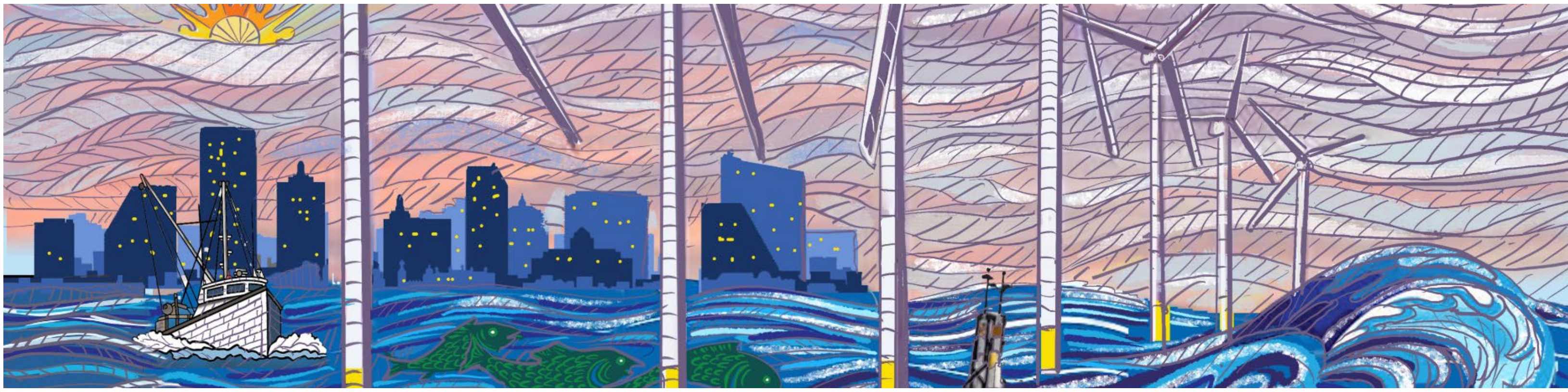

Appendix II-J2

Revised Essential Fish Habitat Assessment

Revised Essential Fish Habitat Assessment

Atlantic Shores Offshore Wind

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March 2021

Revised December 2021

TABLE OF CONTENTS

1.0 Introduction 1

2.0 DESCRIPTION OF PROPOSED ACTION 3

- 2.1 Project Overview 3
- 2.2 Project Design and Construction Activities 4
  - 2.2.1 Project Design Envelope Overview 4
  - 2.2.2 Project Construction Process and Schedule 5
  - 2.2.3 Wind Turbine Generator Foundations 7
  - 2.2.4 Offshore Substation Foundations 7
  - 2.2.5 Offshore Cables 8
  - 2.2.6 Landfall Site Construction Activities 11
  - 2.2.7 Summary of Maximum Design Scenario and Seafloor Disturbance 12
- 2.3 Offshore Operations and Maintenance and Inspections 14
  - 2.3.1 Foundations and Scour Protection 14
  - 2.3.2 Offshore Cables 15
- 2.4 Decommissioning 15

3.0 AFFECTED ENVIRONMENT 16

- 3.1 Pelagic Habitat 16
- 3.2 Benthic Habitat 17
  - 3.2.1 The WTA 18
  - 3.2.2 Atlantic ECC 19
  - 3.2.3 Monmouth ECC 19

4.0 ESSENTIAL FISH HABITAT DESIGNATIONS AND DESCRIPTIONS 21

- 4.1 EFH Designations in the Atlantic Shores Offshore Project Area 21
- 4.2 Description of EFH Species and Life Stages in Offshore Project Area 26
  - 4.2.1 New England Fishery Management Council Finfish Species 26
  - 4.2.2 Mid-Atlantic Fishery Management Council Finfish Species 37
  - 4.2.3 New England Fishery Management Council Invertebrate Species 45
  - 4.2.4 Mid-Atlantic Fishery Management Council Invertebrate Species 46
  - 4.2.5 Highly Migratory Species 48

5.0 DESCRIPTION OF OTHER NOAA TRUST RESOURCES 55

6.0 Essential Fish Habitat summary by life stage and habitat 57

- 6.1 Early Pelagic Life Stages 57
- 6.2 Late Pelagic Life Stages 58
- 6.3 Early Benthic or Demersal Life Stages 58

6.4 Late Benthic or Demersal Life Stages 61
6.5 Summary of Effects to EFH Life Stages and Habitat Types 67
7.0 ASSESSMENT OF potential effects 68
7.1 Temporary Direct Habitat Loss and Disturbance 68
7.2 Suspended Sediment and Deposition 74
7.3 Impingement or Entrainment of Fish Larvae 81
7.4 Habitat Conversion and Creation 81
7.5 Noise 85
7.5.1 Impact Pile Driving Noise 87
7.5.2 Other Noise Sources 90
7.6 Electromagnetic Fields 93
7.7 Lighting 96
8.0 summary of proposed environmental protection measures 98
9.0 CONCLUSION 100
10.0 REFERENCES 101

LIST OF TABLES

Table 1. Anticipated Project Construction Schedule 6
Table 2. Maximum Total Seabed Disturbance 13
Table 3. Area of Habitat Types in the Offshore Project Area 18
Table 4. EFH Designation for Species in the Offshore Project Area[1] 22
Table 5. Other NOAA Trust Resources Habitat and Potential Occurrence in the Offshore Project Area 55
Table 6. Early Pelagic Life Stages of Species with Designated EFH Mapped in the Offshore Project Area 57
Table 7. Late Pelagic Life Stages of Species with Designated EFH Mapped in the Offshore Project Area 58
Table 8. Percentage of Field-Mapped NMFS Habitat Categories within Designated EFH for Early Benthic/Demersal Life Stages in the Offshore Project Area 60
Table 9. Percentage of Field-Mapped NMFS Habitat Categories within Designated EFH for Late Benthic/Demersal Life Stages in the Offshore Project Area 62
Table 10: Estimated Temporary and Permanent Disturbance to NMFS Habitat Types[1] 70
Table 11. Suspended Sediment Modeling Results from Cable Installation and HDD Activities 76
Table 12. Deposition Modeling Results from Cable Installation and HDD Activities 79
Table 13. Interim Fish Injury and Behavioral Acoustic Thresholds Currently used by NOAA Fisheries GARFO and BOEM for Impulsive Pile Driving 86
Table 14. Interim Fish Injury and Behavioral Acoustic Thresholds Currently Recommended by BOEM for Non-impulsive Sources 88

Table 15. Maximum Radial Distance (in kilometers) to Thresholds for Fish due to Impact Pile Driving of One 15 meter monopile with a 4,400 kJ Hammer with Varying Levels of Attenuation 89
Table 16. Peak Magnetic Fields Modeled under Maximum Power Generation for the Atlantic Shores Export and Inter-Array Cables..94

LIST OF FIGURES

Figure 1. Project Overview

Figure 2. Habitat Types in Offshore Project Area

Figure 3. NMFS CMECS Classifications

Figure 4. Proportion of NMFS CMECS Sediments in the WTA, Atlantic ECC, and Monmouth ECC

Figure 5. Habitat Area of Particular Concern for Sandbar Shark

LIST OF ATTACHMENTS

Attachment 1 Benthic Habitat Mapping Methodology

Attachment 2 Benthic Habitat Maps – 1:10,000 landscape scale

Attachment 3 Benthic Habitat Maps – 1:5,000 scale

LIST OF ACRONYMS

AC	Alternating Current
BOEM	Bureau of Ocean Energy Management
CMECS	Coastal and Marine Ecological Classifications Standards
COP	Construction and Operation Plan
dB	Decibels
DC	Direct Current
ECC	Export Cable Corridor
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EMF	Electromagnetic Field
FMP	Fishery Management Plan
GARFO	Greater Atlantic Regional Fisheries Office
GBS	Gravity-Based Structure
HAPC	Habitat of Particular Concern
HDD	Horizontal Directional Drilling
HRG	High Resolution Geophysical
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
kV	Kilovolts
MAFMC	Mid-Atlantic Fishery Management Council
MARACOOS	Mid-Atlantic Regional Association Coastal Ocean Observing System
MARMAP	Marine Resources Monitoring, Assessment and Prediction
MEC	Munitions and Explosives of Concern
MW	Megawatt
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NJDEP OSAP	New Jersey Department of Environmental Protection Ocean Stock Assessment Program
NMFS	National Marine Fisheries Service
NOAA	National Ocean and Atmospheric Administration
O&M	Operations and Maintenance
OSRP	Oil Spill Response Plan
OSS	Offshore Substation
PDE	Project Design Envelope

PK	Peak Sound Level
POI	Point of Interconnection
PTS	Permanent Threshold
SEL	Sound Exposure Level
spl	Sound Pressure Level
TSS	Total Suspended Sediments
TTS	Temporary Threshold Shift
USCG	United States Coast Guard
WTA	Wind Turbine Area
WTG	Wind Turbine Generator

1.0 INTRODUCTION

Atlantic Shores Offshore Wind, LLC (Atlantic Shores) is a 50/50 joint venture between EDF-RE Offshore Development, LLC (a wholly owned subsidiary of EDF Renewables, Inc. [EDF Renewables]) and Shell New Energies US LLC (Shell). On behalf of Atlantic Shores EDR has prepared this Revised Essential Fish Habitat (EFH) Assessment in support of the submission of the Construction and Operations Plan (COP) to the Bureau of Ocean Energy Management (BOEM) for the development of two offshore wind energy generation projects (the Projects) within the southern portion of Lease Area OCS-A 0499 (the Lease Area).

The Atlantic Shores offshore wind energy generation Projects will be located in an approximately 102,124-acre (413.3-square kilometer) Wind Turbine Area (WTA) located in the southern portion of Lease Area OCS-A 0499 (Figure 1). Project 1 is located in the western 54,175 acres (219.2 -square kilometer) of the WTA (Project 1 WTA), and Project 2 is located in the eastern 31,847 acres (128.9 square kilometer) of the WTA (Project 2 WTA), with a 16,102-acre (65.2--square kilometer) area of overlap (Overlap Area) that could be used by either Project 1 or Project 2. Figure 1 also depicts the boundaries of the Project 1 and Project 2 areas within the WTA. In addition to the WTA, the combined Projects will include two offshore export cable corridors (ECCs) within federal and New Jersey state waters as well as two onshore interconnection cable routes. The WTA and ECCs combined, make up the Offshore Project Area which is depicted on Figure 1.

A Preliminary EFH report was submitted as Appendix II-J of the Atlantic Shores Offshore Wind COP in March of 2021. Since the submittal of the Atlantic Shores COP, the following changes, updates, and recommendations have been made:

- Identification of two offshore wind energy generation projects within the southern portion of Lease Area OCS-A-0499 (Project 1 and Project 2);
- Minor adjustments to the Atlantic Landfall and to a portion of the Atlantic ECC and Monmouth ECC;
- Completion of benthic habitat mapping;
- Updated EFH mapping from NOAA Fisheries as of March 2021; and
- Comments from the BOEM requesting additional information.

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), passed in 1976 and amended in 1996, requires that an EFH consultation be conducted for any activity that may adversely affect important habitats of federally managed marine and anadromous species. BOEM, as the lead federal agency for the Projects, has the responsibility to initiate an EFH consultation prior to approving the Projects. This Revised EFH Assessment is prepared as an appendix to Atlantic Shores' COP at the request of BOEM to provide information needed to begin their consultation with National Oceanic and Atmospheric Administration (NOAA) Fisheries regarding EFH and EFH species.

Atlantic Shores conducted high resolution geophysical (HRG) and geotechnical surveys from 2019 to 2021 in the Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC, collectively referred to as the Offshore Project Area (Figure 1), including benthic grab samples, sediment profile imaging (SPI) camera – plan view video (PV) surveys, video transect surveys, and ecological classification of benthic habitats which provide data to inform this EFH Assessment. Data from these surveys, as well as additional publicly available desktop data were used in this assessment to evaluate EFH in the Offshore Project Area.

2.0 DESCRIPTION OF PROPOSED ACTION

2.1 Project Overview

The Atlantic Shores offshore wind energy generation Projects will be located in an approximately 102,124-acre (413.3-square kilometer) WTA located in the southern portion of Lease Area OCS-A 0499 (Figure 1). Project 1 is located in the western 54,175 acres (219.2 -square kilometer) of the WTA (Project 1 WTA), and Project 2 is located in the eastern 31,847 acres (128.9 square kilometer) of the WTA (Project 2 WTA), with the 16,102-acre (65.2-square kilometer) Overlap Area that could be used by either Project 1 or Project 2. Figure 1 also depicts the boundaries of the Project 1 and Project 2 areas within the WTA. In addition to the WTA, the combined Projects will include two offshore ECCs within federal and New Jersey state waters as well as two onshore interconnection cable routes, two onshore substation and/or converter station sites, and a proposed operations and maintenance (O&M) facility in New Jersey. Figure 1 provides an overview of the Offshore Project Area.

At its closest point, the WTA is approximately 8.7 miles (14 kilometers) from the New Jersey shoreline. Within the WTA, the Projects will include:

- a combined maximum of up to 200 wind turbine generators (WTGs), inclusive of the Overlap Area[1]:
  - Project 1: a minimum of 105 WTGs and up to a maximum of 136 WTGs
  - Project 2: a minimum of 64 WTGs and up to a maximum of 95 WTGs
- up to 10 offshore substations (OSSs):
  - five for Project 1
  - five for Project 2
- up to one permanent meteorological (met) tower, to be installed during Project 1 construction
- up to four temporary meteorological and oceanographic (metocean) buoys:
  - three for Project 1
  - one for Project 2

The Projects include three options for WTG, OSS, and meteorological tower (met tower) foundations: piled, suction bucket, or gravity foundations.

Each Project's WTGs and OSSs will be connected by a system of 66 kilovolt (kV) to 150 kV high-voltage alternating current (HVAC) inter-array cables. OSSs within the WTA may be connected to each other by 66 kV to 275 kV HVAC inter-link cables.

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[1] The number of WTGs in Project 1, Project 2, and the associated Overlap Area will not exceed 200 WTG locations. For example, if Project 1 includes 105 WTGs (the minimum) then the Overlap Area would be incorporated into Project 2 which would include the remaining 95 WTGs; and conversely if the Overlap Area is incorporated into Project 1 such that it includes 136 WTGs, then Project 2 would be limited to 64 WTGs. Each Project may also use only part of the Overlap Area.

The Projects' layout is designed to maximize offshore renewable wind energy production while minimizing effects on existing marine uses. The WTGs for the Projects will be aligned in a uniform grid with multiple lines of orientation allowing straight transit corridors through the WTA. The primary east-northeast to west-southwest transit corridors through the WTA were selected to align with the predominant flow of vessel traffic; accordingly, WTGs will be placed along east-northeast to west-southwest rows spaced 1.0 nautical mile (1.9 kilometers) apart to allow for two-way vessel movement. The proposed grid also facilitates north to south transit by positioning WTGs along rows in an approximately north to south direction spaced 0.6 nautical miles (1.1 kilometers) apart (Figure 1). The WTG grid will also create diagonal corridors of 0.54 nautical mile (1.0 kilometers) running approximately northwest to southeast as well as diagonal corridors of 0.49 nautical miles (0.9 kilometers) running approximately north-northeast to south-southwest. The OSS positions will be located along the same east-northeast to west-southwest rows as the WTGs, preserving all of the primary east-northeast transit corridors and the majority of the secondary transit corridors (see Volume 1, Section 3.1 of the COP).

Project 1 and Project 2 will be electrically distinct, and energy from the Projects' OSSs will be delivered to shore via 230 kV to 525 kV HVAC and/or high voltage direct current (HVDC) export cables. Thus, for the combined Projects, a total of up to eight export cables will be installed. The export cables will traverse federal and state waters to deliver energy from the OSSs to landfall sites in New Jersey. The Atlantic ECC travels from the western tip of the WTA westward to the Atlantic Landfall Site in Atlantic City, NJ and has a total length of approximately 12 miles (19 kilometers). The approximately 61 mile (98 kilometer) Monmouth ECC travels from the eastern corner of the WTA along the eastern edge of the Lease Area to the Monmouth Landfall Site in Sea Girt, New Jersey.

At the Monmouth and Atlantic Landfall Sites, horizontal directional drilling (HDD) will be employed to support each export cables' offshore-to-onshore transition. The HDD landfall technique has been selected both to ensure stable cable burial along New Jersey's dynamic coast and to avoid nearshore and shoreline impacts. From each landfall site, up to 12 new 230 kV to 525 kV HVAC and/or HVDC onshore interconnection cables will travel underground to two new onshore substation and/or converter station sites (one for each onshore point of interconnection [POI]). Onshore interconnection cables will continue from each of the new onshore substations and/or converter stations to proposed POIs where the Projects will be interconnected into the electrical grid at the existing Larrabee Substation in Howell, New Jersey (for the Monmouth Landfall Site) and the existing Cardiff Substation in Egg Harbor Township, New Jersey (for the Atlantic Landfall Site). Due to electrical capacity constraints at the POIs, two POIs are needed to accommodate the maximum amount of electricity that could be generated by the Projects.

2.2 Project Design and Construction Activities

2.2.1 Project Design Envelope Overview

Atlantic Shores is requesting BOEM's review and authorization of the Projects in accordance with BOEM's (2018) Project Design Envelope (PDE) guidance. The Projects' PDE includes a reasonable range of designs for proposed Project components (e.g., foundations, WTGs, export cables, onshore elements) and installation techniques (e.g., use of anchored, jack-up, or dynamic positioning vessels). Identifying a range of design parameters and installation methods allows BOEM to analyze the maximum effects that could occur from the Projects while providing Atlantic Shores with the flexibility to optimize the Projects within the approved PDE during later stages of the development process. The PDE will enable Atlantic Shores to employ the best available technology, which often outpaces the permitting process, to maximize renewable energy production, minimize adverse environmental effects, address stakeholder concerns, and minimize cost to ratepayers.

The offshore components of the Projects' PDE include the following elements (see Volume I, Section 4.0 of the COP for additional details):

- A combined maximum of up to 200 WTGs inclusive of the Overlap Area, each with a maximum rotor diameter of approximately 919 feet (280 meters), will be installed on three main foundation types (piled, suction bucket, and gravity foundations). Project 1 will consist of a minimum of 105 WTGs to a maximum of 136 WTGs. Project 2 will consist of a minimum of 64 WTGs to a maximum of 95 WTGs.
- Up to 10 small OSSs, up to five medium OSSs, or up to four large OSSs will serve as common collection points for power from the WTGs and also serve as the origin for the export cables that deliver power to shore. Project 1 will consist of up to five small, two medium, or two large OSSs and Project 2 will consist of up to five small, three medium, or two large OSSs.
- Up to 547 miles (880 kilometers) of HVAC inter-array cables will connect strings of WTGs to a shared OSS (up to 273.5 miles [440 kilometers] each for Project 1 and Project 2).
- Up to 37 miles (60 kilometers) of HVAC inter-link cables may be used to connect OSSs to each other (up to 18.6 miles [30 kilometers] each for Project 1 and Project 2).
- Up to eight total HVAC and/or HVDC export cables will be installed in two offshore ECCs, the Atlantic ECC and the Monmouth ECC, that are each approximately 3,300 to 4,200 feet (1,000 to 1,280 meters) wide. The length per cable in the Atlantic ECC and Monmouth ECC will be 25 miles (40 kilometers) and 85 miles (138 kilometers), respectively.
- Up to one permanent met tower and up to four temporary meteorological and metocean buoys may be installed within the WTA. Project 1 may have one permanent met tower and up to three temporary metocean buoys. Project 2 may have up to one temporary metocean buoy.

2.2.2 Project Construction Process and Schedule

The anticipated Project construction schedule is shown below in Table 1.

Table 1. Anticipated Project Construction Schedule

Activity	Duration[a]	Expected Timeframe[b]	Project 1 Start Date	Project 2 Start Date
Onshore Interconnection Cable Installation	9 - 12 months	2024 - 2025	Q1-2024	Q1-2024
Onshore Substation and/or Converter Station Construction	18 - 24 months	2024 - 2026	Q1-2025	Q1-2025
Export Cable Installation	6-9 months	2025	Q2-2025	Q3-2025
OSS Installation and Commissioning	5-7 months	2025 - 2026	Q2-2026	Q2-2026
WTG Foundation Installation[c]	10 months	2026 – 2027	Q1-2026	Q1-2026[c]
Inter-Array Cable Installation	14 months	2026 - 2027	Q2-2026	Q3-2026[d]
WTG Installation and Commissioning	17 months	2026 - 2027	Q2-2026	Q1-2027[d]

Notes:

a) These durations assume continuous foundation structure installation without consideration for seasonal pauses or weather delays; anticipated seasonal pauses are reflected in the expected timeframe.

b) The expected timeframe is indicative of the most probable duration for each activity; the timeframe could shift and/or extend depending on the start of fabrication, fabrication methods, and installation methods selected.

c) The expected timeframe depends on the foundation type. If piled foundations are utilized, pile-driving will follow a proposed schedule from May to December to minimize risk to North Atlantic Right Whale. No simultaneous pile driving is proposed.

d) The expected timeframe is dependent on the completion of the preceding Project 1 activities (i.e., Project 1 inter-array cable installation and WTG installation) and the Project 2 foundation installation schedule.

Construction of the offshore facilities is expected to begin with installation of the export cables and the WTG and OSS foundations (including scour protection). Once the OSS foundations are installed, the topsides can be installed and commissioned and the inter-link cables (if used) can be installed. At each WTG position, after the foundation is installed, the associated inter-array cables and WTGs can be installed (if WTGs are not installed onto gravity-base structure [GBS] foundations at port). Given the number of WTG and OSS positions, there is expected to be considerable overlap in various equipment installation periods. Installation of the Projects' offshore facilities may occur over a period of up to 2 years to accommodate weather and/or seasonal work restrictions.

HRG and geotechnical surveys will be conducted to verify site conditions prior to offshore construction and HRG surveys will be conducted post-construction to ensure proper installation of the components of each Project . HRG survey equipment may include side-scan sonar, multibeam echo-sounder, magnetometers, gradiometers, and sub-bottom profilers. Based on the results of a munitions and explosives of concern (MEC) desktop study (see Volume II, Appendix II-A4 of the COP) and based on final facility siting and engineering design, Atlantic Shores may also elect to include a MEC study as part of the Projects' pre-construction HRG survey campaign. Geotechnical surveys to inform the final design and engineering of the offshore facilities may include vibracores, cone penetrometer tests, and deep borings. Geotechnical surveys will only be performed in areas that are surveyed and cleared for cultural resources.

2.2.3 Wind Turbine Generator Foundations

The WTG foundations will provide a robust, stable, and level base for the WTG towers. The Projects include three categories of WTG foundations that may be affixed to the seabed using piles, suction buckets, or gravity:

1. **Piled foundations**: monopiles or piled jackets;
2. **Suction bucket foundations**: mono-buckets, suction bucket jackets, or suction bucket tetrahedron bases; and
3. **Gravity foundations**: GBS or gravity-pad tetrahedron bases.

Foundations, particularly gravity foundations, may require some seabed preparation. Seabed preparation involves removing the uppermost sediment layer to establish a level surface, remove any surficial sediments that are too weak to support the planned structure, and enable full contact between the foundation base and the seafloor. This is necessary to ensure that the foundation remains vertical and its weight is uniformly distributed. For gravity foundations it may take three to four days to prepare the seabed prior to installation. Piled and suction bucket foundations are not expected to require seabed preparation unless the seabed is not sufficiently level (i.e., where large sand bedforms are present). Where this occurs, the seabed may need to be prepared prior to pile-driving or suction bucket installation. Seabed preparation could be accomplished using trailing suction hopper dredge, jetting/controlled flow excavation, or backhoe/dipper. For gravity foundations, a gravel pad may be installed after completing seabed preparation. The gravel pad is expected to consist of one or more layer(s) of coarse-grained material. The gravel pads may be comprised of a filter layer (i.e., a layer of finer material) and an armor layer (i.e., a layer of coarser material). Seabed preparation and installation of the gravel pad will likely be performed by a dynamic positioning fallpipe vessel.

Scour protection may be installed at the base of each foundation to protect it from sediment transport/erosion caused by water currents. The PDE includes six types of scour protection: rock placement, rock bags, grout or sand-filled bags, concrete mattresses, ballast-filled mattresses, and frond mattresses. Scour protection consisting of freely-laid rock will likely be installed by a fallpipe vessel, which uses a pipe that extends to just above the seafloor to deposit rock contained in the vessel hopper in a controlled manner. Concrete mattresses, rock bags, grout- or sand-filled bags, and frond mattresses will likely be deployed by a vessel's crane. The need for and selected type(s) of scour protection will be determined by the final design of the foundations and ongoing agency consultations.

2.2.4 Offshore Substation Foundations

The Projects will include one or more OSSs that serve as common collection points for power from the WTGs and also serve as the origin for the export cables that deliver power to shore. Similar to the WTG foundations, the Projects include three categories of OSS foundations that may be affixed to the seabed using piles, suction buckets, or gravity. The type of OSS foundation used depends on the size of the OSS itself. These foundation types are similar to those under consideration for the WTGs, although tetrahedron base foundations are not included in the OSS foundation PDE. OSS foundations (particularly gravity foundations), may require seabed preparation (i.e., removing the uppermost sediment layer beneath the foundation). Gravity foundations are also expected to require gravity pads. Scour protection may be installed at the base of each OSS foundation to protect it from sediment transport/erosion caused by water currents. The different types of scour protection that could be placed around OSS foundations are the same as for WTG foundations.

2.2.5 Offshore Cables

Each Project will include offshore export, inter-array, and possibly inter-link cables (the "offshore cables"). The export cables will deliver electricity from the Project OSSs to the landfall sites. The inter-array cables will connect strings of WTGs to and OSS and interlink cables could be used to connect OSSs to each other. As each Project will be electrically distinct none of the offshore cables will be shared between Projects. The export cables from each Project will however have the potential to utilize either ECC or be co-located in the same ECC.

2.2.5.1 Export Cables

The PDE for export cables includes three transmission options, which are based upon the use of HVAC and/or HVDC offshore export cables. Atlantic Shores is including these three options to provide technical flexibility for ongoing detailed offshore and onshore engineering processes, to account for varying interconnection capacity at each POI, and to provide commercial optionality.

- **Option 1–HVAC transmission**: In this option, each Project would install up to four HVAC cables within either ECC, and each Project would use a separate ECC. Under this scenario, both ECCs would be used, resulting in a total of up to eight export cables (up to four cables per ECC).
- **Option 2–HVDC Transmission**: In this option, each Project would install one HVDC cable bundle (composed of two HVDC cables) within either ECC, and each Project would use a separate ECC. With this option, both ECCs would be used.
- **Option 3–HVAC and HVDC Transmission**: In this option, one Project would install up to four HVAC export cables, and the other Project would install one HVDC export cable bundle, resulting in a total of five export cables for both Projects.

In all three options, the maximum total number of export cables to be installed is eight.

The export cable design will include a monitoring system, such as a distributed temperature system (DTS), distributed acoustic sensing (DAS) system, or online partial discharge (OLPD) monitoring, to continuously assess the status of offshore cables and detect anomalous conditions, insufficient or excess cable depth, or potential cable damage. The target burial depth of the export cables will be 5 to 6.6 feet (1.5 to 2 meters).

The export cables will be installed within the Atlantic ECC and/or the Monmouth ECC (Figure 1). The width of each ECC corresponds to marine survey corridors and ranges from approximately 3,300 to 4,200 feet (1,000 to 1,280 meters) for all of the Monmouth ECC and most of the Atlantic ECC, though the Atlantic ECC widens to approximately 5,900 feet (1,800 meters) near the Atlantic Landfall Site. The width of each ECC is needed to accommodate the planned export cables, as well as the associated cable installation vessel activities, and allows for avoidance of resources such as shipwrecks and sensitive habitats. Variations in width at the landfall sites are needed to accommodate the construction vessel activities necessary to support the landfall of each export cable via HDD.

A minimum separation distance of approximately 330 feet (100 meters) is planned between the export cables installed within each ECC. The cables will typically be separated by 410 to 820 feet (125 to 250 meters), depending on route constraints and water depths. This separation distance, which provides flexibility for routing and installation as well as for future cable repairs (if needed), may be adjusted pending ongoing evaluation and site conditions.

The ECC from the WTA boundary to the Atlantic Landfall Site is approximately 12 miles (19 kilometers). The maximum length of each export cable from the Atlantic Landfall Site to an OSS is approximately 25 miles (40 kilometers), including the length of the export cable within the WTA and contingency for micro-siting. The ECC from the WTA boundary to the Monmouth Landfall Site is approximately 61 miles (98 kilometers). Each export cable from the Monmouth Landfall Site to an OSS has a maximum length of approximately 85 miles (138 kilometers) when accounting for the length of the export cable within the WTA and contingency for micro-siting. If four export cables are installed in each ECC (for a total of eight export cables), the total maximum export cable length will be 441 miles (710 kilometers). Neither ECC crosses established navigation channels.

2.2.5.2 Inter-Array and Inter-Link Cables

The electrically distinct inter-array cables and inter-link cables (if used) for each Project will be installed within surveyed corridors in the WTA where full archaeological and geological assessments will have been completed. Atlantic Shores will engineer potential inter-array and inter-link cable layouts based on the results of surveys conducted in 2021. For both Projects, Atlantic Shores anticipates that up to 547 miles (880 kilometers) of inter-array cables and up to approximately 37 miles (60 kilometers) of inter-link cables may be needed. Project 1 and Project 2 will each have a maximum of 273.5 mi (440 kilometers) of inter-array cables and up to approximately 18.6 mi (30 kilometers) of inter-link cables.

2.2.5.3 Pre-Installation and Offshore Cable Installation

Activities that will be conducted prior to cable installation include sand bedform clearing, relocation of boulders, a pre-lay grapnel run, and a pre-lay survey. Detailed cable pre-installation and installation methods are described in more detail in Volume I, Section 4.5.3 of the COP.

Three common methods may be used to lay and bury the export cables, inter-array cables, and/or inter-link cables: simultaneous lay and burial, post-lay burial, and pre-lay trenching. Atlantic Shores is evaluating available cable installation tools to select techniques that are appropriate for the site and that maximize the likelihood of achieving the target cable burial depth of 5 to 6.6 feet (1.5 to 2 meters). The selection of equipment best suited for the task is an iterative process that involves reviewing seabed conditions, cable properties, laying and burying combinations, burial tool systems, and anticipated performance. The three primary cable installation tools proposed are: jet trenching, plowing/jet plowing, and mechanical trenching.

Cable installation is anticipated to create a trench with a maximum depth of approximately 10 feet (3 meters) and a maximum width of up to approximately 3.3 feet (1 meter). In addition to the direct trench impact, the installation tool's two skids or tracks (each approximately 6.6 feet [2 meters] wide) could result in surficial seabed disturbance on either side of the cable trench. An anchored cable laying vessel may be used in shallow portions of the ECCs; no anchoring is expected to be required to support cable installation in the WTA (see Volume I, Section 4.5.10 of the COP).

Most of the export, inter-array, and inter-link cables are expected to be installed using jet trenching (either simultaneous lay and burial or post-lay burial) or jet plowing, with limited areas of mechanical trenching. It is estimated that 80-90% of the offshore cables could be installed with a single pass of the cable installation tool. However, in limited areas expected to be more challenging for cable burial (along up to 10-20% of the export, inter-array, and inter-link cable routes), an additional one to three passes of the cable installation tool may be required to further lower the cable to its target burial depth.

During export cable installation, an additional pass of the cable installation tool prior to installing the cable (known as pre-pass jetting) may be performed along up to 5% of the cable alignments to loosen sediments and increase the probability of successful burial. HRG and geotechnical surveys performed in 2020 will confirm the most likely locations where pre-pass jetting may be performed for the offshore cables. Finally, for export cable installation in shallow water, a shallow-water barge with tensioners to tow a plow may be used for simultaneous lay-and-bury.

To install an inter-array cable, a cable-laying vessel will first pull the end of an inter-array cable into a WTG or OSS foundation, then lay the cable along the route to the next WTG, where the second cable end will be pulled into the WTG or OSS foundation. The vessel will repeat the process until all WTGs in a string are connected to a single OSS. If post-lay burial is used, a cable burial vessel will then progress along the laid strings of inter-array cables, burying them to target depth. If simultaneous lay and burial is used, the cables will be installed to the target depth in a single operation. If inter-link cables are included in the Projects' final design, the same process will apply to inter-link cables, except these cables will connect OSSs to one another rather than to strings of WTGs.

2.2.5.4 Export Cable Jointing

Given the length of the export cables, it is expected that they will be installed in one or more segments and that cable jointing offshore will be required. For either HVAC and/or HVDC export cables, a single joint per cable is anticipated for the Atlantic ECC. The longer route to the Monmouth Landfall Site could require up to four joints per cable.

After the installation of each export cable segment and prior to jointing, the end of the cable segment will be left on the seabed and held in temporary wet storage. In this case, temporary cable protection (e.g., concrete mattresses) may be placed over the cable end to avoid damage prior to splicing. The cable jointing process can take multiple days. After a joint is complete, the vessel lowers the joint to the seabed and the joint will be buried. If the joint is not too wide, it could be buried with a jet trencher; alternatively, controlled flow excavation could be used to cover the joint. If burial is not possible or practical due to sediment conditions, cable protection could be placed on top of the joint.

2.2.5.5 Offshore Cable Protection

Cable protection may be necessary if sufficient burial depth cannot be achieved (i.e., due to sediment properties or a cable joint). Cable protection may also be required to support the crossing of existing marine infrastructure such as submarine cables or pipelines. While Atlantic Shores will work to minimize the amount of cable protection required, it is conservatively assumed that up to 10% of the export cables, inter-array cables, and inter-link cables may require cable protection where sufficient burial depth is not achieved. Atlantic Shores is considering the use of five types of cable protection: rock placement, concrete mattresses, rock bags, grout-filled bags, and half-shell pipes (see Volume 1, Section 4.5.7 of the COP).

One or more of these types of cable protection may be used. Cable protection consisting of freely-laid rock can be installed by a fallpipe vessel, a vessel's crane, or side dumping from a vessel. If freely-laid rock is used, the fallpipe installation method, which is the most accurate technique, will be used wherever possible. Concrete mattresses, rock bags, and grout-filled bags will likely be deployed by a vessel's crane. Half-shell pipes are expected to be installed around the cable onboard the cable laying vessel prior to installing the cable.

2.2.6 Landfall Site Construction Activities

The offshore-to-onshore transition is proposed to be accomplished using HDD, a trenchless method that will avoid nearshore impacts as well as impacts directly along the shoreline. HDD, in comparison to trenching, also results in a deeper burial depth for cables in the nearshore environment, facilitating sufficient burial over the life of the Projects and decreasing the likelihood that cables will become exposed over time.

Each of the export cables coming ashore will be installed via HDD with each cable contained within a separate conduit. Up to six HDD conduits may be installed at each landfall site to accommodate the HVAC and/or HVDC cables. To support HDD activities, Atlantic Shores will establish an onshore staging area at each landfall site. At both sites, the HDDs will either be initiated or exit landward of the beach to avoid impacts to the beach. At the Atlantic Landfall Site, the HDD trajectory for each of the cables is expected to be approximately 2,800 feet (853 meters) long. At the Monmouth Landfall Site, the HDD trajectory for each of the cables is expected to be approximately 2,800 feet (853 meters) long. The estimated average depth of the HDDs is approximately 16 to 131 feet (5 to 40 meters) below the seabed.

HDD at each landfall site requires the excavation of an entrance pit and exit pit. At the offshore HDD entrance/exit location, a shallow area of up to approximately 66 feet by 33 feet (20 meters by 10 meters) will be excavated. A backhoe dredge may be required to complete the excavation and a cofferdam (or similar method) of approximately the same size as the excavated pit may be utilized. The need for a cofferdam (or similar) will depend on the results of marine surveys conducted near the landfall sites, the depth of burial, and the direction of HDD. A temporary offshore platform (e.g., jack-up barge) may be needed to support the HDD drilling rig.

2.2.7 Summary of Maximum Design Scenario and Seafloor Disturbance

The maximum offshore build-out of the Projects is defined as installation of up to 200 WTGs, 10 small OSSs, one permanent met tower, four temporary metocean buoys, eight offshore export cables (with a maximum total length of 441 miles [mi] [710 kilometers]), 547 miles (880 kilometers) of inter-array cables, and 37 miles (60 kilometers) of inter-link cables, along with associated scour and cable protection.

The maximum offshore build-out of Project 1 is installation of up to 136 WTGs (assumes Project 1 uses all available positions in the Overlap Area), five small OSSs, one permanent met tower, three temporary metocean buoys, four offshore export cables (with a maximum total length of 341.8 miles [550.0 kilometers]), 273.5 miles (440 kilometer) of inter-array cables, and 18.6 mile (30 kilometers) of inter-link cables, along with associated scour and cable protection.

The maximum offshore build-out of Project 2 is installation of up to 95 WTGs (assumes Project 2 uses all available positions in the Overlap Area), 5 small OSSs, one temporary metocean buoy, four offshore export cables (with a maximum total length of 341.8 miles [550.0 kilometers]), 273.5 miles (440 kilometers) of inter-array cables, and 18.6 miles (30 kilometers) of inter-link cables, along with associated scour and cable protection.

The maximum area of total permanent and temporary seabed disturbance in the WTA and ECCs from construction of the Projects' maximum PDE is provided in Table 2. See Volume I, Section 4.11 of the COP for additional details related to the basis of calculation.

