# Coastal Virginia Offshore Wind Project (CVOW)

## Essential Fish Habitat Assessment

**Environment Branch for Renewable Energy**

**February 2019**

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# Introduction

## Background

The Commonwealth of Virginia, Department of Mines Minerals and Energy (DMME) submitted a research lease application to the Bureau of Ocean Energy Management (BOEM) on February 8, 2013 for the installation and operation of two 6-MW turbines, metocean monitoring equipment, and associated cabling to shore offshore of Virginia Beach, Virginia. On July 30, 2013, BOEM published a "Public Notice of an Unsolicited Request for an Outer Continental Shelf (OCS) Research Lease, Request for Competitive Interest, and Request for Public Comment" (78 FR 45965) for a 30-day comment period to obtain public input on the research proposal received from DMME, its potential environmental consequences, and the use of the area in which the proposed project would be located. The notice and comments received are published (*Federal Register*) under Docket No. BOEM-2013-0020. In December 2013, BOEM published a Determination of No Competitive Interest. These notices and DMME's application can be found at http://www.boem.gov/Research-Nomination-Outside-and-to-the-West-of-the-WEADOE/.

In December 2013, under its research lease application, DMME submitted a research activities plan (RAP, 2014) for the Virginia Offshore Wind Technology Advancement Project (VOWTAP). The Virginia Electric and Power Company, a wholly owned subsidiary of Dominion Resources, Inc. (Dominion) would be the owner and operator of VOWTAP and would work under the terms of an operator agreement with DMME and the terms of the research lease. At the time, the Department of Energy (DOE) proposed to provide funding to Dominion to support the development of VOWTAP, however, that is no longer proposed. The RAP detailed the construction, operation and eventual decommission of the two turbines and cabling to shore, and biological and physical survey information consistent with a construction and operations plan (COP) (30 CFR § 585.620, § 585.638). DMME's RAP must be approved or approved with modifications by BOEM before DMME can construct the research facility (30 CFR § 585.628).

On March 14, 2014, BOEM published the Notice of Intent (NOI) (79 FR 14534) to prepare an Environmental Assessment (EA) to consider the reasonably foreseeable environmental consequences associated with the approval of DMME's wind energy-related research activities offshore Virginia. BOEM requested public input regarding important environment issues and the identification of reasonable alternatives that should be considered in the EA. BOEM held a public scoping meeting on April 3, 2014 in Virginia Beach, Virginia to solicit comments on the scope of the VOTAP EA. The notice and comments received are published under Docket ID BOEM-2014-0009 (79 FR 14534). BOEM announced the publication of the VOWTAP EA on December 1, 2014 and extended the public comment period to January 16, 2015.

The essential fish habitat (EFH) assessment was incorporated within the VOWTAP EA sent to National Marine Fisheries Service (NMFS) on December 15, 2014. In a letter received by BOEM on January 10, 2015, NMFS requested additional information to more fully evaluate the proposed project for impacts to EFH.

On May 21, and October 31, 2018 DMME submitted a revised RAP. Since the original RAP was approved, DMME retained Ørsted as the Engineering, Procurement and Construction (EPC) contractor for the Project, now re-named the Coastal Virginia Offshore Wind (CVOW) project. Due to advances in technology since the Project's approval in March 2016, several modifications to the RAP were required to support the Project's current requirements for construction and operation. For the purposes of potential impacts to EFH the biggest change is from the Keystone Inward Battered Guide Structure (IBGS) foundation to an 8 m monopile foundation with scour protection (rock) extending approximately 12 m from the base. The change of foundation type and the addition of scour protection results in an overall increase of 0.56 ac (0.2 ha) to the operational footprint of the WTGs, and a reduction of 90.1 ac (36.47 ha) in the size of the temporary work area. In addition, the installation duration decreases from 20 days to between 2 to 4 days and pile driving duration has decreased from a total of 14 days to a total of 2 to 4 hours.

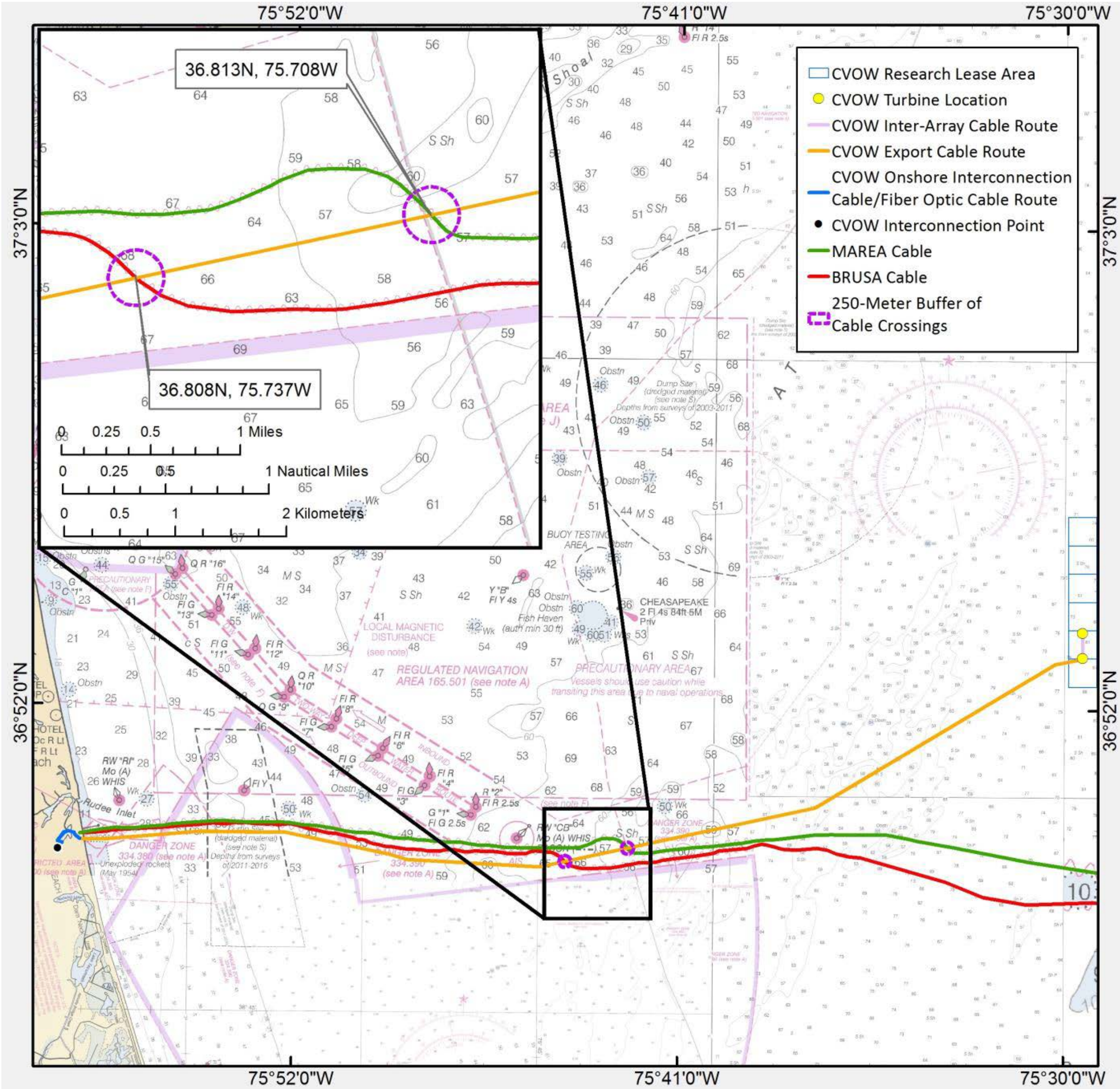
Cable protection will be necessary at the offshore HDD punch-out, and at a minimum of two cable crossings up to five. The cable protection will be comprised of pre-fabricated concrete mattresses installed for a distance of approximately 66 ft. (20 m) and width of approximately 49 ft. (15 m). In addition, cable protection may also be required along sections of the Export Cable Route where the target depth of burial may not have been achieved during installation. The crossing design will comprise placement of a “separation layer” of either rock placement or mattresses on which the Export Cable will be installed. A “protection layer”, also consisting of rock placement or mattresses, will then be installed over the Export Cable. Thus the range area disturbed and changed resulting from cable protection measures is expected to be between 900 $m^2$ (0.22 ac) to 1,500 $m^2$ (0.37 ac).

**Revised Table 3.2-3. Foundation and WTG Construction and Operation Footprint**

| Foundation and WTG [a/] | IBGS Foundation | | MP/TP Foundation | | Change | |
|---|---|---|---|---|---|---|
| | Construction | Operation | Construction | Operation | Construction | Operation |
| Foundation [b/] | 0.2 ac / 0.1 ha | 0.2 ac / 0.1 ha | 0.76 ac / 0.30 ha | 0.76 ac / 0.30 ha | Increase of 0.56 ac / 0.2 ha | Increase of 0.56 ac / 0.2 ha |
| Heavy Lift Vessel [c/] | 0.8 ac / 0.3 ha | 0 | No Change | No Change | N/A | N/A |
| High Lift jack up Vessel [d/] | 0.001 ac / 0.0004 ha | 0 | 0.08 ac / 0.03 ha | No Change | Increase of 0.079 ac / 0.0296 ha | N/A |
| WTG Temporary Work Area [e/] | 190 ac / 76.9 h | 0 | 100.0 ac / 40.5 ha | No Change | Decrease of 90 ac / 36.4 ha | N/A |
| **Foundation and WTG Total** | **191 ac / 77.3 ha** | **0.2 ac / 0.1 ha** | **101.64 ac / 41.13 ha** | **0.76 ac / 0.30 ha** | **Decrease of 89.4 ac / 36.18 ha** | **Increase of 0.56 ac / 0.2 ha** |

[a/] Notes are in reference to impacts approved in the RAP.
[b/] MP/TP foundation area immediately under foundation is based on the area of the monopile diameter at the diameter seabed 25.6 ft (7.8 m) and scour protection installed in a 72 ft (22 m) radius on the seafloor around the base of the foundation. Includes two foundation structures of 0.01 ac (0.005 ha)
[c/] Assumes a single set of an 8-point anchored vessel per WTG. Impact area includes anchors (0.006 ac [ 0.002 ha] per anchor) and anchor chain sweep (.09 ac [0.04 ha]) based on approximate 200 ft (61 m) of anchor chain resting on the bottom and a maximum of 20 ft (6.1 m) of lateral drag per chain.
[d/] Assume 1 jack up vessels per WTG position (approximately 0.02 ac [0.001 ha]). Impacts will all occur within the 50 ac (20 ha) WTG Temporary Work Area at each foundation location.
[e/] Includes the two WTG Work Areas (based on a radius of 250 m during construction work) of 50 ac (20 ha) each All ground disturbing activities will occur within the 50 ac WTG temporary Work Area. A 100 ac (500 m radius) safety area around the turbines will be put in place during construction and maintenance activities to ensure that no vessels enter the area. However, the safety area has not been included in the temporary impacts because there will be no ground disturbing activity outside of the 50 ac WTG Work Areas.

**Figure A: Revised CVOW Cable Route**




## Objective of the Essential Fish Habitat Assessment

BOEM developed this EFH assessment in order to meet the requirements of the Magnuson-Stevens Fishery Conservation and Management Act and the Fish and Wildlife Conservation Act. Insofar as a project involves EFH, as this project does, this process is guided by the requirements of NMFS regulation at 50 CFR 600.95, which mandates the preparation of EFH assessments. This assessment considers the reasonably foreseeable environmental consequences associated with construction, operation, maintenance, and decommissioning of the proposed project to EFH. This assessment contains a description of the proposed action and affected environment and an analysis of the effects of noise, electromagnetic fields (EMF), habitat disturbance and discharges on EFH, managed species and their prey species, as well as BOEM's determinations regarding the effects of the proposed action on EFH.

## Description of the Proposed Action

The proposed action includes the construction, operation, maintenance, and eventual decommissioning of two wind turbine generators (WTGs) in the southern three aliquots of the proposed research lease area (aliquots D, H, L of OCS block 6111) offshore Virginia, of an export cable to shore (approximately 24 nautical miles [44.5 km]), and of a cable from landfall to interconnection point (0.68 nautical miles [1.3 km]). Offshore construction activities of the Project would occur from Mayto July of 2020 (see Revised Table 3.4-1 below). The project would begin operations in September 2020 and continue until the end of the 30-year research term,. At the end of CVOW's operational phase, the lessee would be required to decommission the project. Decommissioning is expected to take approximately 3 months (RAP, 2014; Section 3.4) in its entirety in accordance with a detailed project decommissioning plan that would be developed and submitted to BOEM in compliance with applicable laws (see 30 CFR Part 585.905), regulations, and best management practices following lease termination.

**Revised Table 3.4-1. Projected Project Construction Schedule**

| Activity | Approved in RAP | | Updated Schedule | | Change | |
|---|---|---|---|---|---|---|
| | Anticipated Timeframe [a/] | Duration [b/] (Weeks) | Anticipated Timeframe [a/] | Duration [b/] (Weeks) | Anticipated Timeframe | Duration (weeks) |
| Interconnection Station Installation (including foundation work) [c/] | April through June | 8 | July through November 2020 | 14 | Shift up 2 months | Increase of 6[j/] |
| Onshore Interconnection Cable and Switch Cabinet installation [d/] | February through April | 8 | May 2019 through February 2020 [h/] | 40 | Shift up 3 months | Increase of 32 [g/] |
| Export Cable Landfall Construction (including Offshore HDD installation of cable conduit) [e/] | March through April | 11 | March through April 2020 No Change [i/] | 11 No Change | N/A | N/A |
| Export Cable Landfall Construction (Export Cable pull through and connection to Switch Cabinet) | N/A | N/A | May 2020 | 1 | N/A | N/A |
| Foundation installation and pile driving [f/] | May | 3 | May 2020 No Change | 2 | N/A | Decrease of 1 |
| Export Cable Installation | May through June | 4 | May to June 2020 No Change | 3 | N/A | Decrease of 1 |
| Inter-Array Cable Installation | June | 2 | June 2020 No Change | 1 | N/A | Decrease of 1 |
| WTG installation | June through July | 3 i/ | May through June 2020 | 2 | Shift down 1 month – Shift down 1 month | Decrease of 1 |

| Activity | Approved in RAP | | Updated Schedule | | Change | |
|---|---|---|---|---|---|---|
| | Anticipated Timeframe a/ | Duration b/ (Weeks) | Anticipated Timeframe a/ | Duration b/ (Weeks) | Anticipated Timeframe | Duration (weeks) |
| Commissioning | August through September | 5 | May through July 2020 | 5f/ | Shift down 3 months – Shift down 2 month | No Change |

a/ Schedule does not account for weather delays.
b/ Onshore construction activities assume a 5-day work week, offshore construction activities assume a 7-day work week.
c/ Includes site preparation, equipment installation, and commissioning.
d/ Includes site preparation of onshore HDD Work Area, HDD of the Onshore Interconnection Cable and Fiber Optic Cable (including the HDD under Lake Christine), and Switch Cabinet installation.
e/ Includes HDD and offshore conduit installation, assumes 4 weeks for drilling and reaming.
f/ Includes 4 hours of pile driving.
g/ Increase in duration is based on contractor responses to the onshore RFP.
h/ Work to be performed from May 2019 through February 2020.
i/ Work to be performed in 2019.

CVOW would include two 6 MW (154 m diameter rotor) WTGs, located within the Project Area approximately 24 nautical miles (44.5 km) off the coast of Virginia, in OCS lease blocks 6111, aliquot H. Each of the WTGs would be installed atop an 8m monopile foundation. The WTGs would be arranged in a north-south configuration spaced approximately 3,445 ft (1,050 m) apart, and would be connected by means of a 34.5-kV AC submarine inter-array cable. Water depths of the WTG installation locations are approximately 81 ft (24.7 m) at the northern WTG, and 83.3 ft (25.4 m) at the southern WTG. The inter-array cable would connect the two WTGs for the total length of approximately 0.62 nautical miles (1.3 km). A separately bundled 34.5-kV AC submarine transmission and communications cable (export cable) would connect the WTGs to the existing onshore electrical grid in Virginia Beach, Virginia. The export cable would originate at the southern WTG and travel approximately 24 nautical miles (44.5 km) to a proposed switch cabinet at a landfall site located at Camp Pendleton (RAP, 2014; Section 3.1).

## Potential Impact-Producing Factors

The Project has the potential to produce the following types of impacts to EFH and associated fish species:

1. Direct mortality or injury to fish species;

2. Disturbance or displacement of habitat for fish resources;

3. Direct or indirect effects on fish species through potential changes in water quality;

4. Disturbance or injury of fish species through Project-related noise;

5. Indirect effects on fish species through changes in prey availability; and

6. Direct or indirect effects on fish species through Project-related EMFs.

# Description of the Affected Environment and Impacts to EFH and Associated Fish Species

The mid-Atlantic continental shelf has very diverse and abundant fishery resources due, in part, to its overlapping species ranges from New England and the south Atlantic. Many of the fish species found in the Project Area are of importance due to their value as commercial and/or recreational fisheries. However, some of the species are of special concern due to their depleted population status. All of the species present play a role in the ecosystem of the Middle Atlantic Bight as predator, prey, or in some other ecosystem function**.** The affected environment for the purpose of this assessment is those habitats at the offshore turbine sites and along the cable corridor that have been designated as EFH and the fish and invertebrates for which these habitats were designated.

Below is a detailed description of fish species and associated EFH offshore Virginia, including ESA-listed species and species of concern. The following resource and potential impacts descriptions are incorporated from the Atlantic OCS G&G FPEIS (BOEM, 2014a), the VOWTAP EA (BOEM, 2014b) and from the RAP (2014) and includes any relevant new information for the Project Area that has become available since those documents were prepared.

A detailed description of benthic resources offshore Virginia can be found in Chapter 4.1.2.2.1 of the Mid Atlantic EA (BOEM, 2012a) and Chapter 4.2.1 of the Atlantic G&G FPEIS (BOEM, 2014a). The following information is a summary of the resource description incorporated from these environmental documents, and relevant new information for the Proposed Action area that has become available since those documents were prepared, including information from the RAP (2014) and Revised RAP (2018). Discussion of impacts to fish and essential fish habitat are discussed in Section 3.3.2 of the RAP (2014).

The project area is located in the mid-Atlantic Bight (MAB) of the Northeast Continental Shelf Large Marine Ecosystem. The following MAB characterization and Table 4.2 are adapted from Johnson, 2004. The MAB includes the shelf and slope waters from Georges Bank south to Cape Hatteras and east to the Gulf Stream. Like the rest of the continental shelf, the topography of the MAB was shaped largely by sea level fluctuations caused by past ice ages. The shelf's basic morphology and sediments derive from the retreat of the last ice sheet and the subsequent rise in sea level. Since that time, currents and waves have modified these basic structures.

**Physical Features**

The shelf declines gently from shore out to between 100- and 200-km offshore where it transforms to the slope (100- to 200-m water depth) at the shelf break. In the mid-Atlantic, numerous canyons incise the slope, and some cut up onto the shelf itself. The primary morphological features of the shelf include valleys and channels, shoal massifs, scarps, and sand ridges and swales. The sediment covering most of the shelf in the MAB is sand, with some relatively small, localized areas of sand-shell and sand-gravel. On the slope, silty sand, silt, and clay predominate.

Variations in global sea-level and localized subsidence and uplift of the Earth's crust have created a complex series of sea-level transgressions and regressions. These changes have caused the coastline of Virginia to migrate—varying from low stands where the shoreline was at the continental shelf break, approximately 75 m (120 km) farther offshore than the modern coastline—to extreme highs where the coastline pushed inland and is believed to have covered nearly the entire state of Virginia (Oertel and Foyle, 1995; Hobbs et al., 2004). The geological features observed in the CVOW survey data collected along both the export cable survey corridor and research lease area can be directly attributed to either modern features created by the action of waves and currents or to relic features, deposited or eroded at previous stages of sea level over the last 500,000 years (Hobbs et al., 2004). The seafloor in the project area is composed of unconsolidated sediment, with crystalline bedrock buried deeply below. In areas where older geological units outcrop at or near the seafloor, these units may be stiffer clays or more indurate, harder sands and muds. Erosion channels and other incised features have mostly been filled in by more recent Holocene sediments and have little to no seafloor expression (Hobbs et al., 2008). Localized bathymetric highs experience erosion and winnowing of sediments leaving coarser sands and gravels on the shoals and allowing deposition of finer material in the lows (Snedden and Dalrymple, 1999). Sand ridges, the remnants of offshore bars (Snedden and Dalrymple, 1999) or the roots of barrier islands, now represent the majority of the localized bathymetric highs observed in the survey data (RAP, 2014, Appendix F).

The cable route is approximately 24 nautical miles (44.5 km) in length extending from the seashore to a depth of 26 m. Predominant features along the survey route are small sand ridges made up of 1.5 to 2.5 m of relief with shoreward facing slopes of approximately 4 to 5 degrees (Figure 1). The Dam Neck Disposal Site is traversed between nautical mile 3 and 4.6 (5.5 km and 8.5 km) where anomalous sediment and other materials are present. Predominant surficial sediments are 70 percent fine sand, 19 percent medium sand, 6 percent silt/clay, 3 percent coarse sand, and 2 percent gravel. The project area aliquots range in depth from 21 to 26 m, and on average, the sediment composition is approximately 60 percent fine sand, 29 percent medium sand, 7 percent silt/clay, 2 percent coarse sand, and 2 percent gravel. Some ridges are present in the project area; however they are predominantly in aliquot 6111-D, which has not been selected for the placement of turbine foundations or cabling. Aliquots 6111-H and 6111-L have less relief with seabed slopes no greater than 3 degrees (Figure 1).

