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VINEYARD WIND

Draft Construction and Operations Plan

Volume III Appendices

Vineyard Wind Project

October 22, 2018

Submitted by
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Submitted to
Bureau of Ocean Energy Management
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Sterling, Virginia 20166

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In Association with:

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Capitol Air Space Group	Public Archaeology Laboratory, Inc.
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Appendix III-F

Essential Fish Habitat Impact Assessment

APPENDIX III-F ESSENTIAL FISH HABITAT ASSESSMENT

1.0 Introduction

Essential Fish Habitat ("EFH") is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and is designated by National Oceanic and Atmospheric Administration's ("NOAA") Fisheries and Regional Fishery Management Councils (P.L. 104-297). Included in the Magnuson-Stevens Act in 1996, 16 U.S.C. ch. 38 § 1801 et seq., the primary goal of EFH is to identify and protect important fish habitat from certain fishing practices and coastal and marine development. EFH is typically by assigned by egg, larvae, juvenile and adult life stages and designated as waters or as substrates. NOAA Fisheries defines waters and substrate as (50 C.F.R. § 600.10):

- Waters – Aquatic areas and their associated physical, chemical, and biological properties that are used by fish and, where appropriate, may include aquatic areas historically used by fish.

- Substrate – Sediments, hard bottoms, structures underlying the waters, and associated biological communities.

2.0 Description of the Affected Environment

The Magnuson-Stevens Act requires federal agencies to consult on activities that may adversely affect EFH designated in fishery management plans. Additionally, fishery management councils identify Habitat Areas of Particular Concern ("HAPCs") within fishery management plans. HAPCs are discrete subsets of EFH that serve extremely important ecological functions or are especially vulnerable to degradation. The EFH designations described in this section correspond to those currently accepted and in place, not the new Omnibus Essential Fish Habitat Amendment 2, which is under review (NEFMC, 2017). Upon acceptance of the new amendment, changes may be made to EFH descriptions as needed. Currently, there is no HAPC identified for any listed finfish species within the Project Area, however, the new amendment to EFH designations, currently in review, proposes the addition of HAPCs for juvenile Atlantic Cod (*Gadus morhua*) in coastal areas from Maine to Rhode Island, and inshore waters around Cape Cod to Martha's Vineyard and Nantucket (NEFMC, 2017). The proposed HAPC for juvenile Cod would overlap with the Offshore Export Cable Corridor ("OECC"), but not the Wind Development Area ("WDA"). In addition, EFH designations which overlap with the Project Area are described for individual species below.

Essential Fish Habitat is designated for 40 fish species within the WDA and OECC (see Table 2-1). Both substrate and water habitats are cited as EFH within both the WDA and OECC.

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

Other bottom habitats, such as sand waves, are also important habitat for fish species and provide structured habitat in sandy areas, where such habitat is typically void. Some evidence suggests that complex habitat, such as sand waves, can enhance fish survival by providing refuge from predators (Scharf et al., 2006). In the WDA, sediment primarily consists of fine sand with silt. Most of the OECC will pass through low complexity bottom habitat of a variety of sediment types, including sand/mud, pebble-cobble, and dispersed boulders (see Volume II). Coarser substrates, like pebble-cobble and boulders, were found mainly in Muskeget Channel and are important for habitat for the juveniles of some fish species, like Atlantic Cod (Lindholm et al., 2001). In addition, large sand waves have been observed in the path of the OECC. Ancient stream beds, which typically provide sloping and gravel bottom habitat in predominantly sandy areas, were thought to be present in the WDA. Upon completion of Geological and Geotechnical (G&G) video surveys of bottom habitat in the WDA, no ancient stream beds were detected.

In addition to hard substrate, benthic flora is also considered EFH for many fish species. In the OECC, eelgrass beds may be present at Landfall Sites. Eelgrass is important habitat that provides forage opportunities and refuge to fish and invertebrate species.

Water column or pelagic habitats protected as EFH range from surface waters (for Witch Flounder [*Glyptocephalus cynoglossus*] eggs) to the entire water column (for juvenile and adult Bluefin Tuna [*Thunnus thynnus*]), and demersal waters (for juvenile and adult Scup [*Stenotomus chrysops*]). Although demersal fish species are strongly associated with bottom substrates, many species have pelagic egg and larvae stages and use currents for dispersal of the young life stages. Pelagic species reside within the water column during all life stages and may occupy different strata based on that stage. For example, Atlantic Mackerel (*Scomber scombrus*) eggs are free-floating and remain near the water surface, while larvae are typically observed in mid-water column below 10 meters ("m") (32.8 feet ["ft"]).

Daily, seasonal, and annual ocean current patterns and production regimes dictate the forage and migratory behaviors of some pelagic species. Highly migratory pelagic fish, such as Atlantic Albacore Tuna (*Thunnus alalunga*), are generally only observed in northern Atlantic waters for two months, September and October, to take advantage of productive late summer/early fall production. Additionally, as described in Volume II, the Nantucket Shoal

Tidal Front is an important pelagic habitat feature and may overlap with the WDA. Frontal zones, or areas where water masses converge through tidal forces, are particularly important pelagic habitat as they are often important feeding locations where plankton concentrate.

EFH has been designated for the following species for one or more life stages in the WDA and/or OECC (see Table 2-1).

Table 2-1 EFH Designated Species in Project Area

Species	Eggs		Larvae		Juveniles		Adults	
	WDA	OECC	WDA	OECC	WDA	OECC	WDA	OECC
Atlantic Albacore Tuna (*Thunnus alalonga)*	-	-	-	-	●	●	●	●
Atlantic Butterfish *(Peprilus triacanthus)*			●	●	●	●	●	●
Atlantic Cod *(Gadus morhua)*	●	●	●	●	●	●	●	●
Atlantic Mackerel *(Scomber scombrus)*	●	●	●	●	●	●		
Atlantic Sea Herring *(Clupea harengus)*			●	●	●	●	●	●
Atlantic Wolffish (*Anarhichas lupus*)[A]	●	●	●	●	●	●	●	●
Basking Shark (*Cetorhinus maximus*)	-	-	-	-	●	●	●	●
Black Sea Bass *(Centropristis striata)*					●	●	●	●
Blue Shark (*Prionace glauca)*	-	-	●	●	●	●	●	●
Bluefin Tuna *(Thunnus thynnus)*					●	●	●	●
Bluefish *(Pomatomus saltatrix)*					●	●	●	●
Cobia *(Rachycentron canadum)*	●	●	●	●	●	●	●	●
Common Thresher Shark *(Alopias vulpinus)*[A]	●	●	●	●	●	●	●	●
Dusky Shark *(Carcharhinus obscurus)*	-	-	●	●	●	●	●	●
Haddock *(Melanogrammus aeglefinus)*	●		●				●	●
King Mackerel *(Scomberomorus cavalla)*[A]	●	●	●	●	●	●	●	●
Little Skate *(Leucoraja erinacea)*	-	-	-	-	●	●	●	●
Longfin Inshore Squid *(Loligo pealeii)*	●	●	-	-		●	●	●
Monkfish *(Lophius americanus)*	●	●	●	●	●		●	●
Northern Shortfin Squid *(Illex illecebrosu)*			-	-				●
Ocean Pout *(Macrozoarces americanus)*	●	●	●	●	●		●	●
Ocean Quahog *(Artica islandica)*	-	-	-	-	●	●	●	●
Porbeagle Shark *(Lamna nasus)*[A]	●		●		●		●	
Red Hake *(Urophycis chuss)*	●	●	●	●	●	●	●	
Sand Tiger Shark (*Carcharias taurus*)	-	-	●	●		●		
Sandbar Shark *(Carcharhinus plumbeus)*	-	-			●	●	●	●
Scup *(Stenotomus chrysops)*					●	●	●	●
Skipjack Tuna *(Katsuwonus pelami)*					●	●	●	●
Shortfin Mako Shark *(Isurus oxyrinchus)*[A]	-	-	●		●		●	
Spanish Mackerel *(Scomberomorus maculatus)*[A]	●	●	●	●	●	●	●	●
Spiny Dogfish *(Squalus acanthias)*	-	-	-	-	●	●	●	●
Summer Flounder *(Paralichthys dentatus)*	●	●	●	●		●	●	●
Surf Clam *(Spisula solidissima)*	-	-	-	-		●	●	●
White Shark *(Carcharodon carcharias)*[A]	-	-	●	●	●	●	●	●
Whiting *(Merluccius bilinearis)*	●	●	●	●	●	●	●	●
Windowpane Flounder *(Scophthalmus aquosus)*	●	●	●	●	●	●	●	●
Winter Flounder *(Pseudopleuronectes americanus)*	●	●	●	●	●	●	●	●

Table 2-1 EFH Designated Species in Project Area (Continued)

Species	Eggs		Larvae		Juveniles		Adults	
	WDA	OECC	WDA	OECC	WDA	OECC	WDA	OECC
Witch Flounder *(Glyptocephalus cynoglossus)*	●		●	●				
Yellowfin Tuna (*Thunnus albacares*)					●	●		
Yellowtail Flounder *(Limanda ferruginea)*	●	●	●	●	●	●	●	●

[A] Indicates EFH designations are the same for all life stages or designations are not specified by life stage.
- Indicates EFH has not been designated for this life stage or the life stages are not relevant to that species life cycle.

