through winter. This equates to up to less than one Kemp's ridley sea turtle within the 175-square-mile (453-km^2) SWDA year-round.
- Green sea turtle density estimates are 0.00017 animal per km^2 for spring through winter. This equates to up to less than one green sea turtle within the 175-square-mile (453-km^2) SWDA year-round.
- Loggerhead sea turtle density estimates have a high of 0.0063 animals per km^2 in the fall and a low of 0.0010 animals per km^2 in winter and spring. This equates to up to three leatherback sea turtles within the 175-square-mile (453-km^2) SWDA during their period of expected maximum abundance in the fall.

There are limited measures that have been proven to be effective at reducing collisions between sea turtles and vessels (Schoeman et al. 2020). Also, the relatively small size of turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult, therefore reducing the effectiveness of PSOs to mitigate vessel strike risk on sea turtles. Nevertheless, the use of trained lookouts and other measures presented in Section 1.4.5 would serve to reduce potential collisions. The measures include the following:

- Trained lookouts and reporting:
  - For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, the applicant would have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the strike avoidance requirements can be implemented.
  - For all vessels operating south of the Virginia/North Carolina border, year-round, the applicant would have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the strike avoidance requirements can be implemented. This requirement is in place year-round for any vessels transiting south of Virginia, as sea turtles are present year-round in those waters.
  - The trained lookout would monitor https://seaturtlesightings.org/ prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day.

- The trained lookout would maintain a vigilant watch and monitor a vessel strike avoidance zone (1,640 feet [500 meters]) at all times to maintain minimum separation distances from ESA-listed species. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) would be available to ensure effective watch at night and in any other low visibility conditions. If the trained lookout is a vessel crew member, this would be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts would receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements.
- If a sea turtle is sighted within 328 feet (100 meters) or less of the operating vessel's forward path, the vessel operator would slow down to 4 knots (2 meters per second) (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots (2 meters per second) or less until there is a separation distance of at least 328 feet (100 meters) at which time the vessel may resume normal operations. If a sea turtle is sighted within 164 feet (50 meters) of the forward path of the operating vessel, the vessel operator would shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots (2 meters per second). The vessel may resume normal operations once it has passed the turtle.
- Vessel captains/operators would avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. In the event that operational safety prevents avoidance of such areas, vessels would slow to 4 knots (2 meters per second) while transiting through such areas.
- All vessel crew members would be briefed in the identification of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials would 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) would be clearly communicated and posted in highly visible locations aboard all Project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so.
- The only exception is when the safety of the vessel or crew necessitates deviation from these requirements on an emergency basis. If any such incidents occur, they would be reported to NMFS within 24 hours.
- If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for NARWs, an additional lookout is not required, and this PSO or trained lookout would maintain watch for whales and sea turtles.
- Vessel transits to and from the Project area that require PSOs will maintain a speed commensurate with weather conditions and effectively detecting sea turtles prior to reaching the 328-foot (100-meter) avoidance zone.

- Vessel separation:
  - Vessels will maintain, to the extent practicable, separation distances of greater than 164 feet (50 meters) for sea turtles.

In addition to the previously stated mitigation, under the Proposed Action, all proposed Project vessels would comply with NMFS regulations and speed restrictions as applicable for NARW, including the 10 knot (5 meters per second) speed restrictions in any SMA, DMA, or slow zone and other seasonal restrictions. Although the 10-knot (5 meters per second) speed restrictions in certain areas would reduce potential impacts, sea turtle collisions may still occur at slow speeds, and individuals would still be vulnerable when vessels travel over 2 knots (1 meter per second). Additionally, effective detection of sea turtles in low visibility conditions (nighttime, fog, inclement weather) is likely low, thereby increasing the vulnerability of sea turtles to vessel strike risk during these periods, even with all other mitigative measures implemented.

The contribution of the number of vessel trips under the proposed Project compared to current baseline levels would be moderate to high during construction. As a result, there is a moderate risk of interaction between sea turtles and proposed Project vessel traffic during construction based on the density of sea turtles in the Action Area and the estimated vessel activity over the total construction period. The highest levels of proposed Project-related vessel activity would occur during peak construction, which is expected to occur during pile-driving activities. Due to the implementation of seasonal restrictions for pile driving (Section 1.4.5), these highest levels of projected vessel activity would also coincide with the highest sea turtle densities in the Project area. There is an overall lower risk of vessel interaction with sea turtles in the Action Area during operations based on the density of sea turtles in the Action Area and the estimated activity over the operational life of the proposed Project. Although vessel strike risks to sea turtles are expected to be reduced, some unavoidable effects on sea turtles may occur due to the difficulty in detecting sea turtles, especially during periods of low visibility (i.e., nighttime, fog, inclement weather) or those that just below the surface but within the vessel's draft.

The increase in vessel round trips from Proposed Action construction is likely to increase the relative risk of vessel strike for sea turtles, particularly during nighttime and periods of reduced visibility. Based on this analysis, proposed Project vessel traffic leading to collisions with sea turtles cannot be discounted given the incremental increase in vessel traffic and the difficulty in detecting sea turtles during transits, even with relatively low total abundances expected for all species. The seasonal patterns of sea turtles in the region will result in a reduction in risk during periods of time when individuals are less likely to be present, such as during winter months. Mitigation measures (e.g., minimum vessel separation distances, vessel speed restrictions) would reduce the overall encounter potential. The deployment of trained observers on all vessels along with operable and effective monitoring equipment would additionally serve to minimize the collision risk with sea turtles. As a result of these measures, the probability of a vessel strike between proposed Project vessels and sea turtles throughout all Project stages would be reduced but not eliminated. Therefore, proposed Project-related vessel traffic **may affect, likely to adversely affect** ESA-listed sea turtles.

3.3.5.6 Monitoring Surveys

The components of the fisheries and benthic habitat monitoring surveys during pre- and post-construction, as well as during construction, are described in Section 1.4.4. The stressors associated with survey activities that may affect ESA-listed sea turtles include vessel strike, entanglement or entrapment, and impacts on prey resources.

3.3.5.6.1 Vessel Strike

As discussed in Section 3.3.5.5, vessel strikes are a known source of injury and mortality for ESA-listed sea turtles. Increased vessel activity in the Project area associated with the Proposed Action, including vessel traffic associated with HRG, fisheries, and habitat monitoring surveys, would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species. Propeller and collision injuries from boats and ships are common in sea turtles; vessel speeds greater than 4 knots (2.1 meters per second) may cause serious injury or mortality to sea turtles (Foley et al. 2008). Sea turtles are likely to be most susceptible to vessel collision in coastal waters, where they forage from May through November.

Vessels conducting fisheries monitoring surveys would be commercial fishing vessels, ranging in size from 30 to 100 feet (9.1 to 30 meters) (Table 1-12). Operational survey speeds are survey-type and vessel dependent. Demersal otter trawl surveys are conducted at 3 knots, while neuston net sampling is conducted at 4 knots (Appendix B); all other fisheries monitoring surveys (i.e., drop camera, ventless trap, fish pot, and lobster tagging) are expected to be conducted either stationary or at idle speeds during active gear deployment or recovery. Transit speeds for these vessels may exceed 10 knots but will be maintained as legally mandated (73 Fed. Reg. 60173 and 87 Fed. Reg. 46921 if adopted). Each sampling type (i.e., demersal otter trawl, drop camera, and ventless trap study) would use a single vessel per trip; the neuston net sampling would use the same vessel and trip as the ventless trap study and would require no additional vessel trips. Additionally, the exact ports that would be used by vessels conducting the fisheries monitoring surveys are currently unknown, though homeports for vessels will be in Rhode Island or Massachusetts.

The total number of vessels conducting HRG, fisheries, and benthic habitat monitoring surveys is expected to be a small proportion of the number of vessels and transits analyzed for construction, operations, and decommissioning activities given the limited extent and duration of the proposed surveys relative to ongoing proposed Project activities (Section 1.4.4). The same mechanisms and stressors associated with vessel strike risk analyzed for proposed Project construction, operations, and decommissioning activities would apply to vessel activity associated with HRG, fisheries, and habitat monitoring surveys under the Proposed Action. In addition, the monitoring and mitigation measures for vessel strike avoidance presented in Section 1.4.5 would be implemented during monitoring surveys. This analysis is not repeated here.

The monitoring surveys under the Proposed Action; inclusive of HRG surveys, benthic habitat monitoring surveys, and fisheries monitoring surveys; would not significantly increase vessel traffic in the Project area compared to other proposed Project-related vessel activities and regional vessel traffic already occurring in the Project area. In consideration of proposed Project-related HRG, fisheries, and habitat monitoring survey design; vessel strike risk; and the implementation of mitigation and monitoring measures, the potential for vessel strike would be **discountable**. Therefore, vessel traffic during proposed Project-related monitoring surveys **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.3.5.6.2 Gear Utilization

As described in Section 1.4.4, the applicant is planning to conduct demersal otter trawl, drop camera, ventless trap, fish pot, lobster tagging, and Neuston net sampling surveys. The monitoring plan is proposed to be 6 years in duration, including 2 years of pre-construction baseline monitoring, 1 year of monitoring during construction, and 3 years of post-construction monitoring. Survey design, frequency, and extent are discussed in Section 1.4.4.2. Additionally, multibeam echo sounder, video, and benthic grab sampling would be conducted under the BHMP during pre-construction and Years 1, 3, and, if necessary, Year 5 after construction (Section 1.4.4.1). Each component of the monitoring plan presents differential entanglement risk and impacts on prey species to ESA-listed sea turtles, as discussed below.

A primary threat to sea turtles is their unintended capture in fishing gear, which can result in drowning or cause injuries that lead to mortality (e.g., swallowing hooks). For example, trawl fishing is among the greatest continuing primary threats to the loggerhead turtle (NMFS and USFWS 2008), and sea turtles are also caught as bycatch in other fishing gear including longlines, gillnets, hook and line, pound nets, pot/traps, and dredge fisheries. A substantial impact of commercial fishing on sea turtles is the entrapment or entanglement that occurs with a variety of fishing gear, including both mobile (i.e., trawl) and stationary (i.e., pots).

A number of monitoring and mitigation measures under the Proposed Action are designed to standardize sea turtle handling and reporting procedures in response to an entanglement (Section 1.4.5). In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures. Notably, these measures do not serve to reduce entanglement risk or prevent an entanglement from occurring but would improve response and potential survival of released live animals. The information gathered from the required reporting could be used to inform future deployments, ideally with minimized risk. Additionally, trained observers deployed for marine mammal mitigation onboard fishery survey vessels (Section 3.2.6.7) would serve to minimize potential interactions with ESA-listed sea turtles.

The capture and mortality of sea turtles in bottom trawl fisheries is well documented (Henwood and Stuntz 1987; NMFS and USFWS 1991, 1992, 2008; NRC 1990). 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 2014). The trawl vessel and sampling equipment used for the fisheries monitoring plan would be comparable to that used by the Northeast Area Assessment and Monitoring Program. Trawl tow lengths are limited to 20 minutes, and the vessel operating the trawl (a commercial fishing vessel) would tow at 3 knots. The total effort of trawl surveys for the proposed Project is 50, 20-minute tows four times per year or 66.6 hours per year and 400 hours over a 6-year period.

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). Incidentally captured individuals would most likely suffer stress and potential injury. 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 would 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 minimize the risk of serious injury and mortality from forced submergence for sea turtles caught in the bottom otter trawl survey gear. 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. Incidental capture and entanglement of sea turtles would likely continue in the Action Area at a similar rate over the life of the Proposed Action. Safe release, disentanglement protocols, and rehabilitation would help to reduce the severity of impacts of these interactions, and these efforts are also expected to continue over the life of the proposed Project.

Green, loggerhead, and Kemp’s ridley sea turtles may be captured during trawl surveys, and capture would cause stress and may result in injury and, in rare cases, post-capture mortality. Leatherback sea turtles are less likely to be captured during demersal trawl surveys due to their relative size and foraging preferences. Although the limited tow time (20 minutes) and the use of trained observers that are equipped to recover and release captured live individuals would reduce risk of mortality, potential measurable effects on ESA-listed sea turtles due to demersal trawls may occur and cannot be discounted. Therefore, entanglement in demersal trawl gear associated with the Proposed Action **may affect, likely to adversely affect** ESA-listed sea turtles.

Stationary gear poses a risk of entanglement for ESA-listed sea turtle species due to buoy and anchor lines. Of all the ESA-listed sea turtles included in this assessment, the leatherback seems to be the most vulnerable to entanglement in trap/pot fishing gear, possibly due to its physical characteristics; diving and foraging behaviors; distributional overlap with the gear; and the potential attraction to prey items that collect on buoys and buoy lines at or near the surface (NMFS 2016b). Individuals entangled in pot gear generally have a reduced ability to forage, dive, surface, breathe, or perform other behaviors essential for survival (Balazs 1985). In addition to mortality, gear entanglement can restrict blood flow to extremities and result in tissue necrosis and death from infection. Individuals that survive may lose limbs or limb function, decreasing their ability to avoid predators and vessel strikes (NMFS 2016b). The proposed

Project's ventless trap survey includes 30 stations that would be sampled twice monthly from May through December; soak times would be limited to 3 days (when feasible). In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures. While there is a theoretical risk of sea turtle entanglement, particularly for leatherbacks, in trap and pot gear, the likelihood is considered **discountable** given the limited, dispersed distribution of sea turtles in the Action Area, the small number of vertical lines used in the surveys, and the limited duration of each survey event.

Neuston sampling is conducted with a plankton net towed and slow speeds (4 knots) for short periods (10 minutes) in the top 1.6 feet (0.5 meter) of the water column. The Neuston net frame is 2.4 meters by 0.6 meter by 6.0 meters (7.8 feet by 1.9 feet by 19.6 feet) in size, and the net is made of a 1,320-micrometer mesh; although capture is possible, given the relatively small size of the net, the use of trained observers onboard, and the limited tow length duration, no sea turtle entanglement is expected to occur from Neuston net sampling. Drop camera sampling is conducted directly from the stern of vessel and includes continuous monitoring of the seabed. Similarly, HRG and benthic habitat monitoring surveys would not use gear that pose an entanglement risk to sea turtles. Therefore, entanglement risk due to the methodology presented for Neuston net, drop camera, and benthic habitat monitoring surveys is extremely unlikely and, therefore, **discountable** for ESA-listed sea turtles.

Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish are removed from the marine environment as bycatch in bottom trawls and 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 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. Neuston net sampling is designed to collect planktonic organisms at the ocean's surface, which may include capture of prey for leatherback sea turtles. However, given the short tow lengths (10 minutes) and small net volume, no measurable effect on leatherback prey availability is expected. No effect on overall prey availability is expected for loggerhead, green, and Kemp's ridley sea turtles during Neuston net surveys. Under the BHMP, a benthic/sediment grab sampler (e.g., Van Veen, Day, Ponar) would be employed to retrieve sediments from the upper 10 to 20 centimeters (3.9 to 7.8 inches) of the seabed for analysis; a total of 252 grab samples would be collected for each annual survey, which may include capture of benthic prey items for juvenile and adult loggerhead and Kemp's ridley sea turtles. However, given the limited extent of the benthic grab surveys, any removal of sea turtle prey species would be non-measurable and negligible compared to the overall benthic prey resources. Benthic grab sampling trawl surveys would not affect the availability of prey for leatherback and green sea turtles in the Action Area. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trawl gear and trap would be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are **insignificant**.

In summary, entanglements resulting from neuston net, ventless trap, and benthic habitat monitoring surveys and reductions in prey resulting from all habitat monitoring surveys on sea turtles are considered extremely unlikely to occur and **discountable** or are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of monitoring surveys (excluding trawl surveys) from the proposed Project **may affect, not likely to adversely affect** ESA-listed sea turtles. However, the effects of demersal trawl gear associated with the Proposed Action cannot be discounted and **may affect, likely to adversely affect** ESA-listed sea turtles.

