OCS-A 0501

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VINEYARD WIND

# Draft Construction and Operations Plan

## Volume II-A

## Vineyard Wind Project

October 22, 2018

**Submitted by**
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**Submitted to**
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**Sterling, Virginia 20166**

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Epsilon ASSOCIATES INC.

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# Volume II-A

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*Submitted to:*

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|---|---|
| Biodiversity Research Institute | JASCO Applied Sciences |
| C2Wind | Morgan, Lewis & Bockius LLP |
| Capitol Air Space Group | Public Archaeology Laboratory, Inc. |
| Clarendon Hill Consulting | RPS |
| Ecology and Environment | Saratoga Associates |
| Foley Hoag | Swanson Environmental Associates |
| Geo SubSea LLC | Wood Thilsted Partners Ltd |
| Gray & Pape | WSP |

October 22, 2018

# Executive Summary

The Executive Summary is redacted in its entirety.

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# Section 1.0

## Introduction

Section 1.0 is redacted in its entirety.

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## Site Geology and Environmental Conditions

Section 2.0 is redacted in its entirety.

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Section 3.0 is redacted in its entirety.

# Section 4.0

## Geological Results Relevant to Siting and Design

Section 4.0 is redacted in its entirety.

## Section 5.0

Results of Biological Surveys

# 5.0 RESULTS OF BIOLOGICAL SURVEYS

This section of the report documents the biological studies completed during the three survey seasons, and the results obtained from those investigations.

Nektonic (fish, marine mammals, turtles, seals) and avian (birds and bats) fauna information is based on existing research and historical data, and these topics are addressed in Section 6 of Volume III.

## 5.1 Benthic Habitats

Habitats occupying the benthic (bottom) substrate or seafloor and very shallow subsurface of the seabed are included in this classification. Surficial habitats are initially identified and mapped using the sonar systems of the geophysical instrument suite, in particular the side scan sonar which records changes in the acoustic reflectivity of the seafloor from the high frequency sound transmitted by the system and the multibeam echosounder data which records backscatter intensity analogous to sonar reflectivity. Variations in sediment type, texture, and small-scale morphology are visible on the sonar imagery. Subsequent ground truthing of the sonar data via grab samples, vibracores, and underwater video allows confirmation of interpreted surficial sediments and identification of habitats, and more detailed information to be attained on specific organisms inhabiting those benthic communities. Benthic analysis of grab samples identified and enumerated the epifaunal (surface) and infaunal (burrowing) species inhabiting unconsolidated substrates. Examination of the underwater video imagery provided additional information on epifauna as well as flora. Figure 5.1-1 shows the locations of the grab samples and video transects along the OECC.

### *5.1.1 Dominant Habitat Types*

Benthic habitats observed in the video and grab samples are common and typical for this region of the inner continental shelf including Nantucket Sound. Habitats have been classified based on Auster (1998) and a modified version of Barnhardt et al (1998). For more details regarding the mapping based on review and analysis of the underwater video imagery, please refer to the CR Environmental reports (2017 & 2018) in Appendix H. The classification scheme of Auster (1998) is summarized in Table 5.1-1. Similar to surficial sediments, in reality there are no distinct boundaries between these community types, there are gradational transitions between substrate types and habitats on the seafloor. In general, higher complexity habitats are considered the highest quality because they support a wide range of niches and greater species diversity (Levins, 1979).

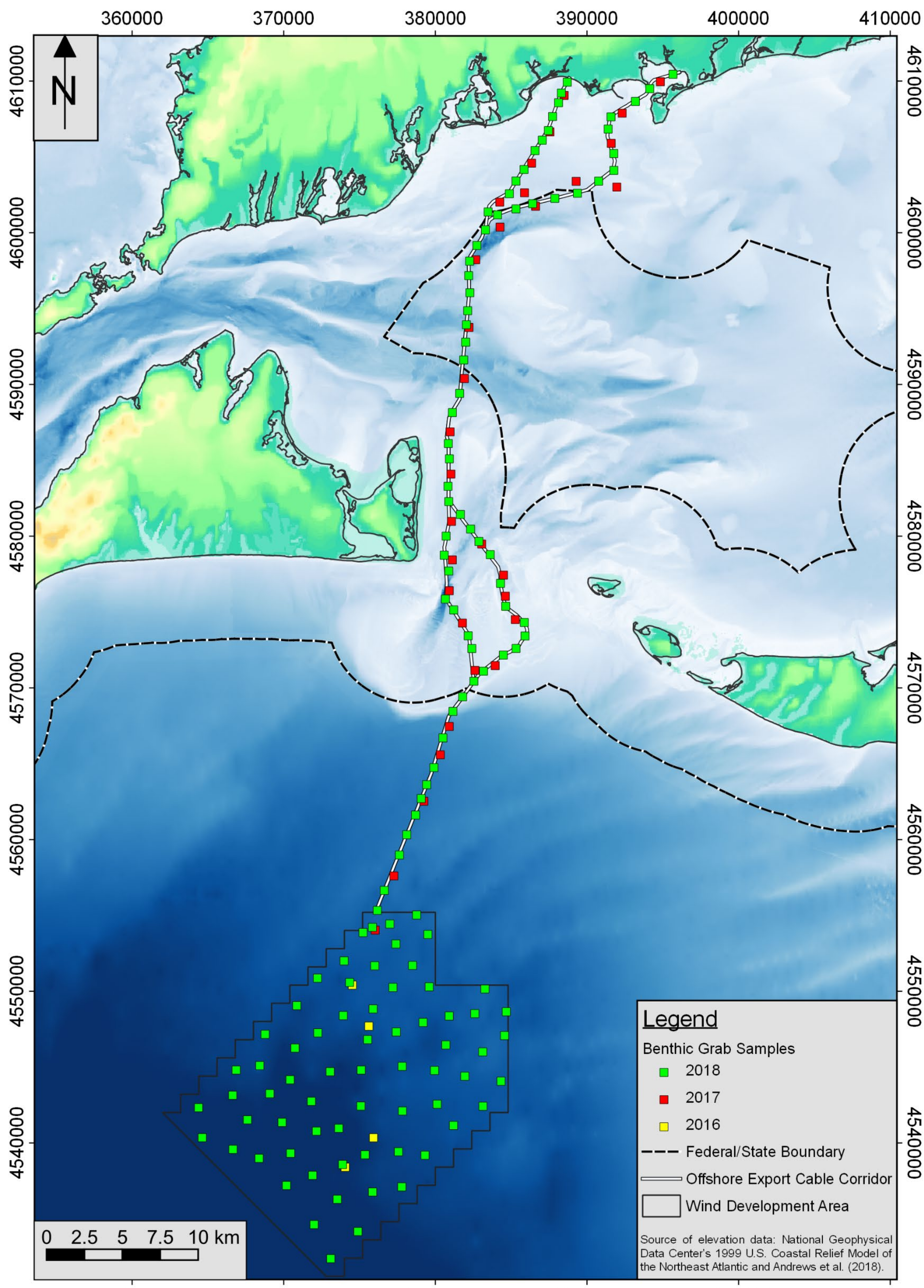


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**Figure 5.1-1a**

*Location of benthic grab samples.*

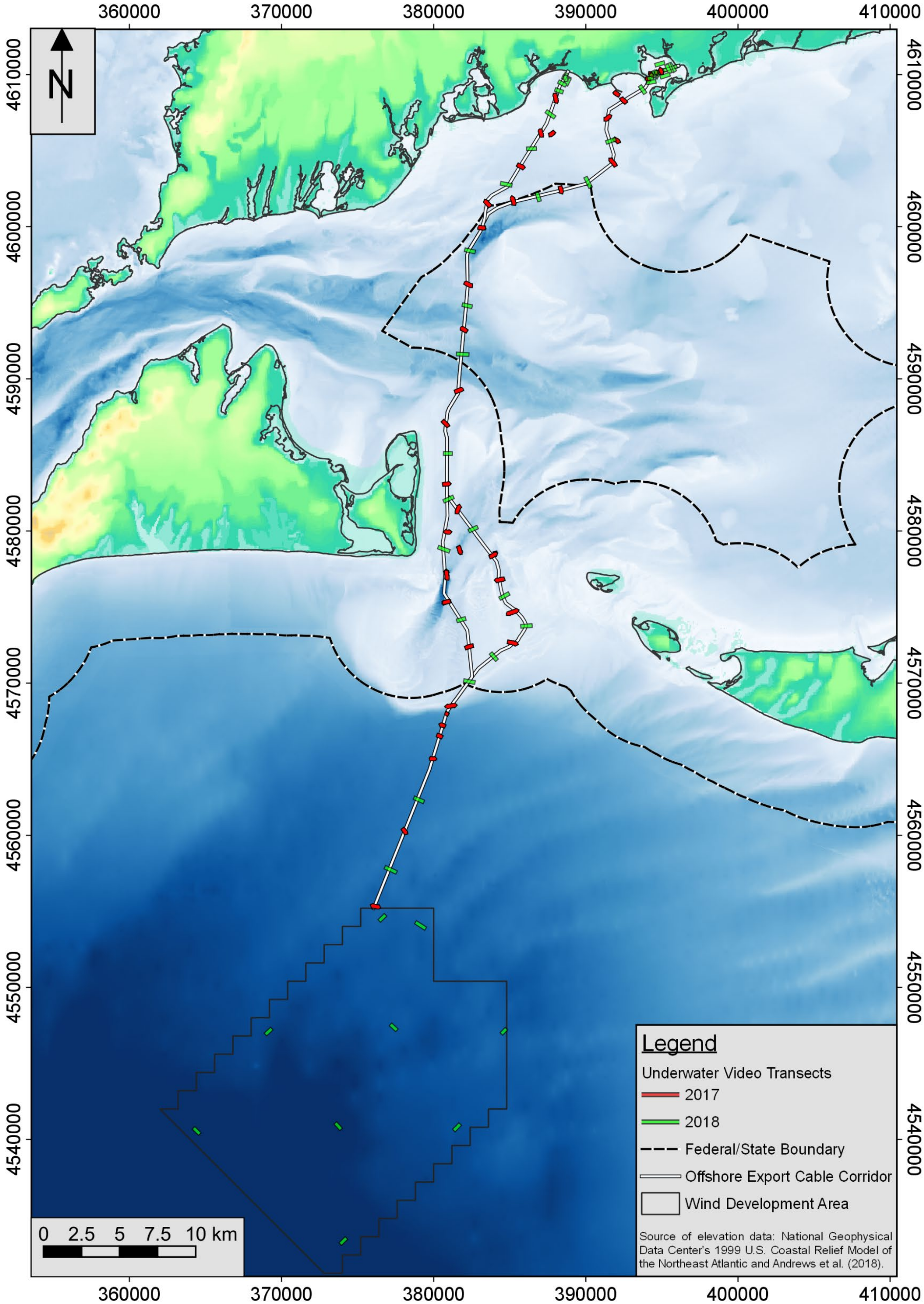


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**Figure 5.1-1b**

*Location of underwater video transects.*

Table 5.1-1 Auster (1998) Habitat Classification

| Habitat Category | Description | Rationale | Complexity Score |
|---|---|---|---|
| 1 | Flat sand/mud | Areas with no vertical structure such as depressions, ripples or epifauna | 1 |
| 2 | Sand waves | Troughs provide shelter from current; previous observations indicate that species such as red hake hold position on the downcurrent sides of sand waves and ambush drifting demersal zooplankton and shrimp | 2 |
| 3 | Biogenic sediments / structures | Burrows, depressions, cerianthid anemones, hydroid patches; features that are created or used by mobile fauna for shelter | 3 |
| 4 | Shell aggregates | Provide complex interstitial spaces for shelter; also provide a complex, high-contrast background that may confuse visual predators | 4 |
| 5 | Pebble-cobble | Provide small interstitial spaces and may be equivalent in shelter value to shell aggregate, but less ephemeral than shell | 5 |
| 6 | Pebble-cobble with sponge cover | Attached fauna such as sponges provide additional spatial complexity for a wider range of size classes of mobile organisms | 10 |
| 7 | Partially buried or dispersed boulders | Partially buried boulders exhibit high vertical relief; dispersed boulders on cobble pavement provide simple crevices; the shelter value of this type of habitat may be less or greater than previous types based on the size class and behavior of associated species | 12 |
| 8 | Piled boulders | Provide deep interstitial spaces of variable sizes | 15 |

#### 5.1.1.1 Wind Development Area

The WDA is comprised entirely (100%) of unconsolidated sediment substrate with predominantly sand and silt sized material. Given site water depths and location on the continental shelf, this is a fairly stable benthic environment dominated by deposition or non-erosion. This is characterized by a seafloor that is relatively flat and void of relief (Habitat 1), with the exception of localized scour depressions containing sand ripples, indicating some minor sediment movement believed to be limited to the feature boundaries (Habitat 2; small, low relief). These features are referred to as rippled scour depressions (RSDs) in the literature. Maximum scour depth is less than 0.8-1 m (2.6-3.3 ft) with ripples typically 0.4-0.8 m (1.3-2.6 ft) in height. Locally, biogenic structures (Habitat 3) are apparent in areas outside of the RSDs.

Grab samples from 2016 and 2018 in both bottom morphologies (flat and rippled sand) reveal the benthos is dominated by annelids (marine worms) with a variety of other infaunal species common, including crustaceans (amphipods), mollusks (bivalves such as clams), and nematode worms (ESS Group, 2016; RPS, 2018). Frequent epifaunal organisms include echinoderms (sand dollars, sea stars), mollusks (gastropods such as snails, bivalves), and tunicates (sea squirts) (NEFSC [Northeast Fisheries Science Center], 2017; Theroux and Wigley, 1998; Wigley and Theroux, 1981). Underwater video shows sand dollars and burrowing anemones are particularly common in the northern portion of the WDA. Abundance and diversity values are known to exhibit variability both spatially and temporally on the shelf.

#### 5.1.1.2 Offshore Export Cable Corridor

The OECC traverses a variety of substrates between the offshore WDA and the south shore of Cape Cod. By far the most common habitat is an unconsolidated sediment substrate, specifically a sandy surficial layer that can be subdivided into (a) a highly mobile benthos comprised of migrating bedforms and (b) a more stable benthic environment mostly void of active sediment transport features. The latter typically trends toward the finer grained substrates outside of high current areas (more silt) or contains increasingly coarser material (gravel) that is not redistributed during normal flow conditions. The primary difference is the grain size and sediment turnover rate which affects the types of organisms that commonly inhabit the various substrates.

Figure 5.1-2 shows the habitat classification at each of the 37 video transects surveyed along the OECC in 2017. Figure 5.1-3 includes the classification at the 53 transects surveyed in the Offshore Project Area (WDA and OECC) in 2018. The habitat categories are defined further in the CR Environmental final reports (2017 and 2018, provided in Appendix H of Volume II-A), along with a full description of the benthic ecological review of the underwater video imagery. Results from 2017 macrofaunal analysis of the 59 sediment grab samples are documented by Normandeau Associates (2017) and identify the primary infaunal community organisms. Further analysis of the 2017 macrofaunal survey including only those samples along the currently proposed OECC (31 grab samples) are included in the RPS (2018) report. Results from the 2018 lab analysis of 131 grab samples are included in the benthic results spreadsheets and RPS (2018) report. Identification of the fauna and flora is to the lowest taxonomic level possible, usually to family and genus-species if detectable from the specimen. All the benthic biological reports are included in Appendix H of Volume II-A.

Table 5.1-2 below lists the results of the video and benthic lab analyses for organism identification and abundance, as well as an overall habitat type and assessment. Habitat classification was made from the underwater video and is based on Auster (1998).

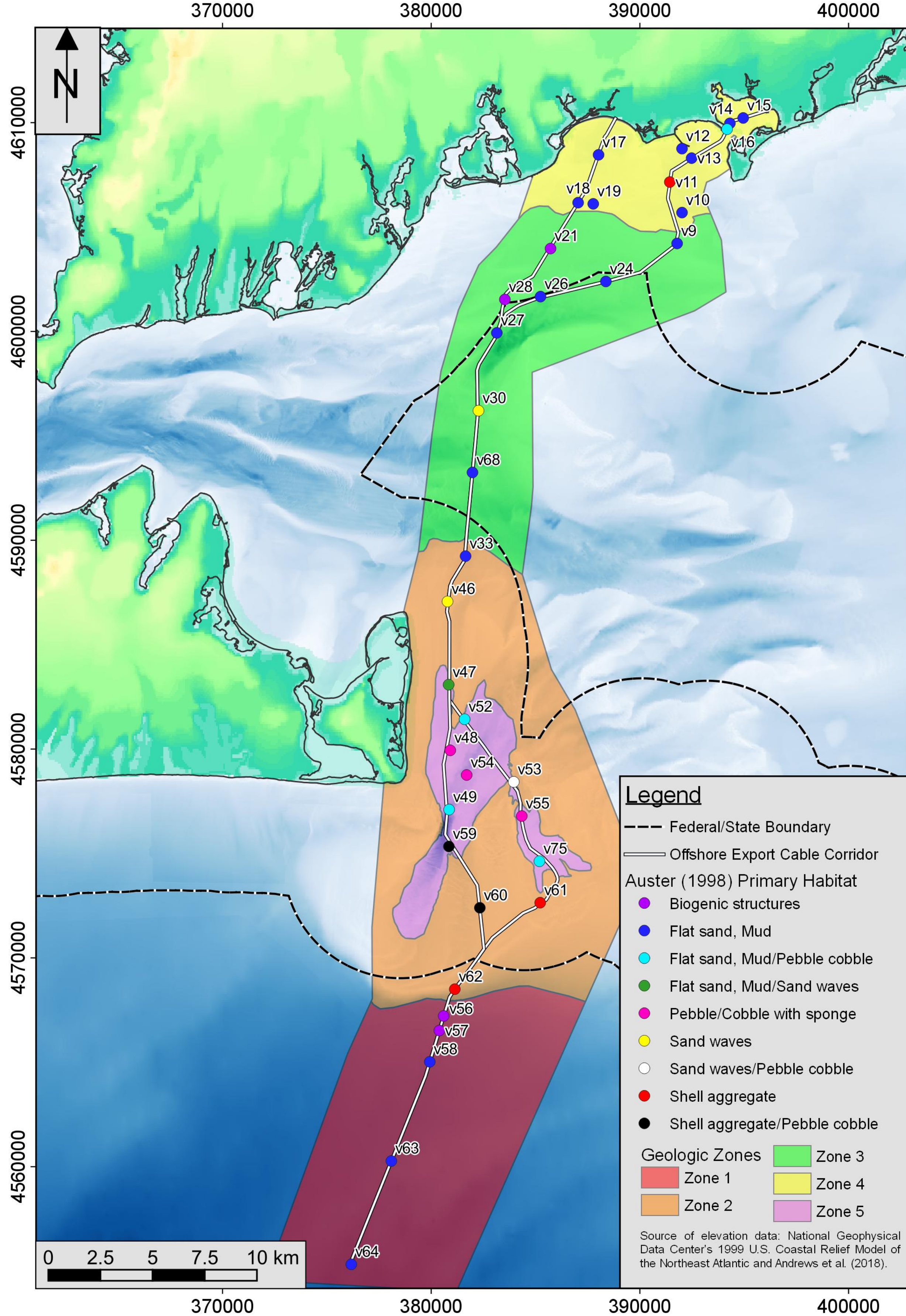


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**Figure 5.1-2**

*2017 primary habitats along the OECC based on Auster (1998).*

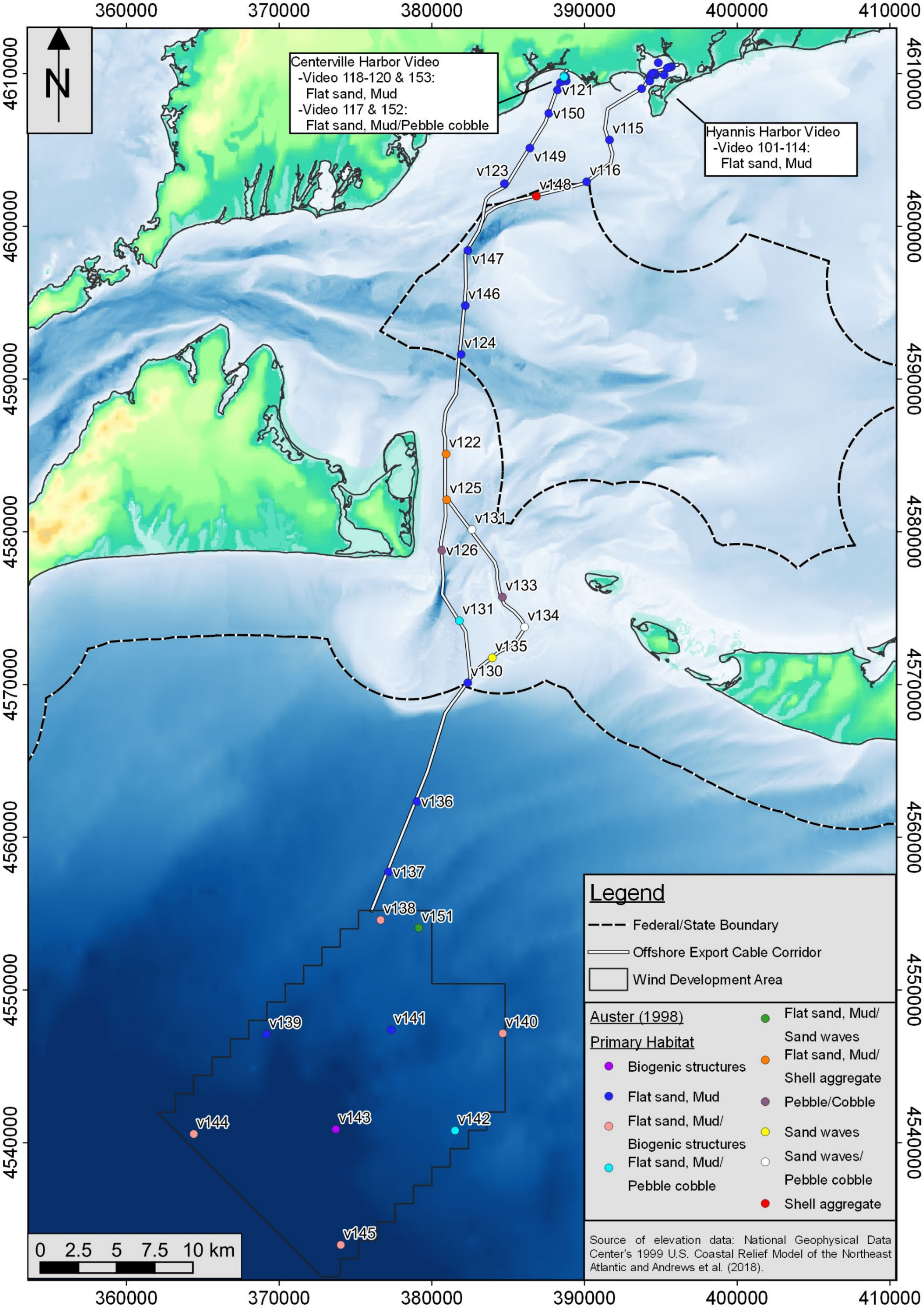




**Figure 5.1-3**

*2018 primary habitats along the OECC and in the WDA based on Auster (1998).*

## Table 5.1-2 Habitats and Benthic Communities Along the OECC

| | | Habitats & Dominant Organisms | |
|---|---|---|---|
| Cable Corridor | Distance (KPs) | Underwater Video (mainly epifauna) | Benthic Grabs (mainly infauna) |
| **South of Muskeget** | KP 0-14 | Habitats 1 and 2, locally Habitat 3; sand dollars, burrowing anemones | Amphipods, polychaete worms, nut clams, nematodes |
| **Western Muskeget Option** | KP 14-29 | Combination of Habitats 2, 5, & 6 with 1 & 4; Sulfur sponge, bread crumb sponge, moss animals (bryozoans) | Amphipods, dove snails, polychaete worms, venus clams, nematodes |
| **Eastern Muskeget Option** | KP 0-10 | Combination of Habitats 2, 5, & 6 with 1 & 4; Sulphur sponge, red beard sponge, blue mussels | Polychaete worms, nematodes, clams (venus & surf) (2 grabs no recovery, G41 and G42) |
| | KP 10-15 | Habitats 1, 2, & 5; sulfur sponge | Nematodes, amphipods, polychaete worms |
| **OECC to Covell's Beach Landfall** | KP 29-59.2 | Habitats 1 and 2, locally Habitat 3; amphipods, slipper limpets, whelks, sponges, polychaetes, spider crabs | Polychaete worms, snails (slipper limpets, pyram shells, dove), amphipods, nematodes (1 grab no recovery, G05) |
| **New Hampshire Avenue Landfall Option** | KP 0-10 | Habitats 1 and 2; slipper limpets, whelks | Polychaete worms, nematodes, snails (slipper limpets) |
| | KP 10-19 | Habitat 1 with Habitats 4 and 5 locally; amphipods, slipper limpets, mud snails, polychaetes, bryozoans | Polychaete worms, amphipods, snails, clams, nematodes |

Note: organisms listed in order of abundance

### *5.1.2 Underwater Video Review*

Over 75% of the video transects recorded low complexity bottom habitats with sand as the dominant constituent and primary classifications of flat sand/mud (Habitat 1), sand waves (Habitat 2), or biogenic structures (Habitat 3). The mobile sand layer within the bedform fields was the least productive of all habitats (CR Environmental, 2017 and 2018). Conversely, the most productive habitats with the highest number of invertebrate species and observations of fish included areas with large colonies of sulfur sponge (*Cliona celata*) and those dominated by slipper limpet (*Crepidula fornicate*) communities. These habitats occur mainly in the Muskeget Channel area (pebble-cobble with sulfur sponge communities) and in northern portions of Nantucket Sound (slipper limpet reefs). Sulphur sponge was also evident offshore in the WDA, as it does not require a hard substrate for attachment. A number of the locations within the Muskeget area also bordered on a dispersed boulder habitat as isolated rocks of significant size are evident at some of those sites, particularly transects along the Eastern Muskeget Corridor Option.

The only commercial invertebrate specie observed in significant numbers was the knobbed whelk (*Busycon carica*) that was usually associated with the slipper limpet habitat. Whelk egg cases were very common on the video. In the fall, whelk forage on slipper limpets before they burrow into the bottom for the winter (CR Environmental, 2017). The only commercial fish species evident more frequently and at numerous transects were scup (*Stenotomus chrysops*), skate (*Raja erinacea*), and red hake (*Urophycis chuss*). Red hake were evident only offshore in the WDA. Bay scallops, sea scallops, surf clams, blue mussels, rock crabs, blue crabs, and horseshoe crabs were observed in low numbers.

Macroalgae was also prominent in a number of the habitats and common throughout Nantucket Sound. It was particularly abundant in habitats 4, 5, and 6 as algae attaches to shells and coarse material (pebbles, cobbles, boulders). Red algae were the most abundant of the three primary macroalgal types observed, including red (phylum Rhodophyta), brown (phylum Phaeophyta), and green (phylum Chlorophyta). Red branching algae was visible at more than 50% of the transects, with varieties of bushy red seaweeds also fairly abundant. Centerville Harbor transects also showed more abundant algal cover including dead man's fingers (*Codium fragile*), sea lettuce (*Ulva lactuca*), and purple laver (*Porphyra umbilicalis*).

Benthic habitats and organisms recorded on the video throughout the OECC and WDA were consistent from 2017 and 2018, with no major differences apparent. Refer to the CR Environmental reports (2017, 2018) in Appendix H for further discussion of these habitats and organisms. Section 4.0 of the 2018 CR reports notes some challenges with visibility due to the time of year the video work was conducted. However, we note that it was conducted on purpose during the time when surveys for eelgrass are recommended. Eelgrass is a resource of great concern to state and federal resource agencies and was therefore prioritized. Visibility issues were also addressed by planning around the tidal cycle.

A small percentage of the OECC is covered by potential special, sensitive, and unique habitats (SSUs) that will be discussed in Section 5.2.

### *5.1.3 Benthic Macroinvertebrate Analysis*

#### 5.1.3.1 Wind Development Area

The WDA was sampled in both 2016 and 2018. The 2016 survey effort included the collection of 4 samples for benthic analysis and the 2018 survey effort included the collection of 67 samples for benthic analysis (Figure 5.1-4).

Grab samples collected in 2016 revealed the high abundance of polychaete worms from multiple taxa in the benthos, from the perspective of total abundance of taxonomic and relative abundance of individual taxa (Table 5.1-3). Nematode roundworms exhibited the highest abundance of any single taxa. The three most abundant taxa from these two macroinvertebrate groups (Nematoda, Scoletoma sp. and Paranidae; see Table 5.1-4) account

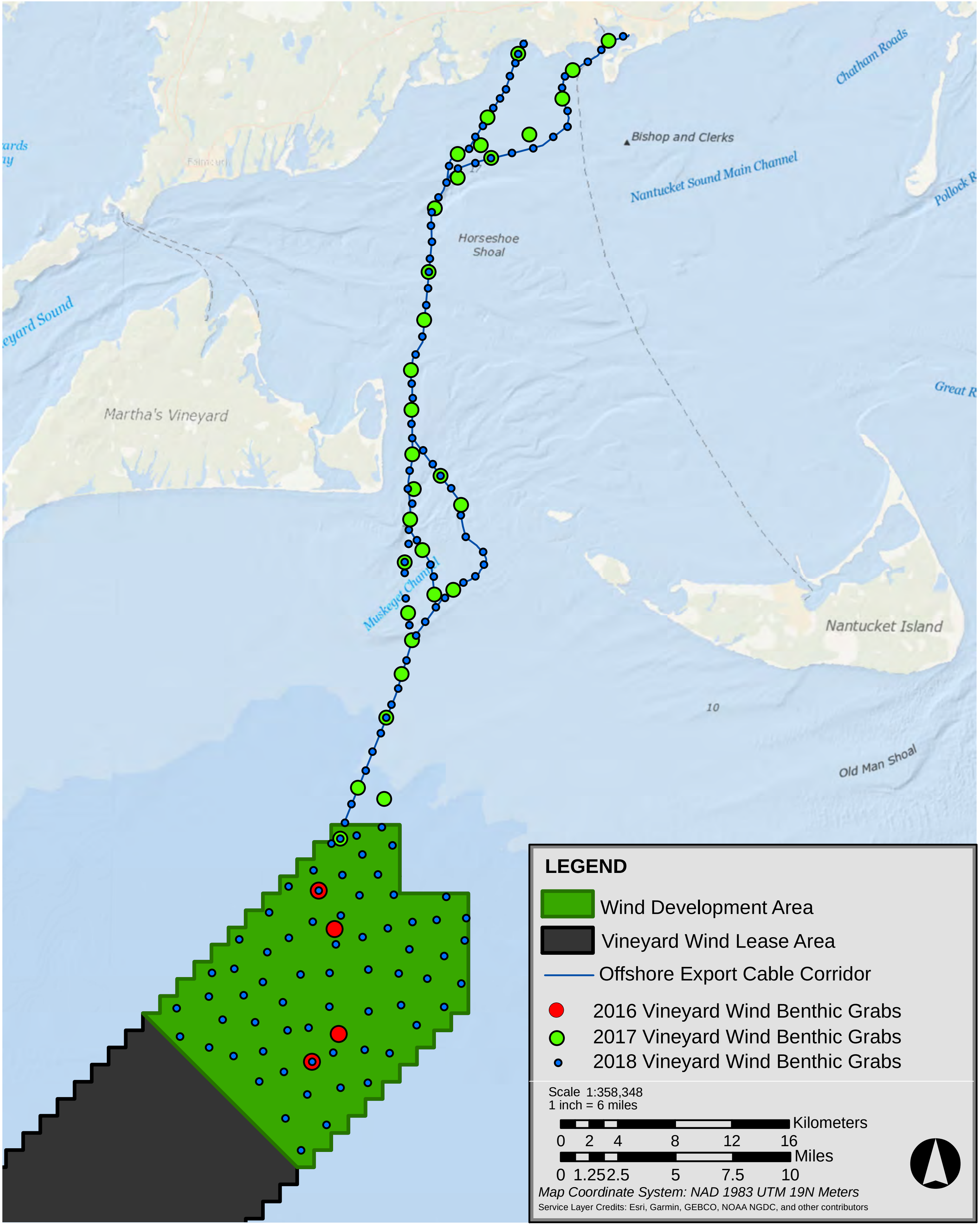


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**Figure 5.1-4**

*Benthic grab sample locations for the 2016, 2017, and 2018 surveys.*

for 55% of all the individuals identified during this analysis. Mean macrofaunal density was over 118,000 individuals/$m^2$ [4] (95 individuals/0.008 $m^2$) for the 32 marine invertebrate taxa observed in the samples.