Atlantic Albacore Tuna (Thunnus alalonga)

EFH for Albacore Tuna is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile Albacore Tuna is designated as offshore the US east coast from Cape Cod to Cape Hatteras. Juveniles migrate to northeastern Atlantic waters in the summer for feeding. EFH for adult Albacore Tuna is designated in the Atlantic east coast from Cape Cod to Cape Hatteras in waters more offshore than EFH for juveniles. Adults are commonly found in northern Atlantic waters in September and October for feeding. Albacore Tuna are top pelagic predators and opportunistic foragers (NMFS, 2009a).

Atlantic Butterfish (Peprilus triacanthus)

EFH for Atlantic Butterfish is designated in the WDA for larvae, juvenile, and adult life stages. EFH for Butterfish larvae is designated as pelagic habitats in inshore estuaries and embayments from Boston Harbor to Chesapeake Bay and over the continental shelf, from the Gulf of Maine to Cape Hatteras. Butterfish larvae are common in high salinity and mixing zones where bottom depths are between 41-350 m (134-1,148 ft). EFH for juvenile and adult Butterfish is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound on the inner and outer continental shelf from the Gulf of Maine to Cape Hatteras. Juvenile and adult Butterfish are generally found over sand, mud, and mixed substrates in bottom depths between 10-280 m (33- 918 ft] (NOAA, 2007). Juvenile and adult Butterfish feed primarily on planktonic prey though adults may eat squids and fishes as well (Cross et al., 1999). Butterfish are found in the project area throughout the year and are present in nearshore areas in the fall, and therefore may be impacted by cable installation (NEFSC, n.d.).

Atlantic Cod (Gadus morhua)

EFH for Atlantic Cod is designated in the WDA and OECC for egg, larvae, juvenile, and adult life stages. EFH for Atlantic Cod eggs is designated as surface waters from the Gulf of Maine to southern New England. Cod eggs are found in the fall, winter, and spring in water depths less than 110 m (361 ft). EFH for larval cod is pelagic waters (depths of 30-70 m [98-230 ft]) from the Gulf of Maine to southern New England and are primarily observed in the spring. EFH for juvenile cod is designated as bottom habitats with substrates composed of cobble or gravel from the Gulf of Maine to southern New England. EFH for adult cod is designated as bottom habitats with substrates composed of rocks, pebbles, or gravel from the Gulf of Maine to southern New England and the middle Atlantic south to Delaware Bay. Cod spawn primarily in bottom habitats composed of sand, rocks, pebbles, or gravel during fall, winter, and early spring (NOAA, 2007). Juvenile and adult cod are opportunistic foragers and consume a wide variety of items including small crustaceans, benthic invertebrates, and fish (Lough, 2004). Atlantic Cod were not included as the most dominant finfish species in the Massachusetts Wind Energy Area ("MA WEA"), designated by BOEM, in any season per New England Fisheries Science Center ("NEFSC") bottom trawl surveys; however, they were present in over 30% of the Region 2 (OECC) spring trawls conducted by Massachusetts Department of Marine Fisheries.

Atlantic Mackerel (Scomber scombrus)

EFH for Atlantic Mackerel is designated in the WDA for the egg and larval life stages. EFH for mackerel (egg and larval stages) is pelagic habitats in inshore estuaries and embayments from Great Bay to Long Island, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras (NOAA, 2007). Eggs float in the upper 10-15m (33-49 ft) of the water column while larvae can be found in depths ranging from 10-130m (33-427 ft) (Studholme et al., 1999). EFH for juvenile Atlantic Mackerel is designated in pelagic waters in the OECC. Depth preference of juvenile mackerel shifts seasonally as they are generally found higher in the water column (20-50 m [66-164 ft]) in the fall and summer, deeper (50-70 m [66-230 ft]) in the winter, and widely dispersed (30-90 m[98-295 ft]) in the spring (NEFSC, n.d.; Studholme et al., 1999). Juvenile mackerel feed on small crustaceans, larval fish, and other pelagic species.

Atlantic Sea Herring (Clupea harengus)

EFH for Atlantic Sea Herring is designated in the WDA and OECC areas for larvae, juvenile, and adult life stages. EFH for larval Atlantic Herring is pelagic waters in the Gulf of Maine, Georges Bank, and southern New England. Larvae are free-floating and generally observed between August and April in areas with water depths from 50-90 m (164-295 ft). EFH for juvenile and adult herring is pelagic and bottom habitats in the Gulf of Maine, Georges Bank, and southern New England. Juvenile and adult herring are found in areas with water depths from 20-130 m (66-427 ft). Herring opportunistically feed on zooplankton, with forage species changing as herring size increases (Reid et al., 1999). Atlantic Herring were captured in the NEFSC Multispecies Bottom Trawl Survey throughout the year within the WDA.

*Atlantic Wolffish (Anarhichas lupus) *Species of Concern*

EFH for Atlantic Wolffish is designated in the OECC for egg, larvae, juvenile, and adult life stages. EFH for Wolffish eggs is bottom habitats over the continental shelf and slope within the Gulf of Maine south to Cape Cod. Wolffish eggs are deposited in rocky substrates in brood nests and are present throughout the year. EFH for Wolffish larvae is water from the surface to the seafloor within the Gulf of Maine south to Cape Cod. EFH for juvenile and adult Wolffish is bottom habitats of the continental shelf and slop within the Gulf of Maine south to Cape Cod. The depth range for all life stages ranges from 40-240 m (131-787 ft). Spawning is thought to occur in September and October. Wolffish utilize rocky habitats for shelter and nesting and softer substrate habitats for feeding (NOAA, 2007). Although the diets of Wolffish can vary, generally they feed on mollusks, crustaceans, and echinoderms (NMFS, 2009b). Atlantic Wolffish is considered a Species of Concern because the stock is overexploited and severely depleted. Wolffish biomass has shown a consistent downward trend since the 1980's and continues to decline because of capture as bycatch in the otter trawl fishery (NMFS, 2009b).

*Basking Shark (Cetorhinus maximus) * Species of Concern*

EFH for Atlantic Basking Shark is designated in the WDA and OECC for juvenile and adult life stages. EFH for other life stages has not been identified because of insufficient information. EFH for juvenile and adult basking sharks is designated in the Atlantic east coast from the Gulf of Maine to the northern Outer Banks of North Carolina (NMFS, 2006). Basking Sharks are generally observed in the northwestern and eastern Atlantic coastal regions from April to October and are thought to follow zooplankton distributions (Sims et al., 2003). Aggregations of basking sharks have been observed offshore of Cape Cod, Martha's Vineyard, and Morishes Inlet, Long Island (NOAA, 2016). Basking Sharks are considered a Species of Concern because of interactions with vessels, being caught as bycatch, and low reproductive rates, which leads to slow recovery (NMFS, 2011a).

Black Sea Bass (Centropristis striata)

EFH for Black Sea Bass is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile and adult Black Sea Bass is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA, 2007). Juveniles prey on benthic and epibenthic crustaceans and small fish while adults tend to forage more generally for crustaceans, fish, and squids. Adults are generally associated with structurally complex habitats. Juveniles and adults are most commonly observed in the WDA and OECC in the spring and fall (Drohan et al., 2007; MADMF, 2017; NEFSC, n.d.).

Blue Shark (Prionace glauca)

EFH for Blue Shark is designated in the WDA and OECC for neonate, juvenile, and adult life stages. EFH for neonate Blue Shark is in areas offshore of Cape Cod through New Jersey (NMFS, 2017). EFH for juvenile and adult Blue Sharks is waters from the southern part of the Gulf of Maine to Cape Hatteras (Lent, 1999). Blue Sharks are highly migratory and observed in New England from late May through October. Blue sharks feed primarily on small pelagic fish and cephalopods (Nakano et al., 2008).