3.3.5.7 Electromagnetic Field and Cable Heat Transfer Effects on Sea Turtles (Operations)

Sea turtles are known to possess geomagnetic sensitivity (but not electro-sensitivity) that is used for orientation, navigation, and migration (Normandeau et al. 2011). They use the earth's magnetic fields for directional or compass-type information to maintain a heading in a particular direction and for positional or map-type information to assess a position relative to a specific geographical destination (Lohmann et al. 1997). Multiple studies have demonstrated magneto-sensitivity and behavioral responses to field intensities ranging from 0.047 to 40,000 mG for loggerhead turtles and 293 to 2,000 mG for green turtles (Normandeau et al. 2011). While green and Kemp's ridley sea turtles have not been studied, anatomical, life history, and behavioral similarities suggest that they could be responsive at similar threshold levels. Hatchling sea turtles are known to use the earth's magnetic field (and other cues) to orient and navigate from their natal beaches to their offshore habitat (Lohmann et al. 1997). However, there are no designated critical habitats for sea turtles in the Action Area, and the only reported sea turtle nesting event in the Northeastern U.S. was for Kemp's ridley sea turtles in Long Island, New York (Section 3.3.3), which is outside the proposed Project construction footprint.

There are no data regarding impacts on sea turtles from EMF generated by underwater cables, although anthropogenic magnetic fields can influence migratory deviations (Luschi et al. 2007; Snoek et al. 2016). Lohmann et al. (2012) speculated that navigation methods used by adult and juvenile sea turtles were dependent upon the stage of migration, initially relying on magnetic orientation. While the specific mechanisms of leatherback sea turtle navigation are not currently known, it is believed that they possess a compass sense similar to hardshell turtle species, possibly related to geomagnetic cues (Eckert et al. 2012; Luschi et al. 2007; NMFS and USFWS 2013).

Sea turtles foraging on benthic organisms may be able to detect magnetic fields while they are foraging on the seafloor near the transmission cables. Modeled magnetic field levels specific to the proposed Project's cables are not available on the New England Wind Project COP webpage following the June 2022 update (BOEM 2022b). However, both OECC and inter-array cable arrays are AC, and the applicant would bury these cables to a target depth of 5 to 8 feet (1.5 to 2.5 meters). Sea turtles may, therefore, detect the EMF over relatively small areas near cables (e.g., when resting on the bottom or foraging on benthic organisms near cables or concrete mattresses).

There are no nesting beaches, critical habitat, or other biologically important habitats identified in the SWDA or OECC that could result in harm to sea turtle populations. Loggerhead and leatherback sea turtles are the two species expected to be most common relative to green and Kemp's ridley sea turtles (Sections 3.3.1, 3.3.2, 3.3.3, and 3.3.4) and, of these, only loggerhead sea turtles would forage on benthic species within the Project area. Loggerhead sea turtles would, therefore, face the highest risk of exposure to EMF during proposed Project operations. However, though desktop studies suggest that turtles are capable of sensing magnetic fields from submarine cables (Normandeau et al. 2011), there is little evidence supporting that these small EMF along a cable corridor would affect sea turtles under natural conditions. Potential effects from proposed Project EMF would be limited to minor deviations in migratory direction, but biologically relevant behaviors such as foraging or mating are not likely to be affected. Effects on sea turtles from potential exposure to EMF from proposed Project cables are expected to be undetectable, not measurable, or so minor that they cannot be meaningfully evaluated and would be **insignificant**.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection, such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. Potential effects on ESA-listed sea turtles from heat transfer from proposed Project cables is unlikely to occur and would be **discountable**.

Therefore, effects from EMF exposure and heat transfer from proposed Project cables installed under the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.3.5.8 Dredging Effects on Sea Turtles (Construction, Decommissioning)

As discussed in Section 1.4.1.2.4, dredging of sand waves along portions of the OECC may occur under the Proposed Action; however, it would be limited to only the extent required to achieve the desired cable burial depth during installation of the offshore export cable for both proposed Project phases (COP Section 3.3.1.3.5 and 4.3.1.3.5; Epsilon 2022). Impacts on sea turtles due to increased turbidity resulting from dredging activities is discussed in Section 3.3.5.3. The geographic extent over which dredging would occur under the Proposed Action is site-specific, not extensive, and estimated to be approximately 119 acres (0.48 km^2) during Phase 1 and Phase 2 combined (Section 1.4.1.2.4). This limited extent minimizes the risk for sea turtles in the Project area. Dredging may be accomplished through the use of a TSHD or through jetting by controlled flow excavation. While both methods would result in seafloor disturbances, as estimated in Table 3-23, only the TSHD equipment would have the additional risk of impingement, entrainment, or capture of sea turtles.

Sea turtles are vulnerable to impingement or entrainment in hopper dredges, which can result in injury or mortality (USACE 2020). Sea turtles have been known to become entrained in trailing suction hopper dredge or trapped beneath the draghead as it moves across the seabed. Direct impacts, especially for entrainment, typically result in severe injury or mortality (Dickerson et al. 2004; USACE 2020). Sea turtles may be crushed during placement of the draghead on the seafloor, impinged if unable to escape the draghead suction and become stuck, or entrained if sucked through the draghead. Of the three direct impacts, entrainment most often results in mortality. However, the risk of interactions between hopper dredges and individual sea turtles is expected to be lower in the open ocean areas where dredging may occur for the proposed Project's offshore export cable compared to nearshore navigational channels (Michel et al. 2013; USACE 2020). This may be due to the lower density of sea turtles in these areas, as well as differences in behavior and other risk factors. Sea turtles are most often able to escape from the oncoming draghead of a hydraulic dredge due to the very slow speed that the draghead advances. During swimming and surfacing, sea turtles are highly unlikely to interact with the draghead and are most vulnerable when foraging or resting on the seafloor. The potential capture of sea turtles in the dredging equipment could occur but is more likely in channels and areas that otherwise have high densities of sea turtles. There are no known large aggregation areas or areas where turtles would be expected to spend large amounts of time stationary on the bottom where they could be entrained in a suction dredge. Additionally, the proposed Project would employ trained observers on dredges (Section 1.4.5), further decreasing the risk of impingement or entrainment of sea turtles during suction-dredging activities. Therefore, given the short duration of dredging where sea turtles are most vulnerable and the use of trained observers, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support proposed Project construction would be low, and population-level effects are unlikely to occur.

Dredging would increase turbidity and temporarily affect an overall very small area that may be used as foraging habitat by sea turtles. Green sea turtles predominantly feed on sea grasses, which would not be impacted by dredging under the Proposed Action. Pelagic prey items are extremely unlikely to be affected due to the operation of both dredges on the seafloor; therefore, leatherback sea turtle prey items are extremely unlikely to be affected (Section 3.3.2). The benthic organisms preyed upon by Kemp's ridley and loggerhead sea turtles may survive entrainment, and motile organisms, such as crabs, may avoid the dredge (Sections 3.3.3 and 3.3.1, respectively). However, entrainment of crabs does occur (Reine and Clark et al. 1998), and it is expected that most small benthic invertebrates in the path of the dredge would be entrained. Given the size of the area where dredging would occur and the short duration of dredging, the loss of benthic invertebrates would be small, temporary, and localized.

Based on the above analyses, entrainment or capture in dredging equipment and effects from the loss of prey items to foraging ESA-listed sea turtles due to dredging is not likely to occur and would be **discountable**. Therefore, effects from dredging under the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea turtles.

3.4 Marine Fish

The only ESA-listed fish species considered for analysis in this BA is the Atlantic sturgeon. Applicable life history and distributional information from previous surveys and available literature are provided in the following subsections.

3.4.1 Atlantic Sturgeon

The Atlantic sturgeon is a large, longlived, benthic fish found from Canada to Florida in river, estuarine, marine coastal, and OCS habitats. Individuals may be up to 13 feet (4 meters) long and can reach up to 600 pounds. Atlantic sturgeon are anadromous, meaning they are born in freshwater, migrate to sea, and then back to freshwater to spawn. There are 22 rivers along the U.S. east coast that currently host spawning Atlantic Sturgeon (NMFS 2023j). Spawning in rivers from Delaware to Canada occurs from spring to early summer; some rivers may support a second fall spawning population, though supporting data are limited (NMFS 2023j). Juveniles typically remain in their natal river for 2 to 3 years before migrating into coastal and ocean waters (NMFS 2023j). Subadults move out to estuarine and coastal waters in the fall; adults inhabit fully marine environments and migrate through deep water when not spawning (ASSRT 2007). While most individual are most common near their natal river, extensive migrations within the marine environment have been documented for both adults and subadults, with some individuals traveling thousands of kilometers from their natal rivers (Kazyak et al. 2021). Five genetically distinct DPSs make up the U.S. east coast population; the Project area falls within the New York Bight DPS, and the Action Area additionally includes the Gulf of Maine DPS. However, given the species' proclivity to migrate, with extensive movements up and down the U.S. east coast and into Canadian waters, Atlantic sturgeon encountered within the Project area and Action Area more broadly may originate from any of the five DPSs (Kazyak et al. 2021).

Atlantic sturgeon primarily feed on benthic invertebrates but will adjust their diet to exploit other types of prey resources when available, such as anchovies, silversides, herrings, and sand lances (NMFS 2023j; Kritzer et al. 2016). For example, Johnson et al. (1997) found that polychaetes composed approximately 86 percent of the diet of adult Atlantic sturgeon captured in the New York Bight. Isopods, amphipods, clams, and fish larvae composed the remainder of the diet, with the latter accounting for up to 3.6 percent of diet in some years (Johnson et al. 1997). In contrast, Guilbard et al. (2007) observed that small fish accounted for up to 38 percent of subadult Atlantic sturgeon diet in the St. Lawrence River estuarine transition zone during summer, but less than 1 percent in fall. The remainder of the species' diet consisted primarily of amphipods, oligochaetes, chironomids, and nematodes, with the relative importance of each varying by season.

There is no available information on the hearing capabilities of Atlantic sturgeon specifically, although the hearing of other species of sturgeon have been studied. Meyer et al. (2010) and Lovell et al. (2005b) studied the auditory system morphology and hearing ability of lake sturgeon (*Acipenser fulvescens*), a closely related species. The Acipenseridae (sturgeon family) have a well-developed inner ear that is independent of the swim bladder, and it, therefore, appears as though sturgeon rely directly on their ears for hearing. The results of these studies indicate a generalized hearing range from 50 Hz to approximately 700 Hz, with greatest sensitivity between 100 and 300 Hz. Popper (2005) summarized studies measuring the physiological responses of the ear of European sea sturgeon (*Acipenser sturio*). The results of these studies suggest sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kHz. While sturgeon have a swim bladder, it is not involved in hearing (Popper et al. 2014).

3.4.1.1 Current Status of the Atlantic Sturgeon

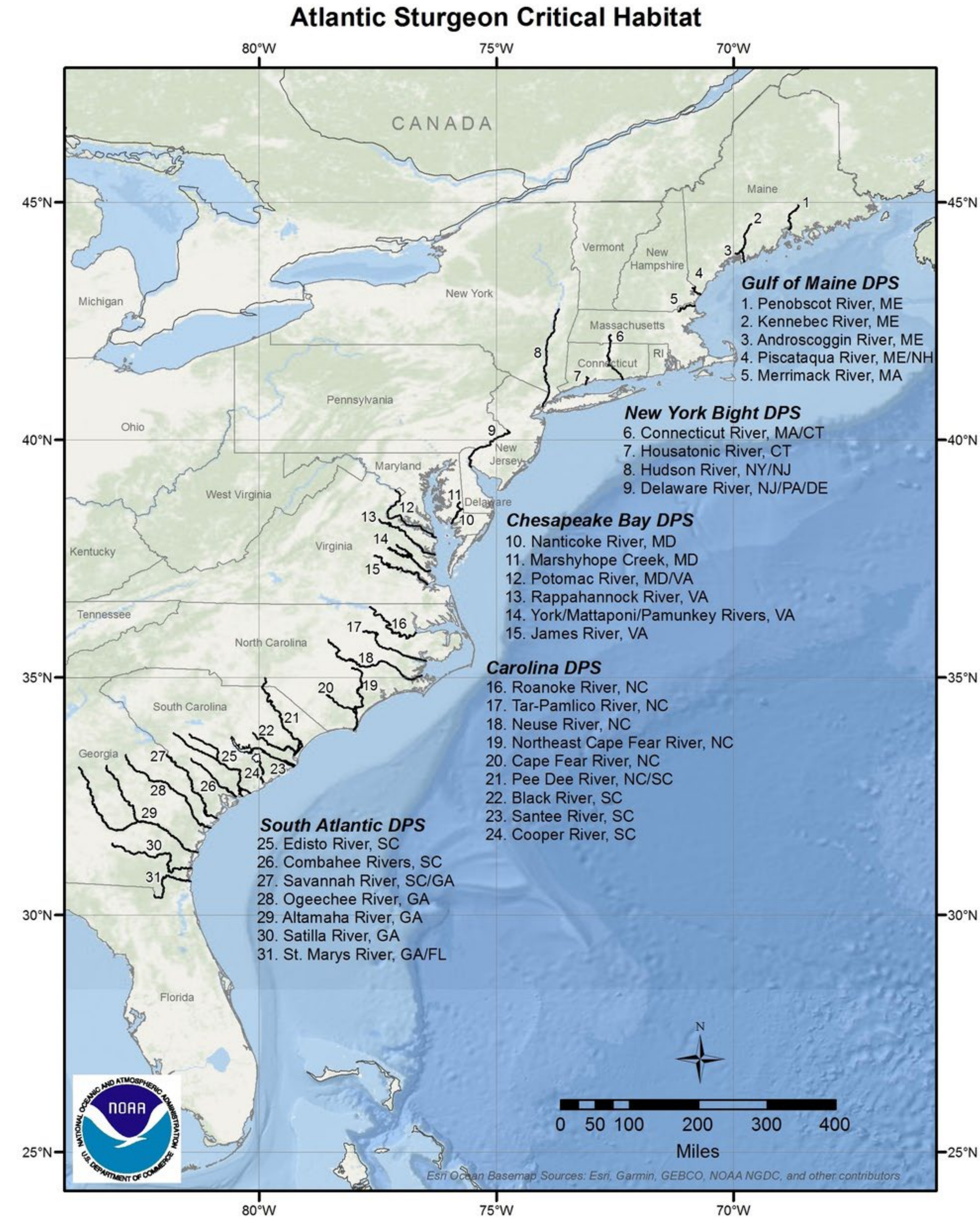
All five DPSs of the Atlantic sturgeon are listed under the ESA; the Gulf of Maine DPS is listed as Threatened, whereas all others are Endangered (77 Fed. Reg. 5880 [February 6, 2012], 77 Fed. Reg. 5914 [February 6, 2012]). Though these DPSs represent distinct geographic populations along the U.S. Atlantic Coast, individuals from all DPSs migrate along the coast and are not easily distinguished visually from one another. Therefore, any Atlantic sturgeon encountered in the Project area is considered Endangered for the purpose of this analysis.

NMFS listed the New York Bight DPS as Endangered in 2012 (77 Fed. Reg. 5879 [February 6, 2012]), and the critical habitat designation was finalized in 2017 (82 Fed. Reg. 39160 [August 17, 2017]; Section 3.4.1.2). The IUCN lists the Atlantic sturgeon as Near Threatened (St. Pierre and Parauka 2006) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora lists the species under Appendix II, which lists species that are not necessarily now threatened with extinction but may become so unless trade is closely controlled. The most recent status review for the Atlantic sturgeon was conducted in 2007. In this review, commercial bycatch was assessed, which showed that the majority (61 percent) of tagged sturgeon recaptures came from ocean waters within 3 miles (4.8 kilometers) of shore, with the lowest ocean bycatch occurring in the summer months (July to September) (ASSRT 2007). The Atlantic Sturgeon benchmark (ASMFC 2017) indicates that all DPS stocks are depleted but recovering. It is estimated that biomass and abundance are currently higher than that in 1998 (last year of available survey data) for the New York Bight DPS (75 percent average probability), which primarily spawn in the Delaware and Hudson RIVERS. The estimated abundance of age-0 to age-1 Atlantic sturgeon in the Delaware River in 2014 was 3,656 individuals (Hale et al. 2016), which is similar to the age-1 estimate of 4,314 for the Hudson River in 1995 (Peterson et al. 2000). Similar estimates from the 2007 status review suggest that the Hudson River population consists of approximately 4,600 wild juveniles with a spawning stock of 870 adults (ASSRT 2007), and the 2014 spawning run abundance was estimated to be 466 adults (NMFS 2020b). Current threats to Atlantic sturgeon within critical habitat include dams and turbines, dredging, water quality, and climate change.

