VINEYARD NORTHEAST

CONSTRUCTION AND OPERATIONS PLAN
VOLUME II APPENDIX

MARCH 2024

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VINEYARD OFFSHORE

PUBLIC VERSION

Vineyard Northeast COP

Appendix II-B Marine Site Investigation Report

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March 2024

Revision	Date	Description
0	July 2022	Initial submission.
1	October 2022	Updated to include additional data collected in 2022.
2	May 2023	Updated to include all geophysical, geotechnical, and biological data collected for the Lease Area and Offshore Export Cable Corridors (OECCs) and to include additional geotechnical analysis prior to the Facility Design Report (FDR)/Fabrication and Installation Report (FIR). Updated to address Bureau of Ocean Energy Management (BOEM) and United States Coast Guard (USCG) Round 1 COP Comments, Round 2 COP Comments, and Deep Geotechnical Departure Request comments.
3	November 2023	Incorporated the 2023 Ground Model and the Preliminary Foundation Feasibility Assessment and Pile Drivability Assessment. Removed reference to the potential New York OECC, which would be developed as part of Phase 2 of Vineyard Northeast. Updated to address BOEM Round 4 COP comments (dated September 29, 2023).
3	March 2024	Resubmitted without revisions.

Executive Summary

The Executive Summary is redacted in its entirety.

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List of Acronyms & Abbreviations

ALARP	As Low As Reasonably Practical
ALS	Accidental Limit State
AML	Applied Microsystems Ltd
AMP	Alternative Monitoring Plan
ANOVA	Analysis of variance
ANOSIM	Analysis of similarities
ASLF	Ancient Submerged Landform Features
ATON	Aid to navigation
AWOIS	Automated Wreck and Obstruction Information System
BOEM	Bureau of Ocean Energy Management
BSB	Below seabed
Chirp	Compressed high intensity radar pulse
CMECS	Coastal Marine Ecological Classification Standard
COP	Construction and Operations Plan
CPT	Cone Penetration Test
CTD	Conductivity, temperature, density
CT DEEP	Connecticut Department of Energy and Environmental Protection
CZM	Coastal Zone Management
DGNSS	Differential global navigation system
DGPS	Differential Global Positioning System
DP	Dynamic positioning
EFH	Essential fish habitat
ESA	Ecologically significant area
ESP	Electrical service platform
FDR	Facility Design Report
FIR	Fabrication and Installation Report
FLS	Fatigue Limit State
g	Peak Ground Acceleration
G&G	Geological and Geotechnical
GNSS	Global navigation satellite system
GRAD	Gradiometer
HAPC	Habitat Areas of Particular Concern
HD	High definition
HRG	High resolution geophysical
HSSE	Health, safety, security, and environment
HVAC	High voltage alternating current
HVDC	High voltage direct current
IHA	Incidental Harassment Authorization
KP	Kilometer post
Lease	Vineyard Northeast Lease OCS-A 0522
LGM	Last glacial maximum

List of Acronyms & Abbreviations (Continued)

LIS	Laurentide ice sheet
LPTL	Lowest practical taxonomic level
M	Magnitude
MA WEA	Massachusetts Wind Energy Area
MBES	Multibeam echo sounder
MCS	Multi-channel seismic
MEC	Munitions and explosives of concern
MLLW	Mean Lower Low Water
MSIR	Marine Site Investigation Report
M/V	Motor Vessel
NBMCT	New Bedford Marine Commerce Terminal
NEFSC	New England Fisheries Science Center
NMDS	Non-metric multidimensional scaling
NMFS	National Marine Fisheries Service
NMO	Normal moveout
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NVB	Night vision binoculars
OCS	Outer continental shelf
OECC	Offshore Export Cable Corridor
PAM	Passive acoustic monitoring
PAPE	Preliminary Area of Potential Effects
PATON	Private Aids to Navigation
PCPT	Piezocone Penetration Test
POI	Points of interconnection
POS	Position and orientation technology
PPK	Post processed kinematic
PSO	Protected species observer
QMA	Qualified Marine Archaeologist
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area
ROV	Remotely operated vehicle
RSD	Ripple scour depressions
RTK	Real time kinematic
R/V	Research vessel
SAP	Site Assessment Plan
SAV	Submerged aquatic vegetation
SBET	Smoothed Best Estimate of Trajectory
SBP	Subbottom profiler
SCS	Single-channel seismic
SEGY	Society of Exploration Geologists

List of Acronyms & Abbreviations (Continued)

SLS	Serviceability limit state
SME	Subject matter expert
SSS	Side scan sonar
SSU	Special, sensitive, and unique (habitats)
SVP	Sound velocity profile(s)
TRI	Terrain ruggedness index
TVG	time variable gain
UConn	University of Connecticut
ULS	Ultimate limit state
US	United States
USBL	Ultra-short baseline
USCG	United States Coast Guard
USCS	Unified Soils Classification System
USGS	United States Geological Survey
UXO	Unexploded ordnance
WTG	Wind turbine generator

Units

mm	millimeter(s)
cm	centimeter(s)
m	meter(s)
km	kilometer(s)
in	inch
ft	feet
mi	statute mile(s)
NM	nautical mile(s)
kHz	kilohertz
kn	knot(s)
m/s	meters per second
ya	years ago
nT	nanoteslas
H’	Shannon diversity index
J’	Pielou’s evenness
N m^{-2}	Number of individuals per square mile

Unit Conversions

1 km = 1,000 m = 3,280.8 ft
1 nm = 6,076 ft = 1,851.9 m = 1.852 km
1 mi = 5,280 ft = 1,609.3 m = 1.609 km
1 m = 3.28 ft = 100 cm
1 fathom = 6 feet = 1.8288 m
1 cm = 10 mm
1 inch = 2.54 cm
1 km^2 = 247.1 acres
1 nT = 1 g

Geology Classifications

Bedforms (BOEM general classification)

Name	Wavelength	Height
Sand wave	>60 m (>196.8 ft)	>1.5 m (>4.9 ft)
Megaripple	5-60 m (16.4-196.8 ft)	0.5-1.5 m (1.6-4.9 ft)
Ripple	<5 m (<16.4 ft)	<0.5 m (<1.6 ft)

Grain Size (Unified Soils Classification System)

Soil Component	Fraction	Particle Size (mm)	Particle Size (inches)
Boulder	--	>300	>11.8
Cobble	--	76-300	2.9-11.8
Gravel	Coarse	19-76	0.75-2.9
	Fine	4.75-19	0.19-0.75
Sand	Coarse	2-4.75	0.08-0.19
	Medium	0.43-2	0.02-0.08
	Fine	0.08-0.43	0.003-0.02
Fines	Silt	0.004-0.074	0.0002-0.003
	Clay	<0.004	<0.003

Slope Gradients (BOEM general classification)

Class	Gradient
Very gentle	<1°
Gentle	1 to 4.9°
Moderate	5 to 9.9°
Steep	10 to 14.9°
Very steep	>15°

NMFS (2021) Benthic Habitat Classifications

<table>
<tr><th>Class</th><th>Subclass</th><th>Group</th><th>Subgroup</th><th>Grain Size (mm)</th><th>Component %</th><th>NMFS Habitat</th></tr>
<tr><td>Rock Substrate</td><td>Bedrock/ Megaclast</td><td>--</td><td>--</td><td>≥ 4,096</td><td>>50% Rock</td><td rowspan="12">Complex</td></tr>
<tr><td rowspan="11">Unconsolidated Mineral Substrate</td><td rowspan="11">Coarse Unconsolidated Substrate</td><td rowspan="4">Gravels</td><td>Boulder</td><td>256–<4,096</td><td rowspan="4">≥80% Gravel</td></tr>
<tr><td>Cobble</td><td>64-<256</td></tr>
<tr><td>Pebble/ Granule</td><td>2–<64</td></tr>
<tr><td>Gravel Pavement</td><td>2–<4,096</td></tr>
<tr><td rowspan="3">Gravel Mixes</td><td>Sandy Gravel</td><td rowspan="3">Mix of Gravels, Sand, and Mud</td><td>30 – 80% Gravel; Sand is ≥90% of remaining Sand-Mud mix</td></tr>
<tr><td>Muddy Sandy Gravel</td><td>30–80% Gravel; Sand is 50–≥90% of remaining Sand-Mud mix</td></tr>
<tr><td>Muddy Gravel</td><td>30–80% Gravel; Mud is ≥50% of remaining Sand-Mud mix</td></tr>
<tr><td rowspan="2">Gravelly</td><td>Gravelly Sand</td><td rowspan="2">Mix of Gravels, Sand, and Mud</td><td>5–<30% Gravel; Sand is ≥90% of remaining Sand-Mud mix</td></tr>
<tr><td>Gravelly Muddy Sand</td><td>5–<30% Gravel; Sand is <50–≥90% of remaining Sand-Mud mix</td></tr>
</table>

NMFS (2021) Benthic Habitat Classifications (Continued)

Class	Subclass	Group	Subgroup	Grain Size (mm)	Component %	NMFS Habitat
Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravelly	Gravelly Mud	Mix of Gravels, Sand, and Mud	5–<30% Gravel; Mud is ≥50% of remaining Sand-Mud mix	Complex
	Fine Unconsolidated Substrate	Sand	Very Coarse/ Coarse Sand	0.5–<2	<5% Gravel; ≥90% Sand	Soft Bottom
			Medium Sand	0.25–<0.5		
			Fine/Very Fine Sand	0.0625–<0.25		
		Muddy Sand	--	<0.0625	<5% Gravel; 50–<50% Sand; remainder is silt-clay mix	
		Sandy Mud	--		<5% Gravel; 10-<50% Sand; remainder is silt-clay mix	
		Mud	--		<5% Gravel; ≥90% Mud; remainder is Sand	
Shell Substrate	Shell Reef Substrate	Clam Reef Substrate	--	>4,096	>50% shell cover	Complex
		Crepidula Reef Substrate	--			
		Mussel Reef Substrate	--			
		Oyster Reef Substrate	--			
	Shell Rubble	--	--	64–<4,096		
	Shell Hash	--	--	2–<64		

1 Introduction

1.1 Overview

Vineyard Northeast LLC (the "Proponent") proposes to develop, construct, and operate offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0522 (the "Lease Area") along with associated offshore and onshore transmission systems. This proposed development is referred to as "Vineyard Northeast." Vineyard Northeast includes 160 total wind turbine generator (WTG) and electrical service platform (ESP) positions within the Lease Area. Up to three of those positions will be occupied by ESPs and the remaining positions will be occupied by WTGs. Two offshore export cable corridors (OECCs) –the Massachusetts OECC and the Connecticut OECC–will connect the renewable wind energy facilities to onshore transmission systems in Massachusetts and Connecticut. Figure 1.1-1 provides an overview of Vineyard Northeast. All figures referenced within the MSIR text can be found in Appendix II-B1.

The Lease Area is approximately 536 square kilometers (km^2) (132,370 acres) in size and orientated in the far eastern portion of the Massachusetts Wind Energy Area (MA WEA). The closest point from the Lease Area to shore is 46 kilometers (km) (29 miles [mi]) respectively south of the island of Nantucket, Massachusetts. The WTGs and ESPs within the Lease Area will be oriented in an east-west, north-south grid pattern with 1.9 km (one nautical mile [NM]) spacing between positions. The Offshore Development Area includes the Lease Area, OECCs, and broad regions surrounding offshore facilities that could be affected by Vineyard Northeast related activities.

The Offshore Development Area was investigated to assess the site conditions and feasibility during the 2019 and 2022 survey field programs referenced within this document. Two OECCs for the installation of offshore export cables were identified from the 2022 survey efforts: the Massachusetts OECC for routing offshore export cables between the Lease Area and landfall site in Massachusetts, and the Connecticut OECC for routing offshore export cables between the Lease Area and potential landfall sites in Connecticut (see Figures 1.1-2 and 1.1-3).

This MSIR addresses offshore areas being considered for the development of Vineyard Northeast at the time of this report submission. This combines the results of the field programs completed in 2019 and 2022, as well as the appropriate supporting information to satisfy the BOEM requirements. These requirements (BOEM 2020b) are laid out in the *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)* dated May 27, 2020, the federal regulations in 30 CFR 585.626(a), and the *FINAL Information Needed for Issuance of a Notice of Intent (NOI) Under the National Environmental Policy Act (NEPA) for a COP* document (BOEM 2023). The detailed list of report components that fulfill the federal regulations and their location within the COP can be found in Table 7.3-2 of COP Volume I.

1.2 Objectives

The site investigations were performed to satisfy the requirements outlined within the stipulations in Lease OCS-A 0522 as well as the relevant BOEM guidelines. The Proponent acquired the rights to Lease Area OCS-A 0522 from Vineyard Wind LLC in late 2021[1]. Survey activities also met the requirements of other federal agencies responsible for oversight of specific tasks associated with the offshore program, such as protected species mitigation (e.g., National Marine Fisheries Service [NMFS]).