For additional information refer to the ESS Group report (2016) in Appendix H summarizing the benthic lab analysis on WDA samples.

**Table 5.1-3 Percent of Total Abundance by Taxonomic Group, 2016 WDA Samples**

| Taxa | Percent of Total Abundance |
|---|---|
| Polychaete worms | 47.7% |
| Crustaceans | 23.6% |
| Nematode round worms | 23.8% |
| Mollusks | 2.5% |
| Nemertean ribbon worms | 1.8% |
| Echinoderms | 0.6% |

**Table 5.1-4 Relative Abundance of Taxa Encountered, 2016 WDA Samples**

| Scientific Name | Common Name | Relative Abundance |
|---|---|---|
| Nematoda | Nematode roundworm | 24% |
| *Scoletoma sp.* | Lumbrinerid polychaete | 19% |
| Paranidae | Paranid polychaete | 12% |
| *Ampelisca sp.* | Ampeliscid amphipod | 10% |
| *Byblis sp.* | Ampeliscid amphipod | 10% |

Analysis of 2018 grab samples provides a more thorough examination of macroinfaunal communities with sample distribution covering the entire WDA, compared to limited sampling performed in 2016. A total of 19,581 organisms from 12 phyla and 86 unique taxa (identified to family or lowest possible identification level (LPIL)) were identified in 67 WDA grab samples collected in 2018. The phyla Annelida (61%), Mollusca (26%), and Arthropoda (11%) represented 98% of all organisms captured in the 2018 survey, with polychaete worms being the most abundant taxa, as observed in 2016 (Tables 5.1-5 and 5.1-6). Other phyla captured in the survey included Chordata, Cnidaria, Echinodermata, Ectoprocta, Entoprocta, Nematoda, Nemertea, Phoronida, Platyhelminthes, and Sipuncula.

4 Data from the 2016 survey was originally reported as cubic meters ($m^3$), however to allow for comparison between the 2017 and 2018 datasets, was converted to square meters, which is typically the metric used to report taxonomic density in benthic grab samples. Densities from the 2016 survey used in the comparative analyses were converted to density/0.008 $m^2$ to match 2017 and 2018 datasets.

As mentioned above, polychaete worms were the most abundant taxa in the WDA with organisms from the Polygordiidae, Paraonidae, Lumbrineridae, and Cirratulidae families accounting for 50% of the total abundance (Table 5.1-6). Organisms from the Paraonidae and Lumbrineridae families were observed in 65 and 67 of the 67 stations, respectively, and were also highly abundant in the 2016 samples. Mollusks in the Nuculidae (or nut clam family) were also abundant (26% of total abundance) and frequently observed, occurring in 64 of the 67 samples. Amphipods from the Ampeliscidae family, common in the 2016 samples as well, made up 4% of the total abundance of organisms and were observed in all but 10 stations in the WDA.

**Table 5.1-5 Percent of Total Abundance by Phylum, 2018 WDA Samples**

| Phyla | Abundant Taxonomic Groups (common names) | Percent of Total Abundance |
|---|---|---|
| Annelida | Polychaete worms, polychaete tube worms | 61% |
| Mollusca | Nut clams | 26% |
| Arthropoda | Benthic Amphipods, seed shrimps, scuds, hooded shrimps | 11% |
| Nematoda | Roundworms | 1% |
| Nemertea | Ribbon worms | 0.30% |
| Echinodermata | Sand dollar | 0.10% |
| Cnidaria | Sea anemone, hydrozoa | 0.08% |
| Sipuncula | Peanut worms | 0.03% |
| Platyhelminthes | Flatworms | 0.02% |
| Entoprocta | Entoprocts | 0.01% |
| Phoronida | Horseshoe worms | 0.01% |

**Table 5.1-6 Relative Abundance of Most Common Taxa, 2018 WDA Samples**

| Taxa (Family or LPIL) | Common Name | Percent of Relative Abundance |
|---|---|---|
| Polygordiidae | Polychaete worms | 29% |
| Nuculidae | Nut clams | 25% |
| Paraonidae | Polychaete worms | 9% |
| Lumbrineridae | Polychaete worms | 6% |
| Cirratulidae | Polychaete worms | 5% |
| Ampeliscidae | Benthic Amphipods | 4% |

For additional information, refer to the 2018 benthic lab results spreadsheet and associated analysis of the 2018 benthic data completed by RPS (2018) in Appendix H. Comparative analysis of the data between 2016 and 2018 sample years is summarized briefly in Section 5.1.4.

Previous studies conducted in and nearby the WDA confirm the presence of these primary infaunal and epifaunal taxa inhabiting the benthos (AECOM, 2012; Guida et al., 2017; NEFCS, 2017; Stokesbury, 2013-2014). Seasonal variability was addressed in the analysis of benthic video imagery acquired by SMAST (Stokesbury, 2013-2014) and demersal trawl data recovered as part of a multi-phase NEFSC study (2017) that covered a 14-year period. Refer to Volume III Section 6.5.1.2 for a summary of these data and results.

#### 5.1.3.2 Offshore Export Cable Corridor

A total of 3,856 organisms from 8 phyla and 90 unique taxa (identified to family or LPIL) were collected in the 31 grab samples for benthic macroinvertebrates in the 2017 survey along the currently proposed OECC (Figure 5.1-4). Table 5.1-7 summarizes the organism abundance by phylum and taxa richness. The phyla Arthropoda (42%), Annelida (24%), Mollusca (19%), and Nematoda (14%) represented 99% of all organisms captured in the survey. The other phyla, including Cnidaria, Echinodermata, Nemertea, and Platyhelminthes, contributed less than 1% to the total abundance.

Four taxa, including Caprellidae (amphipods), Nematoda (nematodes), Columbellidae (dove snails), and Oligochaeta (annelid worms), represented 59% of the abundance among all samples, with the remaining 86 taxa each contributing 0-2% to the total abundance (Table 5.1-8; RPS, 2018). Although no taxa were observed at all 32 stations, Syllidae (polychaete worm), Oligochaeta (oligochaete worm), and Pyramidellidae (sea snail) occurred most frequently at 18, 17, and 15 stations, respectively.

Please refer to the Normandeau (2017) and RPS (2018) benthic reports for further details on the 2017 survey results.

**Table 5.1-7 Phyla Enumerations for Macroinvertebrate Samples, 2017 OECC Samples**

| Phylum | Abundant Taxonomic Groups (common names) | Number of Taxa[1] (Richness) | Abundance – overall # of individuals (# / 0.008 $m^2$) | Percentage |
|---|---|---|---|---|
| Arthropoda | Amphipods, hermit crabs | 29 | 1,599 | 42% |
| Annelida | Polychaete worms, oligochaete worms | 27 | 937 | 24% |
| Mollusca | Dove snails, slipper limpets | 25 | 730 | 19% |
| Nematoda (LPIL) | Roundworms | 1 | 558 | 14% |
| Nemertea | Ribbon worms | 5 | 25 | 1% |
| Platyhelminthes | Flatworms | 1 | 4 | 0.1% |
| Cnidaria | Sea anemones | 1 | 2 | 0.05% |
| Echinodermata | Sand dollars | 1 | 1 | 0.03% |

[1] Identified to the family-level with the exception of Oligochaeta, Archannelida, Nematoda, and Turbellaria (see Normandeau, 2017).

### Table 5.1-8 Relative Abundance of Most Common Taxa, 2017 OECC Samples

| Taxa (Family or LPIL) | Common Name | Percent of Relative Abundance |
|---|---|---|
| Caprellidae | Benthic amphipod | 30% |
| Nematoda | Nematode | 14% |
| Columbellidae | Dove snails | 8% |
| Oligochaeta | Oligochaete worms | 6% |

Grabs of the unconsolidated sediments along the OECC in 2018 show similar phyla as offshore in the WDA with some differences in the most abundant taxa recovered in the samples (Table 5.1-9 and 5.1-10). A total of 7,706 organisms from 11 phyla and 110 taxa (identified to family or LPIL) were recovered and identified in the 64 grab samples along the OECC (Figure 5.1-4). Marine worms (Annelida; 55%) dominate the benthos with arthropods (Arthropoda; 18%), nematodes (Nematoda; 12%), and mollusks (Mollusca; 10%) present in higher quantities as well. Other phyla observed in the samples included Chordata, Cnidaria, Echinodermata, Ectoprocta, Hemichordata, Nemertea, and Platyhelminthes, all of which accounted for only 6% of the total abundance of organisms (Table 5.1-9).

Unlike in 2017, samples collected in 2018 contained a high proportion of annelid worms, primarily from three families, Polygordiidae, Oligochaeta, and Capitellidae, which made up about 35% of the total abundance (Table 5.1-10). Crustaceans including Balanidae (barnacles) and Diastylidae (hooded shrimp) and mollusks including Tellinidae (tellins) were also among the most abundant in the samples. None of the unique taxa identified were present in all 64 samples; Syllidae (polychaete worm), Nematoda (roundworm), Oligochaeta (oligochaete worm), and Tellinidae (tellins) were by far the most common occurring in 52, 47, 45, and 40 stations, respectively.

Please refer to the RPS (2018) benthic report for further details the results of the 2018 sampling program.

### Table 5.1-9 Percent of Total Abundance by Phylum, 2018 OECC Samples

| Phyla | Abundant Taxonomic Groups (common names) | Number of Taxa (richness) | Abundance – overall # of individuals (# / 0.008 m$^2$) | Percent of Total Abundance |
|---|---|---|---|---|
| Annelida | Polychaete worms, oligochaete worms | 32 | 4215 | 55% |
| Arthropoda | Barnacles, hooded shrimp | 33 | 1370 | 18% |
| Nematoda | Roundworms | 1 | 912 | 12% |
| Mollusca | Bivalve mollusks, limpets, nut clams, | 25 | 785 | 10% |
| Chordata | Tunicates | 2 | 150 | 2% |

Table 5.1-9 Percent of Total Abundance by Phylum, 2018 OECC Samples (Continued)

| Phyla | Abundant Taxonomic Groups (common names) | Number of Taxa (richness) | Abundance – overall # of individuals (# / 0.008 $m^2$) | Percent of Total Abundance |
|---|---|---|---|---|
| Cnidaria | Stony corals | 3 | 136 | 2% |
| Nemertea | Ribbon worms | 6 | 110 | 2% |
| Platyhelminthes | Flatworm | 1 | 13 | 0.19% |
| Ectoprocta | Bryozoans | 4 | 12 | 0.18% |
| Echinodermata | Sand dollar, sea cucumber | 2 | 2 | 0.03% |
| Hemichordata | Acorn worm | 1 | 1 | 0.01% |

Table 5.1-10 Relative Abundance of Most Common Taxa, 2018 OECC Samples

| Taxa (Family or LPIL) | Common Name | Percent of Relative Abundance |
|---|---|---|
| Polygordiidae | Polychaete worms | 15% |
| Nematoda | Roundworm | 12% |
| Oligochaeta | Oligochaete worms | 11% |
| Capitellidae | Polychaete worms | 9% |
| Balanidae | Barnacles | 8% |
| Syllidae | Polychaete worms | 7% |
| Diastylidae | Hooded shrimps | 5% |
| Tellinidae | Tellins (bivalve mollusks) | 3% |

As shown in Figure 2.1-5, habitats along the OECC are variable and can be separated into multiple zones. The infaunal assemblages from 2017 and 2018 along the offshore section of the OECC (Zone 1) an abundance of polychaete worms, nematodes, nut clams, and amphipods inhabiting the fine, silty sand. Infaunal assemblages start to change and become more variable as the OECC transitions to shallower nearshore water associated with an overall increase in grain size and greater current flow and sediment mobility in places (Zone 2, 3, 6). In Muskeget Channel, results from the analysis of 2017 samples G-43 and G-23, for example, show the high variability that is possible even within similar habitat conditions. At station G-43, only two taxa and organisms (one Nematode and one polychaete) were observed in the fine sand recovered from 36 m (118.1 ft) of water, the lowest quantity of all the OECC benthic samples. This sample is positioned in the sand wave field that migrates through the deepest section of the channel. In contrast, sample G-23, located just north of the channel in 9 m (29.5 ft) of water exhibited the highest number of organisms of any sample collected at 1,588. While the seabed sediment recovered appears similar (fine sand), water depth and tidal flow conditions are different, which affects the sediment turnover rate.

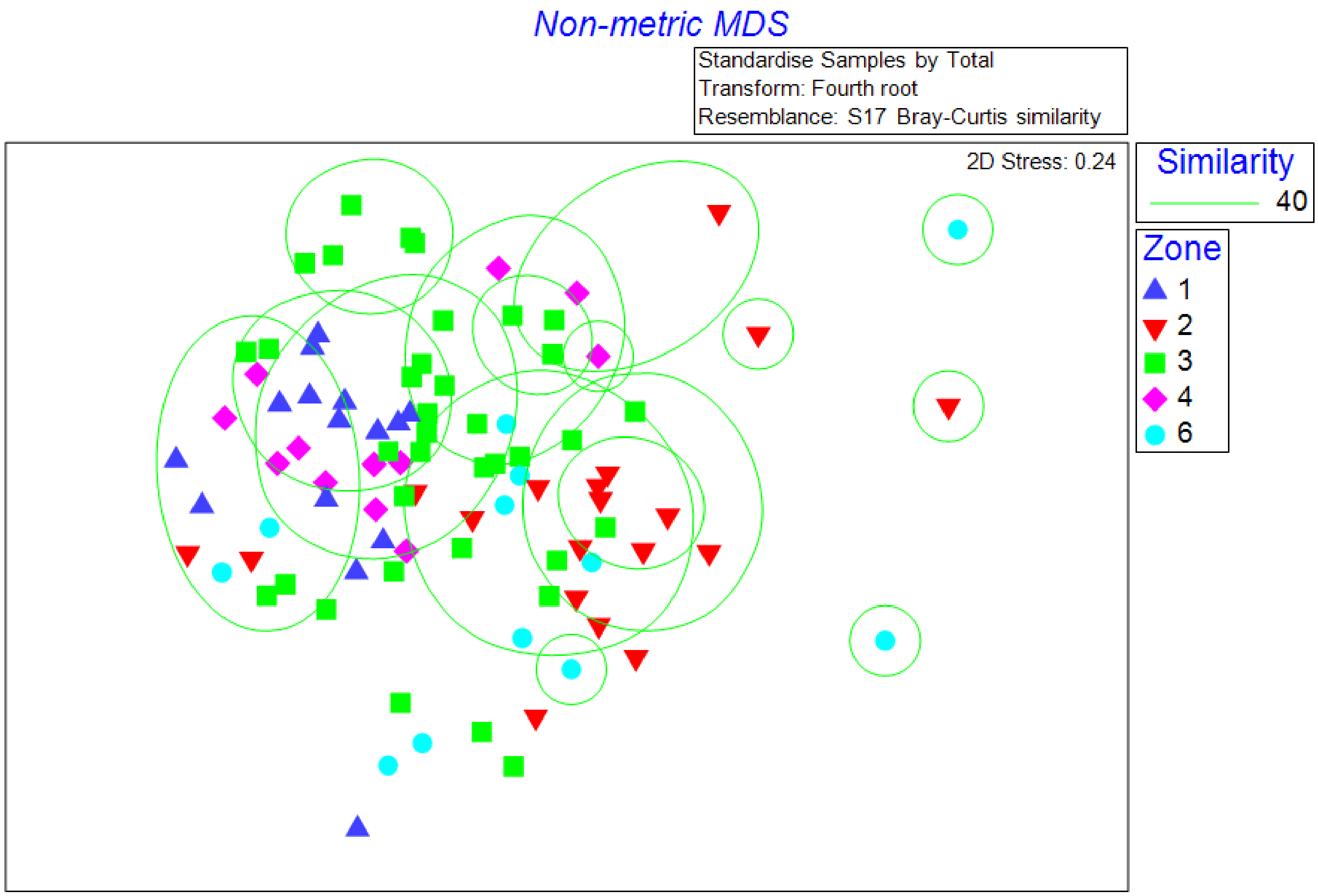





**Figure 5.1-5**

*MDS ordination plot showing Bray-Curtis similarity between samples collected along the OECC in the 2017 and 2018 surveys. Symbology is based on Zone, as defined in Table 2.1-5and as shown on Figure 2.1-11. Green circles represent clusters with Bray-Curtis similarity of 40%.*

The patterns in infaunal abundances in these habitat zones can be seen in the multidimensional scaling (MDS) plot presented in Figure 5.1-5. Points represent individual stations sampled along the OECC in 2017 and 2018 and symbology defines habitat zone. Points in the plot are ordinated based on Bray-Curtis similarity, with close ordination indicating higher similarity in faunal assemblage. As seen in the plot, points from Zone 1 (blue triangle) form a cluster primarily ordinated in one area of the plot, indicating similarity among those stations. Points representing stations from the other habitat zones are spread throughout the plot, indicating overall higher variability between the infaunal assemblages at stations in those areas.

### *5.1.4 Comparative Analyses*

Multivariate analyses were performed by RPS (2018) for the 2016, 2017, and 2018 benthic grab sample datasets to compare infaunal assemblages from multiple surveys across different years as well as in different regions of the Offshore Project Area (farther offshore >30 m depths vs inshore <30 m depths). Bray-Curtis similarity was calculated to understand how similar sample assemblages were to one another. These scores were then used in an Analysis of Similarity (ANOSIM) and to show the ordination of points, which allowed for the visual assessment of similarity between sample stations replicated over two survey years and all samples across the three surveys.

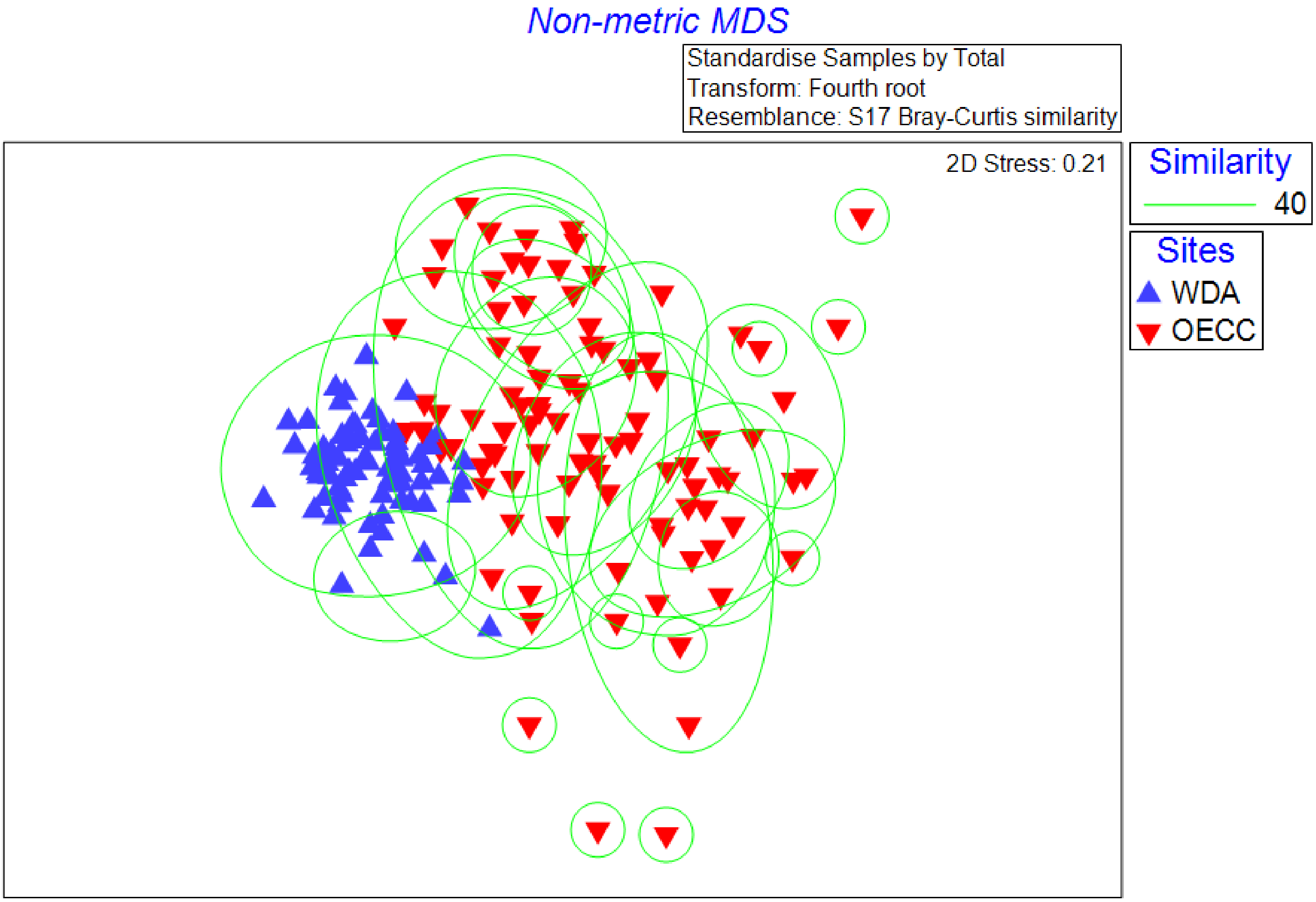
When comparing between samples collected in the WDA or OECC in the 2018 survey, abundance of organisms is higher in the WDA. For stations only within the WDA, mean abundance was 292 individuals, while mean abundance for stations along the OECC was 120 individuals. Richness, which is based on the number of taxa in a sample or area, was lower in the individual samples along the OECC than those collected in the WDA. However, across all stations in the project areas, more unique taxa were observed along the OECC with 110 taxa identified compared to 86 identified in the WDA. Evenness, which is based on the similarity of abundances of taxa, was higher in stations along the OECC, indicating less samples with singularly dominating taxa. Mean diversity for stations only in the WDA or OECC was similar, however, when taxa were combined and analyzed by project area, diversity was higher in the OECC than in the WDA (RPS, 2018). The higher richness, diversity, and evenness in the OECC may, in part, be a result of the increased habitat heterogeneity along the route, which supports more niches and resultant diversity in taxonomic assemblages (Tews et al., 2004). In addition, the relatively homogenous fine sand habitat in the WDA may favor certain taxa and could explain the lower richness and few dominating species (i.e., Polygordiidae and Nuculidae) observed in these samples (Rosenzweig & Abramsky 1993).

Multivariate analyses conducted to capture potential variation between benthic communities in nearshore habitats along the OECC and offshore habitats in the WDA also indicated clear differences in the assemblages in these two regions (Figure 5.1-6, top panel; RPS Group, 2018). The taxonomic assemblages at stations in the WDA were very similar to one another with high abundances of polychaete worms, mollusks, and amphipods from the same families. Along the OECC, there is less of a clear pattern in assemblage structure and taxa abundance within the samples. In addition, for larger taxa, snails, limpets, and barnacles were more abundant in nearshore waters, while sand dollars and nut clams were more common offshore in deeper water, with polychaete worms abundant throughout the Offshore Project Area.

Habitat type was utilized to further describe the relationships between infaunal assemblages in the project areas. These trends can be seen in Figure 5.1-6 (bottom panel) and indicate high similarity (close ordination) of infaunal species assemblages (Bray-Curtis similarity) in two neritic fine sand habitats (Fine Sand 3 and Fine Sand 2; located in the WDA) and more dissimilarity or scatter in the nearshore habitat types (located along the OECC; Appendix H, RPS, 2018). Overall, these results confirm the homogeneity of habitats and infaunal assemblages in the WDA, and the highly variable and heterogeneous nature along the OECC.

As mentioned above, in order to check for major differences in species composition and abundance between surveys, a total of eight stations (5 along the OECC and 3 in the WDA; Figure 5.1-4) were replicated in 2018. An MDS plot presenting the ordination of replicated sample stations that were collected in the 2016 and 2018 or 2017 and 2018 surveys indicated similarity in the infaunal assemblages across surveys for some stations, but overall replicated station was not a good indicator of infaunal assemblage clusters (ANOSIM: Global Test, R = 0.37, significance level = 0.3%; Figure 5.1-7, top panel). The low to medial R-statistic indicated that although there are some similarities between the assemblages at replicated samples, there may also be a high level of similarity between the other samples as well. Sample stations which had infaunal assemblages with >40% similarity between surveys included station 18 (57% similar), 59 (48% similar), 50 (45% similar), and 61 (45% similar). Station 59 and 18 are along the OECC relatively nearshore within Nantucket Sound, and station 50 and 61 are located farther offshore, near or within the WDA.

The relationship between taxonomic assemblages from all samples across the three surveys was also assessed to determine any overall inter-survey patterns. For the WDA, when comparing taxa identified in all samples in the 2016 and 2018 benthic surveys, both had high abundances of organisms from the Paraonidae (polychaete worm), Lumbrineridae (polychaete worm), Ampeliscidae (amphipod) families. Along the OECC, taxa in the 2017 and 2018 benthic surveys that had high abundances in both surveys included Oligochaeta (oligochaete worm), Nematoda (roundworm), Syllidae (polychaete worm), and Ampharetidae (amphipod). In addition, Oligochaeta and Syllidae were present in the most samples in both



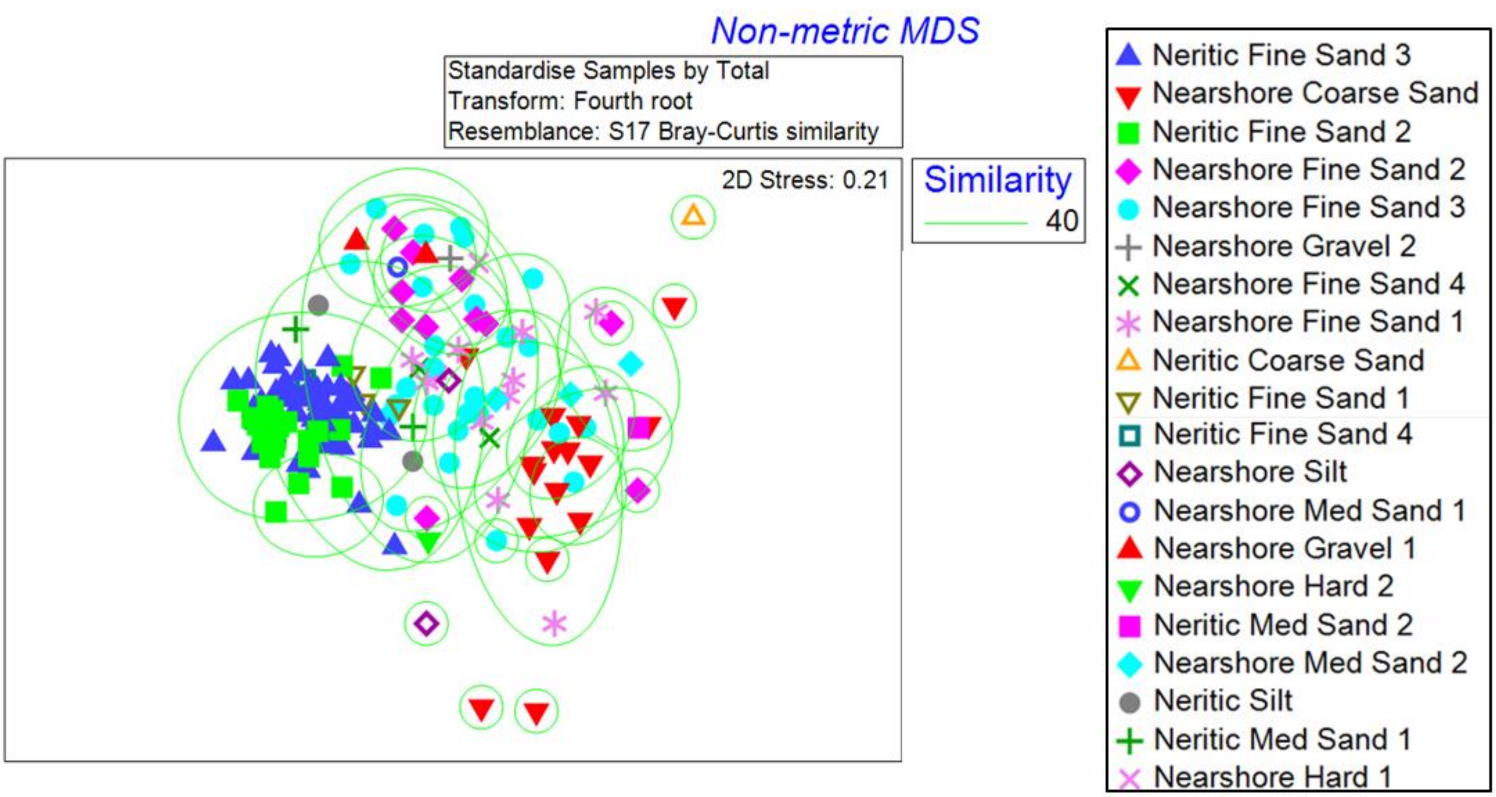
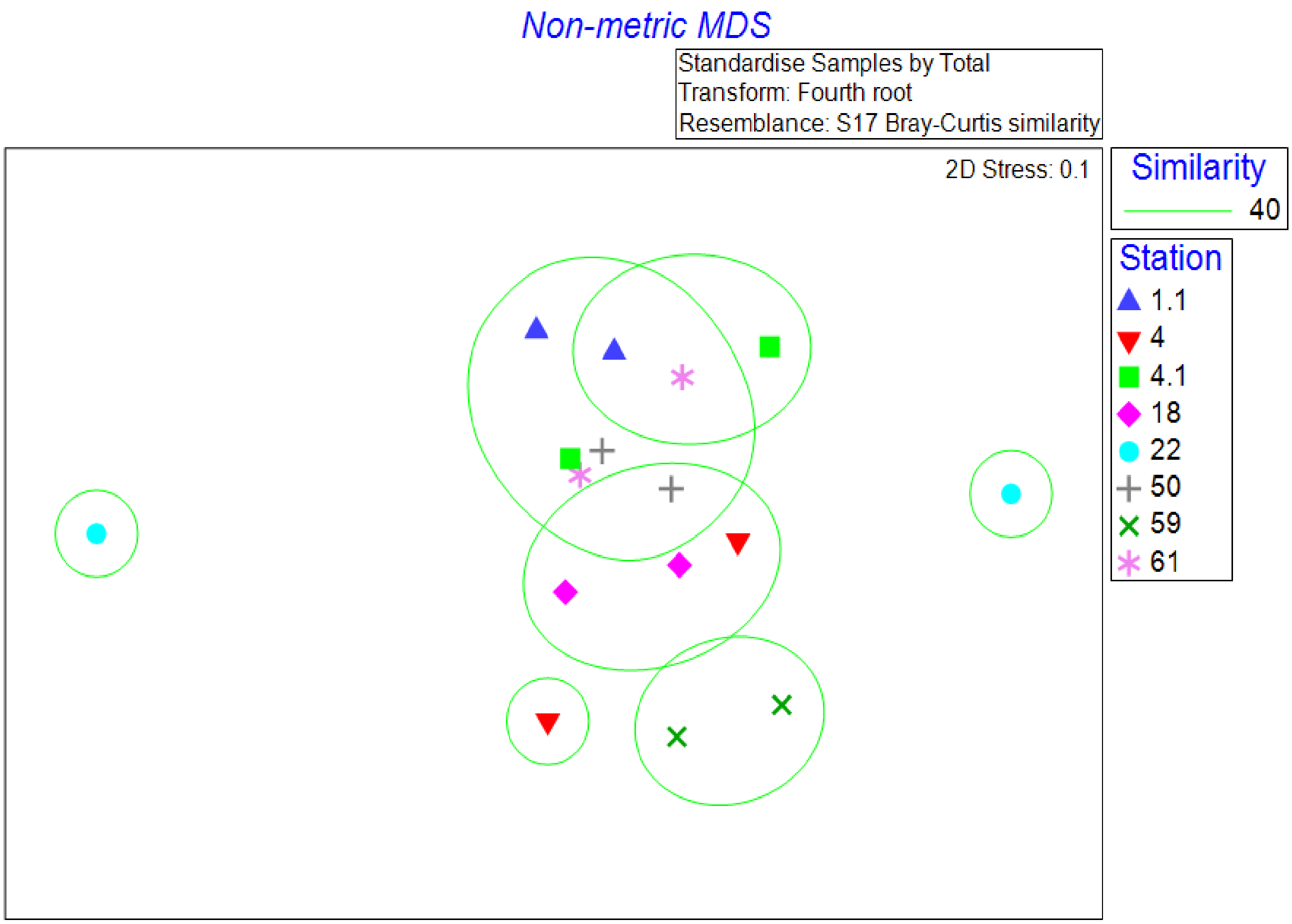
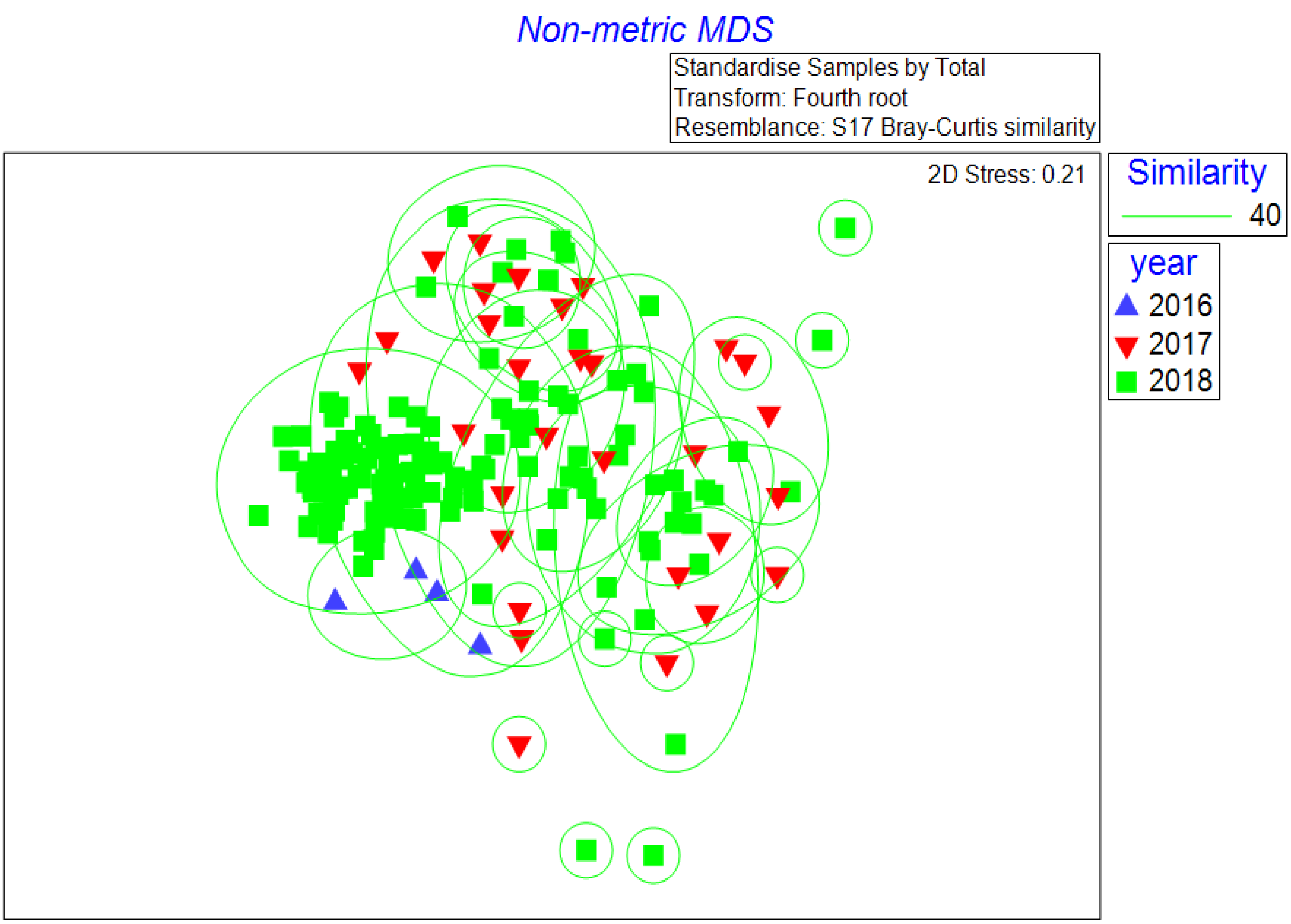