3.4.1.2 Critical Habitat Designated for All Distinct Population Segments of Atlantic Sturgeon

Critical habitat for the Atlantic sturgeon has been designated (82 Fed. Reg. 39160 [August 17, 2017]), which includes a portion of the Action Area (Section 1.3). The final rule for Atlantic sturgeon critical habitat (all listed DPSs) was issued on August 17, 2017 (82 Fed. Reg. 39160 [August 17, 2017]). This rule includes 31 units, all rivers, occurring from Maine to Florida. No marine habitats were identified as critical habitat because the physical and biological features in these habitats essential for the conservation of Atlantic sturgeon could not be identified.

Critical habitat designations for the Atlantic sturgeon Gulf of Maine DPS encompasses seven rivers in Maine, New Hampshire, and Massachusetts. The New York Bight Atlantic sturgeon DPS critical habitat includes four rivers: the Connecticut, Housatonic, Hudson, and Delaware rivers. The Chesapeake Bay DPS critical habitat includes five rivers: the Nanticoke, Marshyhope Creek, Potomac, Rappahonnock, York/Mattaponi/Pamunkey, and James rivers. The Carolina DPS critical habitat includes nine rivers within North and South Carolina. The South Atlantic DPS Atlantic sturgeon critical habitat is composed of nine rivers of South Carolina, Georgia, and Florida (Figure 3-7). The only proposed activity that may affect Atlantic sturgeon critical habitat are Project vessel transits within the Action Area. Proposed Project vessel transits throughout the Action Area do not include the rivers identified for the Gulf of Maine, Chesapeake Bay, Carolina, or South Atlantic DPS critical habitats; these are not discussed further. Potential proposed Project ports overlap with critical habitat for the New York Bight DPS (Figure 3-7), including Capital Region ports (Port of Albany, Coeymans, and New York State Offshore Wind Port) on the Hudson River and Paulsboro, New Jersey on the Delaware River (Table 1-9).



Source: NMFS 2023j
DPS = distinct population segment

Figure 3-7: Map of Atlantic Sturgeon Critical Habitats

The primary physical and biological features identified as being essential for conservation of Atlantic sturgeon include the following: (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 range) for settlement of fertilized eggs, refuge, growth, and development of early life stages; (2) aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 parts per thousand and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development; (3) water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) 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; and (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 (82 Fed. Reg. 39160 [August 17, 2017]).

3.4.1.3 Presence and Abundance in the Action Area

The New York Bight DPS includes all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, Massachusetts, to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in several rivers between Massachusetts and the Chesapeake Bay (Murawski and Pacheco 1977; Secor 2002; ASSRT 2007). Spawning still occurs in the Delaware and Hudson rivers (ASSRT 2007). In June 2014, several age-0 Atlantic sturgeon captured in the Connecticut River were subjected to mitochondrial DNA control region sequence and microsatellite analysis indicating successful spawning within that river in 2013 (Savoy et al. 2017).

The Gulf of Maine DPS includes all Atlantic sturgeon that spawned in watersheds that drained into coastal waters from the Penobscot River, Maine to the Merrimack River on the border of New Hampshire and Massachusetts (ASSRT 2007). Historically this DPS supported at least four spawning populations, however, it is suspected that there are only two subpopulations currently within this DPS; the Penobscot and Kennebec river populations (ASSRT 2007). Trawl surveys conducted by the Maine Department of Marine Resources from 2000 to 2003 collected 13 subadult Atlantic sturgeon at the mouth of the Kennebec River, which had the largest occurrence of the species among the five rivers sampled between Maine and New Hampshire (ASSRT 2007).

In the marine environment, Atlantic sturgeon typically occur within the 50-meter depth contour (NMFS 2023j). During the spring and early summer, adult Atlantic sturgeon travel upstream in spawning rivers in New England and the New York Bight region and move back out to the marine environment in the fall where they are known to spend time during winter (NMFS 2023j). The most likely life stage encountered in the SWDA and OECC would be the sub-adult and adult. The primary habitat type (sand or silt) and depth (mostly less than 164 feet) in the SWDA and OECC fits the preferred coastal habitat occupied by subadult and adult sturgeon. There are no abundance estimates for Atlantic sturgeon outside their designated critical habitat (Section 3.4.1.2), but telemetry studies for the New York Bight indicate they are most abundant in this region during the months of November, December, and January, with tagged fish reportedly traveling up to 44.3 kilometers offshore (Frisk et al. 2019).

Using commercial bycatch data, Stein et al. (2004) reported numerous juvenile and adult Atlantic sturgeon caught in waters offshore Massachusetts and Rhode Island near the RI/MA Lease Areas; therefore, they can be expected to occur in the SWDA, with a peak presence between November and May.

3.4.2 Effects Analysis for Marine Fish

3.4.2.1 Underwater Noise Effects on Marine Fish

Two primary components of underwater noise important for assessing acoustic effects for fish species include pressure and particle motion. Pressure can be characterized as the compression and rarefaction of the water as the noise wave propagates through it. Particle motion is the displacement, or back and forth motion, of the water molecules that create the compression and rarefaction. Both factors contribute to the potential for effects on affected resources from underwater noise. Marine mammal and sea turtle hearing is based on the detection of sound pressure, and there is no evidence to suggest either group is able to detect particle motion for the purposes of hearing and noise detection (Bartol and Bartol 2012; Nedelec et al. 2016), so it was not discussed in Sections 3.2.6.2 or 3.3.5.1.

All fishes can detect and use particle motion (Popper and Hawkins 2019). The organ located in the inner ear of fishes contains a dense structure called the otolith (i.e., ear stone), which lies near the auditory sensory macula (i.e., layer of sensory hair cells). The otolith organ acts as an accelerometer and enables detection of particle motion. Particularly in fish with primitive swim bladders that are not involved in hearing, like Atlantic sturgeon, particle motion is thought to play a key role in detection of underwater noise (Hawkins and Chapman 2020). However, measurements of sensitivity to particle motion and pressure were rarely performed simultaneously, leaving a data gap in the understanding of particle motion sensitivity in fishes (Popper and Hawkins 2018). Additionally, particle motion levels associated with a high intensity noise sources are often difficult to measure and isolate from SPLs (Popper and Hawkins 2018). Current understanding of the potential effects of particle motion on fish and invertebrates is limited, and there are no regulatory thresholds for particle motion from which the potential for effect may be assessed. However, it is expected that particle motion associated with impulsive noise sources, such as impact pile driving, would have similar magnitude-level effects as pressure waves in fish species, so this BA focuses on the pressure component of underwater noise.

Hearing loss in fish is likely to result in reduced fitness of individuals from decreased ability to detect and avoid predators, locate prey, communicate with peers, or sense the physical environment. Fishes with swim bladders (or other gas bubbles) that functionally affect the ear generally have lower hearing thresholds and wider hearing bandwidths than species without these adaptations (Normandeau 2012). Hearing range and sensitivity varies considerably among fish species (Popper et al. 2014). Atlantic sturgeon are particle motion-sensitive species, and although they have physostomous (open) swim bladders, these organs are not involved in their hearing (Hawkins and Johnstone 1978; Knudsen et al. 1992, 1994; Lovell et al. 2005; Meyer et al. 2010; Popper et al. 2014).

The acoustic thresholds for the onset of recoverable injury and behavioral disturbances among fishes are recommended by the GARFO based on the work by the Fisheries Hydroacoustic Working Group (FHWG 2008), which were used in this assessment.

3.4.2.1.1 Acoustic Criteria for Marine Fish

For fish, NMFS has adopted recoverable injury criteria relative to impulsive sources using dual criteria developed by the FHWG (2008). These dual criteria were created to ensure that fish were neither exposed to high levels of accumulated energy for repeated impulsive sounds nor single strikes. The FHWG (2008) criteria include a maximum accumulated SEL and a maximum Lpk for a single pile-driving strike (Popper et al. 2014). Currently, FHWG (2008) recommends a 150 dB re 1 µPa criterion for behavioral response of all fish and does not distinguish between impulsive and non-impulsive noise. Threshold criteria are also available from Popper et al. (2014), which have not been adopted by NMFS, but they distinguish between different types of fish based on their hearing sensitivity. The modeling report associated with the COP presents ranges to the FHWG (2008) and Popper et al. (2014) thresholds. For these reasons, the Popper et al. (2014) thresholds are provided here for reference in the discussion. Table 3-32 outlines the acoustic thresholds for the onset of PTS, significant behavioral disruptions for marine fish, or both, for both impulsive and non-impulsive noise sources.

Swim bladders in some fish play a role in sound detection and perception; therefore, a fish's susceptibility to injury from noise exposure depends, in part, on the presence and function of a swim bladder. Thus, fish are categorized based on the presence or absence and role of the swim bladder in hearing as follows:

- Fish with no swim bladder or other gas chamber: This group includes elasmobranchs (sharks and rays), jawless fishes, flatfish, and gobies that are expected to be only capable of detecting particle motion (Casper et al. 2012). These species are least susceptible to barotrauma (i.e., tissue injury that results from rapid pressure changes [e.g., forced change in depth, explosions, and intense sound]) (Popper et al. 2014). There are no ESA-listed marine fish species included in this BA that fall into this category, so it will not be discussed further.
- Fish with swim bladders or other gas volumes not involved in hearing: This group includes some pelagic species such as Atlantic salmon and Atlantic bluefin tuna (*Thunnus thynnus*), as well as Atlantic sturgeon. These fishes are susceptible to barotrauma and are only capable of detecting particle motion.
- Fish with swim bladder or other gas volumes involved in hearing: This group includes Atlantic cod, herring, shad, otophysans, mormyrids, and squirrelfish. They detect both sound pressure and particle motion and are susceptible to barotrauma. There are no ESA-listed marine fish species included in this BA that fall into this category, so it will not be discussed further.
- Fish eggs and larvae (Popper et al. 2014): This group was not included in the modeling report (COP Appendix III-M; Epsilon 2023) and will not be discussed further in this BA.

Table 3-32: Acoustic Thresholds for Onset of Acoustic Effects (Injury or Behavioral Disturbance) for Endangered Species Act-Listed Fish included in this Analysis

Fish Category	Impulsive Sources			Non-Impulsive Sources		Explosive Sources
	Recoverable Injury		Behavioral Disturbance	Recoverable Injury	Behavioral Disturbance	Mortality
	Lpk	SEL_{24h}	SPL	SPL	SPL	Lpk
Fish <2 grams	206	183	150	-	150	-
Fish ≥2 grams	206	187	150	-	150	-

Source: FHWG 2008; Popper et al. 2014

< = less than; ≥ = greater than or equal to; - = threshold not available; Lpk = peak sound pressure level in units of decibels referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of decibels referenced to 1 micropascal.

The current classification considers effects on fish mainly through sound pressure without taking into consideration the effect of particle motion. Popper et al. (2014) and Popper and Hawkins (2018) suggest that extreme levels of particle motion induced by impulsive sources may also have the potential to affect fish tissues and that proper attention needs to be paid to particle motion as a stimulus when evaluating the effects of sound on aquatic life. However, lack of standardized field measurements of particle motion and corresponding fish sensitivity to particle motion results in significant challenges for establishing of guidelines or thresholds for particle motion (Popper et al. 2014; Popper and Hawkins 2018). Mitigation to minimize adverse effects from underwater noise on ESA-listed marine fish, such as soft-start procedures, have been proposed for the Project (Table 1-15).

3.4.2.1.2 Assessment of Underwater Noise Effects

Foundation Installation

The COP (Appendix III-M; Epsilon 2023) includes acoustic modeling of underwater sound generated and potential effects on sea turtle species during foundation installation for the Proposed Action using the same methods as described previously in Section 3.2.6.2.3

Table 3-33 and 3-34 summarizes the radial distance at which recoverable injury (using both the Lpk and SEL_{24h} metrics) and behavioral change would occur for Atlantic sturgeon. The modeling used the same assumptions for impact pile driving as discussed previously, except the ranges provided in Tables 3-33 and 3-34 represent the acoustic ranges, not the $ER_{95\%}$, as there is no animal movement data for Atlantic sturgeon that could be included in the modeling.

Table 3-33: Summary of Proposed Action 95th Percentile Acoustic Ranges to Acoustic Thresholds for Atlantic Sturgeon for Foundation Installation using Impact Pile Driving Only with 10 dB noise mitigation

Fish Group	Two 12-Meter Monopiles per Day, 6,000 kJ Hammer			Two 13-Meter Monopiles per Day, 5,000 kJ Hammer			Four 4-Meter Pin Piles per day, 3,500 kJ Hammer		
	Injury (Lpk)	Injury (SEL_{24h})	Behavior (SPL)	Injury (Lpk)	Injury (SEL_{24h})	Behavior (SPL)	Injury (Lpk)	Injury (SEL_{24h})	Behavior (SPL)
Fish <2 grams	108	6,295	10,789	126	7,103	11,431	128	10,251	8,656
Fish ≥2 grams	108	4,704	10,789	126	5,362	11,431	128	8,200	8,656

Source: COP Appendix III-M; Epsilon 2023
< = less than; ≥ = greater than or equal to; dB = decibel; kJ = kilojoule; Lpk = peak sound pressure level in units of dB referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal

Table 3-34: Summary of Proposed Action 95th Percentile Acoustic Ranges to Acoustic Thresholds for Atlantic Sturgeon for Foundation Installation using Vibratory Pile Setting Followed by Impact Pile Driving with 10 dB noise mitigation

Fish Group	Two 12-Meter Monopiles per Day, 6,000 kJ Hammer			Two 13-Meter Monopiles per Day, 5,000 kJ Hammer			Four 4-Meter Pin Piles per day, 3,500 kJ Hammer		
	Injury (Lpk)	Injury (SEL_{24h})	Behavior (SPL)[a]	Injury (Lpk)	Injury (SEL_{24h})	Behavior (SPL)[a]	Injury (Lpk)	Injury (SEL_{24h})	Behavior (SPL)[a]
Fish <2 grams	108	7,441	3,693	126	8,280	4,491	128	12,021	5,358
Fish ≥2 grams	108	5,613	3,693	126	6,283	4,491	128	9,268	5,358

Source: COP Appendix III-M; Epsilon 2023
< = less than; ≥ = greater than or equal to; dB = decibel; kJ = kilojoule; Lpk = peak sound pressure level in units of dB referenced to 1 micropascal; SEL_{24h} = sound exposure level over 24 hours in units of dB referenced to 1 micropascal squared second; SPL = root-mean-square sound pressure level in units of dB referenced to 1 micropascal

There are minimal direct mitigation measures that are effective for ESA-listed fish species during pile driving. The primary mitigation measures are the sound mitigation devices that reduce the propagated sound levels and may act as a barrier to the highest sound levels, and soft-start procedures. The use of soft-start procedures for pile driving has been a standard mitigation and engineering measure at the start of most underwater piling events; however, the effectiveness of soft-start procedures for moving fish away from a sound source is largely assumed with minimal empirical data. Acoustic deterrents have been used to manage fish populations (e.g., keep fish from water intake structures; guide fish toward fish passes); however, most of these activities are highly specific to the genera or family of fish species of interest (Putland and Mensigner 2019). In underwater blasting studies, the use of "scare charges" to move fish from zones of mortality were only nominally effective and often temporary (Keevin and Hempen 1997). It is assumed that the activity and disturbance at the site, combined with the soft-start procedures, would result in some movement by fish out of the highest impact zones. Therefore, effects determinations consider the soft-start as effective for minimizing physiological injury to ESA-listed fish species. Once vacated, the noise mitigation system is likely to act as a barrier for re-entry to the highest noise level zones.