To support the site characterization studies required by the Lease OCS-A 0522 stipulations, geological and geotechnical (G&G) surveys were conducted, including high resolution geophysical (HRG) investigations, and data were acquired to map the surface and subsurface site conditions. Extensive research was also performed, and publicly available datasets were integrated into Vineyard Northeast databases for supplementing site condition maps. The purpose of these studies was to:

1. Support the initial design phases of the WTG/ESP foundations as well as other initial deep engineering evaluations in the Lease Area.
2. Provide data for mapping site conditions in the OECCs and to support cable route selection, burial assessment, engineering/design, and construction planning.
3. Acquire information to allow geohazards interpretations and analysis to aid in ground model creation.
4. Inform the Proponent and stakeholders of environmental issues and sensitive habitats for avoidance.
5. Provide data for assessments of cultural/archaeological resources in the area of potential bottom disturbance for all Vineyard Northeast components.
6. Provide the supporting information needed for permitting and approval of the proposed Vineyard Northeast development activities.

1.3 Vineyard Northeast Offshore Surveys

Section 1.3 is redacted in its entirety.

1.4 Supporting Datasets

In addition to the collected 2019 and 2022 field program data and survey campaign results, there are several existing datasets from prior and recent research completed near the region that provided beneficial information and add to the understanding of site conditions. These datasets and associated research articles, which are listed below, were reviewed and appropriate information extracted for use in this MSIR. Many more scientific articles were reviewed and drawn from for the Vineyard Northeast desktop studies, reconnaissance of offshore geology, and cable corridor feasibility studies (see Section 7).

- 2009 MCS air gun seismic data collected on the OCS (Siegel et al. 2012) (see Figure 1.4-1)

[1] At the time, the Proponent was named OCS-A 0522 LLC.

- 2018 compilation of a continuous bathymetry and topography terrain model for coastal Massachusetts (Andrews et al. 2018)
- CT DEEP Long Island Sound Blue Plan
- High-resolution quality-controlled seafloor elevation from NOAA National Ocean Service (NOS) Hydrographic Survey BAGs in US coastal waters.
- Massachusetts Ocean Management Plan (OMP)
- NOAA National Data Buoy Center
- NOAA CO-OPS Tidal Current Predictions
- US Geological Survey (USGS) East-Coast Sediment Texture Database
- USGS and University of Colorado: usSEABED Offshore Surficial-Sediment Database

1.5 Key Personnel

Section 1.5 is redacted in its entirety.

2 Site Geology and Environmental Conditions

This section of the report summarizes the background geologic setting and documents the existing site conditions in the Offshore Development Area based on results of the field programs carried out to-date. The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), the Massachusetts Offshore Export Cable Corridor (OECC), and the Connecticut OECC. The text is focused on geological conditions but includes a discussion of oceanographic and meteorological parameters (environmental conditions) due to their direct influence on the geomorphology of the seafloor and shallow subsurface, and potential impact to Vineyard Northeast.

Sediment descriptions for geological analysis follow the Unified Soils Classification System (USCS), as this is standard practice for engineering projects worldwide and necessary to maintain internal consistency on Proponent projects; refer to the grain size categories listed after the table of contents. Coarse material, or coarse deposits, are defined as sediment greater than 2 millimeters (mm) (0.08 inches [in]) in size and can be comprised of coarse sand, gravel, cobbles, or boulders. These terms are used throughout this section of the report due to their occurrence in Offshore Development Area (mostly in the OECCs) and are found in differing combinations of gravel, cobbles, and boulders in a sand matrix.

In comparison, sediment descriptions for benthic habitat analysis utilize the National Marine Fisheries Service (NMFS)-modified Coastal and Marine Ecological Classification Standard (CMECS), which follows the Wentworth classification system; refer to grain size and percent cover categories listed after the table of contents. NMFS-modified CMECS identifies any sediments over 2 mm (0.08 in) as Gravel and is classified as Complex Habitat. Therefore, 2 mm (0.08 in) in USCS classification is considered sand whereas in the CMECS classification is considered gravel. Ultimately, this is simply a means for classifying soft or complex bottom habitats based on the most recent guidance (NMFS, March 2021). Further details regarding CMECS classification and the benthos within the Offshore Development Area are located in Section 5.

The remainder of Section 2 is redacted in its entirety.

3 Site Hazards Assessment

Section 3 is redacted in its entirety.

4 Geological Results Relevant to Siting and Design

Section 4 is redacted in its entirety.

5 Results of Biological Surveys

This section of the Marine Site Investigation Report (MSIR) documents the benthic (bottom) biological studies completed for Vineyard Northeast during the 2019 and 2022 field programs, as well as background research and historical data. Surveys were conducted in Lease Area OCS-A 0522 (Lease Area) in 2019 with further investigations of the Offshore Development Area completed in 2022 within both the Lease Area and the Massachusetts and Connecticut Offshore Export Cable Corridors (OECCs). The 2019 and 2022 survey data, as well as publicly available data, were used for the benthic habitat mapping described in Section 5.1. Methods used for benthic habitat mapping are described in Section 5.2.

Nektonic (fish, marine mammals, and turtles), and avian (bird and bats) fauna information is based on existing research and historical data. These topics are addressed in Section 4 of COP Volume II.

5.1 Benthic Habitat Survey Results

Benthic habitats located in the Offshore Development Area consist of a diverse assemblage of bottom substrate types. Habitats occupying the seafloor and very shallow subsurface of the seabed are included in the classification of benthic habitats. Sonar data (multibeam echosounder and side scan sonar) and ground truthing information (grab samples, video transects, and vibracore samples) collected in 2019 and 2022 were used to map habitat types within the Lease Area. Data collected during the 2022 field program were used to characterize habitats in the Massachusetts and Connecticut OECCs.

Infauna and epifauna were identified in the Massachusetts and Connecticut OECCs through the use of grab samples and underwater video transects collected in 2022 and identified in the Lease Area using samples from 2019 and 2022. Locations of the grab samples and video transects within the Lease Area are presented in Figure 1.3-4, Figure 1.3-7, and Figure 1.3-8. The locations of the grab samples and video transects within the Massachusetts OECC are shown in Figure 1.3-12 and Figure 1.3-13. Locations of grab samples and video transects within the Connecticut OECC are presented in Figure 1.3-22 through Figure 1.3-26. See Section 2.1 for a full description of geologic conditions of the Offshore Development Area.

5.1.1 Benthic Sediment and Habitat Classification Overview

All benthic habitat ground truthing samples and habitat delineations for Vineyard Northeast were classified following the National Marine Fisheries Service (NMFS) Recommendations for Mapping Fish Habitat (NMFS 2021). This classification scheme uses the Coastal and Marine Ecological Classification Standard (CMECS) (FGDC 2012) as the basis for sample classification. The NMFS Recommendations utilize the Substrate Component and Biotic Component of CMECS. NMFS modified the original CMECS Substrate Component classifications by removing the Slightly Gravelly Substrate Group, combining several Subgroups, and creating a new Subgroup of Gravel Pavement (NMFS 2021) (Table 5.1-1). Per the guidance of NMFS (2021), the NMFS-modified CMECS classifications were used to determine whether a sample or group of samples was either a Soft Bottom, Complex Mix, or Complex station. These station designations were then used to determine whether a sonar-delineated habitat area was either a Soft Bottom habitat, Heterogeneous Complex habitat, Complex habitat, or Large Grained Complex habitat.

Additional details about the benthic habitat mapping process and results can be found in Section 5.2.1, which contains the mapping associated with the Essential Fish Habitat (EFH) Assessment. The full EFH Assessment can be found in COP Volume II Appendix II-D. Within state waters, additional data from historical state mapping efforts were used to assess state-designated sensitive habitats (Section 5.2.2).

Table 5.1-1 NMFS-modified CMECS Classification

Class	Subclass	Group	Subgroup	NMFS Habitat
Rock Substrate	Bedrock/Megaclast	--	--	Complex
Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravels	Boulder	
			Cobble	
			Pebble/Granule	
			Gravel Pavement	
		Gravel Mixes	Sandy Gravel	
			Muddy Sandy Gravel	
			Muddy Gravel	
		Gravelly	Gravelly Sand	
			Gravelly Muddy Sand	
			Gravelly Mud	
	Fine Unconsolidated Substrate	Sand	Very Coarse/Coarse Sand	Soft Bottom
			Medium Sand	
			Fine/Very Fine Sand	
		Muddy Sand	--	
		Sandy Mud	--	
		Mud	--	
Shell Substrate	Shell Reef Substrate	Clam Reef Substrate	--	Complex

Class	Subclass	Group	Subgroup	NMFS Habitat
		Crepidula Reef Substrate	--	
		Mussel Reef Substrate	--	
		Oyster Reef Substrate	--	
	Shell Rubble	--	--	
	Shell Hash	--	--	

5.1.2 Benthic Habitat Overview

5.1.2.1 Lease Area

The Lease Area is comprised of mainly fine unconsolidated, predominantly flat substrate with sand and silt sized material. An area in the center of the Lease Area contains furrows filled with clam shell rubble that are surrounded by sand. In the northeast corner of the Lease Area, there are megaripples with wavelengths up to 20 m (65.6 ft) and heights up to 0.9 m (3 ft). Areas of ripple scour depressions (RSDs) occur in the central west and central east regions of the Lease Area. Additionally, small-scale undulations noted as having a "pitted" appearance are located throughout the center of the Lease Area (see Figure 5.2-3).

In 2019, 40 stations were sampled for grain size analysis using a grab sampler. The grab sample data showed substrate in the Lease Area consists of Sandy Mud, Muddy Sand, Fine/Very Fine Sand, Medium Sand, Very Coarse/Coarse Sand, and Shell Rubble, with the majority being finer grained material (see Figure 5.1-1). Within the RSDs, the sediment is coarser grained sand (Medium and Very Coarse/Coarse Sand), whereas outside the sediment is more muddy (Muddy Sand and Sandy Mud), as determined by the sediment grain size analysis from grab samples. Further sampling was conducted in the Lease Area in 2022, when 25 additional stations were sampled for grain size analysis. Results from the 2022 field program were largely in agreement with the data collected in 2019, showing substrate types including Muddy Sand, Fine/Very Fine Sand, Medium Sand, and Very Coarse/Coarse Sand. Samples from two stations in the center of the Lease Area contained Shell Rubble, which was also consistent with findings from 2019 (see Figure 5.1-2).

Twenty-five video transects were collected in 2019, showing mainly sand and mud except for the transects in the center of the Lease Area showing patches of shell rubble (see Figure 5.1-3). An additional 19 video transects were collected in the 2022 field program, which showed similar trends with sand and mud present in the majority of the Lease Area, except for a section in the center containing sand surrounding patches of shell rubble (see Figure 5.1-4). Due to the homogeneous nature of the Lease Area, grain size from grab samples was more useful than video transects in differentiating habitats. Publicly available datasets such as usSEABED, which uses the Folk classification system (Folk 1954), and the United States Geological Survey (USGS) East-Coast Sediment Texture Database, which uses the classification system developed by Shepard (1954) and modified by Schlee and Webster (1967), Schlee (1973), and Poppe et al. (2005), show agreement of the Lease Area's composition of mainly fine unconsolidated substrate (Buczkowski et al. 2020; McMullen et al. 2014). This publicly available data can be seen in Figures 5.1-5 and 5.1-6. See Section 5.2.1 for additional details about benthic habitat mapping.

Grab samples from 2019 reveal the benthos is dominated by arthropods and annelids, with nematodes, mollusks, and nemertea comprising a small percentage of the total abundance of infauna (see Figure 5.1-16a). Grab samples from 2022 also contained large numbers of arthropods and annelids, but had mollusks as the most abundant phylum, primarily due to a large number of nut clams found in a single grab (see Figure 5.1-17a). Underwater videos from 2019 show a high abundance of sand dollars (*Echinarachinus parma*) in addition to sea stars (*Asterias* spp.), crabs (*Cancer* spp.), sea urchins (Echinoidea), moon snails (*Euspira heros*), and skates (Rajidae). In addition to showing similar species as those observed in 2019, the 2022 video transects also showed a relatively high abundance of hermit crabs (*Pagurus* spp.), scallops (*Placopecten magellanicus*), and hake (Gadidae). Other studies have shown that frequent epifaunal organisms in this area include echinoderms (sand dollars, sea stars) and tunicates (sea squirts) (NEFSC 2017; Theroux and Wigley 1998; Wigley and Theroux 1981), and abundance and diversity values are known to exhibit variability both spatially and temporally on the continental shelf. More information about infauna and epifauna in the Lease Area can be found in Sections 5.1.3.1 and 5.1.4.1.

5.1.2.2 Massachusetts Offshore Export Cable Corridor

The Massachusetts OECC traverses a variety of substrates between the Lease Area and the south coast of Massachusetts. Based on sonar data, grain size analysis from grab samples, video transects, and publicly available data sets, the most common habitat appears to be comprised of fine-grained sediment (mainly sand and silt). However, there were areas of varying amounts of gravel associated with Southwest Shoal, the southwest extension of the Elizabeth Islands, and within state waters. Ripples and ripple scour depressions (RSDs) appear to be common throughout the Massachusetts OECC.