Table 2. Maximum Total Seabed Disturbance

Installation Activity	**Maximum Area of Seafloor Disturbance**		
	Permanent Disturbance	**Additional Temporary Disturbance**	**Total[1]**
Project 1			
WTG Foundation Installation (Including Scour Protection)	0.55 mi^2 (1.42 km^2)	0.37 mi^2 (0.96 km^2)	0.78 mi^2 (2.02 km^2)
WTG Installation and Commissioning	N/A (Included in WTG foundation footprint)	0.08 mi^2 (0.21 km^2)	0.08 mi^2 (0.21 km^2)
OSS Foundation Installation (Including Scour Protection), Topside Installation, and Commissioning	0.02 mi^2 (0.05 km^2)	0.02 mi^2 (0.05 km^2)	0.04 mi^2 (0.10 km^2)
Inter-Array Cable Installation (Including Cable Protection)	0.22 mi^2 (0.57 km^2)	1.46 mi^2 (3.78 km^2)	1.68 mi^2 (4.35 km^2)
Inter-Link Cable Installation (Including Cable Protection)	<0.02 mi^2 (0.05 km^2)	0.13 mi^2 (0.34 km^2)	0.14 mi^2 (0.36 km^2)
Met Tower Installation[2] (Including Scour Protection)	N/A	N/A	N/A
Temporary Metocean Buoy Installation	N/A	0.02 mi^2 (0.05 km^2)	0.02 mi^2 (0.05 km^2)
Export Cable in WTA	0.08 mi^2 (0.21 km^2)	0.52 mi^2 (1.35 km^2)	0.6 mi^2 (1.55 km^2)
Atlantic ECC	0.04 mi^2 (0.11 km^2)	0.27 mi^2 (0.71 km^2)	0.31 mi^2 (1.24 km^2)
Monmouth ECC	0.04 mi^2 (0.11 km^2)	0.25 mi^2 (0.65 km^2)	0.29 mi^2 (0.79 km^2)
Max. Total Seabed Disturbance in the Project 1 WTA[3,4]	**0.84 mi^2 (2.18 km^2)**	**2.33 mi^2 (6.03 km^2)**	**3.02 mi^2 (7.83 km^2)**
Max. Total Seabed Disturbance in the ECCs	**0.38 mi^2 (0.98 km^2)**	**3.09 mi^2 (8.00 km^2)**	**3.47 mi^2 (8.99 km^2)**
Atlantic ECC	0.06 mi^2 (0.16 km^2)	0.83 mi^2 (2.14 km^2)	0.89 mi^2 (2.31 km^2)
Monmouth ECC	0.32 mi^2 (0.83 km^2)	2.26 mi^2 (5.86 km^2)	2.58 mi^2 (6.68 km^2)
Project 2			
WTG Foundation Installation (Including Scour Protection)	0.38 mi^2 (0.99 km^2)	0.26 mi^2 (0.68 km^2)	0.54 mi^2 (1.41 km^2)
WTG Installation and Commissioning	N/A	0.05 mi^2 (0.14 km^2)	0.05 mi^2 (0.14 km^2)
OSS Foundation Installation (Including Scour Protection), Topside Installation, and Commissioning	0.02 mi^2 (0.05 km^2)	0.02 mi^2 (0.05 km^2)	0.04 mi^2 (0.10 km^2)
Inter-Array Cable Installation (Including Cable Protection)	0.22 mi^2 (0.57 km^2)	1.46 mi^2 (3.78 km^2)	1.68 mi^2 (4.35 km^2)
Inter-Link Cable Installation (Including Cable Protection)	<0.02 mi^2 (0.05 km^2)	0.13 mi^2 (0.34 km^2)	0.14 mi^2 (0.36 km^2)
Met Tower Installation (Including Scour Protection)[2]	N/A	N/A	N/A

Installation Activity	Maximum Area of Seafloor Disturbance		
	Permanent Disturbance	Additional Temporary Disturbance	Total[1]
Temporary Metocean Buoy Installation	N/A	0.005 mi^2 (0.01 km^2)	0.005 mi^2 (0.01 km^2)
Export Cable in WTA[3]	0.08 mi^2 (0.21 km^2)	0.52 mi^2 (1.35 km^2)	0.6 mi^2 (1.55 km^2)
Atlantic ECC	0.04 mi^2 (0.11 km^2)	0.27 mi^2 (0.71 km^2)	0.31 mi^2 (1.24 km^2)
Monmouth ECC	0.04 mi^2 (0.11 km^2)	0.25 mi^2 (0.65 km^2)	0.29 mi^2 (0.79 km^2)
Max. Total Seabed Disturbance in the Project 2 WTA[3,4]	**0.68 mi^2 (1.75 km^2)**	**2.18 mi^2 (5.66 km^2)**	**2.76 mi^2 (7.14 km^2)**
Max. Total Seabed Disturbance in the ECCs	**0.38 mi^2 (0.98 km^2)**	**3.09 mi^2 (8.00 km^2)**	**3.47 mi^2 (8.99 km^2)**
Atlantic ECC	0.06 mi^2 (0.16 km^2)	0.83 mi^2 (2.14 km^2)	0.89 mi^2 (2.31 km^2)
Monmouth ECC	0.32 mi^2 (0.83 km^2)	2.26 mi^2 (5.86 km^2)	2.58 mi^2 (6.68 km^2)
Combined Projects[5]			
Max. Total Seabed Disturbance in the WTA	1.40 mi^2 (3.62 km^2)	4.43 mi^2 (11.48 km^2)	5.61 mi^2 (14.5 km^2)
Max. Total Seabed Disturbance in the ECCs	0.38 mi^2 (0.98 km^2)	3.09 mi^2 (8.00 km^2)	3.47 mi^2 (8.99 km^2)

[1] For WTG, OSS, and met tower foundations, the foundation type with the maximum footprint is not the same as the type with the maximum area of additional seabed disturbance. Thus, the sum of the maximum area of permanent disturbance and additional temporary disturbance does not equal the total seabed disturbance.

[2] There is sufficient conservatism in the total estimates of permanent and temporary seafloor disturbance from WTG foundation installation to account for the impacts from the met tower's installation.

[3] Given that the Overlap Area could be incorporated into Project 1 or Project 2, disturbance associated with the Overlap Area is included in both the Project 1 WTA and Project 2 WTA disturbance calculations.

[4] While Project 1 and Project 2 could use either the Atlantic or Monmouth ECC, the Maximum Total Seabed Disturbance in the Project 1 and Project 2 WTAs assumes seabed disturbance from the installation of four export cables within the Monmouth ECC, as that is the scenario that represents the maximum case for disturbance. It should also be noted that only a portion of the Monmouth ECC is included in the Maximum Total Seabed Disturbance in the Project 1 and Project 2 WTAs, as only a small portion of the ECC is located in the WTA. The remaining impacts from the Monmouth ECC is included in the 'Maximum Total Seabed Disturbance in the ECCs'.

[5] The Maximum Total Seabed Disturbance in the WTA for combined Projects includes the Project 1 WTA, Project 2 WTA, and Overlap Area. The Maximum Total Seabed Disturbance in the ECCs includes the Atlantic ECC, and Monmouth ECC.

2.3 Offshore Operations and Maintenance and Inspections

2.3.1 Foundations and Scour Protection

WTG, OSS, and met tower foundations will be inspected both above and underwater at regular intervals to check their condition including checking for corrosion, cracking, and marine growth. Scheduled maintenance of foundations will also include safety inspections and testing, coating touch up, preventative maintenance of cranes, electrical equipment, and auxiliary equipment, and removal of marine growth.

Unscheduled maintenance will be conducted for minor component repair/replacement if damage to a foundation occurs (e.g., due to an accidental event or conditions that exceed the foundation design loads). Corrective actions will be taken if any issues with scour protection are discovered.

2.3.2 Offshore Cables

The offshore cables will be continuously monitored using either a DTS, a DAS system, and/or OLPD monitoring. The inter-array cables and inter-link cables (if used) may also use a monitoring system. In addition, cable surveys will be performed at regular intervals to identify any issues associated with potential scour and depth of burial. Annual surveys will be performed for the first few years of operation, and provided no abnormal conditions are detected during those initial surveys, less frequent surveys will continue for the life of the Projects. Cable terminations and hang-offs will be inspected and maintained during scheduled maintenance of foundations, OSS, or WTGs.

In the unlikely event that a cable becomes exposed, the issue will be addressed by reburying the cable and/or applying cable protection. If a cable repair is required, it is expected that the damaged segment of the cable would be recovered from the seafloor. If required, a new section of cable would be spliced into the existing cable onboard a vessel within a controlled environment. After the new segment of cable was rejoined to the existing cable, the repaired cable would be lowered to the seafloor and reburied. The planned cable spacing is sufficient to allow for a cable repair to occur within each ECC. Vessels supporting these procedures will typically be of the same type as those used during construction.

2.4 Decommissioning

Atlantic Shores will follow the decommissioning requirements stated in Section 13, "Removal of Property and Restoration of the Leased Area on Termination of Lease," of the December 4, 2018 Lease Agreement for Lease Area OCS-A 0499. Pursuant to the applicable regulations in 30 CFR §585.902, and unless otherwise authorized by BOEM under 30 CFR §585.909, Atlantic Shores Project Companies will be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seabed of all obstructions created by activities on the leased area, including any Project easements(s). Removal or decommissioning activities must be completed within two years after lease termination (whether by expiration, cancellation, contraction, or relinquishment) in accordance with an approved Site Assessment Plan, COP, or Decommissioning Application and applicable regulations in 30 CFR Part 585. Per 30 CFR § 585.910(a), all offshore facilities must be removed to 15 feet (4.5 meters) below the mudline, unless otherwise authorized by BOEM.

Atlantic Shores Project Companies will submit a Decommissioning Application to BOEM prior to decommissioning any Project facilities. BOEM's process for reviewing and approving this plan will include consultations with municipal, state, and federal agencies, other stakeholders, and the public.

3.0 AFFECTED ENVIRONMENT

3.1 Pelagic Habitat

The Offshore Project Area is located in the Mid-Atlantic Bight, a region known for diverse species assemblages, with fish and shellfish species of commercial and recreational importance (BOEM, 2012). The Offshore Project Area, which includes the nearshore, areas at the landfall sites, contains tidal, nearshore, and offshore habitat, with water depths ranging from 62 to 121 feet (19 to 37 meters) in the WTA, approximately 0 to 72 feet (0 to 22 meters) in the Atlantic ECC, and approximately 0 to 98 feet (0 to 30 meters) in the Monmouth ECC. Based on data collected at the New Jersey Wind Energy Area between 2003 and 2016, the median salinity of water in the Offshore Project Area is 32.2 parts per thousand and ranges from 29.4 to 34.4 parts per thousand (BOEM, 2017). Within the WTA, water temperature fluctuates seasonally, with variation of temperature as high as 68 °F (20 °C) at the surface and 59 °F (15 °C) at the seabed (BOEM, 2017). Such fluctuations are a primary factor in finfish distribution in the Offshore Project Area (Geo-Marine, 2010). Many species of finfish present in the Offshore Project Area migrate seasonally, spending the spring and summer in nearshore or estuarine environments to breed and spawn, then migrating offshore in the fall and winter for warmer water temperatures.

A key feature of the Mid-Atlantic Bight is the Cold Pool. The Cold Pool is an oceanographic phenomenon referring to a bottom-trapped, cold, nutrient-rich pool that extends from Cape Cod, Massachusetts to Cape Hatteras, North Carolina, located over the mid- and outer-shelf of the Mid-Atlantic Bight (Chen, 2018; Ganim, 2019). The formation of the Cold Pool is driven by seasonal patterns in solar heating and wind (Ganim, 2019) and is not spatially uniform (Lentz, 2017). It forms at the start of spring when wind mixing is reduced, and surface heat fluxes increase causing the water column to become stratified (Ganim, 2019; Lentz, 2017). Freshwater runoff in the spring can further intensify stratification (Castelao et al., 2010). The Cold Pool, located along the seafloor, is isolated from warming surface waters by the seasonal thermocline and creates habitat conditions that provide thermal refuge to colder water species in the Mid-Atlantic Bight ecosystem (Lentz, 2017). Recruitment and settlement of several cold water species, such as yellowtail flounder (*Pleuronectes ferruginea*) and red hake (*Urophycis chuss*), has been linked to the presence of the Cold Pool (Chen, 2018; Lentz, 2017; Sullivan et al., 2005; Miller et al., 2016). This feature also provides temporary habitat for some northern species, like haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*), which thrive in colder temperatures (Steves et al., 1999; Kohut and Brodie, 2019). Cold pool waters are also nutrient-enriched and when upwelled toward the surface, can drive phytoplankton growth and high concentrations of particulate organic matter in the water column (Voynova et al., 2013).

The timing of the formation and breakdown of the Cold Pool, as well as its spatial extent, varies significantly each year but generally develops annually between spring and fall (Chen and Curchitser, 2020). The Cold Pool dissipates in the fall due to enhanced vertical mixing from an increase in the frequency of strong wind events and the cooling of surface temperatures (Ganim, 2019). The breakdown of the stratified Cold Pool is known to influence the timing of migration for fish species like winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), black sea bass (*Centropristis striata*), and Atlantic butterfish (*Peprilus triacanthus*) (Kohut and Brodie, 2019). Additionally, temporal changes in the breakdown of the Cold Pool have been linked to increased mortality in Atlantic surfclams and altered timing of spawning for ocean quahog (Narvaez et al., 2015; Toupoint et al., 2012). Many of the species dependent on the Mid-Atlantic Cold Pool (e.g., yellowtail flounder, winter flounder, summer flounder, black sea bass, etc.) have EFH designated in the Offshore Project Area.

3.2 Benthic Habitat

Topographic features and sediment composition influences the distribution of finfish and invertebrate species, particularly benthic and demersal species, by the type of habitat they provide. Since the submittal of the Preliminary EFH Assessment as part of the March 2021 COP, Atlantic Shores has completed site-specific HRG, geotechnical, and benthic surveys in accordance with BOEM's 2019 guidelines for benthic habitat surveying (BOEM, 2019). Such surveys included side-scan sonar, backscatter, benthic grab, towed video, and SPI camera –PV. The results of these surveying efforts provide Atlantic Shores with an increased understanding of the types of benthic habitat and organisms present in the Offshore Project Area that may be of importance to EFH species.

On behalf of Atlantic Shores, Fugro worked collaboratively to both collect site-specific HRG survey data as well as compile data from other Atlantic Shores' consultants to support the classification and interpretation of habitat areas from the multiple survey campaigns across the Offshore Project Area. From these efforts, Fugro created morphology and habitat shapefiles as well as detailed maps for the Offshore Project Area which are included in Attachment 2 to this EFH Assessment and in Volume II, Appendix II-A1 of the COP. Fugro largely followed the data processing steps outlined in NMFS *Updated Recommendations for Mapping Fish Habitat* (NMFS, 2021), which included the use of side-scan sonar with other geophysical survey data (e.g., multibeam echosounder bathymetry and backscatter data, sub-bottom profiler) to delineate seafloor trends, patterns, and textures. Additional details on mapping methodology and data analysis can be found in Attachment 1 to this EFH Assessment. These data were then used to determine the presence and location of benthic features (e.g., ripples, mega ripples, sandwaves, scarps) and to delineate habitat types (soft bottom, complex, heterogenous complex, and large grained complex) in the Offshore Project Area. It should be noted that no areas of large grained complex habitat were identified in the Offshore Project Area, and therefore will not be discussed in this report.

Soft bottom and complex habitat were also characterized in accordance with the Coastal and Marine Ecological Classifications Standards (CMECS). CMECS is a hierarchical system with classification thresholds based on sediment grain size and the relative percent composition of mud, sand, and gravel-sized components (FGDC, 2012). In the CMECS classification system, grain size and composition is used to describe benthic habitats and define complex and potentially valuable fish habitats. According to NMFS, sediment containing at least 5% gravel content is considered complex habitat, while sediment containing less than 5% is considered soft bottom habitat. Areas identified as heterogenous complex habitats represent the transitional space between soft and complex sediment. Areas where benthic features and surficial sand coverage intersected were also classified as heterogenous complex habitat. In addition to benthic features and habitat classification, biotic components that contribute to the benthic habitat (e.g., tube-dwelling organisms, sand dollar beds) were identified through SPI-PV and towed video surveys. Maps of benthic features, soft bottom habitat, complex habitat, heterogenous habitat, and biotic habitat components can be found in Attachments 2 and 3 to this EFH Assessment.

A summary of the areal extent of delineated habitat types based on results from the site-specific surveys is provided in Table 3 for the WTA, Atlantic ECC, and Monmouth ECC. Key observations and characteristics from these surveys are also summarized for each component of the Offshore Project Area.

Table 3. Area of Habitat Types in the Offshore Project Area

Habitat Type	WTA[1]		Atlantic ECC	Monmouth ECC
	Project 1 WTA	Project 2 WTA		
Soft-Bottom	56.1 mi^2 (145.3 km^2)	38.0 mi^2 (98.5 km^2)	7.5 mi^2 (19.5 km^2)	12.4 mi^2 (32.1 km^2)
Heterogenous	9.4 mi^2 (24.5 km^2)	4.7 mi^2 (12.2 km^2)	0.1 mi^2 (0.2 km^2)	<0.1 mi^2 (<0.1 km^2)
Complex	17.9 mi^2 (46.3 km^2)	9.4 mi^2 (24.2 km^2)	0.7 mi^2 (2.0 km^2)	27.4 mi^2 (71.0 km^2)

[1] The area of habitat use per Project WTA assumes each Project's use of the entire Overlap Area. Applying the Overlap Area to both Projects provides the maximum PDE habitat scenario for each Project's WTA.

3.2.1 The WTA

Using side-scan sonar, bathymetry, backscatter, seafloor slope analyses, and SPI-PV surveys, Atlantic Shores identified the following topographic features in the WTA: sandwaves, ripples, mega ripples, depressional areas, and textured seafloor (i.e., dimpled, rugged, or uneven seafloor). Ripples were the most prevalent, mapped topographic feature in the WTA, comprising the entire surveyed area. In addition to ripples, sandwaves and mega ripples were the second most prevalent topographic features mapped in the WTA. These features are mapped in both the Project 1 WTA and Project 2 WTA. Though these topographic features are present, much of the WTA can be classified as largely flat given that a majority of the features present (e.g., ripples) offer limited relief. Additional information on these topographic features, including maps, can be found in Attachments 2 and 3 to this EFH Assessment and in Volume II, Appendix II-A1 of the COP.

As shown in Table 3, the majority of the Project 1 and Project 2 WTAs consist of soft bottom habitat (Figure 2). According to grab sample surveys, a majority of the soft bottom habitat consists of medium sand which comprised 67% and 84% of grab samples collected in the Project 1 WTA and Project 2 WTA, respectively (Figures 3 and 4). Other CMECS-classified sediments identified in the WTA include fine/very fine sand, muddy sand, and very coarse/coarse sand. Complex habitat was also identified in the WTA. According to grab sample surveys, complex habitat in the Project 1 and Project 2 WTA consists of gravelly muddy sand and gravelly sand. Approximately 3% and 20% of grab samples collected in the Project 1 WTA were identified as gravelly muddy sand and gravelly sand, both of which contain between 5% to less than 30% gravel content, respectively. Grab samples collected within the Project 2 WTA consisted of less complex habitat than samples collected in the Project 1 WTA, accounting for only 8% of samples, all of which were limited to gravelly sand (Figures 3 and 4). No grab samples collected in either the Project 1 WTA or the Project 2 WTA contained gravel content greater than 30%.

In addition to soft bottom and complex habitat, heterogenous habitat was identified in both the Project 1 and Project 2 WTAs (Table 3 and Figure 2). Heterogenous complex habitat within the WTA is characterized by the intersection of sandy surficial sediment and irregular seafloor that exhibit erosional features with exposed underlying transgressive channel units. These areas were identified throughout the Project 1 WTA and in the southeastern portion of the Project 2 WTA. Common biotic features observed in the WTA through towed video and SPI-PV surveys that contribute to benthic habitat in the Offshore Project Area include sand dollar beds, sponge/tunicates, decorator worms and worm tubes (see Attachments 2 and 3 to this EFH Assessment and Volume II, Appendix II-G3 of the COP). No invasive tunicate or solitary hard coral species were identified in the WTA during benthic site characterization surveys (see Volume II, Appendix II-G of the COP).

3.2.2 Atlantic ECC

Side-scan sonar, bathymetry, backscatter, seafloor slope analyses, and SPI-PV surveys have resulted in the identification of the following topographic features in the Atlantic ECC: ripples, mega ripples, sandwaves, textured seafloor (i.e., rugged or uneven texture), and localized areas of relief. Ripples were the most prevalent topographic feature in the Atlantic ECC. Mega ripples, sandwaves, and textured seafloor were the second most predominant features. Small areas within the central portion of the Atlantic ECC were characterized as localized relief features, which refers to raised accumulations of sandy sediment. These areas of localized relief have the potential to provide habitat to a variety of organisms. Additional information on these topographic features, including maps, can be found in Attachments 2 and 3 to this EFH Assessment and in Volume II, Appendix II-A1 of the COP.

The majority of the Atlantic ECC consists of soft bottom habitat, with small areas of complex and heterogenous habitat (Table 3 and Figure 2). Based on the results of grab sample surveys, soft bottom habitat in the Atlantic ECC largely consists of fine/very fine and medium sand, which made up 40% and 30% of the samples collected in the ECC, respectively (Figures 3 and 4). The remaining sediment types that contribute to soft bottom habitat in the Atlantic ECC are muddy sand and very coarse/coarse sand, both of which comprised 10% of grab samples collected in the Atlantic ECC. Smaller areas of complex habitat were identified in the Atlantic ECC. Grab samples collected in the ECC and classified as complex habitat exclusively consisted of gravelly sand which contains between 5% and less than 30% gravel content. No grab samples collected in the Atlantic ECC contained gravel content greater than 30%.

In addition to soft bottom and complex habitat, heterogenous habitat was identified in the Atlantic ECC. Heterogenous habitat in the Atlantic ECC is characterized by the intersection of sandy surficial sediment and irregular seafloor that exhibits erosional features. These areas were identified along the central portion of the ECC and have the potential to impact fish behavior and habitat use. In addition to sediment type and morphological features, biotic features identified in the Atlantic ECC that contribute to the benthic habitat include sand dollar beds, sponge/tunicates, decorator worms, worm tubes and blue mussels (see Attachments 2 and 3 to this EFH Assessment and Volume II, Appendix II-G3 of the COP). No invasive tunicate or solitary hard coral species were identified in the Atlantic ECC during benthic site characterization surveys (see Volume II, Appendix II-G of the COP).

3.2.3 Monmouth ECC

The Monmouth ECC contains more topographic diversity than the WTA and Atlantic ECC based on the results from the site-specific surveys. Similar to the WTA and Atlantic ECC, ripples, mega ripples, and sandwaves were identified in the Monmouth ECC, with ripples being the most dominant topographic feature. Also, similar to the Atlantic ECC, the Monmouth ECC contains small, localized areas of relief in its central portion. However, unlike the WTA and Atlantic ECC, scarps and interbedded surficial sediments (characterized by terraced seafloor with steep slopes) were identified in the nearshore reaches of the Monmouth ECC, near the Monmouth Landfall Site. Features like scarps and interbedded surficial sediments have the potential to add habitat diversity for marine organisms. Additional information on these topographic features, including maps, can be found in Attachments 2 and 3 to this EFH Assessment and in Volume II, Appendix II-A1 of the COP.

The Monmouth ECC differs from the WTA and Atlantic ECC as the majority of the area consists of complex habitat as defined by NMFS (2021) (Table 3 and Figure 2). Data collected from benthic grabs showed gravelly sand to be the most predominant sediment type, comprising approximately 48% of the samples collected in the ECC (Figures 3 and 4). According to the *NMFS Updated Recommendations for Mapping Fish Habitat* (2021), gravelly sand contains between 5% and less than 30% gravel content. Additional sediment types classified as complex habitat per NMFS' recommendations in the Monmouth ECC include sandy gravel (approximately 10% of samples), gravelly muddy sand (approximately 10% of samples), and muddy sandy gravel (approximately 5% of samples). Both sandy gravel and muddy sandy gravel consist of 30% to less than 80% of gravel, while gravelly muddy sand consists of 5% to less than 30% gravel content. No grab samples collected in the Monmouth ECC contained gravel content greater than 80%. NEFSC (2021) reports that surficial sediment of the continental shelf of the Mid-Atlantic Bight is dominated by gravels and sands. Therefore, the surficial sediment conditions documented in site-specific surveys for the Monmouth ECC are consistent with those reported by Northeast Fisheries Science Center (NEFSC) (2021) for the larger Mid-Atlantic Bight region. The remaining portions of the Monmouth ECC largely consist of soft bottom habitat like sand. Data collected from grab samples show that soft bottom habitat consists of medium sand (approximately 14% of grab samples), very coarse/coarse sand (approximately 10% of grab samples), and fine/very fine sediment (approximately 5% of grab samples).

Limited areas of heterogenous habitat were identified in the Monmouth ECC, primarily in small areas around the Monmouth Landfall Site (Figure 2). Heterogenous habitat in these areas are characterized by the intersection of surficial sediment and exposed underlying strata. This type of habitat has the potential to influence fish behavior and habitat use. In addition to sediment type and morphological features, biotic features identified in the Monmouth ECC that contribute to the benthic habitat include included sand dollar beds, sponge/tunicates, decorator worms, worm tubes, slipper shells and blue mussels (see Attachments 2 and 3 to this EFH Assessment and Volume II, Appendix II-G3 of the COP). No invasive tunicate or solitary hard coral species were identified in the Monmouth ECC during benthic site characterization surveys (see Volume II, Appendix II-G of the COP).

4.0 ESSENTIAL FISH HABITAT DESIGNATIONS AND DESCRIPTIONS

The Sustainable Fisheries Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" and requires that the regional fishery management councils, through Fishery Management Plans (FMPs), "describe and identify EFH" for the improved management of that fishery. EFH is typically assigned by egg, larvae, juvenile, and adult life stages and designated as habitat for waters or substrates. NOAA Fisheries further defines the terms associated with EFH (50 CFR § 600.10) as:

- Waters – Aquatic areas and their associated physical, chemical, and biological properties that are used by fish and, where appropriate, may include aquatic areas historically used by fish;
- Substrate – Sediments, hard bottoms, structures underlying the waters, and associated biological communities;
- Necessary – The habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and,
- Spawning, breeding, feeding, or growth to maturity – Stages representing a species' full life cycle.

The following sections provide the EFH designations and life stage summaries for the species with designated EFH in the Offshore Project Area.

4.1 EFH Designations in the Atlantic Shores Offshore Project Area

EFH data and text descriptions were downloaded from the NOAA Fisheries Essential Fish Habitat Data Inventory for the Essential Fish Habitat Mapper, an online mapping application (NOAA, 2021a). The data were then queried using GIS software to obtain results for EFH designations in the WTA for Project 1 and Project 2, Overlap Area, Atlantic ECC, and Monmouth ECC. Within these areas that comprise the Offshore Project Area, a total of 36 fish and five invertebrate species have designated EFH for various life stages. Table 4 summarizes the life stages of each species that has designated EFH within the Project 1 and 2 WTA, Overlap Area, Atlantic ECC, and Monmouth ECC, as defined by NOAA's EFH Mapper. Note that there may be slight differences between EFH designations presented in the Preliminary EFH Assessment and this revised EFH Assessment due to slight modifications to the Project layout as well as updated EFH data published by NOAA in March 2021 (NOAA, 2021). Detailed EFH definitions and life history descriptions for designated species and life stages are included in Section 4.2.

Table 4. EFH Designation for Species in the Offshore Project Area[1]

Species and Life Stages[2]	Eggs					Larvae/Neonate					Juvenile					Adult				
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC
New England Finfish Species																				
Atlantic Cod (*Gadus morhua*)	x			x	x	x	x	x		x						x				x
Atlantic Herring (*Clupea harengus*)											x	x	x	x	x	x	x	x	x	x
Clearnose Skate (*Raja eglanteria*)											x	x	x	x	x	x	x	x	x	x
Haddock (*Melanogrammus aeglefinus*)											x	x	x		x					
Little Skate (*Leucoraja erinacea*)											x	x	x	x	x	x	x	x	x	x
Monkfish (*Lophius americanus*)	x	x	x	x	x	x	x	x	x	x						x	x	x		x
Ocean Pout (*Macrozoarces americanus*)	x	x	x	x	x											x	x	x	x	x
Pollock (*Pollachius virens*)										x										
Red Hake (*Urophycis chuss*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Silver Hake (*Merluccius bilinearis*)	x	x	x	x	x	x	x	x	x	x						x	x	x		x
White Hake (*Urophycis tenuis*)																	x	x		x
Windowpane Flounder (*Scophthalmus aquosus*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Species and Life Stages[2]	Eggs					Larvae/Neonate					Juvenile					Adult				
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC
Winter Flounder (*Pseudopleuronectes americanus*)	x			x	x	x	x	x		x	x	x	x		x	x	x	x		x
Winter Skate (*Leucoraja ocellate*)											x	x	x	x	x	x	x	x	x	x
Witch Flounder (*Glyptocephalus cynoglossus*)	x	x	x	x	x	x	x	x		x						x	x	x	x	x
Yellowtail Flounder (*Limanda ferruginea*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Mid-Atlantic Finfish Species																				
Atlantic Butterfish (*Peprilus triacanthus*)	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Atlantic Mackerel (*Scomber scombrus*)	x	x	x		x	x	x	x		x	x	x	x		x	x	x	x	x	x
Black Sea Bass (*Centropristis striata*)						x	x	x		x	x	x	x	x	x	x	x	x	x	x
Bluefish (*Pomatomus saltatrix*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Scup (*Stenotomus chrysops*)											x	x	x	x	x	x	x	x	x	x
Spiny Dogfish[3] (*Squalus acanthias*)																x	x	x	x	x
Summer Flounder (*Paralichthys dentatus*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
New England Invertebrate Species																				
Atlantic Sea Scallop (*Placopecten magellanicus*)	x	x	x		x	x	x	x		x	x	x	x		x	x	x	x		x
Mid-Atlantic Invertebrate Species																				
Atlantic Surfclam (*Spisula solidissima*)											x	x	x	x	x	x	x	x	x	x

Species and Life Stages[2]	Eggs					Larvae/Neonate					Juvenile					Adult				
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC
Longfin Inshore Squid (*Doryteuthis pealeii*)	x			x	x						x	x	x	x	x	x	x	x	x	x
Northern Shortfin Squid (*Illex illecebrosus*)											x	x	x		x					
Ocean Quahog (*Arctica islandica*)											x					x	x	x		x
Highly Migratory Species																				
Tunas																				
Albacore Tuna (*Thunnus alalunga*)															x					
Bluefin Tuna (*Thunnus thynnus*)											x	x	x	x	x					x
Skipjack Tuna (*Katsuwonus pelamis*)											x	x	x	x	x	x	x	x	x	x
Yellowfin Tuna (*Thunnus albacares*)											x	x	x	x	x					
Sharks																				
Blue Shark (*Prionace glauca*)											x	x	x		x	x	x	x		x
Common Thresher Shark (*Alopias vulpinus*)						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dusky Shark (*Carcharhinus obscurus*)						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sand Tiger Shark (*Carcharias taurus*)						x	x	x	x	x	x	x	x	x	x					
Sandbar Shark (*Carcharhinus plumbeus*)						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Species and Life Stages[2]	Eggs					Larvae/Neonate					Juvenile					Adult				
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC
Shortfin Mako Shark (*Isurus oxyrinchus*)						x	x	x		x	x	x	x		x	x	x	x		x
Smoothhound Shark Complex (Atlantic Stock) (*Mustelus canis*)						x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tiger Shark (*Galeocerdo cuvieri*)											x	x	x	x	x	x	x	x	x	x
White Shark (*Carcharodon carcharias*)						x	x	x	x	x					x					x
South Atlantic Finfish Species[4]																				
King Mackerel (Scomberomorus cavalla)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Spanish Mackerel (Scomberomorus maculatus)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

[1] For the purpose of this analysis, the Offshore Project Area is separated into five parts: Project 1 WTA, Project 2 WTA, Overlap Area, Atlantic ECC, and Monmouth ECC.

[2] A.ECC- Atlantic ECC; M.ECC- Monmouth ECC

[3] Spiny dogfish EFH can be further broken down by sub-male and sub-female life stages. These life stages refer to smaller adults that are not full grown. These stages have a different spatial distribution than full-grown adults. Spiny dogfish sub-female EFH can be found in the WTA, Atlantic and Monmouth ECC. Spiny dogfish sub-male EFH is only located in the Monmouth ECC.

[4] Based on consultations with NOAA, EFH for king and Spanish mackerel occurs in the Mid-Atlantic Bight, and therefore was added to the analysis; however, based on a review of available data, EFH for these species does not exist in the Offshore Project Area.

4.2 Description of EFH Species and Life Stages in Offshore Project Area

This section describes the life stages of EFH-designated species in the Offshore Project Area. EFH definitions were obtained from the EFH Mapper webpage (NOAA, 2021a) that provides links to the appropriate FMP for each species. Although Atlantic Shores recognizes that EFH is based on the habitat that supports species and life stages and not the actual presence of those life stages and species, for context on the actual presence of EFH species in the Offshore Project Area, Atlantic Shores included additional information, where available, on species abundance and seasonal presence. Some of the primary sources used for additional species information includes EFH source documents, fishery management plans, federal and state trawl surveys, and other available literature.

4.2.1 New England Fishery Management Council Finfish Species

EFH for species managed under FMPs developed by the New England Fishery Management Council (NEFMC) are covered under the Omnibus Essential Fish Habitat Amendment 2 (NEFMC, 2017). Sixteen NEMFC finfish species, including skates, have designated EFH in the Offshore Project Area.

4.2.1.1 Atlantic Cod

Eggs: EFH is designated for Atlantic cod eggs in the westernmost part of the Project 1 WTA, along most of the Atlantic ECC, and in the northern-most section of the Monmouth ECC. No EFH is designated in the Project 2 WTA or in the Overlap Area for Atlantic cod eggs. EFH is defined as the pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, as shown on Map 38 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017) and in high salinity zones of the bays and estuaries listed in Table 19 of NEFMC (2017). According to NEFSC's Marine Resources Monitoring, Assessment and Prediction (MARMAP) program, Atlantic cod eggs can be found year round from the Gulf of Maine to Cape Hatteras, with higher abundance in spring and lowest densities in late-summer (NOAA, 1999a). The highest densities of Atlantic cod eggs have been observed in the Gulf of Maine compared to waters off the New England coast (NOAA, 1999a).

Larvae: EFH is designated for Atlantic cod larvae in the northernmost part of the Project 1 WTA, Project 2 WTA, and Overlap Area and along portions of the Monmouth ECC. No EFH is designated in the Atlantic ECC for Atlantic cod larvae. EFH is defined as the pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, as shown on Map 39 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), and in the high salinity zones of the bays and estuaries listed in Table 19 of NEFMC (2017). According to MARMAP Icthyoplankton surveys that spanned from the Gulf of Maine to Cape Hatteras, larvae were abundant year-round throughout the surveyed region. Off the coast of New Jersey, larvae were most abundant in spring and least abundant in late-summer and fall (NOAA, 1999a).

Adults: EFH is designated for Atlantic cod adults in a small area in the southernmost part of the Project 1 WTA and along portions of the Monmouth ECC. No EFH is designated in the Project 2 WTA, the Overlap Area, or the Atlantic ECC for Atlantic cod adults. EFH includes sub-tidal benthic habitats in the Gulf of Maine, south of Cape Cod, and on Georges Bank, between 30 and 160 meters (98 to 525 feet) as shown on Map 41 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including high-salinity zones in the bays and estuaries listed in Table 19 of (NEFMC, 2017). Structurally complex hard bottom habitats composed of gravel, cobble, and boulder substrates with and without emergent epifauna and macroalgae are essential habitats for adult cod. Adult cod are also found on sandy substrates and frequent deeper slopes of ledges along shore. South of Cape Cod, spawning occurs in nearshore areas and on the continental shelf, usually in depths less than 70 meters (230 feet) (NEFMC, 2017). No Atlantic cod were collected in the Offshore Project Area from fishery-independent New Jersey Department of Environmental Protection (NJDEP) Ocean Stock Assessment Program (OSAP), or NEFSC Multi-species Bottom Trawl surveys conducted from 2009 to 2019. Additionally, Guida et al. (2017) examined NEFSC seasonal trawl surveys throughout the entire New Jersey Wind Energy Area from 2003 to 2016 which did not result in any catch of Atlantic cod.

4.2.1.2 Atlantic Herring

Juveniles: EFH is designated for Atlantic herring juveniles throughout the entire Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC. EFH is defined as intertidal and sub-tidal pelagic habitats to 300 meters (984 feet) throughout the region, as shown on Map 100 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the bays and estuaries listed in Table 30 of (NEFMC, 2017). One and two-year old juveniles form large schools and make limited seasonal inshore-offshore migrations. Older juveniles are usually found in water temperatures of 3 to 15 °C (37.4 to 59 °F) in the northern part of their range and as high as 22 °C (71 °F)in the Mid-Atlantic. Young-of-the-year juveniles can tolerate low salinities, but older juveniles avoid brackish water (NEFMC, 2017). According to MARMAP survey results, the majority of juvenile Atlantic herring are caught between depths of 30 to 90 meters (98 to 295 feet) in spring, 15 to 135 meters (49 to 443 feet) in summer, and 30 to 60 meters (98 to 197 feet) in fall and winter (NOAA, 1999b). On the inner shelf off the coast of New Jersey the lowest abundance of juvenile Atlantic herring occurs in the summer and fall. The highest abundance of juveniles occurs in the spring (NOAA, 1999b).

Adults: EFH is designated for Atlantic herring adults throughout the entire Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC. EFH is defined as sub-tidal pelagic habitats with maximum depths of 300 meters (984 feet) throughout the region, as shown on Map 100 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the bays and estuaries listed in Table 30 of NEFMC (2017). Adults make extensive seasonal migrations between summer and fall spawning grounds on Georges Bank and the Gulf of Maine and overwintering areas in southern New England and the Mid-Atlantic region. They seldom migrate beyond a depth of about 100 meters (328 feet) and – unless they are preparing to spawn – usually remain near the surface. They typically avoid water temperatures above 10 °C (50 °F) and low salinities. Spawning takes place on the bottom, generally in depths of 5 to 90 meters (16 to 295 feet) on a variety of substrates (NEFMC, 2017); however, since eggs are not designated as EFH in the Offshore Project Area, spawning is also not expected to occur in the Offshore Project Area. Adult and juvenile Atlantic herring have similar geographic ranges and seasonal distributions (NOAA, 1999b). Atlantic herring were commonly collected throughout the Offshore Project Area between 2009 and 2019 in NJDEP OSAP and NEFSC trawl surveys, with the majority of individuals collected in winter and spring compared to summer and fall.

4.2.1.3 Clearnose Skate

Juveniles: EFH is designated for juvenile clearnose skate (*Raja eglanteria)* in most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along the entire Atlantic ECC. EFH is defined as sub-tidal benthic habitats in coastal and inner continental shelf waters from New Jersey to the St. Johns River in Florida as shown on Table 28 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of Chesapeake Bay, Delaware Bay, and the other bays and estuaries listed in Table 28 of NEFMC (2017). EFH for juvenile clearnose skates occurs from the shoreline to 30 meters (98 feet), primarily on mud and sand, but also on gravelly and rocky bottom (NEFMC, 2017).

Adults: EFH is designated for adult clearnose skate in most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along the entire Atlantic ECC. EFH is defined as sub-tidal benthic habitats in coastal and inner continental shelf waters from New Jersey to Cape Hatteras as shown on Map 96 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of Chesapeake Bay, Delaware Bay, and the other bays and estuaries listed in Table 28 of NEFMC (2017). EFH for adult clearnose skates occurs from the shoreline to 40 meters (131 feet), primarily on mud and sand, but also on gravelly and rocky bottom (NEFMC, 2017). Adult clearnose skates migrate seasonally between inshore and offshore environments. In the winter, adults will concentrate offshore on the continental shelf out to a depth up to 200 meters (656 feet) and inshore during the spring and summer (NOAA, 2003a). During state and federal trawl surveys conducted between 2009 and 2019, clearnose skates were caught in the WTA and Monmouth ECC during fall NEFSC surveys. During NJDEP OSAP surveys, clearnose skates were collected throughout the Offshore Project Area in fall, summer and spring surveys.

4.2.1.4 Haddock

Juveniles: EFH is designated for juvenile haddock in most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC. No EFH is designated along the Atlantic ECC for juvenile haddock. EFH is defined as sub-tidal benthic habitats between 40 and 140 meters (131 to 459 feet) in the Gulf of Maine, on Georges Bank and in the Mid-Atlantic region, and as shallow as 20 meters (66 feet) along the coast of Massachusetts, New Hampshire, and Maine, as shown on Map 46 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Young-of-the-year juveniles settle on sand and gravel on Georges Bank, but are found predominantly on gravel pavement areas within a few months after settlement. As they grow, they disperse over a greater variety of substrate types on the bank. Young-of-the-year haddock do not inhabit shallow, inshore habitats (NEFMC, 2017). Haddock are known to range from West Greenland to Cape Hatteras with most species distribution typically concentrated around the Gulf of Maine and Georges Bank (NEFMC, 1985). During NJDEP OSAP surveys conducted between 2009 and 2019, haddock were occasionally collected in the Monmouth ECC in fall and the Atlantic ECC in summer. Haddock was not collected during NEFSC trawl surveys.

4.2.1.5 Little Skate

Juveniles: EFH is designated for juvenile little skate (*Leucoraja erinacea*) throughout the entire Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC. EFH is defined as intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, extending to a maximum depth of 80 meters (262 feet), as shown on Map 90 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), and including high salinity zones in the bays and estuaries listed in Table 28 of NEFMC (2017). EFH for juvenile little skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC, 2017). Juvenile little skates migrate seasonally between inshore and offshore environments. In winter, juveniles can be found offshore out to the 200 meters (656 foot) depth contour from Georges Bank to Cape Hatteras (NOAA, 2003b). In the spring, juveniles can be found inshore throughout the Mid-Atlantic Bight (NOAA, 2003b).

Adults: EFH is designated for adult little skate throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic ECC, and along portions of the Monmouth ECC. EFH is defined as intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the Mid-Atlantic region as far south as Delaware Bay, and on Georges Bank, extending to a maximum depth of 100 meters (328 feet), as shown on Map 91 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), and including high salinity zones in the bays and estuaries listed in Table 28 of NEFMC (2017). EFH for adult little skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC, 2017). Seasonal migration between inshore environments in the spring and offshore environments in the fall and winter have been observed in adult little skate (NOAA, 2003b). Little skate were frequently collected year-round in the Offshore Project Area during NJDEP and NEFSC trawl surveys conducted between 2009 and 2019. Additionally, according to the NJDEP Environmental Baseline Study, which examined species composition along the New Jersey coastline, little skate were among the ten most dominant species collected during NJDEP OSAP surveys collected from 2003 to 2008 from Barnegat Bay to Hereford Inlet (Geo-Marine, 2010).