Effects of Exposure to Noise Above the Physiological Injury Thresholds

Results indicate that foundation installation noise would exceed physiological injury thresholds for ESA-listed fish up to 26,903 feet (8,200 meters) from the source for fish greater than or equal to 2 grams using impact pile driving (Table 3-33); and 30,407 feet (9,268 meters) using vibratory pile setting followed by impact pile driving (Table 3-34).

Atlantic sturgeon are able to detect sound pressure and particle motion but have a relatively primitive swim bladder, which is not directly connected to the inner ear. In addition, they are able to voluntarily release gas from their swim bladder (Logan-Chesney et al. 2018) to accommodate rapid changes in pressure in their environment. The risk of non-auditory injury due to exposure to impulsive signals from impact pile driving is lower for Atlantic sturgeon relative to fish species that cannot release swim bladder gas. However, because the range to the physiological injury threshold is relatively large (4,898 feet [1,493 meters]), and there are limited mitigation and monitoring methods that would approach any level of effectiveness for this species, there is still risk of auditory injury occurring to individuals within the population.

For injury to occur, however, sturgeon would need to remain within the distances (26,903 feet [8,200 meters] and 30,407 feet 9,268 meters]) to the SEL_{24h} threshold from the source. With the implementation of soft-starts, the potential for serious injury is minimized. Soft-starts would facilitate a gradual increase of hammer blow energy to allow fish to leave the area prior to the start of operations at full energy that could result in injury. Soft-starts could be effective in deterring Atlantic sturgeon from impact pile-driving activities prior to exposure resulting in a serious injury. This would help by reducing the duration that Atlantic sturgeon are within the ensonified area to minimize risk of being exposed to sufficient sound energy to elicit physiological injury. The potential for serious injury is also minimized by using a noise mitigation system during all foundation installation operations. In addition to the 10 dB noise reduction, the noise mitigation system (e.g., bubble curtain) would extend approximately 328 feet (100 meters) from the pile, limiting access to areas in which Atlantic sturgeon could experience physiological injury. Based on this analysis, the potential for Atlantic sturgeon to be exposed to cumulative noise that could result in physiological injury is considered extremely unlikely occur and is, therefore, **discountable**.

Therefore, the effects of noise exposures above PTS thresholds during impact pile driving of foundations **may affect, not likely to adversely affect** ESA-listed fish species.

Effects of Exposure to Noise Above Behavioral Thresholds

Acoustic stressors such as impact and vibratory piling may cause a short-term stress response in fish, but the potential for these activities to cause longer term growth and fitness consequences has not been demonstrated in a field setting. In general, fish may acclimate to long-term or repeated exposures to acoustic stressors (Schreck 2000). Goldfish (*Carassius auratus*) exposed to continuous noise sources, such as the hum or vibration of vessel traffic at SPL of 160 to 170 dB re 1 μPa, exhibited a short-term stress response characterized by increased cortisol and glucose levels, but they did not exhibit a long-term stress response following continued or repeated exposures (Smith et al. 2004). In addition, Neo et al. (2014) indicated that the temporal nature of the noise may influence the rate of recovery following behavioral disturbance. Both intermittent (e.g., pile driving) and continuous (e.g., vessel traffic, drilling) noises elicited behavioral changes in fish, but the time it took to return to normal baseline behavior was longer in response to intermittent noises compared to continuous noises (Neo et al. 2014).

The maximum modeled behavioral threshold range was 37,503 feet (11,431 meters) formonopile foundations installed using impact pile driving; and 28,399 feet (8,656 meters) from ESP pin-pile foundations installed using impact pile driving only (Table 3-33). Maximum modeled behavioral threshold range was 14,734 feet (4,491 meters) from the monopile foundations for the vibratory pile setting portion of the installation and 17,667 feet (5,385 meters) from ESP pin-pile foundations for the vibratory pile setting portion of the installation (Table 3-34).

Atlantic sturgeon may be present in small numbers year-round in the Project area, with a peak presence between November and May (Section 3.4.1.3). During spawning season, adults travel upstream in the spawning rivers, so the likelihood of spawning presence in the Project area is lower (Section 3.4.1). Elevated noise levels could cause Atlantic sturgeon to temporarily vacate the area ensonified above behavioral thresholds (Krebs et al. 2016), resulting in a temporary disruption of feeding, mating, and other essential activities. No long-term avoidance of the Project area or effects on spawning behavior are expected to occur. Atlantic sturgeon have a primitive swim bladder, which allows them to detect sound pressure in addition to particle motion (Popper et al. 2014; Popper and Hawkins 2018), but their swim bladder is not involved in their hearing, making them less sensitive to underwater SPLs than fish with swim bladders involved in hearing. Several studies have been conducted on the behavioral response of fish to impulsive noise sources. Those that have been published show varying results, ranging from avoidance (moving out of the affected area or into deeper water; Dalen and Knutsen 1987; Slotte et al. 2004) to minor changes in behavior (Wardle et al. 2001; Hassel et al. 2004) or no reaction at all (Peña et al. 2013).

As stated above, the potential for Atlantic sturgeon to be present in the Project area is considered possible but no preferred foraging areas or aggregation areas have been identified in the Project area. There is critical habitat for Atlantic sturgeon identified for the Hudson River, which is included in the overall Action Area (Section 1.3), as proposed Project vessels may transit from ports near Albany, New York, but no impact pile-driving activities would occur in any designated critical habitat. Therefore, Atlantic sturgeon could be exposed to noises above behavioral threshold and may avoid the area; however, avoidance of preferred foraging areas and accessing of spawning or overwintering areas would not occur, and only cessation of opportunistic foraging areas during migration period is expected. Soft-start procedures included in the Proposed Action would also facilitate a gradual increase of equipment energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury, further reducing the risk of physiological injury. Should an exposure occur, it would be temporary with effects dissipating once the activity had ceased or the individual had left the area. Potential effects would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it), and any effects from this brief exposure would be so small that they could not be measured, detected, or evaluated and would, therefore, be **insignificant**.

Therefore, the effects of noise exposures above behavioral thresholds during pile driving of foundations **may affect, not likely to adversely affect** ESA-listed fish species.

Foundation Drilling

Foundation drilling may be used on a limited basis to avoid the risk of pile run and ensure the pile can be installed to the target depth. While foundation drilling was not modeled for marine fish, the information provided in the draft ITA addendum (JASCO 2023) enables a qualitative assessment of foundation drilling using published data of potential received noise levels that may be produced during proposed Project drilling. Assuming the unweighted SPL levels at 2,461 feet (750 meters) were approximately 136 dB re 1 µPa during the summer (JASCO 2023), it was estimated that the SPL source level back-calculated to 3.3 feet (1 meter) using spherical spreading loss was 193 dB re 1 µPa m.

Effects of Exposure to Physiological Injury Thresholds

The estimated broadband SEL source level for drilling activities (192 dB re 1 μPa^2 s m^2; JASCO 2023) is would exceed the physiological injury SEL_{24h} threshold of 187 dB re μPa^2 s for fish greater than or equal to 2 grams in response to impulsive sources (Table 3-32), but only within a few meters of the source (<16 feet [<5 meters]) using spherical spreading loss. Therefore, physiological injury in Atlantic sturgeon in responses to foundation drilling is not likely to occur and is **discountable**. Therefore, exposure to noise above PTS thresholds during foundation drilling **may affect, not likely to adversely affect** ESA-listed fish.

Effects of Exposure to Behavioral Thresholds

Based on the estimated SPL source level of 193 dB 1 µPa m, the SPL 150 dB re 1 µPa fish behavioral threshold may be met or exceeded only within approximately 463 feet (141 meters) using the same practical spreading loss equation used to estimate the behavioral disturbance range for marine mammals. Given this small threshold range, the low number of foundations requiring drilling (up to 48 foundations out of a total of 132), and the distance of the SWDA from Atlantic sturgeon spawning rivers, the likelihood of behavioral disturbances that would affect foraging, or spawning behaviors is considered extremely unlikely to occur and is **discountable**. Therefore, the effects of noise exposures above behavioral thresholds resulting from foundation drilling **may affect, not likely to adversely affect** ESA-listed fish.

Vessel and Aircraft Noise

As discussed in Section 1.4.1.2.6, during each proposed Project phase, the applicant anticipates an average of approximately 30 vessels operating during a typical workday in the SWDA and along the OECC. Approximately 60 vessels could be present during the period of maximum construction activity at the start of WTG installation. Many construction vessels would remain at the SWDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning as needed (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). This volume of traffic would vary monthly depending on weather and Proposed Action activities. Approximately 3,200 total vessel round trips are expected to occur during offshore construction of Phase 1, which equates to an approximate average of 6 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 3.3.1.12.1; Epsilon 2022). Approximately 3,800 total vessel round trips are expected to occur during offshore construction of Phase 2, which equates to an approximate average of 7 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 4.3.1.12.1; Epsilon 2022). During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur during both phases (COP Volume I, Sections 3.3.1.12.1 and 4.3.1.12.1; Epsilon 2022). Peak construction vessel activity is expected to occur during pile-driving activities. The applicant has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey that may be used during construction, with some vessels with additional components or materials coming from Canadian and European ports (COP Volume I; Epsilon 2022). Any vessels transiting from Canada and Europe would follow the major navigation routes.

Current vessel traffic in the Action Area and surrounding waters is relatively high, and vessel traffic within the RI/MA Lease Areas and SWDA is relatively moderate (COP Appendix III-I; Epsilon 2022) and includes commercial fishing vessels, recreational vessels, and other commercial vessels (merchant and passenger ships) in order of frequency (COP Appendix III-I; Epsilon 2022). The Action Area experiences increased vessel traffic during the summer months (COP Appendix III-I; Epsilon 2022); however, Proposed Action would not significantly disrupt normal vessel traffic patterns.

Large shipping vessels and tankers produce lower frequency noise with a primary energy near 40 Hz and underwater source levels that can range from 177 to 200 dB re 1 μPa m (McKenna et al. 2012; Erbe et al. 2019), while smaller vessels typically produce higher frequency noise (1,000 to 5,000 Hz) at source levels between 150 and 180 dB re 1 μPa m (Kipple and Gabriele 2003, 2004). Vessels using DP thrusters for station keeping are known to generate substantial underwater noise with sound levels ranging from 150 to 180 dB re 1 μPa m depending on operations and thruster use (BOEM 2013; McPherson et al. 2016).

Effects of Exposure to Noise Above the Physiological Injury Thresholds

Research indicates that the effects of vessel noise, including DP vessel noise, will not cause mortality or injuries in adult fish (Hawkins et al. 2014) given the low source levels and non-impulsive nature of this source. The potential for exposures above physiological injury thresholds to occur is extremely unlikely and is **discountable**. Therefore, the effects of exposure to noise above physiological injury thresholds as a result of vessel activity **may affect, not likely to adversely affect** ESA-listed fish species.

Effects of Exposure to Noise Above the Behavioral Thresholds

Continuous sounds produced by marine vessels have been reported to change fish behavior causing fish to change speed, direction, depth, induce avoidance, or alter schooling behavior (Engås et al. 1995, 1998; Sarà et al. 2007; De Robertis and Handegard 2013; Mitson and Knudsen 2003). DP vessel source levels have been shown to cause several different behavioral responses, auditory masking, and changes in blood chemistry. The most common behavioral responses are avoidance, alteration of swimming speed and direction, and alteration of schooling behavior (Becker et al. 2013; Handegard and Tjøstheim 2005; Sarà et al. 2007; Vabø et al. 2002). Laboratory and field studies have demonstrated several other behaviors that are influenced by DP vessel noise. For example, several studies noted changes in foraging behavior (Bracciali et al. 2012; Purser and Radford 2011; Voellmy et al. 2014a, 2014b), vocalization patterns (Picciulin et al. 2008, 2012), and overall frequency of movement (Buscaino et al. 2010). These studies also demonstrated that behavioral changes were generally temporary. Auditory masking in fish exposed to vessel noise has been demonstrated in a few studies. Auditory thresholds have been shown to increase by as much as 40 dB when fish are exposed to vessel noise playbacks (Codarin et al. 2009; Vasconcelos et al. 2007; Wysocki and Ladich 2005). The degree of auditory masking generally depends on the hearing sensitivity of the fish, the frequency, and the noise levels tested (Wysocki and Ladich 2005).

Evidence suggests fish will return to normal baseline behavior faster following exposure to continuous sources such as vessel noise versus intermittent noise such as pile driving (Neo et al. 2014). Therefore, while vessel noise would be present within the Action Area throughout the life of the Proposed Action, behavioral disturbances would only be expected within and few meters of the vessel and would dissipate once the vessel has moved away. In addition, Atlantic sturgeon have swim bladders, which are not involved in hearing, and are likely to be sensitive to vessel noise but are thought to be more sensitive to particle motion that sound pressure (Popper and Hawkins 2018). Given the nature of non-impulsive sources such as vessels noise, particle motion levels sufficient to result in behavioral disturbances would not occur more than a few meters from the source, and any effects from this brief exposure would be so small that they could not be measured, detected, or meaningfully evaluated and are, therefore, **insignificant**. Therefore, the effects from exposure to noise levels above behavioral thresholds resulting from vessel operations **may affect, not likely to adversely affect** ESA-listed fish species.

Effects of Vessel Noise on Critical Habitat

As discussed in Section 3.4.1.2, the only designated critical habitat that overlaps with the Action Area are some critical habitats for the Gulf of Maine DPS and the New York Bight DPS. The proposed Project vessel ports in the Capital Region along the Hudson River and in Paulsboro, New Jersey, may result in vessels being located in Atlantic sturgeon critical habitat. Under the Proposed Action, it was estimated that an average three round-trips may occur per month from each Paulsboro and Capital Region ports throughout the approximate 3-year construction period (Table 1-10). Additionally, the operations base port would likely be in Bridgeport, Connecticut, which is close to the Housatonic River but does not overlap with the designated critical habitat designated for the New York Bight DPS.

Given that vessel noise is not expected to result in physiological injuries for Atlantic sturgeon and that behavioral disturbances such as avoidance or altered swimming speed and direction that may occur are expected to be temporary, the addition of noise from proposed Project vessels would not affect behaviors important to foraging or spawning within Atlantic sturgeon critical habitat. Any effects on the acoustic environment of Atlantic sturgeon critical habitat from this brief exposure would be so small that they could not be measured, detected, or meaningfully evaluated and are, therefore, **insignificant**. Therefore, the effects from increased noise levels resulting from vessel operations **may affect, not likely to adversely affect** critical habitat for Atlantic sturgeon.

Geophysical Survey Noise

As discussed previously, HRG surveys will be conducted prior to and during construction, as well as during operations, to identify any seabed obstructions or potential cable burial or scour protection issues. HRG survey activities indicate a maximum modeled range to the marine mammal PTS thresholds of less than 1 meter for LFC and MFC for both boomers and sparkers (Table 3-14). The ranges to the SPL 160 dB re 1 μPa behavioral threshold for marine mammals ranged from 463 feet (141 meters) for the sparker to 584 feet (178 meters) for the boomer (Table 3-14). Although acoustic modeling was not conducted specifically for fish for HRG surveys, it can be inferred that the injury and behavioral threshold ranges would be substantially smaller than those noted for marine mammals. This is because, as discussed previously, fish are more sensitive to particle motion that sound pressure, and though Atlantic sturgeon have a swim bladder, which enables detection of underwater sound pressure, it is not directly connected to their hearing, so they are less sensitive to underwater sound than marine mammals (Popper et al. 2014).

In an assessment of HRG survey noise conducted by Baker and Howsen (2021), the physiological injury thresholds for fish were estimated to extend to 30 feet (9 meters) for sparker equipment, and the maximum behavioral disturbance threshold range would extend out to 6,549 feet (1,996 meters) for sparkers. However, this assessment assumed the maximum power and source settings were used for each type of equipment, which is not applicable to the HRG surveys proposed by the applicant (JASCO 2022), so it is expected that with the source and power settings included in the Proposed Action, the maximum range to the fish thresholds would be even lower. Additionally, the ranges for boomers, one of the other types of equipment assessed under the Proposed Action, was estimated to be 10.5 feet (3.2 meters) for the physiological injury threshold and 2,323 feet (708 meters) for the behavioral threshold (Baker and Howsen 2021). HRG survey activities affecting fish would follow the same estimated number of survey days described previously.