In 2022, 57 stations were sampled for grain size analysis using a grab sampler. One hundred and eighteen samples from 56 of these stations have been analyzed for sediment grain size (see Figure 5.1-7). One station (GB056) did not have successful sediment recovery due to hard seafloor, along with two replicates at station GB010 and one replicate at station GB014. In scenarios where insufficient sediment was recovered, video footage from the camera mounted on the grab sampler was used to assign a CMECS classification. The grab samples indicate that the Massachusetts OECC is comprised of Fine/Very Fine Sand in the southeast portion of the OECC near the Lease Area. There were some samples containing Gravelly Sand and Sandy Gravel in areas approaching Southwest Shoal, surrounded by samples containing Very Coarse/Coarse Sand and Medium Sand. Boulders and coarse sediment were also visible on sonar and video transects in this area. Softer sediments including Medium Sand, Muddy Sand, and Fine/Very Fine Sand became more abundant closer to the state-federal boundary. Within the state waters of Massachusetts, the Fine/Very Fine Sand was observed surrounding patches of Gravelly Sand and Boulders. Relatively small and elongated RSDs were also present within state waters. Results from grain size analysis data were supported by sonar coverage in the Massachusetts OECC, which showed softer sediments offshore, with evidence of some coarser sediments and boulders near Southwest Shoal and close to shore.

Publicly available data from previous surveys and mapping efforts were also used to characterize benthic habitats along the Massachusetts OECC. Data from usSEABED samples show mostly fine-grained sediment near the offshore portions of the OECC with more variability and gravel present in the nearshore areas (Buczkowski et al. 2020). Within the offshore portions of the OECC, grabs contained mostly Sand, Muddy Sand, and Mud; gravel areas were mostly associated with Southwest Shoal. At locations closer to state waters and the landfall, the majority of samples were soft bottom, containing Sandy Mud, Sand, Muddy Sand, and Mud. Nearshore samples that contained gravel were classified as Muddy Sandy Gravel, Muddy Gravel, and Gravel (see Figure 5.1-8).

The USGS East-Coast Sediment Texture Database shows similar sediment trends to the usSEABED dataset, with fine-grained sediment present in the offshore areas and more variability closer to state waters and the landfall site (McMullen et al. 2014). Within federal waters, grabs showed mostly Sand and Silty Sand, whereas in state waters, Sand and Gravel was present (see Figure 5.1-9).

Two areas within the Massachusetts OECC, including north of the Lease Area (KP 0.5 to 1.35) and southeast of Southwest Shoal (KP 28.3 to 35), showed irregularly shaped mounds on the side scan and multibeam sonar that are interpreted to represent organic sediments (see Figure 5.1-10). The mounds appear as isolated patches of lower reflectivity material with minimal relief apparent, typically less than 0.4 m (1.3 ft) in height. These mounds were most dense from KP 0 to 1.35 and 30.5 to 33.6, with significantly fewer occurrences between KP 28.3 to 30.5. The reflectivity of the seafloor and irregular shape of the features in these areas is not consistent with bedforms or coarse material (such as boulders). Grain size analysis from grabs within these areas were analyzed as Medium Sand, Muddy Sand, and Fine/Very Fine Sand, and no clear features were visible on video footage. These mounds are likely biogenic in origin and are comprised of soft sediments.

Grab samples collected within the Massachusetts OECC contained annelids (mostly polychaetes) and mollusks (mostly bivalves) as the primary dominant infauna. Crustaceans (amphipods) and nemertine worms were found in benthic grabs in smaller quantities (see Figure 5.1-18a). Video transects showed sponges (Porifera), bryozoans (*Bugula* spp.), sand dollars (*Echinarachnius parma*), and crabs (*Cancer* spp.) as some of the common invertebrate epifauna. Vertebrates in the Massachusetts OECC included species such as red hake *(Urophycis chuss),* cunner (*Tautogolabrus adspersus*), black sea bass (*Centropristis striata*) and butterfish (*Peprilus triacanthus*). Additional information about infauna and epifauna in the

Massachusetts OECC can be found below in Sections 5.1.3.2 and 5.1.4.2, or in the benthic factual report in Appendix II-B20.

5.1.2.3 Connecticut Offshore Export Cable Corridor

Sonar data, grain size analysis from grab samples, video transect observations, and publicly available datasets were used to identify habitat and sediment types within the Connecticut OECC. The most common habitat appears to be comprised of fine-grained sediment, particularly in the offshore portion of the OECC. There is more variation in grain size within state waters and approaching the Connecticut shoreline, where gravelly sediments become more common. Various sizes of bedforms occur within the Connecticut OECC, ranging from ripples to larger megaripples and sand waves.

A total of 112 grab stations were sampled in 2022 for grain size analysis in the Connecticut OECC. One hundred and nine stations were successfully analyzed for grain size; three stations (GB037, GB049, GB070) did not have successful sediment recovery due to presence of hard bottom on the seafloor. Sufficient sediment could also not be collected for two replicates at station GB033 and one replicate at station GB069. For these stations, video imagery from the grab sample camera was used to assign a CMECS classification. Grain size analysis showed that Muddy Sand, Fine/Very Fine Sand, Medium Sand, and Very Coarse/Coarse Sand were common in the offshore section of the OECC (see Figure 5.1-11a). There was a higher frequency of coarse sediments and more variability between samples in nearshore areas and the state-federal boundary, where Gravelly Sand was found along with Sandy Gravel, Very Coarse/Coarse Sand, Medium Sand, and Fine/Very Fine Sand (see Figures 5.1-11b and 5.1-11c). Some grab samples within nearshore areas also contained moderate to high concentrations of shell. Sediment type was very site-specific, with Muddy Sand being found close to other samples containing shell or gravel at times. Detailed descriptions of the benthic habitat present in the Connecticut OECC can be found in Section 5.2.1.3.

Publicly available data were used to provide additional information about the Connecticut OECC. Data from usSEABED samples aligned closely with the data collected during the 2022 field program. Samples collected by usSEABED in the offshore portions of the OECC show mostly fine-grained sediment such as Sand, Mud, Muddy Sand, and Sandy Mud. Near the state-federal boundary and within state waters, usSEABED data also show more variability in sediment type as coarse-grained sediment becomes more common. Grab samples collected close to shore were classified as Gravel, Gravelly Sandy Mud, Gravelly Sand, Muddy Sandy Gravel, and Sandy Gravel as well as Sandy Mud, Sand, Muddy Sand, and Mud (Buczkowski et al. 2020). Figures 5.1-12a and 5.1-12b show sediment classifications from the usSEABED dataset.

The grabs from the USGS East-Coast Sediment Texture Database also show a similar trend of finer-grained sediment offshore and more varied sediment with gravel nearshore (McMullen et al. 2014). Within offshore waters, grabs showed mostly Sand, Silt, and Clay, whereas in state waters, Sand, Sandy Silt, and Silty Sand sediments were present along with Gravel and Gravelly sediment (see Figures 5.1-13a and 5.1-13b).

Grab sample and video transect data were used to characterize the fauna and flora present along the cable corridor. Annelid worms were the most abundant phylum of infauna found in the Connecticut OECC in 2022, followed by crustaceans and mollusks. Echinoderms, nemertine worms, and cnidarians (anemones) were also found in smaller amounts (see Figure 5.1-19a). Bryozoans (*Bugula* spp.), blood stars (*Henricia* spp.), and hermit crabs (*Pagurus* spp.) were some of the most common epifauna seen on video transect footage within the Connecticut OECC. Common vertebrates in the corridor included species such as cunner (*Tautogolabrus adspersus*), scup (*Stenotomus chrysops*), witch flounder (*Glyptocephalus cynoglossus*), and smooth dogfish (*Mustelus canis*). More information on infauna and species observed on video can be found in Sections 5.1.3.3 and 5.1.4.3.

Additionally, eelgrass (*Zostera marina*) was detected on four video transects as well as on video footage from five replicate grab samples at two stations (see Figure 5.2-13). These samples containing eelgrass were spread across all three landfall approach sites, with the Eastern Point Beach Landfall containing the highest density of vegetation. Concentrations of eelgrass ranged from eelgrass beds at some stations to occasional isolated strands at others. For more information on sensitive habitats within the Connecticut OECC, see Section 5.2.2.2.

5.1.3 Underwater Video Review

5.1.3.1 Lease Area

The majority of the 25 video transects conducted in 2019 recorded low complexity Soft Bottom habitats with Sand and Mud as the dominant constituents (see Figure 5.1-3), with the exception of three transects showing shell rubble within the furrows in the center of the Lease Area. Biogenic structures from infauna and epifauna, such as worm tubes, amphipod beds, and burrows, were present in many of the transects throughout the Lease Area. The most abundant megafauna observed in the Lease Area in 2019 were sand dollars (*Echinarachnius parma*), which comprised 83% of the total megafauna count and were most abundant in transects in the western portion of the Lease Area. Other megafauna that were common across transects included sea star (*Asterias* spp.), crab (*Cancer* spp.), sea urchin (Echinoidea), moon snail (*Euspira heros*), and skate (Rajidae). Anemone (Actinaria) and sea sponge (Porifera) were observed in smaller numbers in several transects in the northeast portion of the Lease Area. In total, six fish taxa, ten invertebrate taxa, and two types of egg cases (skate and moon snail) were observed in the Lease Area in 2019.

In 2022, an additional 19 video transects were recorded in the Lease Area. Ten of these transects showed exclusively Soft Bottom habitat, while the remaining nine were classified as a Complex Mix of Soft Bottom and Complex habitats (see Figure 5.1-4). The small areas of Complex habitat identified in these transects contained large amounts of biogenic substrate. Each of the video transects classified as Complex Mix were in the center of the Lease Area, which has been classified as Heterogeneous Complex habitat due to the presence of furrows containing shell rubble.

Sand dollars were also common in the Lease Area in 2022 but were responsible for a much smaller percentage of total megafauna observed. Anemones and crustaceans, including crabs and hermit crabs, were also abundant in 2022. Common fish species included red hake, cunner, and Atlantic silversides. Sand burrows likely created by polychaetes were frequently observed, along with empty shells. Skate, whelk, and moon snail egg cases were found in the Lease Area as well. In total, 23 fish taxa and 22 invertebrate taxa were observed in the Lease Area in 2022.

For more information regarding the 2019 video transect analysis, see the RPS (2021) environmental report in Appendix II-B11. For more information regarding the 2022 video transect analysis, see the TRC (2023) benthic report located in Appendix II-B20.

5.1.3.2 Massachusetts Offshore Export Cable Corridor

During the 2022 field program, 59 video transects were collected using a Remotely Operated Vehicle (ROV) within the Massachusetts OECC. Thirty-three of the 59 transects detected Soft Bottom habitat in the Massachusetts OECC, which showed sediments classified as Fine/Very Fine Sand, Muddy Sand, Medium Sand, and Very Coarse/Coarse Sand. Twenty-five transects were classified as a Complex Mix that showed both Soft Bottom and Complex habitats. In these areas, the videos showed sediments such as Sandy Gravel, Gravel Pavement, Boulders, Medium Sand, and Muddy Sand. One video transect was classified as containing only Complex habitat, showing substrates such as Cobbles, Boulders, and Pebble/Granule (see Figure 5.1-14).

Sand dollars (*Echinarachnius parma*) were frequently found within the Massachusetts OECC, particularly in Soft Bottom habitats. Other commonly observed megafauna included hermit crabs (*Pagurus* spp.), worms (Annelida), barnacles, and bryozoans (*Bugula* spp.). Crabs including spider crabs (*Libinia emarginata*) and Jonah crabs (*Cancer borealis*), along with anemones, moon snails (*Lunatia heros*), and ctenophores, were also found in smaller abundances across Massachusetts video transects. Fish observed included cunner (*Tautogolabrus adspersus*), as well as various species of flatfish, skates, and hake (Gadidae). Northern star coral (*Astrangia poculata*) were found along 14 video transects in the Massachusetts OECC and were observed attached to cobbles and boulders in Heterogeneous Complex and Complex habitats near the Massachusetts state/federal boundary (KP 118). Northern star coral were found near and within state waters at the landfall site as well as offshore from Martha's Vineyard (see Figure 5.2-8). Invasive species within the Massachusetts OECC included white crust tunicate (*Didemnum albidum*), sheath tunicate (*Botrylloides* spp.), and carpet tunicate (*Didemnum vexillum*).

A previous study in the general area of the Massachusetts OECC showed the presence of skates (*Leucoraja ocellata* and *Raja eglanteria*), Jonah/Rock crabs (*Cancer* spp.), scup

(*Stenotomus chrysops*), silver hake (*Merluccius bilineraris*), American lobster (*Homarus americanus*), and summer flounder (*Paralichthys dentatus*) (Malek et al. 2014). Data from fisheries surveys conducted near and within the Massachusetts OECC have caught a range of species including scup, longfin squid, black sea bass, red hake, silver hake, winter flounder, fourspot flounder, Jonah crab, spider crabs, and ocean quahog. For more information on Massachusetts OECC fisheries survey results see Section 4.6.1.3 of COP Volume II.

