Vineyard Wind Offshore Wind Energy Project Essential Fish Habitat Assessment

Final, April 2019

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

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
AC	alternating current
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
D	pile diameter
dB	decibel
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ELMR	Estuarine Living Marine Resources
EMF	electromagnetic field
ESP	electrical service platform
HAPC	Habitat Areas of Particular Concern
kJ	kilojoule
km^2	square kilometers
kV	kilovolt
L_E	sound exposure levels
L_{pk}	peak thresholds
MA DMF	Massachusetts Division of Marine Fisheries
MA WEA	Massachusetts Wind Energy Area
MAFMC	Mid-Atlantic Fishery Management Council
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MARMAP	Marine Resources Monitoring, Assessment and Prediction
mg/L	milligrams per liter
MW	megawatt
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fishery Science Center
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OECC	Offshore Export Cable Corridor
ppt	parts per thousand
Project	Vineyard Wind Offshore Wind Energy Project
SAFMC	South Atlantic Fishery Management Council
SLB	simultaneous lay and bury
TSHD	trailing suction hopper dredge
TSS	total suspended sediment
TTS	temporary threshold shift
Vineyard Wind	Vineyard Wind LLC
WDA	Wind Development Area
WTG	wind turbine generator

1. INTRODUCTION

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) require that an Essential Fish Habitat (EFH) consultation be conducted for any activity that may adversely affect important habitats of federally managed marine and anadromous fish species. The Bureau of Ocean Energy Management (BOEM) has responsibility as the lead federal agency to initiate an EFH consultation prior to approving a Proposed Action, and this document has been prepared in compliance with the Magnuson-Stevens Act in regards Vineyard Wind Offshore Wind Energy Project (Project). BOEM is requesting that National Oceanic and Atmospheric Administration (NOAA) Fisheries use this document in conjunction with the remainder of the Final Environmental Impact Statement in evaluating the Proposed Action relative to EFH and EFH species.

EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 United States Code § 1802(10). In the above definition, “waters” refer to the physical, chemical, and biological properties of aquatic areas that are currently being used or have historically been used by fish, while “substrate” refers to the sediment, hard bottom, or other underwater structures and their biological communities. The term “necessary” indicates that the habitat is required to sustain the fishery and support the fish species’ contribution to a healthy ecosystem. The term “adverse effect” means any impacts that reduce quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate as well as the loss of and/or injury to benthic organisms, prey species, their habitat, and other ecosystem components. Adverse effects may be site-specific or habitat-wide impacts including individual, cumulative, or synergistic consequences of actions (50 Code of Federal Regulations [CFR] § 600.910).

2. DESCRIPTION OF PROPOSED ACTION

The Proposed Action would allow Vineyard Wind LLC (Vineyard Wind) to construct, operate, maintain, and eventually decommission an approximately 800 megawatt (MW) wind energy facility on the Outer Continental Shelf (OCS) offshore Massachusetts within Vineyard Wind’s Wind Development Area (WDA), including associated export cables. Vineyard Wind has submitted a Construction and Operations Plan (COP) outlining its Proposed Action, which is summarized below. The Proposed Action excludes additional mitigation measures that could be implemented by federal agencies as part of their reviews and potential approval processes. Additional details related to the Proposed Action can be found in COP Volume I, Sections 3.1 through 4.4.4 (Epsilon 2018b).

Power generated by the wind turbine generators (WTGs) in the WDA would be transformed by electrical service platforms (ESPs; also in the WDA) and transferred to Cape Cod through two cables buried within a single Offshore Export Cable Corridor (OECC; of which two segments are potentially variable). The offshore export cables would make landfall at one of two sites and be spliced to onshore export cables, which would be buried along existing right-of-way corridors leading to a new electrical substation in the north-central portion of the Town of Barnstable, Massachusetts. Details are described in COP Volume I, Sections 3.1 and 3.2 (Epsilon 2018b). The offshore portions of the proposed Project (Figure 1, Figure 2) are the focus of this document.

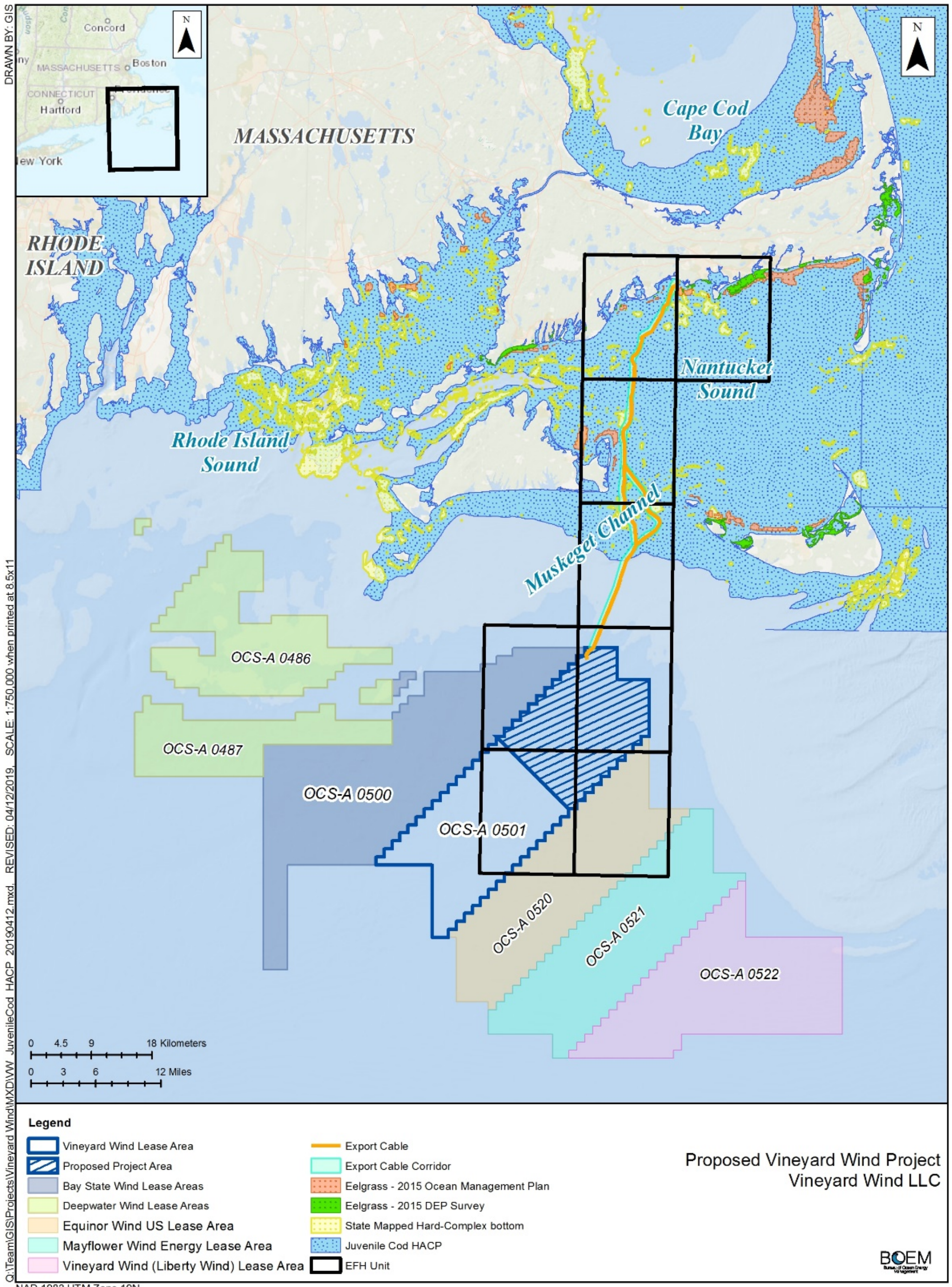
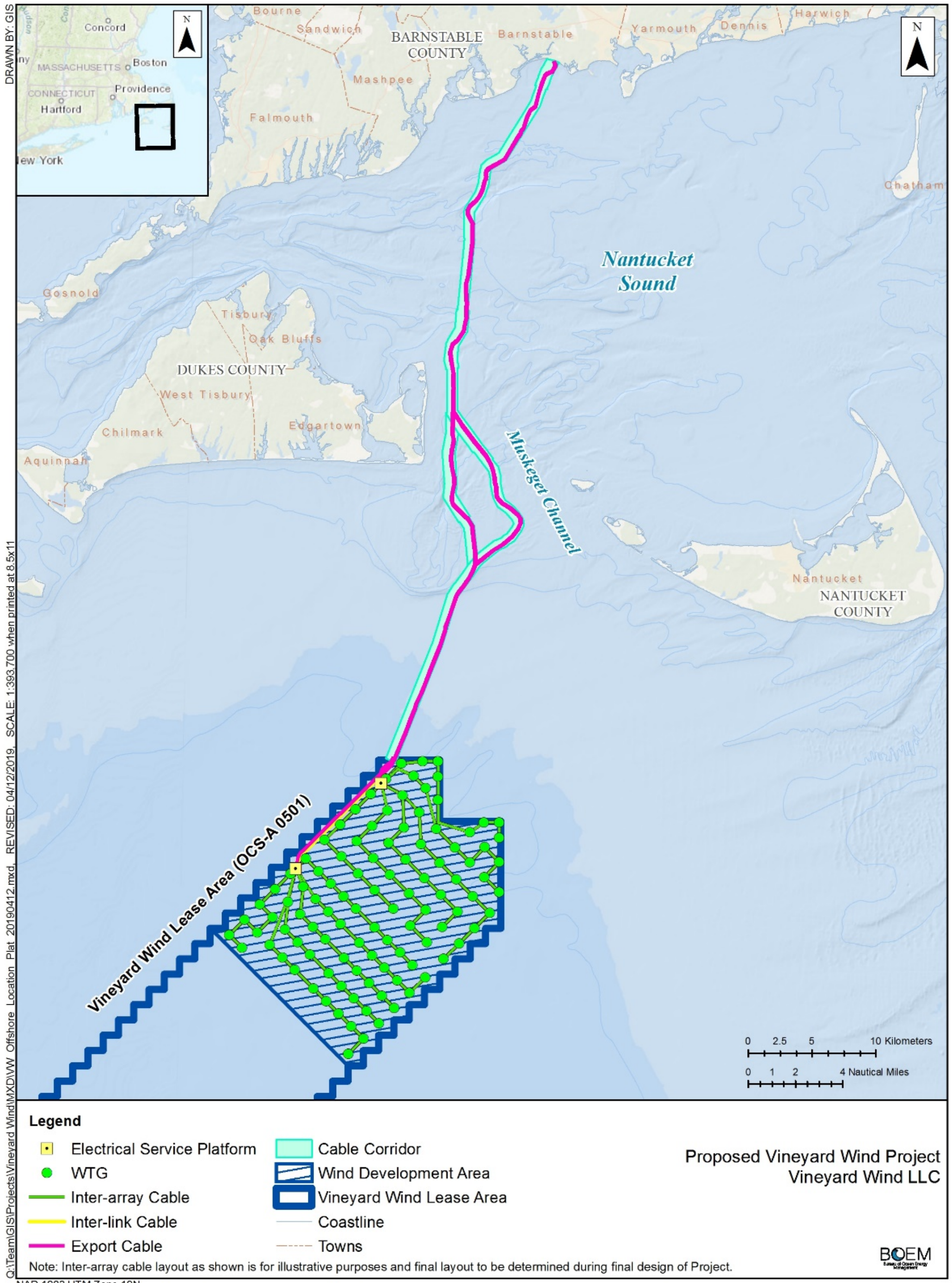


Figure 1: NMFS 10 x 10 Minute Squares for EFH Designation overlaid with the Footprint of the WDA, the OECC, Mapped Eel Grass Beds, Mapped Hard-Complex Bottom, and the New England Juvenile Atlantic Cod HAPC



Note: The inter-array cable layout shown is an example, and the final layout and location of the cables would be located within the approved Project Design Envelope. The 84 WTGs would be located within the 106 locations presented as part of the Proposed Action by Vineyard Wind.

Figure 2: Proposed Offshore Project Elements

Up to 106 WTGs of 8 to 10 MW capacity extending up to 696 feet (212 meters) above mean lower low water would be erected with a spacing between WTGs of approximately 0.75 to 1 nautical mile within the WDA, which is 75,614 acres (306 square kilometers [km^2]). WTGs would be mounted upon either monopile or jacket foundations. A monopile is a long steel tube driven 66 to 148 feet (20 to 45 meters) into the seabed. A jacket foundation is a latticed steel frame with three or four supporting piles driven 98 to 197 feet (30 to 60 meters) into the seabed. Jacket foundations would likely be installed in deeper WTG locations. Schematic drawings and photos of the proposed foundation types are included in COP Volume I, Figures 3.1-3 through 3.1-13 (Epsilon 2018b).

One to four ESPs, each installed on a monopile or jacket foundation, would be constructed in the WDA. The ESPs serve as the interconnection point between the WTGs and the export cable. The proposed ESPs would be located along the northwest edge of the WDA and would include step-up transformers and other electrical equipment needed to connect the 66-kilovolt (kV) alternating current (AC) inter-array cable to the 220 kV AC offshore export cables. Between 6 and 10 WTGs would be connected through each inter-array cable that would be buried below the seabed and then connected to the ESPs. If the proposed Project uses more than one ESP, a 200 kV inter-link cable would be required to connect the EPSs together.

Foundations and WTGs would be installed using a jack-up vessel or a vessel capable of dynamic positioning[1], as well as necessary support vessels and barges. Vessels would be equipped with a crane and a pile-driving hammer. Vineyard Wind would begin pile driving by using a soft start to help enable some marine life to leave the area before driving intensity increases. Pile driving would occur from late May through early December. ESP foundation installations may require specialized crane vessels. It is possible that monopiles would be transported to the WDA by floating them in the water while pulled by tugs.

Scour protection would be placed around all foundations, and would consist of rock and stone ranging from 4 to 12 inches (10 to 30 centimeters). The scour protection would be approximately 3 to 6 feet (1 to 2 meters) in height and would serve to stabilize the seabed near the foundations as well as the foundations themselves.

The proposed wind facility would be connected to the onshore electrical grid via two offshore export cables in one cable corridor. The offshore export cable would consist of three-core 220 kV AC cables that would deliver power from the ESPs to the onshore facilities. Vineyard Wind has proposed to bury the export and inter-array cables.

Vineyard Wind is proposing to lay most of the offshore export cable using simultaneous lay and bury (SLB) via jet embedment. Specifically, the expected installation tool for those portions of the route within state waters (including all of Nantucket Sound) is a jetting tool known as a vertical injector. Within federal waters (south of Muskeget Channel), a type of jet plow/jet trencher would be used. Both tools are appropriate for the specific site conditions along the cable route and are higher specification tools than were used for previous power cable burial projects in Southern New England where target depth was not reached in some areas. Therefore, Vineyard Wind believes that it is minimizing or eliminating the potential need for cable protection through careful site assessment and selection of an appropriate installation tool. For the inter-array cables, based on ongoing review of the 2018 survey data for the

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

WDA, Vineyard Wind expects that cable protection is less likely to be needed in the WDA for the inter-array (and inter-link cables, if used) due to consistent geology and limited coarse materials. The expected installation method for the inter-array cables is to lay the cable section on the seafloor and then subsequently bury the cables using a jet plow/jet trencher. This tool is very suitable for the site conditions of relatively homogeneous consolidated sands, providing a high degree of confidence that sufficient burial would be achieved. Additionally, if sufficient burial is not achieved on the first pass, it is expected that a second or third attempt with the installation tool would be made to achieve sufficient burial. By requiring more than one pass, this increases the likelihood that cable burial would be achieved. Therefore, based on the geological conditions, expected cable installation tool, contract requirements, the need for cable protection is considered less likely in the WDA. In the event that the described processes above are unsuccessful, Vineyard Wind may elect to dredge a trench in order to bury the cable. No drilling or blasting would be required. Project engineers and contractors would use micro-routing of the cable to avoid hard-bottom areas to the greatest extent practicable. In any hard-bottom areas that could not be avoided, the cable would be buried using the vertical injector jetting tool. As with any tool that fluidizes the seabed, this would tend to result in a less coarse, more sandy top layer of seafloor after use (Vineyard Wind 2019a and 2019b). Dredging may be required in some locations to achieve proper burial depth, such as in areas where sand waves are present. It is anticipated that dredging would occur within a corridor that is 65.6 feet (20 meters) wide and 1.6 feet (0.5 meters) deep, and potentially as deep as 14.7 feet (4.5 meters). If dredging is needed, a trailing suction hopper dredge (TSHD) would dredge along the OECC until the hopper is filled to an appropriate capacity, then the TSHD would sail several hundred meters away (while remaining within the OECC) and then bottom dump the dredged material. Dredging and dumping would only occur within sand wave areas. However, the vertical injector tool is able to achieve burial even in sand waves, thus minimizing the need for dredging (Vineyard Wind 2019b). Cable installation methodologies are described in further detail in COP Volume I, Sections 4.2.3.3 and 4.2.3.6 (Epsilon 2018b). Vessels types proposed for the cable installation could be vessels capable of dynamic positioning, anchored vessels, self-propelled vessels, and/or barges.

In the event that cables cannot achieve proper burial depths or where the proposed offshore export cable crosses existing infrastructure, the following protection methods could be used: rock placement, concrete mattresses, or half-shell pipes on up to 10 percent of the route. Rock placement involves laying rocks on top of the cable to provide protection. Concrete mattresses are prefabricated flexible concrete coverings that are laid on top of the cable. In certain cases, the mattresses may be filled with grout and/or sand (referred to as grout/sand bags); this method is generally applied on smaller-scale applications than standard concrete mattresses. Lastly, half-shell pipes or similar products made from composite materials (e.g., Subsea Uraduct from Trelleborg Offshore) or cast iron with suitable corrosion protection. 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.

Based on ongoing review of the 2018 survey data for the WDA, Vineyard Wind expects that cable protection is less likely to be needed in the WDA for the inter-array and inter-link cables due to consistent geology to the cable burial depth with limited coarse material. For the offshore export cables, the geology is more variable closer to shore. According the Vineyard Wind’s initial assessment of burial performance, the kilometer posts (KP) between the ESP (KP 62.6) and KP 42.6 are anticipated to have predominatly no or minimal risk of cable protection being needed with the exception around KP 49 where up to 370 linear meters of cable protection may be necessary (between KP 51.8 and KP 48.7). After KP 48.7 (just south of Muskeget Channel continuing towards shore) the sediment becomes much more variable and so does the risk for needing cable protection. Extensive and iterative analyses of the data would take place up until the time of installation in an effort to ensure burial and avoid the use of cable protection. These analyses may allow Vineyard Wind to identify areas with a greater risk of insufficient cable burial; however, final locations for cable protection, if needed, would not be known until completion of Project installation activities (Vineyard Wind 2019a).

The proposed Project may require anchoring of vessels, especially during the cable burial process. Anchoring would avoid sensitive seafloor habitats to the greatest extent practicable, and would be completely prohibited in eelgrass beds. Where it is considered impracticable to avoid a sensitive seafloor habitat, use of mid-line anchor buoys would be utilized, where feasible and considered safe, as a potential measure to reduce and minimize potential impacts from anchor line sweep. Vineyard Wind estimates that anchoring would affect less than approximately 4.4 acres (17,806 square meters) of seafloor, and most likely would affect no more than 3.9 acres (15,783 square meters) (Section 2.2 of Epsilon 2018c). The design envelope of the proposed Project includes several potentially variable elements. However, the analysis in this document focuses mostly on the Preferred Alternative (Figure 2). The Preferred Alternative would utilize no more than 84 9.5-MW WTGs within the WDA, with the OECC making landfall at Covell’s Beach. The OECC within the Preferred Alternative does not currently identify whether the eastern or western route through Muskeget Channel is preferred; therefore, for this analysis, both options are considered. The 84 WTGs would be located within the 106 locations evaluated in the WDA. The Preferred Alternative does not dictate where the 84 turbines would be placed within the 106 potential locations. The Preferred Alternative would occur within the range of the design parameters outlined in the Vineyard Wind COP, which includes self-implemented measures by Vineyard Wind to avoid or reduce impacts, and the mitigation measures included within the Preferred Alternative.

The proposed Project would have a designed operating phase of 30 years. Vineyard Wind would monitor operations continuously from the Operations and Maintenance Facilities and possibly other remote locations as well. Specifically, Vineyard Wind may use a new operations and maintenance facility in Vineyard Haven on Martha’s Vineyard. The Operations and Maintenance Facilities would include offices, control rooms, shop space, and pier space, which may be supplemented by continued use of the MCT on the mainland; again, Vineyard Wind does not propose to direct or implement any port improvements.

Vessels, vehicles, and aircraft would be needed during operations and maintenance. On average, approximately three vessel trips per day would be expected during regular operations. Access would be provided primarily through dedicated crew transport vessels specifically designed for offshore wind energy work. These vessels would be based primarily at the Operations and Maintenance 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 and Maintenance Facilities.

WTG gearbox oil would be changed after years 5, 13, and 21 of service (COP Volume I, Table 4.2-3; Epsilon 2018b). Additional operations and maintenance information can be found in COP Volume I, Section 4.3 (and see Table 4.3-2; Epsilon 2018b).

At the end of the proposed Project's 30-year designed lifespan, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project, per 30 CFR § 585 and requirements issued by BOEM. Per 30 CFR § 585.910(a), all facilities would need to be removed 15 feet (4.6 meters) below the mudline. Absent permission from BOEM, decommissioning would have to be completed within 2 years of termination of the lease. All materials removed would be reused, recycled, or responsibly disposed.

Although the proposed Project has a designed life span of 30 years, some installations and components may remain fit for continued service after this time. Vineyard Wind would have to apply for an extension to operate the proposed Project for more than 30 years.

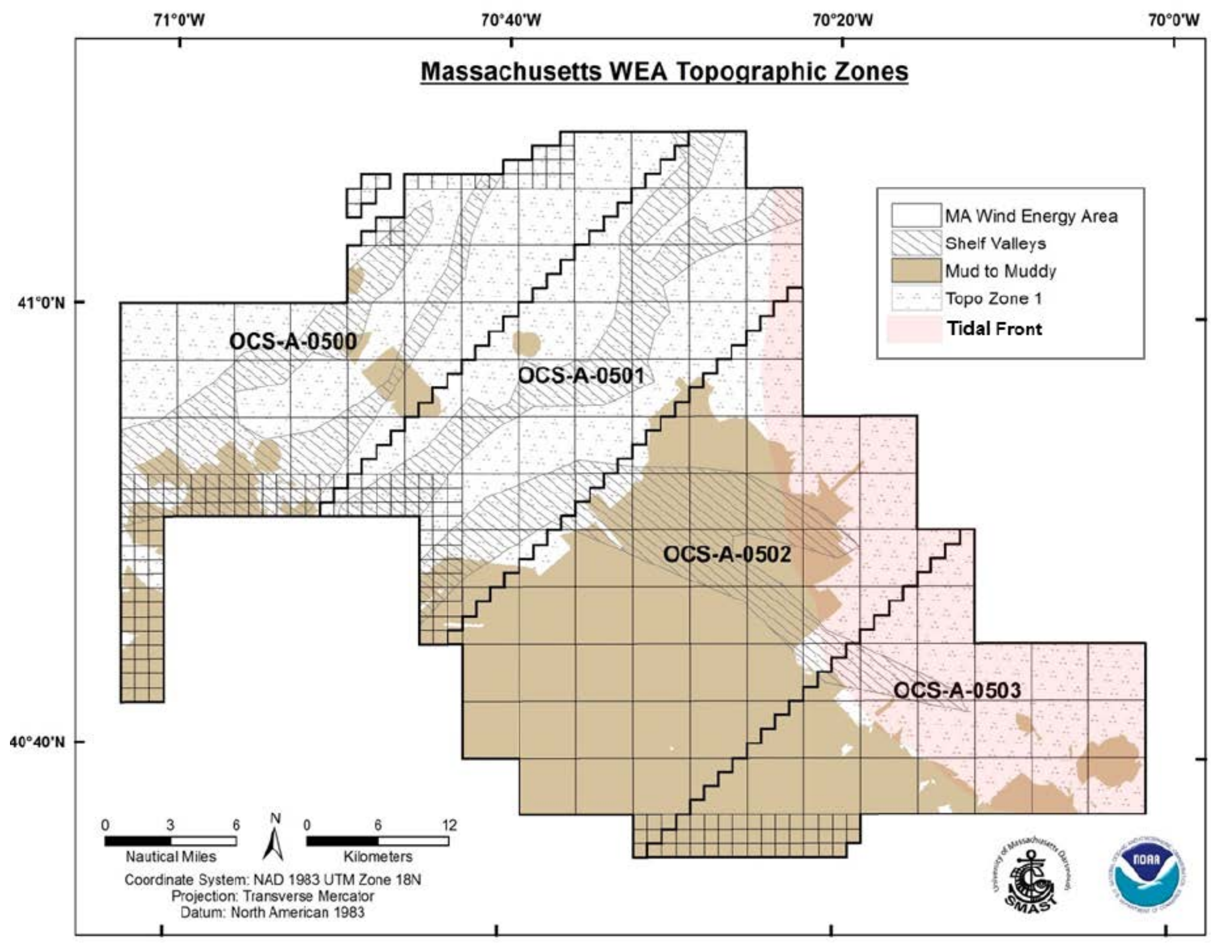
Offshore cables may be retired in place or removed. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gears), Vineyard Wind is committed to removing scour protection during decommissioning. WTGs and ESPs would be drained of all fluids, disassembled, and brought to port. Foundations would be temporarily emptied of sediment, cut 15 feet (4.6 meters) below the mudline in accordance with BOEM regulations (30 CFR § 585.910(a)), and removed. The portion buried below 15 feet (4.6 meters) 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 Project, the decommissioning team would be able to track each piece so that no component would be lost or forgotten. No further surveys or site clearance procedures are planned during or after decommissioning.

3. PROJECT AREA ENVIRONMENTAL SETTING

The Northeast U.S. Shelf Ecosystem extends from the Gulf of Maine to Cape Hatteras, North Carolina (BOEM 2014). The WDA and OECC are located 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). Similar to much of the Northeast U.S. Shelf Ecosystem, the southern sub-region habitat is dominated by sandy substrate, a characteristic reflected in the finfish and invertebrate species assemblages found there. A summary of the major finfish and invertebrate species identified in the vicinity of MA WEA are listed in COP Table 6.6-1 (Volume III, Section 6.6.1; Epsilon 2018b). This resource includes resident and migratory species as well as demersal and pelagic species. Many of the species included also have designated EFH. The major demersal fish species, identified as either shallow or intermediate finfish assemblages by Overholtz and Tyler (1985), are listed in Table 4-8 of the Environmental Assessment prepared for commercial wind lease issuance and site assessment activities on the Atlantic OCS (BOEM 2014). Many of these species (e.g., Atlantic cod [*Gadus morhua*], haddock [*Melanogrammus aeglefinus*], and yellowtail flounder [*Scophthalmus aquosus*]) are species common to shallow and intermediate depth finfish assemblages. These species also have value due to their importance in the commercial and recreational fishing industry or are considered of special concern due to depleted populations regionally (BOEM 2014). Pelagic species present within the Southern New England sub-region include fish that are often of commercial or recreational value (e.g., bluefin tuna [*Thunnus thynnus*], yellowfin tuna [*Thunnus albacares*], king mackerel [*Scomberomorus maculates*], Atlantic mackerel [*Scomber scombrus*], and Atlantic herring [*Clupea harengus*]). Invertebrate resources federally managed for commercial and recreational fisheries include pelagic species like the longfin squid (*Doryteuthis pealeii*) and the shortfin squid (*Illex illecebrosus*) as well as benthic species (Atlantic sea scallop [*Placopecten magellanicus*], ocean quahog [*Arctica islandica*], and Atlantic surfclam [*Spisula solidissima*]).

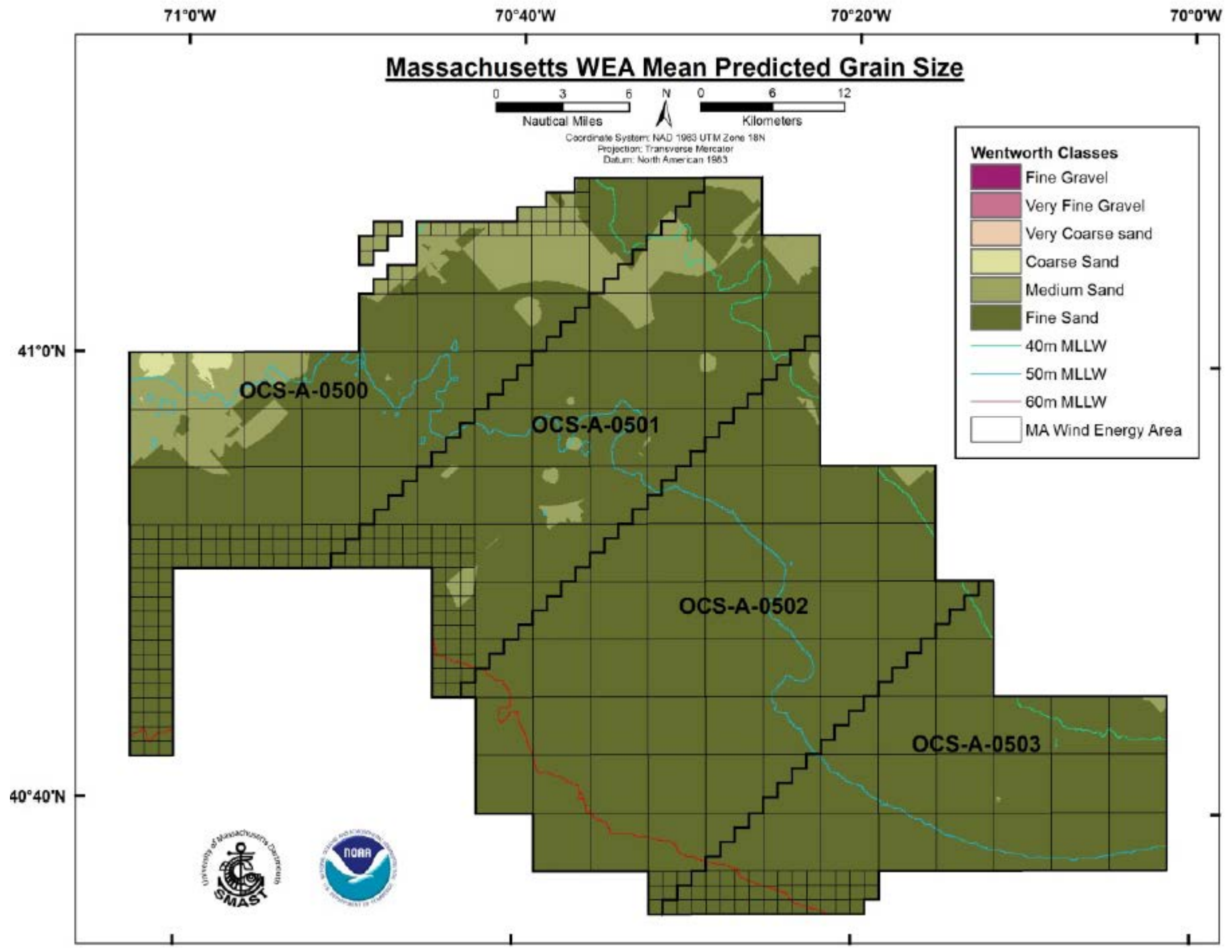
Four federally threatened and endangered species of finfish (giant manta ray, Atlantic salmon [*Salmo salar*], Atlantic sturgeon [*Acipenser oxyrinchus oxyrinchus*], and shortnose sturgeon [*Acipenser brevirostrum*]) might occur in the proposed Project area (BOEM 2018). Candidate Species and Species of Concern include 15 marine and diadromous fish, including many that are valued commercially and recreationally (e.g., bluefin tuna, alewife [BOEM 2018]).

The proposed Project area in southern New England includes a region south of Martha's Vineyard (northern Mid-Atlantic Bight) and extends north through Muskeget Channel to landfall in south-central Cape Cod (COP Volume III, Section 6.6.1; Epsilon 2018b). Benthic habitat in the region is predominantly flat with sand or sand-dominated substrate becoming increasingly muddy toward the south end of the proposed Project area and increasingly coarse toward the northwest corner (Guida et al. 2017). Figures 3a, 3b, and 3c show the region's predicted topographic zones, mean grain size, and percent mud, as determined by Guida et al. (2017).