*Bluefin Tuna (Thunnus thynnus) *Species of Concern*

EFH for Bluefin Tuna is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile Bluefin Tuna is waters off Cape Cod to Cape Hatteras. EFH for adult Bluefin Tuna is pelagic waters from the mid-coast of Maine to southern New England. Bluefin Tuna inhabit northeastern waters to feed and move south to spawning grounds in the spring. Both juveniles and adults exhibit opportunistic foraging behaviors and diets typically consist of fish, jellyfish, and crustaceans (Atlantic Bluefin Tuna Status Review Team, 2011). Bluefin Tuna is considered a Species of Concern because they support important recreation and commercial fisheries and population size is unknown (NMFS, 2011a).

Bluefish (Pomatomus saltatrix)

EFH for Bluefish is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile and adult Bluefish is pelagic waters over the continental shelf from Cape Cod Bay to Cape Hatteras (NOAA, 2007). Bluefish inhabit pelagic waters in and north of the Middle Atlantic Bight for much of the year but make seasonal migrations south in the winter (Shepherd & Packer, 2005). Bluefish opportunistically forage on regionally and seasonally abundant fish species.

Cobia (Rachycentron canadum), Spanish Mackerel (Scomberomorus maculatus), King Mackerel (Scomberomorus cavalla)

Cobia, Spanish Mackerel, and King Mackerel are categorized as coastal migratory pelagic fish and have the same EFH designations. EFH for these three species is designated in the WDA and OECC for egg, larvae, juvenile, and adult life stages. EFH for all life stages occurs in the South- and Mid- Atlantic Bights and includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone; however, from the Gulf Stream shoreward, including *Sargassum.* For cobia, EFH also includes high salinity bays, estuaries, seagrass habitats, and the Gulf Stream, which disperses pelagic larvae. Although EFH is designated within the Project Area, these species prefer warmer waters (above 18 °C [34°F]) and are not regularly present so far north (NOAA, 2014).

Common Thresher Shark (Alopias vulpinus)

EFH for Common Thresher Sharks is designated in the WDA and OECC for all life stages. EFH for all life stages is coastal and pelagic waters from Cape Cod to North Carolina and in other localized areas off the Atlantic coast. Common Thresher Sharks occur in coastal and oceanic waters, but are more common within 64-80 kilometers ("km") (40-50 miles ["mi"]) of shore. Small pelagic fish and pelagic crustaceans make up much of Common Thresher Shark diet (NMFS, 2006).

*Dusky Shark (Carcharhinus obscurus) *Species of Concern*

EFH for Dusky Sharks is designated in the WDA and OECC for neonate, juvenile, and adult life stages. EFH for neonate Dusky Shark includes offshore areas of southern New England to Cape Lookout (NMFS, 2017). EFH for juvenile and adult Dusky Sharks is waters over the continental shelf from southern Cape Cod to Florida (NMFS, 2009a). Dusky Sharks migrate to northern areas of their range in the summer and return south in the fall as water temperatures decrease. Throughout their range, Dusky Sharks forage on bony fishes, cartilaginous fishes, and squid (NMFS, 2011b). Dusky Shark is a Species of Concern because the northwestern Atlantic/ Gulf of Mexico population is estimated to be at 15% to 20% of the mid-1970s abundance (Cortes et al., 2006). Although commercial and recreation fishing is prohibited, the main threat to the Dusky Shark population is from bycatch and illegal harvest.

Haddock (Melanogrammus aeglefinus)

EFH for Haddock is designated in the WDA for egg, larval, and adult life stages. Although adult Haddock spawn near the sea floor, eggs are buoyant and suspend in the water column. EFH for Haddock eggs is surface waters over Georges Bank southwest to Nantucket Shoals and some coastal areas from Massachusetts Bay to Cape Cod Bay (NOAA, 2007). Adult spawning generally occurs from February to May and eggs are observed from March through May (Brodziak, 2005). EFH for Haddock larvae is surface waters from Georges Bank to Delaware Bay and some coastal areas from Massachusetts Bay to Cape Cod Bay. Larvae can be observed from January through July with peaks in April and May and feed on phytoplankton, copepods, and invertebrate eggs. EFH for adult Haddock is bottom habitats with substrates consisting of broken ground, pebbles, smooth hard sand, and smooth areas between rocky patches on Georges Bank and around Nantucket Shoals. Adult Haddock are demersal benthivores and primarily consume ophiuroids and amphipods (Brodziak, 2005; NOAA, 2007). Haddock was one of the dominant species captured in the NEFSC Multispecies Bottom Trawl Surveys in spring, summer, and fall. Adult Haddock move offshore into deeper waters in the winter, which may explain the lower capture rates during this season (Brodziak, 2005; NEFSC, n.d.).

Little Skate (Leucoraja erinacea)

EFH for Little Skate is designated in the WDA and OECC for juvenile and adult life stages. EFH is similar for both life stages and includes intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the mid-Atlantic region. EFH primarily occurs on sand and gravel substrates, but also is found on mud (NEFMC, 2017).

Longfin Inshore Squid (Loligo pealeii)

EFH for Longfin Inshore Squid is designated in the WDA and OECC for egg, juvenile (pre-recruit), and adult (recruit) life stages. EFH for Longfin Inshore Squid eggs is inshore and offshore bottom habitats from Georges Bank to Cape Hatteras. Longfin Inshore Squids lay eggs in masses referred to as "mops" that are demersal and anchored to various substrates and hard bottom types, including shells, lobster pots, fish traps, boulders, submerged aquatic vegetation, sand, and mud (NOAA, 2007). Female Longfin Squid lay these egg mops during three-week periods which can occur throughout the year (reviewed in Hendrickson, 2017). The only known Longfin Squid spawning grounds, which are also the major squid fishery zone, intersect with the ECC. EFH for juveniles and adults, also referred to as pre-recruits and recruits, is pelagic habitats inshore and offshore continental shelf waters from Georges Bank to South Carolina. Pre-recruits and recruits inhabit inshore areas in the spring and summer and migrate to deeper, offshore areas in the fall to overwinter (NOAA, 2007). Forage base for longfin inshore squid varies with individual size, where small squids feed on planktonic organisms and large squids feed on crustaceans and small fish (Jacobson, 2005).

Monkfish (Lophius americanus)

EFH for Monkfish is designated in the WDA and OECC for egg, larval, juvenile, and adult life stages. EFH for Monkfish eggs and larvae is surface and pelagic waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Monkfish eggs float near the surface in veils that dissolve and release zooplanktonic larvae after one to three weeks (MADMF, 2017). Monkfish eggs and larvae are generally observed from March to September. EFH for demersal juvenile and adult monkfish is bottom habitats composed of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic, mid-shelf off southern New England, and all areas of the Gulf of Maine. EFH for adult monkfish also includes the outer perimeter of Georges Bank (NOAA, 2007). Per the Southern New England Juvenile Fish Habitat Research study, adult monkfish were present in the Lease Area from December through April and most abundant in February and March (Siemann & Smolowitz, 2017). Larval monkfish feed on zooplankton, juveniles feed on small fish, shrimp, and squid, and adult monkfish eat other monkfish, crabs, lobsters, squid, and octopus (MADMF, 2017).

Northern Shortfin Squid (Illex illecebrosus)

EFH for Northern Shortfin Squid is designated in the OECC for the adult life stage. EFH for adult Northern Shortfin Squid is pelagic habitat on the continental shelf and slope from Georges Bank to South Carolina and in inshore waters of the Gulf of Maine and southern New England. Adult Northern Shortfin Squid primarily forage for fish, euphausiids, and smaller squids (MAFMC and NOAA, 2011).

Ocean Pout (Macrozoarces americanus)

EFH for Ocean Pout is designated in the WDA and OECC for egg, larval, juvenile, and adult life stages. All Ocean Pout life stages are demersal and therefore have similar EFH designations. EFH for all life stages is bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay (NOAA, 2007). Ocean Pout eggs are laid in masses on hard bottom surfaces and develop from late fall and winter.

Larvae are generally observed from late fall through spring. Juveniles and adults can be found throughout the year, though they move and shift habitats seasonally to remain in preferred temperature range (2-10°C or 36-50°C) (Steimle et al., 1999). Primary prey species shifts depending on location, Ocean Pout near Nantucket Shoals target Jonah Crabs (*Cancer borealis*), though sand dollars are also common in diets (Steimle et al., 1999).