**Figure 5.1-6**

*MDS ordination plot showing Bray-Curtis similarity for all samples symbolized by Project Area (top) and habitat type (bottom).*

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VINEYARD WIND

**Figure 5.1-7**

*MDS ordination plot showing Bray-Curtis similarity between samples replicated over two surveys (top) and across all samples (bottom).*

surveys. The MDS plot in Figure 5.1-7 (bottom panel), which presents similarities between samples in the three surveys based on distance from one another, indicates relatively even spread of samples collected along the OECC in 2017 and 2018 (tight cluster of green points on the left of the plot represent those sampled in the WDA). The clustering of samples from 2016 (blue triangle) separately from the 2018 samples indicates overall dissimilarity between the infaunal abundances between these surveys. With the current data, identifying cause for the dissimilarity is not possible. This result may be due to the limited number of samples (four) and geographical extent of the 2016 dataset compared to the 2018 dataset (67 samples), which limits the comparative strength of these surveys. The level of similarity/dissimilarity between samples could also be the result of a variety of differing conditions between surveys, such as season, exact grab sample location, or natural environmental turnover.

## 5.2 Potential Sensitive Habitats

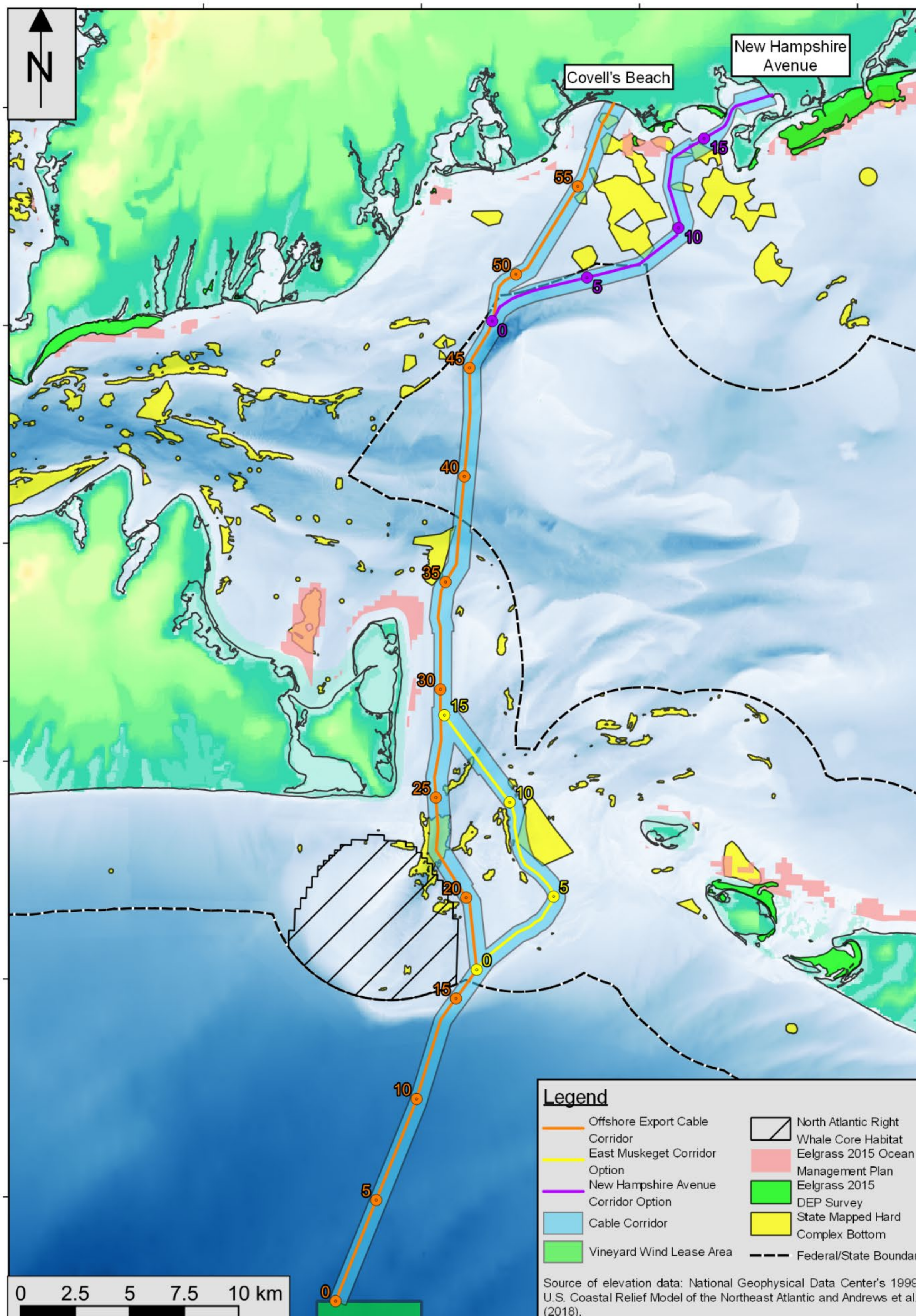
The State of Massachusetts provided information on historic mapping of habitats of interest in Nantucket Sound and surrounding waterways including hard/complex bottom, eel grass areas, and marine mammal habitats which are high priorities for avoidance if possible (Figure 5.2-1). These existing data were compared to the 2018 cable corridor survey data to assess the potential for special, sensitive, and unique (SSU) habitats in the immediate vicinity of the corridors. Some habitats are known to change and move over time (sand wave fields) while others are considered to be prime habitat despite seasonal and long-term changes in organism abundance (eel grass).

### *5.2.1 Hard Bottom*

Hard bottom areas in portions of Nantucket Sound, include high concentrations of coarse material (>50 % gravel, cobbles, boulders in a sand matrix), and even though considered an unconsolidated sediment surface, form a relatively hard substrate to which sessile benthic organisms can attach. Figure 5.2-2 presents those areas where coarse deposits are apparent in Muskeget Channel and the remainder of the OECC. Other areas exhibiting a complex seafloor topography with highly variable bathymetry and slopes, such as bedform fields, have been categorized separately. The distinct differences between the hard bottom and complex seafloor areas, including seabed morphology, texture, sediment types, and benthic communities, support defining these as separate habitats. The complex seafloor areas are discussed in Section 5.2.4.

The State of Massachusetts Ocean Management Plan defines the SSU as:

> *"Areas of hard/complex seafloor, characterized as any combination of the following: 1) areas of exposed bedrock or concentrations of boulder, cobble, or other similar hard bottom distinguished from surrounding unconsolidated sediments, 2) a morphologically rugged seafloor characterized by high variability in bathymetric aspect and gradient, or 3) man-made structures, such as artificial reefs, wrecks, or other functionally equivalent structures that provide additional suitable substrate for development of hard bottom biological communities."*




**Vineyard Wind Project**

VINEYARD WIND

**Figure 5.2-1**

*State designated SSUs in the vicinity of project components.*

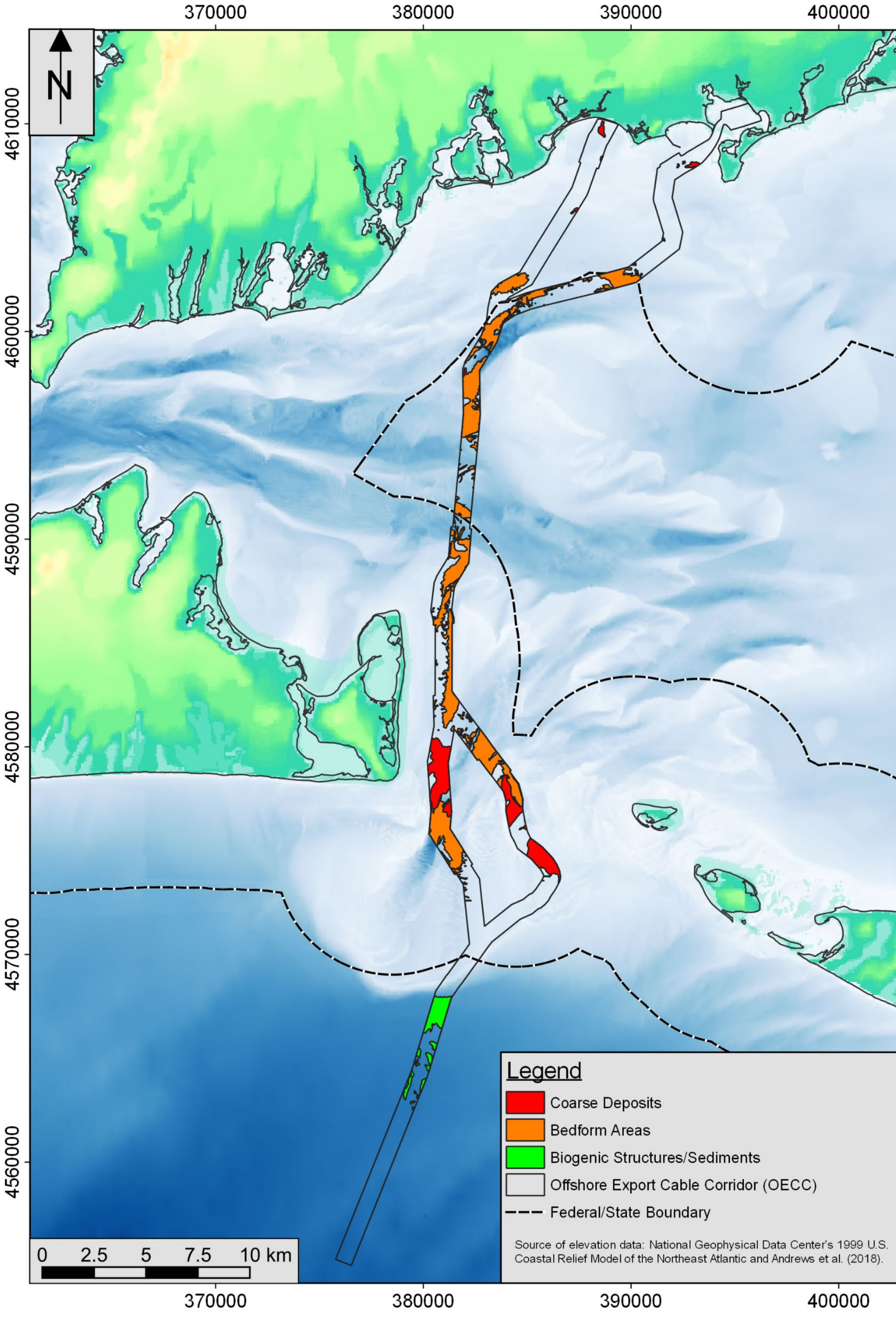





**Figure 5.2-2**
*Possible sensitive habitats along the OECC.*

Based on review of the underwater video imagery, several locations have been designated as possible SSUs that meet this definition, based on the complexity of bottom habitats and observations of more abundant biota (CR Environmental, 2017 & 2018). These include the pebble-cobble with sponge habitats in the Muskeget Channel area (Figure 5.2-3). These habitats represent areas of pronounced vertical relief and energetic stability, making good habitat for fish.

Prior to the 2017 field program, historic maps of hard bottom and complex seafloor obtained from the State of Massachusetts were carefully examined to help position the proposed Offshore Export Cable Corridor to avoid these previously documented SSUs. State maps indicate these bottom types cover much of Muskeget Channel proper while along the Eastern Muskeget Corridor Option in shallow water southwest of Muskeget Rock, the historic maps showed the SSU only covering the shoals to either side of that passage. Conversely, data acquired from the 2017 and 2018 OECC surveys show that there is hard bottom habitat covering a majority of the Eastern Muskeget Corridor Option shallow water passage and a general lack of coarse material in the deepest portion of Muskeget Channel and to the south (see Figure 5.2-1). It is primarily sand waves that constitute the seabed in the main channel, the habitat which has the lowest productivity of those mapped in the OECC. The larger bedforms may be included as rugged topography as part of the complex seafloor discussed in Section 5.2.4.

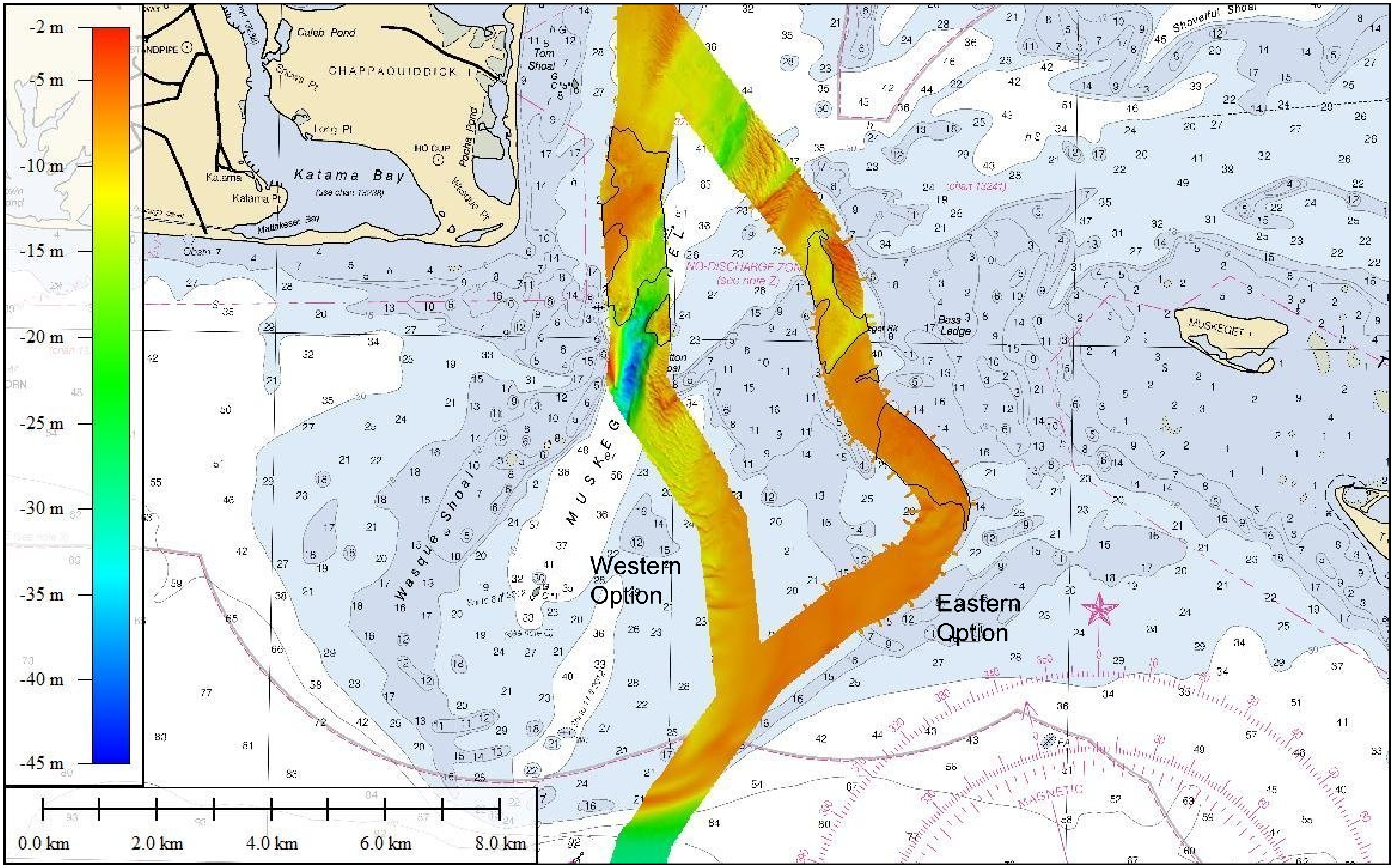
Several more localized patches of coarse deposits and rock piles exist farther north along the OECC. These are predominantly comprised of coarse glacial till (boulders, cobbles, gravel) outcropping on the bottom of Nantucket Sound. In some cases, the tidal currents have removed much of the finer grained sediments and left the larger pieces more resistant to transport. Conversely, other areas are comprised of scattered, isolated boulders exist amongst a predominantly sand with gravel matrix. North of the Muskeget Channel region, these isolated areas include (Figure 5.2-4):

<u>OECC:</u>

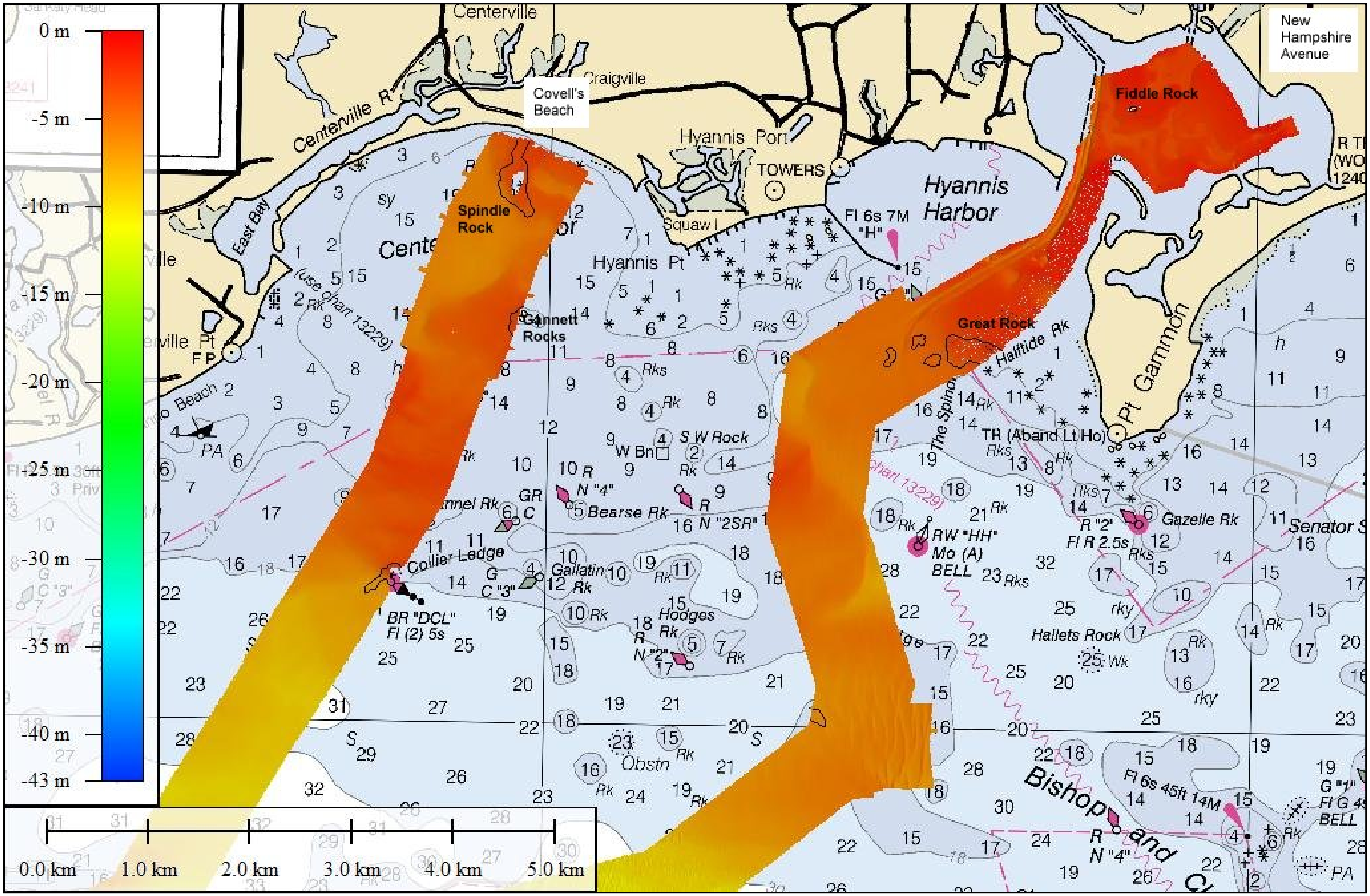
- KP 29-29.5—west half of the corridor, east of Chappaquiddick Island
- KP 44.8-45.2—west edge of the corridor south of Eldridge Shoal
- KP 54.3-54.6—east edge of the corridor, associated with Collier Ledge
- KP 57.2-57.4—east edge of the corridor, associated with Gannett Rocks
- KP 58.4->59—center of corridor at Covell's Beach landfall, associated with Spindle Rock

<u>New Hampshire Avenue Option:</u>

- KP 9.8-9.9—west edge of the corridor at turn, shoal present there
- KP 14-14.8—southeast half of the corridor at entrance to Hyannis Harbor navigation channel, rock piles associated with Great Rock and Gardiners Rock
- KP 17.5—in northern portion of Lewis Bay coverage, Fiddle Head Rock




Coarse deposit areas (outlined in black) in the Muskeget region exhibit varying abundances of boulders.
Nautical chart #13237 in the background.




Areas of coarse deposits (gravel, cobbles, boulders in a sand matrix; black outlines) in the OECC in northern Nantucket Sound approaching the Cape. Nautical chart #13237 in the background.

### *5.2.2 Eel Grass*

Eel grass (*Zostera marina*) in the coastal environment provides habitat and sustenance for waterfowl, shellfish, and finfish, as well as serving as a critical component of sediment and shoreline stabilization. Eel grass beds provide nursery grounds and refuge for many commercially important organisms, such as bay scallops, flounder, striped bass, tautog, and seahorses (Heck et al. 1989). Widgeon grass (*Ruppia maritima*) is another member of the seagrass family found in New England, but is not as prominent or widely distributed as eel grass in Massachusetts coastal embayments (Costello and Kenworthy, 2011). Eel grass is a prominent estuarine species while widgeon grass tends to occupy lower salinity areas in the upper portions of coastal embayments (Heck et al. 1989).

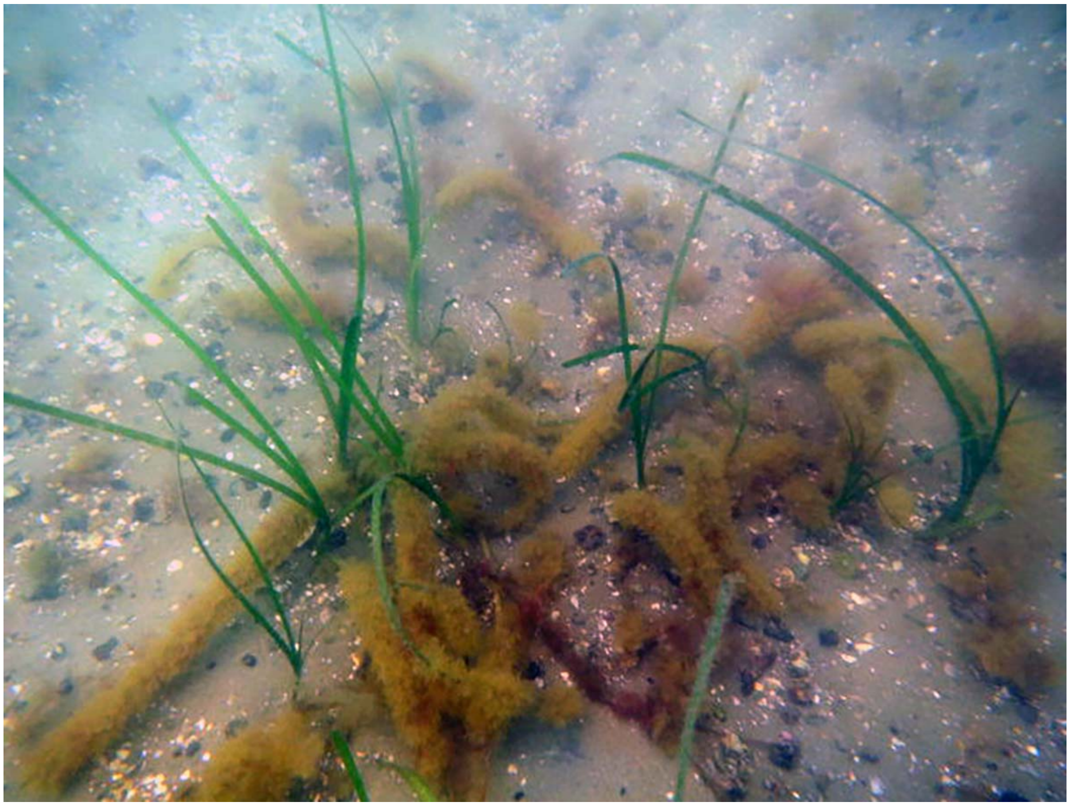
Eel grass is a marine flowering plant with all stages of its life cycle occurring underwater, and is often referred to as SAV (submerged aquatic vegetation). This distinguishes it from macroalgae which are not classified as plants and emergent saltwater plants found in wetlands and marshes (e.g. *Spartina sp.*). Sea grasses are typically found in water depths of less than 5 m (16.4 ft) as light penetration is a significant factor in controlling growth and thus distribution. Communities are occasionally found deeper in areas with suitable conditions, such as high current and increased water clarity.

Eel grass strands were observed on the underwater video along a number of transects, however, these isolated occurrences were interpreted to be dead strands of grass that were drifting/floating and not rooted in the substrate. Drifting strands become embedded in gravel, cobbles, and shells on the bottom giving the appearance of rooted plants. Water depths in excess of 8-10 m (26.2-32.8 ft) and the dark brown-black coloration of the strands was evidence that these were drifting dead plant material.

Conversely, a very sparse to moderate distribution of living eelgrass was identified in two places along the south shore of the Cape within the OECC:

1. In Lewis Bay along the north side of Egg Island; very sparse, isolated strands of eelgrass are apparent amongst thick growths of macroalgae. The same sporadic abundance of plants (very low density of coverage) was observed in November 2017 and July 2018. Identical transects were run to purposely provide comparison for seasonal variation. A healthy, thriving eelgrass bed should be bright green and fill-in during the growing season, which was not observed at this location in 2018.

2. Off Covell's Beach landfall around Spindle Rock; sparse to moderate distribution of eelgrass exists in and around the Spindle Rock boulder pile. Underwater video transects taken during the 2018 survey documented this community inhabiting the sand patches between the rocks (Figure 5.2-5). Towed and diver handheld video and still photos recorded this habitat and allowed mapping of the areal extent of the scattered stands of



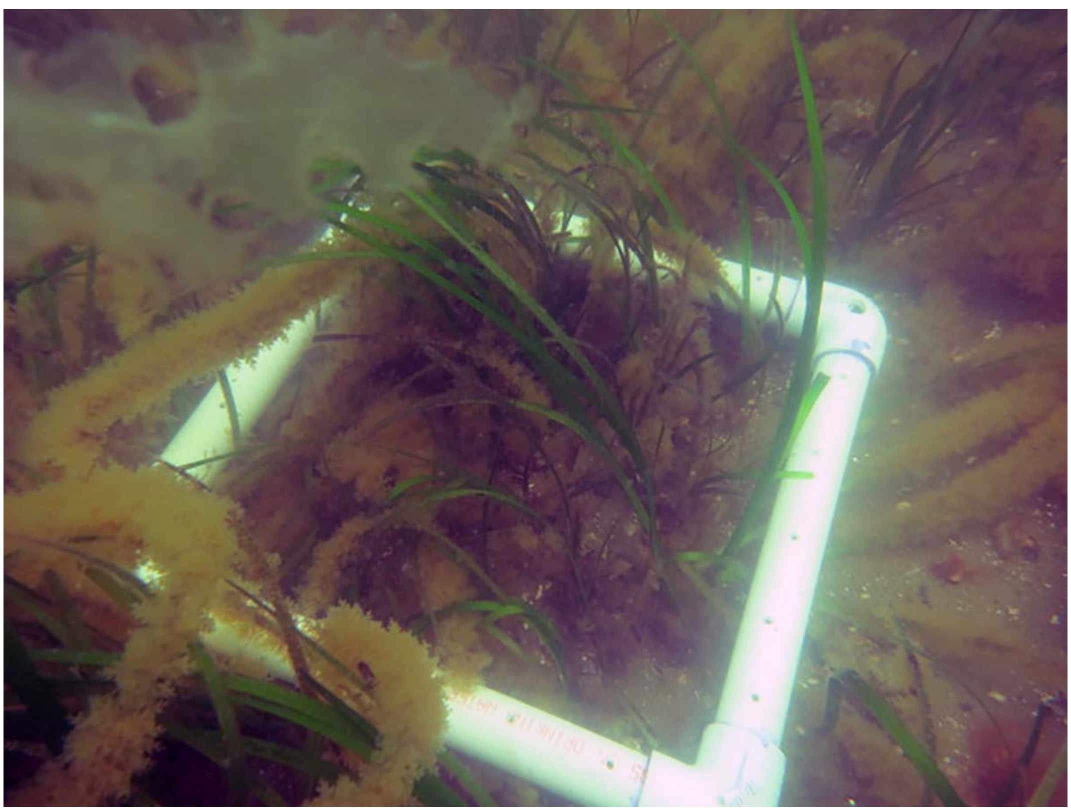




**Figure 5.2-5**
*Underwater photographs of the eelgrass around Spindle Rock.*

grass. Macroalgae was more abundant than the eelgrass again at this location, however, the eelgrass exhibited a greener coloring with more frequent and denser sprigs than observed off Egg Island.

