New England Wind Project
Final Essential Fish Habitat Assessment

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For the National Marine Fisheries Service

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

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1 Acronyms and Abbreviations

°F	degrees Fahrenheit
AC	alternating current
BA	Biological Assessment
BHMP	benthic habitat monitoring plan
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
CTV	crew transfer vessel
d50	median particle diameter
dB	decibel
dB re 1 µPa	decibels referenced to 1 micropascal
DP	dynamic positioning
EFH	essential fish habitat
EIS	Environmental Impact Statement
EMF	electromagnetic fields
ESA	Endangered Species Act
ESP	electrical service platform
FMP	Fishery(ies) Management Plan
HAPC	Habitat Area of Particular Concern
HDD	horizontal directional drilling
Hz	hertz
IPF	impact-producing factor
kV	kilovolt
$L_{E,24hr}$	24-hour cumulative sound exposure level
L_p	root mean squared sound pressure
L_{PK}	peak sound pressure
MAFMC	Mid-Atlantic Fishery Management Council
MAOMP	Massachusetts Ocean Management Plan
Mayflower Wind	Mayflower Wind Energy Project
metocean	meteorological oceanographic
mg/L	milligrams per liter
MSA	Magnuson-Stevens Fishery Conservation and Management Act of 1976
NA	not applicable
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OECC	offshore export cable corridor
OECR	onshore export cable route

PAM	passive acoustic monitoring
PDE	Project design envelope
Project	New England Wind Project
RI/MA Lease Areas	Rhode Island and Massachusetts Lease Areas
ROW	right-of-way
RSD	ripple scour depression
SAV	submerged aquatic vegetation
SCV	South Coast Variant
SOV	service operations vessel
SPL	sound pressure level
SWDA	Southern Wind Development Area
TSHD	trailing suction hopper dredge
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
WTG	wind turbine generator

1 Introduction

In the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSA), Congress recognized that one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Congress also determined that habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States. As a result, one of the purposes of the MSA is to promote the protection of essential fish habitat (EFH) in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect such habitat.

The MSA requires federal agencies to consult with the Secretary of Commerce, through the National Marine Fisheries Service (NMFS), with respect to “any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act,” (16 U.S. Code § 1855(b)(2)). This process is guided by the requirements of the EFH regulation at 50 Code of Federal Regulations (CFR) § 600.905. The Bureau of Ocean Energy Management (BOEM) will be the lead federal agency for the consultation and will coordinate with any other federal agencies that may be issuing permits or authorizations for the New England Wind Project (proposed Project), as necessary, for one consultation that considers the effects of all relevant federal actions, including in offshore and inshore coastal environments (e.g., issuance of permits by the U.S. Army Corps of Engineers [USACE]).

Pursuant to the MSA, each fishery(ies) management plan (FMP) must identify and describe EFH for the managed fishery, and the statute defines EFH as “those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S. Code § 1853(a)(7) and § 1802(10)). The National Oceanic and Atmospheric Administration’s (NOAA) regulations further define EFH adding, “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species' full life cycle.

The EFH final rule published in the *Federal Register* on January 17, 2002, defines an adverse effect as: “any impact which reduces the quality and/or quantity of EFH.” The rule further states that:

> An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. The EFH final rule also states that the loss of prey may have an adverse effect on EFH and managed species. As a result, actions that reduce the availability of prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat may also be considered adverse effects on EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

2 Description of Proposed Project

The Proposed Action would allow Park City Wind, LLC (applicant) to construct, operate, and decommission wind energy facilities on the Outer Continental Shelf (OCS) offshore of Massachusetts. The New England Wind Project (proposed Project) is located within the Southern Wind Development Area (SWDA) and would generate at least 2,036 and up to 2,600 megawatts of electricity. New England Wind is proposed to be developed in two phases: Phase 1 (also known as Park City Wind) and Phase 2 (also known as Commonwealth Wind). The applicant has submitted a Construction and Operations Plan (COP) outlining its Proposed Action (Epsilon 2022). The Proposed Action is being developed and permitted using the Project design envelope (PDE) concept, allowing flexibility in Proposed Action elements while ensuring a timely and thorough environmental review. 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 below.

The Proposed Action and analysis of impacts also include any associated federal activities associated with the Proposed Action from the co-action agencies (Bureau of Safety and Environmental Enforcement, the U.S. Environmental Protection Agency [USEPA], USACE, U.S. Coast Guard, and NMFS). The applicant has not yet submitted a Clean Water Act Section 404/Section 10 permit application. No impacts on onshore wetlands are proposed as part of the Proposed Action. Impacts are anticipated to consist of structures and temporary construction impacts with no permanent losses of waters of the U.S. Any mitigation, monitoring, and reporting measures, if required for the permit, will be developed through Endangered Species Act (ESA) consultations (and EFH consultation) with NMFS. As such, the proposed permit is incorporated by reference in this EFH assessment for consultation. Issuance of an air quality permit received by the USEPA is not expected to have any discernable impacts on listed species or critical habitat, and no related mitigation, monitoring, and reporting measures for listed species are proposed for the Proposed Action. No other permits or authorizations are proposed and are not anticipated by other agencies at this time.

2.1 Offshore Facilities

Proposed Action components include wind turbine generators (WTG) 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 offshore export cable corridor (OECC) located within state waters. The Proposed Action would comprise two phases each with their own associated construction parameters, which are detailed in COP Sections 3.3 and 4.3 for Phase 1 and 2, respectively (Volume I; Epsilon 2022). The offshore Proposed Action components are described below.

2.1.1 Wind Turbine Generators

Table 2-1 summarizes the maximum parameters of WTGs that could be installed for either Phase 1 or Phase 2. The applicant would erect up to 130 WTGs and ESPs within 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. Phase 1 would include at least 41 and up to 62 WTGs, while Phase 2 would include at least 67 and up to 88 WTGs.

The applicant would mount Phase 1 WTGs on either monopile or jacket foundations, and would mount Phase 2 WTGs on either monopile, jacket, or bottom-frame foundations. A monopile is a long steel tube driven up to 180 feet into the seabed using an impact hammer. A jacket foundation is a latticed steel frame with three or four supporting piles (pin piles) driven up to 279 feet into the seabed using an impact hammer. The applicant currently expects to use all monopile foundations for Phase 1; however, jacket foundations are also being considered in the PDE and are assessed in this EFH assessment.

Table 2-1: Proposed Action Maximum-Case Scenario Wind Turbine Generator Specifications

Component	Specification
WTG	
Maximum tip height	1,171 feet mean lower low water[a]
Maximum hub height	702 feet mean lower low water[a]
Maximum height to nacelle top	725 feet mean lower low water[a]
Maximum rotor diameter	937 feet mean lower low water[a]
Maximum tip clearance	89 feet mean lower low water[a]
Maximum tower diameter for WTG	30 feet
Monopile Foundations[b]	
Maximum diameter	43 feet
Pile footprint with scour protection	1.2 acre
Height between seabed and mean lower low water (water depth)	157–203 feet
Maximum penetration	180 feet
Maximum transition piece tower diameter	33 feet
Maximum transition piece length	164 feet
Number of piles/foundation	1
Maximum number of piles driven/day within 24 hours[c]	2
Typical foundation time to pile drive	Approximately 6 hours
Maximum hammer size	6,000 kilojoules
Jacket (Pin Piles) Foundation	
Maximum diameter per pile	13 feet
Maximum jacket structure height	285 feet
Maximum pile penetration	279 feet
Maximum pile footprint with scour protection	1.1 acres
Number of piles/foundation	3 to 4
Maximum number of piles driven/day within 24 hours[c]	1 (up to 4 pin piles)
Typical foundation time to pile drive	Approximately 3 hours
Maximum hammer size	3,500 kilojoules
Bottom-Frame Foundation	
Maximum diameter per pin pile	13 feet
Maximum diameter per bucket pile	49 feet
Maximum bottom-frame structure height	302 feet
Maximum pile penetration (pin pile)	279 feet
Maximum pile penetration (bucket pile)	49 feet
Maximum pin pile footprint with scour protection	1.7 acres
Maximum bucket pile footprint with scour protection	2.4 acres
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 kilojoules

Source: COP Volume I; Epsilon 2022

WTG = wind turbine generator
[a] Elevations relative to mean higher high water are approximately 3 feet lower than those relative to mean lower low water.
[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.
[c] Work would not be performed concurrently. No drilling is anticipated; however, it may be required if a large boulder or refusal is met. If drilling is required, a rotary drilling unit would be mobilized, or vibratory hammering would be used.

The applicant would mount Phase 2 WTGs on either monopile, jacket, or bottom-frame foundations. A bottom-frame foundation 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. The feet of the bottom-frame foundation may be secured either using pin piles (as described for Phase 1) or suction buckets, which would be pushed up to 49 feet into the seabed by pumping water out of the bucket. The applicant currently expects to use only monopile or piled jacket foundations for Phase 2; however, suction bucket jackets and bottom-frame foundations are considered in the PDE and are assessed in this EFH assessment.

Detailed descriptions of WTGs can be found in the COP (Volume I, Sections 3.2.1 and 4.2.1; Epsilon 2022). A complete discussion of the proposed WTG and foundation construction approach for Phase 1 is provided in COP Section 3.3 (Volume I; Epsilon 2022), while Phase 2 is described in COP Section 4.3 (Volume 1; Epsilon 2022) for foundations and WTGs.

2.1.2 Electrical Service Platforms

Phase 1 would include a minimum of one and a maximum of two ESPs, while Phase 2 would include up to three ESPs. Phase 1 ESPs would be installed on a monopile or jacket foundation, while Phase 2 ESPs would be installed on either monopile, jacket, or bottom-frame foundations. Phase 2 jacket or bottom-frame foundations could be installed with pin piles or suction buckets, as described for WTGs (Section 3.1.1). 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 2-2 summarizes the range of pertinent electrical service platform (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).

Each ESP would contain up to 189,149 gallons of oils, lubricants, coolants, and diesel fuel. The COP provides additional details related to chemicals and their anticipated volumes (Volume I, Sections 3.3 and 4.3; Epsilon 2022), detailed specifications of the ESPs (Volume I, Sections 3.2.1.3 and 4.2.1.3; Epsilon 2022), and a complete discussion of the proposed ESP construction approach (Volume I, Section 4.3.1.5; Epsilon 2022).

Table 2-2: Proposed Action Electrical Service Platform Specifications

Foundation Type	Monopile	Jacket	Bottom Frame (Phase 2 Only)
Dimensions (feet)	197 × 328 × 125	197 × 328 × 125	197 × 328 × 125
Number of transformers per ESP	1	1	1
Number of piles/foundation	1	3–12	0
Maximum height[a]	230 feet	230 feet	230 feet

Source: COP Section 4.2.1.3, Volume I; Epsilon 2022

ESP = electrical service platform
[a] The elevations provided are relative to mean lower low water, defined as the average of all the lower low water heights of each tidal day observed over the National Tidal Datum Epoch.

2.1.3 Scour Protection

Scour protection would be placed around all foundations for both Proposed Action phases and would consist of rock material up to 9.8 feet in height above the seabed. The scour protection would serve to stabilize the seabed near the foundations, as well as the foundations themselves. Table 3-2 provides scour protection information for proposed foundations for both Proposed Action phases (more detailed information is in the COP Volume I, Sections 3.2.1.4 and 4.2.1.4; Epsilon 2022).

Table 2-3: Proposed Action Scour Protection Information

Maximum Scour Protection for Foundations	Acres
Monopile, WTG and ESP	1.2
Piled jacket, WTG	1.1
Piled jacket, ESP	2.5
Suction bucket jacket, WTG	1.6
Suction bucket jacket, ESP	5.3
Piled bottom frame, WTG	1.7
Suction bucket bottom frame, WTG	2.4

Source: COP Sections 3.2.1.4 and 4.2.1.4, Volume I; Epsilon 2022

ESP = electrical service platform; WTG = wind turbine generator

2.1.4 Offshore Cables

Two offshore export cables for Phase 1 and three cables for Phase 2 in one cable corridor would connect the proposed wind facility to the onshore electrical grid. The applicant’s COP has identified two variations of the OECC that may be employed for Phase 2: the Western Muskeget Variant (which passes through the western side of Muskeget Channel) and the South Coast Variant (SCV; which connects to a potential second grid interconnection point in Bristol County, Massachusetts). These variations are necessary to provide the proposed Project with commercial flexibility should technical, logistical, grid interconnection, or other unforeseen issues arise during the COP review and engineering processes. At this time, the applicant has not proposed a landing location for the SCV. This assessment does not consider the impacts of the SCV, and BOEM is not requesting consultation on the SCV. Any approval of the COP would be conditioned on the receipt of additional information on the SCV landfall location, route through state waters, and completion of all required statutory consultations including additional consultation on impacts on EFH pursuant to the MSA if the applicant elects to construct the SCV.

Each offshore export cable would consist of three-core 220 to 275 kilovolt (kV) high voltage alternating current (AC) cables for Phase 1 and 220 to 345 kV 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 the Vineyard Wind 1 Project 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 (Section 3.2.1 and COP Volume I, Figure 3.1-6; Epsilon 2022). As the offshore export cable approaches Cape Cod, the final route would be contingent on the choice of landfall site. The Phase 1 landfall site would occur at Craigville Public Beach while the Phase 2 landfall is expected to occur at Dowses Beach. Covell’s Beach (Phase 1) and Wianno Avenue (Phase 2) landfall sites would only be used if unforeseen challenges make use of the preferred landfall sites infeasible (COP Volume I, Sections 3.2.2.1 and 4.2.2.1; Epsilon 2022). This assessment does not consider the impacts of the Covell’s Beach or Wianno Avenue landfall sites and BOEM is not requesting consultation on these alternate landfall locations at this time.

Phase 1 offshore cables would take approximately 12 months to install. A high-level schedule proposed by the applicant has cable installation beginning in December 2024 and ending in November 2025 (COP Volume 1, Figure 3.1-3; Epsilon 2022).

Inter-array cables would link groups (or strings) of WTGs to an ESP for each phase, including up to 139 miles of cable for Phase 1 and up to 201 miles of cable for Phase 2. Inter-link cables would connect multiple ESPs within each phase if more than one ESP is needed, including up 13 miles for Phase 1 and up to and 37 miles 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. 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. 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. The locations of these large bedforms such as sand waves, megaripples, and ripples larger than 1 foot in relief present during benthic surveys are shown in Figure 3.3-3 of COP Volume I (Epsilon 2022). For the installation of the two cables during Phase 1, total dredging could affect up to 52 acres and could include up to 134,800 cubic yards of dredged material. For the installation of up to three cables during Phase 2, total dredging could affect up to 67 acres and could include up to 235,400 cubic yards of dredged material. This would lead to a total of 119 acres of dredging for sand waves and other bedform features (COP Volume III Appendix 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).[1] TSHD would discharge the sand removed from the vessel within the 2,657-foot-wide cable corridor.[2] 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. Sediment suspension and turbidity plumes and the EFH habitat disturbance related to TSHD and jetting installation are discussed in Section 5.1.2 of this EFH.

The applicant anticipates that dredging would occur within a corridor that is 50 feet wide and 1.6 feet deep, and potentially as deep as 17 feet 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. In certain areas, alternative installation methods may be needed. In any case, cable burial would likely use a tool that slides along the seafloor on skids or tracks (up to 3.3 to 10 feet wide), which would not dig or plow into the seafloor but would displace the sediment within the footprint of the jetting sled. This burial method would cause linear ruts that would over time recover without mitigation efforts and considered a short term disturbance. Conditions related to sediment suspension and turbidity plumes are discussed in Section 5.1.2 of this EFH. The installation methodologies for Phase 1 are described in detail in the COP (Volume I, Section 3.3.1.3; 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

[1] TSHD can be used in sand waves of most sizes, whereas the jetting technique is most likely to be used in areas where sand waves are less than 6.6 feet 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.

[2] 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 away (while remaining within the 2,657-foot corridor) and bottom dump the dredged material.

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.[3] 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 vessels capable of dynamic positioning (DP), anchored vessels, self-propelled vessels, and/or barges.

2.1.5 Operations

The Proposed Action would have a designed operating phase of approximately 30 years for each phase.[4] 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. The operations facilities would include offices, control rooms, shop space, and pier space; the applicant does not propose to direct or implement any port improvements. Therefore, none of these activities would be occurring as a direct result of the Proposed Action (COP Volume I; Epsilon 2022).

Crew transfer vessels (CTV) 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 in length), multipurpose vessels, and service operations vessels (SOV) (260 to 300 feet in length), with larger vessels based at the New Bedford Marine Commerce Terminal and smaller vessels based at the onshore operations facility. In a typical year, the Proposed Action would generate approximately 250 vessel trips during operations of each phase (COP Appendix III-I; Epsilon 2022). Dedicated crew transport vessels specifically designed for offshore wind energy work would provide access. These vessels would be based primarily at the operations facilities. Helicopters may also be used for access and/or for visual inspections. The helicopters would be based at a general aviation airport near the operations facilities.

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).

2.1.6 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 Action. All facilities would need to be removed 15 feet below the mudline (30 CFR § 585.910(a)). Absent permission from BOEM, the applicant would have to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed.

Although the Proposed Action has a designed life span of 30 years for operations during each phase, some installations and components may remain fit for continued service after this time. The applicant would

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[3] Half-shell pipes come in two halves and are fixed around the cable to provide mechanical protection. Half-shell pipes or similar solutions are generally used for short spans, at crossings or near offshore structures, where there is a high risk from falling objects. The pipes do not provide protection from damage due to fishing trawls or anchor drags (COP Section 3.2.1.5.4, Volume I; Epsilon 2022).

[4] 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 EFH Assessment analyzes a 30-year operations term.

have to apply for an extension if it wished to operate the Proposed Action for more than 30 years. Offshore cables may be retired in place or removed. In consideration of mobile gear fisheries (i.e., dredge and bottom-trawl gears), the applicant is committed to removing scour protection during decommissioning.

The applicant would drain WTG and ESP fluids 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 below the mudline in accordance with BOEM regulations (30 CFR § 585.910(a)), and removed. The portion buried below 15 feet would remain, and the depression would be refilled with the sediment that had been temporarily removed.

By maintaining an inventory list of all components of the Proposed Action, the decommissioning team would be able to track each piece so that no component would be lost or forgotten. The above decommissioning plans are subject to a separate approval process. This process will include an opportunity for public comment and consultation with municipal, state, and federal agencies. The applicant would require separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. Regulations default to complete site clearance.

2.2 Onshore Facilities

2.2.1 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 also make landfall in Barnstable, Massachusetts at Dowses Beach. The transition of the export cable from offshore to onshore would be accomplished by horizontal directional drilling (HDD), which would bring the proposed cables beneath the nearshore area, the tidal zone, beach, and adjoining coastal areas to the proposed landfall sites. The Draft Environmental Impact Statement (EIS) assesses all proposed landfall locations, as well as the different proposed installation methods. 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 kV AC offshore export cables would be connected to the 220 to 345 kV onshore export cables (with the size of the cables depending on the phase and final PDE).

A detailed description of the proposed landfall sites is provided in COP Sections 3.2 and 4.2 for Phase 1 and 2, respectively (Volume I; Epsilon 2022). Further discussion of proposed landfall site construction approach is provided in COP Sections 3.3 and 4.3 (Volume I; Epsilon 2022).

2.2.2 Onshore Export Cable and Substation Site

The Proposed Action contemplates one onshore export cable route (OECR) for each phase, with alternative options within each route. Figure 2-1 shows the Phase 1 OECR options, while Figure 2-2 shows the Phase 2 OECR options. 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 right-of-way (ROW). 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 wide by 2.5 feet 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 of cover comprised of properly compacted sand topped by pavement.

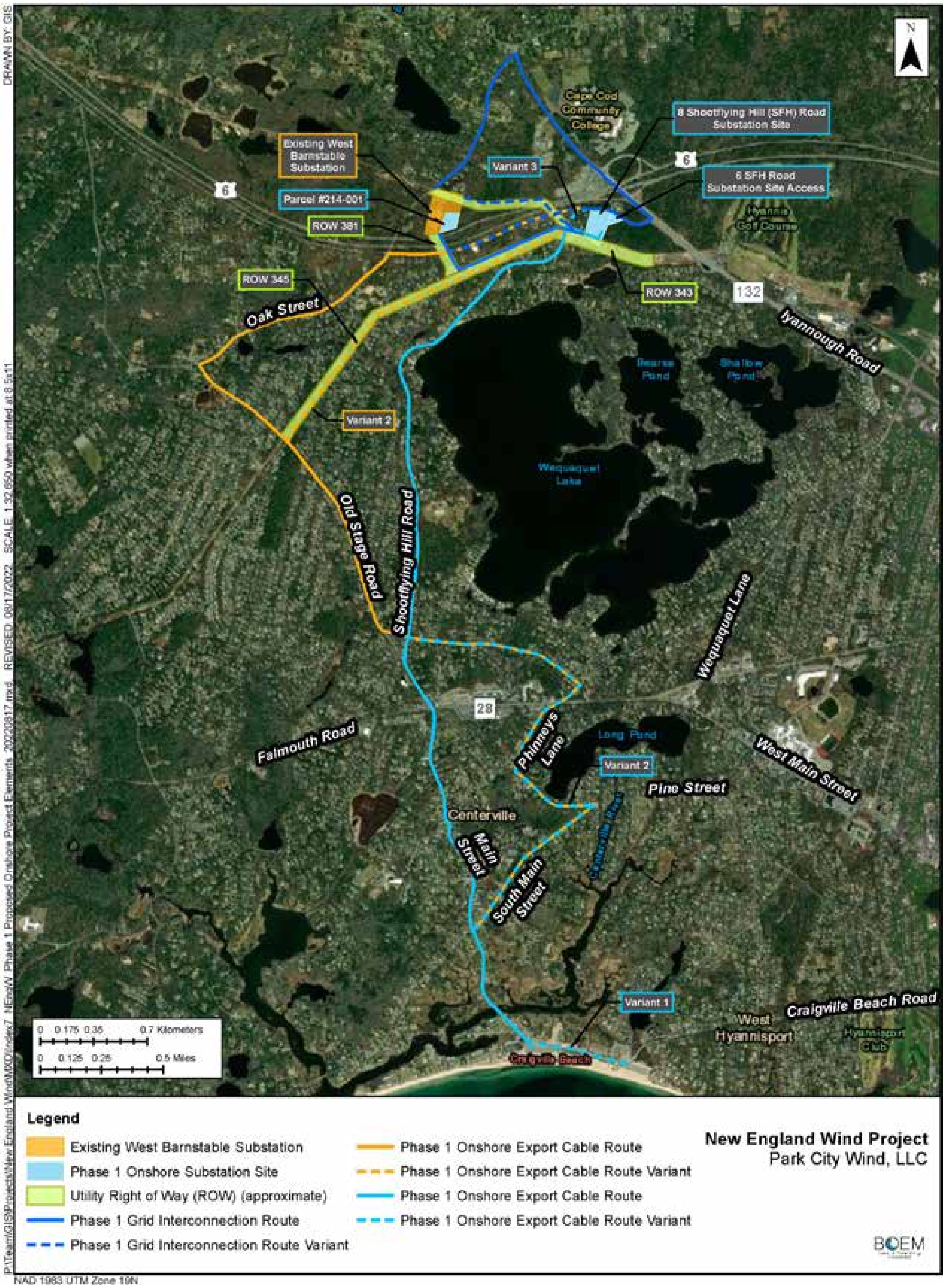
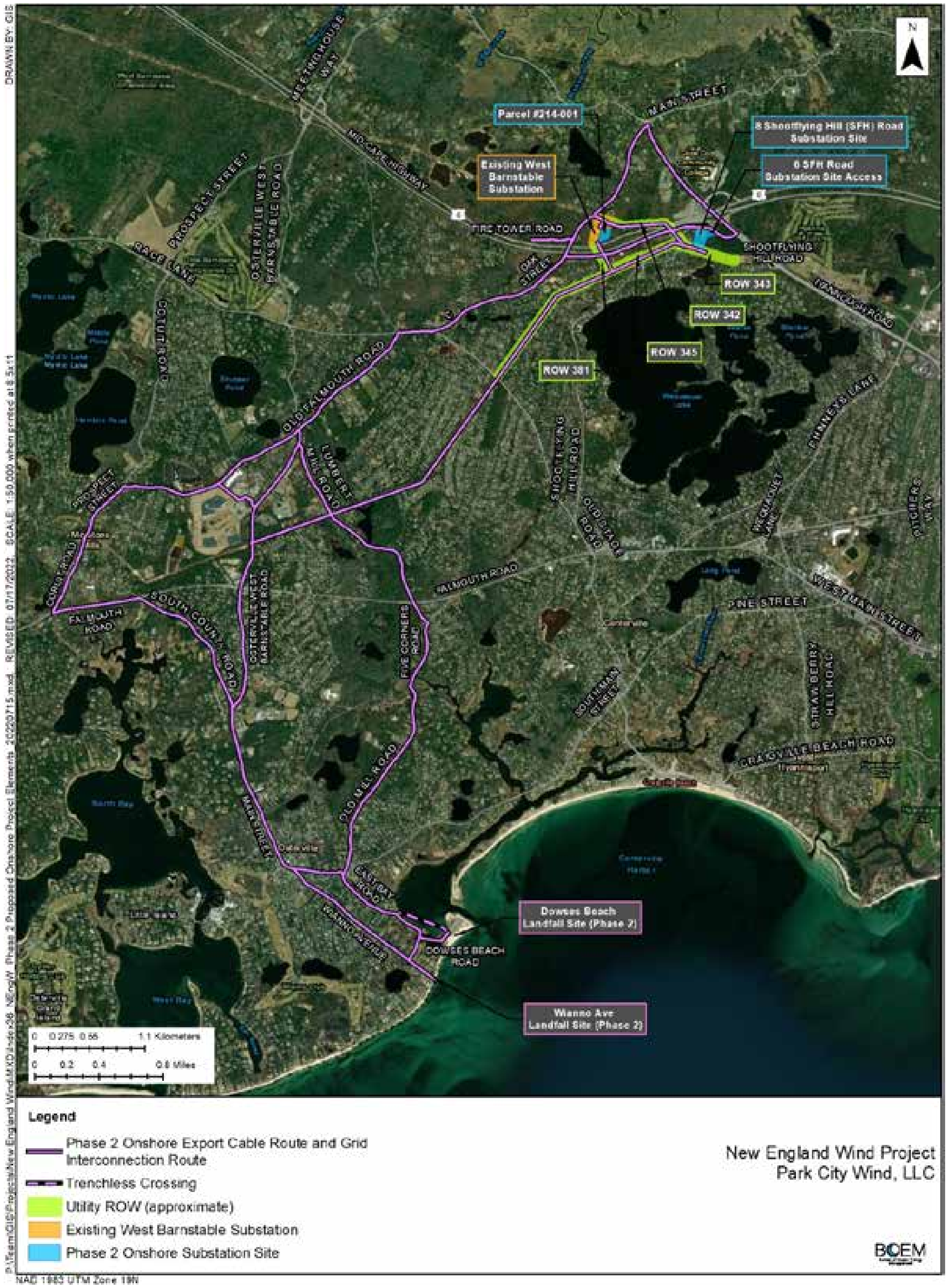


Figure 2-1: Phase 1 Onshore Export Cable Route Options



ROW = right-of-way

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

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).

2.3 Port Facilities and Operations and Maintenance Facility

The applicant would use vessels, vehicles, and aircraft during proposed Project construction, including construction and support vessels to complete tasks in the SWDA and along the OECC. Table 2-4 lists the onshore port facilities that could be used for crew transfer, components shipments, storage, preparing components for installation, and potentially some component fabrication and assembly. In addition, some components, materials, and vessels could come from Canadian and European ports.

The applicant does not propose to direct or implement any potential port improvements but would consider whether the ports are suitable for proposed Project needs if and when the owner or lessor makes any necessary upgrades. Therefore, no port upgrades would occur as a direct result of Phase 1 (COP Volume I, Section 3.2.2.5; Epsilon 2022).

Table 2-4: Possible Ports Used During Proposed Project Construction and Operations

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
Canada	Halifax, Sheet Harbor, Saint John

The applicant would establish a long-term SOV operations base in Bridgeport, Connecticut, and would operate CTVs or the SOV daughter craft out of Bridgeport, Vineyard Haven on Martha's Vineyard, and/or Greenpoint Harbor on Long Island, New York. Other ports listed in Table 2-4 could also be used to support operations activities.

2.4 Impact-Producing Factors

BOEM has identified impact-producing factors (IPF) to be considered for offshore wind projects on the North Atlantic OCS (BOEM 2019a). IPFs identify the cause and effect relationship between the Proposed Action and relevant physical, biological, economic, and cultural resources and define the particular ways in which an action affects a given resource. The IPFs that may affect species covered under this EFH assessment are provided in Table 2-5 and are based on BOEM's IPF analysis (BOEM 2019a). The IPFs cover all stages of the Proposed Action, including construction, operations, and decommissioning. Each IPF is assessed in relation to ongoing activities, planned activities, and the Proposed Action. Planned activities (also referred to as cumulative effects) include planned non-offshore wind activities and future offshore wind activities. Further details regarding impacts determinations are provided in Section 5, Potential Impacts of the Proposed Project.

Table 2-5: Impact-Producing Factors Associated with the Proposed Action for Essential Fish Habitat (Federally Managed Fishes and Invertebrates)

IPF and Definition	Sources and/or Activities
Accidental releases: This includes unanticipated release or spills into receiving waters of a fluid or other substance, such as fuel, hazardous materials, suspended sediment, invasive species, 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)
	Invasive species
Anchoring and gear utilization: This includes an activity or action that attaches objects to the seafloor.	Sediment displacement Sediment suspension Crushing impacts, Habitat modification.
Cable emplacement and maintenance: This includes an activity or action associated with installing new offshore submarine cables on the seafloor, commonly associated with offshore wind energy.	Sediment suspension Larval entrainment Sediment burial
Climate change: This includes the impacts of climate change, such as warming and sea level rise and increased storm severity or frequency. Ocean acidification refers to the impacts associated with the decreasing Ph of seawater from rising levels of atmospheric carbon dioxide.	Storm severity/frequency
	Ocean acidification
	Altered habitat/ecology
	Altered migration patterns
	Disease frequency
	Sediment erosion, deposition
	Protective measures (barriers, sea walls)
Discharges/intakes: This generally refers to routine permitted operational effluent discharges to receiving waters. There can be numerous types of vessel and structure discharges, such as bilge water, ballast water, deck drainage, gray water, fire suppression system test water, chain locker water, exhaust gas scrubber effluent, condensate, and seawater cooling system effluent, among others. These discharges are generally restricted to uncontaminated or properly treated effluents that may have best management practice or numeric pollutant concentration limitations as required through USEPA National Pollutant Discharge Elimination System permits or U.S. Coast Guard regulations. The discharge of dredged material refers to the deposition of sediment at approved offshore disposal sites.	Vessels Structures Onshore point and non-point sources Dredged material ocean disposal Installation and operation of submarine transmission lines, cables, and infrastructure
EMF: Power generation facilities and cables produce electric fields (proportional to the voltage) and magnetic fields (proportional to flow of electric current) around the power cables and generators. 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.	NA
Lighting: This includes lighting associated with offshore wind development and activities that use offshore vessels and may produce light above the water onshore and offshore, as well as underwater.	Vessels
	Structures

IPF and Definition	Sources and/or Activities
Noise: This includes noise from various sources and commonly associated with construction activities, geological and geophysical surveys, and vessel traffic. It may be impulsive (e.g., pile driving) or broad spectrum and continuous (e.g., from Proposed Action-associated marine transportation vessels), and it may also be noise generated from turbines themselves or interactions of the turbines with wind and waves.	Aircraft
	Construction other than pile driving
	Geological and geophysical surveys
	Operations
	Pile driving
	Cable laying/trenching
	Vessels
Port utilization: This involves an activity or action associated with port activity, upgrades, or maintenance that occur only as a result of the Proposed Action, including activities related to port expansion and construction from increased economic activity and maintenance dredging or dredging to deepen channels for larger vessels.	Expansion
Presence of structures: This includes an activity or action associated with onshore or offshore structures other than construction-related impacts.	Entanglement, gear loss, gear damage
	Seabed alterations
	Microclimate and circulation impacts
	Fish aggregation
	Habitat conversion
	Migration disturbances
	Transmission cable infrastructure
	Sediment deposition and burial
Traffic: This includes marine and onshore vessel and vehicle congestion, including vessel strikes; collisions; and allisions.	Vessel strikes

EMF = electromagnetic fields; IPF = impact-producing factor; NA = not applicable; USEPA = U.S. Environmental Protection Agency

2.5 Project Component Area Table

Table 2-6 summarizes the acreages of habitat type within the footprint of proposed Project components, specifically the SWDA, OECC, and Western Muskeget Variant. The OECC would include the eastern route, as there is not a scenario under the Proposed Action that would not use the eastern route through Muskeget Channel as part of Phase 1. As described in Section 6.2, Relevant Alternatives to the Proposed Action, the use of the Western Muskeget Variant as part of Phase 2 ranges from 0 to 2 cables. As a result, there is not a separate description of only the eastern route. The habitat types identified in these locations include the following:

Soft-bottom habitats: mud and/or sand;

Complex habitats: submerged aquatic vegetation (SAV), shell/shellfish, and/or hard-bottom substrate;

Heterogeneous complex habitats: mix of soft and complex stations within a delineated area; and

Large-grained complex habitats: large boulders.