Ocean Quahog (Artica islandica)

EFH for Ocean Quahog is designated in the WDA and OECC for all life stages. EFH for all life stages is designated throughout the substrate, to a depth of 0.9 m (3 ft) below the water/sediment interface from Georges Bank and the Gulf of Maine throughout the Atlantic exclusive economic zone ("EEZ") (NOAA, 2007). Ocean Quahogs feed on phytoplankton and support the diet of invertebrate and fish predators, including sea stars, Ocean Pout, Haddock, and Atlantic Cod (Cargnelli et al., 1999a).

*Porbeagle Shark (Lamna nasus) *Species of Special Concern*

EFH for Porbeagle Shark is combined for all life stages due to insufficient data on the individual life stages and designated EFH overlaps with WDA. EFH for Porbeagle Shark includes offshore and coastal waters of the Gulf of Maine (excluding Cape Cod and Massachusetts Bay) and offshore waters from Georges Bank to New Jersey. Porbeagle Sharks commonly inhabit deep, cold temperate waters and forage primarily on fish and cephalopod species (NMFS, 2017). Porbeagle Shark is a Species of Special Concern due to massive population declines caused by overfishing (NMFS, 2013).

Red Hake (Urophycis chuss)

EFH for Red Hake is designated in the WDA and OECC for all life stages. EFH for Red Hake eggs and larvae is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Red Hake eggs are generally observed from May through November while larvae are commonly observed from May through December. EFH for juvenile Red Hake is bottom habitats with a substrate of shell fragments in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (NOAA, 2007). Juvenile Red Hake are pelagic and congregate around floating debris for a time before descending to the bottom (Steimle, 1999). EFH for adult Red Hake is bottom habitats in depressions with sandy or muddy substrates in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Although adult Red Hake are generally demersal, they can be found in the water column (Steimle, 1999). Red Hake larvae primarily consume copepods, juveniles prey upon small benthic and pelagic crustaceans, and adults prey upon benthic and pelagic crustaceans, fish, and squid (Steimle, 1999).

*Sand Tiger Shark (Carcharias taurus) *Species of Concern*

EFH for Sand Tiger Shark is designated in the WDA and OECC for neonates and in the OECC for juveniles (NMFS, 2017). EFH for Sand Tiger Shark neonates is along the Atlantic east coast from Cape Cod to Northern Florida. Neonate Sand Tiger Sharks inhabit shallow coastal waters within the 25m (82 ft) isobath (NMFS, 2006). EFH for juvenile Sand Tiger Sharks is designated in habitats between Massachusetts and New York and between New Jersey and Florida (NFMS, 2017). The Sand Tiger Shark is a Species of Concern because population levels are estimated to be only 10% of pre-fishery conditions. Population declines were primarily caused by historic overfishing while continued decline is due to capture as bycatch. Although fishing is restricted for Sand Tiger Sharks, low fecundity has limited their ability to recover (NMFS, 2010b).

Sandbar Shark (Carcharhinus plumbeus)

EFH for Sandbar Shark is designated in the WDA and OECC for the juvenile and adult life stages. EFH for juvenile Sandbar Shark includes coastal areas of the Atlantic Ocean between southern New England and Georgia (NMFS, 2017). EFH for adult Sandbar Sharks is coastal areas from southern New England to Florida. Sandbar Sharks are a bottom-dwelling shark species that primarily forages for small bony fishes and crustaceans (NMFS, 2009a).

Scup (Stenotomus chrysops)

EFH for Scup is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile and adult Scup are the inshore and offshore demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (NOAA, 2007). Juvenile Scup feed mainly on polychaetes, epibenthic amphipods, and small crustaceans, mollusks, and fish eggs while adults have a similar diet, they also feed on small squid, vegetable detritus, insect larvae, sand dollars, and small fish (Steimle et al., 1999). Scup occupy inshore areas in the spring, summer, and fall and migrate offshore to overwinter in warmer waters on the outer continental shelf (Steimle et al., 1999). Scup was a dominant finfish species captured in the NEFSC Multispecies Bottom Trawl survey during spring, summer, and fall surveys and in the Massachusetts Division of Marine Fisheries trawl surveys in the spring and fall.

Skipjack Tuna (Katsuwonus pelami)

EFH for Skipjack Tuna is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile and adult Skipjack Tuna is similar, and includes coastal and offshore habitats between Massachusetts and South Carolina. Skipjack Tuna are opportunistic foragers that feed primarily in surface waters, but have also been caught in longline fisheries at greater depths (NMFS, 2017).

Shortfin Mako Shark (Isurus oxyrinchus)

EFH for Shortfin Mako Shark is designated in the WDA. EFH for all life stages is combined and considered the same due to insufficient data needed to differentiate EFH by life stage. EFH for Shortfin Mako Shark is coastal and offshore habitats from Cape Cod to Cape Lookout, North Carolina and additional offshore areas in the Gulf of Maine, Florida, and Gulf of Mexico. Shortfin Mako Shark feed on swordfish, tuna, other sharks, clupeids, crustaceans, and cephalopods (NMFS, 2017).

Spiny Dogfish (Squalus acanthias)

EFH for Spiny Dogfish is designated in the WDA and OECC for juvenile and adult life stages. EFH for juvenile and adult Spiny Dogfish is waters on the continental shelf from the Gulf of Maine through Cape Hatteras (NOAA, 2007). Spiny Dogfish primarily feed on fish, squid, and ctenophores which they detect through olfaction, vision, acoustics, and sensing electrical fields. Spiny Dogfish are a dominant finfish species in the MA WEA throughout the year (NEFSC, n.d.).

Summer Flounder (Paralichthys dentatus)

EFH for Summer Flounder is designated in the WDA and OECC for all life stages. EFH for eggs and larvae is pelagic waters found over the continental shelf from the Gulf of Maine to Cape Hatteras. Eggs are generally observed between October and May, while larvae are found from September through February. EFH for juvenile and adult Summer Flounder is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras. In addition to EFH designations, there is also HAPC designations throughout the region. HAPC is designated as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH (NOAA, 2007). Juvenile Summer Flounder inhabit inshore areas such as salt march creeks, seagrass beds, and mudflats in the spring, summer, and fall and move to deeper waters offshore in the winter. Adults inhabit shallow coastal and estuarine areas during the warmer seasons and migrate offshore during the winter (Packer et al., 1999). Summer Flounder are opportunistic feeders and diets generally correspond to prey availability in relation to flounder size, with smaller individuals primarily consuming crustaceans and polychaetes and larger individuals focusing more on fish prey (Packer et al., 1999).

Surf clam (Spisula solidissima)

EFH for Atlantic Surfclam is designated in the WDA and OECC for juvenile and adult life stages. EFH for surfclams is throughout the substrate, to a depth of three feet below the water/sediment interface, from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Surfclams are generally located from the tidal zone to a depth of about 38 m (125 ft) (NOAA, 2007).

White Shark (Carcharodon carcharias)

EFH for White Shark is designated in the WDA and OECC for neonate, juvenile, and adult life stages. EFH for neonates is inshore waters out to 105 km (65.2 mi) from Cape Cod to New Jersey. EFH for juvenile and adult White Shark is combined and includes inshore waters out to 105 km (65.2 mi) from Cape Ann, Massachusetts to Cape Canaveral (NMFS, 2017). As neonates and juveniles below 300 centimeters ("cm") (120 inches) total length, White Shark primarily consume fish. Upon reaching lengths greater than 300 cm (120 inches), White Sharks begin consuming primarily marine mammals (Estrada et al., 2006).

Whiting (Merluccius bilinearis)

EFH for Whiting, also known as Silver Hake, is designated in the WDA and OECC for egg, larvae, juvenile, and adult life stages. EFH for the egg and larval stages is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Whiting eggs and larvae are observed all year with peaks in egg observations from June through October and peaks in larvae observations from July through September. EFH for juvenile and adult life stages is bottom habitats of all substrate types in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (NOAA, 2007). Whiting are considered ravenous predators at all feeding life stages. Adults are semi-pelagic, nocturnal predators and primarily feed on fish, crustaceans, and squid (Lock & Packer, 2004).

Windowpane Flounder (Scophthalmus aquosus)

EFH for Windowpane Flounder is designated in the WDA and OECC for eggs, larvae, juvenile, and adult life stages. EFH for eggs is surface waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Windowpane Flounder eggs are generally observed from July to August in northern Atlantic areas. EFH for larvae is pelagic waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. EFH for juvenile and adult life stages is bottom habitats that consist of mud or fine-grained sand substrate around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras (NOAA, 2007). Juvenile and adult Windowpane Flounder feed on small crustaceans, especially mysid and decapod shrimp, and fish larvae (Chang et al., 1999).