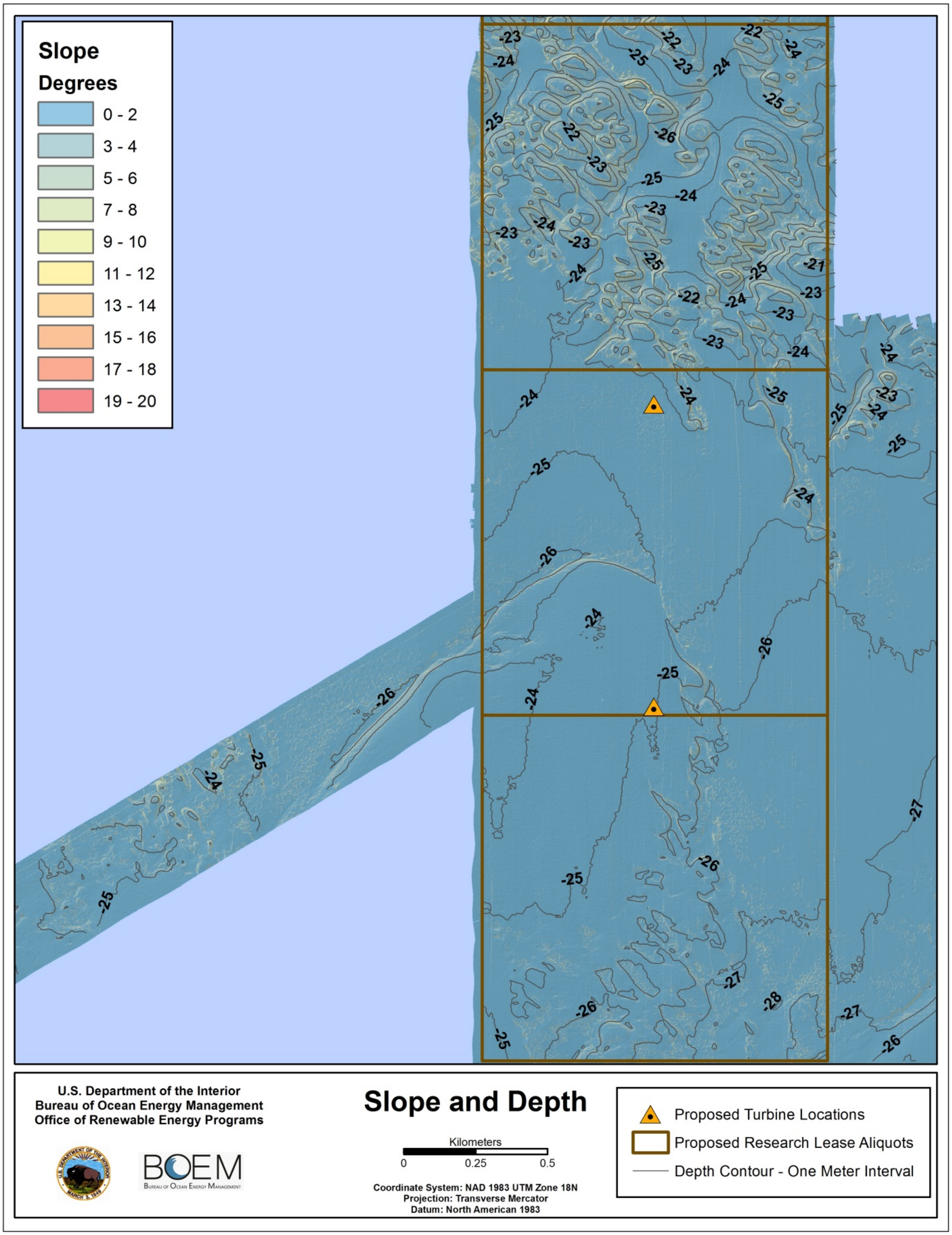



**Figure 1. Slope and Bathymetry of the Cable Route and Turbine Location.**

## Endangered Species Act-Listed Fish Species and Species of Concern

Marine fish species of concern that occur in the Project Area include the Endangered Species Act (ESA)-listed endangered Atlantic sturgeon, and two ESA candidate species, alewife and blueback herring. Possible impacts to ESA-listed and candidate species are being reviewed by NMFS under a separate ESA consultation.

- The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), was listed by NMFS on February 6, 2012, through a final rule listing 4 Distinct Population Segments (DPS) of the species as endangered, and one DPS (the Gulf of Maine) as threatened (77 FR 5914). Atlantic sturgeon are currently known to occur in 35 rivers, including 20 in which spawning is known to occur (ASSRT, 2007). Atlantic sturgeon occupy coastal waters and estuaries when not spawning, generally in shallow, near shore areas dominated by sand or gravel substrate at depth between 33 and 164 feet (10 and 50 meters) (ASSRT, 2007). The closest known spawning river to the Project Area is the James River, which empties into the Hampton Roads/Chesapeake Bay estuary. The presence of juvenile and adult sturgeon in the York River indicates that spawning may occur in that river as well (Greene et al., 2009). Since 2016 BOEM has maintained an acoustic array along the export cable route and project area. Data from this array clearly shows seasonal occupation of the project area and export cable route in the winter (November –April).

**The National Marine Fisheries Service initiated a new status review of alewife (Alosa pseudoharengus) and blueback herring (Alosa aestivalis) on August 15, 2017 to determine whether listing either species as endangered or threatened under the Endangered Species Act is warranted.** **Description of Fish Species with EFH in the Project Area**

The Magnuson-Stevens Fishery Conservation and Management Act requires fishery management councils to: (1) describe and identify EFH in their respective regions; (2) specify actions to conserve and enhance that EFH; and (3) minimize the adverse effects of fishing on EFH. The Act requires Federal agencies to consult on activities that may adversely affect EFH designated in fishery management plans. Chapter 4.2.5.1.3 of the Atlantic G&G FPEIS (BOEM, 2014a) provides additional detail on EFH in the Mid-Atlantic Bight.

The fishery management councils identify habitat areas of particular concern (HAPCs) within fishery management plans. HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. The Project Area and the cable route do not overlap with any designated HAPC. However, sandbar shark and summer flounder HAPCs have been designated within potential vessel transit routes into Hampton Roads, Virginia. Specifically, the summer flounder HAPC overlaps with native species of macroalgae, seagrasses, and freshwater and tidal macrophytes within their defined EFH. Sandbar shark HAPC is within the lower Chesapeake Bay and mouth of the Bay.

The Mid-Atlantic Fisheries Management Council (MAFMC) publishes EFH data by ocean blocks consisting of 10-minute by 10-minute quadrants of latitude and longitude, based on the annual NOAA Fisheries data collected within those same areas. The Project crosses five of these quadrants. For ease of discussion and evaluation, each quadrant crossed by the Project has been assigned a reference number from 1 to 5. The location and boundaries of these five EFH quadrants are shown in Figure 2.

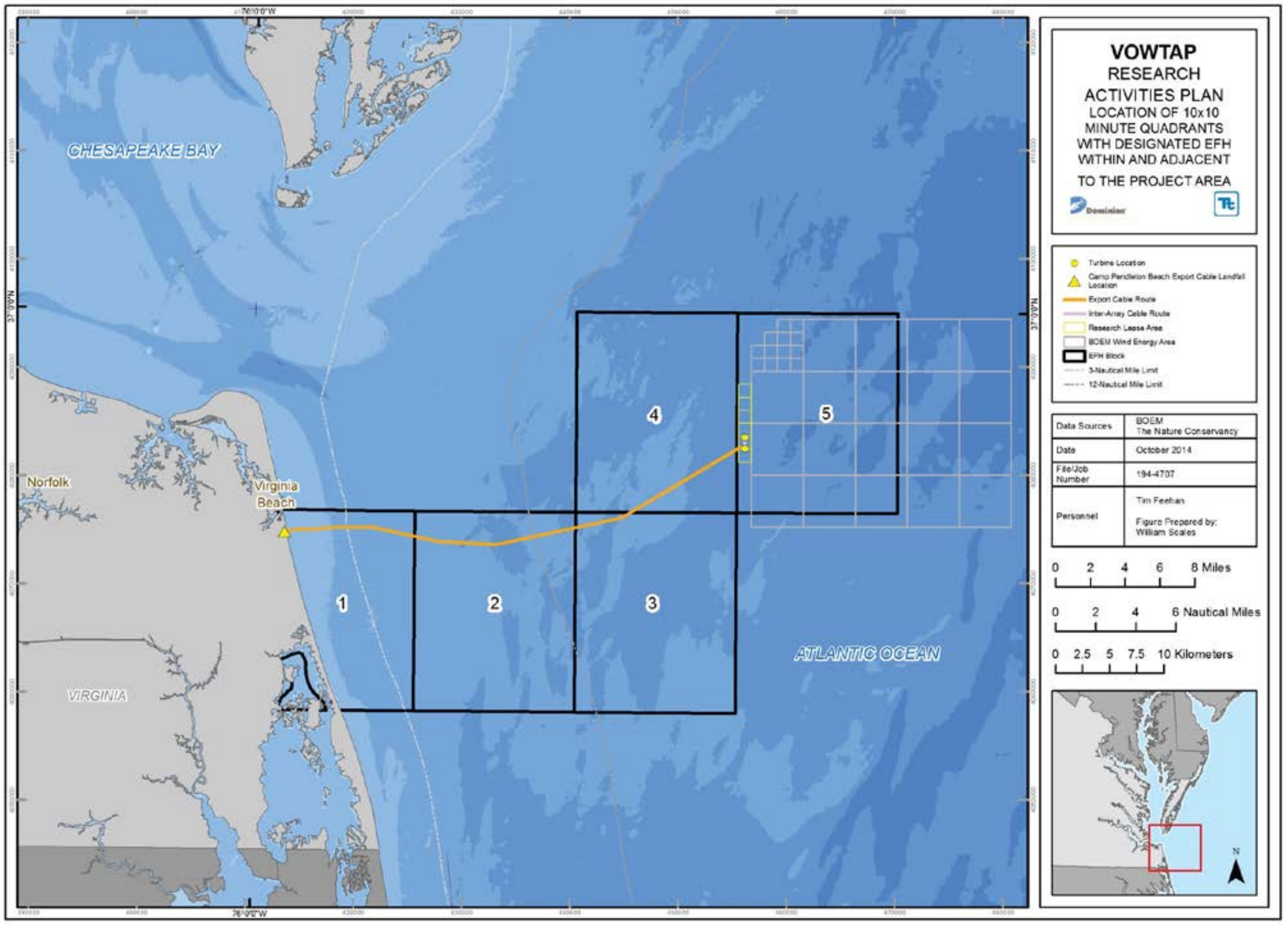



**Figure 2. Location of 10x10 Minute Quadrants with Designated EFH within and Adjacent to the Project Area.**

Important managed shellfish on the mid-Atlantic continental shelf include scallops, horseshoe crabs, surfclams, and ocean quahogs. Pelagic species include herring, menhaden, bluefin tuna, and several shark species. A complete list of the species present in the Project Area that have EFH designated through the Magnuson-Stevens Fishery Conservation and Management Act for each EFH-designated species follows in Table 1, including the life stage where each species can be found within the five quadrants.

**Table 1. Fish Species with EFH by Life Stage within the Project Area.**

| Species | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|
| **Silver hake / Whiting (*Merluccius bilinearis*)** | 4 | 4 | 4 | |
| **Red Hake (*Urophycis chuss*)** | 1 | 1 | 1 | |
| **Witch flounder (*Glyptocephalus cynoglossus)*** | 1,2,4 | 5 | | |
| **Windowpane flounder (*Scophthalmus aquosus*)** | 1,2,3,4 | 2,3,4,5 | 1,2,3,5 | |
| **Atlantic sea herring (*Clupea harengus*)** | | | 2 | 1,2,3,4 |
| **Monkfish (*Lophius americanus*)** | 2,3,4 | 2,3,4 | | |
| **Bluefish (*Pomatomus saltatrix*)** | 4 | 4 | 1,2,3,4,5 | 1,2,3,4, |
| **Long finned squid (*Loligo pealeii*)** | N/A[a/] 1-5 | N/A 1-5 | 3,5 | |
| **Short finned squid (*Illex illecebrosus*)** | N/A 1-5 | N/A 1-5 | | |
| **Atlantic butterfish (*Peprilus triacanthus*)** | | | 2,4 | 4 |
| **Summer flounder (*Paralichthys dentatus*)** | 4 | 4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Scup (*Stenotomus chrysops*)** | N/A 1-5 | N/A 1-5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Black sea bass (*Centropristis striata*)** | N/A 1-5 | 2,4 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Surfclam (*Spisula solidissima*)** | N/A 1-5 | N/A 1-5 | 2,3,4 | 3 |
| **Ocean quahog (*Artica islandica*)** | N/A 1-5 | N/A 1-5 | | |

| Species | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|
| **Spiny dogfish (*Squalus acanthias*)** | | N/A 1-5 | 1,2,3,4,5 | 2,3,4,5 |
| **King mackerel (*Scomberomorus cavalla*)** | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Spanish mackerel (*Scomberomorus maculatus*)** | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Cobia (*Rachycentron canadum*)** | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Red drum (*Sciaenops occelatus*)**[b/] | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Sand tiger shark (*Carcharias taurus*)** | | 1,2,3,4,5 | | 1,2,3,4,5 |
| **Atl. sharpnose shark (*Rhizopriondon terraenovae*)** | | | | 1,2,3,4,5 |
| **Dusky shark (*Carcharhinus obscurus*)** | | 1,2,3,4,5 | 1,2,3,4,5 | |
| **Shortfin mako shark (*Isurus oxyrinchus*)** | | 5 | | |
| **Sandbar shark (*Carcharhinus plumbeus*)** | | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Scalloped hammerhead shark (*Sphyrna lewini*)** | | | 1,2,3,4,5 | |
| **Tiger shark (*Galeocerdo cuvieri*)** | | 1,2,3,4,5 | 1,2,3,4,5 | 1,2,3,4,5 |
| **Bluefin tuna (*Thunnus thynnus*)** | | | 5 | 5 |
| **Thorny Skate** | **N/A 1-5** | **N/A 1-5** | | |
| **Clearnose Skate** | **N/A 1-5** | **N/A 1-5** | **1-5** | **1-5** |
| **Swordfish (*Xiphias gladius*)** | | | 5 | |

| Species | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|
| **Skipjack tuna (*Katsuwonus pelamis*)** | | | | 5 |
| [a] N/A indicates some of the species either have no data available on the designated life stages, or those life stages are not present in the species' reproductive cycle. The designation is followed by the quadrants to which that designation is applicable for that particular life stage.<br>[b] Red Drum EFH is no longer designated outside of the Gulf of Mexico Fishery Management Council. However, designated EFH for this species was shown in the 10' x 10' minute squares overlapping the Project Area. | | | | |

The following sections provide accounts of the habitat requirements for particular species and their life stages for which designated EFH potentially occurs within or in the vicinity of the Project Area. This information was presented in the RAP (2014, p. 4-112 to 4-133) and primary sources of information for the habitat requirements of the EFH species were the EFH source documents developed by the Fishery Management Councils and issued by NOAA Fisheries, with clarifications provided by BOEM. These documents provide descriptions of the habitat for locations where fish have been found to some degree of abundance. The mere occurrence of fish in a particular habitat is not an indication that it is essential, or even in its preferred habitat. It is only an indication that the fish was found in a particular habitat when a sampling event occurred. Regardless of these data limitations, the EFH source documents provide the best available descriptions of the habitat requirements for selected marine species.

### Whiting

Whiting (silver hake) are found along the continental shelf of North America from Canada to the Bahamas and are most abundant between Newfoundland and South Carolina (Collette and Klein-MacPhee, 2002). Two U.S. whiting stocks are managed: one is found in the Gulf of Maine and northern Georges Bank, and the other on southern Georges Bank and the Mid-Atlantic Bight. This species is usually found on sandy or pebbly ground or mud (Collette and Klein-MacPhee, 2002). Spawning is most often observed from May through November, with peaks in June and July.

*Eggs:* EFH for whiting eggs is designated as the surface waters throughout their range. Eggs are typically mixed with the eggs of similar species such as red hake. Generally, whiting eggs are found where sea surface temperatures are below 20°C along the inner continental shelf. In Virginia waters, whiting eggs are most often observed during June through October in water depths ranging from 160 ft to 500 ft (50 m to 150 m) (NMFS, 2000). EFH for whiting eggs has been identified in Quadrant 4 only, and will likely be found in the water column above the near shore Export Cable within the Project Area. The primary impacts potentially caused by this activity are displacement due to habitat modification or disturbance through changes in water quality and prey availability, however, as these eggs are found in surface waters and do not rely on external prey sources, potential impacts from the CVOW would be negligible.

*Larvae:* EFH for larval whiting is designated as surface waters off the coast of Virginia, from June through November. The larvae are typically observed when sea surface temperatures are below 19°C and salinity is greater than 0.5 percent (NMFS, 2000). EFH for whiting larvae has been identified in Quadrant 4 only, and will likely be found in the water column above the near shore Export Cable within the Project Area. The primary impacts potentially caused by this activity are displacement due to habitat modification or disturbance through changes in water quality and prey availability, however, as larvae for this species are found in surface waters, potential impacts from the CVOW would be negligible.

*Juveniles:* EFH for juvenile whiting is designated as the bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops throughout their range, but also includes all other substrates. Juvenile whiting migrate to deeper waters of the continental shelf as water temperatures decline in the autumn and return to shallow waters in spring and summer, preferring a wide range of water temperatures with salinities of greater than 20 parts per thousand (PPT) (NMFS, 2000). EFH for juveniles has been identified in Quadrant 4 only; therefore, the CVOW Export Cable installation is the only aspect of the CVOW that could interact with this life stage of whiting, potentially causing displacement due to habitat disturbance through changes in water quality and prey availability.

*Adults:* No adult whiting EFH is found in the Project Area.

### Red Hake

Red hake are found in the coastal waters off southern Newfoundland to North Carolina, with their center of abundance concentrated along Georges Bank, in the Gulf of Maine off Cape Cod, and in the northern mid-Atlantic Bight off Long Island, New York. Within this range, red hake are managed as two U.S. stocks: a northern stock from the Gulf of Maine to northern Georges Bank, and a southern stock from southern Georges Bank into the Mid-Atlantic Bight. All life stages of the red hake are also found in estuaries from southern Maine to the Chesapeake Bay (Steimle et al., 1999). Red hake make seasonal migrations to follow preferred temperature ranges. They are most common in depths less than 330 ft (100 m) during warmer months, and at depths greater than this during colder months. They commonly occur in coastal bays and estuaries less than 32 ft (less than 10 m) deep (Tyler, 1971; Jury et al., 1994; Stone et al., 1994). Historically, red hake were targeted in coastal Virginia waters by commercial fishermen; however, the southern stock for red hake is considered overfished (Sosebee, 1998). This species is usually found on sandy or pebbly ground or mud, preferring soft sediments over harder substrate (Collette and Klein-MacPhee, 2002). Spawning is most often observed from April through November.

*Eggs:* EFH for red hake eggs is surface waters throughout their range. Eggs are typically mixed with the eggs of similar species such as whiting. Generally, the following conditions exist where hake eggs are found: sea surface temperatures below 10°C along the inner continental shelf with salinity less than 25 PPT (NMFS, 2000). These preferred water column conditions limit the months where appropriate conditions exist in Virginia to early May or November. EFH for red hake eggs has been identified in Quadrant 1 only, and will likely be found in the water column above the near shore Export Cable within the Project Area. The primary impacts potentially caused by this activity are displacement due to habitat modification or disturbance through changes in water quality and prey availability, however, as these eggs are found in surface waters and do not rely on external prey sources, potential impacts from CVOW would be negligible.

*Larvae:* EFH for red hake larvae is designated as surface waters throughout their range, including waters off the coast of Virginia. Larvae are present from May through December, with peaks in September and October. The larvae are typically observed when sea surface temperatures are below 19°C and salinity is greater than 0.5 PPT (NMFS, 2000). These conditions are met within the Project Area in May, October or November, based on water temperature. EFH for whiting larvae has been identified in Quadrant 1 only and will likely be found in the water column above the near shore Export Cable within the Project Area. The primary impacts potentially caused by this activity are displacement due to habitat modification or disturbance through changes in water quality and prey availability, however, as larvae for this species are found in surface waters potential impacts from CVOW would be negligible.

*Juveniles:* EFH for juvenile red hake is designated as the bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops throughout their range, but also includes all substrates. Juvenile red hake migrate to deeper waters of the continental shelf as water temperatures decline in the autumn and return to shallow waters in spring and summer, preferring water temperatures less than 16° C and salinities of 31-33 PPT (NMFS, 2000). EFH for juveniles has been identified in Quadrant 1 only; therefore, the CVOW near shore cable installation operation is the only aspect of the CVOW that could interact with juvenile hake, potentially causing displacement due to habitat disturbance through changes in water quality and prey availability.

*Adults:* No adult whiting EFH is found in the Project Area.