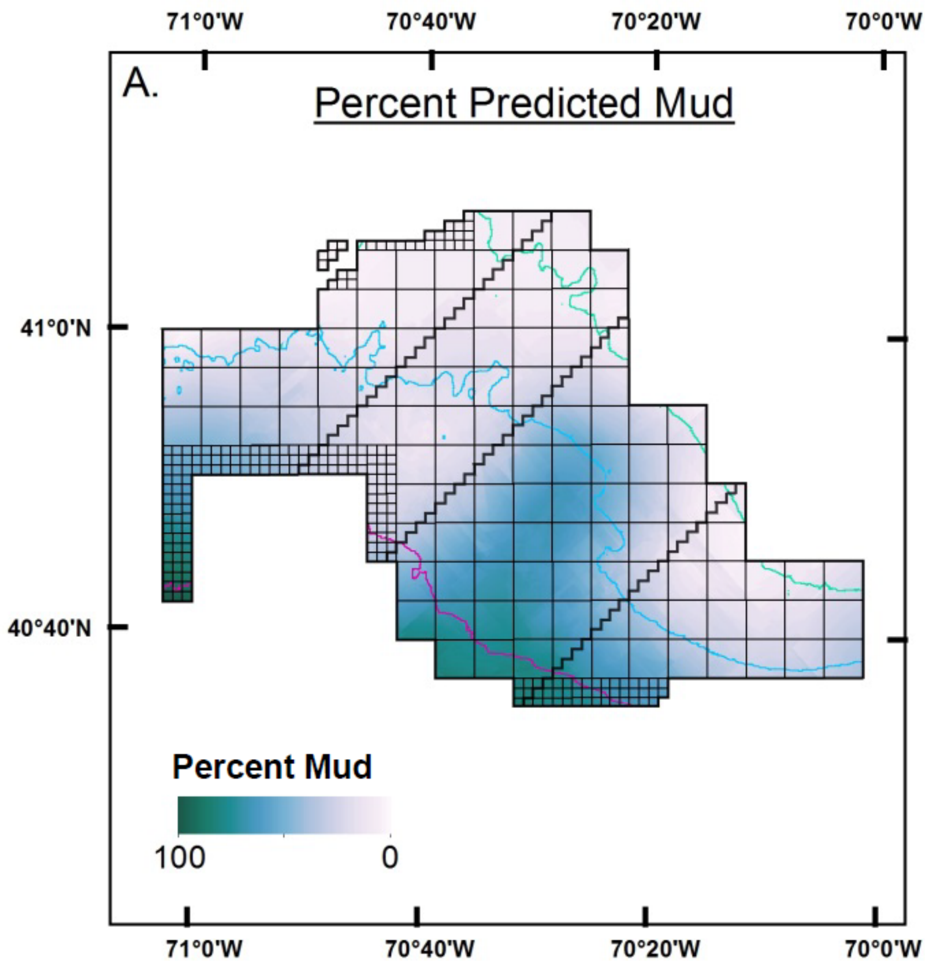
Source: Guida et al. 2017

Figure 3a: Topographic Zones in the Massachusetts Wind Energy Area



Source: Guida et al. 2017

Figure 3b: Mean Predicted Grain Size in the Massachusetts Wind Energy Area



Source: Guida et al. 2017

Figure 3c: Percent Predicted Mud in the Massachusetts Wind Energy Area

The pelagic (water column) habitat in this region is dominated by seasonal water stratification and turnover. The temperature regimes found in the Project area is found throughout the Northeast Large Marine Ecosystem. This ecosystem features large seasonal variations, making temperature a major driver for the activities, distribution, and movement of marine fishes and other organisms. The features of this system are that large temperature changes occur between the surface and bottom over the course of a year. The system begins in the cold season with the same temperature at all depths but progressively stratifies during the warm season, with a pattern of wide variation (scatter) of temperature values for any given day of the year (Guida et al. 2017).

> This shelf-wide seasonal temperature pattern is driven by the interaction of atmospheric climate and currents. Specifically, solar warming heats surface water in spring through fall. Simultaneously a cold current flows southward from the Gulf of Maine through the Great South Channel between the landward end of Georges Bank and Cape Cod across Nantucket Shoals into Southern New England. This current continues southwestward along the bottom down the length of the mid-Atlantic shelf. This “cold pool” water mass is maintained throughout much of the warm season over the extent of the shelf bottom via complex interactions with shelf topography. Resulting stratification persists until broken in September or October by a combination of solar warming and wind-mixing. While the interactions of the cold pool and other water masses maintain seasonal temperature regimes across latitudinal and depth gradients, changes in these can these induced by cyclic (e.g. North Atlantic Oscillation or NAO) and long-term climatic change can influence the intensity and timing of local hydrographic conditions, e.g. rapid erosion of the cold pool and subsequent early fall turnover events (Fratantoni et al. 2017), that can result in the redistribution of benthic and demersal faunas. …Where water masses of very different temperature and salinities meet, horizontal hydrographic fronts are apparent. Some of these associated with the output of low salinity water from estuaries (e.g. river plumes) tend to be ephemeral; their location and strength is weather-dependent. Though all, being water column features, have some tendency to move, strengthen and weaken, others, like those associated with temperature and salinity differences among major offshore water masses, are more persistent and predictable. Any of these hydrographic features can cause plankton to be concentrated, resulting in concentration of the marine food chain in their vicinity, but the persistent fronts probably play larger ecological roles over the long term. (Guida et al. 2017)

The WDA is closely associated with a frontal system caused by upwelling along the western side of Nantucket Shoals (east of the WDA) (Guida et al. 2017).

4. SPECIES WITH EFH DESIGNATION

During preparation of the COP, Vineyard Wind prepared an EFH Assessment (COP Appendix H, Volume II; Epsilon 2018b) that was used with other sources for the preparation of this document.

In the Northeast, NMFS works with the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), and the South Atlantic Fishery Management Council (SAFMC) to define essential habitat for key species in New England coastal waters. Essential habitat for highly migratory species are managed through a fishery management plan implemented by NOAA to manage the marine fishery resource in the Exclusive Economic Zone (EEZ) that extends from 3 to 200 miles (4.8 to 321.9 kilometers) under the Magnuson Stevenson Act (NMFS 2017). The management councils and NMFS designate EFH for species in association with a mapped grid of 10 x 10 minute squares covering all marine habitat along the U.S. coast. The site of the Proposed Action lies within eight of the 10 x 10 minute squares within and south of Nantucket Sound (four in the WDA and four in the OECC) (see Figure 1).

This location requires the investigation of EFH for at least one life stage of 47 federally managed finfish and invertebrate species (see Table 1). Additional life stages for certain species may be present in an area in which EFH was not designated, and specific habitat conditions may indicate EFH does not exist for some of these species or life stages in the WDA and OECC. Habitat Areas of Particular Concern (HAPC) are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation (50 CFR § 600). HAPC for summer flounder (*Paralichthys dentatus*) and inshore juvenile Atlantic cod (*Gadus morhua*) are included in this EFH assessment for portions of the OECC.

4.1. Species with EFH Designation

A brief summary of the life history characteristics of federally managed species with EFH designation within the Proposed Action area are listed in this section. Although EFH is partially based on abundance data from sources including NOAA’s Estuarine Living Marine Resources (ELMR) program, National Marine Fishery Service bottom trawl surveys beginning in the 1960s, and Northeast Fishery Science Center (NEFSC) Marine Resources Monitoring, Assessment and Prediction (MARMAP) ichthyoplankton survey data (1977-1987), EFH should also be designated based on the habitat that support species and life stages and not the actual presence of those life stages/species. Additional resources including Massachusetts Division of Marine Fisheries (MA DMF) spring/fall bottom trawl surveys (1978 to 2018) from Region 2 (an area covering much of the OECC), an analysis of NEFSC bottom trawl surveys occurring within the WDA, and the ELMR program were used to provide greater detail regarding the presence of species and life stages with designated EFH in the WDA and the OECC.

4.2. New England Fishery Management Council EFH Designations

4.2.1. Northeast Multispecies (Groundfish) Fishery Management Plan

EFH for species managed under Fishery Management Plans developed by the NEFMC and NOAA are covered under Omnibus Essential Fish Habitat Amendment 2 of the Northeast Multispecies Fishery Management Plan (NEFMC 2017).

Table 1: Summary of the Specific Life Stage EFH Designation for Species in the 10 x 10 Minute Squares Encompassing the Footprint of the WDA and OECC

Species	Eggs		Larvae		Juvenile		Adult	
	OECC	**WDA**	**OECC**	**WDA**	**OECC**	**WDA**	**OECC**	**WDA**
Northeast Multispecies (groundfish) Fishery Management Plan (NEFSC)								
Atlantic Cod (*Gadus morhua*)	●	●	●	●	●	●	●	●
Atlantic Wolffish (*Anarhichas lupus*)	●	●	●	●	●	●	●	●
Haddock (*Malongrammus aeglefinus*)		●	●	●				
Ocean Pout (*Macrozoarces americanus*)	●	●	NA[a]	NA[a]	●	●	●	●
Pollock (*Pollachius virens*)		●		●		●		
White Hake (*Urophycis tenuis*)			●		●	●		
Windowpane Flounder (*Scophthalmus aquosus*)	●	●	●	●	●	●	●	●
Winter Flounder (*Pseudopleuronectes americanus*)	●		●	●	●	●	●	●
Witch Flounder (*Glyptocephalus cynglossus*)		●	●	●				●
Yellowtail Flounder(*Pleuronectes ferruginea*)	●	●	●	●	●	●	●	●
Silver Hake (*Merluccius bilinearis*)	●	●	●	●		●		
Red Hake (*Urophycis chuss*)	●	●	●	●	●	●	●	●
Monkfish Fishery Management Plan (NEFSC)								
Monkfish (*Lophius americanus*)	●	●	●	●		●		●
Skate Fishery Managemennt Plan (NEFSC)								
Barndoor Skate (*Dipturus laevis*)	NA[b]	NA[b]	NA[b]	NA[b]		●		●
Little Skate (*Leucoraja erinacea*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Winter Skate (*Leucoraja ocellata*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Atlantic Sea Scallop Fishery Management Plan (NEFSC)								
Atlantic Sea Scallop (*Placopecten magellanicus*)	●	●	●	●	●	●	●	●
Atlantic Herring Fishery Management Plan (NEFMC)								
Atlantic Herring (*clupea harengus*)				●	●	●	●	●
Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan (MAFMC)								
Atlantic Butterfish (*Peprilus triacanthus)*		●		●	●	●	●	●
Atlantic Mackerel (*Scomber scombrus*)	●	●	●	●	●	●		
Longfin Inshore Squid (*Doryteuthis pealeii*)	●	●	NA[b]	NA[b]	●		●	●
Northern Shortfin Squid (*illex illecebrosus*)			NA [b]	NA[b]			●	
Spiny Dogfish Management Plan (MAFMC)								
Spiny Dogfish (*Squalus acanthias*)	NA[b]	NA[b]	NA[b]	NA[b]			●	●
Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan (MAFMC)								
Summer Flounder (*Paralichthys dentatus*)	●	●	●	●	●		●	●
Scup (*Stenotomus chrysops*)					●	●	●	●

Species	Eggs		Larvae		Juvenile		Adult	
	OECC	WDA	OECC	WDA	OECC	WDA	OECC	WDA
Black Sea Bass (*Centropristis striata*)					●	●	●	●
Bluefish Fishery Management Plan (MAFMC)								
Bluefish (*Pomatomus saltatrix*)					●	●	●	●
Atlantic Surfclam and Ocean Quahog Fishery Management Plan (MAFMC)								
Atlantic Surfclam (*Spisula solidissima*)	NA[b]	NA[b]	NA[b]	NA[b]	●		●	●
Ocean Quahog (*Arctica islandica*)	NA[b]	NA[b]	NA[b]	NA[b]		●		●
Consolidated Atlantic Highly Migratory Species Fishery Mangement Plan (NOAA Highly Migratory Species Division)								
Albacore Tuna (*Thunnus albacares*)					●	●	●	●
Atlantic Bluefin Tuna (*Thunnus thynnus*)					●	●	●	●
Atlantic Skipjack Tuna (*Katsuwonus pelamis*)						●	●	●
Atlantic Yellowfin Tuna (*Thunnus albacares*)					●	●		●
Sandbar Shark (*Carcharhinus plumbeus*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Tiger Shark (*Galeocerdo cuvier*)	NA[b]	NA[b]	NA[b]	NA[b]		●		●
Blue Shark (*Prionace glauca*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Porbeagle Shark (*Lamna nasus*)	NA[b]	NA[b]	NA[b]	NA[b]		●		●
Shortfin Mako Shark (*Isurus oxyrinchus*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Common Thresher Shark (*Alopias vulpinus*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Smooth Dogfish (*Mustelus canis*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Basking Shark (*Cetorhinus maximus*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Dusky Shark (*Carcharhinus obscurus*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Sand Tiger Shark (*Carcharias taurus*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●		
White Shark (*Carcharadon carcharias*)	NA[b]	NA[b]	NA[b]	NA[b]	●	●	●	●
Coastal Migratory Pelagics Fishery Management Plan (ASFMC)								
Cobia (*Rachycentron canadum*)	●	●	●	●	●	●	●	●
King Mackerel (*Scomberomorus cavallaIa*)	●	●	●	●	●	●	●	●
Spanish Mackerel (*Scomeromorus maculatus*)	●	●	●	●	●	●	●	●
HAPC (Summer Flounder and Inshore Juvenile Atlantic Cod)								
Summer Flounder HAPC					●		●	
Juvenile Inshore Atlantic Cod HAPC					●		●	

ASFMC = Atlantic States Marine Fisheries Commission; HAPC = Habitat Areas of Particular Concern; MAFMC = Mid-Atlantic Fishery Management Council; NA = not applicable; NEFSC = Northeast Fishery Science Center; NOAA = National Oceanic and Atmospheric Administration; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area

[a] Lack of true larval stage for eel pout considered reason to remove EFH for this life stage.

[b] EFH does not exist for life stage.

4.2.1.1. Atlantic Cod

Atlantic cod (*Gadus morhua*) is a demersal species found from Greenland south to Cape Hatteras, North Carolina, with the highest densities in U.S. waters occurring in the western Gulf of Maine and Georges Bank (Lough 2004). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-190 (Lough 2004). EFH is designated for egg, larvae, juveniles, and adults in the WDA and OECC (see Table 1 above and Section 2.2.1.3 of NEFMC 2017).

Eggs: EFH is designated for Atlantic cod eggs in both the WDA and OECC for pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, as well as in high-salinity zones of bays and estuaries (NEFMC 2017). Egg distribution in southern New England occurs year round with the lowest densities occurring in August and September (Lough 2004). NOAA's ELMR program indicates that in the closest survey areas to the OECC, Atlantic cod, were rare or absent in Waquoit Bay in Nantucket Sound but were common in adjacent Buzzards Bay. In areas of higher salinity (greater than 25 parts per thousand [ppt]), Atlantic cod eggs were common from October through May (NOAA 2018).

Larvae: EFH is designated for Atlantic cod larvae in both the WDA and OECC and is defined as including the pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, as well as in high salinity zones of bays and estuaries (NEFMC 2017). Pelagic-stage larvae are most abundant throughout their range from March through May (Lough 2004). The NOAA ELMR database indicates larvae as being common from December to May in the higher salinity zones of Buzzards Bay but were not present in Waquoit Bay.

Juveniles: EFH for juvenile Atlantic cod includes intertidal and sub-tidal benthic habitats in the Gulf of Maine, southern New England, and on Georges Bank, to a maximum depth of 394 feet (120 meters) including the high-salinity zones of bays and estuaries (NEFMC 2017). Structurally complex habitats, including eelgrass, mixed sand and gravel, and rocky habitats (gravel pavements, cobble, and boulder) with and without attached macroalgae and emergent epifauna, are considered EFH for juvenile Atlantic cod within the geographical range above. Transformation from pelagic to demersal habitat occurs at lengths between 1.5 to 2.4 inches (4 to 6 centimeters) on Georges Bank with greater abundance on gravel pavement and rocky habitats and an absence on sandy and fine sediment habitats, likely due to the greater predator avoidance and increased food availability (Lough 2004). In southern New England, juvenile Atlantic cod are concentrated during winter and summer along the 164-foot (50-meter) depth contour (Lough 2004) and high numbers in the spring inshore Massachusetts trawl surveys occurred around Cape Cod, Martha's Vineyard, and Nantucket Sound (Reid et al. 1999, as cited in Lough 2004). NOAA's ELMR database indicated that juvenile Atlantic cod are common in Buzzards Bay from October to May but were not present in Waquoit Bay.

HAPC: An inshore juvenile Atlantic cod HAPC was designated for areas in the Gulf of Maine and southern New England between 0 to 66 feet (0 to 20 meters) deep that also fit the text definition for juvenile Atlantic cod EFH (NEFMC 2017). All of the hard-bottom habitat within the proposed Project OECC would be considered HAPC for juvenline Atlantic cod.

Adults: EFH for adult Atlantic cod includes sub-tidal habitats in the Gulf of Maine, south of Cape Cod, and on Georges Bank between 98 and 525 feet (30 and 160 meters) as well as high-salinity zones in bays and estuaries. Structurally complex hard-bottom habitats composed of gravel, cobble, and boulder substrates with and without emergent epifauna and macroalgae are essential habitats for adult Atlantic cod. Adult Atlantic cod are also found on sandy substrates and frequent deeper slopes of ledges along shore. Atlantic cod inhabiting the outer reaches of their range exhibit migratory behavior associated with ocean temperature regimes. Cod inhabiting the southern reaches (Mid-Atlantic Bight) typically migrate north to southern New England (including Nantucket Shoals) during warmer months when water temperatures approach 68 degrees Fahrenheit (°F) (20 degrees Celsius [°C]; Heyerdahl and Livingstone 1982, as cited in Lough 2004). Spawning peaks from late winter through spring depending on seasonal environmental variables and range (Lough 2004). South of Cape Cod, spawning occurs in nearshore areas and on the continental shelf, usually in depths less than 230 feet (70 meters). NOAA's ELMR database indicates that in areas of higher salinity (greater than 25 ppt) Atlantic cod adults were common from October to April in Buzzards Bay. Atlantic cod were present (54.7 percent occurrence) in Region 2 (Nantucket Sound region) spring trawl surveys (1978 to 2018) but were virtually absent from the fall surveys (Matt Camissa, Pers. Comm., July 25, 2018). In an analysis of NEFSC bottom trawl surveys (2003 to 2016), Atlantic cod were not considered one of the dominant finfish species captured in the Massachusetts Wind Energy Area (MA WEA) and were only a small percentage of the overall catch (Guida et al. 2017).

4.2.1.2. Atlantic Wolffish

A detailed summary of the geographic distribution, life history, and habitat characteristics of Atlantic wolffish (*Anarhichas lupus*) can be found in NEFMC 2009. EFH is designated for egg, larvae, juveniles, and adults in the WDA and OECC (see Table 1 above and Section 2.2.1.5 of NEFMC 2017). General EFH for Atlantic wolffish life stages includes anywhere within the geographic area shown on Map 43 of the Omnibus Essential Fish Habitat Amendment 2 that meet the below specific text conditions (NEFMC 2017)

Eggs: EFH for eggs is sub-tidal benthic habitats at depths less than 328 feet (100 meters). Atlantic wolffish egg masses are hidden under rocks and boulders in nests. Egg masses have been collected on the Scotian Shelf in depths of 328 to 426 feet (100 to 130 meters), indicating that spawning is not restricted to coastal waters (NEFMC 2017).

Larvae: EFH for larvae is pelagic and sub-tidal benthic habitats. Atlantic wolffish larvae remain near the bottom for up to six days after hatching, but gradually become more buoyant as the yolk sac is absorbed (NEFMC 2017).

Juveniles (less than 65 centimeters total length): EFH for juveniles is benthic habitats at depths of 230 to 604 feet (70 to 184 meters). Juvenile Atlantic wolffish do not have strong substrate preferences (NEFMC 2017).

Adults (greater than or equal to 65 centimeters total length): EFH for adults is sub-tidal benthic habitats at depths less than 567 feet (173 meters). Adult Atlantic wolffish have been observed spawning and guarding eggs in rocky habitats in less than 98 feet (30 meters) of water in the Gulf of St. Lawrence and Newfoundland and in deeper (164 to 328 feet [50 to 100 meters]) boulder reef habitats in the Gulf of Maine. Adults are distributed over a wider variety of sand and gravel substrates once they leave rocky spawning habitats, but are not caught over muddy bottom (NEFMC 2017).

No Atlantic wolffish were found in NOAA's ELMR program or MA DMF spring and fall bottom trawl surveys (1978 to 2018). The NEFSC bottom trawl fall surveys (2005 to 2014) indicated wolffish were rare in the region, which includes the WDA (NEFSC 2014a).

4.2.1.3. Haddock

Haddock (*Melanogrammus aeglefinus*) are a demersal gadid found in the northwest Atlantic from Cape May, New Jersey, to the Straight of Belle Isle, Newfoundland. Two stocks (Georges Bank and Gulf of Maine) occur in U.S. waters (Klein-MacPhee 2002, as cited in Broadziak 2005). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-196 (Broadziak 2005). EFH is designated for eggs in the WDA and for larvae in the OECC and WDA (see Table 1 above and Section 2.2.1.6 of NEFMC 2017).

Eggs: EFH for haddock eggs is defined as pelagic habitats in coastal and offshore waters in the Gulf of Maine, southern New England, and on Georges Bank (NEFMC 2017). Haddock eggs are buoyant, with the majority of eggs collected at 39 to 50 °F (4 to 10 °C) and at depths ranging from 16 to 427 feet (5 to 130 meters; Broadziak 2005). The distribution of eggs in the northwest Atlantic ranged from New Jersey to Nova Scotia primarily from January through August, with the highest concentrations occurring from March through April (Broadziak 2005).

Larvae: EFH for larval haddock includes pelagic habitats in coastal and offshore waters in the Gulf of Maine, the Mid-Atlantic, and on Georges Bank (NEFSC 2017). Haddock larvae were present in MARMAP survey data primarily from January through July, with the highest densities occurring April through June (Broadziak 2005). Larvae were captured at temperatures ranging from 39 to 57 °F (4 to 14 °C) and at depths of 98 to 295 feet (30 to 90 meters; Broadziak 2005).

4.2.1.4. Ocean Pout

Ocean pout (*Macrozoarces americanus*) are a cool-temperate species ranging in the North Atlantic from Labrador, Canada, to Virginia, with the highest catch abundance reported in otter trawls off southern New England (Steimle et al. 1999a). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-129 (Steimle et al. 1999a). Ocean pout are managed by the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designated for ocean pout eggs, juveniles, and adults in both the OECC and WDA (see Table 1). No true larval stage exists for this species, resulting in the removal of this life stage from EFH consideration (NEFMC 2017). In general, EFH for ocean pout includes the geographic region depicted in Maps 48 to 50 and Table 20 in Section 2.2.1.7 of the Omnibus Essential Fish Habitat Amendment 2 that also adhere to the text descriptions for each life stage (NEFMC 2017).

Eggs: EFH for ocean pout eggs includes rocky bottom habitat in less than 328 feet (100 meters) on Georges Bank, in the Gulf of Maine, and in the Mid-Atlantic Bight, as well as the high-salinity zones of the bays and estuaries. Eggs are laid in gelatinous masses, generally in sheltered nests, holes, or rocky crevices. As a result, the characteristics, distribution, temperature range, etc., are not well known (Steimle et al. 1999a).

Juveniles: EFH for juveniles includes intertidal and sub-tidal benthic habitats up to 394 feet (120 meters) in the Gulf of Maine and on the continental shelf north of Cape May, New Jersey, on the southern portion of Georges Bank, and in the high-salinity zones of a number of bays and estuaries north of Cape Cod (NEFMC 2017). Substrates included as EFH include shells, rocks, algae, soft sediments, sand, and gravel (NEFMC 2017). Juvenile ocean pout were captured in NEFSC bottom trawl surveys south and west of Cape Cod during winter. While they were commonly captured in shallow coastal waters of Cape Cod Bay at water temperatures less than 52 °F (11 °C) during spring and autumn, few were captured south of Cape Cod (Steimle et al. 1999a).

Adults: EFH for adult ocean pout includes mud and sand, particularly in association with structure-forming habitat types in sub-tidal and benthic habitats between 66 and 459 feet (20 and 140 meters) in the Gulf of Maine, on Georges Bank, and in coastal and continental shelf waters north of Cape May, New Jersey (NEFMC 2017). Spawning ocean pout congregate in rocky areas and often occupy nesting holes under rocks or in crevices in depths less than 328 feet (100 meters; NEFMC 2017). Adult ocean pout were an abundant species captured in coastal Cape Cod waters during spring, with declining abundance during summer and fall (Steimle et al. 1999a). Ocean pout were present in 0.5 percent of spring bottom trawl surveys (1978 to 2018) conducted by MA DMF (Matt Camissa, Pers. Comm., July 25, 2018). Ocean pout were present in the WDA region based on a review of the 2005-2014 fall bottom trawl surveys conducted by NEFSC (NEFSC 2014b).

4.2.1.5. Pollock

Pollock (*Pollachius virens*) are a gadid species commonly found on the Scotian Shelf, Georges Bank, in the Great South Channel, and in the Gulf of Maine (Cargnelli et al. 1999a). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-131 (Cargnelli et al. 1999a). Pollock are managed by the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designated for pollock eggs, larvae, and juveniles in the WDA (see Table 1 above and NEFMC 2017). Generally, EFH for pollock includes the geographic area depicted in Maps 51 through 54 and Table 21 in Section 2.2.1.8 of the Omnibus Essential Fish Habitat Amendment 2 that also meets the text description for each life stage.

Eggs: EFH for pollock eggs includes pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in Southern New England (NEFMC 2017). Pollock eggs are pelagic and were present in ichthyoplankton surveys from October through June at a temperature range of 36 to 63 °F (2 to 17 °C) with the majority collected between 164 to 295 feet (50 to 90 meters; Cargnelli et at. 1999a).

Larvae: EFH for larvae includes inshore and offshore pelagic and benthic habitats from the Gulf of Maine and Georges Bank to the Mid-Atlantic region (NEFMC 2017). The pelagic larval stage for pollock lasts for 3 to 4 months and occurs from September to July, with the highest densities occurring off Cape Cod during February (Cargnelli et al. 1999a). Similar to eggs, larvae were present primarily at temperatures ranging from 36 to 63 °F (2 to 17 °C) and at depths from 164 to 295 feet (50 to 90 meters; Cargnelli et al. 1999a).

Juveniles: EFH for juvenile pollock includes rocky bottom habitats with attached macroalgae (rockweed and kelp) that provide refuge from predators while older juveniles move into deeper water habitats that are occupied by adults (NEFMC 2017). Geographically, the EFH definitions apply to inshore and offshore pelagic and benthic habitats from the intertidal zone to 591 feet (180 meters) in the Gulf of Maine, Long Island Sound, and Narragansett Bay, between 131 to 591 feet (40 to 180 meters) on western

Georges Bank and the Great South Channel, and in bays and estuaries with mixed and full salinity waters north of Cape Cod (NEFMC 2017). Juvenile pollock migrate inshore to inhabit rocky subtidal and intertidal zones where age 0 and age 1 fish have been found over a wide variety of bottom substrates (Cargnelli et al. 1999a). Juveniles taken in Massachusetts trawl surveys were collected primarily at temperatures ranging from 43 to 55 °F (6 to 13 °C) and at depths from 0 to 246 feet (0 to 75 meters; Cargnelli et al. 1999a). Age 2, fish moved offshore and were found in water ranging from 427 to 492 feet (130 to 150 meters; Cargnelli et al. 1999a). NOAA's ELMR database indicates that in Waquoit Bay and adjacent Buzzards Bay, pollock juveniles were common from March to June in higher salinity waters (greater than 25 ppt).

4.2.1.6. White Hake

White hake (*Urophycis tenuis*) cover a large range of temperatures and habitats throughout its range in the North Atlantic, occurring in estuaries and bays out to the deep waters of the Gulf of Maine and continental slope (Chang et al. 1999a). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-136 (Chang et al. 1999a). White hake are managed under the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designated for white hake eggs in the WDA and for juveniles in the WDA and OECC (see Table 1). EFH for white hake includes anywhere within the geographic areas shown in Maps 55 to 58 in Section 2.2.1.9 of the Omnibus Essential Fish Habitat Amendment 2 that also meets the text conditions described for each life stage (NEFMC 2017).

Eggs: EFH for white hake eggs includes pelagic habitats in the Gulf of Maine, including Massachusetts and Cape Cod bays and the OCS and slope (NEFMC 2017). White hake eggs are buoyant and remain near the surface, typically hatching within 3 to 7 days (Chang et al. 1999a). Hake species eggs (eggs of white hake are difficult to differentiate from other regional hake species) were collected in 33 to 820 feet (10 to 250 meters) at temperatures ranging from 39 to 77 °F (4 to 25 °C) and are found primarily in August and September (Chang et al. 1999a)

Juveniles: EFH for juvenile white hake includes Gulf of Maine, southern New England, and Georges Bank intertidal and subtidal estuarine and marine habitats to a maximum depth of 984 feet (300 meters), as well as mixed and high-salinity zones of estuaries and bays (NEFMC 2017). This designation includes pelagic waters as juveniles remain in the water column for approximately 2 months (May to June) before becoming demersal, at which point EFH includes nearshore waters with fine-grained, sandy substrates in eelgrass, macroalgae, and un-vegetated habitats (NEFMC 2017; Chang et al. 1999a). In southern New England, juveniles often move into estuaries and inshore habitats during the warmer seasons (Chang et al. 1999a). White hake contributed to a small portion of the MA DMF bottom trawl survey catch (1978 to 2018) primarily in the spring surveys (6.8 percent occurrence; Matt Camissa, Pers. Comm., July 25, 2018).

4.2.1.7. Windowpane Flounder

Windowpane flounder (*Scophthalmus aquosus*) are a left-eye flounder found in the Western Atlantic from the Gulf of St. Lawrence to Florida, although it is most abundant in the region encompassing Georges Bank to Chesapeake Bay (Chang et al. 1999b). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-137 (Chang et al.

1999b). Windowpane flounder are managed under the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designated for all life stages (egg, larvae, juvenile, and adult) within the WDA and OECC (Table 1). EFH for windowpane flounder includes anywhere within the geographic areas shown in Maps 59 to 62 in Section 2.2.1.10 of the Omnibus Essential Fish Habitat Amendment 2 that also meets the text conditions described for each life stage (NEFMC 2017).

Eggs and Larvae: EFH for windowpane flounder eggs includes pelagic habitats on the continental shelf from Georges Bank to Cape Hatteras and in mixed and high-salinity zones of coastal bays and estuaries throughout that range (NEFMC 2017). Windowpane flounder eggs are buoyant and are found primarily at depths of less than 131 feet (40 meters) from February to November, with peak abundance occurring during July and August (Chang et al. 1999b). Eggs hatch in approximately 8 days at 52 °F (11 °C) and larvae remain in the water column until becoming demersal when lengths reach 0.4 to 0.8 inches (10 to 20 millimeters; Chang et al. 1999b). Similar to eggs, larvae are found over a wide range of months and when pelagic are typically in water less than 230 feet (70 meters; Chang et al. 1999b). Peak abundance of pelagic larvae occurs during May and November in the Mid-Atlantic Bight and July through October on Georges Bank (Chang et al. 1999b). NOAA's ELMR database indicates eggs and larvae are common in Waquoit and Buzzards Bays from May through October.

Juveniles: EFH for juvenile windowpane flounder includes areas of mud and sand substrate to a depth of 197 feet (60 meters) in intertidal and sub-tidal habitats of estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to northern Florida, including mixed and high-salinity zones in bays and estuaries (NEFMC 2017). Juveniles in southern New England typically occur at depths less than 164 feet (50 meters) moving into deeper waters as they age (Chang et al. 1999b). Juveniles from Massachusetts inshore waters were most abundant at temperatures ranging from 5 to 12 °C (41 to 54 °F) in the spring and 54 to 66 °F (12 to 19 °C) during autumn (Chang et al. 1999b). Juvenile windowpane flounder were common all year in local bays and estuaries according to NOAA's ELMR database.