Effects of Exposure to Noise Above the Physiological Injury Thresholds

The sparker and boomer HRG equipment included in this BA produce noise in low frequencies below 1 kHz that overlap with the hearing sensitivity for most fish (Section 3.4.1) and may, therefore, be detectable by Atlantic sturgeon. Based on the previous assessment conducted by Baker and Howsen (2021), sparker equipment used during these surveys has the potential to produce noise that would exceed physiological injury thresholds for fish up to 30 feet (9 meters), which is a small enough range from the source that the likelihood of any individual experiencing sufficient sound energy to result in injury is low. Additionally, HRG sources would be moving throughout the survey activities, so individuals present near the vessel would only be exposed for a short duration before the survey vessel moves away. Soft-start procedures included in the Proposed Action would also facilitate a gradual increase of equipment energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury, further reducing the risk of injury. Given the small ranges, transient nature of the survey equipment, and soft-start procedures, the potential for physiological injury in Atlantic sturgeon resulting from HRG surveys is **discountable**. Therefore, effects of noise exposures above physiological injury thresholds during HRG surveys **may affect, not likely to adversely affect** ESA-listed fish species.

Effects of Exposure to Noise Above the Behavioral Thresholds

Behavioral thresholds for fish up may extend up to 1.2 miles (2 kilometers) based on previous assessments (Baker and Howsen 2021). However, the behavioral threshold does not account for exposure duration; given the transient nature of these sources, individuals near the source would only be exposed to above-threshold noise for a short duration before the survey vessel moves away, so no long-term effects would be expected. Should an exposure occur, the potential effects would be brief, and no long-term avoidance of the Project area or effects on reproduction are expected. Effects of this brief exposure could result in temporary disruptions to foraging behavior; however, any impacts associated with this avoidance would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Therefore, the effects exposure to noise above behavioral thresholds during HRG surveys **may affect, not likely to adversely affect** ESA-listed fish species.

Unexploded Ordinance Detonations

Acoustic modeling was not conducted for potential UXO detonation effects on fish; however, modeling results are available for sea turtles for the Revolution Wind Project, which is also located offshore Rhode Island and Massachusetts and would, therefore, have comparable seafloor and oceanographic conditions applicable for underwater acoustic modeling. Preliminary survey data for the Action Area indicates there is a risk of UXOs that cannot be avoided or removed through non-explosive methods. The analysis in the draft ITA application (JASCO 2023) estimated up to 10 UXO may be detonated over a 2-year period during construction. Underwater detonations of UXO present the risk of mortality and potential mortal injury and behavioral disturbances (Popper et al. 2014). A quantitative analysis of ranges to physiological injury ranges was not included for fish (JASCO 2022); however, based on the thresholds modeled for the Revolution Wind Project (Hannay and Zykov 2022), a qualitative assessment of potential effects can be conducted for fish.

Effects of Exposure to Noise Above the Mortality Thresholds

Due to their swim bladder, Atlantic sturgeon are susceptible to barotrauma from underwater noise (Popper et al. 2014). When a fish with a swim bladder is exposed to a sound wave, gas in their swim bladder expands and contracts more than the surrounding tissue during the periods of under pressure and overpressure, respectively. This can cause the swim bladder to oscillate, resulting in tissue damage and possible rupture.

Modeling conducted for the Revolution Wind Project (Hannay and Zykov 2022) estimated a maximum range to the injury and mortality threshold for fish of 951 feet (290 meters) during detonation of a 454-kilogram (1,000-pound) charge in 148-foot (45-meter) water depths. As described in Section 3.4.1, Atlantic sturgeon could occur in the SWDA, where they could be exposed to UXO detonations. Individuals present in the area will likely occur intermittently, moving through the SWDA with a peak presence between November and May and may forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area, which further reduces the potential for impact on this species from UXO detonations. Given the dispersed distribution of Atlantic sturgeon in the SWDA, the potential for co-occurrence in time and space is considered unlikely but possible with greater exposures during the colder months. The applicant is not planning to monitor for Atlantic sturgeon prior to detonations but has committed to the implementation of a noise mitigation systems during all detonation events, though the exact system has not yet been selected. This, coupled with the unlikely detonation of UXO, the conservative approach to modeling distances, the low number of potential detonations required for the Proposed Action (estimated to be no more than 10), and the commitment to a noise mitigation system with 10 dB attenuation, further reduces the potential for exposure to Atlantic sturgeon. The full extent of the potential for injuries is not known and if they occur, they could result in physiological impacts that lead to injury or mortality of small numbers of Atlantic sturgeon if they are present within the detonation area of PTS effects as estimated for marine mammals (Table 3-17). However, there is no critical habitat that overlaps with the Project area where potential UXO detonations may occur (Section 3.4.1.2), and the limit of one detonation per 24-hour period would effectively reduce the likelihood of any exposures above threshold for Atlantic sturgeon and would be **discountable**. Therefore, the effects of noise and blast exposure from proposed Project UXO detonations leading to mortality **may affect, not likely to adversely affect** ESA-listed fish.

Effects of Exposure to Noise Above the Behavioral Thresholds

Reactions of fish to explosives is absent from the literature. Fish are likely to react in a similar way to sea turtles. Finneran et al. (2017) assumed that sea turtles would exhibit no more than a brief startle response to any individual explosive. Prolonged avoidance of the area is only considered likely if the event includes multiple explosives events, which is not part of the Proposed Action.

The low number of potential UXOs identified in the Project area, the applicant’s commitment to using a noise mitigation system for all detonations, and the BOEM-proposed seasonal restriction would further reduce all potential underwater noise effects associated with UXO detonations. Additionally, UXO detonations would only occur within the SWDA and OECC, which does not overlap with any designated critical habitat (Section 3.4.1.2). 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 from this brief exposure would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Therefore, the effects of noise exposure from proposed Project UXO detonations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed fish.

Wind Turbine Generator Noise

Noise produced by WTGs is within the hearing range of most marine fish. Depending on the noise intensity, such noises could disturb or displace fish within the surrounding area or cause auditory masking (MMS 2007). However, with generally low noise levels expected from WTG operations, fish would be affected only at close ranges (within 328 feet [100 meters]) (Thomsen et al. 2006, 2020). Thomsen et al. (2006) reviewed the observations of fish behaviors in proximity to an operational WTG and found varying results, from no perceived changes in swimming behavior of European eels (*Anguilla anguilla*) and both increased and decreased catch rates of cod within 328 feet (100 meters) of the operational WTGs.

The analyses conducted by Tougaard et al. (2020) showed that sound levels produced by individual WTG were low in all literature and comparable to or lower than sound levels within 0.6 mile (1 kilometer) of commercial ships. The complied data also showed an increase in noise levels with increasing WTG power and wind speed. However, Tougaard et al. (2020) noted that the noise produced from a WTG is stationary and persistent, which differs from the transitory nature of sound produced by vessel traffic, and the cumulative contribution of multiple WTG within a region must be critically assessed and planned. Stöber and Thomsen (2021) reviewed published literature and also identified an increase in underwater sound level with increasing power size with a nominal 10 MW WTG. However, they also reported a sound decrease of roughly 10 dB re 1 µPa from WTG using gear boxes to WTG using direct drive technology. In addition, Atlantic sturgeon are an anadromous species that primarily use rivers, bays, estuaries, coastal, and shallow OCS waters, and their occurrence in the Project area is expected to be seasonal and in very low numbers.

Effects of Exposure to Noise Above the Physiological Injury Thresholds

Noise produced by WTG operations is within the hearing range of Atlantic sturgeon; however, this is a non-impulsive sound source, which produces relatively low noise levels (compared to construction noise), so noise produced at levels sufficient to elicit injury in either species would only occur within of few meters of the WTG foundations. Therefore, the potential for injury resulting from WTG noise is extremely low and would be **discountable** for Atlantic sturgeon. Therefore, the effects of exposure to noise above physiological injury thresholds resulting from WTG operations and **may affect, not likely to adversely affect** ESA-listed fish species.

Effects of Exposure to Noise Above the Behavioral Thresholds

Depending on the intensity, noises produced by WTG operations could disturb or displace fish within the surrounding area or cause auditory masking (MMS 2007). However, with generally low noise levels, fish would be affected only at close ranges (within 100 meters) to the operating WTG (Thomsen et al. 2006, 2020). As described previously, Atlantic sturgeon would be more likely to be present around the wind farm in non-spawning years as spawning adults typically travel upriver to reproduce (Section 3.4.1), so there is potential for this species to be found around the WTG foundations during operations. While there may be some behavioral modifications, these would be localized and would not be likely to affect activities such as foraging or reproduction. Effects of the behavioral disturbances resulting from WTG noise would be minor enough that they cannot be meaningfully evaluated and are **insignificant**. Therefore, the effects of exposure to noise above physiological injury thresholds during WTG operations **may affect, not likely to adversely affect** ESA-listed fish species.

3.4.2.1.3 Effects on Prey Organisms

Effects of noise during construction, operations, and decommissioning of the Proposed Action (as described previously in Section 3.2.6.2, Section 3.3.5.1, and Section 3.4.2.1) on prey organisms for the Atlantic sturgeon has the potential to result in behavioral disturbances for certain species. Atlantic sturgeon are benthic foragers, typically feeding on invertebrates and bottom-dwelling fish, such as sand lance (NMFS 2022a).

Invertebrates appear to be able to detect both sound pressure and particle motion (André et al. 2016; Budelmann 1992; Solé et al. 2016, 2017) and are most sensitive to low frequency noises (Budelmann and Williamson 1994; Lovell et al. 2005a, 2005b; Mooney et al. 2010; Packard et al. 1990). Reduction of prey fish availability could affect marine mammals and sea turtles if rising sound levels affect fish populations and alter prey abundance, behavior, and distribution (McCauley et al. 2000a, 2000b; Popper and Hastings 2009; Slabbekoorn et al. 2010).

Cephalopods (i.e., octopus, squid) and decapods (i.e., lobsters, shrimps, crabs) are capable of sensing both particle motion and sound pressure at lower frequencies. Packard et al. (1990) showed that three species of cephalopod (common cuttlefish, common octopus, and European squid) were sensitive to particle motion rather than sound pressure, with the highest sensitivity to particle motion reported at 1 to 2 Hz. In longfin squid, Mooney et al. (2010) also observed responses to particle motion at lower frequencies between 100 and 300 Hz and also observed responses to sound pressure at 200 Hz. These data indicate that some prey species may be responding to both the particle motion and pressure component of low frequency noises, but thresholds for physiological or behavioral responses to particle motion in invertebrates are not currently available.

Potential onset thresholds for both physiological and behavioral respones to the pressure component of underwater noise are available in published literature. Solé et al. (2017) showed that SPL ranging from 139 to 142 dB re 1 µPa at one-third octave bands centered at 315 Hz and 400 Hz may be suitable threshold values for trauma onset from sound pressure in cephalopods. Hearing thresholds for sound pressure at higher frequencies have been reported, such as 134 and 139 dB re 1 µPa at 1,000 Hz for the oval squid and the common octopus, respectively (Hu et al. 2009). Cephalopods have also exhibited behavioral responses to low frequency noises (below 1,000 Hz) including inking, locomotor responses, body pattern changes, and changes in respiratory rates (Hu et al. 2009; Kaifu et al. 2008). McCauley et al. (2000a) reported that caged squid exposed to seismic airguns showed behavioral responses such as inking. Wilson et al. (2007) exposed two groups of longfin squid in a tank to killer whale echolocation clicks at SPL from 199 to 226 dB re 1 µPa, which resulted in no apparent behavioral effects or any acoustic debilitation. However, both the McCauley et al. (2000a) and Wilson et al. (2007) experiments used caged squid, so it is unclear how unconfined animals would react. André et al. (2011) exposed four cephalopod species (European squid, common cuttlefish, common octopus, and southern shortfin squid) to 2 hours of continuous noise from 50 to 400 Hz at received SPL of 157 dB re 1 µPa and reported lesions occurring on the sensory hair cells of the statocyst that increased in severity with time, suggesting that cephalopods are particularly sensitive to low frequency noise. Similarly, Solé et al. (2013) conducted a low frequency (50 to 400 Hz) controlled exposure experiment on two deep-diving squid species (southern shortfin squid and European squid), which resulted in lesions on the statocyst epithelia. Solé et al. (2013) described their findings as "morphological and ultrastructural evidence of a massive acoustic trauma induced by low-frequency sound exposure." In experiments conducted by Samson et al. (2014), common cuttlefish exhibited escape responses (i.e., inking, jetting) when exposed to frequencies between 80 and 300 Hz with SPL above 140 dB re 1 µPa, and they habituated to repeated 200 Hz noises. The intensity of the cuttlefish response with the amplitude and frequency of the noise stimulus suggest that cuttlefish possess loudness perception with a maximum sensitivity of approximately 150 Hz (Samson et al. 2014). Jones et al. (2020) exposed longfin inshore squid to playbacks of impact pile driving recorded at the Block Island Wind Farm ranging from approximately 190 to 194 dB re 1 µPa, which were meant to match sound levels recorded 500 meters from the piles. Most of the squid tested showed alarm behavior (e.g., inking, jetting, body pattern change), but the proportion of the trial in which squid exhibited these behaviors decreased substantially following the first 30 impulses of the playback, indicating the squid may become habituated to the noise (Jones et al. 2020).

Several species of aquatic decapod crustaceans are also known to produce sounds. Popper et al. (2001) reviewed behavioral, physiological, anatomical, and ecological aspects of noise and vibration detection by decapod crustaceans and noted that many decapods also have an array of hair-like receptors within and upon the body surface that potentially respond to water- or substrate-borne displacements, as well as proprioceptive organs that could serve secondarily to perceive vibrations. They concluded that many are able to detect substratum vibrations at sensitivities sufficient to tell the proximity of mates, competitors, or predators (Popper et al. 2001). However, the acoustic sensory system of decapod crustaceans remains poorly studied (Popper et al. 2001). Lovell et al. (2005a, 2005b, 2006) reported potential auditory-evoked responses from prawns that showed auditory sensitivity of noises from 100 to 3,000 Hz. Filiciotto et al. (2016) also reported behavioral responses to vessel noise within this frequency range. Lovell et al. (2005b) found that the greatest sensitivity for prawns was an SPL of 106 dB re 1 µPa at 100 Hz, noting that this was the lowest frequency at which they tested and that prawns might be more sensitive at frequencies below this.

Marine fish are typically sensitive to the 100 to 500 Hz range, and several studies have demonstrated that seismic airguns and impulsive sources might affect the behavior of at least some species of fish. For example, field studies by Engås et al. (1996) and Løkkeborg et al. (2012a) showed that the catch rate of haddock and Atlantic cod significantly declined over 5 days immediately following seismic surveys, after which the catch rate returned to normal. Other studies found only minor responses by fish to noise created during or following seismic surveys, such as a small decline in lesser sand eel abundance that quickly returned to pre-seismic levels (Hassel et al. 2004) or no permanent changes in the behavior of marine reef fishes (Wardle et al. 2001). However, both Hassel et al. (2004) and Wardle et al. (2001) noted that when fish sensed the airgun firing, they performed a startle response and sometimes fled.

While noise produced by proposed Project activities is likely to affect prey species for Atlantic sturgeon, effects on these species is unlikely to result in an effect on their survival and fitness based on the ability of the species to adjust their diet to exploit other types of prey resources when available and the availability of foraging opportunities outside the immediate Project area. The effects on Atlantic sturgeon ay due to reduction in prey items resulting only from underwater noise generated by the Project are likely to be undiscernible from prey changes due to overall wind farm construction and operations and, therefore, would be so small that they could not be measured, detected, or evaluated and are, therefore, **insignificant**. Therefore, effects from underwater noise sources due to activities conducted under the Proposed Action **may affect, not likely to adversely affect** prey organisms for ESA-listed fish species.