These areas will be avoided during construction activities to prevent adverse impact to these habitats.

### *5.2.3 Essential Fish Habitats*

Surveys aimed at identifying benthic habitats and possible SSUs concurrently provided information on essential fish habitats (EFHs). Underwater video imagery indicates some of the animals inhabiting or using the benthic communities in the vicinity of the proposed Vineyard Wind project components. This data can be added to the historical information available on EFHs and habitats on the continental shelf and nearshore embayments of Massachusetts. For a detailed summary of historical and current research results on EFHs and specific habitat designations covering the WDA and OECC please refer to Section 6.6 of Volume III. This information includes results from the NMFS EFH mapper tool for eggs larvae, juveniles, adults, and spawning adults as well as NMFS designated Areas of Concern (http://www.habitat.noaa.gov/protection/efh/habitatmapper.html).

Sonar data acquired as part of the geophysical field programs (multibeam echo sounder, side scan sonar) provide 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. As documented from the Vineyard Wind mapping efforts to-date, coarse deposits including gravel, cobbles, and boulders as well as large bedforms within the shifting sand layer on the seafloor provide sharp relief and structure for benthic and nektonic organisms.

While it is understood EFH covers large offshore regions based on different datasets, results from review of the underwater video data reveal discrete locations where higher concentrations of fish were observed within the OECC. Extrapolation of the video imagery to surrounding seabed areas based on the sonar data, allows an estimation of corridor sections where enhanced bottom structure supportive of more abundant fish communities may exist, and includes:

- Coarse deposits-hard bottom/Habitats 5, 6, 7 in the Muskeget Channel area:

    KP 22-28 on the Western Muskeget Corridor Option

    KP 7-13.5 on the Eastern Muskeget Corridor Option

Review of the video imagery identified evidence of the following vertebrate fish in the OECC; Little Skate (*Leucoraja erinacea*), Black Sea Bass (*Centropristis striata*), Red Hake (*Urophycis chuss*), and Scup (*Stenotomus chrysops*). Among these, black sea bass, red hake, and scup are recognized as viable commercial species in this area but only scup were observed in significant quantities. Red hake was more common offshore in the WDA.

Observations of fishing activity made during the field programs also suggest that the seafloor slope south of Muskeget from KP 13-15 along OECC is an area where fish congregate. This slope is strategically located to receive planktonic and nektonic organisms and a wide variety of drifting biota that is discharged from Nantucket Sound during each ebb tide. Longshore currents also deliver sediment and biological material to the area from the east.

### *5.2.4 Complex Seafloor*

This broad characterization of the seafloor was developed by the Massachusetts Office of Coastal Zone Management (CZM) and is documented in the "Regional Sediment Resource Management Work Group Report – 2014 Massachusetts Ocean Management Plan Update" (CZM, 2014). As defined by CZM in this report, complex seafloor is "a morphologically rugged seafloor characterized by high variability in bathymetric aspect and gradient." CZM (2014) determined the complex seafloor areas by utilizing a USGS 30 m by 30 m low resolution bathymetry dataset and calculated areas of high rugosity using a Vector Ruggedness Measure (VRM) tool, based on a method developed by Sappington et al. (2007) with a 9x9-cell neighborhood size. The values produced by the VRM analysis range from 0 to 1 with 0 indicating no seabed complexity and 1 indicating complete seabed complexity. The seabed was classified as complex for VRM values greater than 3/8 standard deviation from the mean value of the whole dataset (CZM, 2014).

Using the CZM (2014) analysis as a guide, Vineyard Wind performed an analysis on the 2018 multibeam depth sounding dataset. A Vector Ruggedness Measure was performed on the 0.5 by 0.5 m high resolution bathymetry collected along the OECC using a 9-cell search radius. Polygons were then created from the VRM grids by clipping the extents to include only values greater than the mean value plus 3/8 standard deviation which resulted in a cutoff of 0.0035 and greater to indicate a complex seafloor. Results of the ruggedness analysis on the 2018 dataset show much more detail and complexity due to the data point spacing considered. Smaller, localized features exhibiting high enough slope gradients and sharp bathymetry aspects are in some areas individually mapped.

The results indicate increased seafloor ruggedness is mostly associated with bedform fields (Habitat 2) due to the heightened local slopes and gradients. Figure 5.2-6 shows the locations in the OECC where bedforms greater than 0.3 m relief are present. Hard bottom and biogenic structures can get included in this category depending on how robust the ruggedness analysis is. For mapping the complex seafloor specifically to define the bedform habitat, these other seabed substrates were not considered.

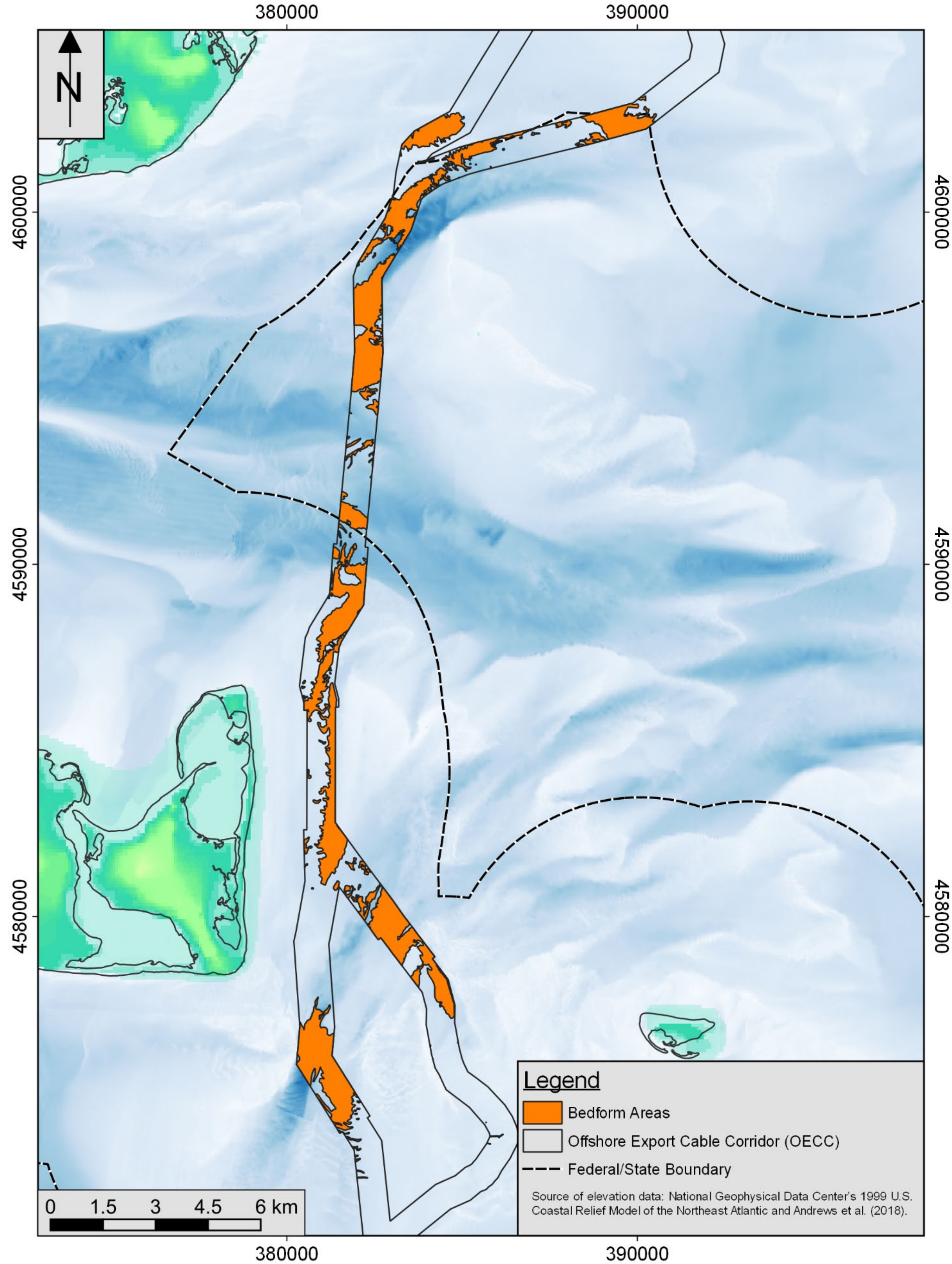





**Figure 5.2-6**
*Bedform areas as complex seafloor in the OECC.*

[redacted]

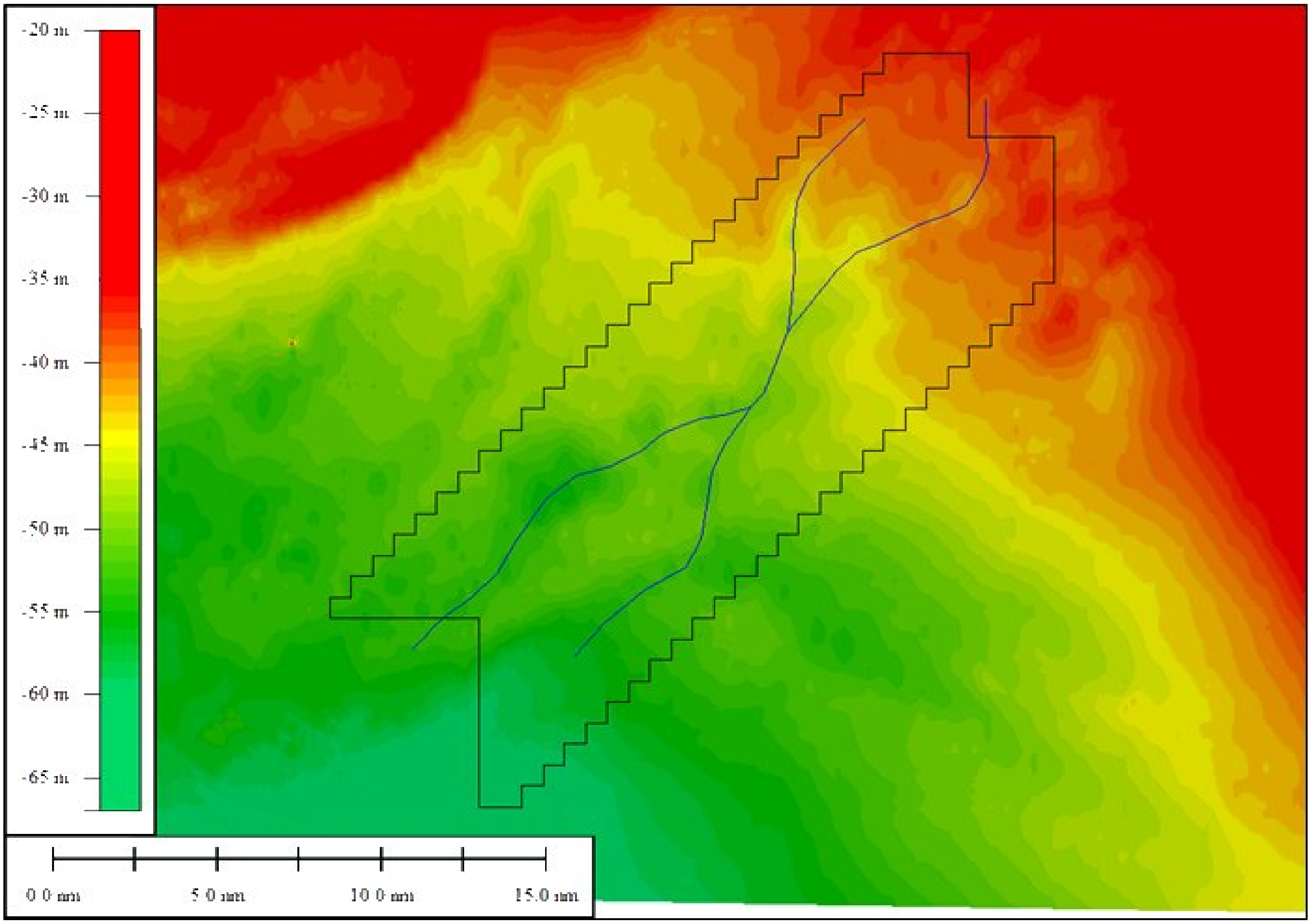
## 5.4 Discussion of Other Biological Features

While there is a wide range of surficial sediments, morphology, and hence habitats along the OECC to shore that transit Nantucket Sound, benthic conditions are more uniform with increased stability offshore in the Lease area. The only larger scale (from an areal extent perspective) topographic features present are some broad, very shallow depressions forming subtle linear trends that might represent former drainage patterns on the previously exposed inner continental shelf. These may be remnants of glacial meltwater streams/rivers that flowed across the coastal plain when sea level was lower (Figure 5.4-1). Data acquired in the wind farm in 2016 were analyzed and compared to historical fisheries data and direct personal communication with commercial fisherman to determine if this seafloor morphology might play a role as some type of habitat.

First, water depth data show these broad topographic features exhibit minimal elevation changes (< 2 m or 6.6 ft) over a width that varies from 2-5 km (1.1-2.7 nm), equating to slopes well less than 1°. These characteristics are not normally associated with paleochannels representative of former meltwater pathways, which exhibit sharper, more localized topography. The existing bottom morphology is believed to be simply an expression of the overall shaping of the inner shelf by water circulation and episodic events (storms), creating minor variations and broad undulations in the seafloor along the coast since its submergence 10,000-13,000 years ago.

Second, review of subbottom profiles did not show the existence of any paleochannels in the subsurface that might indicate these features were related to glacial meltwater rivers. The relict buried channels that are present in the subsurface do not correlate with the location and orientation of the broad depressions on the seafloor. Furthermore, most of the buried channels are deeper below the seafloor and would thus not be contemporaneous with surficial features.

Third, analysis of surficial sonar data (surface reflectivity) does not reveal any difference in seafloor characteristics from surrounding areas. Drag marks on the seafloor evident on the sonar imagery are randomly distributed throughout the northeast portion of the lease area and do not exhibit any particular pattern or focus. The drag marks are not predominantly concentrated within the limits of these features, as might be expected if the areas were targeted by the fisherman as a known resource.




Vineyard Wind Lease OCS-A 0501 with surface features (blue trend lines) that could be inferred from the seafloor topography. Bathymetry from NOAA's coastal relief model dataset, approximately 90 m gridded depth points. https://www.ngdc.noaa.gov/mgg/coastal/crm.html. These features are extremely broad with low relief and no associated subsurface structures, not indicative of a preserved paleofeature.

Finally, information from fisherman based on extensive project outreach suggests there is no targeting of any specific location within the Lease area for commercial fishing activities, benthic or nektonic. Vessels are typically moving through the area generally from west-northwest to east-southeast, whether they are simply transiting, trawling, or deploying traps. The Lease area is generally fished the same as surrounding areas of the shelf.

# Section 6.0

Conclusions and Summary

Section 6.0 is redacted in its entirety.

# Section 7.0

## References

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# Appendix II-A

## Data Processing and Quality Summary

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# Appendix II-B

## Hazard Definitions

Appendix II-B is redacted in its entirety.

# Appendix II-C

2016 Geophysical Operations Reports

Appendix II-C is redacted in its entirety.

# Appendix II-D

2016 Geotechnical Operations Reports

Appendix II-D is redacted in its entirety.

# Appendix II-E

2017 Geophysical and Geotechnical Operations Report

Appendix II-E is redacted in its entirety.

# Appendix II-F

2018 Geotechnical Interpretative Report (GIR)

Appendix II-F is redacted in its entirety.

# Appendix II-G

2018 MEC Desktop Research Report

Appendix II-G is redacted in its entirety.

# Appendix II-H

## 2016-2018 Benthic Reports

1. ESS Group 2016 Benthic Macroinvertebrate Sample Analysis Report
2. Normandeau Associates 2017 Benthic Sample Processing Report
3. CR Environmental 2018 Underwater Video Review
4. RPS 2018 Benthic Macrofaunal Data Analysis
5. CR Environmental June/July 2018 Underwater Video Review

1. ESS Group 2016 Benthic Macroinvertebrate Sample Analysis Report

# Benthic Macroinvertebrate Sample Analysis Report

Vineyard Wind Project
Offshore Lease Area OCS-A 0501
Massachusetts

**PREPARED FOR:**
Vineyard Wind, LLC
367 Herrontown Road
Princeton, New Jersey 08540

**PREPARED BY:**
ESS Group, Inc.
10 Hemingway Drive, 2nd Floor
East Providence, Rhode Island 02915

Project No. O207-000

January 27, 2017

**BENTHIC MACROINVERTEBRATE SAMPLE ANALYSIS REPORT**
**Vineyard Wind Project**
**Massachusetts**

*Prepared For:*

**Vineyard Wind, LLC**
367 Herrontown Road
Princeton, New Jersey 08540

*Prepared By:*

**ESS Group, Inc.**
10 Hemingway Drive, 2nd Floor
East Providence, Rhode Island 02915

**Project No. O207-000**

**January 27, 2017**

## TABLE OF CONTENTS

## 1.0 INTRODUCTION

On behalf of Vineyard Wind, LLC (the Client), ESS Group, Inc. (ESS) analyzed four samples collected from benthic habitats within the Offshore Lease Area OCS-A 0501. Benthic macroinvertebrates were the primary target of the analysis and are defined as organisms greater than 500 microns (μm) in length that either live on or in aquatic sediments, including mollusks, primitive (unsegmented) worms, annelids (segmented worms), crustaceans, and echinoderms.

## 2.0 METHODS

### 2.1 Laboratory Analysis

Four benthic grab samples were collected by Geo SubSea LLC on November 10, 2016 using a 0.1 $m^2$-modified Day grab sampler. All samples originated from Massachusetts waters of Offshore Lease Area OCS-A 0501.

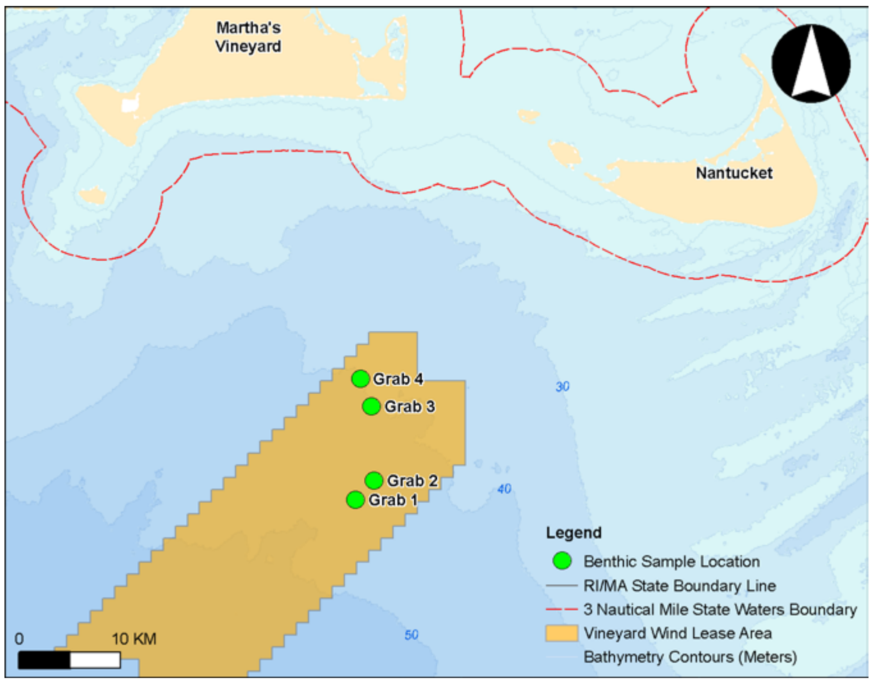


**Figure 1. Benthic Grab Sample Locations**

The four samples were transferred to ESS on November 11, 2016 and returned to ESS's office in East Providence, Rhode Island for processing. Upon return to the office, each sample was split into two portions: one for grain size analysis and one for benthic analysis. The benthic portion of each sample was passed through a 0.5-mm sieve and fixed in 10% neutral buffered formalin.

Prior to sorting, sample material from each sample was emptied in its entirety into a 0.5-mm mesh sieve. Tap water was gently run over the sieve to rinse away the formalin fixative and any additional fine sediment that was not removed during the initial sieving process. Rinsed samples were preserved in 70% ethanol.

Each benthic sample was sorted to remove benthic organisms from residual debris. Samples were sorted in their entirety under a high-power dissecting microscope (up to 90X magnification)

For quality assurance and control (QA/QC) purposes, a second qualified staff member (quality assurance officer) resorted 10% of the samples (or one, whichever was greater) analyzed by each sorter to ensure organisms were being adequately removed from the samples. The quality assurance officer checked the sorted sample material for remaining organisms and calculated an efficiency rating ($E$) using the following formula:

$$E = 100 \times \frac{n_a}{n_a + n_b}$$

Where $n_a$ is the number of individuals originally sorted *and* verified as identifiable organisms by the QC checker and $n_b$ is the number of organisms recovered by the QC checker. If the original sorter achieved $E < 90\%$ (i.e., less than 90% of the organisms in the sample removed), an additional sample sorted by that analyst was re-examined by the quality assurance officer.

All sorted organisms were subsequently identified by a qualified taxonomist to the lowest practicable taxonomic level using a dissecting microscope with magnification up to 90X and readily available taxonomic keys. Very small polychaete specimens were mounted in CMC-10 mounting media using methods consistent with those outlined in Epler (2001). Identification of slide-mounted organisms was conducted under a compound microscope with magnification up to 1,000X.

Enumerations of macroinvertebrates identified from each sample were recorded directly in an electronic spreadsheet. Prior to data summary, species abundances for each sample were standardize to number of individuals per square meter, taking into account the sampling equipment dimensions and sub-sampling effort.

## 2.2 Data Analysis

Measures of benthic macrofaunal diversity, abundance, and community composition were selected to describe existing conditions. The rationale behind selection of each measure follows.

### Diversity (Taxa Richness)

*Taxa richness* is the number of different taxa that are found within a given area or community and is widely accepted as a robust assessment measure of diversity (Magurran 2003). For this study, taxa richness is defined as the total number of unique taxa found in a sample.

### Abundance (Macrofaunal Density)

*Macrofaunal density* is an estimate of the number of individuals per unit area. The density of benthic organisms responds to disturbance as mitigated by the tolerance (or preference) of a given organism to the particular source of disturbance. Density may vary substantially over small areas or short periods of time and should therefore be interpreted cautiously. For this study, macrofaunal density is expressed as the number of organisms per cubic meter.

### Community Composition

*Community composition* is a multivariate measure identifying the different benthic taxa present and respective abundances of each taxon. This descriptive measure uses information regarding the taxa present, providing detail to complement and help interpret summary metrics of diversity and abundance.

## 3.0 RESULTS

Results of the benthic sample analysis, including taxa richness, density, and community composition are presented in the following sections.

## 3.1 Taxa Richness

The total number of taxa identified from the samples examined was 32 (Table A). Taxa richness per sample ranged from 6 taxa at Grab 4 to 19 taxa at Grab 1 (Appendix A) with a mean taxa richness of 15 taxa per site (Table A).

**Table A. Summary of Key Statistics from the Benthic Sample Analysis**

| Statistic | Value |
|---|---|
| Number of Samples | 4 |
| Mean Density per Cubic Meter (±1 SD) | 118,370 ± 80,581 |
| Mean Taxa Richness (±1 SD) | 15 ± 6 |
| Total Number of Taxa | 32 |
| **Number of Taxa Observed by Taxonomic Group** | |
| Polychaete worms | 14 |
| Crustaceans | 9 |
| Mollusks | 4 |
| Echinoderms | 1 |
| Nemertean ribbon worms | 3 |
| Nematode roundworms | 1 |
| **Percent of Total Abundance by Taxonomic Group** | |
| Polychaete worms | 47.7% |
| Crustaceans | 23.6% |
| Mollusks | 2.5% |
| Echinoderms | 0.6% |
| Nemertean ribbon worms | 1.8% |
| Nematode roundworms | 23.8% |

## 3.2 Macrofaunal Density

The mean macrofaunal density for the analyzed samples was 118,370 individuals/$m^3$ (Table A). The highest macrofaunal density (234,409 individuals/$m^3$) was found at Grab 4, while macrofaunal density was lowest (48,227 individuals/$m^3$) at Grab 2 (Appendix A). Of the four samples analyzed, three were characterized by densities of 90,000 individuals/$m^3$ or more.

## 3.3 Macrofaunal Community Composition

The benthic macrofaunal assemblage documented in the analyzed samples consisted of polychaete worms, crustaceans, mollusks, echinoderms, nematode roundworms, and nemertean ribbon worms. (Appendix A).

The most speciose taxonomic group was polychaete worms, which contributed approximately 45% of the taxa documented in the analyzed samples (Table A).

The taxonomic group with the highest density was polychaete worms, followed by nematode roundworms and crustaceans (Table A).

The most abundant taxa observed were nematode roundworms (Nematoda), the lumbrinerid polychaete *Scoletoma* sp., and a paraonid polychaete (Paraonidae) (Table B). Together, these taxa accounted for more than 50% of all individuals identified in this study.

**Table B. Relative Abundance of Taxa Encountered***

| Scientific Name | Common Name | Relative Abundance (%) |
|---|---|---|
| Nematoda | Nematode roundworm | 24 |
| *Scoletoma sp.* | Lumbrinerid polychaete | 19 |
| Paraonidae | Paraonid polychaete | 12 |
| *Ampelisca sp.* | Ampeliscid amphipod | 10 |
| *Byblis sp.* | Ampeliscid amphipod | 10 |

*Includes taxa accounting for at least 10% of total abundance

The most widespread taxa (i.e., observed in the most samples) were the lumbrinerid polychaete *Scoletoma* sp. and the hooded shrimp *Diastylis* sp. which were observed in all four samples (Table C). Other widely distributed taxa included ampeliscid amphipods, immature bivalves, nematode roundworms, ribbon worms, ampharetid bristle worms, bamboo worms, and paranoid worms (all found in three samples).

**Table C. Most Widespread Taxa Encountered***

| Scientific Name | Common Name | Number of Samples Containing this Taxon |
|---|---|---|
| *Diastylis* sp. | Hooded shrimp | 4 |
| *Scoletoma* sp. | Lumbrinerid worms | 4 |
| *Ampelisca* sp. | Ampeliscid amphipod | 3 |
| Bivalvia | Immature bivalves | 3 |
| Nematoda | Nematode roundworm | 3 |
| Nemertea | Ribbon worms | 3 |
| Ampharetidae | Ampharetid bristle worms | 3 |
| *Clymenella* sp. | Bamboo worm | 3 |
| Paraonidae | Paraonid worms | 3 |

*Includes taxa observed in at least three samples

## 3.4 Quality Assurance/Quality Control

QA/QC sorting efficiency checks were conducted on two samples. All QA/QC criteria were met for this project.

Identifications represent the lowest practicable taxonomic level, given the maturity and condition of the organisms encountered, as well as the current state of taxonomic consensus. With the exception of heavily damaged or immature specimens, organisms were successfully identified to family level or better.

### 3.5 Summary of Results

- Thirty-two marine invertebrate taxa were observed in the 4 samples analyzed for this project.
- Taxa richness averaged 15 per site, and all but one sample contained at least 16 taxa.
- Mean macroinvertebrate density was over 118,000 organisms/$m^3$.
- The benthic community in the analyzed samples consisted of polychaete worms, bivalve mollusks, nematode roundworms, nemertean ribbon worms, common sand dollars, and crustaceans including amphipods, cumaceans, ostracods, and isopods.
- The most speciose taxonomic group was polychaete worms, which contributed approximately 45% of taxa documented in the analyzed samples
- The most abundant organisms observed were nematode roundworms and the lumbrinerid polychaete *Scoletoma* sp.
- The most widely distributed taxa observed were the lumbrinerid polychaete *Scoletoma* sp. and the hooded shrimp *Diastylis* sp., both of which were observed in all 4 samples.

## 4.0 REFERENCES

Epler, J.H. 2001. Identification Manual for the Larval Chironomidae (Diptera) of North and South Carolina. Version 1.0.

Magurran, A.E. 2003. Measuring Biological Diversity. Malden, MA: Blackwell Publishing Ltd

## Appendix A

## Benthic Sample Taxonomy and Enumeration Results

| | Organisms/m³ | | | |
|---|---|---|---|---|
| | Grab 1 | Grab 2 | Grab 3 | Grab 4 |
| **Conversion Factor (multiply by density to find raw sample abundance)** | **0.00182** | **0.00141** | **0.00142** | **0.000465** |
| **Taxa** | | | | |
| **Crustacea** | | | | |
| **Amphipoda** | | | | |
| *Ampelisca sp.* | 6,593 | 9,220 | 18,310 | |
| Unidentified Amphipoda | | | 704 | |
| *Byblis sp.* | | | 3,521 | 94,624 |
| Cumacea | 549 | | | |
| *Diastylis sp.* | 549 | | | 2,151 |
| *Harpinia sp.* | 549 | | 704 | |
| *Leptocheirus pinguis* | | 709 | | |
| **Cumacea** | | | | |
| Unidentified Cumacea | | | 704 | |
| *Diastylis sp.* | | 2,128 | 1,408 | |
| **Isopoda** | | | | |
| *Cyathura polita* | | | 704 | |
| **Ostracoda** | | | | |
| Unidentified Ostracoda | 549 | | | |
| **Echinodermata** | | | | |
| *Echinarachnius parma* | 549 | 1,418 | | |
| **Mollusca** | | | | |
| **Bivalvia** | | | | |
| Unidentified Bivalvia | 1,648 | 709 | 1,408 | |
| *Lucinoma sp.* | 1,648 | | 0 | |
| *Periploma papyratium* | 549 | | | |
| *Tellina sp.* | | | 1,408 | |
| **Nematoda** | | | | |
| Nematoda | 21,978 | | 14,789 | 118,280 |
| **Nemertea** | | | | |
| *Cephalothrix sp.* | | 1,418 | | |
| *Cerebratulus luridus* | | 709 | | |
| Unidentified Nemertea | 1,099 | 1,418 | | 4,301 |
| **Polychaeta** | | | | |
| Ampharetidae | 1,099 | 709 | | 2,151 |
| Cirratulidae | 1,099 | | | |
| *Clymenella sp.* | 7,692 | 709 | 1,408 | |
| *Drilonereis longa* | | | 1,408 | |
| *Exogone sp.* | 549 | | | |
| *Glycera sp.* | | 1,418 | 704 | |
| Nephtyidae | 1,099 | | | |
| *Nephtys sp.* | | 1,418 | | |
| *Ninoe nigripes* | | 9,220 | 19,718 | |
| Paraonidae | 23,077 | 7,801 | 4,225 | |
| *Pholoe minuta* | | 709 | | |
| Unidentified Polychaeta | 3,297 | | | |
| *Scoletoma sp.* | 25,824 | 8,511 | 18,310 | 12,903 |
| Sigalionidae | | | 1,408 | |
| **Total Density** | **100,000** | **48,227** | **90,845** | **234,409** |
| **Taxa Richness** | **19** | **16** | **18** | **6** |

2. Normandeau Associates 2017 Benthic Sample Processing Report

# Benthic Sample Processing Results
# Vineyard Wind Cable Route Survey
# September 2017

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November 2017
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# Table of Contents

# 1.0 Introduction

Normandeau Associates, Inc. (Normandeau), as a subcontractor to Alpine Ocean Seismic Survey, Inc. (Alpine), was contracted to process benthic samples that were collected by Alpine as part of a benthic survey of the Vineyard Wind cable route, located in waters south of Cape Cod, MA. The subsea cable route is located mostly within shallow waters south of Cape Cod, with a concentration of sampling effort in the area between Martha's Vineyard and Nantucket.

Fifty-nine benthic samples were collected using a 0.1 $m^2$ modified Day Grab. Three subsamples were collected from each grab sample using a 4-inch diameter hand core in the field. Each subsample represented 0.008 $m^2$. A total of 177 samples (3 core samples from 59 stations) were delivered to Normandeau's Bedford, NH office by Alpine. Normandeau processed one core sample from each station (59 core samples). The other two samples (118 core samples) from each station were washed with fresh water, transferred to 70-80% ethanol, and will be stored for one year from the submittal of the report. These archived samples allow for subsequent additional infaunal data if requested by regulatory agencies.