Adults: EFH for adult windowpane flounder extends from the intertidal zone to 230 feet (70 meters) and includes mud and sand substrates within intertidal and sub-tidal benthic habitats of estuarine (mixed and high-salinity zones), coastal marine, and continental shelf waters from the Gulf of Maine to Cape Hatteras, North Carolina (NEFMC 2017). Adult windowpane flounder aggregate in Nantucket Sound and on Nantucket Shoals in the spring and were a component of MA DMF spring (30.1 percent occurrence) and fall (73 percent occurrence) bottom trawl surveys (1978 to 2018; Matt Camissa, Pers. Comm., July 25, 2018). South of Cape Cod, adults were captured at depths of less than 49 feet (15 meters) and bottom temperature between 48 to 55 °F (9 to 13 °C) during spring and at depths of less than 98 feet (30 meters) and temperatures ranging from 48 to 66 °F (9 to 19 °C) during autumn (Chang et al. 1999b). Adult windowpane flounder were common all year in local bays and estuaries according to NOAA's ELMR database.

4.2.1.8. Winter Flounder

Winter flounder (*Pseudopleuronectes americanus*) range from Labrador to Georgia and are a common component of fish communities from Massachusetts to New Jersey (Pereira et al. 1999). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-138 (Pereira et al. 1999). Winter flounder are managed under the NEFMC

Northeast Multispecies Fishery Management Plan. EFH is designated for all life stages (egg, larvae, juvenile, adult) within the OECC and for larvae, juvenile, and adult in the WDA (Table 1). EFH for winter flounder includes anywhere within the geographic areas shown in Maps 63 to 65 in Section 2.2.1.11 of the Omnibus Essential Fish Habitat Amendment 2 that also meets the text conditions described for each life stage (NEFMC 2017).

Eggs: EFH for winter flounder eggs is designated in the OECC and includes sub-tidal estuarine and coastal benthic habitats from mean low water to 16 feet (5 meters) from Cape Cod, Massachusetts, to Absecon Inlet, New Jersey, as deep as 230 feet (70 meters) on Georges Bank and in the Gulf of Maine, and also including mixed and high-salinity zones in the bays and estuaries (NEFMC 2017). Essential habitats include mud, muddy sand, sand, gravel, macroalgae, and submerged aquatic vegetation (NEFMC 2017). Winter flounder eggs are generally collected in shallow water (less than16 feet [5 meters]) at temperatures less than 50 °F (10 °C) and over a wide range of salinities (10 to 30 ppt; Pereira et al. 1999). Eggs hatch approximately 2 to 3 weeks after deposition depending on temperature (Pereira et al. 1999) and were present all year in Waquoit Bay, Massachusetts, based on records in the ELMR database.

Larvae: EFH for larval winter flounder include estuarine, coastal, and continental shelf waters column habitats from the shoreline to a maximum depth of 230 feet (70 meters) from the Gulf of Maine to Absecon Inlet, New Jersey, as well as Georges Bank (NEFMC 2017). Essential habitats also include mixed and high-salinity zones in bays and estuaries (NEFMC 2017). Larvae are initially planktonic until approximately 5 to 6 weeks after hatching when metamorphosis approaches (Pereira et al. 1999). In southern New England, winter flounder larvae were common from March through June (NOAA ELMR database, Pereira et al. 1999) in temperatures ranging from 32 to greater than 68 °F (0 °C to 20 °C) and at depths ranging from shallow inshore waters to 230 feet (70 meters; Pereira et al. 1999).

Juveniles: Winter flounder juvenile EFH includes a variety of bottom types (mud, sand, rocky with attached maccroalgae, tidal wetlands, and eelgrass) from the intertidal zone to a maximum depth of 197 feet (60 meters) in estuarine, coastal, and continental shelf benthic habitats from the Gulf of Maine to Absecon Inlet, New Jersey, including Georges Bank and mixed and high-salinity zones in bays and estuaries (NEFMC 2017). Young-of-year winter flounder reside in shallow water over a variety of substrates and NEFSC bottom trawl surveys found these juveniles to be common in waters less than 82 °F (28 °C), depths from 0 to 32 feet (0 to 10 meters), and salinities ranging from 5 to 33 ppt (Pereira et al. 1999), indicating tolerance of a wide array of habitat and environmental conditions. Older juveniles (age 1+) are common in Nantucket Sound and typically inhabit deeper, cooler waters than the young-of-year (Pereira et al. 1999). NOAA's ELMR database indicates that juvenile Winter flounder are present all year long in Waquoit Bay and are common to highly abundant from April to October. Juveniles were common to abundant in high and low salinities in Buzzards Bay.

Adults: EFH for adult winter flounder includes muddy and sandy substrates as well as hard bottom on offshore banks in estuarine, coastal, and continental shelf benthic habitats extending from the intertidal zone (mean high water) to a maximum depth of 230 feet (70 meters) from the Gulf of Maine to Absecon Inlet, New Jersey, and including Georges Bank, and in mixed and high-salinity zones in the bays and estuaries (NEFMC 2017). Adults migrate to inshore waters during autumn and early winter and then spawn during winter and early spring. Peak spawning occurs during February and March south of Cape Cod (Pereira et al. 1999). In inshore spawning areas, EFH includes a variety of substrates where eggs are deposited on the bottom (NEFMC 2017). Adults were common year round in southern New England waters and have been present in both spring (79.4 percent occurrence) and fall (19.6 percent occurrence) bottom trawl surveys in Nantucket Sound from 1978 to 2018 (M. Camissa Per Comm.). Preferred temperatures range from 54 to 59 °F (12 °C to 15 °C) although presence at temperatures as high as 72 °F (22.2 °C) and as low as 39 °F (4 °C) are recorded (Pereira et al. 1999). NOAA's ELMR database indicates adult winter flounder were common to highly abundant during most months in high and low-salinity zones of Buzzards Bay and, while present in all months, were common to abundant from November through June in Waquoit Bay.

4.2.1.9. Witch Flounder

Witch flounder (*Glyptocephalus cynglossus*), a right-eyed flounder occurring in the North Atlantic, is common in the Gulf of Maine, deeper areas on Georges Bank, and south to Cape Hatteras, North Carolina (Cargnelli et at. 1999b). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-139 (Cargnelli et al. 1999b). Witch flounder are managed under the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designed for larvae in the OECC and eggs, larvae, and adults in the WDA (Table 1). EFH includes the designated area depicted in Maps 66 to 69 in Section 2.2.1.12 of the Omnibus Essential Fish Habitat Amendment 2 (NEFMC 2017).

Eggs and Larvae: EFH for witch flounder eggs and larvae are considered pelagic habitats on the continental shelf throughout the Northeast region (NEFMC 2017). Eggs appear in May and June in New England. The eggs are buoyant and rise in the water column over deep water areas at temperatures ranging from 39 to 55 °F (4 to 13 °C) and depths typically from 98 to 492 feet (30 to 150 meters), (Cargnelli et al. 1999b). Hatching occurs after 7 to 8 days and larvae were present from March through November at temperatures ranging from 39 to 55 °F (4 to 13 °C) and at depths from 33 to 689 feet (10 to 210 meters; Cargnelli et al. 1999b). No records of witch flounder eggs or larvae are present in the ELMR database.

4.2.1.10. Yellowtail Flounder

Yellowtail flounder (*Pleuronectes ferruginea*) inhabit the Northwest Atlantic Ocean from the Gulf of St. Lawrence to Chesapeake Bay and are most common in the Northeast region, including southern New England (Johnson et al. 1999). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-140 (Johnson et al. 1999). Management of yellowtail flounder falls under the Northeast Fishery Management Plan. EFH is designated for all life stages (egg, larvae, juvenile, and adult) in the OECC and WDA (NEFMC 2017). EFH is considered anywhere within Maps 70 to 73 in Section 2.2.1.13 of the Omnibus Essential Fish Habitat Amendment 2 that also fits the text descriptions (NEFMC 2017).

Eggs: EFH for yellowtail flounder eggs is designated for coastal and continental shelf habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, including high-salinity zones and bays (NEFMC 2017). The buoyant eggs are present in the water column from September through May at temperatures ranging from 36 to 59 °F (2 to 15 °C) and depths from 33 to 2,460 feet (10 to 750 meters; Johnson et al. 1999).

Larvae: EFH for larval yellowtail flounder includes the coastal marine and continental shelf pelagic habitats in the Gulf of Maine, on Georges Bank, and the Mid-Atlantic region, including high-salinity zones or bays and estuaries (NEFMC 2017). Larvae were collected at temperatures ranging from 41 to 63 °F (5 to 17 °C) with the majority at depths from 33 to 296 feet (10 to 90 meters) from May through August with the highest abundance in southern New England occurring May through July (Johnson et al. 1999).

Juveniles: EFH for juvenile yellowtail flounder includes sand and muddy sand bottoms in sub-tidal and benthic habitats at 131 to 230 feet (40 to 70 meters) in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic including high-salinity zones of bays and estuaries (NEFMC 2017). High concentrations of juvenile yellowtail flounder were identified in NEFSC bottom trawl surveys in spring and autumn around Cape Cod at depths from 7 to 410 feet (2 to 125 meters) and temperatures ranging from 37 to 57 °F (2 to 14 °C; Johnson et al. 1999).

Adults: EFH for adult yellowtail flounder is sand or sand with mud, shell hash, gravel, and rocks between 82 and 295 feet (25 and 90 meters) deep in sub-tidal benthic coastal waters from the Gulf of Maine to the Mid-Atlantic, including high-salinity zones in bays and estuaries (NEFMC 2017). Adults are present throughout southern New England at depths typically less than 328 feet (100 meters) and are most frequently captured in MA DMF and NEFSC trawl surveys at temperatures less than 59°F (15 °C; Johnson et al. 1999). While there are no records of yellowtail flounder from MA DMF bottom trawl surveys from Region 2, Guida et al. (2017) indicated that yellowtail flounder were a component of both warm and cold season sampling in the MA WEA based on 2003 to 2016 NEFSC bottom trawl surveys.

4.2.1.11. Silver Hake

Silver hake (*Merluccius bilinearis*) are distributed on the continental shelf from the Gulf of St. Lawrence to Cape Fear, North Carolina (Lock and Packer 2004). A more detailed geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-186 (Lock and Packer 2004). Silver hake are managed under the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designated for silver hake eggs and larvae in the OECC and WDA and for juveniles and adults in the WDA (Table 1). EFH is generally designated anywhere within the geographic area depicted in maps or tables in Section 2.2.2.1 of the Omnibus Essential Fish Habitat Amendment 2 that meets the requirements detailed in the text descriptions (NEFMC 2017).

Eggs and Larvae: EFH for the eggs and larvae includes pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays (NEFMC 2017). Eggs are pelagic and hatch in about 2 days at 20 °C (68 °F), while larvae remain pelagic between 1 to 5 months (Lock and Packer 2004). Eggs were collected during all months with increasing abundance in southern New England occurring in May and June and declining abundance through October, with the few eggs captured in November and December occurring in the deep waters of the Mid-Atlantic Bight (Lock and Packer 2004).

Juveniles: Juvenile silver hake EFH includes pelagic and benthic habits from the Gulf of Maine to Cape May, New Jersey (NEFMC 2017). Juveniles were identified in coastal waters greater than 33 feet (10 meters) and at depths of between 131 and 1,312 feet (40 and 400 meters) in the Gulf of Maine, on Georges Bank, and the Mid-Atlantic (NEFMC 2017). In southern New England, juvenile silver hake were found during winter and spring in both NEFSC bottom trawl surveys and MA DMF trawl surveys, preferring higher salinity waters and temperatures ranging from 34 to 64 °F (1 to 18 °C; Lock and Packer 2004). Juveniles are found in association with sand waves and flat sand habitats (NEFMC 2017).

4.2.1.12. Red Hake

Red hake (*Urophycis chuss*) are a demersal species occurring in the North Atlantic from North Carolina to Newfoundland, Canada, with the greatest abundance found between Georges Bank and New Jersey (Steimle et al. 1999b). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-133 (Steimle et al. 1999b). Red hake are managed under the NEFMC Northeast Multispecies Fishery Management Plan. EFH is designated for red hake eggs, larvae, juveniles, and adults in both the OECC and WDA (Table 1). EFH is generally designated anywhere within the geographic area depicted in maps or tables in Section 2.2.2.2 of the Omnibus Essential Fish Habitat Amendment 2 that meets the requirements detailed in the text descriptions (NEFMC 2017).

Eggs and Larvae: EFH for eggs and larvae are the same, including pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic (NEFMC 2017). While the understanding of habitat requirements for red hake eggs is poor due to difficulty in separating them out from other species, larvae are more easily identified and can be found in the upper water column from May through December (Steimle et al. 1999b). Red hake larvae were collected on the middle to outer continental shelf of the Mid-Atlantic Bight at temperatures primarily between 52 to 66 °F (11 to 19 °C) and at depths between 33 to 656 feet (10 and 200 meters), although they were also found in bays and estuaries including Buzzards Bay and in bays north of Cape Cod (Steimle et al. 1999b). Undifferentiated hake eggs were collected at the edge of the continental shelf from December through April while red hake larvae peak presence occurred during September and October (Steimle et al. 1999b). NOAA's ELMR database identifies red hake eggs and larvae as rare or common in Buzzards Bay from May through November in both high and low salinity zones. No records of red hake at any life stage are recorded for Waquoit Bay.

Juveniles: EFH designation for juvenile red hake includes intertidal and sub-tidal benthic habitats on mud and sand substrates to a maximum depth of 262 feet (80 meters; NEFMC 2017). EFH for juvenile red hake are bottom habitats providing shelter, including mud substrates with biogenic depressions, substrates providing biogenic complexity like eelgrass or macroalgae, and artificial reefs (NEFMC 2017). Newly settled juveniles occur in depressions on open seabeds, while older fish are often associated with structure and other shelter (NEFMC 2017). Juvenile red hake were collected at temperatures ranging from 36 to 72 °F (2 to 22 °C), at depths from 16 to greater than 164 feet (5 to greater than 50 meters), and at salinities ranging from 24 to 32 ppt in inshore waters of Southern New England (Steimle et al. 1999b). NOAA's ELMR database indicates that larvae were common in adjacent Buzzards Bay from July through October but were not present in Waquoit Bay.

Adults: EFH for adult red hake includes benthic habitats in the Gulf of Maine and the OCS and slope, with depths from 164 to 2,460 feet (50 to 750 meters) to as shallow as 66 feet (20 meters) in a number of inshore estuaries and embayments as far south as Chesapeake Bay (NEFMC 2017). Shell beds, soft sediments (mud and sand), and artificial reefs provide essential habitats for adult red hake, which are usually found in depressions in softer sediments or in shell beds and not on open sandy bottom (NEFMC 2017). Adults were generally found at depths greater than 82 feet (25 meters) and over a wide array of temperatures (36 to 72 °F [2 to 22 °C]). Red hake migrate into southern New England during summer months and inhabit shallow inshore coastal waters (less than 33 feet [10 meters]), migrating back offshore into deeper waters (up to 3,215 feet [980 meters]) during winter (Steimle et al. 1999b). Spawning occurs in water temperatures between 41 to 50 °F (5 to 10 °C) from April to November on the continental shelf off southern New England (Steimle et al. 1999b). Red hake were a component of warm and cold season sampling conducted by NEFSC (2003 to 2016) and occurred in the MA WEA. They were more common in Nantucket Sound during spring bottom trawl surveys conducted by MA DMF (15.6 percent) than during fall sampling (2.8 percent; Matt Camissa, Pers. Comm., July 25, 2018). Red hake were identified in NOAA's ELMR database as rare or common primarily in the higher salinity areas of Buzzards Bay and spawning was identified as common from June through September.

4.2.2. Monkfish Fishery Management Plan

Monkfish are managed under the Monkfish Fishery Management Plan and EFH is designated under the NEFMC (2017) Omnibus Essential Fish Habitat Amendment 2. Monkfish (*Lophius americanus*) are a bottom-dwelling species of anglerfish that inhabits the Northwest Atlantic Ocean from the Gulf of St. Lawrence south to Florida, although it is most commonly found north of Cape Hatteras, North Carolina (Steimle et al. 1999c). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-127 (Steimle et al. 1999c). Monkfish EFH is designated for eggs and larvae in both the OECC and WDA and for juveniles and adults in the WDA (Table 1). EFH is defined as anywhere within the geographic description and maps/tables found in Section 2.2.3 of the Omnibus Essential Fish Habitat Amendment 2 that meets the requirements detailed in the text descriptions (NEFSC 2017).

Eggs and Larvae: EFH for monkfish eggs and larvae includes pelagic habitat in inshore areas and the continental shelf and slope throughout the Northeast region (NEFMC 2017). The eggs occur within a mucus veil in the upper part of the water column for May through September and typically hatch within 6 to 7 days at temperatures of 59 °F (15 °C; Steimle et al. 1999c). Larvae are a common component of ichthyoplankton surveys off southern New England and are most abundant during June and July, although they are present from April through September, preferring water temperatures ranging from 52 to 59 °F (11 to 15 °C; Steimle et al. 1999c).

Juveniles: Juvenile monkfish EFH includes a variety of habitats, including hard sand, pebbles, gravel, broken shells, and soft mud often among rocks with attached algae from sub-tidal benthic habitats. These habitats are at depths of 164 to 1,312 feet (50 to 400 meters) in the Mid-Atlantic, 66 to 1,312 feet (20 to 400 meters) in the Gulf of Maine, and up to 3,280 feet (1,000 meters) on the continental slope (NEFMC 2017). Juveniles tend to concentrate further offshore in waters greater than 197 feet (60 meters) during winter and become more widespread in the spring and summer (Steimle et al. 1999c). The temperature range in which they were captured during NEFSC bottom trawls ranged from 37 to 55 °F (3 to 13 °C; Steimle et al. 1999c).

Adults: Adult EFH consists of hard sand, pebbles, gravel, broken shells, and soft mud in sub-tidal benthic habitats in depths of 164 to 1,312 feet (50 to 400 meters) in southern New England and Georges Bank and up to 3,280 feet (1,000 meters) on the continental slope (NEFMC 2017). Adults are found in benthic habitats, favoring and bottoms with which they can conceal themselves (Steimle et al. 1999d). Adults are most common at temperatures ranging from 39 to 57 °F (4 to 14 °C) and are typically found in deeper waters (up to 1,640 feet [500 meters]) in spring and shallower during autumn (less than 656 feet [200 meters]; Steimle et al. 1999d). Spawning occurs from spring through early fall, peaking in May and June over (Steimle et al. 1999d).

4.2.3. Skate Complex Fishery Management Plan

4.2.3.1. Barndoor Skate

Barndoor skate (*Dipturus laevis*) are long-lived benthic species occurring from Newfoundland, Canada, to North Carolina (Packer et al. 2003a). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage is in NOAA Technical Memorandum NMFS-NE-173 (Packer et al. 2003a). Barndoor skate are managed through the Northeast Skate Complex Fishery Management Plan. EFH is designated for juveniles and adults in the WDA (Table 1). No EFH occurs in the footprint of the OECC. EFH is defined as anywhere within the geographic description and maps/tables found in Section 2.2.4.3 of the Omnibus Essential Fish Habitat Amendment 2 that meets the requirements detailed in the text descriptions (NEFMC 2017).

Adults and Juveniles: EFH in southern New England includes benthic habitats on the continental shelf in depths of 131 to 1,312 feet (40 to 400 meters) over mud, sand, and gravel substrates (NEFMC 2017). Juveniles in southern New England were most common during the summer. While adults were rare but present during winter NEFSC bottom trawl surveys, they were most abundant in this region during the summer in shallow waters (Packer et al. 2003a).

4.2.3.2. Little Skate

Little skate (*Leucoraja erinacea*) occur from Nova Scotia to Cape Hatteras and are one of the dominant members of the fish community in the Northwest Atlantic Ocean, with the greatest abundance in the Mid-Atlantic Bight and Georges Bank (Packer et al. 2003b). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage is in NOAA Technical Memorandum NMFS-NE-175 (Packer et al. 2003b). Little skate are managed through the Northeast Skate Complex Fishery Management Plan. EFH is designated for juveniles and adults in both the OECC and WDA (Table 1). EFH is defined as anywhere within the geographic description and maps/tables found in Section 2.2.4.4 of the Omnibus Essential Fish Habitat Amendment 2 that meets the requirements detailed in the text descriptions (NEFMC 2017).

Juveniles: EFH includes sand, gravel, or mud substrates in intertidal and sub-tidal benthic habitats up to 262 feet (80 meters) in depth in coastal waters from the Gulf of Maine as far south as Delaware Bay and extending to Georges Bank as well as the high-salinity zones in bays and estuaries (NEFMC 2017). Juvenile little skate are a year-round component in the southern New England fish community, exhibiting some seasonal movements to shallower waters during spring and deeper waters during colder months (Packer et al. 2003b).

Adults: EFH for adult little skate includes sand, gravel, and mud substrates of high-salinity bays and estuaries and in the intertidal and sub-tidal benthic habitats of coastal waters from the Gulf of Maine south to Delaware Bay and extending to Georges Bank (NEFMC 2017). As with juveniles, adults are present in southern New England during all months (Packer et al. 2003b). Little skate were common during MA DMF spring (65.1 percent occurrence) and fall (52.3 percent occurrence) bottom trawl surveys (1978 to 2018) (Matt Camissa, Pers. Comm., July 25, 2018). In an analysis of NEFSC bottom trawl surveys (2003 to 2016) occurring within the MA WEA, Guida et al. (2017) found little skate to be a dominant component in both warm and cold season sampling.

4.2.3.3. Winter Skate

Winter skate (*Leucoraja ocellata*) occur from Newfoundland to Cape Hatteras in the Northwest Atlantic Ocean, with the greatest abundance in the Mid-Atlantic Bight and Georges Bank (Packer et al. 2003c). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage is in NOAA Technical Memorandum NMFS-NE-179 (Packer et al. 2003c). Winter skate are managed through the Northeast Skate Complex Fishery Management Plan. EFH is designated for juveniles and adults in both the OECC and WDA (Table 1). EFH is defined as anywhere within the geographic description and maps/tables found in Section 2.2.4.5 of the Omnibus Essential Fish Habitat Amendment 2 that meets the requirements detailed in the text descriptions (NEFMC 2017).

Juveniles: EFH includes sand, gravel or mud substrates in sub-tidal benthic habitats to a depth of 295 feet (90 meters) in coastal waters from the Gulf of Maine as far south as Delaware Bay, including the continental shelf in southern New England and the Mid-Atlantic Bight as well as the high-salinity zones in bays and estuaries (NEFMC 2017). Juvenile winter skate were a common inhabitant of southern New England waters during all seasons (Packer et al. 2003c).

Adults: EFH includes sand, gravel, or mud substrates in sub-tidal benthic habitats to a depth of 262 feet (80 meters) from the southwestern Gulf of Maine, the continental shelf waters of southern New England and the Mid-Atlantic Bight, and Georges Bank, as well as the high-salinity zones in bays and estuaries (NEFMC 2017). Adult winter skate were a year round inhabitant of southern New England waters (Packer et al. 2003c). Winter skate were encountered in both spring (45.2 percent occurrence) and fall (38.6 percent occurrence) MA DMF 1978-2018 bottom trawl surveys (Matt Camissa, Pers. Comm., July 25, 2018). In an analysis of NEFSC bottom trawl surveys (2003 to 2016) occurring within the MA WEA, Guida et al. (2017) found winter skate to be a dominant component in both warm and cold season sampling.

4.2.4. Atlantic Sea Scallop Fishery Management Plan

4.2.4.1. Atlantic Sea Scallop

The Atlantic sea scallop (*Placopecten magellanicus*) is a bivalve mollusk occurring on the continental shelf of the northwest Atlantic from the Gulf of St. Lawrence south to Cape Hatteras, North Carolina (Hart and Chute 2004). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-189 (Hart and Chute 2004). EFH for Atlantic sea scallops is defined as anywhere within the geographical area shown on Map 97 of the Omnibus Essential Fish Habitat Amendment 2 Section 2.2.5 that meet the environmental conditions for a specific life stage as described in the text (NEFMC 2017). EFH is designated for all life stages (egg, larvae, juvenile, adult) of Atlantic sea scallops in the WDA and OECC Table 1).

Eggs: Eggs are negatively buoyant and therefore EFH includes benthic habitats in inshore areas and on the continental shelf in the vicinity of adult scallops (NEFMC 2017). Eggs remain on the bottom until after hatching, when they develop into the free-swimming larval stage (NEFMC 2017). Spawning typically occurs from August through October, although evidence of spring spawning exists in the Mid-Atlantic Bight (Hart and Chute 2004).

Larvae: EFH for larvae includes benthic and water column habitats in inshore and offshore areas throughout the region (NEFMC 2017). Free-swimming larvae eventually become benthic, and any hard surface can provide an essential habitat for settling pelagic larvae ("spat"), including shells, pebbles, and gravel (NEFMC 2017). They also attach to macroalgae and other benthic organisms such as hydroids. Spat attached to sedentary branching organisms or any hard surface have greater survival rates; spat that settle on shifting sand do not survive (NEFMC 2017).

Juveniles: EFH for juveniles includes benthic habitats between 59 to 361 feet (18 and 110 meters) in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic on shells, gravel, and small rocks (gravel, pebble, and cobble) on which the juveniles attach themselves by byssal threads (NEFMC 2017). Older juveniles become relatively active, swimming to avoid predation, and can be carried long distances by currents (NEFMC 2017). Bottom currents stronger than 4 inches/second (10 centimeters/second) negatively affect growth and optimal temperatures range from 34 to 59 °F (1.2 to 15 °C) optimal salinities above 25 ppt (NEFMC 2017).

Adults: Older juvenile and adult EFH includes sand and gravel substrates at depths of 59 to 361 feet (18 to 110 meters) on benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic (NEFMC 2017). Bottom currents stronger than 10 inches/second (25 centimeters/second) inhibit feeding. Growth is optimized at temperatures ranging between 50 and 59 °F (10 and 15 °C), and they prefer full strength seawater (NEFMC 2017). Atlantic sea scallops were widespread across the MA WEA, an area that encompasses the WDA (Guida et al. 2017). Sea scallops were present in low densities in the WDA and OECC areas (VMIS and SMAST 2018).

4.2.5. Atlantic Herring Fishery Management Plan

4.2.5.1. Atlantic Herring

Atlantic herring (*Clupea harengus*) are a schooling, coastal, pelagic species inhabiting the western North Atlantic from Labrador, Canada, to Cape Hatteras, North Carolina (Stevenson and Scott 2005). This range includes the stock complex found in the Gulf of Maine and Georges Bank (Stevenson and Scott 2005). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-192 (Stevenson and Scott 2005). Atlantic herring are managed under the Atlantic Herring Fishery Management Plan. EFH is designated for larvae, juveniles, and adults in the WDA and juveniles and adults in the OECC (Table 1). Generally, EFH for Atlantic herring includes the geographical areas depicted in Maps 98 to 101 and Table 30 in Section 2.2.6 of the Omnibus Essential Fish Habitat Amendment 2 that also include the environmental conditions defined by the text description (NEFMC 2017).

Larvae: EFH for larvae includes inshore and offshore pelagic habitats in the Gulf of Maine, Georges Bank, the upper Mid-Atlantic Bight, and listed bays and estuaries (NEFMC 2017). Larval stages last between 4 to 8 months, and herring can be transported long distances to inshore and estuarine regions prior to transformation to the juvenile stage (NEFMC 2017). Larvae from Nantucket Shoals tend to drift southwest with currents, and herring larvae perform vertical migrations associated with light, turbidity, tidal currents, or shifts in prey abundance (primarily copepods; Stevenson and Scott 2005).

Juveniles: EFH for juveniles includes intertidal and sub-tidal pelagic habitats to 300 meters (NEFMC 2017). One- and 2-year-old juveniles are found in water temperatures ranging from 37 to 59 °F (3 to 15 °C) in the northern part of their range and as high as 72 °F (22 °C) in the Mid-Atlantic (NEFMC 2017). Juveniles (1 and 2 year olds) form large schools off the coast of southern New England during spring and summer, and overwinter offshore in deep bays near bottom during winter, returning inshore during spring where 2-year-old fish are recruited into the fishery (Stevenson and Scott 2005). NOAA's ELMR database indicates juveniles were common in Buzzards Bay during October through May.

Adults: EFH for adults includes subtidal and pelagic habitats with maximum depths of 984 feet (300 meters) throughout the region (NEFMC 2017). Extensive seasonal migrations between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region (NEFMC 2017). Adults prefer high-salinity waters (greater than 28 ppt) and the highest catch rates in the NEFSC bottom trawl surveys occurred at depths in spring and winter ranging from 98 to 328 feet (30 to 100 meters) and in summer and fall ranging from 66 to 558 feet (20 to 170 meters), where water temperatures ranged from 41 to 46 °F (5 to 8 °C; Stevenson and Scott 2005). Like juveniles, adults were listed as common in Buzzards Bay from October to May in the ELMR database.

4.3. Mid-Atlantic Fishery Management Council EFH Designations

4.3.1. Atlantic Mackerel, Squid, and Butter Fish Fishery Management Plan

4.3.1.1. Atlantic Butterfish

Atlantic butterfish (*Peprilus triacanthus*) range from the Gulf of St. Lawrence to the Gulf Coast of Florida, although the greatest abundance occurs in the waters between the Gulf of Maine and Cape Hatteras, North Carolina (Cross et al. 1999). A detailed description of the geographic distribution, life history, and habitat characteristics for this species by life stage is found in NOAA Technical Memorandum NMFS-NE-145 (Cross et al. 1999). Atlantic butterfish are managed under the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan and EFH is designated (under Amendment 11 of that document) for eggs and larvae in the WDA and for juvenile and adult in both the WDA and OECC (Table 1) (MAFMC 2011).

Eggs: EFH for Atlantic butterfish eggs includes pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Chesapeake Bay, and pelagic waters on the continental shelf and slope from Georges Bank to North Carolina (MAFMC 2011). EFH includes waters over bottom depths of 4,921 feet (1,500 meters) or less, with average water temperature of 44 to 71 °F (6.5 to 21.5 °C) in the upper 656 feet (200 meters) of the water column (MAFMC 2011). Eggs are buoyant and typically found in the upper 656 feet (200 meters) of the water column. In southern New England, they are common in high-salinity zones of estuaries and embayments (Cross et al. 1999). The NOAA's ELMR database indicated they were common in Waquoit Bay, Massachusetts, during May through August in high-salinity zones (greater than 25 ppt).

Larvae: EFH for larvae is designated as the pelagic inshore estuaries and embayments from the south shore of Cape Cod to the Hudson River and on the continental shelf from western Georges Bank to Cape Hatteras, North Carolina (MAFMC 2011). EFH for larvae includes waters over bottom depths of 135 to 1,148 feet (41 to 350 meters), where the average water temperature ranges from 47 to 71 °F (8.5 to 21.5 °C) in the upper 656 feet (200 meters; MAFMC 2011). In NOAA's ELMR database, larvae were commonly encountered in Waquoit Bay, Massachusetts, from June through October.

Juveniles: EFH for juvenile Atlantic butterfish includes pelagic habitat over bottom depths of 33 to 919 feet (10 to 280 meters) and at temperatures ranging from 6.5 to 27 °C (44 to 82 °F) in inshore estuaries and embayments from Massachusetts Bay to North Carolina and also include inshore water of the Gulf of Maine, South Atlantic Bight, and on the continental shelf from southern New England to South Carolina. Juvenile Atlantic butterfish were rare to highly abundant, primarily in higher salinity zones, from April to December in Buzzards Bay and rare to common in Waquoit Bay according to NOAA's ELMR database.