### Witch Flounder

Witch flounder are distributed from Cape Hatteras, North Carolina, to Labrador, Canada. The areas of highest abundance have been reported to be the Gulf of St. Lawrence, the southwestern edge of the Grand Bank, and deep waters directly north of the Grand Bank. In U.S. waters, witch flounder are most common in the Gulf of Maine off of Cape Ann, Massachusetts. Witch flounder is typically a deepwater fish that inhabits depths to approximately 4,921 ft (1,500 m). The egg and larval stages are pelagic, generally over deep water (Collette and Klein-MacPhee, 2002). Witch flounder spawning occurs at or near the bottom, although the eggs become buoyant. Spawning occurs in the Mid-Atlantic Bight between April and August (Cargnelli et al., 1999b). Witch flounder tend to prefer muddy sand, clay, and mud bottoms (Collette and Klein-MacPhee, 2002). The pelagic egg and larval stages are spent in the water column over deep water for this species. The juvenile stage occurs in very deep water, when fish settle to the bottom and remain separated from the adult population, occupying deeper waters until they are sexually mature. Witch flounder eggs and larvae have been reported in the waters east of Virginia Beach, but they are not considered an abundant finfish within the Project Area.

*Eggs:* EFH for witch flounder eggs is the surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Witch flounder eggs typically occur over deep water with high salinities and where sea surface temperatures are below 13°C (NMFS, 2000). Witch flounder eggs are most often observed from March through October; however, the preferred conditions associated with witch flounder eggs are only found within the Project Area in March and April, based on water temperature. EFH for witch flounder eggs has been identified in Quadrants 1, 2 and 4 will likely be found in the water column above the Export Cable within the Project Area. The primary impacts potentially caused by this activity are displacement due to habitat modification or disturbance through changes in water quality and prey availability, however, as eggs for this species are found in surface waters potential impacts from CVOW would be negligible.

*Larvae*: EFH for witch flounder larvae is designated as surface waters to 820 ft (250 m) in the Gulf of Maine, Georges Bank, the continental shelf off of southern New England, and the middle Atlantic south to Cape Hatteras (NMFS, 2000). Witch flounder larvae are most often observed from March through November, with peaks in May through July; however, the above conditions are only met within the Project Area in March and early April, and late October and November based on water temperature. EFH for witch flounder larvae has been identified in Quadrant 5 only and may be found in waters associated with the CVOW WTGs and Inter-Array Cable. The primary impacts potentially caused by these activities are displacement due to habitat modification or disturbance through changes in water quality and prey availability and noise (Popper et al., 2014).

*Juveniles:* No designated EFH for this life stage occurs within the Project Area.

*Adults*: No designated EFH for this life stage occurs within the Project Area.

### Windowpane Flounder

Windowpane flounder are distributed from the Gulf of St. Lawrence to Cape Hatteras, but they are most common south of Nova Scotia. The largest catches of this species occur on Georges Bank. Windowpane flounder is a left-eyed flounder with a thin body and nearly round outline that prefers sandy bottom types (Collette and Klein-MacPhee, 2002). The eggs of this species are buoyant and spawning occurs typically from February through May (Chang et al. 1999). Larvae settle to the bottom at approximately 0.4 to 0.8 inches (in) (10 millimeters [mm] to 20 mm) in length (Collette and Klein-MacPhee, 2002). Windowpane flounder juveniles serve as important prey species for a number of other finfish species, including spiny dogfish, thorny skate, goosefish, Atlantic cod, black sea bass, weakfish, and summer flounder (NMFS, 2000).

*Egg*: EFH for windowpane flounder eggs is designated as the surface waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the Mid-Atlantic south to Cape Hatteras. Windowpane flounder eggs typically occur where sea surface temperatures are less than 68° F (20°C) and water depths less than 230 ft (70 m). Windowpane flounder eggs are often observed from February to November with peaks in May and October (NMFS, 2000). EFH for windowpane eggs has been identified in Quadrants 1, 2, 3, and 4 and may be found in waters associated with the Export Cable within the Project Area. The primary impacts potentially caused by this activity are displacement due to habitat modification or disturbance through changes in water quality and prey availability, however, as eggs for this species are found in surface waters potential impacts on this life stage by the CVOW would be negligible.

*Larvae*: EFH for larval windowpane flounder is designated as the pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Windowpane flounder eggs typically occur where sea surface temperatures are less than 68° F (20°C) and water depths less than 230 ft (70 m). Windowpane flounder larvae are often observed from February to November, with peaks in May and October in the Mid-Atlantic (NMFS, 2000). EFH for windowpane larvae has been identified in Quadrants 2, 3, 4, and 5, and may be found in waters associated with the Export Cable as well as the WTGs. The primary impacts potentially caused by these activities are displacement due to habitat modification or disturbance through changes in water quality and prey availability and noise (Popper et al., 2014).

*Juvenile*: EFH for juvenile windowpane flounder are bottom habitats with substrates of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the Mid-Atlantic south to Cape Hatteras. Windowpane flounder juveniles typically occur where water temperatures are below 77°F (25°C), depths are 3 ft to 328 ft (1 m to 100 m), and salinities range between 5.5 and 36 PPT (NMFS 2000). EFH for juveniles has been identified in Quadrants 1, 2, 3, and 5. Site specific habitat surveys indicate that potentially suitable habitat for juveniles may occur along the

CVOW Export Cable route, as well as at the WTG locations. The primary impacts potentially caused by these activities are displacement due to habitat modification or disturbance through changes in water quality and prey availability and noise (Popper et al., 2014).

*Adult*: No designated EFH for this life stage occurs within the Project Area.

### Atlantic Sea Herring

Atlantic sea herring is a pelagic species that occurs in large schools and inhabits coastal and continental shelf waters from Labrador south to Virginia. Juvenile herring, which are commonly called sardines, migrate from shallow, inshore waters during the summer to deeper, offshore waters during the winter. Adult fish older than 3 years will migrate from their spawning grounds in the Gulf of Maine and Georges Bank to spend the winter months in southern New England and the Mid-Atlantic. Herring will spawn during October and November in the southern Gulf of Maine, Georges Bank, and Nantucket Shoals. They prefer rock, gravel, or sand bottoms between 50 ft and 150 ft (15 m and 45 m) in depth for spawning (ASMFC, 2008). Herring are filter feeders and feed on plankton, primarily copepods. They usually feed at night, following the zooplankton that inhabit deeper waters during the day and travel to the surface to feed at night (ASMFC, 2008). Herring themselves play a very important role in the ecosystem, as they are a significant source of food for many species of fish, including cod, haddock, silver hake, striped bass, bluefish, monkfish, mackerel, tuna, and spiny dogfish, as well as birds and marine mammals (Collette and Klein-MacPhee, 2002).

*Egg*: No designated EFH for this life stage occurs within the Project Area.

*Larvae*: No designated EFH for this life stage occurs within the Project Area.

*Juvenile*: Juvenile Atlantic herring are known to occur in pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras. Atlantic herring juveniles typically occur where water temperatures are below 50°F (10°C) at water depths from 49 ft to 443 ft (15 m to 135 m) throughout the water column as they seek prey (see above). They prefer a salinity range from 26 PPT to 32 PPT (NMFS, 2000). EFH for juveniles has been identified in Quadrant 2, where juvenile herring may be found in waters associated with the CVOW Export Cable. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification or disturbance through changes in water quality and prey availability.

*Adult*: Atlantic herring adults typically occur where water temperatures are below 50°F (10°C), water depths are from 66 ft to 427 ft (20 m to 130 m), and salinities are above 28 PPT (NMFS, 2000). EFH for adults has been identified in Quadrants 1, 2, 3 and 4, and adult herring may be found throughout the water column in waters associated with the CVOW Export Cable. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification or disturbance through changes in water quality and prey availability.

### Monkfish

Monkfish (also known as goosefish) range from Newfoundland to North Carolina, and in the Gulf of Mexico. They tolerate a wide range of depth, temperature, and habitat and are found from the tideline out to depths of greater than 2,000 ft (610 m) on the continental slope. They live on various types of substrate, including sand, gravel, rocks, mud, and beds of broken shells. They have also been found in a variety of temperatures, from 32°F to 70°F (0°C to 21°C), but prefer temperatures of 37°F to 48°F (3°C to 9°C) (Ross, 1991). Reproduction for this species often occurs in shallow water from spring through early fall; however, it has been documented on the Mid-Atlantic OCS as well. They produce large masses of eggs (up to 2.8 million eggs at one time) in a single ribbon that can be up to 25 ft to 36 ft (7 m to 11 m) in length that floats within the water column. Adult monkfish are voracious predators, feeding on skates, herring, mackerel, and silver hake, as well as lobsters and crabs. The monkfish often feeds by lying motionless and waving its "lure" to attract fish. The monkfish is also known to eat seabirds, including cormorants, herring gulls, loons, and other sea birds (Collette and Klein-MacPhee, 2002).

*Egg*: EFH for monkfish eggs is designated as surface waters from the Gulf of Maine, Georges Bank, southern New England, and the Mid-Atlantic Bight south to Cape Hatteras (NMFS, 2000). EFH for monkfish eggs has been identified in Quadrants 2, 3, and 4; therefore, eggs associated with this species have the potential to occur along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification or disturbance through changes in water quality and prey availability. However, Monkfish eggs occur in surface waters and do not rely on external prey sources; therefore, potential impacts from the CVOW would be negligible.

*Larvae:* EFH for monkfish larvae is designated as the pelagic waters from the Gulf of Maine, Georges Bank, southern New England, and the Mid-Atlantic Bight south to Cape Hatteras (NMFS, 2000). EFH for monkfish larvae has been identified in Quadrants 2, 3, and 4; therefore, larvae associated with this species have the potential to occur along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability.

*Juvenile:* No designated EFH for this life stage occurs within the Project Area.

*Adult:* No designated EFH for this life stage occurs within the Project Area.

### Bluefish

The bluefish is a schooling species found in most oceans of the world, except the eastern Pacific Ocean. In the western Atlantic Ocean, the bluefish distribution ranges from Nova Scotia and Bermuda to

Argentina, but is considered rare between southern Florida and northern South America (Goodbread and Graves, 1996). Bluefish adults are highly migratory and perform both north-south and inshore-offshore movements. Bluefish move north in the spring to summer seasons, when their highest abundance is found off the coast of New York and coastal southern New England (Collette and Klein-MacPhee, 2002). In the fall and winter, bluefish move both southward and offshore to overwinter in the South Atlantic Bight, between coastal Florida and the Gulf Stream. Light levels and water temperature are the primary triggers for migratory movements, but offshore and inshore migrations also parallel the movements of their prey (Collette and Klein-MacPhee, 2002). There are two discrete spawning events for the western Atlantic bluefish: 1) a spring spawning event occurs near the edge of the continental shelf in the South Atlantic Bight during March through May; and 2) a summer spawning event occurs over the mid-continental shelf in the Mid-Atlantic Bight between June and August in waters with temperatures between 64.4°F and 77°F (18°C and 25°C) and salinities from 25 to 31 PPT (Collette and Klein-MacPhee, 2002).

*Eggs:* EFH for bluefish eggs is designated as mid-shelf waters greater than 64° F (18° C) with a salinity of greater than 31 PPT on the continental shelf. They are usually spawned between April and August (NMFS, 2000). EFH for bluefish eggs has been identified in Quadrant 4; therefore, eggs associated with this species have the potential to occur along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability. However, Bluefish eggs do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

*Larvae:* EFH for bluefish larvae is designated within the pelagic waters north of Cape Hatteras on the continental shelf to Montauk Point, New York. It is also found south of Cape Hatteras along the continental shelf south to Key West, Florida, within the Gulf Stream along the continental slope between latitudes 29° N and 40° N (NMFS 2000). EFH for bluefish larvae has been identified in Quadrant 4; therefore, larvae associated with this species have the potential to occur along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification disturbance through changes in water quality and prey availability.

*Juvenile:* The EFH for juvenile bluefish (a.k.a., snapper blues) north of Cape Hatteras is pelagic waters found over the continental shelf from the coast out to the limits of the EEZ and beyond north to Nantucket Island, Massachusetts within the areas of highest abundance for their range. Inshore, EFH is all major estuaries between Penobscot Bay, Maine, and St. Johns River, Florida (NMFS, 2000). Juvenile bluefish can be found in waters with salinities as low as 3 PPT. EFH for juvenile bluefish has been identified in Quadrants 1, 2, 3, 4, and 5 and will likely be found in waters associated with all marine portions of the CVOW. The primary potential impacts caused by construction, operation and decommissioning activities are displacement due to habitat modification or disturbance through changes in water quality, prey availability and noise.

*Adult:* EFH for adult bluefish is the same as that described for juvenile bluefish. EFH for adult bluefish has been identified in Quadrants 1, 2, 3, and 4; therefore, these fish will likely be found in waters associated with the CVOW Export Cable. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability.

### Long-Finned Squid

Long-finned squid are distributed from Cape Cod through Cape Hatteras. The greatest abundance of long-finned squid is found in continental shelf and slope waters at depths between 328 ft and 551 ft (100 m and 168 m). They generally migrate inshore to waters off of southern New England in May or June, and by late November/early December they migrate to deeper waters along the edge of the continental shelf (Macy and Brodziak, 2001). Adult long-finned squid are demersal during the day, coming to the surface at night to feed. Egg masses are typically attached to hard substrates. Newly hatched squid are found at the surface and move deeper in the water column as they grow, becoming demersal when they reach just under 2 in (45 mm) in length (NEFSC, 2005). There is evidence that squid spawn throughout the year, with two main spawning periods in the summer and winter (Macy and Brodziak, 2001). Adults feed on small fish, while juveniles feed on small crustaceans (Rathjen, 1973). Squid are an important prey species to a number of other species, including sharks, haddock, hake, striped bass, black sea bass, bluefish, scup, mackerel, summer flounder, and tuna (Ross, 1991).

*Pre-recruits*: EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras in areas that comprise the highest 75 percent of the catch where pre-recruit long-finned squid were collected in the Northeast Fisheries Science Center (NEFSC) trawl surveys. Generally, pre-recruit long-finned squid are collected from shore to 700 ft (213 m) depth and temperatures between 39°F and 81°F (3.9°C to 27.2°C) (NMFS, 2000). Given this broad range, there is the potential for pre-recruit long-finned squid to occur throughout all five quadrants within the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat disturbance through changes in water quality and prey availability.

*Recruits*: EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras in areas that comprise the highest 75 percent of the catch where recruited long-finned squid were collected in the NEFSC trawl surveys. Generally, recruited long-finned squid are collected from shore east to the 1,000 ft (305 m) depth contour and temperatures between 39°F and 81°F (3.9°C to 27.2°C) (NMFS, 2000). Given this broad range, there is the potential for recruit long-finned squid to occur throughout all five quadrants within the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat disturbance through changes in water quality and prey availability.

*Juveniles*: EFH is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch where juvenile long-finned squids have been collected in NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras (NMFS, 2000). EFH for long-finned squid juveniles has been identified in Quadrants 3 and 5, and is likely to be found along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance through changes in water quality and prey availability.

*Adults*: EFH for adult long-finned squid is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch where recruited adult long finned squid were collected in the NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras (NMFS, 2000). EFH for adults has been identified in Quadrant 5, and is therefore likely to be found at the WTG and Inter-Array Cable locations. The primary impacts potentially caused by these activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability.

### Short-Finned Squid

Short-finned squid is a pelagic, schooling species generally distributed across the continental shelf and slope. In the western Atlantic Ocean, the northern short-finned squid distribution is from the Labrador Sea south to Florida (Wigley, 1982). This species is most abundant in the Newfoundland region, is moderately abundant between Newfoundland and New Jersey (Wigley, 1982), and is commercially exploited from Newfoundland south to Cape Hatteras (Cargnelli et al., 1999a). Northern short-finned squid are highly migratory and are capable of long-distance migrations of more than 869 nm (1,609 km) between boreal, temperate, and subtropical waters (Cargnelli et al., 1999a). They also undergo inshore-offshore migrations, which may be related to temperature, food, or both (MAFMC, 1998). The northern short-finned squid forms dense aggregations in waters ranging from 46.4°F to 57.2°F (8°C to 14°C) in the winter from January to March along the OCS and upper slope, and they migrate shoreward in the spring from April to May (Wigley, 1982). Spawning of the northern short-finned squid is believed to occur in the deep waters of the continental shelf primarily from August through March, depending on location. The principal spawning habitat is hypothesized to occur south of Cape Hatteras over the Blake Plateau (Cargnelli et al., 1999a; Hendrickson and Holmes, 2004). The only confirmed spawning area is between Southern New Jersey to Cape Hatteras along the shelf break in the Mid-Atlantic Bight during May (Hendrickson, 2004).

*Pre-recruits*: EFH for these pre-recruits is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch where pre-recruits were collected in the NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras. No short-finned squid egg masses have ever been found in nature (O'Dor and Dawe, 1998). The NEFSC bottom trawl surveys have captured northern short-finned squid pre-recruits (under 3.4 in [10 cm] mantel length) during all seasons. Highest catches were made from the Middle Atlantic region. By summer, pre-recruits were caught throughout the continental shelf, from the shoreline out to the 600-ft (183-m) depth contour and from North Carolina to Georges Bank. The highest catches were made south of Cape Cod and Long Island. Given this broad range, there is the potential for pre-recruit short-finned squid to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability.

*Recruits*: EFH for these recruits is designated as pelagic waters found over the continental shelf in areas that comprise the highest 75 percent of the catch, where recruited adult northern short-finned squid were collected during NEFSC trawl surveys from the Gulf of Maine through Cape Hatteras. Recruits (4.3 in [11 cm] mantel length and greater) undergo seasonal migrations similar to pre-recruits and are also pelagic. The abundance of recruits during spring, autumn, and winter seems to be greater in NEFSC bottom trawl surveys. In winter, recruits were distributed offshore, with only low numbers taken at the 600-ft (183-m) depth contour. Recruits were taken at depths ranging from 32 ft to 1,378 ft (10 m to 420 m) and seem to inhabit shallower (i.e., inshore) waters in summer and autumn as opposed to during winter and spring. Recruits were also found at temperatures ranging from 39.2°F to 66.2°F (4°C to 19°C) (NEFSC, 2005). Given this broad range, there is the potential for recruits of short-finned squid to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability.

*Juveniles*: No designated EFH for this life stage occurs within the Project Area.

*Adults*: No designated EFH for this life stage occurs within the Project Area.

**Atlantic Butterfish**

Butterfish are pelagic fish forming loose schools from Newfoundland to Florida (NEFSC, 1999). They will often come close to shore into sheltered bays and estuaries, and have a preference for sandy bottom (as opposed to rocky or muddy bottom). They spend much of their time near the surface when they are near to shore, but spend the winter and early spring near the bottom at depths of up to 600 ft to 690 ft (183 m to 210 m) (Collette and Klein-MacPhee, 2002). Butterfish are found along the southern New England shoreline and estuaries from late spring through fall, spawning in the Gulf of Maine within a few miles of the coast during the late spring and early summer. They then migrate to the edge of the continental shelf during the winter (Collette and Klein-MacPhee, 2002). Butterfish eggs are found within southern New England estuaries from June through August (NEFSC, 1999). Butterfish feed primarily on tunicates and mollusks, as well as cnidarians, polychaetes, crustaceans, and other invertebrates (Collette and Klein-MacPhee, 2002). Ctenophores have been found to make up an important component of the diet of juvenile butterfish in southern New England estuaries (Oviatt and Kremer, 1977). Butterfish themselves serve as prey to a number of species including hake, bluefish, weakfish, and swordfish, and are used commonly as bait in recreational tuna fisheries (Ross, 1991).

*Eggs:* No designated EFH for this life stage occurs within the Project Area.

*Larvae:* No designated EFH for this life stage occurs within the Project Area.

*Juvenile:* Juvenile butterfish are distributed throughout the continental shelf from the Gulf of Maine to

Cape Hatteras, North Carolina as well as in estuaries such as Massachusetts Bay, Cape Cod Bay, Raritan Bay, Delaware Bay, Chesapeake Bay and the associated York and James Rivers. They prefer a broad range of water temperatures from 37° F to 82° F (3° to 28° C) depending on the season. Accordingly, they are found on the continental shelf during the winter and in bays and estuaries from the spring through the fall. While these fish are generally pelagic, larger individuals can be found in close association with sandy and muddy substrate areas. They assemble in pelagic schools, but are also sometimes found near flotsam and large jellyfish (NMFS, 2000). EFH for juvenile butterfish has been noted along the CVOW Export Cable route in Quadrants 2 and 4. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance through changes in water quality and prey availability.

*Adult:* Adult butterfish are distributed throughout the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina as well as in estuaries such as Massachusetts Bay, Cape Cod Bay, Raritan Bay, Delaware Bay, Chesapeake Bay and the associated York and James Rivers. They prefer a broad range of water temperatures from 37° F to 82° F (3° to 28° C) depending on the season (NMFS, 2000). Accordingly, they are found on the continental shelf during the winter and in bays and estuaries from the spring through the fall. While these fish are generally pelagic, larger individuals can be found in close association with sandy and muddy substrate areas. EFH for adult butterfish has been noted in Quadrant 4 along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance through changes in water quality and prey availability.