4.2.1.6 Monkfish

Eggs/Larvae: EFH is designated for monkfish (*Lophius americanus*) eggs/larvae throughout most of the Project 1 WTA and Atlantic and Monmouth ECCs and throughout the entire Project 2 WTA and Overlap Area. EFH is defined as pelagic habitats in inshore areas, and on the continental shelf and slope throughout the Northeast region, as shown on Map 82 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Monkfish eggs are shed in very large buoyant mucoidal egg “veils.” Monkfish larvae are more abundant in the Mid-Atlantic region and occur over a wide depth range, from the surf zone to depths of 1,000 to 1,500 meters (3280 to 4921 feet) on the continental slope (NEFMC, 2017). Based on NEFSC MARMAP Icthyoplankton surveys, monkfish eggs and larvae have been collected between Cape Cod and Cape Hatteras (NOAA, 1999c). Peak monkfish larvae abundance occurs between May and July off the coast of New Jersey in offshore environments (NOAA, 1999c). Monkfish larvae are seldom present in inshore environments (NOAA, 1999c).

Adults: EFH is designated for monkfish adults in most of the Project 1 WTA, Project 2 WTA, and Overlap Area, and along a small portion of the Monmouth ECC. No EFH is designated along the Atlantic ECC for adult monkfish. EFH is defined as sub-tidal benthic habitats in depths of 50 to 400 meters (164 to 1,312 feet) in southern New England and Georges Bank, between 20 and 400 meters (66 to 1312 feet) in the Gulf of Maine, and to a maximum depth of 1,000 meters (328 feet) on the continental slope, as shown on Map 84 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017). EFH for adult monkfish is composed of hard sand, pebbles, gravel, broken shells, and soft mud. They seem to prefer soft sediments (fine sand and mud) over sand and gravel, and, like juveniles, utilize the edges of rocky areas for feeding (NEFMC, 2017). Monkfish migrate between inshore and offshore environments based on water temperatures (Geo-Marine, 2010). Based on NEFSC bottom trawl data from 1963 to 1997, adult monkfish can occur year-round off the coast of New Jersey (NOAA, 1999c). Their presence has also been documented by NJDEP OSAP trawl surveys from 2003 to 2008 as reported in the NJDEP Baseline Study (Geo-Marine, 2010). Monkfish distribution along the Mid-Atlantic Bight has been linked to food availability (Wood, 1982 as referenced in NOAA, 1999c). Monkfish distribution has been associated with the presence of silver hake (*Merluccius bilinearis*), spiny dogfish (*Squalus acanthias*), and red hake, all of which have been documented by state and federal trawls in the Offshore Project Area (Colvocoresses and Musick, 1984 as referenced in NOAA, 1999c).

4.2.1.7 Ocean Pout

Eggs: EFH is designated for ocean pout (*Macrozoarces americanus*) eggs throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along the offshore portions of the Atlantic ECC. EFH is defined as hard bottom habitats on Georges Bank, in the Gulf of Maine, and in the Mid-Atlantic Bight as shown on Map 48 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), as well as the high salinity zones of the bays and estuaries listed in Table 20 of NEFMC (2017). Eggs are laid in gelatinous masses, generally in sheltered nests, holes, or rocky crevices. EFH for ocean pout eggs occurs in depths less than 100 meters (328 feet) on rocky bottom habitats (NEFMC, 2017).

Adults: EFH is designated for ocean pout adults throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along the offshore portions of the Atlantic ECC. EFH is defined as sub-tidal benthic habitats between 20 and 140 meters (65 to 459 feet) in the Gulf of Maine, on Georges Bank, in coastal and continental shelf waters north of Cape May, New Jersey, and in the high salinity zones of a number of bays and estuaries north of Cape Cod as shown on Map 50 and Table 20 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017). EFH for adult ocean pout includes mud and sand, particularly in association with structure forming habitat types (e.g., shells, gravel, or boulders). In softer sediments, they burrow tail first and leave a depression on the sediment surface. Ocean pout congregate in rocky areas prior to spawning and frequently occupy nesting holes under rocks or in crevices in depths less than 100 meters (328 feet) (NEFMC, 2017). Based on NMFS trawl surveys conducted between 1968 and 1967, ocean pout inhabit inshore environments off the coast of New Jersey in the spring, and offshore environments in the fall and winter (NOAA, 1999d). The same trawling data indicated low adult abundance in the summer in both inshore and offshore environments off the coast of New Jersey (NOAA, 1999d). Based on NJDEP OSAP and NEFSC surveys conducted between 2009 and 2019, a small number of ocean pout were collected in the Monmouth ECC and WTA and all collections occurred in spring.

4.2.1.8 Pollock

Larvae: EFH is designated for pollock (*Pollachius virens*) larvae along one northern section of the Monmouth ECC and near the Monmouth Landing Site. No EFH is designated in the Project 1 and Project 2 WTAs, Overlap Area, or along the Atlantic ECC for larval pollock. EFH is defined as pelagic inshore and offshore habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region, as shown on Map 52 of the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the bays and estuaries listed in Table 21 of NEFMC (2017). Based on MARMAP Icthyoplankton surveys conducted between 1977 and 1987, pollock larvae have been collected off the coast of New Jersey from February to May in both inshore and offshore environments (NOAA, 1999e).

4.2.1.9 Red Hake

EFH is designated for red hake eggs/larvae/juveniles throughout most of the Project 1 WTA, the entire Project 2 WTA and Overlap Area, and along the entire Atlantic and Monmouth ECCs.

Eggs/Larvae: EFH is defined as pelagic habitats in the Gulf of Maine, on Georges Bank, and in the MidAtlantic, as shown on Map 77 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), and in the bays and estuaries listed in Table 27 of NEFMC (2017). Red hake egg distribution is seasonally dependent. In the winter, eggs are typically located on the edge of the continental shelf throughout the Mid-Atlantic Bight (NOAA, 1999f). During warmer months, eggs can be found across the entire continental shelf (NOAA, 1999f). Based on ichthyoplankton surveys conducted between 1978 and 1987, eggs were most prevalent off the coast of New Jersey between May and October (NOAA, 1999f). Ichthyoplankton surveys conducted between 1982 and 1987 found evidence of larval red hake off the coast of New Jersey between the months of July and November (NOAA, 1999f).

Juveniles: EFH is defined as intertidal and sub-tidal benthic habitats throughout the region on mud and sand substrates, to a maximum depth of 80 meters (262 feet), as shown on Map 77 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the bays and estuaries listed in Table 27 of NEFMC (2017). Bottom habitats providing shelter are essential for juvenile red hake. These habitats include mud substrates with biogenic depressions, substrates providing biogenic complexity (e.g., eelgrass, macroalgae, shells, anemone and polychaete tubes), and artificial reefs. Newly settled juveniles occur in depressions on the open seabed. Older juveniles are commonly associated with shelter or structure (e.g., rocks, shells, sponges) and often inside live bivalves (NEFMC, 2017; Geo-Marine, 2010). Based on NMFS seasonal trawl surveys conducted between 1964 and 1997, juvenile red hake are present year-round off the coast of New Jersey, with the greatest nearshore abundance occurring in the spring and the greatest offshore abundance occurring in the fall (NOAA, 1999f).

Adults: EFH is designated for red hake adults in the northern portion of the Project 1 WTA, the northern and eastern portions of the Project 2 WTA and Overlap Area, and along portions of the Atlantic and Monmouth ECCs. EFH is defined as benthic habitats in the Gulf of Maine and the outer continental shelf and slope in depths of 50 to 750 meters (164 to 2461 feet) as shown on Map 78 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), and as shallow as 20 meters (66 feet) in a number of inshore estuaries and embayments as shown in Table 27 of NEFMC (2017), as far south as Chesapeake Bay. Shell beds, soft sediments (mud and sand), and artificial reefs provide essential habitats for adult red hake. They are usually found in depressions in softer sediments or in shell beds and not on open sandy bottom. In the Gulf of Maine, they are much less common on gravel or hard bottom, but they are reported to be abundant on hard bottoms in temperate reef areas of Maryland and northern Virginia (NEFMC, 2017). Adult red hake exhibit similar seasonal distribution as juveniles within the Mid-Atlantic Bight, inhabiting inshore waters in the spring and summer, and offshore waters in the fall and spring (NOAA, 1999f). Red hake were collected year-round in relatively small numbers within the WTA, Atlantic ECC, and Monmouth ECC during state and federal trawl surveys from 2009 to 2019. Presence within the Offshore Project Area could be attributed to the extensive presence of soft sediment, which is preferred habitat for adult red hake (Geo-Marine, 2010). Also, water depth in the Offshore Project Area is within the typical habitat of adult red hake which ranges from 35 to 98 meters (115 to 322 feet) (Geo-Marine, 2010).

4.2.1.10 Silver Hake

Eggs/Larvae: EFH is designated for silver hake eggs/larvae throughout the entire Project 1 WTA, most of the Project 2 WTA, Overlap Area, and Monmouth ECC, and along the entire Atlantic ECC. EFH is defined as pelagic habitats from the Gulf of Maine to Cape May, New Jersey, including Cape Cod and Massachusetts Bays as shown on Map 74 and Table 26 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Within the Mid-Atlantic Bight, egg abundance for silver hake is higher in inshore and continental shelf waters. In winter and fall, eggs are typically found in smaller numbers in deep waters within the Mid-Atlantic Bight (NOAA, 2004). Based on MARMAP ichthyoplankton surveys conducted between 1977 and 1987, silver hake larvae are abundant in depths from 60 to 130 meters (197 to 427 feet) between Georges Bank and Virginia during May and June (NOAA, 2004). Peak larvae abundance occurs in the summer months, typically between July and September. The lowest abundance of silver hake typically occurs during winter (NOAA, 2004).

Adults: EFH is designated for silver hake adults in part of the Project 1 and Project 2 WTAs and Overlap Area and along most of the Monmouth ECC. No EFH is designated along the Atlantic ECC for adult silver hake. EFH is defined as pelagic and benthic habitats at depths greater than 35 meters (115 feet) in the Gulf of Maine and the coastal bays and estuaries listed in Table 26 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), between 70 and 400 meters (230 to 1,312 feet) on Georges Bank and the outer continental shelf in the northern portion of the Mid-Atlantic Bight, and in some shallower locations nearer the coast, on sandy substrates as shown on Map 76 of NEFMC (2017). Adult silver hake are often found in bottom depressions or in association with sandwaves and shell fragments. They have also been observed at high densities in mud habitats bordering deep boulder reefs, resting on boulder surfaces, and foraging over deep boulder reefs in the southwestern Gulf of Maine. This species makes greater use of the water column (for feeding, at night) than red or white hake (*Urophycis tenuis*) (NEFMC, 2017). During NEFSC bottom trawls conducted between1963 to 2002, adult silver hake were observed throughout the shelf of the Mid-Atlantic Bight at depths ranging from 11 to 400 meters (36 to 1,312 feet) (NOAA, 2004). Silver hake were commonly collected during NJDEP OSAP trawls between 2009 and 2019 throughout the Offshore Project Area. The largest catch numbers occurred in the spring and summer. Silver hake were also caught in NEFSC trawl surveys in the Offshore Project Area between 2009 and 2019, but in lower quantities than those collected during NJDEP OSAP surveys.

4.2.1.11 White Hake

Adults: EFH is designated for white hake adults in the eastern portion of the Project 2 WTA and Overlap Area, and along central and southern portions of the Monmouth ECC. No EFH is designated in the Project 1 WTA or along the Atlantic ECC for adult white hake. EFH is defined as sub-tidal benthic habitats in the Gulf of Maine, including depths greater than 25 meters (82 feet) in certain mixed and high salinity zones portions of a number of bays and estuaries as shown, in Table 22 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), between 100 and 400 meters (328 to 1,312 feet) in the outer gulf, and between 400 and 900 meters (1,312 to 2,953 feet) on the outer continental shelf and slope (see Map 58 of NEFMC (2017)). EFH for adult white hake occurs on fine-grained, muddy substrates and in mixed soft and rocky habitats.

Spawning takes place in deep water on the continental slope and in Canadian waters (NEFMC, 2017). During NEFSC bottom trawl surveys conducted between 1963 and 1996, adult white hake were most abundant between depths of 50 to 325 meters (1,066 feet) (NOAA, 1999g). These depths exceed depths in the Offshore Project Area. Additionally, no white hake were observed during state and federal trawl surveys conducted in the Offshore Project Area between 2009 and 2019. Based on habitat preferences and lack of individuals collected during state and federal trawl surveys, the presence of white hake in the Offshore Project Area is expected to be rare.

4.2.1.12 Windowpane Flounder

Eggs & Larvae: EFH is designated for windowpane flounder (*Scophthalmus aquosus*) eggs throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs and for larvae throughout most of the Project 1 and Project 2 WTAs and Overlap Area, the western part of the Atlantic ECC, and the central and northern parts of the Monmouth ECC. EFH is defined as pelagic habitats on the continental shelf from Georges Bank to Cape Hatteras and in mixed and high salinity zones of coastal bays and estuaries throughout the region as shown on Map 59, Map 60, and Table 23 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017)). During MARMAP ichthyoplankton surveys, conducted between 1978 and 1987, eggs were typically found at depths less than 40 meters (131 feet) from Georges Bank to Cape Hatteras (NOAA, 1999h). Off the coast of New Jersey, eggs were present in MARMAP ichthyoplankton surveys between the months of March and November, with peak abundance occurring in April, May June, and October (NOAA, 1999h).

Juveniles: EFH is designated for windowpane flounder juveniles throughout the entire Project 1 WTA, most of the Project 2 WTA, Overlap Area, and Monmouth ECC, and along the entirety of the Atlantic ECC. EFH is defined as intertidal and sub-tidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to northern Florida, as shown on Map 61 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including mixed and high salinity zones in the bays and estuaries listed in Table 23 of NEFMC (2017). EFH for juvenile windowpane flounder is found on mud and sand substrates and extends from the intertidal zone to a maximum depth of 60 meters (197 feet). Young-of-the-year juveniles prefer sand over mud (NEFMC, 2017). In the Mid-Atlantic Bight, juvenile windowpane are typically found nearshore, in water depths less than 40 meters (131 feet) (NOAA, 1999h). Therefore, given that depths within the Offshore Project Area range from 0 to 37 meters (0 to 121 feet), juvenile windowpane could inhabit the Offshore Project Area.

Adults: EFH is designated for windowpane flounder adults throughout the entire Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. EFH is defined as intertidal and sub-tidal benthic habitats in estuarine, coastal marine, and continental shelf waters from the Gulf of Maine to Cape Hatteras, as shown on Map 62 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including mixed and high salinity zones in the bays and estuaries listed in Table 23 of NEFMC (2017). EFH for adult windowpane flounder is found on mud and sand substrates and extends from the intertidal zone to a maximum depth of 70 meters (230 feet) (NEFMC, 2017). Adult windowpane are typically found at depths less than 75 meters (246 feet) in the spring and less than 50 meters (164 feet) in the fall (NOAA, 1999h). Windowpane were frequently collected year-round throughout the Offshore Project Area in both state and federal trawl surveys between 2009 and 2019.

4.2.1.13 Winter Flounder

Eggs: EFH is designated for winter flounder eggs in an extremely small section in the northwestern corner of the Project 1 WTA, near the Atlantic Landfall Site, and the inshore reaches of the Monmouth ECC. No EFH is designated in the Project 2 WTA or Overlap Area for winter flounder eggs. EFH is defined as sub-tidal estuarine and coastal benthic habitats from mean low water to 5 meters (16 feet) from Cape Cod to Absecon Inlet (39° 22′ N), and as deep as 70 meters (230 feet) on Georges Bank and in the Gulf of Maine as shown on Map 63 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including mixed and high salinity zones in the bays and estuaries listed in Table 24 of NEFMC (2017). The eggs are adhesive and deposited in clusters on the bottom. Essential habitats for winter flounder eggs include mud, muddy sand, sand, gravel, macroalgae, and submerged aquatic vegetation. Bottom habitats are unsuitable if exposed to excessive sedimentation which can reduce hatching success (NEFMC, 2017).

Larvae: EFH is designated for winter flounder larvae in an extremely small section along the northern border of the Project 1 WTA, Project 2 WTA, and Overlap Area, and along most of the Monmouth ECC. No EFH is designated along the Atlantic ECC for winter flounder larvae. EFH is defined as estuarine, coastal, and continental shelf water column habitats from the shoreline to a maximum depth of 70 meters (230 feet) from the Gulf of Maine to Absecon Inlet (39° 22′ N), and including Georges Bank, as shown on Map 65 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including mixed and high salinity zones in the bays and estuaries listed in Table 24 of NEFMC (2017). Larvae hatch in nearshore waters and estuaries or are transported shoreward from offshore spawning sites where they metamorphose and settle to the bottom as juveniles. They are initially planktonic but become increasingly less buoyant and occupy the lower water column as they get older (NEFMC, 2017). Winter flounder larvae have been documented in New Jersey estuaries and rivers including the Manasquan River located 0.6 miles (.97 kilometers) south of the Monmouth Landfall Site (NOAA, 1999i).

Juveniles: EFH is designated for winter flounder juveniles in an extremely small section along the northern border of the Project 1 WTA, Project 2 WTA, and Overlap Area, and along most of the Monmouth ECC. No EFH is designated along the Atlantic ECC for winter flounder juveniles. EFH is defined as estuarine, coastal, and continental shelf benthic habitats from the Gulf of Maine to Absecon Inlet (39° 22′ N), and including Georges Bank, as shown on Map 64, and in mixed and high salinity zones in the bays and estuaries listed in Table 24 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017). EFH for juvenile winter flounder extends from the intertidal zone (mean high water) to a maximum depth of 60 meters (197 feet) and occurs on a variety of bottom types, such as mud, sand, rocky substrates with attached macroalgae, tidal wetlands, and eelgrass. Juveniles are found inshore on muddy and sandy sediments in and adjacent to eelgrass and macroalgae, in bottom debris, and in marsh creeks. They tend to settle to the bottom in soft-sediment depositional areas where currents concentrate late-stage larvae and disperse into coarser-grained substrates as they get older (NEFMC, 2017). Juvenile flounder are common in the inshore waters of New Jersey, according to NMFS trawl surveys conducted between 1964 and 1997, with the highest presence occurring in fall and spring (NOAA, 1999i).

Adults: EFH is designated for winter flounder adults in an extremely small section along the northern border of the Project 1 WTA, Project 2 WTA, and Overlap Area, and along most of the Monmouth ECC. No EFH is designated along the Atlantic ECC for winter flounder adults. EFH is defined as estuarine, coastal, and continental shelf benthic habitats extending from the intertidal zone (mean high water) to a maximum depth of 70 meters (230 feet) from the Gulf of Maine to Absecon Inlet (39° 22′ N), and including Georges Bank, as shown on Map 65 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), and in mixed and high salinity zones in the bays and estuaries listed in Table 24 of NEFMC (2017). EFH for adult winter flounder occurs on muddy and sandy substrates, and on hard bottom on offshore banks. In inshore spawning areas, EFH includes a variety of substrates where eggs are deposited on the bottom (see eggs) (NEFMC, 2017). Off the coast of New Jersey, winter flounder have been observed in protected bays and coastal ponds (NOAA, 1999i). Winter flounder have also been observed in the Offshore Project Area during state and federal trawls conducted between 2009 and 2019. In these surveys, winter flounder were collected in the WTA, Atlantic ECC, and Monmouth ECC.

4.2.1.14 Winter Skate

Juveniles: EFH is designated for winter skate (*Leucoraja ocellate*) juveniles throughout the entire Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. EFH is defined as sub-tidal benthic habitats in coastal waters from eastern Maine to Delaware Bay and on the continental shelf in southern New England and the Mid-Atlantic region, and on Georges Bank, from the shoreline to a maximum depth of 90 meters (295 feet), as shown on Map 92 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of the bays and estuaries listed in Table 28 of NEFMC (2017). EFH for juvenile winter skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC, 2017). In winter, winter skates are found from Georges Bank to Cape Hatteras, out to the 200-meter (656-foot) depth contour (NOAA, 2003c). In the spring, winter skates can be found in nearshore environments in the Mid-Atlantic Bight (NOAA, 2003c). Based on NEFSC bottom trawl surveys conducted between 1964 and 2002, the highest concentrations of juvenile winter skate off the coast of New Jersey occurs in spring, while the lowest occurs in the summer (NOAA, 2003c).

Adults: EFH is designated for winter skate adults throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along portions of the Atlantic ECC. EFH is defined as sub-tidal benthic habitats in coastal waters in the southwestern Gulf of Maine, in coastal and continental shelf waters in southern New England and the Mid-Atlantic region, and on Georges Bank, from the shoreline to a maximum depth of 80 meters (262 feet), as shown on Map 93 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of the bays and estuaries listed in Table 28 of NEFMC (2017). EFH for adult winter skates occurs on sand and gravel substrates, but they are also found on mud (NEFMC, 2017). Similar seasonal distribution has been observed in adult winter skate as juvenile winter skate, with higher abundance in nearshore environments in the spring and offshore in the winter (NOAA, 2003c). Winter skates were collected year-round during state and federal trawl surveys in the WTA, Atlantic, and Monmouth ECC.

4.2.1.15 Witch Flounder

Eggs & Larvae: EFH is designated for witch flounder (*Glyptocephalus cynoglossus*) eggs throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic ECC, and along a portion of the Monmouth ECC. EFH is designated for witch flounder larvae throughout most of the Project 1 and Project 2 WTAs and Overlap Area, and along a portion of the Monmouth ECC. No EFH is designated along the Atlantic ECC for witch flounder larvae. EFH is defined as pelagic habitats on the continental shelf throughout the Northeast region, as shown on Map 66 and Map 67 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Based on MARMAP ichthyoplankton surveys, eggs have been collected from Nova Scotia to Cape Hatteras, with eggs appearing sooner in the Mid-Atlantic Bight than in the New England Region. Witch flounder eggs have been collected from a wide range of depths spanning from 10 to 1,250 meters (32 to 4,101 feet), depending on the season, with most catches occurring between 30 and 150 meters (98 to 492 feet). Most larvae have been collected between 10 and 210 meters (33 to 689 feet).

Adults: EFH is designated for witch flounder adults throughout most of the Project 1 and Project 2 WTAs and Overlap Area and along portions of the Atlantic and Monmouth ECCs. EFH is defined as sub-tidal benthic habitats between 35 and 400 meters (115 to 1,312 feet) in the Gulf of Maine and as deep as 1,500 meters (4,921 feet) on the outer continental shelf and slope, with mud and muddy sand substrates, as shown on Map 69 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Witch flounder can typically be found along the outer continental shelf in the winter and throughout the shelf in spring (NOAA, 1999j). Witch flounder were occasionally caught in the WTA during state and federal trawl surveys between 2009 and 2019. These catches all occurred during spring trawls which aligns with witch flounder seasonal migration patterns and presence (NOAA, 1999j).

4.2.1.16 Yellowtail Flounder

Eggs: EFH is designated for yellowtail flounder eggs throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic ECC and along portions of the Monmouth ECC. EFH is defined as coastal and continental shelf pelagic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic region as far south as the upper Delmarva peninsula, as shown on Map 70 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of the bays and estuaries listed in Table 25 of NEFMC (2017). Yellowtail flounder eggs begin to appear off the coast of New Jersey between March and April on the continental shelf, typically within water depths of 30 to 90 meters (98 to 295 feet) (NOAA, 1999k).

Larvae: EFH is designated for yellowtail flounder larvae throughout most of the Project 1 and Project 2 WTAs and Overlap Area, and along portions of the Atlantic and Monmouth ECCs. EFH is defined as coastal marine and continental shelf pelagic habitats in the Gulf of Maine, and from Georges Bank to Cape Hatteras, as shown on Map 71 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of the bays and estuaries listed in Table 25 of NEFMC (2017). Yellowtail larvae begin to appear on the continental shelf in April in waters of the New York Bight, south to the Delmarva peninsula (NOAA, 1999k). A majority of yellowtail flounder larvae can be found in water depths ranging from 10 to 90 meters (33 to 295 feet) (NOAA, 1999k). According to MARMAP Ichthyoplankton surveys conducted between April and October, 1977 to 1987, larvae are largely present off the coast of New Jersey between May and July (NOAA, 1999k).

Juveniles: EFH is designated for yellowtail flounder juveniles throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along portions of the Atlantic ECC. EFH is defined as sub-tidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic as shown on Map 72 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of the bays and estuaries listed in Table 25 of NEFMC (2017). EFH for juvenile yellowtail flounder occurs on sand and muddy sand between 20 and 80 meters (66 to 262 feet). In the MidAtlantic, young-of-the-year juveniles settle to the bottom on the continental shelf, primarily at depths of 40 to 70 meters (131 to 230 feet), on sandy substrates (NEFMC, 2017). During spring and fall NEFSC bottom trawl surveys conducted between 1,968 and 1,987, yellowtail flounder juveniles were found at depths ranging from 5 to 75 meters (16 to 246 feet). According to NMFS year-round trawl surveys between 1968 and 1997, juvenile yellowtail flounder were most prevalent in nearshore waters off the coast of New Jersey in the spring and offshore in the fall (NOAA, 1999k).

Adults: EFH is designated for yellowtail flounder adults along the northern and southern edges of the Project 1 WTA, northern and eastern edges of the Project 2 WTA and Overlap Area, and along the entirety of the Monmouth ECC. No EFH is designated along the Atlantic ECC for adult yellowtail flounder. EFH is defined as sub-tidal benthic habitats in coastal waters in the Gulf of Maine and on the continental shelf on Georges Bank and in the Mid-Atlantic as shown on Map 73 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), including the high salinity zones of the bays and estuaries listed in Table 25 of NEFMC (2017). EFH for adult yellowtail flounder occurs on sand and sand with mud, shell hash, gravel, and rocks at depths between 25 and 90 meters (82 to 295 feet) (NEFMC, 2017). Adult yellowtail flounder are frequently found at depths less than 100 meters (328 feet), which could include areas of the Offshore Project Area which ranges in depth from 0 to 37 meters (0 to 121 feet) (NOAA, 1999k). However, no yellowtail flounder were collected during state and federal trawl surveys between 2009 and 2019.

4.2.2 Mid-Atlantic Fishery Management Council Finfish Species

EFH for finfish species managed by the Mid-Atlantic Fishery Management Council (MAFMC) are covered under the following FMPs: Amendment 11 to the Atlantic Mackerel, Squid, and Butterfish FMP (MAFMC, 2011); Amendment 12 to the Summer Flounder, Scup, and Black Sea Bass FMP (MAFMC, 1998a); Amendment 1 to the Bluefish FMP (MAFMC and ASMFC, 1998); and Amendment 3 to the Spiny Dogfish FMP (MAFMC, 2014). Seven MAFMC finfish species have designated EFH in the Offshore Project Area.

4.2.2.1 Atlantic Butterfish

Eggs: EFH is designated for Atlantic butterfish eggs in the northwestern corner of the Project 1 WTA, and along portions of the Monmouth ECC. No EFH is designated in the Project 2 WTA, Overlap Area, or along the Atlantic ECC for Atlantic butterfish eggs. EFH is defined as pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York, in Chesapeake Bay, and on the continental shelf and slope, primarily from Georges Bank to Cape Hatteras, North Carolina. EFH for Atlantic butterfish eggs is generally found over bottom depths of 1,500 meters (4,921 feet) or less where average temperatures in the upper 200 meters (656 feet) of the water column are 6.5 – 21.5 °C (43.7 – 70.7 °F) (MAFMC, 2011). During MARMAP ichthyoplankton surveys conducted between 1978 to 1987, Atlantic butterfish were collected in nearshore and offshore environments between May and August off the coast of New Jersey (NOAA, 1999l).

Larvae: EFH is designated for Atlantic butterfish larvae throughout most of the Project 1 and Project 2 WTAs and Overlap Area, and along portions of the Atlantic and Monmouth ECCS. EFH is defined as pelagic habitats in inshore estuaries and embayments in Boston harbor, from the south shore of Cape Cod to the Hudson River, and in Delaware and Chesapeake bays, and on the continental shelf from the Great South Channel (western Georges Bank) to Cape Hatteras, North Carolina. EFH for Atlantic butterfish larvae is generally found over bottom depths between 41 and 350 meters (135 to 1,148 feet) where average temperatures in the upper 200 meters (656 feet) of the water column are 8.5-21.5 °C (47.3 – 70.7 °F) (MAFMC, 2011). Atlantic butterfish larvae have been observed in Great Bay in New Jersey, located 9 miles (14.5 kilometers) north of the Atlantic Landfall Site (NOAA, 1999l). Atlantic butterfish larvae have been collected in MARMAP ichthyoplankton surveys from 1977 to 1987 off the coast of New Jersey between July and September (NOAA, 1999l).

Juveniles: EFH is designated for Atlantic butterfish juveniles throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. EFH is defined as pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, in inshore waters of the Gulf of Maine and the South Atlantic Bight, and on the inner and outer continental shelf from southern New England to South Carolina. EFH for juvenile Atlantic butterfish is generally found over bottom depths between 10 and 280 meters (32 to 919 feet) where bottom water temperatures are between 6.5 and 27 °C (43.7 and 80.6 °F) and salinities are above 5 parts per thousand. Juvenile butterfish feed mainly on planktonic prey (MAFMC, 2011). Juvenile Atlantic butterfish undergo seasonal migrations. In the Mid-Atlantic Bight, juveniles spend winters along the outer continental shelf and summers inshore (NOAA, 1999l). According to NEFSC bottom trawl surveys conducted between 1963 and 1997, juvenile Atlantic butterfish can be found off the coast of New Jersey year-round; however, the largest abundance of juveniles typically occurs in the fall (NOAA, 1999l).

Adults: EFH is designated for Atlantic butterfish adults throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and the entirety of the Atlantic ECC. EFH is defined as pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound, North Carolina, inshore waters of the Gulf of Maine and the South Atlantic Bight, on Georges Bank, on the inner continental shelf south of Delaware Bay, and on the outer continental shelf from southern New England to South Carolina. EFH for adult Atlantic butterfish is generally found over bottom depths between 10 and 250 meters (33 to 820 feet) where bottom water temperatures are between 4.5 and 27.5 °C (40.1 and 81.5 °F) and salinities are above 5 parts per thousand. Spawning probably does not occur at temperatures below 15 °C (59 °F). Adult butterfish feed mainly on planktonic prey, including squids and fishes (MAFMC, 2011). Similar to juveniles, adult Atlantic butterfish undergo seasonal migration within the Mid-Atlantic Bight, spending winters along the outer edge and spring in inshore reaches (NOAA, 1999l). Butterfish were frequently caught, year-round, during state and federal trawl surveys between 2009 and 2019 in the WTA, Atlantic ECC, and Monmouth ECC.

4.2.2.2 Atlantic Mackerel

Eggs: EFH is designated for Atlantic mackerel (*Scomber scombrus*) eggs throughout most of the Project 1 and Project 2 WTAs and Overlap Area, and along the northern portions of the Monmouth ECC. No EFH is designated along the Atlantic ECC for Atlantic mackerel eggs. EFH is defined as pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire to the south shore of Long Island, New York, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N). EFH for Atlantic mackerel eggs is generally found over bottom depths of 100 meters (328 feet) or less with average water temperatures of 6.5 12.5 °C (43.7 – 54.5 °F) in the upper 15 meters (49 feet) of the water column (MAFMC, 2011). During MARMAP ichthyoplankton surveys conducted between April and August from 1977 to 1987, eggs were caught most frequently in April and May off the coast of New Jersey (NOAA, 1999m).

Larvae: EFH is designated for Atlantic mackerel larvae within part of the Project 1 and Project 2 WTAs and Overlap Area, and along the northern portion of the Monmouth ECC. No EFH is designated along the Atlantic ECC for Atlantic mackerel larvae. EFH is defined as pelagic habitats in inshore estuaries and embayments from Great Bay, New Hampshire to the south shore of Long Island, New York, inshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina (mostly north of 38°N). EFH for Atlantic mackerel larvae is generally found over bottom depths between 21 and 100 meters (69 to 328 feet) with average water temperatures of 5.5-11.5 °C (41.9 – 52.7 °F) in the upper 200 meters (656 feet) of the water column (MAFMC, 2011). During MARMAP ichthyoplankton surveys conducted between May and August from 1977 to 1987, larvae were caught most frequently in May and June off the coast of New Jersey (NOAA, 1999m).

Juveniles: EFH is designated for Atlantic mackerel juveniles throughout most of the Project 1 WTA, the entire Project 2 WTA and Overlap Area, and along portions of the Monmouth ECC. No EFH is designated along the Atlantic ECC for juvenile Atlantic mackerel. EFH is defined as pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay and Penobscot Bay, Maine to the Hudson River, in the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for juvenile Atlantic mackerel is generally found over bottom depths between 10 and 110 meters (361 feet) and in water temperatures of 5 to 20 °C (41 to 68 °F). Juvenile Atlantic mackerel feed primarily on small crustaceans, larval fish, and other pelagic organisms (MAFMC, 2011). During NEFSC bottom trawl surveys conducted between 1963 and 1987, juvenile Atlantic mackerel were frequently caught off the coast of New Jersey, with the largest catch numbers occurring in spring surveys compared to fall surveys (NOAA, 1999m).

Adults: EFH is designated for Atlantic mackerel adults throughout most of the Project 1 WTA, the entire Project 2 WTA and Overlap Area, most of the Atlantic ECC, and along portions of the Monmouth ECC. EFH is defined as pelagic habitats in inshore estuaries and embayments from Passamaquoddy Bay, Maine to the Hudson River, and on the continental shelf from Georges Bank to Cape Hatteras, North Carolina. EFH for adult Atlantic mackerel is generally found over bottom depths less than 170 meters (558 feet) and in water temperatures of 5 to 20 °C (41 to 68 °F). Spawning occurs at temperatures above 7 °C (44.6 °F), with a peak between 9 and 14 °C (48.2 and 57.2 °F). Adult Atlantic mackerel are opportunistic predators that feed on a wide range of larger pelagic crustaceans, as compared to juveniles, as well as fish and squid (MAFMC, 2011).

Atlantic mackerel were occasionally caught during state and federal trawl surveys between 2009 and 2019 in the WTA and Monmouth ECC.

4.2.2.3 Black Sea Bass

Larvae: EFH is designated for black sea bass larvae throughout most of the Project 1 and Project 2 WTAs and Overlap Area and along portions of the Monmouth ECC. No EFH is designated along the Atlantic ECC. North of Cape Hatteras, EFH is defined as the pelagic waters found over the continental shelf (from the coast out to the limits of the Exclusive Economic Zone [EEZ]), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all ranked ten-minute squares of the area where black sea bass larvae are collected in the MARMAP survey. EFH also is estuaries where black sea bass were identified as common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally, the habitats for the transforming (to juveniles) larvae are near the coastal areas and into marine parts of estuaries between Virginia and New York. When larvae become demersal, they are generally found on structured inshore habitat such as sponge beds (MAFMC, 1998a). During MARMAP ichthyoplankton surveys conducted between 1977 and 1987, larvae were collected off the coast of New Jersey from July to October (NOAA, 1999n).

Juveniles: EFH is designated for black sea bass juveniles throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic and Monmouth ECCs. Offshore, EFH is defined as the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked squares of the area where juvenile black sea bass are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where black sea bass are identified as being common, abundant, or highly abundant in the ELMR database for the mixing" and "seawater" salinity zones. Juveniles are found in the estuaries in the summer and spring. Generally, juvenile black sea bass are found in waters warmer than 43 °F (6.1 °C) with salinities greater than 18 parts per thousand and coastal areas between Virginia and Massachusetts, but winter offshore from New Jersey and south. Juvenile black sea bass are usually found in association with rough bottom, shellfish and eelgrass beds, man-made structures in sandy shelly areas; offshore clam beds and shell patches may also be used during the wintering (MAFMC, 1998a). Juvenile black sea bass undergo seasonal migrations, traveling between the outer continental shelf in the winter and inshore environments in the spring (NOAA, 1999n). During NEFSC bottom trawl surveys conducted between 1963 and 1987, the abundance of juvenile black sea bass off the coast of New Jersey was highest in inshore environments in the fall and offshore in the winter (NOAA, 1999n). During spring and summer surveys, most black sea bass were caught south of New Jersey (NOAA, 1999n).

Adults: EFH is designated for black sea bass adults throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic and Monmouth ECCs. Offshore, EFH is defined as the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares of the area where adult black sea bass are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where adult black sea bass were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Black sea bass are generally found in estuaries from May through October. Wintering adults (November through April) are generally offshore, south of New York to North Carolina.

Temperatures above 43 °F (6.1 °C) seem to be the minimum requirements. Structured habitats (natural and man-made), sand, and shell are usually the substrate preference (MAFMC, 1998a). During state and federal trawl surveys conducted between 2009 and 2019, black sea bass were collected throughout the Offshore Project Area, primarily in fall and summer surveys.

4.2.2.4 Bluefish

Eggs: EFH is designated for bluefish eggs along the northern edge of the Project 1 and Project 2 WTAs and Overlap Area and along portions of the Atlantic and Monmouth ECC. North of Cape Hatteras, EFH is defined as pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) at mid-shelf depths, from Montauk Point, NY south to Cape Hatteras in the highest 90% of the area where bluefish eggs were collected in the MARMAP surveys. Bluefish eggs are generally not collected in estuarine waters and thus there is no EFH designation inshore. Generally, bluefish eggs are collected between April through August in temperatures greater than 64 °F (18 °C) and normal shelf salinities (> 31 parts per thousand) (MAFMC and ASMFC, 1998). Water temperature in the Offshore Project Area reaches a high of 68 °F (20 °C) at the surface and 59 °F (15 °C) at the seabed. Given the water temperatures in the Offshore Project Area, bluefish eggs could be present in the Offshore Project Area. If bluefish eggs are present in the Offshore Project Area, they would occur between May and August, with the highest abundance occurring in July (MAFMC and ASMFC, 1998)

Larvae: EFH is designated for bluefish larvae throughout most of the Project 1 and Project 2 WTAs and Overlap Area and along portions of the Atlantic and Monmouth ECCs. North of Cape Hatteras, EFH is defined as pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) most commonly above 49 feet (15 meters), from Montauk Point, New York south to Cape Hatteras, in the highest 90% of the area where bluefish larvae were collected during the MARMAP surveys. EFH is also defined as the "slope sea" and Gulf Stream between latitudes 29° 00 N and 40° 00 N. Bluefish larvae are not generally collected inshore, so there is no EFH designation inshore for larvae. Generally, bluefish larvae are collected April through September in temperatures greater than 64 °F (18 °C) in normal shelf salinities (> 30 parts per thousand) (MAFMC and ASMFC, 1998). Off the coast of New Jersey, peak larval abundance occurs in June (MAFMC and ASMFC 1998). Within the Mid-Atlantic Bight, MARMAP sampling between 1977 and 1987 found that the majority of larvae were collected at sea surface temperatures between 62 and 79 °F (16.6 and 26.1°C) over depths of 30 to 70 meters (98 to 230 feet) (MAFMC and ASMFC, 1998). Given that the sea surface temperatures can reach a high of 68 °F (20 °C) in the Offshore Project Area, and depths within the Offshore Project can reach up to 37 meters (121 feet), the Offshore Project Area could provide habitat to bluefish larvae.

Juveniles: EFH is designated for bluefish juveniles along the northern and western edges of the Project 1 WTA, the northern edge of the Project 2 WTA and Overlap Area, along most of the Atlantic ECC, and along portions of the Monmouth ECC. North of Cape Hatteras, EFH is defined as pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) from Nantucket Island, Massachusetts south to Cape Hatteras, in the highest 90% of the area where juvenile bluefish are collected in the NEFSC trawl survey. EFH is also defined as the "slope sea" and Gulf Stream between latitudes 29° 00 N and 40° 00 N and all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Generally juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones. Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed (MAFMC and ASMFC, 1998). Within the Mid-Atlantic Bight, abundance of juvenile bluefish is greatest between Rhode Island and New Jersey (MAFMC and ASMFC, 1998).