Adults: EFH for adults includes pelagic habitats in inshore estuaries and embayments from Massachusetts to South Carolina, inshore waters from the Gulf of Maine and the South Atlantic Bight, on Georges Bank, and on the OCS from southern New England to South Carolina (MAFMC 2011). EFH includes waters over bottom depths of 33 to 820 feet (10 to 250 meters) over a wide array of temperatures (40 to 82 °F [4.5 to 27.5 °C]) and salinities (greater than 5 ppt). In southern New England, Atlantic butterfish were distributed along the OCS during winter and spring (Cross et al. 1999). NOAA's ELMR database indicated adults were common in Waquoit Bay from May through October. Bottom trawl surveys conducted by MA DMF from 1978 to 2018 (Matt Camissa, Pers. Comm., July 25, 2018) show butterfish are common in both spring (30.8 percent occurrence) and fall (92.1 percent occurrence). In an analysis of NEFSC bottom trawl surveys (2003 to 2016) that were collected within the MA WEA, Atlantic butterfish were present during both warm and cold sampling seasons and were a dominant species during the warm season (Guida et al. 2017).

4.3.1.2. Atlantic Mackerel

Atlantic mackerel (*Scomber scombrus*) are a pelagic schooling species present in the Northwest Atlantic Ocean from the Gulf of St. Lawrence, Canada, to North Carolina (Studholme et al. 1999). A detailed description of the geographic distribution, life history, and habitat characteristics of this species by life stage is found in NOAA Technical Memorandum NMFS-NE-141 (Studholme et al. 1999). Atlantic mackerel are managed under the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan and EFH is designated (under Amendment 11 of that document) for eggs, larvae, and juveniles in both the WDA and OECC (Table 1) (MAFMC 2011).

Eggs: EFH includes pelagic habitats over bottom depths at or less than 328 feet (100 meters) in inshore estuaries and embayments from Great Bay, New Hampshire, to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and the continental shelf from Georges Bank to Cape Hatteras, North Carolina (MAFMC 2011). Eggs typically occur in a temperature range of 44 to 53 °F (6.5 to 11.5 °C) and in the upper 49 feet (15 meters) of the water column (MAFMC 2011). In southern New England, eggs were most often identified during the spring and summer (Studholme et al. 1999). In NOAA's ELMR database, eggs were rare in Waquoit Bay from May through August, and in Buzzards Bay were present from May through August in both high and low salinity zones, but abundant and common in higher salinity zones from May through July.

Larvae: EFH for larvae includes pelagic habitats over bottom depths at or less than 328 feet (100 meters) in inshore estuaries and embayments from Great Bay, New Hampshire, to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and the continental shelf from Georges Bank to Cape Hatteras, North Carolina (MAFMC 2011). Larval EFH occurs over depths between 69 and 656 feet (21 and 200 meters) at average water temperatures of 42 to 53 °F (5.5 to 11.5 °C; MAFMC 2011). Larvae were collected in NEFSC MARMAP ichthyoplankton surveys from May through August, with the highest abundance in June (Studholme et al. 1999). Larvae were rare from May through August in both Waquoit and Buzzards Bay according to NOAA's ELMR database.

Juveniles: Juvenile EFH includes pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay, Maine, to the Hudson River, and in the Gulf of Maine and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (MAFMC 2011). EFH for juvenile Atlantic mackerel was considered generally over bottom depths of 33 to 328 feet (10 to 100 meters) at water temperatures from 41 to 68 °F (5 to 20 °C; MAFMC 2011). During spring, juvenile and adult Atlantic mackerel were most abundant in the waters between Chesapeake Bay and southern New England as they moved north (Studholme et al. 1999). NOAA's ELMR database indicates juvenile were present but rare in Waquoit Bay and Buzzards Bay from May through September.

4.3.1.3. Longfin Inshore Squid

Longfin inshore squid (*Doryteuthis pealeii*) are a schooling invertebrate distributed in continental and slope waters from the Gulf of Venezuela to Newfoundland and occurring in commercial abundance in southern New England (Jacobson 2005). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-193 (Jacobson 2005). Longfin inshore squid are managed under the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. EFH is designated (under Amendment 11) for eggs, juveniles, and adults in the OECC and for eggs and adults in the WDA (Table 1; MAFMC 2011).

Eggs: EFH for longfin inshore squid eggs includes inshore and offshore bottom habitats from Georges Bank to Cape Hatteras, North Carolina, where bottom temperatures range from 50 to 73 °F (10 to 23 °C), salinities from 30 to 32 ppt, and at depths of less than 164 feet (50 meters; MAFMC 2011). Egg mops are found attached to rocks, boulders, and aquatic vegetation in sand or mud bottoms (Jacobson 2005). MA DMF inshore bottom trawl surveys conducted from 1978 to 2018 indicated that longfin inshore squid egg mops are more prevalent in spring trawl samples (8.2 percent) than in fall samples (5.5 percent; Matt Camissa, Pers. Comm., July 25, 2018).

Juvenile/Pre-recruits: EFH for juvenile longfin inshore squid includes pelagic inshore and offshore continental shelf waters and in some embayments (i.e., Long Island Sound, Narragansett Bay; MAFMC 2011). Pre-recruits are typically found in the upper 33 feet (10 meters) of the water column at depths ranging from 33 to 492 feet (10 to 150 meters; Jacobson 2005), temperatures ranging from 47 to 76 °F (8.5 to 24.5 °C), and high-salinity waters (greater than 25 ppt; MAFMC 2011). Pre-recruits feed primarily on planktonic organisms and conduct diel migrations, rising in the water column at night and returning to deeper waters during the day (Jacobson 2005). Juveniles make a migration offshore in the fall and overwinter along the edge of the continental shelf (MAFMC 2011).

Adult/Recruits: EFH is pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay (MAFMC 2011). EFH for recruit longfin inshore squid is bottom depths between 20 to 656 feet (6 and 200 meters), where bottom water temperatures are 47 to 57 °F (8.5 to 14 °C) and salinities are 24 to 36.5 ppt (MAFMC 2011). Recruits can be found over depths of 1,312 feet (400 meters), although depths tend to vary seasonally, with longfin inshore squid being found in shallow depths (20 to 92 feet [6 to 28 meters]) during summer and autumn and in deeper waters (360 to 1200 feet [110 to 365 meters]) during winter and spring (Jacobson 2005). Spawning occurs from May to August in New England waters. Females deposit eggs, often over a period of several weeks, in gelatinous capsules that are attached in clusters to rocks, boulders, aquatic vegetation and sand or mud bottoms, generally in depths less than 164 feet (50 meters; MAFMC 2011, Jacobson 2005). Longfin inshore squid were present in the majority of spring (89.6 percent) and fall (99.7 percent) samples from the 1978-2018 MA DMF spring and fall bottom trawl surveys in Nantucket Sound (Matt Camissa, Pers. Comm., July 25, 2018). Longfin squid were also a dominant species captured during warms season sampling in an analysis of NEFSC bottom trawl surveys (2003 to 2016) in the MA WEA (Guida et al. 2017).

4.3.1.4. Northern Shortfin Squid

Northern shortfin squid (*Illex illecebrosus*) are highly migratory species distributed in the northwest Atlantic from the Sea of Labrador and the Florida Straits, with a single stock constituting the commercially exploited region from Newfoundland to Cape Hatteras, North Carolina (Hendrickson and Holmes 2004). The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-191 (Hendrickson and Holmes 2004). Northern shortfin squid are managed under the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. EFH is designated (under Amendment 11) for adults in the OECC (Table 1; MAFMC 2011).

Adults/Recruits: EFH for northern shortfin squid includes pelagic habitats on the continental shelf and slope from Georges Bank to South Carolina, as well as inshore and offshore waters of the Gulf of Maine (MAFMC 2011). EFH for recruit northern shortfin squid is generally the shelf over bottom depths between 135 to 1,312 feet (41 and 400 meters), although recruits are typically found in the depths of 328 to 656 feet (100 to 200 meters) during summer (MAFMC 2011; Hendrickson and Holmes 2004). In coastal Massachusetts waters, recruits were rarely recorded during inshore bottom trawl surveys. Those captured during the spring were collected primarily in waters 36 to 180 feet (11 to 15 meters) deep at approximately 52 °F (11 °C), while those from spring samples were caught at depths of 102 to 180 feet (31 to 55 meters) and at temperatures from 43 to 50 °F (6 to 10 °C; Hendrickson and Holmes 2004). Recruits make daily vertical migrations, moving up in the water column at night and down in the daytime. They feed primarily on fish and euphausiids and are also cannibalistic (MAFMC 2011). Northern shortfin squid migrate inshore during the spring onto the continental shelf in southern New England. They were not common (1.1 percent occurrence) in spring bottom trawl surveys by MA DMF (1978 to 2018) in

Nantucket Sound (Matt Camissa, Pers. Comm., July 25, 2018). With the onset of fall, shortfin squid migrate off the continental shelf to spawn (Hendrickson and Holmes 2004).

4.3.2. Spiny Dogfish Management Plan

4.3.2.1. Spiny Dogfish

Spiny dogfish (*Squalus acanthias*) are a circumglobal species with a population in the North Atlantic ranging from Labrador, Canada, to Florida (Stehlik 2007). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage for this species is in NOAA Technical Memorandum NMFS-NE-203 (Stehlik 2007). Spiny dogfish are managed through the Spiny Dogfish Fishery Management Plan and EFH is designated under Amendment 3 for the sub-adult and adult life stages in both the OECC and WDA (Table 1; MAFMC 2014).

Sub-adults: Sub-adult EFH is designated for both female and male spiny dogfish. Female sub-adult EFH includes pelagic and epibenthic habitats over a wide depth range, in full salinity seawater (32 to 35 ppt), and at temperatures between 43 to 59 °F (7 to 15 °C; MAFMC 2014). Male sub-adult EFH includes pelagic and epibenthic habitats primarily in the Gulf of Maine and on the OCS from Georges Bank to Cape Hatteras, North Carolina (MAFMC 2014).

Adults: EFH includes pelagic and epibenthic habitats through their range, including a wide range of depths, water temperatures between 49 to 59 °F (7 to 15 °C), and in full salinity sea water (32 to 35 ppt; MAFMC 2014). Adults have a similar winter distribution to juveniles during winter, occurring primarily along the shelf from Cape Hatteras to Georges Bank (Stehlik 2007). In southern New England, adult spiny dogfish were most abundant during the spring (Stehlik 2007). Both male and female sub-adults and adults are widely distributed regionally in the winter and spring when water temperatures are low, but leave the Mid-Atlantic Bight as temperatures rise above 15 °C (59 °F; MAFMC 2014).

4.3.3. Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan

4.3.3.1. Black Sea Bass

The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-200 (Drohan et al. 2007). Black sea bass (*Centropristis striata*) are managed under the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan (MAFMC 1998a). EFH is designated for juveniles and adults under Amendment 12 of that document (Table 1).

Juveniles: EFH for juvenile black sea bass is separated into offshore and inshore descriptions. The offshore EFH includes demersal waters of the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina. Inshore EFH includes the estuaries where black sea bass are identified as being common, abundant, or highly abundant in the ELMR database for the mixing (0.5 to 25 ppt) and seawater (greater than 25 ppt) salinity zones (MAFMC 1998a). Generally, juvenile black sea bass are found in waters warmer than 43 °F (6.1 °C) with salinities greater than 18 ppt and coastal areas between Virginia and Massachusetts (Drohan et al. 2007). Juveniles are common in Nantucket Sound from May to October as indicated in NOAA’s ELMR database. Most juvenile settlement does not occur in estuaries, but in coastal areas (Drohan et al. 2007). Juveniles then move into estuarine nurseries in and around oyster beds, typically in the higher salinity areas from southern Cape Cod to North Carolina (Drohan et al. 2007). Juvenile black sea bass are usually found in association with rough bottom, and are most commonly found in the nearshore waters of southern New England during autumn (Drohan et al. 2007).

Adults: Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina. Inshore, EFH is the estuaries where adult black sea bass were identified as being common, abundant, or highly abundant in the ELMR database for the mixing (0.5 to 25 ppt) and seawater (greater than 25 ppt) salinity zones (MAFMC 1998a). Adults are common in Waquoit Bay, Massachusetts, from May to October as indicated by NOAA's ELMR database and were more commonly caught in MA DMF fall bottom trawl surveys (83.1 percent occurrence) than in spring surveys (36.1 percent occurrence) from 1978 to 2018 (Matt Camissa, Pers. Comm., July 25, 2018). They are heavily associated with manmade structures, rough and hard bottom substrate along the sides of navigational channels, shellfish and eelgrass beds, and sandy/shelly areas (Drohan et al. 2007). Temperatures above 43 °F (6.1 °C) appear to be the minimum preferred winter temperature and black sea bass generally winter offshore south of New York, returning as water temperatures rise in the spring (Drohan et al. 2007). Black sea bass were captured during both warm and cold season sampling in an analysis of NEFSC 2003 to 2016 bottom trawl survey data from the MA WEA (Guida et al. 2017).

4.3.3.2. Scup

The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-149 (Steimle et al. 1999d). Scup (*Stenotomus chrysops*) are managed under the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan and EFH is designated under Amendment 12 of that document (MAFMC 1998a). EFH is designated for juvenile and adult life stages in the WDA and OECC for scup (Table 1).

Juveniles: EFH for juvenile scup includes an offshore and inshore component. Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ, from the Gulf of Maine to Cape Hatteras, North Carolina; MAFMC 1998a). Inshore, EFH is the estuaries where scup are identified as being common, abundant, or highly abundant in NOAA's ELMR database for the mixing (0.5 to 25 ppt) and seawater (greater than 25 ppt) salinity zones (MAFMC 1998a). In general, juvenile scup are found during the summer and spring in estuaries and bays between Virginia and Massachusetts in association with various sands, mud, mussel, and eelgrass bed type substrates and in water temperatures greater than 45 °F (7.2 °C) and salinities greater than 15 ppt (Steimle et al. 1999d). Juvenile scup leave inshore waters as temperatures decline and move to warmer waters in the Mid-Atlantic Bight, returning in the spring with increasing water temperatures (Steimle et al. 1999d). Juveniles will often use biogenic depressions, sand wave troughs, and possible mollusk shell fields for cover during winter (Steimle et al. 1999d). Sand waves of varying heights are present in both the OECC and WDA.

Adults: EFH for adult scup includes an offshore and inshore component. Offshore, EFH is the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina (MAFMC 1998a). Inshore, EFH is the estuaries where scup are identified as being common, abundant, or highly abundant in the ELMR database for the mixing (0.5 to 25 ppt) and seawater (greater than 25 ppt) salinity zones (MAFMC 1998a). Adults are abundant in Nantucket Sound from May to September and common in October as indicated by NOAA's ELMR database. Generally, wintering adults (November through April) are usually offshore to North Carolina in waters above 45 °F (7 °C; Steimle et al. 1999d). With rising temperatures in spring, scup return inshore (Steimle et al. 1999a). Scup occurred in MADMF spring bottom trawl surveys (1978 to 2018; over 50 percent occurrence) while during fall surveys (1978 to 2017) the occurrence approached 100 percent (Matt Camissa, Pers. Comm., July 25, 2018). Based on 2003 to 2016 NEFSC bottom trawl surveys occurring within the MA WEA, scup were present in both warm and cold water sampling periods although more abundant during the warm season (Guida et al. 2017).

4.3.3.3. Summer Flounder

The geographic distribution, life history, and habitat characteristics by life stage are described in NOAA Technical Memorandum NMFS-NE-151 (Packer et al. 1999). Summer flounder (*Paralichthys dentatus*) are managed under the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan, and EFH is designated under Amendment 12 of that document (MAFMC 1998a). EFH is designated for all four life stages (egg, larvae, juvenile, adult) in the OECC and for egg, larvae, and adult in the WDA for summer flounder (Table 1).

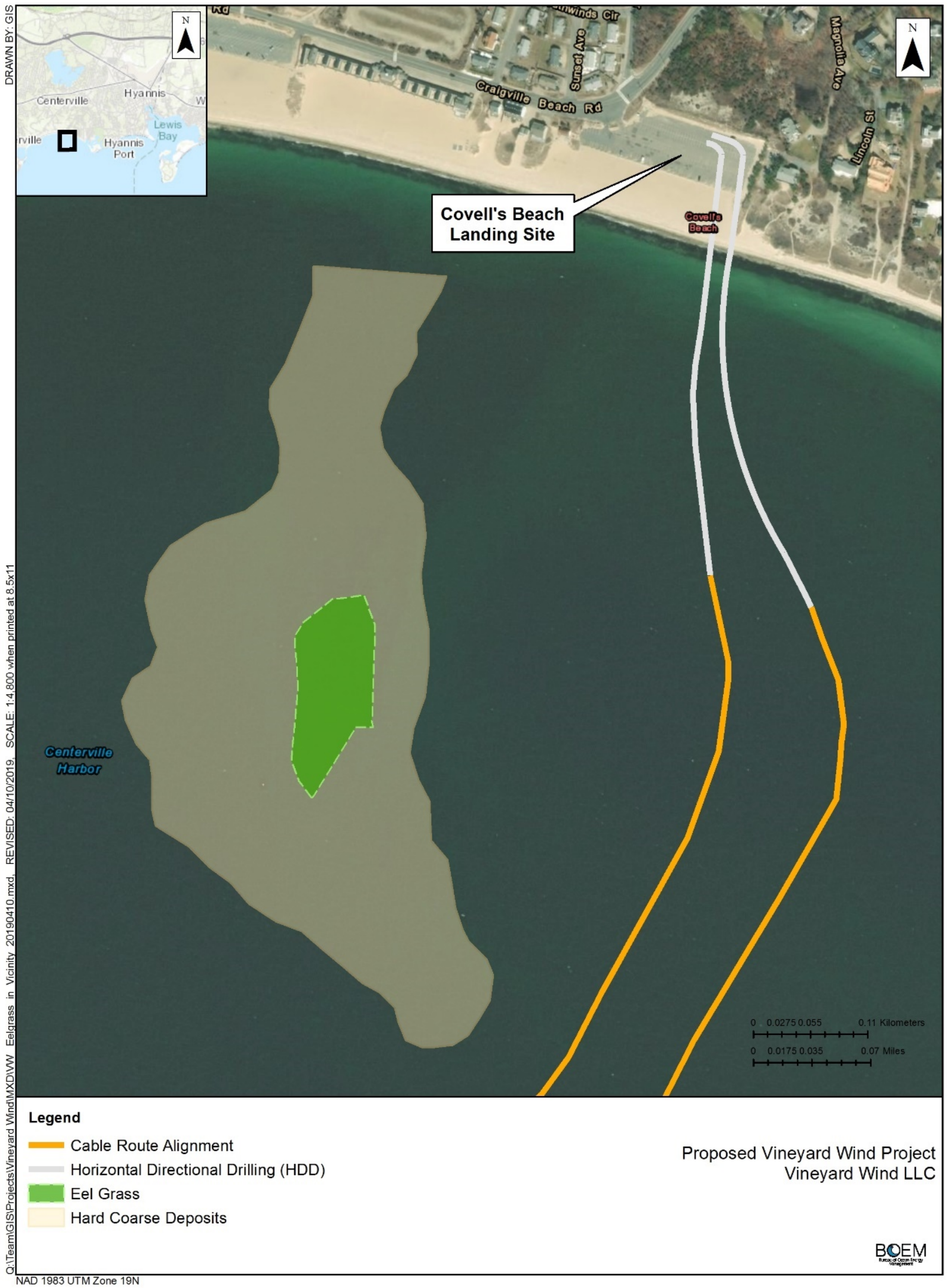
Eggs: EFH for summer flounder eggs includes pelagic waters found over the continental shelf (coast to EEZ) from the Gulf of Maine to Cape Hatteras, North Carolina, and inshore mixed and high-salinity estuaries where summer flounder were identified as present in NOAA's ELMR database (MAFMC 1998a). Summer flounder eggs are found in southern New England between October and May with the peak abundance occurring in October and November (Packer et al. 1999). The depth of capture ranges between seasons with eggs more abundant in shallow waters during spring (33 to 98 feet [10 to 30 meters]) than fall (98 to 230 feet [30 to 70 meters]; Packer et al. 1999).

Larvae: North of Cape Hatteras, larval EFH includes pelagic waters over the continental shelf (coast to EEZ) and inshore mixed and high-salinity zones of estuaries where they were identified as present in NOAA's ELMR database (MAFMC 1998a). Larvae are most commonly found from September through February in the northern Mid-Atlantic Bight and are most abundant in nearshore waters 39 to 164 feet (12 to 50 meters) from shore and at depths ranging from 33 to 253 feet (10 to 77 meters; Packer et al. 1999).

Juveniles: EFH for juveniles includes demersal waters over the continental shelf (coast to EEZ) and estuaries of mixed and high-salinity zones where they were present in NOAA's ELMR database (MAFMC 1998a). Juvenile summer flounder also inhabit salt marsh creeks, mudflats, and eel grass beds ranging in salinity from 10 to 30 ppt, as well as open bay areas (Packer et al. 1999). These regions act as nursery areas for juvenile summer flounder (Packer et al. 1999).

Adults: North of Cape Hatteras, North Carolina, adult summer flounder EFH includes the demersal waters over the continental shelf (coast to EEZ) and estuaries of mixed and high-salinity zones where they were present in NOAA's ELMR database (MAFMC 1998a). Adult summer flounder inhabit shallow coastal and estuarine waters during the warmer months and move offshore seasonally to depths up to 500 feet (154 meters) during colder months (MAFMC 1998a). Summer flounder migrate inshore beginning in May and inhabit the region and are common in Nantucket Sound, especially over sand substrate (Packer et al. 1999). The areas east and south of Cape Cod, including estuaries, bays, and harbors are considered critical habitat by the MA DMF (Packer et al. 1999). Summer flounder have been a common component of the catch in Nantucket Sound during spring (55.6 percent occurrence) and fall (69.9 percent occurrence) MA DMF bottom trawl surveys from 1978 to 2018 (Matt Camissa, Pers. Comm., July 25, 2018). Summer flounder occurred during both warm and cold seasons in an analysis of NEFSC (2003-2016) trawl sampling stations within the MA WEA (Guida et al. 2017).

HAPC: The HAPC for summer flounder is defined as all areas included as EFH that also contain native species of macroalgae, seagrasses, and freshwater/tidal macrophytes in any size bed as well as loose aggregations. Where native species have been eliminated, exotic species are included as HAPC. Figure 1 and Figure 4 show the footprint of the OECC and WDA in relation to eelgrass beds mapped during 2015 by the Commonwealth of Massachusetts. Eelgrass beds and macroalgae in the summer flounder HAPC and may occur in or near proposed Project activities. Macroalagae is expected to occur seasonally (in warm water months) on exposed hard bottom surfaces including shell hash. Thus HAPC for summer flounder could occur throughout much of the OECC in the summer (May through October). However, persistent seagrass habitat within the proposed Project area was only found in one location near Covell’s Beach (Figure 4). The seagrass bed near Covell’s beach is no closer than 1,000 feet (305 meters) from the western cable. Direct impacts to eelgrass beds are not anticipated (see Sections 5.1.2.2 and 5.1.2.3 for impact assessment).



Source: Vineyard Wind 2019c

Figure 4. Eelgrass Near the Covell's Beach Landfall Site

4.3.4. Bluefish Fishery Management Plan

4.3.4.1. Bluefish

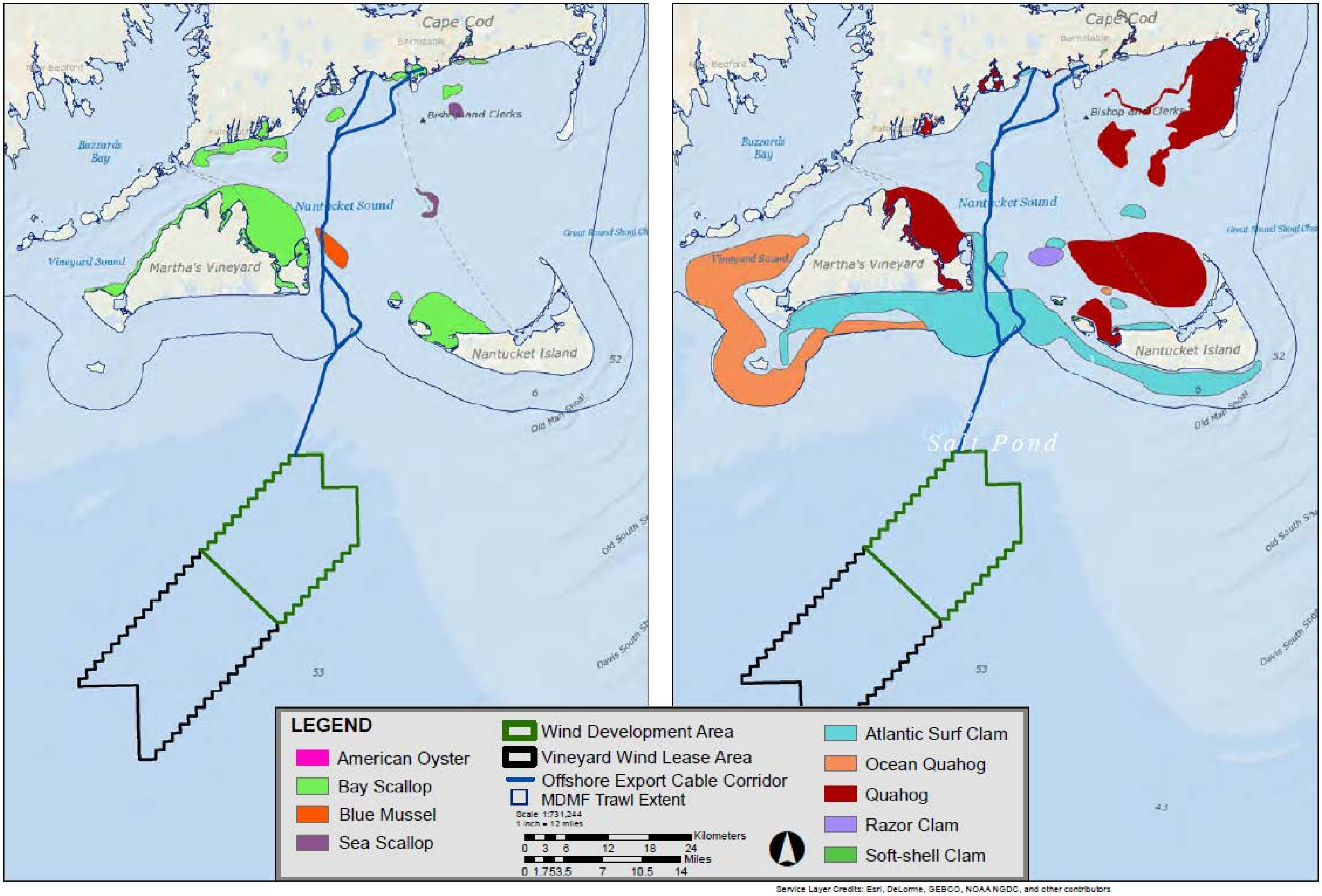
Bluefish (*Pomatomus saltatrix*) are a warm-water migratory species found in the North Atlantic Ocean from Nova Scotia to Argentina (Shepherd and Packer 2006). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage is in NOAA Technical Memorandum NMFS-NE-198 (Shepherd and Packer 2006). Bluefish are managed under the Bluefish Fishery Management Plan and EFH is designated under Amendment 1 of that document for juvenile and adult life stages in the WDA and OECC (Table 1) (MAFMC 1998b).

Juveniles: EFH for juvenile bluefish north of Cape Hatteras includes pelagic waters over the continental shelf (coast to EEZ) up to Nantucket Island, Massachusetts (MAFMC 1998b).

Adults: EFH for adult bluefish north of Cape Hatteras includes waters over the continental shelf (coast to EEZ) up to Cape Cod Bay, Massachusetts (MAFMC 1998b). Adults and juveniles are seasonal migrants to southern New England, not being typically found north of the Mid-Atlantic Bight when water temperatures are less than 61 °F (16 °C; Shepherd and Packer 2006). Schools typically move north in the spring and summer to southern New England and south in the fall with dropping water temperatures (Shepherd and Packer 2006). Bluefish adults are typically found in high-salinity waters (greater than 25 ppt) and were commonly found in Waquoit and Buzzards Bay, as indicated by NOAA's ELMR database. Juveniles were more common in Waquoit Bay from June through November in waters ranging from 0.5 to 25 ppt, while adults were common from July through October in higher salinity waters (greater than 25 ppt). Both life stages were more abundant in adjacent Buzzards Bay than in Waquoit Bay. Bluefish were more abundant in the OECC and WDA regions during fall compared to the spring in NEFSC bottom trawl surveys (2005 to 2014) and MA DMF bottom trawl surveys (1978 to 2017) (Matt Camissa, Pers. Comm., July 25, 2018; NEFSC 2014c).

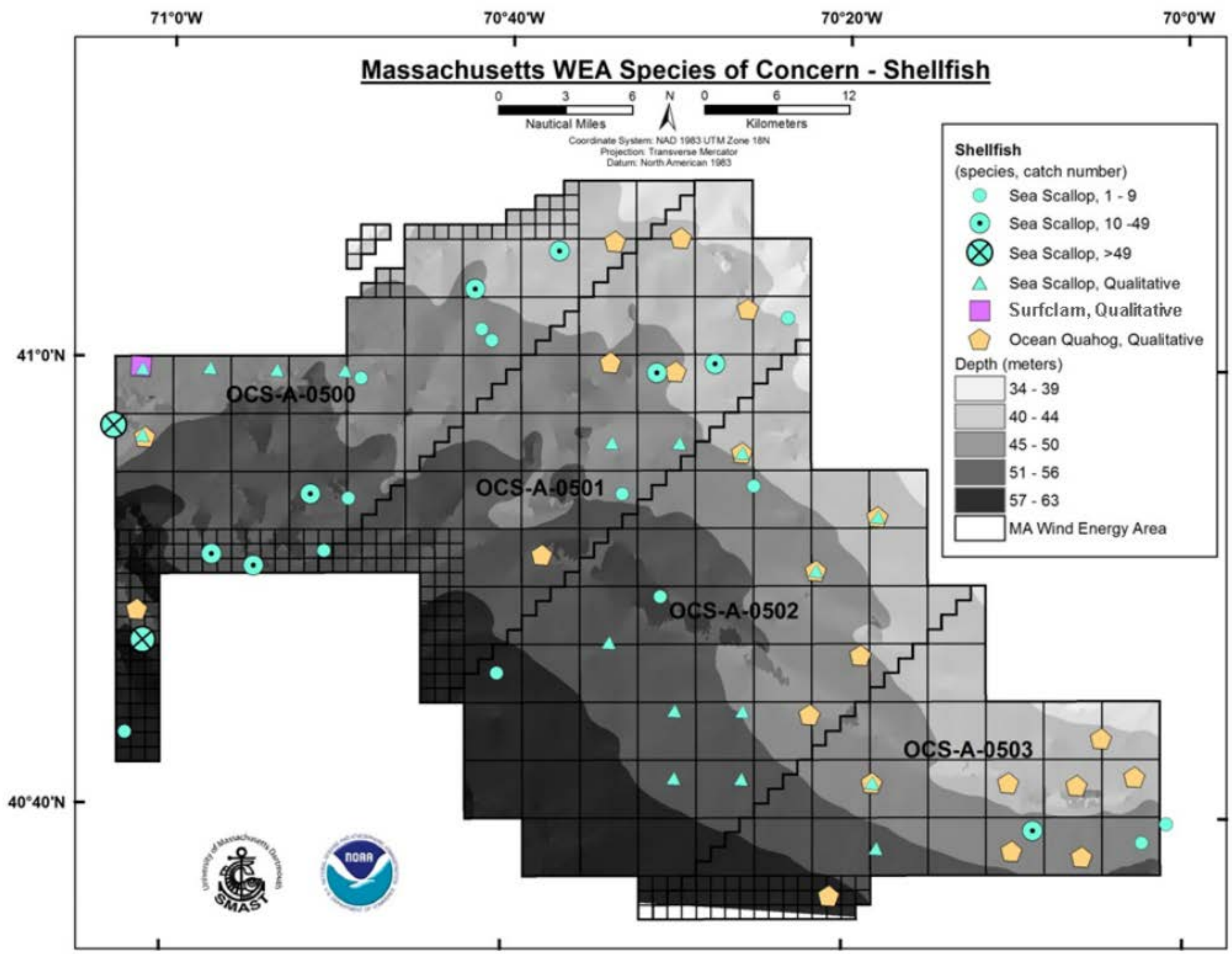
4.3.5. Atlantic Surfclam and Ocean Quahog Fishery Management Plan

Shellfish habitats near the proposed Project area are shown in Figures 5 and 6.