### Summer Flounder

Summer flounder (or fluke) are found in both inshore and offshore waters from Nova Scotia to Florida, although they are most abundant from Cape Cod south to Cape Fear, North Carolina (ASMFC, 2008). They are left-eyed flatfish (family bothidae) and are concentrated in bays and estuaries from late spring through early fall, when they migrate offshore to the continental shelf to waters between 120 ft and 600 ft (37 and 183 m) in depth. These fish usually spend the fall and winter seasons offshore. Adult summer flounder spend most of their lives near the bottom, and prefer to bury themselves into sandy substrate. During the summer, they are often found on hard sand, and prefer mud during the fall. They are often found hiding motionless in eelgrass or among the pilings of docks, but swim very quickly if disturbed (Collette and Klein-MacPhee, 2002). This species spawns offshore in the fall. Larvae will migrate inshore to coastal and estuarine areas from October through May. Upon reaching the coast, the larvae will move to the bottom, and spend the first year of their lives in bays and other inshore areas. Summer flounder have well-developed teeth that allow them to capture such prey as small fish, squid, sea worms, shrimp, and other crustaceans (ASMFC, 2008). Summer flounder are common to Virginia waters and are considered a key species for commercial and recreational fisheries.

*Eggs:* EFH for summer flounder eggs is comprised of the pelagic waters over the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras. Summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 mi (14.5 km) of shore off of New Jersey and New York. Eggs are most commonly collected at depths of 30 ft to 360 ft (9.1 m to 109.7 m) (NMFS, 2000). EFH for summer flounder eggs has been identified in Quadrant 4; therefore, eggs may occur within the waters associated with the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance through changes in water quality and prey availability. However, summer flounder eggs do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

*Larvae:* EFH for summer flounder larvae is comprised of the pelagic waters found of the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras. Inshore, EFH is estuarine systems including Waquoit Bay, Narragansett Bay, Raritan Bay and the Hudson River, Barnegat Bay, Chesapeake Bay and its major rivers, Albemarle Sound, and Pamlico Sound and the Indian and Neuse Rivers. In general, summer flounder larvae are most abundant near shore (within 12 mi to 50 mi

[20.9 km to 80.5 km] from shore) at depths between 30 ft and 230 ft (20.9 m to 370.1 km). They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February (NMFS, 2000). EFH for summer flounder larvae has been identified in Quadrants 4 and 5; therefore, larvae may occur within the waters associated with the seaward end of the Export Cable, as well as the WTGs and inter-array cable within the Project Area. The primary impacts potentially caused by these activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Juveniles:* Juveniles are typically found in the demersal waters of the continental shelf from the Gulf of Maine to as far south as Florida. Inshore, EFH is estuaries from Waquoit Bay to the James River to the Indian River and Albemarle Sound. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, sea grass beds, mudflats, and open bay areas in water temperatures greater than 37ºF (2.8°C) and salinities from 10 PPT to 30 PPT range (NMFS, 2000). EFH for summer flounder juveniles has been identified in all five quadrants of the Project Area; therefore, juveniles may occur within the waters associated with the Export Cable, as well as the WTGs and Inter-Array Cable within the Project Area. The primary impacts potentially caused by these activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adults:* EFH for adult summer flounder comprises the demersal waters of the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras in the highest 90 percent of all the ranked 10-minute squares for the area where adult summer flounder are collected in the NEFSC trawl survey. Inshore, EFH consists of estuaries such as Buzzards Bay, Narragansett Bay, the Connecticut River, the James River, Albemarle Sound, the Broad River, the St. Johns River, and the Indian River. Generally, summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the OCS at depths of 500 ft (152.4 m) in colder months (NMFS, 2000). EFH for adults has been identified in all five quadrants, and may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area. The primary impacts potentially caused by these activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Scup

Scup (porgy) are a migratory species found from Cape Cod to Cape Hatteras. Scup are most commonly found in waters between 55°F and 77°F (13°C and 25°C). They spend the winters in offshore waters from southern New Jersey to Cape Hatteras, and spawn in the summer in inshore waters from southern New England to Long Island, moving north and into New England waters in the spring and returning south the fall. Scup spawn in inshore waters during the summer, with spawning reaching its peak in June off of southern New England. The eggs will hatch about 40 hours after fertilization and then scup form into schools of similarly sized individuals. Juvenile scup use coastal habitats, and will sometimes dominate the fish population of estuarine areas during the summer months (ASMFC, 2008). They prefer areas with smooth or rocky bottoms, and are often found around piers, rocks, offshore ledges, jetties, and mussel beds. During the winter, they prefer depths of 240 ft to 600 ft (73 m to 183 m) where the water temperature is at least 45°F (7.2°C). Adult scup feed on benthic invertebrates, including small crabs, squid, worms, clams, mussels, amphipods, jellyfish, and others. They are eaten by a variety of different fish. It is estimated that as many as 80 percent of all juvenile scup annually are eaten by fish such as cod, bluefish, striped bass, and weakfish (Ross, 1991).

*Eggs:* EFH for scup eggs is comprised of pelagic waters from New England to coastal Virginia, at depths of less than 98 ft (30 m) and in waters between 55°F and 73°F (12.8°C and 22.8°C). They are found in salinities greater than 15 PPT (NMFS, 2000). There is currently insufficient EFH data for this life stage within the Project Area; however, it is possible that eggs could occur in the waters associated with all five quadrants. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability. However, summer flounder eggs are planktonic and do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

*Larvae:* EFH for scup larvae is comprised of pelagic waters from New England to coastal Virginia, at depths of less than 66 ft (20 m). In general, scup larvae are most abundant near shore from May through September, in waters between 55°F and 73°F (12.8°C and 22.8°C), and in salinities greater than 15 PPT (NMFS, 2000). There is currently insufficient EFH data for this life stage in the Project Area; however, it is possible that larvae could occur in the waters associated with all five quadrants. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability.

*Juveniles:* Juvenile scup EFH is comprised of the demersal waters of the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras, wherein the highest 90 percent of all the ranked 10-minute squares of the area where juvenile scup are collected in the NEFSC trawl survey occur. Inshore, EFH consists of estuaries including Massachusetts Bay, Cape Cod Bay, Long Island Sound, Gardiners Bay, Delaware Bay and Chesapeake Bay. During the summer and spring, juvenile scup are found 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 (NMFS, 2000). EFH for juveniles has been identified in all five quadrants, and may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adults:* Adult scup EFH is comprised of the demersal waters of the continental shelf (from the coast out to the limits of the EEZ) from the Gulf of Maine to Cape Hatteras, wherein the highest 90 percent of all the ranked 10-minute squares of the area where adult scup are collected in the NEFSC trawl survey occur. Inshore, EFH includes Cape Cod Bay, Long Island Sound, Gardiners Bay, Hudson River, Raritan Bay, Delaware Bay and Chesapeake Bay. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 45°F (7.2°C) (NMFS, 2000). EFH for these adult fish has been identified in all five quadrants, and may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Black Sea Bass

Black sea bass are concentrated from Cape Cod to Cape Canaveral, Florida and prefer to inhabit rock bottoms near pilings, wrecks, and jetties within this range. There are two distinct and overlapping stocks of black sea bass along the Atlantic coast. They are found in inshore waters at depths of less than 120 ft (37 m) in the summer, and move offshore to deeper waters to the south during the winter and prefer water temperatures of about 48.2°F (9°C) (ASMFC, 2008). Larger adults are usually found in deeper waters than smaller individuals, and larger adults typically begin their migration earlier than the younger adults and juveniles, starting in August (Ross, 1991). Juvenile sea bass migrate inshore and prefer sheltered habitats such as SAV, oyster reefs, and man-made structures. Black sea bass are protogynous hermaphrodites, beginning life as females and then changing to males when they reach about 9 in to 13 in (23 cm to 33 cm) in length. In the Mid-Atlantic, 38 percent of females will change sex between August and April, after the majority of the fish have already spawned. The northern stock of black sea bass spawns off New England from mid-May until the end of June (Ross, 1991), and an average-sized fish will produce roughly 280,000 eggs. The eggs float in the water column, hatching a few days after fertilization. The larvae will drift offshore until they grow to 0.5 in (1 cm) in length, at which point the young sea bass will migrate inshore into estuaries, bays, and sounds (ASMFC, 2008). Black sea bass are common in Rhode Island waters and are considered important to both commercial and recreational fisheries.

*Eggs:* EFH for black sea bass eggs is designated as pelagic waters at depths of about 98 ft (30 m). Generally, black sea bass eggs are found from May through October on the continental shelf, from southern New England to North Carolina (NMFS, 2000). There is currently insufficient EFH data for this life stage in the Project Area; however, it is possible that eggs could occur in the waters associated with all five quadrants. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability. However, black sea bass eggs are planktonic and do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

*Larvae:* EFH for black sea bass larvae is found within any pelagic waters of the continental shelf from the Gulf of Maine to Cape Hatteras, North Carolina. These larvae require temperatures of between 52° to 78° F (11° to 26° C) and salinities of 30 to 35 PPT. Seasonally, these larvae are observed from May to November but their peak is in June and July (NMFS, 2000). EFH for these larvae has been identified in Quadrants 2 and 4 and may be found in waters associated with the Export Cable route within the Project Area. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance through changes in water quality and prey availability. As they transform from larvae into juveniles, they prefer demersal structure such as sponge beds. These structured areas of seabed are generally avoided by the CVOW transmission cable in these two quadrants.

*Juveniles:* Juvenile black sea bass EFH is comprised of 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, wherein the highest 90 percent of all the ranked 10-minute squares of the area where juvenile black sea bass are collected in the NEFSC trawl survey occur. Generally, juvenile black sea bass are found in waters warmer than 42.8°F (6°C) with salinities greater than 18 PPT and coastal areas between Virginia and Massachusetts. These juveniles spend winter offshore from New Jersey south to North Carolina. Juvenile black sea bass are usually found in association with rough bottom, shellfish and eelgrass beds and man-made structures in sandy-shelly areas; offshore clam beds and shell patches may also be used during overwintering (NMFS, 2000). EFH for juveniles has been identified in all five quadrants, and may be found in waters associated with all marine components of the CVOW. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise. In general, the CVOW avoids areas of distinguishable seabed structure, which should minimize potential impacts to juvenile black sea bass. Once installed, the WTG foundations will likely be a favored area of offshore structure for black sea bass.

*Adults:* Mature black sea bass EFH is comprised of the demersal waters of the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras wherein the highest 90 percent of all the ranked 10-minute squares of the area where adult black sea bass are collected in the NEFSC trawl survey occur. Temperatures above 42.8°F (6° C) are preferred, as are salinities greater than 20 PPT. Habitats of seabed relief (natural and man-made) are preferred, although sea bass can also be found in association with sand and shell substrates (NMFS, 2000). EFH for adults has been identified in all five quadrants; therefore, adult sea bass may be found in waters associated with all marine components of the CVOW. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise. In general, the CVOW avoids areas of distinguishable seabed structure, which should minimize potential impacts to black sea bass. Once installed, the VWTG foundations will likely be a favored area of offshore structure for adult black sea bass.

### Surfclam

The Atlantic surfclam is a bivalve mollusk that inhabits sandy continental shelf habitats from the southern Gulf of St. Lawrence to Cape Hatteras. This species may reach a maximum size of 8.9 in (226 mm) and a maximum age of approximately 31 years (Cargnelli et al., 1999c). High concentrations of the planktonic eggs and larvae of Atlantic surfclams can occur from May to June and September to October. Juveniles settle to the substrate and remain there through adulthood. They burrow in medium to coarse sand and gravel substrates, as well as silty to fine sand, but have not been found to burrow in mud (Cargnelli et al., 1999c). The greatest concentrations of Atlantic surfclams are usually found in well-sorted, medium grained sand (Cargnelli et al., 1999c). The size and age of sexual maturity in surfclams is variable. Off of New Jersey, Atlantic surfclams may reach maturity as early as 3 months after settlement, while at the northern extreme of their range, maturity may not be reached until 4 years of age (Cargnelli et al., 1999c). Atlantic surfclams serve as a prey item for finfish species such as haddock and Atlantic cod (Cargnelli et al., 1999c). In the New York Bight, crabs account for 48.3 to 100 percent of Atlantic surfclam mortality, while moon snails accounted for 2.1 percent (MacKenzie et al., 1985).

*Juveniles:* EFH for juvenile surfclams is defined as federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90 percent of all the ranked 10-minute squares for the area where surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys. Juvenile and adult surfclams are found within the substrate to a depth of 3 ft (0.9 m) below the water/sediment interface. Surfclams generally occur from the beach zone to a depth of about 200 ft (61 m), but beyond about 125 ft (38.1 m) their densities are low (NMFS, 2000). EFH for juveniles has been identified in Quadrants 2, 3, and 4 and may occur along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance as well as changes in water quality and prey availability.

*Adults:* EFH for adult surfclams is defined as federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90 percent of all the ranked 10-minute squares for the area where surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys. Adult surfclams are found within the substrate to a depth of 3 ft (0.9 m) below the water/sediment interface. Surfclams generally occur from the beach zone to a depth of about 200 ft (61 m), but beyond about 125 ft (38.1 m) their densities are low (NMFS, 2000). EFH for adults has been identified in Quadrant 3, and adult surfclams may occur along the CVOW Export Cable route. The primary impacts potentially caused by cable laying and cable protection activities are displacement due to habitat disturbance as well as changes in water quality and prey availability. No *Spisula sp.* were identified from grab sample analysis from the cable route or foundations.

**Ocean Quahog**

*Eggs and larvae*: Ocean quahog EFH for eggs and larvae has not been defined. However, eggs and larvae are planktonic and could occur over large portions of the Atlantic EEZ and are thus included in Table 1.

*Juveniles and adults*: Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where ocean quahogs were caught in the NEFSC surfclam and ocean quahog dredge surveys. Distribution in the western Atlantic ranges in depths from 30 feet to about 800 feet. Ocean quahogs are rarely found where bottom water temperatures exceed 60 degrees F, and occur progressively further offshore between Cape Cod and Cape Hatteras.

The NEFSC's 2012 ocean quahog/Atlantic surfclam resource survey report (Delmarva – Long Island) (see: http://www.nefsc.noaa.gov/femad/ecosurvey/mainpage/rsr/clam/clam_2012/large_file.pdf) indicates that there are no ocean quahogs found south of 37 degrees N latitude (approximately equal to Norfolk Canyon). It is highly unlikely that the proposed project area could be considered EFH for juveniles and adults because they do not encompass the top 90% of all the ranked 10-minute squares from logbook data from 1981-2008 (see Figure B-11 – B-13 in 48$^{th}$ SAW assessment workshop: http://www.nefsc.noaa.gov/publications/crd/crd0915/pdfs/quahog.pdf). Furthermore there was no evidence of any ocean quahogs from the extensive grab sampling effort conducted as part of the benthic habitat assessment (see Benthic Habitat Assessment Appendix). Furthermore, if any additional pre-construction survey work revealed a shellfish bed then the area would need to be identified per BOEM's regulations at 30 CFR 585.627 and avoided per BOEM's best management practices (see COP submission guidelines (http://www.boem.gov/COP-Guidelines-Version-2.0-Final/). If however, in a rare instance that construction activity impacts an individual ocean quahog by direct impact or covering from deposition of suspended sediment, then that animal may suffer impacts ranging from diminished biological functioning (i.e. feeding) to total mortality. Planktonic eggs and larvae could be present in the action area, however since the proposed action is not anticipated to significantly alter the quality and quantity water column habitat outside the presence of the two foundations of the facility, no impacts to eggs and larvae are anticipated.

## Spiny Dogfish

Spiny dogfish range from Labrador to Florida. They migrate north during the spring and summer, and south in the fall and winter. Juvenile and adult spiny dogfish are abundant in the Mid-Atlantic waters extending to the southern part of Georges Bank during the winter. During the summer months, they are found farther north through Canadian waters, and will move inshore into bays and estuaries (ASMFC, 2008). In the fall, they are commonly found closer to shore, and are abundant in southern New England waters (NEFSC, 2006). Spiny dogfish are ovoviviparous and usually give birth in the fall or winter. Newborn spiny dogfish are about 10 in (26 cm to 27 cm) in length at birth and they do not reach maturity for 10 years or more. Mating occurs in the winter months, and pups are delivered on the offshore wintering grounds (ASMFC, 2008). Females will produce a litter of between 1 and 15 pups each, usually averaging 6 to 7 pups, and females do so every 2 years. Spiny dogfish eat a variety of fish of many sizes, including herring and hake, squid, and ctenophores. They also eat bivalves, especially scallops, off southern New England and within the mid-Atlantic.

*Eggs:* Not applicable, since this species is ovoviviparous.

*Larvae:* There is not enough data in the literature to determine larval dogfish EFH.

*Juveniles:* North of Cape Hatteras, EFH for juvenile spiny dogfish is designated as the waters of the continental shelf from the Gulf of Maine through Cape Hatteras, in areas that encompass the highest 90 percent of all ranked 10-minute squares for the area where juvenile dogfish were collected in the NEFSC trawl surveys. Spiny dogfish are usually epibenthic, but occur throughout the water column and are found from near shore shallows to offshore shelf waters to 1,279 ft (390 m). In the spring, juveniles occur in deeper, generally warmer waters on the outer shelf from North Carolina to Georges Bank. In the fall, they occur in the shallower, moderately warm waters from the mid-Atlantic into the Gulf of Maine. Their seasonal distribution is similar in coastal areas. Dogfish are transient visitors to estuaries where they prefer higher salinities (NMFS, 2000). EFH for juveniles has been identified in all five quadrants, and may occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adults:* EFH for adult spiny dogfish is designated as the waters of the continental shelf from the Gulf of Maine through Cape Hatteras, in areas that encompass the highest 90 percent of all ranked 10-minute squares for the area where adult dogfish were collected in the NEFSC trawl surveys. Spiny dogfish are usually epibenthic, but occur throughout the water column and are found from near shore shallows to offshore shelf waters to 1,476 ft (450 m). In the spring, adults occur in deeper, generally warmer waters on the outer shelf from North Carolina to Georges Bank. In the fall, they occur in the shallower, moderately warm waters from the mid-Atlantic into the Gulf of Maine. Their seasonal distribution is similar in coastal areas. Dogfish are transient visitors to estuaries where they prefer higher salinities of 30 to 32 PPT (NMFS, 2000). EFH for adults has been identified in Quadrants 2, 3, 4, and 5, and may occur throughout the offshore portion of the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### King Mackerel

King mackerel, a coastal migratory pelagic species, are commonly distributed along the continental shelf in the warmer waters of the western Atlantic Ocean from North Carolina to Brazil, but occasionally stray as far north as Massachusetts (Collette and Klein-MacPhee, 2002). This species does not typically occur beyond the continental shelf break (GMFMC and SAFMC, 2004). King mackerel have a protracted spawning season, which runs from May to October, and their eggs are pelagic (Godcharles and Murphy, 1986). King mackerel exhibit seasonal movements. During the summer, these fish migrate north occurring in the waters off of Virginia and the Carolinas, remaining there through fall. As the waters become cooler in the winter, they migrate south again towards Florida (Godcharles and Murphy, 1986; Schaefer and Fable, 1994).

*Eggs, Larvae, Juveniles, and Adults:* EFH for all life stages of this species includes all estuaries; the United States/Mexican border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council (GMFMC) and the South Atlantic Fishery Management Council (SAFMC) from estuarine waters out to depths of 600 ft (183 m). EFH also 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, but from the Gulf Stream shoreward, including Sargassum. In addition, EFH includes all coastal inlets and all state-designated nursery habitats of particular importance to coastal migratory pelagic species (NMFS, 2000). EFH for all king mackerel life stages has been identified in all five quadrants; therefore, all life stages of king mackerel may be found within the Project Area during summer and early fall, based on water temperature. Depending on the life stage, the primary impacts potentially caused by construction, operation and decommissioning activities include displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise. However, king mackerel eggs are planktonic and do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

### Spanish Mackerel

Spanish mackerel, a coastal migratory pelagic species, are abundant from the waters surrounding the Chesapeake Bay south through the Gulf of Mexico; however, they occasionally occur as far north as coastal southern New England (Collette and Klein-MacPhee, 2002). Spanish mackerel have a protracted spawning season, which runs from April to September (GMFMC and SAFMC 2004; Godcharles and Murphy, 1986). The onset of spawning progresses from south to north and occurs over the inner continental shelf in waters 39 ft to 112 ft (12 m to 34 m) deep. Spawning of this species' pelagic eggs starts in April off the Carolinas, occurs in mid-June in the Chesapeake Bay and from late August into September off the coasts of New Jersey and New York (Godcharles and Murphy, 1986; Collette and Klein-MacPhee, 2002). Spanish mackerel make seasonal migrations along the Atlantic coast. They are found off of Florida during the winter and migrate north as coastal waters warm. They arrive off of the Carolinas in April, off of Virginia by May, and as far north as Martha's Vineyard, Massachusetts by July in some years. They remain in the cooler northern waters until September before beginning their migration south again following their preferred water temperatures (GMFMC and SAFMC, 2004).

*Eggs, Larvae, Juveniles, and Adults:* EFH for all life stages of Spanish mackerel includes all estuaries; the United States/Mexican border to the boundary between the areas covered by the GMFMC, and the

SAFMC from estuarine waters out to depths of 600 ft (183 m). EFH also 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, but from the Gulf Stream shoreward, including Sargassum. In addition, EFH includes all coastal inlets and all state-designated nursery habitats of particular importance to coastal migratory pelagic species (NMFS, 2000). EFH for all Spanish mackerel life stages has been identified in all five quadrants; therefore, all life stages of the Spanish mackerel may be found within the Project Area during summer and early fall, based on water temperature. Depending on the life stage, the primary impacts potentially caused by construction, operation and decommissioning activities include displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise. However, Spanish mackerel eggs are planktonic and do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

**Cobia**

Cobia, a coastal migratory pelagic species, is distributed worldwide throughout tropical, subtropical, and warm-temperate waters, with the exception of the eastern Pacific Ocean (Williams, 2001). In the northwest Atlantic, cobia range from Massachusetts to Argentina, including Bermuda, but are most common along the U.S. coast from Virginia to the northern Gulf of Mexico (Franks et al., 1999). Spawning occurs in the daylight hours between April and September in estuarine or shelf waters (Ditty and Shaw, 1992). Cobia are batch spawners and form large breeding aggregations during spawning events (Bester, 1999; Williams, 2001). Cobia eggs and larvae are pelagic and found at the surface or within the upper meter of the water column (Ditty and Shaw, 1992). Following the spawning season, cobia migrate south to warmer offshore waters of the Florida Keys during the autumn and winter. In the spring, they begin their migration north to the poly/mesohaline waters of coastal Virginia and the Carolinas for the summer and to spawn (Williams, 2001).