Adults: EFH is designated for bluefish adults throughout the entirety of the Project 1 and Project 2 WTAs and Overlap Area, and along most of the Atlantic and Monmouth ECCs. North of Cape Hatteras, over the continental shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay, Massachusetts south to Cape Hatteras, EFH is defined as the highest 90% of the area where adult bluefish were collected in the NEFSC trawl survey. EFH is also defined as all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Adult bluefish are found in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from April through October, and in South Atlantic estuaries from May through January in the "mixing" and "seawater" zones. Bluefish adults are highly migratory, and distribution varies seasonally and according to the size of the individuals comprising the schools. Bluefish are generally found in normal shelf salinities (> 25 parts per thousand) (MAFMC and ASMFC, 1998). Bluefish were frequently collected throughout the Offshore Project Area during state and federal trawl survey conducted between 2009 and 2019. These catches occurred exclusively in fall and summer surveys in the Offshore Project Area.

4.2.2.5 Scup

Juveniles: EFH is designated for scup juveniles throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. Offshore, EFH is defined as the demersal waters over the continental shelf (from the coast out to the limits of the EEZ, from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares of the area where juvenile scup are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where scup are identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juvenile scup are found during the summer and spring in estuaries and bays between Virginia and Massachusetts, in association with various sands, mud, mussel and eelgrass bed type substrates and in water temperatures greater than 45 °F (7.2 °C) and salinities greater than 15 parts per thousand (MAFMC, 1998a). According to data collected during NEFSC bottom trawl surveys, conducted between 1963 and 1966, juvenile scup abundance is greatest in inshore reaches of New Jersey waters in the fall and offshore reaches in the spring (NOAA, 1999o).

Adults: EFH is designated for scup adults throughout the entirety of the Project 1 and Project 2 WTAs and Overlap Area and along most of the Atlantic and Monmouth ECCs. Offshore, EFH is defined as the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares of the area where adult scup are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where scup were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing and "seawater" salinity zones. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 45 °F (7.2 °C) (MAFMC, 1998a). Adult scup commonly inhabit the Mid-Atlantic Bight, where they migrate from offshore winter habitat to coastal waters (NOAA, 1999o). Scup were frequently collected throughout the Offshore Project Area during state and federal trawl surveys conducted between 2009 and 2019. All catches occurred in fall, summer, and spring surveys. No scup were collected during winter NJDEP OSAP surveys.

4.2.2.6 Spiny Dogfish

Adults: EFH is designated for adult male spiny dogfish throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along the entire Atlantic ECC. EFH is designated for adult female spiny dogfish in the entire Project 1 WTA, Project 2 WTA and Overlap Area, and along the entire Atlantic and Monmouth ECCs. EFH is defined as pelagic and epibenthic habitats throughout the region. Adults are found over a wide depth range in full salinity seawater (32-35 parts per thousand) where bottom temperatures range from 7 to 15 °C (44.6 to 59 °F). They are widely distributed throughout the region in the winter and spring when water temperatures are lower, but very few remain in the Mid-Atlantic area in the summer and fall after water temperatures rise above 15 °C (59 °F) (MAFMC, 2014). Spiny dogfish were frequently collected throughout the Offshore Project Area, year-round, during state and federal trawl survey conducted between 2009 and 2019.

4.2.2.7 Summer Flounder

Eggs: EFH is designated for summer flounder eggs along the northern edge of the Project 1 and Project 2 WTAs and Overlap Area, and along small portions of the Atlantic and Monmouth ECCs. North of Cape Hatteras, EFH is defined as the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of the all the ranked ten-minute squares for the area where summer flounder eggs are collected in the MARMAP survey. In general, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles (14.5 kilometers) of shore off New Jersey and New York. Eggs are most commonly collected at depths of 9 to 109 meters (30 to 358 feet) (MAFMC, 1998a).

Larvae: EFH is designated for summer flounder larvae along the northern edge of the Project 1 and Project 2 WTAs and Overlap Area, and along portions of the Atlantic and Monmouth ECCs. North of Cape Hatteras, EFH is defined as the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where summer flounder larvae are collected in the MARMAP survey. Inshore, EFH is all the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database, in the "mixing" (defined in ELMR as 0.5 to 25.0 parts per thousand) and "seawater" (defined in ELMR as greater than 25 parts per thousand) salinity zones. In general, summer flounder larvae are most abundant nearshore (12-50 miles or 19-80 kilometers from shore) at depths between 9 to 70 meters (30 to 230 feet). They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February, and in the southern part from November to May (MAFMC, 1998a).

Juveniles: EFH is designated for summer flounder juveniles throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic ECC, and along portions of the Monmouth ECC. North of Cape Hatteras, EFH is defined as the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where juvenile summer flounder are collected in the NEFSC trawl survey. Inshore, EFH is all of the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 37 °F (2.7 °C) and salinities from 10 to 30 parts per thousand range (MAFMC, 1998a). Juvenile summer flounder have been observed in Great Bay which is located between the two landfall sites (10 miles or 16 kilometers north of the Atlantic Landfall Site, 42 miles or 68 kilometers south of the Monmouth Landfall Site, and 10 miles or 16 kilometers northwest of the WTA) (NOAA, 1999p).

Adults: EFH is designated for summer flounder adults throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. North of Cape Hatteras, EFH is defined as the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina, in the highest 90% of all the ranked ten-minute squares for the area where adult summer flounder are collected in the NEFSC trawl survey. Inshore, EFH is the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally, summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer continental shelf at depths of 500 feet (152 meters) in colder months (MAFMC, 1998a). Adult summer flounder exhibit strong seasonal migration between inshore and offshore environments (NOAA, 1999p). Adult summer flounder spend warmer months in coastal and estuarine waters, and colder months offshore (NOAA, 1999p). Tagging studies have shown that during winter, summer flounder can be found offshore of New Jersey at water depths of 30 to 183 meters (98 to 600 feet) (NOAA, 1999p). Additionally, through tagging studies off the coast of New Jersey and New York, homing behavior was observed in adult summer flounder meaning adults will return to the same inshore environment every spring and summer (NOAA, 1999p). Summer flounder were frequently collected throughout the Offshore Project Area, year-round, during state and federal trawl surveys conducted between 2009 and 2019.

Habitat of Particular Concern (HAPC): Summer flounder HAPC is defined as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH. The HAPC definition also states that if native species of submerged aquatic vegetation (SAV) are eliminated then exotic species should be protected because of functional value, however, all efforts should be made to restore native species (MAFMC, 2016). Due to the absence of identified areas of SAV in the Offshore Project Area, it is assumed that summer flounder HAPC does not occur in the Offshore Project Area.

4.2.3 New England Fishery Management Council Invertebrate Species

One NEFMC-managed invertebrate species has EFH in the Offshore Project Area, the Atlantic sea scallop (*Placopecten magellanicus*). This species is covered under the Omnibus Essential Fish Habitat Amendment 2 (NEFMC, 2017) and managed under Amendment 14 to the Atlantic Sea Scallop FMP.

4.2.3.1 Atlantic Sea Scallop

EFH is designated for Atlantic sea scallop eggs/larvae/juveniles/adults along the northern and southern edges of the Project 1 WTA, northern and eastern edges of the Project 2 WTA and Overlap Area, and along most of the Monmouth ECC. No EFH is designated along the Atlantic ECC.

Eggs: EFH is defined as benthic habitats in inshore areas and on the continental shelf as shown on Map 97 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), in the vicinity of adult scallops. Eggs are heavier than seawater and remain on the seafloor until they develop into the first free-swimming larval stage (NEFMC, 2017).

Larvae: EFH is defined as benthic and water column habitats in inshore and offshore areas throughout the region, as shown on Map 97 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Any hard surface can provide an essential habitat for settling pelagic larvae ("spat"), including shells, pebbles, and gravel. They also attach to macroalgae and other benthic organisms such as hydroids. Spat attached to sedentary branching organisms or any hard surface have greater survival rates; spat that settle on shifting sand do not survive (NEFMC, 2017).

Juveniles: EFH is defined as benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, as shown on Map 97 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017), in depths of 18 to 110 meters (59 to 361 feet). Juveniles (5-12 millimeter shell height) leave the original substrate on which they settle (see larvae, above) and attach themselves by byssal threads to shells, gravel, and small rocks (pebble, cobble), preferring gravel. As they grow older, they lose their byssal attachment. Juvenile scallops are relatively active and swim to escape predation. While swimming, they can be carried long distances by currents. Bottom currents stronger than 10 centimeters per second retard feeding and growth. In laboratory studies, maximum survival of juvenile scallops occurred between 1.2 and 15 °C (34.2 and 59 °F) and above salinities of 25 parts per thousand. On Georges Bank, age 1 juveniles are less dispersed than older juveniles and adults and are mainly associated with gravel-pebble deposits. Essential habitats for older juvenile scallops are the same as for the adults (gravel and sand) (NEFMC, 2017).

Adults: EFH is defined as benthic habitats in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic, as shown on Map 97 in the Final Omnibus EFH Amendment 2 (NEFMC, 2017). Essential habitats for older juvenile and adult sea scallops are found on sand and gravel substrates in depths of 18 to 110 meters (59 to 361 feet), but they are also found in shallower water and as deep as 180 meters (591 feet) in the Gulf of Maine. In the Mid-Atlantic they are found primarily between 45 and 75 meters (148 to 246 feet) and on Georges Bank they are more abundant between 60 and 90 meters (197 to 295 feet). They often occur in aggregations called beds which may be sporadic or essentially permanent, depending on how suitable the habitat conditions are (temperature, food availability, and substrate) and whether oceanographic features (fronts, currents) keep larval stages in the vicinity of the spawning population. Bottom currents stronger than 25 cm/sec (half a knot) inhibit feeding. Growth of adult scallops is optimal between 10 and 15°C (50 and 59 °F) and they prefer full strength seawater (NEFMC, 2017). Sea scallops were occasionally collected, year-round, during state and federal trawl surveys in the WTA and Monmouth ECC between 2009 and 2019. No collections of Atlantic sea scallops occurred in the Atlantic ECC during that time period.

4.2.4 Mid-Atlantic Fishery Management Council Invertebrate Species

EFH for invertebrate species managed by the MAFMC are covered under the following FMPs: Amendment 12 to the Atlantic Surfclam and Ocean Quahog FMP (MAFMC, 1998b) and Amendment 11 to the Atlantic Mackerel, Squid, and Butterfish FMP (MAFMC, 2011). Four MAFMC invertebrate species have designated EFH in the Offshore Project Area.

4.2.4.1 Atlantic Surfclam

Juveniles & Adults: EFH is designated for juvenile and adult Atlantic surfclam throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and along most of the Atlantic and Monmouth ECCs. EFH is defined as occurring throughout the substrate, to a depth of three feet (0.9 meters) 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 surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys. Surfclams generally occur from the beach zone to a depth of about 200 feet (61 meters), but beyond about 125 feet (38 meters) abundance is low (MAFMC, 1998b). Atlantic surfclam can be found on well-sorted, medium and fine sandy sediment (NOAA, 1999r). Atlantic surfclam were frequently collected in the WTA during NEFSC Atlantic Surf Clam – Ocean Quahog surveys conducted between 2011 and 2012. Additional catches occurred in the Atlantic ECC, but at smaller quantities. No surveys were conducted within the Monmouth ECC.

4.2.4.2 Longfin Inshore Squid

Eggs: EFH is designated for longfin inshore squid (*Doryteuthis pealeii*) eggs in the northwestern corner of the Project 1 WTA, along the nearshore reaches of the Atlantic ECC, and along most of the Monmouth ECC. No EFH is designated in the Project 2 WTA or Overlap Area. EFH is defined for *Doryteuthis pealeii* eggs as inshore and offshore bottom habitats from Georges Bank southward to Cape Hatteras, generally where bottom water temperatures are between 10 °C and 23 °C (50 and 73.4 °F), salinities are between 30 and 32 parts per thousand, and depth is less than 50 meters (164 feet). *Doryteuthis pealeii* eggs have also been collected in bottom trawls in deeper water at various places on the continental shelf. Like most loliginid squids, *D. pealeii* egg masses or "mops" are demersal and anchored to the substrates on which they are laid, which include a variety of hard bottom types (e.g., shells, lobster pots, piers, fish traps, boulders, and rocks), submerged aquatic vegetation (e.g., Fucus sp.), sand, and mud (MAFMC, 2011).

Juveniles (Pre-recruits): EFH is designated for longfin inshore squid juveniles throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth and Atlantic ECCs . EFH is defined as pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in the southwestern Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, and Raritan

Bay. EFH for recruit longfin inshore squid is generally found over bottom depths between 6 and 160 meters (20 to 525 feet) where bottom water temperatures are 8.5-24.5 °C (47.3 – 76.1 °F) and salinities are 28.5-36.5 parts per thousand. Pre-recruits migrate offshore in the fall where they overwinter in deeper waters along the edge of the shelf. They make daily vertical migrations, moving up in the water column at night and down in the daytime. Small immature individuals feed on planktonic organisms while larger individuals feed on crustaceans and small fish (MAFMC, 2011). During NEFSC bottom trawls conducted between 1969 and 2003, as reported in the NOAA EFH Source Document, pre-recruits were generally found offshore, concentrated around the 200-meter (656-foot) depth contour during winter months (NOAA, 2005a). During summer, pre-recruits can generally be found within the 50-meter (164-foot) depth contour off the coast of New Jersey (NOAA, 2005a).

Adults (Recruits): EFH is designated for longfin inshore squid adults throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC, and along the entirety of the Atlantic ECC. EFH is defined as pelagic habitats in inshore and offshore continental shelf waters from Georges Bank to South Carolina, in inshore waters of the Gulf of Maine, and in embayments such as Narragansett Bay, Long Island Sound, Raritan Bay, and Delaware Bay. EFH for recruit longfin inshore squid is generally found over bottom depths between 6 and 200 meters (20 to 656 feet) where bottom water temperatures are 8.5-14 °C (47.3 – 57.2 °F) and salinities are 24-36.5 parts per thousand. Recruits inhabit the continental shelf and upper continental slope to depths of 400 meters (1,312 feet). They migrate offshore in the fall and overwinter in warmer waters along the edge of the shelf. Like the pre-recruits, they make daily vertical migrations. Individuals larger than 12 centimeters feed on fish and those larger than 16 centimeters feed on fish and squid. Females deposit eggs in gelatinous capsules which are attached in clusters to rocks, boulders, and aquatic vegetation and on sand or mud bottom, generally in depths less than 50 meters (164 feet) (MAFMC, 2011). Data from NEFSC bottom trawl surveys conducted between 1981 and 2003 show similar seasonal distribution for pre-recruits and recruits (NOAA, 2005a). During winter months, recruits can be found along the edge of the continental shelf, concentrated around the 200-meter isobath (NOAA, 2005a). During summer, recruits can generally be found within the 50-meter (164 foot) isobath off the coast of New Jersey (NOAA, 2005a). Longfin squid were frequently collected in large quantities throughout the WTA, Atlantic ECC and Monmouth ECC during state and federal trawl surveys conducted between 2009 and 2019.

4.2.4.3 Northern Shortfin Squid

Juveniles (Pre-recruits): EFH is designated for northern shortfin squid *(Illex illecebrosus)* juveniles throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth ECC. No EFH is designated for northern shortfin squid juveniles in the Atlantic ECC. EFH is defined as pelagic habitats along the outer continental shelf and slope as far south as South Carolina, on Georges Bank, and on the inner continental shelf off New Jersey and southern Maine and New Hampshire. EFH for pre-recruit Northern shortfin squid is generally found over bottom depths between 41 and 400 meters (135 to 1,312 feet) where bottom temperatures are 9.5-16.5 °C (49.1 – 61.7 °F) and salinities are 34.5-36.5 parts per thousand. They also inhabit pelagic habitats in the Gulf Stream where water temperatures are above 16 °C (60.8 °F) and migrate onto the shelf as they grow. Pre-recruits make daily vertical migrations, moving up in the water column at night and down in the daytime. They feed primarily on euphausiids at night near the surface (MAFMC, 2011).

Shortfin squid were occasionally collected during NJDEP OSAP trawl surveys in the WTA, Atlantic ECC, and Monmouth ECC. These catches occurred exclusively during summer surveys.

4.2.4.4 Ocean Quahog

Juveniles & Adults: EFH is designated for ocean quahog (*Arctica islandica*) juveniles in the southern tip of the Project 1 WTA. No EFH is designated for ocean quahog juveniles in the Project 2 WTA, Overlap Area, or along the Atlantic and Monmouth ECCs. EFH is designated for ocean quahog adults along the southern tip of the Project 1 WTA, the eastern edge of the Project 2 WTA and Overlap Area, and the southern portion of the Monmouth ECC. No EFH is designated along the Atlantic ECC for adult ocean quahogs. EFH is defined as occurring throughout the substrate, to a depth of three feet (0.9 meters) 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 (9 to 244 meters) (MAFMC, 1998b), typically on sandy sediment of medium to fine grain size (NOAA, 1999q). Ocean quahogs are rarely found where bottom water temperatures exceed 60 °F (15.5 °C) and occur progressively further offshore between Cape Cod and Cape Hatteras (MAFMC, 1998b). Ocean quahogs were occasionally collected in the WTA during NEFSC Atlantic Surf Clam – Ocean Quahog surveys from 2011 to 2012.

4.2.5 Highly Migratory Species

EFH for highly migratory species are managed by NOAA's Highly Migratory Species Division under Amendment 10 to the Consolidated Atlantic Highly Migratory Species FMP (NOAA, 2017). Four highly migratory tuna species and nine highly migratory shark species have designated EFH in the Offshore Project Area.

4.2.5.1 Tunas

4.2.5.1.1 Albacore Tuna

Juveniles: EFH is designated for albacore tuna (*Thunnus alalunga*) juveniles along portions of the Monmouth ECC. No EFH is designated in the Project 1 WTA, Project 2 WTA, Overlap Area, or Atlantic ECC for albacore tuna juveniles. Offshore, EFH is defined as pelagic habitats of the Atlantic Ocean from the outer edge of the U.S. EEZ through Georges Bank to pelagic habitats south of Cape Cod, and from Cape Cod to Cape Hatteras, North Carolina (NOAA, 2017). The central Atlantic provides wintering habitat for juvenile albacore tuna. In the summer, juveniles migrate to productive waters in the northeast Atlantic for feeding opportunities (NOAA, 2017).

4.2.5.1.2 Bluefin Tuna

Juveniles: EFH is designated for bluefin tuna (*Thunnus thynnus*) juveniles throughout the entirety of the Project 1 WTA, Project 2 WTA, Overlap Area, and Monmouth ECC, and along portions of the Atlantic ECC. EFH is defined as coastal and pelagic habitats of the Mid-Atlantic Bight and the Gulf of Maine, between southern Maine and Cape Lookout, from shore (excluding Long Island Sound, Delaware Bay, Chesapeake Bay, and Pamlico Sound) to the continental shelf break. EFH follows the continental shelf from the outer extent of the U.S. EEZ on Georges Bank to Cape Lookout. EFH is associated with certain environmental conditions in the Gulf of Maine (16 to 19 °C (60.8 to 66.2 °F); 0 to 40 meters or 0 to 131 feet deep). EFH in other locations associated with temperatures ranging from 4 to 26 °C (39.2 to 78.8 °F), often in depths of less than 20 meters (66 feet) (but can be found in waters that are 40-100 meters or 131 to 328 feet in depth in winter) (NOAA, 2017). Tagging studies have shown that summer distribution of juvenile bluefin tuna includes coastal areas, the Gulf Stream margin, and the continental shelf break between the Gulf of Maine and Cape Hatteras. In the fall, juveniles have been observed migrating south along the continental shelf break to the South Atlantic Bight and Bahamas. Winter and spring distributions of juvenile bluefin tuna were dependent on the Gulf Stream position (NOAA, 2017).

Adults: EFH is designated for bluefin tuna adults along portions of the Monmouth ECC. No EFH is designated in the Project 1 WTA, Project 2 WTA, Overlap Area, or Atlantic ECC for bluefin tuna adults. EFH is defined as offshore and coastal regions of the Gulf of Maine the mid-coast of Maine to Massachusetts; on Georges Bank; offshore pelagic habitats of southern New England; from southern New England to coastal areas between the mouth of Chesapeake Bay and Onslow Bay, North Carolina; from coastal North Carolina south to the outer extent of the U.S. EEZ, inclusive of pelagic habitats of the Blake Plateau, Charleston Bump, and Blake Ridge (NOAA, 2017). Bluefin tuna can be found in waters overlying the continental shelf and slope of the Mid-Atlantic Bight between June and March (NOAA, 2017).

4.2.5.1.3 Skipjack Tuna

Juveniles: EFH is designated for skipjack tuna (*Katsuwonus pelamis*) juveniles throughout most of the Project 1 WTA, the entire Project 2 WTA and Overlap Area, most of the Monmouth ECC, and along a small portion of the Atlantic ECC. EFH is defined as offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts); coastal and offshore habitats between Massachusetts and South Carolina; localized in areas off Georgia and South Carolina; and from the Blake Plateau through the Florida Straits. In all areas, juveniles are found in waters greater than 20 meters (66 feet) (NOAA, 2017).

Adults: EFH is designated for skipjack tuna adults throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and Monmouth and Atlantic ECCs. EFH is defined as coastal and offshore habitats between Massachusetts and Cape Lookout, North Carolina and localized areas in the Atlantic off South Carolina and Georgia, and the northern east coast of Florida (NOAA, 2017). Optimum temperature for skipjack tuna is 80 °F (26.7 °C), with a range from 68 to 88 °F (20 to 31.1 °C) (NOAA, 2017). Other studies state preferred temperature ranges from 58 to 86 °F (14.4 to 20 °C) (Geo-Marine, 2010).

4.2.5.1.4 Yellowfin Tuna

Juveniles: EFH is designated for yellowfin tuna (*Thunnus albacares*) juveniles throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic ECC, and along portions of the Monmouth ECC. EFH is defined as offshore pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank and Cape Cod, Massachusetts and offshore and coastal habitats from Cape Cod to the mid-east coast of Florida and the Blake Plateau (NOAA, 2017).

4.2.5.2 Sharks

4.2.5.2.1 Blue Shark

Juveniles/Adults: EFH is designated for blue shark (*Prionace glauca*) juveniles/adults in the eastern portion and southern tip of the Project 1 WTA, the eastern portion of the Project 2 WTA and Overlap Area, and the southern portion of the Monmouth ECC. No EFH is designated for juvenile or adult blue shark along the Atlantic ECC. EFH is defined as localized areas in the Atlantic Ocean in the Gulf of Maine, from Georges Bank to North Carolina, South Carolina, Georgia, and off Florida (NOAA, 2017). Studies have shown that blue shark movement can be seasonally dependent, with restricted movements over the continental shelf occurring in the summer, and offshore movement occurring in the fall (Howey 2010 and Campana et al., 2011 as cited in NOAA, 2017). Movement of blue shark in the water column can vary, with depths ranging from the sea surface to 600 meters (1,969 feet) (Geo-Marine, 2010). Though the species is oceanic, blue sharks can be found close to shore at night (Geo-marine, 2010). Blue sharks are typically found in waters with temperatures ranging from 44.6 to 60.8 °F (7 to 16 °C) but can tolerate waters as warm as 69.8 °F (21 °C)(Geo-Marine, 2010). Since temperatures within the Offshore Project Area are within the thermal range of blue shark, the species could be present in the vicinity of the Project.

4.2.5.2.2 Common Thresher Shark

All (Neonate/Young of Year [YOY], Juveniles, and Adults): EFH is designated for common thresher shark (*Alopias vulpinus*) neonates/YOY/juveniles/adults throughout the entire Project 1 and 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. Currently, insufficient data is available to differentiate EFH between the juvenile and adult size classes; therefore, EFH is the same for those life stages. EFH is located in the Atlantic Ocean, from Georges Bank (at the offshore extent of the U.S. EEZ boundary) to Cape Lookout, North Carolina; and from Maine to locations offshore of Cape Ann, Massachusetts (NOAA, 2017). EFH occurs with certain habitat associations in nearshore waters of North Carolina, especially in areas with temperatures from 18.2 to 20.9 °C (64.8 to 69.6 °F) and at depths from 4.6 to 13.7 meters (15 to 45 feet) (McCandless et al. 2002 as reported in NOAA, 2017). Common thresher sharks are typically found within 40 to 75 miles (64 to 121 kilometers) of land (Geo-Marine, 2010). Juvenile common threshers inhabit coastal bays and nearshore waters while adults commonly inhabit waters over the continental shelf (Geo-Marine, 2010).

4.2.5.2.3 Dusky Shark

Neonate/YOY: EFH is designated for dusky shark (*Carcharhinus obscurus*) neonates/YOY throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic and Monmouth ECCs. EFH in the Atlantic Ocean includes offshore areas of southern New England to Cape Lookout, North Carolina. Specifically, EFH is associated with habitat conditions including temperatures from 18.1 to 22.2 °C (64.6 to 72 °F), salinities of 25 to 35 parts per thousand and depths at 4.3 to 15.5 meters (14 to 51 feet). Seaward extent of EFH for this life stage in the Atlantic is 60 meters (197 feet) in depth (NOAA, 2017). Major nursey areas have been identified in coastal waters from Massachusetts to North Carolina, where dusky shark give birth from April to May (Geo-Marine, 2010).

Juveniles/Adults: EFH is designated for dusky shark juveniles/adults throughout most of the Project 1 WTA, the entire Project 2 WTA and Overlap Area, along most of the Monmouth ECC, and along a small portion of the Atlantic ECC. EFH is defined as coastal and pelagic waters inshore of the continental shelf break (< 200 meters or 656 feet in depth) along the Atlantic east coast from habitats offshore of southern Cape Cod to Georgia, including the Charleston Bump and adjacent pelagic habitats. Inshore extent for these life stages is the 20-meter (66 foot) bathymetric line. Adults are generally found deeper (to 2,000 meters or 6,562 feet) than juveniles, however there is overlap in the habitats utilized by both life stages (NOAA, 2017). Dusky shark have a large distributional range spanning from inshore waters to the outer reaches of the continental shelf (NOAA, 2017). The species also undergoes a seasonal migration, traveling north in the summer and south in the fall in search of warmer waters (Geo-Marine, 2010).

4.2.5.2.4 Sand Tiger Shark

Neonate/Juveniles: EFH is designated for sand tiger shark (*Carcharias taurus*) neonates/juveniles in the western half of the Project 1 and Project 2 WTAs, the northern portion of the Overlap Area, along most of the Monmouth ECC, and along the entirety of the Atlantic ECC. Neonate EFH ranges from Massachusetts to Florida, specifically the PKD bay system, Sandy Hook, and Narragansett Bays as well as coastal sounds, lower Chesapeake Bay, Delaware Bay (and adjacent coastal areas), Raleigh Bay and habitats surrounding Cape Hatteras. Juvenile EFH includes habitats between Massachusetts and New York (notably the PKD bay system), and between mid-New Jersey and the mid-east coast of Florida. EFH can be described via known habitat associations in the lower Chesapeake Bay and Delaware Bay (and adjacent coastal areas) where temperatures range from 19 to 25 °C (66.2 to 77 °F), salinities range from 23 to 30 parts per thousand at depths of 2.8-7.0 meters (9 to 23 feet) in sand and mud areas, and in coastal North Carolina habitats with temperatures from 19 to 27 °C (66.2 to 80.6 °F), salinities from 30 to 31 parts per thousand, depths of 8.2-13.7 meters (27 to 45 feet), in rocky and mud substrate or in areas surrounding Cape Lookout that contain benthic structure (NOAA, 2017). Based on numerous tagging programs, juvenile sand tiger sharks are known to occur from Maine to the Delaware Bay during summer, then migrate south during winter (NOAA, 2017).

4.2.5.2.5 Sandbar Shark

Neonate/YOY: EFH is designated for sandbar shark (*Carcharhinus plumbeus*) neonates/YOY throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and Atlantic ECC, and along most of the Monmouth ECC. EFH is defined as Atlantic coastal areas from Long Island, New York to Cape Lookout, North Carolina, and from Charleston, South Carolina to Amelia Island, Florida. Important neonate/YOY EFH includes Delaware Bay (Delaware and New Jersey) and Chesapeake Bay (Virginia and Maryland), where the nursery habitat is limited to the southeastern portion of the estuaries (salinity is greater than 20.5 parts per thousand and depth is greater than 5.5 meters or 18 feet); Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. In all nursery areas between New York and North Carolina, unless otherwise noted, EFH is associated with water temperatures that range from 15 to 30 °C (59 to 86 °F); salinities that vary from 15 to 35 parts per thousand; water depths that range from 0.8 to 23 meters (2.6 to 75 feet); and sand, mud, shell, and rocky sediments/benthic habitat (NOAA, 2017). Nursery areas occur in shallow, coastal waters from Massachusetts to Florida. One known important nursery area in New Jersey that is designated as sandbar shark HAPC is at the mouth of Great Bay, part of which overlaps with the inshore portion of the Atlantic ECC (NOAA, 2017). Given the habitat preferences for neonate sandbar sharks, and the presence of important nursey grounds near the Offshore Project Area, occurrence of neonates in the Offshore Project Area is possible. Sandbar shark neonates and juveniles occupy the nursery grounds to feed in early summer until they migrate to warmer waters in the fall (Rechisky and Wetherbee, 2003; Springer, 1960). The majority of neonates and juvenile sandbar shark activity within the Great Bay HAPC have been documented in mid-summer, in shallow, near-shore areas including inside Great Bay and in the vicinity of Little Egg Inlet, and not within the Atlantic ECC area (Rechisky and Wetherbee, 2003; Merson and Pratt, 2007). Young sandbar sharks occupy shallow, near-shore areas most likely due to predator avoidance, distribution of prey, and avoidance of strong currents.

Juveniles: EFH is designated for sandbar shark juveniles throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic and Monmouth ECCs. EFH is defined as coastal portions of the Atlantic Ocean between southern New England (Nantucket Sound, Massachusetts) and Georgia in water temperatures ranging from 20 to 24 °C (68 to 75.2 °F) and depths from 2.4 to 6.4 meters (7.9 to 21 feet). Important nurseries include Delaware Bay, Delaware and New Jersey; Chesapeake Bay, Virginia; Great Bay, New Jersey; and the waters off Cape Hatteras, North Carolina. For all EFH, water temperatures range from 15 to 30 °C (59 to 86 °F), salinities range from 15 to 35 parts per thousand, water depth ranges from 0.8 to 23 meters (2.6 to 75 feet), and substrate includes sand, mud, shell, and rocky habitats (NOAA, 2017).

Adults: EFH is designated for sandbar shark adults throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic and Monmouth ECCs. EFH in the Atlantic Ocean is defined as coastal areas from southern New England to the Florida Keys, ranging from inland waters of Delaware Bay and the mouth of Chesapeake Bay to the continental shelf break (NOAA, 2017). Sandbar sharks are a bottom-dwelling species that are commonly found at depths between 20 to 55 meters (66 to 180 feet) (NOAA, 2017). Comparatively, water depths within the Offshore Project Area range from 0 to 37 meters (0 to 121 feet). Also, as previously stated, coastal waters of New Jersey, such as Great Bay, provide nursery and pupping grounds for sandbar sharks (NOAA, 2017). Given the depth ranges present in the Offshore Project Area, and the presence of important nursery grounds in the vicinity of the Project, sandbar sharks could be present in the Offshore Project Area.

HAPC: HAPC for sandbar shark constitutes important nursery and pupping grounds which have been identified in shallow areas and at the mouth of Great Bay, New Jersey, in lower and middle Delaware Bay, Delaware, lower Chesapeake Bay, Maryland, and offshore of the Outer Banks of North Carolina in water temperatures ranging from 15 to 30 °C; salinities at least from 15 to 35 ppt; water depth ranging from 0.8 to 23 meters; and in sand and mud habitats (NOAA, 2017). Part of the HAPC for sandbar shark at the mouth of Great Bay, New Jersey overlaps with the inshore portion of the Atlantic ECC (Figure 5). Pregnant sandbar shark females have the potential to occur in the area between late spring and early summer, when they reportedly give birth and depart shortly after (Merson and Pratt 2007). Sandbar shark neonates and juveniles occupy the nursery grounds to feed in early summer until they migrate to warmer waters in the fall (Rechisky and Wetherbee, 2003; Springer, 1960). The majority of neonates and juvenile sandbar sharks within the Great Bay HAPC have been documented in mid-summer in shallow, near shore-areas including inside Great Bay and in the vicinity of Little Egg Inlet, and not within the Atlantic ECC area (Rechisky and Wetherbee, 2003; Merson and Pratt, 2007).

4.2.5.2.6 Shortfin Mako Shark

<u>All:</u> EFH is designated for all life stages of the shortfin mako shark (*Isurus oxyrinchus*) throughout most of the Project 1 and Project 2 WTAs, Overlap Area, and the Monmouth ECC. No EFH is designated along the Atlantic ECC for shortfin mako life stages. At this time, available information is insufficient for the identification of EFH by life stage, therefore all life stages are combined in the EFH designation. EFH in the Atlantic Ocean is defined as pelagic habitats seaward of the continental shelf break between the seaward extent of the U.S. EEZ boundary on Georges Bank (off Massachusetts) to Cape Cod (seaward of the 200-meter or 656-foot bathymetric line); coastal and offshore habitats between Cape Cod and Cape Lookout, North Carolina; and localized habitats off South Carolina and Georgia (NOAA, 2017). Shortfin mako sharks are typically found in warm-temperate to tropical waters around the world, but rarely in waters less than 60.8 °F (16 °C) (Geo-Marine, 2010). Based on data collected in the Offshore Project Area, waters off the coast of New Jersey fluctuate seasonally, but have reached 68 °F (20 °C) at the surface and 59 °F (15 °C) at the seafloor. Water temperatures in the Offshore Project Area are within the suitable temperature range for shortfin mako.

4.2.5.2.7 Smoothhound Shark Complex (Atlantic Stock)

<u>All:</u> EFH is designated for all life stages of the smoothhound shark complex (Atlantic Stock) (*Mustelus canis*) throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic and Monmouth ECCs. At this time, available information is insufficient for the identification of EFH for this life stage, therefore all life stages are combined in the EFH designation. Smoothhound shark EFH identified in the Atlantic is exclusively for smooth dogfish. EFH in Atlantic coastal areas ranges from Cape Cod Bay, Massachusetts to South Carolina, inclusive of inshore bays and estuaries (e.g., Pamlico Sound, Core Sound, Delaware Bay, Long Island Sound, Narragansett Bay, etc.). EFH also includes continental shelf habitats between southern New Jersey and Cape Hatteras, North Carolina (NOAA, 2017). Smooth dogfish seasonally migrate inshore in the spring and summer, and offshore in the fall and winter, and can be found at depths of up to 200 meters (656 feet). Telemetry studies have shown the use of estuaries by smooth dogfish within New Jersey. Estuaries and marsh creeks serve as critical nursery habitat to YOY (NMFS, 2010). Smooth dogfish were frequently collected during state and federal trawl surveys conducted between 2009 and 2019 in the WTA, Atlantic and Monmouth ECCs during fall, spring, and summer surveys. Winter trawl surveys did not result in any catch of smooth dogfish.

4.2.5.2.8 Tiger Shark

<u>Juveniles/Adults:</u> EFH is designated for tiger shark (*Galeocerdo cuvieri*) juveniles/adults throughout the entirety of the Project 1 and Project 2 WTAs, Overlap Area, and the Atlantic and Monmouth ECCs. EFH in the Atlantic Ocean extends from offshore pelagic habitats associated with the continental shelf break at the seaward extent of the U.S. EEZ boundary (south of Georges Bank, off Massachusetts) to the Florida Keys, inclusive of offshore portions of the Blake Plateau (NOAA, 2017). Tiger sharks can be found along the continental shelf, estuaries, harbors, and inlets at depths ranging from surface water to 350 meters (1,148 feet) (Geo-Marine, 2010). Given the wide-range distribution of tiger sharks, the species could be present in the Offshore Project Area.

4.2.5.2.9 White Shark

Neonate: EFH is designated for white shark (*Carcharodon carcharias*) neonates throughout the northern half of the Project 1 WTA, Project 2 WTA, and Overlap Area, along the entire Atlantic ECC, and along most of the Monmouth ECC. EFH is defined as inshore waters out to 105 kilometers (65 miles) from Cape Cod, Massachusetts, to an area offshore of Ocean City, New Jersey (NOAA, 2017).

Juveniles/Adults: EFH is designated for white shark juveniles/adults along portions of the Monmouth ECC. No EFH is designated in the Project 1 or Project 2 WTAs, Overlap Area, or Atlantic ECC for juvenile or adult white sharks. Known EFH is defined as inshore waters to habitats 105 kilometers (65 miles) from shore, in water temperatures ranging from 9 to 28 °C (48.2 to 82.4 °F), but more commonly found in water temperatures from 14 to 23 °C (57.2 to 73.4 °F) from Cape Ann, Massachusetts, including parts of the Gulf of Maine, to Long Island, New York, and from Jacksonville to Cape Canaveral, Florida (NOAA, 2017). The Mid-Atlantic Bight is known for having the highest occurrence of white shark when compared to other areas in their habitat range (NOAA, 2017). Within the Mid-Atlantic Bight, white sharks have been spotted from April through December along the continental shelf (NOAA, 2017; Geo-Marine, 2010).

5.0 DESCRIPTION OF OTHER NOAA TRUST RESOURCES

At the request of NOAA, a summary of the preferred habitat and potential occurrence of other NOAA-trust resources in the Offshore Project Area is included in Table 5. The species evaluated in these sections are based on a list provided during a virtual meeting held on May 20, 2020 between NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) and Atlantic Shores (NOAA, 2020).

Table 5. Other NOAA Trust Resources Habitat and Potential Occurrence in the Offshore Project Area

Species	Description of Preferred Habitat	Potential Occurrence in Offshore Project Area[1]
	Finfish	
River Herring (Alewife and Blueback Herring) (*Alosa pseudoharengus* and *Alosa aestivalis*)	Adults utilize offshore waters between 184 to 361 feet (56 and 110 meters) for most of their lives but migrate to freshwater environments to spawn every four to five years (NOAA, 2021b; ASMFC, 2021).	Potential occurrence of adults and some juveniles is likely throughout the Offshore Project Area. Occurrence of eggs and larvae is not expected given the absence of freshwater habitat in the Offshore Project Area.
American Eel (*Anguilla rostrata*)	Larvae utilize the water column of the continental shelf to passively drift, where they mature into glass eels (ASMFC, 2017). Glass eels mature into elvers and migrate to freshwater habitat or coastal rivers and estuaries. Upstream migration can continue as elvers mature into yellow eels. As yellow eels mature into silver eels, they migrate downstream, returning to the marine environment (ASMFC, 2017). While in marine environments, silver eels have been observed throughout the water column from 49 to 1,312 feet (15 to 400 meters) (ASMFC, 2012).	Potential occurrence of larval eels is likely throughout the Offshore Project Area between February and April (Brust, 2006). Potential occurrence for silver eels is likely throughout the Offshore Project Area when traveling between freshwater and offshore marine environments.
American Shad (*Alosa sapidissima*)	Adults utilize coastal riverine habitat in the spring with sand, silt, muck, gravel, or boulder substrates for spawning, productive coastal waters in the summer, and offshore waters in the winter (ASFMC, 2021). Juveniles utilize the mouths of natal rivers for the first year, then emigrate to the ocean (ASFMC, 2021).	Potential occurrence throughout the Offshore Project Area, primarily during summer, fall and winter. Occurrence of American shad is not anticipated during spring as they typically utilize coastal riverine habitat which is not present in the Offshore Project Area.
Atlantic Menhaden (*Brevoortia tyrannus*)	Larvae and juveniles utilize estuarine waters (ASMFC, 2021). Adults utilize productive coastal waters for feeding opportunities between spring and fall, and offshore waters (20 to 30 miles [32 to 48 kilometers]) for spawning in fall and winter (ASMFC, 2021).	Potential occurrence throughout the Offshore Project Area is likely between spring and early fall.
Striped bass (*Morone saxatilis*)	Adults largely utilize open ocean and coastal waters along rocky shores and sandy beaches. In the ocean, striped bass migrate northward in the summer and south in the winter (VIMS, 2021). In spring, adults migrate inshore to freshwater to spawn (URI, 2021). Larvae and juveniles utilize inland portions of sounds and estuaries (ASMFC, 2021).	Potential occurrence throughout the Offshore Project Area for adults, likely during spring, fall, and winter. Occurrence of larvae and juveniles is not expected due to the absence of sounds and estuaries in the Offshore Project Area.