Source: Epsilon 2018b

Figure 5: Shellfish Habitats in State Waters Near the Proposed Project Area



Source: Guida et al. 2017

Figure 6: Shellfish Habitats in the Massachusetts Wind Energy Area

4.3.5.1. Atlantic Surfclam

The Atlantic surfclam (*Spisula solidissima*) is a bivalve mollusk inhabiting the Northwest Atlantic Ocean from the Gulf of St. Lawrence to Cape Hatteras, North Carolina (Cargnelli et al. 1999c). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage of this species is in NOAA Technical Memorandum NMFS-NE-142 (Cargnelli et al. 1999c). Atlantic surfclam is managed under the Atlantic Surfclam and Ocean Quahog Fishery Management Plan and EFH is designated under Amendment 12 to this document (MAFMC 1998c). EFH is designated for juveniles in the OECC and WDA and for adult Atlantic surfclam in the WDA (Table 1).

Juveniles and Adults: EFH for juvenile and adult Atlantic surfclam is in federal waters from the eastern edge of Georges Bank and the gulf of Maine throughout the Atlantic EEZ, includes substrates to a depth of 3 feet (1 meter) below the water/sediment interface, and encompasses the top 90 percent of 10 minute squares where Atlantic surfclam were caught in the NEFSC surfclam and ocean quahog dredge surveys (MAFMC 1998c). The greatest concentrations of Atlantic surfclams occurred in medium sand substrates at depths from 26 to 217 feet (8 to 66 meters; Cargnelli et al. 1999c).

4.3.5.2. Ocean Quahog

The ocean quahog (*Arctica islandica*) is a long-lived bivalve mollusk inhabiting temperate and boreal waters of the Northwest Atlantic Ocean (Cargnelli et al. 1999d). A detailed description of the geographic distribution, life history, and habitat characteristics by life stage of this species is in NOAA Technical Memorandum NMFS-NE-148 (Cargnelli et al. 1999d). Ocean quahog is managed under the Atlantic Surfclam and Ocean Quahog Fishery Management Plan and EFH is designated under Amendment 12 to this document (MAFMC 1998c). EFH is designated for juvenile and adult Atlantic surfclam in the OECC and WDA (Table 1).

Juveniles and Adults: EFH for juvenile and adult ocean quahog is in federal waters from the eastern edge of Georges Bank and the gulf of Maine throughout the Atlantic EEZ, includes substrates to a depth of 3 feet (1 meter) below the water/sediment interface and encompasses the top 90 percent of 10 minute squares where Atlantic surfclam were caught in the NEFSC surfclam and ocean quahog dredge surveys (MAFMC 1998c). Distribution includes depths from 30 to 800 feet (9 to 244 meters) and in areas where the bottom temperature typically do not exceed 60 °F (16 °C); MAFMC 1998c). Ocean quahogs prefer fine- to medium-grain sand substrates. The greatest concentrations are found south of Nantucket where they inhabit waters below 60 °F (16 °C) and are found further offshore as their range progresses south (Cargnelli et al. 1999d). According to NOAA’s ELMR database, juvenile and adult ocean quahog were highly abundant in Waquoit and Buzzards Bays during all months.

4.4. NOAA HIGHLY MIGRATORY SPECIES DIVISION

4.4.1. Consolidated Atlantic Highly Migratory Species Fishery Management Plan

4.4.1.1. Tunas

Four species of tuna managed by NOAA's Highly Migratory Species Division (albacore [*Thunnus alalunga*], bluefin tuna [*Thunnus thynnus*], skipjack tuna [*Katsuwonus pelamis*], and yellowfin tuna [*Thunnus albacares*]) have EFH designated under Amendment 10 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan. The life history, distribution, and EFH descriptions for these four species are described in detail in the Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Amendment 10, Section 6.2 (NMFS 2017). All four of these species are typically seasonal migrants, moving north into the region, including the WDA and OECC, during summer and fall to take advantage of the productive feeding grounds in the North Atlantic. Albacore tuna have EFH designated for juvenile/sub-adult and adult life stages in both the OECC and WDA (Table 1). Preferring surface temperatures of greater than 60 °F (15.6 °C), these fish are typically found in southern New England during the summer and fall months where they migrate for feeding. Their EFH includes offshore pelagic regions of the Atlantic Ocean from Georges Bank and south of Cape Cod (NMFS 2017). Bluefin tuna have EFH designation for juveniles and adults in coastal and pelagic habitats from the Gulf of Maine to the Mid-Atlantic Bight, including both the OECC and WDA (Table 1). Bluefin tuna migrate north during summer and fall foraging on fish, jellyfish, and crustaceans (NMFS 2017).

Skipjack tuna are circumglobal but limited generally by the 59 °F (15 °C) isotherm, making them another seasonal (summer-fall) migrant to the OECC and WDA. These fish have EFH designated for juveniles in the WDA and for adults in both the OECC and WDA (Table 1). EFH for juveniles is considered coastal and offshore habitats between Massachusetts and South Carolina. For adults, the designation ranged from Massachusetts to Cape Lookout, North Carolina (NMFS 2017).

Yellowfin tuna EFH is designated for juveniles in the OECC and WDA and for adults in the WDA (Table 1). EFH for this species is considered coastal and offshore habitats between Massachusetts and Cape Lookout, North Carolina (NMFS 2017).

4.4.1.2. Large Coastal Sharks

Sandbar shark (*Carcharhinus plumbeus*) and tiger shark (*Galeocerdo cuvier*) are large coastal sharks with designated EFH in the OECC and WDA (Table 1) under Amendment 10 of the Consolidated Atlantic Highly Migratory Species Fishery Management Plan. The life history, distribution, and EFH descriptions for these two shark species are described in detail within the Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Amendment 10, Section 6.5 (NMFS 2017). Sandbar sharks have designated EFH for juveniles and adults in both the OECC and WDA (Table 1). Sandbar sharks are a slow-growing, shallow-water species that feeds on fish and crustaceans. EFH for juveniles includes coastal waters from southern New England to Georgia at depths between 2.6 to 75 feet (0.8 to 23 meters), salinities of 15 to 35 ppt, and temperatures ranging from 59 to 86 °F (15 to 30 °C), over sand, mud, shell, and rock bottom substrates (NMFS 2017). Adult EFH includes coastal areas from southern New England to Florida.

Tiger sharks are warm water sharks that occasionally migrate north of the Mid-Atlantic Bight during warmer seasons (NMFS 2017). EFH, designated in the WDA for juveniles and adults (Table 1), includes offshore pelagic habitats associated with the continental shelf break at the seaward extend of the U.S. EEZ boundary (NMFS 2017).

4.4.1.3. Pelagic Sharks

Four species of sharks classified as pelagic sharks under the Consolidated Highly Migratory Species Fishery Management Plan have EFH designated in the OECC and/or WDA under definitions in Amendment 10 (NMFS 2017). The life history, distribution, and EFH descriptions for blue shark (*Prionace glauca*), porbeagle (*Lamna nasus*), shortfin mako (*Isurus oxyrinchus*), and common thresher shark (*Alopias vulpinus*) are described in detail in the Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Amendment 10, Section 6.7 (NMFS 2017). EFH is designated for blue shark neonates, juveniles, and adults in the OECC and WDA (Table 1). Blue sharks are a common and wide-ranging species inhabiting tropical to temperate waters (NMFS 2017). EFH for neonates includes offshore waters from Cape Cod to Cape Hatteras, North Carolina. EFH for juveniles and adults includes waters from the southern Gulf of Maine to Cape Hatteras, North Carolina (NMFS 2017).

Due to a lack of available data, all life stages for porbeagle are combined in the EFH designation, which includes offshore and coastal waters of the Gulf of Maine and offshore waters of the Mid-Atlantic Bight from Georges Bank to New Jersey (but excluding waters in Massachusetts Bay and Cape Cod Bay; NMFS 2017). Due to this lack of data, EFH is designated for parts of the WDA (Table 1) The porbeagle inhabits deep, cold temperate waters where it feeds on fish and cephalopods and is listed as a species of concern due to population declines from overfishing (NMFS 2017).

Shortfin mako EFH is designated for parts of the WDA and the southern portion of the OECC (Table 1) and includes all life stages due to a lack of available data for designation of EFH by individual life stages (NMFS 2017). EFH in the northeast Atlantic includes pelagic habitats on Georges Bank to Cape Cod and coastal and offshore habitats between Cape Cod and Cape Lookout, North Carolina (NMFS 2017). 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).

Due to insufficient data needed to differentiate EFH by life stage, EFH for common thresher shark is designated for all life stages in both the OECC and WDA (Table 1) (NMFS 2017). EFH includes the Atlantic Ocean from Georges Bank to Cape Lookout, North Carolina (NMFS 2017).

4.4.1.4. Smoothhound Shark Complex

The smooth dogfish (*Mustelus canis*) has EFH designated under Amendment 10 of the Consolidated Highly Migratory Species Fishery Management Plan. The life history, distribution, and EFH descriptions for smooth dogfish are described in detail in the Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Amendment 10, Section 6.8 (NMFS 2017). The smooth dogfish is a coastal shark found from Massachusetts inhabiting nearshore waters to depths of up to 656 feet (200 meters; NMFS 2017). This species is migratory, moving south in the winter in response to water temperatures and feeds primarily on invertebrates including crab species and American lobster (NMFS 2017). EFH for individual life stages is not available currently; therefore, EFH is designated for all life stages in the OECC and

WDA (Table 1). EFH for this species regionally includes Atlantic coastal areas (including inshore bays and estuaries) from Cape Cod Bay, Massachusetts, to South Carolina (NMFS 2017).

4.4.1.5. Prohibited Sharks

Basking shark (*Cetorhinus maximus*), dusky shark (*Carcharhinus obscurus*), sand tiger shark (*Carcharias taurus*), and white shark (*Carcharadon carcharias*) are “prohibited sharks” in that their retention from commercial and sport fishing efforts is not allowed. The life history, distribution, and EFH descriptions for these four species are described in detail within the Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Amendment 10, Section 6.9 (NMFS 2017). These four species all have EFH designated in the OECC or WDA (Table 1) under Amendment 10 of the Consolidated Highly Migratory Species Fishery Management Plan (NMFS 2017). Basking sharks inhabit the northwestern Atlantic Ocean, occurring in coastal regions from April through October where the filter feeders take advantage of productive waters in the Northeast (NMFS 2017). While feeding, these sharks are typically found near the surface. South and east of Cape Cod, aggregations of basking sharks have been observed (NMFS 2017). As with other species, insufficient data are available to designate EFH for individual life stages; therefore, EFH for all life stages is established in the OECC and WDA, defined as the Atlantic east coast from the Gulf of Maine to the northern Outer Banks, North Carolina (NMFS 2017).

Dusky shark is listed as a species of concern due to population declines associated with commercial and recreational harvest throughout its range (NMFS 2017). The Northwest Atlantic and Gulf of Mexico population has been established as a distinct population segment under the Endangered Species Act, although currently this species has not warranted listing (79 *Federal Register* 74684). This shark inhabits warm and temperate warm waters, migrating seasonally with changing water temperatures (NMFS 2017). EFH for juveniles and adults includes coastal and pelagic waters inshore of the continental shelf break from southern Cape Cod to Georgia (NMFS 2017). EFH for neonates/young-of-year includes offshore areas of southern New England to Cape Lookout, North Carolina, with habitat conditions that include temperatures from 65 to 72 °F (18.1 to 22.2 °C), salinities from 25 to 35 ppt, and depths of 11 to 51 feet (3.4 to 15.5 meters; NMFS 2017). The neritic waters of the Mid-Atlantic to South Carolina provide nursery habitat for dusky sharks (McCandless et al. 2014).

Sand tiger sharks are large coastal species typically found in subtropical and warm temperate shallow waters. Sand tiger shark EFH is designated for neonate/young-of-year and juveniles in the OECC and WDA (Table 1). Neonate and juvenile EFH ranges from Massachusetts to Florida, including shallow habitats of sand and mud substrates (NMFS 2017). Historic overfishing and continuing loss due to bycatch in commercial and recreational fisheries led to a population decline compounded by a low fecundity (Carlson et al. 2009). This species is currently listed as a Species of Concern.

White sharks are seasonally abundant in New England waters, being restricted generally to waters between 54 to 77 °F (12 to 25 °C) and in water depths of less than 328 feet (100 meters; NMFS 2017). EFH for white shark is designed for neonate/young-of-year, juvenile, and adult in the OECC and WDA (Table 1). EFH for neonates includes inshore waters out to 65 miles (105 kilometers) from Cape Cod, Massachusetts, to offshore of Ocean City, New Jersey (NMFS 2017). The occurrence of young white sharks regionally in the coastal waters of Massachusetts indicates this area provides nursery habitat juveniles (Skomal 2007). Juvenile white sharks (less than 118 inches [300 centimeters]) feed primarily on fish while adults (greater than 118 inches [300 centimeters]) shift toward a diet of marine mammals. EFH for juveniles and adults includes inshore waters to habitats 65 miles (105 kilometers) from shore, in water temperatures ranging from 48 to 82 °F (9 to 28 °C) from Cape Ann, Massachusetts, to Cape Canaveral, Florida (NMFS 2017).

4.5. South Atlantic Fishery Management Council

4.5.1. Coastal Migratory Pelagics Fishery Management Plan

Spanish mackerel (*Scomeromorus maculatus*), king mackerel (*Scomberomorus cavallaIa*), and cobia (*Rachycentron canadum*) are all species managed by the SAFMC under the Coastal Migratory Pelagic Fishery Management Plan (SAFMC 1998). EFH exists for all life stages of these species. EFH has been designated from the South Atlantic Bight to the Mid-Atlantic Bight. EFH in this area includes sandy shoals of capes and offshore bars, high-profile rocky bottom areas, and the seaward side of barrier islands; these habitats are EFH only from the surf zone to the shelf break zone, and only shoreward of the Gulf Stream. Therefore, the OECC and WDA are EFH for all life stages of these species (Table 1). In addition, all coastal inlets and all state-designated nursery habitats of particular importance are considered EFH to coastal migratory pelagics. For cobia, EFH is also designated for high-salinity bays, estuaries, and seagrass habitat. These species are uncommon in southern New England as they typically prefer water temperatures above 64 °F (18 °C; NOAA, 2014), and despite the EFH designation, there is little documentation indicating eggs and larvae from these species have been found in the OECC waters (BOEM 2009). Only some minor landings have been reported in Nantucket Sound from MA DMF commercial databases (BOEM 2009).

5. ANALYSIS OF POTENTIAL ADVERSE IMPACTS ON EFH

5.1. Construction and Installation

5.1.1. Acoustic

Manmade underwater noise has the potential to cause behavioral disturbances, hearing impairment or threshold shifts, physical injury, or mortality to marine organisms (Southall et al. 2007; Popper and Hastings 2009; Popper et al. 2014).

Sound is described as having two components: a pressure component and a particle motion component. Sound pressure consists of two basic sound types: continuous (e.g., motorized vessel) and impulsive (e.g., explosions, pile driving, or hydraulic hammering) (Southall et al. 2007; Hawkins and Popper 2014). Continuous sounds may be tonal or include a wide range of frequencies. Continuous sounds that are “rougher” than others have a high crest factor (Hawkins and Popper 2014). Impulsive sounds are characterized by a sharp rise time, brief duration, and a wide range of frequencies. They generally have an increased capacity to induce physical injury compared to continuous sounds. Particle motion is the oscillatory displacement, velocity, or acceleration of fluid particles in a sound field. All fish are sensitive to particle motion; however, some fish have adaptions (e.g., gas bubbles near the ear or swim bladders that functionally affect the ear) that also make them sensitive to sound pressure (Popper et al. 2014). Fishes with swim bladders (or other gas bubbles) that functionally affect the ear generally have lower thresholds and wider hearing bandwidths than species without these adaptations (Normandeau 2012). Hearing range and sensitivity varies considerably among fish species (Popper et al. 2014).

The types of effect on and response from fishes to a sound source depends on distance. Very close to the source, effects may range from mortality to physical injury. Underwater sound pressure waves can injure or kill fish (Normandeau 2012; Popper et al. 2014). Fish with swim bladders are particularly sensitive to underwater impulsive sounds with a sharp sound pressure peak occurring in a short interval of time (NMFS 2012). As the pressure wave passes through a fish, the swim bladder is rapidly squeezed due to the high pressure, and then rapidly expanded as the under-pressure component of the wave passes through the fish. The pneumatic pounding on tissues contacting the swim bladder may rupture capillaries in the internal organs, as indicated by observed blood in the abdominal cavity and maceration of the kidney tissues (NMFS 2012). Potential physiological effects resulting from sound exposure are highly diverse and range from very small ruptures of capillaries in fins (which are not likely to have any effect on survival) to severe hemorrhaging of major organ systems such as the liver, kidney, or brain. Other potential effects include rupture of the swim bladder. Behavioral changes can occur when the fishes are further from the noise source where mortality is no longer an issue. The effects can range from physiological to behavioral. The potential for effects declines as distance increases between the individual and the source. The actual nature of effects depends on a number of other factors, such as fish hearing sensitivity, source level, sound propagation and resultant sound level at the fish, whether the fish stays in the vicinity of the source, and motivation level of the fish. Generally speaking, species are thought to have different tolerances to noise and may exhibit different responses to the same noise source.

Construction noise that would impact finfish and invertebrate resources in the WDA and OECC would come primarily from pile driving used to install up to 100 pile foundations (100 monopiles or a combination of monopiles and up to 10 jacketed foundations [each jacket could have up to 4 pin piles]) (COP Volume III, Appendix III-M; Epsilon 2018b; Pyć et al. 2018). Marine fish have been generally categorized based on their sensitivity to noise by Popper et al. (2014). As shown in Table 2, fish hearing categories from least sensitive to most sensitive are: fish without swim bladders (flatfish, some tunas, sharks and rays), fish with swim bladders not involved in hearing (sturgeons, striped bass, yellowfin and bluefin tuna), and fish with swim bladder involved in hearing (some tuna species, gadids, Herring; Popper et al. 2014).

Table 2: Fish and Invertebrate Categorized by Hearing and Susceptibility to Sound Pressure

Category	Description	Examples	Hearing and Susceptibility to Sound Pressure
1	Fish without swim bladder or hearing associated gas chamber, invertebrates (shellfish, cephalopods), fish eggs and larvae	Flatfish, sharks, rays, some tunas, cephalopods, crabs, lobster	Species are less susceptible to barotrauma. Detect particle motion but not sound pressure, but some barotrauma may result from exposure to sound pressure. Invertebrate species have no air bladder or associated gas chamber for hearing. Invertebrate susceptibility to noise impacts is likely similar to fish with no swim bladder.
2	Fish with swim bladder that does not affect hearing	Sturgeons, striped bass, yellowfin and bluefin tuna, eggs, larvae	Species have a swim bladder, but hearing is not connected to it or other associated gas chamber. Species detect only particle motion but are susceptible to barotrauma. Eggs and larvae are susceptible to sound and some barotrauma, and are categorized the same as fish with no swim bladder or associated gas chamber.
3	Fish with swim bladder or gas chamber associated with hearing	Atlantic cod, haddock, Herring spp.	Hearing connected to swim bladder or other associated gas chamber. Species detect sound pressure as well as particle motion and are most susceptible to barotrauma.

Source: Popper et al. 2014

In regards to invertebrates and sound, sensitivity thresholds for sound exposure have been established for few species. Mooney et al. (2016) reported evidence of behavioral responses and habituation to sound by longfin squid, and Przeslawski et al. (2018) assessed noise impacts on scallops. While no clear evidence of scallop mortality associated with seismic survey sound was found, the possibility of sub-lethal impacts were not assessed (Przeslawski et al. 2018). The lack of a swim bladder or any other gas bubble structure associated with hearing suggests their ability to hear may be most similar to fish without swim bladders (see Category 1 in Table 2; Normandeau 2012). Eggs and larvae of fish are also sensitive to noise and are categorized separately with thresholds the same as fish with swim bladders not involved in hearing (see Category 2 in Table 2; COP Volume III, Appendix III-M; Epsilon 2018b; Pyć et al. 2018).

As mentioned previously, fish and invertebrates are likely more sensitive to particle motion than sound pressure levels. Unfortunately, standards for measuring and modelling particle motion are still a developing field of research (Hawkins and Popper 2016). Furthermore, there are no agreed-upon thresholds for injury or behavioral effects for fish and invertebrates based on particle motion as there are for sound pressure levels (NMFS 2016). Thus for the purposes of this assessment, standards and thresholds for sound pressure levels are used.

5.1.1.1. Pile Driving

Pile driving would be used to install foundation piles for WTGs and ESPs. Each WTG and ESP would be on a foundation consisting of either a monopile (24.6 or 33.8 feet [7.5 or 10.3 meters]) or jacketed pile (three or four 4.9 or 9.8 feet [1.5 to 3-meter piles]). Up to 106 WTGs (maximum-case scenario) could be installed necessitating 96 monopile and 10 jacketed pile foundations. The Proposed Action includes up to two ESPs (one 800 MW or two 400 MW) would also be installed on either a monopile or jacketed foundation. Monopile foundations require approximately 3 hours to install using a 4,000-kilojoule (kJ) hammer; two foundations can be installed in a 24-hour period. Installation of jacketed foundations would occur at a rate of one foundation (three to four pin piles) per day. Each jacket would take less than 3 hours to install using a 3,000 kJ hammer. See Table 3 below and COP Appendix III-M for the radial distance at which mortality or mortal injury, recoverable injury, and temporary threshold shift (TTS) would occur as a result of modeled peak noise level (L_{pk}) and 24-hour cumulative (L_E) pile-driving noise for different fish hearing categories. Vineyard Wind would implement sound reduction technology (i.e., bubble curtains) that would attempt to reduce sound levels to a target attenuation of 12 decibels (dB). The specific technologies have not yet been selected; potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). Pile-driving noise modeling calculated radial impact distances for attenuation levels of 0 dB (no attenuation), 6 dB, and 12 dB (Epsilon 2018b; Pyć et al. 2018). The maximum radial impact distances were modeled based on two positions for driving a 9-meter (29.5-foot) monopile, a 10.3-meter (33.8-foot) monopile, and a 3-meter (9.8-foot) jacketed pile (with four pin piles). The sound exposure levels (L_E) in ocean areas surrounding an instance of pile driving are illustrated in COP Volume III, Appendix III-M (Epsilon 2018b; Pyć et al. 2018). A summarized version of the greatest radial impact position for each foundation modeled is presented in Table 3.

Noise impacts on fish and invertebrates with EFH in the WDA and OECC would vary depending on the ability of the fish to detect sound pressure (through air bladder) and whether the air bladder and auditory system are linked, making the species more sensitive to sound impacts (Popper et al. 2014). Species with EFH in the WDA, where pile driving would occur, that are most sensitive to sound would be fishes where the swim bladder is involved with hearing (i.e., Atlantic herring, gadids). With no attenuation (0 dB), these species are potentially subject to mortality or mortal injury at a maximum range of 5,856 to 6,900 feet [1,785 to 2,103 meters]) from the noise source, depending on the type of monopile or jacket being installed (Table 3). A number of species with an air bladder not involved in hearing have designated EFH in the WDA (i.e., yellowfin tuna, bluefin tuna). Mortality and potential mortal injuries from cumulative pile-driving noise has a maximum range of 3,786 to 4,829 feet (1,154 to 1,472 meters) with no attenuation. Included in this category are fish eggs and larvae. While eggs and larvae may be less vulnerable to the impacts of sound pressure, their inability to escape would likely subject those within the radial distance to injury and mortality. The least-impacted species with EFH designated in the WDA include sharks, rays, flounders, squid, and some tunas. These species do not have an air bladder and rely on particle motion for hearing, reducing any damage induced by sound pressure (Popper et al. 2014). Mortality and potential mortal injury from pile-driving sound for these species has the smallest radius, ranging from 755 to 1,152 feet (230 to 351 meters) with no attenuation. Included in this group are sessile species (Atlantic surfclam and ocean quahog). Although these species are less sensitive to sound pressure, they are similar to eggs and larvae in that they cannot avoid or retreat from potentially damaging sound pressure and would be subject to injury and mortality when sound pressure occurs within a certain radial distance from pile driving.

Table 3: Maximum Radial Distance of Peak (L_{pk}) and 24-Hour Cumulative (L_E) Pile-Driving Noise Levels

Group	Metric	Threshold (dB)	9 meter pile impact distance (meters) by attenuation [a]			10.3 meter pile impact distance (meters) by attenuation			four 3 meter piles impact distance (meters) by attenuation		
			0 dB	6 dB	12 dB	0 dB	6 dB	12 dB	0 dB	6 dB	12 dB
Mortality and Potential Mortal Injury											
Fish without swim bladder	L_E	219	230	106	71	305	112	71	351	127	71
	L_{pk} [b]	213	75	34	17	78	38	19	26	13	7
Fish with swim bladder not involved in hearing	L_E	210	1,154	419	152	1,220	503	160	1,472	584	182
	L_{pk} [b]	207	169	75	34	157	78	38	50	26	13
Fish with swim bladder involved in hearing	L_E	207	1,785	749	230	2,003	798	305	2,103	1,054	351
	L_{pk} [b]	207	169	75	34	157	78	38	50	26	13
Eggs and larvae	L_E	210	1,154	419	152	1,220	503	160	1,472	584	182
	L_{pk} [b]	207	169	75	34	157	78	38	50	26	13
Recoverable Injury											
Fish without swim bladder	L_E	216	419	152	75	503	160	79	584	182	79
	L_{pk} [b]	213	75	34	17	78	38	19	26	13	7
Fish with swim bladder	L_E	203	2,820	1,302	520	3,044	1,465	590	3,193	1,616	691
	L_{pk} [b]	207	169	75	34	157	78	38	50	26	13
Temporary Threshold Shift											
All fish	L_E	186	10439	6,999	4,409	10,960	7,444	4,702	13,660	8,538	5,077

Source: Data from Tables A-14 - A17 in Pyć et al. 2018

dB = decibels; kJ = kilojoule; L_E = sound exposure levels; L_{pk} = peak thresholds

[a] Maximum impact distances for attenuation (sound reductions) of 0, 6, and 12 dB (to compare the use of sound reduction technology at multiple levels of attenuation).

[b] L_{pk} given as the maximum range for a hammer energy of 2,500 kJ for an IHC S-4000 hammer and 2,200 kJ for an IHC S-2500 hammer.

As shown in Table 3, the impact range for mortality and potential mortality is reduced for all categories of hearing through attenuation (6 dB and 12 dB). Ranges of mortality and potential mortality at 12 dB of attenuation ranged from 233 to 1,152 feet (71 to 351 meters) when considering all three hearing categories.

TTSs indicate cumulative noise exposure that causes temporary hearing or sensitivity loss that recovers at some point of time after the exposure has ended (Popper et al. 2014). While these impacts are the least damaging, they are the most wide ranging. Exposure to pile-driving noise without attenuation can induce TTS as far as 34,249 to 44,816 feet (10,439 to 13,660 meters) from the source. The radius from the noise source drops to 14,465 to 28,015 feet (4,409 to 8,539 meters) with 12 dB attenuation. The TTS model (Pyć et al. 2018) provided relevant estimates for all species and life stages with EFH in the WDA.

For the purposes of this assessment, it assumed that noise attenuation of 6 dB is achievable and would be a minimum requirement for pile driving. Using the largest potential pile with 6 dB attenuation yields an injury zone of between approximately 367 feet and 2,618 feet (112 meters and 798 meters) around each pile-driving event. Pile driving could occur from July through December 2020 (COP Volume III, Section 4.2.2; Epsilon 2018b). Species present within the WDA during this period would likely be affected by pile-driving noise; effects would range from avoidance behavior to mortality. Eggs, larvae, and sessile species are less sensitive than some fish species, but are more vulnerable due to a lack of motility. Species such as longfin squid, black sea bass, and Atlantic butterfish are summer migrants to the area. Longfin squid migrate to shallow waters during spring and summer and were common components in NEFSC bottom trawl surveys within the MA WEA and within MA DMF bottom trawl surveys in Nantucket Sound. Spawning occurs from May through August and eggs are demersal. Egg mop mapping by MA DMF indicates that egg mops are routinely identified along the OECC route (COP Volume III, Section 6.6.1.3, Figures 6.6-8 and 6.6-9; Epsilon 2018b). OECC locations are not likely to be impacted by pile driving operations in the WDA. In areas of the WDA where egg mop deposition overlaps with the impact radius of pile driving, egg mops could be subject to injury/mortality from the noise. Spawning squid exposed to pile-driving noise would likely avoid/flee areas of potentially lethal or injurious noise, creating pockets of temporarily unavailable habitat. Where the noise is not injurious, it is expected that squid would habituate to the noise.

5.1.1.2. Vessel and Construction

Noise associated with non-pile-driving construction (vessel and construction noise) may create temporary avoidance in pelagic and demersal species but generally would not be loud enough over a long enough time period to induce injury or death (MMS 2009a). Analysis of vessel noise related to the Cape Wind Energy Project found that noise levels from construction vessels at 10 feet were loud enough to induce avoidance, but not enough to do physical harm (MMS 2009a). Pelagic species (e.g., Atlantic herring, Atlantic mackerel, Atlantic butterfish, and highly migratory pelagic species) would be the most likely impacted species by vessel and construction noise.

5.1.2. Non-Acoustic

5.1.2.1. Temporary Benthic Habitat Loss or Disturbance

Construction of the proposed Project would cause temporary impacts from direct habitat disturbance. Disturbance to benthic habitat from proposed construction activities is described in Section 6.6.2 of the COP, Volume III (Epsilon 2018b), and the potential impacts are quantified in terms of area impacted (acres [km^2]) in Table 4.

Table 4: Maximum Areas of Impact Predicted from Installation, Vessels, and Dredging

Bottom Disturbance Due to Installation, Jack-up Vessels, and Dredging	Maximum Area of Disturbance [b]	
	Acres	km^2
Export Cables	117	0.47
Inter-link Cable	7	0.03
Inter-array Cables	204	0.83
Dredging [a]	69	0.28
Jack-up Vessels (WTG Installation)	65	0.26
Jack-up Vessels (ESP Installation)	0.3	0.001
Anchoring	4.4	0.017
Total in the WDA (Cables and Jack-up)	277	1.12
Total in the OECC (Cables and Dredging)	186	0.75

Source: Modified from COP Table 6.5-5 (Volume III; Epsilon 2018a); FEIR Table 2-3 (Epsilon 2018c)

ESP = electrical service platform; km^2 = square kilometers; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area; WTG = wind turbine generator

[a] Dredging prior to cable installation. The corridor with the maximum-case scenario of dredging is along the Western Muskeget Option, west through Muskeget Channel to New Hampshire Avenue landfall site. To avoid double-counting impacts, Vineyard Wind’s total area of dredging disturbance does not include the 6.6-foot (2-meter) wide export cable.[b] The maximum area of disturbance is assumed to be 100 tubrines and 2 export cables within the corridor. Corridor width for siting purposes; each trench would be approximately 3.2 feet (1 meter) wide and there would be an up to 3.3-6.6 feet (1-2 meters) wide temporary disturbance zone from the tracks or skids of the cable installation equipment.In the WDA (Figure 7), direct bottom disturbance resulting in temporary habitat loss would occur over 277 acres (0.85 km^2) of seafloor as a result of the installation of inter-link and inter-array cables and the use of jack-up vessels for construction (see Charts 2 and 3 in the COP Appendix II-I [Epsilon 2018b]). Along the OECC, direct bottom disturbance would occur over 186 acres (0.60 km^2) of seafloor from dredging and from the installation of the export cables (see Figure 8). Approximately 3.7 to 4.4 acres (0.015 to 0.018 km^2) further in the OECC would be disturbed by anchoring. As described above under Section 2, anchoring vessels would avoid sensitive seafloor habitats to the greatest extent practicable. The direct habitat disturbances described above are expected to recover through natural processes. Recovery from jet plowing was modeled to require anywhere from 1 to 38 days (MMS 2009a). Within the broad direct impacts described above, there are specific habitat types within the OECC that are more sensitive to disturbance. There are not any identified habitat types that are sensitive to construction disturbance in the WDA. Table 5 summarizes the areas of seafloor habitat present in the OECC leading to the Covell’s Beach landfall site. Table 5 also quantifies the area within 328 feet (100 meters) of the proposed cable route alignments. Although direct benthic habitat impacts are only expected within 2 meters of the cable

centerline, sediment deposition of 1 millimeter or greater is typically constrained within 80 meters (262 feet) from the route centerline, though may extend up to 100 meters (328 feet) in limited areas. The values in Table 5 do not represent the total acres that could be disturbed, they are the total amount present. The amount that will be disturbed is a fraction of that which is present within the 1000-meters-wide OECC.