*Eggs, Larvae, Juveniles, and Adults:* EFH for all life stages of cobia includes all estuaries; the U.S./Mexican border to the boundary between the areas covered by the GMFMC, and the SAFMC from estuarine waters out to depths of 600 ft (183 m). EFH also includes high salinity bays, estuaries, and sea grass habitat. In addition, the Gulf Stream is an EFH because it provides a mechanism to disperse coastal migratory pelagic larvae. EFH also 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, but from the Gulf Stream shoreward, including Sargassum. In addition, EFH includes all coastal inlets and all state designated nursery habitats of particular importance to coastal migratory pelagic species (NMFS, 2000). EFH for all cobia life stages has been identified in all five quadrants; therefore, cobia may be found throughout the Project Area during summer and early fall, based on water temperature. Depending on the life stage, the primary impacts potentially caused by construction, operation and decommissioning activities include displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise. However, cobia eggs are planktonic and do not rely on external prey sources; therefore, potential impacts to this life stage by the CVOW would be negligible.

**Red Drum**

Red drum EFH is no longer designated outside of the GMFMC; however, designated EFH for this species was shown in the 10 by 10 minute squares overlapping the Project Area. Therefore, for the sake of completeness, it has been discussed here. According to the Atlantic States Marine Fisheries Council (ASMFC), the historic distribution of red drum on the Atlantic coast is from Massachusetts through Florida, though few fish have been reported north of Delaware Bay in recent years. Juveniles are quite abundant in estuarine waters and inlets, while fish older than age 4 inhabit deeper, coastal waters. The adult fish migrate seasonally, moving offshore or south in the winter and inshore or north in the spring. Spawning occurs at night in the near shore waters during the summer and fall. Red drums are known for their spawning events when large females produce up to 2 million eggs in a single spawning season. Eggs hatch within 24 to 36 hours of being spawned, and the larvae are carried by wind and tidal action into shallow, low-salinity estuarine nursery areas. Juveniles and sub-adults stay in estuarine areas feeding on zooplankton and micro-invertebrates such as small crabs and shrimp. As they grow, red drums start to consume finfish and larger invertebrates. Depending on the area, males mature between age 1 and 4 (20-28 inches in length), while females mature between age 3 and 6 (31-36 inches in length). Red drum may reach 60 years of age and 60 inches in length (corresponding to greater than 90 pounds in weight (ASMFC, 2013).

*Eggs and Larvae:* Eggs and pelagic larvae utilize low-salinity waters inside inlets, passes and bays as well as estuarine systems within their range as a whole. As such, these life stages are unlikely to be present within the Project Area.

*Juveniles and Adults:* Redfish juveniles utilize a variety of inshore habitats, including those potentially found in the Project Area, such as shell banks and areas of unconsolidated substrate (soft sediments). Sub-adults are found along coastal beaches during certain times of the year. During fall migrations, adults use hard/live bottom areas and artificial reefs, especially off South Carolina and Georgia. As such, juvenile and adult redfish seem more likely to be found within the Project Area. It is not appropriate to use sea surface temperature tolerances to predict the presence or absence of redfish, as these fish are considered nearly eurythermic (ASMFC, 2013). The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Sand Tiger Shark

Sand tiger sharks are known to have a broad inshore distribution in tropical and warm-temperate waters throughout the world, but are nonexistent in the eastern Pacific Ocean (Castro, 1983; Collette and Klein-MacPhee, 2002). In the western Atlantic, the sand tiger sharks occur from the Gulf of Maine to Florida, the northern Gulf of Mexico, the Bahamas, Bermuda, and southward to Argentina (Castro, 1983; Compagno, 1984). In warmer months, this species is common from Cape Cod to the Chesapeake Bay (Castro, 1983). Sand tiger sharks mate in the winter and spring, with parturition beginning during the early winter months from late October to the end of November (Collette and Klein-MacPhee, 2002). In Florida, sand tiger sharks are born from November to February (Castro, 1983). The neonates then migrate northward to their summer nurseries. Sand tiger sharks are migratory in the northern portion of their range, moving northward and shoreward during the summer and south and offshore in the fall and winter (Castro, 1983; Compagno, 1984). Sand tiger sharks are demersal sharks found primarily in shallow bays and around coral or rocky reefs (depths less than 65.6 ft [20 m]), but also can be found to depths of 627 ft (191 m) over the continental shelf (Compagno, 1984; Collette and Klein-MacPhee, 2002). Neonate and juvenile sand tiger sharks utilize estuarine waters as nurseries from Massachusetts to South Carolina (McCandless et al., 2002). As with many shark species, the sand tiger shark is common in the waters of Virginia and is frequently targeted by recreational fishermen.

*Neonates:* EFH for neonate sand tiger sharks is designated as the shallow coastal waters to 82 ft (25 m) from Cape Cod to Cape Canaveral, Florida. EFH for neonate sand tiger sharks has been identified in all five quadrants, and has the potential to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Juveniles:* No designated EFH for this life stage occurs within the Project Area.

*Adults:* EFH for adult sand tiger sharks extends from southern New Jersey to the east coast of Florida.

EFH has been identified in all five quadrants; therefore, these sharks have the potential to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Atlantic Sharpnose Shark

The Atlantic sharpnose shark has a broad distribution and can be commonly found from New Brunswick, Canada, through the Gulf of Mexico as well as along the coast of Brazil. This shark commonly inhabits both temperate and tropical waters from the Canadian maritime coast to Mexico's Yucatan peninsula. As year round residents off the shore of South Carolina, Florida, and the Florida Keys, this species makes regular inshore to offshore migrations. Atlantic sharpnose sharks have been observed to form large sexually segregated schools during these migrations. As winter approaches, the sharks move offshore into deeper water, returning inshore to mate in spring and give birth after a 10 to 11 month gestation period. They are found at depths to 920 ft (280 m), but most remain in waters less than 32 ft (10 m) deep. Along with being common residents of the surf zone, the Atlantic sharpnose shark is also found in estuaries and harbors. Although this shark is able to tolerate lower salinity levels, they do not venture into freshwater like the bull shark (*Carcharhinus leucas*) (FMNH, 2013).

*Neonates:* No EFH for neonatal sharpnose sharks has been identified in the Project Area.

*Juveniles:* No EFH for juvenile sharpnose sharks has been identified in the Project Area.

*Adults:* EFH for adult sharpnose sharks has been identified in all five quadrants; therefore, these sharks have the potential to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Dusky Shark

The dusky shark has a wide-ranging distribution in warm-temperate and tropical continental waters throughout the world and can be found in the western Atlantic from southern Massachusetts and Georges Bank southward through the northern Caribbean Sea and Gulf of Mexico to as far south Nicaragua and southern Brazil (Compagno, 1984; Castro, 1993). Dusky sharks are coastal and pelagic in distribution and occur from the surf zone to well offshore and from surface waters to depths of 1,312 ft (400 m) (Compagno, 1984). Mating for this species in the western Atlantic occurs in the spring, and birth to live young can occur over several months from late winter to summer (Compagno, 1984). Females mate in alternate years as a result of their long gestation period (9 to 16 months). The dusky shark undertakes long seasonal, temperature-related migrations. On both coasts of the United States, this species migrates northward in summer as the waters warm and retreats southward in fall as water temperatures decline (Compagno, 1984). Major nursery areas have been identified in coastal waters from Massachusetts to the South Carolina coast, including Bulls Bay, South Carolina (Castro, 1993). As with many shark species, the dusky shark is common in the waters of Virginia and typically targeted by recreational fishing.

*Neonates:* Unlike other shark species of the western Atlantic, these newborn sharks do not use estuarine habitats for protection during their development. These sharks are usually born at 33 to 39 in (0.8 to 1 m) long and are, therefore, less vulnerable to predators than smaller, inshore species. In addition, they do not tolerate water of lower salinities, as is often found in river-fed estuaries. These sharks are more often found in the surf zone and offshore. That said, female dusky sharks can birth their young at a variety of sizes and ages and in locations that they select based upon how likely their young are to thrive. Neonatal dusky shark EFH has been identified in all five quadrants, and has the potential to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Juveniles:* Juvenile dusky sharks consume a wide variety of prey including boney fish and cephalopods as well as occasional crustaceans, sea stars, bryozoans, sea turtles, marine mammals, carrion, and even garbage (NOAA Fisheries, 2011). EFH for juvenile dusky sharks has been identified in all five quadrants, and has the potential to occur throughout the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adults:* No designated EFH for this life stage occurs within the Project Area.

### Shortfin Mako Shark

The shortfin mako shark has a worldwide distribution. It ranges from the Grand Banks and Gulf of Maine in the western Atlantic southward to the tropics, including the Gulf of Mexico (Schultz, 2004). It is commonly found offshore from Cape Cod to Cape Hatteras, though it can be scarce during specific years (Castro, 1983). Relatively little data exist on the migratory patterns of the shortfin mako shark. Within the northern extent of its range, this species is believed to follow the movement of warm-water masses towards the poles in the summer (Compagno, 1984). The shortfin mako shark has a 2- or 3-year reproductive cycle, a gestation period of approximately 18 months, and a late winter to mid-spring parturition (Mollet et al., 2000). The shortfin mako shark is found in warm-temperate to tropical waters around the world, but is rarely found in water temperatures lower than 60.8°F (16°C) (Compagno, 1984). This shark is an epipelagic species typically found from the surface to depths of 498 ft (152 m), but has been recorded as deep as 2,427 ft (740 m) (Compagno, 1984; Wood, 2007). The shortfin mako shark is common in the waters of Virginia and typically targeted by offshore recreational fishing.

*Neonates:* EFH for neonate shortfin mako is designated between 164 ft and 6,561 ft (50 m and 2,000 m) water depth from southeast of Georges Bank to Cape Lookout, North Carolina and from 82 ft to 164 ft (25 m to 50 m) offshore from the Chesapeake Bay to a line running west of Long Island, New York to just southwest of Georges Bank. Localized areas in the central Gulf of Mexico and around the Florida Keys have been designated EFH, as well as areas off South Carolina (NMFS, 2009). EFH for neonatal shortfin mako sharks has been identified in Quadrant 5; therefore, neonatal shortfin makos have the potential to occur in and around the WTG foundation areas. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Juvenile:* No designated EFH for this life stage occurs within the Project Area.

*Adult:* No designated EFH for this life stage occurs within the Project Area.

### Sandbar Shark

Sandbar sharks are found in shallow coastal waters from Cape Cod southward to Brazil, including the Gulf of Mexico and the Caribbean Sea, but are most common from South Carolina to Florida and in the eastern Gulf of Mexico (Castro, 1983; Compagno, 1984). This bottom-dwelling species is found in temperate to tropical waters over the continental shelf and in deep water adjacent to the shelf break. Sandbar sharks are found in water depths ranging from the intertidal zone to 918 ft (280 m) during migration, but are common in 66 ft to 213 ft (20 m to 65 m) depths (Compagno, 1984). Sandbar sharks avoid surf zones, coral reefs, or rough benthic substrates, preferring smooth substrates (Castro, 1983; Compagno, 1984). They are common in inshore areas with mud or sand substrates such as estuaries, river mouths, and harbors, but do not enter freshwater (Compagno, 1984). Sandbar sharks make an extensive seasonal migration, moving to the northern part of their range in the summer and the southern part during the winter (Castro, 1983). Seasonal temperature changes are the primary trigger for the migration; however, oceanographic features also influence this behavior (Compagno, 1984). In the northwest Atlantic, mating occurs from May to June with young being born from March to August after a gestation period of approximately 1 year (Castro, 1983). This species segregates by sex, with large females dominating shallow, nursery areas from Delaware Bay to Cape Canaveral, Florida, as well as the Gulf of Mexico (Castro, 1983). The Chesapeake Bay is regarded as one of the primary nursery grounds in the mid- Atlantic (Grubbs, 2001). As with many shark species, the sandbar shark is common in the waters of Virginia and typically targeted by recreational fishing.

*Neonates, Juveniles and Adults:* EFH for juvenile and neonatal sandbar sharks is designated as all coastal and pelagic waters offshore from Cape Poge Bay and the south shore of Cape Cod to Long Island, New York; shallow coastal areas out to the 82-ft (25-m) depth contour from Barnegat Inlet, New Jersey to Cape Canaveral, Florida; and in the Mid-Atlantic Bight during the winter, the benthic areas underlying the shelf break between the 295-ft to 656-ft (90-m to 200-m) depth contours. Neonatal sandbar sharks are born between June-August in the western Atlantic and are born live at 22 to 28 in (55 to 70 cm) in length. While the neonates are not known to travel into riverine environments, they are often found in large estuaries like Delaware and Chesapeake Bay. Recent studies indicate that this preference is likely due to the prevalence of soft shelled blue crabs, a preferred food item for these newborn sharks. EFH for juvenile and neonatal sandbar sharks has been identified in all five quadrants (NMFS, 2000). EFH for the adult sandbar shark is shallow coastal waters to the 82 ft (25 m) depth contour from Barnegat Inlet, New Jersey to south of Cape Canaveral, Florida. Additional EFH designated for this life stage is areas north of Barnegat Inlet, New Jersey and regions off western Florida. A comprehensive stock assessment for this species is considered difficult as they are found in the United States to Yucatan, Mexico, Cuba and Bahamas; possibly to Belize, Honduras, Costa Rica, Panama, Columbia, Trinidad and Tobago, and Venezuela, with southern population extending from southern Brazil to northern Argentina. EFH for sandbar shark adults has been identified in all five quadrants (NMFS, 2000). The primary impacts potentially caused by construction, operation and decommissioning activities to these life stages are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Scalloped Hammerhead Shark

Scalloped hammerhead sharks are fairly large sharks with a nearly universal oceanic distribution. The eight species of hammerhead sharks are characterized by the flat, extended head called a cephalofoil. The cephalofoil of a scalloped hammerhead shark is characterized by an indentation located in the center of the head. Two additional indents are seen on both sides of the first, giving this shark its name. They feed on various crustaceans, teleost fish, cephalopods, and rays. The scalloped hammerhead is a coastal pelagic shark that can also be found well offshore. It is commonly found on continental shelves adjacent to deeper water. It has been observed close inshore and even entering estuarine habitats, as well as offshore to depths of 3,280 ft (1,000 m). Adult aggregations are common at seamounts, especially near Malpelo Ridge, Columbia, Revillagigedo Islands, Jalisco, Mexico, and in specific locations within the Gulf of California, but otherwise adults are solitary or found in pairs (Baum et al., 2007).

*Neonates:* No designated EFH for this life stage occurs within the Project Area.

*Juveniles:* EFH for juvenile scalloped hammerhead sharks has been identified in all five quadrants within the Project Area. Recent research shows that juveniles usually remain near shore to avoid predation by larger pelagic sharks, as well as to remain close to concentrated prey such as small schooling fish like mackerel and herring. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adults:* No designated EFH for this life stage occurs within the Project Area.

### Tiger Shark

The tiger shark is found throughout the Atlantic coast of the United States from Cape Cod, Massachusetts, to the Gulf of Mexico and the Caribbean Sea (Randall, 1992). This shark inhabits coastal waters close to shore as well as the outer continental shelf. One of the largest shark species, the largest individuals are believed to exceed 18 ft (5.5 m) and 2,000 lb. Tiger sharks are opportunistic feeders that take advantage of nearly any prey item they can find including sea turtles, rays, other sharks, bony fishes, sea birds, dolphins, squid, various crustaceans, and even carrion and human refuse. Adults mature at approximately 9 feet in length and litters are large, mean litter sizes often comprising from 35 to 55 pups (Tester 1969, Bass et al. 1975, Simpfendorfer 1992). In the Northern Hemisphere, mating takes place between March and May and the young are born between April and June of the following year. It is believed by some scientists that because of the large size of the young at birth, uterine nutrition is supplemented by 'uterine milk' secreted by the lining of the uterus – a very unique anatomical trait. The pups are long and slender, measuring from 20 to 35 in (51 to 90 cm, TL) (Randall 1992, Simpfendorfer 1992). These neonates have clearly defined vertical stripes which fade as they mature into adults. They grow slowly and feed readily, which makes them vulnerable to declines in population due to overfishing.

*Neonates, Juveniles and Adults:* EFH for neonatal, juvenile and adult tiger sharks has been identified in all five quadrants within the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

### Bluefin Tuna

Bluefin tuna have a worldwide distribution in tropical and temperate waters from Argentina and South Africa north to Labrador and northern Scandinavia in the Atlantic Ocean, including the Gulf of Mexico and the Caribbean Sea (Schultz, 2004). The western Atlantic bluefin tuna spawns from mid-April to mid-June in the Gulf of Mexico, the Florida Straits, the western edge of the Bahamas Banks, and along the eastern portion of the Florida current at temperatures of 76.8°F to 85.1°F (24.9°C to 29.5°C) (Gusey, 1981; Collette and Nauen, 1983). The Gulf of Mexico spawning site is considered the primary spawning area of the northwest Atlantic (Mather et al., 1995; Block et al., 2001). The adult bluefin tuna moves seasonally from offshore spawning grounds in the Gulf of Mexico through the Straits of Florida to inshore seasonal feeding grounds in the northern part of their range in the northwestern Atlantic (Jeffreys Ledge, Stellwagen Bank, Cape Cod Bay, Great South Channel, the continental shelf south of Martha's Vineyard and Nantucket) in the early spring and summer and finally to North Carolina, Blake Plateau, or the Bahamas during the winter (Gusey, 1981; Block et al., 2001; Chase, 2002). Data on the three-way movements of adults from these feeding areas to wintering areas and back to breeding areas are limited. It is postulated that juveniles have a shorter two-way movement from feeding to wintering areas (Mather et al., 1995; Chase, 2002). This species can tolerate a considerable range of temperatures and has been observed at depths greater than 3,280.8 ft (1,000 m) (Block et al., 2001). Although bluefin tuna are epipelagic and oceanic, they often occur over continental shelf waters and in embayments during the summer months (Collette and Klein-MacPhee, 2002). Juveniles typically inhabit regions off the continental shelf, from North Carolina to Maine, in waters with depths less than 131 ft (40 m) and temperatures greater than 68°F (20°C) in the summer (Schuck, 1982; Brill et al., 2002). Juveniles along the continental shelf utilize the entire water column, including the benthic habitat, but spend the majority of their time near the surface (Brill et al. 2002). Fertilized eggs are buoyant (Collette and Klein-MacPhee, 2002).

*Eggs:* No designated EFH for this life stage occurs within the Project Area.

*Larvae:* No designated EFH for this life stage occurs within the Project Area.

*Juvenile:* EFH for the juvenile bluefin tuna is designated as all inshore and pelagic surface waters warmer than 53.6°F (12°C) from the Gulf of Maine to Cape Cod Bay, and Nantucket Shoals south to Cape Hatteras between the 82-ft and 656-ft (25-m and 200-m) isobaths. Additional EFH designated for this life stage is found in the Florida Straits. EFH for juvenile bluefin tuna has been identified in Quadrant 5 of the

Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adult:* EFH for adult bluefin tuna is designated in the Gulf of Maine, Georges Bank, the Mid-Atlantic Bight, and the Gulf of Mexico. EFH for adults has been identified in Quadrant 5 of the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

**Thorny Skate (excerpted from NE Skate FMP)**

In its Report to Congress: Status of the Fisheries of the United States (January 2001), NMFS determined that thorny skate is in an overfished condition, based on stock size assessment. Because recent assessments determined that more information is needed to draw valid conclusions regarding the status of this stock, it is not known whether overfishing is occurring. For thorny skate, essential fish habitat is described as those areas of coastal and offshore waters (out to the offshore U.S. boundary of the exclusive economic zone) that are designated on Figure 11 – Figure 12 (for Figures see: http://www.greateratlantic.fisheries.noaa.gov/hcd/skateefhmaps.htm) and meet the following conditions:

*Eggs*: There is no information available on the habitat associations or distribution of the egg stage for this species.

*Larvae*: No larval life stage exists for this species. Upon hatching, they are fully developed juveniles (ELMR Report Number 12, March 1994).

*Juveniles*: Bottom habitats with a substrate of sand, gravel, broken shell, pebbles, and soft mud in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where thorny skate juveniles are found: Depth: The full depth range is from 18-2000 meters, but they are most abundant between 111-366 meters. Temperature: Juveniles are found in waters with temperatures ranging from –1.3 °C to 17 °C, with most found between 5-9 °C.

*Adults*: Bottom habitats with a substrate of sand, gravel, broken shell, pebbles, and soft mud in the Gulf of Maine and Georges Bank. Generally, the following conditions exist where thorny skate adults are found: Depth: The full depth range is from 18-2000 meters, but they are most abundant between 111-366 meters. Temperature: Adults are found in waters with temperatures ranging from –1.3 °C to 17 °C, with most found between 5-8 °C.