Species	Description of Preferred Habitat	Potential Occurrence in Offshore Project Area[1]
Tautog (*Tautoga onitis*)	Adults utilize structures like wrecks, reefs, rocks, and shellfish beds at depths up to 120 feet (37 meters) (ASMFC, 2021). Juveniles utilize vegetated estuaries or inshore areas (ASMFC, 2021).	Potential occurrence in Offshore Project Area, likely around shipwrecks, a majority of which are located along the outer boundaries of the Offshore Project Area, and the two artificial reefs, located along the outside boundary of the WTA and Monmouth ECC.
Weakfish (*Cynoscion regalis*)	Adults utilize offshore environments in the winter, and nearshore bays, sounds, and estuaries in the spring for spawning (ASMFC, 2021). While inshore, adults and juveniles can be found along the periphery of eelgrass beds (ASMFC, 2021).	Potential occurrence throughout the Offshore Project Area for adults during winter. Occurrence of adult weakfish during spring is not expected due to the absence of bays, sounds, and estuaries in the Offshore Project Area. Occurrence of juvenile weakfish are not anticipated due to the absence of eelgrass beds in the Offshore Project Area.
Invertebrates		
Blue Crab *(Callinectes sapidus*)	Utilizes grasses and oyster reefs, ranging from shallow brackish water to deeper, saltier water (NOAA, 2021b). Blue crab larvae are free-floating and enter the ocean via currents (CBP, 2021)	Potential occurrence in the nearshore areas of the ECCs; however, there are no documented underwater grasses in the Offshore Project Area.
Blue Mussel (*Mytilus edulis*)	Utilizes intertidal shallow waters attached to rocks, pilings, shells, or other solid objects (URI, 2021). Blue mussel larvae drift through water column for one to two months before settling.	Potential occurrence in Offshore Project Area, particularly in nearshore regions of the Atlantic and Monmouth ECC, or around artificial reefs, shipwrecks and other hard structures/ substrates.
Eastern Oyster (*Crassostrea virginica*)	Utilizes brackish and salty waters between 8 to 35 feet (2.4 to 10.6 meters)) deep, often concentrated in beds and forming dense reefs (CBP, 2021). Eggs and larvae are free-swimming, and adults are sessile (CBP, 2021)	Potential occurrence in the nearshore reaches of the Atlantic and Monmouth ECC. Occurrence of eastern oyster is not expected in the WTA due to depth thresholds.
Horseshoe Crab (*Limulus polyphemus*)	Utilizes inshore sandy substrates during spring spawning, then migrates to deeper estuarine and continental shelf habitats during fall (ASMFC, 2015). Juveniles can be found nearshore for the first two years of their life (ASMFC, 2021).	Potential occurrence throughout the Offshore Project Area.
Soft-Shell Clam (*Mya arenaria*)	Utilizes sandy or muddy substrate in bays and estuaries ((URI, 2021).	Occurrence unlikely due to the absence of bays and estuaries in the Offshore Project Area.

[1] Occurrence in the Offshore Project Area is based on NEFSC and NJDEP OSAP trawl results and known habitat requirements.

6.0 ESSENTIAL FISH HABITAT SUMMARY BY LIFE STAGE AND HABITAT

The extent that EFH and EFH-designated species may be affected by Project construction, installation, O&M, and decommissioning activities is based in part on the habitat type and life stage of the organism at the time of various Project activities. The following sections categorize species into groups by presence near the seafloor (benthic/demersal) or in the water column (pelagic) as well as life stage (egg, larvae, juvenile, adult) to assist in evaluating effects. A summary of the species and life stages with the greatest potential to be affected by Project activities is presented in Section 6.5; these species and their EFH are the focus of the more detailed assessment of potential Project effects to EFH and EFH species presented in Section 7.0.

6.1 Early Pelagic Life Stages

Table 6 summarizes early (eggs and larvae) pelagic life stages of species that have designated EFH within the Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC, as defined by NOAA's EFH Mapper database. The table also indicates the percentage of mapped EFH within each of these portions of the Offshore Project Area.

Table 6. Early Pelagic Life Stages of Species with Designated EFH Mapped in the Offshore Project Area

Species with Early Pelagic Life Stages	Eggs					Larvae/Neonate				
	Percent Mapped EFH within Areas					Percent Mapped EFH within Areas				
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC
Finfish										
Atlantic Butterfish	4%	---	---	---	32%	81%	50%	88%	37%	32%
Atlantic Cod	25%	---	---	69%	15%	10%	20%	9%	---	56%
Atlantic Mackerel	67%	69%	97%	---	32%	57%	50%	88%	---	15%
Black Sea Bass	---	---	---	---	---	67%	69%	97%	---	36%
Bluefish	10%	19%	9%	33%	18%	92%	69%	97%	37%	50%
Monkfish	75%	100%	100%	63%	82%	75%	100%	100%	63%	82%
Pollock	---	---	---	---	---	---	---	---	---	24%
Red Hake	96%	100%	100%	100%	100%	96%	100%	100%	100%	100%
Silver Hake	100%	69%	98%	100%	92%	100%	69%	98%	100%	92%
Summer Flounder	10%	19%	9%	33%	18%	14%	19%	9%	34%	36%
Windowpane Flounder	96%	69%	97%	93%	55%	2%	69%	97%	56%	56%
Winter Flounder*	1%	--	---	---	---	2%	2%	1%	.049%	88%
Witch Flounder	92%	69%	97%	69%	18%	67%	69%	97%	---	18%
Yellowtail Flounder	92%	69%	97%	69%	32%	67%	69%	97%	33%	38%
Highly Migratory Species – Sharks										
Common Thresher Shark	---	---	---	---	---	100%	100%	100%	94%	100%
Dusky Shark**	---	---	---	---	---	100%	100%	100%	94%	100%
Shortfin Mako Shark	---	---	---	---	---	68%	100%	100%	---	58%
White Shark**	---	---	---	---	---	53%	88%	25%	91%	98%

* Winter flounder larvae are initially pelagic and then settle to the bottom where they metamorphose to juveniles.

** Dusky shark and white shark have neonate life stages designated in the Offshore Project Area; however, neonate sharks are considered more similar to the juvenile life stage than the larval life stages for this analysis.

6.2 Late Pelagic Life Stages

Table 7 summarizes late (juvenile and adult) pelagic life stages of species that have designated EFH within the Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC, as defined by NOAA's EFH Mapper database. The table also indicates the percentage of mapped EFH within each of these portions of the Offshore Project Area.

Table 7. Late Pelagic Life Stages of Species with Designated EFH Mapped in the Offshore Project Area

Species with Late Pelagic Life Stages	Juveniles					Adults				
	Percent Mapped EFH within Areas					Percent Mapped EFH within Areas				
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC
Finfish										
Atlantic Butterfish	100%	100%	100%	94%	100%	96%	69%	97%	94%	92%
Atlantic Herring	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Atlantic Mackerel	67%	100%	100%	---	59%	96%	100%	100%	69%	58%
Bluefish	39%	19%	9%	71%	51%	100%	100%	100%	71%	77%
Silver Hake*	---	---	---	---	---	57%	49%	88%	---	74%
Spiny Dogfish	---	---	---	---	---	100%	100%	100%	90%	100%
Invertebrates										
Longfin Inshore Squid	100%	100%	100%	94%	100%	100%	69%	97%	94%	92%
Northern Shortfin Squid	67%	69%	97%	---	86%	---	---	---	---	---
Highly Migratory Species - Tunas										
Albacore Tuna	---	---	---	---	44%	---	---	---	---	---
Bluefin Tuna	100%	100%	100%	39%	100%	---	---	---	---	31%
Skipjack Tuna	92%	100%	100%	4%	92%	100%	100%	100%	94%	100%
Yellowfin Tuna	100%	100%	100%	94%	58%	---	---	---	---	---
Highly Migratory Species - Sharks										
Blue Shark	4%	24%	8%	---	7%	4%	24%	8%	---	7%
Common Thresher Shark	100%	100%	100%	94%	100%	100%	100%	100%	94%	100%
Dusky Shark	93%	100%	100%	4%	92%	93%	100%	100%	4%	92%
Shortfin Mako Shark	68%	100%	100%	---	58%	68%	100%	100%	---	58%
Tiger Shark	100%	100%	100%	94%	100%	100%	100%	100%	94%	100%
White Shark	---	---	---	---	45%	---	---	---	---	45%

* Silver hake adult EFH is defined as pelagic and benthic habitats.

6.3 Early Benthic or Demersal Life Stages

Table 8 summarizes early (eggs and larvae) benthic or demersal life stages that have designated EFH within the Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC, as defined by NOAA's EFH Mapper database. The table also indicates the percentage of field-mapped benthic habitat delineations (soft bottom and complex and/or heterogenous complex) applicable to each species that are within designated EFH for these portions of the Offshore Project Area. A description of the preferred habitat for each species or life stage is also included. The detailed benthic habitat maps that support this summary are included as Attachments 2 and 3 to this EFH Assessment

The most dominant sediment type in the Offshore Project Area, except for the Monmouth ECC, is soft bottom habitat (Table 3). As shown in Table 8, only three species have benthic or demersal early life stages with EFH that prefer or utilize soft bottom habitat. These include winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs. For the portions of the Offshore Project Area that consist of complex or heterogenous complex bottom habitat (Table 3), four species have early life stages with EFH that are known to utilize this habitat type including ocean pout eggs, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs (Table 8). Winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae and longfin inshore squid eggs can also be found on soft bottom habitats. The complex habitat in the Offshore Project Area consists mainly of gravelly sand and occurs primarily in the Monmouth ECC. No large-grained (equal to or greater than 80% gravel) occurs in the Offshore Project Area (Table 3). Although sand tiger shark and sandbar shark have neonate life stages designated in the Offshore Project Area that utilize both sandy, muddy, and rocky habitats, neonate sharks are considered more similar to the juvenile life stage than the larval life stage in terms of mobility and capability of avoiding Project activities and are evaluated in Section 6.4.

Table 8. Percentage of Field-Mapped NMFS Habitat Categories within Designated EFH for Early Benthic/Demersal Life Stages in the Offshore Project Area

Species with Early Benthic Life Stages	Eggs					Larvae/Neonate					Description of Preferred Habitat
	Percent Field-Mapped Habitat Categories within Designated EFH					Percent Field-Mapped Habitat Categories within Designated EFH					
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	
Finfish											
Ocean Pout *											Eggs: Hard bottom habitats – sheltered nests, holes, and crevices.
Complex and/or Heterogenous	18%	22%	13%	19%	74%	---	---	---	---	---	
Winter Flounder**											Eggs: Bottom habitats with substrate of mud, muddy sand, sand, gravel, macroalgae, and submerged aquatic vegetation. Larvae: Pelagic and bottom waters.
Soft bottom	26%	---	---	84%	33%	17%	24%	15%	---	24%	
Complex and/or Heterogenous	12%	---	---	15%	65%	8%	45%	8%	---	76%	
Invertebrates											
Atlantic Sea Scallop											Eggs and Larvae: Hard surfaces for pelagic larvae to settle, including shells, pebbles, and gravel. Larvae also attach to macroalgae and other benthic organisms such as hydroids.
Soft bottom	32%	50%	35%	---	31%	32%	50%	35%	---	31%	
Complex and/or Heterogenous	40%	26%	15%	---	69%	40%	26%	15%	---	69%	
Longfin Inshore Squid											Eggs: Egg masses or "mops" are laid on a variety of substrates, including hard bottom (shells, lobster pots, fish traps, boulders, and rocks), SAV (e.g., *Fucus*), sand, and mud
Soft bottom	35%	---	---	98%	21%	---	---	---	---	---	
Complex and/or Heterogenous	8%	---	---	<1%	78%	---	---	---	---	---	
Highly Migratory Species – Sharks* **											
Sand Tiger Shark											Neonate: Rocky, sand and mud substrate or in areas surrounding Cape Lookout that contain benthic structure
Soft bottom	---	---	---	---	---	28%	34%	41%	89%	25%	
Complex and/or Heterogenous	---	---	---	---	---	21%	28%	1%	10%	75%	
Sandbar Shark											Neonate: Sand, mud, shell, and rocky sediments/benthic habitats. Sandbar shark HAPC is designated in shallow areas in sand, mud, shell, and rocky habitats. All life stages tend to swim, associate, and feed near the bottom.
Soft bottom	---	---	---	---	---	31%	53%	45%	89%	27%	
Complex and/or Heterogenous	---	---	---	---	---	17%	22%	7%	10%	73%	

* Percentage of mapped soft bottom habitat not reported since this species prefers hard bottom habitat.

**Winter flounder larvae are initially pelagic and then settle to the bottom where they metamorphose to juveniles.

*** Sand tiger shark and sandbar shark have neonate life stages designated in the Offshore Project Area; however, neonate sharks are considered more similar to the juvenile life stage than the larval life stages for this analysis.

6.4 Late Benthic or Demersal Life Stages

Table 9 summarizes late (juvenile and adult) benthic or demersal life stages that have designated EFH within the Project 1 and Project 2 WTAs, Overlap Area, Atlantic ECC, and Monmouth ECC, as defined by NOAA's EFH Mapper database. The table also indicates the percentage of field-mapped benthic habitat delineations (soft bottom and complex and/or heterogenous complex) applicable to each species that are within designated EFH for these portions of the Offshore Project Area. A description of the preferred habitat for each species or life stage is also included. The detailed benthic habitat maps that support this summary are included as Attachments 2 and 3 to this EFH Assessment.

The most dominant habitat type in the Offshore Project Area, with the exception of the Monmouth ECC, is soft bottom habitat (Table 3). As shown inTable 9, only two species have more sensitive sessile benthic later life stages with EFH that prefer soft bottom habitat. These include Atlantic surfclam juveniles and adults and ocean quahog juveniles and adults. The remaining species are mobile benthic or demersal later life stages that can temporarily leave the area during Project activities. Approximately 24 species have mobile benthic or demersal later life stages with EFH in the Offshore Project Area that prefer or utilize soft bottom habitat and approximately 19 species have mobile benthic or demersal later life stages that utilize complex habitats (hard bottom, rocky, or gravel substrates) (Table 9); however, these species are not limited to complex habitats and also utilize soft bottom habitat. The complex habitat in the Offshore Project Area consists mainly of gravelly sand and occurs primarily in the Monmouth ECC. No large-grained (equal to or greater than 80% gravel) occurs in the Offshore Project Area.

Table 9. Percentage of Field-Mapped NMFS Habitat Categories within Designated EFH for Late Benthic/Demersal Life Stages in the Offshore Project Area

Species with Late Benthic Life Stages	Juveniles: Percent Field-Mapped Habitat Categories within Designated EFH					Adults: Percent Field-Mapped Habitat Categories within Designated EFH					Description of Preferred Habitat
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	
Finfish											
Atlantic Cod											<u>Adults:</u> Bottom habitats with a substrate of cobble, gravel, or boulders. Also found on sandy substrates.
Soft bottom	---	---	---	---	---	36%	---	---	---	27%	
Complex and/or Heterogenous	---	---	---	---	---	4%	---	---	---	73%	
Black Sea Bass											<u>Juveniles</u>: Rough bottom, shellfish and eelgrass beds, man-made structures in sandy shelly areas; offshore clam beds and shell patches may also be used during the wintering. <u>Adult</u>: Structured habitats (natural and man-made), sand and shell are usually the substrate preference.
Soft bottom	32%	57%	47%	88%	16%	32%	51%	45%	88%	25%	
Complex and/or Heterogenous	18%	17%	13%	12%	83%	18%	22%	13%	12%	74%	
Haddock											<u>Juveniles</u>: Young-of-the-year juveniles settle on sand and gravel but are found predominantly on gravel pavement areas. As they grow, they disperse over a greater variety of substrate types.
Soft bottom	34%	58%	47%	---	37%	---	---	---	---	---	
Complex and/or Heterogenous	18%	19%	12%	---	63%	---	---	---	---	---	
Monkfish											<u>Adults</u>: Bottom habitats with substrates of hard sand, pebble, gravel, broken shells, and soft mud.
Soft bottom	---	---	---	---	---	---	57%	47%	---	4%	
Complex and/or Heterogenous	---	---	---	---	---	---	17%	13%	---	95%	
Ocean Pout											<u>Adults</u>: Mud and sand, particularly in association with structure forming habitat types; i.e. shells, gravel, or boulders.
Soft bottom	---	---	---	---	---	31%	51%	45%	81%	25%	
Complex and/or Heterogenous	---	---	---	---	---	18%	22%	13%	19%	74%	

Species with Late Benthic Life Stages	**Juveniles**					**Adults**					**Description of Preferred Habitat**
	Percent Field-Mapped Habitat Categories within Designated EFH					**Percent Field-Mapped Habitat Categories within Designated EFH**					
	Project 1 WTA	**Project 2 WTA**	**Overlap Area**	**A. ECC**	**M. ECC**	**Project 1 WTA**	**Project 2 WTA**	**Overlap Area**	**A. ECC**	**M. ECC**	
Red Hake											Juveniles: Intertidal and sub-tidal benthic habitats on mud and sand substrates. Bottom habitats providing shelter, including mud substrates with biogenic depressions, substrates providing biogenic complexity (e.g., eelgrass, macroalgae, shells, anemone and polychaete tubes), and artificial reefs. Newly settled juveniles occur in depressions on the open seabed. Older juveniles are commonly associated with shelter or structure and often inside live bivalves. Adults: Shell beds, soft sediments (mud and sand), and artificial reefs. Usually found in depressions in softer sediments or in shell beds and not on open sandy bottom.
Soft bottom	32%	54%	45%	89%	31%	32%	50%	35%	90%	34%	
Complex and/or Heterogenous	18%	22%	13%	10%	69%	11%	26%	15%	10%	66%	
Scup											Juveniles: Various sands, mud, mussel and eelgrass bed type substrates Adults: Demersal waters in estuaries
Soft bottom	32%	57%	47%	87%	26%	32%	54%	45%	85%	31%	
Complex and/or Heterogenous	18%	17%	13%	12%	74%	17%	22%	13%	15%	69%	
Silver Hake*											Adult: Bottom depressions or in association with sandwaves and shell fragments. They have also been observed at high densities in mud habitats bordering deep boulder reefs, resting on boulder surfaces, and foraging over deep boulder reefs.
Soft bottom	---	---	---	---	---	34%	57%	47%	---	21%	
Complex and/or Heterogenous	---	---	---	---	---	18%	17%	13%	---	78%	
Spiny Dogfish											Adults: Pelagic and epibenthic habitats throughout the region
Soft bottom	---	---	---	---	---	32%	32%	27%	54%	18%	
Complex and/or Heterogenous	---	---	---	---	---	17%	13%	10%	6%	41%	

Species with Late Benthic Life Stages	Juveniles Percent Field-Mapped Habitat Categories within Designated EFH					Adults Percent Field-Mapped Habitat Categories within Designated EFH					Description of Preferred Habitat
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	
Summer Flounder											Juveniles: Prefer sandy substrates. Also salt marsh creeks, seagrass beds, mudflats, and open bay areas. Adults: Prefer sandy substrates. Also shallow coastal and estuarine waters during warmer months and move offshore on the outer continental shelf at depths of 500 feet (152 meters) in colder months.
Soft bottom	32%	57%	47%	88%	17%	32%	54%	45%	89%	31%	
White Hake											Adult: Fine-grained, muddy substrates and in mixed soft and rocky habitats.
Soft bottom	---	---	---	---	---	---	60%	59%	---	55%	
Complex and/or Heterogenous	---	---	---	---	---	---	22%	9%	---	45%	
Windowpane Flounder											Adults and Juveniles: Bottom habitats with a substrate of mud or sand.
Soft bottom	32%	50%	45%	89%	25%	32%	54%	45%	89%	31%	
Winter Flounder											Juveniles: Variety of bottom types such as mud, sand, rocky substrates with attached macroalgae, tidal wetlands, and eelgrass. YOY juveniles found inshore on muddy and sandy sediments in and adjacent to eelgrass and macroalgae, in bottom debris, and in marsh creeks. They tend to settle to the bottom in soft-sediment depositional areas and disperse into coarser-grained substrates as they get older. Adults: Muddy and sandy substrates, and on hard bottom on offshore banks.
Soft bottom	17%	24%	15%	---	24%	17%	24%	15%	---	24%	
Complex and/or Heterogenous	8%	44%	7%	---	76%	8%	45%	8%	---	76%	
Witch Flounder											Adult: Mud and muddy sand substrates
Soft bottom	---	---	---	---	---	31%	54%	45%	81%	53%	

Species with Late Benthic Life Stages	Juveniles					Adults					Description of Preferred Habitat
	Percent Field-Mapped Habitat Categories within Designated EFH					Percent Field-Mapped Habitat Categories within Designated EFH					
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	
Yellowtail Flounder											<u>Juveniles</u>: Sand and muddy sand. <u>Adults</u>: Sand and sand with mud, shell hash, gravel, and rocks.
Soft bottom	31%	54%	45%	81%	29%	32%	50%	35%	---	31%	
Complex and/or Heterogenous	N/A	N/A	N/A	N/A	N/A	9%	26%	15%	---	69%	
Skates											
Clearnose Skate											<u>Juveniles and Adults</u>: Mud and sand, but also on gravelly and rocky bottom.
Soft bottom	32%	51%	45%	89%	25%	32%	51%	45%	89%	25%	
Complex and/or Heterogenous	18%	22%	13%	10%	75%	18%	22%	13%	10%	74%	
Little Skate											<u>Juveniles and Adults</u>: Bottom habitats with a sandy or gravelly substrate or mud.
Soft bottom	32%	54%	45%	89%	31%	32%	57%	47%	88%	12%	
Complex and/or Heterogenous	18%	22%	13%	10%	69%	18%	17%	13%	12%	88%	
Winter Skate											<u>Juveniles and Adults</u>: Bottom habitats with a substrate of sand and gravel or mud.
Soft bottom	32%	54%	45%	89%	31%	34%	58%	47%	93%	29%	
Complex and/or Heterogenous	18%	22%	13%	10%	69%	16%	19%	12%	6%	71%	
Invertebrates											
Atlantic Sea Scallop											<u>Juveniles</u>: Bottom habitats with a substrate of shells, gravel, and small rocks (pebble, cobble), preferring gravel. <u>Adults</u>: Bottom habitats with sand and gravel substrates.
Soft bottom	N/A	N/A	N/A	N/A	N/A	32%	50%	35%	---	31%	
Complex and/or Heterogenous	9%	26%	15%	---	69%	9%	26%	15%	---	69%	
Atlantic Surfclam											<u>Juveniles and Adults</u>: Prefers well-sorted medium and fine sandy substrates.
Soft bottom	32%	54%	45%	85%	31%	32%	54%	45%	85%	31%	
Ocean Quahog									---		<u>Juveniles and Adults</u>: Prefers medium to fine sandy bottom.
Soft bottom	36%	---	---	---	---	36%	23%	59%	---	95%	

Species with Late Benthic Life Stages	Juveniles Percent Field-Mapped Habitat Categories within Designated EFH					Adults Percent Field-Mapped Habitat Categories within Designated EFH					Description of Preferred Habitat
	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	Project 1 WTA	Project 2 WTA	Overlap Area	A. ECC	M. ECC	
Highly Migratory Species - Sharks											
Sand Tiger Shark											Juveniles: Sand, mud, and rocky substrates. Coastal and shallow bays; generally near bottom.
Soft bottom	28%	34%	41%	89%	25%	---	---	---	---	---	
Complex and/or Heterogenous	22%	28%	1%	10%	75%	---	---	---	---	---	
Sandbar Shark											Juveniles and Adults: Sand, mud, shell, and rocky sediments/benthic habitat.
Soft bottom	32%	54%	45%	89%	31%	32%	54%	45%	89%	31%	
Complex and/or Heterogenous	18%	22%	7%	10%	69%	18%	22%	7%	10%	69%	
Smoothhound Shark Complex (Atlantic Stock)											Juveniles and Adults: Near or on the bottom.
Soft bottom	32%	54%	45%	89%	31%	32%	54%	45%	89%	31%	
Complex and/or Heterogenous	18%	22%	7%	10%	69%	18%	22%	7%	10%	69%	

* Silver hake adult EFH is defined as pelagic and benthic habitats.

6.5 Summary of Effects to EFH Life Stages and Habitat Types

As demonstrated in Tables 6 and 7, many of the species with designated EFH in the Offshore Project Area have a completely pelagic lifestyle and most species have pelagic early life histories (Table 6) and are not dependent on benthic habitat. These species are expected to experience negligible impacts to their EFH as the pelagic zone will not be directly affected by most Project activities. Given their mobile nature, pelagic juvenile and adult life stages (Table 7) should largely avoid the areas affected by Project disturbance and are expected to return shortly after activities cease in a given location.

For most Project activities, early life stages of EFH species that are benthic or demersally-oriented (Table 8) or later life stages of benthic -oriented sessile species (Table 9) are subject to the greatest potential effects (injury or mortality) from temporary disturbance to their EFH. Mobile benthic or demersal later life stages of EFH species (Table 9) may also experience temporary effects to EFH; however, impacts to individual species are expected to be less than those for eggs and larvae since these older life stages are mobile and can temporarily leave the area during Project activities.

As stated in Section 3.0, the Offshore Project Area consists primarily of fine, medium, and gravelly sand and includes seabed features (e.g., ripples and mega ripples) indicative of a dynamic system where species are adapted to periodic disturbances. Only three species (winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs) have sensitive benthic or demersal early life stages (Table 8) and two species (Atlantic surfclam juveniles and adults and ocean quahog juveniles and adults) have sensitive sessile benthic later life stages (Table 9) with EFH that prefer soft bottom habitat. The remaining species that prefer soft bottom habitat are mobile benthic or demersal later life stages (Table 9) and can temporarily leave the area during Project activities. As described further in Section 7.0, the EFH and EFH species in these dynamic areas are adapted to periodic disturbances (Guida et al., 2017) similar to those associated with Project activities and tend to recover quickly from disturbances.

EFH and EFH -designated species that rely on sensitive habitat areas such as hard bottom habitats, could experience longer-term effects from Project activities; however, as stated in Section 3.0, most of the complex habitat in the Offshore Project Area consists of gravelly sand with no large-grained complex habitat. Most of the gravelly sand occurs throughout the Monmouth ECC, with small portions located in the WTA. In addition, only four species (ocean pout eggs, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs) have the most sensitive early life stages with EFH that utilize complex habitats (Table 8). Of these species, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs may also be found in soft bottom habitat. The remaining species that may utilize complex habitat are mobile benthic or demersal later life stages (Table 9) that can temporarily leave the area during Project activities.

Section 7.0 provides a complete assessment of potential Project effects on these EFH and EFH-designated species in the Offshore Project Area.

7.0 ASSESSMENT OF POTENTIAL EFFECTS

Effects to EFH and EFH species from Project construction, operation and decommissioning activities are expected to be temporary, localized and not result in population effects. This section addresses potential species effects – direct and indirect - of each Project phase on EFH and EFH-designated species in the Offshore Project Area. These effects include:

- Temporary disturbance or displacement of habitat for marine resources;
- Direct mortality or injury to marine species;
- Habitat conversion and creation;
- Disturbance or injury of marine species through Project-related noise;
- Direct or indirect effects on marine species through Project-related EMFs; and
- Direct or indirect effects on marine species through Project-related lighting.

The following sections discuss each of these effects as they relate to construction, operation, and decommissioning based on the maximum PDE for the offshore build-out of the Projects as defined in Section 2.2.7, including the use of piled foundations to support the assessment of underwater noise. The Project activity and characteristics (e.g., timing, duration, extent, intensity) of each potential effect on EFH and/or EFH species as well as the environmental measures Atlantic Shores will implement during each Project phase to avoid, minimize, and/or mitigate effects to the maximum extent practicable are addressed in Sections 7.1 through 7.6. A complete summary of environmental protection measures is also provided in Section 8.0.

7.1 Temporary Direct Habitat Loss and Disturbance

This section focuses on the temporary direct disturbances to EFH and EFH species that will primarily occur during the construction phase. Section 7.4, Habitat Conversion and Creation, addresses permanent seafloor disturbance from the footprints of foundations, scour protection, and offshore cable protection that will result in habitat conversion of primarily sandy substrate to hard substrate. The O&M phase is expected to have significantly lower seafloor disturbance than Project construction. During O&M, Project components will be monitored as described in Volume I, Section 5.0 of the COP. If portions of buried offshore cables require maintenance, the sediment cover may need to be removed temporarily for inspection and possible replacement of a portion of the cable. These activities would temporarily disturb the seafloor but would be short-term and extremely localized. The decommissioning phase is expected to have similar, but less seafloor disturbance than Project construction.

Seafloor-disturbing activities during construction of the WTG and OSS foundations include jack-up vessel positioning and anchoring, seabed preparation, foundation placement, and scour protection installation. Seabed preparation may be required for gravity-based foundations or in areas with large sand bedforms. Seafloor-disturbing activities during installation of the offshore cables include anchoring, pre-installation activities (e.g., sand bedform removal, boulder relocation, and pre-lay grapnel run), offshore cable installation, cable protection installation, where needed, and excavation of the offshore HDD pit. Detailed methodologies for conducting these activities are described in Volume I, Section 4.0 of the COP.

The maximum area of seabed disturbance associated with these activities in the Offshore Project Area is summarized in Table 2. A summary of the number of square miles of each NMFS habitat type that may be disturbed for various project activities in the WTA and ECCs, including the total impacts in the WTA and ECCs for the combined Projects, is provided in Table 10. Based on the range of activities in the Project lifecycle associated with the maximum case PDE, the total area of temporary seafloor disturbance (not including the area of the seafloor that will be permanently occupied by structures or cables [Section 7.4]) for the WTA of the combined Projects (i.e., inclusive of the Project 1 WTA, Project 2 WTA and Overlap Area) is approximately 4.43 square miles, with 69% of impacts occurring to soft bottom habitat, 10% to heterogenous habitat, and 21% to complex habitat. Table 10 also provides the square miles of temporary disturbance for Project 1 and Project 2, individually, both of which include the full Overlap Area in order to provide the most conservative estimations of impacts. Temporary seafloor disturbance in the Project 1 and Project 2 WTAs is approximately 2.33 square miles and 2.18 square miles, respectively. Of the temporary impacts occurring in the Project 1 WTA, approximately 64% will result in disturbance to soft sediment, while the remaining 10% and 26% of temporary disturbance will occur in heterogenous and complex habitat, respectively. Within the Project 2 WTA, approximately 68% of the total temporary disturbance will occur to soft bottom habitat, while the remaining 8% and 24% will occur to heterogenous and complex habitats, respectively.

The Atlantic and Monmouth ECC from the landfall to the WTA boundary will result in a total temporary impact of approximately 0.83 square miles and 2.26, square miles respectively. Within the Atlantic ECC, approximately 90% of temporary impacts will occur to soft bottom habitat, while 1% occurs to heterogenous habitat and 9% occurs to complex habitat. Given that the Monmouth ECC contains a greater presence of complex habitat, approximately 69% of the total temporary impacts within the ECC will occur to complex habitat, while approximately 31% of the temporary impacts will occur to soft bottom habitat and less than 1% will occur to heterogenous habitat. These estimated areas of temporary disturbance are small relative to the total area of available surrounding habitat in the WTA and ECCs.

In addition to impacts in the offshore environment, the Cardiff Onshore Interconnection Cable Route will traverse tidal wetland habitat which contains a mixture of *Phragmites* and *Spartina* species. Tidal wetlands provide habitat for invertebrate and fish species, particularly in the juvenile stage (NYSDEC, 2021). Though tidal wetlands exist along the Cardiff Onshore Interconnection Cable Route, impacts will be avoided through the use of HDD. The use of HDD allows Atlantic Shores to avoid approximately 51.2 acres of impacts to tidal wetlands. Atlantic Shores will also implement an Inadvertent Return Plan to minimize potential impacts from HDD activities (See Volume II, Section 4.1 of the COP for more detail on wetland habitat).

Table 10: Estimated Temporary and Permanent Disturbance to NMFS Habitat Types[1]

Installation Activity	Temporary Impact (square miles)			Permanent Impact (square miles)		
	Soft	Heterogenous	Complex	Soft	Heterogenous	Complex
Project 1						
Project 1 WTA[2]						
WTG Foundation Installation (including scour protection)	0.249	0.042	0.079	0.370	0.062	0.118
WTG Installation and Commissioning	0.054	0.009	0.017	N/A	N/A	N/A
OSS Foundation Installation (Including Scour Protection), Topside Installation, and Commissioning	0.013	0.002	0.004	0.013	0.002	0.004
Inter-Array Cable Installation (Including Cable Protection)	0.983	0.165	0.312	0.148	0.025	0.047
Inter-Link Cable Installation (Including Cable Protection)	0.087	0.015	0.028	0.013	0.002	0.004
Metocean Buoy Installation	0.013	0.002	0.004	N/A	N/A	N/A
Export Cable in WTA						
Atlantic ECC	0.242	0.002	0.025	0.036	0.000	0.004
Monmouth ECC	0.078	0.000	0.172	0.012	0.000	0.028
Subtotal - Project 1 WTA[3]	**1.478**	**0.235**	**0.617**	**0.558**	**0.092**	**0.201**
Project 1 ECCs						
Atlantic ECC to WTA	0.745	0.007	0.078	0.054	0.001	0.006
Monmouth ECC to WTA	0.703	0.002	1.557	0.100	0.000	0.220
Project 2						
Project 2 WTA[2]						
WTG Foundation Installation (including scour protection)	0.190	0.024	0.047	0.277	0.035	0.068
WTG Installation and Commissioning	0.037	0.005	0.009	N/A	N/A	N/A
OSS Foundation Installation (Including Scour Protection),	0.015	0.002	0.004	0.015	0.002	0.004

Installation Activity	Temporary Impact (square miles)			Permanent Impact (square miles)		
	Soft	Heterogenous	Complex	Soft	Heterogenous	Complex
Topside Installation, and Commissioning						
Inter-Array Cable Installation (Including Cable Protection)	1.066	0.133	0.261	0.161	0.020	0.039
Inter-Link Cable Installation (Including Cable Protection)	0.095	0.012	0.023	0.015	0.002	0.004
Metocean Buoy Installation	0.004	0.000	0.001	N/A	N/A	N/A
Export Cable in WTA						
Atlantic ECC	0.242	0.002	0.025	0.036	0.000	0.004
Monmouth ECC	0.078	0.000	0.172	0.012	0.000	0.028
Subtotal -Project 2 WTA[3]	**1.483**	**0.175**	**0.517**	**0.480**	**0.058**	**0.142**
Project 2 ECCs						
Atlantic ECC to OSS	0.745	0.007	0.078	0.054	0.001	0.006
Monmouth ECC to OSS	0.703	0.002	1.557	0.100	0.000	0.220
Maximum Total For Both Projects[4]						
Max. Total Seabed Disturbance in the WTA	**3.035**	**0.456**	**0.939**	**0.959**	**0.144**	**0.297**
Max. Total Seabed Disturbance in the ECCs[5]	**1.447**	**0.010**	**1.635**	**0.153**	**0.001**	**0.226**

[1] Impacts to NMFS habitat types were calculated using proportional percentages of sediment types within each Project component area rather than on a specific locational basis. First, total acres of each habitat type were calculated within the Project 1 WTA, Project 2 WTA, Atlantic ECC, and Monmouth ECC. Next, the acres of each habitat type were divided by the total surveyed area in each Project component area to yield a percent of each habitat type in each Project component area. Lastly, these percentages were applied to the temporary and permanent footprint of each installation activity.

[2] In order to provide conservative estimations of impacts, the Overlap Area was included in both Project 1 WTA and Project 2 WTA impact calculations.

[3] While Project 1 and Project 2 could use either the Atlantic or Monmouth ECC, the subtotal for the Project 1 and Project 2 WTAs assumes seabed disturbance from the installation of four export cables within the Monmouth ECC, as that is the scenario that represents the maximum case for disturbance. It should also be noted that only a portion of the Monmouth ECC is included in the subtotal for the Project 1 and Project 2 WTAs, as only a small portion of the ECC is located in the WTA. The remaining impacts from the Monmouth ECC is included in the Project 1 and Project 2 ECC calculations.

[4] The Maximum Total Impact for Both Projects is not the sum of the WTA and ECC impacts for the individual projects (i.e,, Project 1 and Project 2). Calculations for both Project 1 and Project 2 include the Overlap Area, as well as the Atlantic and Monmouth ECCs. Summing the Project 1 and Project 2 totals would result in a significant overestimation of impacts. Therefore, a separate analysis was conducted that examined the WTA as a whole and the two ECCs.

[5] While Project 1 and Project 2 could use either the Atlantic or Monmouth ECC, the ‘Project 1 Total’ and ‘Project 2 Total’ only assume seabed disturbance from the installation of four export cables within the Monmouth ECC (minus the portion of the ECC which crosses the WTA), as the installation of the Monmouth ECC would result in the largest impacts compared to the Atlantic ECC.

Given the dynamic nature of sediment processes in the Offshore Project Area, Project seabed disturbing activities are expected to create only temporary and localized alterations to the seafloor habitat. The benthic community associated with the fine, medium, and gravelly sand that dominates the Offshore Project Area is expected to rapidly recover following construction (Brooks et al., 2004; Guarinello et al., 2017; Guida et al., 2017). A review of studies of the recovery and recolonization along the U.S. East Coast by Brooks et al. (2004) reported that recovery of benthic assemblages to background levels following dredging disturbance can range from three months to two and a half years with recovery time dependent on site-specific taxa, type of sediment disturbance, and environmental conditions. BOEM (2021) reported that benthic assemblages subjected to physical disturbance in soft sediment communities typically recover in 6 to 18 months through dispersal from adjacent areas, assuming the affected area is not disturbed during the recolonization period. Therefore, Project-related seabed disturbance is unlikely to result in long-term adverse effects on EFH or displacement of EFH species because these habitats have persisted through natural and anthropogenic disturbances (e.g., vessel traffic and fishing activities) and the EFH and EFH species in these dynamic areas are adapted to disturbances similar to those associated with Project activities.

For those locations in the Offshore Project Area identified by site-specific surveys as complex habitat, the installation and maintenance of new structures, cables, and associated vessel anchoring and jacking activities could result in longer-term effects to EFH because complex habitats are reported to have longer recovery times than areas with soft sediment (HDR 2020). As provided in Table 10, the total temporary impact to complex habitat from installation activities for the combined Projects is estimated to be approximately 0.94 and 1.63 square miles in the WTA and ECCs, respectively. The total temporary impact for the combined Projects to heterogenous habitat is estimated to be approximately 0.46 and 0.01 square miles in the WTA and ECCs, respectively. A majority of these impacts will occur within the Monmouth ECC, which contains more complex habitat than the Atlantic ECC or WTA. However, the complex habitat in the Offshore Project Area consists mainly of gravelly sand which is common in the region (NEFSC, 2021). No large-grained sediment (equal to or greater than 80% gravel) occurs in the Offshore Project Area. Mapped complex habitat in the Offshore Project Area is displayed in Attachments 2 and 3 to this EFH Assessment and in Volume II, Appendix II-A1 of the COP. Additionally, Section 6 of this Report provides context regarding the percentage of mapped complex habitat in designated EFH. All Project activities will occur in previously surveyed areas. Atlantic Shores has selected installation tools and methods that minimize disturbance to bottom habitats, including complex habitats, to the maximum extent practicable. In addition, the Offshore Project Area does not contain any salt marshes, mud flats, coral reefs, or significant areas of submerged aquatic vegetation such as eel grass, which are considered sensitive habitat for EFH species. Atlantic Shores will further reduce impacts to hard bottom and structurally complex habitats, identified by site-specific surveys as complex habitat, through the use of anchor midline buoys and by following an anchoring plan designed to avoid impacts to these identified complex habitats to the maximum extent practicable.

Another sensitive habitat in the Offshore Project Area is the sandbar shark HAPC, part of which overlaps with the nearshore portion of the Atlantic ECC (Figure 5). The portion of the HAPC closest to the Atlantic Landfall Site will be avoided by using HDD techniques. The remaining approximately 4.7 miles (7.67 kilometers) of Atlantic ECC that traverses the HAPC will be temporarily disturbed during ECC cable installation. Specifically, offshore cable installation is anticipated to create a trench with a maximum width of up to approximately 3.3 feet (1 meter) with the installation tool's skids or tracks creating an additional 13 feet (4 meters) of surficial seabed disturbance. This results in approximately 0.01 square miles of direct seabed disturbance to sandbar shark HAPC, which is a small area in relation to the surrounding available undisturbed HAPC for sandbar shark. In addition, nearshore cable installation activities will be conducted outside of the anticipated peak period of sandbar shark nursery and pupping activity between June 1st and September 1st. Other environmental protection measures employed to minimize impacts to EFH and EFH species (e.g. cable burial, use of anchor midline buoys and anchor plan) will also contribute to minimizing impacts to sandbar shark HAPC. Atlantic Shores will coordinate with BOEM, NOAA Fisheries, and NJDEP during the EFH Consultation process to further establish mutually agreeable mitigation measures for sandbar shark HAPC, as necessary.