Winter Flounder (Pseudopleuronectes americanus)

EFH for Winter Flounder is designated in the WDA and OECC for eggs, larvae, juvenile and adult life stages. EFH for eggs is bottom habitats with sandy, muddy, mixed sand/mud, and gravel substrates on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Eggs are primarily observed from February through June. EFH for larvae is pelagic and bottom waters in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Larvae are generally observed from March through July. EFH for juvenile and adult Winter Flounder is bottom habitats with muddy or sandy substrate in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Winter flounder spawning occurs in the winter with peaks in February and March (NOAA, 2007). Previous research has reported that Winter Flounder spawning is confined to shallow inshore waters; however, a recent study conducted by the Coonamessett Farm Foundation identified gravid and recently spent winter flounder females in the offshore areas of southern New England, indicating that winter flounder spawning is not confined to shallow inshore waters (Siemann & Smolowitz, 2017). Winter Flounder are considered opportunistic feeders throughout each life stage and consume a wide range of prey. Adults feed on bivalves, eggs, and fish, but shift diets based on prey availability (Pereira et al., 1999).

Witch Flounder (Glyptocephalus cynoglossus)

EFH for Witch Flounder is designated in the WDA for egg and larvae and in the OECC for larvae life stages. EFH for eggs is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. EFH for larvae is surface waters to 250 m (820 ft) in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Witch Flounder eggs are generally observed from March through October while larvae are observed from March through November (NOAA, 2007). Witch Flounder diets consist primarily of polychaetes and crustaceans (Cargnelli et al., 1999b).

Yellowfin Tuna (Thunnus albacares)

EFH for Yellowfin Tuna is designated in the WDA and OECC for the juvenile life stage. EFH for juveniles is in offshore waters from Cape Cod to the mid-east coast of Florida. Yellowfin Tuna diets primarily consist of *Sargassum* or *Sargassum*-associated fauna (NMFS, 2009a).

Yellowtail Flounder (Limanda ferruginea)

EFH for Yellowtail Flounder is designated in the WDA and OECC for egg, larvae, juvenile, and adult life stages. EFH for eggs and larvae is surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay. Eggs are most often observed from April through June and larvae are observed from May through July. EFH for juvenile and adult Yellowtail Flounder is bottom habitats with sandy or mixed sand and mud substrates on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay (NOAA, 2007). Yellowtail Flounder forage primarily for benthic macrofaunal and diets largely consist of amphipods, polychaetes, and crustaceans (Johnson et al., 1999).

Table 2-2 provides a summary of the annual presence of each life stage of the EFH species within the Project Area. Those species with commercial or recreational importance are indicated with an asterisk (*).

Table 2-2 Annual Presence of Each Life Stage of EFH Species in Project Area

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic Albacore Tuna (*Thunnus alalonga) **)						J	J	J A	J A	J A		
Atlantic Butterfish *(Peprilus triacanthus)**	J A	J A	E J A	E J A	E J A	E L J A	E L J A	E L J A	L J A	L J A	L J A	J A
Atlantic Cod *(Gadus morhua)**	E J A	E J A	E L J A	E L J A	E L J A	J A	J A	J A	E J A	E J A	E J A	E J A
Atlantic Mackerel *(Scomber scombrus)**	A	A	A	E L A	E L J A	E L J A	J A	J A	A	A	A	A
Atlantic Sea Herring *(Clupea harengus)**	E J L A	E J L A	E J L A	E J L A	A	A	A	E L J A	E L J A	E L J A	E L J A	E L J A
Atlantic Wolffish (*Anarhichas lupus*)[A]	All	All	All	All	All	All	All	All	All	All	All	All
Basking Shark (*Cetorhinus maximus*)				J A	J A	J A	J A	J A	J A	J A		
Black Sea Bass *(Centropristis striata) **				J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	L J A	J A
Blue Shark (*Prionace glauca)*					J A	J A	J A	J A	J A	J A		
Bluefin Tuna *(Thunnus thynnus) **							J A	J A	J A	J A	J A	
Bluefish *(Pomatomus saltatrix) **						J A	J A	J A	J A	J A		
Cobia *(Rachycentron canadum)*	R	R	R	R	R	R	R	R	R	R	R	R
Common Thresher Shark *(Alopias vulpinus)*[A]	All	All	All	All	All	All	All	All	All	All	All	All
Dusky Shark *(Carcharhinus obscurus)*						J A	J A	J A	J A			
Haddock *(Melanogrammus aeglefinus) **	L J A	L J A	E L J A	E L J A	E L J A	L J A	L J A	J A	J A	J A	J A	J A
King Mackerel *(Scomberomorus cavalla)*[A]	R	R	R	R	R	R	R	R	R	R	R	R
Little Skate *(Leucoraja erinacea) **	All	All	All	All	All	All	All	All	All	All	All	All
Longfin Inshore Squid *(Loligo pealeii) **	All	All	All	All	All	All	All	All	All	All	All	All
Monkfish *(Lophius americanus) **	J A	J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	J A	J A	J A
Northern Shortfin Squid *(Illex illecebrosu) **	All	All	All	All	All	All	All	All	All	All	All	All
Ocean Pout *(Macrozoarces americanus)*	E L J A	E L J A	L J A	L J A	L J A	J A	J A	J A	J A	J A	E L J A	E L J A
Ocean Quahog *(Artica islandica) **	All	All	All	All	All	All	All	All	All	All	All	All
Porbeagle Shark *(Lamna nasus)*[A]	All	All	All	All	All	All	All	All	All	All	All	All
Red Hake *(Urophycis chuss) **	J A	J A	J A	J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	L J A
Sand Tiger Shark (*Carcharias taurus*)					N J	N J	N J	N J	N J			
Sandbar Shark *(Carcharhinus plumbeus)*						J A	J A	J A	J A			
Scup *(Stenotomus chrysops) **					E L J A	E L J A	E L J A	E L J A	L J A	L J A		
Skipjack Tuna *(Katsuwonus pelami)*					J A	J A	J A	J A	J A	J A	J A	
Shortfin Mako Shark *(Isurus oxyrinchus)*[A]						J A	J A	J A	J A	J A		
Spanish Mackerel *(Scomberomorus maculatus)*[A]	R	R	R	R	R	R	R	R	R	R	R	R
Spiny Dogfish *(Squalus acanthias) **	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A

Table 2-2 Annual Presence of Each Life Stage of EFH Species in Project Area (Continued)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Summer Flounder *(Paralichthys dentatus)* *	E L J A	E L J A	E J A	E J A	E J A	J A	J A	J A	L J A	E L J A	E L J A	E L J A
Surf Clam *(Spisula solidissima)* *	All	All	All	All	All	All	All	All	All	All	All	All
White Shark *(Carcharodon carcharias)*[A]					J A	J A	J A	J A	J A	J A	J A	
Whiting *(Merluccius bilinearis)* *	All	All	All	All	All	All	All	All	All	All	All	All
Windowpane Flounder *(Scophthalmus aquosus)*	J A	J A	J A	J A	J A	J A	E L J A	E L J A	J A	J A	J A	J A
Winter Flounder *(Pseudopleuronectes americanus)* *	J A	E J A	E L J A	E L J A	E L J A	E L J A	L J A	J A	J A	J A	J A	J A
Witch Flounder *(Glyptocephalus cynoglossus)* *	L J A	L J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	E L J A	L J A	L J A
Yellowfin Tuna (*Thunnus albacares*) *						J A	J A	J A	J A			
Yellowtail Flounder *(Limanda ferruginea)* *	J A	J A	J A	E J A	E L J A	E L J A	L J A	J A	J A	J A	J A	J A

E - Eggs; L - Larvae, N - Neonate; J - Juvenile, A - Adult, All- All life stages potentially present throughout the year; R – Rare
[A] Indicates EFH designations are the same for all life stages or designations are not specified by life stage.
* Species of commercial or recreational importance.

3.0 Potential Impacts of the Project

The impact-producing factors for EFH are provided in Table 3-1 and will be discussed in more detail in this section.