Since there is no adult or juvenile thorny skate EFH designated in the action area offshore Virginia then none is expected to be impacted from the proposed action. Planktonic eggs and larvae could be present in the action area however since the proposed action is not anticipated to significantly alter the quality and quantity water column habitat outside the presence of the two foundations of the facility, no impacts to eggs and larvae are anticipated.

**Clearnose Skate (excerpted from NE Skate FMP)**

(for figures see: http://www.greateratlantic.fisheries.noaa.gov/hcd/skateefhmaps.htm).

Eggs: There is no information available on the habitat associations or distribution of the egg stage for this species.

Larvae: No larval life stage exists for this species. Upon hatching, they are fully developed juveniles (ELMR Report Number 12, March 1994).

Juveniles: Bottom habitats with a substrate of soft bottom along the continental shelf and rocky or gravelly bottom, ranging from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina (the southern boundary of the NEFMC management unit). Generally, the following conditions exist where clearnose skate juveniles are found: Depth: Their full range is from the shore to 500 meters, but they are most abundant at depths less than 111 meters. Temperature: Occurs over a temperature range of 9-30 °C, but are most abundant from 9-21 °C in the northern part of its range and 19-30 °C around North Carolina.

Adults: Bottom habitats with a substrate of soft bottom along the continental shelf and rocky or gravelly bottom, ranging from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina (the southern boundary of the NEFMC management unit) as depicted on the map (http://www.greateratlantic.fisheries.noaa.gov/hcd/skateefhmaps.htm). Generally, the following conditions exist where clearnose skate adults are found: Depth: Their full range is from the shore to 400 meters, but they are most abundant at depths less than 111 meters. Temperature: Occurs over a temperature range of 9-30 °C, but are most abundant from 9-21 °C in the northern part of its range and 19-30 °C around North Carolina.

Clearnose skate EFH for juveniles and adults occurs throughout the action area (all 5 quadrants). Individuals may be found in waters associated with the Export Cable as well as the WTGs and Inter-Array Cable within the Project Area. The primary impacts to individuals and EFH potentially caused by these activities are temporary and permanent displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

**Swordfish**

The swordfish is a unique and poorly understood animal. Swordfish are pelagic fish, living within the water column rather than on the bottom or in coastal areas. They are found at depths of 590 to 1,900 ft (180 to 580 m), and are distributed worldwide in temperate and tropical waters. They are believed to prefer waters where the surface temperature is above 58° F (15° C), although they can tolerate temperatures as low as 50° F (10° C), especially larger individuals. Male swordfish rarely exceed 200 pounds, so nearly all of the largest specimens are female (Schwartz et al., 1993).

Swordfish are summer and fall visitors to Mid-Atlantic and New England waters, entering the warming Atlantic coastal waters from far offshore in the Gulf Stream around June and departing in late October. Evidence suggests that such onshore-offshore seasonal migrations are more prevalent than are migrations between the northern feeding areas off Cape Hatteras and the southern spawning grounds off Florida and the Caribbean. Swordfish reach sexual maturity at about 2 to 3 years of age, and live for at least 9 years. While they may survive longer, no such documentation exists. The majority of swordfish caught in the North Atlantic sport fishery are thought to be 4 to 5 years old. Spawning is year-round in the Caribbean Sea, Gulf of Mexico, the Florida coast and other warm equatorial waters but seasonal in the north

Atlantic. Spawning is known to occur in the Sargasso Sea in water warmer than 73 ° F (23 ° C) and less than 246 ft (75 m) deep (Schwartz et al., 1993).

*Eggs:* No designated EFH for this life stage occurs within the Project Area.

*Larvae:* No designated EFH for this life stage occurs within the Project Area.

*Juveniles:* EFH for juvenile swordfish has been identified in Quadrant 5 within the Project Area. Young adults and juveniles are eaten by a variety of sharks and other large predatory fish including blue marlin, black marlin, sailfish, yellowfin tuna and the mahi mahi, some of which are also expected in the Project Area. The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

*Adults:* No designated EFH for this life stage occurs within the Project Area.

### Skipjack Tuna

The skipjack tuna is found throughout many of the world's oceans, mainly in the tropical areas of the Atlantic, Indian, and Pacific Oceans. The greatest abundance of skipjack in all these oceans is seen near the equator. It is a small tuna and matures at an early age, making it resilient to extremely high levels of fishing when compared to most other tuna species. It is the smallest of all the commercially harvested tunas worldwide and is often found schooling with small yellowfin and bigeye tuna. It is an important commercial fish, especially in the equatorial distant water fleet, and is usually caught using purse seine nets. Skipjack tuna was the world's second most important captured fish species in 2009, with reported global commercial landings of almost 2.6 million tons. Skipjack are oviparous. In warm equatorial waters, skipjack spawn year-round while further away from the equator, spawning season is limited to warm months. Sexual maturity may occur as small as 15 inches (40 cm) in length, however, most fish appear to mature at larger sizes. Large females produce significantly more eggs than smaller females, with the average adult producing 80,000 to 2 million eggs per year (Collette and Nauen, 1983).

*Eggs:* No designated EFH for this life stage occurs within the Project Area.

*Larvae:* No designated EFH for this life stage occurs within the Project Area.

*Juveniles:* No designated EFH for this life stage occurs within the Project Area.

*Adults:* EFH for adult skipjack tuna has been identified in Quadrant 5. Aggregations of skipjack tuna are often associated with convergences and/or other hydrographic discontinuities, such as thermoclines or haloclines. Skipjack tuna schools also associate with birds, drifting objects, whales, sharks, and schools of other tuna species (Colette and Nauen, 1983). The optimum temperature for the species is 81° F (27° C) with a range from 68° F (20° C) to 88° F (31° C; ICCAT, 1995). The primary impacts potentially caused by construction, operation and decommissioning activities are displacement due to habitat modification and disturbance through changes in water quality and prey availability, and noise.

## Analysis of the Effects of the Proposed Action on EFH and Associated Fish Species

The following section provides an in-depth analysis, and subsequent determinations, of each of the potential impacts to EFH and associated fish species identified in the section above.

### Noise Impacts

There are very substantial gaps in the current understanding of the effects of man-made sounds on fish (Hawkins et al., 2014); however, sufficient information is available to confirm that man-made sources of noise can and do affect fish, fisheries and invertebrates adversely (Normandeau, 2012). The introduction of acute and chronic sound sources into the marine environment may impact fish through masking of communication and other sounds of the natural environment and through physical sound pressure related impacts. The primary sounds that CVOW would introduce during construction would be acute in that they would be of limited spatial and temporal exposure.

Due to the fact that an important impact producing factor to fish from the proposed activities is from the sound produced during construction of the two turbines, primarily pile driving, it is important to give a brief summary of the hearing capabilities of fish. Sound plays a major role in the lives of all fishes (e.g., Zelick et al., 1999; Fay and Popper, 2000). This is particularly the case because sound travels much farther in water than other potential signals, and it is not impeded by darkness, currents, or objects in the open water environment. In addition to listening to the overall environment and being able to detect sounds of biological relevance (e.g., the presence of a reef, the sounds produced by swimming predators), many species of bony fishes (but not elasmobranchs [sharks and rays]) communicate with sounds and use sounds in a wide range of behaviors including, but not limited to, mating and territorial interactions (see Zelick et al., 1999).

Basic data on hearing provide information about the range of frequencies that a fish can detect and the lowest sound level that a fish is able to detect at a particular frequency; this level is often called the "threshold." Hearing thresholds have been determined for perhaps 100 species (Fay, 1988; Popper et al., 2003; Ladich and Popper, 2004; Nedwell et al., 2004; Ramcharitar et al., 2006; Popper and Schilt, 2008). Table 2 summarizes data for selected species of interest for this analysis. The explanation of the hearing categories shown in the fourth column is explained below the table. These data demonstrate that, with few exceptions, fishes cannot hear sounds above about 3-4 kHz, and the majority of species are only able to detect sounds to 1 kHz or below. There have also been studies on a few species of cartilaginous fishes, with results suggesting that they detect sounds to no more than 600 or 800 Hz (e.g., Myrberg et al., 1976; Myrberg, 2001; Casper et al., 2003; Casper and Mann, 2006). Because most fish tissue is similar in density to water, sound pressure and particle motion propagate through the body of a fish, affected only by tissue, bone, or organs of differing density. Any structures within the body with different densities respond differently from other tissues and provide a mechanism for sound detection (Helfman et al., 1997). Available data, while very limited, suggest that the majority of marine species do not have specializations to enhance hearing and probably rely on both particle motion and sound pressure for hearing. Most importantly, it should be noted that hearing capabilities vary considerably between different bony fish species, and there is no clear correlation between hearing capability and environment. There is also broad variability in hearing capabilities within fish families (Table 2).

**Table 2. Marine Fish Hearing Sensitivities.**

| Family | Common Name of Taxa | Highest Frequency Detected (Hz)[a] | Hearing Category[b] | Reference | Notes |
|---|---|---|---|---|---|
| **Asceripensidae** | Sturgeon | 800 | 2 | Lovell et al., 2005; Meyer et al., 2010 | Several different species tested. Relatively poor sensitivity |
| **Anguillidae** | Eels | 300 | 2 | Jerkø et al., 1989 | Poor sensitivity |
| **Batrachoididae** | Toadfishes | 400 | 2 | Fish and Offutt, 1972; Vasconcelos and Ladich, 2008 | N/A |
| **Clupeidae** | Shad, menhden | >120,000 | 4 | Mann et al., 1997; Mann et al., 2001 | Ultrasound detecting, but sensitivity relatively poor |
| | Anchovy, sardines, herrings | 4,000 | 4 | Mann et al., 2001 | Not detect ultrasound, and relativley poor sensitivitiy |
| **Chondrichthyes [Class]** | Rays, sharks, skates | 1,000 | 1 | Casper et al., 2003 | Low frequency hearing, not very sensitive to sound |
| **Gadidae** | Atlantic cod, haddock, pollack, hake | 500 | 2 | Chapman and Hawkins, 1973; Sand and Karlsen, 1986 | Probably detect infrasound (below 40 Hz). Best hearing 100-300 Hz |
| | Grenadiers | -- | 3? | Deng et al., 2011 | Deep sea, highly specialized ear structures suggesting good hearing, but no measures of hearing |

| Family | Common Name of Taxa | Highest Frequency Detected (Hz)[a] | Hearing Category[b] | Reference | Notes |
|---|---|---|---|---|---|
| **Gobidae** | Gobies | 400 | 1 or 2 | Lu and Xu, 2009 | N/A |
| **Labridae** | Wrasses | 1,300 | 2 | Tavolga and Wodinksy, 1963 | N/A |
| **Lutjanidae** | Snappers | 1,000 | 2 | Tavolga and Wodinksy, 1963 | N/A |
| **Malacanthidae** | Tilefish | -- | 2 | N/A | No data |
| **Moronidae** | Striped bass | 1,000 | 2 | Ramcharitar unpublished | N/A |
| **Pomacentridae** | Damselfish | 1,500 – 2,000 | 2 | Myrberg and Spires, 1980 | N/A |
| **Pomadasyidae** | Grunts | 1,000 | 2 | Tavolga and Wodinsky, 1963 | N/A |
| **Polyprionidae** | Wreckfish | -- | 2 | N/A | No data |
| **Sciaenidae** | Drums, weakfish, croakers | 1,000 | 2 | Ramcharitar et al., 2004; Ramcharitrar et al., 2006 | Hear poorly |
| | Silver perch | 3,000 | 3 | Ramcharitar et al., 2004; Ramcharitrar et al., 2006 | N/A |
| **Serranidae** | Groupers | -- | 2 | N/A | No data |
| **Scombridae** | Yellowfin tuna | 1,100 | 2 | Iversen, 1967 | With swim bladder |
| | Tuna | 1,000 | 1 | Iversen, 1969 | Without swim bladder |

| Family | Common Name of Taxa | Highest Frequency Detected (Hz)[a] | Hearing Category[b] | Reference | Notes |
|---|---|---|---|---|---|
| | Bluefin tuna | 1,000 | 2 | Song et al., 2006 | Based only on ear anatomy |

[a] Lower frequency of hearing is not given because, in most studies, the lower end of the hearing bandwidth is more a function of the equipment used than determination of actual lowest hearing threshold. In all cases, fish hear below 100 Hz, and there are some species studied, such as Atlantic cod, Atlantic salmon, and plaice, where fish have been shown to detect infrasound, or sounds below 40 Hz.

[b] See text below for explanation.

Note: Hearing capabilities of fish in gray cells can only be surmised from morphological data.

Sources: Data compiled from reviews in Fay (1988) and Nedwell et al. (2004). Updated names available at: www.fishbase.org.

The hearing categories included in column 4 of Table 2 refer to the following:

**Group 1:**

Fishes that do not have a swim bladder. These fishes are likely to use only particle motion for sound detection. The highest frequency of hearing is likely to be no greater than 400 Hz, with poor sensitivity compared to fishes with a swim bladder. Fishes within this group would include flatfish, some gobies, some tunas, and all sharks and rays (and relatives).

**Group 2:**

Fishes that detect sounds from below 50 Hz to about 800-1,000 Hz. These fishes have a swim bladder but no known structures in the auditory system that would enhance hearing, and sensitivity (lowest sound level detectable at any frequency) is not very great. Sounds would have to be more intense to be detected when compared to fishes in Group 3. These species detect both particle motion and pressure, and the differences between species are related to how well the species can use the pressure signal. A wide range of species fall into this category, including tuna with swim bladders, sturgeons, salmonids, etc.

**Group 3:**

Fishes that have some kind of structure that mechanically couples the inner ear to the swim bladder (or other gas bubble), thereby resulting in detection of a wider bandwidth of sounds and lower intensities than fishes in other groups. These fishes detect sounds to 3,000 Hz or more, and their hearing sensitivity, which is pressure driven, is better than in fishes of Groups 1 and 2. There are not many marine species in Group 3, but this group may include some species of sciaenids (Ramcharitar et al., 2006). It is also possible that a number of deep-sea species fall within this category based on the morphology of their auditory system (e.g., Popper, 1980; Deng et al., 2011). Other members of this group would include all of the tophysan fishes, though few of these species other than catfishes are found in marine waters.

**Group 4:**

All of these fishes are members of the herring family and their relatives (Clupeiformes). Their hearing below 1,000 Hz is generally similar to fishes in Group 1, but their hearing range extends to at least 4,000 Hz, and some species (e.g., American shad) are able to detect sounds to over 180 kHz (Mann et al., 2001).

NMFS has established interim acoustic impact thresholds for marine fish. The criteria were developed for the acoustic levels at which physiological effects (i.e., physical injury) to fish could be expected. It should be noted that these are onset of physiological effects and not levels at which fish are necessarily mortally damaged. Interim criteria consist of the following:

- Peak sound pressure level (SPL): 206 decibels relative to one micro-Pascal (dB re 1 μPa);
- Cumulative sound exposure level ($SEL_{cum)}$: 187 decibels relative to one micro-Pascal-squared second (dB re $\mu Pa^2$-s) for fishes above 2 grams (0.07 ounces); and
- $SEL_{cum}$: 183 dB re 1 $\mu Pa^2$-s for fishes below 2 grams (0.07 ounces).

For the purposes of establishing behavioral effects, NMFS has used 150 dB re 1 μPa root mean square (RMS) as a conservative indicator of the noise level at which there is the potential for behavioral effects on fish. NMFS has been clear that exposure to noise levels of 150 dB re 1 μPa (RMS) would not always result in behavioral modifications nor that any behavioral modifications would rise to the level of take (i.e., harm or harassment). However, the potential exists, upon exposure to noise at this level, for fish to experience some behavioral response. Behavioral responses could range from a temporary startle to avoidance of an ensonified area. As indicated above, for assessing injury, NMFS has a cumulative sound exposure level of 187 dB 1 $\mu Pa^2$s. However, recent ANSI-accredited criteria proposed by Popper et al., 2014 recommends a dual criteria approach (peak pressure and cumulative sound exposure level) for fish:activity should be 207 dB ($SEL_{pk}$ and $SEL_{cum}$) Group 3 fish, 210 dB $SEL_{cum,}$ and 207 $SEL_{pk}$ for Group 2 fish, 219 dB $SEL_{cum}$ and 213 $SEL_{pk}$ for Group 1 fish, and 210 dB $SEL_{cum}$ and 2017 $SEL_{pk}$ for eggs and larvae.

Total foundation installation time, including pile driving and transition piece installation, for CVOW proposed activities is expected to take between 2 to 4 days, whereas the pile driving duration alone is expected to take approximately 2 - 4 hours. During the offshore construction period from May through July (RAP, 2018, Revised Table 3.4-1), vessel movement, specifically the use of dynamic positioning thrusters, would cause sound-producing impacts. Additional geophysical and geotechnical work during operation and maintenance would be intermittent throughout the operational life of the project (RAP, 2014, Section 3.6). Of these sound sources the only one likely capable of producing physical injury to fish is the pile-driving activity. The other sources would likely only result in temporary, on the order of hours, behavioral impacts. Thus, the discussion below focuses on the impact from pile driving during installation of the monopile foundation.

The monopile foundation consists of one approximately 26.2 (8m) diameter pile at the base. The total footprint will be approximately 0.01 acre (0.005 ha) for each foundation. At sea level, the monopile

(MP)/transition piece (TP) foundation has a diameter of approximately 20.3 ft (6.2 m). Depending on the specific depth of installation, the length of the monopile will be between 164 ft to 197 ft (50 m to 60 m), and will weigh approximately 600 tons to 800 tons. Attachment 6 of the revised RAP provides a plan and profile of the monopile foundation. Table 3 (below) provides a summary of the construction and operation footprints for the two MP foundations.

**Table 3. Construction and operation footprints for IBGS foundations compared to revised monopile foundations (Table 3.2-3 of Revised RAP).**

| Foundation and WTG [a/] | IBGS Foundation | | MP/TP Foundation | | Change | |
|---|---|---|---|---|---|---|
| | Construction | Operation | Construction | Operation | Construction | Operation |
| Foundation [b/] | 0.2 ac / 0.1 ha | 0.2 ac / 0.1 ha | 0.76 ac / 0.30 ha | 0.76 ac / 0.30 ha | Increase of 0.56 ac / 0.2 ha | Increase of 0.56 ac / 0.2 ha |
| Heavy Lift Vessel [c/] | 0.8 ac / 0.3 ha | 0 | No Change | No Change | N/A | N/A |
| High Lift jack up Vessel [d/] | 0.001 ac / 0.0004 ha | 0 | 0.08 ac / 0.03 ha | No Change | Increase of 0.079 ac / 0.0296 ha | N/A |
| WTG Temporary Work Area [e/] | 190 ac / 76.9 h | 0 | 100.0 ac / 40.5 ha | No Change | Decrease of 90 ac / 36.4 ha | N/A |
| **Foundation and WTG Total** | **191 ac / 77.3 ha** | **0.2 ac / 0.1 ha** | **101.64 ac / 41.13 ha** | **0.76 ac / 0.30 ha** | **Decrease of 89.4 ac / 36.18 ha** | **Increase of 0.56 ac / 0.2 ha** |

[a/] Notes are in reference to impacts approved in the RAP.
[b/] MP/TP foundation area immediately under foundation is based on the area of the monopile diameter at the diameter seabed 25.6 ft (7.8 m) and scour protection installed in a 72 ft (22 m) radius on the seafloor around the base of the foundation. Includes two foundation structures of 0.01 ac (0.005 ha)
[c/] Assumes a single set of an 8-point anchored vessel per WTG. Impact area includes anchors (0.006 ac [ 0.002 ha] per anchor) and anchor chain sweep (.09 ac [0.04 ha]) based on approximate 200 ft (61 m) of anchor chain resting on the bottom and a maximum of 20 ft (6.1 m) of lateral drag per chain.
[d/] Assume 1 jack up vessels per WTG position (approximately 0.02 ac [0.001 ha]). Impacts will all occur within the 50 ac (20 ha) WTG Temporary Work Area at each foundation location.
[e/] Includes the two WTG Work Areas (based on a safety radius of 500 m during construction work) of 50 ac (20 ha) each.

Offshore installation of the MP foundations would be accomplished by a self-propelled jack-up vessel supported by a heavy lift vessel with an 8-point anchoring system (see Table 3 above). The initial penetration of the pile into the seafloor would be achieved under the weight of the MP itself. The MP will then be driven into the seafloor to its design penetration depth of approximately 98 ft to 105 ft (30 m to 32 m) using a maximum energy of 1000 kilojoule (kJ) rated hydraulic hammer located on jack-up vessel. After the MP is installed, the TP would be lifted from the jack-up vessel and lowered onto MP After mounting, the transition piece will be fastened to the monopile by a bolted connection. Total installation time for the foundation, including pile driving and transition piece installation, is expected to take between 2 to 4 days per foundation, whereas the pile driving duration alone is expected to take approximately 1 to 2 hours per foundation.

As approved in the original RAP, pile driving activities will occur during daylight hours only, starting approximately 30 minutes after dawn and ending approximately 30 minutes prior to dusk, unless a situation arises where ceasing the pile driving activity would compromise safety (both human health and environmental) and/or the due to safety concerns from the stability of a partially driven pile.