In total, 27 fish taxa, 45 invertebrate taxa, and four types of egg cases (hairy spiny doris, skate, whelk, and moon snail) were observed in the Massachusetts OECC. In addition to the organisms that were observed, there was also evidence of macrofaunal activity such as mud tubes and sand burrows in Soft Bottom habitat. Green and red algae, along with occasional brown algae, were observed throughout the OECC. For more information regarding species observed on video transects in the Massachusetts OECC, see the TRC (2023) benthic report in Appendix II-B20.

5.1.3.3 Connecticut Offshore Export Cable Corridor

During the 2022 field season, 118 video transects were collected using an ROV within the Connecticut OECC. Of these 118 transects, 114 were analyzed for habitat type and megafauna presence. The remaining four transects (VT063, VT071, VT099, and VT103) were collected in areas with extremely difficult site conditions and were ultimately not used for habitat analysis due to poor video and/or navigation data quality. Some transects consisted of multiple runs due to the site conditions and other factors affecting the survey (fishing gear, vessel traffic).

The video transects conducted in the Connecticut OECC were used to help determine sediment and NMFS (2021) benthic habitat type. They were also used to identify and quantify flora and fauna within the cable corridor. Of the 114 video transects analyzed, 46 detected exclusively Soft Bottom habitat, 32 detected Complex habitat, and 36 were classified as a Complex Mix of both Soft Bottom and Complex habitat (see Figure 5.1-15a and Figure 5.1-15b). In Soft Bottom habitat, the video footage showed sediments such as Muddy Sand, Very Fine/Fine Sand, and Very Coarse/Coarse Sand. Complex habitat transects often contained Gravel Pavement, Shell Hash, or Shell Rubble in high concentrations. In video transects classified as a Complex Mix, there were a wide variety of sediment types, including Sandy Gravel, Gravelly Sand, Very Coarse/Coarse Sand, Very Fine/Fine Sand, and Shell Hash.

Northern sea stars (*Asterias vulgaris*) were very common in the Connecticut OECC. These sea stars were found in Soft Bottom habitat beginning at approximately KP 96 and extending towards the Lease Area. Other common invertebrates included worms, hydroids (Corymorpha), sea urchins (Echinoidea), and bryozoans (*Bugula* spp.). Invertebrates that were observed less frequently included crabs (such as *Cancer borealis*), sea pens (Pennatulidae), anemones (*Cerianthus* spp.), and sand dollars (*Echinarachnius parma*). Invasive species in the Connecticut OECC included diplosoma tunicates (*Diplosoma listerianum*), sheath tunicates (*Botrylloides* spp.), white crust tunicates (*Didemnum albidum*), and carpet tunicates (*Didemnum vexillum*). Northern star corals (*Astrangia poculata*) were also found within the

Connecticut OECC in 24 transects, which were classified as Complex, Complex Mix, and Soft Bottom stations. Corals were found in areas within and approaching state waters and were found on the Niantic Beach Approach and Ocean Beach Approach. The locations of the coral observations were similar to those areas predicted by the Connecticut Blue Plan (CT DEEP Long Island Sound Blue Plan) (see Figure 5.2-12).

Vertebrates were also found in the Connecticut OECC, with the most common being flatfish (such as witch flounder or four spot founder), cunner (*Tautogolabrus adspersus*), scup (*Stenotomus chrysops*), smooth dogfish (*Mustelus canis*), Atlantic silversides (*Menidia menidia*), and red hake (*Urophycis chuss*). Skates, eels, and anchovies were also occasionally found.

A previous study that was conducted near the Connecticut OECC found spiny dogfish (*Squalus acanthias*), sea scallops (*Placopecten magellanicus*), scup, summer flounder (*Paralichthys dentatus*), yellow flounder (*Limanda ferruginea*), sand dollars, and sea stars (*Asterias* and *Astropecten* spp.) in large abundances (Malek et al. 2014). Data from fisheries surveys conducted near and within the Connecticut OECC have caught a range of species including scup, longfin squid, northern sea robin, silver hake, little skate, winter skate, and ocean quahog (see Section 4.6.1.4 of COP Volume II for more information on Connecticut OECC fisheries survey results).

In total, 49 invertebrate and 31 vertebrate taxa were identified in the video transects collected in the Connecticut OECC, along with squid mops and skate, whelk, and moon snail egg cases. Red and green algae were found throughout the OECC and were often free-floating in Soft Bottom habitats and anchored to coarse material or hard bottom when available. Algae was particularly dense within state waters and near the three landfall sites. Eelgrass (*Zostera marina*) was observed on two video transects near the Niantic Beach Landfall Site, one video transect at the Ocean Beach Landfall Site, and one video transect at the Eastern Point Beach Landfall Site. Eelgrass was also recorded on grab sample camera footage at the Eastern Point Beach Landfall Site. More information about sensitive habitats in Connecticut state waters can be found in Section 5.2.2.2. Additional details regarding fauna observed on video transects can be found in the TRC (2023) benthic report in Appendix II-B20.

5.1.4 Benthic Infauna Analysis

In addition to identifying fauna and flora recorded on video transect footage, organisms present in grab sample sediment (infauna) were also quantified and identified to the lowest practical taxonomic level (LPTL). In Sections 5.1.4 and 5.1.5, benthic communities are described within the Lease Area and OECCs and compared across a number of factors including project area, nearshore versus offshore samples, and NMFS classification. Table 5.1-2 describes key terms that are used throughout the following sections.

Table 5.1-2 Statistical Measures and Community Composition Metrics Used to Describe Infauna

Term	Definition
Taxonomic Richness	Taxonomic richness refers to the number of taxa (species or LPTL) present in a sample. Organisms were identified to the species level whenever possible, though there were some occasions where this was not feasible and individuals were classified to the genus or family level instead.
Shannon Diversity Index (H’)	The Shannon diversity index describes how diverse the species in a given community (or sample) are. Values for Shannon diversity typically range from approximately 1.5 to 3.5, with larger numbers representing more diverse communities. Shannon diversity is calculated using the following equation: $$H' = -\sum_{j=1}^{S} p_i \ln p_i$$ Where S is the number of species present in the sample, and p_i equals the proportion of individuals found in the *i*th species.
Pielou’s Evenness (J’)	Pielou’s evenness is a metric that considers both diversity as well as species richness to provide a measure of how evenly distributed species abundances are in a community or sample. This can indicate whether a sample is dominated by one or two species, or if all species have an equal number of individuals. Values for Pielou’s evenness range from 0 (no evenness) to 1 (complete evenness). Pielou’s evenness can be calculated using the following equation: $$J' = \frac{H'}{\ln S}$$ Where H’ is equal to the Shannon diversity index and S is equal to the number of species in the sample.
Analysis of Variance (ANOVA)	ANOVA is a statistical test which determines whether two or more categorical groups are statistically different. This is done by testing for a difference of means using a variance. The resulting p value from an ANOVA test can indicate whether the tested groups are significantly different. P values of 0.05 or less are considered to be significantly different.
ANOSIM (Analysis of Similarities), Global R	ANOSIM is used to analyze the similarity between community samples. This is a multivariate statistic, which can determine if biological communities differ significantly between samples. This is done by comparing the mean of ranked dissimilarities between groups to the mean of ranked dissimilarities within groups. One of the results of an ANOSIM test is a Global R value. An R value close to 1 suggests that the groups being tested are dissimilar, while an R value close to 0 suggests that the groups are similar.

Term	Definition
Bray-Curtis Similarity	Bray-Curtis Similarity is a way to measure the amount of dissimilarity between biological communities at two different sites or samples. Values for Bray-Curtis Similarity typically range from 0 to 1, where 0 indicates that the two samples are identical (exact same number of each type of species), and 1 indicates that the sites are completely dissimilar (they do not share any of the same species). Bray-Curtis Similarities were used to create Non-Metric Multi-Dimensional Scaling (NMDS) plots for infauna data, which are described below.
NMDS	NMDS plots shows an ordination based on dissimilarity between samples (in this case, Bray-Curtis Similarity, described above). The closer two points are to each other on an NMDS plot, the more similar the communities in those samples are. Conversely, if two points are on opposite sides of an NMDS plot, it can be inferred that those samples are not very similar to one another.

5.1.4.1 Lease Area

2019 Lease Area Infauna Results

A total of 40 grab stations were sampled in 2019 within the Lease Area for infauna analysis, with 39 stations containing benthic organisms for analysis. An infauna sample was not able to be obtained from one grab station (GB03) due to shell rubble preventing proper closure of the grab sampler. A total of 7,749 individual organisms from 10 phyla and 82 families or lowest practical taxonomic level were found among the benthic macroinvertebrates captured during the grab survey. Dominant phyla included Arthropoda (amphipods and crustaceans), Mollusca (nut clams), and Annelida (polychaete worms), representing 96% of all organisms and 84% of taxa (see Figure 5.1-16a and Figure 5.1-16b). The remaining community was comprised of Chordata (tunicates), Cnidaria (hydroids), Echinodermata (sand dollars and sea cucumbers), Ectoprocta (bryozoa), Nematoda (nematodes), Nemertea (ribbon worms), and Sipuncula (peanut worms) (RPS 2021).

The mean density in 2019 Lease Area grab samples was 24,836 individuals m^{-2}, though this varied significantly, with 162,625 individuals m^{-2} in grab GB05, and only 3,000 individuals m^{-2} in grab GB25 (see Figure 5.1-16c). Grab sample GB05 had an extremely high density of organisms compared to other grabs in the Lease Area due to the presence of 1,136 nut clams (*Nucula* spp.). A smaller number of these nut clams also dominated sample GB34, leading to lower species diversity and evenness than measured in other samples (see Figure 5.1-16d and Figure 5.1-16e).

Taxonomic richness ranged from 5 to 28 with an average richness of 15. Grab samples GB06, GB14, GB22, and GB23 had a large number of taxa in particular, though this was not correlated with any particular water depth, sediment type, or section of the Lease Area (see Figure 5.1-16f). Average diversity across the grab samples was 1.43 with a range from 0.18 to 2.29. Evenness ranged from 0.11 to 0.92. More detailed infauna information can be found in the RPS (2021) report in Appendix II-B11.

2022 Lease Area Infauna Results

An additional 25 grab samples were sampled in the Lease Area in 2022. Of these, 14 were analyzed for the presence of infauna. Five phyla and 58 taxa were found in the 2022 grab samples. Dominant phyla included mollusks, arthropods, and annelids. Smaller numbers of echinoderms and nemertean worms were also identified in the 2022 grab samples, but were each responsible for less than 1% of total infauna abundance (see Figure 5.1-17a and Figure 5.1-17b). Infauna community composition in 2022 samples was similar to that which was observed in 2019 samples (see Figure 5.1-20). Annelids were the most speciose phylum, and were responsible for more than 43% of taxa observed. Ampeliscid amphipods (*Ampelisca* spp.) were the most widespread taxa, and were present in 92% of Lease Area samples, while nut clams (*Nucula* spp.) were the most abundant.

The mean density of organisms was 41,664 individuals m^{-2}, with a large range from 2,088 to 249,483 individuals m^{-2}. It should be noted that there was a positive outlier at GB001, which contained 218 nut clams. Nut clams can be found in patchy distributions within Soft Bottom habitats, and it appears as that GB001 was collected in one of these patches. GB001 infauna density may also be artificially inflated due to the small core size (9.58 cm^2) used to recover sediment at this site. Richness based on lowest practical taxonomic level (LPTL) ranged from 9 to 25 with an average richness of 17. Average diversity across the grab samples was 1.91 with a range from 0.46 to 2.45, and evenness ranged from 0.20 to 0.95. Species diversity and evenness were lowest at GB001 due to the large abundance of nut clams and relatively low taxonomic richness. Additional information about infauna data collected from the Lease Area in 2022 can be found in the benthic report located in Appendix II-B20. Community metrics for each grab sample are shown in Figure 5.1-17c through Figure 5.1-17f.

5.1.4.2 Massachusetts Offshore Export Cable Corridor

A total of 57 grab stations were sampled in 2022 along the Massachusetts OECC, 27 of which were analyzed for infauna. Organisms from 6 phyla and 70 taxa, or LPTL, were found among the benthic macroinvertebrates captured during the grab survey. Dominant phyla included Annelida (mostly polychaete and oligochaete worms), Mollusca (primarily bivalves), and Arthropoda (amphipods and other malacostracans). Annelids and mollusks were the most abundant phyla and contributed to 50% and 42% of individuals found in grab samples, respectively. Additional phyla including Cnidaria (anemones), Nemertea (ribbon worms), and Echinodermata (sand dollars) were each responsible for less than 2% of total taxa (see Figure 5.1-18a). Of the 27 grab samples analyzed for infauna, five were comprised of coarse unconsolidated substrates such as Sandy Gravel or Gravelly Sand (samples GB007, GB023, GB027, GB031, and GB055). Annelids were responsible for >90% of infauna in each of these coarse-grained samples. The remaining samples with abundant annelids were classified as Very Coarse/Coarse Sand. Samples where mollusks were the dominant phylum (responsible for more than 65% of individuals) were classified as Fine/Very Fine Sand, Muddy Sand, or Medium Sand. Echinoderms were present in a single grab sample (GB045), where they were responsible for 25% of all organisms (see Figure 5.1-18b).