Most species with designated EFH in the Offshore Project Area have pelagic early life histories (eggs and larvae) (Section 6.0, Table 6) and are not dependent on benthic habitat. Therefore, modification and/or disturbance of the seafloor, including temporary sediment suspension and deposition will not substantially 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 suspension in the lower water column; however, as discussed further in Section 7.2, any sediment plume generated during Project construction is expected to be small, localized, and temporary. In addition, given their mobile nature, pelagic juvenile and adult life stages (Section 6.0,Table 7) should largely avoid these areas during the period of disturbance. During this time, these species will be able to forage in nearby areas and are expected to return soon after sediment disturbing activities are complete.

Sessile benthic species (e.g., Atlantic surfclam and ocean quahog juveniles and adults [Section 6.0, Table 9]) or species with early life stages (eggs and larvae) that are dependent on benthic habitat (e.g., ocean pout eggs, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs [Section 6.0, Table 8]) will be more susceptible to injury or mortality from seabed disturbing Project activities. Mortality of these species will most likely be limited to the direct footprint of the disturbance. These species will also be more susceptible to temporary increases in sediment suspension and deposition; however, as discussed further in Section 7.2, any sediment plume generated during Project construction is expected to be small, localized, and temporary. Any injury of mortality to these species and life stages is not expected to result in population level effects given the surrounding available habitat that will not be disturbed. The extent of impacts on the early life stages of these EFH species will also be dependent on the time of year that Project activities occur, as early life stages will only be present for short periods during specific times of year depending on the species. Therefore, the potential exposure of the most vulnerable early life stages to seabed disturbance will be limited to only their seasonal presence in the Offshore Project Area.

Mobile juvenile and adult life stages (including the neonate stage of sand tiger shark and sandbar shark) of benthic and demersal EFH species (Section 6.0, Table 6 and 8) are less likely to experience injury or mortality during seafloor disturbing activities because they are expected to temporarily leave the immediate area during these activities. By moving away from Project-related activities, mobile finfish would be able to avoid direct mortality and injury; however, they may be temporarily displaced from a portion of available habitat in the Offshore Project Area. During this time, these species will be able to forage in nearby areas and are expected to return soon after sediment disturbing activities are complete. The extent of impacts to individual older life stages of EFH species is also affected by the time of year that Project activities occur. Many species within the Offshore Project Area migrate seasonally, such as black sea bass, scup, monkfish, and spiny dogfish and use benthic habitat for only a portion of their life stage. Therefore, the potential exposure of these species to seabed disturbance will be limited to their seasonal presence in the Offshore Project Area.

Based on documented cases of habitat recolonization and recovery after significant disturbances involving benthic communities like those found in the Offshore Project Area, and the assumption that the surrounding available habitat will not be disturbed, seafloor-disturbing Project activities are not expected to result in long-term population-level effects to the resident benthic organisms and communities that support EFH and EFH species. For the combined Projects, an estimate of 4.43 and 3.09 square miles of temporary disturbance is expected to occur from installation activities in the WTA and ECCs, respectively. These areas of disturbance are fairly small compared to the entire Offshore Project Area, comprising 2.1% and 1.5% of the Offshore Project Area, and overall surrounding habitat. Although localized mortality of some benthic invertebrates is anticipated in the Offshore Project Area, impacts are not expected to be significant at the population level and would not measurably alter the environmental baseline as similarly concluded in BOEM (2021).

Environmental protection measures, such as using HDD techniques to avoid seabed disturbance impacts at the landfall sites, burying offshore cables to a target depth of 5 to 6.6 feet (1.5 to 2 meters), using installation tools that minimize seabed disturbance to the maximum extent practicable, and using anchor midline buoys and an anchoring plan, where feasible, will avoid and further minimize impacts to EFH and EFH-designated species as described in detail in Section 8.0.

7.2 Suspended Sediment and Deposition

Various sediment-disturbing Project activities conducted during construction, O&M, and decommissioning have the potential to suspend sediments into the water column resulting in the transport and deposition of these sediments on the seafloor. As described in Volume II, Section 2.1 of the COP, sediments disturbed during Project activities are not expected to contain hazardous contaminants. Therefore, during all Project phases, EFH and EFH species will primarily be affected by the short-term, localized, and temporary physical suspension of sediments and resulting deposition.

The primary construction activities that will result in elevated suspended sediment concentrations and deposition include seabed preparation, sandwave clearance, offshore cable installation, and excavation at the offshore HDD pit. In order to determine the extent of suspended sediment and deposition produced by construction activities, a Sediment Transport Modeling study was conducted (see Volume II, Appendix II-J3 of the COP). This study examined the extent and duration of elevated total suspended solids (TSS) concentrations and sediment deposition as a result of offshore cable installation and HDD activities at the

Monmouth and Atlantic Landfall Sites. Additional modeling of sandwave clearance[2] was performed to bound the potential effects of seabed preparation, prior to cable installation (see Volume II, Appendix II-J3, Attachment A of the COP).

Suspended Sediment Concentration Predictions

Model simulation results of above-ambient TSS concentrations stemming from cable installation for the inter-array cable, Monmouth ECC, and Atlantic ECC remained relatively close to the route centerline, were constrained to the bottom of the water column, and were short-lived. Table 11 summarizes the extent and duration of suspended sediment concentrations resulting from cable installation, HDD activities, and sandwave clearance. Two TSS concentration thresholds are provided in Table 11, 10 milligram per liter (mg/L) and 100 mg/L. A threshold of ≥10 mg/L is cited in literature as within the range of ambient TSS concentration conditions of the Mid-Atlantic Bight (Balthis et al., 2009). A threshold of ≥100 mg/L has been cited in literature as a level at which larval fish and mobile benthic organisms exhibit signs of sensitivity (Auld and Schubel, 1978; Turner and Miller, 1991, Wilber and Clarke, 2001; Anderson and Mackas, 1986).

Simulations of several possible inter-array cable or offshore export cable installation methods using either jet trenching installation parameters (for inter-array cable and export cable installation) or mechanical trenching installation parameters (for inter-array cable installation only) predicted above-ambient TSS of ≥10 mg/L stayed relatively close to the route centerline. This is due to sediments being introduced to the water column close to the seabed. TSS concentrations of ≥10 mg/L traveled a maximum distance of approximately 1.8 miles (2.9 kilometers), 1.6 miles (2.6 kilometers), and 1.1 miles (1.7 kilometers) for inter-array, Monmouth ECC, and Atlantic ECC cable installation, respectively (Table 11). For the landfall approach scenarios, use of an excavator was assumed and sediment was introduced at the surface. This resulted in a maximum distance for the predicted above-ambient TSS concentrations ≥10 mg/L of approximately 2.1 miles (3.3 kilometers) and 1.2 miles (1.9 kilometers) for the Monmouth and Atlantic HDD pits, respectively (Table 11).

For the inter-array cable and Atlantic ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 4 hours and fully dissipated in 6 or less hours. For the Monmouth ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 6 hours but required up to 13 hours to fully dissipate, likely due to the relatively longer route (i.e., larger volume of suspended sediment), route orientation in relation to currents, and more frequent occurrence of fine sediment. For the landfall approach scenarios, the tails of the plumes, with concentrations of ≥10 mg/L, were transported away from the source and were short-lived, while concentrations around the HDD pits dissipated within 12 hours for the Monmouth HDD pit and 11 hours for the Atlantic HDD pit. The larger areas of TSS concentrations above thresholds and the longer time for the plume to diminish to ambient conditions for the Monmouth HDD pit may be attributed to sediments being released in deeper water, the higher fraction of fine sediments taking longer to settle, and slightly stronger currents transporting the sediments parallel with the shore.

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[2] Dredged material from sandwave removal will be discharged low in the water column within surveyed areas that contain sand bedforms, used for ballast in GBS foundations if those foundations are selected for the Projects, or transported a short distance to an agreed-upon disposal site outside the Lease Area.

Predicted above-ambient TSS concentrations stemming from sandwave clearance activities also remained relatively close to the route centerline and were short-lived. The maximum distance for predicted above-ambient TSS concentrations of ≥10 mg/L was approximately 2.0 miles (3.2 kilometers) (Table 11). Above-ambient TSS concentrations were predicted to substantially dissipate within 4 to 6 hours and to fully dissipate in less than 12 hours for most areas.

Table 11. Suspended Sediment Modeling Results from Cable Installation and HDD Activities

Scenario	Maximum Duration of TSS >10 mg/L (hrs)	Maximum Extent of TSS ≥10 mg/L	Maximum Duration of TSS >100 mg/L (hrs)	Maximum Extent of TSS ≥100 mg/L
Offshore Cable Installation				
Inter-array Cable - Jet Trencher	5.7	1.6 mi (2.6 km)	2.5	0.9 mi (1.5 km)
Inter-array Cable - Mechanical Trencher	6.3	1.8 mi (2.9 km)	2.7	0.6 mi (0.9 km)
Monmouth Export Cable - Jet Trencher	12.8	1.6 mi (2.6 km)	6.0	0.9 mi (1.5 km)
Atlantic Export Cable - Jet Trencher	5.5	1.1 mi (1.7 km)	0.8	<0.1 mi (<0.1 km)
HDD Activities at Landfall Site				
Monmouth Landfall Representative HDD Pit Excavator	12.3	2.1 mi (3.3 km)	11	0.25 mi (0.4 km)
Atlantic Landfall Representative HDD Pit Excavator	10.7	1.2 mi (1.9 km)	10.3	< 0.1 mi (0.1 km)
Sandwave clearance				
Representative Sandwave Clearance, Monmouth ECC	12.5	2.0 mi (3.2 km)	7.0	1.3 mi (2.1 km)

These model predictions agree with modeling results conducted for similar projects in similar sediment conditions (BOEM, 2021; Elliot et al., 2017; West Point Partners, LLC 2013; ASA, 2008). Actual suspended sediment concentrations and sediment transport during installation may be even lower given that environmental monitoring surveys conducted during installation of the Block Island Wind Farm submarine cable found that suspended sediment levels measured during jet plow installation were up to 100 times lower than those predicted by the modeling (Elliot et al., 2017).

Elevated suspended sediment concentrations have the potential to influence feeding and foraging behavior, respiratory functionality, and survival of finfish species; however, impacts vary by species and life stage (Wilber and Clark 2001). Historically, studies on the impacts of suspended sediments on marine organisms have heavily focused on sediment concentrations. More recent studies have shown that exposure duration is also an important influencing factor (Wilber and Clark, 2001). Wilber and Clark (2001) compiled numerous studies which examined the impacts of suspended sediment concentration and exposure duration. A majority of the studies observed lethal impacts at high sediment concentrations and long exposure durations. One study conducted by Auld and Schubel (1978) showed a 13% mortality rate in American shad larvae when exposed to suspended sediment concentration of 100 mg/L for a duration of 4 days (Wilber and Clark, 2001). Another study conducted by Sherk et al. (1974) showed a 10% mortality in Atlantic silverside juveniles and adults when exposed to sediment concentrations of 580 mg/L for 1 day (Wilber and Clark 2001).

Effects from elevated suspended sediment concentrations on benthic invertebrates, including some EFH species or prey of EFH species. can include abrasion, respiration interference, feeding disruption, reduced growth rate, and in some cases, mortality (Johnson, 2018; Wilber and Clarke, 2001; Kjelland et al., 2015). A typical adult bivalve response to elevated suspended sediment reported by Wilber and Clarke (2001) is a reduction in net pumping rate and rejecting excess filtered material. Johnson (2018) reports that adult bivalves are relatively tolerant of TSS but could still exhibit reduced growth and survival rates; however, very high TSS concentrations would be required to induce mortality. Wilber and Clarke (2001) reported that adult bivalves exposed to TSS levels below 100,000 mg/L for shorter than 5 days did not experience mortality.

Results from the Sediment Transport Modeling report showed that suspended sediment concentrations greater than 100 mg/L are only anticipated to last up to 11 hours for HDD activities, 6 hours for cable installation, and 7 hours for sandwave clearance (Table 11), all of which are significantly less than the multiple-day studies compiled by Wilber and Clark (2001). Additionally, concentrations greater than 100 mg/L are expected to be localized, extending up to a maximum distance of 0.9 mile (1.5 kilometers), 0.2 mile (0.4 kilometer), and 1.3 miles (2.1 kilometers) from cable centerlines, HDD activities, and sandwave clearing respectively. Therefore, while effects could occur to sessile and less mobile individuals and early life stages of EFH species in the immediate vicinity of the cable and HDD activities, these effects are expected to be short-term and not result in high levels of mortality.

Effects to finfish EFH species are dependent on the time of year of that these activities occur, as species presence differs seasonally. Demersal and pelagic egg and larval stages of EFH fish species potentially present in the Offshore Project Area (Tables 6 and 8) will be most sensitive to the increased suspended sediment concentrations. Juvenile and adult EFH life stages (Tables 7 and 9) will likely temporarily avoid the disturbed area which could have a temporary displacement effect; however, these species are expected to return after the activities cease in a given location. Potential impacts to finfish and benthic invertebrate EFH species would be short-term and localized since sediment-disturbing Project activities are expected to only reach high TSS concentrations for a limited time and the sediment plume is expected to be limited to the relative proximity of the activity. In addition, as described in Section 6.0 and 7.1, much of the habitat in the Offshore Project Area is indicative of a dynamic system and the species that live in the mobile sandy habitat areas are adapted to survive periodic natural disturbances similar to what they would experience from sediment-disturbing Project activities. Furthermore, the area affected by increased suspended sediment is expected to be small compared to the surrounding habitat. Therefore, population-level effects to EFH and EFH species are not anticipated.

Sediment Deposition Predictions

Installation and maintenance of structures and cables will also result in the transport of sediment that will subsequently deposit over time as sediment particles settle through the water column to the seabed. Sediment deposition levels were modeled, as part of the Sediment Transport Modeling study, for the offshore installation of inter-array cables, the Monmouth ECC, Atlantic ECC, as well as HDD activities at the Monmouth and Atlantic Landfall Sites and sandwave clearance in a representative area of the Monmouth ECC.

Table 12 summarizes the areal extent and maximum distance of sediment deposition due to cable installation, HDD activities, and sandwave clearance. Two depositional thresholds are provided in the table below, 0.04 inch (1 millimeter) and 0.4 inch (10 millimeters). A threshold of 0.04 inch (1 millimeter) is cited in literature as the level at which burial and mortality occurs in demersal eggs (Berry et al., 2011). A threshold of 0.4 inch (10 millimeters) is cited in literature as the level at which sessile benthic invertebrates exhibit signs of sensitivity (Essink, 1999).

Based the results of the Sediment Transport Model, deposition of ≥0.04 inch (1 millimeter) was limited to 360 feet (110 meters) from the inter-array cable centerline for jet trenching installation parameters and to 164 feet (50 meters) for mechanical trenching installation parameters (Table 12). Variations in plume extent and duration for inter-array cable installation can be attributed to differences in cross-sectional area and advance rates, which impacted the timing of the currents. Deposition of ≥0.04 inch (1 millimeter) was limited to 656 feet (200 meters) from the Monmouth ECC centerline and to 164 feet (50 meters) of the Atlantic ECC centerline. Deposition of ≥ 0.4 inch (10 millimeters) from offshore cable installation was limited to the Monmouth ECC which was modeled at 98 feet (30 meters) from the ECC centerline (see Table 12). Deposition did not reach 0.4 inch (10 millimeters) for the inter-array or Atlantic ECC. The maximum deposition associated with inter-array cable, Atlantic ECC, and Monmouth ECC model scenarios was less than 0.2 inch (5 millimeters), between 0.2 to 0.4 inch (5 to10 millimeters), and between 0.4 to 0.8 inch (10 to 20 millimeters), respectively.

For the Monmouth and Atlantic HDD pit excavations, deposition of ≥0.04 inch (1 millimeter) was predicted to extend a maximum distance of 1,571.5 feet (479 meters) and 656 feet (200 meters), respectively and deposition of ≥0.4 inch (10 millimeters) was predicted to extend a maximum distance of 334 feet (102 meters) and 338 feet (103 meters), respectively. The Atlantic landfall approach scenario was predicted to have higher areas of deposition due to a higher fraction of coarse sediment. In combination with the sediment type and the relatively more shore-perpendicular nature of the currents at the Atlantic HDD pit, more sediment remained close to the pit and settled to the bottom rather than lingering in the water column or being transported as a suspended sediment plume.

Deposition of ≥0.04 inch (≥1 millimeter) resulting from sandwave clearance was limited to 2,805 feet (855 meters) from the route centerline and covered a maximum area of 2.01 square miles (5.20 square kilometers). Deposition of ≥0.4 in (≥10 millimeters) resulting from sandwave clearance was limited to 541 feet (165 meters) from the route centerline and covered a maximum area of 0.9 square miles (2.34 square kilometers). The maximum deposition predicted for sandwave clearance was ≥3.9 inches (100 millimeters) and predicted to extend a maximum distance of 66 feet (20 meters) from the route centerline.

Table 12. Deposition Modeling Results from Cable Installation and HDD Activities

Scenario	Area of Deposition 0.04 in (≥1 mm)[1]	Maximum Extent of Deposition ≥0.04 in (1 mm)[1]	Area of Deposition ≥0.4 in (10 mm)[2]	Maximum Extent of Deposition ≥0.4 in (10 mm)[2]
Offshore Cable Installation				
Inter-array Cable Jet Trencher[3]	0.23 mi^2 (0.60 km^2)	361 ft (110 m)	N/A	N/A
Inter-array Cable Mechanical Trencher[3]	0.16 mi^2 (0.42 km^2)	164 ft (50 m)	N/A	N/A
Monmouth Export Cable - Jet Trencher	3.21 mi^2 (8.32 km^2)	656 ft (200 m)	<0.01 mi^2 (0.02 km^2)	98 ft (30 m)
Atlantic Export Cable - Jet Trencher[4]	0.54 mi^2 (1.39 km^2)	164 ft (50 m)	N/A	N/A
HDD Activities at Landfall Site				
Monmouth Landfall Representative HDD Pit Excavator	0.03 mi^2 (0.09 km^2)	1,572 ft (479 m)	<0.01 mi^2 (0.01 km^2)	335 ft (102 m)
Atlantic Landfall Representative HDD Pit Excavator	0.02 mi^2 (0.04 km^2)	656 ft (200 m)	<0.01 mi^2 (0.02 km^2)	338 ft (103 m)
Sandwave clearance				
Representative Sandwave Clearance, Monmouth ECC	2.01 mi^2 (5.20 km^2)	2,805 ft (855 m)	0.90 mi^2 (2.34 km^2)	541 ft (165 m)

[1] A depositional threshold of 0.04 inch (1 millimeter) was used in the Sediment Transport Modeling report as it is the burial and mortality threshold for demersal eggs (Berry et al 2011).
[2] Sensitivity in sessile benthic organisms has been observed 0.4 inch (10 millimeter) (Essink, 1999).
[3] Installation of inter-array cables resulted in deposition less than 0.2 inch (5 millimeter) for both jet and mechanical trenching.
[4] Installation of the Atlantic ECC results in deposition less than 0.4 inch (10 millimeter).

Project-induced sediment deposition has the potential to bury demersal eggs and larvae of EFH species (Table 8) that are within the zone of deposition. Thresholds for lethal burial depths are species-dependent, with sessile organisms being most sensitive (Essink, 1999). According to Berry et al. (2011), deposition of ≥0.04 inch (1 millimeter) can result in delayed hatching or mortality of demersal eggs (e.g., Atlantic herring, winter flounder, longfin inshore squid). According to Essink (1999), sessile organisms such as oysters and mussels can survive in sediment deposition of 0.4 to 0.8 inches (10 to 20 millimeters), while other macrozoobenthos can survive in deposition of 8.0 to 11.8 inches (200 to 300 millimeters). One study, conducted by Colden and Lipcius (2015), showed deposition-caused mortality occurring in eastern oysters only when over 90% of the individual was covered in sediment.

Results from the Sediment Transport Modeling report show that deposition greater than 0.04 inch (1 millimeter) (e.g., the threshold of burial for demersal eggs) will occupy a maximum area of 3.21 square miles (8.32 square kilometers), 0.03 square miles (0.09 square kilometer), and 3.2 square miles (5.20 square kilometers) for cable installation, HDD activities, and sandwave clearing, respectively. Based on the modeling results, the area of deposition of ≥ 0.04 inch (1 millimeter) will be minimal compared to the surrounding available habitat and limited to the cable corridor.

Sediment deposition could result in delayed hatching or mortality of non-mobile benthic organisms (e.g., sea scallops) or non-mobile finfish life stages (e.g., demersal eggs and larvae); however impacts will be restricted to the vicinity of cable installation and HDD activities. In addition, only four species with demersal or benthic eggs or larvae have designated EFH in small portions of the Offshore Project Area (Table 8) and these early life stages are only present for short periods of time throughout the year further reducing the likelihood of impacts. Therefore, sediment disturbing Project activities are not expected to result in population-level effects to EFH species. Although sessile juvenile and adult EFH life stages (e.g., Atlantic surfclam, ocean quahog) could experience localized increases in physical abrasion, burial, or limited mortality, mobile older life stages (Tables 7 and 9) are expected to temporarily vacate the area during these activities and return shortly after sediment conditions return to ambient conditions, a phenomenon that has commonly been observed following dredging activities and other physical disturbance of seafloor conditions (Brooks et al., 2004; BOEM, 2021; Guida et al., 2017).

Potential impacts from offshore spills, discharges, and accidental releases are considered to have a low likelihood of occurrence. Atlantic Shores will implement measures to minimize the potential for accidental releases and discharges, including drilling fluid release and frac-outs during HDD installation at the landfall sites. These measures include the development of an Oil Spill Response Plan (OSRP) and HDD Contingency Plan.

The degree of suspended sediment and deposition will be significantly lower during O&M activities than during Project construction. Some sediment suspension and deposition may occur from maintenance of structures and cables if repairs are required, but impacts are expected to be short-term and temporary due to the predominantly sandy seafloor and shallow sediments in the Offshore Project Area. Decommissioning of structures and cables is expected to have similar limited impacts as those described for construction. During all Project phases, dynamically-positioned vessels and jet plow embedment will be used to the maximum extent practicable to reduce sediment disturbance during cable laying processes.

7.3 Impingement or Entrainment of Fish Larvae

Project operations requiring the use of water, such as standard vessel operations, jet plow, or jet trenching activities, will likely result in the impingement and/or entrainment of pelagic planktonic species. During the construction, operation, and decommissioning phases, direct mortality of pelagic planktonic species is expected as a result of entrainment and impingement during water withdrawals for vessel operation and jet plowing activities. Entrainment of planktonic species typically results in high levels of mortality due to temperature changes and injury as organisms travel through piping systems (USDOE, 2009). With respect to jet plowing activities, injury to entrained organisms can occur when water is injected into sediments as high pressure, resulting in mortality. However, such occurrence will be limited to periods of vessel operation and jet plowing.

Assuming an installation rate between 150 meters and 300 meters (492 feet and 984 feet) per hour for export, inter-array, and interlink cable installation using jet plowing, and a water withdrawal rate between 400 cubic meters and 1,400 cubic meters (14,125 and 49,441 cubic feet) per hour for jet plow activities, water withdrawal volumes are expected to range from approximately 4,400 to 7,700 million liters (1,100 to 2,100 million gallons) from jet plowing activities for both Projects (3,100 to 5,500 million liters [831 to 1,500 million gallons] per Project). Additional water withdrawal may be required for sandwave clearance using a hydraulic dredge. Though the exact locations of sandwave clearance will be determined closer to construction, a conservative estimate of 30% of the export and interlink cable lengths and 15% of the inter-array cable length was used to calculate total water withdrawal. Assuming an installation rate between 105 meters and 450 meters (344 feet and 1,476 feet) per hour for export, inter-array, and interlink cable and a water withdrawal rate between 10 cubic meters and 30 cubic meters (353 cubic feet and 1,060 cubic feet) per hour, water withdrawal volumes are expected to range from approximately 29 to 38 million liters (7.6 to 10 million gallons) from sandwave clearing activities using a hydraulic dredge for both Projects (22 to 31 million liters [5.8 to 8.2 million gallons] per Project).

Mortality of ichthyoplankton is considered likely due to water withdrawal activities; however, many species that inhabit the Offshore Project Area produce millions of eggs per year (e.g., Atlantic herring, Atlantic cod, haddock, winter flounder) which allows the species to persist in the presence of natural and anthropogenic-related effects (NOAA, 2021b; Adams, 1980). Additionally, cable installation activities requiring water withdrawal will be limited in time and space. As a result, water withdrawal activities are not expected to cause population-level impacts to ichthyoplankton.

7.4 Habitat Conversion and Creation

This section addresses permanent seafloor disturbance from the footprints of foundations, scour protection, and offshore cable protection that will result in habitat conversion of primarily sandy substrate to hard substrate. Within the Offshore Project Area, the presence of foundations, cable protection, and scour protection may result in habitat conversion/creation, increased food availability, localized hydrodynamic alterations, and species attraction.

The presence of foundations and scour protection will result in localized habitat conversion of any sandy, soft bottom habitat to a coarser, complex habitat. The maximum estimated total area of permanent seafloor disturbance in the WTA for the combined projects, using the foundation type with the maximum footprint, is approximately 1.40 square miles (3.62 square kilometers) (Table 2), which represents approximately 0.9% of the 160 square mile (413 square kilometers) WTA area. The maximum estimated total permanent seafloor disturbance in the Atlantic and Monmouth ECCs from the placement of cable protection, excluding the portion of the ECCs located in the WTA, is approximately 0.06 square miles (0.16 square kilometers) and 0.32 square miles (0.83 square kilometers), which represents 0.72% and 0.80% of the total area within each ECC, respectively (Table 2). This permanent habitat conversion of predominantly sandy and gravelly benthic habitat to hard structure habitat will be localized and restricted to the foundation, cable protection, and scour protection footprints (ICF, 2020).

Even though the presence of foundations, cable and scour protection will eliminate a small percentage of flat sandy habitat in the Offshore Project Area, the Projects are expected to produce ecological benefits by creating new, diverse habitat for structure-oriented species. In two different wind farms, the Block Island Wind Farm off the coast of Rhode Island and the Horns Rev Wind Farm in the North Sea, abundance within soft-bottom communities largely remained the same between pre- and post-construction (ICF, 2020). At the Block Island Wind Farm, abundance of small invertebrates (e.g., nematodes and polychaetes) in existing soft-bottom benthic communities increased after construction around some WTGs. The increase in smaller invertebrate species can lead to the attraction of predators with EFH in the Offshore Project Area (e.g., larger invertebrates, fish) due to increased prey availability (ICF, 2020; HDR, 2018).

Structure-oriented species with EFH in the Offshore Project Area or identified as NOAA Trust Resources include black sea bass, ocean pout, adult silver hake, juvenile red hake, longfin squid egg mops, tautog, blue mussel, and eastern oyster. Foundations can create a "reef effect", providing ecological benefits and habitat diversity in the Mid-Atlantic Bight. Introduction of hard structures such as foundations and scour protection provide shelter and feeding opportunities as well as spawning and nursery grounds in an area that is largely comprised of flat, sandy habitat with small topographic features (e.g., ripples) (ICF, 2020). Leonhard et al. (2011) studied fish assemblages one year before and eight years after the construction of the Horns Rev Wind Farm in the North Sea and observed an increase in species diversity close to WTGs, specifically in reef fishes (Leonhard et al., 2011). This increase in fish diversity may be attributed to the diversification of feeding opportunities by newly established epibenthic invertebrates (Leonhard et al., 2011). A visual transect study of two windfarms in the Baltic Sea observed higher fish abundance in the vicinity of the turbines, and at individual turbines when compared with the surrounding environment, indicating that turbine foundations may function as combined artificial reefs and fish aggregation devices for small demersal and semi-pelagic fish (Wilhelmsson et al., 2006). The same study observed the retreat of some species to the monopile foundation upon the introduction of disturbance, which could indicate that turbines provide a source of refuge (Wilhelmsson et al., 2006).

The presence of foundations and scour protection have the potential to provide supporting habitat for structure-oriented species that seasonally migrate from nearshore to offshore environments, a common phenomenon for species off the coast of New Jersey and within the Offshore Project Area (Steimle and Zetlin, 2000; Causon and Gill, 2018). Structure-oriented species that participate in seasonal migrations and have EFH in the Offshore Project Area or are identified as NOAA Trust Resources include, black seabass, ocean pout, silver hake, and tautog. Structures may also attract highly migratory species. However, limited evidence of this behavior in operating windfarms has been documented (ICF, 2020). Studies have shown aggregations of highly migratory species, around oil platforms and artificial reefs. One study in the North Sea examined the presence of porbeagle sharks at an oil platform and found a minimum of 20 individuals aggregating around the structure at one time (Haugen and Papastamatiou, 2019). In the U.S., a study off the coast of North Carolina found a high presence of transient predator density, mainly sand tiger shark and sandbar shark, around artificial reefs compared to natural reefs (Paxton et al., 2020). Similar aggregations of highly migratory species could occur at structures within the Offshore Project Area. Though foundations and cable protection could be utilized by migratory species for food and shelter, migration is largely driven by water temperatures and seasonality rather than the availability of resources (BOEM, 2020). Therefore, any use of structures by migratory species is expected to be temporary, and the overall presence of foundations and cable protection is not expected to hinder migration patterns (BOEM, 2020).

The presence of WTGs and other foundation structures in the WTA may affect currents and water movement within the WTA; however, effects are expected to be highly localized at the foundations. As water moving along a current approaches a turbine or foundation, it changes and accelerates around a structure, creating turbulence (ICF, 2020). This phenomenon is known as the wake effect (ICF, 2020). The magnitude of wake effect depends on the diameter of foundation structures, volume of impervious surface in the water column and seafloor, and current speed (ICF, 2020; English et al., 2017). Wake effect from monopile foundations has been observed approximately 600 feet (200 meters) downcurrent of the structures (English et al., 2017). During peak tidal movements, turbulent wakes have been observed as far as 1,312 feet (400 meters) from the monopile (English et al., 2017). These localized wake effects could influence larval settlement, primary productivity, and feeding efficiency of predators (ICF 2020; English et al. 2017; Vanhellemont and Ruddick 2014). However, changes in turbulence around the foundations could also result in increased food availability for plankton-consuming species with EFH in the Offshore Project Area like filter-feeding invertebrates (e.g., Atlantic sea scallop, Atlantic surfclam, ocean quahog) as well as larval and juvenile fish species (e.g., Atlantic cod, haddock, monkfish, scup, windowpane) (Andersson, 2011; ICF, 2020). Increases in food availability could result in fish and invertebrate aggregation. Increased turbulence also has the potential to reduce visibility around the turbine, which may reduce feeding efficiency of predators, thereby indirectly affecting the risk of predation on prey species (English et al., 2017; Vanhellemont and Ruddick, 2014).

In addition to changes in currents, it is important to understand how the placement of WTGs may affect Cold Pool processes, specifically with regards to ocean mixing, and EFH species in the Offshore Project Area. The formation and the nutrient fluxes of the Cold Pool are important to fish and their movement in the Mid-Atlantic Bight. The breakdown of the stratified Cold Pool is known to influence the timing of migration for EFH species such as winter flounder, summer flounder, black sea bass, and Atlantic butterfish (Kohut and Brodie, 2019). Additionally, temporal changes in the breakdown of the Cold Pool have been linked to mortality in Atlantic surfclam and changes in spawning timing for ocean quahog, both of which have EFH in the Offshore Project Area (Narvaez et al., 2015; Toupoint et al., 2012). Modeling studies, considering varying sizes of wind projects and technology, have indicated that wind turbines may cause atmospheric disturbances to near-surface winds that influence ocean mixing (Afsharian and Taylor, 2019). The extent of changes to ocean mixing at local and regional, or mesoscale, scales is not well known and can vary widely in magnitude as local mixing is dependent on atmospheric forcing, daily heating and cooling, wind, changes in temperature and humidity associated with mesoscale weather, and other processes (Paskyabi et al., 2015). Measuring and predicting any possible effects to ocean mixing is highly dependent on the characteristics of the wind project (e.g., spacing between turbines, size of turbines) and the local and regional atmospheric and oceanographic conditions (Moum and Smyth, 2019), including conditions of fish and fisheries in the local and regional areas.

Conditions and observations at local and regional scales are necessary to understand if effects to mixing may occur from the Projects and if so, whether those effects may influence the Cold Pool dynamics. Drawing early conclusions from European or modeling studies have inherent differences, as the Mid-Atlantic Bight has weaker tidal currents and more intense stratification than the North Sea and is different from other western boundary currents or mesoscale circulation features in European waters. It has been suggested that slower ocean velocities in the southern Mid-Atlantic Bight would result in significantly less mixing than has been found in Europe (Carpenter et al., 2016). European studies are more representative of Mid-Atlantic Bight conditions during weaker stratification. Therefore, it is not likely that structure-induced mixing would be sufficient to overcome intense summer stratification to influence the Cold Pool and cause broader ocean mixing (Miles et al., 2020). As a result, substantial effects to the Cold Pool and ocean mixing from the presence of Project WTGs is not expected. However, considering the seasonal, annual, and longer scale changes in the Cold Pool and Mid-Atlantic Bight, Atlantic Shores is supportive of contributing to regional collaborative science to study and monitor the Cold Pool and its influence on benthic invertebrates, fish and fisheries.

In 2019, Atlantic Shores, in collaboration with Rutgers University and Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS), deployed a metocean buoy to contribute to the study of the Mid-Atlantic Cold Pool. This buoy contains sensors at the atmospheric-boundary layer and ocean floor that allow for continuous measurements of the Cold Pool, as well as support regional oceanographic and atmospheric modeling efforts. The data collected by this buoy is publicly accessible and can be accessed through the MARACOOS data portal *at https://ioos.noaa.gov/regions/maracoos*. Once operational, the Projects will also represent a living laboratory as they provide abundant opportunities for direct ocean and ecological observations, such as the anticipated beneficial effects of introducing structure to a homogenous sandy sea floor.

As stated, the presence of foundations and cable and scour protection could create a range of positive effects to EFH and species with designated EFH in the Offshore Project Area during the O&M phase of the Projects. Most of these effects will be permanent throughout the life of the Projects and mostly beneficial. Foundations and cable and scour protection are expected to produce ecologically beneficial effects that could outweigh the risk of introducing hard structure to a small area of the vast flat, sandy habitat found in the Mid-Atlantic Bight. Once the Projects are decommissioned, the local environmental and ecological features of the area are expected to revert back to pre-construction conditions. Potential effects from decommissioning include the loss of Project-related hard structures, which are expected to be colonized at the time of decommissioning. Reef or structure-oriented species will be displaced during decommissioning as the foundations and scour protection are removed.

7.5 Noise

This section addresses underwater sound that may be generated during activities conducted in the Offshore Project Area, including impulsive pile driving and other noise sources (e.g., HRG surveys, vessels, cable installation, vibratory pile driving, operational WTGs, operational offshore cables, and decommissioning) and assesses the potential effects noise generated from these activities may have on EFH-designated species. Noise, defined as unwanted sound, is detected by fish and invertebrates as particle motion, with some fish additionally sensing pressure. Noise generated during Project construction, O&M, and decommissioning has the potential to result in physiological stress and behavioral changes, as well as limited mortality or injury in finfish and pelagic invertebrates when the noise is present. As described in the following sections, effects to finfish and pelagic invertebrates from underwater noise will be limited to radial distances from the source where sound levels are above regulatory thresholds. Pile driving noise during construction (if a piled foundation type is chosen) would be mitigated through the use of noise abatement systems such as bubble curtains and hydro-dampeners and noise mitigating measures such as soft starts and ramp up procedures.

Fish and invertebrates are sensitive to particle motion and some fish are additionally sensitive to pressure. Particle motion is described by displacement, velocity and acceleration. Because the ears of fish function as inertial accelerometers, all fish are sensitive to particle motion. In contrast, sensitivity to sound pressure in fish is functionally correlated to the presence or absence of gas-filled chambers, such as the swim bladder. Sensing pressure extends hearing to higher frequencies (Ladich and Popper, 2004, Braun and Grande, 2008). The presence of a swim bladder, or other gas-filled cavity, makes fish more susceptible to injury from anthropogenic sound as these loud, often impulsive, noises can cause swim bladders to vibrate with enough force to cause damage to tissues and organs around the bladder (Halvorsen et al., 2011, Casper et al., 2012). Invertebrates and crustaceans lack swim bladders and are therefore less sensitive to sound.

The most sensitive fish species are those with swim bladders connected or close to the inner ear. These species can acquire both recoverable and mortal injuries at lower sound levels than other species (Thomsen et al. 2006, Popper et al. 2014). EFH-designated species and other NOAA trust resource species that may be present in the WTA and are considered high-sensitivity fish species (Popper et al. 2014) due to swim bladder involvement in hearing, include Atlantic cod, Atlantic herring, silver hake, white hake, alewife, blueback herring, American eel, American shad, Atlantic menhaden, and weakfish.

Some fish found in the WTA have swim bladders not involved in hearing (e.g., Atlantic sturgeon, Atlantic butterfish, Atlantic mackerel, black sea bass, bluefish, haddock, monkfish, ocean pout, red hake, scup, bluefin tuna, yellowfin tuna, striped bass, tautog). Their detection of sound is mediated primarily through particle motion, and these species have relatively low susceptibility to anthropogenic sound-induced effects (Popper et al. 2014). The least sound-sensitive fish species are those that have no swim bladder, including elasmobranchs (i.e., sharks and rays) and flatfish such as summer flounder.

Impact (impulsive) pile driving may occur if piled foundation types (monopile and jackets) are chosen as the foundation type for the Projects. Impulsive sounds are discontinuous, high intensity sounds that are extremely short in duration (with a rapid onset and decay) but may be repetitive. There are also other noise sources associated with offshore Project construction, O&M, and decommissioning that are primarily non-impulsive in nature. Non-impulsive sounds are continuous sounds that remain constant and relatively stable over time (e.g., vessel sounds, WTG operational noise, vibratory pile driving noise).

To assess the potential effects from impact pile driving to finfish, if piled foundations are used, Atlantic Shores conducted quantitative acoustic modeling and compared the results against impulsive acoustic thresholds. For other sound sources from the Projects, Atlantic Shores provides a qualitative assessment of potential impacts to finfish and invertebrates in relation to the relevant acoustic thresholds. These other sound sources were not quantitatively modeled because the potential acoustic impact of these sound sources is expected to be much less than impulsive pile driving.

Injury and behavioral response exposure criteria for impulsive and non-impulsive sounds are based on relevant regulatory-defined thresholds and best available science for fish (NOAA, 2005b; Andersson et al., 2007; Wysocki et al., 2007; FHWG, 2008; Mueller-Blenkle et al., 2010; Purser and Radford, 2011) and are described in detail in Volume II, Appendix II-L of the COP. Table 13 provides regulatory approved acoustic thresholds to evaluate the potential for finfish to experience injury and behavioral response from impulsive sounds. Because few data are available regarding particle motion sensitivity in fish (Popper and Fay, 2011; Popper et al., 2014), the thresholds for acoustic sensitivity are based on sound pressure only (FHWG, 2008; Stadler and Woodbury, 2009). The thresholds that are currently used by NOAA Fisheries GARFO and BOEM to assess potential impacts to fish exposed to pile driving sounds are based on criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG, 2008; Stadler and Woodbury, 2009). Table 13 also presents threshold levels suggested by Popper et al. (2014) for injury and temporary threshold shift (TTS) for impulsive sounds, which are based on the presence, and role, of a swim bladder.