Table 5: Areas of Seafloor Habitat Present in the OECC and Areas Within 328 feet (100 meters) of the Proposed Cable Route Alignment

Seafloor Habitat Type	Area in OECC[a] (acres)		Area within 328 feet[b] (100 meters) of the Proposed Cable[c] (acres)	
	Eastern Muskeget Option	Western Muskeget Option	Eastern Muskeget Option	Western Muskeget Option
Hard Bottom / Coarse Deposits	646.6	695.2	274.2	206.0
Complex Seafloor	3001.1	3038.1	994.6	1022.2
Biogenic Surface	420.8	420.8	154.4	154.4
Eelgrass	2.7	2.7	0.0	0.0
Other (mostly flat sand and mud)	8804.5	8391.0	3401.7	3235.9
Total	12875.7	12547.9	4824.9	4618.5

Source: Vineyard Wind 2019d

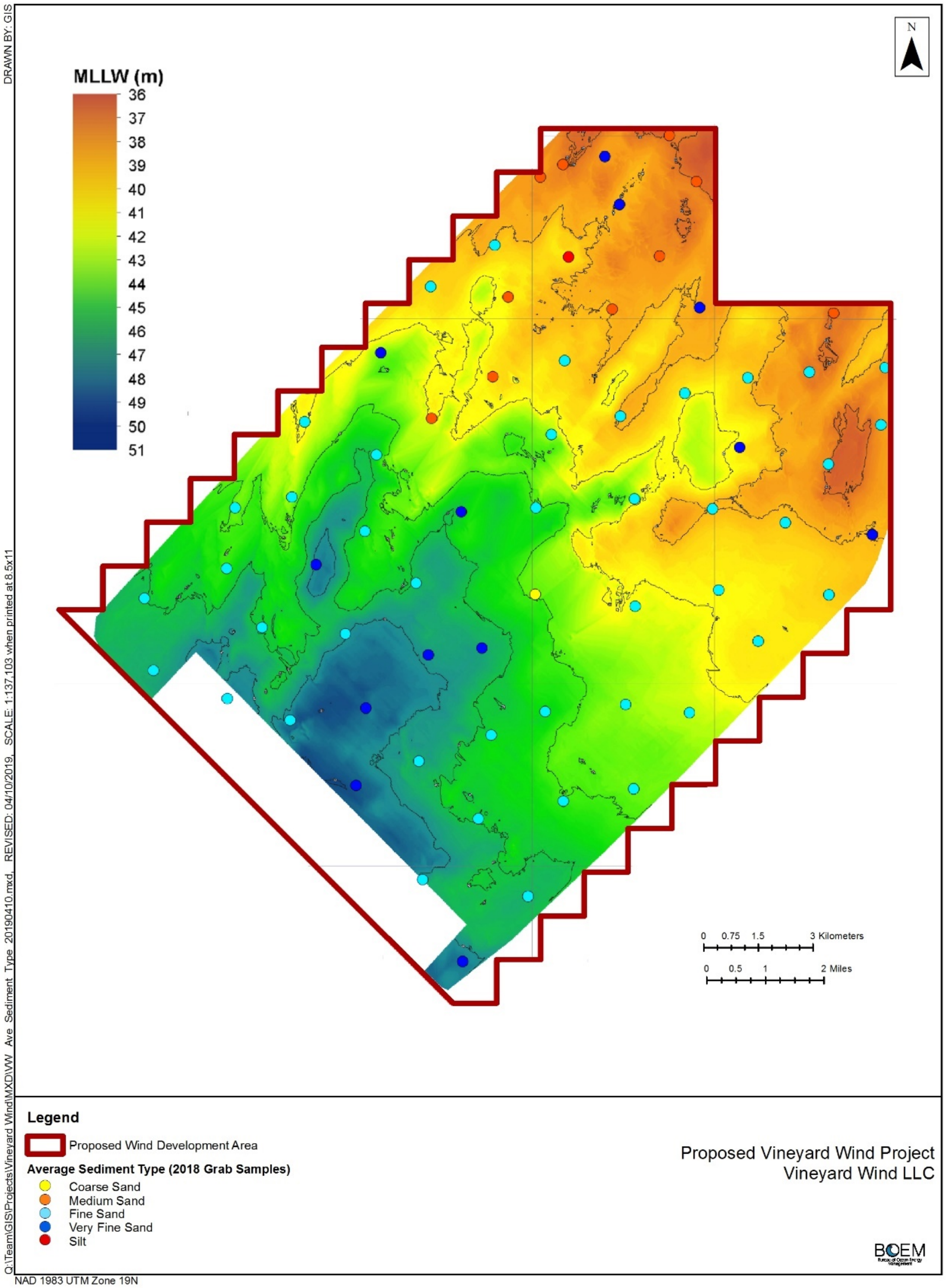
Note: The OECC branch leading to the New Hampshire Avenue landfall site is not included here. The proposed cable route alignment should be considered preliminary.

[a] The total width of the OECC is 3,280 feet (1,000 meters).

[b] The maximum distance from cable centerline that may be disturbed through deposition of sediment greater than 1 millimeter. Deposition of 1 millimeters or greater is typically constrained within 80 meters (262 feet) from the route centerline, though may extend up to 100 meters (328 feet) in limited areas.

[c] This is based off the cable preliminary alignment. The proposed cable could be located anywhere within the OECC; no bottom disturbing activities would occur outside of the OECC.

While Vineyard Wind would use micro-routing of the cable to avoid sensitive seafloor habitats to the greatest extent practicable, there may be places where it is impractical to avoid them completely. In these cases, cable installation atop hard bottom could result in permanent conversion of the top layer of seafloor to a sandy habitat. Complex seafloor (mostly sand waves and fields of mega-ripples) and biogenic surfaces (e.g., anemones, shellfish) would likely recover naturally over time. Eelgrass would be avoided completely. In addition to the seafloor habitat types described above shellfish such as surfclams, ocean quahogs, sea scallops, bay scallop, and blue mussel have been documented as occurring in and around the WDA and OECC (see Figure 5 and Figure 6) above. It is expected that, much like in response to direct harvesting of these resources, these shellfish grounds would recover from direct bottom disturbance following the benthic habitat disturbance from cable installation, anchoring, and sand wave dredging on the scale of a few months (NMFS 2004).



Source: Vineyard Wind 2019e

Figure 7: Sediment Types Observed in the WDA

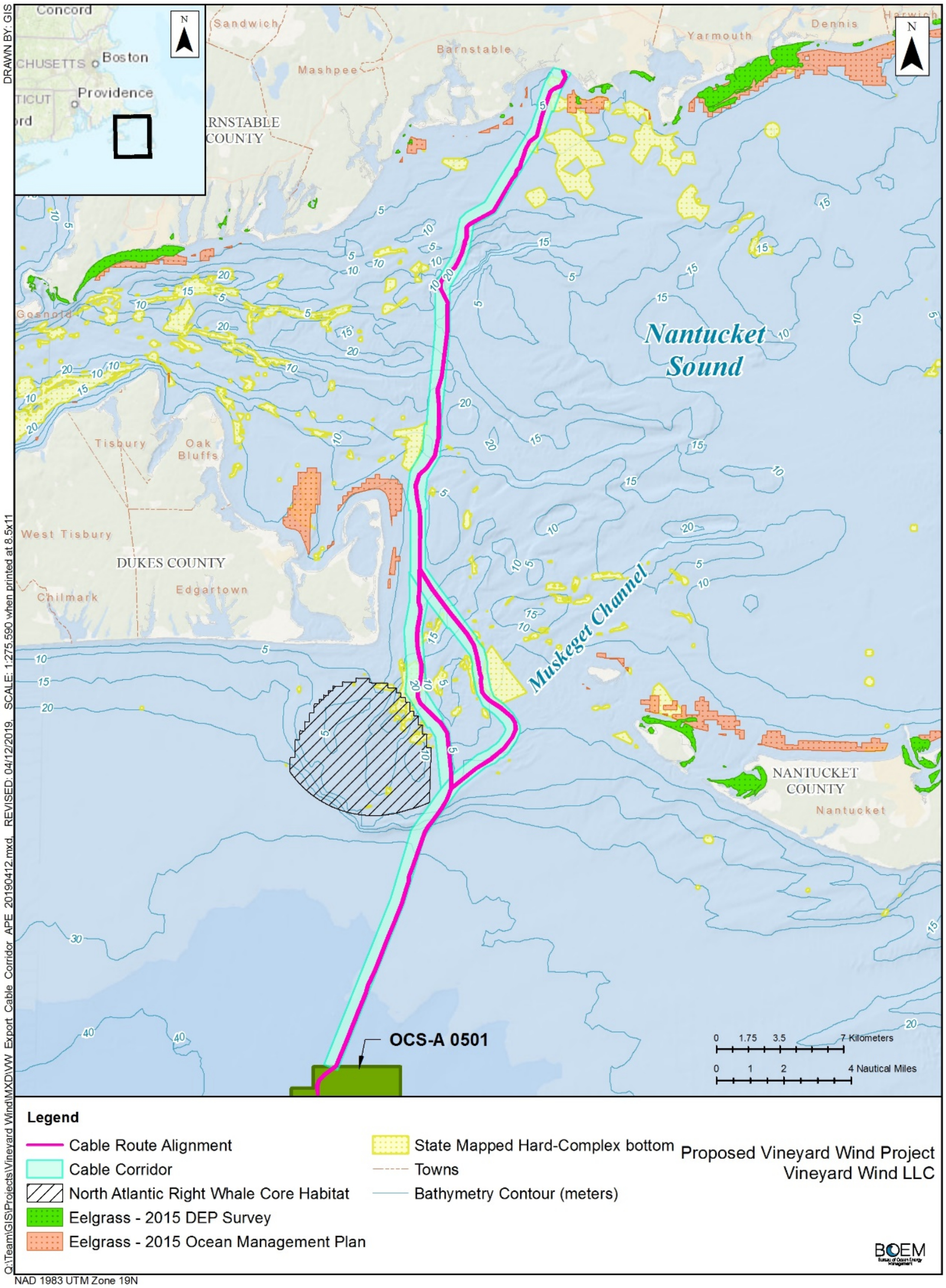
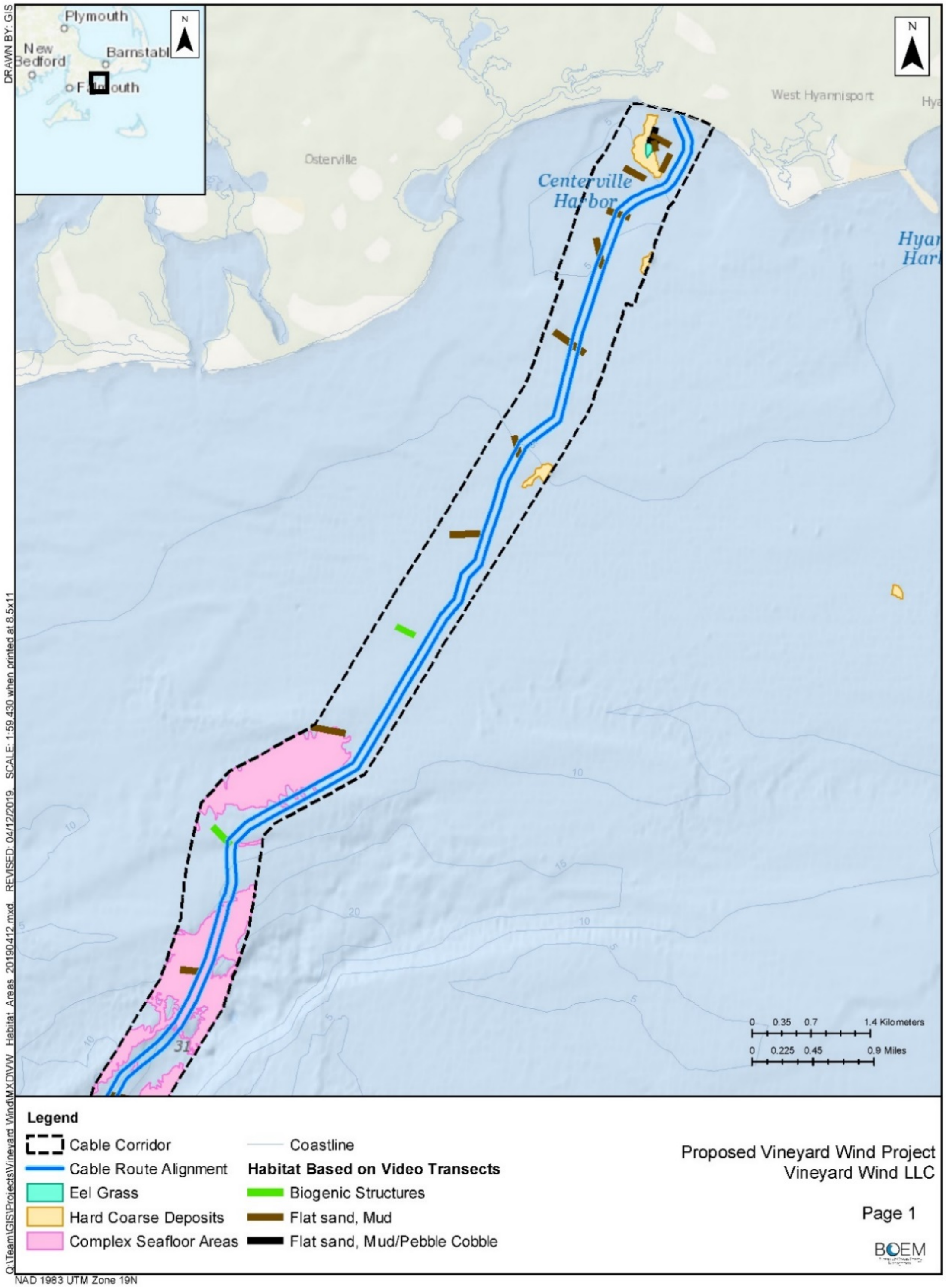
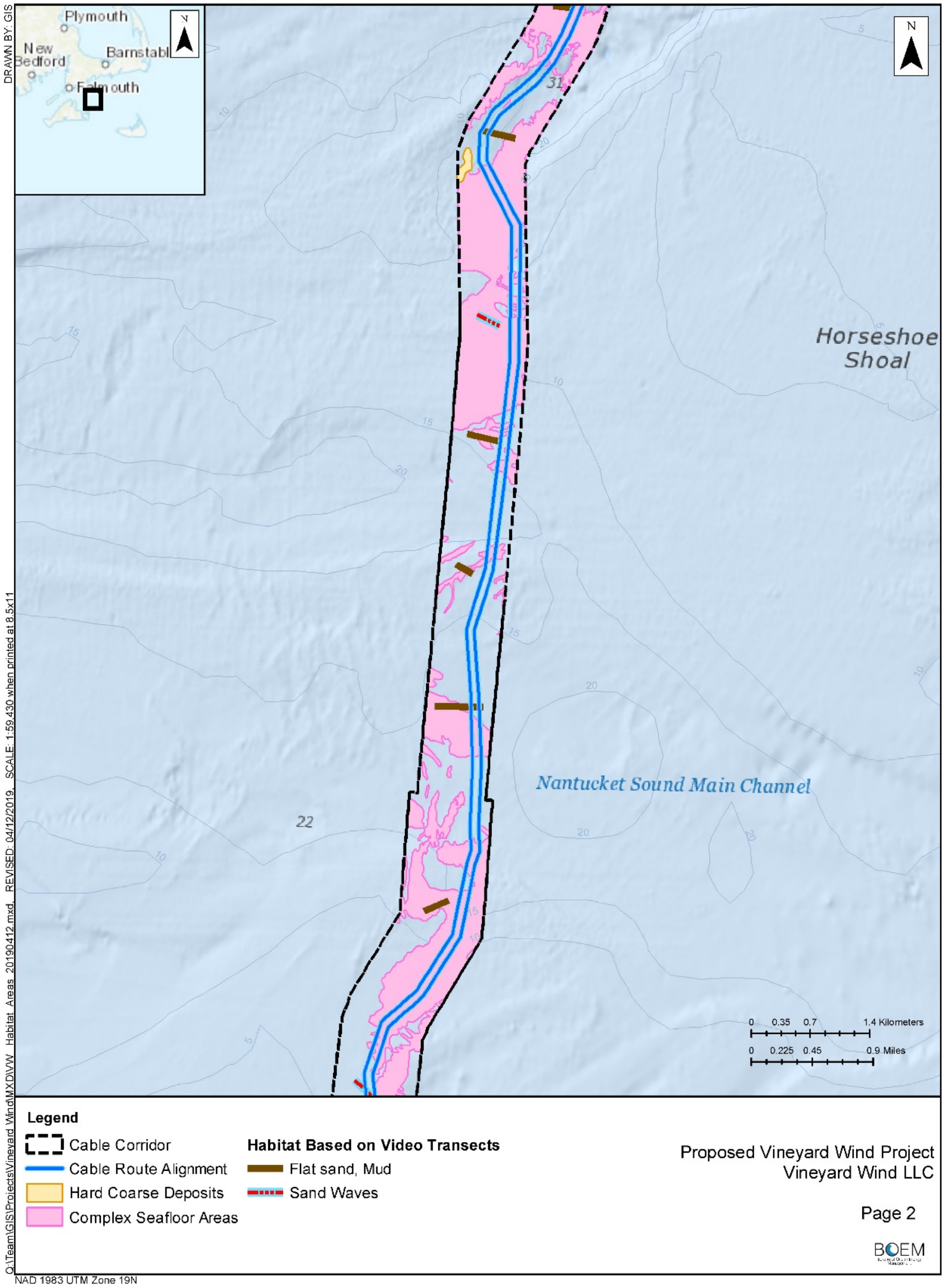


Figure 8: Bathymetric Chart of the OECC Showing State-Mapped Eel Grass Beds and Hard-Complex Bottom Areas



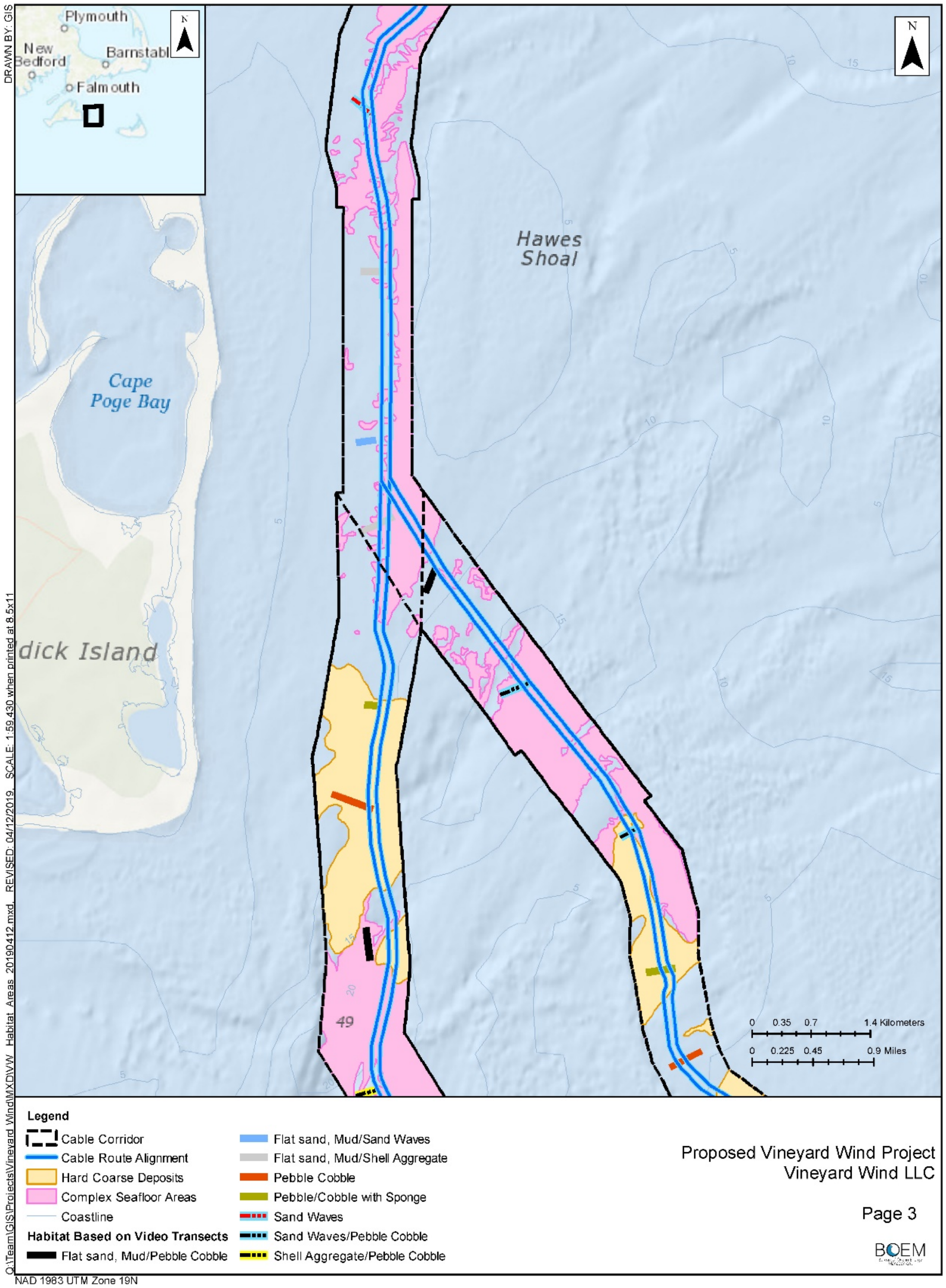
Source: Vineyard Wind 2019e

Figure 9a: Seafloor Habitats within the Project Area



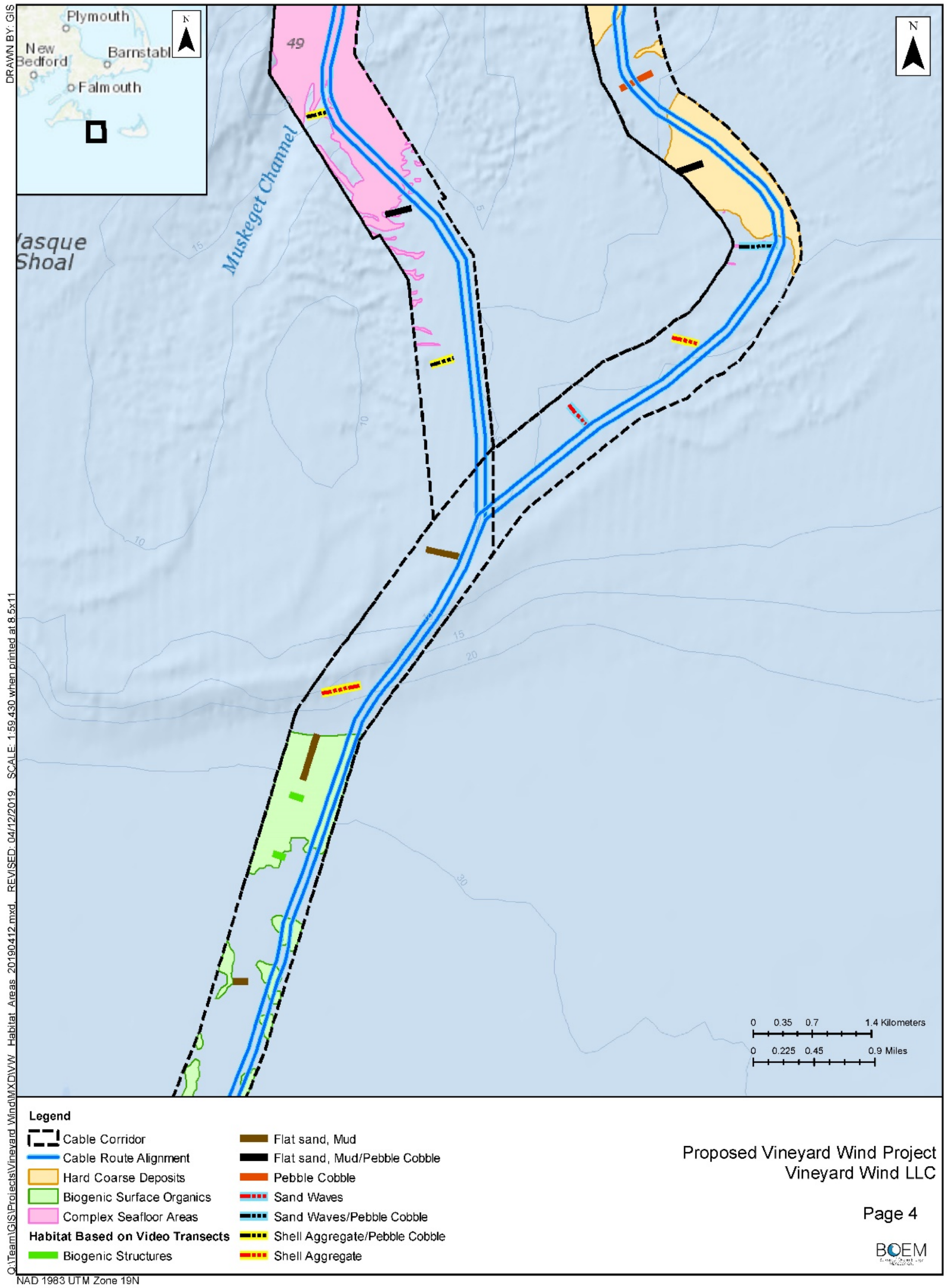
Source: Vineyard Wind 2019e

Figure 9b: Seafloor Habitats within the Project Area



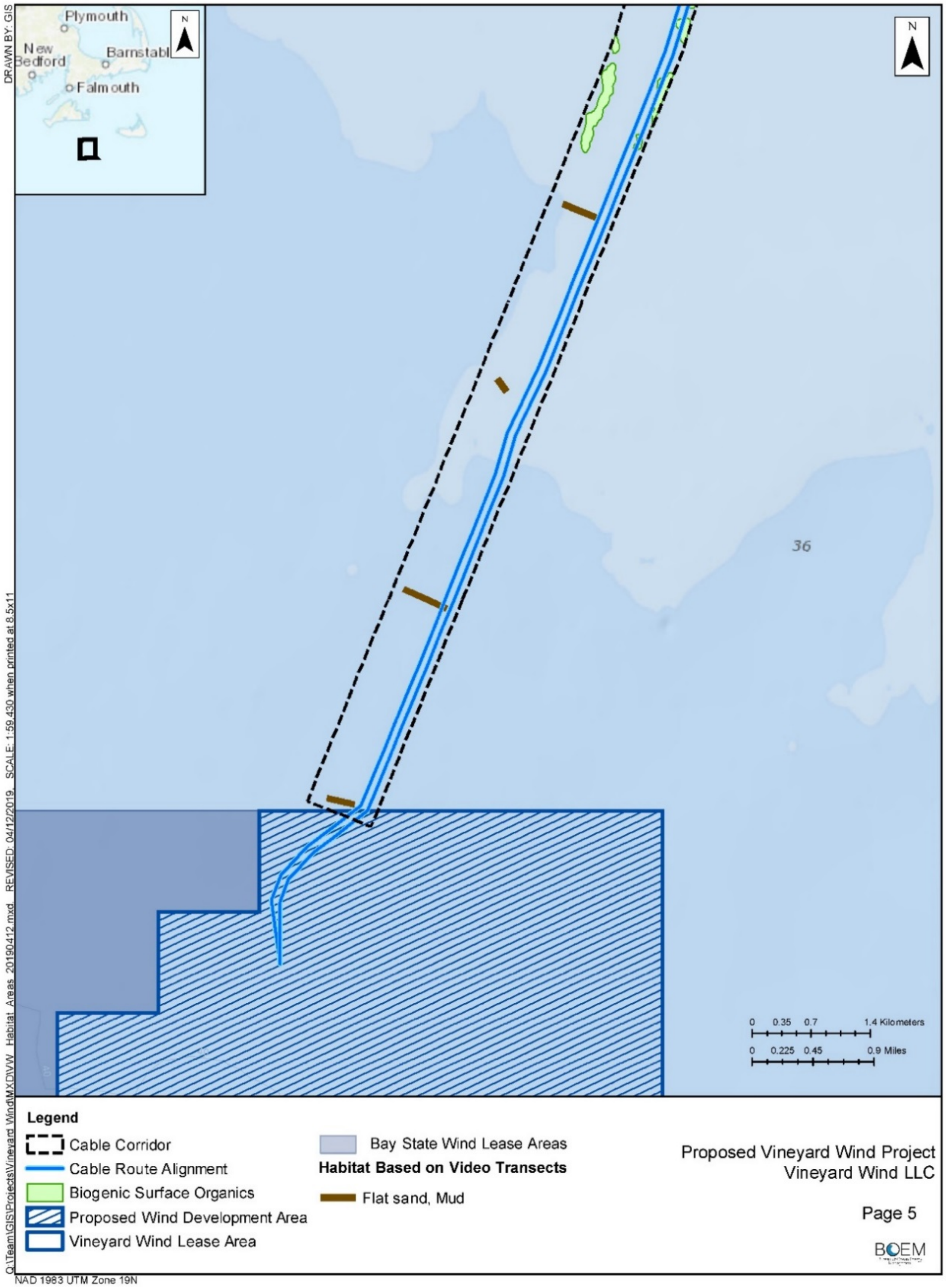
Source: Vineyard Wind 2019e

Figure 9c: Seafloor Habitats within the Project Area



Source: Vineyard Wind 2019e

Figure 9d: Seafloor Habitats within the Project Area



Source: Vineyard Wind 2019e

Figure 9e: Seafloor Habitats within the Project Area

5.1.2.2. Turbidity/Suspended Sediment

Installation of the export cable and inter-array cable at the WDA and OECC as well as construction of WTGs and ESPs in the WDA would disrupt bottom habitat and suspend sediment in the water column. A maximum impact assessment includes 171 miles (275 kilometers) of 66 kV inter-array cable at the WDA and 98 miles (158 kilometers) of 220 kV export and inter-array cables in the WDA and OECC. Dredging the entire route would lead to the maximum impact, followed by mechanical techniques and then jet plowing.

A sediment dispersal modeling study was conducted to assess expected sediment disturbing construction activities (COP Volume III, Appendix III-A). The model assumed a fine sand- and silt-dominated seafloor across the entire disturbed area. The activities that could potentially impact EFH include inter-array cable installation in the WDA, dredging of sand waves prior to cable installation along the OECC, and installation of the export cable along the OECC. Model simulations show that the use of a TSHD to pre-dredge sand waves can potentially generate temporary plumes extending throughout the water column and horizontally several kilometers from the route centerline. Cable installation plumes generally remained close to the bottom and remained relatively close to the centerline. Any dredged material would be deposited elsewhere within the defined cable corridor.

Modeling of the inter-array cable installation in the WDA was run for a typical installation (expected 90 percent) and maximum installation (expected 10 percent). Vertically, the sediment suspension was limited to the bottom 10 feet (3 meters) of the water column with 85 percent modeled to remain in the bottom meter (COP Volume III, Appendix III-A; Epsilon 2018b). For typical installation, TSS in excess of 10 milligrams per liter (mg/L) of the baseline levels in the WDA are expected to extend as far as 1.9 miles (3.1 kilometers) from the centerline with concentration in excess of 50 mg/L extending to 525 feet (160 meters) from the centerline (Figures 10a and 10b). Maximum modeled impacts due to installation indicated the 10 mg/L plume could extend up to 7.5 kilometers from the center line while plumes of 50 mg/L and 100 mg/L would extend up to 1.2 miles (2 kilometers) and 0.53 miles (0.86 kilometer) from the centerline respectively.