The mean density was 13,336 organisms m^{-2} across the 27 stations that were analyzed from the Massachusetts OECC in 2022, with a large density range of 1,044 to 43,451 individuals m^{-2} across samples. Species richness (based on lowest practical taxonomic level) ranged from 4 to 19 with an average richness of 10. Average diversity across the grab samples was 1.55 with a range of 0.45 to 2.49. Evenness ranged from 0.23 to 0.97 with an average value of 0.69. Grab sample GB015 had the lowest richness and evenness of the Massachusetts samples, due to a large abundance of nut clams and few other taxa. Variation in the number of individuals in an infauna sample, as well as the number of taxa (richness), evenness, and diversity did not show an association with depth of water or sediment type. Additional information about infauna in the Massachusetts OECC can be found Appendix II-B20, and community metrics for each grab sample are shown in Figure 5.1-18c through Figure 5.1-18f.

5.1.4.3 Connecticut Offshore Export Cable Corridor

In 2022, 112 grab stations were sampled in the Connecticut OECC. Sixty-five of these stations were analyzed for infauna, and the remaining stations were used for grain size analysis only. Organisms from 7 phyla and 126 taxa were found among the benthic macroinvertebrates captured during the grab survey. Dominant phyla included Annelida (polychaete worms, oligochaete worms, and sipunculids), Arthropoda (primarily amphipods), and Mollusca (slipper snails and bivalves). Annelids and arthropods were particularly abundant and were responsible for 54% and 31% of individuals observed, respectively. Additional phyla included Echinodermata (brittle stars and sand dollars), Nemertea (ribbon worms), Cnidaria (anemones), and Chordata (ascidians), which were each responsible for less than 3% of total taxa observed (see Figure 5.1-19a).

Grab samples in the Connecticut OECC were typically dominated by annelids, mollusks, or crustaceans. Samples collected from Soft Bottom habitat approaching the Lease Area (grabs GB002, GB004, GB006, GB008, GB012, and GB014) contained abundant crustaceans (responsible for more than 50% of individuals) and fewer annelids (less than 15% of organisms). Crustaceans were also common in other grab samples closer to shore that contained fine unconsolidated substrate such as Muddy Sand and Fine/Very Fine Sand (see Figure 5.1-19b).

The mean density was 8,293 organisms m^{-2} across the 65 stations that were analyzed from the Connecticut OECC in 2022, though there was considerable variability between samples with a total density range from 130 to 82,117 individuals m^{-2}. This large range is due in part to a positive outlier at GB092, which contained 53 polychaetes (*Polygordius* spp.). GB092 had an artificially inflated infauna density due to the small core size (7.18 cm^2) that was used to recover sediment at this site. Total number of species (or LPTL) ranged from 1 to 27 in each grab sample with an average richness of 10. Many taxa were present in grabs GB020 and GB022, and very few taxa were found in grabs GB034, GB048, and GB050, which were classified as Gravelly Sand, Very Coarse/Coarse Sand, and Medium Sand, respectively. Average diversity across the grab samples was 1.72 with a range from 0 to 2.62. Evenness ranged from 0 to 1 with an average value of 0.81. Grab sample GB048 had diversity and evenness values of zero due to the presence of a single bivalve of the species *Crassinella lunulata* in the sample. CMECS sediment type, depth, and distance from the Lease Area did not appear to be associated with organism abundance, diversity, evenness, or richness. Additional information about infauna in the Connecticut OECC can be found in Appendix II-B20. Community metrics for each grab sample are shown in Figure 5.1-19c through Figure 5.1-19f.

5.1.5 Infauna Comparative Analysis

A total of 65 benthic grab samples from the Connecticut OECC, 27 from the Massachusetts OECC, and 14 from the Lease Area were analyzed for infauna in 2022. One sample (522CT22-GB048) was removed from comparative analysis because it contained a single organism.

Existing infauna data (39 grabs) from the 2019 field program that were collected within the Lease Area were also used in general comparisons, though it should be noted that the 2019 data were not incorporated into multivariate analysis or calculations of community metrics because organisms were only identified to the family level. Trends observed between infauna communities in the Lease Area and the two OECCs, as well as the impact of sediment type and distance from shore, are described below.

Community Comparison Between Project Areas

Statistical comparisons and calculations of community metrics for infauna data were completed by TRC in association with TDI-Brooks, with additional analysis completed by GSS environmental subject matter experts (SMEs). The Massachusetts OECC was dominated primarily by annelids (50%) and mollusks (42%). By comparison, the Connecticut OECC had fewer mollusks (12%) and a much larger number of arthropods (31%). Mollusks (44%) and arthropods (42%) were the most abundant infauna within the Lease Area, along with a smaller number of annelids (14%) (see Figure 5.1-20). Univariate comparisons of community metrics were completed using two-way analysis of variance (ANOVA) tests to compare density, richness, evenness, and diversity between project areas. Results showed that infauna were most dense in the Lease Area, followed by the Massachusetts OECC and the Connecticut OECC (Table 5.1-3), with statistically significant differences between the Lease Area and Connecticut OECC (ANOVA, $p < 0.05$, densities log-transformed to meet assumptions of normality). Taxa richness was significantly higher in the Lease Area compared to the two OECCs (ANOVA, $p < 0.05$). Pielou's evenness and Shannon diversity did not differ significantly between project areas.

Table 5.1-3 Comparison of Infauna Community Metrics Within the Offshore Development Area

Community Metrics	Lease Area	Massachusetts OECC	Connecticut OECC
Average Density (N m^{-2})	41,664 ± 63,399[a]	13,336 ± 11,764[ab]	8,293 ± 12,091[b]
Average Richness (Taxa m^{-2})	17.14 ± 5.0[a]	10.04 ± 3.2[b]	9.77 ± 4.8[b]
Average Evenness (J')	0.69 ± 0.21[a]	0.69 ± 0.18[a]	0.81 ± 0.18[a]

Community Metrics	Lease Area	Massachusetts OECC	Connecticut OECC
Average Diversity (H')	1.91 ± 0.51[a]	1.55 ± 0.44[a]	1.72 ± 0.55[a]
Number of Samples	14	27	65*

Notes:

1. Superscripts [a] and [b] are used to show statistical significance (ANOVA, $p < 0.05$). Density data were log-transformed prior to statistical testing to better meet the assumption of normality associated with ANOVA.

2.One sample from the Connecticut OECC (522CT22-GB048) was excluded from statistical testing and calculations of richness, evenness, and diversity due to the presence of only a single organism within the sample. The sample was incorporated into the average density calculation.

Multivariate analyses were conducted using Bray-Curtis similarities of fourth root transformed raw abundances to compare community composition across project areas, CMECS sediment types, and NMFS sediment categories. Results were visualized using three-dimensional Non-Metric Multi-Dimensional Scaling (NMDS) plots, which show samples with more similar infauna communities as being located more closely together while also separating dissimilar samples. There was no statistically significant difference in community composition between project areas (ANOSIM, $p = 0.68$, Global $R = -0.018$). This comparison is visualized in Figure 5.1-21, which shows a lack of separation between the three project areas. Lease Area infauna communities were more tightly clustered together than those found in the Massachusetts or Connecticut OECC grab samples, though this is unsurprising given the mostly homogeneous nature of the Lease Area compared to the Massachusetts or Connecticut OECCs, which contain a wider variety of habitat types. Additional information regarding multivariate analysis of infauna samples can be found in the Benthic Factual Report (Appendix II-B20).

Comparison Across Sediment Types

Infauna communities were also compared across CMECS sediment groups, including Sand (n=56), Muddy Sand (n=25), Sandy Mud (n=1), Gravelly (n=19), and Gravel Mixes (n=4). There were no infauna samples belonging to the CMECS Mud group, and the single Sandy Mud sample was excluded from univariate analysis because it was not possible to compare means within the substrate group with only one sample. This sample was able to be included in multivariate analysis.

There were no significant differences in organism density, taxa richness, Pielou's evenness, or Shannon diversity based on CMECS group (ANOVAs, all $p > 0.05$). Multivariate analysis showed that there are statistically significant differences in community composition between CMECS groups (ANOSIM, $p = 0.001$, Global $R = 0.269$). Muddy Sand and Gravel Mixes had the greatest community difference ($p = 0.001$, $R = 0.643$), followed by Muddy Sand and Gravelly substrate ($p = 0.001$, $R = 0.437$) (see Figure 5.1-22). Muddy Sand was significantly different from all other sediment types in pairwise comparison except for Sandy Mud (n=1). Samples classified in the Sand CMECS group contained statistically distinct infauna communities from Gravelly ($p = 0.001$, $R = 0.238$) or Gravel Mix ($p = 0.01$, $R = 0.423$) samples. For more information on infauna multivariate analysis, please see the Benthic Factual Report (Appendix II-B20).

Differences in community comparison were driven by greater densities of the amphipod *Ampelisca* spp. found in Muddy Sand samples compared to other sediment types. Gravel Mix samples typically contained more slipper snails (*Crepidula fornicata*) and bivalves (*Crassinella lunulata*) than other sediment types but contained fewer polygordiid polychaetes (*Polygordius* spp.) than habitats containing Sand.

Comparison Between NMFS Classifications

Infauna communities were also compared between NMFS Soft and Complex classifications. Figure 5.1-23 shows some clustering of Soft and Complex samples, with occasional overlap between samples. The majority of Complex samples that had overlapping communities with samples taken from Soft Bottom habitats belonged to the CMECS substrate subgroup of Gravelly Sand, which was unsurprising due to the fact that samples classified as Gravelly Sand contain a very small amount of gravel ranging from 5-30%. The average dissimilarity between Soft and Complex samples is 87.7%. Samples classified as Soft contained large numbers of *Ampelisca* spp. amphipods (17%) as well as the polychaete *Nephtys* spp. (11%). Meanwhile, Complex samples had much fewer amphipods and were dominated by polychaetes such as Cirratulidae (19%) and Syllidae (12%).

Comparison Between Nearshore and Offshore Waters

Samples collected from state (nearshore) and federal (offshore) waters were compared to determine if infauna communities changed approaching the landfall sites. Nearshore and offshore samples had overlapping compositions (see Figure 5.1-28), and an average dissimilarity of 87.2%. Offshore samples were comprised of large numbers of amphipods (*Ampelisca* spp.) (11%), followed by polychaetes belonging to the genus *Polygordius* and the genus *Nephtys* (11% and 9%, respectively). These taxa were also abundant in samples containing NMFS-classified Soft sediment. Samples collected within state waters contained polychaete worms belonging to the family Cirratulidae (13%) and oligochaetes belonging to the family Naididae without hair chaetae (11%).

Outliers

It should be noted that there were four outliers identified in the infauna density dataset. One previously mentioned sample (522CT22-GB048) contained only one individual organism. The remaining three samples (522LA22-GB001, 522LA22-GB017, and 522CT22-GB092) had small sample sizes, which can lead to overinflated density. Grabs 522LA22-GB001 and 522CT22-GB092 had particularly small sample sizes of 9.58 cm^2 and 7.18 cm^2, respectively. Cumulative affects to data integrity caused by small sample sizes can be seen in the graphs of infauna density from the Lease Area and Connecticut OECC (see Figure 5.1-17cand Figure 5.1-19c). Statistical tests were conducted a second time with the outlier samples removed to assess their impacts on results.

Table 5.1-4 Comparison of Average Infauna Density with and Without Outliers

Project Area	Average Infauna Density with All Samples (Individuals m^{-2})	Average Infauna Density with Outliers Removed (Individuals m^{-2})
Lease Area	41,664 ± 63,399	22,251 ± 18,853
Connecticut OECC	8,293 ± 12,091	7251 ± 7799

Notes:
1. Lease Area outliers included samples 522LA22-GB001 and 522LA22-GB017. Connecticut OECC outliers included samples 522CT22-GB048 and 522CT22-GB092. There were no outliers identified in the Massachusetts OECC.

Average infauna density decreased dramatically when outlier samples were removed. The change to the Lease Area infauna data was particularly apparent, with the new average density dropping to approximately half the value which included the two outlier samples (Table 5.1-4). This was largely driven by sample 522LA22-GB001, which had a density of 249,483 individuals m^{-2}. Statistical tests were conducted a second time with the revised dataset to compare the density between the project areas, and indicated the same results as presented in Table 5.1-3, showing the Lease Area and Connecticut OECC infauna densities as being significantly different from one another, with Massachusetts OECC densities statistically similar to both of these areas.