3.4.2.2 Habitat Disturbance Effects on Marine Fish (Construction, Operations, Decommissioning)

Similar to the effects described for this stressor in marine mammals in Section 3.2.6.3 and sea turtles in Section 3.3.5.2, habitat disturbance related to the proposed Project would occur throughout construction, operations, and decommissioning. Potential effects on ESA-listed fish species and their prey from habitat disturbance range from short- to long-term impacts. Individual stressors under habitat disturbance encompass displacement from physical disturbance of sediment, changes in oceanographic and hydrological conditions due to presence of structures, conversion of soft- to hard-bottom habitat, and concentration of prey species due to the reef effect. These are discussed separately and organized by proposed Project stage in the following subsections.

3.4.2.2.1 Displacement from Physical Disturbance of Sediment (Construction, Decommissioning)

Construction of the Proposed Action would result in temporary disturbance of the seabed within the Project area resulting in short-term displacement of ESA-listed fish and their prey species present during construction or decommissioning. Based on information provided in Table 3-23, an estimated 1,710.9 acres (6.93 km^2) would be temporarily disturbed during proposed Project construction. As discussed previously in Section 3.2.6.3.1, there are no sensitive resources, hard-bottom, or biogenic (sea grass beds, corals, shellfish reefs and beds, etc.) substrates identified within the SWDA, but there was hard-bottom habitat identified in the Muskeget Channel section of the OECC.

After proposed Project construction activities are completed, the areas of temporary disturbance should return to the baseline state. The restoration of marine soft-sediment habitats occurs through a range of physical (e.g., currents, wave action) and biological (e.g., bioturbation, tube building) processes

(Dernie et al. 2003). Disturbed areas not replaced with hardened structures (i.e., scour or cable protection) would be resettled, and the benthic community would be expected to approach normal conditions within approximately 1 to 2 years (Dernie et al. 2003; Department for Business, Enterprise and Regulatory Reform 2008; Collie et al. 2000; Gerdes et al. 2008). However, the actual mechanisms of recovery are highly complex and site-specific; recovery to baseline conditions may take much longer in some areas and for some benthic species. Generally, soft-bottom habitats are more rapidly restored following a disturbance compared to complex or hard-bottom habitats (Collie et al. 2000).

Atlantic sturgeon are known to eat a variety of benthic organisms and are believed to be opportunistic feeders with stomach contents ranging from mollusks, worms, amphipods, isopods, shrimp, and small benthic fish (e.g., sand lance; Smith 1985; Johnson et al. 1997; Dadswell 2006; Novak et al. 2017). Generally, the disturbance of benthic habitat would be short term and localized, with an abundance of similar foraging habitat and prey available in adjacent areas for Atlantic sturgeon. Given their generalist feeding behaviors and the limited total area of potential habitat disturbance, Atlantic sturgeon are unlikely to be affected by the effects of short-term, localized, seabed disturbance. Therefore, the effects of displacement of Atlantic sturgeon and their prey from physical disturbance of sediment are expected to be minimal.

The presence of the WTGs, ESPs, and scour protection would convert 360.7 acres (1.46 km^2; Table 3-23) of current soft-bottom to new permanent hard-bottom habitat, which could lead to potential changes in foraging habitat for Atlantic sturgeon. The only forage fish anticipated to be affected by this permanent disturbance of sediment would be sand lance, which are strongly associated with sandy substrate. There would be a reduction in availability of habitat for sand lance, as proposed Project infrastructure would result in a loss of a portion of soft bottom. This, theoretically, could result in a localized reduction in the abundance of sand lance in the Project area. Although these effects would be long term, the small area of converted habitat is not likely to affect the Atlantic sturgeon. Given this small, localized reduction in sand lance and the generalist feeding strategies of Atlantic sturgeon, any effects are expected to be minimal.

Habitat disturbance effects on fish during decommissioning would likely be similar to or less than those experienced during construction. Given that decommissioning techniques are expected to advance over the life of the proposed Project, potential impacts would need to be evaluated at that time; however, effects on ESA-listed fish species are not expected to be greater than those experienced during construction.

The impacts on the Atlantic sturgeon from sediment disturbance cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

As discussed in Section 3.4.1.2, the only designated critical habitat that overlaps with the Action Area are some critical habitats for the New York Bight DPS. The proposed Project vessel ports in the Capital Region and Paulsboro, New Jersey, may result in vessels being located in Atlantic sturgeon critical habitat. However, vessels potentially present in critical habitat would only be transiting or moored quaside, so no anchoring or other bottom-disturbing activities would result from proposed Project vessels; therefore, effects on Atlantic sturgeon critical habitat from sediment disturbance is **discountable**.

3.4.2.2.2 Changes in Oceanographic and Hydrological Conditions due to the Presence of Structures (Operations)

The greatest concern for ESA-listed fish and changes in oceanographic and hydrologic conditions resulting from structures in the open ocean would be potential impacts on prey sources. Atlantic sturgeon prey, such as sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, are not closely affected by physical oceanographic features. Potential impacts on larval dispersion and survival of Atlantic sturgeon prey species could be affected by hydrologic conditions on a very localized level. The potential hydrodynamic effects identified from the presence of vertical structures in the water column affect nutrient cycling and mixing patterns, which could influence the distribution and abundance of fish and planktonic prey resources throughout operations (van Berkel et al. 2020). Given the colonization seen on the Block Island Wind Farm foundations (HDR 2020), recruitment of mollusk and decapod larvae do not appear to be negatively affected by hydrologic conditions at the WTG; therefore, recruitment of larval prey species for Atlantic sturgeon would likely not be affected.

As discussed in Section 3.2.6.3.3, the anticipated hydrodynamic effects of structures are expected to be localized and not extend beyond a few hundred meters to 1 kilometer from the proposed Project foundations (Floeter et al. 2017; Miles et al. 2017; Schultze et al. 2020). Additionally, Atlantic sturgeon in the Project area would primarily feed on benthic invertebrates and small fish (Section 3.4.1), which lowers the risk of changes in oceanographic conditions due to the Proposed Action affecting Atlantic sturgeon prey availability. Any effects resulting from oceanographic and hydrographic conditions produced by the foundations and structures would be small and unlikely to be meaningfully evaluated and, therefore, are considered **insignificant** for Atlantic sturgeon.

3.4.2.2.3 Effects of Changes in and Concentration of Prey Species due to the Reef Effect of Structures (Operations)

Long-term habitat alterations from soft-bottom to hard-bottom conversion during operations of the proposed Project would occur through placement of monopiles and jacketed piles, scour protection, and cable protection. The presence of the WTGs, ESPs, and scour protection would convert 360.7 acres (1.46 km^2; Table 3-23) of current soft-bottom to new permanent hard-bottom habitat, which could lead to potential changes in foraging habitat for Atlantic sturgeon (Table 3-23). The addition of the hard-bottom habitat is expected to result in a shift in the area immediately surrounding each monopile to a structure-oriented system, including an increase in fouling organisms (Degraer et al. 2020; Mavraki et al. 2020). Over time (weeks to months), the areas with scour protection are likely to be colonized by sessile or mobile organisms (e.g., sponges, hydroids, and crustaceans) (Degraer et al. 2020). This results in a modification of the benthic community in these areas from primarily infaunal organisms (e.g., amphipods, polychaetes, and bivalves). The addition of new hard-bottom substrate in a predominantly soft-bottom environment will enhance local biodiversity (Mavraki et al. 2020); enhanced biodiversity associated with hard-bottom habitat is well documented (Pohle and Thomas 2001). Hard-bottom habitat and vertical structures in a soft-bottom habitat can create artificial reefs, thus, inducing the “reef” effect (Taormina et al. 2018). The reef effect is usually considered a **beneficial** impact, associated with higher densities and biomass of fish and decapod crustaceans (Taormina et al. 2018), which may provide a potential increase in available forage items for sturgeon compared to the surrounding soft-bottom habitat.

3.4.2.2.4 Summary of Habitat Disturbance Effects

As discussed above, all effects of habitat disturbance on ESA-listed fish are either **insignificant** or **beneficial**. Therefore, the effects of habitat disturbance from activities conducted under the Proposed Action **may affect, not likely to adversely affect** ESA-listed fish species.

Additionally, the likelihood of habitat disturbances affecting Atlantic sturgeon critical habitat is so low it is **discountable**. Therefore, the effects of habitat disturbance from activities conducted under the Proposed Action **may affect, not likely to adversely affect** Atlantic sturgeon critical habitat.

3.4.2.3 Water Quality Effects on Marine Fish (Construction, Decommissioning)

Construction is likely to result in elevated levels of turbidity in the immediate proximity of seafloor-disturbing activities like pile driving, placement of scour protection, vessel anchoring, and burial of the inter-array and offshore export cables. There would be temporary increases in sediment suspension and deposition during activities that entail the disturbance of the seabed. Mitigation measures to minimize and reduce the potential for adverse effects from water quality changes on ESA-listed marine fish resulting from construction and decommissioning are included in the Proposed Action (Table 1-15).

As described in Section 2.1.1, the Project area is predominantly composed of unconsolidated sediments ranging from silt and fine-grained sands to gravel and the sediment plume that could result from temporary and intermittent bottom-disturbing activities is expected to settle out of the water column within a few hours. The installation of inter-array cables and offshore export cables (Section 1.4.1.2.4) can cause temporary increases in turbidity and sediment resuspension. Other projects using similar installation methods (e.g., jet plowing, pile driving) have been characterized as having minor effects on water quality due to the short-term and localized nature of the disturbance (Latham et al. 2017). The Sediment Transport Modeling Study (COP Appendix III-A; Epsilon 2022) predicts that suspended sediments from cable installation activities in the SWDA and along the OECC (including the Western Muskeget Variant) would settle out within approximately 6 hours or less at any given location. These effects on water quality for finer sediments are anticipated to be localized adjacent to the trench and temporary in nature.

Many vessels for the proposed Project would be equipped with DP systems, but some anchoring would be required to support specific construction activities. Increased vessel anchoring along with cable laying and other construction activities during construction and decommissioning would cause increased turbidity levels, which would also be staggered, localized, and short term.

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). Johnson (2018) recommends that sturgeon should not be exposed to TSS levels of 1,000 milligrams per liter above ambient levels for longer than 14 days at a time to avoid behavioral and physiological effects. Tolerance of juvenile Atlantic sturgeon to suspended sediments has been evaluated in a laboratory setting and exposed individuals to TSS concentrations of 100, 250, and 500 milligrams per liter for a 3-day period (Wilkens et al. 2015). Of the fish exposed, 96 percent survived the test, and the authors suggested that the absence of any significant effects on survival or swimming performance indicates that the impacts of sediment plumes in natural settings are minimal where fish can move or escape. 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). Given this, adult and subadult sturgeon expected to occur in the Project area are likely tolerant of elevated suspended sediment levels.

Atlantic sturgeon are opportunistic benthivores that feed primarily on mollusks, polychaete worms, amphipods, isopods, shrimps and small bottom-dwelling fishes; therefore, suspended sediment and turbidity could result in some temporary avoidance of turbid areas or feeding challenges. Any effects from elevated level of turbidity from the proposed Project on Atlantic sturgeon or their prey are considered so small that they could not be measured. In addition, mitigation measures to minimize and reduce the potential for adverse effects from water quality changes on ESA-listed fish resulting from the proposed Project are included in the Proposed Action (Table 1-15). Fish would likely depart or avoid unfavorable water quality conditions they may encounter. Suspended sediment and turbidity could result in some temporary avoidance of turbid areas, but these short-term responses are expected to result in minor, non-measurable effects. Therefore, the risk of water quality effects on the Atlantic sturgeon is assumed to be very low, and effects, if any, would be **insignificant.**

The COP (Volume I, Appendix I-F; Epsilon 2022) presents results from a spill model assessing the trajectory and weathering of spilled material following a catastrophic release of all oil contents from an offshore ESP located at the closest potential position to shore from the SWDA. Each WTG would contain up to 17,413 gallons (65,915 liters) of oils, lubricants, coolant, and diesel fuel, while each ESP could contain up to 189,149 gallons (716,007 liters) of these fluids. Oils and lubricants would comprise the largest share of these stored materials. The maximum most probable discharge volume is 189,149 gallons (716,007 liters) (COP Volume I, Appendix 1-F; Epsilon 2022). According to Bejarano et al. (2013), the probability of occurrence of this type of catastrophic release, such as the topple of an ESP, is extremely small. Effects on Atlantic sturgeon would be likely due to decreased water quality in the immediate area of a spill or other non-routine event, although such events are considered unlikely. Although also unlikely, vapors from fuel spills resulting either from vessel collisions/allisions or from servicing could affect air and water quality. Such a spill, if it were to occur, would be expected to dissipate rapidly and then evaporate and biodegrade within a few days. Execution of the applicant's required oil spill response plan would decrease potential effects by establishing response, containment, and removal procedures. Because such events are unlikely, and with the implementation of an oil spill response plan, the effects of spills on Atlantic sturgeon are not likely to occur and would be **discountable**.

Similarly, proposed Project vessels transiting within Atlantic sturgeon critical habitat in the Hudson and Delaware rivers (Section 3.4.1.2) may present a risk of accidental releases or spills. However, only a limited number of proposed Project vessels would be present in these rivers throughout Project construction (Table 1-10), and they would be expected to follow all applicable guidelines such as those recommended by the International Convention for the Prevention of Pollution from Ships to minimize releases. Therefore, the likelihood of releases from proposed Project vessels that would alter the quality of Atlantic sturgeon critical habitat is **discountable**.

Water quality effects resulting from activities under the Proposed Action **may affect, not likely to adversely affect** ESA-listed fish and critical habitat.

3.4.2.4 Vessel Traffic Effects on Marine Fish (Construction, Operations, Decommissioning)

Proposed Project-related vessels may pose a potential collision risk to Atlantic sturgeon. Based on information provided by the applicant, a wide variety of vessels would be used during construction, ranging from tugboats (52 to 115 feet [16 to 35 meters] in length) to jack-up, heavy-lift, and heavy transport vessels (more than 700 feet [213 meters] in length) (COP Volume I, Table 3.3-1; Epsilon 2022). Construction activities (including offshore installation of WTGs, ESPs, array cables, interconnection cable, and export cable) would require a daily average of approximately six and seven vessel round trips per day under an 18-month offshore construction schedule for Phase 1 and Phase 2, respectively. An estimated total of 3,200 vessel round trips are expected during Phase 1 and 3,800 vessel round trips during Phase 2. New Bedford Harbor in Massachusetts is expected to be the primary port used to support construction activities, though ports in Connecticut (i.e., Bridgeport), Rhode Island (i.e., Port of Providence), and Martha's Vineyard, Massachusetts, would also be used (Table 1-9). Capitol Region ports in New York on the Hudson River and Paulsboro, New Jersey on the Delaware River are also under consideration but would represent a small percentage of total vessel transits during construction compared to the primary ports listed above. Additionally, a small percentage of vessel transits would originate from Europe and Canada. Vessels, ports, and number of trips for decommissioning would be similar to that for construction.

During operations, the Proposed Action would generate trips by crew transport vessels (about 75 feet [23 meters] in length) and service operations vessels (260 to 300 feet [79 to 91 meters] in length); other vessels may be used for routine and non-routine maintenance activities, as discussed in Section 1.4.2.2. Approximately 250 vessel round trips are estimated to take place annually for Phase 1 operations, equating to less than 1 round-trip transit per day. While vessel activity during Phase 2 operations would be similar to that of Phase 1, some vessels may be shared between Phases 1 and 2, thus consolidating trips while both phases are operating. Approximately 470 vessel round trips are estimated to take place annually during the simultaneous operations of both phases, which equates to an average of less than 2 vessel round trips per day. The majority of vessel transits during Phase 1 and Phase 2 operations would originate from Bridgeport, Connecticut, and Vineyard Haven, Massachusetts.