A soft-start procedure, starting at 100 kJ will reduce the initial range over which instantaneous injury may occur and be effective in deterring aquatic life to a safe distance before full-energy piling is reached. The assessment for impact pile driving included the distance to threshold analysis for the 600 kJ and 1000 kJ impact forces, thereby describing the full range of sound levels expected to be experienced throughout an entire piling sequence. In addition, it is proposed to abate the noise from pile driving using a Big Bubble

Curtain. Bubble curtains are commonly used to reduce acoustic energy emissions from high-amplitude sources and are generated by releasing air through multiple small holes drilled in a hose or manifold deployed on the seabed near the source. The resulting curtain of air bubbles in the water provides significant attenuation for sound waves propagating through the curtain. For the unmitigated piles, the distances to the 150 dB (RMS) limit for fisheries resources are between 10,225 m and 11,375 m (Table 4). For the noise mitigated piling, the distances to the 150 dB (RMS) limit are 5,120 m and 5,670 m for the maximum expected impact force necessary to seat the pile at 1,000 kJ (Table 4).

To evaluate the 187 dB accumulated sound exposure level, it is assumed that the fish remain stationary. To achieve the necessary penetration depth, the pile driving will require an estimated 1,133 to 2,470 blows per pile. The resulting distance for determining the accumulated 187 dB cSEL is 3,900 m to 4,400 m for unmitigated piles and 2,050 m to 2,625 musing the Big Bubble Curtain.

Noise generated from pile driving could have pathological, physiological, or behavioral effects on marine fish. Unmitigated construction noise could disturb normal behaviors (e.g., feeding) of marine fish if they were present within the construction area during pile-driving activities. However, the soft start procedure and the bubble curtain noise abatement system mitigates the initial sound exposure in order to allow marine fish that may be impacted to leave the ensonified area (see Table 4). The dB RMS value within Table 4 represents the sound level at a given moment during the activity whereas the dB cSEL value represents the accumulation of sound over the duration of the activity; hence the resulting larger distance from the source. There is a difference between impulse and “continuous” sources in that there is no effective quiet period that would diminish the accumulated exposure.

For impact pile driving, soft-start requires an initial set of three strikes from the impact hammer at 40 percent energy with a 1-minute waiting period between subsequent three-strike sets. The procedure will be repeated two additional times.

The soft starts are estimated to take 3.25 - 6 minutes based upon a one-minute rest between strikes and an estimate of 2-36 strikes per minute. Although finfish swim speeds are highly variable most fish can manage swimming speeds of at least 1 meter per second (m/s). Squid can swim up to 2 m/s and bluefin tuna can swim up to 29 m/s. If slow swimming fish were all concentrated around the anchoring and installation activity prior to pile driving and thus starting at 1 m or less from the pile when pile driving began then they are within the range of being exposed to injurious levels of noise. However, it is not anticipated that the majority of fish would be within 1m of the piles prior to commencement of the soft start due to vessel activity/seafloor disturbance in the work zone.

As stated previously, cumulative SEL injury is based upon a fish remaining in the same zone of exposure during the entire period of exposure. The modeled zone for behavioral modification is up to 11,375 m if the pile driving were unmitigated to 5,670 m using the noise mitigation. It is not anticipated that fish will be able to vacate the 150 dB behavioral zone immediately or prior to the termination of the noise source. Thus it is anticipated that some fish may exhibit modified behavior and may be potentially adversely affected by the pile driving noise. This model includes a 12-hour daylight window (summer daylight time off Virginia) and 12 hour recovery period since there will be no pile driving at night.

The distances to the 150 $dB_{RMS}$ behavior limit for fish for wind turbine installation (e.g. placing the TP and nacelle) would be 600 meters or less. Additionally, if it is assumed that a fish remains near the construction area, and that multiple thrusters are continually in use over a 24-hour period, then the distance reached for the 187 dB cSEL accumulated sound exposure level would be 50 m. However, at this worst case distance and assuming continuous exposure to a stationary fish, the real time received noise level that would potentially result in a cumulative exceedance of 187 dB cSEL are approximately equivalent to a 1-second SEL of 137 to 138 $dB_{RMS}$, well below the known thresholds which cause physiological or even a potential behavioral impacts for fish.

For cable lay operations the distances to the 150 $dB_{RMS}$ behavior limit for fish would be 350 m or less from a DP vessel with thrusters operating at full power. The real-time received noise that could potentially result in a cumulative exposure of 187 dB re µPa cSEL is approximately equivalent to a 1-second SEL of 137 $dB_{RMS}$ for the 24 hour period, well below the known threshold for physiological or behavioral effects for fish.

Based upon review of the geophysical and benthic habitat data there is no reason to believe that EFH within the action area possesses any unique characteristics compared to the habitat immediately surrounding the area and thus accessible by nektonic organisms.

**Table 4. CVOW Modeled Distances to NMFS Interim Fish Acoustic Threshold Criteria.**

| Regulatory Threshold | Criteria Level | Pile Driving 600 kJ | Pile Driving 600 kJ (mitigated) | Pile Driving 1000 kJ | Pile Driving 1000 kJ (mitigated) | Cable Lay Operations | Wind Turbine Installation | Operational Wind Turbine Generators [a] |
|---|---|---|---|---|---|---|---|---|
| **Fish Injury (peak SPL[b])** | 206 dB re 1 µPa | 200 m | <100m | 200 m | <100 m | N/A | < 1 m | < 20 m |
| **Fish Injury (SEL$_{cum}$ >2g[c])** | 187 dB $1\mu Pa^2 s$ | 3,900-4,400 m | 2,050 - 2,625 m | 4,400-5,200 m | 1,700-2,050 m | N/A | 50 m | < 20 m |
| **Fish Behavioral Modification** | 150 dB re 1 µPa (RMS) | 8,750 – 9,725 m | 4,570-4,700 m | 10,225-11,375 m | 5,120-5,670 m | 350m | 600 m | < 20 m |

The predicted sound level for operation of a wind turbine is no greater than 130 db at 20m from foundation.

[b] Sound pressure level

[c] Cumulative sound exposure level

(Source: Revised CVOW RAP, 2018 Tables 10-13, and Attachment 8 Revised Appendix M-2)

Other potential noise sources that could be perceived by fish include routine High Resolution Geophysical (HRG) surveys, horizontal directional drilling (HDD) to shore, jet plowing, ROV jet trenching and vessel and equipment noise. These sources are broadly assessed in the Mid- and South Atlantic G&G FPEIS (BOEM, 2014a, Section 4.2.5.2.2). Upon completion of the cable laying activities, Dominion will conduct post-lay HRG surveys to verify both the location and depth of buried cable. Post-lay surveys could be conducted from the cable installation vessel using an ROV or Burial Assessment Sled as well. These vehicles may be equipped with a single or multi-beam depth sounder and/or side-scan sonar or HRG equipment may be deployed directly from the vessel. Table 5 lists the equipment used by the VOWTAP team during the 2013 marine surveys. It is expected the same or similar equipment would be used for the short-duration post-lay surveys. Results of the post-lay survey will determine the need for any additional cable protection along the Inter-Array Cable or Export Cable routes. Routine HRG surveys are anticipated to occur at low levels, below 206 dB re 1 µPa and should result only in the temporary disturbance of fish. For HRG surveys, the Mid- and South Atlantic G&G FPEIS (BOEM, 2014a, Section 4.2.5.2.2) concludes that, because HRG surveys are conducted from moving vessels, their impacts to fish are spatially and temporally limited and only minor impacts to fish are anticipated. For vessel and equipment noise associated with HRG surveys, impacts are considered short-term and minor for fish and EFH (BOEM, 2014b, p. 83).

**Table 5. Equipment used by the VOWTAP team during marine surveys conducted in 2013.**

| Geophysical Equipment | Frequency (kHz) | Source Level (dB) | Beamwidth (degree) | Pulse Duration (msec) |
|---|---|---|---|---|
| Reson SeaBat 7125 Multibeam Sonar | 400 kHz | 190 to 220 | 1° by 0.5° | 33 to 300 |
| EdgeTech 2000-DSS Sidescan Sonar | 120 kHz | 210 | 1.08° along | 2.5-16.1 |
| EdgeTech 2000-DSS Sidescan Sonar | 540 kHz | 210 | 0.26° along | 0.8-5 |
| USBL IXSEA Gaps | 20-30 kHz | 188 | 200° | Unknown |

## Conclusions – Noise

Fish are expected to be exposed to harassing noise levels that may modify their behavior based upon NMFS interim noise criteria for marine fish. This is primarily expected to come from the pile driving activity. This behavioral modification may occur intermittently during the construction window for the foundations. As evidenced by post-construction monitoring in European offshore wind facilities following the conclusion of the construction activities fish are expected to re-occupy the disturbed area with some expected increase in abundance of fish within approximately 20m of the foundation (Bergstrom et al., 2014). Noise from HRG surveys are expected to be largely above the hearing range of fish in all categories. The movement of vessels (including DPS vessels) may result in temporary modification of fish behavior during those activities. Although there is the risk of physical injury due to noise during pile driving, the risk is considered low to most nektonic species and life stages because of their ability to swim away from potentially injurious levels of noise. Shellfish beds are not indicated from the benthic survey results. The Revised RAP 2018 included revised acoustic modeling that revised downward the area of acoustic disturbance for cumulative sound exposure and behavioral disturbance. The only threshold that increased was the peak injurious exposure which increased from less than 1 m to 200 m. These changes do not change the overall conclusions regarding acoustic impacts between 2015 and 2019.

## Habitat Disturbance

Minimizing the total length of the export cable was the primary criteria used in determining the export cable route, including reducing the total length of the marine cable route to minimize impacts to the surrounding marine environment and selecting a shore landing location that allows for minimal impact and minimal terrestrial distance to the point of interconnection on shore. Avoidance of impact to sensitive biological habitat and minimization of impact to other sensitive environmental receptors in the surrounding area were also criteria in determining the cable corridor (RAP 2014, p. 2-10). However, the installation of the inter-array cable and export cable, placement of cable protection (e.g. rock berm or concrete mattresses), anchor-cable sweep and construction of the two turbine foundations would result in temporary to permanent alteration of benthic habitats.

The total area expected to be disturbed by construction of the wind turbine foundations is 101.64 acres (41.13 hectares)). This includes impacts from the foundations, heavy-lift vessels, high-lift jack-up vessel, and temporary work areas (Revised RAP, 2018, Table 3.2-3). The expected direct impact from cable laying (both export and inter-array cables) is approximately 106 acres (43 hectares). There would be permanent loss of unconsolidated sand habitat within the footprint of the two turbine foundations, as well as within the 23.3 acre (9.4 hectare) footprint associated with the additional cable protection. While conditions along the proposed Inter-Array Cable route indicate that the minimum depth of cable burial is achievable, should less than 3 ft (1 m) of burial be achieved, Dominion may elect to install additional cable protection such as concrete mattresses, sandbags, rock berm and/or articulated split pipe to prevent damage to the cable from factors such as anchor damage or exposure due to seabed mobility/scouring. The location, type, and method for installing additional cable protection would be determined after the cable has been laid, in consultation and coordination with relevant jurisdictional agencies. Please refer to Appendix D-2 from the approved RAP for the preliminary Inter-Array Cable plan and profile drawings. Unconsolidated habitat would be replaced with a hard vertical and some hard horizontal structures, which would be utilized by fish and invertebrates over time.

DMME has indicated that scour protection is needed for the MP foundations. The scour protection system will consist of a preinstalled filter layer of crushed rock material deployed in a radius of approximately 72.2 ft (22 m) and a height of about 2.6 ft (0.8 m) at each foundation location. This layer will be deployed prior to installation of the MP/TP foundations. The second layer, also referred to as the “armor layer,” will be installed on top of the filter layer once the monopile is installed, and the Export and/or Inter-Array Cable(s) have been pulled through. The armor layer consists of crushed rock material weighing between 88.2 lb to 440.9 lb (40 kg and 200 kg), installed in a radius of approximately 39.4 ft (12 m) and a height of about 4.9 ft (1.5 m) around each foundation. Details are included in Table 3 above also show the changes between VOWTAP and CVOW.

In addition to the direct impacts, it is expected that sediment would become suspended around the foundation construction and cable-laying operations along the approximately 52-km transmission corridor. Re-suspended sediment would temporarily interfere with filter-feeding benthic fauna until the sediment resettled. The time of sediment suspension would depend upon ocean currents and sediment grain size. Based upon the sediment transport model included in this assessment as Appendix G of the RAP (2014), total suspended sediment concentrations would be elevated up to approximately 6.6 ft (2 m) above the trench, extending at increasingly shallow depths out to 100 to 160 m. Suspension would last for 6 to 7 minutes and the deposition of the re-suspended sediment would be less than 1 mm within 100 m of the activity. This would give a total area of disturbance of approximately 2,785 acres (1,127 hectares).

Analyses of sediment transport modeling conducted for the 2014 RAP (refer to Appendix G) assumes that all of the fine material (< 200 µm) in the plowed trench is mobilized instantly into the water column immediately above the plow footprint and within 2 m of the seafloor. The initial fine suspended sediment concentration rapidly diminishes by several orders of magnitude within 5 to 10 m from the trench. The maximum zone of elevated suspended sediment on either side of the trench is on the order of 150 m (Appendix G). While the suspended sediment concentrations are elevated even near the edge of the plume, the sediment is moving in a very thin layer, less than a tenth of a meter, at the edge of the plume. The fine sediment suspended in this plume settles into a thin layer on the ocean floor generally less than 1 mm. The maximum depositional thickness occurs roughly 10 to 25 m from the trench and the maximum zone of influence on either side of trench generally varies from between 50 m (offshore) and 200 m (nearshore) and is less than 250 m. Trench installation accomplished during periods of higher current velocity reduces the thickness of settled sediments over a larger footprint, and, likewise, trench installation during lower velocity tides reduces the overall footprint of sediment deposition, while increasing the thickness in a narrow zone adjacent to the cable route (Appendix G).

The Inter-Array Cable would be installed using a jet plow that will create a narrow, temporary trench up to 3.3 ft (1 m) wide. The cable would be fed into this trench as the jet plow moves along the ocean floor. The jet plow will rest on skids or wheels with a width of approximately 18.4 ft (5.6 m). The cable would be buried to a minimum depth of 3 ft (1 m); the exact depth would be dependent on the substrate encountered along the route. At the foundations, the cable would be buried using an ROV. The jetting of the cable via ROV would be similar to the process described for the jet plow and will occur for a maximum distance of approximately 164 ft (50 m) at each end of the cable. The export cable would be installed using a towed jet plow supported by a maximum 8-point anchored barge from the proposed HDD punch-out location, for a distance of approximately 4.5 mi (7.2 km), followed by the use of a dynamic positioning (DP) cable-lay vessel for the remainder of the route. An ROV jet trencher supported from the DP cable-lay vessel would be used to install the export cable at the foundation location within a distance of not less than 656.2 ft (200 m) from the foundation.

To ensure the protection of sensitive beach and dune habitat, the Export Cable would be brought to shore through a 12-in (300-mm) diameter conduit installed via HDD. The HDD will extend from the designated temporary Onshore HDD Work Area located in the existing parking lot adjacent to Camp Pendleton Beach, to the HDD punch-out location within the designated temporary Offshore HDD Work Area located approximately 0.62 mi (1 km) offshore in approximately 19.7 ft (6 m) of water. Offshore activities at the HDD punch-out location will require a 0.92 ac (0.37 ha) temporary Offshore HDD Work

Area. The final location of the proposed Offshore HDD Work Area and associated punch-out location would be determined upon final engineering design. Export Cable landfall construction will require the support of a HDD rig located onshore and a winching system located offshore. The offshore work area will provide vessel anchorage for a diver support vessel and an anchored barge or jack-up vessel to act as a winch vessel to pull the cable conduit into the drilled HDD bore. HDD will initiate from shore with the drilling of a pilot hole that will then be reamed back to a diameter of approximately 18 in (450 mm) to support the installation of the conduit. A non-toxic drilling mud would be used to support the HDD activities. During the HDD activities, drilling fluids would be pumped back to shore for recycling and cleaning. To minimize the potential for frac-out of drilling fluid, the conduit would be drilled on a single arc. The burial depth beneath the beach would be a minimum of approximately 20 ft (6 m) to ensure the conduit would be protected from breaking wave-induced scour during operation. Concrete mattresses will also be deployed at the HDD punch-out location to further protect the cable and conduit. The maximum burial depth offshore would be between approximately 65 ft and 100 ft (20 m and 30 m) under the seabed. The final depths of burial of the conduit would be determined upon final engineering design. To further minimize the potential for the release of drilling fluid offshore, the bore would be stopped approximately 100 ft (30 m) short of the punch-out location. The actual position would be dictated by an analysis of the seabed conditions and depth. This leaves a soil plug to control the drilling fluid from leaking out into the surrounding marine environment. Dominion will also develop an HDD Contingency Plan prior to construction to support the management of HDD activities in the event a frac-out of drilling fluid should occur. The total duration of the HDD-associated work activities is anticipated to be approximately 11 weeks, including set up, drilling, installation of the conduit, and demobilization. Drilling will comprise approximately 4 weeks of this period. All HDD activity will occur during daytime hours in conformance with local noise requirements.

Tetra Tech, Inc. conducted a benthic survey for VOWTAP in June of 2013. The benthic survey covered the six OCS sub-blocks of the CVOW Research Lease and an approximately 27.3-mile (44-kilometer corridor to accommodate the siting of an offshore electric transmission cable (the Export Cable). Please refer to the Benthic Survey Report (Appendix J of the 2014 RAP) included with this assessment. Results of the benthic surveys indicate that all benthic habitats within the lease block aliquots and cable corridor were softbottom; no hardbottom habitats were observed within the survey area. Sand dominated the benthic substrate composition across all grab sample locations, with a mean of 91.5 percent (primarily fine sand), followed by silt and clay (6.3 percent), and gravel (2.2 percent). Annelids (specifically, polychaete worms) were numerically dominant across all sampling areas (Research Lease Area, cable corridor, and reference sites), followed by mollusks, then crustaceans.

Overall, annelids (segmented worms) dominated the project site samples within the cable corridor and accounted for approximately 67 percent of all species sampled within the cable corridor. Mollusks were the second most abundant taxon, with approximately 18 percent of all species identified within the cable corridor, and arthropod crustaceans were the third most abundant taxon, with approximately 9 percent of all species identified within the cable corridor. No significant shellfish resources were identified along the cable corridor.

Disturbance of the seafloor from project construction activities will create the risk of direct and indirect mortality or injury for benthic resources. Benthic immobile fauna such as surfclams and ocean quahogs, and selected epibenthic and demersal species directly within the footprint (spatial area and penetration depth) of the WTG foundations, anchors, jack-up barge spuds, and locations of additional cable protection would be crushed when these objects contact the seafloor. Pile driving will also push any organisms within the footprint more deeply into the substrate, removing them as possible contributions to the detrital or nutrient cycles within the benthic ecosystem. In the soft-sediment areas of anchor chain sweep, tube-dwelling amphipods and polychaetes, solitary anemones, and other larger infauna are probably the most susceptible to harm. However, the presence of sand waves throughout much of the Project Area is a strong indicator that bottom currents transport surface sediments routinely, making the presence of any demersal eggs unlikely. Furthermore, benthic fauna are likely well adapted and able to withstand small amounts of sedimentation in this highly dynamic environment of the mid-Atlantic Bight and are expected to be able to quickly repopulate disturbed areas that are not otherwise occupied by installed project structures. Overall, the area of benthic habitat potentially affected by construction activities is extremely small compared to the total area of available surrounding habitat and no population level effects are anticipated.

Demersal fish species also have the potential for impact in the Project Area during construction activities associated with cable protection, because they are directly dependent on the substrate for at least some portion of their life cycle. Juvenile whiting, juvenile red hake, juvenile windowpane, juvenile and adult butterfish, juvenile and adult summer flounder, all life stages of red drum, neonatal and adult sand tiger sharks, neonatal, juvenile and adult sandbar sharks all have a close affinity for soft substrates. However, habitat displacement due to disturbance or modification of the substrate during construction activities associated with cable protection is anticipated to be short-term and localized. Suspended sediment plumes generated during project construction are expected to be small, localized, and temporary, and will not produce concentrations that are known to cause harm to fish.

Of the EFH species identified as potentially occurring in the Project Area, many organisms have a completely pelagic lifestyle, including the bluefish, Atlantic sea herring, bluefin tuna, skipjack tuna, and most sharks. In addition, most species with designated EFH in the Project Area have pelagic early life histories (eggs and larvae) and are not dependent on benthic habitat. Therefore, modification and/or disturbance of the substrate during construction, including temporary increases in suspended sediment, will not impact these species or life stages. There may be some temporary impacts on the use of specific areas by these species during construction resulting from increased sediment concentrations in the lower water column; however, any sediment plume generated during project construction is expected to be small, localized, and temporary, and will not produce concentrations that are known to cause harm to fish. In addition, given their mobile nature, pelagic juvenile and adult life stages should largely avoid these areas.

Upon completion of construction, the substrates within the offshore Project Area will remain fundamentally the same as pre-existing conditions, except for the maximum permanent conversion of 1.13 ac (0.46 hectares) of soft substrate associated with the combined presence of the two WTG foundations with scour protection (0.76 ac) and cable protection (0.37 ac). Epifaunal and infaunal species will recolonize the sediments disturbed through the mechanisms of larval recruitment, and mobile species of both fish and invertebrates will repopulate the Project Area, allowing this area to continue to serve as foraging habitat for EFH species.