With outliers removed, Pielou's evenness and Shannon diversity become significantly lower in the Massachusetts OECC compared to the Connecticut OECC and Lease Area (ANOVAs, $p < 0.05$). Prior to the removal of these samples, there was no statistically significant difference found between the project areas for evenness or diversity. Additionally, Pielou's evenness becomes significantly higher in shallow samples than in deep samples (ANOVA, $p < 0.05$), whereas before there was no statistical difference. Finally, Shannon diversity becomes significantly higher in nearshore samples than offshore samples when outlier samples are excluded (ANOVA, $p < 0.05$).

5.2 Mapping of Potential Sensitive Habitats

Benthic habitats are classified and mapped using NMFS's Recommendations for Mapping Fish Habitat (NMFS 2021) for the entire Offshore Development Area (see Section 5.2.1). In addition, information regarding specific sensitive habitats in state waters are described using information from each state environmental agency where landfall locations are present (Massachusetts Coastal Zone Management and Connecticut Department of Energy and Environmental Protection) (see Section 5.2.2).

5.2.1 Essential Fish Habitat

NMFS's Recommendations for Mapping Fish Habitat (NMFS 2021) requires the following habitat areas to be mapped:

- Soft Bottom habitats (i.e., mud and/or sand)

- Complex habitats (i.e., SAV [submerged aquatic vegetation], shell/shellfish, and/or hard bottom substrate)
- Heterogeneous Complex habitats (i.e., mix of soft and complex stations within a delineated area)
- Large Grained Complex habitats (i.e., large boulders)
- Benthic features (i.e., ripples, megaripples, and sand waves)

The sections below outline the data and methods used to create the essential fish habitat maps within the Offshore Development Area while meeting NMFS (2021) guidelines.

Lease Area

Within the Lease Area, sonar data acquired in 2019 and 2022 as part of geophysical field programs provided the first layer of information regarding seafloor composition based on the acoustic reflectivity, which is a function of the bottom texture, roughness, slope, relief, and sediment grain size. These data allow characterization of the seafloor substrate and are directly related to the types of habitats occupying the benthos and were therefore used to delineate habitat boundaries within the Lease Area.

These data were then used to select sample locations for the ground truthing survey (grabs, video transects, and vibracores) in the Lease Area. Samples were collected during 2019 and 2022 field programs and further assisted in classifying habitat types within the Lease Area. Habitat maps created for the MSIR were made using all ground truthing samples collected in 2019 and 2022.

Offshore Export Cable Corridors

Sonar data were collected for the full extent of the Massachusetts and Connecticut OECCs in 2022 and were used for the characterization of the seafloor and delineation of its habitat boundaries. Similar to the Lease Area, these data were used to place ground truthing samples throughout the OECCs. These samples were collected during the field season in 2022. All results from the field program were used to create benthic habitat maps.

Mapping Procedure

Habitat boundaries were made using sonar data to delineate zones with different sediment types. Then, ground truthing samples were classified using the NMFS-modified CMECS classification system, which was then translated into a final classification of Soft, Complex, or Complex Mix (both soft and complex samples) for each station. Based on sonar reflectivity and classifications of video transects and grab samples, each delineated area was assigned to one of the four NMFS (2021) habitat categories: Complex, Heterogeneous Complex, Large Grained Complex, or Soft Bottom. Each of these categories is further described in the sections below.

Sonar-delineated boundaries that bordered other boundaries of the same habitat category were kept as separate boundaries (i.e., not merged) to illustrate differences in seabed morphology that indicated potentially different benthic conditions. Benthic features (i.e., bedforms) in the Lease Area and OECCs were also mapped using sonar data to align with the NMFS 2021 Recommendations.

The NMFS's Recommendations for Mapping Fish Habitat (NMFS 2021) habitat classification system is particularly focused on hard bottom habitat and how it relates to essential fish habitat. Complex habitat is defined as hard bottom substrates, hard bottom with epifauna or macroalgae cover, and vegetated habitats (NMFS 2021). These are delineated areas where all ground truthing included Complex stations that showed hard bottom (defined in CMECS as the substrate groups: Gravels, Gravel Mixes, Gravelly, and Shell), or where sonar data appeared similar to areas with Complex stations. Heterogeneous Complex habitat is defined as delineated areas where ground truthing and/or sonar data showed both Complex habitat and Soft Bottom habitat. Large Grained Complex habitat is defined as delineated areas where ground truthing or sonar data showed rock outcrops or abundant large boulders (greater than 4 m [13.1 ft] in size). Soft Bottom habitat is defined as areas where all ground truthing samples showed sand or mud. Varying amounts of these types of habitats were found within the Lease Area and OECCs and are discussed in the following sections. It should be noted that habitat boundaries can be degradational in nature, particularly between Complex and Heterogeneous Complex habitats, as well as Heterogeneous Complex and Soft Bottom habitats. As a result, occasional isolated boulders surrounded by soft sediment may be found in Soft Bottom habitats.

The definition of Complex in the NMFS (2021) mapping recommendations has a small grain size threshold (greater than 2 mm [0.08 in]) and low composition threshold (greater than 5% gravel), making it a very conservative classification system. Therefore, many ground truthing samples may be classified as Complex, potentially more so than if other classification systems had been used (e.g., Auster [1998] or USCS). Many of the samples that are considered Complex, such as those in the Gravelly Group, have low percentages of gravel (5 to 30%) and a small grain size of Pebbles/Granules (2-64 mm [0.08-2.5 in]). Areas with this low percentage of gravel and small grain size, although classified as Complex habitats, do not have the same habitat values as areas with a higher quantity and larger grain size such as those within dense boulder fields and moraines.

See Appendix II-B2 for the complete methodology of the Benthic and Essential Fish Habitat mapping. Additionally, see Appendix II-B22 for a complete set of plan view charts of the Lease Area and Massachusetts and Connecticut OECCs showing full sonar data coverage from 2022 with the habitat mapping data and associated screen captures and pictures from 2019 and 2022 ground truthing samples.

5.2.1.1 Lease Area

The Lease Area is comprised of mainly Soft Bottom habitat, with an area of Heterogeneous Complex habitat located in the center. Grab samples and video transects collected in 2019 and 2022 show that sediment within Soft Bottom habitat ranges from Very Coarse/Coarse Sand to Sandy Mud, with coarser grained material in the northeast and finer grained material in the southwest and northern most tip of the Lease Area.

The area in the center of the Lease Area containing Heterogeneous Complex habitat includes northwest to southeast trending furrows that contain shell rubble mixed with sand surrounded by Soft Bottom habitat (see Figure 5.2-1). The depressions containing concentrated shell do not appear to contain live bivalves, but bivalve siphons are visible in the sediment surrounding these aggregations. Shell furrows are densest within the central portion of the Heterogeneous Complex habitat boundary, and become smaller, less elongated, and sparser within the outer regions (see Figure 5.2-2). The transition from Heterogeneous Complex to Soft Bottom habitat in the Lease Area is very gradual and could lead to small, isolated shell furrows being found in areas classified as Soft Bottom Habitat. No Complex or Large Grained Complex habitats are present within the Lease Area.

Pitted sand is also found in the Lease Area. Video transects reveal that this pitted sand is associated with abundant tube-building fauna, likely amphipods or polychaetes (see Figure 5.2-3). It is hypothesized that this feature is caused by erosion due to currents and storms, with tube structures holding sediment in place, thus creating an irregular seafloor. Plateaus around these pits range from approximately 2 m to 10 m (6.6 ft to 32.8 ft) across, and pits have a depth of approximately 0.2 m (0.7 ft). The transition between the pitted sand and the flat seafloor surrounding it is very gradual, which makes delineating this feature difficult. As a result, two separate boundaries were drawn for the large section of pitted sand on the western and southern portions of the Lease Area. The inner boundary shows the area where the pits are the densest, and the outer boundary indicates where this feature is less developed. Due to the degradational nature of this feature, it is possible that some pitted sand may exist outside of this outer boundary. Appendix II-B2 contains a detailed study that was conducted on pitted sand and other seasonal seafloor textures within the Lease Area and further describes the methods used to delineate this habitat (Fugro 2023).

Organic mounds are also present in the northern portion of the Lease Area near the Massachusetts OECC. The mounds appear to be more irregular in shape than the round features located in KP 0 to 1.35 in the Massachusetts OECC. It is unclear if these mounds have the same origin as those found in the OECC or if they are more similar to the pitted sand found farther south in the Lease Area, but regardless they appear to be comprised of soft sediment and are interpreted to be possibly biogenic in nature. This feature can be observed in Figure 5.2-4 and is further described in Appendix II-B2.

Ripples and megaripples are present in the northeast corner of the Lease Area closest to Nantucket Shoals. Some ripples in this area have wavelengths larger than 5 m (16.4 ft). These features were not classified as megaripples due to their heights, which were shorter than the 0.5 m (1.6 ft) Bureau of Ocean Management (BOEM) requirement to meet the megaripple classification. Additional ripples occur within ripple scour depressions in relatively isolated areas east and west of the shell furrow area. Small, circular shaped RSDs measuring 25 m (82 ft) or less in length can be found in the southeastern-most portion of the Lease Area. See Figure 5.2-2 for the benthic habitat map of the Lease Area following the NMFS 2021 Recommendations.

5.2.1.2 Massachusetts Offshore Export Cable Corridor

Data interpretation from the 2022 field program, publicly available datasets of benthic samples (usSEABED and USGS East-Coast Sediment Texture Database), and sonar data (NOAA) show a diverse range of habitat types within the Massachusetts OECC. In the eastern portion of the OECC closest to the Lease Area (approximately KP 0 to 66.7), Soft Bottom habitat appears to be the dominant habitat type. Within this section of Soft Bottom, there are isolated mounds of organic mud located directly outside of the Lease Area (KP 0 to 1.35) and further down the corridor (KP 28.3 to 35). From KP 28.3 to 34.8, there are also interspersed areas containing ripple scour depressions (RSDs) between this organic sediment.

The area bordering Southwest Shoal (KP 65.7 to 90.2) contains Gravel with grain sizes ranging from pebble/granule to boulders in varying concentrations. This area is primarily characterized as Heterogeneous Complex habitat, with localized areas of Complex habitat present, particularly between KP 81.3 and 88.5. There are boulders within this area that could be classified as Large Grained Complex due to their size of greater than 4 meters (13.1 ft), but because these isolated boulders do not cover 50% of the seafloor as required by the NMFS Recommendations (2021) to meet the substrate subclasses of Bedrock or Megaclast, the habitat was classified as Complex rather than Large Grained Complex. Patches of Soft Bottom habitat were detected between Heterogeneous Complex areas from approximately KP 70.5 to 71.3 and KP 73 to 80.5.

Soft Bottom habitat becomes more common north of Southwest Shoal (KP 90.2) until close to the landfall (KP 119.5), though occasional patches of Heterogeneous Complex habitat containing Gravelly Sand and Sandy Gravel are also present. This is particularly true where the route crosses the submerged extension of the Elizabeth Island chain. Localized areas containing boulders and boulder fields can also be found within this range. There is a 2.5 km (1.6 mi) area of Heterogeneous Complex habitat with interspersed Complex habitat near the landfall (KP 119.5 to 122.7), after which the remainder of the corridor is almost entirely Soft Bottom habitat (KP 122.7 to 125.6).

Benthic features present in the Massachusetts OECC include RSDs, which are most common in the eastern and central portions of the route (KP 23 to 92, and 99.5 to 101.7). Additional RSDs are also present on the western portion of the OECC, where they tend to be smaller and have a thin, elongated shape oriented in a north-to-south direction. No megaripples or sand waves are present in the Massachusetts OECC. See Figure 5.2-5 for an overview of habitat types within the Massachusetts OECC. Benthic charts for the Massachusetts OECC can be found in Appendix II-B22.

5.2.1.3 Connecticut Offshore Export Cable Corridor

The 2022 field program data (sonar and results from benthic grab samples, video transects, and vibracores) as well as publicly available datasets of benthic grab samples (usSEABED and USGS East-Coast Sediment Texture Database) were used to characterize the habitats present within the Connecticut OECC. Due to the large size of the Connecticut OECC and the presence of multiple landfall sites, the description of these habitats is divided across multiple sections.

Offshore

Heading west from the Lease Area and north towards landfall (approximately KP 0 to 123), the data show mainly Soft Bottom habitat comprised of Muddy Sand, Fine/Very Fine Sand, Medium Sand, and Very Coarse/Coarse Sand with occasional areas of Heterogeneous Complex habitat containing isolated areas of Gravelly Sand (see Figure 5.2-6a). Areas closest to the Lease Area (KP 0 to 55) contain Sandy Mud and Muddy Sand as the primary substrate types. Some features resembling the organic mounds found in the Massachusetts OECC were observed on sonar in this area. However, these features are spread discontinuously throughout this part of the corridor in very low concentrations, with minimal relief, and without clear delineations. The sparse distribution of the features did not warrant an overlay on the Connecticut benthic maps.