Atlantic sturgeon strikes are most likely to occur in areas where Atlantic sturgeon populations overlap with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries, vessel strikes are less likely in the marine environment, likely due to the space between bottom-oriented sturgeon and the propellers and hull of vessels. Atlantic sturgeon are a demersal species and most likely to occur at or near the bottom of the water column in the marine environment. Although vessel drafts have not been provided by the applicant, this analysis proceeds with using an estimated maximum of 45 feet (13.7 meters) for a deep-draft foundation installation vessel. Water depths in the SWDA range from 141 to 203 feet (43 to 62 meters) (COP Section 2.2; Epsilon 2022). At these depths and in open coastal and marine environments, which would not constrain the distribution or movement of individuals, Atlantic sturgeon are not likely to be struck by proposed Project-related vessels. Therefore, in the offshore areas of the Project area, vessel-related mortalities are not expected.

The dispersed nature of vessel traffic and individual sturgeon reduces the potential for co-occurrence of individual sturgeon and individual vessels throughout most of the Project area, with the exception of vessels transiting in riverine habitat. The ports and vessels under consideration for the Proposed Action are described in Section 1.4.1.2.6. Capitol Region ports, which include the Port of Albany, Coeymans, and New York State Offshore Wind Port, are located on the Hudson River in upstate New York, approximately 150 miles (241 kilometers) upriver. Additionally, Paulsboro Marine Terminal in New Jersey is located approximately 60 miles (97 kilometers) upriver on the Delaware River. Both rivers support adult and juvenile Atlantic sturgeon populations. An average of up to three round trips per month are expected for proposed Project vessels transiting on the Delaware and Hudson rivers from each the Paulsboro and Capitol Region ports, respectively; an average of up to 100 transits in total may occur throughout the duration of proposed Project construction (Table 1-10). Therefore, this analysis proceeds with a maximum case of 100 total vessel transits on the Delaware River and 100 total transits on the Hudson River over the Phase 1 and Phase 2 36-month construction period. Depths along the Hudson River vary, with main channel depths of 43 feet (13 meters) in the lower Hudson River and 32 feet (9.7 meters) in areas north to Albany. The Delaware River main channel depth ranges from 40 to 45 feet (12 to 14 meters). No transits from ports on the Delaware or Hudson rivers are anticipated to occur during operations.

Vessel strike mortalities on the Hudson River are likely a greater threat to Atlantic sturgeon than previously thought. In 2019, 17 mortalities (including 10 adults) were recorded exhibiting injuries consistent with vessel strike in the Hudson River (NMFS 2022g). A total of 28 mortalities were reported in the Delaware Estuary between 2005 and 2008 (Brown and Murphy 2010). Propeller boats and barges can pose a risk to fish that swim near the water surface and are a potential source of mortality for Atlantic sturgeon as a result of direct collisions with the hull or propeller (Brown and Murphy 2010). The majority of vessel-related Atlantic sturgeon mortality is likely caused by large transoceanic vessels in river channels (Brown and Murphy 2010; Balazik et al. 2012). Large vessels have been implicated because of their deep draft (up to 40 to 45 feet [12.2 to 13.7 meters]) relative to smaller vessels (15 feet [less than 4.5 meters]), which increases the probability of vessel collision with demersal fishes like Atlantic sturgeon, even in deep water (Brown and Murphy 2010). A majority of the proposed Project vessel fleet for construction activities have draft between that of the most dangerous large vessels and small vessels examined by Balazik et al. (2012). Although smaller vessels and those with relatively shallow drafts provide more clearance with the river bottom, they can operate at a higher speed, which is expected to limit a sturgeons' ability to avoid being struck. Additionally, vessel speed restrictions are unlikely to reduce the likelihood of a vessel strike, as Atlantic sturgeon are unlikely to avoid oncoming vessels (NMFS 2022g). The effectiveness of visual observers for reducing vessel strike risk is also limited, given sturgeon are not visible when underwater.

Atlantic sturgeon strikes are most likely to occur in areas with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). Vessel transits for the proposed Project through the critical habitat of the Delaware and Hudson rivers during spawning periods when sturgeon aggregate in the spring pose an increased risk of vessel strikes with Atlantic sturgeon. Notably, proposed Project-related vessel traffic would only operate in established navigation channels or open water areas of sufficient depth to make the potential for vessel strike extremely unlikely to occur. Additionally, due to the infrequent nature of these transits and the existing amount of vessel traffic, vessel transits in the Delaware and Hudson rivers resulting from the proposed Project are not expected to have a significant or measurable effects on Atlantic sturgeon or their critical habitat. In offshore areas, the risk of a vessel strike is likely to be minimal due to overall lower densities of sturgeon and available space for sturgeon to avoid vessels in these areas. The risk of vessel strikes is assumed to be extremely low, as outlined, thus the potential for vessel strikes to ESA-listed Atlantic sturgeon is considered extremely unlikely to occur and **discountable** given their limited presence at the water's surface, overall low dispersed density throughout their riverine habitats, and the low volume of proposed Project-related transits.

As discussed in Section 3.4.1.2, Atlantic sturgeon critical habitat is present within the Action Area. This includes the Hudson and Delaware rivers, as previously discussed. However, the number of proposed Project-related vessels that may transit Atlantic sturgeon critical habitat is considered very low when compared to the existing commercial and recreational vessel traffic in the rivers. It is not anticipated that any proposed Project-related vessel transits would disrupt Atlantic sturgeon foraging resources or spawning behaviors to any appreciable or measurable level given the low frequency of these transits. Therefore, proposed Project-related vessel transits would have an **insignificant** effect on Atlantic sturgeon critical habitat.

In summary, the likelihood of vessel strikes from proposed Project vessel activities leading to injury and mortality is extremely low for Atlantic sturgeon in both their marine and riverine habitat. Furthermore, proposed Project-related vessel transits in the Delaware and Hudson rivers are not expected to have any measurable effects on Atlantic sturgeon critical habitat. Therefore, the risk of vessel strikes on the Atlantic sturgeon and impacts on their critical habitat is assumed to be extremely low, and effects, if any, would be **discountable** and **insignificant**. Therefore, vessel traffic effects **may affect, not likely to adversely affect** ESA-listed fish and Atlantic Sturgeon critical habitat.

3.4.2.5 Secondary Entanglement due to Increased and Altered Fishing Activity Caused by the Presence of Structures (Operations)

As discussed in other resource sections (Sections 3.2.6.5 and 3.3.5.4), the presence of structures during operations has the potential to concentrate recreational fishing around foundations and alter the existing distribution and gear type of existing commercial fisheries.

3.4.2.5.1 Redistribution of Commercial Fisheries

Commercial fishing using fixed and mobile occurs in and around the SWDA and OECC (COP Appendix III-N; Epsilon 2022). The primary trap/pot fisheries that use vertical lines in Project area is the commercial lobster fishery, which is primarily active within Nantucket Sound and limited south of Muskeget Channel and in the SWDA (COP Volume III; Epsilon 2022). In the limited bycatch data for these fisheries, only finfish and invertebrates captured were in the pots/traps rather than vertical line entanglements. There were no sturgeon captures reported in pot fisheries in a U.S. fisheries assessment (Savoca et al. 2020). Additionally, fish pots were not identified as a threat to sturgeon in a bycatch review conducted by Zollett (2009). There is no evidence that vertical lines pose a substantial entanglement risk to Atlantic sturgeon.

Fishing effort by gillnet and mobile-tending vessels also operate in the SWDA and OECC at variable levels (COP Volume III; Epsilon 2022). Commercial fisheries that use gillnet and trawl gear have the greatest risk of Atlantic sturgeon bycatch (Stein et al. 2004; ASSRT 2007; Dunton et al. 2010; ASMFC 2017), with the highest levels of bycatch in the mid-Atlantic occurring in dogfish and monkfish fisheries. Tie-down gillnets with long soak time produced the greatest sturgeon mortality (ASSRT 2007). Observer data indicated up to 25,035 pounds (11,356 kilograms) of Atlantic sturgeon were captured in gill nets in coastal waters from North Carolina to Maine; 84 percent of these captures were from sinking gill nets, 1 percent was from drift gill nets. Recommendations by the Atlantic Sturgeon Bycatch Working Group in 2021 that include modifications of tie-down length, reduced soak times, and seasonal set restrictions are likely to reduce bycatch. Fisheries recommendations regarding both pot fisheries (e.g., weak links) and gill net fisheries would likely reduce the risk of sturgeon bycatch around the Project area in a comprehensive manner.

The USCG undertook a Massachusetts and Rhode Island Port Access Route Study to evaluate the need for vessel routing measures, including regional transit lanes, within the Massachusetts WEA and RI/MA Lease Areas (COP Appendix III; Epsilon 2022). The layout of the SWDA is consistent with recommendations from the USCG and will facilitate ongoing transit and fishing activities by commercial fisherfolk; the proposed layout is expected to accommodate traditional fishing patterns and the placement of mobile and fixed gear within the WEAs (COP Appendix III; Epsilon 2022). However, vessels towing mobile gear in the SWDA may choose to exit the SWDA before retrieving gear or reversing course for a subsequent tow through the SWDA, thereby extending the amount of time fishing gear is deployed and/or more frequent retrieval and deployment of gear, which could increase exposure of Atlantic sturgeon to potential bycatch risk. However, a trawling vessel turn analysis performed for Vineyard Wind 1 (located in in Lease Area OCS-A 0501), demonstrated that trawling vessels are expected to have sufficient room to maneuver, including executing a 180-degree turn, within the proposed 1-nautical-mile (1.15-mile) navigation corridors (Epsilon 2022), indicating a change in towing methodology may not be warranted.

The intrinsic characteristics of fishing gear and methods pose a greater risk to ESA-listed fish species than changes in the distribution or patterns of commercial fishing in response to offshore wind, including the Proposed Action. Therefore, the effects of redistribution of commercial fisheries to ESA-listed fish species would be **discountable.**

3.4.2.5.2 Increased Recreational Fishing

Increased recreational fishing poses a secondary entanglement risk for ESA-listed fish species. Abandoned or lost recreational and commercial fishing gear may become entangled with foundations, resulting in an increased the risk of entanglement for the Atlantic sturgeon. Currently, published data do not exist on the amount or type of debris that accumulates on offshore wind foundations in the U.S. Atlantic; therefore, the scale of entanglement risk is not known. To date, no published reports exist regarding assessment and enumeration of fishing gear, or the associated entanglement risk for Atlantic sturgeon. Although there are unpublished, ancillary reports of sturgeon entanglement in fishing line, recreational bycatch is not noted as a significant threat to these species. It is likely, therefore, that the incidents of secondary entanglement are low. Additionally, the following monitoring and mitigation measure (Table 1-15) will act to reduce potential impacts on marine fish resulting from lost or discarded fishing gear that accumulates around WTG foundations:

- The applicant must monitor indirect effects associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 of the WTGs located closest to shore in the SWDA annually. Survey design and effort may be modified with review and concurrence by the U.S. Department of the Interior. The applicant may conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The applicant must report the results of the surveys to BOEM and BSEE in an annual report for the preceding calendar year. 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). Annual reports must also include claim data attributable to the Project from the applicant corporate gear loss compensation policy and procedures. Required data and reports may be archived, analyzed, published, and disseminated by BOEM.

The monitoring and disposition requirement provides BOEM with the ability to require removal of entanglement hazards should they occur. Secondary entanglement would pose a low risk to Atlantic sturgeon due to their relatively low occurrences in the Project area and expected minimal direct use of or foraging at the foundations. The consequences of any entanglement are high in that it often results in a mortality; however, the expectation for secondary entanglement by Atlantic sturgeon is extremely low such that it is **discountable**.

Therefore, effects of secondary entanglement due to increased and altered fishing activity caused by the presence of structures **may affect, not likely to adversely affect** ESA-listed fish species.

3.4.2.6 Monitoring Surveys

The components of the fisheries and benthic habitat monitoring surveys during pre- and post-construction, as well as during construction, are described in Section 1.4.4. The stressors associated with survey activities that may affect Atlantic sturgeon include vessel strike, entanglement or entrapment, and impacts on prey resources.

3.4.2.6.1 Vessel Strike

As discussed in Section 3.4.2.4, vessel strikes are a known source of injury and mortality for Atlantic sturgeon. Increased vessel activity in the Project area associated with the Proposed Action, including vessel traffic associated with HRG, fisheries, and habitat monitoring surveys, would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species. In general, strikes are most likely to occur in areas where Atlantic sturgeon populations overlap with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007).

Vessels conducting fisheries monitoring surveys would be commercial fishing vessels, ranging in size from 30 to 100 feet (9.1 to 30 meters) (Table 1-12). Operational survey speeds are survey-type and vessel dependent. Demersal otter trawl surveys are conducted at 3 knots, while neuston net sampling is conducted at 4 knots (Appendix B); all other fisheries monitoring surveys (i.e., drop camera, ventless trap, fish pot, and lobster tagging) are expected to be conducted either stationary or at idle speeds during active gear deployment or recovery. Transit speeds for these vessels may exceed 10 knots but will be maintained as legally mandated (73 Fed. Reg. 60173 and 87 Fed. Reg. 46921 if adopted). Each sampling type (i.e., demersal otter trawl, drop camera, and ventless trap study) would use a single vessel per trip; the neuston net sampling would use the same vessel and trip as the ventless trap study and require no additional vessel trips. Additionally, the exact ports that would be used by vessels conducting the fisheries monitoring surveys are currently unknown, though homeports for vessels would be in Rhode Island or Massachusetts.

The total number of vessels conducting HRG, fisheries, and benthic habitat monitoring surveys is expected to be a small proportion of the number of vessels and transits analyzed for construction, operations, and decommissioning activities given the limited extent and duration of the surveys relative to ongoing proposed Project activities (Section 1.4.4). The same mechanisms and stressors associated with vessel strike risk analyzed for proposed Project construction, operations, and decommissioning activities would apply to vessel activity associated with fisheries and habitat monitoring surveys under the

Proposed Action. In addition, the monitoring and mitigation measures for vessel strike avoidance presented in Section 1.4.5 would be implemented during monitoring surveys. This analysis is not repeated here.

The monitoring surveys under the Proposed Action; inclusive of HRG surveys, benthic habitat monitoring surveys, and fisheries monitoring surveys; would not significantly increase vessel traffic in the Project area compared to other proposed Project-related vessel activities and regional vessel traffic already occurring in the Project area. In consideration of proposed Project-related HRG, fisheries, and habitat monitoring survey design; vessel strike risk; and the implementation of mitigation and monitoring measures; the potential for vessel strike would be **discountable**. Therefore, vessel traffic during proposed Project-related monitoring surveys **may affect, not likely to adversely affect** ESA-listed fish.

3.4.2.6.2 Gear Utilization

As described in Section 1.4.4, the applicant is planning to conduct demersal otter trawl, drop camera, ventless trap, fish pot, lobster tagging, and Neuston net sampling surveys. The monitoring plan is proposed to be 6 years in duration, including 2 years of pre-construction baseline monitoring, 1 year of monitoring during construction, and 3 years of post-construction monitoring. Survey design, frequency, and extent are discussed in Section 1.4.4.2. Additionally, multibeam echo sounder, video, and benthic grab sampling would be conducted under the BHMP during pre-construction and Years 1, 3, and, if necessary, Year 5 after construction (Section 1.4.4.1). Each component of the monitoring plan presents differential entanglement risk and impacts on prey species to Atlantic sturgeon, as discussed below.

A number of monitoring and mitigation measures under the Proposed Action are designed to standardize Atlantic sturgeon handling and reporting procedures in response to an entanglement. These measures will reduce impacts on Atlantic sturgeon by ensuring that the handling of any sturgeon caught in fisheries sampling gear would not cause or exacerbate any direct injury to the animal. Sufficient training and proper technique would also reduce impacts on captured sturgeon by minimizing the time of handling and, therefore, the individuals' stress (Beardsall et al. 2013; Bartholomew and Bohnsack 2005).