As stated in Section 2.3, Port Facilities and Operations and Maintenance Facility, the proposed Project does not include any port expansions or upgrades to support construction, operations, or decommissioning, or to establish an operations and maintenance facility; therefore, those proposed Project components are not listed in Table 2-6.

Table 2-6: Benthic Habitat Classification for the Proposed Project

	SWDA[a]		OECC[b]		OECC and Western Muskeget Variant[c]	
Habitat Type	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Complex	0	0	1,956	9	3,039	13
Heterogeneous complex	0	0	6,171	30	7,463	32
Large-grained complex	0	0	10	<0.1	10	<0.05
Soft bottom	111,939	100	12,511	61	12,511	61
Total	111,939	100	20,648	100	23,023	100

Source: COP Appendix III-F Table 3.0-2; Epsilon 2022

< = less than; OECC = offshore export cable corridor; SWDA = Southern Wind Development Area
[a] This includes seafloors conditions for the entire SWDA.
[b] This includes habitat types within the corridor that travels from the SWDA northward along the eastern side of Muskeget Channel toward landfall sites in the Town of Barnstable.
[c] This includes habitat types within both the corridor that that travels along the eastern side of Muskeget Channel and the variant that travels along the western side of Muskeget Channel. Therefore subtracting the OECC column from the OECC and Western Muskeget Variant column, will provide the total for only the Western Muskeget Variant portion of the route.

3 Proposed Project Area Environmental Setting

The Northeast U.S. Shelf Ecosystem extends from the Gulf of Maine to Cape Hatteras, North Carolina (BOEM 2014). The offshore area where the applicant's wind energy generation facilities would be physically located in and includes the SWDA and OECC. The SWDA is located south of Martha's Vineyard within the Southern New England sub-region of the Northeast U.S. Shelf Ecosystem, separated from other regions based on differences including productivity, species assemblages and structure, and habitat features (Cook and Auster 2007). The OECC is the surveyed area identified for routing the offshore export cables.

3.1 Habitat Evaluation Methodology

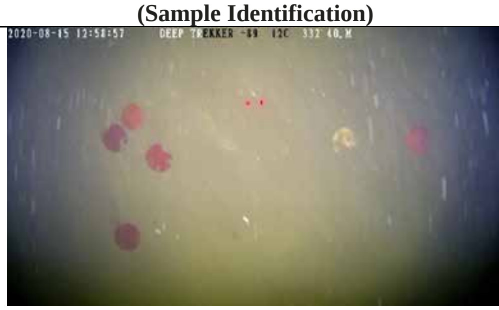
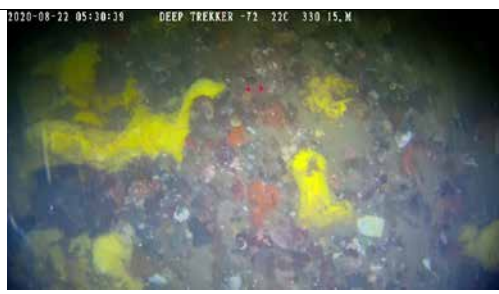
Habitat along the OECC and within the SWDA was evaluated using approximately 15,946 miles of geophysical trackline data, 259 benthic grab samples, 379 vibracores (a technique that extracts material from below the seafloor for laboratory analysis), and 155 underwater video transects collected from 2016 to 2020. Within the 2,371-acre Western Muskeget Variant, habitat was evaluated using 488 miles of geophysical trackline data, 11 benthic grab samples, 22 vibracores, and 6 underwater video transects collected from 2017 to 2018 (COP Volume II, Table 1.2-2; Epsilon 2022). Potential sensitive habitat boundaries were classified and mapped in two ways: using the *Massachusetts Ocean Management Plan* (MAOMP) definition of special, sensitive, and unique habitats (Commonwealth of Massachusetts 2021), and using the NMFS *Recommendations for Mapping Fish Habitat* (NMFS 2021) (COP Volume II, Section 5.2; Epsilon 2022). NMFS (2021) requires the following habitat areas to be mapped:

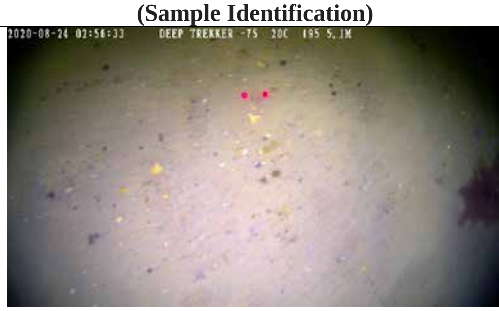
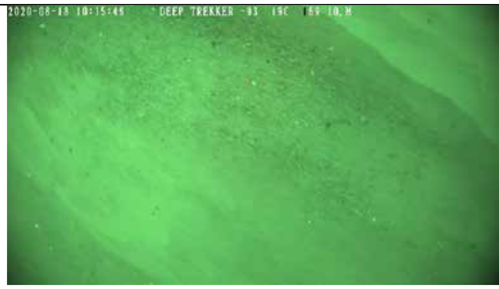
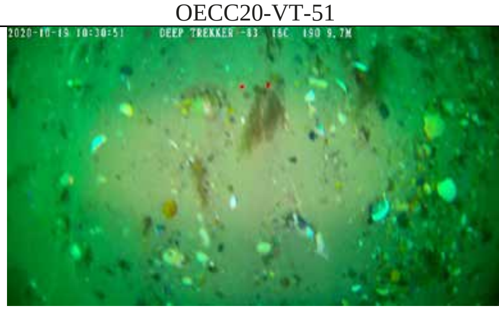
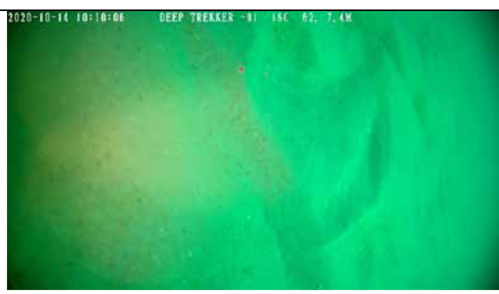
- Soft-bottom habitats (i.e., mud and/or sand);
- Complex habitats (i.e., SAV, shell/shellfish, and/or hard-bottom substrate);
- Heterogeneous complex habitats (i.e., mix of soft and complex stations within a delineated area);
- Large-grained complex habitats (e.g., large boulders); and
- Benthic features (i.e., ripples, megaripples, and sand waves).

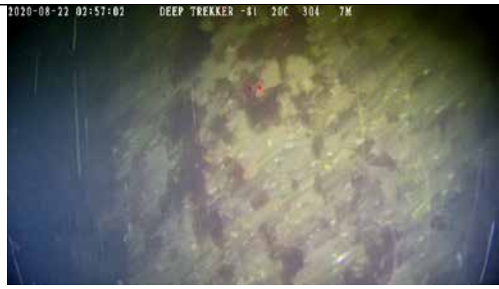
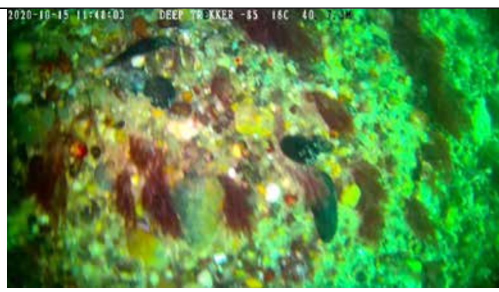
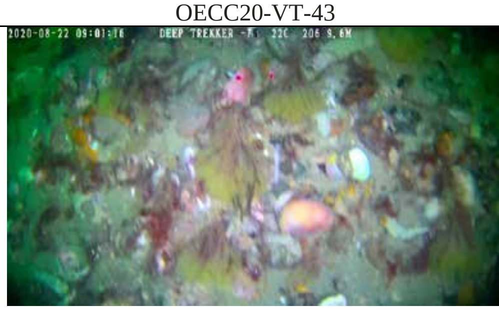
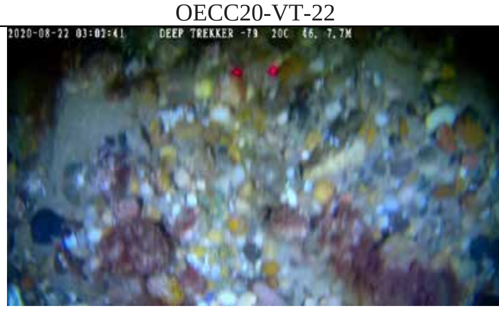
A comparison of the two classification systems indicates that NMFS (2021) is a much more conservative classification system. In particular, the definition of complex in the NMFS (2021) mapping recommendations has a smaller grain-size threshold (greater than 2 millimeters [0.08 inch]) and lower composition threshold (greater than 5 percent gravel) than what is required in the MAOMP and what was classified in previously used classification systems such as Auster (1998) and Barnhardt et al. (1998). This results in more ground-truthing samples (e.g., benthic grab samples, underwater video, borings, and cone penetration tests) being classified as complex, resulting in increased areas of complex or heterogeneous complex habitats versus the MAOMP methodology. Many of these samples that are now considered complex, such as those in the Gravelly Group, have low percentages of gravel (5 to 30 percent) and a small grain size of Pebbles/Granules (0.08 to 2.5 inches). This more conservative assessment (NMFS 2021) with a low percentage of gravel and small grain size such as those outside Muskeget Channel are classified as complex or heterogeneous complex habitats. The NMFS recommendations consider that these habitats can be vital and preferred habitat supporting the life history requirements of EFH species as much as habitats with larger gravel such as benthic habitats within Muskeget Channel. Because the NMFS (2021) habitat classifications are broad enough to include such varying levels of habitat values within the complex and heterogeneous complex habitat categories, some habitat areas with lower habitat value under the MAOMP methodology are now classified as complex or heterogeneous complex habitat under the NMFS (2021) mapping recommendations.

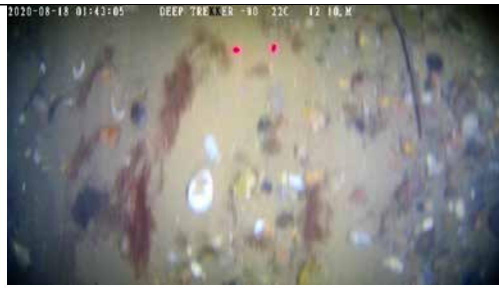
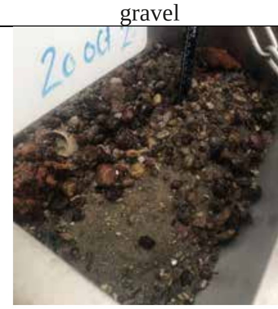
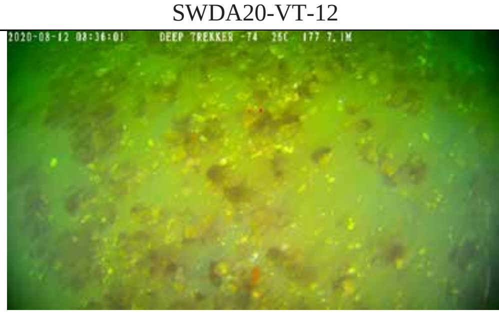
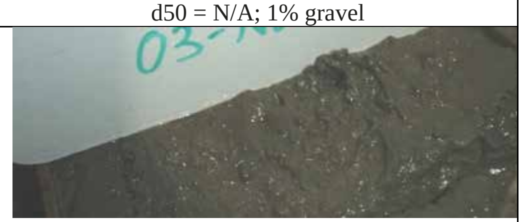
While the COP (Volume II, Section 5.2; Epsilon 2022) presents both the MAOMP classification and the NMFS (2021) classification, COP Appendix III-F (Epsilon 2022) focuses on the habitat classifications under NMFS (2021). To classify habitat boundaries according to NMFS (2021), multibeam, side scan, and backscatter data were used to define seafloor composition based on acoustic reflectivity, which is a function of the bottom texture, roughness, slope, relief, and sediment grain size (COP Volume II, Section 5.2.2; Epsilon 2022). Benthic grab samples, vibracores, and video transects were sampled to ground-truth acoustic data. Both benthic grab samples and video transects were classified using the NMFS-modified Coastal and Marine Ecological Classification Standard (CMECS) system (FGDC 2012) through grain-size analysis and percent cover of still images, respectively (Table 3-1). All ground-truthing samples (grabs, video, and vibracores) were then assigned a final classification of soft or complex. Some video transects were designated as complex mix if the transect traversed both soft and complex bottom habitats.

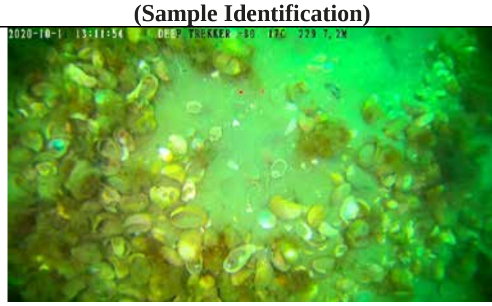
Table 3-1: Examples of Coastal and Marine Ecological Classification Standard in the Proposed Project Area

CMECS Substrate and NMFS (2021) Designation	**Underwater Video (Sample Identification)**	**Grab Sample (Sample Identification) (Diameter and Gravel Composition)**
Fine/Very Fine Sand; Soft Bottom	 OECC20-VT-62	 OECC20-GB-07 d50 = 0.2071 millimeter (0.008 inch); 0% gravel
Gravel Pavement; Complex	 OECC20-VT-26	 OECC20-GB-30 d50 = no data available, no recovery; 74% gravel
Gravelly Mud; Complex	 OECC20-VT-28	 OECC20-GB-03 d60 = 0.0784 millimeter (0030 inch); 7% gravel

CMECS Substrate and NMFS (2021) Designation	Underwater Video (Sample Identification)	Grab Sample (Sample Identification) (Diameter and Gravel Composition)
Gravelly Muddy Sand; Complex	 OECC20-VT-28	 WB19-GB-08 d50 = 0.42 millimeter (0.02 inch); 6% gravel
Gravelly Sand; Complex	 OECC20-VT-51	 OECC20-GB-66 d50 = 1.053 millimeter (0.041 inch); 9% gravel
Gravelly Sand/Shell Hash; Complex	 OECC20-VT-37	 OECC20-GB-12 d50 = 0.5444 millimeter (0.0214 inch); 17% gravel
Medium Sand; Soft Bottom	 OECC20-VT-21	 OECC20-GB-73 d50 = 0.3567 millimeter (0.0140 inch); 0% gravel
Mud; Soft Bottom	 OECC20-VT-54	 OECC20-GB-14

CMECS Substrate and NMFS (2021) Designation	Underwater Video (Sample Identification)	Grab Sample (Sample Identification) (Diameter and Gravel Composition)
		d50 = no data available; 0% gravel
Muddy Gravel/Shell Hash; Complex	 OECC20-VT-30	 OECC20-GB-02 d50 = 0.1778 millimeter (0.007 inch); 38% gravel
Muddy Sand; Soft Bottom	 SWDA20-VT-09	 SWDA20-GB-28 d50 = 0.1833 millimeter (0.0072 inch); 1% gravel
Muddy Sandy Gravel; Complex	 OECC20-VT-43	No data available
Muddy Sandy Gravel/Shell Hash; Complex	 OECC20-VT-22	 OECC20-GB-02 d50 = 0.1778 millimeter (0.007 inch); 38% gravel
Pebble/ Granule; Complex	 OECC-VT-30	 OECC20-GB-29

CMECS Substrate and NMFS (2021) Designation	**Underwater Video (Sample Identification)**	**Grab Sample (Sample Identification) (Diameter and Gravel Composition)**
		d50 = no data available, no recovery
Sandy Gravel; Complex	 OECC20-VT-35	 OECC20-GB-43 d50 = 0.3419 millimeter (0.0135 inch); 37% gravel
Sandy Gravel/Shell Hash; Complex	 OECC20-VT-38	 OECC20-GB-45 d50 = 7.7342 millimeters (0.3045 inches); 69% gravel
Sandy Mud; Soft Bottom	 SWDA20-VT-12	 SWDA20-GB-40 d50 = N/A; 1% gravel
Shell Hash/Muddy Sand; Complex	 OECC20-VT-03	 WB19-GB-09 d50 = 0.11 millimeter (0.004 inch); 4% gravel

CMECS Substrate and NMFS (2021) Designation	Underwater Video (Sample Identification)	Grab Sample (Sample Identification) (Diameter and Gravel Composition)
Shell Rubble; Complex	 OECC20-VT-02	No data
Very Coarse/ Coarse Sand; Soft Bottom	 OECC20-VT48	 OECC20-GB-63 d50 = 0.6387 millimeter (0.0251 inch); 0% gravel

Source: COP Appendix III-F, Table 3.0-1; Epsilon 2022

CMECS = Coastal and Marine Ecological Classification Standard; d50 = median particle diameter, NMFS = National Marine Fisheries Service

Delineated habitat boundaries were assigned one of four habitat categories: complex, heterogeneous complex, large-grained complex, or soft bottom based on classification of ground-truthing samples within those areas. Habitat boundaries were then refined using other ground-truthing data (video and vibracores) where there was no difference in sonar data over a large area or the only difference was bedform fields. Sonar-delineated boundaries that bordered other boundaries of the same habitat category were kept as separate boundaries (i.e., not merged) to illustrate differences in sonar data that showed potentially different ground types (i.e., variation in quantity of type of complex habitat). Benthic features, including bedforms and Organic Mud were delineated using vertically exaggerated multibeam and side scan sonar data. Organic Mud, though not a benthic feature specified in the NMFS (2021) mapping guidelines, was a prominent feature in the southern OECC and therefore was mapped as a separate benthic feature. In addition, larger scale characterizations of the Rhode Island and Massachusetts Lease Areas (RI/MA Lease Areas) from Guida et al. (2017) were used to describe the regional setting. The COP (Appendix III-F; Epsilon 2022) and Appendix A presents large-scale maps of bottom habitats and benthic features located within the proposed Project area, based on NMFS (2021).

Although the COP states that the logistic habitat suitability for soft coral (Alcyonacea), hard coral (Scleractinia) and sea pens (Pennatulacea) is low for the entire Project area as shown in Figure 6.5-2 (COP Volume III; Epsilon 2022), star corals (*Astrangia poculata*) were observed during video transects approximately seven times, mostly within the Muskeget channel. According to known observations within the NOAA Deep Sea Coral Data Portal database (NOAA 2020b), the closest unspecified stony coral (Scleractinia) is approximately 11 nautical miles from the SWDA. Surveys dating back as far as 2017 and 2018 observed several star corals (COP Volume II-H; Epsilon 2022).

3.2 Southern Wind Development Area

Seafloor conditions within the SWDA are entirely homogenous soft-bottom habitat, consisting of CMECS substrate groups Muddy Sand, Sandy Mud, and Sand (Fine/Very Fine, Medium, and Very Coarse/Coarse), with most of the area being Muddy Sand (Figure 3-1; Table 3-1; COP Appendix III-F, Annex I; Epsilon 2022). These homogenous conditions were identified by multibeam echo sounding and side scan sonar imaging techniques that have been ground-truthed via benthic grab samples, underwater video, borings, and cone penetration tests, as described above, and further verified via historic grab sample and still photo data (Guida et al. 2017; Stokesbury 2013, 2014). Ground-truth data also identified dominant biotic elements, which included aggregations of burrowing anemones and patches of sulfur sponge (*Cliona celata*) with mobile megafauna such as hake, cancer crabs, sea stars, and shrimp also observed throughout this area (COP Appendix II-H; Epsilon 2022). Lower current velocities and finer grain sizes in the SWDA equate to bedforms with low relief and short wavelengths, mostly ripples (less than 1.6 feet height) and some megaripples (1.6 to 2.6 feet height). Large, broad, well-defined areas of rippled bedforms and ripple scour depressions (RSD) are located on the surface of the bathymetric highs, oriented northeast-to-southwest in the southeastern portion of the SWDA. Smaller groupings of RSDs are found in the northern and western portion of the SWDA, which provide the only relief as compared to the relatively flat seafloor that gradually slopes offshore. These features within the SWDA provide less than 3.2-foot relief, far smaller than sand waves in some other parts of the Atlantic that can stretch hundreds of meters.

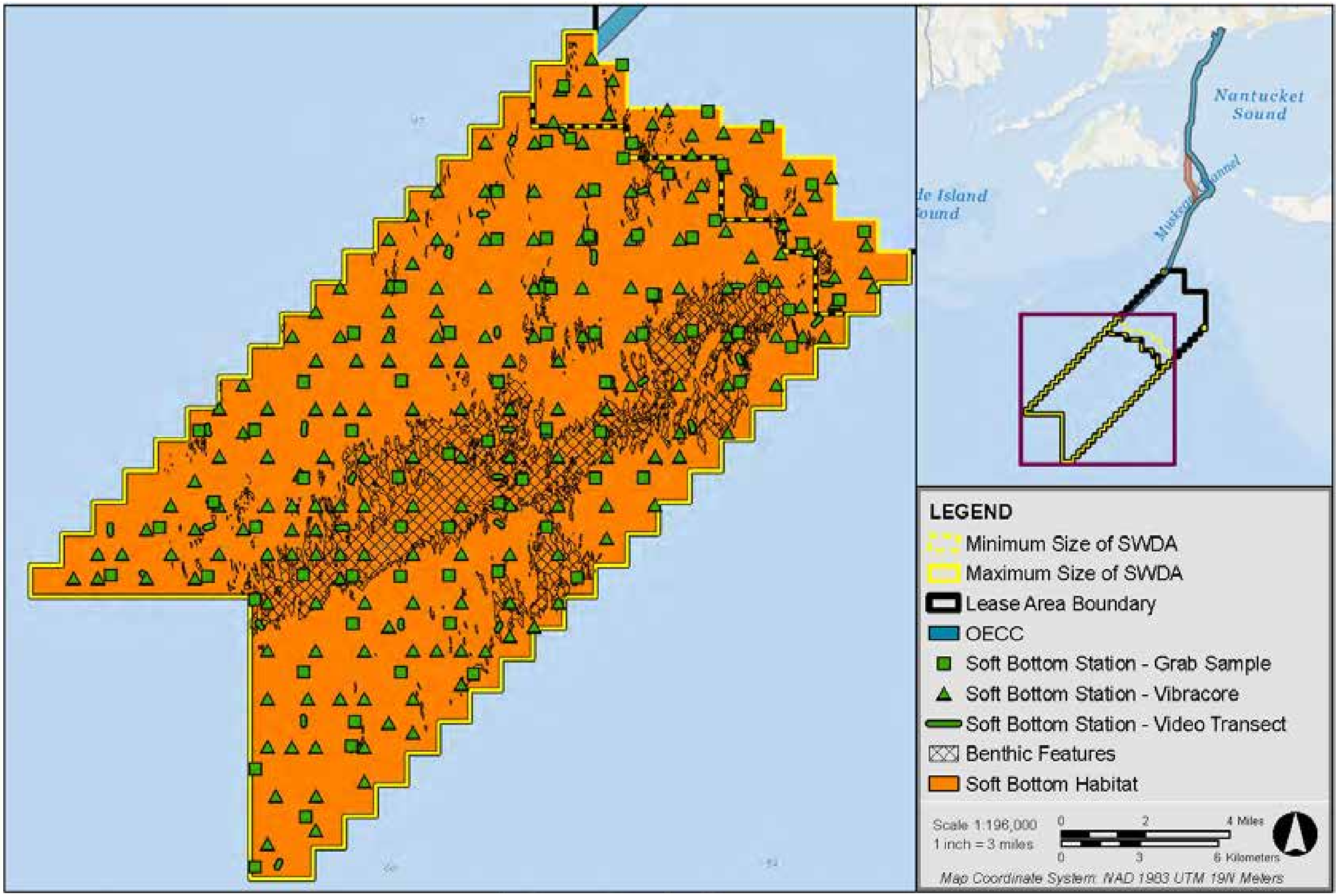
No state-managed artificial reefs have been documented within the SWDA. There are five reported shipwrecks in the SWDA, and geophysical field programs identified three potential shipwrecks within the SWDA and one in the OECC. Other types of potentially sensitive or unique benthic habitat types, such as live bottom, are not present based on the *Shallow Hazards Assessment* (COP Volume II, Section 3.0; Epsilon 2022). Pelagic habitats within and near the SWDA vary seasonally and interannually. Water depths in the SWDA (excluding the two separate aliquots—small areas of the ocean surface) generally range from approximately 141 to 203 feet. Water temperature in this region, which is a major catalyst for faunal movements and distributions, follows a seasonal structure with increased surface temperatures starting in April and into August, vertical turnover in September or October (during which bottom temperatures are at their highest), large temperature drops throughout the water column through January, and stable temperatures less than 41 degrees Fahrenheit (°F) in February and March (Guida et al. 2017).

3.3 Offshore Export Cable Corridor

As described in the COP (Volume II; Epsilon 20221), soft bottom is the most common habitat along the OECC, comprising approximately 61 percent of the entire corridor (Table 2-6). Large stretches of soft-bottom habitat were found in the northern and southern portions of the OECC (Figures 3-2 and 3-3; COP Appendix III-F, Annex I; Epsilon 2022). These areas typically contain a sandy surficial layer that is either highly mobile and comprised of migrating bedforms or flat and stable, mostly void of active sediment transport features. Within the southern portion of the OECC, dense aggregations of sand dollars and burrowing anemones were frequently observed in soft-bottom habitat (COP Appendix II-H; Epsilon 2022).

Complex habitat, defined as hard-bottom substrates, hard bottom with epifauna or macroalgae cover, and vegetated habitats (NMFS 2021), was identified along approximately 9 percent of the OECC, primarily in smaller patches in Muskeget Channel and near the Phase 2 landfall site (Figure 3-3; Figure 3-4; COP Appendix III-F, Annex I; Epsilon 2022). Ground truthing revealed most of the complex habitat in Muskeget Channel to be Sandy Gravel, Gravelly Sand, or Shell Hash/Rubble (Table 3-1). Although rare, several locations within Muskeget Channel contained coarse deposits and hard bottom (Pebble/Granule

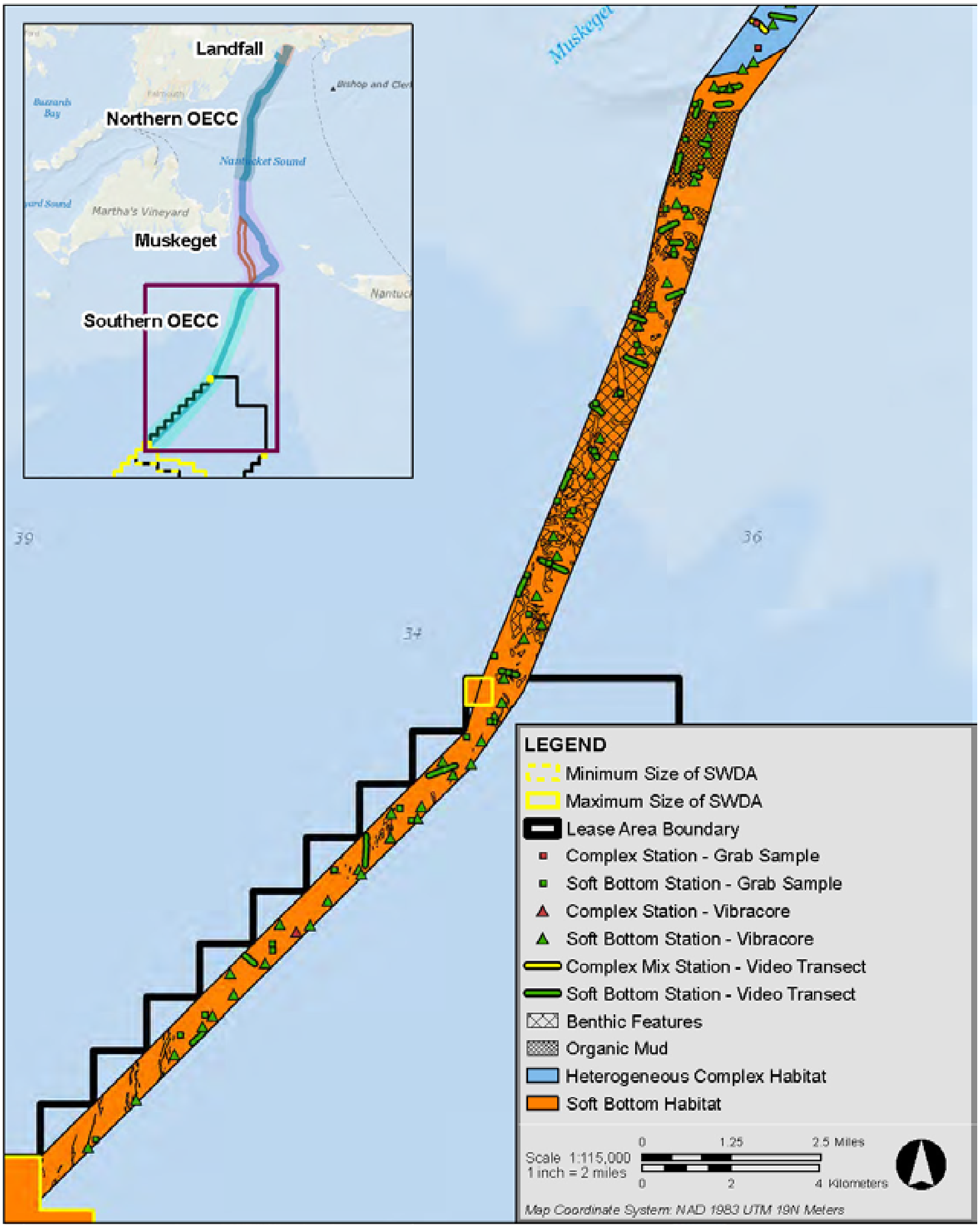
Gravel and Gravel Pavement) with sulfur sponge and other encrusting organism communities (COP Appendix II-H; Epsilon 2022).



Source: COP Appendix III-F; Epsilon 2022

SWDA = Southern Wind Development Area

Figure 3-1: Habitat Types, Benthic Features, and Sample Locations in the Southern Wind Development Area



Source: COP Appendix III-F; Epsilon 2022

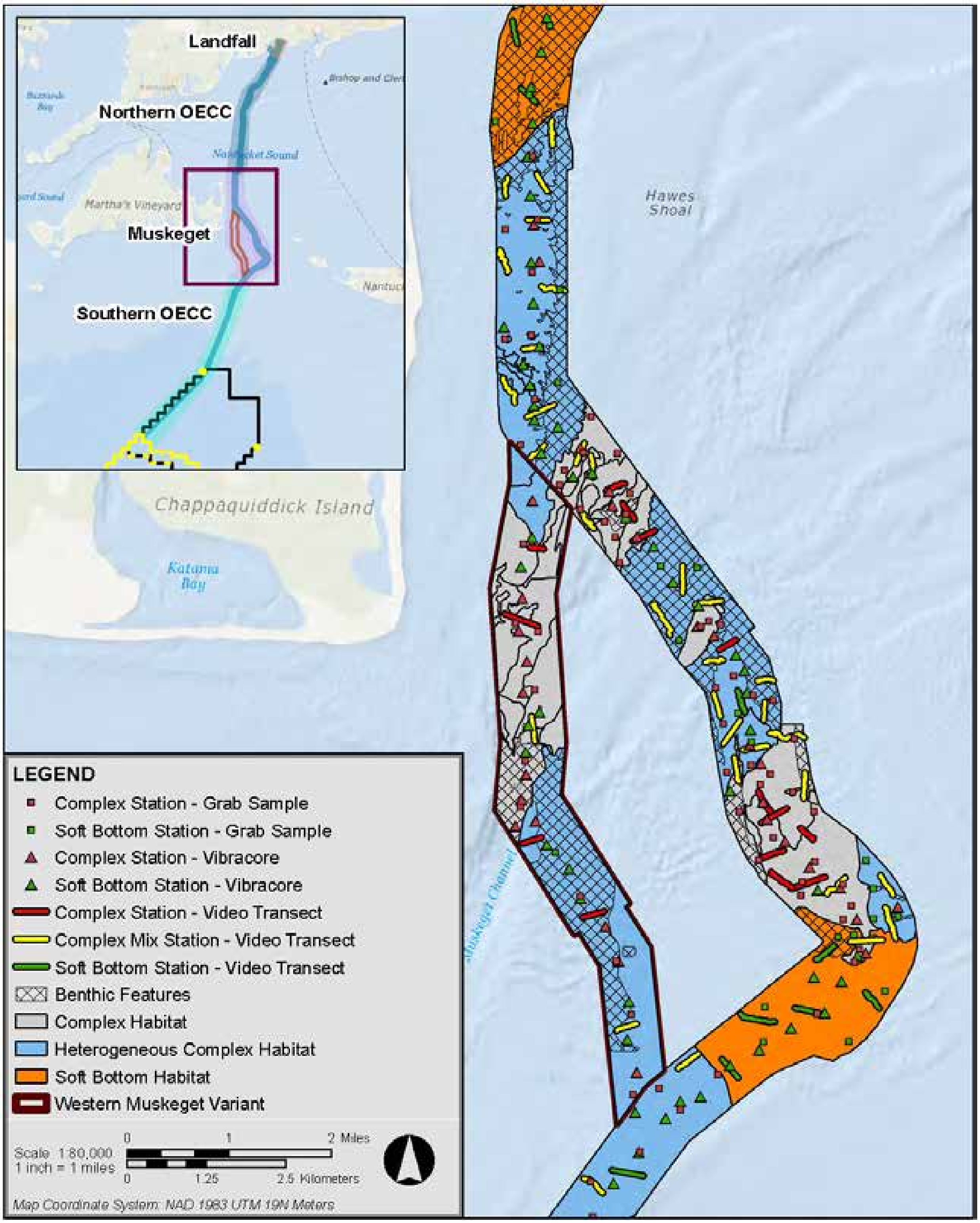
OECC = offshore export cable corridor; SWDA = Southern Wind Development Area

Figure 3-2: Habitat Types, Benthic Features, and Sample Locations in the Southern Portion of the Offshore Export Cable Corridor

Source: COP Appendix III-F; Epsilon 2022

OECC = offshore export cable corridor

Figure 3-3: Habitat Types, Benthic Features, and Sample Locations in the Northern Portion of the Offshore Export Cable Corridor



Source: COP Appendix III-F; Epsilon 2022

OECC = offshore export cable corridor

Figure 3-4: Habitat Types, Benthic Features, and Sample Locations in the Muskeget Channel Portion of the Offshore Export Cable Corridor

Near the Phase 2 landfall site, ground truthing showed Gravelly Sand and Gravelly Muddy Sand were predominant. Heterogeneous complex habitat includes areas in which ground truthing revealed mixed patches of both complex and soft-bottom habitat (NMFS 2021). This type of habitat was found in roughly 30 percent of the OECC, scattered throughout the middle and northern portion of the corridor. These habitats included areas of shell aggregate, specifically common Atlantic slipper shell (*Crepidula fornicata*) hash, but mostly included areas with small-grained coarse material and/or low percentages of gravel. In addition, one area of heterogeneous complex habitat was mapped in the southern portion of the OECC, based on grab samples categorized as Gravelly Sand, although the percentage of gravel was very low, and the grain size was very small within these samples. Large-grained complex habitat, or areas with rock outcrops or large boulders, was the rarest type of habitat identified along the OECC, only mapped at Spindle Rock and near Collier Ledge as shown on the inset of Figure 3-3 above. Boulders are present within Muskeget Channel in the OECC and the Western Muskeget Variant, but not in high enough density to warrant the designation of large-grained complex habitat and therefore are designated under complex or heterogeneous complex habitat. (COP Appendix II; Epsilon 2022)..