Table 3-1 Impact- producing Factors on Essential Fish Habitat

Impact-producing Factors	Wind Development Area	Offshore Export Cable Corridor	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Pile driving for WTG and ESP Foundations	X		X		
Cable installation	X	X	X	X	X
Scour protection installation	X		X		
Increased vessel traffic	X	X	X	X	X
Increased noise	X	X	X	X	X
Water Withdrawals	X	X	X	X	X
Dredging		X	X	X	X

3.1 Construction and Installation

3.1.1 Direct Habitat Loss and Alteration

Wind Development Area and Offshore Export Cable Corridor

As shown in Table 6.5-5 in Section 6.5 of Volume III, approximately 0.22 square kilometers ("km^2") (53 acres) of EFH bottom habitat will be permanently altered by installation of Wind Turbine Generator ("WTG") and Electrical Service Platform ("ESP") foundations and scour protection, and approximately 0.26 km^2 (63 acres) will be altered through the placement of cable protection in the WDA. Installation of the inter-array and inter-link cables will result in the temporary disturbance of roughly 0.86 km^2 (211 acres) of bottom habitat, along with 0.27 km^2 (66 acres) of temporary disturbance due to impacts from jack-up vessel legs. The total area of alteration within the WDA due to foundation and scour protection installation, jack-up vessel use, inter-array and inter-link cable installation, and potential cable protection installation is 1.59 km^2 (393 acres), which is 0.5% of the entire WDA. Sediment dispersion modeling for inter-array cable installation (see Appendix III-A) indicated that deposition over 0.2 millimeter (mm) (0.008 inches [in]) was primarily constrained to within 200 m (656 ft) from the route centerline.

Cable installation along the OECC will result in the disturbance of approximately 0.47 km^2 (117 acres) of habitat; dredging in limited areas prior to cable installation will impact an additional 0.28 km^2 (69 acres). The installation of cable protection (rock or concrete mattresses, etc.) in areas where the cable did not achieve the target burial depth and is too shallow will impact 0.14 km^2 (35 acres) along the OECC.

EFH for demersal and benthic species in the WDA will be permanently altered from sandy, soft bottom habitats to hard, structured habitats near the turbines. Hard structure EFH habitat, such as gravel, along the OECC will also be permanently lost during cable installation as finer sediments are expected to resettle over coarse substrates. Groundfish species (including Winter, Yellowtail, and Windowpane Flounder, and Red Hake) and shellfish species (including Surf Clam and Ocean Quahog) prefer soft sand or mud habitats. Other demersal species, including Haddock, Atlantic Cod, Longfin Squid, Monkfish, and Ocean Pout, prefer hard, structured habitats. Impacts to groundfish EFH would be greatest in the WDA, while impacts to EFH for the other demersal species would be most severe in the OECC. The addition of the hard structure habitat may also provide additional habitat for demersal species that prefer these habitat types and would still act as EFH for these species.

Permanent habitat alteration from coarse to fine sediment along the OECC is expected when installing cables over coarse pebble-cobble substrates, as finer, sandy substrates may resettle over gravel once cable plowing or trenching is complete. Sediment dispersion modeling (see Appendix III-A) indicated that deposition over 0.2 mm (0.008 in) was primarily constrained to within 200 m (656 ft) from the route centerline. The integrity and function of hard bottom substrate in the 0.2 mm or less deposition area will likely not be lost.

Installation along the OECC requires additional pre-installation sediment removal to remove sand waves and achieve safe burial depths; as described in Appendix III-A, this will likely be accomplished with a trailing suction hopper dredge (TSHD) on its own or through a combination of a TSHD and a jetting technique. Although previous research suggests that sand waves provide important structured habitat for fish and invertebrates, their presence also indicates that these habitats are dynamic and change frequently. In areas along the OECC where sand wave dredging was simulated to have occurred, the deposition greater than 0.2 mm (0.008 in) associated with the TSHD drag arm is mainly constrained to within 150 m (492 ft) from the route centerline, whereas the deposition greater than 0.2 mm (0.008 in) associated with overflow and disposal extends to greater distances from the source, mainly within 1 km (0.62 mi) though such deposition can extend up to 5 km (3.1 mi) in isolated patches when subject to swift currents through Muskeget Channel.

3.1.2 Suspended Sediments and Water Withdrawals

Wind Development Area and Offshore Export Cable Corridor

The two greatest impacts to EFH within the water column are increased suspended sediments and water withdrawals. Increased suspended sediments during construction and installation in the WDA and OECC will temporarily impact water column EFH. As mentioned in Section 6.6.2 Finfish and Invertebrates, increases suspended sediment impairs the visual abilities of fish and may result in increased susceptibility to predation and decreased foraging abilities. Sublethal and lethal concentrations of suspended sediment differ by species and life stage. Previous research indicates that reductions in growth and mortality of the most sensitive organisms can occur when concentrations above 100 milligrams per liter ("mg/L") persist for over 24 hours (Wilber & Clarke, 2001). Modeling of sediment and transport potential in the WDA (see Appendix III-A) indicates that under typical cable installation methods, maximum suspended sediment concentrations between 200-300 mg/L occur in <0.02 km^2 (5 acres) for at least 60 minutes. After two hours, concentrations of suspended sediments drop below 50 mg/L. Concentrations of suspended sediments with lower concentrations (10 mg/L) would extend up to 3.1 km (1.2 mi) from the cable trench centerline and are suspended in any given location for less than six hours. Concentrations of suspended sediments are in the lower water column (i.e. bottom three meters [9.8 ft]).

Sediment dispersion modeling of sand wave removal via TSHD along the OECC indicated that concentrations of suspended sediments above 10 mg/L extended up to 16 km (10 mi) from the cable trench centerline. Most of the sediment settles out in less than three hours; however, suspended sediments at this concentration can persist for six–twelve hours in smaller areas (0.06 km^2 [15 acres]). In addition, high concentrations (>1000 mg/L) occurred at distances up to 5 km (3.1 mi) from the dredge site for short periods of time (less than two hours) due to the TSHD overflow and hopper dumping of sediments. After removing sand waves, a jet plow, mechanical plow, or one of the other techniques listed in Section 4.2.3.3 of Volume I will be used to install cables. The plume from jet plow installation as delineated by excess suspended sediment concentrations greater than 10 mg/L typically extended less than 200 m (656 ft) from the route centerline, though did extend up to 2 km (1.2 mi) in some places. Further, the excess concentrations were confined to the lower portion of the water column, and resettled rapidly (within four-six hours) due to the high proportion of coarse sand throughout the route (see Appendix III-A).

Mortality of EFH species with pelagic or planktonic early life stages would occur during water withdrawal, potentially from the cable laying vessel (i.e., jet plow or jetting). Assuming that 90% of the offshore cable system is installed at a rate of 200 m/hr (656 ft/hr), 10% of the cable system is installed at a rate of 300 m/hr (984 ft/hr), and a jet plow uses 11,300 – 30,300 liters per minute (3000 – 8000 gallons per minute) of water, water withdrawal volumes are expected to be approximately 1,700 – 4,540 million liters (450 – 1,200 million gallons). Entrainment of early pelagic life stages via water withdrawals would result in 100% mortality because of the stresses associated with being flushed through the pump system and temperature changes (USDOE MMS, 2009).

3.1.3 Increased Noise

Wind Development Area

As mentioned in Section 6.6 Finfish and Invertebrates, noise generated from pile driving could impact EFH species in the WDA during construction. All fish have hearing structures that allow them to detect sound particle motion. Some fish also have swim bladders near or connected to the ear that allows them to detect sound pressure as well, which increases hearing sensitivity and broadens hearing abilities (reviewed in Popper et al., 2014). In general, increased sound sensitivity and the presence of a swim bladder makes a fish more susceptible to injury from pile driving as the loud impulsive noises can cause swim bladders to vibrate with enough force to inflict damage to tissues and organs around the bladder (Halvorsen et al., 2011; Casper et al., 2012). The least sound-sensitive fish species include those that do not have a swim bladder, including flatfish like Winter Flounder and elasmobranchs. Fish, such as Yellowfin Tuna, with swim bladders not connected or near inner-ear structures also primarily detect noise through particle motion, and are therefore less sensitive to noise. The most sensitive species are those with swim bladders connected or close to the inner ear, such as Atlantic Herring and Cod, and can acquire both recoverable and mortal injuries at lower noise levels than other species (Thomsen et al., 2006; Popper et al., 2014).

Vineyard Wind conducted acoustic modeling (see Appendix III-M of the COP and associated appendix) to estimate the noise propagation of pile driving with a target of approximately 12dB of noise reduction in relation to thresholds of mortality and recoverable injury for fish with different hearing structures (based on thresholds in Popper et al., 2014). Modeling results indicated that cumulative sound levels causing mortality or injury to fish without swim bladders, such as Winter Flounder, could extend up to 71 m (233 ft) from the source. Cumulative sound levels causing recoverable injury in fish without swim bladders could extend 71-79 m (233-259 ft). For fish, such as Yellowfin Tuna, with swim bladders not involved in hearing, cumulative sound levels that potentially cause mortality could extend 127-182 m (417-597 ft) from the source. Fish, such as Atlantic Cod, with swim bladders involved in hearing could be impacted by pile driving noises at the farthest distances from the source, with mortal impacts potentially occurring at 200-351 m (656-1,152 ft) from the source. Recoverable injury for all fish with swim bladders could occur between 451-691 m (1,480-2,267 ft) from the source. Eggs and larvae are similarly sensitive to impulse noises and have the same thresholds for mortality or injury as fish with swim bladders not involved in hearing (Popper et al., 2014).