## Conclusion-Habitat Disturbance

The introduction of two turbine foundations and associated cabling offshore Virginia is anticipated to have habitat disturbance impacts similar to those observed for offshore oil rigs in the Gulf of Mexico and offshore wind facilities in Europe. These anthropogenic structures would likely have an artificial reef effect that would increase both the diversity of fish and abundance of some fish species within one to five meters from the foundations (Bergstrom et al., 2014 and Wilhelmsson et al., 2006). There is still debate regarding whether or not the structures aggregate fish or actually increase productivity. If the foundations purely aggregate fish species, those species may become more susceptible to predation or targeted in a fishery. Regardless, the construction of two turbine foundations, cable laying and protection and the foundation scour protection would not result in large population impacts to any marine fish. The Chesapeake Light Tower, located several miles west of the Project Area has similar artificial reef effects and is not known to have negatively impacted marine fish populations in the area and is a popular dive and sport fishing attraction. There would be direct mortality to benthic macro-invertebrates (primarily annelid worms and mollusks) around the jet plow path; however this area, plus the depositional sediment area comprises a very small portion, less than 0.04 percent of the inner/central-shelf zone (0-50 m) offshore Virginia. The impacts due to permanent habitat changes are thus anticipated to result in moderate disturbance to fish and EFH.

## Electromagnetic Fields

EMFs generated by alternating current (AC) cables have been widely used in Europe and for several transmission cables in the U.S. including an NSTAR AC power cable to Martha's Vineyard and other island communities along the Atlantic coast. The AC power cables are shielded and would not emit any electric fields directly, rather just the induction of electric fields produced by the action of fish and currents moving through the magnetic fields produced by the cable. Most marine species do not sense very low-intensity electric or magnetic fields at AC power transmission frequencies (i.e., 60 Hz in the US). AC magnetic fields at intensities below 5 μT may not be sensed by magnetite-based systems (e.g., mammals, turtles, fish, invertebrates), although this AC threshold is theoretical and remains to be confirmed experimentally (Normandeau et al., 2011). A study conducted by the Pacific Northwest National Laboratory that evaluated impacts of EMF was not able to find significant effects to demersal fish and crustaceans at electromagnetic field levels an order of magnitude greater (1.1 mT [1,100 μT]) than the maximum peak magnetic field of 31 μT (peak level for minimally buried export cable) that was modelled for this project (RAP, 2014, Appendix K; Woodruff et al., 2013; and Normandeau et al., 2011). The average magnetic field strength as modelled in the RAP is 0.1 to 0.3 μT (Appendix K). This modelled estimate is supported by a literature synthesis conducted by BOEM in 2011 (Normandeau et al., 2011). Thus, the electromagnetic fields produced by the export and inter-array cables are expected to be detectable by marine fish at peak levels where target burial depths cannot be achieved. This detection, however, is based upon a theoretical range that needs further testing (Normandeau et al., 2011). This range could be undetectable to many fish but the assessment takes a conservative approach to the evidence. These levels are not expected to result in any negative impacts to individual fish or fish populations.

The burial of the CVOW Inter-Array and Export Cables at target burial depths of at least 3.3 ft to 6.6 ft (1 m to 2 m), respectively, below the seafloor in soft sediments (e.g., sand) will likely minimize the potential for interactions of elasmobranchs, or other demersal and pelagic fishes, with the EMF associated with the project marine cables. EMF modeling of both the Inter-Array Cable and Export Cables (included within this assessment as Appendix K of the 2014 RAP) indicates that for the Inter-Array Cable the average magnetic field would be 3.1 mG and the maximum field would be 9.1 mG at the target burial depth of 3.3 ft (1 m). For the Offshore Export Cable, the average magnetic field would be 1.6 mG and the maximum field would be 4.8 mG at the target burial depth of 6.6 ft (2 m). Magnetic fields will attenuate with distance both vertically and horizontally.

These predicted EMF levels at the seafloor are well below the theoretical detection level of 5 nanovolts/cm for electrosensitive fish with magnetite-based sensory systems that are known to occur in the Project Area (Normandeau et al. 2011). Therefore, it is unlikely that EMF from either the Inter-Array or Export Cable during average or peak loads will affect or alter the fish community or their behavior in the Project Area (Normandeau et al. 2011) (RAP, 2014, p. 4-51).

## Water Quality Impacts

Isolated and temporary increases in turbidity will result from jet plowing and ROV jet trenching during installation activities for the Inter-Array Cable and the Export Cable, which has the deepest target range of burial depth. Activities that re-suspend sediments have the potential to negatively impact early life stages of fish species (EPA 1976; Colby and Hoss, 2004). Turbidity-related impacts may include reductions in growth and feeding rates and the clogging of respiratory structures. Results of the VOWTAP/CVOW Sediment Transport Analysis (included with this assessment as Appendix G of the RAP) indicate that under worst-case assumptions initial suspended sediment concentrations directly above (within 6.6 ft [2 m] above the seafloor) the immediate centerline of the route may be quite high, ranging between 6,700 mg/L to 400,000 mg/L, but would decrease to ambient levels within 6 to 7 minutes. Higher concentrations of suspended sediments may also occur along the portion of the cable route closer to shore, due to the presence of stronger currents. However, concentrations would diminish rapidly by several orders of magnitude within 16 ft to 33 ft (5 m to 10 m) of the centerline. The maximum zone of the lowest concentrations of suspended sediments would be confined to an area within 328 ft to 492 ft (100 m to 150 m) of the jet plow trench (Figure 4).

Since the modeled plume would extend only about 6.6 ft (2 m) above the seafloor, pelagic species will not encounter the turbidity resulting from the jet plow activities. Impacts on demersal fish species from excess suspended sediments from proposed cable installation activities have the potential to result in varying degrees of effects ranging from no effect to lethal effects (Newcombe and Jensen, 1996). The severity of impacts is typically associated with both the concentration of suspended sediments and the duration of exposure. According to Wilber and Clarke (2001), the estimated levels of total suspended sediment that are anticipated to occur outside of the immediate vicinity (beyond 16.4 ft to 32.8 ft [5 m to 10 m] from the center) of the jet plow/ROV jet trencher path are unlikely, in terms of both concentration and duration, to cause either lethal or sub-lethal effects to fish. The demersal fish located along the immediate centerline would likely leave the area as the jet-plow/ROV jet trencher approaches, thus avoiding the turbidity plume. In the unlikely event individuals remain within the immediate path of the trench, effects ranging from temporary physiological stress to mortality could occur (Wilber and Clarke, 2001). Upon completion of jet-plowing/ROV jet trenching activities and re-deposition of the suspended sediments, demersal species are expected to return to the Project Area (RAP, 2014, p. 4-48) and no population level effects are anticipated.

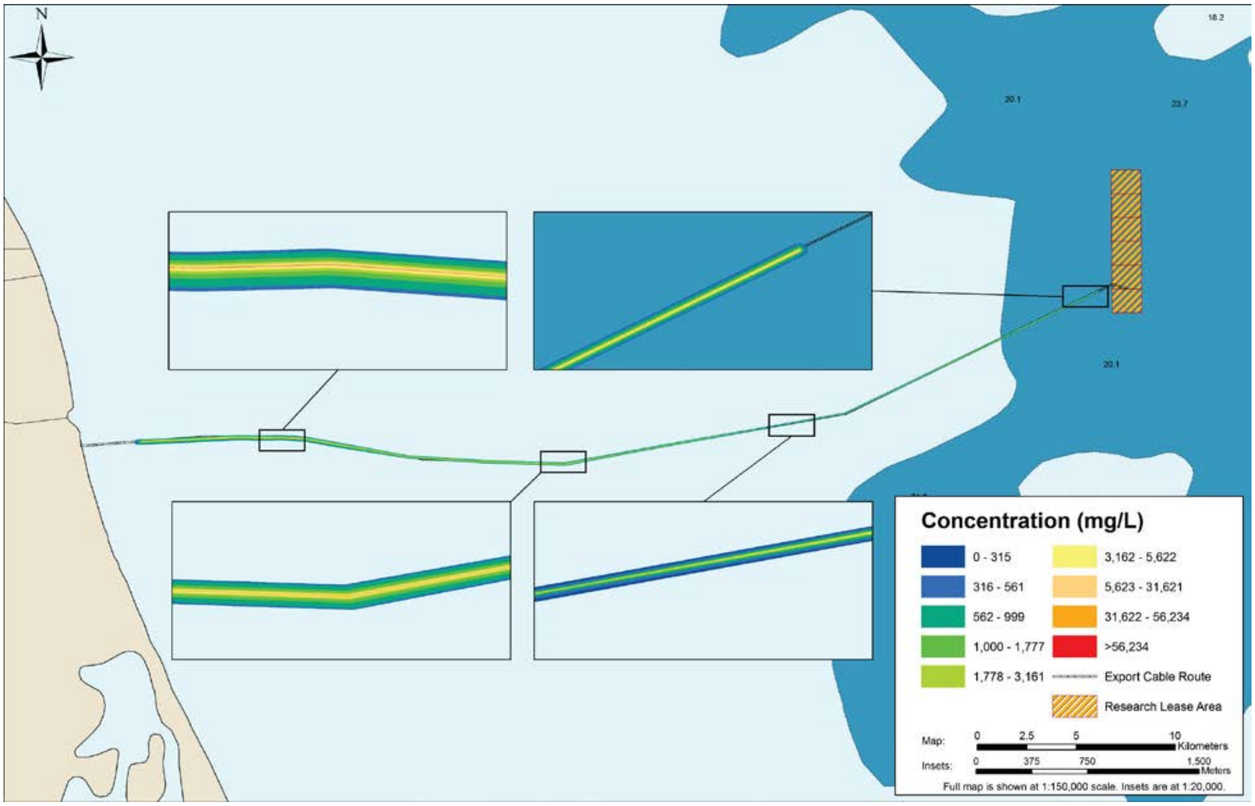



**Figure 4. Jet Plow Fine Sediment Plume Along Proposed Cable Route (RAP, 2014).**

During decommissioning, the removal of the scour control system would disturb the same area disturbed when they were installed and would introduce a proximate cloud of turbidity over the seafloor for each MP foundation. Re-suspended sediment would temporarily interfere with filter feeding benthic fauna until the sediment resettled. The time of sediment suspension would depend upon ocean currents and sediment grain size, but is anticipated to be short-lived, as described for construction-related habitat disturbance. Decommissioning is anticipated to result in moderate but temporary impacts to fish and EFH. An EFH consultation will likely be necessary at the time a decommissioning application is received as information regarding the affected area and the details on the decommissioning methodology will be more fully known.

## Alternatives

The VOWTAP EA considered three geographic alternatives to the Proposed Action (Alternative A) and their impacts to fish and EFH.

- *Alternative B – Alternate Turbine Location (adjacent to the Virginia WEA) (Section 3.2.5.3 of the VOWTAP EA):* Under Alternative B, research activities including the construction, operation, maintenance and eventual decommission of two turbines would occur in the three northern aliquots of the proposed research area (OCS block 6061 aliquots H, L, P), directly north of the area identified under the Preferred Alternative. Like the Proposed Action, this alternative also includes the construction, operation, maintenance, and eventual decommission of the export cable to shore; however, the export cable would be approximately 1.5 nautical miles longer (total of approximately 25.5 nautical miles).
- *Alternative C – Alternate Turbine Location (within the Virginia WEA) (Section 3.2.5.4 of the VOTAP EA):* Alternative C would approve the construction, operation, maintenance and eventual decommission of two turbines within the Virginia WEA. Like the Proposed Action, this alternative also includes the export cable to shore in its analysis. All the environmental consequences associated with selecting Alternative C would be the same as those associated with Alternative A, except for the specific local impacts associated with the placement of two turbines, a longer cable route to shore, impacts to navigation, and additional site characterization surveys.
- *Alternative D – Alternate Export Cable Landfall (Croatan Beach) (Section 3.2.5.5 of the VOWTAP EA):* Under Alternative D, Croatan Beach public parking lot would be used as the export cable landfall location. Several criteria were considered when examining potential export cable landfall locations (RAP, 2014, Section 2.3.1). This location is slightly north of the landfall location identified in the Preferred Alternative (Camp Pendleton Beach). Landfall to interconnection point would be 0.9 miles (1.46 km) which is slightly longer than the length under the Proposed Action (0.68 mile [1 km]).

The assessment of Proposed Action (Alternative A) concludes that the impact of construction, operation, and decommissioning activities are anticipated to have minor to moderate impacts to fish and essential fish habitat. There is no known change in the occurrence of fish or essential fish habitat between Alternatives B-D and Alternative A. The primary impacts to fish and EFH, i.e., pile-driving noise, foundation and export cable installation, and cable protection, are unchanged between alternatives. Thus, it can be concluded that the impacts to fish and EFH from Alternatives B, C, and D are no different than those assessed under Alternative A.

## Conclusions

Based upon the analysis above, the impact of construction, operation, and decommissioning activities are anticipated to have moderate temporary impacts during construction and minor to negligible impacts over the life of the Project to fish and EFH. The principal impact-producing factors during the construction phase are habitat disturbance and construction (pile-driving) noise. It is expected that the physical and biological habitat would recover to pre-construction conditions within 1 to 2.5 years and the acoustic environment would return to pre-construction conditions immediately after the cessation of construction activity. The only anticipated permanent impact to fish and fish habitat would be the loss of existing habitat within the footprint of the two turbine foundations and along the cable route if and where cable protection is utilized. There are no impacts expected at the population level of any fish or fishery. BOEM has determined that the Proposed Action would temporarily adversely affect the quality of EFH to species and life stages listed in Table 1 offshore Virginia but not substantially affect the quality and quantity of EFH in the inner shelf zone offshore Virginia over the life of the Project. There are no EFH habitat areas of particular concern in the proposed lease area and cable route. These conclusions remain the conclusion of the assessment after the 2018 revisions to the RAP. Principally the total area temporarily disturbed and permanently altered has been reduced by approximately 88 acres, primarily during construction. Additionally acoustic disturbance, although having a greater unmitigated exposure distances for injury, has been significantly decreased from a total of 14 days (6 piles and two caissons) to a total of 2 to 4 hours (2 piles). As a result modelled cumulative exposure distances and behavioral exposure distances have decreased. CVOW has proposed to implement a noise abatement program to reduce pile driving noise to levels to an even greater extent. However, in consultation with NMFS, BOEM is looking at doing a comparison study of the acoustic disturbance from the mitigated and unmitigated pile, thus for the purposes of this assessment BOEM assumes that fish and fish habitat will be exposed to unabated noise from the pile driving activity.

## Standard Operating Conditions

BOEM has adopted several Standard Operating Conditions that are included as part of the Proposed Action. These measures, which were developed principally for threatened and endangered species, confer benefits to other living marine resources by mitigating noise exposure. The relevance of these measures to marine fish were recently reinforced by NMFS for a similar project offshore Rhode Island. The EFH conservation measures (July 12, 2013) recommended as part Deepwater Wind Block Island Wind Facility project a similar mitigation related to noise (conservation recommendation #5).

Continuation of Pile Driving After Daylight Hours. If the driving of a pile commenced during daylight hours, then the Lessee, by itself or through its designated operator, may complete driving that pile after daylight hours. However, the Lessee, by itself or through its designated operator, may not start driving a new pile after daylight hours, unless allowed pursuant to an alternative monitoring plan.

Modification of Visibility Requirement. If the Lessee, by itself or through its designated operator, intends to conduct pile driving for a Monopile foundation at night or when visual observation is otherwise impaired, the Lessee, by itself or through its designated operator, must submit an alternative monitoring plan detailing the Lessee's proposed alternative monitoring methodology (e.g., active or passive monitoring technologies) to the Lessor. The alternative monitoring plan must demonstrate the effectiveness of the methodology proposed to the Lessor's satisfaction. The Lessor may, after consultation with NMFS, decide to approve, approve with conditions, or disapprove the alternative monitoring plan.

Limitations on Pile Driving. The Lessee, by itself or through its designated operator, must ensure that no pile-driving activities occur from November 1 – April 30.

Field Verification of Exclusion Zone. The Lessee, by itself or through its designated operator, must conduct acoustic monitoring of pile driving activities during the installation of each Monopile foundation requiring pile driving. Acoustic measurements must take place during the driving of the last half of the Monopile (deepest segment) during installation of the first Monopile foundation. The Lessee, by itself or through its designated operator, must take acoustic measurements at a minimum of two reference locations that are sufficient to establish the following: source level (peak at 1 m) and distance to the 180, 166, 160, and 150 dB re 1μPa (RMS) SPL isopleths, the 210 dB re 1μPa cSEL and 207 dBpeak distances, the 187 dB re 1μPa cSEL, and the NOAA guidance for assessing marine mammal impacts from underwater noise. Such sound measurements must be taken at the reference locations at two depths (i.e., a depth at midwater and a depth at approximately 1m above the seafloor). Sound pressure levels must be measured in the field in dB re 1 μPa (RMS) and reported by the Lessee, by itself or through its designated operator, to the Lessor and NMFS (per Section 7.10). The Lessee, by itself or through its designated operator, must report the azimuthal bearing from the central pile to the receivers. Additionally, the Lessee, by itself or through its designated operator, must record the bearings from the central caisson to the strike surfaces of each Monopile, as well as the bearing from the central caisson to where each Monopile enters the ocean floor.

<u>Modification of Exclusion Zone</u>. The Lessee, by itself or through its designated operator, must submit results of the acoustic monitoring for field verification of the exclusion zone to the Lessor. Based on the results of this field verification:

> If the Lessor determines that the exclusion zone does not encompass the 180 dB Level A harassment radius (and notifies the Lessor and NMFS per Section 7.11), the Lessor may impose additional, relevant requirements on the Lessee, including but not limited to, expansion of this exclusion zone.
>
> The Lessee, by itself or through its designated operator, may modify the default exclusion zone for pile driving activities. The Lessee, by itself or through its designated operator, should use the results of its field verification in establishing any new exclusion zone, regardless of whether it is greater than or less than the default exclusion zone. Any new exclusion zone radius must be based on the most conservative measurement (i.e., the largest safety zone configuration) of the target (i.e. 180 dB or 160 dB) zone. The Lessee, by itself or through its designated operator, must obtain the Lessor's approval for any new exclusion zone before it may be implemented.

<u>Clearance of Exclusion Zone</u>. The Lessee, by itself or through its designated operator, must ensure that visual monitoring of the exclusion zone begins no less than 60 minutes prior to the start of any pile driving operations and continues for at least 60 minutes after pile driving operations cease. If a marine mammal or sea turtle is observed, the PSO must note and monitor the position, relative bearing and estimated distance to the animal until the animal dives or moves out of visual range of the PSO. The PSO must continue to watch for additional marine mammals or sea turtles that may surface in the area. The Lessee, by itself or through its designated operator, must ensure that pile driving operations do not begin until the PSO has reported the exclusion zone clear of all marine mammals and sea turtles for at least 60 minutes.

<u>Implementation of Soft Start</u>. The Lessee, by itself or through its designated operator, must ensure that a "soft start" be implemented at the beginning of each pile installation. This will provide additional protection to marine mammals and sea turtles near the project area by allowing them to vacate the area

prior to the commencement of pile driving activities.  The Lessee, by itself or through its designated operator, must ensure the following at the beginning of all in-water pile driving activities or when pile driving has ceased for one hour or more:  The impact hammer soft start requires 3 strike sets, with a 1-minute wait period between each strike set.  The initial strike set will be at approximately 10 percent energy, the second strike set at approximately 25 percent energy and the third strike set at approximately 40 percent energy.  The soft start procedure must last for at least 20 minutes.  Strikes may continue at full operational power following the soft start period. In addition to noise mitigation measures, Section 3.6.1 of the RAP (2014) contains measures to monitor other environmental impacts. BOEM will review and share these reports with NMFS upon request in order to monitor environmental impacts associated with impacts to benthic habitat, including EFH. If impacts are greater than that assessed then additional mitigation measures may be required. The environmental monitoring measures include the following:

IBGS Foundation Monitoring Reports: The lessee must provide BOEM with visual inspection reports of the IBGS foundation within 45 calendar days following the inspection schedule described in the RAP (e.g., six-month intervals for the first year, and 12 month-intervals thereafter). These monitoring reports must include the type and thickness of marine growth on the IBGS foundation and within 5 meters of the piles on the seabed identified to the lowest taxonomic group possible. Report will be shared with NMFS once received.

Foundation Scour Monitoring Reports: The lessee must provide BOEM with foundation scour monitoring reports within 45 calendar days following the inspections schedule described in the approved RAP (e.g., within 6 months of commissioning, and again within commissioning anniversary years 1, 2, 5, and 10, and after major storm events). Report will be shared with NMFS once received.

Inter-array and Export Cable Monitoring Reports: The lessee must provide BOEM with the inter-array and export cable monitoring reports within 45 calendar days following the inspections schedule described in the approved RAP (e.g., within 6 months of commissioning, and again within commissioning anniversary 1, 2, 5, and 10, and after major storm events). Report will be shared with NMFS once received.

Cable Protection Measure Report.  If the Lessee, by itself or through its designated operator, determines that cable protection measures are necessary, it must consider utilizing measures that minimize impacts to essential fish habitat (e.g., cable protection measures with the smallest footprint practicable) and reduce potential for interactions with fishing gear.  Prior to selecting cable protection measures Should the Lessee, by itself or through its designated operator, determine that it is necessary to implement cable protection measures, it must consult with the Lessor regarding the cable protection measures considered to reduce impacts to bottom habitat and fishing gear.

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# APPENDICES

(Taken from RAP, 2014 and Revised RAP 2018)

Appendix G: Sediment Transport Analysis

Appendix J: Benthic Survey Report

Appendix K: Magnetic Fields from Submarine Cables

Revised 2018 RAP (10/31/2018)

Attachment 8: Revised Underwater Acoustic Modelling (2014 RAP Appendix M-2)