Ripple scour depressions (RSDs) are scattered throughout the soft sediment offshore from KP 55 to 127. Some of these RSDs from KP 106.5 to 111.3 and KP 116 to 117.3 contain Gravelly Sand in the ripple troughs, causing these areas to be classified as Heterogeneous Complex habitat.

Soft Bottom habitat transitions to primarily Heterogeneous Complex and Complex habitats between KP 123 and 139.2. From KP 123 to 132, the primary habitat type is Heterogeneous Complex with one patch of Complex habitat containing boulders near KP 127. Small ripples are dispersed throughout the corridor between KP 125 and 132, and a single sand wave crosses the OECC at KP 129. Grab samples collected from this area contained Gravelly Sand and Sandy Gravel, while some video transects showed a mixture of fine and coarse sediments.

State Waters

Shell hash and rubble made primarily of shells from *Crepidula fornicata* are present between KP 132.2 and 135 and are interspersed with gravel pavement including pebbles and cobbles. These shell aggregations are visible on side scan and multibeam sonar in addition to video imagery from transects and grab samples. Between KP 135 and 139.2, there is a mixture of Heterogeneous Complex and Complex habitats (see Figure 5.2-6b). Unlike in the previous section of the corridor, the Complex habitats within this area primarily contain boulders with smaller quantities of gravel, cobbles, and pebbles intermixed. Sand ripples and megaripples are common in this area, particularly along the northern edge of the corridor.

Soft Bottom habitat is present from KP 139.2 to 144, with a small section of Heterogeneous Complex habitat surrounding KP 141. Ripples and megaripples cover most of this area, with small patches of shell hash observed in the ripple troughs in video transect VT039 near KP 141. Bedforms continue to cover much of the corridor between KP 144 and 154.4, though much of this area is categorized as Heterogeneous Complex due to increased presence of gravel and shell.

From KP 154.4 to 160, the corridor transitions to primarily Complex habitat, with some Heterogeneous Complex habitat containing ripples and megaripples present on the north side of the corridor from KP 154.4 to 156. Complex habitats in this area contain either cobbles and boulders or large amounts of shell.

Niantic Beach Approach

The previously mentioned Complex habitat continues along the Niantic Beach Approach from KP 0 to 12.3. Most of the benthos is covered by gravel pavement or rubble comprised of *Crepidula fornicata* shells. There are pockets containing boulders scattered throughout this area, with some of these boulders classified as Large Grained Complex habitat on the southern edge of the corridor between KP 1.5 to 3 (see Figure 5.2-6b). Closer to shore, benthic habitats transition to primarily Heterogeneous Complex (KP 12.3) and then later Soft Bottom habitat (KP 13.4). Ripples and megaripples are present between KP 10.2 and 13.4.

Approaching the landfall site (KP 13.4 to 17.3), the habitat transitions to primarily Soft Bottom, though there are some rock outcroppings on the eastern side of the OECC which are classified as Complex and Large Grained Complex including Black Rock (KP 16.8) and Waterford Island (KP 17.1). One area of Heterogeneous Complex habitat is present between KP 17.3 and the landfall. Dense macroalgae is present within this area, which appears to be covering shell hash or shell rubble in some areas. Eelgrass was observed in two video transects (VT109 and VT110) near the Niantic Beach Landfall Site.

Ocean Beach Approach

The Ocean Beach and Eastern Point Beach approaches follow the same corridor from KP 0 to 4. The approach contains Complex habitat from KP 0 to 2.5. The area between KP 1 and 2.5 is particularly rocky, with areas of Large Grained Complex habitat present as well (see Figure 5.2-6b). Megaripples and ripples are present between KP 2.5 and 4.2, where the habitat transitions to Heterogeneous Complex and then Soft Bottom. This Soft Bottom habitat continues along the Ocean Beach approach as it splits from the Eastern Point Beach approach until approximately KP 6.5. There is a patch of Heterogeneous Complex Habitat between KP 5 and 6. There are also occasional small areas containing boulders classified as Complex in this area that are otherwise surrounded by soft sediment.

Past KP 6.5, the route remains classified as Heterogeneous Complex habitat until reaching the Landfall Site. Much of the sediment is soft, with patches of shell hash present along the route. There are some rocky outcroppings classified as Complex and Large grained Complex close to shore past KP 10. One video transect very close to shore (VT113) contained occasional strands and clumps of eelgrass.

Eastern Point Beach Approach

The Eastern Point Beach Approach is identical to the Ocean Beach Approach (described above) until KP 4, where the two routes diverge. Soft Bottom habitat is present from KP 4 to 6.5, with some small rocky areas classified as Complex between KP 4 and 5. There is one patch of Heterogeneous Complex habitat present at approximately KP 5.7, which contains shell aggregations (see Figure 5.2-6b).

Heterogeneous Complex habitat containing ripples is present from KP 6.5 to 7.7, where it transitions to Soft Bottom habitat continuing to KP 9.4. The remainder of the route closest to shore contains primarily Heterogeneous Complex habitat, with patches of Complex Habitat containing boulders present between KP 10 and 11. Ripples are scattered throughout the corridor between KP 9.7 and the Landfall Site. There are also patches of Large Grained Complex habitat very close to shore. One video transect (VT117), and two grab stations (GB111 and GB112) indicated the presence of eelgrass at the Eastern Point Beach Landfall Site.

Figures 5.2-6a and 5.2-6b provide an overview of habitat types within the Connecticut OECC, with more detailed charts available in Appendix II-B22. Sensitive habitats are further discussed below in Section 5.2.2.2.

5.2.2 State-Mapped Sensitive Habitats

Each state where landfall sites are located has distinct definitions of sensitive habitats. Information regarding historical mapping of these habitats in state waters is described separately for each OECC. These definitions of sensitive habitats are separate from the NMFS 2021 Guidance definitions and guidelines. The 2022 field program data were used to ground truth these state-mapped areas and update the distribution of these habitats in state waters. The presence of sensitive habitats within the state of Massachusetts and the state of Connecticut is described below alongside a comparison of original state-mapped sensitive habitat areas and additional findings from 2022 field data.

5.2.2.1 Massachusetts Offshore Export Cable Corridor

The 2021 Massachusetts Ocean Management Plan describes habitat types that were determined to be special, sensitive, and unique (SSU) natural resources within Massachusetts state waters (MA EOEEA 2021). According to Coastal Zone Management (CZM 2020), three habitat types are relevant to the survey work conducted as part of this MSIR: hard/complex seafloor, eelgrass, and North Atlantic right whale core habitat. Hard/complex seafloor is defined as "seabed characterized singly or by any combination of hard seafloor, complex seafloor, artificial reefs, biogenic reefs, or wrecks and obstructions" (CZM 2020). Hard seafloor is seabed characterized by exposed bedrock or concentrations of boulder, cobble, or other similar hard bottom, distinguished from surrounding unconsolidated sediments. Complex seafloor is a morphologically rugged seafloor characterized by high variability in bathymetric aspect and gradient.

Eelgrass (*Zostera marina*) SSU habitat was mapped as an aggregation of all eelgrasses that have ever been mapped along the Massachusetts coastline with a 100 m (328 ft) buffer added to account for intra- and interannual changes in eelgrass distribution (see Figure 5.2-7). These existing data are being used to assess the potential for SSUs within Massachusetts state waters. Data collected during the 2022 field program were used to detect SSU habitats within Massachusetts state waters and to compare these observations to existing historical data. No eelgrass or SAV was detected in video transects or grab samples within the Massachusetts OECC during the 2022 field program. However, cold water corals (*Astrangia poculata*) were found along a total of 14 video transects, both within state waters and federal waters (see Figure 5.2-8).

Hard/complex seafloor mapping included hard seafloor, complex seafloor, artificial and biogenic reefs, wrecks, and obstructions (CZM 2020). Massachusetts state-mapped hard/complex seafloor is sparsely scattered throughout the Massachusetts OECC within state waters (CZM 2020). Isolated regions of complex seafloor were present between KP 120 and 122.6. Hard/complex seafloor was also present between KP 115.6 to 120, but was more scattered with larger areas of soft sediment in between. As the OECC approaches the landfall, the seafloor transitions to exclusively soft bottom habitat from KP 122.7 to 125.6. Survey results of hard/complex seafloor were very similar to what had previously been mapped using the State of Massachusetts public data (see Figure 5.2-9).

5.2.2.2 Connecticut Offshore Export Cable Corridor

The Connecticut OECC traverses both New York and Connecticut state waters. Sensitive areas have been mapped extensively within Long Island Sound, but less so within New York state waters outside of Long Island Sound. Ecologically Significant Areas (ESAs) defined by the Connecticut Department of Energy and Environmental Protection in the Long Island Sound Blue Plan (CT DEEP Long Island Sound Blue Plan) fall within two Criteria Pillars:

1. Areas with rare, sensitive, or vulnerable species, communities, or habitats;
2. Areas of high natural productivity, biological persistence, diversity, and abundance, including areas important for supporting or exhibiting such features.

ESAs that are relevant to the benthic survey work and present within the Connecticut OECC are listed and described in Table 5.2-1. Figure 5.2-10 through Figure 5.2-16 portray these relevant ESAs along the nearshore portion of the Connecticut OECC using publicly available historical data. Data from the 2022 field program were used to further identify ESAs within Connecticut state waters with comparison to public data. The observations from these comparisons are discussed in Table 5.2-1. See Figure 1.1-3 for kilometer post (KPs) locations along each landfall site.

Some ESAs cover large expanses of the corridor, such as complex seafloor and significant areas for cetaceans, while most are sparsely distributed throughout the corridor, such as hard bottom, cold water corals, and sessile mollusk beds. Other ESAs, such as SAV (eelgrass) and the Connecticut Natural Diversity Database, are only present at the landfall sites. Mobile invertebrates' ESA within the OECC is due to decapod (crab) and long-finned squid presence as detected by the Long Island Sound Trawl Survey (CT DEEP Marine Fisheries Program 2019). Managed shellfish bed areas are located at the very eastern edge of the Niantic Beach Approach within Connecticut state waters, as well as a small area at the landfall. Special attention will be given to cold-water corals and eelgrass during cable installation.

Table 5.2-1 State Mapped Ecologically Significant Areas (ESAs) within the Connecticut OECC

ESA	Offshore OECC (KPs)	Niantic Beach Approach (KPs)	Ocean Beach Approach (KPs)	Eastern Point Beach Approach (KPs)
Hard Bottom	*Granules, pebbles, and cobbles (collectively called gravel) as well as boulders and outcrops of bedrock. State mapped boundaries for hard bottom were created by the Connecticut Department of Energy and Environmental Protection as part of the Long Island Sound Blue Plan using hard bottom points from public datasets and adding a 160 m (525 ft) buffer. Hard bottom was also detected during the 2022 field program in sonar coverage and ground truthing samples (grabs, video transects, and vibracores). Figure 5.2-10 shows a comparison between hard bottom areas identified by CT DEEP and the benthic habitats identified in the 2022 field program.*			
State Mapped Hard Bottom	159–160.4	1.5–3, 4, 7, 8–8.5, 11–13, 16.5–18	2–2.5, 7, 9	2–2.5, 10
Field Program Hard Bottom	154.5–160.4	0–12.3, 16, 17.2–17.8	0–2.5, 10–10.6	0–2.5, 10.2–12.1 (scattered)
Complex Seafloor	*Complex seafloor is defined as the top 20% of complexity as measured by the Terrain Ruggedness Index (TRI). The TRI metric reflects the difference between the depth at each point on the seafloor and the depth of the points surrounding it. The higher the TRI metric, the more complex the seafloor is. Comparison between complex seafloor identified by the CT DEEP Long Island Sound Blue Plan and the 2022 field program can be seen in Figure 5.2-11.*			
State Mapped Complex Seafloor	159–160.4	0–13.5, 16	0–3.2, 3.2–10.6 (very scattered)	0–3.2, 3.2–5.3 (very scattered), 9.8–12.1 (very scattered)
Field Program Complex Seafloor	159–160.4	0–14, 15–18.3 (scattered)	0–3.3, 5–8.3 (scattered), 10	0–3.3, 6.7–8, 9.5–12.1 (scattered)
Wrecks and Obstructions	*Wrecks tend to serve as artificial reefs, and obstructions can include boulders or other hard bottom not delineated in geologic maps. Areas identified by the Connecticut Blue Plan as containing wrecks and obstructions are shown in Figure 5.2-10.*			
State Mapped Wrecks and Obstructions	159	8,17	3–4, 7, 8, 9–10.6	3–4, 6.5, 10.5–11
Corals	*The boundaries provided by CT DEEP as part of the Long Island Sound Blue Plan for cold water corals show areas where cold water corals have been observed or where habitat suitability or other scientific models predict they occur. Cold water corals were also observed on video transects from the 2022 field program. Cold water corals are a visibly unique expression of a healthy, thriving marine*			