3.1.4 Avoidance, Minimization, and Mitigation Measures

The Project Area is located in the MA WEA, designated by BOEM, and this area is less sensitive to important fish and invertebrate habitat and therefore reduces impacts. Overall, mitigation measures would be the same as discussed in Section 6.6.2 of Volume III and include:

- Avoiding important habitats such as eelgrass and hard bottom sediments where feasible.
- Using impact-minimizing technologies where practicable, such as horizontal directional drilling ("HDD") in nearshore areas, if sensitive resources are present.
- Implementing a soft start procedure to pile driving, which will reduce impacts to fish by allowing fish to move out of the activity area.
- Use of sound reduction technologies.

- The WTGs will also be widely spaced, leaving a huge portion of the WDA undisturbed by WTG and ESP installation.

- Conducting pre- and post-construction fisheries monitoring as described in Section 6.6.

3.1.5 Summary

The impacts of construction and installation to EFH habitat in the Project Area include habitat alteration of soft and flat to hard structured habitat around WTG and ESPs, deposition of fine sediments over hard bottom habitats, and water withdrawals from construction vessels. In addition, noise from pile driving could impact all EFH species in the WDA during construction.

Overall impacts to EFH in the Project Area are anticipated to be short-term and localized. The use of a soft start during pile driving will give fish in the WDA sufficient time to move away from the noise source before full impact strikes are made. Sound reduction technologies will also be used to minimize impacts. Temporary impacts to EFH habitat would occur during all construction activities in the WDA and OECC. The resettling of sediments is expected to fill in cable trenches but may also bury or smother immobile benthic life stages or invertebrates. All habitat within the Project Area is expected to remain the same, apart from the approximately 0.22 km^2 (53 acres) that would be converted into hard substrate from foundations and scour protection, the 0.40 km^2 (99 acres) where cable protection would be installed in the WDA and along the OECC, and the portion of hard bottom habitat that would be covered along the OECC.

Recovery of disturbed habitats is expected and previous research indicates that communities begin to repopulate within a few months of disturbance (Dernie et al., 2003; Van Dalfsen & Essink, 2001). Alteration of sand wave habitat will likely be temporary and will have little impact on fish in the area, as they may be conditioned to a changing environment. In addition, as explained in Section 6.6.2 Finfish and Invertebrate Resources, most mobile pelagic and demersal fish will be able to avoid areas where habitat disturbance will occur and mortality of these fish will be minimal. Sessile benthic organisms, such as Surf Clams, and demersal egg or larval life stages will be unable to avoid construction and are likely to be buried by associated habitat disturbance. No population level impacts are expected for any of the species with EFH in the area as the Project Area is only a very small portion of habitat in the region.

3.2 Operations and Maintenance

3.2.1 Habitat Loss and Alteration

Wind Development Area

The addition of structured habitat in the WDA would increase EFH for species that prefer rocky substrate and minimally decrease EFH for species that prefer sandy bottoms. Previous research on fish habitat utilization after wind farm installation observed that turbine structures were large enough to attract and support new communities of rocky habitat fishes, but not large enough to negatively impact fish communities that prefer sandy bottom areas between the turbines (Stenberg et al., 2015).

Offshore Export Cable Corridor

Recovery of the habitat along the OECC is expected; therefore, additional habitat alteration would only occur during rare cable maintenance events. Procedures employed to repair segments of the OECC are expected to be similar to cable installation activities. Impacts to EFH would be similar to that explained above, and expected to include temporary destruction of benthic and pelagic habitat, displacement of mobile juvenile and adult fish and invertebrates, and injury or mortality to immobile or slower life stages or species.

3.2.2 Increased Noise

Wind Development Area and Offshore Export Cable Corridor

Operation of the WTG and increased vessel traffic in the Project Area will increase underwater noise levels. Avoidance of areas around the WTG may occur, but is not expected to significantly impact EFH as the WDA is only a small portion of available habitat in the area.

3.2.3 Electromagnetic Fields

Wind Development Area and Offshore Export Cable Corridor

Recent research investigating habitat use around energized cables found no evidence that fish or invertebrates were attracted to or repelled by electromagnetic fields ("EMF") emitted by cables (Love et al., 2017). Cables will be buried at an approximate depth of two meters (6 ft) and EMF would be weak and only detected by benthic and demersal organisms. For more information refer to Section 6.6, Finish and Benthic Resources, in Volume III of the COP.

3.2.4 Avoidance, Minimization, and Mitigation Measures

The mitigation measures and impact would be the same as discussed previously for construction and installation.

3.3 Decommissioning

3.3.1 Overall Impacts

Wind Development Area and Offshore Export Cable Corridor

Decommissioning activities would include removal of WTG and ESP pile foundations and cables within the WDA and OECC. These activities would be similar to those associated with construction. Removal of the piles from the WDA would shift habitat type back to pre-construction conditions and likely result in a reversion of local finfish and invertebrate species assemblages to non-structure communities. Cable removal will result in direct disturbance of EFH along the path of the cables and will resuspend bottom sediments and impact organisms temporarily.

3.3.2 Avoidance, Minimization, and Mitigation Measures

The mitigation measures would be the same as discussed previously for construction and installation.

4.0 References

Atlantic Bluefin Tuna Status Review Team. (2011). Status Review Report of Atlantic Bluefin Tuna *Thunnus thynnus*. Report to National Marine Fisheries Service, Northeast Regional Office. March 22, 2011. 104 pp.

Brodziak, J. K. T. (2005). Essential fish habitat source document: Haddock, *Melanogrammus aeglefinus*, life history and habitat characteristics. 2nd edition. NOAA Tech Memo NMFS NE,196, 64 pp.

Cargnelli, L. M., Griesbach, S. J., Packer, D. B., & Weissberger, E. (1999a). Essential fish habitat source document: ocean quahog, *A. islandica*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE, 148, 20 pp.

Cargnelli, L. M., Griesbach, S. J., Packer, D. B., Berrien, P. L., Morse, W. W., & Johnson, D. L. (1999b). Essential fish habitat source document: Witch flounder *Glyptocephalus cynoglossus* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 139, 29 pp.

Casper, B. M., Popper, A. N., Matthews, F., Carlson, T. J. & Halvorsen, M. B. (2012). Recovery of barotrauma injuries in Chinook salmon, Oncorhynchus tshawytscha from exposure to pile driving sound. PLoS ONE 7, e39593. (doi:10.1371/journal.pone.0039593).

Chang, S., Berrien, P. L., Johnson, D. L., & Morse, W. W. (1999). Essential fish habitat source document: Windowpane *Scophthalmus aquosus* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 137, 32 pp.

Cortés, E., Brooks, E., Apostolaki, P., & Brown, C. A. (2006). Stock assessment of dusky shark in the US Atlantic and Gulf of Mexico. Panama City Laboratory Contribution, 6(05).

Cross, J. N. & Fahay, M. P. (1999). Essential fish habitat source document. Butterfish *Peprilus triacanthus* life history and habitat characteristics. DIANE Publishing.

Dernie, K. M., Kaiser, M. J., & Warwick, R. M. (2003). Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*, 72 (6), 1043-1056.

Drohan, A. F., Manderson, J. P., Packer, D. B. (2007). Essential fish habitat source document: Black sea bass *Centropristis striata* life history and habitat characteristics, 2nd edition. NOAA Tech Memo NMFS NE, 200, 68 pp.

Estrada, J. A., Rice, A. N., Natanson, L. J., & Skomal, G. B. (2006). The use of isotopic analysis of vertebrae in reconstructing ontogenetic feeding ecology in white sharks. *Ecology*, 87, 829-834.

Halvorsen, M. B., Casper, B. C., Matthews, F., Carlson, T. J., Popper, A.N. (2012). Effects of exposure to pile driving sounds on the lake sturgeon, *Nile tilapia*, and hogchoker. Proceedings of the Royal Society of London 279:4705–4714.

Hendrickson, L. C. 2017. Longfin Inshore Squid (*Doryteuthis (Amerigo) pealeii*) Stock Assessment Update for 2017. NMFS. 11 pp.