Normandeau sorted the remaining sample from each station then identified and enumerated individual organisms. Laboratory subsampling was employed on a few occasions to facilitate sorting of certain sample fractions. All organisms were identified to the family level and enumerated, with the following exceptions: nemerteans, nematodes, and sipunculids which were identified to phylum; oligochaetes, turbellarians, and anthozoans which were identified to class; and benthic copepods, ostracods, or other meiofaunal groups were not enumerated. Immature or damaged specimens that were missing the necessary diagnostic features for identification to the target taxonomic level were identified to the lowest practical taxon (above family). To ensure consistency for assessment of the soft-bottom macrofaunal community, any incidental pelagic organisms or fauna attached to hard-substrates were not identified.

This report summarizes processing methods and presents the macroinvertebrate data that were collected from the samples. Laboratory processing methods and data handling procedures are described in Section 2.0. Quality control results for the laboratory sort and taxonomy are provided in Section 3.0. Laboratory processing results are provided in Section 4.0, and macroinvertebrate data are provided in Appendix A.

The contents of this report provide the raw data and a brief data summary as delineated in the project work scope which includes tables presenting the following parameters:

- Number of Samples
- Mean Density per Square Meter (±1 SD) across all samples
- Mean Taxa Richness (±1 SD)
- Total Number of Taxa
- Number of Taxa Observed by Taxonomic Group
- Percent of Total Abundance by Taxonomic Group
- Relative Abundance of Taxa Recovered, and
- Most Common/Widespread Taxa Encountered.

# 2.0 Methods

## 2.1 Laboratory Methods

Soft-bottom macroinvertebrate samples from 59 stations were processed by Normandeau's Bedford, NH laboratory following standard processing protocols. Upon arrival at the laboratory, all 177 samples were rinsed with fresh water through a 0.5 mm mesh screen and re-preserved in 70% ethanol to protect specimens from decalcification. Following a subsequent rinsing through a 0.5 mm mesh screen, one randomly selected sub-sample from each station (a total of 59 samples) was elutriated to separate heavy and light materials and those with heterogeneously sized debris or organisms were washed through a series of graduated sieves down to a 0.5 mm mesh to facilitate sorting. Laboratory subsampling was also employed for samples where large quantities of uniform, coarse sand was present. This material was spread evenly in a pan, divided into 36 similar sized quadrants and subsampled by randomly selecting and sorting material from 6 of the 36 quadrants. Specimens were vialed and labeled separately; identifications and counts presented on data sheets were prorated to present an estimate for the entire sample. Macroinvertebrates were sorted from the debris into major taxonomic groups using a dissecting microscope. Organisms removed from each sample were placed in labeled vials with 70% Ethanol. All organisms were identified to the family level and enumerated, except nematodes (identified to phylum) and oligochaete annelids were identified to class. Meiofauna (e.g., benthic copepods, ostracods) were not enumerated.

Normandeau's internal quality control for sorting and taxonomy follows the National Coastal Condition Assessment 2015 Laboratory Operations Manual (Version 2.1 May 2016; USEPA 2016) guidelines. At least the first three samples undertaken by each new macroinvertebrate sorter were re-checked by the Quality Control Supervisor. At the discretion of the Quality Control Supervisor, additional samples could be checked prior to releasing any sorter from training. The first sorted sample for each seasoned sorter was rechecked. Regardless of experience level, a minimum of 10% of each sorter's subsequent samples (one in each batch of 10 samples) was randomly selected and subjected to quality control. Any sorted sample failing quality control resulted in returning to all samples from that batch of 10 for re-checking, with appropriate retraining of the sorter. In addition, 10% of each taxonomists' samples were re-identified. Any work of insufficient quality due to not meeting the National Coastal Condition Assessment guideline resulted in re-checking samples in that batch, returning to earlier program samples possibly affected, and retraining as appropriate.

Identified specimens were logged into the laboratory storage inventory and placed into storage for one-year. Sorted samples were re-preserved in 70% Ethanol and will be held until report acceptance, or for one-year.

## 2.2 Data Handling and Reduction Methods

Data handling was conducted by Normandeau's Data Center in Bedford, NH. All data were double keypunched using Normandeau's keypunch verification software. Using this software, data are entered electronically into a file that is then keyed a second time to detect data entry errors. When this inspection reveals errors in excess of those acceptable, a full inspection of the data is performed to remove any chance of error in the data, prior to presentation of the data.

Data preparation, reduction, and computation of summary statistics were run in SAS system software (version 9.3). Where laboratory subsampling was employed, estimated total counts were extrapolated for each sample (station and replicate) based on counts from the subsampled fraction of the sample. Macroinvertebrate community structure parameters were calculated based on the biotic abundance estimates (based on subsamples) for each sample. Summary statistics for the macroinvertebrate community included: total abundance, number of species, Shannon diversity index (H′ per sample, log base e), and Pielou's evenness index (J′ per sample) (Magurran 1988). Abundance was reported as counts per 0.008 $m^2$ core sample and taxonomic group and the overall density across all samples was adjusted to organisms per square meter. The PRIMER 6 package of statistical routines (Clarke & Gorley, 2006) was used to calculate the diversity index Shannon's H′ (loge), and Pielou's evenness value J′. Both H′ and J′ indices are based on the proportional abundances of species (Magurran 1988). Evenness (J′) is entirely a function of proportional abundance; J′ values are unaffected by the number of species in a sample. Values for J' can range between 0 and 1, with J' = 1 when all species in a sample have equal abundances. Diversity (H′) is a function of both proportional abundance and the number of species in the sample. The maximum possible H′ diversity (Hmax) for a given number of species occurs where all species have equal abundances. Any log base can be used to calculate H′; loge is used most commonly (Magurran 1988). H′ values calculated using different log bases are not comparable and must be converted to a common base prior to comparison. J' values are not affected by log base. H′ increases both with increasing numbers of species, and with increasingly even distributions of the total abundance among those species. Thus, H′ values depend on the log base used and on the numbers of taxa per sample, in addition to proportional abundance. H′ can range from 0 (with only one species in a sample) to a typical maximum of around 4.5 (Magurran 1988).

## 3.0 Quality Control/Quality Assurance Results

Twelve samples were rechecked during the training phase of the sorting, with an additional four samples being resorted and determined to either pass or fail (Table 3-1). Percent sorting efficiency (PSE) must be less than or equal to 90% sorting efficiency (less than 10% difference between sorter and quality control check) and is calculated using the following equation:

$$PSE = \frac{A}{A+B}x100$$

The PSE is the number of organisms recovered by the sorter (A) compared to the combined (total) number of recoveries by the sorter (A) and independent sorter (B). Sample results for PSE were favorable so further checking was not required (Table 3-2).

**Table 3-1. Number of samples rechecked for Percent Sorting Efficiency (PSE).**

| Technician | Training QC | Processing QC | Total |
|---|---|---|---|
| 1 | 3 | 1 | 4 |
| 2 | 3 | 1 | 4 |
| 3 | 3 | 2 | 5 |
| 4 | 1* | 0 | 1 |
| 5 | 1* | 0 | 1 |
| 6 | 1* | 0 | 1 |
| **Total** | **12** | **4** | **16** |

* Seasoned sorter requiring one initial sample checked; Few samples were processed, eliminating the need for additional processing QC's.

**Table 3-2. Sample Results for Percent Sorting Efficiency (PSE).**

| Technician | Processed Sample | % Difference | PSE |
|---|---|---|---|
| 1 | 30C | 0% | 100.0% |
| 2 | 19B | 3.0% | 97.0% |
| 3 | 28B | 1.3% | 98.7% |
| 3 | 39B | 1.6% | 98.4% |

Quality control of taxonomic processing, both identification and enumeration of specimens, was conducted on 10% of the 59 processed samples. Results of this QC comparison are discussed in the following paragraphs. A total of six randomly selected samples were re-identified with PDE (percent disagreement in enumeration) and PTD (percent taxonomic disagreement) for each taxonomist's work.

The first step involved examining the overall counts of individual organisms in each sample using the following equation:

$$PDE = \frac{|n_1 - n_2|}{n_1 + n_2}\ x100$$

The PDE compares the number of organisms, $n_1$, counted in a sample by the primary taxonomist with the number of organisms, $n_2$, counted by the internal or external QC taxonomist. The target percent difference for counts below which no additional quality resolution is required is less than or equal to 5%. Comparison of count differences (PDE) for each of the six selected samples required no further examination (Table 3-3).

**Table 3-3. Sample Results for Percent Disagreement in Enumeration (PDE).**

| QC | Sample | Phyla | | |
|---|---|---|---|---|
| | | Polychaeta | Mollusca | Arthropoda & Misc |
| 1 | 10B | 0% | 0% | 4.2% |
| 2 | 15C | 0% | 0% | 0% |
| 3 | 27C | 0% | 0% | 0% |
| 4 | 32B | 0% | 2.7% | 0% |
| 5 | 49C | 0% | 0% | 0% |
| 6 | 61C | 0% | 0% | 4.8% |

The second step involved examining the accuracy of taxonomic identifications using the following equation:

$$PTD = \left[1 - \frac{comp_{pos}}{N}\right]\ x100$$

The PTD measures the taxonomic precision comparing the number of agreements (positive comparisons, $comp_{pos}$) of the primary taxonomist and internal or external QC taxonomists with N, the total number of organisms in the larger of the two counts. The target percent difference for taxonomic accuracy below which no additional quality resolution is required is less than or equal to 15%. Comparison of differences for each of the six selected samples required no further examination (Table 3-4).

**Table 3-4. Sample Results for Percent of Taxonomic Disagreement (PTD).**

| QC | Sample | Phyla | | |
|---|---|---|---|---|
| | | Polychaeta | Mollusca | Arthropoda & Misc |
| 1 | 10B | 4.0% | 0% | 0% |
| 2 | 15C | 0% | 0% | 0% |
| 3 | 27C | 0% | 0% | 0% |
| 4 | 32B | 0% | 0% | 0% |
| 5 | 49C | 0% | 0% | 0% |
| 6 | 61C | 0% | 0% | 0% |

# 4.0 Results

The 59 subsample cores yielded a total of 104 macroinvertebrate families (and higher taxonomic-level organisms including Oligochaeta, Archannelida, Nematoda, and Turbellaria) from nine phyla. Ninety-nine percent of the macroinvertebrates were from four phyla: Arthropoda (contributing 30%), Annelida (27%), Mollusca (25%), and Nematoda (16%; Table 4-1 and Figure 4-1). The other phyla recorded in the samples: Nemertea, Echinodermata, Platyhelminthes, Cnidaria, and Chordata together contributed less than 1 percent to the total abundance.

Arthropoda was represented by the highest number of taxa (n=34) including amphipods, decapods, isopods, and tanaids; followed by Annelida (n=29) including polychaetes and oligochaetes; and Mollusca (n = 28) including gastropods (snails and nudibranchs), chitons, and bivalves. The remaining six phyla were represented by one to five taxa each (Table 4-1).

Arthopods were also the most abundant organisms with a total of 2,474 individuals among all samples, followed by Annelida with 2,235 individuals, Mollusca (2,008 individuals), and Nematoda (1,333 individuals; Table 4-1). Total abundances of Nemertea, Echinodermata, Platyhelminthes, Cnidaria, and Chordata were relatively low ranging from 44 nemerteans to 1 individual chordate.

Overall, the mean abundance was 138 individuals per sample (17,015 organisms per $m^2$) ranging from two individuals in sample # 43 to 1,588 individuals in sample # 23 (Table 4-2). The two individuals in sample # 43 were one nematode and one polychaete from the family Capitellidae. The relatively high abundance in sample #23 was primarily due to two taxa, caprellid amphipods, Caprellidae (1,146 individuals) and dove snails, Columbellidae (174 individuals; see Appendix Table A). The mean number of taxa among all samples was 15 with a range of 2 in sample #43 to 39 taxa in sample # 7. The mean Shannon diversity index for all samples was 1.80, ranging from 0.63 in sample #16 to 2.73 in sample #21. Pielou's evenness values ranged from 0.34 in sample #23 to 1.00 in sample #33 with an average of 0.73 (Table 4-2). Both of these measures are typically calculated for data analyzed to the species level, so comparisons of these metrics to other survey results should be done with caution.

Among all stations, the most abundant taxon was Nematoda (with total abundance of 1,333 individuals), followed by Caprellidae (1,188 individuals), Tellinidae (518 individuals), and Oligochaetes (480 individuals; Table 4-3).

**Table 4-1. Phyla represented in the macroinvertebrate samples collected during the Vineyard Wind cable route survey in September 2017.**

| Phylum | Number of Taxa[1] | Total abundance (overall number of individuals) | Percentage |
|---|---|---|---|
| Arthropoda | 34 | 2,474 | 30.43 |
| Annelida | 29 | 2,235 | 27.49 |
| Mollusca | 28 | 2,008 | 24.70 |
| Nematoda | 1 | 1,333 | 16.40 |
| Nemertea | 5 | 44 | 0.54 |
| Echinodermata | 2 | 16 | 0.20 |
| Platyhelminthes | 1 | 13 | 0.16 |
| Cnidaria | 3 | 5 | 0.06 |
| Chordata | 1 | 1 | 0.01 |

[1]Identified to the family-level with the exception of Oligochaeta, Archannelida, Nematoda, and Turbellaria.

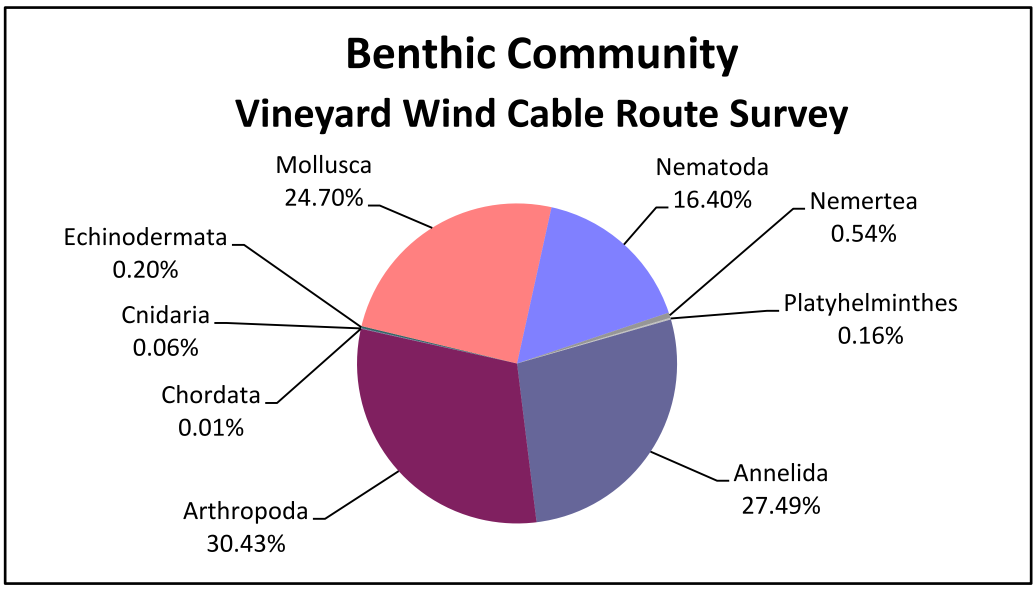


**Figure 4-1. Percent contribution to total abundance by phyla in benthic samples collected during the Vineyard Wind cable route survey in September 2017.**

**Table 4-2. Community parameters for samples collected during the Vineyard Wind cable route survey in September 2017.**

| Station (Sample ID) | Total Number of Taxa | Total Count (no. per 0.008 $m^2$) | Diversity (H') | Evenness (J') |
|---|---|---|---|---|
| 1 | 15 | 85 | 2.26 | 0.84 |
| 2 | 23 | 136 | 2.55 | 0.81 |
| 3 | 20 | 62 | 2.32 | 0.77 |
| 4 | 11 | 37 | 1.84 | 0.77 |
| 6 | 26 | 612 | 2.07 | 0.63 |
| 7 | 39 | 394 | 2.54 | 0.69 |
| 8 | 26 | 241 | 1.94 | 0.60 |
| 9 | 5 | 18 | 1.08 | 0.67 |
| 10 | 19 | 61 | 2.52 | 0.85 |
| 11 | 16 | 32 | 2.58 | 0.93 |
| 12 | 6 | 10 | 1.61 | 0.90 |
| 13 | 12 | 34 | 2.07 | 0.83 |
| 14 | 9 | 23 | 1.91 | 0.87 |
| 15 | 10 | 20 | 1.99 | 0.86 |
| 16 | 4 | 18 | 0.63 | 0.46 |
| 17 | 4 | 11 | 1.34 | 0.97 |
| 18 | 11 | 183 | 1.44 | 0.60 |
| 19 | 19 | 33 | 2.69 | 0.91 |
| 20 | 27 | 170 | 2.31 | 0.70 |
| 21 | 30 | 157 | 2.73 | 0.80 |
| 22 | 4 | 13 | 0.79 | 0.57 |
| 23 | 34 | 1588 | 1.19 | 0.34 |
| 24 | 8 | 47 | 1.64 | 0.79 |
| 25 | 3 | 8 | 0.74 | 0.67 |
| 26 | 20 | 348 | 1.56 | 0.52 |
| 27 | 22 | 78 | 2.46 | 0.79 |
| 28 | 19 | 77 | 1.97 | 0.67 |
| 29 | 15 | 98 | 1.56 | 0.58 |
| 30 | 15 | 136 | 1.48 | 0.55 |
| 31 | 16 | 148 | 1.87 | 0.68 |
| 32 | 12 | 92 | 1.07 | 0.43 |
| 33 | 6 | 6 | 1.79 | 1.00 |
| 34 | 7 | 31 | 1.61 | 0.83 |
| 35 | 9 | 38 | 1.46 | 0.66 |
| 36 | 16 | 244 | 1.51 | 0.54 |

**Table 4-2. Continued.**

| Station | Total Number of Taxa | Total Count (no. per 0.008 m$^2$) | Diversity (H') | Evenness (J') |
|---|---|---|---|---|
| 37 | 19 | 423 | 1.29 | 0.44 |
| 38 | 12 | 57 | 1.80 | 0.72 |
| 39 | 28 | 401 | 2.24 | 0.67 |
| 40 | 10 | 38 | 1.97 | 0.85 |
| 43 | 2 | 2 | 0.69 | 1.00 |
| 44 | 11 | 38 | 2.07 | 0.86 |
| 45 | 11 | 38 | 1.85 | 0.77 |
| 46 | 6 | 53 | 1.40 | 0.78 |
| 47 | 32 | 323 | 2.67 | 0.77 |
| 48 | 4 | 4 | 1.39 | 1.00 |
| 49 | 10 | 41 | 1.79 | 0.78 |
| 50 | 18 | 89 | 2.30 | 0.80 |
| 51 | 11 | 80 | 1.65 | 0.69 |
| 52 | 18 | 86 | 2.07 | 0.72 |
| 53 | 14 | 97 | 1.97 | 0.75 |
| 54 | 15 | 311 | 1.37 | 0.50 |
| 55 | 18 | 176 | 2.22 | 0.77 |
| 56 | 12 | 21 | 2.34 | 0.94 |
| 57 | 12 | 51 | 1.94 | 0.78 |
| 58 | 7 | 30 | 1.42 | 0.73 |
| 59 | 19 | 343 | 1.56 | 0.53 |
| 60 | 11 | 76 | 1.58 | 0.66 |
| 61 | 15 | 55 | 2.32 | 0.86 |
| 62 | 3 | 7 | 0.96 | 0.87 |
| **Mean** | 14.5 | 137.8 | 1.80 | 0.73 |

**Table 4-3. Total macroinvertebrate abundance for samples collected during the Vineyard Wind cable route survey in September 2017.**

| Phylum | Family | Abundance (total number of individuals per 0.008 m²) |
|---|---|---|
| Annelida | Ampharetidae | 32 |
| | Archiannelida | 135 |
| | Capitellidae | 389 |
| | Chaetopteridae | 2 |
| | Cirratulidae | 208 |
| | Dorvilleidae | 22 |
| | Glyceridae | 35 |
| | Hesionidae | 2 |
| | Lumbrineridae | 46 |
| | Magelonidae | 34 |
| | Maldanidae | 41 |
| | Nephtyidae | 82 |
| | Oenonidae | 1 |
| | Oligochaeta | 480 |
| | Onuphidae | 1 |
| | Opheliidae | 12 |
| | Orbiniidae | 10 |
| | Oweniidae | 2 |
| | Paraonidae | 76 |
| | Pectinariidae | 1 |
| | Phyllodocidae | 56 |
| | Pilargidae | 3 |
| | Polynoidae | 27 |
| | Sabellaridae | 54 |
| | Sigalionidae | 22 |
| | Sphaerodoridae | 2 |
| | Spionidae | 170 |
| | Syllidae | 175 |
| | Terebellidae | 115 |
| Annelida Total | | 2235 |

**Table 4-3. Continued.**

| Phylum | Family | Abundance (total number of individuals per 0.008 m$^2$) |
|---|---|---|
| Arthropoda | Ampeliscidae | 699 |
| | Anthuridae | 3 |
| | Aoridae | 45 |
| | Argissidae | 1 |
| | Bateidae | 26 |
| | Bathyporeiidae | 14 |
| | Bodotriidae | 5 |
| | Callianassidae | 3 |
| | Cancridae | 3 |
| | Caprellidae | 1188 |
| | Corophiidae | 11 |
| | Diastylidae | 14 |
| | Epialtidae | 1 |
| | Haustoriidae | 38 |
| | Idoteidae | 1 |
| | Inachoididae | 2 |
| | Ischyroceridae | 22 |
| | Janiridae | 29 |
| | Leptocheliidae | 1 |
| | Liljeborgiidae | 6 |
| | Lysianassidae | 11 |
| | Maeridae | 8 |
| | Mysidae | 5 |
| | Oedicerotidae | 13 |
| | Paguridae | 81 |
| | Parthenopidae | 1 |
| | Photidae | 32 |
| | Phoxocephalidae | 71 |
| | Pinnotheridae | 13 |
| | Stenothoidae | 17 |
| | Tanaissuidae | 40 |
| | Unciolidae | 40 |
| | Upogebiidae | 1 |
| | Xanthidae | 29 |
| Arthropoda Total | | 2474 |

**Table 4-3. Continued.**

| Phylum | Family | Abundance (total number of individuals per 0.008 m²) |
|---|---|---|
| Mollusca | Acteocinidae | 41 |
| | Arcidae | 22 |
| | Astartidae | 39 |
| | Busyconidae | 1 |
| | Calyptraeidae | 367 |
| | Cerithiopsidae | 18 |
| | Chaetopleuridae | 24 |
| | Columbellidae | 387 |
| | Corambidae | 6 |
| | Crassatellidae | 5 |
| | Lyonsiidae | 37 |
| | Mactridae | 31 |
| | Mangeliidae | 3 |
| | Margaritidae | 8 |
| | Muricidae | 3 |
| | Myidae | 1 |
| | Mytilidae | 5 |
| | Nassariidae | 18 |
| | Naticidae | 8 |
| | Nuculidae | 50 |
| | Pandoridae | 3 |
| | Pectinidae | 2 |
| | Pharidae | 18 |
| | Pyramidellidae | 380 |
| | Semelidae | 1 |
| | Tellinidae | 518 |
| | Veneridae | 3 |
| | Yoldiidae | 9 |
| Mollusca Total | | 2008 |

**Table 4-3. Continued.**

| Phylum | Family | Abundance (total number of individuals per 0.008 m$^2$) |
|---|---|---|
| Chordata | Harrimaniidae | 1 |
| Cnidaria | Alcyoniidae | 1 |
| | Edwardsiidae | 1 |
| | Halcampidae | 3 |
| Cnidaria Total | | 5 |
| Echinodermata | Amphiuridae | 5 |
| | Echinarachniidae | 11 |
| Echinodermata Total | | 16 |
| Nematoda | Nematoda | 1333 |
| Nemertea | Amphiporidae | 21 |
| | Carinomidae | 7 |
| | Lineidae | 6 |
| | Tetrastemmatidae | 4 |
| | Tubulanidae | 6 |
| Nemertea Total | | 44 |
| Platyhelminthes | Turbellaria | 13 |

## 5.0 References

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# Appendix A

## Macroinvertebrate Data

**Appendix Table A. Benthic macroinvertebrate counts (per 0.008 m²) collected during the Vineyard Wind cable route survey; Sept., 2017.**

| | | Station | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Annelida | Ampharetidae | | 1 | | 1 | | 1 | | | | | | 2 | | | | | 1 | 2 | 2 |
| | Archiannelida | | 16 | 3 | | | | | | 4 | 1 | | | | | | | | | |
| | Capitellidae | 11 | 10 | | 6 | | | | | 1 | 5 | | 1 | | | | 2 | 24 | | |
| | Chaetopteridae | | | | | | | | | | | | | | | | | | | |
| | Cirratulidae | | 1 | | | 6 | 108 | 1 | | 1 | | | 3 | 1 | | | | 5 | | 14 |
| | Dorvilleidae | | | | | | 14 | | | | | | | | | | | | | |
| | Glyceridae | | | 2 | | | 1 | | | | | | | | | | | 1 | | |
| | Hesionidae | | | | 1 | | 1 | | | | | | | | | | | | | |
| | Lumbrineridae | | 1 | | | | | | | | | | 2 | | | | | | | 4 |
| | Magelonidae | | | | | | | | | | 1 | | | | | | | | | |
| | Maldanidae | 1 | | 2 | 1 | | 1 | | | 2 | | | | | | | | | 1 | |
| | Nephtyidae | | | 2 | | | | 2 | 1 | 2 | 1 | 1 | 6 | 2 | | | | 2 | 2 | |
| | Oenonidae | | | | | | | | | | | | | | | | | | | |
| | Oligochaeta | 13 | 14 | 1 | 14 | 30 | 31 | | | | 3 | | | | | | | 93 | 1 | |
| | Onuphidae | | | | | | | | | | | | | 1 | | | | | | |
| | Opheliidae | | | | | | | | | | | | | | | | | | | |
| | Orbiniidae | | 1 | | | | | | | | | | | | | | | | | |
| | Oweniidae | | | | | | | | | | | | | | | | | | | |
| | Paraonidae | | 2 | | | | 45 | | | 1 | 1 | | | | | | | | | |
| | Pectinariidae | | | | 1 | | | | | | | | | | | | | | | |
| | Phyllodocidae | | 1 | | | 11 | 6 | 2 | | | | | | | | | | | 2 | 1 |
| | Pilargidae | | | 1 | 1 | | 1 | | | | | | | | | | | | | |
| | Polynoidae | | | | | 12 | 2 | 1 | | | | | | | | | | | | 2 |
| | Sabellaridae | | | | | | | | | | | | | | | | | | | |
| | Sigalionidae | | | | | | | | | 2 | | | | | | 1 | | | | |
| | Sphaerodoridae | | | | | | | | | | | | | | | | | | | |
| | Spionidae | 19 | 2 | | | 7 | 19 | | | | 1 | | | 1 | | | | | | 2 |
| | Syllidae | 1 | 8 | 1 | | 7 | 9 | 2 | | 3 | | | | | | | | 6 | | 6 |
| | Terebellidae | | 5 | 2 | | 1 | 11 | | | 9 | | | | | | 1 | 2 | 2 | | |

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**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Arthropoda | Ampeliscidae | | | | | | | | | | 4 | | | 1 | | | | 5 | 4 | 1 |
| | Anthuridae | | | | | | | | 2 | | | | | | | | | | | |
| | Aoridae | 4 | | | | 31 | 2 | | | | | | | | | | | | | 3 |
| | Argissidae | | | | | | | | | | | | | | | | | | | |
| | Bateidae | | | | | 1 | 22 | | | | | | | | | | | | | 1 |
| | Bathyporeiidae | | | 4 | | | | | | 2 | | | | | | | | | | |
| | Bodotriidae | | | | | | | 3 | | | 1 | | 1 | | | | | | | |
| | Callianassidae | | | | | | | | | 1 | | | | | | | | | | |
| | Cancridae | | | | | | | 1 | | | | | | | | | | | | |
| | Caprellidae | 8 | 9 | 2 | | 1 | | 10 | | | | | | | | | | | 1 | |
| | Corophiidae | 1 | | | | 7 | | | | | | | | | | | | | | |
| | Diastylidae | | | 2 | 2 | | | 2 | 2 | | | 1 | 1 | | | | | | 1 | |
| | Epialtidae | | | | | | | | | | | | | | | | | | | |
| | Haustoriidae | | | | | | | | | | 2 | 2 | | | 2 | | | | | |
| | Idoteidae | | | | | | | | | | | | | | | | | | | 1 |
| | Inachoididae | | | | | | | | | | | | | | | | | | 1 | |
| | Ischyroceridae | | 1 | | | | | | | | | | | | | | | | | |
| | Janiridae | | | | | 12 | 10 | 2 | | | | | | | | | | | | 1 |
| | Leptocheliidae | | | | | 1 | | | | | | | | | | | | | | |
| | Liljeborgiidae | | | | | | | 1 | | 2 | 1 | | | | 1 | | | | | |
| | Lysianassidae | 1 | | | | | | | | | | | | | | | | | | 2 |
| | Maeridae | | | | | | 2 | | | | | | | | | | | | | 2 |
| | Mysidae | | | | | 1 | 1 | | | | | | | | | | | | | |
| | Oedicerotidae | | 1 | 1 | 1 | | | 2 | | | 1 | 1 | 2 | | | | | | | |
| | Paguridae | | | 1 | | | 1 | 1 | | | | | | | | | | | 1 | 2 |
| | Parthenopidae | | | | | | 1 | | | | | | | | | | | | | |
| | Photidae | | | | | | | | | | | | | | | | | | | 8 |
| | Phoxocephalidae | | | 2 | | | 6 | 3 | | 4 | 4 | | 1 | 8 | 1 | | 3 | | | 2 |
| | Pinnotheridae | | | | | | | | | 3 | 3 | 1 | 1 | | 1 | | | | | |

(continued)

**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Arthropoda (cont'd) | Stenothoidae | | | | | | | 3 | | | | | | | | | | | | |
| | Tanaissuidae | | | | | | | | | | | | | | 5 | 1 | | | | |
| | Unciolidae | | 1 | 1 | | | 3 | | | | | | | | 1 | | | | 1 | |
| | Upogebiidae | | | | | | | | | | | | | | | | | | | |
| | Xanthidae | 2 | | | | 11 | 4 | 1 | | | | | | | | | | 1 | | 1 |
| Chordata | Harrimaniidae | | | | | | 1 | | | | | | | | | | | | | |
| Cnidaria | Alcyoniidae | | | | | | | | | | | | | | | | | | | |
| | Edwardsiidae | | | | | | | 1 | | | | | | | | | | | | |
| | Halcampidae | | 1 | | | | | | | | | | | | | | | | | |
| Echinodermata | Amphiuridae | | | | | | 1 | | | | | | | | | | | | | |
| | Echinarachniidae | | | | | | | | | | | | | | | | | | | |
| Mollusca | Acteocinidae | | 24 | | | | | | | | | | | | | | | | | |
| | Arcidae | 1 | | | | 5 | | 2 | | | | | | | | | | | | |
| | Astartidae | | | | | | | | | | | | | | | | | | | |
| | Busyconidae | | | | | | 1 | | | | | | | | | | | | | |
| | Calyptraeidae | 9 | | | | 181 | 6 | 31 | | | | | | | | | | | 1 | 59 |
| | Cerithiopsidae | | 11 | | | 3 | 1 | 1 | | | | | | | | | | | | |
| | Chaetopleuridae | | | | | 2 | 1 | | | | | | | | | | | | | 1 |
| | Columbellidae | 1 | 1 | | | 14 | 4 | 48 | | | | | | | | | | | 1 | 13 |
| | Corambidae | | | | | | | | | | | | | | | | | | | |
| | Crassatellidae | | | 1 | | | 1 | | | | | | | | | | | | 1 | 1 |
| | Lyonsiidae | | | 4 | | | | | | | | | | | | | | | 1 | |
| | Mactridae | | | | | | | | | | | | | | | | | | | |
| | Mangeliidae | | | | | | | | | | | | | | 1 | | | | | |
| | Margaritidae | | | | | | | | | | | | | | | | | | | |
| | Muricidae | | | | | 1 | | | | | | | | | | | | | | |
| | Myidae | | | | | | | | | | | | | | | | | | | |
| | Mytilidae | | | | | | | | | | | | | | | | | | | |
| | Nassariidae | | | | | | | | | | | | | | 1 | | | | | |