ESA	Offshore OECC (KPs)	Niantic Beach Approach (KPs)	Ocean Beach Approach (KPs)	Eastern Point Beach Approach (KPs)
	ecosystem. Figure 5.2–12 compares CT DEEP Long Island Sound Blue Plan coral areas with transects where they were observed during the field program.			
State Mapped Corals	160	0, 4, 11.5, 16	2.5	2.5, 8
Field Program Corals	127–140, 144–145, 153, 156–160	2–3, 4–5, 8–8.5, 10–13, 15–16	1–2, 5.5, 8	1–2
SAV	*Areas where submerged aquatic vegetation (SAV), e.g., eelgrass (Zostera marina), are present or have been found previously. SAV refers to rooted, vascular plants that occur in the shallow waters of Long Island Sound. SAV was detected in Connecticut state waters during the 2022 field program, and is shown in Figure 5.2-13.*			
State Mapped SAV	none	17.5-18.4	10.6	12.1
Field Program SAV	none	17.6-18.3	10.3-10.6	11.2-12.1
Mobile Invertebrates	*Areas of high mobile invertebrate abundance and concentration (shown in Figure 5.2-14). Mobile invertebrates include large benthic crustaceans such as lobster and crabs, as well as pelagic invertebrates such as squid.*			
State Mapped Mobile Invertebrates	none	10, 14-16	7-10	8-11.8
Sessile Mollusks	*Areas where wild, natural sessile-mollusk-dominated communities occur (see Figure 5.2-15). Sessile-mollusk-dominated communities are assemblages of non-mobile gastropods (e.g., slipper shells) and bivalves (e.g., blue mussels, clams) that are not harvested by humans.*			
State Mapped Sessile Mollusks	none	11.5, 16	6.5	none
CT Natural Diversity Database	*Approximate locations of endangered, threatened, and special concern species and significant natural communities in Long Island Sound (see Figure 5.2-16).*			
State Mapped Natural Diversity Database	none	17-18.3	10.5-10.6	11.5-12.1
Cetaceans	*Areas where cetaceans occur in higher concentrations and/or significant areas that support cetaceans (e.g., particular feeding areas, nursery grounds) (see Figure 5.2-16). Cetaceans include whales, dolphins, and porpoises.*			
State Mapped Cetaceans	none	6-18.3	6.5-10.6	7.5-12.1
Sea Turtles and Other Reptiles	*Areas where sea turtles and other reptiles occur in higher concentrations and/or significant areas that support sea turtles and other reptiles (e.g., particular feeding areas, nesting grounds, hibernation areas) (see Figure 5.2-16). Includes sea turtle species common in the Sound such as Loggerhead, Kemp's Ridley, and Green, as well as a different species of turtle, the Northern diamondback terrapin.*			
State Mapped Sea Turtles and Other Reptiles	none	none	none	9-10, 11-12.1
Managed Shellfish Beds	*Locations of commercial and recreational shellfishing harvest areas, including shellfish restoration activities and areas closed to shellfishing (see Figure 5.2-15). In Connecticut, shellfish are defined as oysters, clams, mussels, and scallops.*			

ESA	Offshore OECC (KPs)	Niantic Beach Approach (KPs)	Ocean Beach Approach (KPs)	Eastern Point Beach Approach (KPs)
State Mapped Managed Shellfish Beds	none	9-16.5, 17.5-18.3	none	none

<u>Northern Star Coral</u>

Northern star corals (*Astrangia poculata*) were identified in 24 video transects approaching and within Connecticut waters. The video imagery was acquired on transects along the Niantic Beach and Ocean Beach Approaches as well as within New York state and federal waters. Video transects containing northern star coral were classified as Complex and Complex Mix under the NMFS Recommendations for Mapping Fish Habitat (NMFS 2021), and corals were seen anchored to boulders and cobbles. Observations of cold water coral were often within or very close to the state-mapped boundaries for corals in the Connecticut Blue Plan (see Figure 5.2-12).

<u>Submerged Aquatic Vegetation</u>

Eelgrass (*Zostera marina*) was observed on grab camera and video transect footage at all three landfall sites, and coincides closely with areas mapped as part of the Connecticut Blue Plan (CT DEEP Long Island Sound Blue Plan) (see Figure 5.2-13). Eelgrass was observed to be the densest at the Eastern Point Beach Landfall Site, which showed eelgrass beds in video footage for all three replicates of grab sample GB112. Significantly smaller numbers of eelgrass plants were also observed in the video footage for GB111 replicates B and C as well as along video transect VT117, which showed a small section of eelgrass beds surrounded by more sparse individual plants in areas otherwise dominated by macroalgae. Eelgrass beds were also detected at the Niantic Beach Landfall Site, where they were found at the beginning of VT109. Video transect VT110, also at Niantic Beach, showed occasional, sparsely distributed plants throughout the transect with one larger eelgrass clump, which were surrounded by areas of dense macroalgae. Eelgrass was less common at the Ocean Beach Landfall Site, where video transect VT113 showed occasional eelgrass plants in low concentrations.

<u>Hard Bottom Substrate and Complex Seafloor</u>

Areas characterized as hard bottom substrate in the Connecticut Blue Plan contain cobbles, pebbles, or granules. These areas are labeled as Complex or Large Grained Complex on NMFS habitat figures (see Figures 5.2-6a and 5.2-6b), and areas labeled as Heterogeneous Complex may also include isolated areas of hard bottom as defined above. The NMFS Recommendations for Habitat Mapping also classifies shell hash and rubble (greater than 50% coverage) as Complex habitat. Many areas that were not classified as hard bottom substrate under the Connecticut Blue Plan were classified as Complex following the NMFS guidelines (see Figure 5.2-10). This was particularly true between KP 0 to 12.3 on the Niantic Beach

Approach, where the Connecticut Blue Plan showed small pockets of hard bottom substrate, while the NMFS habitat maps classified nearly the entire area as Complex habitat. Video transects indicate that gravel pavement and shell rubble are common in this section of the corridor. KP 0 to 2.5 on the Ocean Beach and Eastern Point Approaches was also classified as Complex and Large Grained Complex under the NMFS system, but only contained small patches of hard bottom substrate in the Connecticut Blue Plan dataset.

Additionally, the Connecticut Blue Plan calculates the Terrain Ruggedness Index (TRI) for state waters and classifies the top 20% of values as complex seafloor. The more complex the benthic habitat, the higher the TRI value will be. Multibeam data collected during the 2022 field program were binned to 3 m (9.8 ft) grids and analyzed through the Terrain Ruggedness Index function in QGIS. The most rugged areas, shown in Figure 5.2-11 in red and orange, were compared to areas identified by the Connecticut Blue Plan, which used lower resolution data ranging from 8 to 83 m (26.2 to 272.3 ft). Despite this difference in resolution, there was a significant amount of overlap between areas identified as part of the Connecticut Blue Plan and those characterized using multibeam data from the 2022 field program. However, there were some additional areas of complex habitat which were identified using the survey data that were not present in the Connecticut Blue Plan dataset.

5.2.3 Observed Fisheries Species Information

Underwater video imagery provides insight into some of the animals inhabiting or using the benthic communities in the Offshore Development Area. These data were compared to public information available on Essential Fish Habitat (EFH) as well as habitats on the continental shelf and nearshore embayments of Massachusetts and Connecticut. For a detailed summary of historical and current research results on EFH and specific habitat designations covering the Offshore Development Area, please refer to Appendix II-D. While it is understood that EFH covers large offshore regions based on different datasets, results from the underwater video data can reveal distinct locations where higher concentrations of fish were observed within the Offshore Development Area. Extrapolation of the video imagery to surrounding seabed areas based on the sonar data allows an estimation of sections in the Offshore Development Area where enhanced bottom structure supportive of more abundant fish communities may exist.

Video footage was collected from the Lease Area in 2019 and 2022, and from the Massachusetts OECC and Connecticut OECC in 2022. Fisheries species observed on video transects from 2022 are summarized below in Table 5.2-2. Each of the species listed in the table has EFH overlapping with a portion of the project area. Most frequently observed species included red hake (*Urophycis chuss*), Atlantic butterfish (*Peprilus triacanthus*), and scup (*Stenotomus chrysops*). Species observed on video transects in the Lease Area in 2019 were primarily identified to the family level rather than species, and as such are not included in Table 5.2-2. Additional information on fauna observed during the 2019 field program can be found in Appendix II-B11.

Table 5.2-2 Fisheries Species Observed During 2022 Field Program

Fisheries Species		Area Observed			Total Number Observed in 2022 Survey
Common Name	Scientific Name	Lease Area	MA OECC	CT OECC	
Atlantic butterfish	*Peprilus triacanthus*		X	X	361
Black seabass	*Centropristis striata*		X	X	194
Little skate	*Leucoraja erinacea*	X	X	X	71
Northern sea robin	*Prionotus carolinus*	X	X	X	125
Ocean pout	*Zoarces americanus*	X	X	X	11
Pollock	*Pollachius virens*	X	X	X	6
Red hake	*Urophycis chuss*	X	X	X	770
Scup	*Stenotomus chrysops*		X	X	302
Sea scallop	*Placopecten meagellanicus*	X	X	X	276
Silver hake	*Merluccius bilinearis*	X	X	X	209
Summer flounder	*Paralichthys dentatus*	X	X	X	5
Longfin inshore squid	*Loligo pealeii*	X	X	X	196
Quahog[1]	Veneridae	X	X	X	136
Winter flounder	*Pseudopleuronectes americanus*			X	1
Winter skate	*Leucoraja oceallata*		X	X	14
Witch flounder	*Glyptocephalus cynoglossus*	X	X	X	210

Notes:
1. EFH for ocean quahogs (*Arctica islandica*) overlaps with portions of the Offshore Development Area. Due to the speed of the ROV, distance above the seafloor, and burrowing nature of these bivalves, it was not always possible to identify quahogs to a species level from video footage. Instead, quahogs were identified to the family level (Veneridae).

In addition to EFH zones, there are also Habitat Areas of Particular Concern (HAPC) for summer flounder (*Paralichthys dentatus*) and Atlantic cod (*Gadus marhua*) in the Offshore Development Area. 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" (NOAA 2007). Within the Massachusetts OECC, summer flounder EFH is located from KP 122.5 to 125.6. Summer flounder were observed on one video transect along the Massachusetts OECC just past KP 40 outside of the EFH area. Summer flounder EFH is present in all parts of the Connecticut OECC within state waters. Two individual summer flounder were recorded on video transects between KP 100 and 105 as well as close to shore on the Ocean Beach Approach just past KP 10. All three landfall sites in the Connecticut OECC contained patches of eelgrass and dense algae, which make them habitat areas of particular concern for summer flounder.

Atlantic cod HAPC is located in the Massachusetts OECC within state waters (KP 115 to 125.6). This also includes waters near the moraines associated with Southwest Shoal and the southwest extension of the Elizabeth Islands that are structurally complex with mixed sand and gravel and discontinuous rocky habitats (NEFSC 2017). Cod were not observed on any video transects during the 2022 field program.

Crustaceans are also significant for fisheries in New England and were frequently observed during the field program. In the Lease Area, crabs were abundant in Heterogeneous Complex habitats containing shell (TRC 2023), suggesting that the structured seabed provided good habitat and foraging opportunity for the crabs. Observations of fishing activity made during the 2019 and 2022 field programs suggest that the seafloor in the vicinity of the Race within the Connecticut OECC, where a high concentration of fixed gear was located (KP 0 to 6 in the Niantic Beach Approach and KP 0 to 2.5 in the shared Ocean Beach Approach and Eastern Point Beach Approach), has an abundance of bottom dwelling crustaceans. It is possible that there is also increased fish diversity and abundance in this area due to the enhanced seabed structure formed by strong currents.

While crabs were certainly common in the Race and nearshore waters (particularly near KP 2 on the Niantic Beach Approach), crabs were also abundant just outside of Connecticut state waters at KP 155. Surprisingly, crabs were most abundant in the Massachusetts OECC on video transects VT047 and VT058, which were located very close to the Lease Area (KP 0.5) and contained Soft Bottom habitat. This shows that although crabs may be found in Heterogeneous Complex and Complex areas, they are also making use of Soft Bottom habitats. American lobsters were observed in video transects near and within the Race in the Connecticut OECC as well as in Soft Bottom habitat closer to the Lease Area, showing that they too inhabit a variety of substrates. In Massachusetts, lobsters were observed along two video transects, which were classified as containing Heterogeneous Complex and Complex habitats.

For a detailed report on EFH and fisheries species within the Offshore Development Area, please see Essential Fish Habitat Assessment located in Appendix II-D of COP Volume II. For additional information about fauna observed during the 2019 and 2022 field programs, please see Appendix II-B11 and Appendix II-B20.

5.3 Protected Species Observation Results

Section 5.3 is redacted in its entirety.

6 Conclusions and Summary

Section 6 is redacted in its entirety.

7 References

Section 7 is redacted in its entirety.