The benthic habitat types within the Western Muskeget Variant are heterogeneous complex and complex. Substrate samples from 2017 and 2018 collected in heterogeneous complex area of the Western Muskeget Variant consisted of Gravelly Sand, Sandy Gravel, or Medium Sand and substrate from samples collected in complex habitat included Gravelly Sand, Sandy Gravel, and Gravel Pavement. In several locations within the complex habitat, sulfur sponge and macroalgae were associated with larger-grained hard-bottom substrates such as Gravel Pavement. The eight samples collected from the Western Muskeget Variant in 2017 and 2018 were characterized by the dominance of polychaete worms and extreme patchiness between samples. Benthic features ranged from ripples to sand waves and were usually a range of sizes within a given geographical area. Benthic features within the central portion of the corridor include complex ripples to sand waves in the channel with sand waves 9.8 to 26.2 feet high and wavelengths approximately 246 feet, and bedforms up to 3.3 feet high with wavelengths 98 to 197 feet. To the south, benthic features include megaripples/sand waves up to 16.4 feet high and a larger bedform 2.6 to 16.4 feet high with wavelengths 148 to 820 feet.

Table 2-6 summarizes the benthic habitat classification for the SWDA, OECC alone, and OECC including the Western Muskeget Variant. As stated above, construction of the Western Muskeget Variant would be in addition to the proposed OECC through the eastern portion of Muskeget Channel. Accordingly, the benthic habitat classification in Table 2-6 includes the sum of habitat types within the OECC and Western Muskeget Variant.

In general, the larger bedforms are found in waters where tidal currents force large volumes of water to enter and exit constricted pathways along the OECC. Ripples, megaripples, and sand waves (all categorized as benthic features here) along the OECC are typically less than 9.8 feet high with a maximum height of 29.5 to 31.2 feet for a single sand wave located along the Eastern Muskeget Channel stretch of the OECC. RSDs were a common benthic feature in the southern portion of the OECC. In addition, patches of Organic Mud were identified in the southern OECC, and although not a benthic feature specified in the NMFS (2021) mapping guidelines, were a prominent feature in the data. This area is composed of very soft sediment, with the grabs being categorized as Muddy Sand and Sandy Mud that appears as textured relief in the sonar data.

There are no artificial reefs directly along the OECC, although there are three artificial reef locations well outside the proposed Project area (Northeast Ocean Data Portal 2020). Surveys have revealed isolated human-made objects to be avoided in the OECC and one debris pile/possible shipwreck in the OECC, approximately 5.9 nautical miles (6.8 miles) southwest of Covell’s Beach. Possible sensitive habitats, mainly in the Muskeget Channel area, were also identified in surveys (COP Volume II; Epsilon 2022).

Eelgrass was identified in multiple locations along the OECC, with the largest patch having sparse to moderate distributions in and around the Spindle Rock boulder pile near the landfall site. Several isolated rooted plants were observed at the Phase 1 (Craigville Public Beach) and Phase 2 (Dowses Beach) landfall sites, but none were considered part of an eelgrass bed. (See Figure 5.2-6 for underwater photographs of the eelgrass around Spindle rock [COP Volume II; Epsilon 2022]). A patch of eelgrass was found outside the OECC to the southwest of the Phase 2 landfall site at the very end of a video transect (CR Environmental 2020). This may indicate the edge of a bed that extends to the southwest or inshore but does not occur within the proposed Project OECC. At this time, impacts on these identified resources are not expected to occur. Both eelgrass locations will be avoided by New England Wind activities based on the planned routes, with the closest cable more than 650 feet to the west of the eelgrass bed at Spindle Rock and the possible Phase 2 cable approximately 3,000 feet from the eelgrass near the Dowses Beach landfall (Geo Subsea 2023; see Appendix B). Vessel anchors will be required to avoid these eelgrass beds as long as it does not compromise vessel’s safety (New England Wind 2023)

3.4 Port Modifications and Operations and Maintenance Facility

As stated in Section 2.3, the applicant does not propose to direct or implement any potential port improvements, and no port upgrades would occur as a direct result of the proposed Project (COP Volume I, Section 3.2.2.5; Epsilon 2022). The applicant would consider whether the ports are suitable for proposed Project needs if and when the owner or lessor makes any necessary upgrades.

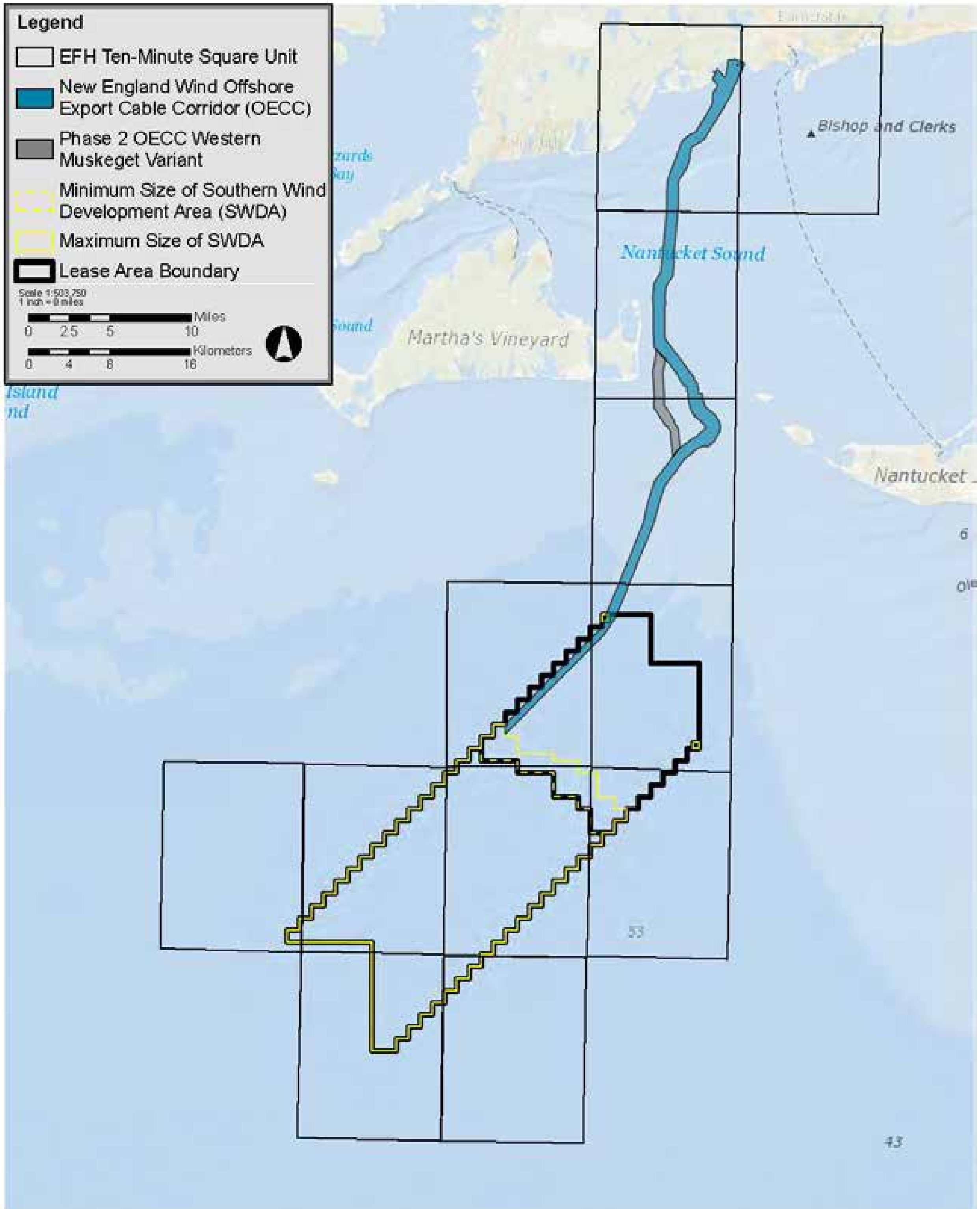
4 Designated Essential Fish Habitat

4.1 Overview

The EFH designations described in this section correspond to those currently accepted and designated by the New England Fishery Management Council (NEFMC), Mid-Atlantic Fishery Management Council (MAFMC), South Atlantic Fishery Management Council, and the NOAA Highly Migratory Species Division (NEFMC 2017). Many EFH designations are determined for each cell in a 10-minute latitude by 10-minute longitude square grid in state and federal waters. The SWDA intersects eight of these cells and the OECC intersects six cells (Figure 4-1). The specific FMPs with protective designations of EFH include:

- NEFMC
  - Northeast Multispecies FMP
  - Atlantic Sea Scallop FMP
  - Monkfish FMP
  - Atlantic Herring FMP
  - Skate FMP
- MAFMC
  - Atlantic Mackerel, Squid, and Butterfish FMP
  - Spiny Dogfish FMP
  - Summer Flounder, Scup, and Black Sea Bass FMP
  - Bluefish FMP
  - Atlantic Surf clam and Ocean Quahog FMP
- NOAA Highly Migratory Species Division
  - Consolidated Atlantic Highly Migratory Species FMP
- South Atlantic Fishery Management Council
  - Coastal Migratory Pelagics FMP

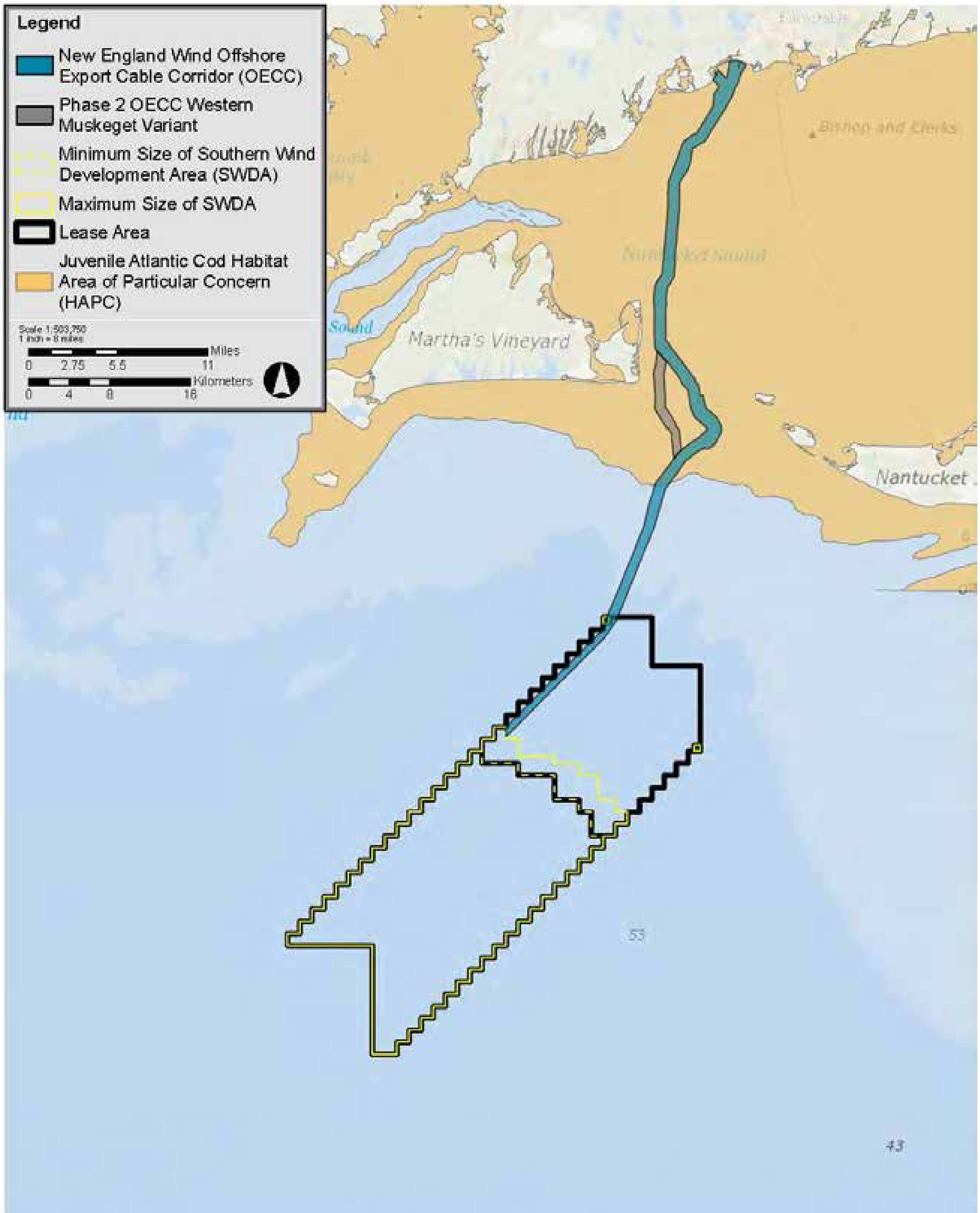
EFH is designated for 48 fish species within the SWDA, OECC, and Western Muskeget Variant (Table 4-1). Both substrate and water habitats are cited as EFH within both the SWDA and OECC. A Habitat Area of Particular Concern (HAPC) is also designated for juvenile Atlantic cod (*Gadus morhua*) (Figure 4-2) and summer flounder (*Paralichthys dentatus*) that overlaps with the OECC and Western Muskeget Variant (juvenile Atlantic cod only), but not the SWDA. EFH and HAPC designations that overlap with the proposed Project area are described for individual species below. On July 18, 2022, the NEFMC proposed a new HAPC for juvenile cod that encompasses the entirety of the RI/MA Lease Areas including a 10-kilometer buffer on all sides (Figure 4-3) (NEFMC 2022). As of the date of publication of this assessment, NMFS had not approved or disapproved this candidate HAPC.



Source: COP Appendix III-F; Epsilon 2022

EFH = essential fish habitat

Figure 4-1: National Marine Fisheries Service-Designated Essential Fish Habitat Grid Units



Source: COP Appendix III-F; Epsilon 2022

Figure 4-2: Habitat Area of Particular Concern for Juvenile Atlantic Cod as Designated by the New England Fishery Management Council

Bottom habitats protected as EFH range from areas with substrates comprised of cobble or gravel (complex habitat), for juvenile Atlantic cod, to areas with muddy and sandy substrates (soft-bottom habitat), for juvenile and adult winter flounder (*Pseudopleuronectes americanus*). The importance of bottom habitat varies between species and within life stages. Coarse substrate, such as gravel or cobble, is considered EFH for the egg, larval, and juvenile life stages of many species because it provides a place for fish to find food, hide from predators, and shelter from strong currents. Studies have found that survivorship of juvenile Atlantic cod was enhanced in areas with coarse substrates (Grabowski et al. 2018; Lindholm et al. 2001). Alternatively, flatfish, such as winter flounder, prefer sandy or muddy habitats where they can easily bury themselves to avoid predation or wait for prey (Pereira et al. 1999).

Heterogeneous complex habitat occurs primarily in the northern and Muskeget Channel portions of the OECC (including the Western Muskeget Variant). The substrate in these areas consists of sand/mud and gravel mixes, mostly with a very low (5 to 10 percent) gravel component. Although considered complex under the NMFS (2021) guidelines, this habitat is likely used by EFH species with a range of substrate preferences due to the low relief and gravel component of the substrate. For example, juvenile cod have higher survival rates where gravel content is low relative to sand (Tupper and Boutilier 1995). Skates, flounders, scup (*Stenotomus chrysops*), crabs, and whelks were the most commonly observed species in the 2020 video transects near areas with gravelly substrates (COP Appendix III-F; Epsilon 2022).

Other bottom habitats, such as bedforms (i.e., sand waves), are also important habitat for fish species and provide structured habitat in sandy areas, where such habitat is otherwise absent. Some evidence suggests that bedform habitat such as sand waves, which are present in the OECC, can enhance fish survival by providing refuge from predators (Diaz et al. 2003; Scharf et al. 2006, Vasslides and Able 2008). Most of the OECC would pass through soft-bottom habitats, and underwater video samples collected along the OECC indicated that soft-bottom habitats in the southern portion of the OECC had the highest abundances per meter for both vertebrates and invertebrates (COP Volume II, Appendix II-H; Epsilon 2022). However, the OECC also passes through a variety of other sediment types, including areas with gravel and pebble-cobble substrate and dispersed boulders (COP Volume II and Appendix III-F Annex I; Epsilon 2022). These coarser substrates, like pebble-cobble and boulders, were found mainly in Muskeget Channel and are important for habitat for the juveniles of some fish species, like Atlantic cod (Tupper and Boutilier 1995; Grabowski et al. 2018).

In addition to hard substrate, benthic flora is also considered EFH and HAPC for fauna in the region. Eelgrass is important habitat that provides forage opportunities and refuge to fish and invertebrate species (Hily and Bouteille 1999). In the OECC, a sparse to moderate distribution of eelgrass was found and mapped near the Spindle Rock boulder pile in the OECC near the Phase 1 landfall site. Several isolated rooted plants were also observed on multiple transects in 2019 at the Phase 1 and Phase 2 landfall areas, but none were considered part of an eelgrass bed. A patch of eelgrass was also found to the southwest and outside of the Phase 2 landfall area at the very end of a video transect (CR Environmental 2020). This may indicate the edge of a bed that extends to the southwest or inshore but does not occur within the proposed Project OECC. At this time, impacts on these identified resources are not expected to occur.

Water column or pelagic habitats protected as EFH range from surface waters (for witch flounder [*Glyptocephalus cynoglossus*] eggs) to the entire water column (for juvenile and adult Atlantic bluefin tuna [*Thunnus thynnus*]), and demersal waters (for juvenile and adult scup). Although demersal fish species are strongly associated with bottom substrates, many species have pelagic egg and larval stages and use currents for dispersal of the early life stages. Pelagic species reside within the water column during all life stages and may occupy different strata based on the stage. For example, Atlantic mackerel (*Scomber scombrus*) eggs are free-floating and remain near the water surface, while larvae are typically observed in mid-water column below 32.8 feet.

Table 4-1: Essential Fish Habitat-Designated Species in Proposed Project Offshore Area

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			Larvae/Neonates[a]			Juveniles			Adults				
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	HAPC	
American plaice (*Hippoglossoides platessoides*)				P										**General habitat description**: Eggs and larvae are passively transported via currents and while eggs have been mostly observed farther north of the proposed Project area, larvae have been observed between Georges Bank and Delaware (Johnson et al. 2004). Plaice are found at depths ranging from 49 to 656 feet in the spring and 164 to 902 feet in the autumn. Plaice are most generally found on fine sand and gravel substrates (Scott and Scott 1988; Bowering and Brodie 1991). **Eggs:** Eggs can be found over depths ranging from 33 to 591 feet, with the majority occurring between 164 and 295 feet (Johnson et al. 2004). **Larvae:** Area designated as EFH includes scattered pelagic habitats in the Gulf of Maine, Georges Bank, and southern New England (Johnson et al. 2004). **Juveniles**: Occur at depths ranging from 49 to 656 feet in the spring and 164 to 902 feet in the autumn (Johnson et al. 2004). **Adults:** Have been found as far south as Montauk Point, New York, at a depth range of 49 to 984 feet on sand and gravel substrates. Depth used is highly correlated to water temperature (Johnson et al. 2004).
Atlantic albacore tuna (*Thunnus alalunga*)	—	—		—	—		P	P	P	P	P	P		**General habitat description**: Juveniles migrate to northeastern Atlantic waters in the summer for feeding. Adults are commonly found in northern Atlantic waters in September and October for feeding. **Juveniles**: EFH for juvenile albacore tuna is designated as offshore the U.S. Atlantic east coast from Cape Cod to Cape Hatteras. **Adults**: Adult albacore tuna EFH is also designated along the U.S. Atlantic east coast from Cape Cod to Cape Hatteras generally farther offshore than EFH for juveniles.
Atlantic bluefin tuna (*Thunnus* thynnus)[c]							P	P		P	P	P		**General habitat description**: Bluefin tuna inhabit northeastern waters to feed and move south to spawning grounds in the spring. Bluefin tuna is considered a Species of Concern because they support important recreation and commercial fisheries, and population size is unknown (NMFS 2011). **Juveniles**: EFH for juvenile bluefin tuna is waters off Cape Cod to Cape Hatteras. **Adults**: EFH for adult bluefin tuna is pelagic waters from the mid-coast of Maine to southern New England.
Atlantic butterfish (*Peprilus triacanthus*)	P			P			P	P	P	P	P	P		**General habitat description**: Butterfish are found in the proposed Project area throughout the year and are present in nearshore areas in the fall, and therefore may be impacted by cable installation (NEFSC Undated). Butterfish larvae are common in high salinity and mixing zones where bottom depths are between 134 and 1,148 feet. Juvenile and adult butterfish are generally found over sand, mud, and mixed substrates in bottom depths between 33 to 918 feet (NOAA 2013). **Eggs**: EFH is designated for butterfish eggs in pelagic habitats with depths under 4,921 feet and average temperatures between 48 to 71°F in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and in patches on the continental shelf/slope from Maine southward to Cape Hatteras, North Carolina. **Larvae**: EFH for butterfish larvae is designated as pelagic habitats in inshore estuaries and embayments from Boston Harbor to Chesapeake Bay and over the continental shelf, from the Gulf of Maine to Cape Hatteras. **Juveniles/adults**: EFH for juvenile and adult butterfish is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound on the inner and OCS from the Gulf of Maine to Cape Hatteras.
Atlantic cod (*Gadus morhua*)	C	C	C	P	P	P	C	C	C	C	C	C	OECC, WMV	**General habitat description**: Structurally complex areas within the OECC and WMV, including eelgrass, mixed sand and gravel, and rocky habitats are appropriate for cod (NEFMC 2017). These habitats are particularly important for juvenile Atlantic cod as it provides protection from predation and readily available prey sources. Cod spawn primarily in bottom habitats composed of sand, rocks, pebbles, or gravel during fall, winter, and early spring (NOAA 2013). Cod eggs are found in the fall, winter, and spring in water depths less than 361 feet. **Eggs**: EFH for Atlantic cod eggs is designated as surface waters from the Gulf of Maine to southern New England. **Larvae**: EFH for larval cod is pelagic waters (depths of 98 to 230 feet) from the Gulf of Maine to southern New England and are primarily observed in the spring (Lough 2004). **Juveniles**: EFH for juvenile cod is designated as bottom habitats with substrates composed of cobble or gravel from the Gulf of Maine to southern New England. Inshore juvenile Atlantic cod HAPC is designated in coastal areas (from the shore to 20-meter depth contour) from Maine to Rhode Island, and inshore waters around Cape Cod to Martha's Vineyard and Nantucket (NEFMC 2017) (Figure 4-2). **Adults**: EFH for adult cod is designated as bottom habitats with substrates composed of rocks, pebbles, or gravel from the Gulf of Maine to southern New England and the middle Atlantic south to Delaware Bay.
Atlantic herring (*Clupea harengus*)	HC			P			P, HC	P, HC	P, HC	P, HC	P, HC	P, HC		**General habitat description**: Larvae are free-floating and generally observed between August and April in areas with water depths from 164 to 295 feet. Juvenile and adult herring are found in areas with water depths from 66 to 427 feet. Atlantic herring were captured in the NEFSC *Multispecies Bottom Trawl Survey* (1948 to 2016) throughout the year within the SWDA (NEFSC Undated). **Eggs**: Herring eggs adhere to the bottom; therefore, EFH is designated as inshore and offshore benthic habitats mainly in the Gulf of Maine, Georges Bank, and Nantucket Shoals in depths of 16 to 295 feet on coarse sand, pebbles, cobbles, and boulders and/or macroalgae (NEFMC 2017). **Larvae**: EFH for larval Atlantic herring is pelagic waters in the Gulf of Maine, Georges Bank, and southern New England.

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			**Larvae/Neonates[a]**			**Juveniles**			**Adults**				
Species	**SWDA**	**OECC**	**WMV**	**SWDA**	**OECC**	**WMV**	**SWDA**	**OECC**	**WMV**	**SWDA**	**OECC**	**WMV**	**HAPC**	**EFH Description**
														Juveniles/adults: EFH for juvenile and adult herring is pelagic and bottom habitats in the Gulf of Maine, Georges Bank, and southern New England.
Atlantic mackerel (*Scomber scombrus*)	P	P	P	P	P	P	P	P	P	P				**General habitat description**: Eggs float in the upper 33 to 49 feet of the water column, while larvae can be found in depths ranging from 33 to 427 feet (Studholme et al. 1999). The depth preference of juvenile mackerel shifts seasonally as they are generally found higher in the water column (66 to 164 feet) in the fall and summer, deeper (66 to 230 feet) in the winter, and widely dispersed (98 to 295 feet) in the spring (NEFSC Undated; Studholme et al. 1999). **Eggs/larvae**: EFH for mackerel (egg and larval stages) is pelagic habitats in inshore estuaries and embayments from Great Bay to Long Island, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras (NOAA 2013). **Juveniles**: EFH for juvenile Atlantic mackerel is designated in pelagic waters in the OECC. **Adults**: EFH for adult mackerel includes pelagic habitats in the same regions as for juveniles, but in waters with bottom depths less than 230 feet.
Atlantic sea scallop (*Placopecten magellanicus*)	C, S	C, S	C, S	P	P	P	C, HC	C, HC	C, HC	S, HC	S, HC	S, HC		**General habitat description**: All life stages have the same EFH spatial designation, which extends across much of the greater Atlantic region. During the larval stage, scallops are free-swimming and occur within the water column and near the seafloor. Hard substrate is particularly important as it provides essential habitat for settling larvae, which were found to have higher survival rates when attaching to hard surfaces rather than shifting sand or macroalgae. **Eggs**: Because sea scallop eggs are heavier than seawater and remain on the seafloor until the larval stage, EFH is designated in benthic habitats in inshore areas and the continental shelf. **Larvae**: EFH for the larval stage (referred to as "spat") includes benthic and pelagic habitats in inshore and offshore areas throughout the region. Any hard surface can provide an essential habitat for settling larvae, including shells, pebbles, gravel, and other benthic organisms. Spat that settle on shifting sand and macroalgae have lower survival rates. **Juveniles/adults**: EFH for juvenile and adult sea scallops include sand and gravel substrates in the benthic habitats in depths of 59 to 361 feet (NEFMC 2017).
Atlantic skipjack tuna (*Katsuwonus pelamis*)							P	P		P	P	P		**General habitat description**: Designated EFH for spawning, eggs, and larvae is not found in the proposed Project area. **Juveniles/adults**: EFH for adult skipjack tuna includes coastal and offshore habitats between Massachusetts and South Carolina. Juvenile EFH is the same range, but offshore waters only.
Atlantic surf clam (*Spisula solidissima*)	—	—		—	—			S	S		S	S		**General habitat description**: Surf clams are generally located from the tidal zone to a depth of about 125 feet along the continental shelf from southern portions of the Gulf of St. Lawrence to Cape Hatteras, North Carolina (Cargnelli et al. 1999c; NOAA 2013). **Juveniles/adults**: EFH for surf clams is throughout the substrate, to a depth of 3 feet below the water/sediment interface, from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic Exclusive Economic Zone. EFH is designated in the OECC and WMV for juvenile and adult life stages.
Atlantic wolffish (*Anarhichas lupus*)[b,c]	C	C	C	P, HC	P, HC	P, HC	HC	HC	HC	HC	HC	HC		**General habitat description**: Wolffish eggs are deposited in rocky substrates in brood nests and are present throughout the year. The depth range for all life stages ranges from 131 to 787 feet. Wolffish use rocky habitats for shelter and nesting and softer substrate habitats for feeding (NOAA 2013). Atlantic wolffish is considered a Species of Concern because the stock is overexploited and severely depleted (NMFS 2009a). **Eggs**: EFH for wolffish eggs is bottom habitats over the continental shelf and slope within the Gulf of Maine south to Cape Cod. **Larvae**: EFH for wolffish larvae is water from the surface to the seafloor within the Gulf of Maine south to Cape Cod. **Juveniles/adults**: EFH for juvenile and adult wolffish is bottom habitats of the continental shelf and slope within the Gulf of Maine south to Cape Cod.
Atlantic yellowfin tuna (*Thunnus albacares*)							P	P	P	P				**General habitat description**: The Atlantic yellowfin tuna is a global species with a wide range from the central region of the Gulf of Mexico from Florida to southern Texas and from the mid-east coast of Florida and Georgia to Cape Cod. They are also located south of Puerto Rico. **Juveniles**: EFH for juveniles is in offshore pelagic and coastal waters from Cape Cod to the mid-east coast of Florida. **Adults**: EFH for adults is in offshore pelagic and coastal waters from Cape Cod to the mid-east coast of North Carolina.
Barndoor skate (*Dipturus laevis*)[a]	—	—		—	—		S, C			S, C				**General habitat description**: Barndoor skates have a relatively wide range which extends from Newfoundland to North Carolina. In southern New England, both juveniles and adults were most frequently observed in the summer, with few rare sightings of adults during the winter (Packer et al. 2003a). **Juveniles/adults**: EFH includes benthic habitats on the continental shelf in depths between 131 and 1,312 feet, and on the continental slope in depths up to 2,461 feet, within Georges Banks and southern New England. Substrates included in the EFH are mud, sand, and gravel (NEFMC 2017).