Table 13. Interim Fish Injury and Behavioral Acoustic Thresholds Currently used by NOAA Fisheries GARFO and BOEM for Impulsive Pile Driving

Fish Group	Injury Thresholds		TTS	Behavior Thresholds
	L_{PK}	L_E	L_E	L_p
Fish without a swim bladder (particle motion detection)[1]	213	216	186	—
Fish with swim bladder not involved in hearing (particle motion detection)[1]	207	203		—
Fish with swim bladder involved in hearing (primarily pressure detection)[1]				—
Fish weighing ≥2 grams[2,3]	206	187	—	150[4]
Fish weighing <2 grams[2,3]		183	—	

All thresholds are unweighted.
L_{PK} – peak sound pressure (dB re 1 μPa).
L_E – sound exposure level (dB re 1 $\mu Pa^2 \cdot s$).
L_p – root mean square sound pressure (dB re 1 μPa).
TTS – temporary, recoverable hearing effects.

1. Popper et al. (2014).
2. NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
3. Stadler and Woodbury (2009)
4. Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007).

Impulsive underwater noise generated from Project activities has the potential to cause mortality or injury (e.g., ruptured gas bladders, damage to auditory processes) mainly to the finfish identified above that have swim bladders connected or close to the inner ear (Casper et al., 2012; Popper and Hastings, 2009; Riefolo et al,. 2016). Exposure to intense anthropogenic sound levels can also cause an increase in the hearing thresholds of fishes, resulting in less sensitive (i.e., poorer) hearing abilities. This change in hearing threshold may be temporary (i.e., TTS) or permanent (i.e., permanent threshold [PTS]). In addition, underwater noise may elicit a behavioral response in finfish and pelagic invertebrates, such as avoidance, changes in feeding, breeding, schooling, migration behavior, or masking of environmental auditory cues (Buerkle, 1973; Mitson and Knudsen, 2003; Olsen et al., 1983; Ona et al,. 2007; Sarà et al., 2007; Schwarz and Greer, 1984; Soria et al., 1996; Vabø et al., 2002). Behavioral responses in fish differ depending on species and life stage, with younger, less mobile age classes being the most vulnerable (Gedamke et al., 2016; Popper and Hastings, 2009).

The effects of impulsive sound on fish eggs and larvae have been studied in the context of offshore pile driving. Bolle et al. (2012) investigated the risk of mortality in common sole larvae by exposing them to impulsive stimuli in an acoustically well-controlled study. Even at the highest exposure level tested, at a sound exposure level (SEL) of 206 decibels (dB) re 1 µPa2·s (corresponding to 100 strikes at a distance of 100 meters) no statistically significant differences in mortality were found between exposure and control groups. Popper et al. (2014) published exposure guidelines for fish eggs and larvae, which are based on pile driving data. The guidelines proposed a precautionary threshold for mortality of fish eggs and larvae of >207 dB re 1 µPa PK, which they note is likely conservative. As no thresholds exist for pelagic invertebrates, fish eggs and larvae thresholds are used as a proxy for these species.

There are very few studies on the effect of non-impulsive sound sources on fish and no data exist for eggs and larvae (Popper et al. 2014). Acoustic thresholds for fish used to qualitatively evaluate impacts from non-impulsive sounds are provided in Table 14. As with impulsive sounds, the eggs and larvae thresholds are considered proxy for marine invertebrates.

7.5.1 Impact Pile Driving Noise

Atlantic Shores conducted site-specific acoustic propagation modeling assuming the maximum PDE to assess the potential risks to marine mammals from pile driving noise. This analysis can also be used to evaluate potential risks to finfish from pile driving noise during construction (Volume II, Appendix II-L of the COP). The model evaluated distances to NMFS thresholds based on a range of operational conditions (e.g., foundation type, hammer type, pile-driving schedule) as well as levels of potential noise attenuation (ranging from 0 to 15 dB) that could potentially be achieved through the application of industry standard noise abatement systems (NAS). For the exposure assessment conducted, the 10 dB attenuation level was conservatively chosen as the minimum sound reduction achievable with the application of a single NAS. The acoustic modeling maximum radial distances to regulatory thresholds results are provided in summary below (Table 15) and in detail in Volume II, Appendix II-L of the COP.

Table 14. Interim Fish Injury and Behavioral Acoustic Thresholds Currently Recommended by BOEM for Non-impulsive Sources

Fish Group	Mortality and Potential Mortal Injury	Impairment			Behavior
		Recoverable Injury	TSS	Masking	
Fish without a swim bladder (particle motion detection)[1]	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish with swim bladder not involved in hearing (particle motion detection)[1]					
Fish with swim bladder involved in hearing (primarily sound pressure detection)[1]		170 (SPL_{48hr})	158 (SPL_{12hr})	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Eggs and larvae[1]		(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low
Fish weighing ≥2 grams[2,3]	—	—	—	—	150[4]
Fish weighing <2 grams[2,3]					

All thresholds are unweighted.

Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N – tens of meters), intermediate (I – hundreds of meters), and far (F – kilometers).

SPL – sound pressure level

1. Popper et al. (2014).
2. NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
3. Stadler and Woodbury (2009)
4. Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007)

Table 15. Maximum Radial Distance (in kilometers) to Thresholds for Fish due to Impact Pile Driving of One 15 meter monopile with a 4,400 kJ Hammer with Varying Levels of Attenuation

Fish Group	**Metric**	**Threshold**	**Distance from Pile to Threshold (km)**			
Attenuation Level			**0 dB**	**6 dB**	**10 dB**	**15 dB**
Fish without a swim bladder (particle motion detection)[1]	Injury (L_{PK})	213	0.21	0.08	0.05	0.01
	Injury (L_E)	216	1.45	0.64	0.34	0.15
	TTS (L_E)	186	9.85	7.56	6.27	4.86
Fish with swim bladder not involved in hearing (particle motion detection) [1]	Injury (L_{PK})	207	0.46	0.21	0.10	0.06
	Injury (L_E)	203	4.34	2.89	1.97	1.13
	TTS (L_E)	186	9.85	7.56	6.27	4.86
Fish with swim bladder involved in hearing (primarily sound pressure detection) [1]	Injury (L_{PK})	207	0.46	0.21	0.10	0.06
	Injury (L_E)	203	4.34	2.89	1.97	1.13
	TTS (L_E)	186	9.85	7.56	6.27	4.86
Fish weighing ≥2 grams[2,3,4]	Injury (L_{PK})	206	0.50	0.25	0.11	0.07
	Injury (L_E)	187	9.46	7.22	5.99	4.60
	Behaviour (L_P)	150	11.16	8.72	7.23	5.68
Fish weighing <2 grams[2,3,4]	Injury (L_{PK})	206	0.50	0.25	0.11	0.07
	Injury (L_E)	183	11.05	8.67	7.22	5.70
	Behaviour (L_P)	150	11.16	8.72	7.23	5.68

All thresholds are unweighted.

L_{PK} – peak sound pressure (dB re 1 µPa).

L_E – sound exposure level (dB re 1 µPa^2·s).

L_p – root mean square sound pressure (dB re 1 µPa).

TTS – temporary, recoverable hearing effects.

1. Popper et al. (2014).
2. NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
3. Stadler and Woodbury (2009)
4. Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007)

Based on the regulatory-defined thresholds for fish and the corresponding exposure ranges, and the intermittent nature of the sound source, effects on EFH-designated finfish and invertebrates from pile driving noise are expected to be localized and short-term. Therefore, the risk of noise-related impacts from pile driving is expected to be low. In addition, the most sensitive species will likely only be present in the WTA between fall and winter. By spring, all high-sensitive species discussed above, except for Atlantic cod, are expected to migrate inshore or southward, to spawn (NOAA, 2021b; ASMFC, 2021; Geo-Marine, 2010).

Atlantic Shores is implementing measures to avoid Project-related impacts to finfish and invertebrates. In addition to continuing existing marine programs to study important habitats, key noise mitigation and monitoring strategies that will be implemented throughout all phases of the Projects include equipment operating procedures to protect or prevent finfish and invertebrate species from harmful underwater sound levels generated by pile driving. For example, noise abatement systems that reduce the likelihood for exposure to threshold sound levels arising from pile driving for marine mammals will also benefit other marine fauna, including finfish. Soft starts will be implemented for activities such as impact pile driving. Standard soft-start procedures are a "ramp-up" procedure whereby the sound source level is increased gradually before full use of power. In combination, these impact mitigation strategies are expected to minimize impacts to fish and invertebrates.

7.5.2 Other Noise Sources

There are several other potential anthropogenic sound sources associated with offshore Project construction, O&M, and decommissioning. These sources were not quantitatively modeled because the potential acoustic impact of these noise sources is expected to be much less than impulsive pile driving. A qualitative assessment of possible effects to finfish and pelagic invertebrates from other noise sources generated by Project activities, including HRG surveys, vessels, cable installation, vibratory pile driving (if needed), operational WTGs, operational offshore cables, and decommissioning is summarized in this section.

As detailed in Volume I, Sections 4.5.3 and 4.5.9 of the COP, HRG surveys may be conducted to support pre-construction site clearance activities as well as post construction facilities surveys. The HRG survey equipment used for this type of survey work would be the same or similar to the equipment deployed during Atlantic Shores' 2019-2021 site characterization surveys including multibeam echosounders, side scan sonars, sub-bottom profilers, and high-resolution seismic equipment. Of this equipment, sub-bottom profilers and high-resolution seismic equipment emit acoustic signals vertically downwards into the water column, some of which will penetrate the seabed. Studies of stronger HRG survey equipment (not being deployed by Atlantic Shores, e.g., seismic airguns), have shown mortality is very unlikely; however, behavioral responses have been observed in fish exposed to airgun sound levels exceeding 147–151 sound pressure level (SPL) (Fewtrell and McCauley, 2012) and some HRG active acoustic sound sources can produce these sound levels within tens of to a few hundred meters of the source (Halvorsen and Heaney, 2018). Based on the variable responses observed in studies used to establish threshold levels of sound for impulsive sources (Table 13), finfish would be expected to either vacate the survey area, experience short-term TTS and/or masking of biologically relevant sounds, show no visible effects, or be completely unaffected. Given the results of these studies, the mobile and intermittent nature of HRG surveys, the short-term and infrequent nature of surveying small areas of the seafloor relative to the overall area, and the likelihood that finfish will move away from the sound source, noise from HRG surveys is not expected to pose a risk to EFH-designated finfish or pelagic invertebrates.

Vessel noise includes non-impulsive sounds that arise from vessel engines, propellers, and thrusters. Sound levels emitted from vessels depend on the vessel's operational state (e.g., idling, in transit) and are strongly weather dependent. Zykov et al. (2013) and McPherson et al. (2019) report a maximum broadband source level of 192 dB re 1 μPa for numerous vessels with varying propulsion power. The characteristics of these noises are described in more detail in Volume II, Appendix II-L of the COP. Noise from Project vessels is likely to be similar in frequency characteristics and sound levels to existing commercial vessel traffic in the region. Given the rapid attenuation of underwater vibrations with increasing distance from a sound source (Morley et al. 2014), it is unlikely that these stimuli will cause more than short-term behavioral effects (e.g., flight or retraction) or physiological (e.g., stress) responses. Overall, impacts to EFH-designated finfish and pelagic invertebrates from vessel noise are expected to be short-term and localized and are not anticipated to pose a risk to these resources.

Noise impacts from cable installation activities (e.g., from sand bedform removal [if needed], jet trenching, plowing/jet plowing, mechanical trenching) are expected to be similar to those described for vessel noise. A detailed modeling and measurement study conducted for construction activities associated with cable installations concluded that underwater sound generated by cable laying vessels was similar to that of other vessels already operating in the area and no significant acoustic impacts were identified (JASCO 2006). Therefore, noise associated with cable laying activities is not expected to pose a risk to EFH-designated finfish or pelagic invertebrates.

Non-impulsive, vibratory pile driving could be an additional source of noise generated during construction. Vibratory pile driving may be used for a short period at the beginning of pile driving or to install the entire pile, depending on sediment conditions (see Volume I, Section 4.2.1 of the COP). Compared to noise generated from impulsive pile driving, vibratory pile installation typically produces lower amplitude sounds in the marine environment (Rausche and Beim, 2012). Received peak sound pressure levels (PK) and SEL near impact pile driving can exceed 200 dB, while studies of vibratory pile driving measured source levels ranging from 177 to 195 dB PK and 174.8 to 190.6 dB SEL (Hart Crowser, Illingworth and Rodkin, 2009; Houghton et al., 2010). Suction bucket installation, which is also a non-impulsive pile installation method, is expected to result in lower peak pressure levels than impact pile driving. Exposure to vibratory hammer and suction bucket installation noise is unlikely to induce injury in EFH-designated fish or pelagic invertebrates because of its lower peak pressure levels and its relatively short duration.

During Project operation, WTGs will generate non-impulsive sound in the nacelle that will be transmitted down the WTG tower to the foundation and then radiated into the water. Underwater sound levels generated by an operational WTG are related to the WTG's power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg, 2005). Under normal conditions, the sound level that results from WTG operation is of low intensity (Madsen et al., 2006), with energy concentrated at low frequencies (below a few kilohertz) (Tougaard et al., 2008). At high wind speeds, Wahlberg and Westerberg (2005) estimated permanent avoidance by fish would only occur within a range of 13 feet (4 meters) to 820 feet (250 meters) of a turbine. These findings were dependent on the number and size of windmills, wind speed, background noise level, hearing abilities of the fish, bathymetry, and seabed characteristics (Wahlberg and Westerberg, 2005).

Pangerc et al. (2016) recorded SPL measurements at approximately 164 feet (50 meters) from two individual 3.6 megawatt (MW) monopile wind turbines over a 21-day operating period. The sound pressure level increased with wind speed up to an average value of 128 dB re 1 µPa at a wind speed of about 10 meters per second, and then showed a general decrease. Additional studies conducted during operation of the Block Island Wind Farm measured sound levels below 120 dB SPL at wind speeds less than 13 meters per second (HDR, 2019). These sound levels are expected to be similar to those reported for cable laying/trenching, and are well below existing non-impulsive acoustic thresholds for injury or behavioral response in fish (Table 14). Overall, current literature indicates sound generated from the operation of wind farms is of minor significance for fish (Wahlberg and Westerberg, 2005; Stenberg et al., 2015). Therefore, the effects of WTG noise on finfish, while long-term, are not expected to be substantial and will not cause population-level effects.

HVAC offshore cables are expected to produce non-impulsive low-frequency tonal vibration sound in the water. HVDC cables do not produce a similar tonal sound because the current is not alternating. Low level tonal sound from an existing 138 kV transmission line buried up to 4 feet (1 meter) was measured in Trincomali Channel, offshore Vancouver Island, British Columbia during a quiet period of recording. The SPL at approximately 328 feet (100 meters) from the cable was below 80 dB. Assuming cylindrical spreading of sound, the source level of the submarine cable was approximately 100 dB SPL (JASCO, 2006). Anticipated SPL arising from the vibration of alternating current (AC) cables during operation are significantly lower than SPL that may occur during cable installation (Meißner et al., 2006) and may be undetectable in the ambient soundscape of the WTA. Based on these studies, no effects to EFH-designated finfish or pelagic invertebrates are expected from low-frequency tonal vibration sound emitted during cable operation.

Sounds associated with decommissioning are reasonably assumed to be similar to, or less than, those produced during either the construction or O&M phases of the Projects. The methods used to decommission and remove the Projects' foundations will depend on the type of foundation (see Volume I, Section 6.2.3 of the COP); therefore, the level and duration of sounds emitted during decommissioning will depend on the type (e.g., gravity versus piled foundation), size, and location of the foundation. Piled foundations, if used, will be cut below the mudline, likely using underwater acetylene cutting torches, mechanical cutting, and/or a high-pressure water jet. Mechanical cutting tools and high-pressure water jetting will generate non-impulsive broadband sound (Topham and McMillan 2017). Regardless of the foundation type used, removal and transport of Project components (e.g., foundations, WTGs, OSSs, etc.), will require the use of vessels, which will also generate non-impulsive sound. Potential impacts to finfish and pelagic invertebrates, including EFH species, from sound generated during decommissioning activities are expected to be similar or less than those produced during the construction or O&M phases of the Projects.

The risks of noise-related impacts from other sound sources to EFH-designated finfish and invertebrates due to noise exposure and associated behavioral responses are expected to be very low. The mitigation measures that will be implemented for both marine mammals and sea turtles such as noise abatement systems and soft starts, are expected to minimize any sound-related impacts during all phases of the Projects.

7.6 Electromagnetic Fields

This section addresses electromagnetic fields (EMF) generated during operation of the Projects and the localized effects on EFH species and other NOAA trust resource species. EMFs are invisible areas of electric and magnetic energy that occur both naturally and anthropogenically in the marine environment. Atlantic Shores conducted an EMF study to predict EMF levels from operation of the Projects' submarine electrical system which includes a combination of HVDC and HVAC cables and OSSs (see Volume II, Appendix II-I of the COP). The modeling results show that EMF levels are predicted to decrease exponentially with increasing distance from the cables and are therefore expected to cause minimal risk to EFH species.

EFH species equipped with specialized sensory organs (e.g. elasmobranchs with ampullary receptors) or chemical or mechanical receptors (e.g., select invertebrates) may be able to detect electric fields generated in a marine environment (Normandeau et al. 2011). Studies have shown that the purpose of electrical field detection in invertebrates and fish is for prey and predator detection and also navigation (CSA Ocean Sciences Inc. and Exponent 2019; Normandeau et al. 2011). However, due to cable configuration and shielding, electric fields will not be released into the marine environment from Project cable operation, and therefore were not modeled in Volume II, Appendix II-I of the COP and are not further discussed in this section.

Magnetic fields will however be generated by the offshore cable system, which includes HVAC and HVDC export cables, HVAC interlink cables, and HVAC inter-array cables. Multiple theories have been proposed for finfish and invertebrate detection of magnetic fields. The most supported theory proposes the use of a magnetite-based system which involves the presence of magnetic crystals (magnetite) that can detect differences in magnetic fields (CSA Ocean Sciences, Inc. and Exponent 2019; Normandeau et al. 2011). Researchers believe magnetosensitive fish and invertebrate species use magnetic fields for orientation, migration, and navigation (Normandeau et al. 2011). Additionally, finfish species may also use magnetic field detection to locate food, habitat, and spawning grounds (CSA Ocean Sciences, Inc. and Exponent 2019). Magnetosensitivity has been observed in elasmobranchs and select bony fish, including the following species with EFH in the Offshore Project Area: clearnose skate, little skate, winter skate, spiny dogfish, yellowfin tuna, blue shark, common thresher shark, dusky shark, sand tiger shark, sandbar shark, shortfin mako shark, smooth dogfish, tiger shark, and white shark (CSA Ocean Science Inc. and Exponent 2019). Based on available literature, magnetosensitivity in invertebrates has been identified in three phyla including Mollusca (e.g. snails and bivalves), Echinodermata (e.g. sea urchins), and Arthropoda (e.g. lobsters) (Normandeau et al. 2011); however, the identification of specific magnetosensitive invertebrate species is lacking. Other finfish and invertebrate species with EFH in the Offshore Project Area (e.g. flounders, mackerels, scup, bluefish, black sea bass) likely lack the physiological components necessary to detect electric and magnetic fields and therefore are not expected to be adversely affected by EMF outputs from Project HVAC and HVDC export cables, HVAC inter-link cables, and HVAC inter-array cables.

Well-established magnetic field thresholds are lacking for finfish and invertebrates; however, research suggests that marine species may be more likely to detect magnetic fields from direct current (DC) sources than AC sources (Normandeau et al. 2011). Magnetic fields generated from HVAC and HVDC export cables and HVAC inter-link and inter-array cables used for the Projects will be minimized by cable burial (between approximately 5 to 6.6 feet [1.5 to 2 meters]) and armoring (see Volume 1, Section 4.5.1 of the COP), which will minimize potential impacts to demersal and pelagic species. Table 16 summarizes the modeled peak magnetic field production anticipated for Project HVAC and HVDC export cables and HVAC inter-array cables under maximum power generation scenarios for cable crossing and normal conditions. Model results also showed that magnetic fields produced by HVAC and HVDC export cables and HVAC inter-array cables decrease exponentially with increasing horizontal and vertical distance (see Volume II, Appendix II-I of the COP).

Table 16. Peak Magnetic Fields Modeled under Maximum Power Generation for the Atlantic Shores Export and Inter-Array Cables

Cable Type	Peak Magnetic Field (mG) for Maximum Modeled Case
HVAC[1]	
Export Cable	107.82
Export Cable (at cable crossing)	244.42
Inter-array Cable	60.07
HVDC	
Export Cable	152.68
Export Cable (at cable crossing)	349.22

[1] HVAC inter-link cables are part of the larger OSS electrical system, and were not analyzed as isolated, individual cables. However, due to the configuration of the inter-link cables, they are expected to operate in a similar fashion as either HVAC export cables or the inter-array cables.

Biologically significant impacts to EFH species have not been documented for EMF generated from AC cables (BOEM, 2020). Multiple studies provide evidence that fish and invertebrate species are unlikely to detect high frequency fields (e.g. 60 Hz) produced by AC cables (CSA Ocean Sciences Inc. and Exponent 2019; Normandeau et al. 2011). Laboratory studies examining frequency impacts from an AC source on skates found decreasing sensitivity as frequencies incrementally increased above 1 hertz (CSA Ocean Sciences Inc. and Exponent 2019). Researchers also believe that marine species with magnetite-based systems may not be able to detect magnetic fields below 50 milligauss from a high frequency (e.g. 50 or 60 hertz) AC source (Normandeau et al. 2011). Modeling of Atlantic Shores' HVAC export and inter-array cables, which will operate at 60 hertz, predict magnetic fields ranging from 60.07 to 244.42 milligaus at the cable centerline. However, the field is predicted to drop to approximately 50 milligauss between 5.4 and 8.4 feet (1.6 to 2.6 meters) in horizontal distance from the HVAC export cables and between 1.7 and 2.8 feet (0.52 to 0.85 meter) in horizontal distance from the inter-array cables. Additionally, magnetic field strength will drop to approximately 50 milligauss between 3.0 and 5.0 feet (0.91 and 1.5 meters) in vertical distance from HVAC export cables and 0.61 feet (0.19 meter) in vertical distance from inter-array cables. Since the HVAC export and inter-array cables will operate at 60 hertz, and the magnetic fields are predicted to drop to approximately 50 milligauss at a maximum horizontal distance of 8.4 feet (2.6 meters) and a maximum vertical distance of 5.0 feet (1.5 meters), it can reasonably be assumed that magnetic fields produced by Project HVAC offshore cables will result in minimal impacts to EFH-designated species in the Offshore Project Area.

It is likely that EFH-designated species potentially present in the immediate vicinity of the HVAC export and HVAC inter-array cables, where modeled magnetic levels are larger than 50 milligauss, may not experience effects. Studies on bamboo sharks, a small shark in the same family as dogfish (Scyliorhinidae), observed no impacts to behavior when exposed to magnetic field strengths of 14,300 milligauss from a 50 hertz AC source (CSA Ocean Sciences Inc. and Exponent 2019). Additional studies conducted on Atlantic salmon and American eel in the presence of a 950 milligauss magnetic field from a 50 hertz AC power source showed no impact on swimming behavior (CSA Ocean Sciences Inc. and Exponent 2019). Results of these studies provide evidence that magnetosensitive species may not be able to detect magnetic fields above 50 milligauss emitted from a high frequency AC source. Since magnetosensitive species have shown minimal effects in the presence of high magnetic field strengths emitted from high frequency AC sources, it can reasonably be assumed that other species in the Offshore Project Area which lack the physiological components to detect magnetic fields would not experience adverse impacts from magnetic fields produced by AC cable operation.

As previously stated, studies have shown finfish and invertebrates to be more sensitive to magnetic fields produced by DC cables than AC cables (Normandeau et al. 2011). Though thresholds have not been established for marine species in the presence of magnetic fields from a DC source, studies have aimed to determine potential impacts from such sources. Hutchison et al. (2018) examined behavioral impacts in little skates when exposed to a magnetic field of 655 milligauss from a DC cable. Results of this field study showed changes in behavior such as altered travel pattens and increased travel speed; however, the cable did not represent a barrier for crossing. Additional field studies observed migrating European eels (*Anguilla anguilla*) across a DC cable. While slower swimming speeds were observed when crossing the DC cable, the cable did not create a barrier to crossing or present any permanent obstacles to migrating adult eels or elvers (Normandeau et al. 2011). Woodruff et al. (2013) studied responses in the non-mangetosensitive Atlantic halibut (*Hippoglossus hippoglossus*) to graduated magnetic field strengths from a DC source ranging from 2,700 to 12,300 milligauss and found no significant changes in behavior. Given that the magnetic fields used in these studies far exceed the modeled magnetic fields from HVDC export cables for the Projects (Table 16 and the results of those studies did not result in substantial effects to the subject species, impacts from the Projects' HVDC export cables are not expected to adversely affect fish behavior in the Offshore Project Area.

Studies have also been conducted for benthic invertebrates to determine potential effects on behavior and movement from a DC source. Hutchison et al. (2018) conducted a field study which used enclosures situated over an existing DC cable to examine American lobster response in the presence of a maximum magnetic field of 653 milligauss DC. Results of the field study showed that though subtle changes in behavior (e.g. exploration activity) and differences in spatial distribution (e.g. use of enclosure space, proximity to seabed) were observed, the magnetic field did not present a barrier to movement. Laboratory studies have also been conducted on marine invertebrates to determine potential effects of magnetic fields produced by a DC source on invertebrate behavior and movement. Studies conducted by Woodruff et al. (2012 and 2013) examined responses of Dungeness crab and American lobster in the presence of high DC magnetic fields and observed no statistically significant difference in behavior (e.g. feeding) or spatial use (e.g. distribution in tanks). Woodruff et al. (2012) examined behavioral changes such as antennular flicking and feeding in Dungeness crabs when exposed to 30,000 milligauss DC. Results of the study showed no statistically significant differences between controlled (i.e. no DC field exposure) and experimental trials (i.e. 30,000 milligauss DC exposure). Woodruff et al. (2013) continued their study in 2012 and examined spatial distribution (e.g. location in tanks with respect to EMF source) and activity levels (e.g. time spent buried or active) of Dungeness crabs when exposed to 10,000 milligauss DC and found no statistical significance with respect to magnetic field strength. Woodruff et al. (2013) also studied changes in spatial use and behavior in American lobster when exposed to a maximum EMF level of 11,000 milligauss DC. Unlike the results of the Hutchison et al. (2018) field study, results from Woodruff et al. (2013) laboratory studies showed no correlation between EMF levels and spatial use (e.g. location in tank, time spent under shelter or buried) and behavior in American lobsters (e.g. activity levels). The magnetic DC fields used in the Hutchison et al. (2018) and Woodruff et al (2012 and 2013) studies are significantly greater than the modeled magnetic field levels expected to be generated by HVDC export cables for these Projects. Although some effects to the spatial distribution of American lobster were observed in the field studies conducted by Hutchison et al. (2018), the presence of the cable did not represent a barrier to crossing meaning effects to orientation, navigation, and homing would be unlikely.

Of the studies reviewed regarding effects of EMF on invertebrate and fish species, exposure did not result in substantial impacts to behavior. Demersal and benthic-oriented species that live on or close to the bottom have the greatest likelihood of encountering EMF from the Projects. Pelagic species that swim higher in the water column have a lower likelihood of encountering Project-generated EMF given the modeling results which showed an exponential decrease in magnetic fields with increasing vertical distance from the export or inter-array cable. CSA Ocean Sciences, Inc. and Exponent (2019) concluded that finfish species that are exposed to EMF from buried power cables may experience a behavioral effect during the time of exposure; however, most exposures would be short in duration (minutes, not hours) and the area affected would be small compared to surrounding available habitat for fish. Given the localized spatial extent of expected EMF emissions from the Projects and proposed mitigation measures, EMFs associated with Project operation are not expected to pose a risk to EFH species. Therefore, although magnetic fields would be present as long as the Projects are in operation, impacts from EMFs generated by Project offshore cables on EFH species would be highly localized and would likely be biologically insignificant, a conclusion also reached by BOEM (2020).

7.7 Lighting

Artificial light can attract or deter certain finfish and invertebrates. Reactions to artificial light are considered highly species-dependent. The amount of artificial Project lighting that would penetrate the sea surface is expected to be minimal and not likely to cause adverse effects to finfish or invertebrates, including EFH-designated species.

During construction, O&M, and decommissioning, vessels working or transiting during periods of darkness and fog will utilize navigational and deck lighting. During O&M, regardless of the foundation type selected, all WTG and OSS foundations will contain marine navigational lighting and marking in accordance with U.S. Coast Guard (USCG) and BOEM guidance. In addition to any required marine navigational lighting, some outdoor lighting on the OSS structures will be necessary for maintenance at night, which would be illuminated only when the OSS is manned.

Artificial light has the potential to cause behavioral reactions in finfish or pelagic invertebrates such as attraction or avoidance in a highly localized area. Artificial light could also disrupt diel vertical migration patterns in some fish and potentially increase the risk of predation or disrupt predator/prey interactions (Orr, 2013; BOEM, 2020). Artificial light generated from Project vessels used during construction, O&M, and decommissioning would be more intense from downward directed deck lighting compared to navigational lights. However, potential impacts from vessel lights will be transient and will only occur in a limited and localized area relative to surrounding unlit areas. Therefore, no substantial impacts to finfish or pelagic invertebrates with designated EFH are expected from vessel and deck lighting. The navigation lighting on the WTG and OSS structures during O&M is also not expected to substantially impact EFH-designated finfish or pelagic invertebrates since it is not downward-focused and the amount of light penetrating the sea surface is expected to be minimal (BOEM, 2020).

8.0 SUMMARY OF PROPOSED ENVIRONMENTAL PROTECTION MEASURES

The following provides a summary of proposed environmental protection measures that Atlantic Shores will implement to avoid and minimize impacts to EFH and EFH-designated species within the Offshore Project Area. Additional measures will be evaluated further in cooperation and coordination with Federal and state jurisdictional agencies and other stakeholders as the Projects continue to progress through development and permitting.

- Comprehensive benthic habitat surveys (seafloor sampling, imaging, and mapping) have been designed and conducted in consultation with BOEM and NOAA to support the identification of sensitive and complex habitats and the development of strategies for minimizing impacts to identified areas to the maximum extent practicable.
- HDD will be used to avoid seabed disturbance impacts to benthic habitat at the landfall sites. All HDD activities will be managed by an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid to ensure the protection of marine and inland surface waters from an accidental release of drilling fluid. All drilling fluids will be collected and recycled upon HDD completion.
- Nearshore cable installation activities will be conducted outside of the anticipated peak period of sandbar shark nursery and pupping activity between June 1st and September 1st.
- Inter-array, inter-link, and export cables will be buried to a target depth of 1.5 to 2 meters (5 to 6.6. feet) which will allow the benthic community to recover and recolonize, avoid direct interaction with finfish and benthic invertebrates, and minimize effects from EMF.
- Dynamically-positioned vessels and jet plow embedment will be used to the maximum extent practicable to reduce sediment disturbance during cable laying processes.
- Vessels will operate in compliance with regulatory requirements related to the prevention and control of discharges and accidental spills.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Volume I, Appendix I-C of the COP).
- Anchor midline buoys will be used on anchored construction vessels, where feasible, to minimize seabed disturbance.
- An anchoring plan will be employed for areas where anchoring is required to avoid impacts to sensitive habitats, to the maximum extent practicable, including hard bottom and structurally complex habitats, identified through the interpretation of site-specific HRG and benthic assessments.
- Soft starts and gradual "ramp-up" procedures (i.e., gradually increase sound output levels) will be employed for activities such as pile driving to allow mobile individuals to vacate the area during noise-generating activities.

- During impact pile-driving, a noise abatement system consisting of one or more available technologies (e.g., bubble curtains evacuated sleeve systems, encapsulated bubble systems, Helmholtz resonators) will be implemented to decrease the propagation of potentially harmful noise.
- A fisheries monitoring plan will be implemented to monitor baseline environmental conditions relevant to fisheries and how these conditions may change throughout Project construction and operation. Proposed fisheries surveys detailed in the Fisheries Monitoring Plan (see Volume II, Appendix II-K of the COP) include a demersal fish trawl survey, fish pot survey, and clam dredge survey.
- A benthic habitat monitoring plan will be implemented to measure and assess the disturbance and recovery of marine benthic habitats and communities as a result of Project construction and operation (see Volume II, Appendix II-H of the COP).

9.0 CONCLUSION

Most of the anticipated Project-related effects on EFH and EFH-designated species are expected to be localized and reversible as natural processes are expected to return temporarily disturbed areas to pre-construction conditions. The permanent impacts from the presence of structures and cables will only occur within a small area compared to the available surrounding undisturbed habitat. The introduction of structures to the Offshore Project Area are expected to be ecologically beneficial to structure-oriented species over the life of the Projects. The maximum total seabed disturbance in the WTA (temporary and permanent) is 5.61 square miles (14.5 square kilometers) which represents approximately 3.5% of the 160 square miles (413 square kilometers) WTA area. The maximum total seabed disturbance in the ECCs (temporary and permanent), excluding the portion of the ECCs located in the WTA, is 3.47 square miles (8.99 square kilometers), which represents approximately 7.2% of the total ECC area.

The majority of the temporary and permanent habitat disturbance will occur to soft bottom habitat, with the exception of the Monmouth ECC which contains larger portions of complex habitat compared to the rest of the Offshore Project Area. Though complex habitat is present in the Offshore Project Area and is expected to be temporarily and permanently disturbed by installation activities, such habitat consists of gravelly and gravelly mixes which is consistent with other areas of the Mid-Atlantic Bight. These areas of temporary and permanent habitat disturbance are small compared to the available undisturbed surrounding habitat in the Offshore Project Area. Where impacts are unavoidable, Atlantic Shores has selected installation tools and methods that minimize disturbance to bottom habitats, including complex and sensitive habitats, to the maximum extent practicable.

As demonstrated in Tables 6 and 7, many of the species with designated EFH in the Offshore Project Area have a completely pelagic lifestyle and most species have pelagic early life histories (Table 6) and are not dependent on benthic habitat. These species are expected to experience negligible impacts to their EFH as the pelagic zone will not be directly affected by most Project activities. Given their mobile nature, pelagic juvenile and adult life stages (Table 7) should largely avoid the areas affected by Project disturbance and are expected to return shortly after activities cease in a given location.

Project-related effects to EFH-designated species are expected to primarily occur to sensitive benthic early life stages and later sessile life stages. As described in Section 6.0, only four EFH-designated species have EFH for benthic early life stages in the Offshore Project Area (ocean pout eggs, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs) (Table 8). Additionally, only two EFH-designated species have sessile benthic later life stages in the Offshore Project Area (Atlantic surfclam juveniles and adults and ocean quahog juveniles and adults) (Table 9). Tables 8 and 9 show that these species have EFH designated in only a portion of each of the components of the Offshore Project Area. The remaining benthic or demersal species are mobile later life stages (Table 9) and can temporarily leave the area during Project activities. Therefore, overall Project impacts to EFH and EFH-designated species are not expected to be biologically significant.

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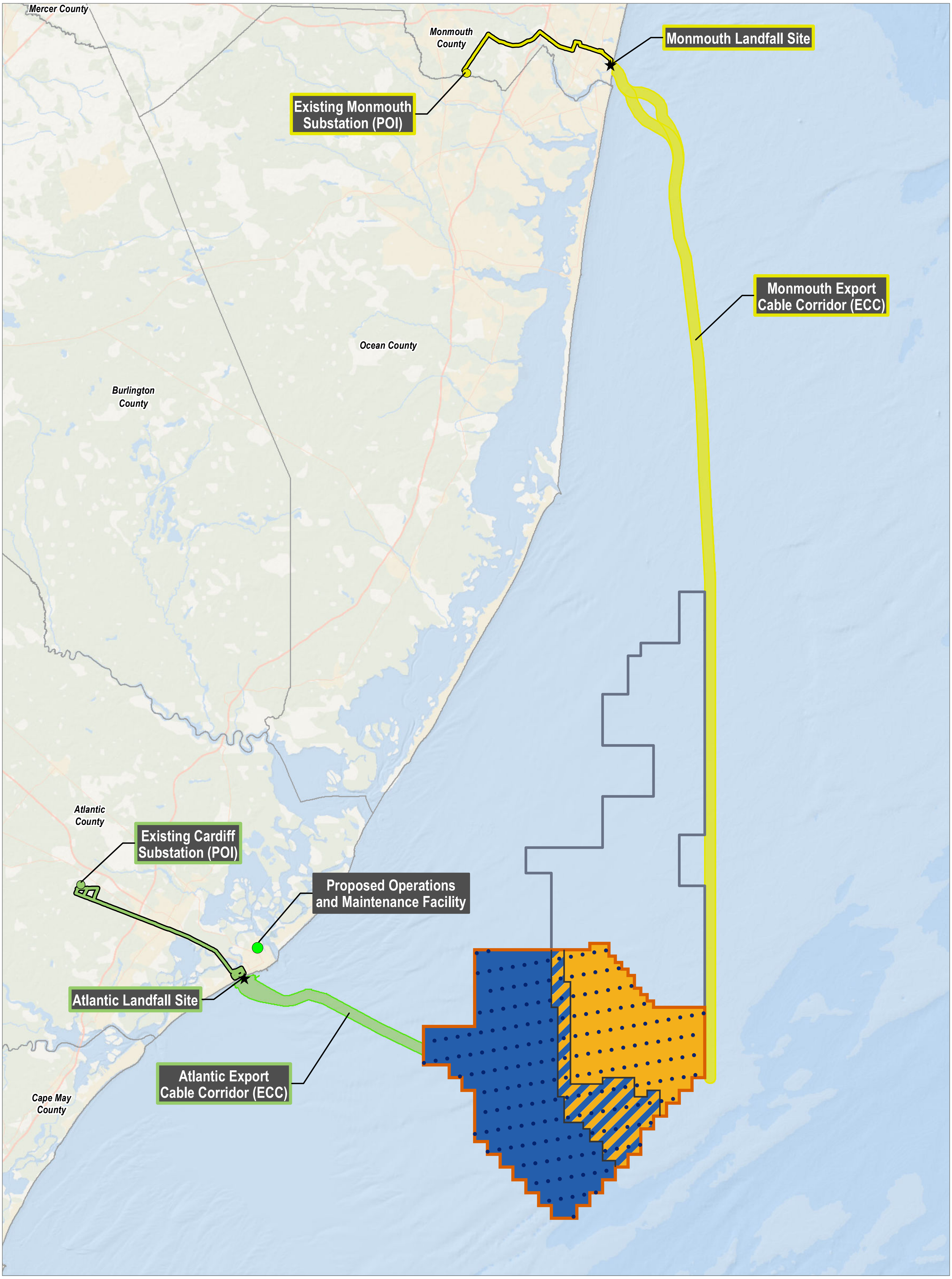
Figures

Figure 1. Project Overview



Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ● Proposed Operations and Maintenance Facility
- ● Existing Cardiff Substation (POI)
- ● Existing Larrabee Substation (POI)
- • Wind Turbine Generators
- ▬ Cardiff Onshore Interconnection Cable Route
- ▬ Larrabee Onshore Interconnection Cable Route
- 🟩 Atlantic Export Cable Corridor (ECC)
- 🟨 Monmouth Export Cable Corridor (ECC)
- ☐ Atlantic Shores Wind Turbine Area (WTA)
- 🟦 Project 1 WTA
- 🟧 Project 2 WTA
- ▨ Overlap Area
- ☐ Atlantic Shores Lease Area OCS-A 0499

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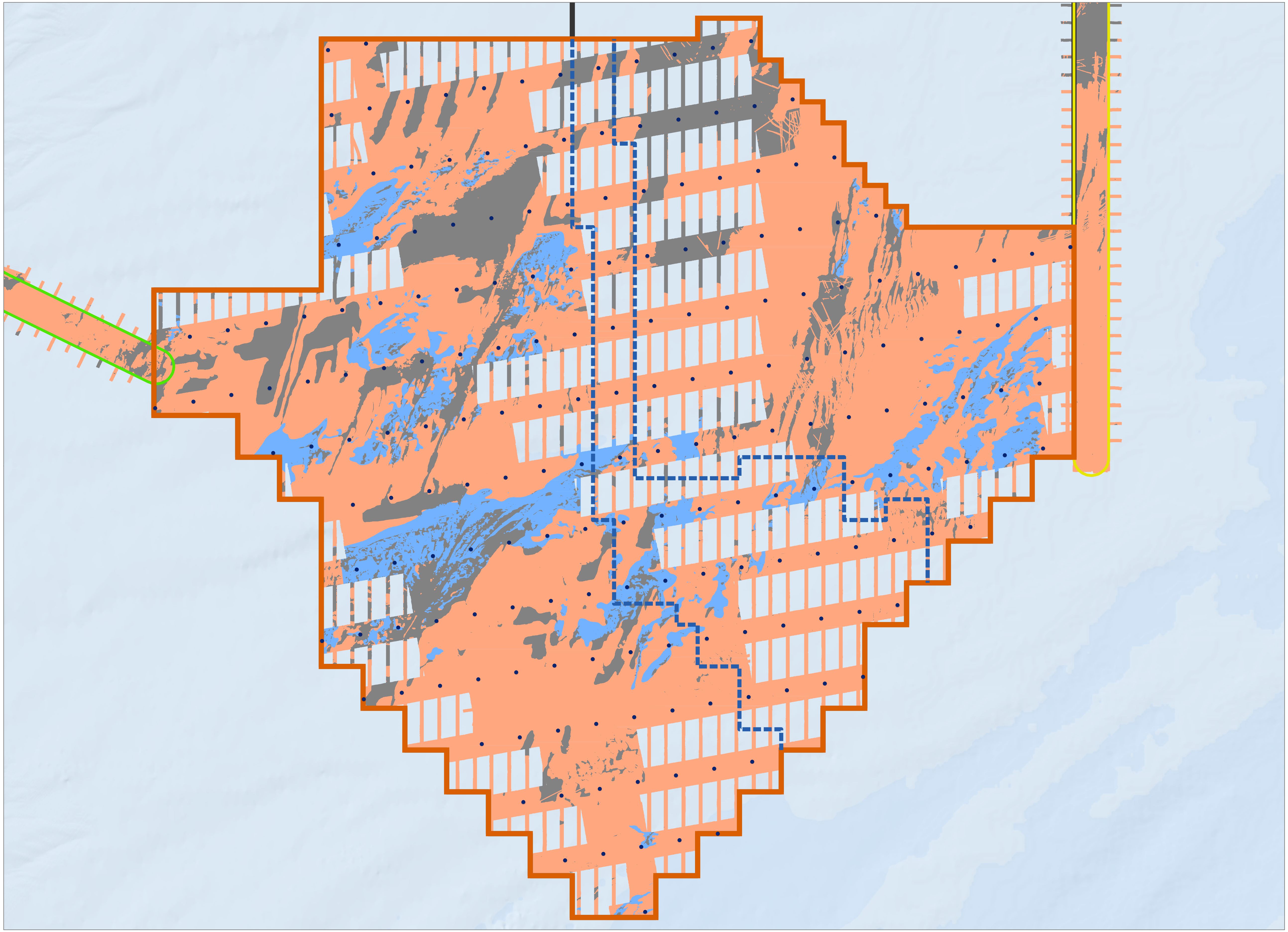
Basemap: ESRI ArcGIS Online "World Ocean" map service.