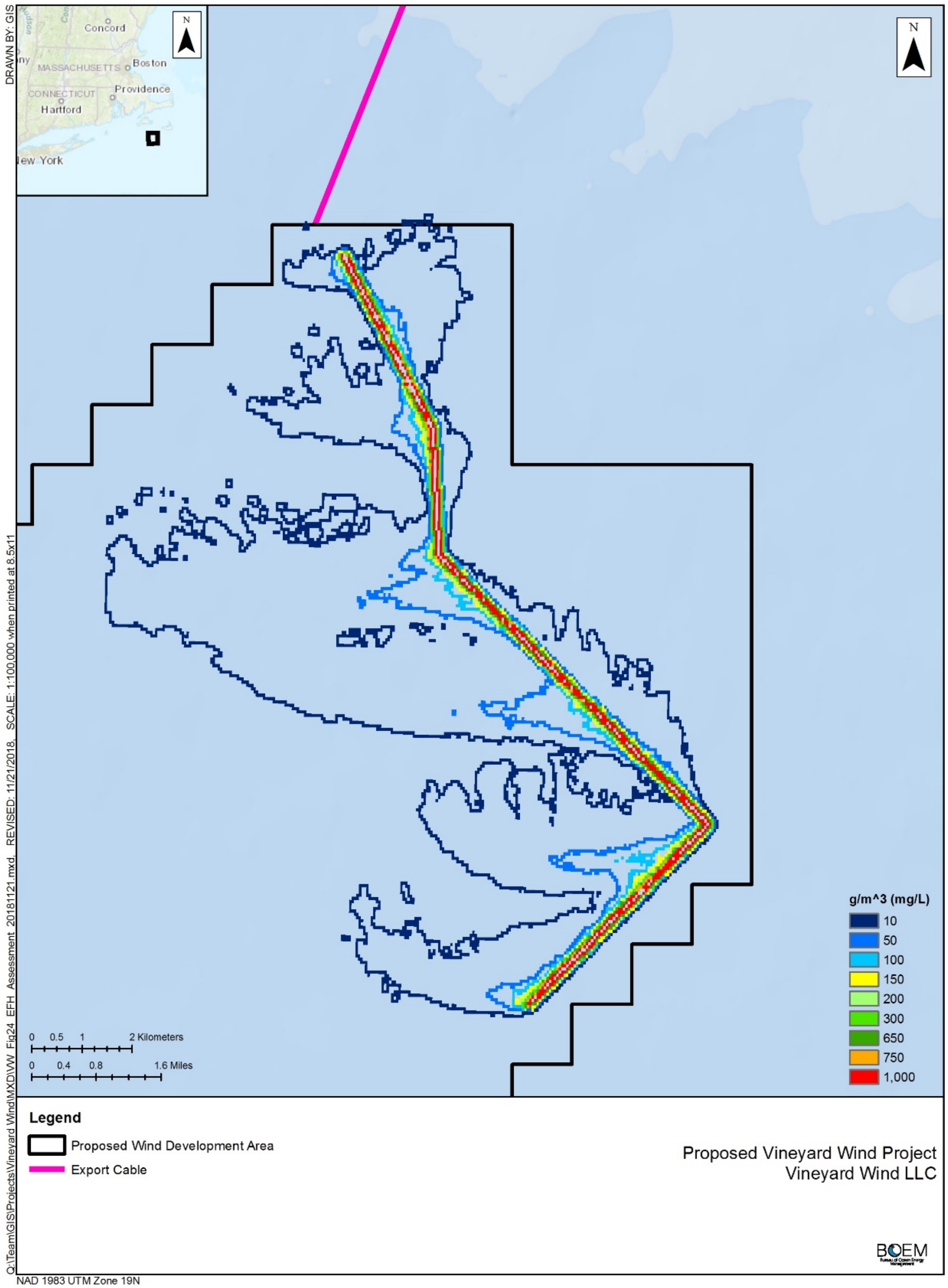
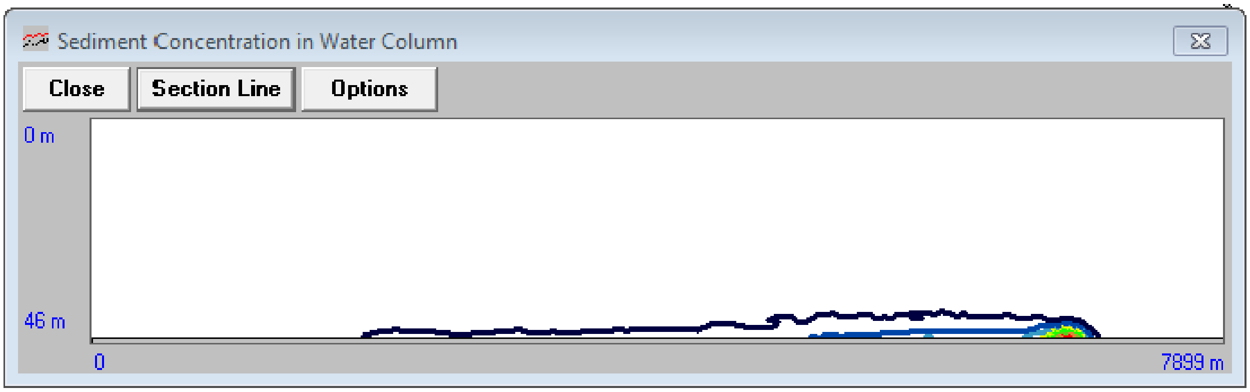


Figure 10a: Simulated Time-Integrated Maximum Concentrations of Suspended Sediment Associated with Inter-array Cable Installation using Maximum Impact Parameters



This figure shows a representative vertical cross section of the plume shown in Figure 10a. Distance is shown on the x-axis, and depth on the y-axis.

Figure 10b: Simulated Time-Integrated Maximum Concentrations of Suspended Sediment Associated with Inter-array Cable Installation using Maximum Impact Parameters

OECC installation includes dredging with a TSHD in regions where sand waves needed to be removed to bury the cable in stable seafloor. Vertically, the sediment plume from dredging can impact the entire water column. TSS in excess of 10 mg/L of the baseline were modeled to extend up to 16 kilometers from the centerline while plumes of 750 mg/L and 1,000 mg/L higher than the baseline could extend 3.2 miles (5 kilometers) and 1.2 miles (2 kilometers) respectively (Figures 11a through 11d). Overall, TSS are expected to remain in the water column for less than 3 hours. Dredge hopper dump sites are located 820 feet (250 meters) east of the OECC centerline. High loading and dumping and swift transport of dumped materials have the potential to create TSS plumes in excess of 1,000 mg/L above the baseline up to 3.1 miles (5 kilometers) from dump sites, which would persist for less than 2 hours.

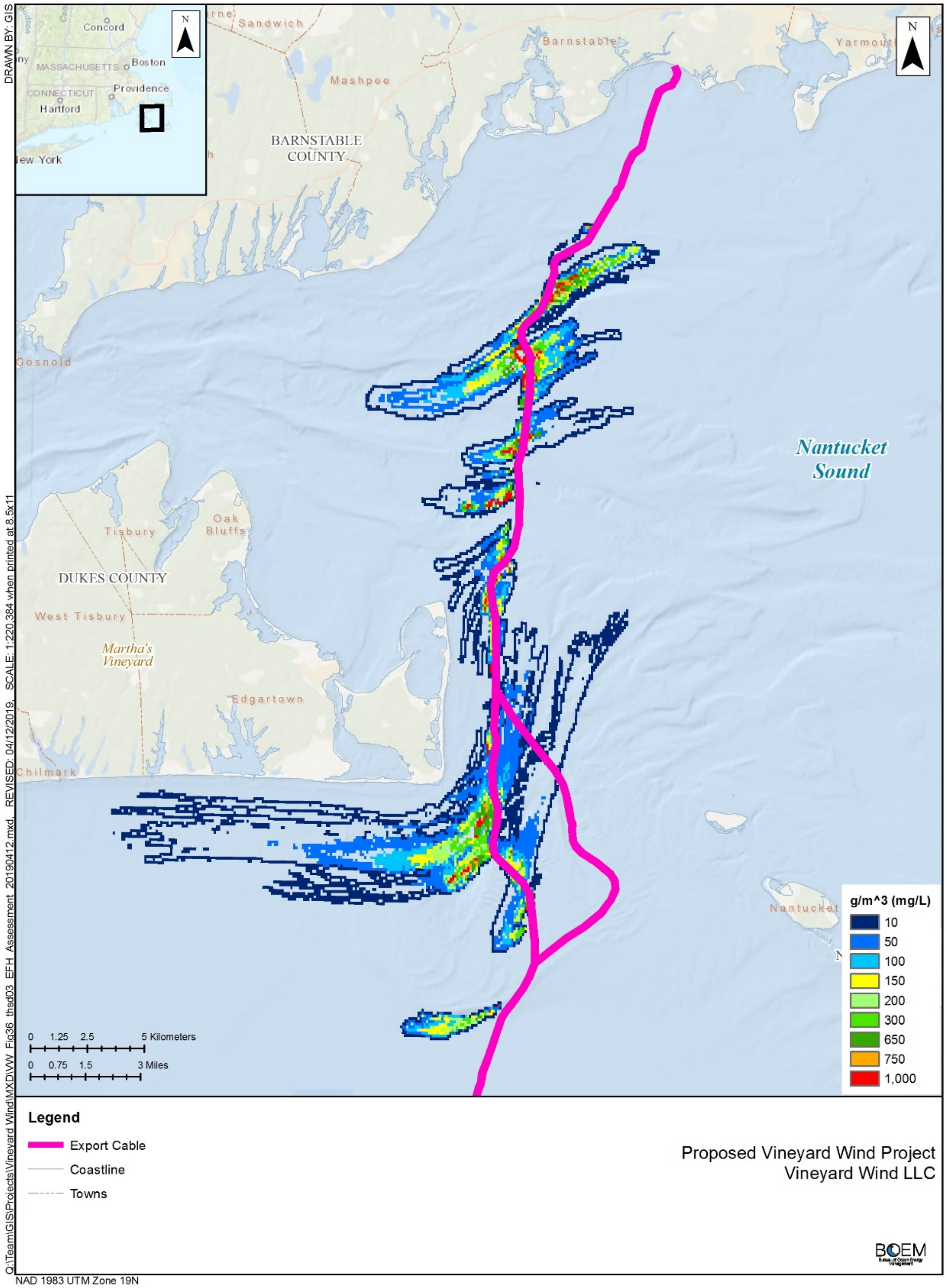


Figure 11a: Simulated Time-Integrated Maximum Concentrations of Suspended Sediment Associated with OECC Cable Installation using a TSHD (West Muskeget Variant to Covell's Beach)

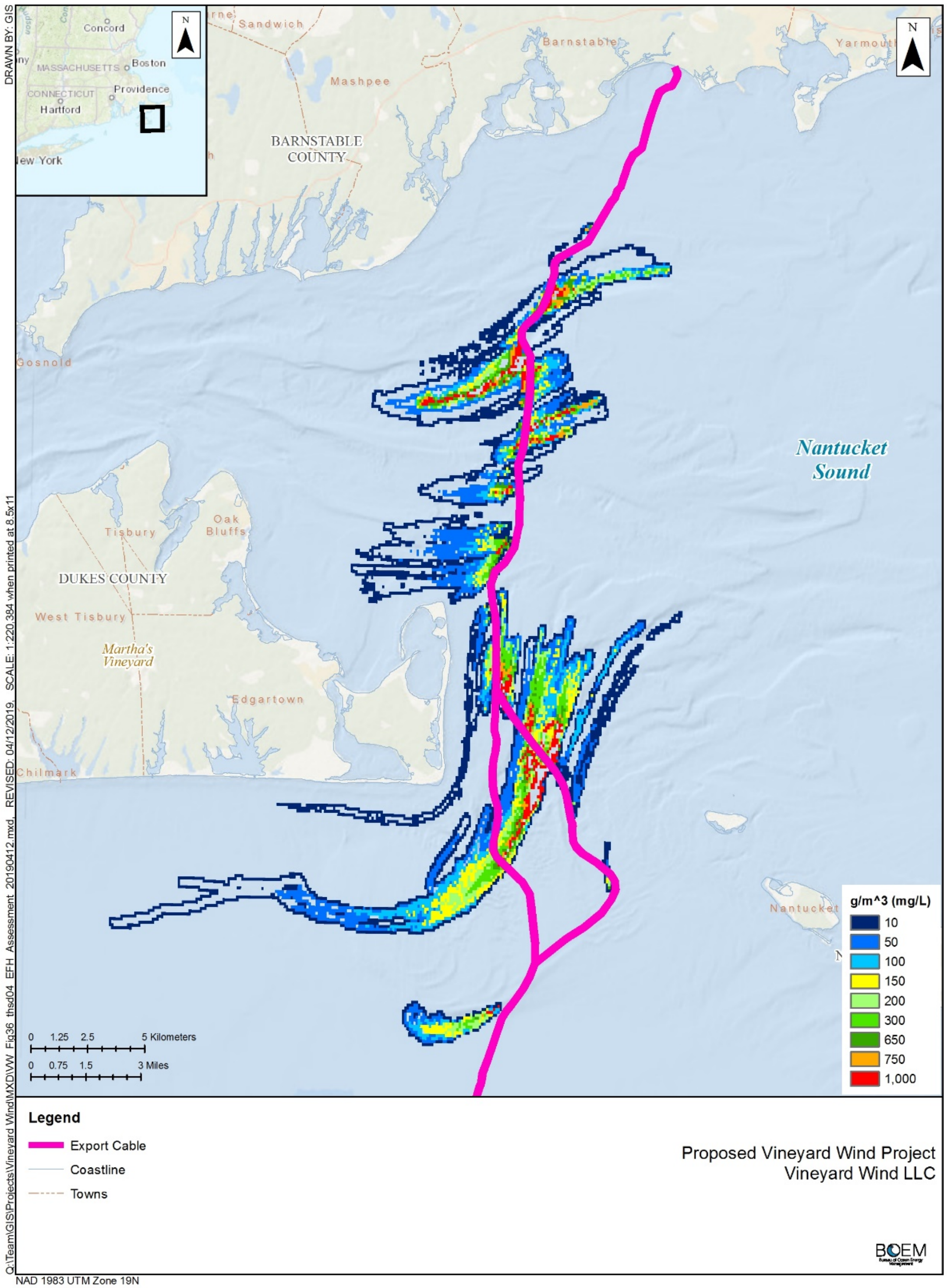


Figure 11b: Simulated Time-Integrated Maximum Concentrations of Suspended Sediment Associated with OECC Cable Installation using a TSHD (East Muskeget Variant to Covell's Beach)

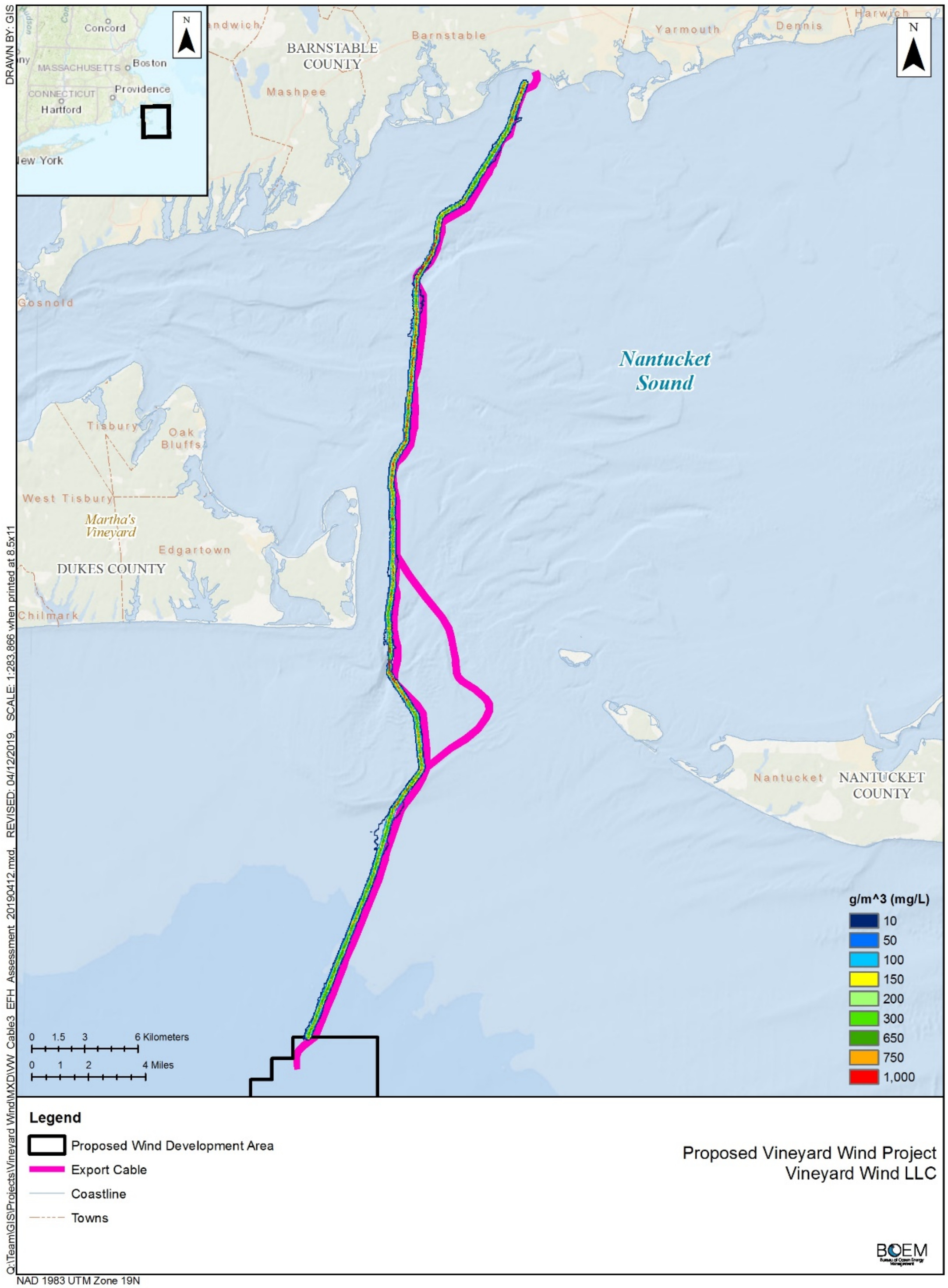


Figure 11c: Simulated Time-Integrated Maximum Concentrations of Suspended Sediment Associated with OECC Cable Installation (West Muskeget Variant to Covell's Beach)

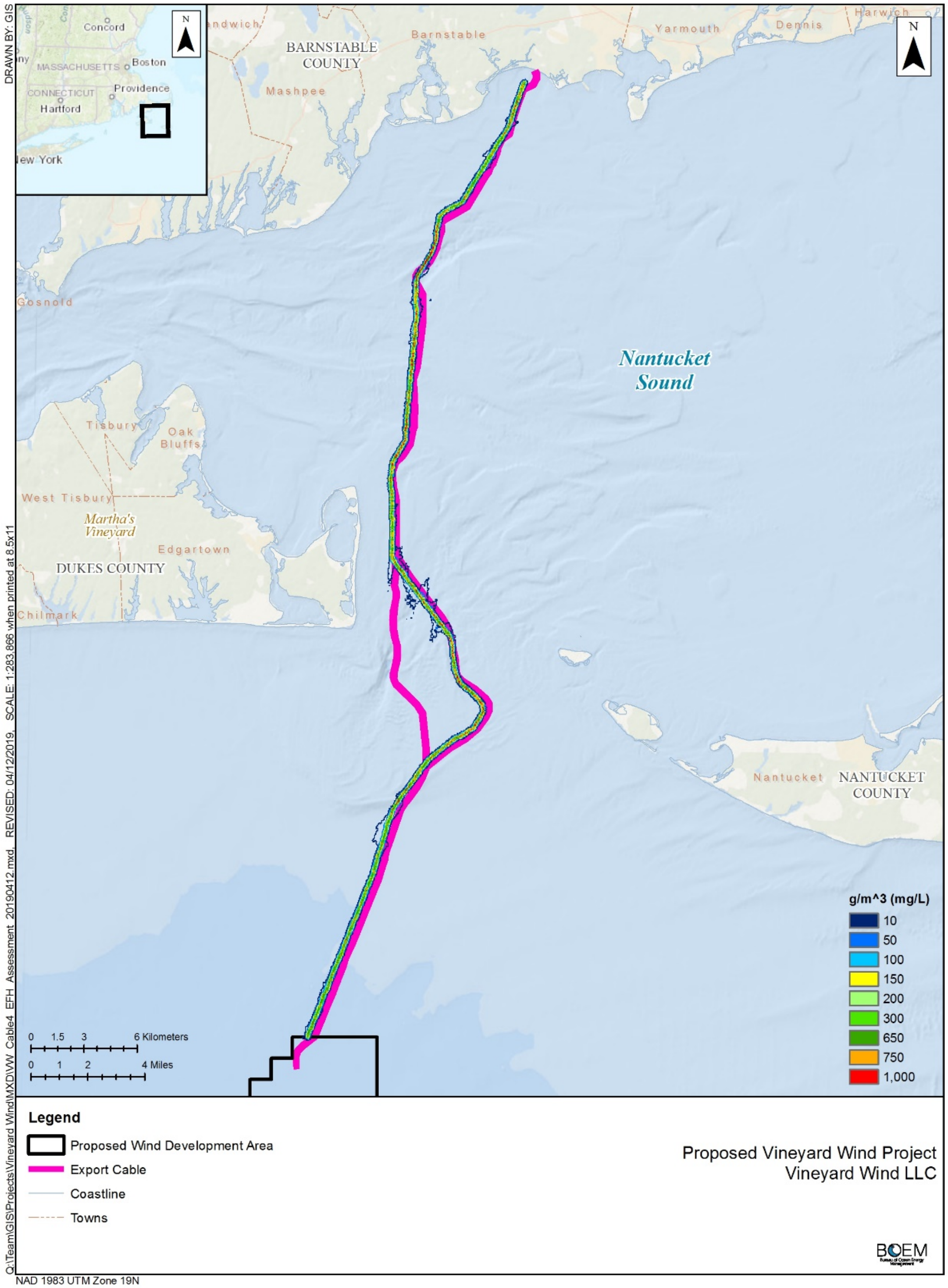


Figure 11d: Simulated Time-Integrated Maximum Concentrations of Suspended Sediment Associated with OECC Cable Installation (East Muskeget Variant to Covell's Beach)

OECC installation was modeled for typical (expected for 90 percent of route) and maximum impact (expected for 10 percent of route). Modeling indicates that both methods would produce TSS plumes concentrated in the bottom of the water column and lasting less than 6 hours. Typical installation methods were modeled to create TSS plumes exceeding the baseline by 10 mg/L extending up to 2 kilometers (1.2 miles) from the centerline, with most remaining less than 656 feet (200 meters) from the centerline. Maximum impacts had a similar impact to the typical installation.

Overall, the impacts to benthic and pelagic EFH would be limited due to the small amount of habitat impacted (in relation to the amount of similar habitat available regionally), the short period of time (hours) that suspended sediment is expected to remain in the water column at 10 mg/L above baseline levels, and the limited vertical range that the plume is expected to occupy (i.e., near the seafloor) (COP Volume III, Appendix III-A; Epsilon 2018b). For context, BOEM's recent analysis of background turbidity in Block Island Sound found TSS ranging from 0.5 – 5.3 mg/L (Elliott et al. 2017). In southern New England, tides, currents, wind, and storms create an environment in which many species deal with suspended sediment already. Although no thresholds for injury or morality are available for TSS, it is not expected that EFH would be substantially impacted by temporary increases in TSS due to cable installation. Mobile juvenile and adult species with EFH in the areas would likely be temporarily displaced, which could expose them to increased predation or temporarily reduce their ability to find prey. For sessile organisms unable to escape the suspended sediment plumes, the impacts could range from mortality to reduced fitness. Wilber and Clark (2001) found reduced feeding and respiration in oysters exposed to suspended sediment from dredging, while heavy sedimentation induced mortality. Sessile species, eggs, and larval stages would be the most vulnerable, but the majority of sediment suspension would remain below levels (concentration and temporal) at which mortality would occur (Berry et al. 2011; Wilber and Clark 2001).

5.1.2.3. Sediment Deposition

Sediment deposition for inter-array cable installation in the WDA, pre-cable installation dredging in the OECC, and export cable installation in the OECC are described in the sediment transport modeling (COP Volume III, Appendix III-A; Epsilon 2018b).

Sediment deposition from inter-array cable installation in the WDA for a typical installation is modeled to produce depositions of 0.04 inches (1 millimeter) or greater up to 100 meters from the centerline. Depositions are not predicted to exceed 0.2 inches (5 millimeters). The maximum impact installation modeled shows depositions of greater than 0.04 inches (1 millimeter) extending to 459 feet (140 meters) from the centerline with depositions not exceeding 0.2 inches (5 millimeters).

Dredging associated with sand-wave removal prior to cable installation is modeled to have deposition of greater than 0.04 inches (1 millimeter) less than 262 feet (80 meters) from the centerline. Greater depositions are expected in situation of dredge hopper overflow and at dredge sediment dumping sites located 250 meters east of the OECC centerline. Depositions associated with overflow and disposal could exceed 0.04 inches (1 millimeter) in areas up to 0.62 miles (1 kilometer) from dumping sites except in areas around Muskeget Channel with higher currents where these deposits could extend up to 1.4 miles (2.3 kilometers) in isolated patches. Depositions associated with dumping exceeding 20 millimeters could extend up to 0.22-0.56 mile (0.35-0.9 kilometer) from source locations.

Sediment depositions associated with OECC export cable installation are modeled to exceed 0.04 inches (1 millimeter) up to 328 feet (100 meters) from the centerline under a typical installation. The areas of various seafloor habitat types within 328 feet (100 meters) of the proposed cable alignments are shown in Table 4. Of those areas, all of the hard-bottom habitat would be considered HAPC for juvenline Atlantic cod. Table 4 represents the total amount that habitat type within the OECC. The actual area of impact to that habitat type is less. Maximum impact installation methods would extend to 459 feet (140 meters) the areas of deposition expected to exceed 0.04 inches (1 millimeter), while physical bottom disturbance is 3 meters over centerline track (1 meter of trench plus 1 meter on either side for skid track)

Sediment transport modeling indicates the potential for suspended sediment to settle on hard-bottom habitat (COP Volume III, Appendix III-A; Epsilon 2018b). This would occur in areas where suspended sediment from dredging and cable installation occurs within Muskeget Channel, where there are patches of hard-bottom habitat (see Figures 9c and 9d). In this conservative model, the entire route was assumed to consist of the sediment sample with the greatest relative fraction of fine material, which was approximately 23 to 29 percent; the model evaluated sediment suspended by dredging and cable burial. Settling of sediment to thicknesses greater than 0.04 inches (1 millimeter) is expected to occur within 262 to 328 feet (80 to 100 meters) of typical cable installation activities. Maximum impact methods extend the distance to 459 feet (140 meters). Within the WDA, maximum depositions are predicted not to exceed 0.2 inches (5 millimeters). Along the OECC, dredging associated with sand wave removal to facilitate cable installation is modeled to cause deposition of more than 0.04 inches (1 millimeter) no farther than 262 feet (80 meters) from the centerline. Thicker depositions are expected near dredged sediment dumping sites located approximately 250 meters east of the OECC centerline, and in the abnormal but possible situation of dredge hopper overflow. Deposition associated with overflow and disposal could exceed 0.04 inches (1 millimeter) across areas up to 0.62 miles (1 kilometer) from dumping sites, except in areas around Muskeget Channel with higher currents, where these deposits could extend up to 1.4 miles (2.3 kilometers) away. Dredge dumping could lead to deposition exceeding 20 millimeters thick as far as 0.22 to 0.56 miles (0.35 to 0.9 kilometer) from source locations.

Impacts associated with deposition could include the loss of habitat along the OECC, including juvenile Atlantic cod HACP, and impacts on macroalgae and submerged aquatic vegetation, which constitutes summer flounder HACP (see Figure 1). While deposition affects mobile species by causing avoidance of preferred habitat, deposition could result in mortality for sessile organisms and life stages. Demersal eggs (e.g., Atlantic sea scallops, winter flounder, and longfin squid) could be covered by deposition resulting from dredging and cable installation. Berry et al. (2011) indicated that the hatching of demersal winter flounder eggs did not differ in sediment depositions of up to 0.04 inches (1 millimeter), but very few hatched at depositions of sediment greater than 0.12 inches (3 millimeters). Wilber and Clark (2001) found that deposits of 0.04 to 0.08 inches (1 to 2 millimeters) inhibited the settlement of oyster larvae. Atlantic sea scallop larvae could be negatively impacted in this aspect as their larvae settle on hard bottom following the pelagic larval stage (NEFMC 2017). The severity of any potential impacts to eggs or newly settled larvae would depend on time of year. OECC cable laying activities may start in the month of April (Rachel Pachter, Pers. Comm., August 14, 2018). Thus, winter flounder and longfin squid eggs could be impacted; if cable laying activities continued into the fall, scallop eggs or newly settled spat could also be impacted.

Temporary impacts from sediment deposition range from avoidance and retreat to mortality. Mobile species of finfish and invertebrates (primarily juveniles and adults) are likely to avoid deposition areas or move away in the event that they are within the impact zone. Sessile species (Atlantic surfclam, ocean quahog) and demersal eggs and larvae (i.e., Atlantic wolffish, winter flounder, longfin squid) would be subject to injury or mortality depending on deposition depth. Wilber and Clark (2001) found reduced respiratory and feeding rates in oysters when exposed to deposition from dredging. Mortality can occur of sessile shellfish in sedimentation levels greater than 0.8 inches (20 millimeters) (COP Volume III; Epsilon 2018b) and as benthic eggs and larvae are more susceptible with increased mortality rates in depositions over 0.04 inches (1 millimeter). Based on the limited distribution of sediment depositions exceeding 0.04 inches (1 millimeter) along the export cable route and the overall proportion of soft-bottom habitat being affected in relation to that available regionally, it is unlikely that direct mortality to benthic eggs and larvae or sessile adults would have a substantial impact.

5.1.2.4. Water Withdrawal

Water withdrawals are necessary for jet-plow cable installation, one of the primary methods of installing the OECC export cable as well as the WDA inter-array and inter-link cables. Due to the surface-oriented intake for the jet plow, water withdrawal has the potential to entrain pelagic finfish and invertebrate eggs and larvae, resulting in 100 percent mortality due to the stress associated with the pump system (MMS 2009a). COP Section 6.5.2.1.3 approximates needing to withdraw 450 to 1,200 million gallons (1,700 to 4,540 million liters) over the course of cable installation (COP Volume III; Epsilon 2018b). Scheduled installation of the inter-array and inter-link cables is expected to occur from May through September 2021 while installation of the OECC cable is expected to occur from March through June 2021 (COP Volume III, Section 4.2.2; Epsilon 2018b). Species with pelagic eggs or larvae during this period include numerous flatfish species (i.e., windowpane flounder, winter flounder, witch flounder, yellowtail flounder, and summer flounder), important commercial groundfish species (i.e., Atlantic cod, pollock), and other recreationally and commercially important species (monkfish, Atlantic herring, Atlantic mackerel, silver hake, butterfish). The eggs of species with demersal eggs, which adhere to bottom substrate, would not be affected by the water withdrawal portion of jet plowing (i.e., longfin squid, Atlantic wolfish, ocean pout, winter flounder). The relatively small area in which the jet plowing would occur (in relation to the region) and the short period of time in which jet plowing would be employed indicate that only a fraction of the potential habitat for most vulnerable pelagic life forms would be impacted. The EFH assessment for Cape Wind indicated the potential for entraining 48.5 million eggs and larvae through water withdrawal for jet plowing would have a minimal impact on finfish and invertebrates due to the high fecundity of species and the relatively small proportion of eggs and larvae that survive to adulthood (MMS 2009a). The entrainment number from jet plowing was also minor when compared to the 16 billion eggs and larvae estimated entrained at Brayton Point Station (stationary water withdrawal occurring year round; MMS 2009b)

5.2. OPERATIONS AND MAINTENANCE

5.2.1.1. Permanent Habitat Loss

Permanent habitat loss (e.g., permanent conversion of soft sediment to hard bottom, sediment deposition on hard bottom) would occur during the construction phase but persist through the operational phase of the proposed Project. Permanent disturbance to pelagic and benthic habitat from construction activities is described in Section 6.6.2 of the COP (Epsilon 2018b), and the potential impacts are quantified in terms of area impacted (acres [km^2]) in Table 6.