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			Larvae/Neonates[a]			Juveniles			Adults				
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	HAPC	
Basking shark (*Cetorhinus maximus*)[c]	—	—	—	—	—	—	P	P	P	P	P	P		**General habitat description**: Basking sharks are generally observed in the northwestern and eastern Atlantic coastal regions from April to October and are thought to follow zooplankton distributions (Sims et al. 2003). Basking shark aggregations have been observed offshore Cape Cod, Martha's Vineyard, and Morishes Inlet, Long Island (NMFS 2017). Basking sharks are considered a Species of Concern because of interactions with vessels, being caught as bycatch, and low reproductive rates, which lead to slow recovery (NMFS 2011). **Juveniles/adults**: EFH for juvenile and adult basking sharks is designated in the U.S. Atlantic east coast from the Gulf of Maine to the northern Outer Banks of North Carolina (NMFS 2017).
Black sea bass (*Centropristis striata*)							C, HC	C, HC	C, HC	C, HC	C, HC	C, HC		**General habitat description**: Adult black sea bass are generally associated with structurally complex habitats. Juveniles and adults are commonly observed in the SWDA and OECC in the spring and fall (Drohan et al. 2007; NEFSC Undated; Northeast Ocean Data Portal 2020). **Juveniles/adults**: EFH for juvenile and adult black sea bass is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA 2013).
Blue shark (*Prionace glauca*)	—	—	—	P	P		P	P		P	P			**General habitat description**: The blue shark is a pelagic, highly migratory species, occurring in temperate and tropical inshore and offshore waters, and ranging from Newfoundland and the Gulf of St. Lawrence south to Argentina (DFO 2017). Prefers deep, clear waters with temperatures ranging from 50°F to 68°F (Castro 1983). Blue sharks are observed in New England from late May through October. **Neonates**: EFH is in areas offshore of Cape Cod through New Jersey, seaward of the 98.4-foot bathymetric line (and excluding inshore waters such as Long Island Sound). EFH follows the continental shelf south of Georges Bank to the outer extent of the U.S. Exclusive Economic Zone in the Gulf of Maine. **Juveniles/adults**: EFH for juvenile and adult blue sharks is waters from the southern part of the Gulf of Maine to Cape Hatteras (Lent 1999).
Bluefish *(Pomatomus saltatrix*)										P	P	P		**General habitat description**: Bluefish inhabit pelagic waters in and north of the Middle Atlantic Bight for much of the year but make seasonal migrations south in the winter (Shepherd and Packer 2006). **Eggs/larvae**: Eggs are found in mid-shelf waters ranging from 98 to 230 feet in southern New England to Cape Hatteras, in temperatures ranging from 64.4°F to 71.6°F, with salinities greater than 31 parts per thousand (Hardy 1978; Fahay et al. 1999; MAFMC 1998a). Eggs are not found in estuarine waters. Larvae are found in oceanic waters in temperatures of 64°F, with salinities of greater than 30 parts per thousand (Able and Fahay 1998; Shepherd and Packer 2006). EFH for bluefish eggs/larvae is pelagic waters over the continental shelf at mid-shelf depths, from Montauk Point, New York, south to Cape Hatteras **Juveniles**: EFH for juvenile bluefish north of Cape Hatteras includes waters over the continental shelf (coast to Exclusive Economic Zone) up to Nantucket Island, Massachusetts (MAFMC 1998a). Juvenile EFH also includes all major estuaries between Penobscot Bay, Maine, and St. Johns River, Florida. **Adults**: EFH for adult bluefish north of Cape Hatteras includes waters over the continental shelf (coast to Exclusive Economic Zone) up to Cape Cod Bay, Massachusetts (MAFMC 1998a). Adult EFH also includes all major estuaries between Penobscot Bay, Maine, and St. Johns River, Florida.
Cobia (*Rachycentron canadum*) King mackerel (*Scomberomorus cavalla*)[b] Spanish mackerel (*Scomberomorus maculatus*)[b]	P, HC	P, HC		P, HC	P, HC		P, HC	P, HC		P, HC	P, HC			**General habitat description**: Although EFH is designated within the proposed Project area, these species prefer warmer waters (above 34°F) and are not regularly present so far north (NOAA 2014). **All life stages**: EFH for all life stages occurs in the South- and Mid-Atlantic Bights and includes sandy shoals of capes and offshore bars, high profile rocky bottom, and barrier island ocean-side waters, from the surf to the shelf break zone. EFH also includes *Sargassum* from the Gulf Stream shoreward. For cobia, EFH also includes high-salinity bays, estuaries, seagrass habitats, and the Gulf Stream, which disperses pelagic larvae.
Common thresher shark (*Alopias vulpinus*)[b]	—	—	—	P	P	P	P	P	P	P	P	P		**General habitat description**: Common thresher sharks occur in coastal and oceanic waters but are more common within 35 to 43 nautical miles (40.3 to 49.5 miles) of the shoreline. **All life stages**: EFH for all life stages is coastal and pelagic waters from Cape Cod to North Carolina and in other localized areas off the Atlantic coast.
Dusky shark (*Carcharhinus obscurus*)[b,c]	—	—	—	P	P		P	P		P	P			**General habitat description**: Dusky sharks migrate to northern areas of their range in the summer and return south in the fall as water temperatures decrease. Dusky shark is a Species of Concern because the northwestern Atlantic/Gulf of Mexico population is estimated at 15 to 20 percent of the mid-1970s abundance (Cortés et al. 2006). Although commercial and recreation fishing is prohibited, the main threat to the dusky shark population is from bycatch and illegal harvest. **Neonate**: EFH for neonate dusky shark includes offshore areas of southern New England to Cape Lookout, North Carolina (NMFS 2017). **Juveniles/adults**: EFH for juvenile and adult dusky sharks is waters over the continental shelf from southern Cape Cod to Florida (NMFS 2009b).
Haddock (*Melanogrammus aeglefinus*)	P			P	P		HC			HC				**General habitat description:** Northwest Atlantic where haddock are distributed from Cape Charles, Virginia, to Labrador, Canada. Areas of highest abundance include Georges Bank, the Scotian Shelf (including Browns Bank), and the southern

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			Larvae/Neonates[a]			Juveniles			Adults				
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	HAPC	
														Grand Bank (Cargnelli et al 1999a). Although adult haddock spawn near the sea floor, eggs are buoyant and suspend in the water column. **Eggs**: EFH for haddock eggs is surface waters over Georges Bank southwest to Nantucket Shoals and coastal areas from Massachusetts Bay to Cape Cod Bay (NOAA 2013). **Larvae**: EFH for haddock larvae is surface waters from Georges Bank to Delaware Bay and some coastal areas from Massachusetts Bay to Cape Cod Bay. **Juveniles**: EFH for juveniles is benthic habitats as shallow as 66 feet. **Adults**: EFH for adult haddock is bottom habitats with substrates consisting of broken ground, pebbles, smooth hard sand, and smooth areas between rocky patches on Georges Bank and around Nantucket Shoals in water depths of 131 to 492 feet (Bigelow and Schroeder 1953; Murawski and Finn 1988; Perry and Neilson 1988); 164 and 328 feet is the preferred depth range (Scott 1982; Waiwood and Buzeta 1989).
Little skate (*Leucoraja erinacea*)	—	—	—	—	—	—	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description**: Demersal species that has a range from Nova Scotia to Cape Hatteras and is highly concentrated in the Mid-Atlantic Bight and on Georges Bank. Found year-round on Georges Bank and tolerates a wide range of temperatures (Packer et al. 2003d). Prefers sandy or pebbly bottom but can also be found on mud and ledges (Collette and Klein-MacPhee 2002). **Juveniles/adults**: EFH is similar for both life stages and includes intertidal and subtidal benthic habitats in coastal waters of the Gulf of Maine and in the mid-Atlantic region. EFH primarily occurs on sand and gravel substrates, but also is found on mud (NEFMC 2017).
Longfin inshore squid (*Loligo pealeii*)		C, S, HC	C, S, HC	—	—	—	P	P	P	P	P	P		**General habitat description**: Longfin inshore squids lay eggs in masses referred to as "mops" that are demersal and anchored to various substrates and hard-bottom types, including shells, lobster pots, fish traps, boulders, SAV, sand, and mud (NOAA 2013). Female longfin squid lay these egg mops during 3-week periods, which can occur throughout the year (Hendrickson 2017). Known longfin squid spawning grounds, which coincide with areas of concentrated squid fishing, intersect with the OECC. Pre-recruits (juveniles) and recruits (adults) inhabit inshore areas in the spring and summer and migrate to deeper, offshore areas in the fall to overwinter (NOAA 2013). **Eggs**: EFH for longfin inshore squid eggs is inshore and offshore bottom habitats from Georges Bank to Cape Hatteras. **Juveniles/adults**: EFH for juveniles and adults, also referred to as pre-recruits and recruits, is pelagic habitats inshore and offshore continental shelf waters from Georges Bank to South Carolina.
Monkfish (*Lophius americanus*)	P	P	P	P	P	P	S, HC			S. HC	S, HC			**General habitat description**: Monkfish eggs float near the surface in veils that dissolve and release zooplanktonic larvae after 1 to 3 weeks (Massachusetts Division of Marine Fisheries 2017). Monkfish eggs and larvae are generally observed from March to September. Per the *Southern New England Juvenile Fish Habitat Research Paper*, adult monkfish were present in the SWDA from December through April and most abundant in February and March (Siemann and Smolowitz 2017). **Eggs/larvae**: EFH for monkfish eggs and larvae is surface and pelagic waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. **Juveniles/adults**: EFH for demersal juvenile and adult monkfish is bottom habitats composed of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the OCS in the middle Atlantic, mid-shelf off southern New England, and all areas of the Gulf of Maine. EFH for adult monkfish also includes the outer perimeter of Georges Bank (NOAA 2013).
Northern shortfin squid (*Illex illecebrosu*)				—	—	—					P	P		**General habitat description**: Highly migratory species distributed in the northwest Atlantic Ocean between the Sea of Labrador and the Florida Straits. Its range is from Newfoundland to Cape Hatteras, North Carolina (Hendrickson and Holmes 2004). **Adults**: EFH for adult northern shortfin squid is pelagic habitat on the continental shelf and slope from Georges Bank to South Carolina and in inshore waters of the Gulf of Maine and southern New England.
Ocean pout (*Macrozoarces americanus*)	C	C	C	—	—	—	S, HC	S, HC	S, HC	S, HC	S, HC			**General habitat description**: Ocean pout eggs are laid in masses on hard-bottom surfaces and develop from late fall and winter. Larvae are generally observed from late fall through spring. Juveniles and adults can be found throughout the year, though they move and shift habitats seasonally to remain in preferred temperature range (36 to 50°F) (Steimle et al. 1999b). **All life stages**: All ocean pout life stages are demersal and therefore have similar EFH designations. EFH for all life stages (eggs, juveniles, and adults) is bottom habitats in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay (NOAA 2013).
Ocean quahog (*Artica islandica*)	—	—	—	—	—	—	S, HC	S, HC		S. HC	S, HC			**General habitat description**: Ocean quahogs prefer fine- to medium-grain sand substrates. The greatest concentrations are found south of Nantucket where they inhabit waters below 60°F and are found further offshore as their range progresses south (Cargnelli et al. 1999c). **All life stages**: EFH for all life stages is designated throughout the substrate, to a depth of 3 feet below the water/sediment interface from Georges Bank and the Gulf of Maine throughout the Atlantic Exclusive Economic Zone (NOAA 2013).
Pollock (*Pollachius virens*)	P	P		P	P		S, HC	S, HC						**General habitat description**: Pollock eggs are buoyant upon fertilization and occur in the water column (Cargnelli et al. 1999b). The larval stage lasts between 3 and 4 months and is also pelagic. As juveniles, pollock migrate between inshore and offshore waters with movements typically linked to water temperatures (Cargnelli et al. 1999b). Adult pollock typically remain offshore and EFH is not designated in the proposed Project area. **Eggs**: EFH for pollock eggs is pelagic inshore and offshore habitat in the Gulf of Maine, Georges Bank, and southern New England (NEFMC 2017).

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			Larvae/Neonates[a]			Juveniles			Adults				
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	HAPC	
														Larvae: EFH designations for larvae are similar to those for eggs and includes pelagic inshore and offshore habitats in the Gulf of Maine, Georges Bank, and farther south in the Mid-Atlantic region, with bays and estuaries also included in these regions. **Juveniles**: Due to migrations, EFH for juvenile pollock is designated as inshore and offshore pelagic and benthic habitats from the intertidal zone to 591 feet in the Gulf of Maine, Long Island Sound, and Narragansett Bay; between 131 and 591 feet on western Georges Bank and the Great South Channel; and in mixed and full salinity waters in several bays and estuaries north of Cape Cod. Habitat types included in this designation consist of rocky bottom habitats with attached macroalgae and shallow eel grass beds, which provides refuge from predators (NEFMC 2017).
Porbeagle shark (*Lamna nasus*)[b,c]	—	—	—	P			P			P				**General habitat description**: Porbeagle sharks commonly inhabit deep, cold, temperate waters and forage primarily on fish and cephalopod species (NMFS 2017). Porbeagle shark is a Species of Special Concern due to substantial population declines caused by overfishing (Curtis et al. 2016). **All life stages**: EFH for porbeagle shark includes offshore and coastal waters of the Gulf of Maine (excluding Cape Cod and Massachusetts Bay) and offshore waters from Georges Bank to New Jersey.
Red hake (*Urophycis chuss*)	P	P		P	P		S, HC	S, HC		S	S			**General habitat description**: Red hake eggs are generally observed from May through November while larvae are commonly observed from May through December. Juvenile red hake are pelagic and congregate around floating debris for a time before descending to the bottom (Steimle et al. 1999a). Although adult red hake are generally demersal, they can be found in the water column (Steimle et al. 1999a). **Eggs/Larvae**: EFH for red hake eggs and larvae is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. **Juveniles**: EFH for juvenile red hake is bottom habitats with a substrate of shell fragments in the same locations as eggs/larvae (NOAA 2013). **Adults**: EFH for adult red hake is bottom habitats in depressions with sandy or muddy substrates in the same locations as other life stages.
Sand tiger shark (*Carcharias taurus*)[c]	—	—	—	HC	HC	HC	HC	HC	HC					**General habitat description**: Neonate sand tiger sharks inhabit shallow coastal waters within the 82-foot isobath (NMFS 2017). The sand tiger shark is a Species of Concern because population levels are estimated to be only 10 percent of pre-fishery conditions. Population declines were primarily caused by historic overfishing while continued decline is due to capture as bycatch. Although fishing is restricted for sand tiger sharks, low fecundity has limited their ability to recover (NMFS 2010). **Neonates**: EFH for sand tiger shark neonates is along the U.S. Atlantic east coast from Cape Cod to northern Florida. **Juveniles**: EFH for juvenile sand tiger sharks is designated in shallow mud and sand habitats between Massachusetts and New York and between New Jersey and Florida (NMFS 2017).
Sandbar shark (*Carcharhinus plumbeus*)	—	—	—				P	P	P	P	P			**General habitat description**: Sandbar sharks are a bottom-dwelling shark species that primarily forages for small bony fishes and crustaceans (NMFS 2009b). **Juveniles**: EFH for juvenile sandbar shark includes coastal areas of the U.S. Atlantic between southern New England and Georgia (NMFS 2017). **Adults**: EFH for adult sandbar sharks is coastal areas from southern New England to Florida.
Scup (*Stenotomus chrysops*)							S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description**: Scup occupy inshore areas in the spring, summer, and fall and migrate offshore to overwinter in warmer waters on the OCS (Steimle et al. 1999c). Scup was a dominant finfish species captured in the NEFSC *Multispecies Bottom Trawl Survey* (NEFSC Undated) during spring, summer, and fall surveys and in the Massachusetts Division of Marine Fisheries trawl surveys in the spring and fall. **Juveniles/adults**: EFH for juvenile and adult scup are the inshore and offshore demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA 2013).
Shortfin mako shark (*Isurus oxyrinchus*)[b]	—	—	—	P			P			P				**General habitat description**: The shortfin mako is a warm to warm-temperate species inhabiting all oceans and feeding on, among other things, fast-moving species such as tuna and billfishes (NMFS 2017). **All life stages**: EFH for all life stages is combined and considered the same due to insufficient data needed to differentiate EFH by life stage. EFH for shortfin mako shark is coastal and offshore pelagic habitats from Cape Cod to Cape Lookout, North Carolina, and additional offshore areas in the Gulf of Maine, Florida, and Gulf of Mexico.
Silver hake (*Merluccius bilinearis*)	P	P	P	P	P	P	S			S				**General habitat description**: Silver hake (also known as whiting) eggs and larvae are observed all year with peaks in egg observations from June through October and peaks in larvae observations from July through September. **Eggs/larvae**: EFH for the egg and larval stages is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. **Juveniles/adults**: EFH for juvenile and adult life stages is bottom habitats of all substrate types in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (NOAA 2013).

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			Larvae/Neonates[a]			Juveniles			Adults				
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	HAPC	
Smooth dogfish (*Mustelus canis*)[b]	—	—	—	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description**: Smooth dogfish are primarily demersal and undergo temperature stimulated migrations between inshore and offshore waters to a maximum depth of 656.2 feet (NMFS 2017). **All life stages**: Due to insufficient information on the individual life stages (neonate, juvenile, and adult), EFH for smooth dogfish is designated for all life stages combined. EFH for smooth dogfish includes coastal areas, inshore bays, and estuaries from Cape Cod Bay to South Carolina. EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras, North Carolina (NMFS 2017).
Spiny dogfish (*Squalus acanthias*)	—	—	—	—	—	—	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description**: Spiny dogfish are widely distributed throughout the world, with populations existing on the continental shelf of the northern and southern temperate zones, which includes the North Atlantic from Greenland to northeastern Florida, with concentrations from Nova Scotia to Cape Hatteras. Based on seasonal temperatures, spiny dogfish migrate up to 994.2 miles along the east coast, and spiny dogfish have been observed along the New Jersey coast in March (Bigelow and Schroeder 1953). NEFSC bottom-trawl surveys collected spiny dogfish juveniles at depths ranging from 36 to 1,640.4 feet (NEFSC Undated). Adults are found in deeper waters inshore and offshore from the shallows to approximately 2,952.7 feet deep (Collette and Klein-MacPhee 2002). Spiny dogfish are a dominant finfish species in the RI/MA Lease Areas throughout the year (NEFSC Undated). **Juveniles/adults**: EFH for juvenile and adult spiny dogfish is waters on the continental shelf from the Gulf of Maine through Cape Hatteras (NOAA 2013).
Summer flounder (*Paralichthys dentatus*)	S, P	S, P	S, P	P	P	P		S, HC	S, HC	S, HC	S, HC	S, HC	OECC	**General habitat description**: Eggs are generally observed between October and May, while larvae are found from September through February. Juvenile summer flounder inhabit inshore areas such as salt marsh creeks, seagrass beds, and mudflats in the spring, summer, and fall and move to deeper waters offshore in the winter. Adults inhabit shallow coastal and estuarine areas during the warmer seasons and migrate offshore during the winter (Packer et al. 1999). **Eggs/larvae**: EFH for eggs and larvae is pelagic waters found over the continental shelf from the Gulf of Maine to Cape Hatteras. **Juveniles/adults**: EFH for juvenile and adult summer flounder is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras. HAPC is designated as areas of all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH (NOAA 2013).
Tiger shark (*Galeocerdo cuvier*)	—	—	—				P			P				**General habitat description**: Tiger sharks are a warm water shark species and primarily remain south of the Mid-Atlantic Bight; however, they will occasionally travel farther north during the warmer summer months (NMFS 2017). **Juveniles/adults**: EFH for these life stages extends from Georges Bank to the Florida Keys in offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. Exclusive Economic Zone boundary (NMFS 2017).
White hake (*Urophycis tenuis*)	P	P	P	P	P	P	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description:** White hake eggs are buoyant and can be found in the surface waters of Gulf of Maine, Georges Bank, and southern New England in August through September. Juveniles are pelagic until they reach a certain length and become demersal (Chang et al. 1999). **Eggs**: Eggs are buoyant and occur in the water column; therefore, EFH is designated as pelagic habitats in the Gulf of Maine, including Massachusetts and Cape Cod Bays, and the OCS and slope (NEFMC 2017). **Larvae:** Pelagic waters for Gulf of Maine, Georges Bank, and southern New England to the middle Atlantic. Larvae are present in May within the Mid-Atlantic and Gulf of Maine and Georges Bank in August through September. **Juveniles**: EFH for the juvenile stage is designated as intertidal and subtidal estuarine and marine habitats in the Gulf of Maine, Georges Bank, and southern New England, including mixed- and high-salinity zones in a number of bays and estuaries north of Cape Cod, to a maximum depth of 984 feet (NEFMC 2017). For the demersal phase, EFH occurs on fine-grained, sandy substrates in eel grass, macroalgae, and unvegetated habitats. **Adults**: Bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic. Adults are found in water temperatures below 57°F and depths from 16 to 1,066 feet (NEFMC 2022).
White shark (*Carcharodon carcharias*)[b]	—	—	—	P	P	P	P	P	P	P	P	P		**General habitat description**: White sharks range within all temperate and tropical belts of oceans, including the Mediterranean Sea. This species occurs in coastal and offshore waters and has a very sporadic presence. Because of this shark's sporadic presence, very little is known about its breeding habits. Sightings of white sharks in the Mid-Atlantic Bight occur from April to December. **Neonates**: EFH for neonates is inshore waters out to 57 nautical miles (65.6 miles) from Cape Cod to New Jersey. **Juveniles/adults**: EFH for juvenile and adult white shark is combined and includes inshore waters out to 57 nautical miles (65.6 miles) from Cape Ann, Massachusetts to Cape Canaveral, Florida (NMFS 2017).
Windowpane flounder (*Scophthalmus aquosus*)	P	P	P	P	P	P	S	S	S	S	S	S		**General habitat description**: Windowpane flounder are usually associated with non-complex benthic habitats (Collette and Klein-MacPhee 2002) from the Gulf of Saint Lawrence to Florida (Gutherz 1967). Spawning occurs from April to December along areas of the northwest Atlantic. Windowpane flounder eggs are generally observed from July to August in northern Atlantic areas. **Eggs**: EFH for eggs is surface waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras.

Species	EFH Habitat within the Proposed Project Area													EFH Description
	Eggs			Larvae/Neonates[a]			Juveniles			Adults				
	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	SWDA	OECC	WMV	HAPC	
														Larvae: EFH for larvae is pelagic waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. **Juvenile/adults**: EFH for juvenile and adult life stages is bottom habitats that consist of mud or fine-grained sand substrate around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras (NOAA 2013).
Winter flounder (*Pseudopleuronectes americanus*)		S, HC	S, HC	P	P	P	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description**: Eggs are primarily observed from February through June. Larvae are generally observed from March through July. Winter flounder spawning occurs in the winter with peaks in February and March (NOAA 2013). Previous research has reported that winter flounder spawning is confined to shallow inshore waters; however, a recent study identified gravid and recently spent winter flounder females in the offshore areas of southern New England, indicating that winter flounder spawning is not confined to shallow inshore waters (Siemann and Smolowitz 2017). **Eggs**: EFH for eggs is bottom habitats with sandy, muddy, mixed sand/mud, and gravel substrates on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. **Larvae**: EFH for larvae is pelagic and bottom waters in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. **Juveniles/adults**: EFH for juvenile and adult winter flounder is bottom habitats with muddy or sandy substrate in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay.
Winter skate (*Leucoraja ocellata*)	—	—	—	—	—	—	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC		**General habitat description**: Demersal species that has a range from the southern coast of Newfoundland to Cape Hatteras and has concentrated populations on Georges Bank and the northern section of the Mid-Atlantic Bight (Packer et al. 2003c). The winter skate has very similar temperature ranges and migration patterns as the little skate. **Juveniles/adults**: EFH for juvenile and adult winter skate includes sand and gravel substrates in subtidal benthic habitats in depths from the shore to 262 to 295 feet from eastern Maine to Delaware Bay, on the continental shelf in southern New England and the mid-Atlantic region, and on Georges Bank.
Witch flounder (*Glyptocephalus cynoglossus*)	P	P		P	P	P				S, HC				**General habitat description**: Witch flounder is a groundfish species that ranges from the Gulf of Maine to Cape Hatteras, North Carolina (Cargnelli et al. 1999e), and tends to concentrate near the southwest portion of the Gulf of Maine (Collette and Klein-MacPhee 2002). Spawning occurs from May through September and peaks in July and August. Witch flounder eggs are generally observed from March through October, while larvae are observed from March through November (NOAA 2020a). **Eggs**: EFH for eggs is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. **Larvae**: EFH for larvae is surface waters to 820 feet in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. **Juveniles/adults**: Found over mud, clay, silt, or muddy sands at depths ranging from 66 to 5,135 feet, although the majority are found at 295 to 984 feet (Cargnelli et al. 1999d.)
Yellowtail flounder (*Limanda ferruginea*)	P	P	P	P	P	P	S	S	S	S, HC	S, HC	S, HC		**General habitat description**: This groundfish species ranges along the Atlantic coast from Newfoundland to the Chesapeake Bay, with the majority located on the western half of Georges Bank, the western Gulf of Maine, east of Cape Cod, and southern New England (Collette and Klein-MacPhee 2002). Present on Georges Bank from March to August. Spawning occurs in both inshore areas as well as offshore on Georges Bank in July. Eggs are most often observed from April through June and larvae are observed from May through July. **Eggs/larvae**: EFH for eggs and larvae is surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay. **Juveniles:** EFH for juveniles occurs on sand and muddy sand between subtidal and benthic habitats at 263 feet in coastal waters in the Gulf of Maine and on the continental shelf on Gorges Bank and in the mid-Atlantic, including high-salinity zones in bays and estuaries. **Adults**: EFH for adults occurs on sand or sand with mud, shell hash, gravel, and rocks at depths between 82 and 295 feet from the Gulf of Maine to the mid-Atlantic, including high-salinity zones in bays and estuaries (NOAA 2013).

— = EFH has not been designated for this life stage or the life stages are not relevant to that species life cycle; °F = degrees Fahrenheit; C = complex habitat; EFH = essential fish habitat; HAPC = Habitat Area of Particular Concern; HC = heterogeneous complex; NEFSC = Northeast Fisheries Science Center; NOAA = National Oceanic and Atmospheric Administration; OCS = Outer Continental Shelf; OECC = offshore export cable corridor; P = pelagic; S = soft-bottom habitat; SAV = submerged aquatic vegetation; SWDA = Southern Wind Development Area; RI/MA Lease Areas = Rhode Island and Massachusetts Lease Areas; WMV = Western Muskeget Variant

[a] Shark species emerge from egg cases fully developed and are referred to as neonates.

[b] This indicates EFH designations are the same for all life stages or designations are not specified by life stage.

[c] This indicates Species of Concern.

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Daily, seasonal, and annual ocean current patterns and production regimes dictate the foraging and migratory behaviors of some pelagic species. Highly migratory pelagic fish, such as Atlantic albacore tuna (*Thunnus alalunga*), are generally only observed in northern Atlantic waters for 2 months (September and October) when they take advantage of productive late summer/early fall production. Frontal zones, or areas where water masses converge, are particularly important pelagic habitats that are often feeding locations where plankton become concentrated. The SWDA is susceptible to intrusions of warm water from off the OCS or cold shelf water from the Gulf of Maine that could periodically create fronts and associated times of increased presence of pelagic species, particularly in the summer and fall. Table 4-1 describes designated EFH in the proposed Project area. The following sections include discussion on the relevant life stages in the proposed Project area.

4.2 Southern New England Habitat Area of Particular Concern

On July 30, 2022, the NEFMC approved a new HAPC designation to address concerns over potential adverse impacts from offshore wind development on sensitive hard-bottom habitats and cod-spawning activity. The Southern New England HAPC comprises all large-grained complex and complex benthic habitats wherever present within the area bounded by a 10-kilometer (6.2-mile) buffer around the RI/MA Lease Areas and Massachusetts Wind Energy Areas (NEFMC 2022), as shown on Figure 4-3. The designation is intended to protect high-value complex habitats within this area, emphasizing currently known and potentially suitable areas used by Atlantic cod for spawning (Bachman and Couture 2022; NEFMC 2022). This EFH designation was informed by the findings of a 3-year, BOEM-funded study investigating the use of Cox Ledge and surroundings by spawning Atlantic cod (Stanley et al. 2021).

The designation would also apply to large-grained complex and complex benthic habitats used by Atlantic herring (*Clupea harengus*), Atlantic sea scallop (*Placopecten magellanicus*), little skate (*Leucoraja erinacea*), monkfish (*Lophius americanus*), ocean pout (*Macrozoarces americanus*), red hake (*Urophycis chuss*), silver hake (*Merluccius bilinearis*), windowpane flounder (*Scophthalmus aquosus*), winter flounder, winter skate (*Leucoraja ocellata*), and yellowtail flounder (*Limanda ferruginea*). This new HAPC designation has not yet been implemented and is pending final approval by NMFS.

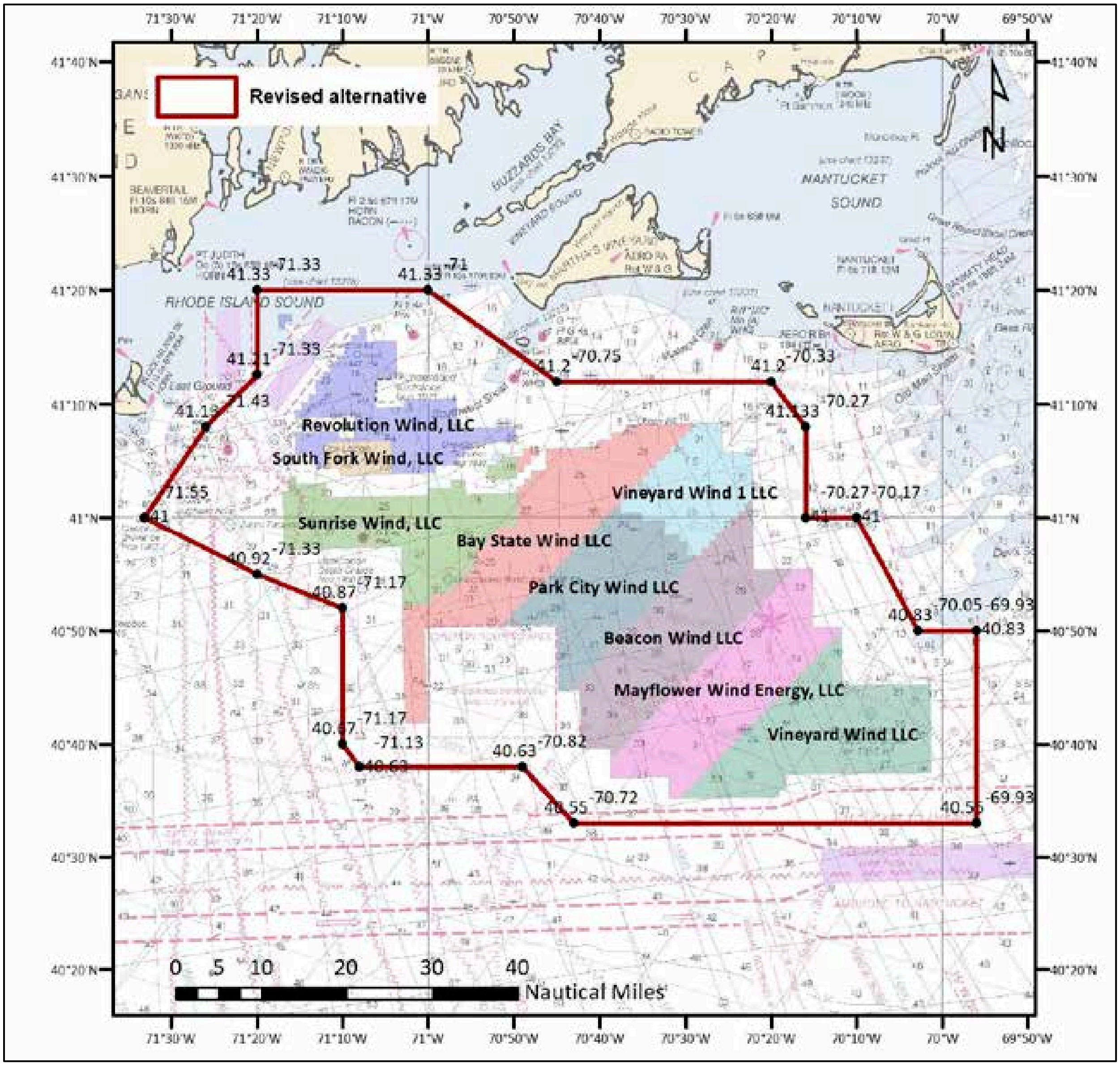

Figure 4-3. Proposed Southern New England Habitat Area of Particular Concern Designation

4.3 Species Groups

Species groups are used throughout this assessment. Species groups are groups of EFH species and/or life history stages that predominantly share the same habitat type. Benthic/epibenthic species groups are sorted into two habitat types (soft bottom or complex) based on the benthic habitat with which the species is most typically associated. Any species could potentially be found in the heterogenous complex habitat type that could include both soft-bottom and complex habitat. Prey species are included as species groups because they are consumed by managed fish and invertebrate species as prey, and thus are a component of EFH. For acoustic impacts, acoustic groups are defined according to Popper et al. (2014). See Section 5.2.2 for more information.