Atlantic sturgeon are susceptible to capture in trawl nets, which may result in injury or death. Non-lethal effects could include reduced fecundity and delayed or aborted spawning migrations (Collins et al. 2000; Moser et al. 2000; Moser and Ross 1995). 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. The risk to the species is greatest where high fishing efforts occur in regions with high Atlantic sturgeon abundances. Capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations (Moser and Ross 1995; Collins et al. 2000; Moser et al. 2000). 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 2014).

Negative impacts on sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). Northeast Fisheries Observer Program data from Miller and Shepherd (2011) indicate that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5 percent. Short tow durations and careful handling of individuals once on deck are likely to result in a very low risk of mortality to captured individuals (NMFS 2014, 2016b). Both the Northeast Fisheries Science Center and Northeast Area Assessment and Monitoring Program surveys have recorded the capture of hundreds of Atlantic sturgeon since the inception of each. To date, there have been no recorded serious injuries or mortalities. A single capture of Atlantic sturgeon has occurred in trawl surveys currently being conducted for the South Fork Offshore Wind Project. The trawl vessel and sampling equipment used for the fisheries monitoring plan would be comparable to that used by the Northeast Area Assessment and Monitoring Program. Trawl tow lengths are limited to 20 minutes, and the vessel operating the trawl (a commercial fishing vessel) would tow at 3 knots. The total effort of trawl surveys for the proposed Project is 50, 20-minute tows four times per year or 66.6 hours per year and 400 hours over a 6-year period. The relatively short tow duration is expected to minimize the potential for interactions with Atlantic sturgeon and pose a negligible risk of mortality. Furthermore, in the event of an Atlantic sturgeon capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures to reduce potential mortality.

Given the dispersed nature of Atlantic sturgeon, the limited number of trawl tows that would be conducted, the short tow times of 20 minutes for the proposed Project, evidence that fisheries research surveys are associated with a low risk of mortality, and the application of mitigation measures for captured sturgeon, BOEM does not anticipate serious injury or mortality of Atlantic sturgeon captured during proposed Project trawl surveys. However, given that trawl surveys from proposed Project monitoring activities could still lead to potential capture and/or minor injury, effects cannot be discounted. Therefore, entanglement in demersal trawl gear associated with the Proposed Action **may affect, likely to adversely affect** ESA-listed fish.

Stationary pots that are baited pose a potential risk to Atlantic sturgeon. However, fish traps and pots were not recorded as potential sources for capture of Atlantic sturgeon in the Northeast Fisheries Observer Program data (Dunton et al. 2015), and it is unlikely that the species would become entangled in the lines or pots. The proposed Project’s ventless trap survey includes 30 stations that would be sampled twice monthly from May through December; soak times would be limited to 3 days (when feasible). In the event of an Atlantic sturgeon capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures. However, the likelihood of an entanglement occurring in trap and pot gear is extremely unlikely to occur and is considered **discountable** given the limited, dispersed distribution of Atlantic sturgeon in the Action Area, the application of mitigation measures, and the limited duration of each survey event.

Neuston sampling is conducted with a plankton net towed and slow speeds (4 knots) for short periods (10 minutes) in the top 1.6 feet (0.5 meter) of the water column. The Neuston net frame is 2.4 meters by 0.6 meter by 6.0 meters (7.8 feet by 1.9 feet by 19.6 feet) in size, and the net is made of a 1,320-micrometer mesh; although capture is possible, given the limited tow length duration and surface location of sampling, no sturgeon entanglement is expected to occur from Neuston net sampling. Drop camera sampling is conducted directly from the stern of vessel and includes continuous monitoring of the seabed. Similarly, HRG and benthic habitat monitoring surveys would not use gear that pose an entanglement risk to Atlantic sturgeon. Therefore, entanglement risk due to the methodology presented for Neuston net, drop camera, and benthic habitat monitoring surveys is extremely unlikely and, therefore, **discountable** for ESA-listed fish.

Atlantic sturgeon prey items such as mollusks and fish may be removed from the marine environment as bycatch in trap gear and during demersal trawl surveys. However, any bycatch prey items would be returned to the site. Injured or deceased bycatch would still be available as prey for Atlantic sturgeon, which are known to eat a variety of live prey, as well as scavenge dead organisms. Neuston net sampling is designed to collect planktonic organisms at the ocean’s surface, which would have no effect on Atlantic sturgeon prey availability. Under the BHMP, a benthic/sediment grab sampler (e.g., Van Veen, Day, Ponar) would be employed to retrieve sediments from the upper 10 to 20 centimeters (3.9 to 7.8 inches) of the seabed for analysis; a total of 252 grab samples would be collected for each annual survey, which may include capture of benthic prey items for Atlantic sturgeon. However, given the limited extent of the benthic grab surveys, any removal of prey species would be non-measurable and negligible compared to the overall benthic prey resources. Benthic grab sampling trawl surveys would, therefore, not affect the availability of prey for Atlantic sturgeon in the Action Area. In summary, effects from the proposed trawl, trap, Neuston net, and benthic grab sampling surveys on the availability of prey for ESA-listed fish are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**.

In summary, entanglements resulting from neuston net, ventless trap, and benthic habitat monitoring surveys and reductions in prey resulting from all habitat monitoring surveys on ESA-listed fish are considered extremely unlikely to occur and **discountable** or are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the effects of monitoring surveys (excluding trawl surveys) from the proposed Project **may affect, not likely to adversely affect** ESA-listed fish. However, the effects of demersal trawl gear associated with the Proposed Action cannot be discounted and **may affect, likely to adversely affect** ESA-listed fish.

3.4.2.7 Electromagnetic Field and Cable Heat Transfer Effects on Marine Fish (Operations)

During Proposed Action operations, powered transmission cables would produce EMF (Taormina et al. 2018). To minimize EMF generated by cables, all cabling would be contained in grounded metallic shielding and buried at a target depth of 5 to 8 feet (1.5 to 2.5 meters) below the surface. These measures, including the use of AC cables only, will reduce but will not entirely eliminate EMF (Taormina et al. 2018). Modeled magnetic field levels specific to the proposed Project's cables are not available on the New England Wind Project COP webpage following the June 2022 update (BOEM 2022b).

Marine fish have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 millivolts per meter (Gill et al. 2012; Normandeau et al. 2011). Based on magnetic field strength, the induced electrical field in Atlantic sturgeon in proximity to exposed cable segments is likely to exceed the 0.5 millivolts per meter threshold. This suggests that fish would likely be able to detect the induced electrical fields in immediate proximity to exposed cable segments. Sturgeon species have been reported to respond to low frequency AC electric signals. For example, migrating Danube sturgeon (*Acipenser gueldenstaedtii*) have been reported to slow down when crossing beneath overhead high voltage cables and speed up once past them (Gill et al. 2012). This is not a useful comparison, however, because overhead power cables are unshielded and generate relatively powerful induced electrical fields compared to shielded subsea cables. Insufficient information is available to associate exposure with induced electrical fields generated by subsea cables with behavioral or physiological effects (Gill et al. 2012). However, natural electrical field effects generated by wave and current actions are on the order of 10 to 100 millivolts per meter, many times stronger than the induced field generated by buried cable segments. Given the range of baseline variability and limited area of detectable effects relative to available habitat on the OCS, the effects of fish's exposure to proposed Project-related EMF would be non-measurables and **insignificant** for Atlantic sturgeon.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection, such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. It is possible that recolonizing invertebrate species may be displaced laterally or vertically in avoidance of temperatures they are sensitive to. However, as discussed in Section 3.4.2.2.1, Atlantic sturgeon are generalist feeders and are unlikely to be affected by temporary and spatially-limited impacts on some prey species. Potential effects on ESA-listed fish from heat transfer from proposed Project cables is unlikely to occur and would be **discountable.**

Therefore, effects of EMF exposure and heat transfer from the Proposed Action **may affect, not likely to adversely affect** ESA-listed fish.

3.4.2.8 Dredging Effects on Marine Fish (Construction, Decommissioning)

As discussed in Section 1.4.1.2.4, dredging of sand waves along portions of the OECC may occur under the Proposed Action; however, it would be limited to only the extent required to achieve the desired cable burial depth during installation of the offshore export cable for both proposed Project phases (COP

Section 3.3.1.3.5 and 4.3.1.3.5; Epsilon 2022). The geographic extent over which dredging would occur under the Proposed Action is site-specific, not extensive, and estimated to be approximately 119 acres (0.48 km^2) during Phase 1 and Phase 2 combined (COP Appendix III-T; Epsilon 2022). This limited extent minimizes the risk for ESA-listed fish in the Project area. The area where potential dredging activities may occur does not overlap with any designated critical habitat for Atlantic sturgeon (Section 3.4.1.2). Impacts on ESA-listed fish due to increased turbidity resulting from dredging activities is discussed in Section 3.4.2.3. Dredging may be accomplished through the use of a TSHD or through jetting by controlled flow excavation. While both methods would result in seafloor disturbances, as estimated in Table 3-23, only the TSHD equipment would have the additional risk of impingement, entrainment, or capture of Atlantic sturgeon. Atlantic sturgeon are vulnerable to impingement or entrainment in hopper dredges, which can result in injury or mortality (Reine et al. 2014; USACE 2020).

Dredging during construction could carry a variety of impacts on Atlantic sturgeon related to injury and mortality associated with dredging techniques, as well as impacts on prey. The risk of interactions between sturgeon and mechanical dredges is thought to be highest in areas where large numbers of sturgeon are known to aggregate. There are no known areas of sturgeon aggregations within the areas for dredging for the proposed Project. The risk of capture may also be related to the behavior of the sturgeon in the area. While foraging, sturgeon are at the bottom interacting with the sediment (Dadswell 2006). This behavior may increase the susceptibility of capture with a dredge bucket. For entrapment to occur, an individual sturgeon would have to be present directly below the dredge bucket at the time of operation. Given the rarity of sturgeon in the area to be dredged, the co-occurrence of an Atlantic sturgeon and the dredge bucket is extremely unlikely. As such, entrapment of sturgeon during the temporary performance of mechanical dredging operations is also extremely unlikely. Due to their bottom foraging and swimming behavior, adult Atlantic sturgeon have been known to become entrained in hydraulic-cutterhead dredges they move across the seabed (Novak et al. 2017; Balazik et al. 2020; NMFS 2022h). Given the need for a sturgeon to approach within 1 meter (3.28 feet) of the dredge head to become entrained and the lack of attraction or deterrence relationship observed between Atlantic sturgeon and dredges, the likelihood of effects on Atlantic sturgeon from proposed Project dredging is low (Balazik et al. 2020; NMFS 2022h).

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

Based on the above analyses, the potential effects of dredging on Atlantic Sturgeon, including entrainment and impacts on prey species, are not likely to occur and would be **discountable**. Therefore, effects from dredging under the Proposed Action **may affect, not likely to adversely affect** ESA-listed fish.

4 Conclusions

Table 4-1 summarizes the effects determinations for the listed marine mammals, sea turtles, and marine fish considered in this BA. Effects determinations incorporated the monitoring and mitigation measures outlined in Table 1-15. The following three effects determinations were made in this BA.

1. A **may affect, not likely to adversely affect** determination was made when the proposed Project stressors were determined to have **no effect**, **insignificant** effects or were **discountable**.
    a. **No effect:** No effect was assigned if it is determined the proposed Project would have no effects, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the proposed Project and its environmental consequences.
2. **Insignificant:** Effects relate to the size or severity of the effect and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effects 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 affect a listed species), but it is extremely unlikely to occur (NMFS and USFWS 1998).

In addition, if the proposed Project had the potential to result in beneficial effects on listed species (for example, the aggregation of prey due to structures) but was also likely to cause some adverse effects, then a determination of **may affect, likely to adversely affect** was made.

A may affect, likely to adversely affect determination was made when a proposed Project stressor could not be fully mitigated and was expected to result in an adverse effect on an ESA-listed species that could result in an ESA-level take.

Table 4-1: Effects Determination Summary for National Marine Fisheries Service Endangered Species Act-Listed Species Known or Likely to Occur in the Project Area

Stressor	Proposed Project Stage	Potential Effect	ESA-Listed Marine Mammals	ESA-Listed Sea Turtles	ESA-Listed Fish	Critical Habitat
Foundation Installation	Construction	PTS	LAA for fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), and blue whales (*Balaenoptera musculus*) NLAA for NARW (*Eubalaena glacialis*) NE for sperm (*Physeter macrocephalus*),	LAA	NLAA	–
		Behavioral disturbance	NLAA blue whales LAA for fin, NARW, sei, and sperm whales	LAA	NLAA	–
Foundation drilling	Construction	PTS	NLAA	NLAA	NLAA	–
		Behavioral disturbance	NLAA	NLAA	NLAA	–
Vessel and aircraft noise	Construction, operations	PTS	NLAA	NLAA	NLAA	NLAA
		Behavioral disturbance	NLAA	NLAA	NLAA	
HRG survey noise	Construction, operations, decommissioning	PTS and behavioral disturbance	NLAA	NLAA	NLAA	–
UXO detonations	Construction	Non-auditory Injury	NLAA	NLAA	NLAA	–
		PTS	LAA	NLAA	–	–
		Behavioral disturbance/TTS	NLAA	NLAA	NLAA	–
WTG operational noise	Operations	PTS and behavioral disturbance	NLAA	NLAA	NLAA	–
Displacement from physical disturbance	Construction, operations, decommissioning	Altered migration/ displacement	NLAA	NLAA	NLAA	–

Stressor	Proposed Project Stage	Potential Effect	ESA-Listed Marine Mammals	ESA-Listed Sea Turtles	ESA-Listed Fish	Critical Habitat
Structure presence	Operations	Altered migration/ Displacement/ Foraging/Prey availability	NLAA	NLAA	NLAA	–
Effects of changes in oceanographic and hydrological conditions	Operations	Altered migration/ Displacement/ Foraging/Prey availability	NLAA	NLAA	NLAA	–
Changes in prey availability	Operations	Foraging/Prey availability	NLAA	NLAA	NLAA	–
Secondary entanglement from increased recreational fishing due to reef effect	Operations	Secondary entanglement	NLAA	LAA for loggerhead and leatherback sea turtles NLAA for Kemp's ridley and green sea turtles	NLAA	–
Turbidity	Construction, decommissioning	Foraging/Prey availability	NLAA	NLAA	NLAA	NLAA
Oil spills/chemical release	Construction, operations, decommissioning	Contaminant exposure	NLAA	NLAA	NLAA	NLAA
Vessel traffic	Construction, operations, decommissioning	Vessel strike resulting in injury/mortality	NLAA	LAA	NLAA	NLAA
EMF	Operations	Effects on orientation/ migration or navigation	NLAA	NLAA	NLAA	–
HRG and benthic monitoring surveys	Construction, operations, decommissioning	Vessel strike resulting in injury/mortality	NLAA	NLAA	NLAA	–
		Entanglement	NLAA	NLAA	NLAA	–
		Foraging/prey availability	NLAA	NLAA	NLAA	–
Fishery monitoring surveys	Construction, operations, decommissioning	Vessel strike resulting in injury/mortality	NLAA	NLAA	LAA	–

Stressor	Proposed Project Stage	Potential Effect	ESA-Listed Marine Mammals	ESA-Listed Sea Turtles	ESA-Listed Fish	Critical Habitat
		Entanglement	NLAA	LAA for demersal trawl entanglement NLAA for all other fisheries monitoring surveys	LAA for demersal trawl entanglement NLAA for all other fisheries monitoring surveys	–
		Foraging/prey availability	NLAA	NLAA	NLAA	–
Overall effects determination	Construction, operations, decommissioning	PTS and behavioral disturbance Vessel strike resulting in injury/mortality Entanglement	LAA	LAA	LAA	NLAA

– = not applicable; EMF = electromagnetic fields; ESA = Endangered Species Act; HRG = high-resolution geophysical; LAA = likely to adversely affect; NARW = North Atlantic right whale; NLAA = not likely to adversely affect; PTS = permanent threshold shift; TTS = temporary threshold shift; UXO = unexploded ordnance; WTG = wind turbine generator

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Appendix A: Draft Benthic Habitat Monitoring Plan

Appendix B: Fisheries Monitoring Plan