Jacobson, L. D. (2005). Essential fish habitat source document: Longfin inshore squid *Loligo pealeii* life history and habitat characteristics (2nd edition). NOAA Tech Memo NMFS NE 193; 42 pp.

Johnson, D. L., Morse, W. W., Berrien, P. L., Vitaliano, J. J. (1999). Essential fish habitat source document: Yellowtail flounder *Limanda ferruginea* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 140, 29 pp.

Kober, J. H., Messina, F.D., and Dean, D. (2002). Advances in Jet-Assisted Plowing. Retrieved from www.marcon.com/marcon2c.cfm?SectionListsID=85&PageID=237

Lent, R. (1999). Final fishery management plan for Atlantic tunas, swordfish and sharks, Vol. 2. U.S. Department of Commercial Fisheries, NOAA, NMFS, Washington, D.C., 302 pp.

Lindholm, J. B., Auster, P. J., Ruth, M., & Kaufman, L. (2001). Modeling the effects of fishing and implications for the design of marine protected areas: juvenile fish responses to variations in seafloor habitat. *Conservation Biology*, 15(2), pp. 424-437.

Lock, M. C., & Packer, D. B. (2004). Essential fish habitat source document: Silver hake *Merluccius bilinearis* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 135, 42 pp.

Lough, R. G. (2004). Essential fish habitat source document: Atlantic cod *Gadus morhua* life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE, 190, pp. 1-94.

Love, M. S., Nishimoto, M. M., Clark, S., McCrea, M., & Bull, A. S. (2017). The Organisms Living Around Energized Submarine Power Cables, Pipe, and Natural Sea Floor in the Inshore Waters of Southern California. Bulletin, Southern California Academy of Sciences, 116(2), pp. 61-87.

MADMF (Massachusetts Division of Marine Fisheries). (2017). Monkfish. Retrieved from http://www.mass.gov/eea/agencies/dfg/dmf/recreational-fishing/monkfish.html

MAFMC and NOAA (Mid Atlantic Fishery Management Council and National Oceanic and Atmospheric Administration). (2011). Amendment 11 to the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. Retrieved from http://static.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/518968c5e4b0884a65fe5067/1367959749407/Amendment%2011%20FEIS%20-%20FINAL_2011_05_12.pdf#page=236

Nakano, H. & Stevens, J. D. (2008). The biology and ecology of the Blue Shark *Prionace glauca*. Sharks of the open ocean: Biology, fisheries and conservation, pp. 140-151.

NEFMC (New England Fishery Management Council). (2017). Omnibus Essential Fish Habitat Amendment 2: Volume II EFH and HAPC Designation Alternatives and Environmental Impacts.

NEFSC. (n.d.) NOAA Northeast fisheries Science Center, Ecosystem Surveys Branch. Data requested February 2, 2017. "Multispecies Bottom Trawl Survey." http://www.nefsc.noaa.gov/esb/mainpage/

NMFS (National Marine Fisheries Service). (2006). Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document, pp. 1600.

NMFS. (2009a). Amendment 1 to the Final consolidated Atlantic Highly Migratory Species Fishery Management Plan. Silver Spring, Maryland: National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division.

NMFS. (2009b). Species of Concern; Atlantic Wolffish. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticwolffish_detailed.pdf

NMFS. (2010a). Species of Concern; Basking Shark. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/species/baskingshark_highlights.pdf

NMFS. (2010b). Species of Concern; Sand Tiger Shark. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/species/sandtigershark_detailed.pdf

NMFS. (2011a). Species of Concern; Bluefin Tuna. Retrieved from http://www.fisheries.noaa.gov/pr/pdfs/species/bluefintuna_highlights.pdf

NMFS. (2011b). Species of Concern; Dusky Shark. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/species/duskyshark_detailed.pdf

NMFS. (2013). Species of Concern; Porbeagle Shark. Retrieved from: http://www.nmfs.noaa.gov/pr/pdfs/species/porbeagleshark_detailed.pdf

NMFS. (2017). Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat. Silver Spring, Maryland: National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division.

NOAA. (2007). Guide to Essential Fish Habitat Designations in the Northeastern United States. Retrieved from https://www.greateratlantic.fisheries.noaa.gov/hcd/index2a.htm

NOAA. (2014). Essential Fish Habitat for Coastal Migratory Pelagics. Retrieved fromhttp://www.greateratlantic.fisheries.noaa.gov/hcd/mackcobia.htm

NOAA. (2016). Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat. Retrieved fromhttp://www.nmfs.noaa.gov/sfa/hms/documents/fmp/am10/draft_maps/hms_efh_ amendment _10_draft_ea_0648_xd990_final_090716.pdf

Packer, D. B., Griesbach, S. J., Berrien, P. L., Zetlin, C. A., Johnson, D. L., & Morse, W. W. (1999). Essential fish habitat source document: Summer flounder *Paralichthys dentatus* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 151, 88 pp.

Pereira J. J., Goldberg, R., Ziskowski, J. J., Berrien, P. L., Morse, W. W., & Johnson, D. L. (1999). Essential fish habitat source document: Winter flounder *Pseudopleuronectes americanus* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 138, 39 pp.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, … & Tavolga, W. N. (2014). Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI – Accredited Standards Committee S3/SC1 and registered with ANSI. ASA Press/Springer, Cham. 88 pp.

Reid, R. N., Cargnelli, L. M., Griesbach, S. J., Packer, D. B., Johnson, D. L., Zetlin, C. A., Morse, W. W., & Berrien, P. L. (1999). Essential fish habitat source document: Atlantic herring *Clupea harengus* life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE, 126, pp.48.

Scharf, F. S., Manderson, J. P., & Fabrizio, M. C. (2006). The effects of seafloor habitat complexity on survival of juvenile fishes: species-specific interactions with structural refuge. *Journal of Experimental Marine Biology and Ecology*, 335(2), pp.167-176.

Siemann, L. & Smolowitz, R. (2017). Southern New England Juvenile Fish Habitat Research Paper. OCS Study BOEM 2017-028. Retrieved from https://www.boem.gov/ESPIS/5/5592.pdf.

Sims, D. W., Southall, E. J., Richardson, A. J., Reid, P. C., & Metcalfe, J. D. (2003). Seasonal movements and behavior of basking sharks from archival tagging: no evidence of winter hibernation. Marine Ecology Progress Series, 248, 187–196.

Shepherd G. R., & Packer, D. B. (2005). Essential fish habitat source document: Bluefish *Pomatomus saltatrix* life history and habitat characteristics (2nd Edition). NOAA Tech Memo NMFS NE, 198, 89 pp.

Stenberg, C., Støttrup, J., Deurs, M. V., Berg, C. W., Dinesen, G. E., Mosegaard, H., Grome, T., & Leonhard, S. B. (2015). Long-term effects of an offshore wind farm in the North Sea on fish communities. Marine Ecology Progress Series, 528, pp. 257-265.

Steimle, F.W., Morse, W. W., Berrien, P. L., & Johson, D. L. (1999). Essential fish habitat source document: Red Hake *Urophycis chuss* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 133, 34 p.

Steimle, F.W., Morse, W. W., Berrien, P. L., Johson, D. L., & Zetlin, C. A. (1999). Essential fish habitat source document: Ocean pout *Macrozoarces americanus* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 129, 26 pp.

Steimle, F.W., Morse, W. W., Berrien, P. L., Johson, D. L., & Chang, S. (1999). Essential fish habitat source document: Scup *Stenotomus chrysops* life history and habitat characteristics. NOAA Tech Memo NMFS NE, 149, 39 pp.

Studholme, A. L., Packer, D. B., Berrien, P. L., Johnson, D. L., Zetlin, C. A., & Morse, W.W. (1999). Essential fish habitat source document: Atlantic mackerel *Scomber scombrus* life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE, 141, p.35.

Thomsen, F., Lüdemann, K., Kafemann, R., and Piper, W. (2006). Effects of Offshore Wind Farm Noise on Marine Mammals and Fish. Biola, Hamburg, Germany, on behalf of COWRIE Ltd., Newbury, UK, 62 pp.

USDOE MMS (US Department of Energy Minerals Management Service). (2009). Final Environmental Impact Statement for the Proposed Cape Wind Energy Project, Nantucket Sound, Massachusetts (Adopted), DOE/EIS-0470.

Van Dalfsen, J. A., & Essink, K. (2001). Benthic community response to sand dredging and shoreface nourishment in Dutch coastal waters. *Senckenbergiana marit*, 31(2), 329-32.