Sessile Benthic/Epibenthic—Soft-Bottom: includes slow-moving benthic/epibenthic species and/or life stages; could include heterogenous complex habitat

- Atlantic sea scallop (eggs, juveniles, adults)
- Atlantic surf clam (juveniles, adults)
- Longfin inshore squid and northern shortfin squid (eggs)
- Ocean pout (eggs, larvae)
- Ocean quahog (eggs, juveniles, adults)
- Skates (eggs)
- Winter flounder (eggs)

Mobile Benthic/Epibenthic—Soft-Bottom: could include heterogenous complex habitat

- American plaice (juveniles, adults)
- Atlanitc herring (juveniles, adults)
- Flatfish (juveniles, adults)
- Monkfish (eggs, larvae, juveniles, adults)
- Ocean pout (juveniles, adults)
- Porbeagle shark (juveniles, adults)
- Pollock (juveniles, adults)
- Red hake (juveniles, adults)
- Scup (eggs, larvae, juveniles, adults)
- Silver hake (juveniles, adults)
- Skates (neonates, juveniles, adults)
- Spiny dogfish (juveniles, adults)
- Summer flounder (juveniles, adults)
- White hake (adults)
- Windowpane flounder (juveniles, adults)
- Winter flounder (juveniles, adults)
- Witch flounder (eggs, larvae, juveniles, adults)
- Yellowtail flounder (juveniles, adults)

Sessile Benthic/Epibenthic—Complex Habitat: includes slow-moving species and/or life stages; could include heterogenous complex habitat

- Longfin inshore squid and northern shortfin squid (egg mops, adults)

Skates (eggs)

Mobile Benthic/Epibenthic—Complex Habitat: could include heterogenous complex habitat

- Atlantic cod (juveniles, adults)
- Atlantic Wolffish (eggs, larvae, juveniles, adults)
- Barndoor skate (juveniles, adults)
- Black sea bass (juveniles, adults)
- Haddock (juveniles, adults)
- Little skate (juveniles, adults)
- Red hake (juveniles, adults)
- Scup (juveniles, adults)
- Sandbar shark (juveniles, adults)
- Sand tiger shark (neonates juveniles, adults)
- Smooth dogfish (juveniles, adults)
- Spiny dogfish (juveniles, adults)
- Summer flounder (eggs, larvae, juveniles, adults)
- White hake (juveniles)
- Winter skate (neonates juveniles, adults)

Pelagic

- American plaice (eggs, larvae)
- Atlantic Albacore tuna (juveniles, adults)
- Atlantic bluefin tuna (juveniles, adults)
- Atlantic butterfish (eggs, larvae, juveniles, adults)
- Atlantic cod (larvae)
- Atlantic herring (eggs, larvae, juveniles, adults)
- Atlantic mackerel (eggs, larvae, juveniles, adults)
- Atlantic skipjack tuna (juveniles, adults)
- Atlantic sea scallop (larvae)
- Atlantic yellowfin tuna (juveniles, adults)
- Basking shark (juveniles, adults)
- Bluefish (eggs, larvae, juveniles, adults)
- Blue shark (neonates juveniles, adults)
- Cobia (eggs, larvae, juveniles, adults)

- Common thresher shark (juveniles, adults)
- Dusky shark (juveniles, adults)
- Haddock (eggs, larvae)
- Longfin inshore squid (juveniles, adults)
- King mackerel (eggs, larvae, juveniles, adults)
- Monkfish (eggs, larvae)
- Northern shortfin squid (juveniles, adults)
- Pollock (eggs, larvae)
- Porbeagle shark (neonates juveniles, adults)
- Red hake (eggs, larvae)
- Sandbar shark (juveniles, adults)
- Shortfin mako (juveniles, adults)
- Silver hake (eggs, larvae)
- Spanish mackerel (eggs, larvae, juveniles, adults)
- Summer flounder (eggs, larvae)
- Tiger shark (juveniles, adults)
- White hake (eggs, larvae)
- White shark (neonates juveniles, adults)
- Windowpane flounder (eggs, larvae)
- Winter flounder (Larvae)
- Witch flounder (eggs, larvae)
- Yellowtail flounder (eggs, larvae)

Prey Species—Benthic/Epibenthic

- Bivalves such as blue mussel, eastern oyster, hard clams, soft-shell clams
- Annelid worms
- Crustaceans, e.g., amphipods, shrimps, crabs

Prey Species—Pelagic

- Anchovy, bay and striped
- River herring (alewife, blueback herring)
- Sand lance

4.4 National Oceanic and Atmospheric Administration Trust Resources

NOAA trust resources have been identified in the vicinity of the proposed Project area. These resources are summarized in Table 4-2 and discussed in detail in Section 7, National Oceanic and Atmospheric Administration Trust Resource Species.

Table 4-2: National Oceanic and Atmospheric Administration Trust Resources within the Proposed Project Area

	Life Stage within the Proposed Project Area			
Species	**Egg**	**Larvae**	**Juvenile**	**Adult**
River herring (alewife [*Alosa pseudoharengus*], blueback herring [*Alosa aestivalis*])			x	x
American eel (*Anguilla rostrata*)		x	x	x
Striped bass (*Morone saxatilis*)			x	x
Blackfish/tautog (*Tautoga onitis*)			x	x
Weakfish (*Cynoscion regalis*)	x	x	x	x
Forage species (Atlantic menhaden [*Brevoortia tyrannus*], bay anchovy [*Anchoa mitchilli*], and sand eel/sand lance [*Ammodytes americanus*])	x	x	x	x
American shad (*Alosa sapidissima*)			x	x
American lobster (*Homarus americanus*)	x	x	x	x
Blue crab (*Callinectes sapidus*)	x	x	x	x
Horseshoe crab *(Limulus polyphemus*)	x	x	x	x
Bivalves (blue mussel [*Mytilus edulis*], eastern oyster [*Crassostrea virginica*], ocean quahog [*Mercenaria mercenaria*], and soft-shell clams [*Mya Arenaria*])	x	x	x	x
Spot (*Leiostomus xanthurus*)	x	x	x	x
Atlantic croaker (*Micropogonias undulatus*)	x	x	x	x
Spotted hake (*Urophycis regia*)	x	x	x	x
Smallmouth flounder (*Etropus microstomus*)	x	x	x	x
Bobtail squid	x	x	x	x
Northern kingfish *(Menticirrhus saxatilis*)	x	x	x	x
Sea robins	x	x	x	x
Gulf stream flounder (*Citharichthys arctifrons*)	x	x	x	x

5 Potential Impacts of the Proposed Project

Potential impacts on finfish and invertebrates are related to the specific sizes of offshore components (WTGs, ESPs, and associated foundations and scour protection) included in each Phase of the proposed Project and the portion of the seafloor occupied. This section assesses the full 130 WTG/ESP buildout of the SWDA.

As described in the COP (Volume III, Section 3.0; Epsilon 2022), the seafloor impacts presented for the full buildout of the SWDA assume the smallest area for Phase 1 and the largest possible area for the greater potential seafloor disturbance associated with Phase 2 (e.g., larger areas of scour protection and larger areas of cable installation impacts). This section also presents the maximum amount of seafloor disturbance within the SWDA associated with the maximum size of each individual phase. For seafloor impacts within the OECC, the proposed Project includes the installation of four or five offshore export cables—two for Phase 1 and two or three for Phase 2; therefore, seafloor impacts are presented for the installation of five cables within the OECC.

Construction schedules provided in the COP are considered “high level.” Estimated time for Phase 1 export cable installation is 12 months beginning in December and ending in November of the following year. Foundations for Phase 1 would be installed in approximately 6 months overlapping the last half export cable schedule. Phase 2 offshore export cable installation would also take about 12 months to complete. Phase 1 and Phase 2 foundations would take about 6 months each to install, and WTGs would be erected in about 8 months (COP Volume 1, Sections 3.1 and 4.1; Epsilon 2022).

The IPFs for EFH are provided in Table 5-1. The estimated maximum area of potential temporary and permanent impact on benthic habitat in the SWDA and OECC (with and without the Western Muskeget Variant) are presented in Table 5-2. Values are primarily based on the percentage of each habitat type in the SWDA and OECC (including the Western Muskeget Variant) and should be considered approximate since the specific locations of permanent and temporary impacts (such as placement of cable protection and location of any needed dredging) are highly dependent upon the ongoing export cable engineering process and the final selected cable routes.

Table 5-1: Impact-Producing Factors for Essential Fish Habitat

IPFs	SWDA	OECC	Construction	Operations	Decommissioning
Accidental releases	x	x	x	x	x
Anchoring and gear utilization	x	x	x	x	x
Cable emplacement and maintenance (dredging, cable protection)	x	x	x	x	
Climate change	x	x	x	x	x
Discharges/intakes	x	x	x	x	x
EMF	x	x		x	
Lighting	**x**	**x**	**x**	**x**	**x**
Noise	x	x	x	x	x
Port utilization			x	x	x
Presence of structures (habitat alteration)	x	x	x	x	x
Presence of structures (sediment deposition)	x	x	x	x	x
Presence of structures (suspended sediments)	x	x	x	x	x
Presence of structures (water withdrawals)	x	x	x	x	x
Traffic (increased vessel traffic)	x	x	x	x	x

EMF = electromagnetic fields; IPF = impact-producing factor; OECC = offshore export cable corridor; SWDA = Southern Wind Development Area

Table 5-2: Proposed Project Approximate Maximum Area of Benthic Habitat Impact (Acres)

	SWDA		OECC		Western Muskeget Variant (one cable)[a]		Western Muskeget Variant (two cables)[b]	
Habitat Type	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**
Complex	0	0	48	20	71	25	75	27
Heterogeneous complex	0	0	198	25	206	25	205	25
Large-grained complex	0	0	0	0	0	0	0	0
Soft bottom	1,014	295	366	10	331	10	326	7
Total	**1,014**	**295**	**612**	**55**	**608**	**60**	**606**	**59**

Source: COP Appendix III-T; Epsilon 2022
OECC = offshore export cable corridor; Perm. = permanent; SWDA = Southern Wind Development Area; Temp. = temporary
Note: This includes potential temporary (Temp.) and permanent (Perm.) impacts on benthic habitat during construction within the SWDA and OECC with and without the Phase 2 OECC Western Muskeget Variant.
[a] This includes two Phase 1 cables and two Phase 2 cables in the proposed Project OECC and one Phase 2 cable in the Western Muskeget Variant.
[b] This includes two Phase 1 cables and one Phase 2 cable in the proposed Project OECC and two Phase 2 cables in the Western Muskeget Variant.

5.1 Construction and Installation

5.1.1 Habitat Alteration (Phases 1 and 2)

5.1.1.1 Southern Wind Development Area—Overview (Phases 1 and 2)

Impacts on EFH would be expected near the proposed WTGs and ESPs as a result of foundation installation, scour protection installation, and the use of jack-up and/or anchored vessels for the installation of each WTG and ESP. WTG/ESP foundations may have scour protection consisting of rock or stone placed around the base of the foundation.[5] This design may promote deposition of a sand/silt matrix in the interstices of the boulder framework with the eventual burial of some of the scour protection (USDOE and MMS 2012). Tidal currents may expose portions of the scour protection at the surface for short periods of time. However, the bi-directional nature of these currents should lead to establishment of a dynamic equilibrium, allowing the average condition of the scour-protected zone to be buried by sand.

Since all of the SWDA is comprised of soft-bottom habitat (homogeneous fine sand and silt-sized sediments), bottom habitat may be temporarily or permanently altered to hard-bottom substrate through the installation of cable protection (rocks, concrete mattresses, gabion rock bags, or half-shell pipes or similar) in areas where the inter-array, inter-link, or offshore export cables within the SWDA cannot achieve sufficient burial depth. The applicant intends to avoid or minimize the use of cable protection to the greatest extent feasible through careful site assessment and selection of the most appropriate cable installation tool to achieve sufficient burial. Although scour and/or cable protection has the potential to turn exposed, biodiversity-poor soft-bottom areas into species-rich ecosystems (Langhamer 2012), these flat, expansive, sand/mud habitats are designated as EFH for multiple demersal fish species, such as winter flounder and red hake. Bottom and pelagic habitat would also be permanently altered to hard substrate from the installation of WTG/ESP foundations and associated scour protection. These actions would displace members of the Sessile Benthic and Mobile Benthic species groups including winter, yellowtail, and windowpane flounders, red hake, Atlantic surf clam and ocean quahog. The Sessile

[5] As described further in the COP (Volume I; Epsilon 2022), if jacket and bottom-frame foundations are used for WTGs or ESPs, these foundation types may or may not have scour protection.

Benthic and Mobile Benthic Complex Habitat groups including haddock, Atlantic cod, longfin inshore squid, monkfish, black sea bass, blackfish/tautog (*Tautoga onitis*), and ocean pout would likely be attracted to the novel structures. Conversion of the fine, unstructured habitats in the SWDA into complex, hard habitats through the addition of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would likely create more EFH for species that depend on hard and complex structure at the expense of EFH for species that prefer fine, unconsolidated substrate. Given the abundance of similar fine, unconsolidated habitats in the SWDA and surrounding area, loss of these habitats would result in a very small change in the total EFH for species that depend on them in the region. Although the artificial structured habitat would provide novel opportunities for feeding and shelter by the complex habitat group and some members of the Pelagic species group, these structures can disrupt migration patterns, create predator traps, and be colonized by invasive species, and other sessile invertebrates. The invasive tunicate *Didemnum vexillum* was identified in post construction surveys at the Block Island Wind Farm (HDR 2020; Erickson et al. 2022) but has been present within the coastal waters of Rhode Island since it was discovered in Newport Harbor in 2000 (Auker 2019). The alteration of habitat and additional structures may provide stepping stones for invasive species already present within the region. BOEM is currently conducting research to evaluate various options that will improve the quality of construction-derived complex habitats. The Final EIS for adjacent Vineyard Wind 1 determined that impacts from added scour and cable protection would possibly have long-term moderate benefit (BOEM 2021). Likewise, New England Wind would also likely have moderate benefits.

Additional EFH alteration is expected from the use of jack-up or anchored vessels and from installation of the inter-array, inter-link, and offshore export cables within the SWDA. Anchored vessels may be equipped with spud legs that are deployed to secure the cable-laying vessels while its anchors are being repositioned. Bottom habitat in the direct path of the inter-array, inter-link, and offshore export cables within the SWDA would be disturbed from the surface to a depth of 5 to 8 feet. Additionally, to monitor weather and sea state conditions during Phase 1 and Phase 2 construction, the applicant expects to temporarily deploy one or more meteorological oceanographic (metocean) buoys in up to 50 locations within the SWDA (only within areas that have been surveyed). Anchors for the metocean buoys would also temporarily disturb bottom habitat.

Two thresholds of concern have been identified for sediment deposition: one for demersal eggs and one for shellfish. The most sensitive life stage of the species considered for New England Wind is demersal eggs. Several species of fish and invertebrates have demersal eggs, including the Atlantic wolffish, Atlantic herring, winter flounder, longfin inshore squid, and whelk species. For demersal eggs, deposition greater than 0.04 inches can result in the burial and mortality of that life stage (Berry et al. 2011). Simulations of typical and maximum-impact cable installation methods in the SWDA indicated that deposition of 0.04 inch or greater extended up to 328 feet from the route centerline for typical installation parameters (COP Appendix III-A; Epsilon 2022). The sediment dispersion modeling with typical and maximum-impact installation techniques (COP Appendix III-A; Epsilon 2022) also indicated that, for the representative cable installation activities in the SWDA, there would be no area of deposition greater than 0.2 inch for the typical installation parameters, and only small areas (2.5 acres for representative section) of deposition greater than 0.2 inch for the maximum-impact installation parameters. Most subtidal shellfish like oysters, mussels, and scallops displayed lethal responses to deposition of either fine sand or mud at thicknesses greater 2 inches, with oysters and mussels sensitive to around 0.8 inches of deposition (Colden and Lipcius 2015). Although the modeled areas with sedimentation greater than 0.2 inch were small (2.5 acres), winter flounder eggs buried under more than 0.11 inches of sediment rarely hatched in experimental lab trails (Berry et al. 2011). For both the typical and maximum-impact installation parameters, there were no areas with deposition above 0.4 inches. Henderick et al. (2016) found that mortality increased with duration of burial. Mobile benthic species such as lobsters, crabs, and demersal fish would be temporarily displaced by sedimentation events but are likely able to avoid burial. In addition, sedimentation of marine organisms will be subject to currents and over time that may remove sediment before it can affect benthic organisms. No permanent or population level changes to EFH are expected from sediment deposition.

The following sections present impacts within the maximum size of the proposed Project, within the maximum size of Phase 1, and within the maximum size of Phase 2. As described in the COP (Volume III; Epsilon 2022), due to the range of buildout scenarios for Phases 1 and 2, the sum of the maximum design scenarios for Phase 1 and Phase 2 does not equal the total maximum design scenario of the proposed Project.

5.1.1.2 Southern Wind Development Area—Maximum Impact (Phases 1 and 2)

Within the maximum size of the SWDA and encompassing both Phases 1 and 2, the amount of soft-bottom habitat permanently altered to complex or heterogeneous complex habitat from the installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would be approximately 289 acres (COP Appendix III-T; Epsilon 2022). The amount of temporary disturbance to soft-bottom habitat from the use of jack-up or anchored vessels, cable installation, and metocean buoy anchors would be approximately 1,008 acres.[6] The total area of alteration within the SWDA due to foundation and scour protection installation; jack-up and/or anchored vessel use; inter-array, inter-link, and offshore export cable installation; potential cable protection (if required); and metocean buoy anchors is 1,283 acres, which is 1.1 percent of the maximum size (111,939 acres) of the SWDA.

Sediment deposition may also occur within the SWDA from inter-array, inter-link, and offshore export cable installation (offshore export cables in the SWDA would extend from the northern SWDA boundary to the ESP[s]). Given the broad similarity in grain sizes throughout the SWDA, modeling of sediment transport and deposition potential in the SWDA was conducted for one representative inter-array cable route (COP Appendix III-A; Epsilon 2022) as discussed in Section 5.1.1.1.

5.1.1.3 Southern Wind Development Area—Phase 1

Within the maximum size of Phase 1, bottom habitat primarily consists of sand and mud-sized sediments (COP Appendix III-T; Epsilon 2022). The amount of permanent habitat alteration from sandy, soft-bottom habitats to hard, structured habitats through the installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would be approximately 86 acres.

The amount of temporary habitat disturbance from the use of jack-up and/or anchored vessels, cable installation, and metocean buoy anchors would be approximately 421 acres. The total area of alteration within the maximum size of Phase 1 due to foundation and scour protection installation; jack-up and/or anchored vessel use; inter-array, inter-link, and offshore export cable installation; potential cable protection (if required); and metocean buoy anchors is 502 acres, which is 0.9 percent of the maximum size (57,081 acres) of the Phase 1 SWDA.

As described above, sediment deposition may also occur within the SWDA in Phase 1 from inter-array, inter-link, and offshore export cable installation (offshore export cables in the SWDA would extend from the northern SWDA boundary to the ESP[s]). Such impacts would typically be limited to within approximately 328 feet or less from the route, which is the modeled extent of deposition of 0.04 inch or greater (i.e., the threshold of concern for demersal eggs). Due to a lack of coarse, complex substrate in the SWDA, no permanent habitat changes are expected from sediment deposition.

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[6] The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the proposed Project planning stage.

5.1.1.4 Southern Wind Development Area—Phase 2

Within the maximum size of the Phase 2 SWDA, all bottom habitat is classified as soft-bottom habitat with fine and mud-sized sediments throughout (COP Appendix III-T; Epsilon 2022). The amount of permanent habitat alteration from the installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) would be approximately 221 acres. The amount of temporary habitat disturbance from the use of jack-up and/or anchored vessels, cable installation, and metocean buoy anchors would be approximately 686 acres. The total area of alteration within the maximum size of Phase 2 due to foundation and scour protection installation; jack-up and/or anchored vessel use; inter-array, inter-link, and offshore export cable installation; potential cable protection (if required); and metocean buoy anchors is 897 acres, which is 1.2 percent of the maximum size (74,873 acres) of the Phase 2 SWDA.

As described above, sediment deposition may also occur within the SWDA in Phase 2 from inter-array, inter-link, and offshore export cable installation (offshore export cables in the SWDA would extend from the northern SWDA boundary to the ESP[s]). Such impacts would typically be limited to within approximately 328 feet or less from the route, which is the modeled extent of deposition of 0.04 inch or greater (i.e., the threshold of concern for demersal eggs). Due to a lack of coarse, complex, substrate in the SWDA, no permanent habitat changes are expected from sediment deposition.

5.1.1.5 Offshore Export Cable Corridor—Overview (Phases 1 and 2)

Potential impacts on benthic habitats within the OECC (including the Western Muskeget Variant) may occur from cable installation, anchoring and gear utilization, dredging, and installation of cable protection. Most of the OECC and the OECC including the Western Muskeget Variant are classified as soft-bottom habitat (61 percent and 54 percent, respectively) or heterogeneous complex habitat (30 percent and 32 percent, respectively), with smaller percentages of complex habitat (9 percent and 13 percent, respectively) and large-grained complex habitat (less than 0.1 percent and less than 0.1 percent, respectively [Table 2-6]).

Benthic habitat in the direct path of the cable installation vessels, vessel anchors, and anchor sweep zone would be disturbed while cables are being installed along the proposed cable corridors (OECC, the Western Muskeget Variant). Sediment transport modeling results from a representative cable within the OECC indicated that sediment deposition of 0.04 inches or greater was constrained to within 328 feet from the centerline and maximum deposition was usually less than 0.20 inches. An isolated area where the vertical injector was modeled indicated that deposition would be between 0.2 and 0.4 inches. In areas along the OECC where sand wave dredging was simulated, deposition greater than 0.04 inches was mainly constrained to within 0.54 nautical miles but extended up to 1.2 nautical miles in isolated patches when subject to swift currents through Muskeget Channel. While dredging of sand shoals may be necessary the actual need and location of dredging of sand waves has not been determined. Dredging in sand wave areas prior to cable installation would result in the temporary disturbance of habitat. Sand waves are designated as EFH for silver hake and may assist in their foraging mechanisms or provide shelter from current flows (Auster et al. 2003). Benthic features, such as sand waves, provide important structured habitat for fishes and invertebrates (Diaz et al. 2003; Scharf et al. 2006; Vasslides and Able 2008) and these habitats are dynamic and change frequently. If dredging is required, disposal of dredged materials would only occur within sand wave areas; dumping of dredged materials would be prohibited in hard-bottom habitats. Recovery of dredged sand waves, at minimum, depends on water depth, sand wave height, local sand source, wave climate, and type of dredging cut made (CSA et al. 2010). Campmans et al. (2021) found some dredged sand waves recovered in 5 years, with recovery depending on wave shape and heigh after disturbance. Therefore, any dredging disturbances to EFH are likely to be short term.

In addition, temporary to permanent habitat alteration from complex or heterogeneous complex to soft-bottom habitat may occur along limited sections of the OECC and Western Muskeget Variant when installing cables in coarse pebble-cobble substrates, as finer, sandy substrates may settle over gravel (granule-size or larger) substrates. However, because sedimentation thicknesses are typically expected to be less than 0.2 inch, larger grains (greater than 0.2 inch) would likely not be completely covered, and dynamic processes would uncover smaller (0.08 to 0.2 inch) grains with time.

As in the SWDA, conversion of fine, unstructured habitats within the proposed corridors (OECC and Western Muskeget Variant) into complex, hard habitats through addition of cable protection would likely create more EFH for species that depend on hard and complex structure at the expense of EFH for species that prefer fine, unconsolidated substrate. Although this novel habitat is not equivalent to a natural rocky habitat, functionally these habitats will be utilized by EFH species. Furthermore, although artificial materials may modify ecological connectivity in offshore marine environments, it is not yet fully understood to what degree the impacts are the greatest (Bishop et al. 2017). The applicant intends to avoid or minimize the use of cable protection to the greatest extent feasible through careful site assessment and selection of the most appropriate cable installation tool to achieve sufficient burial. Crossing of complex habitat is likely unavoidable, particularly in the Muskeget Channel area. Many of these hard-bottom habitats are designated as HAPC for juvenile Atlantic cod (HAPC for cod specifically includes mixed sand and gravel and rocky habitats). Additionally, these structurally complex habitats provide shelter and refuge habitat for small fishes and invertebrates and substrates for attachment epibenthic organisms (Auster 1998).

Eelgrass, important EFH habitat for many species and included in the designation of HAPC for summer flounder, is present within the OECC near the Phase 1 landfall site and may also be present outside of the OECC near the Phase 2 landfall site. These sites were surveyed in June 2018 (CR Environmental 2020), and new surveys in state waters will occur prior to construction, per the applicant. Specifically, no later than 12 months before the start of non-HDD cable-laying activities, a survey plan on eelgrass beds shall be submitted to state and Federal regulators. Before the start of cable-laying activities, the lessee will submit the results of eelgrass survey. Post-construction eelgrass survey results will be submitted one year after the cable laying is completed (MassDEP 2023). The cables would be routed within the OECC and Western Muskeget Variant to avoid impacts on any eelgrass identified in those future surveys. The presence of any native species of macroalgae, seagrasses, or freshwater and tidal macrophytes in any size bed, as well as loose aggregations within the OECC and Western Muskeget Variant qualify that habitat type as HAPC for summer flounder. Presence of these habitat types were noted in site characterization video surveys of the OECC and Western Muskeget Variant surveys and would be avoided. At this time, no impacts on eelgrass or other SAV are expected to occur during the course of proposed Project construction and operations. If future surveys identify eelgrass beds the lessee work to first avoid impacts to those areas. However, if impacts to these resources can not be avoided a mitigation plan will be developed in conjunction with the USACE mitigation (Final Rule 4/10/08; 33 CFR Parts 325 and 332). A detailed map of the video surveys adjacent to mapped submerged aquatic vegetation is included as Appendix B (Geo Subsea 2023).

5.1.1.6 Offshore Export Cable Corridor—Maximum Impact (Phases 1 and 2)

Within the OECC for Phases 1 and 2, the amount of permanent habitat alteration from the potential installation of cable protection (if required) would be approximately 54 acres (COP Appendix III-T; Epsilon 2022). The amount of temporary habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 612 acres.[7] Total seafloor impacts in the OECC would be approximately 642 acres. Table 5-2 provides an estimate of permanent and temporary impacts by habitat type; these values should be considered approximate since the specific locations of permanent and temporary impacts (such as placement of cable protection and location of any needed dredging) are highly dependent upon the ongoing export cable engineering process and the final selected cable routes.

If the Western Muskeget Variant is used for one or two Phase 2 export cables, the amount of permanent habitat alteration for both phases combined from the potential installation of cable protection (if required) would be approximately 59 to 60 acres. The amount of habitat disturbance for both phases combined from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 611 to 614 acres. Total seafloor impacts in the OECC for both phases combined would be approximately 646 acres (COP Appendix III-T; Epsilon 2022). Table 5-2 provides an estimate of permanent and temporary impacts by habitat type.

Modeling of sediment transport potential was conducted for one representative cable installation within the OECC that is illustrative of expected impacts for each of the four or five cables that may be installed within the OECC and for the Western Muskeget Variant (COP Appendix III-A; Epsilon 2022). Simulations of typical and maximum-impact cable installation parameters (without sand wave removal) in the OECC indicate that deposition of 0.04 inch or greater (i.e., the threshold of concern for demersal eggs) was constrained to within 328 feet from the route centerline and there was no deposition above 0.2 inch (COP Appendix III-A; Epsilon 2022). At this deposition thickness, there would be limited areas with potential temporary negative impacts on demersal eggs or species of similar sensitivity and habitat. In areas along the OECC where sand wave dredging was simulated to occur, deposition greater than 0.04 inch associated with the TSHD was mainly constrained to within 0.54 nautical mile (0.62 mile) but extended up to 1.2 nautical miles (1.4 miles) in isolated patches when subject to swift currents through Muskeget Channel. Modeling results also indicate that there would be some small areas of deposition greater than 0.8 inch from dredging and cable installation activities extending up to 0.49 nautical mile (0.56 mile) from the route centerline. At this deposition thickness (lethal to winter flounder eggs [Berry et al. 2011]), there are limited areas with potential temporary or permanent negative impacts on the hard-bottom habitats and associated sessile or immobile species or life stages. Modeling indicates extent of sedimentation greater than 0.8 inch along the OECC would be 98.8 acres under a TSHD (used for sand waves under 6.6 feet) and 222.4 acres under limited TSHD (used for sand waves greater than 6.6 feet) (COP Appendix III-A; Epsilon 2022).

The OECC is the same for Phases 1 and 2 until approximately 1 to 2 miles from shore, at which point the OECC would diverge for each Phase to reach separate landfall sites in Barnstable. Modeling of the Phase 1 landfall site was considered as a conservative representation of a worst-case plume for the Phase 2 landfall site because this location has a relatively high fraction of fine sediments compared with those of Phase 2.

5.1.1.7 Offshore Export Cable Corridor—Phase 1

The maximum impacts within the OECC for Phase 1 includes approximately 22 acres for the potential installation of cable protection (if required) (COP Appendix III-T; Epsilon 2022). The amount of habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up

[7] The impacts from anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the proposed Project planning stage.

vessels for cable splicing would be approximately 251 acres for Phase 1. Total seafloor impacts in the OECC would be approximately 263 acres for Phase 1.

5.1.1.8 Offshore Export Cable Corridor—Phase 2

The maximum impacts within the OECC for Phase 2 includes approximately 32 acres for the potential installation of cable protection (if required) (COP Appendix III-T; Epsilon 2022). The amount of habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 361 acres for Phase 2. Total seafloor impacts in the OECC would be approximately 379 acres for Phase 2.

5.1.1.9 Offshore Export Cable Corridor—Phase 2 Western Muskeget Variant

If the Western Muskeget Variant is used for Phase 2, there would be either (1) one export cable installed in the Western Muskeget Variant and two export cables installed in the OECC or (2) two export cables installed in the Western Muskeget Variant and one export cable installed in the OECC. In either scenario involving the Western Muskeget Variant, the amount of permanent habitat alteration from the potential installation of cable protection (if required), which alters habitat through the addition of artificial hard substrate, would be approximately 35 to 38 acres for Phase 2. The amount of temporary habitat disturbance from cable installation, anchoring, the potential dredging of the tops of sand waves in certain locations, the potential for limited vessel grounding in the nearshore, and the limited use of jack-up vessels for cable splicing would be approximately 360 to 364 acres. Total seafloor impacts in the Phase 2 OECC Western Muskeget Variant would be approximately 381 to 383 acres.

5.1.2 Suspended Sediments and Water Withdrawals (Phases 1 and 2)

5.1.2.1 Southern Wind Development Area and Offshore Export Cable Corridor—Overview (Phases 1 and 2)

Potential impacts on EFH within the water column include increased suspended sediments and water withdrawals that could potentially lead to temporary contraction of EFH areas from localized changes in habitat. Results from all modeled scenarios were analyzed to determine the spatial and temporal extent of the above-ambient sediment concentrations. It is important to recall that dredging is intermittent and does not occur along the entire cable route simultaneously. The results showed that there were no areas in which the threshold of 10 milligrams per liter (mg/L) was exceeded for more than six hours.. Details of the models, their applications, and the results of the calculations are summarized in COP Volume III Section 5.2.2.1.2. and COP Appendix III-A (Epsilon 2022). In most instances of the model, the sediment plume from cable installation remained in the bottom 20 feet of the water column, except in shallow water. Above-ambient total suspended solids (TSS) concentrations substantially dissipate within one to two hours and fully dissipate in less than four hours for most of the model scenarios. Within the OECC modeling showed over 3,286.5 acres would have elevated suspended sediments above the threshold (10 mg/L), but only 2.5 acres would be above 200 mg/L The area with elevated suspended sediment would drop from 3,286.5 acres to 173 , 25, and 0 acres for two, three, and four hours respectively. The area with TSS concentrations above 50 mg/L only persists for more than two hours in the cases of the TSHD and vertical injector methods within the OECC. The plumes caused by TSHD activities reach a farther extent due to the introduction of sediments higher in the water column, thereby taking longer to settle. The suspended sediment threshold for the next most sensitive benthic species that may be present within the Project area, which likely provides a reasonable conservative threshold, is either 100 mg/L for one day or 200 mg/L for 12 hours. Even 12 hours exceeds the duration of time in which increased suspended sediments are expected based on the modeled results. The result of the extent and persistence of the plume for export or inter-array cable installation scenarios are generally similar regardless of the route location (SWDA versus OECC).

The increased suspended sediments during construction in the SWDA and OECC would temporarily impair the visual abilities of fishes and may result in increased susceptibility to predation and decreased foraging, filter feeding, and respiration abilities, reducing growth potential for many species (COP Volume III, Section 6.6.2; Epsilon 2022). Sublethal and lethal concentrations of suspended sediment differ by species and life stage, but previous research indicates that reductions in growth and mortality of the most sensitive species is 10 (mg/L) for 24 hours. Based on the results of the Project sediment modeling, the maximum length of increased sediment suspension is six hours.

Along with the concentration, the duration of the increased sediment suspension determines the severity of the effects to fish and benthic organisms. Wilber and Clarke (2011) noticed reduced growth and oxygen consumption of some mollusk species when sediment concentrations of 100 mg/L persisted for two days. Sublethal effects for adult white perch were observed at 650 mg/L for 5 days and lethal effects for other adult fish species have been observed when suspended solids were greater than 1,000 mg/L for at least 24 hours (Wilber and Clarke 2011). Demersal semi-buoyant and pelagic eggs such as those laid by striped bass and bay anchovy have higher thresholds. Delayed hatching of striped bass eggs has been observed when the eggs were exposed to sediment concentrations of 800 mg/L for one day and larvae experienced increased mortality when exposed for 3 days (Wilber and Clarke 2001). The sediment dispersion modeling for the trailing suction hoper dredge or jetting showed that most of the sediment settled out in three to four hours, with all of the sediment settled within six hours of disturbance (COP Volume III Section 6.5.2.1.2). Therefore, based on the timeframe, the level of sediment dispersion and the duration of the suspended sediments are not anticipated to cause adverse effects to even the most sensitive fish species.