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**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Mollusca (cont'd) | Naticidae | | | | | | | | | | | | | | | | | | | 1 |
| | Nuculidae | | | | 1 | 1 | 2 | | | | | | | | | | | | | |
| | Pandoridae | | | | | | | | | | | | | | | | | | | |
| | Pectinidae | | | | | 1 | 1 | | | | | | | | | | | | | |
| | Pharidae | | | | | | | 1 | | | | | | | | | | | | 1 |
| | Pyramidellidae | 3 | 2 | 3 | | 167 | | 106 | | 2 | 2 | | | 3 | | | | | 1 | 33 |
| | Semelidae | | | | | | | | | | | | | | | | | | | 1 |
| | Tellinidae | | 2 | 1 | | | | 5 | 1 | 1 | 1 | 4 | 2 | 4 | 1 | | | | 7 | |
| | Veneridae | | | | | | | | | | | | | | | | | | | |
| | Yoldiidae | | | | | | | | | | | | | | | | | | | |
| Nematoda | Nematoda | 10 | 21 | 26 | 8 | 97 | 68 | 8 | 12 | 17 | | | 12 | 2 | 6 | 15 | 4 | 43 | 3 | 5 |
| Nemertea | Amphiporidae | | | | | | 1 | | | 1 | | | | | | | | | | |
| | Carinomidae | | | | | | 1 | | | | | | | | | | | | | |
| | Lineidae | | | | | | | 1 | | | | | | | | | | | 1 | |
| | Tetrastemmatidae | | | | | | 1 | | | | | | | | | | | | | |
| | Tubulanidae | | | | | | | | | | | | | | | | | | | |
| Platyhelminthes | Turbellaria | | | | | 1 | 2 | | | 3 | | | | | | | | | | |

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**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| Annelida | Ampharetidae | 1 | | 2 | | | | | | | | | 1 | | | | | | 1 | 7 | |
| | Archiannelida | | | | | | | 1 | 1 | | | | | | | | | | | 2 | 1 |
| | Capitellidae | | | | | 6 | 160 | 6 | 3 | | | 27 | | | | | 65 | 39 | | 6 | |
| | Chaetopteridae | | | | | | | | | | | 1 | 1 | | | | | | | | |
| | Cirratulidae | 4 | | 2 | | | 1 | 4 | 3 | | | 2 | | | | | 1 | | 4 | | |
| | Dorvilleidae | | | | | | | | | | | | | | | | | | | | |
| | Glyceridae | | | 1 | 3 | | 2 | 1 | | 1 | 4 | 1 | | | | 6 | 1 | | | 1 | |
| | Hesionidae | | | | | | | | | | | | | | | | | | | | |
| | Lumbrineridae | 2 | | 4 | | | 1 | | 1 | 1 | | 1 | | | | | 1 | 3 | | 6 | |
| | Magelonidae | | | | | | | | 12 | | | | | | 1 | | | | | | |
| | Maldanidae | | | | | | 8 | | | 1 | 1 | | 1 | | | | | 3 | 1 | 6 | |
| | Nephtyidae | | | | 1 | | 4 | 14 | 5 | 3 | | 2 | | | | 1 | 3 | 1 | 2 | 3 | |
| | Oenonidae | | | | | | | | | | | | | | | | | | | | |
| | Oligochaeta | 6 | | 12 | | | 18 | 9 | 1 | | | 12 | 1 | | | | 4 | 1 | 7 | 14 | |
| | Onuphidae | | | | | | | | | | | | | | | | | | | | |
| | Opheliidae | | | | | | | | | | | | | | | | | | | | 11 |
| | Orbiniidae | | | | | | | | 1 | 1 | | | | | | | | 1 | | | |
| | Oweniidae | | | 1 | | | 1 | | | | | | | | | | | | | | |
| | Paraonidae | | | | | | | | | | | | | | | | | | | | |
| | Pectinariidae | | | | | | | | | | | | | | | | | | | | |
| | Phyllodocidae | 1 | | 5 | | | | 1 | | 1 | | 2 | 1 | | | | 1 | 1 | | 10 | |
| | Pilargidae | | | | | | | | | | | | | | | | | | | | |
| | Polynoidae | 3 | | 1 | | | | | | | | | | | | | | | | | |
| | Sabellaridae | 1 | | 2 | | | | | | | | | | | | | | | | | |
| | Sigalionidae | | | | | | | | | | | | | | | | | | | 9 | 2 |
| | Sphaerodoridae | | | | | | | | | | | | | | | | | | | | |
| | Spionidae | 1 | 1 | 89 | | | | 1 | 1 | | | | | | | 2 | 1 | 1 | 1 | 4 | 2 |
| | Syllidae | 14 | | 12 | | | | 1 | | | | 1 | | | | | | | 2 | 5 | 4 |
| | Terebellidae | 2 | | 2 | | | | | | | | | | | | | | | 2 | 65 | 2 |

(continued)

**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** |
| Arthropoda | Ampeliscidae | 1 | | | | | 10 | 1 | | 49 | 69 | 59 | 68 | | | 1 | 100 | 245 | | | |
| | Anthuridae | | | | | | | | | | | | | 1 | | | | | | | |
| | Aoridae | 2 | | | | | | | | | | | | | | | | | | | |
| | Argissidae | | | | | | | | | | | | | | | | | | | | |
| | Bateidae | 2 | | | | | | | | | | | | | | | | | | | |
| | Bathyporeiidae | | | | | | | | 1 | | | | | | | | | | | | |
| | Bodotriidae | | | | | | | | | | | | | | | | | | | | |
| | Callianassidae | | | | | | | 1 | 1 | | | | | | | | | | | | |
| | Cancridae | | | 1 | | | | | | | | | | | | | | | | 1 | |
| | Caprellidae | 6 | | 1146 | | 1 | | 1 | | | | | | | | | | | | | |
| | Corophiidae | | | 2 | | | | | | | | | | | | | | | | | |
| | Diastylidae | | | | | | | | | | | | | 1 | | | | | | | |
| | Epialtidae | | | | 1 | | | | | | | | | | | | | | | | |
| | Haustoriidae | | | | | | | | 2 | | | | | 1 | 5 | 2 | | 1 | | | |
| | Idoteidae | | | | | | | | | | | | | | | | | | | | |
| | Inachoididae | | | 1 | | | | | | | | | | | | | | | | | |
| | Ischyroceridae | | | 20 | | | | | | | | | | | | | | | | | |
| | Janiridae | | | 1 | | | | | | | | | | | | | | | | | |
| | Leptocheliidae | | | | | | | | | | | | | | | | | | | | |
| | Liljeborgiidae | | | | | | | | | | | | | | | | | | | | |
| | Lysianassidae | 4 | | | | | | | | | | | | | | | | | | | |
| | Maeridae | | | 4 | | | | | | | | | | | | | | | | | |
| | Mysidae | | | | | | | | | | | | | | | | | | | | |
| | Oedicerotidae | | | | | | | 1 | | | | | | | | | | | | | |
| | Paguridae | 4 | | 34 | | | | | | 1 | | | 1 | | | | | | | | |
| | Parthenopidae | | | | | | | | | | | | | | | | | | | | |
| | Photidae | 3 | | 4 | | | | | | | | | | | | | | | | | |
| | Phoxocephalidae | 5 | | | | | | 2 | 3 | | | | | | 4 | | | | | | |
| | Pinnotheridae | | | | | | | | | | | 1 | | 1 | | | 2 | | | | |

(continued)

**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** |
| Arthropoda (cont'd) | Stenothoidae | 2 | | 10 | | | | | | | | | | | | | | | | | |
| | Tanaissuidae | | | | | | | | | | | | | | 11 | | | | | | |
| | Unciolidae | 2 | 1 | 3 | | | | | | | 1 | | | | 1 | | | | | 1 | |
| | Upogebiidae | | | | | | | | | | | | | | | | 1 | | | | |
| | Xanthidae | | | 1 | | | | | | | 1 | | | | | | | | | 4 | |
| Chordata | Harrimaniidae | | | | | | | | | | | | | | | | | | | | |
| Cnidaria | Alcyoniidae | | | | | | | | 1 | | | | | | | | | | | | |
| | Edwardsiidae | | | | | | | | | | | | | | | | | | | | |
| | Halcampidae | | | 1 | | | | | | | | | | | | | | | | 1 | |
| Echinodermata | Amphiuridae | | | | | | 2 | | 1 | | 1 | | | | | | | | | | |
| | Echinarachniidae | | | | | | | | | | | | | | | | | | | | |
| Mollusca | Acteocinidae | | | | | | 1 | | | 2 | 2 | | 2 | | | | | 10 | | | |
| | Arcidae | 6 | | | | | | | | | | | | | | | | | | 7 | |
| | Astartidae | | | | | | | | | | | | | | | | | | | | 6 |
| | Busyconidae | | | | | | | | | | | | | | | | | | | | |
| | Calyptraeidae | 13 | | 3 | | | | | | | 3 | | | | | 2 | | | | 18 | |
| | Cerithiopsidae | 1 | | | | | | | | | | | | | | | | | | | |
| | Chaetopleuridae | 1 | | | | | | | | | | | | | | | | | | 18 | |
| | Columbellidae | 30 | | 174 | 6 | | 1 | 6 | 1 | | 5 | | | | | | | | | | |
| | Corambidae | 1 | | | | | | | | | | | | | | | | | | | |
| | Crassatellidae | | | | | | | | | | | | | | | | | | | | |
| | Lyonsiidae | | | | | | 2 | | | 2 | | 4 | | | | | | 5 | | 16 | 1 |
| | Mactridae | | | | | | | | | | | | | | | 1 | | | | | 1 |
| | Mangeliidae | | | | | | | 1 | | | 1 | | | | | | | | | | |
| | Margaritidae | | | 1 | | | | | | | | | | | | | | | | 6 | |
| | Muricidae | | | | | | | | | | | | | | | | | | | | |
| | Myidae | | | | | | | | | | | | | | | | | | | | |
| | Mytilidae | | | 3 | | | | | | | | | | | | | | | | | |
| | Nassariidae | | | | | | 1 | 3 | 1 | 3 | 3 | 3 | 2 | | | | | | | | |

(continued)

**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** |
| Mollusca (cont'd) | Naticidae | | | | | | | 1 | | | | | | | | | | | | 6 | |
| | Nuculidae | | | | | | | | | | | | 1 | | | | | | | | |
| | Pandoridae | | | | | | 1 | | | | | | | | | | | | 1 | | |
| | Pectinidae | | | | | | | | | | | | | | | | | | | | |
| | Pharidae | | | | | | 3 | | 1 | 1 | 2 | | | | | | 3 | 2 | 1 | 1 | |
| | Pyramidellidae | | | 1 | | | 10 | | | 3 | 1 | | 2 | 1 | | | | | | 6 | |
| | Semelidae | | | | | | | | | | | | | | | | | | | | |
| | Tellinidae | 1 | | 1 | 10 | | 114 | 20 | 37 | 28 | 41 | 24 | 11 | 1 | 8 | 1 | 56 | 104 | 9 | 6 | |
| | Veneridae | | | | | | | 1 | | | | | | | | | | 1 | | | |
| | Yoldiidae | | | | | | | | | | | 1 | | | | | 1 | 2 | | | |
| Nematoda | Nematoda | 33 | 10 | 39 | 19 | 1 | 7 | 1 | | | 1 | 7 | | | 1 | 22 | 2 | 1 | 26 | 171 | 8 |
| Nemertea | Amphiporidae | 4 | | | 6 | | | | | | | | | | | | | 1 | | | |
| | Carinomidae | | | 2 | | | | | | | | | | | | | | | | | |
| | Lineidae | 1 | | | 1 | | | 1 | | 1 | | | | | | | | | | | |
| | Tetrastemmatidae | | | 3 | | | | | | | | | | | | | | | | | |
| | Tubulanidae | | | | | | 1 | | | | | | | | | | 2 | 1 | | | |
| Platyhelminthes | Turbellaria | | 1 | | | | | | | | | | | | | | | | | 1 | |

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**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **43** | **44** | **45** | **46** | **47** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** |
| Annelida | Ampharetidae | | | | | 2 | | 1 | 1 | | | | | | | | | | 3 | 3 | |
| | Archiannelida | | | | | | | | 14 | 15 | 21 | 13 | 6 | | 4 | | | | 22 | 11 | |
| | Capitellidae | 1 | | | | | 1 | | 4 | | | | 1 | 5 | | 2 | | 2 | 1 | | |
| | Chaetopteridae | | | | | | | | | | | | | | | | | | | | |
| | Cirratulidae | | 2 | | | 6 | | | 5 | 1 | | 7 | | 5 | 1 | 20 | | | | | |
| | Dorvilleidae | | 2 | | | | | | | | | 1 | 1 | 3 | | | | | 1 | | |
| | Glyceridae | | 2 | 2 | | | 1 | | | | 1 | | | | | | 4 | | | | |
| | Hesionidae | | | | | | | | | | | | | | | | | | | | |
| | Lumbrineridae | | | | | | | 3 | 1 | 2 | 5 | 1 | | | | | | | 2 | 5 | |
| | Magelonidae | | | | | | | | | | | | | 20 | | | | | | | |
| | Maldanidae | | | | | | | | | | 1 | 1 | 1 | | | | | | | 9 | |
| | Nephtyidae | | | | | | | | | | | | 6 | 10 | 3 | | | 1 | 2 | | |
| | Oenonidae | | | | | | | | | | | | | | | | | | | 1 | |
| | Oligochaeta | | 4 | | | 1 | | | 2 | 2 | 1 | 28 | 25 | 37 | | 9 | | 78 | 7 | 1 | |
| | Onuphidae | | | | | | | | | | | | | | | | | | | | |
| | Opheliidae | | | | | | | | | | | | | | | | 1 | | | | |
| | Orbiniidae | | | | | | | 1 | 2 | | 1 | 1 | | | | | | | | 1 | |
| | Oweniidae | | | | | | | | | | | | | | | | | | | | |
| | Paraonidae | | | | | | | | 2 | 2 | | 2 | 15 | | | 4 | | | 2 | | |
| | Pectinariidae | | | | | | | | | | | | | | | | | | | | |
| | Phyllodocidae | | | | | 5 | | | 2 | | | | | | | 1 | | 2 | | | |
| | Pilargidae | | | | | | | | | | | | | | | | | | | | |
| | Polynoidae | | | | | 4 | | | | | | | | | 1 | | | 1 | | | |
| | Sabellaridae | | | | | 50 | | | | | | | | | | | | 1 | | | |
| | Sigalionidae | | | 1 | 5 | 1 | | | | | | | | | | 1 | | | | | |
| | Sphaerodoridae | | | | | | | | | | | | 2 | | | | | | | | |
| | Spionidae | | 4 | | | 5 | | 1 | 1 | | | | 1 | 2 | | | | 1 | | | |
| | Syllidae | | 10 | 9 | 4 | 20 | | 5 | 2 | 2 | | 9 | 22 | 6 | | | 1 | 3 | | | |
| | Terebellidae | | 1 | 1 | | 6 | | | 1 | | | | | | | | | | | | |

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**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **43** | **44** | **45** | **46** | **47** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** |
| Arthropoda | Ampeliscidae | | | | | | | 16 | 19 | 11 | 30 | | | | | 1 | | | | 4 | |
| | Anthuridae | | | | | | | | | | | | | | | | | | | | |
| | Aoridae | | | | | 3 | | | | | | | | | | | | | | | |
| | Argissidae | | | | | | | | | | 1 | | | | | | | | | | |
| | Bateidae | | | | | | | | | | | | | | | | | | | | |
| | Bathyporeiidae | | | | | | | | | | | | | 7 | | | | | | | |
| | Bodotriidae | | | | | | | | | | | | | | | | | | | | |
| | Callianassidae | | | | | | | | | | | | | | | | | | | | |
| | Cancridae | | | | | | | | | | | | | | | | | | | | |
| | Caprellidae | | | | | | | | | | 1 | | | | 1 | | | | | 1 | |
| | Corophiidae | | | | | 1 | | | | | | | | | | | | | | | |
| | Diastylidae | | | | | | | | | | 1 | | | | | | | | | 1 | |
| | Epialtidae | | | | | | | | | | | | | | | | | | | | |
| | Haustoriidae | | | | | | | | | | | | | 16 | | | 5 | | | | |
| | Idoteidae | | | | | | | | | | | | | | | | | | | | |
| | Inachoididae | | | | | | | | | | | | | | | | | | | | |
| | Ischyroceridae | | | | | 1 | | | | | | | | | | | | | | | |
| | Janiridae | | | | | 2 | | | | | | | | | | | | 1 | | | |
| | Leptocheliidae | | | | | | | | | | | | | | | | | | | | |
| | Liljeborgiidae | | | | | | | | | | | | | | 1 | | | | | | |
| | Lysianassidae | | | | | 4 | | | | | | | | | | | | | | | |
| | Maeridae | | | | | | | | | | | | | | | | | | | | |
| | Mysidae | | | | | | | | | | | | | | | | | 3 | | | |
| | Oedicerotidae | | | | | | | | | | | 1 | | | 2 | | | | | | |
| | Paguridae | | | | | 35 | | | | | | | | | | | | | | | |
| | Parthenopidae | | | | | | | | | | | | | | | | | | | | |
| | Photidae | | | | | 5 | | | | | 1 | | | | | | | 8 | | 3 | |
| | Phoxocephalidae | | | | | 9 | | | 1 | 5 | 3 | 1 | | | 2 | 1 | | | | 1 | |
| | Pinnotheridae | | | | | | | | | | | | | | | | | | | | |

(continued)

**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
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| | | **43** | **44** | **45** | **46** | **47** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** |
| Arthropoda (cont'd) | Stenothoidae | | | | | 2 | | | | | | | | | | | | | | | |
| | Tanaissuidae | | | | | | | | | | | | 22 | 1 | | | | | | | |
| | Unciolidae | | | | | 24 | | | | | | | | | | | | | | | |
| | Upogebiidae | | | | | | | | | | | | | | | | | | | | |
| | Xanthidae | | | | | 1 | | | | | | | | | | | | 2 | | | |
| Chordata | Harrimaniidae | | | | | | | | | | | | | | | | | | | | |
| Cnidaria | Alcyoniidae | | | | | | | | | | | | | | | | | | | | |
| | Edwardsiidae | | | | | | | | | | | | | | | | | | | | |
| | Halcampidae | | | | | | | | | | | | | | | | | | | | |
| Echinodermata | Amphiuridae | | | | | | | | | | | | | | | | | | | | |
| | Echinarachniidae | | | | | | | | | 1 | | | 5 | 5 | | | | | | | |
| Mollusca | Acteocinidae | | | | | | | | | | | | | | | | | | | | |
| | Arcidae | | | | | 1 | | | | | | | | | | | | | | | |
| | Astartidae | | 2 | 15 | 15 | | | | | | | | | | | | | | 1 | | |
| | Busyconidae | | | | | | | | | | | | | | | | | | | | |
| | Calyptraeidae | | | | | 9 | | | | | | | | | | | | 32 | | | |
| | Cerithiopsidae | | | | | | | | | | | | | | | | | 1 | | | |
| | Chaetopleuridae | | | | | 1 | | | | | | | | | | | | | | | |
| | Columbellidae | | 1 | | | 71 | | | | | | | | | | | | 10 | | | |
| | Corambidae | | | 1 | | 4 | | | | | | | | | | | | | | | |
| | Crassatellidae | | | 1 | | | | | | | | | | | | | | | | | |
| | Lyonsiidae | | | | | | | | | | | | | 2 | | | | | | | |
| | Mactridae | | | 2 | 24 | | | | 1 | | 1 | | | 1 | | | | | | | |
| | Mangeliidae | | | | | | | | | | | | | | | | | | | | |
| | Margaritidae | | | | | 1 | | | | | | | | | | | | | | | |
| | Muricidae | | | | | | | | | | | | | | | | | 2 | | | |
| | Myidae | | | | | | 1 | | | | | | | | | | | | | | |
| | Mytilidae | | | 1 | 1 | | | | | | | | | | | | | | | | |
| | Nassariidae | | | | | | | | 1 | | | | | | | | | | | | |

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**Appendix Table A. (Continued)**

| | | Station | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **43** | **44** | **45** | **46** | **47** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** |
| Mollusca (cont'd) | Naticidae | | | | | | | | | | | | | | | | | | | | |
| | Nuculidae | | | | | | | 3 | 17 | | 8 | 3 | | | | 2 | | | | 10 | 2 |
| | Pandoridae | | | | | | | | | | | | | 1 | | | | | | | |
| | Pectinidae | | | | | | | | | | | | | | | | | | | | |
| | Pharidae | | | | | | | | | | | | 1 | | 1 | | | | | | |
| | Pyramidellidae | | | 2 | | 12 | | | | | 1 | | | | | 1 | 1 | 17 | | | |
| | Semelidae | | | | | | | | | | | | | | | | | | | | |
| | Tellinidae | | 1 | | | 1 | | 1 | | 1 | | | 1 | 2 | 3 | 4 | 2 | | 1 | | |
| | Veneridae | | | | | | | | | | 1 | | | | | | | | | | |
| | Yoldiidae | | | | | | | | | | | | | | | | | | | 1 | 4 |
| Nematoda | Nematoda | 1 | 9 | 3 | 4 | 28 | 1 | 9 | 13 | 38 | 5 | 26 | 202 | 51 | 1 | 5 | 16 | 177 | 34 | 3 | 1 |
| Nemertea | Amphiporidae | | | | | 6 | | | | | | | | | 1 | | | 1 | | | |
| | Carinomidae | | | | | | | 1 | | | 3 | | | | | | | | | | |
| | Lineidae | | | | | | | | | | | | | | | | | | | | |
| | Tetrastemmatidae | | | | | | | | | | | | | | | | | | | | |
| | Tubulanidae | | | | | 2 | | | | | | | | | | | | | | | |
| Platyhelminthes | Turbellaria | | | | | | | | | | | 3 | | 2 | | | | | | | |

3. CR Environmental 2018 Underwater Video Review

CR ENVIRONMENTAL, INC.

Ecological and Oceanographic Consultants

**MEMORANDUM**

**Date: July 12, 2018**

**To: Jeff Gardner, GEO SUBSEA**

**From: CR Environmental, Inc., 639 Boxberry Hill Road, East Falmouth, MA 02536**

**Re: Underwater Video Review Vineyard Wind Project, Proposed Export Cable Corridor, Nantucket Sound and Atlantic Ocean**

CR Environmental, Inc. reviewed underwater video collected from 37 transects along the proposed Vineyard Wind corridors within Nantucket Sound and the Atlantic Ocean (Figure 1 - Export Cable Corridor). Video transect review included:

- Identification of the dominant fauna and its relative abundance,
- Bottom habitat classification based on Auster (1998),
- MA CZM modified Barnhardt et al. (1998) bottom type classification.
- The potential for Special, Sensitive or Unique Resources, and
- Presence/absence data for biota observed.

Auster (1998) developed a hierarchical approach for classifying marine bottom habitats in the outer continental shelf of the northwest Atlantic. Sediments are classified along a gradient of grain sizes from mud to boulders. The eight general habitat categories are ranked by Auster (1998) based on their complexity and effectiveness in providing habitat, attachment surfaces and shelter for a variety of marine plants and animals. Those with the *highest rankings are pebble-cobble with sponge, partially buried or dispersed boulders and piled boulders* (Table 1). The various forms these bottom habitats take and the infauna and epifauna associated with the sediments produce a wide diversity of habitat types for fish and associated fauna.

The bottom classifications based on a MACZM modified Barnhardt et al. (1998) sediment classification scheme are: Fine, Fine with Gravel, Fine with Rock, Gravel with Fine, Gravel, Gravel with Rock, Rock with Fine, and Rock.

Massachusetts CZM Special, Sensitive or Unique Resources (SSUs) include resources such as eelgrass beds and hard complex bottom (Figure 1).

**RESULTS**

Each of the 37 video transects were approximately fifteen minutes in length. Table 2 provides the primary bottom habitat classification observed at each video transect based on Auster (1998) (Table 1). A secondary bottom classification is provided for alternate bottom types observed over at least 25% of the video based on time lapse. Otherwise no secondary bottom class is reported. In addition, Table 2 provides MACZM's modified Barnhardt et al. (1998) sediment classification scheme, the dominant faunal species observed, and identifies transects where Special, Sensitive or Unique Areas (SSUs) may be present. The centroid coordinates for each transect and water depth in meters below mean lower low water (MLLW) at each centroid is also provided.

A list of flora and fauna observed by transect along with summary statistics of species richness by transect and frequency across transects are provided on Table 3.

The primary bottom classification (Auster 1998) for each video transect along the Export Cable Corridor is graphically represented on Figure 2. Figure 3 is a graphical representation of the dominant fauna observed on each transect.

<u>Bottom Habitat Classification Results</u>

- Approximately 67% of transects predominantly along the northern and southern portions of the Export Cable Corridor consisted of low complexity bottom habitats with a primary bottom classification of Flat Sand Mud, Sand Waves, or Biogenic Structures (Figure 2). At these stations, the fewest invertebrate species and only rare observations of fish were recorded. Areas of observed Sand Waves were the least productive of all habitats. Note that the number of transects identified as having sand waves may be underestimated as they were difficult to detect on the underwater video. Project side scan records may more accurately detect their presence.

- Shell Aggregate bottom was observed as the primary or secondary habitat at 10 Transects or 27%.

- Pebble Cobble bottom was observed as a component of the primary or secondary habitat at 9 transects or 24%.

- Higher complexity bottom types included, Pebble Cobble with Sponge observed at T-48, T-52, T-54, and T-55, and Partially Buried or Dispersed Boulders observed at T-49 and T-75. No Piled Boulders or Rock Ledge bottom habitat was observed along the video transects.

- The most productive transects with the highest number of invertebrate species and observations of fish tended to be in areas with large colonies of sulfur sponge and in areas with partially buried or dispersed boulders in the vicinity of Muskeget Channel.

- Three transects with Pebble Cobble with Sponge (sulfur sponge) bottom habitat (T-48, T-52, and T-54), one transect T-75 with dispersed boulders and blue mussels have been flagged as potential Special, Sensitive, or Unique Areas (SSUs) because of their biological communities, vertical relief and energetic stability. The *possible* SSU designation was based on the complexity of bottom habitat and the observation of more abundant biota along these transects.

  Sulfur sponge starts growing on shells and small pebbles that eventually dissolve. Many times these large colonies of sulfur sponge were 3 to 4 feet in height and were not associated with any cobble or boulder bottom appearing to grow right out of the sand. These large colonies were usually found in high current areas and appeared to provide good fish habitat.

- Floating eelgrass strands were observed at five transects (14%), however, no eelgrass SSUs were identified. At T-52, rooted eelgrass was initially recorded. However, upon further observation, the strands were determined to be dead eelgrass that had became embedded in shell or pebbles on the bottom. These observations were also confirmed by the black blade color and the water depths in excess of 30 feet. No eelgrass beds with dense eelgrass growth were observed during the survey.

<u>Biota Results</u>

In addition to the dominant habitats listed in Table 2, the dominant fauna at each transect are listed. Four-eyed amphipods and slipper limpets were the dominant species at 7 transects (19%), and sulfur sponge at 5 transects (14%). The remaining dominant species at 2-3 transects were sedentary polychaetes, knobbed whelk, red beard sponge, four-eyed amphipods, bryozoans, burrowing anemones, and sand dollars.  Blue mussel, spider crabs, and plumed worms were dominant at only one transect. Burrowing anemones and sand dollar were dominant in deeper waters at the southern end of the Export Cable Corridor.

Table 3 is a list of invertebrates, fish, and algal species found at each transect, species richness for each transect, and species percent frequency across the 37 transects of the Export Cable Corridor.

- A total of 29 invertebrates, 4 fish, and approximately 4 algal species were observed during the video review.

- Three transects ( T-49, T-52, T-54) all within the Muskeget Channel had the greatest species richness (8-9 faunal species)

- Frequencies along the corridor of over 20% were observed for: three invertebrate species: red beard sponge, encrusting bryozoan, and sedentary polychaetes; and the algae: dead man's fingers, *Sargassum*, and branching red algae.

  Red branching algae was observed at 49% of the transects and this general classification represents 4 to 5 different species of bushy red seaweeds 1-2 feet in length and 2 to 3 species of tuft-like algae 3-4 inches in height that were attached to pebble-cobbles and shell.

- Commercial species: Knobbed whelks and their egg cases were the only commercial invertebrate species recorded in significant numbers. Bay scallops, blue mussels, rock crabs, and Jonah crabs were observed in low numbers. Sea scallop shells were noted at a few stations but these are likely associated with shucking outside the harbor entrances. Of the commercial fish species observed: scup, black sea bass, and red hake; only scup were noted at a significant number of transects (19%).

<u>General Observations along the Proposed Export Cable Corridor</u>

- The more complex and species rich habitats, Pebble Cobble with Sponge and areas of Partially Buried Boulders or Dispersed Boulders tend to be found within the higher currents of Muskeget Channel.

- Offshore at the southern end of the proposed Export Cable Corridor there were a variety of species associated with deeper water including sand dollars, burrowing anemones and mysid shrimp.

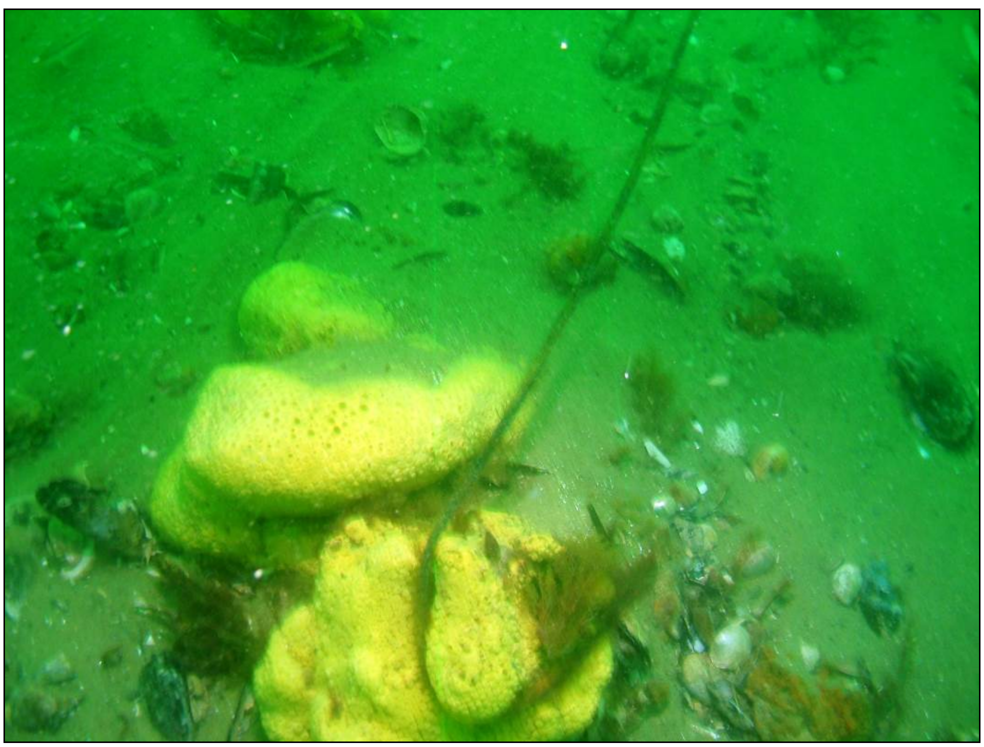
<u>References</u>

Auster, P.J. 1998. *The conceptual model of the impacts of fishing gear on the integrity of fish habitat.* Conservation Biology V12 (6): 1198-1203.