Table 6: Maximum Areas of Impact Predicted from Scour/Cable Protection

Bottom Disturbance Due to Addition of Rock or Structures (Protection)	Total Area of Protection [b]	
	Acres	km^2
WTG Foundations and Scour Protection	52	0.21
ESP Foundations and Scour Protection	1	0.01
Export Cables [a]	35	0.14
Inter-link Cable	2	0.01
Inter-array Cables	61	0.25
Total Scour and Cable Protection in the WDA	117	0.47
Total Cable Protection along the OECC	35	0.14

Source: Modified from COP Table 6.5-5 (Volume III; Epsilon 2018a).

km^2 = square kilometers; OECC = Offshore Export Cable Corridor; WDA = Wind Development Area

[a] Maximum length of export cable includes the length for both export cables to be installed within the corridor.

[b] The maximum area of disturbance is assumed to be 100 tubrines and 2 export cables within the corridor. Corridor width for siting purposes; each trench would be approximately 3.2 feet (1 meter) wide and there would be an up to 3.3-6.6 feet (1-2 meters) wide temporary disturbance zone from the tracks or skids of the cable installation equipment.

The seafloor of the WDA is relatively homogenous, ranging in depth from 114.8 to 170.6 feet (35 to 52 meters) (Figure 7; also see Charts 2 and 3 in the COP Appendix II-I [Epsilon 2018b]). The sediment is primarily composed of fine sand and silt-sized sediments with coarser grain substrates occurring in shallower water; finer-grain sediment becomes more dominant with increasing depth (COP Section 2.1.2.1, Volume II; Epsilon 2018b).

Within the WDA, permanent habitat alteration from the construction of WTG and ESP foundations (monopile or jacket),scour protection, and cable protection would amount to a total of approximately 117 acres (0.47 km^2) in the WDA that would be converted from sand/silt bottom habitat to rock/hard-bottom substrate.

The OECC runs from the WDA north through one of two routes in Muskeget Channel towards landfall in one of two locations on southern Cape Cod, Massachusetts (Figure 9a through 9e). Surficial seafloor conditions are described in COP Table 2.1-5 (Volume II, Section 2.1.3.1; Epsilon 2018b). In the region south of Nantucket Island, the benthic habitat is similar to that within the WDA. As the corridor tracks north into Muskeget Channel, the depth decreases, and high currents are the dominant factor influencing bedform structure. The Muskeget Channel seafloor is characterized by large sand waves with patches of coarse material. In central and northern parts of Muskeget Channel, gravel and coarse materials become more abundant, with patchy hard bottom present. Where the OECC traverses Nantucket Sound, the dominant bottom habitat is composed of sand with sand waves as high as 3 to 4 meters near Horseshoe Shoal. The nearshore areas of Cape Cod include shallow sand and silt bottom habitat with no sand waves. In relation to the Covell’s Beach landfall location, there is only one identified sandwave area just north of Muskeget Channel on the western side of the OECC adjacent to complex seafloor habitat (see Figure 9c).

Along the OECC, permanent habitat alteration from the placement of cable protection would affect up to 35 acres (0.14 km^2) in areas where the cable cannot be buried to the acceptable depth. This could effectively convert soft-bottom habitat to hard-bottom habitat, although the habitat value may be less if concrete mattresses and/or duct/shell-type protection were used, as opposed to rock protection. The installation of the offshore export cable over coarse pebble/cobble substrates in Muskeget Channel and surrounding areas could result in permanent bottom change when fine sediment settles over existing coarse substrates. Although the proposed Project would use micro-routing to avoid hard-bottom areas to the greatest extent practicable, any hard-bottom areas that could not be avoided would be converted to a less coarse, more sandy habitat type by cable burial. Although the total extent of hard-bottom and complex habitat impacts would not be determined until just prior to installation, Table 4 provides estimates of the total amount of these habitat types that occur in the cable corridor (Epsilon 2018b).

The installation of scour protection for the WTG and ESP platforms and within the OECC is projected to occur in May through September 2020. Habitat conversion from soft to hard bottom would displace species and life stages adapted to sand/fine sediment bottoms (e.g., Atlantic surfclam, ocean quahog). Adult and juvenile life stages of several benthic species (i.e., yellowtail flounder, summer flounder, red hake, and winter flounder) would be displaced from preferred habitat while other species (i.e., Atlantic cod, Atlantic wolffish, and black sea bass) that prefer hard-bottom habitat would gain habitat. For some species, the impact of habitat conversion could differ by life stage. Although adult Atlantic cod may benefit from the additional hard bottom introduced by scour protection, existing coarse pebble/cobble substrates could be altered through the placement of scour protection in HAPC for juvenile cod. Nonetheless, these alterations to soft and hard-bottom habitat are unlikely to have a population-level impact on species with designated EFH in the area, as the total habitat disturbance to the WDA, including both permanent and temporary alterations, would include 0.4 percent of the WDA (COP Volume III, Section 4.2.2; Epsilon 2018b). The monopile or jacketed (pin pile) foundations may also produce a “reef effect.” This effect could manifest in two ways. First, structure-oriented species may be attracted to the vertical portions of the foundations, although the smooth vertical surfaces would not likely initially exhibit the attached communities and productivity of a natural reef (English et al. 2017; MMS 2009a). Thus, foundations could aggregate some species without increasing the actual number of individuals in the region. Second, the rocky scour protection around foundations and any hard cable protection installed could create habitat more similar to the existing hard bottom habitat in the region (Causon and Gill 2018). Utilization of the structures by fish would likely vary by species depending on the season. For example, black sea bass and some other species are highly temperature dependent and would not remain in an artificial reef area when temperatures are unfavorable (Secor et al. 2018).

5.3. Avoidance, Minimization, and Mitigation

5.3.1. Construction and Installation

COP Section 6.6.2.1.3 describes measures for the construction and installation process as avoidance, minimization, mitigation, or monitoring (COP Volume III; Epsilon 2018b). Vineyard Wind has also made a voluntary agreement with several non-governmental organizations that includes additional measures for avoidance and mitigation, collaboration, monitoring, and adaptive management (Vineyard Wind 2019f); however, this EFH Assessment analyzes potential impacts regardless of these additional measures.

- Avoidance:

- The location within the MA WEA is considered less sensitive to important fish and invertebrate habitat, reducing the overall impacts of the WDA and OECC.
- WTGs would be widely spaced, leaving a large portion of the WDA undeveloped.
- In response to a request from the MA DMF, Vineyard Wind has agreed to avoid cable laying activities in the spring season (April through June) within Nantucket Sound waters, in light of high concentrations of fishing activities and natural resource events (spawning and egg laying). Thus, Vineyard Wind would conduct cable laying of nearshore segments from early September to late October 2020 (from the Landfall Site to the northeast portion of Martha's Vineyard) using SLB, most likely starting offshore and working towards shore. The remaining segments would be laid from about March/April to June/July 2021. During this period, two vessels would work simultaneously to install the middle segment (through Muskeget Channel and vicinity) and offshore segment of each cable using SLB.
- Pile driving would not occur January through April.

* Mitigation:
  - Pile driving would be initiated with a "soft start" procedure, delivering lower-intensity strikes to elicit an avoidance response from mobile fish and invertebrates and giving them time to reach areas outside the radial distance at which full-strike pile driving can cause injury or mortality.
  - Targeted 12 dB attenuation, but a minimum of 6 dB attenuation, in pile-driving sound would be used to reduce the radial distance at which pile-driving noise causes injury to fish and invertebrates. The specific technologies have not yet been selected; potential options include a Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, a bubble curtain, or similar (Pyć et al. 2018). In addition to the use of one sound attenuation system, Vineyard Wind has committed to complete sound field verification and to have a second attenuation technology on hand, which would be deployed if sound field verification demonstrates a need for greater attenuation.
  - Mid-line buoys and horizontal drilling in nearshore areas would be used (if feasible and safe) in an effort to reduce direct mortality of benthic invertebrates and immobile life stages of fish and invertebrates (i.e., eggs).
* Monitoring
  - Vineyard Wind is developing a framework for pre and post construction fisheries monitoring to measure Project impacts on fisheries.
  - Benthic Monitoring would include a total of ten monitoring sites, two sites from the five different bottom habitat types present in the WDA and OECC, which would be sampled before and after construction for comparative analyses. Two sites of each habitat type would be chosen to ensure reliability in conclusions and increase statistical power of the data. Three control sites outside of, but near to, the Project area and with comparable physical and environmental characteristics would also be sampled to monitor natural environmental shifts that occur unrelated to the Project. The habitat monitoring sites and control sites would be monitored after construction during years one, three, and, five and includes the following methodologies:

  - Benthic Grab Sampling and Analysis
  - Sediment Profile Imaging Acquisition and Processing
  - High Resolution Multibeam Depth Sounding and Video Survey
- Fisheries Monitoring would also be conducted before, during, and after construction in the Project area and control areas to support a "beyond before-after-control-impact (BACI)" analysis (e.g., sampling at multiple control sites at multiple periods before and after impact). Sampling would be conducted four times: pre-construction (to assess baseline conditions); during construction; and at two different intervals during operation (i.e., 1 year after construction and then post-construction). Each of these four assessment periods would capture all four seasons of the year. Fisheries survey methodologies include:
  - Trawl Survey for Finfish and Squid
  - Ventless Trap Survey
  - Plankton Survey
  - Optical Survey (Drop-camera) of Benthic Invertebrates and Habitats

5.3.2. Operations

Post construction impacts on EFH in the WDA and OECC would be operational noise, noise from maintenance and repairs, and electromagnetic fields (EMFs) generated by the inter-link, inter-array, and export cables.

5.3.2.1. Acoustic

Noise effects due to operations are likely limited to the increased vessel traffic, noise associated with maintenance and repairs, and the operational noise generated by the WTGs.

Wind Facility Operational Noise

Noise generated by operation of the wind facility would be much less than noise generated during construction. Measurements of operational noise at the Block Island Wind Farm recorded peak sound intensities equal with an average of 119 dB at a distance of 50 meters from a turbine foundation (HDR 2019). The NMFS interim criteria for behavior impacts to fish is 150 dB. For context, the background noise levels under calm conditions were up to 110 dB 50 meters from the turbine and 107 dB 30 kilometers from the turbine. Thus, the operational sound should not be considered as 119 dB above background levels. Based on this analysis, BOEM does not anticipated any detectable impact on the acoustic habitat during Project operation.

Vessel and Maintenance

As discussed, noise from vessels and associated maintenance would create temporary disturbances that may induce avoidance in pelagic and demersal species but is unlikely to have a major negative impact on species with EFH in the WDA or OECC.

5.3.2.2. Non-Acoustic

Habitat Alteration

Habitat alteration completed during construction would have permanently altered habitat (scour protection, WTGs, ESPs, cable installation through hard bottom) or temporarily altered it (cable installation, construction activities). Temporarily disturbed habitat should begin to revert back to the original state allowing recolonization. MMS (2009a) indicated jet-plowing scars recovered in up to 38 days. Permanent and temporary habitat alterations include 0.4 percent of the entire WDA and species inhabiting soft-bottom areas that are displaced by hard-bottom habitat conversion should be able to move to nearby preferable habitat. Soft-bottom areas that were temporarily disturbed should be readily recolonized by adjacent populations. Impacts to existing hard-bottom habitats would minimized, but not mitigated; however, the addition of scour protection and cable protection, if used, would likely result in a net increase in hard-bottom habitat in the Project area. An artificial reef effect may increase hard-bottom community productivity in the Project area and/or lead to fish aggregation. Chen et al. 2016 modelled impacts to waves and circulation from a hypothetical wind farm in the Massachusetts Wind Energy Area. His analysis of acute storm events (hurricanes and nor-easters) found that there would be increased water column mixing during those events. To understand normal environmental conditions, tank tests, such as the one conducted by Miles (2017), conclude that mean flows are reduced immediately downstream of an offshore wind monopile foundation, but return to background levels within a distance proportional to the pile diameter (D). In a current-only regime, mean flows returned to within 5 percent of background levels by approximately 8.3 D away from the pile. In a combined current and wave regime, flow returned to background levels within 3.5 D. Miles (2017) suggests a rule of thumb that downstream effects have a length scale of 8 to 10 D. Thus, this research if applied to the Vineyard wind project would mean that background conditions would exist 100 meters (10x10) from each monopile foundation.

Electromagnetic Fields

Inter-array and export cables associated with the WDA and OECC would generate EMF that may affect some marine species. EMFs would be generated by passing current through power cables during the operation of the WTGs. The export cable and inter-link cable would be composed of a three-core 220 kV AC cable for power transmission while inter-array cables would be composed of 66 kV AC cables (COP Volume II; Epsilon 2018b). Buried cables reduce, but do not entirely eliminate, the EMF generated by submarine cables (Taormina et al. 2018). Many marine species are sensitive to EMF fields, which may affect the ability to navigate, detect predators/prey, and have physiological and developmental effects (Taormina et al. 2018). Current data suggest that while the swimming capability of some fish may be affected by EMF from submarine cables and some species specific avoidance behavior has been observed, no evidence of population-scale impacts or adverse physiological impacts have been reported (Taormina et al. 2018). As cables would be buried between 5 to 8 feet (1.5 to 2.5 meters), the effect of EMF would be diminished and likely only impact demersal species. Atlantic sturgeon have both electro and magneto sensitivity that can affect feeding, predator detection, and navigation (BOEM 2011), although research suggests marine species may be less likely to detect EMF from AC cables (BOEM 2011). Studies of impacts of EMF on benthic invertebrates are scarce (Taormina et al. 2018). Little skate (EFH designated in OECC and WDA) and American lobster (*Homarus americanus*) displayed behavioral differences when in pens exposed to EMF from a direct current cable in Long Island sound as opposed to when in pens without. However, both species continued to make full use of the enclosure, travelling back and forth over the cable, and it is unclear what the overall effect of EMFs on these species may have been (Hutchison et al. 2018). Teleost fish, especially diadromous species, use magnetic fields for navigation. Although there is some evidence that they are affected by EMF, there is no evidence of population-level or physiological negative impacts (Taormina et al. 2018). Based on the available literature, it is apparent that many of the species with EFH in the WDA and OECC may sense EMFs emitted by the inter-link, inter-array, and export cables; at present, there is no evidence that population-level negative impacts on those species would result from EMFs (Taormina et al. 2018; Hutchison et al. 2018). By burying cables and containing them in grounded metallic shielding, no measurable impacts of EMFs to populations of species with EFH designated in the proposed Project area would be expected.

Avoidance, Minimization, and Mitigation

According to COP Section 6.6.2.2.5, the avoidance, minimization, or mitigation measures for the operations and maintenance process are identical to those for the construction and installation process (COP Volume III; Epsilon 2018b). In addition, to mitigate any impacts related to EMF from buried cables, inter-array and export cables would be buried up to 5 to 8 feet (1.5 to 2.5 meters) and contained in grounded metallic shielding.

5.3.3. Decommissioning

According to COP Section 6.6.2.3, decommissioning activities include removing WTG and ESP foundations 15 feet below the mudline. Scour protection and cable arrays can either be removed or left in place (COP Volume III; Epsilon 2018b).

5.3.3.1. Acoustic

Acoustic effects would reflect those associated with non-pile driving noise from the construction and installation and the operations and maintenance sections of this document and are unlikely to have permanent negative impacts on fish with EFH in the WDA or OECC.

5.3.3.2. Non-Acoustic

If scour protection and cable arrays are left in place, hard-bottom habitat created by the scour protection would remain and the original habitat would continue to exist in its altered state. Removal of the scour protection would result temporary and permanent habitat alterations in the form or removal of hard bottom and disruption of soft bottom due to cable removal. These temporary and permanent alterations would have similar impacts on those discussed in the construction and installation portion of this document. Removal of the hard-bottom habitat would likely result in a recolonization of species preferring soft-bottom sand and fine-sediment habitat and the loss of any species that previously colonized and maintained populations on the hard-bottom scour protection.

5.3.3.3. Avoidance, Minimization, and Mitigation

According to COP Section 6.6.2.3.2, the measures for the decommissioning process for avoidance, minimization, or mitigation are identical to those found in the construction and installation process (COP Volume III; Epsilon 2018b).

6. CONCLUSIONS

Activities associated with the construction and installation, operations and maintenance, and decommissioning of the WDA and OECC fall within a series of eight 10 x 10 minute squares that contain designated EFH for one or more life stage of 47 species of finfish and invertebrates as well as two HACPs (inshore juvenile Atlantic cod, summer flounder). Impacts associated with construction, operations and maintenance, and decommissioning are often specific to the life stage and habitat requirements of a species. Atlantic mackerel EFH consists entirely of pelagic habitats for all life stages and is not likely to be impacted by activities that primarily affect benthic habitat (i.e., cable installation, foundations, and scour protection). Conversely, benthic species and life stages such as skates, flatfish, squid egg mops, and Atlantic sea scallops are likely to be displaced or subject to mortality by the above mentioned activities.

Acoustic impacts from pile driving and increased vessel traffic would occur during construction. Noise associated with pile driving can impact benthic and pelagic EFH through direct injury, mortality, TTS, or behavioral avoidance. These impacts could affect all life stages and species depending on the specifics of how they hear. Mitigation through bubble curtain attenuation and soft start techniques are likely reduce the extent of potential impacts and the number of individuals exposed, and the overall short timeframe of the pile driving should keep adverse effects to a relatively short time period. These acoustic impacts are likely to affect species with EFH in the vicinity of the activity to some degree (potential mortality to avoidance) although the overall activity would occur in a restricted area over a short time period. Vessel noise associated with increased traffic and construction is another acoustic impact source. These acoustic impacts are likely to result in temporary avoidance behavior for mobile fauna.

Permanent habitat alteration from the conversion of soft-bottom habitat to hard bottom by installing foundations/scour protection, and the potential for gravel substrate to be covered through sediment deposition. These impacts may result in the mortality of sessile species and life stages that are not able to escape while causing more mobile species/life stages to leave altered areas and occupy undisturbed adjacent habitat. While these impacts are unavoidable and permanent (until decommissioning), they represent a small area of the habitat available in the WDA and OECC and are unlikely to adversely impact the species depending on the EFH that has been altered. Temporary alteration (disruption of soft-sediment habitat, sediment deposition on soft sediment, turbidity, and water withdrawal) is also only going to occur in a small area in comparison to the regional habitat available and is unlikely to have a major impact on EFH.

Impacts associated with operations and maintenance on EFH and species with EFH in the region are likely to be less than those from construction and installation. In addition to those already discussed (vessel noise, habitat alteration), there should be fewer adverse impacts as there would not be any pile driving or turbidity/sediment deposition from installation (with the exception of some repairs/maintenance activities). Impacts not covered in the above include:

EMFs generated by inter-array and export cables are detected by fish and invertebrates and may impact behavior or temporarily disrupt navigation. Overall, there is little evidence pointing to any population-level adverse impacts, and the burying of the cables and containment in grounded metallic shielding would reduce any impacts that EMFs might have on species with benthic EFH in the WDA and OECC.

Similar to operations and maintenance, many of the impact-causing factors during decommissioning are discussed above in the construction and operations section. During decommissioning, there would be substantial habitat disruption as foundations and scour protection are removed and bottom habitat returned to the original substrate. There would also be additional temporary impacts (turbidity, sediment deposition, habitat disruption) from cable removal from the OECC. These activities could result in mortality of sessile benthic organisms and life stages while mobile life stages and species are likely to retreat and avoid the impacted area. Demersal species and life stages dependent on hard bottom would be losing habitat while those species that require soft bottom would regain habitat lost during the construction phase.

Overall, species and life stages with demersal EFH are more likely to be impacted than those with pelagic EFH as the majority of activities affect benthic habitat. Turbidity, especially associated with dredging, and water withdrawal from jet plowing have the potential to temporarily impact habitat for pelagic eggs and larvae. Pile-driving noise, although temporary, has the potential to have the widest-ranging impact on EFH. The noise associated with this activity would impact both pelagic and benthic species and life stages. The adverse impacts associated with the construction and installation, operations and maintenance, and decommissioning of the proposed Project are likely to have impacts that are temporary or small in proportion to the overall habitat available regionally.

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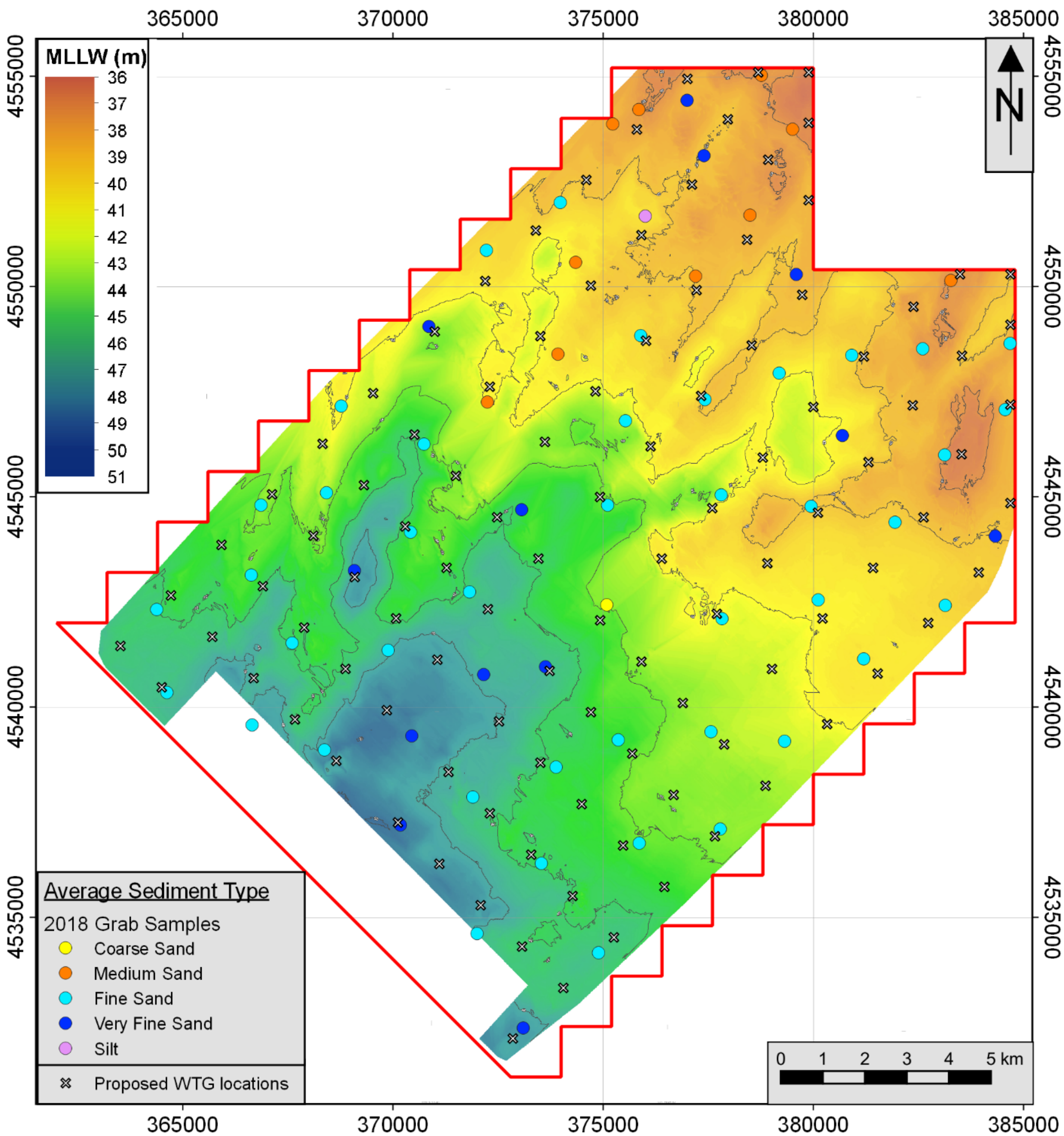
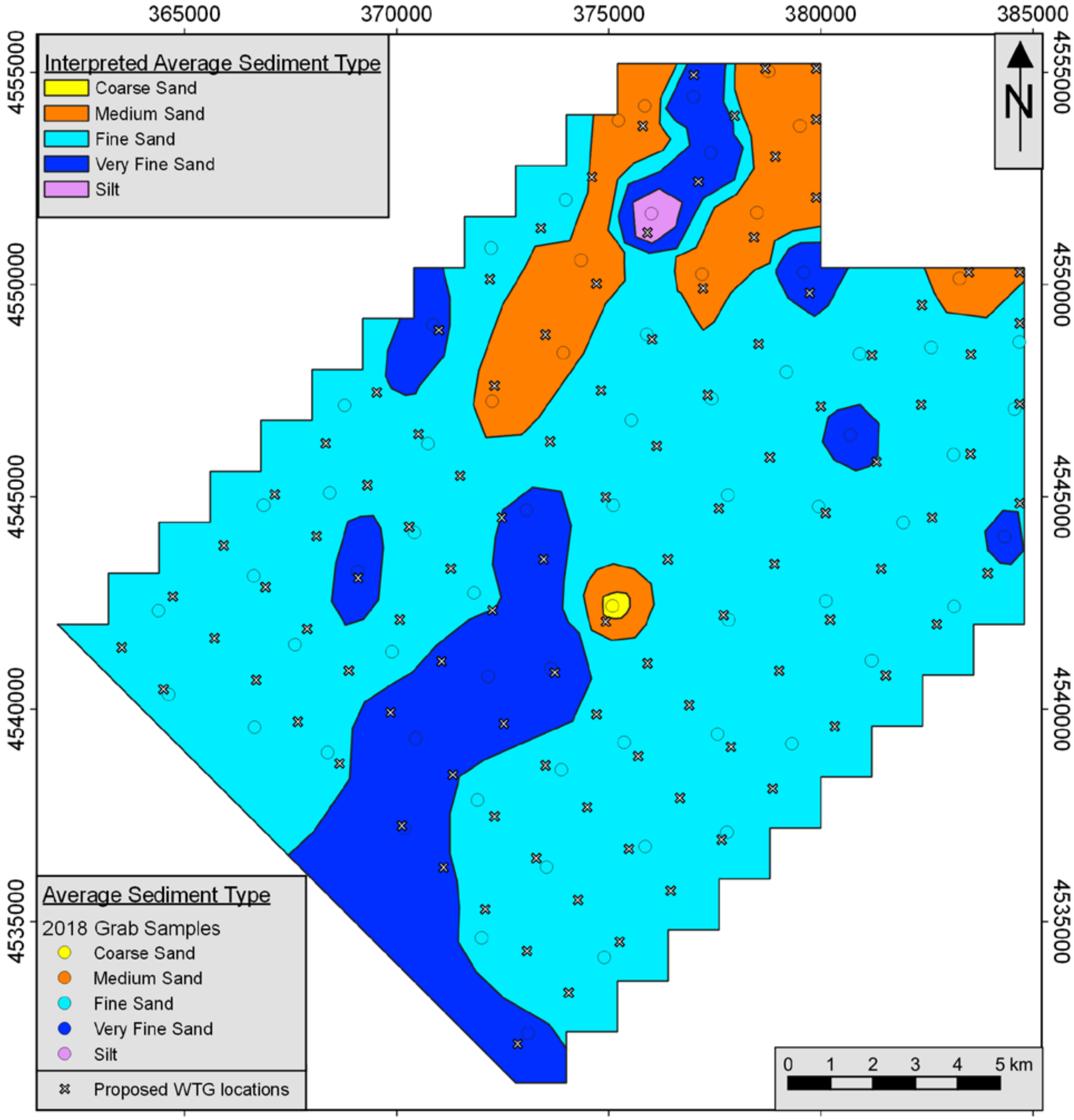
ADDENDUM

Clarification of Information to April 19, 2019 Essential Fish Habitat Assessment for the Vineyard Wind Project April 29, 2019

The following are points of clarification regarding the information contained in the subject EFH Assessment:

- In regards to Figure 7 we have added the 106 turbine locations and changed the color scheme to be more legible. We have also included an additional representation of the same information interpolating sediment type from the grab sample data.





- In regards to Table 5 we were able to calculate the subset of area of direct impact from the cable installation (trench and sled, 3m per cable for 2 cables) from the preliminary cable alignment (see below).

Seafloor Habitat Type	Area of Potential Cable Installation Disturbance (acres)		Area within 328 feet[b] (100 meters) of the Proposed Cable[c] (acres)	
	Eastern Muskeget Option	Western Muskeget Option	Eastern Muskeget Option	Western Muskeget Option
Hard Bottom / Coarse Deposits	5.5612	4.122585	274.2	206.0
Complex Seafloor	19.69696	20.607875	994.6	1022.2
Biogenic Surface	3.559048	3.559048	154.4	154.4
Eelgrass	0	0	0.0	0.0
Other (mostly flat sand and mud)	96.483878	92.354589	3401.7	3235.9
Total	125.3011	120.6441	4824.9	4618.5

Source: Vineyard Wind 2019d

Note: The OECC branch leading to the New Hampshire Avenue landfall site is not included here. The proposed cable route alignment should be considered preliminary.

[b] The maximum distance from cable centerline that may be disturbed through deposition of sediment greater than 1 millimeter. Deposition of 1 millimeters or greater is typically constrained within 80 meters (262 feet) from the route centerline, though may extend up to 100 meters (328 feet) in limited areas.

[c] This is based off the cable preliminary alignment. The proposed cable could be located anywhere within the OECC; no bottom disturbing activities would occur outside of the OECC.

- The definition of "complex seafloor" in Table 5 should be interpreted to mean sand wave area.
- In Figures 9a – 9e, the MA Ocean Plan Special, Sensitive, or Unique Areas are the ones classified. The background blue color means there are no SSUs in the area, which is otherwise dominated by sand.
- Bottom imagery is found in Vineyard Wind COP Volume II Appendix H (see PDF file page 62 at www.boem.gov/Vineyard-Wind-Cop-Vol-II/). The full imagery is found in the following COP Volumes: 2018 samples (includes WDA): COP Volume II-B, Appendix II-Z (the photos start on page 146 of the report), the 2017 survey, benthic grab photos are in COP Volume II-B, Appendix II-O, and the 2016 survey, benthic grab photos are in COP Volume II-B, Appendix II-M.
- The VW Eelgrass Report is found in Attachment P (pdf pg 1099) of the August 31, 2018 Supplemental Draft Environment Report.
- Additional information regarding the technique for horizontal directional drilling is found in Section 1.4.4.2 of the Supplemental DEIR (beginning on page 1-58/73 of PDF).
- In Section 5.1.1 of the EFH Assessment we reference work done by Dr. Popper and Dr. Mooney in regards to assessing acoustic impacts to invertebrates, including squid. Although squid are not the same as vertebrate fish, the closest analog to how squid may process sound (via particle motion) is the category of a fish without a swim bladder. This comparison between the two systems is explored by Mooney et al 2010 (attached) stating: "There are two separate receptor systems within the statocyst, a macula that provides orientation information on the gravitational field and on linear acceleration, and a crista–cupula system that acts as an angular accelerometer (Budelmann, 1990). Consequently, the general morphology and vestibular role of the statocyst organ functions like that of the fish inner ears (de Vries, 1950; Fay and Popper,

1975). As with vertebrate otoliths (Chapman and Sand, 1974), the statocyst in squid may sense sound-induced displacement between the statolith and its hair cells (Budelmann, 1992b), and as an accelerometer may play an auditory role (Packard et al., 1990). Because a sound field consists of both particle motion and pressure components available for potential detection (Chapman and Sand, 1974; Fay and Popper, 1974), hearing can be defined as the auditory detection of either of these two sound field components (Chapman and Sand, 1974; Webster et al., 1992)." Mooney 2016, which is cited in the EFH Assessment also includes a comparison between the particle acceleration and produced sound pressure levels (Figure 4). Additionally, I have attached recent presentations to the American Fisheries Society regarding a specific study to evaluate the response of squid to the playback of pile driving noise at a distance of 500 meters from the pile. These results support the habituation response first reported by Mooney et al 2016.