Although the early life stages of some warm, shallow water coral species can be sensitive to deposition levels of 0.008 inches, star coral, is a cold-water species that is less sensitive to sedimentation and tends to form in areas with strong bottom currents, which can help keep corals free of sediment and prevent local deposition. Therefore, 0.04 inches of sediment deposition is the lowest threshold of concern for New England Wind (COP Volume III; Epsilon 2022). The value for the most sensitive species is derived from studies of tropical coral that are not present within the SWDA or OECC; however, cold-water corals have been found along the OECC. Solitary corals were observed during video surveys at Station VT- 55, VT-28, V-133, V-127, GB-24, V-137, and V-138 in Muskeget Channel (COP Volume II, Appendix H; Epsilon 2022). The available literature does not provide a definitive threshold of turbidity from disturbed sediment for cold-water corals; therefore, the 10 mg/L threshold for tropical coral is conservatively retained as a potential threshold for the most sensitive species (i.e., cold-water coral) that may be present. The most recent study on turbidity effects on corals was a metadata analysis conducted by Tuttle and Donahue in 2022. They found that adults were slightly less sensitive to sediment concentrations and deposition than immature corals, and that adverse effects were observed as quickly as 12 hours of exposure (Tuttle and Donahue 2022). Limited impacts on EFH and coral species are expected due to the short durations of elevated suspended sediments modeled.

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Within the SWDA, OECC, and Western Muskeget Variant, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawal from the cable-laying vessel. Entrainment of early pelagic life stages via water withdrawals would result in 100 percent mortality because of the stresses associated with being flushed through the pump system and temperature changes (USDOE and MMS 2012). Planktonic eggs and larvae from all broadcast spawning members of all species groups (Section .4.3) would be susceptible to entrainment. Examples from the Mobile Benthic/Epibenthic species group would be Atlantic cod, summer flounder, windowpane, and silver hake. The Sessile

Benthic/Epibenthic Soft-Bottom group with planktonic early life stages includes Atlantic sea scallop, Atlantic surf clam, and ocean quahog. Vulnerability to entrainment would depend on the alignment of spawning times for individual species with pelagic eggs and larvae and the cable-laying activities. Actual water withdrawal volumes associated with jet plowing were not provided in the COP, but Cape Wind estimated a standard jet plow withdraws 4,500 gallons (17,034.4 liters) of water per minute and moves on average 300 ft/hr (USDOI and MMS 2009, Table 5.3.2-6) and the South Fork project performed a entrainment study that estimated 6,000 gallons (22,712.5 liters) of water withdrawal per minute (South Fork Wind 2021). Using the Cape Wind withdrawals, this would result in average daily (24 hours) water withdrawals of 6,480,000 gallons (24,529,468 liters) and using the South Fork withdrawals, this would result in 8,640,000 gallons (32,705,958 liters) for conventional jet plowing. By contrast the stationary water withdrawl from the previous Brayton Point station resulted in the annual mortality of at least 16 billion fish eggs and larvae annually (USEPA 2003). Therefore the loss of adults based on Project-related water withdrawl activities is expected to be negligible due to the rate of survival of many of the local species. For example, only 1 in every 2,700 winter flounder larvae survives into adulthood; therefore, the loss of roughly 2,600 winter flounder larvae is not likely to result in the loss of more than a few adults (MMS 2009).

5.1.2.2 Southern Wind Development Area—Maximum Impact (Phases 1 and 2)

Given the broad similarity in grain sizes throughout the SWDA, modeling of sediment transport potential in the SWDA was conducted for one representative inter-array cable route (COP Appendix III-A; Epsilon 2022). The modeled route was conservatively selected as one of the longer potential inter-array cable routes and in a location where grain sizes were slightly finer (though grain size is broadly similar throughout the SWDA). These model results are representative of inter-array, inter-link, or offshore export cable installation within the SWDA, for either Phase 1 or Phase 2.

Modeling indicated that under typical or maximum-impact cable installation methods, the maximum anticipated suspended sediment concentrations that persisted for at least 60 minutes would be greater than 200 mg/L but less than 650 mg/L and would occur in an area of 395 acres or less. These concentrations would drop rapidly to below 50 mg/L within a maximum of 1 to 2 hours. Concentrations of suspended sediments with lower concentrations (10 mg/L) would extend up to 1.2 nautical miles (1.4 miles) from the inter-array cable centerline and be suspended at any given location for less than 4 hours. Suspended sediment could affect spawning by winter flounder or Atlantic cod in the proposed Project area. Winter flounder spawn in winter and deposit demersal eggs that would be susceptible to sediment burial (Berry et al. 2011). Atlantic cod aggregate to spawn in winter with a peak during November and December. Excessive suspended sediment during these months could potentially disrupt Atlantic cod spawning or courtship behavior. The short durations of these elevated concentrations would limit sublethal or lethal impacts on fish and invertebrates during cable installation.

Within the SWDA, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawal from the jetting techniques proposed during the cable-laying vessel operations. The calculations provided below were adapted from the information presented in the Cape Wind Final EIS (USDOE and MMS 2012). These calculations are considered accurate because the equipment and procedures for the proposed Project cable installation will be equivalent. Water withdrawals for the maximum size of the SWDA can be estimated using the following assumptions:

Cable installation occurs at a rate of up to 656 feet per hour[8];

[8] The final installation speed will be specific to the contractor and cable installation equipment and may be different than listed here. A speed of 656 feet per hour is used to provide a general estimate of water usage.

A jetting technique uses an average of 6,000 gallons per minute of water; and

The maximum total length of inter-array, inter-link, and offshore export cables within the SWDA is 379 nautical miles (436 miles).

Under these assumptions, water withdrawal volumes for the maximum size of the SWDA are expected to be approximately 14 billion gallons. Such water withdrawals could entrain eggs and larvae of certain fish or invertebrate species from all groups listed in Section 4.2. Using the same basis as the calculations performed as part of the South Fork Offshore Wind project, an estimated 26.9 billion zooplankton could be entrained during jetting operations used to bury export cables for the New England Wind Project (South Fork Wind 2021). These numbers are less than annual entrainment by coastal power plants (South Fork Wind 2021).

5.1.2.3 Southern Wind Development Area—Phase 1

As described above and in the COP (Appendix III-A; Epsilon 2022), modeling indicated that suspended sediments would settle out rapidly, within 4 hours. The short durations of the elevated concentrations modeled are below those documented to cause sublethal or lethal impacts on fish and invertebrates, limiting the impact on pelagic EFH during cable installation.

Water withdrawals for the maximum size of Phase 1 can be estimated using the above assumptions and a maximum total length of inter-array, inter-link, and offshore export cables within the SWDA of approximately 152 nautical miles (175 miles). Under these assumptions, water withdrawal volumes are expected to be approximately 0.3 to 1.0 billion gallons for Phase 1.

5.1.2.4 Southern Wind Development Area—Phase 2

As described above and in the COP (Appendix III-A; Epsilon 2022), modeling indicated that suspended sediments would settle out rapidly, within 4 hours. The modeled concentrations and durations of exposure are below those causing sublethal or lethal impacts on fish and invertebrates, limiting the impact on pelagic EFH during cable installation.

Water withdrawals for the maximum size of Phase 2 can be estimated using the above assumptions and a maximum total length of inter-array, inter-link, and offshore export cables within the SWDA of approximately 267 nautical miles (307 miles). Under these assumptions, water withdrawal volumes are expected to be approximately 0.4 to 1.8 billion gallons for Phase 2.

5.1.2.5 Offshore Export Cable Corridor—Maximum Impact (Phases 1 and 2)

Modeling of sediment transport potential was conducted for one representative cable installation within the OECC that is illustrative of expected impacts for each of the four to five cables that may be installed within the OECC. Model results indicated that the sediment deposition associated with OECC installation at the landfall sites would be limited to 0.04- 0.2 inches within approximately 328 feet of the route alignment (COP Volume III- Appendix-A). Given that the closest distances from the cables are beyond 328 feet, no adverse impacts to eelgrass from sediment deposition associated with cable installation are expected. In addition, the nearshore segment of the cables at both landfall sites will be installed with HDD. This trenchless installation technique will reduce the amount of bottom disturbance, and therefore reduced sediment deposition in nearshore areas.

Installation along the OECC may require discontinuous (i.e., intermittent) dredging of the tops of sand waves to achieve sufficient burial depths. This would likely be accomplished with a TSHD or by jetting for smaller sand waves (COP Volume III, Appendix III-A; Epsilon 2022). TSHD would remove a section between approximately 49 and 65 feet wide from a sand wave, whereas jetting would remove a smaller 6 foot-wide section. Sediment dispersion modeling of cable installation with and without sand wave removal and with multiple methods along the OECC indicated that concentrations of suspended sediments above 10 mg/L extended up to a maximum of 8.6 nautical miles (9.9 miles) from the cable trench centerline. Most of the sediment settles out in less than 3 hours; however, suspended sediments at this concentration can persist for between 4 to 6 hours in smaller areas (less than 297 acres). However, the furthest sediment plume extents are created when TSHD is used. For model results without TSHD (i.e., just cable installation), concentrations of suspended sediments above 10 mg/L extended up to a maximum of only 1.1 nautical miles (1.3 miles) from the cable trench centerline. Pelagic EFH may be affected by the mobilization and suspension of sediments during dredging and installation activities, but all sediments settle out of suspension within 6 hours, thus concentrations do not exceed the potential impact thresholds for fish and invertebrates within those waters.

The applicant may elect to use a vertical injector cable installation tool with deeper penetration such that dredging of the tops of sand waves is not required to achieve sufficient burial depths. A representative section of deeper installation was modeled, and results indicated that concentrations of suspended sediments above 10 mg/L extended up to a maximum of 0.6 nautical mile (0.7 mile) from the cable trench centerline. Most of the sediment settles out in less than 3 hours; however, suspended sediments at this concentration can persist for between 4 to 6 hours in smaller areas (less than 22 acres). This method is not anticipated to affect fish and invertebrates within pelagic habitats because all sediments settle out of suspension 6 hours, and thus do not exceed the sublethal and lethal sensitivity thresholds.

The OECC is the same for Phases 1 and 2 until approximately 1 to 2 miles from shore, at which point the OECC would diverge for each phase to reach separate landfall sites in Barnstable. Modeling of the Phase 1 landfall site was considered as a conservative representation of a worst-case plume for the Phase 2 landfall site because this location has a relatively high fraction of fine sediments compared with those of Phase 2. Within the OECC, mortality of species with EFH for pelagic or planktonic early life stages may occur during water withdrawal from the cable-laying vessel. Water withdrawals for the four or five offshore export cables within the OECC can be similarly estimated using the following assumptions:

- Cable installation occurs at a rate of up to 394 feet per hour[9];
- A jetting technique uses 3,000 to 12,000 gallons per minute of water; and
- The maximum total length of offshore export cables (outside the SWDA) is 222 nautical miles (255.5 miles).

Under these assumptions, water withdrawal volumes for installation of Phase 1 and Phase 2 cables within the OECC are expected to be approximately 0.6 to 2.4 billion gallons.

5.1.2.6 Offshore Export Cable Corridor—Phase 1

The construction vessel would move along the route at about 400 to 600 feet per hour, which should allow suspended sediment to settle. Overall, the OECC would take about 12 months to complete, and suspended sediments would be present in the vicinity of the vessel as it moves along the corridor.

The maximum water withdrawals within the OECC for Phase 1 can be estimated using the above assumptions and a maximum total length of export cables (outside the SWDA) for Phase 1 of approximately 89 nautical miles (102 miles). Under these assumptions, water withdrawal volumes are expected to be approximately 0.2 to 1.0 billion gallons for Phase 1. As mentioned in Section 5.1.2.1, planktonic eggs and larvae of federally managed invertebrates and fishes occurring near the intake of the

[9] The final installation speed will be specific to the contractor and cable installation equipment and may be different than listed here. A speed of 394 feet per hour is used to provide a general estimate of water usage.

system could be entrained. In addition, zooplankton, which many species and early life stages feed upon, would also be affected.

5.1.2.7 Offshore Export Cable Corridor—Phase 2

Modeling indicated that suspended sediments would settle our rapidly, within 4 to 6 hours (COP Appendix III-A; Epsilon 2022). The modeled concentrations and durations of exposure are below those causing sublethal or lethal impacts on fish and invertebrates, limiting the impact on pelagic EFH during dredging and cable installation.

The maximum water withdrawals within the OECC for Phase 2 can be estimated using the above assumptions and a maximum total length of offshore export cables (outside the SWDA) for Phase 2 of approximately 133 nautical miles (153 miles). Under these assumptions, water withdrawal volumes are expected to be approximately 0.4 to 1.5 billion gallons for Phase 2. Large water withdrawals can entrain large numbers of planktonic eggs and larvae broadcast by fishes and invertebrates from the Benthic and Pelagic species groups described in Section 4.3

5.1.2.8 Offshore Export Cable Corridor—Phase 2 Western Muskeget Variant

Modeling of sediment transport potential was conducted for one representative cable installation within the OECC including the Western Muskeget Variant that is illustrative of expected impacts for each of the one or two cables that may be installed within the Western Muskeget Variant. Given the similarities in substrate type, ocean conditions, and the shorter corridor distance within the Western Muskeget Variant, suspended sediment concentrations and durations are similar to the values presented for the OECC (COP Appendix III-A; Epsilon 2022). The increased concentrations of suspended sediments are not expected to affect fish and invertebrates within pelagic habitat because of the very limited duration of suspension before settlement.

Similarly, potential impacts on the water column EFH because of water withdrawals for installation of the Western Muskeget Variant cables are expected to be the same or less than those presented above for the OECC because of the shorter length of the cable.

5.1.3 Increased Sound Exposure (Phases 1 and 2)

5.1.3.1 Southern Wind Development Area and Offshore Export Cable Corridor—Overview (Phases 1 and 2)

Underwater sounds generated during proposed Project construction would include repetitive, high-intensity (impulsive) sounds produced by pile driving, and continuous (non-impulsive), lower-frequency sounds produced by vessel propulsion and cable installation. Intensity of produced sound would vary with some sounds being louder than ambient noise. Ambient noise can influence how fish detect other sounds as fish have localized noise filters that separate background noise and other sounds simultaneously (Popper and Fay 1993). The mean ambient noise within Lease Area OCS-A 501 was measured to be approximately 75 decibels (dB) re 1 μPa^2/Hz in the 100 hertz (Hz) frequency band, 57 dB re 1 μPa^2/Hz in the 1,000 Hz frequency band, and 75 dB re 1 μPa^2/Hz in the 30,000 Hz frequency band (Alpine Ocean Seismic Surveying, Inc. 2017). The highest noise levels were measured below 1,000 Hz with peaks between 20,000 and 30,000 Hz attributed to the close proximity of the survey vessel that could not be removed from the ambient noise analysis (Alpine Ocean Seismic Surveying, Inc. 2017). This study was performed prior to the segregation of Lease Area OCS-A 0501 into Lease Area OCS-A 0501 and Lease Area OCS-A 0534.

Noise generated from the proposed Project could potentially impact species with EFH in the SWDA and OECC during construction (Volume III, Section 6.6, Epsilon 2022). All fishes have hearing structures that allow them to detect sound particle motion. Some fishes also have swim bladders near or connected to the ear that allows them to detect sound pressure, which increases hearing sensitivity and broadens hearing abilities (Hawkins and Popper 2017; Popper et al. 2014). In general, increased sound sensitivity and the presence of a swim bladder makes a fish more susceptible to injury from anthropogenic sounds because loud, usually impulsive, noises can cause swim bladders to vibrate with enough force to inflict damage to tissues and organs around the bladder (Casper et al. 2012; Halvorsen et al. 2012). The most sensitive species are those with swim bladders connected or close to the inner ear, such as Atlantic herring and Atlantic cod; these species can acquire both recoverable and mortal injuries at lower noise levels than other species (Popper et al. 2014; Thomsen et al. 2006). Fish with swim bladders not connected or near inner-ear structures, such as yellowfin tuna, also primarily detect noise through particle motion, and are therefore less sensitive to noise. The least sound-sensitive fish species include those that do not have a swim bladder, including flatfish like winter flounder and elasmobranchs.

The Popper et al. (2014) criteria for impulsive pile-driving sound are described in Table 5-3. Multiple levels of impairment presented in this table include:

Recoverable injury, which could include fin hematomas, capillary dilation, and loss of sensory hair cells;

Temporary threshold shift, which is a reduction in hearing ability due to loss of sensory hair cells until the addition of new hair cells over time; and

Masking, which reduces an organism’s ability to detect relevant sound natural sources (Popper et al. 2014).

NMFS lists separate "interim guidance" of peak onset of injury or mortality regardless of source type, fish size, or hearing type, and a cumulative sound level exposure onset of injury or mortality for fish 2 grams or larger; and fish smaller than 2 grams (FHWG 2008) (Table 5-4). There is no American National Standards Institute-accredited behavioral threshold for fish.

To assess the potential impacts of anthropogenic sound on fish, Popper et al. (2014) classified fishes into three animal groups comprising: (1) fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes (e.g., tuna [*Thunnus* sp.], or Atlantic salmon [*Salmo salar*]); (2) fishes whose hearing does involve a swim bladder or other gas volume (e.g., Atlantic cod or herring); and (3) fishes without a swim bladder (e.g., sharks) that can sink and settle on the substrate when inactive (Carroll et al. 2017; Popper et al. 2014). Quantitative acoustic criteria are therefore defined for these species. The suite of generally accepted acoustic thresholds used in this assessment to determine potential impacts on fish exposed to sounds likely to occur during construction are described in Table 5-4.

Table 5-3: Impact Pile Driving Acoustic Thresholds for Fish

	Mortality or Impairment						
	Potential Mortal Injury[a]		Recoverable Injury		Temporary Threshold Shift		
Faunal Group	L_{PK}	$L_{E,24hr}$	L_{PK}	$L_{E,24hr}$	$L_{E,24hr}$	**Masking[b]**	**Behavior[b]**
Fishes without swim bladders	>213	>219	>213	>216	>>186[d]	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fishes with swim bladders not involved in hearing	>207	210	>207	203	>186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fishing with swim bladders involved in hearing	>207	207	>207	203	186	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate

Faunal Group	Mortality or Impairment					Masking[b]	Behavior[b]
	Potential Mortal Injury[a]		Recoverable Injury		Temporary Threshold Shift		
	L_{PK}	$L_{E,24hr}$	L_{PK}	$L_{E,24hr}$	$L_{E,24hr}$		
Eggs and larvae	>207	>210	(N) Moderate (I) Low (F) Low		Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Source: Popper et al. 2014

$L_{E,24hr}$ = 24-hour cumulative sound exposure level (dB re 1 µPa^{2}s [decibels referenced to 1 micropascal-squared-second]); L_{PK} = peak sound pressure (dB re 1 µPa [decibels referenced to 1 micropascal]); > = greater than; >> = greater than or equal to;

[a] This was adapted from American National Standards Institute-accredited Popper et al. 2014; all thresholds are unweighted. Recoverable injury thresholds were modeled for this study.

[b] Relative risk is defined at three levels (low, moderate, high) for distances: N = near (tens of feet), I = intermediate (hundreds of feet), and F = far (thousands of feet).

Table 5-4: General Interim Acoustic Thresholds for Fish[a]

Fish Group	Injury: L_{PK}	Injury: $L_{E,24hr}$	Behavior: L_p
Fish ≥ 2 grams	206[b,c]	187[b,c]	150[c]
Fish < 2 grams	206[b,c]	183[b,c]	150[c]
Fish without swim bladders[d]	213	216	No data available
Fish with swim bladders not involved in hearing[d]	207	203	No data available
Fish with swim bladders involved in hearing[d]	207	203	No data available

Source: Epsilon 2022

BOEM = Bureau of Ocean Energy Management; $L_{E,24hr}$ = 24-hour cumulative sound exposure level (dB re 1 µPa^{2}s [decibels referenced to 1 micropascal-squared-second]); L_p = root mean squared sound pressure (dB re 1 µPa [decibels referenced to 1 micropascal]); L_{PK} = peak sound pressure (dB re 1 µPa); NMFS = National Marine Fisheries Service; ≥ = greater than or equal to; < = less than

[a] This includes only unweighted thresholds currently used by NMFS and BOEM.

[b] This is NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).

[c] Sources: Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007

[d] Source: Popper et al. 2014

Exposure to anthropogenic sound sources could have a direct consequence on the functionality and sensitivity of the sensory systems of marine invertebrates. Although less research has been conducted on the impact of anthropogenic noise on invertebrates, studies have observed acoustic trauma in some species, including adult squid and octopus, when exposed to high-intensity, low-frequency noise (sinusoidal sweeps between 50 and 400 Hz [1 second duration] generated by an in-air speaker) (André et al. 2011; Solé et al. 2013). Longfin inshore squid have also been observed exhibiting behavioral responses to noise with varied patterns of habituation after prolonged exposure (Mooney et al. 2016).

Research on the response of blue mussels to pile driving indicated that clearance or filtration rate increased with pile-driving noise, likely in response to increased metabolic demands triggered by stress (Spiga et al. 2016). Similarly, feeding changes were observed in American lobster (*Homarus americanus*) exposed to high sound levels (seismic air gun) and persisted as long as several weeks post-exposure (Payne et al. 2007). Research on larval scallops exposed to seismic noises showed delays in development and malformations (Aguilar de Soto et al. 2013), while field studies on two species of adult scallops showed no adverse effects linked to a seismic survey (Przeslawski et al. 2018). A lobster species (Norway lobster [*Nephrops norvegics*]) exposed to pile-driving noises showed decreased burying, bio irrigation, and locomotion, which indicated alterations to overall behavior and habitat usage during pile-driving activities (Solan et al. 2016).

Lower frequency, more continuous noises, such as those from vessels, have been linked to changes in the behavior or recruitment of some benthic invertebrates (Nedelec et al. 2014). Although numerous studies have investigated the effect of sound on marine invertebrates, many have been conducted in confined environments that make it difficult to control and assess the acoustic conditions. Moreover, by measuring and reporting only the pressure component of sound, the results are of reduced relevance for assessing any observed effects. Most crustacean species lack swim bladders and are considered less sensitive to sound, though understanding of the impact of sound on invertebrates is limited (Edmonds et al. 2016).

Effects elicited by other non-impulsive sound sources such as DP are not described in peer-reviewed publications or other literature. It is reasonable to assume that the potential effects of sound from these activities are comparable to those documented for sound from vessel propulsion as described in the non-impulsive sound category below.

The Final EIS for the adjacent Vineyard Wind 1 with similar construction noise and habitat (BOEM 2021) determined that impacts on fishes and invertebrates from vessel sounds and pile driving during construction would be minor and short term.

5.1.3.2 Southern Wind Development Area—Phases 1 and 2

5.1.3.2.1 Impulsive Sound

Sound generated from pile driving could potentially impact fishes and invertebrates nearby because the high-intensity, impulsive sounds of pile driving can produce sound over 200 decibels referenced to 1 micropascal (dB re 1 µPa) at the source and have been linked to mortality, ruptured gas bladders, damage to auditory processes, and altered behavior in some fish species (Casper et al. 2012; Popper and Hastings 2009; Riefolo et al. 2016).

Impact pile driving is carried out using an impact hammer, which consists of a falling ram that strikes the top of a pile repeatedly and drives it into the ground. The ram is lifted or driven by one of several methods, including mechanical winching, diesel combustion, pneumatic air pressure, or hydraulic pressure. When the ram strikes the pile, the impact creates stress waves traveling down the length of the pile, which couples with the surrounding medium, radiating acoustic energy into the water (COP Appendix III-M; Epsilon 2022). Pile driving also generates vibration waves in the sediment, which can radiate acoustic energy back into the water from the seabed. The sound from impact pile driving is temporary, repetitive, and discontinuous (McPherson et al. 2017; Reinhall and Dahl 2011). Pile driving can be conducted both above the surface and subsea and has a typical strike interval of 1.5 to 2 seconds (COP Appendix III-M; Epsilon 2022).

Field measurements of pile driving show that source levels are typically in the range of 210 to 250 dB re 1 µPa-m (Bailey et al. 2010; McHugh 2005) and frequency is predominantly less than 1 kilohertz (Robinson et al. 2007; Tougaard et al. 2009), although they can extend to much higher frequencies (MacGillivray 2018), including at least 100 kilohertz (Tougaard et al. 2009). Sound thresholds derived from Popper et al. (2014) indicate that pile-driving sound above a peak sound pressure level (SPL) of 207 dB re 1 µPa can lead to mortality of the most sensitive fish species, such as Atlantic herring, while noise above 186 dB re 1 µPa can lead to impairment. Longfin inshore squid exhibited a startle response to recorded pile-driving sound measured 0.5 kilometer from the Block Island Wind Farm pile driving site, which received zero-to-peak sound pressure (L_{PK}) levels of 190 to 194 dB re 1 µPa, but habituated quickly; startle responses typically diminished within the first eight strikes, although the response returned when the squid were tested again 24 hours later (Jones et al. 2020). The authors did not report any physical harm from the sound exposure but speculated that it could reduce the ability to detect and avoid predators.

The effects of impulsive sound on fish eggs and larvae have been studied in the context of offshore pile driving. Bolle et al. (2012) investigated the risk of mortality in common sole (*Solea solea*) larvae by exposing them to impulsive stimuli in an acoustically well-controlled study. Even at the highest exposure level tested, at a sound level exposure of 206 (dB re 1 $\mu Pa^2 s$) (corresponding to 100 strikes at a distance of 100 meters [328.1 feet]), no statistically significant differences in mortality were found between exposure and control groups.

Popper et al. (2014) published exposure guidelines for fish eggs and larvae, which are based on pile-driving data. The guidelines proposed a precautionary threshold for mortality of fish eggs and larvae of greater than a peak L_{PK} levels of 207 dB re 1 μPa, which they note is likely conservative.

The applicant conducted acoustic modeling (COP Appendix III-M; Epsilon 2022) to estimate the noise propagation of pile driving assuming broadband noise attenuation levels of 0, 10, and 12 dB in relation to thresholds of mortality and recoverable injury for fishes with different hearing structures (based on thresholds in Popper et al. 2014 and presented in Table 5-3). The applicant expects to implement noise attenuation mitigation technology to reduce sound levels by a target of approximately 12 dB or greater; impacts on marine species were assessed based on 10 dB of noise attenuation.

Table 5-5 summarizes the modeled radial distances to injury thresholds for fish with various attenuation levels. The estimates of ranges to 24-hour cumulative sound exposure level ($L_{E,24hr}$) thresholds represent the distance a fish would have to remain for the entirety of the installation and do not account for any aversion that might occur. Popper et al. (2014) does not define quantitative acoustic thresholds for behavioral response in fish. A root-mean-square SPL threshold of 150 dB re 1 µPa is used by NOAA Greater Atlantic Regional Fisheries Office for all fish (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007). When this criterion is used, distances to potential behavioral disturbance for fish are more than 8 kilometers (5 miles) and 14 kilometers (8.7 miles) from jacket foundation piles and monopiles respectively (COP Appendix III-M; Epsilon 2022).

Atlantic cod, hake species, and black sea bass belong to the hearing specialist group and rely on sound for communication and other important behaviors. Stanley et al. (2021) determined that noise from activities like impact pile driving could interfere with black sea bass communication during spawning but concluded that they would likely return to normal spawning behavior once the impact ceased. In contrast, other species, such as Atlantic cod, may be more sensitive to noise impacts. Atlantic cod are sensitive to noise and other forms of disturbance during spawning. Atlantic cod rely on communication during spawning, using low-frequency grunts to locate potential mates and signal fertility (Rowe and Hutchings 2006). Cod may interrupt or abandon spawning when repeatedly exposed to intense disturbance (Andersson et al. 2017; Dean et al. 2012; Engås et al. 1996; Mueller-Blenkle et al. 2010), but brief disturbance may not necessarily disrupt spawning. For example, Morgan et al. (1997) observed the dispersal of a spawning aggregation of Atlantic cod by the passage of a single bottom trawl for a brief period (approximately 1 hour), after which the aggregation returned to the affected area and resumed spawning. In the North Sea, a recent study examining spawning cod behavior in response to seismic air gun sound found that cod did not abandon the spawning site (McQueen et al. 2022). These contrasting findings suggest that short-term periods of disturbance may not necessarily result in adverse effects on Atlantic cod spawning. In southern New England, Atlantic cod spawning has not been studied extensively. Recent findings indicate spawning centers around specific locations where individuals aggregate during November and December. Activity during these months is highest on full moons during daytime hours and involves a vocal courtship (Van Parijs et al. 2022). Construction activity, including impulsive and non-impulsive sounds coinciding with temporal and spatial aggregation of Atlantic cod, could potentially disrupt spawning. Avoidance of the November and December spawning periods could be implemented as a mitigation measure to help reduce adverse impacts of construction activities within the New England Wind project area.

Stanley et al. (2021) conducted experiments with longfin squid in a controlled lab environment evaluating response to pile-driving noise at rest, during feeding, and during reproduction. Regarding reproductive responses, overall, there was no indication that the high-intensity, repeated pile-driving noise affected any of the suite of reproductive behaviors measured including agonistic, mate guarding, mating, or egg-laying behaviors. Typical behavioral dynamics (Shashar and Hanlon 2013) of sexually active squid continued to occur despite the repeated, high-intensity, impulsive noise treatment. These results are perhaps surprising given the array of impacts seen in other behaviors of cephalopods and in other taxa (Mooney et al. 2020); however, they underscore the exceptionally strong motivation of these squid to reproduce. Squid engaging in these behaviors are nearing the end of their lifespan; females may continue to mate with multiple males and spawn over a few weeks, but both sexes will soon senesce (Maxwell and Hanlon 2000; Hanlon et al. 2013). From an evolutionary standpoint, persistence of reproductive behaviors during environmental stressors is advantageous for species with limited opportunity to reproduce in their lifetime. The present results are consistent with the theory that reproductive behaviors of semelparous species should be relatively uninfluenced from potentially inhibitory effects of stress (Wingfield and Sapolsky 2003; de Jong et al. 2020). These data imply that mating behaviors of semelparous species are at a lower risk of adverse effects from noise exposure.

In summary, with 10 dB attenuation, injury to fish from pile driving could extend out to a few kilometers with behavioral impacts up to 14 kilometers (8.7 miles). However, impairment from pile-driving noise is less likely to occur during construction because a soft-start technique would be employed, and mobile fishes and invertebrates would be able to leave the area before full strength pile driving occurs and the $L_{E,24hr}$ threshold is reached. The behavioral threshold of 150 dB re 1 µPa has not been tested for biologically significant behavioral reactions in fish, and behavioral responses in fish may range from a heightened awareness of the noise to changes in movement or feeding activity (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Popper and Hastings 2009; Purser and Radford 2011; Wysocki et al. 2007); therefore, it should be considered a conservative estimate for the onset of behavioral responses in fish and does not necessarily equate to biologically significant impacts.

5.1.3.2.2 Non-Impulsive Sound

Non-impulsive sound associated with construction of the proposed Project is primarily vessel-related and includes sounds that arise from vessel propulsion and the use of DP thrusters. Sound emission from vessels in general, but especially under DP, depends on vessel operational state and is strongly weather-dependent. Zykov et al. (2013) and McPherson et al. (2017) report a maximum broadband source level of 192 dB re 1 µPa-m for numerous vessels with varying propulsion power under DP.

Vessel noise can represent a chronic impact for fish species (Popper 2003) whose communication is mainly based on low-frequency sound signals (Ladich and Myrberg 2006; Myrberg and Lugli 2006). Continuous SPLs above 170 dB re 1 µPa for 48 hours can lead to injury, while exposure to noise of 158 dB re 1 µPa or above for 12 hours can lead to behavioral disturbance (Hawkins and Popper 2017; Popper et al. 2014). Underwater vessel noise can cause avoidance behavior that interferes with feeding and breeding, alter schooling behaviors and migration patterns, and mask important environmental auditory cues (Barber 2017; CBD 2012). Masking is of concern because although fishes are generally not loud (120 dB re 1 µPa-m, with the loudest on the order of 160 dB re 1 µPa-m), species make unique noises that allow for individual identification (Normandeau Associates 2012). In addition, vessel noise has the capacity to provoke short-term changes in the spatial position and group structure of pelagic fish in the water column (Buerkle 1973; Handegard et al. 2003; Mitson and Knudsen 2003; Olsen et al. 1983; Ona et al. 2007; Sarà et al. 2007; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002).

Fish can respond to approaching vessels by diving toward the seafloor or by moving horizontally out of a vessel’s path, with reactions often initiated well before a vessel reaches the fish (Berthe and Lecchini 2016; Ona et al. 2007). Behavioral responses in fishes differ depending on species and life stage, with younger, less mobile age classes being the most vulnerable (Gedamke et al. 2016; Popper and Hastings 2009). Avoidance or flight behavior away from vessels has been observed for Atlantic herring and Atlantic cod and is likely the behavior exhibited by other species as well (Handegard et al. 2003; Vabø et al. 2002).