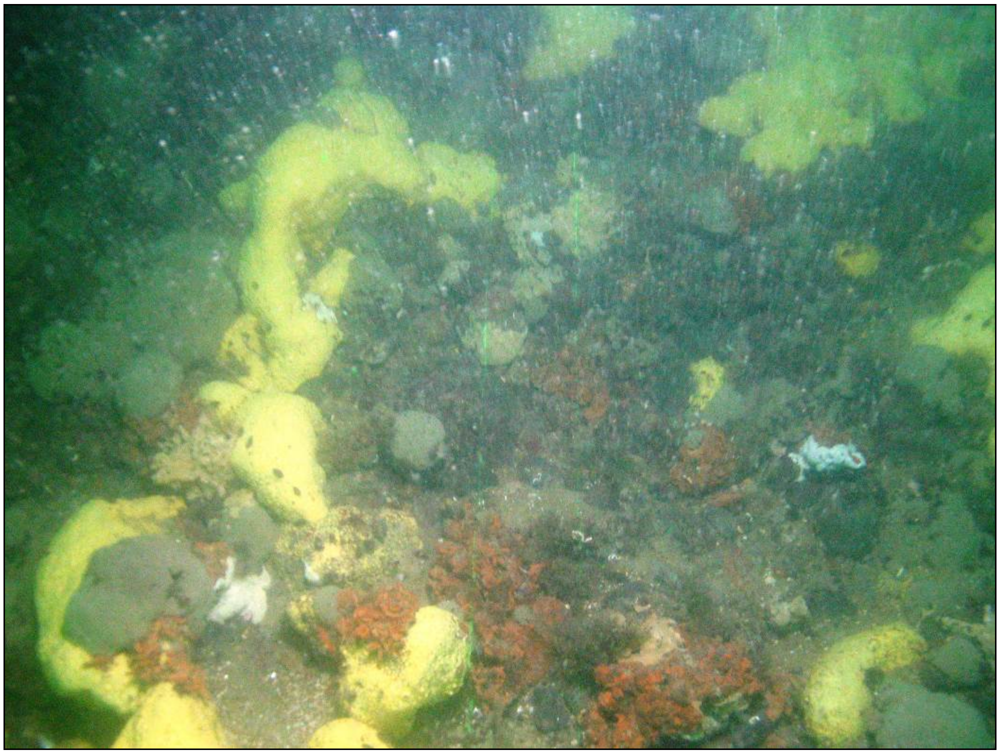
Barnhardt, W.A., J.T. Kelley, S.M. Dickson, and D.F. Belknap. 1998. *Mapping the Gulf of Maine with Side-Scan Sonar: A New Bottom-Type Classification for Complex Seafloors.* Journal of Coastal Research.14(2): 646-659.

**Screen Captures of Bottom Classifications (Auster, 1998) in Areas of Potential SSUs**

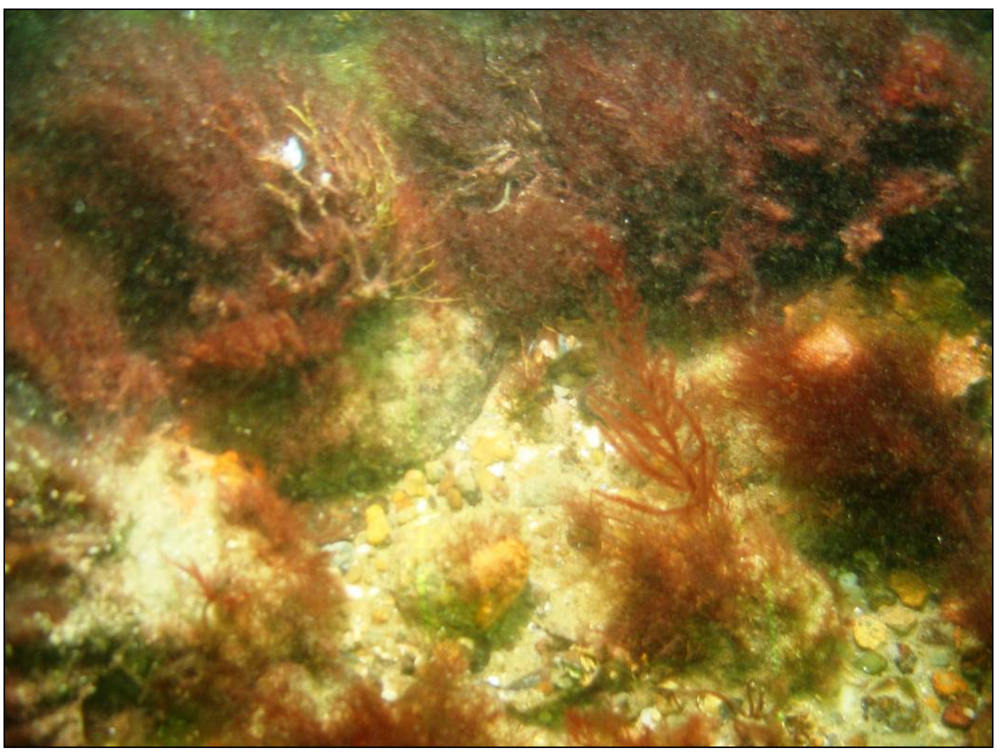
**Transect 48 –** The primary bottom classification was pebble cobble with sponge, with some large sulfur sponge (*Cliona celata*) colonies, common sea stars (*Asterias forbesi*), hydroids and abundant attached red and brown algae.



**Transect 52 –** Flat sand, Mud/Pebble cobble was the primary bottom classification and Pebble cobble with sponge (*Cliona celata*) was the secondary bottom classification. Black sea bass, blue mussels, sand sponge (*Amaroucium* sp.), hermit crabs and hydroids were present.



**Transect 54 –** The primary bottom classification was Pebble cobble with sponge, and secondary of Flat sand, Mud/Pebble cobble. Present were sulfur sponge, red beard sponge (*Microciona prolifera*), sand sponge, bread crumb sponge (*Holichondria panacea*) black sea bass, and common sea star.



**Transect 75 –** The primary bottom classification was Flat sand, Mud/ Pebble cobble with a secondary classification of partially buried or dispersed boulders. Present were bread crumb and red beard sponges, bryozoans, hydroids, slipper limpets, hermit crabs, purple sea urchin, and branching red algae.

**TABLE 1. Bottom Habitat Classification (Auster, 1998)**

| Habitat Category | Description | Rationale | Complexity Score |
|---|---|---|---|
| 1 | Flat sand/mud | Areas with no vertical structure such as depressions, ripples or epifauna | 1 |
| 2 | Sand waves | Troughs provide shelter from current; previous observations indicate that species such as red hake hold position on the downcurrent sides of sand waves and ambush drifting demersal zooplankton and shrimp | 2 |
| 3 | Biogenic structures | Burrows, depressions, cerianthid anemones, hydroid patches; features that are created or used by mobile fauna for shelter | 3 |
| 4 | Shell aggregates | Provide complex interstitial spaces for shelter; also provide a complex, high-contrast background that may confuse visual predators | 4 |
| 5 | Pebble-cobble | Provide small interstitial spaces and may be equivalent in shelter value to shell aggregate, but less ephemeral than shell | 5 |
| 6 | Pebble-cobble with sponge cover | Attached fauna such as sponges provide additional spatial complexity for a wider range of size classes of mobile organisms | 10 |
| 7 | Partially buried or dispersed boulders | Partially buried boulders exhibit high vertical relief; dispersed boulders on cobble pavement provide simple crevices; the shelter value of this type of habitat may be less or greater than previous types based on the size class and behavior of associated species | 12 |
| 8 | Piled boulders | Provide deep interstitial spaces of variable sizes | 15 |

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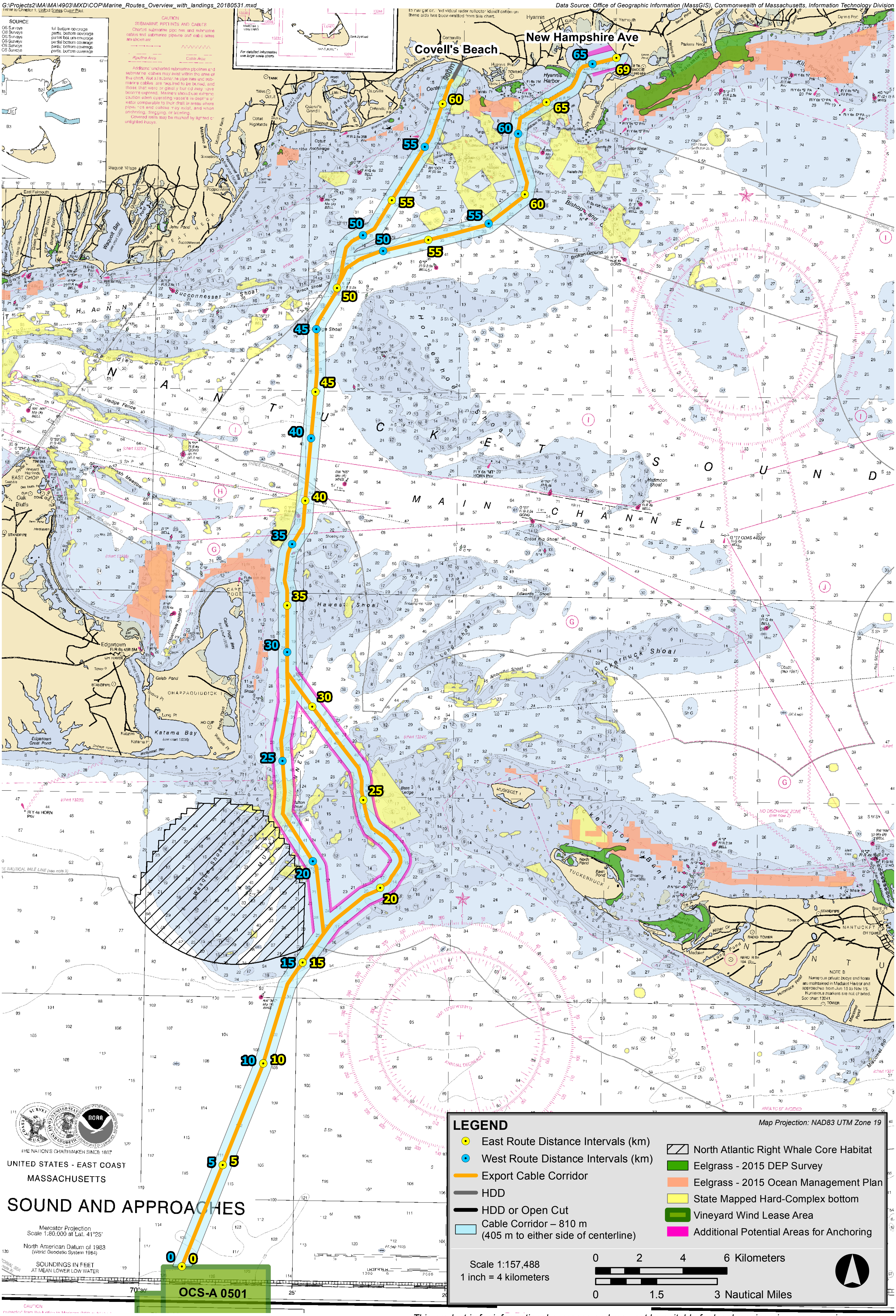
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



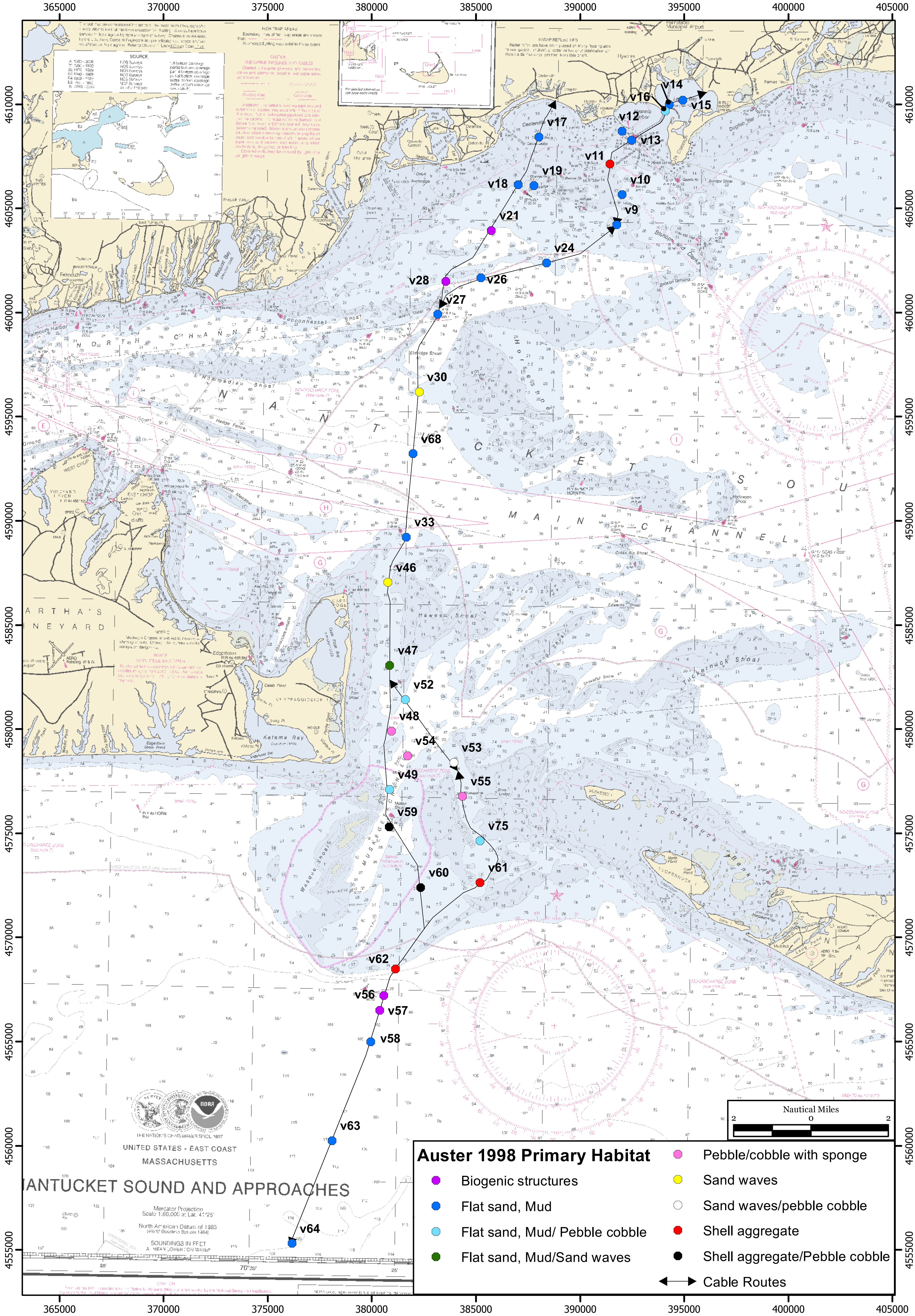

*This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.*

**Vineyard Wind Project**

VINEYARD WIND

**Figure 1**

*Export Cable Corridor*




| Transect Primary Habitat Classification (Auster, 1998)<br>Vineyard Wind Project<br>Nantucket Sound and Atlantic Ocean | N W E S |
|---|---|
| NOTES:<br>1) Underwater video data collected September 1-9, 2017.<br>2) Grid: UTM, Zone 19N, NAD83, metric. | Figure 2 |

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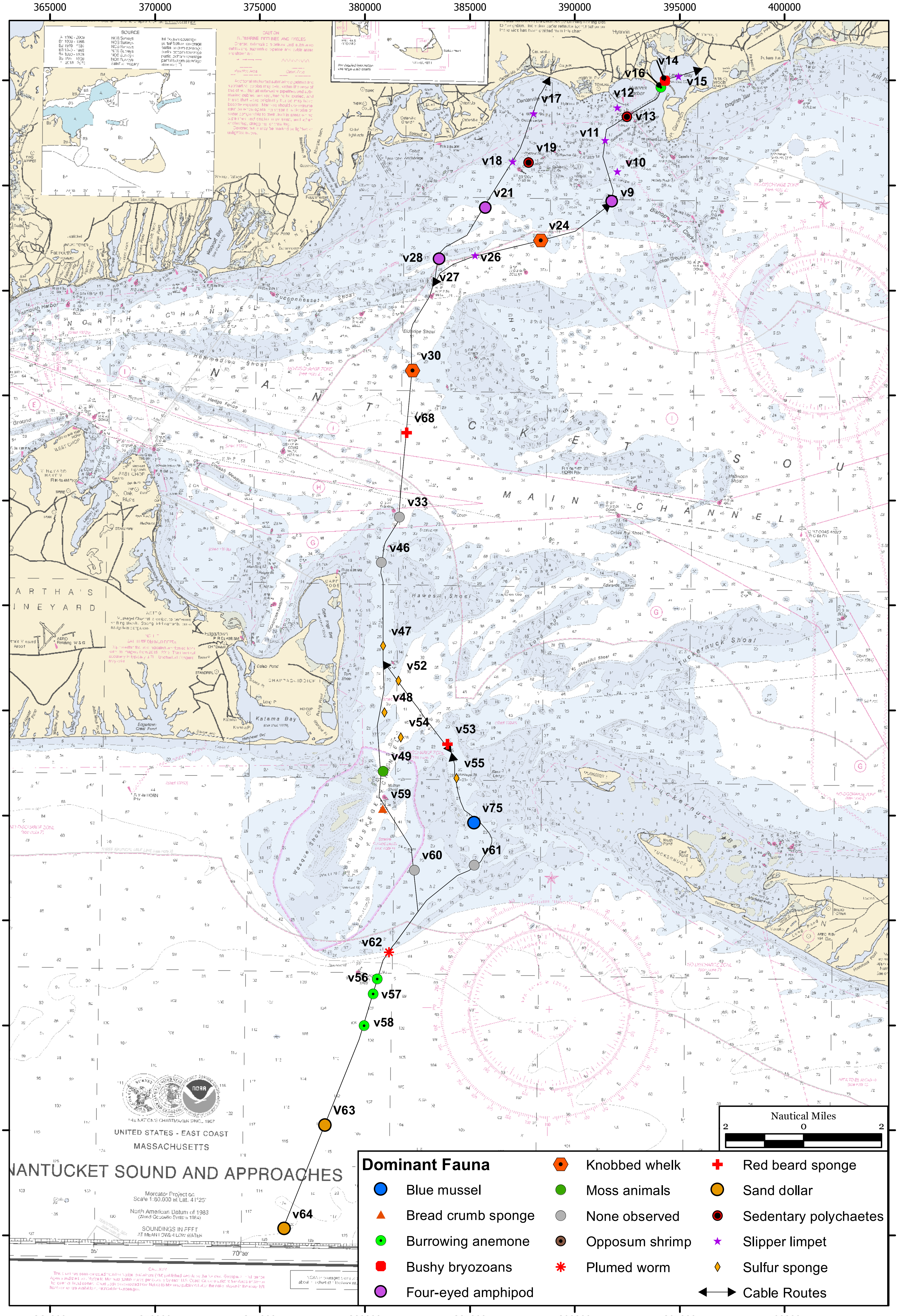


Transect Dominant Species
Vineyard Wind Project
Nantucket Sound and Atlantic Ocean

NOTES:
1) Underwater video data collected September 1-9, 2017.
2) Grid: UTM, Zone 19N, NAD83, metric.

Figure 3

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| Transect ID | POINT_X[2] | POINT_Y[2] | Dominant_Fauna | | Abundance of Dominant Spp. | Auster (1998) - primary | Auster (1998) -secondary[3] | CZM - Barnhardt et. al (1998) | Eelgrass | SSUs[5] | Depth (m) Below MLLW [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 391766 | 4604244 | Four-eyed amphipod | *Ampelisca sp.* | Rare | Flat sand, Mud | | Fine | Absent | Absent | 6.49 |
| 10 | 392025 | 4605680 | Slipper limpet | *Crepidula fornicata* | Occasional | Flat sand, Mud | Shell aggregate/ Pebble cobble | Fine | Absent | Absent | 7.58 |
| 11 | 391450 | 4607157 | Slipper limpet | *Crepidula fornicata* | Abundant | Shell aggregate | | Fine | Absent | Absent | 5.54 |
| 12 | 392033 | 4608726 | Slipper limpet | *Crepidula fornicata* | Common | Flat sand, Mud | Shell aggregate | Fine | Absent | Absent | 4.48 |
| 13 | 392485 | 4608287 | Sedentary polychaetes[1] | Polychaeta | Occasional | Flat sand, Mud | | Fine | Absent | Absent | 5.19 |
| 14 | 394296 | 4610004 | Bushy bryozoans | *Bryozoa* | Rare | Flat sand, Mud | | Fine | Floating strands | Absent | 2.37 |
| 15 | 394948 | 4610218 | Slipper limpet | *Crepidula fornicata* | Occasional | Flat sand, Mud | | Fine | Absent | Absent | 3 |
| 16 | 394106 | 4609686 | Burrowing anemone | *Cerianthus borealis* | Occasional | Flat sand, Mud/Pebble cobble | | Fine with gravel | Absent | Absent | 2.63 |
| 17 | 388032 | 4608443 | Slipper limpet | *Crepidula fornicata* | Abundant | Flat sand, Mud | Flat sand, Mud/Shell Aggregate | Fine | Floating strands | Absent | 4.78 |
| 18 | 387047 | 4606148 | Slipper limpet | *Crepidula fornicata* | Common | Flat sand, Mud | Flat sand, Mud/Shell Aggregate | Fine | Absent | Absent | 4.92 |
| 19 | 387791 | 4606115 | Sedentary polychaetes | *Polychaeta* | Common | Flat sand, Mud | Sand ripples | Fine | Absent | Absent | 3.31 |
| 21 | 385748 | 4603955 | Four-eyed amphipod | *Ampelisca sp.* | Common | Biogenic structures | | Fine | Absent | Absent | 9.54 |
| 24 | 388388 | 4602405 | Knobbed whelk | *Busycon carica* | Occasional | Flat sand, Mud | Sand ripples | Fine | Absent | Absent | 8.89 |
| 26 | 385245 | 4601687 | Slipper limpet | *Crepidula fornicata* | Abundant | Flat sand, Mud | Flat sand, Mud/Shell Aggregate | Fine | Absent | Absent | 11.78 |
| 27 | 383168 | 4599929 | Spider crab | *Lubinia emarginata* | Rare | Flat sand, Mud | Biogenic structures | Fine | Absent | Absent | 15.54 |
| 28 | 383556 | 4601512 | Four-eyed amphipod | *Ampelisca sp.* | Common | Biogenic structures | Flat sand, Mud/Biogenic structures | Fine | Absent | Absent | 6.7 |
| 30 | 382278 | 4596201 | Knobbed whelk | *Busycon carica* | Rare | Sand waves[4] | Flat sand, Mud | Fine | Absent | Absent | 8.88 |
| 33 | 381657 | 4589231 | None observed | | | Flat sand, Mud | Sand ripples | Fine | Absent | Absent | 9.34 |
| 46 | 380780 | 4587057 | None observed | | | Sand waves | Flat sand, Mud | Fine | Absent | Absent | 7.33 |
| 47 | 380869 | 4583082 | Sulfur sponge | *Cliona celata* | Occasional | Flat sand, Mud/Sand waves | Pebble cobble | Fine with gravel | Absent | Absent | 8.6 |
| 48 | 380944 | 4579925 | Sulfur sponge | *Cliona celata* | Abundant | Pebble/cobble with sponge | | Gravel with rock | Absent | **Possible** | 9.54 |
| 49 | 380872 | 4577119 | Moss animals | *Bryozoa* | Common | Flat sand, Mud/Pebble cobble | Flat sand, Mud/Partially buried or dispersed Boulders | Fine with rock | Absent | Absent | 29.8 |
| 52 | 381615 | 4581435 | Sulfur sponge | *Cliona celata* | Abundant | Flat sand, Mud/Pebble cobble | Pebble cobble with sponge | Fine with gravel | Floating strands | **Possible** | 12.49 |
| 53 | 383940 | 4578412 | Red beard sponge | *Microciona prolifera* | Occasional | Sand waves/Pebble cobble | | Fine with gravel | Floating strands | Absent | 11.8 |
| 54 | 381719 | 4578731 | Sulfur sponge | *Cliona celata* | Abundant | Pebble/cobble with sponge | Flat sand, Mud/Pebble/cobble | Fine with gravel | Absent | **Possible** | 14.69 |
| 55 | 384360 | 4576786 | Sulfur sponge | *Cliona celata* | Abundant | Pebble/cobble with sponge | Flat sand, Mud/Pebble cobble | Fine with gravel | Absent | Absent | 9.98 |
| 56 | 380583 | 4567222 | Burrowing anemone | *Cerianthus borealis* | Occasional | Biogenic structures | | Fine | Absent | Absent | 29.6 |
| 57 | 380394 | 4566508 | Burrowing anemone | *Cerianthus borealis* | Common | Biogenic structures | | Fine | Absent | Absent | 30.32 |
| 58 | 379964 | 4564996 | Burrowing anemone | *Cerianthus borealis* | Common | Flat sand, Mud | | Fine | Absent | Absent | 32.7 |
| 59 | 380844 | 4575326 | Bread crumb sponge | *Halichondria panicea* | Common | Shell aggregate/Pebble cobble | | Fine with gravel | Absent | Absent | 14.6 |
| 60 | 382351 | 4572408 | None observed | | | Shell aggregate/Pebble cobble | | Fine with gravel | Absent | Absent | 9.35 |
| 61 | 385204 | 4572643 | None observed | | | Shell aggregate | | Fine | Absent | Absent | 6.76 |
| 62 | 381142 | 4568488 | Plumed worm | *Diopatra cuprea* | Rare | Shell aggregate | | Fine | Absent | Absent | 12.49 |
| 63 | 378105 | 4560247 | Sand dollar | *Echinoarachnius parma* | Abundant | Flat sand, Mud | | Fine | Absent | Absent | 33.92 |
| 64 | 376170 | 4555316 | Sand dollar | *Echinoarachnius parma* | Abundant | Flat sand, Mud | | Fine | Absent | Absent | 37.86 |
| 68 | 381988 | 4593233 | Red beard sponge | *Microciona prolifera* | Rare | Flat sand, Mud | | Fine | Absent | Absent | 10.04 |
| 75 | 385212 | 4574654 | Blue mussel | *Mytilis edulis* | Common | Flat sand, Mud/Pebble cobble | Partially buried or dispersed Boulders | Fine with gravel | Floating strands | **Possible** | 7.12 |

**References:**

Auster, P.J. 1998. The conceptual model of the impacts of fishing gear on the integrity of fish habitat. Conservation Biology V12 (6): 1198-1203.

Barnhardt, W.A., J.T. Kelley, S.M. Dickson, and D.F. Belknap. 1998. Mapping the Gulf of Maine with Side-Scan Sonar: A New Bottom-Type Classification for Complex Seafloors. Journal of Coastal Research.14(2): 646-659.

**Notes:**

1) Sedentary polychaetes = observed worm holes
2) Location coordinates and depth in meters below MLLW are at the centroid of the ~ 15 minute video transects
3) A secondary bottom classification for transects is provided for alternate bottom types observed over at least ~25% of the video based on time lapse. Otherwise none is reported.
4) Sand waves not always able to be detected on video segments refer to side scan record
5) Designation of possible SSUs based on complexity of bottom habitat and the presence of more abundant biota

| TRANSECT ID | | T-9 | T-10 | T-11 | T-12 | T-13 | T-14 | T-15 | T-16 | T-17 | T-18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAUNA** | | | | | | | | | | | |
| **PORIFERA** | | | | | | | | | | | |
| Bread crumb sponge | *Halichondria panicea* | | | | | | X | | | | |
| **Red beard sponge[3]** | *Microciona prolifera* | | X | | | | | | | | |
| Sulfur sponge | *Cliona celata* | | | | | | | | | | |
| | | | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | | | |
| Bell shaped jellyfish | | | | | | | | | | | |
| Burrowing anemone | *Cerianthus borealis* | | | | | | | | | | |
| Star Coral | *Astrangia poculata* | | | | | | | | | | |
| Hydroid | Hydrozoa | | | | | | | | | | |
| | | | | | | | | | | | |
| **CTENOPHORA** | Ctenophora | | | | | | | | | | |
| | | | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | | | |
| Bushy bryozoan | Bryozoa | | | | | | X | | | | |
| **Encrusting bryozoan** | *Schizoporella unicornis* | | X | X | X | X | | | X | | X |
| | | | | | | | | | | | |
| **MOLLUSCA** | | | | | | | | | | | |
| Bay Scallop | *Argopecten irradians* | | | | | | | X | | X | |
| Blue mussel | *Mytilis edulis* | | | | | | | | | | |
| Knobbed whelk*[1] | *Busycon carica* | | X | | | | | | X | | |
| Knobbed whelk egg case* | *Busycon carica* | | X | | | | | | | | |
| Moon snail | Naticidae | | | | | | | | | | |
| Slipper limpet | *Crepidula fornicata* | | X | X | X | | X | X | X | | |
| Threeline Mudsnail | *Ilyanassa trivittata* | X | | | | | | | | | |
| | | | | | | | | | | | |
| **ANNELIDA** | | | | | | | | | | | |
| **Polychaeta** | | | | | | | | | | | |
| Lug worm | *Arenicola sp.* | | | | | | X | | | | X |
| Plumed worm | *Diopatra cuprea* | | | | | | | | | X | |
| **Sedentary polychaetes** | Polychaeta | X | | | | X | | | | | X |
| | | | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | | | |
| **Crustacea** | | | | | | | | | | | |
| Barnacle | *Balanus* sp. | | | | | | | | X | | |
| Four-eyed amphipod | *Ampelisca sp.* | X | | | | | | | | | |
| Hermit crab | *Pagurus sp.* | X | | | | | | X | | | X |
| Jonah crab* | *Cancer borealis* | | | | | | | | | | |
| Mysid shrimp | Mysids | | | | | | | | | | |
| Rock crab | *Cancer irroratus* | | | | | | | | | | |
| Spider crab | *Lubinia emarginata* | | X | | | | | | | | |
| **Echinoderms** | | | | | | | | | | | |
| Common sea star | *Asterias forbesi* | | | | | | | | | | |
| Sand dollar | *Echinarachnius parma* | | | | | | | | | | |
| Purple sea urchin | *Arbacia punctulata* | | | | | | | | | | |
| | | | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | | | |
| Little Skate egg case* | *Raja erinacea* | | | | | | | | | | |
| Little Skate* | *Raja erinacea* | | | | | | | | | X | |
| **Osteichthyes** | | | | | | | | | | | |
| Black sea bass* | *Centropristis striata* | | | | | | | | | | |
| Red Hake* | *Urophycis chuss* | | | | | | | | | | |
| Scup* | *Stenotomus chrysops* | X | X | | | | | | | | |
| | | | | | | | | | | | |
| **CHORDATA** | | | | | | | | | | | |
| Sand Sponge | *Amaroucium sp.* | | | | | | | | | | |
| White invasive tunicate | *Didemnum candidum* | | | | | | | | | | |
| **SPECIES RICHNESS FAUNA[2]** | | 5 | 7 | 2 | 2 | 2 | 4 | 3 | 5 | 3 | 4 |
| | | | | | | | | | | | |
| **FLORA** | | | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | | | |
| **Dead Man's Fingers** | *Codium fragile* | | X | X | X | X | X | X | X | X | X |
| Sea Lettuce | *Ulva lactuca* | | | | X | | | | | | |
| | | | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | | | |
| Rockweed | *Fucus* sp. | | | | | X | | | | | X |
| **Sargassum** | *Sargassum sp.* | | X | X | X | X | X | | X | X | |
| | | | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | | | |
| **Branching red alga** | Rhodophyta | X | X | X | X | | | X | X | X | X |
| **SPECIES RICHNESS FLORA[2]** | | 1 | 3 | 3 | 4 | 3 | 2 | 2 | 3 | 3 | 3 |
| **Water depth (m) below MLLW at transect centroid** | | 6.49 | 7.58 | 5.54 | 4.48 | 5.19 | 2.37 | 3 | 2.63 | 4.78 | 4.92 |

**Notes:**

**1) An * designates species selected for assessment of 'important fish resource areas' an SSU under the Mass. Ocean Management Plan**