Figure 2. Habitat Types in Offshore Project Area

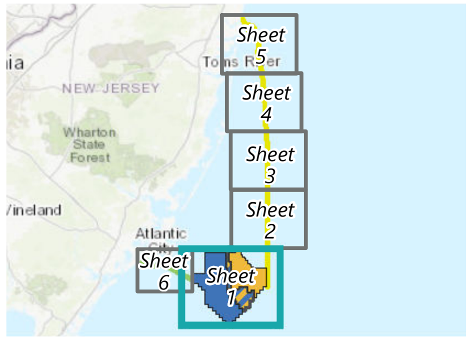


Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

■ Complex Sediment
■ Heterogeneous Complex Sediment
■ Soft Sediment
• Wind Turbine Generators
□ Atlantic Export Cable Corridor (ECC)
□ Monmouth Export Cable Corridor (ECC)
□ Atlantic Shores Wind Turbine Area (WTA)
┅ Atlantic Shores WTA Project Boundary
■ Project 1 WTA
■ Project 2 WTA
▨ Overlap Area
□ Atlantic Shores Lease Area OCS-A 0499



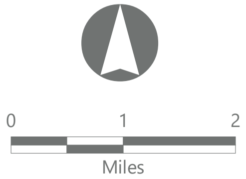


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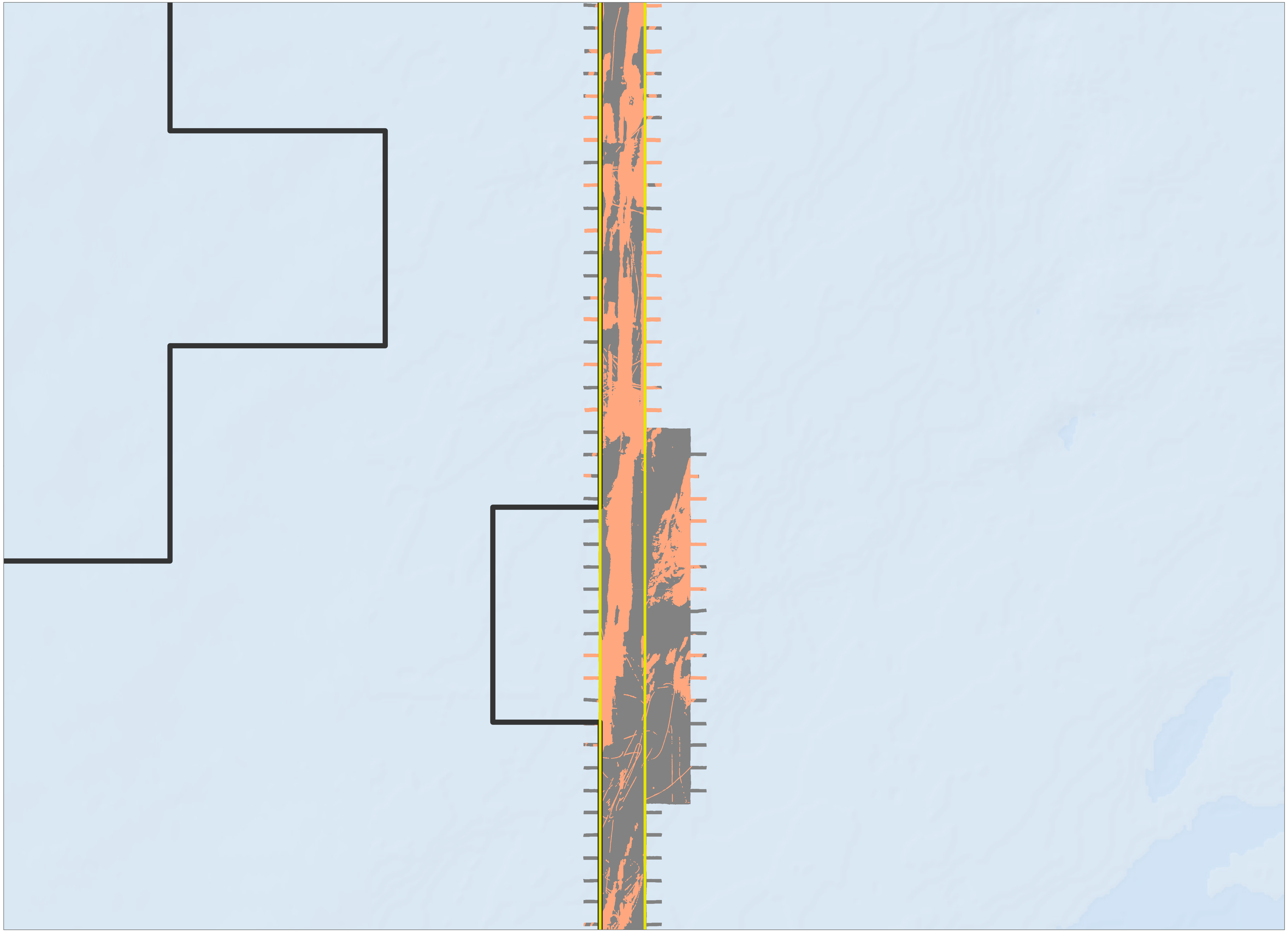
Figure 2. Habitat Types in Offshore Project Area



Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ■ Complex Sediment
- ■ Soft Sediment
- □ Monmouth Export Cable Corridor (ECC)
- □ Atlantic Shores Wind Turbine Area (WTA)
- ■ Project 1 WTA
- ■ Project 2 WTA
- ▨ Overlap Area
- □ Atlantic Shores Lease Area OCS-A 0499

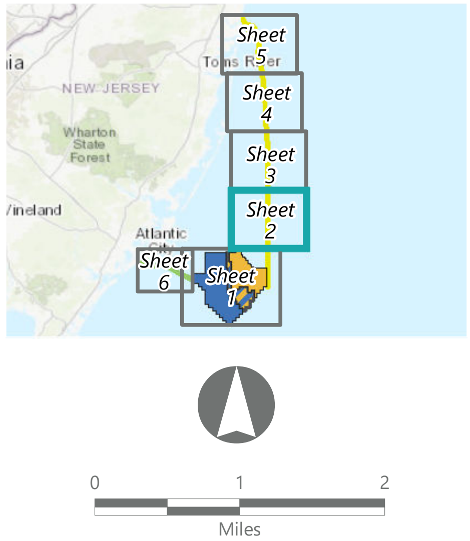


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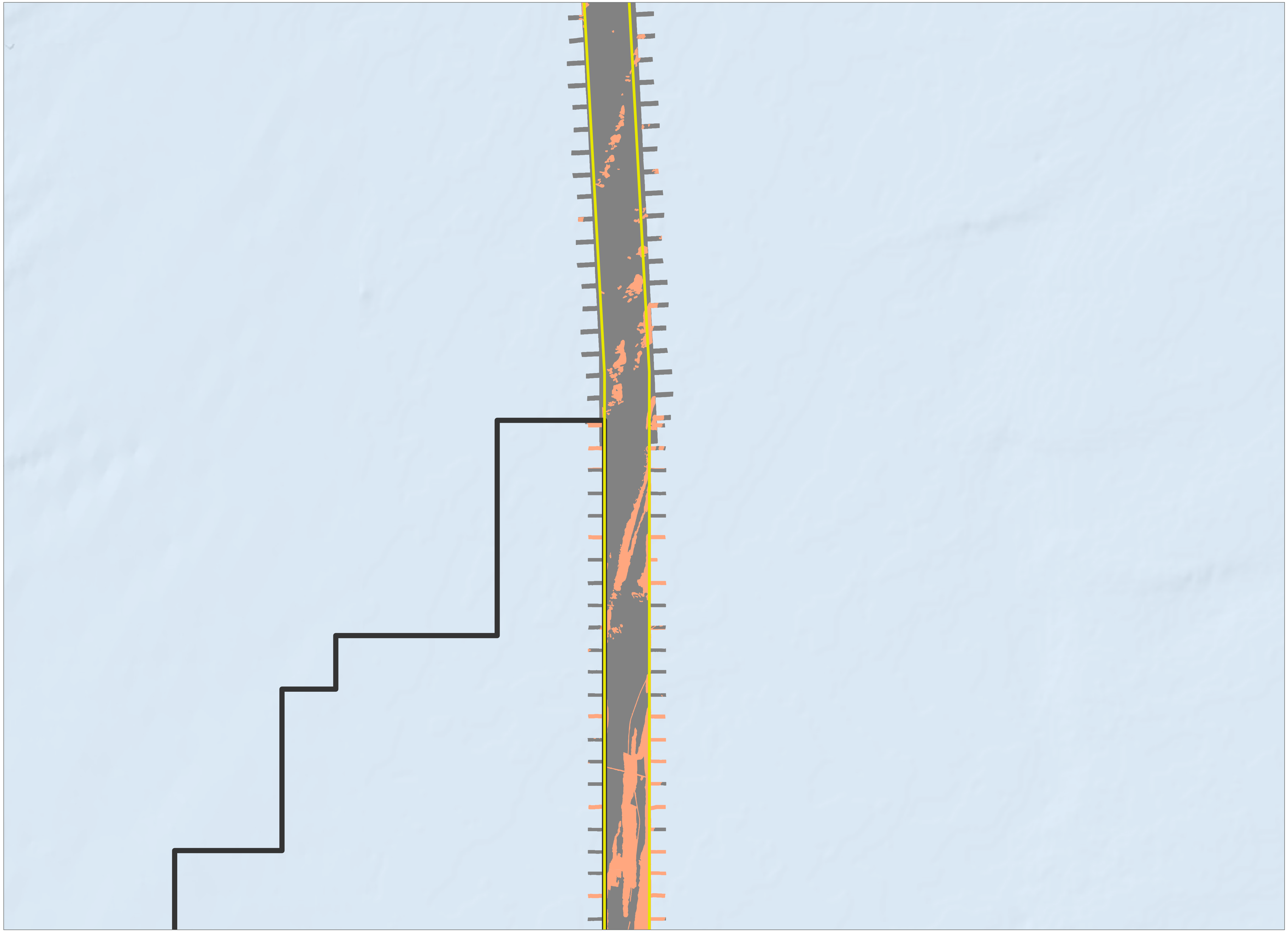
Figure 2. Habitat Types in Offshore Project Area

Sheet 3 of 6



Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ■ Complex Sediment
- ■ Soft Sediment
- □ Monmouth Export Cable Corridor (ECC)
- □ Atlantic Shores Wind Turbine Area (WTA)
- ■ Project 1 WTA
- ■ Project 2 WTA
- ▨ Overlap Area
- □ Atlantic Shores Lease Area OCS-A 0499

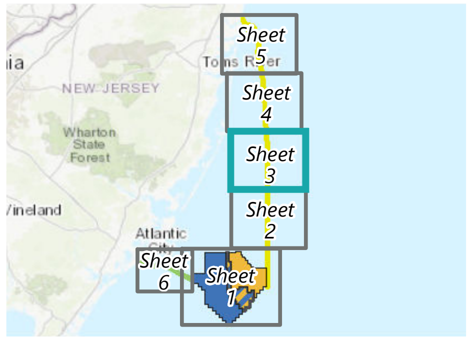


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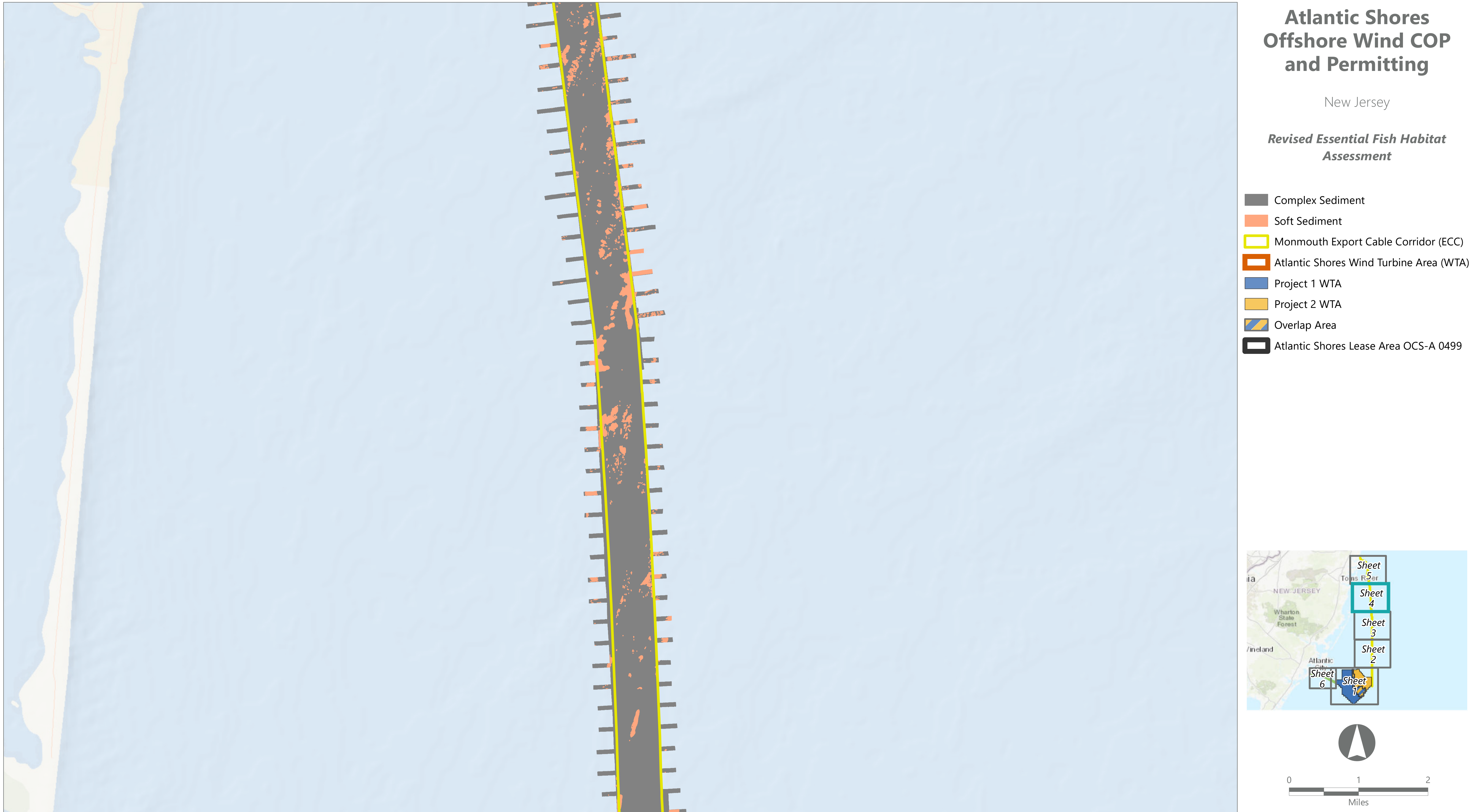
Figure 2. Habitat Types in Offshore Project Area



Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ■ Complex Sediment
- ■ Soft Sediment
- □ Monmouth Export Cable Corridor (ECC)
- □ Atlantic Shores Wind Turbine Area (WTA)
- ■ Project 1 WTA
- ■ Project 2 WTA
- ▨ Overlap Area
- □ Atlantic Shores Lease Area OCS-A 0499

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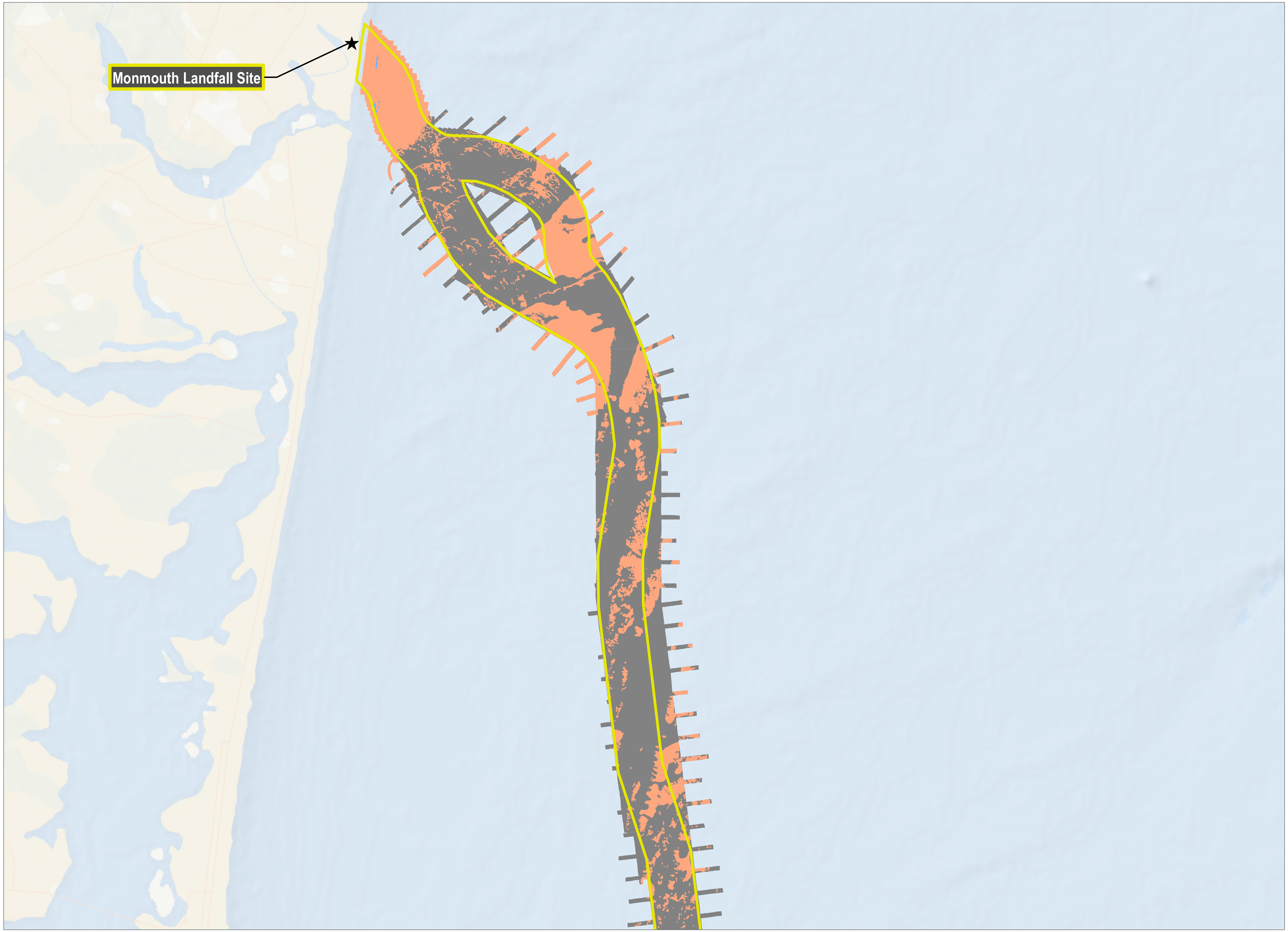
Figure 2. Habitat Types in Offshore Project Area



Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ▇ Complex Sediment
- ▇ Heterogeneous Complex Sediment
- ▇ Soft Sediment
- ☐ Monmouth Export Cable Corridor (ECC)
- ☐ Atlantic Shores Wind Turbine Area (WTA)
- ▇ Project 1 WTA
- ▇ Project 2 WTA
- ▨ Overlap Area
- ☐ Atlantic Shores Lease Area OCS-A 0499

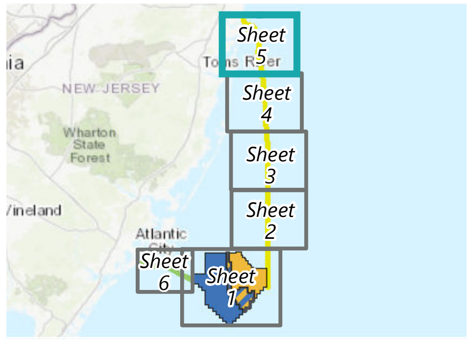


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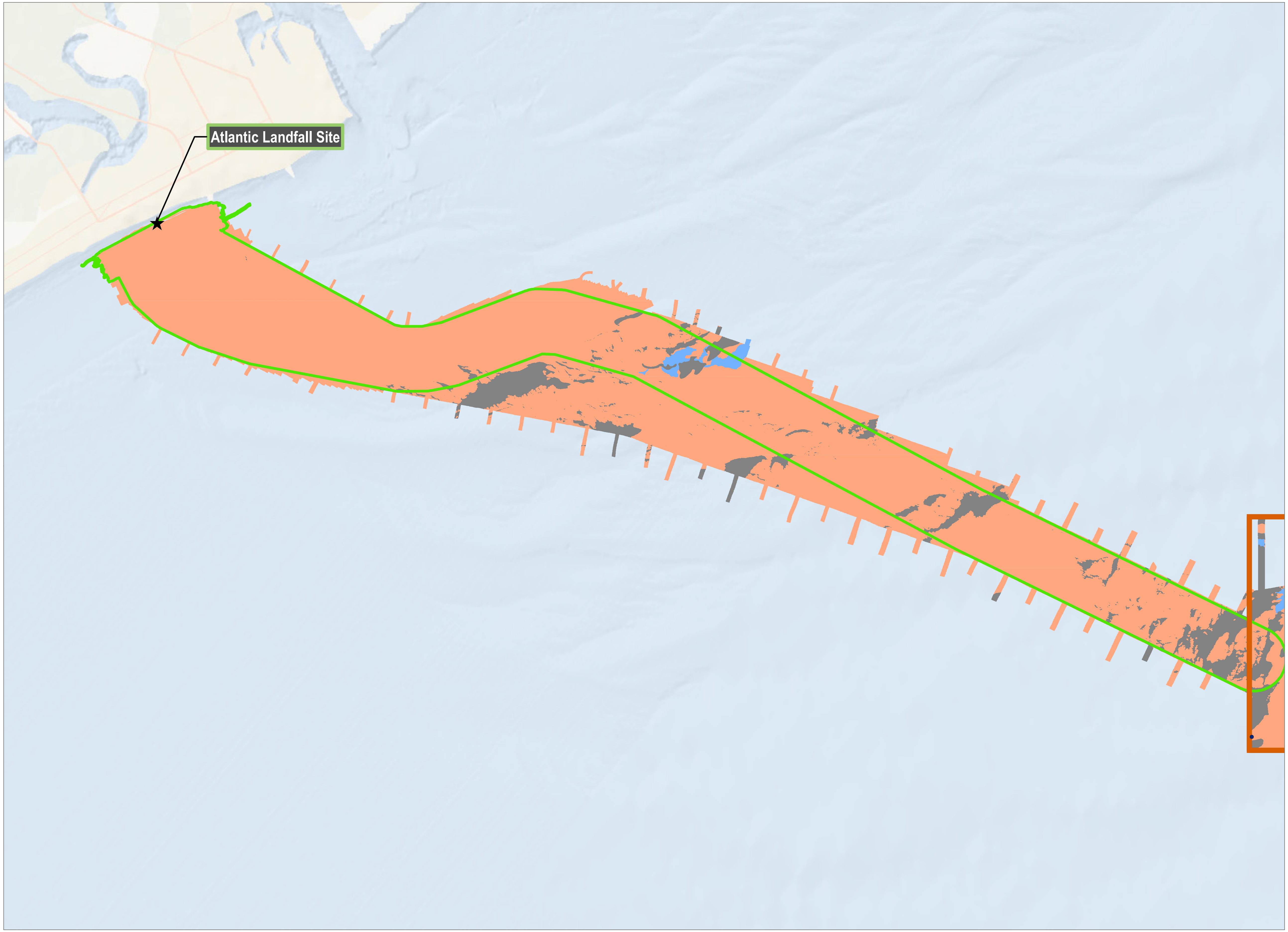
Figure 2. Habitat Types in Offshore Project Area

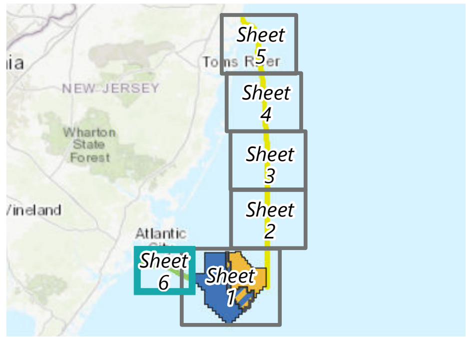


Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ▆ Complex Sediment
- 🟦 Heterogeneous Complex Sediment
- 🟧 Soft Sediment
- • Wind Turbine Generators
- 🟩 Atlantic Export Cable Corridor (ECC)
- 🟥 Atlantic Shores Wind Turbine Area (WTA)
- 🟦 Project 1 WTA
- 🟨 Project 2 WTA
- ▨ Overlap Area
- ⬛ Atlantic Shores Lease Area OCS-A 0499



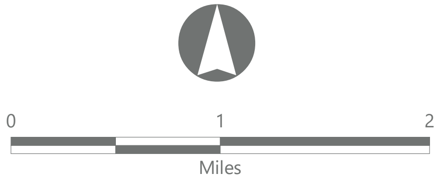


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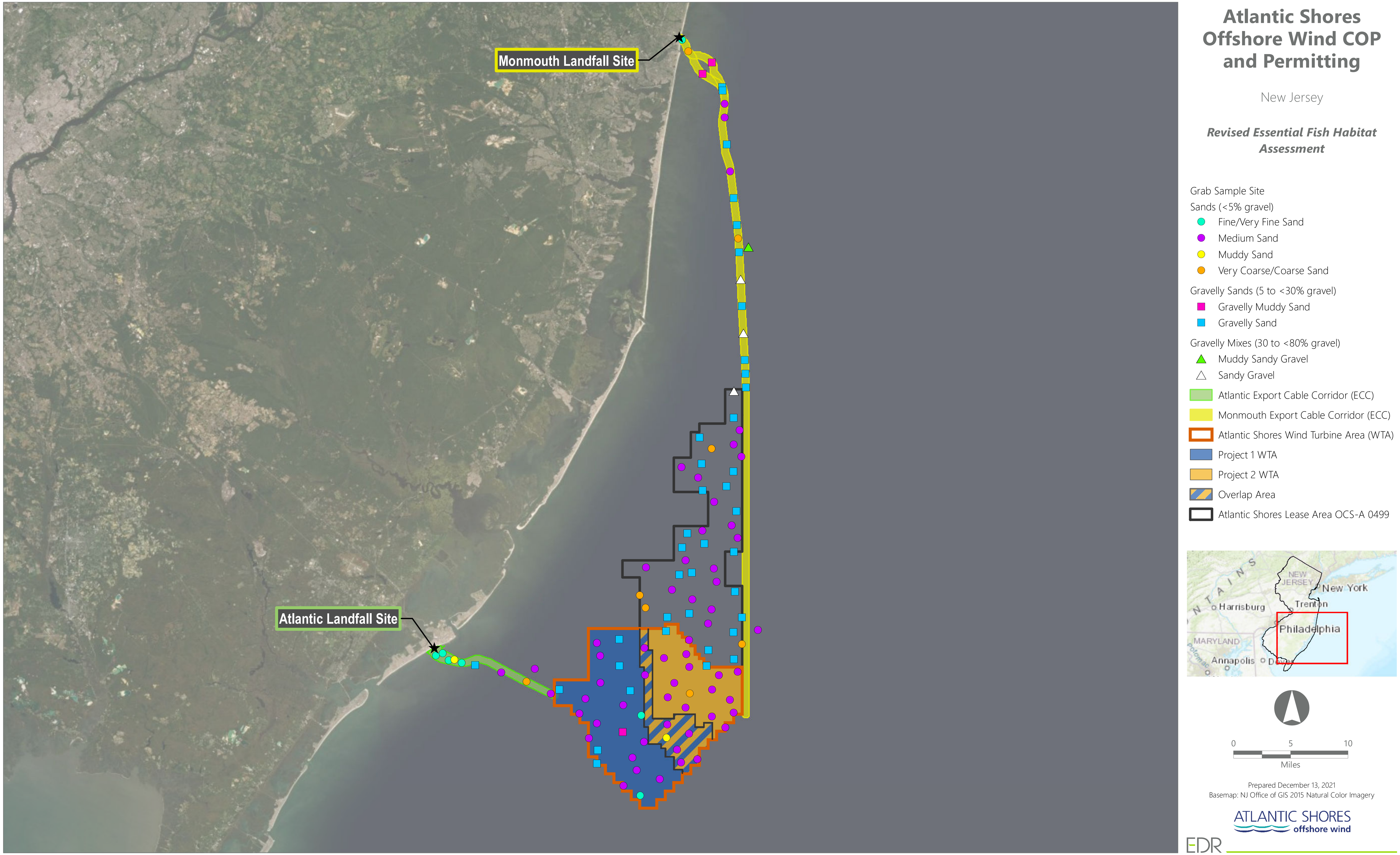
Figure 3. NMFS CMECS Classifications



Atlantic Shores Offshore Wind COP and Permitting

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Revised Essential Fish Habitat Assessment

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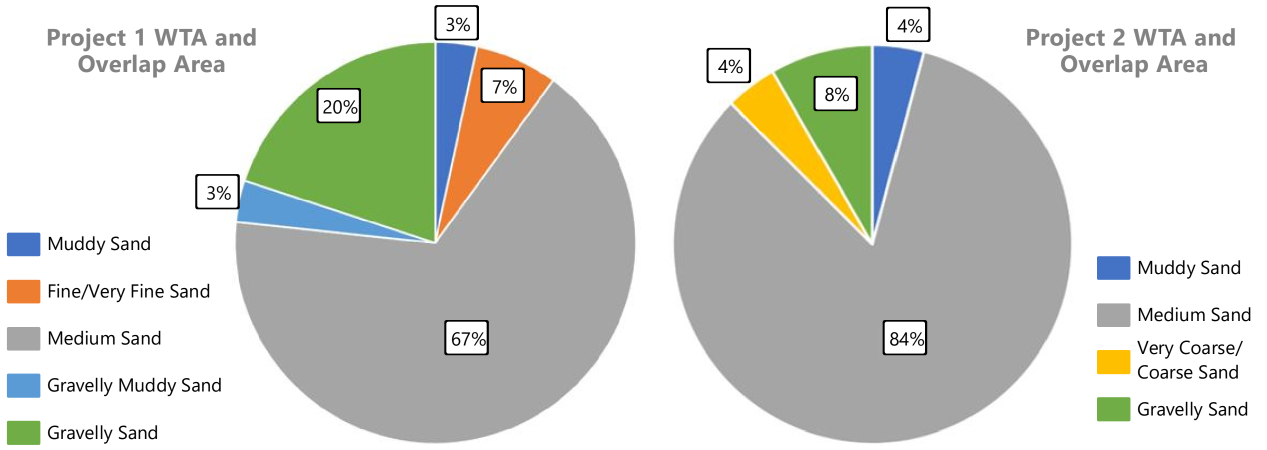
Figure 4. Proportion of NMFS CMECS Sediments in the WTA, Atlantic ECC, and Monmouth ECC

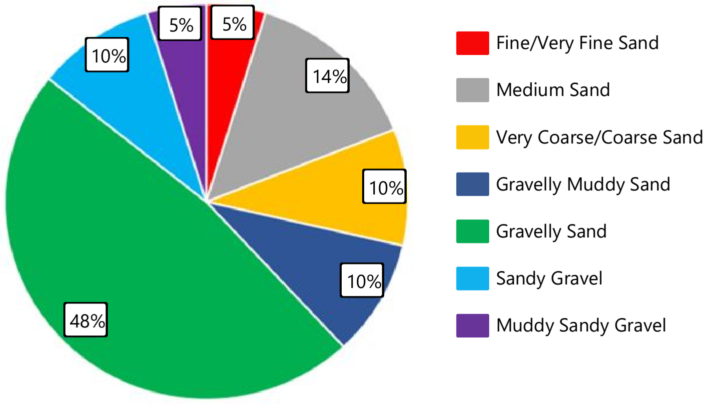
Wind Turbine Area (WTA)

Percent of WTA Samples in Each CMECS Subgroup



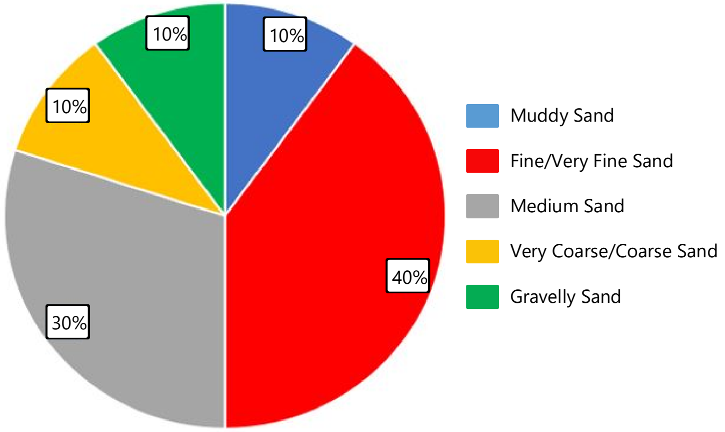
Monmouth Export Cable Corridor (ECC)

Percent of Monmouth ECC Samples in Each CMECS Subgroup



Atlantic Export Cable Corridor (ECC)

Percent of Atlantic ECC Samples in Each CMECS Subgroup



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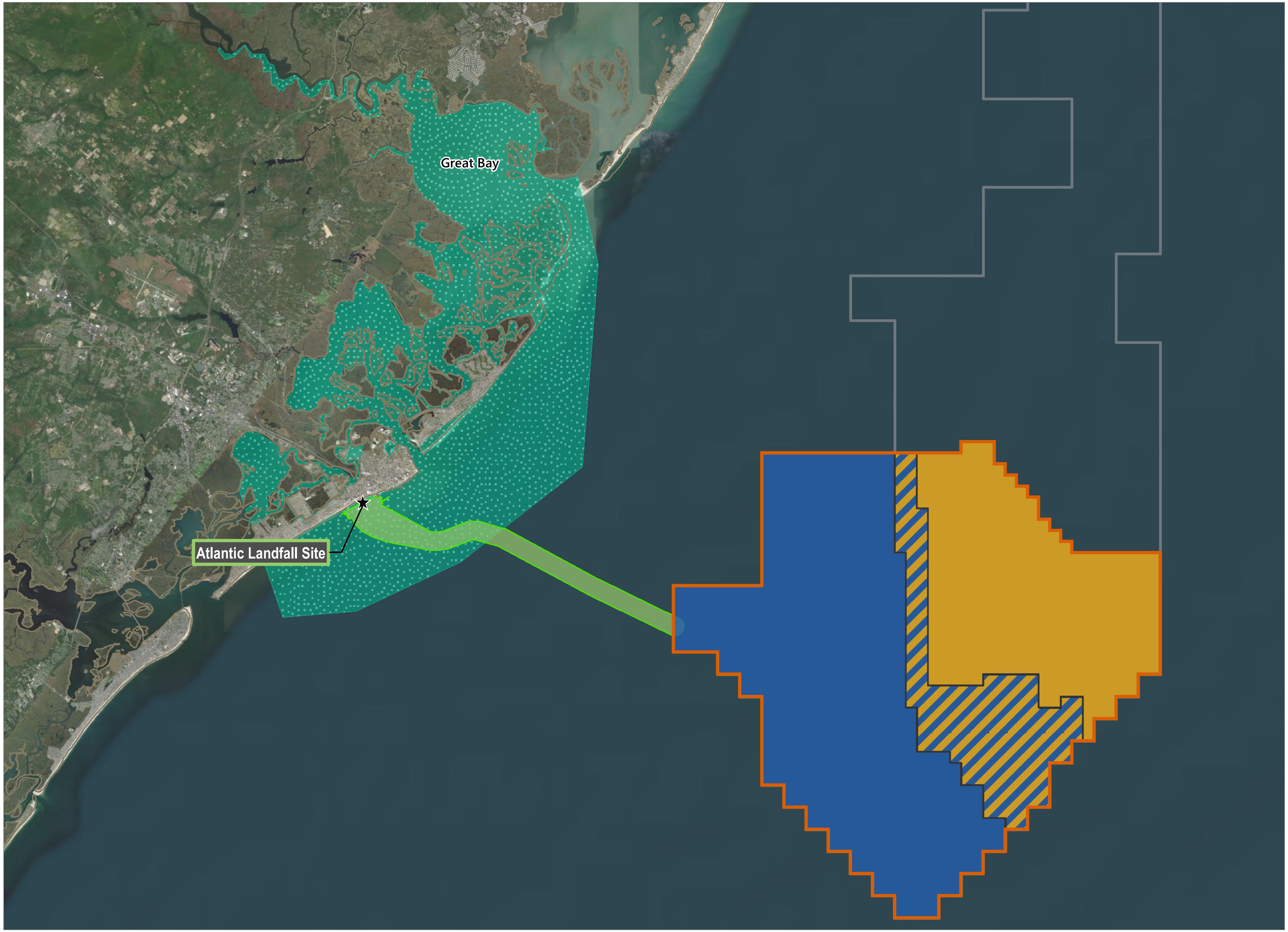
Data Source: RPS Benthic Assessment Report (2020) (Appendix II-G2)

Figure 5. Habitat Area of Particular Concern for Sandbar Shark



Atlantic Shores Offshore Wind COP and Permitting

New Jersey

Revised Essential Fish Habitat Assessment

- ▨ Sandbar Shark Habitat Area of Particular Concern (HAPC)
- 🟩 Atlantic Export Cable Corridor (ECC)
- ☐ Atlantic Shores Wind Turbine Area (WTA)
- 🟦 Project 1 WTA
- 🟨 Project 2 WTA
- ▨ Overlap Area
- ☐ Atlantic Shores Lease Area OCS-A-0499

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Basemap: ESRI ArcGIS Online "World Imagery" map service.

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