Table 5-5: Modeled Radial Distances (Meters) for Fish Auditory Injury Thresholds[a]

Sound Source	Faunal Group	Metric	Threshold[b]	Attenuation Level (dB) 0	10	12
4-meter (13-foot) pin pile installation (3,500 kilojoules; 1 pile)	Fish without swim bladders	L_{PK}	213	131	8	5
		$L_{E,24hr}$	216	408	85	45
	Fish with swim bladders not involved in hearing	L_{PK}	207	410	100	33
		$L_{E,24hr}$	203	3,437	721	490
	Fish with swim bladders involved in hearing	L_{PK}	207	410	100	33
		$L_{E,24hr}$	203	3,437	721	490
	Fish ≥2 grams	L_{PK}	206	440	108	87
		$L_{E,24hr}$	187	16,714	6,807	5,342
	Fish <2 grams	L_{PK}	206	440	108	87
		$L_{E,24hr}$	183	22,684	10,021	8,265
12-meter (39-foot) monopile foundation installation (5,000 kilojoules)	Fish without swim bladders	L_{PK}	213	210	47	36
		$L_{E,24hr}$	216	616	100	63
	Fish with swim bladders not involved in hearing	L_{PK}	207	540	105	79
		$L_{E,24hr}$	203	3,900	1,047	760
	Fish with swim bladders involved in hearing	L_{PK}	207	540	105	79
		$L_{E,24hr}$	203	3,900	1,047	760
	Fish ≥2 grams	L_{PK}	206	580	157	94
		$L_{E,24hr}$	187	16,282	7,204	5,960
	Fish <2 grams	L_{PK}	206	580	157	94
		$L_{E,24hr}$	183	21,542	10,290	8,648
12-meter (39-foot) monopile foundation installation (6,000 kilojoules)	Fish without swim bladders	L_{PK}	213	210	47	36
		$L_{E,24hr}$	216	900	128	89
	Fish with swim bladders not involved in hearing	L_{PK}	207	540	105	79
		$L_{E,24hr}$	203	4,825	1,365	982
	Fish with swim bladders involved in hearing	L_{PK}	207	540	105	79
		$L_{E,24hr}$	203	4,825	1,365	982
	Fish ≥2 grams	L_{PK}	206	580	157	94
		$L_{E,24hr}$	187	19,149	8,756	7,242
	Fish <2 grams	L_{PK}	206	580	157	94
		$L_{E,24hr}$	183	24,623	12,283	10,395

Sound Source	Faunal Group	Metric	Threshold[b]	Attenuation Level (dB)		
				0	10	12
13-meter (42.7-foot) monopile foundation installation (5,000 kilojoules)	Fish without swim bladders	L_{PK}	213	260	52	27
		$L_{E,24hr}$	216	560	108	80
	Fish with swim bladders not involved in hearing	L_{PK}	207	580	114	93
		$L_{E,24hr}$	203	4,198	1,031	691
	Fish with swim bladders involved in hearing	L_{PK}	207	580	114	93
		$L_{E,24hr}$	203	4,198	1,031	691
	Fish ≥2 grams	L_{PK}	206	620	127	104
		$L_{E,24hr}$	187	19,306	8,133	6,648
	Fish <2 grams	L_{PK}	206	620	127	104
		$L_{E,24hr}$	183	26,101	11,881	9,815

Source: COP Appendix III-M; Epsilon 2022

< = less than; ≥ = greater than or equal to; dB = decibel; dB re 1 µPa = decibels referenced to 1 micropascal; $L_{E,24hr}$ = 24-hour cumulative sound exposure level (dB re 1 µPa^{2}s [decibels referenced to 1 micropascal-squared-second]); L_{PK} = peak sound pressure (dB re 1 µPa)

[a] Distances indicate 95 percent of the maximum distance to the auditory threshold.

[b] This is expressed in dB re 1 µPa.

Previous impact assessment studies for various cable projects have concluded that sound related to subsea cable installation or cable operation is not a significant issue. This was based on the prediction that anticipated sound levels would not exceed existing ambient sound levels in the area, although background sound level measurements were often not presented (Meißner et al. 2006). A detailed modeling and measurement study of construction activities associated with cable installations concluded that underwater sound generated by the cable-laying vessels was similar to that of other vessels already operating in the area and no significant acoustic impacts were identified (Austin et al. 2006). Nedwell et al. (2003) calculated a maximum source level of 178 dB re 1 µPa-m, expressed as SPL, created by trenching, operation of vessels and machinery (based on measurements of large vessels operating in deep water) during construction of an offshore wind farm in United Kingdom waters. In the same study, a recorded SPL of 123 dB re 1 µPa was measured for cable-trenching activities in very shallow water at a range of 160 meters (525 feet) from the source. The sound was described as highly variable and dependent on the physical properties of the seabed that was being cut at the time.

There is a moderate risk within tens to hundreds of feet proximity to the source, where sounds emitted by trenching, vessel operations, and cables may elicit behavioral reaction in fish without a swim bladder and those with a swim bladder not involved in hearing. At larger distances, the risk is low. The risk that fish with a swim bladder involved in hearing display behavioral reactions near the sources is high. At intermediate distances the risk is moderate, and at greater distances, the risk is low (Popper et al 2014). As stated in the environmental assessment and the alternative energy programmatic EIS prepared for the assessment and designation of wind energy areas (BOEM 2007, 2014), regular vessel traffic occurs throughout this area, thus implying that biological resources in the area are presumably habituated to this noise. In addition, the Final EIS for Vineyard Wind 1 determined that short- and long-term impacts from construction noise would have minor impacts on finfish and invertebrate species (BOEM 2021).

5.1.3.3 Offshore Export Cable Corridor—Phases 1 and 2

The principal noise from the OECC (including the Western Muskeget Variant) installation would be from tugs and other vessels used for cable installation. Fish in the OECC would be able to hear the vessels, but sound levels would be below those that cause injury or stress (USDOE and MMS 2012). Cable installation is not expected to be a significant source of noise; if a jetting technique is used, there would be the sound of water rushing from the nozzles (USDOE and MMS 2012). Neither of these sound sources are expected to significantly impact EFH, especially after construction activities for the proposed Project have ceased.

5.1.4 Avoidance, Minimization, and Mitigation Measures (Phases 1 and 2)

The SWDA is located in the RI/MA Lease Areas, which were identified as suitable for wind energy development after a multi-year, multi-agency public process partially because of its relatively low amount of important fish and invertebrate habitat, therefore reducing potential for impacts. The OECC was also sited taking environmental factors into consideration (COP Volume I, Section 2.3; Epsilon 2022).

Several avoidance, minimization, and mitigation measures could be employed to avoid and minimize potential impacts on EFH within the SWDA and OECC. These measures include the following:

- Apply a soft-start procedure to the pile-driving process, which delivers initial pile drives at a lower intensity, allowing fish to move out of the activity area before the full-power pile driving begins.
- Implement noise attenuation mitigation technology to reduce sound levels by a target of approximately 10 dB or greater. Noise attenuation technologies such as Hydro-sound Damper, AdBm encapsulated bubble sleeve, or bubble curtains, will be utilized. The appropriate technology will be applied in relation to the type of construction activity to reduce sound levels by a target of approximately 10 dB or greater (COP Volume III, Table 6.7-14; Epsilon 2022).

- Use widely spaced WTGs and ESPs so that the foundations (and associated scour protection) for the WTGs and ESPs, along with cable protection (if required) for inter-link and inter-array cables, only occupy a minimal portion of the SWDA, leaving the large majority of the SWDA undisturbed.
- Install offshore export cable to avoid important habitats and those considered HAPC, such as eelgrass beds and hard-bottom sediments, if feasible.
- Use mid-line buoys on anchor lines where feasible and considered safe to minimize impacts from anchor line sweep.
- Use HDD to avoid or minimize impacts on benthic habitat at the Phase 1 and Phase 2 landfall sites (COP Volume I, Sections 3.3.1.8 and 4.3.1.8; Epsilon 2022).

It is expected that the identified eelgrass resources near Spindle Rock in proximity to the landfall sites will be avoided (COP Volume III, Figure 6.4-1; Epsilon 2022). No later than 12 months before the start of non-HDD cable-laying activities, a survey plan on eelgrass beds according to state and Federal permit conditions would be developed. Before the start of cable-laying activities, the lessee will submit the results of eelgrass surveys to state and Federal regulators. Post-construction eelgrass maps shall be generated one year after the cable laying is completed. At this time, no impacts on eelgrass or other SAV are expected to occur during proposed Project construction and operations. However, if unanticipated impacts on these resources become reasonably certain to occur, the applicant will undertake the necessary data collection using the 2016 agency guidance (USACE and NMFS 2016) for SAV surveys to quantify the extent of any SAV detected within the proposed Project area, quantify expected impacts on SAV, coordinate with co-action agencies to identify locations for any SAV restoration work, and submit a SAV restoration plan as part of applications to BOEM and the USACE if necessary. If necessary, this plan will be included as a condition of Project authorization and include off-site restoration of SAV impacts within the construction area, restoration of the areas disturbed by construction, and monitoring of both the off-site and on-site restoration areas. It is also expected that isolated areas of hard bottom may be avoided, such as at Spindle Rock; however, in areas such as Muskeget Channel where hard bottom extends across the entire corridor, it will not be possible to avoid hard bottom.

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 must provide the U.S. Department of the Interior (USDOI) with a boulder relocation plan.

The boulder relocation plan 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; and
- Methods to minimize the quantity of seafloor obstructions from relocated boulders in areas of active bottom-trawl fishing.

The applicant must submit its boulder relocation plan to BOEM (at renewable_reporting@boem.gov) and the Bureau of Safety and Environmental Enforcement (at OSWSubmittals@bsee.gov). The USDOI 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 USDOI's satisfaction before the plan is implemented. If the USDOI does not provide comments on the plan within 90 calendar days of its submittal, the applicant may conclude that the plan is not accepted and should not implement the plan.

Any boulders that can not be avoided will be shifted perpendicular to the cable route, where feasible, and no boulders will be removed from the OECC. The locations of any relocated boulders that will protrude 6.5 feet or more on the seafloor will be reported to BOEM, MassDEP, Massachusetts CZM, RI CRMC, the US Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), and the local harbormaster (if within a town's jurisdiction) within 30 days of relocation. These locations will be reported in latitude and longitude degrees to the nearest 10 thousandth of a decimal degree (roughly the nearest meter), or as precise as practicable. Where technically practicable, relocated boulders will be grouped with other boulders to minimize creating new fishing hangs (New England Wind 2023).

The applicant is committed to fisheries science and research as it relates to offshore wind energy development. Working with the Massachusetts School for Marine Science and Technology, the applicant is currently collecting pre-construction fisheries data (via trawl and drop camera surveys) within the SWDA. The applicant plans to develop a framework for during- and post-construction fisheries studies within the proposed New England Wind Project. Surveys from 2019 through 2022 for the Vineyard Wind 1 area and the New England Wind (501 S) and the 522 lease have been complected and have provided baseline data demonstrating presence and utilization of the managed species within the SWDA. Cadrin 2021 has provided a review report summarizing the survey results for 2019 - 2020 surveys for Vineyard Wind 1 and the control site. A total of 45 species have been collected within the Vineyard Wind 1 project area and a control site. During the 2019 and 2020 surveys spiny dogfish, little skate, silver hake and red hake were the four most abundant species within the study sites resulting in 71 and 78 % of total catch weight at the Vineyard Wind 1 and control site, respectively (Cadrin 2021). Vineyard Wind plans to use the data collected to evaluate impacts to fisheries resources during construction and operational activities (Cardin 2021). In recognition of the regional nature of fisheries science, the applicant expects that such during- and post-construction studies will involve coordination with other offshore wind energy developers in the RI/MA Lease Areas. The proposed Project also expects the development of the fisheries studies will be undertaken in coordination with BOEM, other federal and state agencies, fisheries stakeholders, academic institutions, and other stakeholders. The applicant is already engaging in collaboration with other developers, fishing industry representatives, and state and federal agencies through its participation in the Responsible Offshore Science Alliance and the Regional Wildlife Science Entity partnership.

The applicant is also committed to developing an appropriate benthic monitoring framework for the proposed Project (COP Volume III, Appendix III-U; Epsilon 2022 [outlines the draft framework]). The framework considers the *Vineyard Wind Benthic Habitat Monitoring Plan* for Vineyard Wind 1 in Lease Area OCS-A 0501 (Geo Subsea et al. 2020). Due to the similarities in habitat across the RI/MA Lease Areas OCS-A 0501 and OCS-A 0534, the monitoring data collected during the Vineyard Wind 1 monitoring effort may also inform potential impacts on and recovery of benthic communities within the SWDA. The applicant will continue to consult with BOEM and other federal and state agencies as appropriate to further refine the benthic monitoring framework for the proposed Project.

5.1.5 Summary of Impacts (Phases 1 and 2)

Overall, impacts on EFH in the proposed Project area are anticipated to be short term and localized during construction of the proposed Project. Many impacts are expected to be temporary, such as seafloor disturbance from cable installation (including any required dredging along the OECC), the resuspension and settlement of sediments during cable installation and dredging activities, habitat disturbance from the use of jack-up and/or anchored vessels, and water withdrawal during cable installation. In addition, temporary noise from pile driving could potentially impact all species with EFH in the SWDA during construction. However, the use of a soft start during pile driving would give fish in the SWDA time to avoid the noise source before full impact strikes are made. Sound reduction technologies would be used to reduce the impacts from pile driving. This would be involve noise attenuation technologies such as Hydro-sound Damper, AdBm encapsulated bubble sleeve, or bubble curtains, deployed near to the pile.

The appropriate technology will be utilized to reduce sound levels by a target of approximately 10 dB or greater level of sound reduction and (COP Volume III, Table 6.7-14; Epsilon 2022). BOEM proposes requiring a Pile Driving Monitoring Plan and Sound Field Verification Plan as part of the FEIS (Appendix H Mitigation and Monitoring) in which the Applicant will have to detail the proposed noise attenuation system and the methods with which they will measure it's efficacy to be submitted for agency review and approval prior to construction.

Recovery of disturbed habitats is expected, and previous research indicates that communities begin to repopulate within a few months of disturbance (Dernie et al. 2003; Van Dalfsen and Essink 2001). Alteration of sand wave habitat would likely be temporary and would have little impact on fishes in the area, as these are dynamic, ever-changing environments. In addition, most mobile pelagic and demersal fishes would be able to avoid areas where habitat disturbance would occur, and mortality of these fishes would be minimal (COP Volume III, Section 6.6.2; Epsilon 2022). Sessile Benthic organisms and demersal egg or larval life stages would be unable to avoid construction and may be buried by associated habitat disturbance. Burrowing mollusks in the area, such as surf clams and quahogs, would likely be able to avoid most lethal burial depths and are only expected to be slightly impacted and exhibit short-term avoidance/feeding behavior. No population-level impacts are expected for any of the species with EFH in the area because the proposed Project area represents a very small portion of available habitat in the region.

5.2 Operations and Maintenance

5.2.1 Habitat Alteration (Phases 1 and 2)

5.2.1.1 Southern Wind Development Area—Phases 1 and 2

The addition of structured habitat in the SWDA from WTG/ESP foundations and associated scour protection as well as cable protection (if required) may act as an artificial reef and would increase EFH for species that prefer complex habitat and minimally decrease (relative to total area available nearby) EFH for species that prefer Sand Bottom habitat. Habitat complexity is an important contributor to diversity and abundance of a large number of EFH finfish and ecologically important fish and invertebrate prey species utilized by EFH species (e.g., through facilitating refuge from prey during early life stages, providing areas of post-larval settlement; Loren et al. 2007; Malatesta and Auster 1999). Previous research on fish habitat use after wind farm installation observed that WTG structures were large enough to attract and support new communities of rocky-habitat fishes, but not large enough to negatively impact fish communities that prefer sandy bottom areas between the WTGs (Stenberg et al. 2015). Initial recruitment to these hard substrates may result in the increased abundance of certain fish and epifaunal invertebrate species (Claisse et al. 2014; Smith et al. 2016); such recruitment may result in the development of diverse demersal Complex Habitat Sessile/Epibenthic and Mobile fish and Invertebrate Species Groups. However, such high initial diversity levels may decline over time as early colonizers are replaced by successional communities (Degraer et al. 2018).

Locally, cobble and boulder-type habitats are particularly important to lobsters because they serve as both nursery grounds for benthic juveniles and as home substrata for adults (Linnane et al. 1999); the addition of scour protection could attract lobsters to these artificial habitats. Recent attention has been focused on the utilization of nature-inclusive design materials to enhance the ecological services that scour protection structures may support as artificial hardbottom habitat. The nature-inclusive design materials would be chosen to better mimic the complex and diverse interstitial spaces that are important EFH habitats for multiple EFH and ecologically important species and their life history stages. Within the SWDA, the total area of soft-bottom habitat permanently altered to complex or heterogeneous complex habitat from installation of WTG/ESP foundations, associated scour protection, and potential cable protection (if required) is 295 acres of the 111,939 acres total area. The addition of new structure in the SWDA, which consists of only soft-bottom habitat, may increase biodiversity and secondary production but introduced habitats could also provide opportunities for the spread and colonization of non-indigenous species (Glasby et al. 2007).

The addition of the WTG structure throughout the water column may alter pelagic EFH as WTG foundations provide substrata for shellfish to attach and colonization by these species can change nutrient and plankton concentrations previously observed in the area (Norling and Kautsky 2007; Slavik et al. 2017). For example, biofouling by blue mussels, a filter feeder, on WTG structures in wind farms located in the North Sea notably reduced the daily net primary productivity on a regional scale. However, reduction in primary production resulted in increased production and biodiversity of higher trophic levels (Slavik et al. 2017). Raoux et al. (2017) also observed that total ecosystem activity increased and that high trophic level organisms responded positively to increased biomass near monopiles after the construction of a wind farm. In addition, increases in commercially important species, such as Atlantic cod and whiting, were observed near deep water wind farms (Hille Ris Lambers and ter Hofstede 2009; Løkkeborg et al. 2002). There is also evidence that WTG reef habitats and the resources they provide increase the growth and condition of juvenile Atlantic cod and whiting-pout (*Trisopterus luscus*) (Reubens et al. 2013).

The presence of the WTGs in the SWDA may also alter the local ocean circulation in the region, potentially changing planktonic distributions and dispersal patterns. However, hydrodynamic modeling simulating larval transport around WTGs in the RI/MA Lease Areas found that the presence of WTG structures would not have significant influence on southward larval transport during storm events (Chen et al. 2016). BOEM recently published a white paper that modeled the "mesoscale" (intermediate-sized) effects of offshore wind energy facilities on coastal and oceanic environmental conditions and habitat using three target fish and invertebrate larvae (sea scallops, silver hake and summer flounder [Johnson et al. 2021]). The results of this modeling effort indicated that, at a regional fisheries management level, the shifts predicted in their modeling results showed larval settlement density are not considered overly relevant. However, analysis did suggest that there could be a risk of impact on certain subpopulations within the Mid Atlantic Bight, warranting future localized investigations.

5.2.1.2 Offshore Export Cable Corridor—Phases 1 and 2

As in the SWDA, cable protection (rock, concrete mattresses, gabion rock bags, or half-shell pipes [or similar]) may be required along the OECC (including the Western Muskeget Variant) in areas where target burial depths cannot be achieved. The addition of cable protection would locally alter soft-bottom habitat to complex habitat. In other areas, cable protection would be placed on bottom habitat already classified as complex. The estimated total amount of potential permanent bottom habitat altered by cable protection would be approximately 55 acres for the OECC for both phases (Table 5-2). If the Western Muskeget Variant is used for one or two Phase 2 export cables, the total amount of permanent habitat alteration for both phases combined from the potential installation of cable protection (if required) would be approximately 59 to 60 acres. As noted above for the SWDA, the addition of hard-bottom structure in these previously flat, soft sediment areas may attract different species and act as artificial reef habitat. Impacts on EFH would be similar to that explained above and would include temporary and permanent impacts on benthic and pelagic habitat, displacement of mobile juvenile and adult fishes and invertebrates. Some of the area to be impacted could be complex hard bottom habitat but this cannot be determined until the OECC routes are selected and post burial surveys are completed. There is a potential that some of the habitat will be modified from fine, unconsolidated habitat to a habitat that may function similar but not equal to complex, hard-bottom habitat with the placement of the cable protection features proposed.

5.2.2 Increased Sound Exposure (Phases 1 and 2)

The acoustic characteristics of vessel sounds associated with operations are the same as those produced during construction. It is reasonable to assume that the amount of sound produced during operations is similar to, or less than, those generated during the construction phase due to a lower number and smaller size of vessels. Possible sound sources other than vessel operations include the WTGs themselves, which generate sound in the nacelle that is transmitted from the topside to the foundation and then radiated into the water, and subsea cable vibration.

Avoidance of areas around the WTG due to operational noise may occur but is not expected to significantly impact EFH as the SWDA is only a small portion of available habitat in the area. In addition, measurements at the Block Island Wind Farm found sound would likely decline to ambient levels at a distance of 0.5 nautical mile (0.6 mile) from the WTG, and the average sound level was recorded to be between 112 to 120 dB re 1 µPa when wind speed was 4.4 to 26.9 miles per hour (HDR 2019). Closer to operational WTGs in Europe, SPLs ranged from 109 dB to 127 dB measured at 46 to 66 feet (Tougaard et al. 2009), which is below the NMFS interim criteria for behavior impacts on fish (150 dB re 1 µPa). WTG foundation design was found to make a difference in SPL at farther distances. Steel monopile WTG designs were observed producing louder sounds (133 dB re 1 µPa with peak frequency of 50 and 140 hertz) than jacket foundations (122 dB with peak frequency of 50 hertz and secondary peaks at 150 hertz, 400 hertz, 500 hertz, and 1,200 hertz) when both were measured at 150 meters (492 feet). However, at a closer distance of 40 meters (131 feet), SPLs were comparable between the steel monopile and jacket foundation WTGs (135 and 137 dB re 1 µPa, respectively) (Thomsen et al. 2016).

Underwater sound produced by a WTG is also related to WTG power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). At high wind speeds, Wahlberg and Westerberg (2005) estimated avoidance by fish would only occur within a range of 13 feet of a WTG. In a study on fishes near the Svante wind farm in Sweden, Atlantic cod and roach (*Rutilus rutilus*) catch rates were significantly higher near WTGs when rotors were stopped, which could indicate fish attraction to WTG structure and avoidance to generated noise (Westerberg 2000 as cited in Thomsen et al. 2006). Alternatively, no avoidance behavior was detected, and fish densities increased around WTG foundations of the Lillgrund offshore wind farm in Sweden (Bergström et al. 2013). In addition, ambient noise can influence how fish detect other sounds and a change in background noise could alter how fish perceive and react to biological noise stimuli (Popper and Fay 1993). Ambient noise within the 70.8 to 224 hertz frequency band in the RI/MA Lease Areas was measured to be between 96 and 103 dB re 1 µPa 50 percent of the time with greater sound levels 10 percent of the time (Kraus et al. 2016). More specifically, ambient noise within the Lease Area OCS-A 501 was measured to be approximately 75 dB re 1 $\mu Pa^2/Hz$ in the 100 Hz frequency band, 57 dB re 1 $\mu Pa^2/Hz$ in the 1,000 Hz frequency band, and 75 dB re 1 $\mu Pa^2/Hz$ in the 30,000 Hz frequency band (Alpine Ocean Seismic Surveying, Inc. 2017). Overall, current literature indicates noise generated from the operation of wind energy facilities is minor and does not cause injury or lead to permanent avoidance of EFH (Stenberg et al. 2015; Wahlberg and Westerberg 2005; Wilber et al. 2022). There is the potential to have minimal effects at much closer distances up to within a few meters of the WTG (Bergström et al. 2013) such as masking auditory sensitivity and communication of fishes within a few tens of meters of WTGs (Zhang et al. 2021). Subsea cables are expected to produce low-frequency tonal vibration sounds in the water, since Coulomb forces between the conductors cause the high voltage AC lines to vibrate at twice the frequency of the current (direct current cables do not produce a similar tonal sound because the current is not alternating). Low-level tonal sound from an existing 138 kV transmission line was measured in Trincomali Channel, offshore Vancouver Island, British Columbia, during a very quiet period of recording. The SPL at approximately 328 feet from the cable was below 80 dB re 1 µPa. Assuming cylindrical spreading of sound, the source level of the submarine cable was approximately 100 dB re µPa-m (Austin et al. 2006). Anticipated SPLs arising from the vibration of AC cables during operations are significantly lower than

SPLs that may occur during cable installation (Meißner et al. 2006) and may be undetectable in the ambient soundscape of the proposed Project area, especially after consideration of the 5- to 8-foot target burial depth.

5.2.3 Electromagnetic Fields (Phases 1 and 2)

Electromagnetic fields (EMF) would be generated by inter-array cables connecting WTGs in the SWDA, inter-link cables between the ESPs, and offshore export cables along the OECC (including the Western Muskeget Variant). Fish use electromagnetic sense for orientation and prey detection; therefore, the function of key ecological mechanisms may be impacted by EMF generated by the cables (Riefolo et al. 2016).

Recent research investigating habitat use around energized cables found no evidence that fishes or invertebrates were attracted to or repelled by EMF emitted by cables (Love et al. 2017). A white paper review study funded by BOEM determined that there would be negligible, if any, effects on bottom-dwelling commercial and recreational fish species and no negative effects on pelagic commercial and recreational fish species in the southern New England area from EMF produced by power transmission cables (CSA Ocean Sciences Inc. and Exponent 2019). Recent studies funded by BOEM found that although there were changes in the behavior of little skate (an elasmobranch) and American lobster in the presence of energized cables, EMF from cables did not act as a barrier to movement in any way (Hutchison et al. 2018, 2020). In addition, because EMF produced by cables decreases with distance, and the target burial depth for the wrapped cables is 5 to 8 feet, the EMF at the seabed would be weak and likely only detectable by benthic or demersal species (Normandeau Associates 2011). To date, there is no evidence linking anthropogenic EMF from WTG cables to negative responses in fish (Baruah 2016; Normandeau et al. 2011), but there is some evidence of attraction in a species of cancer crab when EMF strength was hundreds of times greater than expected by modeling for the proposed Project (Scott et al. 2021; Gradient 2020, 2021). Furthermore, there are already subsea transmission cables present in the region (outside of the proposed Project area) with five between Martha's Vineyard and Falmouth and two more between Nantucket and Cape Cod (COP Volume III, Section 7.9; Epsilon 2022).

Modeling of proposed Project-specific cables was conducted to assess potential impacts of EMF. As submarine offshore export cables would not produce any electric fields in the seafloor or ocean due to the shielding effect of the cable covering, modeling of potential impacts from proposed Project cables was focused on magnetic fields. High voltage AC cables (which would be used for Phase 1 and Phase 2) were modeled. All modeling assumed cables were buried beneath 5 feet of sediments. In areas where sufficient burial is not achieved and cable protection is used, the protection would serve as a physical barrier in the same manner as cable burial, preventing organisms from experiencing the full strength of the magnetic field.

Modeling of the 220 and 275 kV high voltage AC cables demonstrated that magnetic fields at the seafloor from the buried cables decrease with distance, with a maximum magnetic field of 84.3 milligauss directly above the centerline that decreases to 5.6 milligauss at 20 feet from the centerline (Gradient 2020, 2021). These model results indicate that magnetic fields are likely only able to be sensed, if at all, directly over the buried cable centerline. Consistent with the modeled magnetic field levels and the findings on 60 Hz AC EMF (CSA Ocean Sciences Inc.and Exponent 2019), and because cables in the proposed Project area would have a minimum target burial depth of approximately 5 feet, it is unlikely that demersal or benthic organisms would be affected by magnetic fields from the offshore cable system.

The EFH assessment for Vineyard Wind 1 also determined no measurable impacts of EMF would be expected on populations of species with EFH designated in the Vineyard Wind 1 Lease Area (BOEM 2019).

5.2.4 Cable Maintenance (Phases 1 and 2)

Cable maintenance and/or repair, as described in the COP (Volume I Section 4.3.2.4; Epsilon 2022) may infrequently occur along limited segments of the offshore cables. Procedures employed to repair segments of cable in the SWDA and OECC (including the Western Muskeget Variant) may involve bringing the cable to the surface for repair, followed by reinstallation of the cable. The types of activities and vessels/equipment used for corrective maintenance are similar to those during construction (Volume I, Section 4.3.1) and explained above for cable installation, but the impacts from repair activities would be much smaller in extent and duration. Based on previous experience in the Northeast Atlantic BOEM anticipates cable repair activities could include additional trenching. Where trenching is not an option a Controlled Flow Excavation (CFE) and/or a combination with use of gravel bags and/or rock placement. CFE would not have contact with the cable and would not be expected to leave excess berms elevating seabed contours. To the extent gravel bags and/or rock placement needs to be used in conjunction with CFE, minimal elevation above seabed may be experienced. Through CFE activities, the cable would be expected to be buried by its own weight. In the event that it is deemed necessary to protect the cable with gravel bags or rock placement due to CFE operation giving unsuccessful or insufficient protection to the cable, the elevation above natural seabed will not be expected to be more than 0.5 meters, which would be the height of gravel bags/rock beam from natural seabed if no trench was achieved at all.

Seafloor disturbance would be associated with uncovering/extracting and the subsequent reburial of the cable in the seabed as described in the methodologies above and from the anchoring impacts from vessels used in the operations. Other impacts would include temporary displacement, potential burial for sessile immobile or slow-moving life stages or species, and turbidity and sediment dispersion impacts of benthic and pelagic habitat. Such impacts would be confined to the specific area of the repair(s) and, given the limited area(s) where repair(s) may occur, would be considerably less than the impacts during the initial installation of the Inter-array and OECC routes.

5.2.5 Other Impacts (Phases 1 and 2)

Geophysical or geotechnical survey work may occur during operations. Geotechnical sampling may have highly localized impacts on EFH and species with EFH that are limited to the immediate area of the geotechnical sample location or any benthic grab or drop camera sampling stations.

Anchoring of CTVs or other accommodation vessels may occur within the SWDA during normal operations. If repair work is required, both anchoring (within the SWDA or along the OECC) and the use of jack-up vessels (within the SWDA) may occur. As described in the COP (Volume III, Section 7.8; Epsilon 2022), approximately 290 vessel trips are expected per year during operations for each phase (assuming each phase’s maximum design scenario), which is significantly less than during construction. Such impacts would be highly localized and short term.

5.2.6 Avoidance, Minimization, and Mitigation Measures (Phases 1 and 2)

The potential impacts and avoidance, minimization, and mitigation measures would be broadly the same as discussed previously for construction, except for pile-driving mitigation measures and HDD as they are not expected during operations of the proposed Project.

5.2.7 Summary of Impacts (Phases 1 and 2)

5.2.7.1 Southern Wind Development Area and Offshore Export Cable Corridor—Phases 1 and 2

Impacts that may occur during operations of the proposed Project include alteration of benthic and pelagic EFH, increased noise, EMF, and maintenance activities. Limited benthic EFH would likely be altered from fine, unconsolidated substrate to structured habitat in the SWDA and may cause changes in fish assemblages in the area. Cable protection may also be used along the OECC (including the Western Muskeget Variant) and increase the amount of complex or heterogeneous complex habitat present in the area. Increased noise from the operation of the WTGs would increase background noise and, as previous research indicates, may elicit avoidance responses in some species. Due to time-of-year restrictions established for marine mammals, no pile driving will occur between January 1 and April 30th. Required maintenance of the WTGs, ESPs, or cables may impact organisms in a similar manner as construction.

In summary, impacts on EFH and the associated species during operations of the proposed Project are expected to be localized and population-scale impacts are unlikely. Little to no direct mortality of EFH species would occur, other than potentially during cable repair, which is expected to be rare and localized. The addition of hard-structure habitat would increase the amount of hard-bottom EFH and add complexity to the area that did not exist before, which is likely to attract commercially important species that prefer structured habitat, but could also provide habitat for of invasive species present in the region. Overall, current literature indicates noise generated from the operation of wind energy facilities is minimal and only localized avoidance behaviors are expected; acclimation to noise may also occur over time. The addition of EMF from submarine cables would likely not limit the use of EFH by elasmobranchs or other electro-sensitive fish species because cables would be buried in the substrate or covered with cable protection.

5.3 Proposed Project Monitoring Activities

The COP does not discuss potential impacts associated with the proposed monitoring activities. This assessment assumes that the impacts of monitoring activities would be similar in nature to, but of substantially lower magnitude than, impacts described for proposed Project construction and operations.

5.4 Conceptual Decommissioning

5.4.1 Overall Impacts (Phases 1 and 2)

Decommissioning activities would include removal of WTG/ESP foundations to below the mudline, removal of scour protection, and retirement in place or removal of cables within the SWDA and OECC (including the Western Muskeget Variant). These activities would be similar to those associated with construction. Removal of the piles from the SWDA would shift habitat type back to pre-construction conditions and likely result in a reversion of local finfish and invertebrate species assemblages to non-structure communities. Cable removal, if required, would result in direct disturbance of EFH along the path of the cables and would resuspend bottom sediments and impact organisms temporarily.

Decommissioning would not involve pile driving or associated hydroacoustic impacts, but underwater decommissioning noise could be emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jet, and vacuum pumps. SPLs are not available for these types of equipment but are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 µPa [Pangerc et al. 2016; Tougaard et al. 2020]).

5.4.2 Avoidance, Minimization, and Mitigation Measures (Phases 1 and 2)

The avoidance, minimization, and mitigation measures would be the same as discussed previously for construction although pile-driving activities, and associated avoidance, minimization, and mitigation measures are not expected during decommissioning.

5.5 Summary

A summary table of the primary IPFs and their anticipated effect level on EFH species and their associated life stages are provided in Table 5.6.

The table illustrates the following:

For short-term adverse effects on EFH, factors like construction noise (e.g., pile driving - see Sections 5.1.3 and 5.2.7.1) and impaired water quality construction activities (e.g., turbidity and sedimentation, see Section 5.1.2) could temporarily affect any life stage of any of the EFH species listed. Species with demersal life stages would be susceptible to burial/crushing from the limited construction activities (e.g., placement of armoring or fill - see Section 5.1.1). And EFH species with planktonic life stages (e.g., pelagic eggs and/or larvae) would be susceptible to entrainment (e.g., water intake for jet plows – see Section 5.1.2).

Long term adverse effects on EFH species were more limited. Habitat disturbance and conversion (e.g., armoring – see Section 5.1.1) would affect life stages of species that had a habitat association with the seafloor, particularly those associated with soft-bottom habitat. And EFH species with planktonic life stages (e.g., pelagic eggs and/or larvae) could be susceptible to long term hydrodynamic changes of dispersal at the regional fisheries management scale (see Section 5.1.2). It is not anticipated that operation noise will have permanent, long-term adverse effects on EFH for any species (e.g., potential for temporary avoidance during high wind speeds and subsequent increased noise levels – see Section 5.2.1). It is also not anticipated that EMF will have permanent, adverse effects as a result of anticipated cable burial depths and additional cable shielding where necessary (see Sections 5.2.3 and 5.2.7.1).

Table 5-6: Summary of the expected adverse effects on the various life stages of EFH species

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Gadids	Atlantic cod (*Gadus morhua*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Complex habitat	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Complex habitat	Yes	Yes	--	Yes	Yes	No	No	--
	Pollock (*Pollachius virens*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	No	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	No	Yes
		Juvenile	Benthic complex/ non-complex	Yes	Yes	--	Yes	Yes	No	No	--
	Red hake (*Urophycis chuss*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	--
	Silver hake (*Merluccius bilinearis*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	--
Other finfish	White hake (*Urophycis tenuis*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Pelagic/ soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--
	Atlantic butterfish (*Peprilus triacanthus*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom habitat	Yes	--	No	Yes	Yes	No	No	No
		Adult	Soft-bottom habitat	Yes	--	No	Yes	Yes	No	No	No
	Atlantic herring (*Clupea harengus*)	Eggs	Heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	Yes

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Pelagic/heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No
		Adult	Pelagic/heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No
	Atlantic wolffish (*Anarhichas lupus*)	Eggs	Complex habitat	Yes	Yes	--	Yes	Yes	No	No	Yes
		Larvae	Pelagic/heterogeneous complex	Yes	Yes	Yes	Yes	Yes	No	No	Yes
		Juvenile	Heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
	Black sea bass (*Centropristis striata*)	Juvenile	Complex/heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Complex/heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
	Bluefish (*Pomatomus saltatrix*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	--	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	--	No
	Haddock (*Melanogrammus aeglefinus*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Pelagic/heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No
		Adult	Heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
	Monkfish (*Lophius americanus*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No
	Ocean pout (*Macrozoarces americanus*)	Eggs	Complex	Yes	Yes	No	Yes	Yes	No	No	No
		Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	No	Yes	Yes	No	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
	Scup (*Stenotomus chrysops*)	Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
Flatfish	American plaice (*Hippoglossoides platessoides*)	Larvae	Pelagic	Yes	--	Yes	Yes	Yes	No	--	Yes
	Barndoor skate (*Dipturus laevis*)	Juvenile	Soft-bottom/ complex habitat	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom/ complex habitat	Yes	Yes	--	Yes	Yes	No	No	No
	Summer flounder (*Paralichthys dentatus*)	Eggs	Soft-bottom/pelagic	Yes	Yes	Yes	Yes	Yes	No	No	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
	Windowpane flounder (*Scophthalmus aquosus*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	No
	Winter flounder (*Pseudopleuronectes americanus*)	Eggs	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	No
	Witch flounder (*Glyptocephalus cynoglossus*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
	Yellowtail flounder (*Limanda ferruginea*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	--	Yes
		Juvenile	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Highly migratory species	Atlantic mackerel (*Scomber scombrus*)	Eggs	Pelagic	Yes	--	Yes	Yes	--	No	No	Yes
		Larvae	Pelagic	Yes	--	Yes	Yes	--	No	No	Yes
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Atlantic albacore tuna (*Thunnus alalunga*)	Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Atlantic bluefin tuna (*Thunnus thynnus*)	Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Atlantic skipjack tuna (*Katsuwonus pelami*)	Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Atlantic yellowfin tuna (*Thunnus albacares*)	Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
Coastal Migratory	Cobia (*Rachycentron canadum*), Spanish mackerel (*Scomberomorus maculatus*), and king mackerel (*Scomberomorus cavalla*)	Eggs	Pelagic/ heterogeneous complex	Yes	--	Yes	Yes	Yes	No	No	Yes
		Larvae	Pelagic/ heterogeneous complex	Yes	--	Yes	Yes	Yes	No	No	Yes
		Juvenile	Pelagic/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Adult	Pelagic/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
Sharks	Basking shark (*Cetorhinus maximus*)	Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Blue shark (*Prionace glauca*)	Neonate/ YOY	Pelagic	Yes	--	No	Yes	--	No	No	No
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Subadult	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
Sharks (cont.)	Common thresher (*Alopias vulpinus*)	Neonate/ YOY	Pelagic	Yes	--	No	Yes	--	No	No	No
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Subadult	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
Sharks (cont.)	Dusky shark (*Carcharhinus obscurus*)	Neonate/ YOY	Pelagic	Yes	--	No	Yes	--	No	No	No
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Subadult	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Porbeagle shark (*Lamna nasus*)	Neonate/ YOY	Pelagic	Yes	--	No	Yes	--	No	No	No
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Sand tiger shark (*Carcharias taurus*)	Neonate/ YOY	Heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Juvenile	Heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Subadult	Heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
	Sandbar shark (*Carcharhinus plumbeus*)	Juvenile	Pelatic	Yes	--	No	Yes	--	No	No	No
		Subadult	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Shortfin mako shark (*Isurus oxyrinchus*)	Neonate/YOY	Pelagic	Yes	--	No	Yes	--	No	No	No
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Subadult	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Tiger shark (*Galeocerdo cuvier*)	Juvenile	Pelagic	Yes	--	No	Yes	--	No	No	No
		Subadult	Pelagic	Yes	--	No	Yes	--	No	No	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	No	No
	Smooth dogfish (*Mustelus canis*)	Neonate/ YOY	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Juvenile	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	Crushing and Burial	Entrainment	Water Quality	Habitat Disturbance and Conversion	Operational Noise	EMF	Hydrodynamic
		Subadult	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
	Spiny dogfish (*Squalus acanthias*)	Juvenile	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Subadult	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	--	No	Yes	Yes	No	No	No
	White shark (*Carcharodon carcharias*)	Neonate/ YOY	Pelagic	Yes	--	No	Yes	--	No	--	No
		Juvenile	Pelagic	Yes	--	No	Yes	--	No	--	No
		Adult	Pelagic	Yes	--	No	Yes	--	No	--	No
Skates	Little Skate (*Leucoraja erinacea*)	Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	No	Yes	--	Yes	Yes	No	No	No
	Winter skate (*Leucoraja ocellata*)	Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	No
Invertebrates	Atlantic sea scallop (*Placopecten magellanicus*)	Eggs	Complex/ soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	--
		Larvae	Pelagic/Complex /heterogeneous complex	Yes	Yes	Yes	Yes	Yes	No	No	Yes
		Juvenile	Complex/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--
	Atlantic surf clam (*Spusula solidissima*)	Juvenile	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Soft-bottom habitat	Yes	Yes	--	Yes	Yes	No	No	--
	Longfin inshore squid (*Loligo pealeii*)	Eggs	Complex/ soft-bottom/ heterogeneous complex habitat	Yes	Yes	--	Yes	Yes	No	No	--
		Juvenile	Pelagic	Yes	--	Yes	Yes	Yes	No	--	No
		Adult	Pelagic	Yes	--	No	Yes	Yes	No	--	No

EFH Species Group	EFH Species	Life Stage	Habitat Association	Short-Term Adverse Effects on EFH				Long-Term and Permanent Adverse Effects on EFH			
				Construction Noise	**Crushing and Burial**	**Entrainment**	**Water Quality**	**Habitat Disturbance and Conversion**	**Operational Noise**	**EMF**	**Hydrodynamic**
	Northern shortfin squid (*Illex illecebrosu*)	Adult	Pelagic	Yes	--	No	Yes	--	No	--	No
	Ocean quahog (*Artica islandica*)	Juvenile	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--
		Adult	Soft-bottom/ heterogeneous complex	Yes	Yes	--	Yes	Yes	No	No	--

6 Avoidance, Minimization, and Mitigation

The following definitions are used for Proposed Action impacts and avoidance, minimization, and mitigation measures.

Monitoring zone: The monitoring zone is the area around an impact-producing activity observed for the presence of endangered and threatened species and biological indicators such as schools of fish, jellyfish, or other indicators of possible marine mammal and sea turtle presence. This zone includes and extends beyond the exclusion zone and is observed to the greatest extent practicable. This area is demarcated and intended to document animal presence in the area and monitor movements toward the clearance zone. Identification of the species, direction of travel, behavior, oceanic and biological conditions, and other data reporting are conducted within this zone.

Clearance zone: The clearance zone is the area around an impact-producing activity observed to ensure no endangered or threatened species are present prior to the commencement of the activity. Adequate numbers of protected species observers and monitoring conditions must be present for effective monitoring of the clearance zone. The size of this zone may vary depending on the activity. Data collection, such as animal behavior, actions taken, and other data, is conducted in this zone.

Soft start: The soft start would include an initial set of three strikes from the impact hammer at reduced energy, followed by a 1-minute waiting period. This process is repeated a total of three times prior to initiation of pile driving. Soft start is required for any impact driving, including at the beginning of the day and at any time following a cessation of impact pile driving of 30 minutes or longer. This approach is consistent with the requirements in the NMFS-issued Incidental Take Authorizations for the Vineyard Wind 1 and South Fork Wind Projects.

6.1 Avoidance and Minimization Measures

The applicant’s avoidance and minimization measures are aimed to reduce potential impacts on protected marine species are listed below. Additional mitigation, monitoring, and reporting measures are also proposed by BOEM for consultation in the Biological Assessment (BA) for NMFS (BOEM 2022). Although these measure were designed to target protected species, they will also benefit species that are managed or associated with EFH:

Establish a seasonal restriction on pile driving between January 1 and April 30.[10]

Implement soft start during pile driving.

[10] This restriction is intended to minimize the amount of pile driving that occurs when the migratory North Atlantic right whale is likely to be in the offshore proposed Project area and would, thus, limit sound exposure for this endangered species. Density data from Roberts and Halpin (2022) and survey data (both visual and acoustic) from Kraus et al. (2016) suggest that the highest density of North Atlantic right whales in the SWDA occurs annually in March. Over 93 percent of the sightings in the Kraus et al. (2016) study occurred in January through April, with no North Atlantic right whales sighted from May through August.

Consider both human and animal safety if a protected species observer recommends pile driving be halted. For safety reasons during the initial stages of pile driving, the piling cannot be stopped because the pile penetration must be deep enough to ensure pile stability in an upright position. Later in the pile-driving process, piling must often continue to ensure foundation stability by reaching the target penetration depth without early refusal due to cessation of pile-driving. In the instance where pile driving is already started and a protected species observer recommends pile driving be halted, the lead engineer on duty will evaluate the following:

The site-specific soil data and the real-time hammer log information to judge whether a stoppage will risk causing piling refusal at re-start of piling;

The pile penetration to determine if it is deep enough to secure pile stability in the interim situation, taking into account weather statistics for the relevant season and the current weather forecast; and

Each pile as the installation progresses and not for the site as a whole. Where shutdown is not possible to maintain installation feasibility, reduced hammer energy will be requested and implemented where practicable. Reduced hammer energy is more likely to be feasible under circumstances where the pile is advancing at a typical rate and will be expected to continue to advance under lower hammer energy. After shutdown, piling can be initiated once the clearance zone is absent of the animals for the minimum species-specific time period, or if required to maintain installation feasibility.

Require use of automatic identification system on each Proposed Action vessel.

The applicant's avoidance measures to reduce potential impacts on Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*) include the following:

Use soft start during pile driving;

Use mid-line buoys, if feasible and safe, for equipment that minimizes installation impacts, such as jet plow;

Avoid, to the extent feasible, eelgrass and hard-bottom sediments; and

Bury cables in the substrate or covered with rock or concrete mattresses to mitigate the impacts of EMF.

6.2 Relevant Alternatives to the Proposed Action

The following discusses alternative cable routes proposed for the proposed Project. Compared to Alternative B, Proposed Action, Alternatives C-1 and C-2 would limit the number of export cables installed in the Eastern Muskeget route or Western Muskeget Variant but would not affect the number or placement of WTGs or ESPs for the proposed Project. The proposed cable route scenarios for Alternatives B, C-1, and C-2 and associated phases are provided in Table 6-1. Additional figures depicting the layout of Phase 2 cables for each scenario are provided in Appendix C. All other proposed Project components; including construction, operations, and decommissioning; would be identical to Alternative B. Table 5-2 presents the approximate maximum area of potential impacts on benthic habitat during proposed Project construction within the SWDA and OECC with and without the Phase 2 OECC Western Muskeget Variant.

Table 6-1: Project Alternatives and Associated Cable Layout Scenarios for Each Phase

Alternative	Phase	Scenario	Cable Layout (Number of Cables)		
			Eastern Muskeget OECC	Western Muskeget Variant OECC	SCV OECC
Alternative B: Proposed Action	1	NA	2	—	—
	2	1	3	—	—
		2	2	1	
		3	2	—	1
		4	1	2	—
		5	1	—	2
		6	—	—	3
Alternative C-1: Western Muskeget Variant Avoidance	1	NA	2	—	—
	2	1	3	—	—
		3	2	—	1
		5	1	—	2
		6	—	—	3
Alternative C-2: Eastern Muskeget Route Minimization	1	NA	2	—	—
	2	4	1	2	—
		5	1	—	2
		6	—	—	3

NA = not applicable; OECC = offshore export cable corridor; SCV = South Coast Variant

6.2.1 Alternative C – Habitat Impact Minimization Alternative

Under Alternative C, construction, operations, and decommissioning of the proposed Project's WTGs and ESPs would occur within the range of design parameters outlined in the COP, subject to applicable mitigation and monitoring measures described above. This alternative would minimize impacts on complex fisheries habitats—areas of seafloor that are stable, exhibit vertical relief, and/or provide rare habitat compared to the broad sand flats that characterize much of the OCS. Complex habitats include gravel or pebble-cobble beds, sand waves, biogenic structures (e.g., burrows, depressions, sessile soft-bodied invertebrates), shell aggregates, boulders, hard-bottom patches, and cobble beds, among other features (COP Volume II-A, Section 5.2; Epsilon 2022). There are two sub-alternatives.

Alternatives C-1 and C-2 would reduce or avoid some impacts on finfish, invertebrates, and EFH during construction, operations, and decommissioning in either the Western Muskeget Variant or Eastern Muskeget route due to a decrease in the extent of cable installation in complex habitat areas, including the avoidance of cod habitat in the area avoided. This would reduce the impacts from IPFs for accidental releases, anchoring and gear utilization, EMF, lighting, cable emplacement and maintenance, noise, and presence of structures (i.e., scour protection and foundations) in the specific area avoided.

6.2.1.1 Alternative C-1, Western Muskeget Variant Avoidance.

This alternative would preclude the use of the Western Muskeget Variant, limiting available scenarios to those that include only the Eastern Muskeget route and SCV. Avoiding use of the Western Muskeget Variant would avoid a crossing of a proposed OECC route for the Mayflower Wind Energy Project (Mayflower Wind) (Lease Area OCS-A 0521) within the Western Muskeget Channel. Cable crossings typically require portions of one of the cable systems (either from Mayflower Wind or the proposed Project) to be laid on the seafloor and covered with protective structures, such as half-shell pipes in lieu of burial. If the crossing occurs in complex habitat areas, the added protective structures could damage or destroy complex habitat features. By avoiding a cable crossing within the Muskeget Channel, Alternative C-1 would limit the total number of potential crossings of the Mayflower Wind cable to a single crossing south of Muskeget Channel, where complex fisheries habitat is rarer.

Alternative C-1 would avoid impacts on complex habitats in the Western Muskeget Variant by removing that route as an option for Phase 2. Under this alternative, all three Phase 2 export cables would be installed in the Eastern Muskeget route, as well as two cables for Phase 1.

Alternative C-1 would use only the Eastern Muskeget route, which would eliminate the impacts on finfish, invertebrates, and EFH in the Western Muskeget Variant. The Eastern Muskeget route contains more types of habitat than the Western Muskeget Variant but less of the habitat is complex seafloor. Using only the Eastern Muskeget route in Alternative C-1 would, therefore, affect more habitat types and a wider variety of finfish and invertebrate species inhabiting these habitats (as well as EFH, where present) than if the Western Muskeget Variant alone were used. However, Alternative C-1 would affect less of the complex habitat compared to Alternative B (which includes the potential use of the Western Muskeget Variant).

6.2.1.2 Alternative C-2, Eastern Muskeget Route Minimization.

This alternative would minimize, to the degree practicable, the use of the Eastern Muskeget route and maximize the use of the Western Muskeget Variant and/or the SCV for all Phase 2 export cables. Under this alternative, the two Phase 1 cables would be installed in the Eastern Muskeget route, along with a maximum of one Phase 2 cable. This eliminates the option for a total of two to three Phase 2 cables to be installed in the Eastern Muskeget route. This alternative could potentially reduce impacts on productive complex habitats along the Eastern Muskeget route compared to Alternative B.

Alternative C-2 would limit the number of export cables installed in the Eastern Muskeget route to three (both Phase 1 cables and one Phase 2 cable) and include installation of up to two cables in the Western Muskeget Variant. This would reduce impacts on complex habitats in the Eastern Muskeget route.

Alternative C-2 could use both the Eastern Muskeget route and the Western Muskeget Variant and would, therefore, affect finfish, invertebrates, and EFH in complex seafloor, hard coarse deposits, and soft-bottom habitats across a larger area than Alternative C-1. Under Alternative C-2, dredging for Phase 2 cable installation could impact up to 73 acres and could include up to 274,800 cubic yards of dredged material (compared to 67 acres and 235,400 cubic yards for Alternative B and Alternative C-1). The impacts of Alternative C-2 on finfish, invertebrates, and EFH in the Eastern Muskeget route would be less than those under Alternative C-1, and potentially less than those of Alternative B because Alternative C-2 would involve installation of fewer cables in the Eastern Muskeget route. The impacts of Alternative C-2 on finfish, invertebrates, and EFH in the Western Muskeget Variant would be greater than those of Alternative C-1, due to the installation of up to two cables in that corridor (where no such cables would be installed under Alternative B or Alternative C-1). Overall, Alternative C-2 would have greater impacts than Alternative C-1 on finfish and invertebrates that use complex seafloor habitats and on EFH in those habitats due to impacts within both the Eastern and Western Muskeget.

6.2.2 Alternative A – No Action Alternative

Under the No Action Alternative, BOEM would not approve the COP; proposed Project construction, operations, and decommissioning would not occur; and no additional permits or authorizations for the proposed Project would be required. Any potential environmental and socioeconomic impacts, including benefits, associated with the Proposed Action would not occur. However, all other existing or other planned impact-producing activities would continue. Alternative A serves as the baseline against which all action alternatives are evaluated.

6.3 Mitigation and Environmental Monitoring

The applicant's mitigation and monitoring measures aim to reduce and record potential impacts on ESA-listed marine species. Although these measures are intended to mitigate impacts on marine mammals, numerous species including federally managed EFH species will also benefit from the mitigation measures. Additional mitigation, monitoring, and reporting measures are also proposed by BOEM for consultation in the BA:

Implement noise attenuation technology to reduce sound levels produced during impact pile driving by a target of approximately 12 dB at the source. The BA analyzes a maximum-impact scenario in which only a 10 dB reduction is achieved since the type of sound reduction system that will be used is not yet identified and, thus, cannot be evaluated for past effectiveness during use. This measure includes implementation of a primary attenuation technology (e.g., noise mitigation system, hydrosound damper, noise abatement system, bubble curtain, or similar) and a secondary (backup) attenuation technology (e.g., bubble curtain or similar), if needed, pending results of field verification.

Complete sounds source characterization during pile-driving activities to ensure that the required 10 dB noise attenuation is met. The applicant will submit a sound source verification plan to USACE, BOEM, and NMFS for review 90 days prior to the commencement of field activities for pile driving. Detailed monitoring requirements have not yet been established.

Use the passive acoustic monitoring (PAM) system by trained PAM operators to monitor for acoustic detections. The PAM system will operate in accordance with the pre-piling clearance timing to be developed by the applicant. BOEM expects that the clearance timing for the Proposed Action will be similar to that described for the Vineyard Wind 1 Project (Table 31 of Appendix III-M in the COP for the Vineyard Wind 1 Project).

BOEM's mitigation and monitoring measures being considered for the Proposed Action are listed below. The measures may not all be within BOEM's statutory and regulatory authority to be required; however, they could potentially be imposed by other governmental entities and include, but are not limited to:

Require use of noise reduction technologies during all impact pile-driving activities that achieve a minimum reduction of 10 dB re 1 μPa to reduce noise impacts during construction.

Require use of fixed PAM buoys or autonomous PAM devices to continuously record ambient noise in the lease area (before, during, and immediately after construction), record marine mammal vocalizations, and monitor Proposed Action noise including vessel noise, pile driving, and WTG operation. Data collection, archival, analysis, and reporting of the results will be conducted by third parties following established guidelines specified by BOEM.

Require daily pre-construction PAM and visual surveys before pile driving begins to establish the abundance, presence, behavior, and travel directions of protected species in the area.

Require long-term monitoring to document the changes to the ecological communities on, around, and between WTG foundations and other benthic areas disturbed by the Proposed Action, including listed species movement and habitat use.

Provide centrally funded long-term regional monitoring of population-level impacts with the goal of identifying monitoring priorities for the regional monitoring strategy. There are active discussions among stakeholders and the offshore wind industry on this collaborative effort to answer specific scientific research questions about long-term impacts from the offshore wind industry as a whole.

Conduct annual underwater remotely operated vehicle surveys, reporting, and cleanup of monofilament and other fishing gear around WTG foundations. These surveys and cleanup activities will catalog indirect impacts associated with charter and recreational gear lost from expected increases in fishing around WTG foundations. Surveys will inform frequency and locations of debris removal to decrease ingestion by and entanglement of listed species.

6.3.1 Fisheries Monitoring Plan

The applicant's mitigation and monitoring plans to avoid or reduce potential impacts on EFH resources and threatened and endangered finfish species are summarized below and provided in the New England Wind Fisheries Monitoring Plan (Appendix D). The applicant has developed a comprehensive Fisheries Monitoring Plan to assess potential impacts of the proposed development on marine fish and invertebrate communities within and surrounding the proposed Project areas (SWDA and OECC). The proposed monitoring plan incorporates multiple gear types utilizing 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 study. Implementation of the monitoring plan will provide a holistic assessment of the key fisheries resources in the SWDA and assess the potential impact of offshore wind energy development with the use of a common control area. These surveys would provide information about EFH species in the Project area and potential changes to their ecosystem and population structure as a result of the proposed Project, helping to inform regulatory agencies as it relates to wind project impacts on EFH species resulting in better management of the EFH resources.

6.3.2 Benthic Habitat Monitoring Plan

The applicant's mitigation and monitoring plans to avoid or reduce potential impacts on the benthic resources within the proposed Project area is summarized below and provided in the New England Wind Draft Benthic Habitat Monitoring Plan (BHMP; Appendix E). The applicant is committed to developing an appropriate BHMP for the proposed Project in consultation with federal and state agencies. The New England Wind BHMP is based on the approved Vineyard Wind 1 BHMP and will replicate the Vineyard Wind 1 BHMP to the greatest extent practicable, including sharing the same six habitat zones, sampling effort, sampling equipment types, sample station design, control sites, and timing.

Monitoring efforts are proposed to occur in 2026 (pre-construction), 2027 or 2028 (Year 1); 2029 or 2030 (Year 3); and possibly 2031 or 2032 (Year 5). Because the proposed Project shares an OECC with Vineyard Wind 1, pre-construction sampling in 2026 allows for 3 years between Vineyard Wind 1 offshore export cable installation (occurring in 2022 and2023) and pre-construction sampling, eliminating potential impacts or interruption by Vineyard Wind 1 cable installation in the same OECC. As described in Section 2.4 of the BHMP, the survey design includes collection of bathymetry, video data, and benthic grab sample data. 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. These monitoring efforts would provide information about benthic resources in the proposed Project area and potential changes to their ecosystem and population structure as a result of the proposed Project, helping to inform regulatory agencies as it relates to wind project impacts on benthic habitats and associated EFH species resulting in better management of the EFH resources.

6.4 Adaptive Management Plans

BOEM's adaptive management measures being considered for the Proposed Action are listed below. The measures may not all be within BOEM's statutory and regulatory authority to be required; however, such measures could potentially be imposed by other governmental entities. These measures include, but are not limited to:

> Implement adaptive management to reduce impacts on marine trust resources through near-term refinement of exclusion zones based on field measurements of noise reduction systems, and long-term refinements of other pile-driving monitoring protocols based on monthly and/or annual monitoring results.

7 National Oceanic and Atmospheric Administration Trust Resource Species

This section includes a discussion on anadromous fish, shellfish, crustaceans, or their habitats that are not managed under a federal FMP. Some of these species, including diadromous fishes, serve as a prey for several federally managed species and are therefore considered a component of EFH pursuant to the MSA. Twenty-four NOAA trust resource species have been identified within the general vicinity of the proposed Project area. Detailed species descriptions and life history information are provided in FMPs (MAFMC 1998a, 1998b; NEFMC 2017; NOAA 2009). Table 7-1 discusses species and life stages within the proposed Project area as well as the impact determination for each NOAA trust resource species.

The following NOAA trust resource species or species groups may use habitat within the proposed Project SWDA, OECC, and Western Muskeget Variant:

- River herring (alewife, and blueback herring)
- American shad (*Alosa sapidissima*)
- American lobster
- Striped bass (*Morone saxatilis*)
- Blackfish/tautog
- Weakfish (*Cynoscion regalis*)
- Forage species (Atlantic menhaden [*Brevoortia tyrannus*], bay anchovy [*Anchoa mitchilli*], and sand eel/sand lance)
- Horseshoe crab (*Limulus polyphemus*)
- Bivalves (blue mussel [*Mytilus edulis*], eastern oyster [*Crassostrea virginica*], ocean quahog [*Mercenaria mercenaria*], and soft-shell clams [*Mya Arenaria*])
- Atlantic croaker (*Micropogonias undulatus*)
- Spotted hake (*Urophycis regia*)
- Smallmouth flounder (*Etropus microstomus*)
- Northern kingfish (*Menticirrhus saxatilis*)
- Sea robins

Table 7-1: Trust Resources Determination by Species or Species Group

Species	Life Stage within Proposed Project Area	Impact Determination	Rationale for Determination
River herring (alewife [*Alosa pseudoharengus*], blueback herring [*Alosa aestivalis*])	Juvenile, Adult	Negligible short-term and permanent impacts	Short-term disturbance effects would occur over approximately 1,925 acres of benthic habitat. Only a small area (tens of acres) would be affected at any given time. Benthic community structure would recovery rapidly, within a few months of the activity. Approximately 361 acres of benthic habitat would be displaced or altered over the long term by placement of the WTG foundations and cable and foundation scour protection (boulders, concrete pillows). The affected area represents a small portion of suitable habitat for these species groups. Once scour protection is colonized, it would provide habitat features for species associated with hard substrates. Dredging would be limited only to the extent required to achieve adequate cable burial depth during cable installation. Dredging may result in increased local total suspended solids or short-term displacement, but impacts are expected to be short term and limited in spatial extent. Collectively, areas affected by short-term construction-related impacts would rapidly return to existing conditions within minutes to months after the proposed Project is completed. Long-term habitat alterations and operational effects on habitat would be negligible because:
American eel (*Anguilla rostrata*)	Larvae, Juvenile, Adult	Negligible short-term and permanent impacts	
Striped bass (*Morone saxatilis*)	Juvenile, Adult	Negligible short-term and permanent impacts	
Blackfish/tautog (*Tautoga onitis*)	Juvenile, Adult	Negligible short-term and permanent impacts	
Weakfish (*Cynoscion regalis)*	All	Negligible short-term and permanent impacts	
Atlantic croaker (*Micropogonias undulatus*)	Juvenile, Adult	Negligible short-term and permanent impacts	
Spotted hake (*Urophycis regia*)	Juvenile, Adult	Negligible short-term and permanent impacts	
Smallmouth flounder (*Etropus microstomus*)	Juvenile, Adult	Negligible short-term and permanent impacts	
Northern kingfish (*Menticirrhus saxatilis*)	Juvenile, Adult	Negligible short-term and permanent impacts	

Species	Life Stage within Proposed Project Area	Impact Determination	Rationale for Determination
Sea robins	Juvenile, Adult	Negligible short-term and permanent impacts	Impacts are limited in intensity and extent; Species occurrence is limited; Long-term impacts may produce new potentially suitable habitats; and/or The area affected is insignificant relative to available habitat in the proposed Project area.
Forage species (Atlantic menhaden [*Brevoortia tyrannus*], bay anchovy [*Anchoa mitchilli*], and sand eel/sand lance [*Ammodytes americanus*])	All	Negligible short-term and permanent impacts	
American shad (*Alosa sapidissima*)	Juvenile, Adult	Negligible short-term and permanent impacts	Short-term noise disturbance from monopile installation would reduce habitat suitability for this species within a 10-mile radius of pile-driving activity. Habitat conditions would be unaffected after construction is complete. Operational noise effects are below established behavioral and injury effects thresholds for fish. As an anadromous species, juveniles have the potential to occur within nearshore waters near the export cable. Individuals could be displaced for the short term during construction activities, but long-term impacts are not expected.
American lobster (*Homarus americanus*)	All	Minor short-term and permanent impacts	Short-term noise disturbance from monopile installation would reduce habitat suitability for this species within a 10-mile radius of pile-driving activity. Habitat conditions would be unaffected after construction is complete. EMF impacts have been shown to be minimal within the buried cable corridors.
Horseshoe crab (*Limulus polyphemus*)	All	Minor short-term and permanent impacts	Horseshoe crabs are known to occur within the proposed Project area. Adults may use the habitat for spawning. Dredging associated with the proposed Project would impact a small portion of soft-bottom habitat. Dredging impacts could include increased local total suspended solids, loss of juveniles due to suction dredging, or short-term displacement of individuals. However, these impacts are short term and limited in spatial extent.

Species	Life Stage within Proposed Project Area	Impact Determination	Rationale for Determination
Bivalves (blue mussel [*Mytilus edulis*], eastern oyster [*Crassostrea virginica*], ocean quahog [*Mercenaria mercenaria*], and soft-shell clams [*Mya Arenaria*])	All	Minor short-term and permanent impacts	Short-term disturbance effects would occur over approximately 1,925 acres of benthic habitat. Only a small area (tens of acres) would be affected at any given time. Benthic community structure would recovery rapidly, within a few months of the activity. Approximately 361 acres of benthic habitat would be displaced or altered over the long term by placement of the monopile foundations and cable and foundation scour protection (boulders, concrete pillows). SWDA and OECC impacts have been sited to avoid and minimize overlap of long-term impacts with known shellfish habitats in designated EFH. Based on the small area affected relative to the extent of designated EFH in the proposed Project area and vicinity, the proposed Project would have an insignificant effect on habitat for these species. The benthic community structure would adapt and recover rapidly, within a few months of the activity.

EFH = essential fish habitat; EMF = electromagnetic fields; OECC = offshore export cable corridor; SWDA = Southern Wind Development Area; WTG = wind turbine generator

8 Conclusions

The most impactful EFH IPFs during the construction, operations, and eventual decommissioning of the proposed Project include the cable emplacement and maintenance (including dredging and cable protection [if required]), the presence (installation and operation) of structures (habitat alteration/scour protection, sediment deposition, suspended sediments, and water withdrawals), noise (especially pile driving for WTG/ESP foundations), vessel traffic, and EMF. These factors might impact EFH for various species and life stages by direct habitat alterations, suspended sediments in the water column, increased noise, interference by EMF, and physical harm. Most potential impacts on EFH are expected to be temporary except for direct habitat alterations. Direct habitat alterations from the installation of WTG/ESP foundations, scour protection, and potential cable protection have the potential to result in permanent (lasting for the duration of the proposed Project operations) impacts on EFH, specifically by changing habitat from soft-bottom, unconsolidated, or open pelagic habitat to structured habitat. However, this habitat alteration would only impact approximately 289 acres of the 111,939 acres SWDA, which is 0.26 percent of the SWDA, and 54 acres of the 20,648 acres OECC, which is 0.26 percent of the OECC for both phases. If the Western Muskeget Variant is used for one or two Phase 2 export cables, the amount of permanent habitat alteration for both phases combined from the potential installation of cable protection (if required) would be approximately 57 to 60 acres.

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Appendix A: Large-Scale Maps of Benthic Habitats and Benthic Features Located Within the Proposed Project Area

Appendix B: New England Wind Project Draft Fisheries Monitoring Plan

Appendix C: New England Wind Project Draft Benthic Habitat Monitoring Plan

Appendix D: Phase 2 Cable Layout Figures

Appendix E: New England Wind Project Draft Benthic Habitat Monitoring Plan