**2) Species Richness = the total number of species observed**

**3) Species with a frequency across all transects greater than 20% are bolded and shaded**

| **TRANSECT ID** | **T-19** | **T-21** | **T-24** | **T-26** | **T-27** | **T-28** | **T-30** | **T-33** | **T-47** | **T-48** | **T-49** | **T-52** | **T-53** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAUNA** | | | | | | | | | | | | | |
| **PORIFERA** | | | | | | | | | | | | | |
| Bread crumb sponge | | | | | | | | | | | X | | |
| **Red beard sponge**[3] | | | | | | | X | | | | X | | X |
| Sulfur sponge | | | | | | | | | X | X | X | X | |
| | | | | | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | | | | | |
| Bell shaped jellyfish | | | | | | X | | X | | | | | |
| Burrowing anemone | | | | | | X | | | | | | | |
| Star Coral | | | | | | | | | | | | | |
| Hydroid | | | | | | | | | | X | X | X | X |
| | | | | | | | | | | | | | |
| **CTENOPHORA** | | | | | | | | X | | X | | X | |
| | | | | | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | | | | | |
| Bushy bryozoan | | | | | | | | | | | X | | X |
| **Encrusting bryozoan** | | | | X | | | | | X | X | X | X | X |
| | | | | | | | | | | | | | |
| **MOLLUSCA** | | | | | | | | | | | | | |
| Bay Scallop | | | | | | | | | X | | | | |
| Blue mussel | | | | | | | | | | | | X | |
| Knobbed whelk*[1] | | | X | | | | X | | | | | | |
| Knobbed whelk egg case* | | X | | | | | | | | | | | |
| Moon snail | | | | | | | | | | | | | |
| Slipper limpet | | | | | | | | | | | | | |
| Threeline Mudsnail | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **ANNELIDA** | | | | | | | | | | | | | |
| **Polychaeta** | | | | | | | | | | | | | |
| Lug worm | | | | | | | | | | | | | |
| Plumed worm | | | | | | | | | | | | | |
| **Sedentary polychaetes** | X | X | | X | X | X | | | | | | | |
| | | | | | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | | | | | |
| **Crustacea** | | | | | | | | | | | | | |
| Barnacle | | | | | | | | | | | X | | X |
| Four-eyed amphipod | | | | | X | | | | | | | | |
| Hermit crab | | | X | | | | | | | | | X | |
| Jonah crab* | | | | | | | | | | | | | |
| Mysid shrimp | | | | | | | | | | | | | |
| Rock crab | | | | | | | | | | | | | X |
| Spider crab | | | | | X | | | | | | | | |
| **Echinoderms** | | | | | | | | | | | | | |
| Common sea star | | | | | | | | | | X | | | |
| Sand dollar | | | | | | | | | | | | | |
| Purple sea urchin | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | | | | | |
| Little Skate egg case* | | | | | | | | | | | | | |
| Little Skate* | | | | | X | | | | | | | | |
| **Osteichthyes** | | | | | | | | | | | | | |
| Black sea bass* | | | | | | | | | | | | | |
| Red Hake* | | | | | | | | | | | | | |
| Scup* | | | X | | X | | X | | | | | | |
| | | | | | | | | | | | | | |
| **CHORDATA** | | | | | | | | | | | | | |
| Sand Sponge | | | | | | | | | | | X | X | |
| White invasive tunicate | | | | | | | | | | | X | X | |
| **SPECIES RICHNESS FAUNA**[2] | 1 | 2 | 3 | 2 | 6 | 3 | 3 | 2 | 3 | 5 | 9 | 8 | 6 |
| | | | | | | | | | | | | | |
| **FLORA** | | | | | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | | | | | |
| **Dead Man's Fingers** | | | | | | | | | | | | | |
| Sea Lettuce | | | | | | | | X | | | | | |
| | | | | | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | | | | | |
| Rockweed | | | | | | | | | | | | | |
| **Sargassum** | | | | | | | | X | | | | X | |
| | | | | | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | | | | | |
| **Branching red alga** | | | | | | | | X | X | X | | X | X |
| **SPECIES RICHNESS FLORA**[2] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 0 | 2 | 1 |
| **Water depth (m) below MLLW** | 3.31 | 9.54 | 8.89 | 11.78 | 15.54 | 6.7 | 8.88 | 9.34 | 8.6 | 9.54 | 29.8 | 12.49 | 11.8 |

| TRANSECT ID | T-54 | T-55 | T-56 | T-57 | T-58 | T-59 | T-60 | T-61 | T-62 | T-63 | T-64 | T-68 | T-75 | Freqency % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAUNA** | | | | | | | | | | | | | | |
| **PORIFERA** | | | | | | | | | | | | | | |
| Bread crumb sponge | X | | | | | X | | | | | | | X | 13.51 |
| **Red beard sponge[3]** | X | X | | | | | | | | | | X | X | **21.62** |
| Sulfur sponge | X | X | | | | | | | | X | | | | 18.92 |
| | | | | | | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | | | | | | |
| Bell shaped jellyfish | | | | | | | | | | | | | | 5.41 |
| Burrowing anemone | | | X | X | | | | | | | | | | 8.11 |
| Star Coral | | X | | | | | | | | | | | | 2.70 |
| Hydroid | | | | | | | | | | | | | X | 13.51 |
| | | | | | | | | | | | | | | |
| **CTENOPHORA** | | | | | | | | | | | | | | 8.11 |
| | | | | | | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | | | | | | |
| Bushy bryozoan | X | | | | | X | | | | | | | | 13.51 |
| **Encrusting bryozoan** | X | | | | | | | | | | | | X | **37.84** |
| | | | | | | | | | | | | | | |
| **MOLLUSCA** | | | | | | | | | | | | | | |
| Bay Scallop | | | | | | | | | | | | | | 8.11 |
| Blue mussel | | | | | | | | | | | | | | 2.70 |
| Knobbed whelk*[1] | | | | | X | | | | | | | | | 13.51 |
| Knobbed whelk egg case* | | | | | | | | | | | | X | | 13.51 |
| Moon snail | | | | | | | | | | X egg mass | | | | 2.70 |
| Slipper limpet | | | | | | | | | | | | | X | 18.92 |
| Threeline Mudsnail | | | X | | X | | | | | | | | | 8.11 |
| | | | | | | | | | | | | | | |
| **ANNELIDA** | | | | | | | | | | | | | | |
| **Polychaeta** | | | | | | | | | | | | | | |
| Lug worm | | | | | | | | | | | | | | 5.41 |
| Plumed worm | | | | | | | | | X | | | | | 5.41 |
| **Sedentary polychaetes** | | | X | | | | | | | | | X | | **27.03** |
| | | | | | | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | | | | | | |
| **Crustacea** | | | | | | | | | | | | | | |
| Barnacle | | | | | | | | | | | | | | 8.11 |
| Four-eyed amphipod | | | X | X | X | | | | | X | X | | | 18.92 |
| Hermit crab | | | | | | X | | | | | | | X | 18.92 |
| Jonah crab* | | | | X | | | | | | | | | | 2.70 |
| Mysid shrimp | | | | | X | | | | | X | X | | | 8.11 |
| Rock crab | | | | | | | | | | | | | | 2.70 |
| Spider crab | | | | | | X | | | | | | | | 8.11 |
| **Echinoderms** | | | | | | | | | | | | | | |
| Common sea star | X | X | | | | | | | | | | | | 8.11 |
| Sand dollar | | | | | | | | | | X | X | | | 5.41 |
| Purple sea urchin | | | | | | | | | | | | | X | 2.70 |
| | | | | | | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | | | | | | |
| Little Skate egg case* | | | | | | X | | | | X | X | | | 10.81 |
| Little Skate* | | | | | | | | | | | | | | 5.41 |
| **Osteichthyes** | | | | | | | | | | | | | | |
| Black sea bass* | X | | | | | | | | | | | | | 2.70 |
| Red Hake* | | | | | | | | | | X | | | | 2.70 |
| Scup* | | | | | | X | | | X | | | | | 18.92 |
| | | | | | | | | | | | | | | |
| **CHORDATA** | | | | | | | | | | | | | | |
| Sand Sponge | X | | | | | | | | | | | | | 8.11 |
| White invasive tunicate | X | | | | | | | | X | | | | | 10.81 |
| **SPECIES RICHNESS FAUNA[2]** | 9 | 4 | 4 | 3 | 5 | 6 | 0 | 0 | 3 | 7 | 4 | 3 | 7 | 97.2973 |
| | | | | | | | | | | | | | | |
| **FLORA** | | | | | | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | | | | | | |
| **Dead Man's Fingers** | | | | | | | | | | | | | | **24.32** |
| Sea Lettuce | | | | | | | | | | | | | | 5.41 |
| | | | | | | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | | | | | | |
| Rockweed | | | | | | | | | | | | | | 5.41 |
| **Sargassum** | | | | | | | | X | | | | | | **27.03** |
| | | | | | | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | | | | | | |
| **Branching red alga** | | X | | | | | X | X | | | | X | X | **48.65** |
| **SPECIES RICHNESS FLORA[2]** | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | |
| **Water depth (m) below MLLV** | 14.69 | 9.98 | 29.6 | 30.32 | 32.7 | 14.6 | 9.35 | 6.76 | 12.49 | 33.92 | 37.86 | 10.04 | 7.12 | |

4. RPS 2018 Benthic Macrofaunal Data Analysis

# Benthic Macrofaunal Data Analysis at the Vineyard Wind Project Site

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# Document Control Form

**Title:**

"Benthic Macrofaunal Data Analysis at the Vineyard Wind Project Site"

**Location & Operator:**

Offshore Massachusetts in the Vineyard Wind Project Area

**RPS ASA Project Number:**

RPS 18-P-200033 Vineyard Wind Benthic Macrofaunal Data Analysis

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**Internal Review:**

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| Release | File Name | Date Submitted | Notes |
|---|---|---|---|
| Draft Report | BenthicMacroAnalysis_Report_17Oct2018.docx | Oct 2018 | Technical report |
| | | | |

## Disclaimer:

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# 1 Introduction and Scope

RPS Group, Inc. was contracted by Geo SubSea LLC. to conduct a statistical analysis of benthic macroinfauna grab sample data from the Vineyard Wind project area. Samples were taken in the summer of 2018 along the proposed offshore export cable corridor (OECC) and within the Wind Development Area (WDA) in order to characterize the benthic habitat and infaunal communities throughout the project area. In addition, some replicate samples from prior survey efforts during 2016 in the WDA and 2017 along the OECC (described in additional detail below) were compared to the 2018 samples to analyze interannual and/or seasonal differences in the habitat and communities.

## 1.1 2018 Survey Summary

Marine benthic habitat sampling was conducted in the Vineyard Wind WDA and along the OECC by CSA Ocean Sciences, Inc. (CSA) and Alpine Ocean Seismic Survey, Inc. (Alpine) between May 28 and July 5, 2018. Samples were collected at 141 stations (67 in WDA and 74 along OECC) with a 0.1 $m^2$ Day Grab Sampler (CSA, 2018). Complete samples could not be obtained from ten (10) stations along the OECC due to improper closure of the grab sampler after three attempts. From each of the 131 successful grab samples, two infauna subsamples were taken with a 10-cm diameter core, which were then sieved through a 500-µm mesh. Organisms were preserved in 1-liter jars fixed with 10% formalin and Rose Bengal stain. Lab processing and taxonomic identification of all samples were conducted by EcoAnalysts, INC. (EcoAnalysts). Laboratory methods and the Standard Operating Procedures (SOP) are described in further detail in Appendix A of this report. The abundance of taxa collected and identified in the samples was reported as number of organisms in 0.008 $m^2$, which represents the surface area of the subsample corer used. In the initial processing of the grab samples, organisms in the phylum Nematoda were not enumerated. Reanalysis of all samples was conducted by EcoAnalysts, however, different methods in enumeration were utilized, which could have resulted in inaccurate estimates of abundances.

Of the 131 successful grab samples, eight were from stations previously sampled in the 2016 and 2017 surveys: stations 61, 210, and 265 in the WDA and stations 4, 18, 22, 50, and 59 along the OECC (Figure 1). These replicate samples informed the comparative analysis (Section 3), which tested major differences in species composition and abundance between surveys.

All stations sampled for all surveys are shown in Figure 2, with station numbers provided for reference.

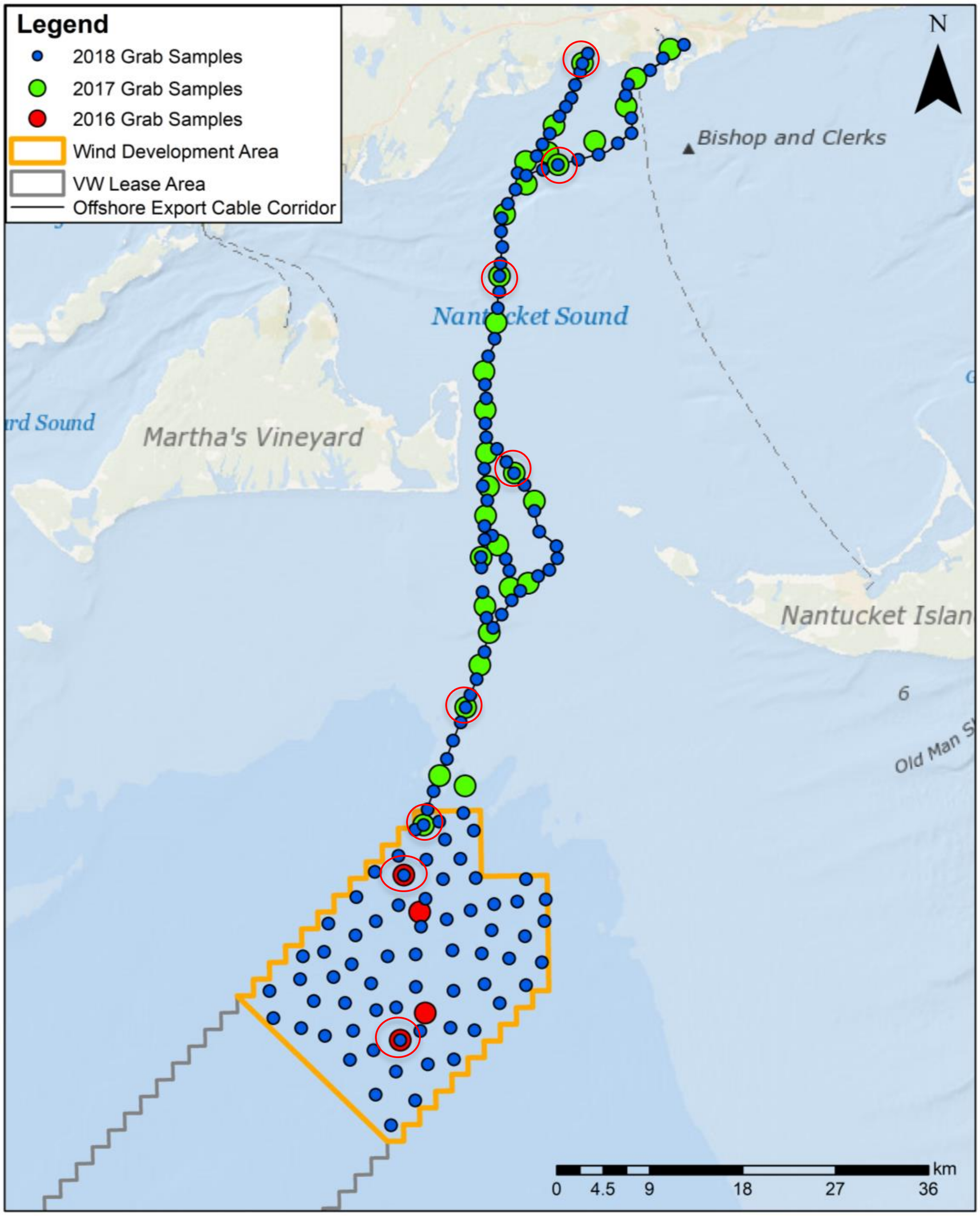


Figure 1. Locations of the benthic grab samples collected in 2016 (red), 2017 (green), and 2018 (blue). Samples that were sampled in two surveys are circled in red.

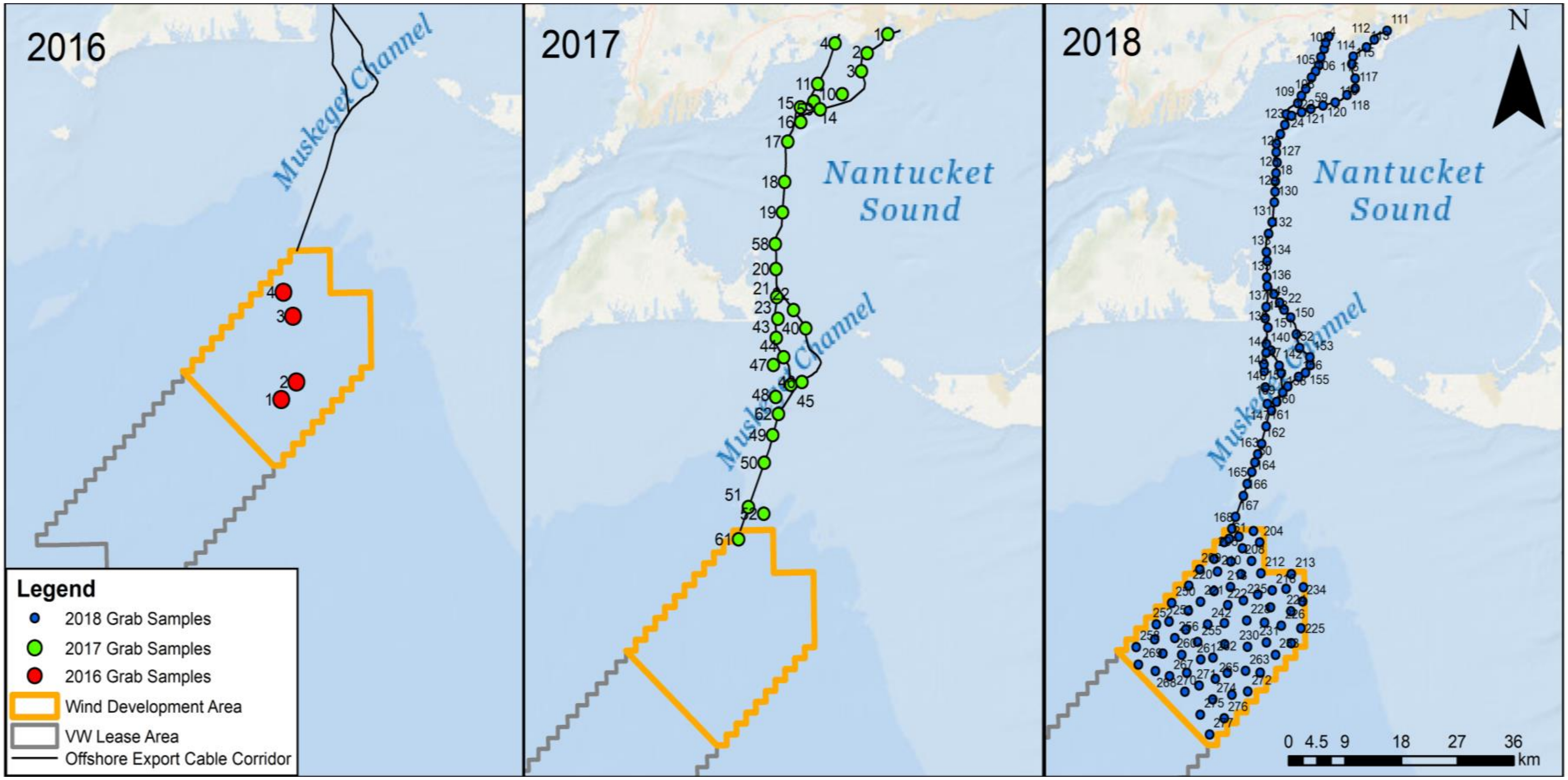


Figure 2. Locations of the benthic grab samples collected in 2016 (red), 2017 (green), and 2018 (blue) with station number labeled for each survey

## 1.2 2017 Survey Summary

Benthic samples at 59 stations along the proposed OECC were collected by Alpine in 2017 using a 0.1 $m^2$ modified Day Grab. Abundance of taxa in each sample was reported as counts per 0.008 $m^2$ (size of subsample corer) and organisms were identified to the family-level except for Oligochaeta, Archannelida, Nematoda, and Turbellaria (Normandeau Associates, Inc. (Normandeau), 2017). Normandeau processed samples and conducted basic summary statistics on the data, including total abundance, number of identifiable taxa, Shannon diversity index (H' per sample, log(e), and Pielou's evenness index (J' per sample). Results and additional details on methods implemented from the full benthic macroinfauna assessment were documented in a report by Normandeau (2017). Due to changes to the proposed OECC route after sampling and the Normandeau analysis occurred, we re-assessed the 2017 survey data including only samples on the new route. The 31 stations along the currently proposed OECC are presented in the center panel in Figure 2 above and results are explained in detail in Section 2.2.

## 1.3 2016 Survey Summary

Benthic macroinfaunal sampling was conducted in 2016 by Geo Subsea LLC. in the Vineyard Wind WDA. Four grab samples at four sites (i.e., no replicates) were collected using a 0.1 $m^2$ modified Day Grab Sampler. Samples were processed and analyzed by ESS Group, Inc. (ESS; ESS, 2017). Analysis metrics included taxa richness, macrofaunal density, and community composition. There were 32 total taxa identified ranging from 6 (Grab 4) to 19 (Grab 1) taxa per site. Mean density for the four samples was 118,370 individuals/$m^3$ with the highest density observed in Grab 4 and the lowest in Grab 2. The macroinfaunal community sampled was composed of polychaete worms, crustaceans, mollusks, echinoderms, nematode roundworms, and nemertean ribbon worms. The taxonomic group with the most representative taxa and the highest density was polychaeta worms (Figure 3). Further details on this study are documented in a full assessment report (ESS, 2017).

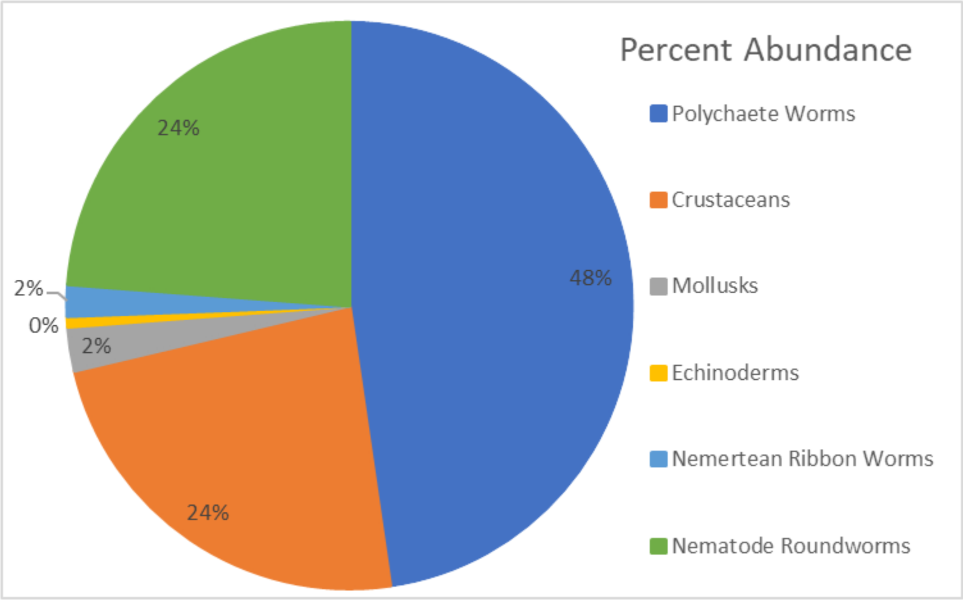


Figure 3. Percent abundance of each phyla collected in the benthic grab samples in the Vineyard Wind WDA during the 2016 survey.

# 2 Ecological Parameter Data Analysis Methods and Results (2017 and 2018)

## 2.1 Methods

As mentioned above, the potential routes for the Vineyard Wind OECC, which will connect the offshore wind farm to the mainland, were refined and currently include one main western route, near Martha's Vineyard, and two possible landing sites in Lewis Bay and Covell's Beach. Due to the change in the proposed OECC, data from the 2017 survey, originally analyzed by Normandeau (2017), was reanalyzed to only include samples collected on the new route. Similar methods were applied to both the 2017 and 2018 datasets and are explained in the following subsections. All subsequent analyses were based on the benthic macroinfauna abundance estimates obtained from subsamples of each grab sample collected in the surveys. In most cases, analyses were performed using data from all samples combined and for each station individually.

### 2.1.1 Taxa Composition

Taxa composition was assessed to characterize the high-level trends in taxa data. Taxa composition includes te relative proportions of taxonomic groups by number of identifiable taxa and number of individuals, used to evaluate dominance of common phyla across all samples. Taxa composition was summarized for both individual samples and across all samples in a survey year.

### 2.1.2 Richness, Diversity, and Evenness

Species richness, evenness, and diversity are common ecological parameters used to measure the overall biodiversity of a community or discrete unit. Species richness is the number of unique species or taxonomic group represented in an area of interest. In this assessment, species richness was calculated using Margalef's Richness Index (Formula 1) for each station and across stations to acquire individual, mean, and regional richness indices.

*Formula 1. Margalef's Richness Index (RI).*

$$\mathrm{RI} = \frac{(\mathrm{S} - 1)}{\ln \mathrm{N}}$$

*Where:*

*S= the number of species*

*N= the total number of individuals in the sample*

*Interpretation: The higher the index, the greater the species richness.*

The diversity of a community considers species richness and the proportion of each unique species. The Shannon Diversity Index (H'; Formula 2) was calculated using the number of each species, the proportion of each species relative to the total number of individuals, and the sum of the proportions. This index was used to assess diversity at each station and for the overall region. The diversity index (H') increases with increasing species richness and evenness.

*Formula 2. H'- Shannon Diversity Index.*

$$\mathrm{H}' = -\sum_{\mathrm{i}=1}^{\mathrm{R}} \mathrm{p_i} \ln \mathrm{p_i}$$

*Where:*

*$p_i$ is the proportion of individuals belonging to the with species in the dataset of interest*

*Interpretation: The greater the H', the greater the richness and evenness.*

Evenness of a community refers to the similarity in abundances of different species making up a population or sample. Pielou's Index of Evenness includes H' (Shannon-Weiner Diversity Index) in its calculation. We used abundance data for organisms identified to the family or lowest possible identification level, and because these indices were designed for and are typically calculated at the species level, evenness results may not be comparable to other studies where evenness was analyzed at the species level.

*Formula 2. J'- Pielou's Index of Evenness.*

$$\mathrm{J}' = \frac{\mathrm{H}'}{\mathrm{H_{Max}}}$$

*Where:*

*H' is the Shannon- Weiner Diversity Index*

*$H_{Max}$ is the maximum possible value of H', where each species occurs in equal abundances.*

$$\mathrm{H_{Max}} = \ln \mathrm{s}$$

*Where: s = Number of species*

*Interpretation: J' is constrained between 0 and 1. The greater is J', the greater is the evenness.*

### 2.1.3 Multivariate Analyses

Multivariate analyses were conducted using PRIMER v7 (Plymouth Routines in Multivariate Ecological Research) to examine similarity of stations based on infaunal composition. These analyses included classification via cluster analysis and multidimensional scaling (MDS). Both the dendrogram and MDS were built on a Bray-Curtis Similarity Index, using a fourth-root transformation of the data to ensure all taxa (not just those that dominated samples) would contribute to similarity measures. Dendrograms are useful in presenting the discrete groupings of samples with similar community structures. MDS plots present these data and groupings spatially, with samples ordinating based on similarity to one another. Higher similarity between samples is represented by the closer proximity of points in the plot.

Differences in the infaunal abundances between stations were assessed using habitat classifications and bottom depth parameters. Grab samples were classified into habitats using field survey notes and the Coastal and Marine Ecological Classification Standard (CMECS) Version III (Madden et al. 2008). Stations fell within one of twelve habitat classifications that encompassed a variety of bottom habitat types (Figure 4; Figure 5; Table 1). Bottom depth was categorized into two depth zones: nearshore (< 30 m deep) and neritic (> 30 m deep).

An analysis of similarity percentages (SIMPER; Clarke 1993) and analysis of similarities (ANOSIM) were also performed for the 2017 and 2018 survey samples using PRIMER v7. These assessments were conducted using Bray-Curtis Similarity Index scores, habitat classifications, and depth zones. SIMPER was used to identify taxa that were most responsible for similarity or dissimilarity between habitat classification clusters. ANOSIM was used to help determine if habitat or depth classifications were predictive of the infaunal assemblage clusters. The R statistic calculated in the Global ANOSIM indicates whether samples within classification groups were more similar than samples between groups. R statistic values closer to 1 than 0 and significance level percentages of <5% indicate that samples within a group are more similar to each other than to those in different groups. Specifically, ANOSIM was used to test two null hypotheses:

- $H_0 1$: Infaunal assemblages do not change within depth classifications.
- $H_0 2$: Infaunal assemblages do not change within habitat types.

In addition, to further categorize and describe the infaunal assemblages in samples in the 2018 survey, a third null hypothesis was tested using categories combining both depth and habitat classifications.

Table 1. Habitat classifications used to describe 2016, 2017, and 2018 survey stations.

| Classification | Description |
|---|---|
| Fine Sand 1 | Fine sand with some shell hash |
| Fine Sand 2 | Silty fine sand with some shell hash |
| Fine Sand 3 | Plain fine sand |
| Fine Sand 4 | Fine sand with some larger hard substrate and/or seaweed |
| Med Sand 1 | Fine to coarse sand over dark silty sand |
| Med Sand 2 | Medium sand with shell or gravel |
| Coarse | Coarse sand with some shell |
| Gravel 1 | Gravel and shell hash |
| Gravel 2 | Gravel and organics |
| Silt | Silty anoxic sand |
| Hard 1 | Hard bottom with corals present |
| Hard 2 | Large rocks or cobbles |

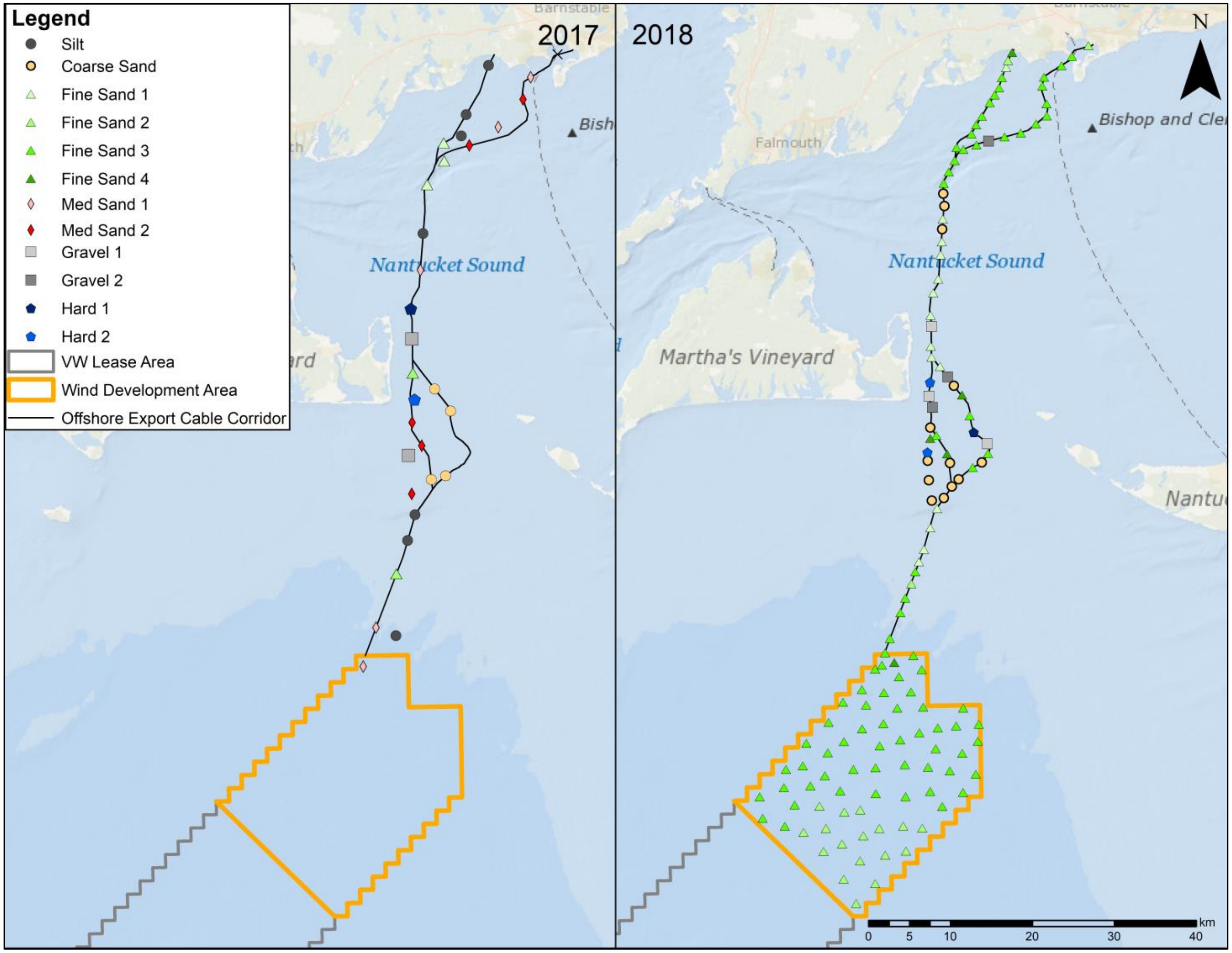


Figure 4. Benthic grab station locations for the 2017 (left) and 2018 (right) surveys with symbology based on habitat type.

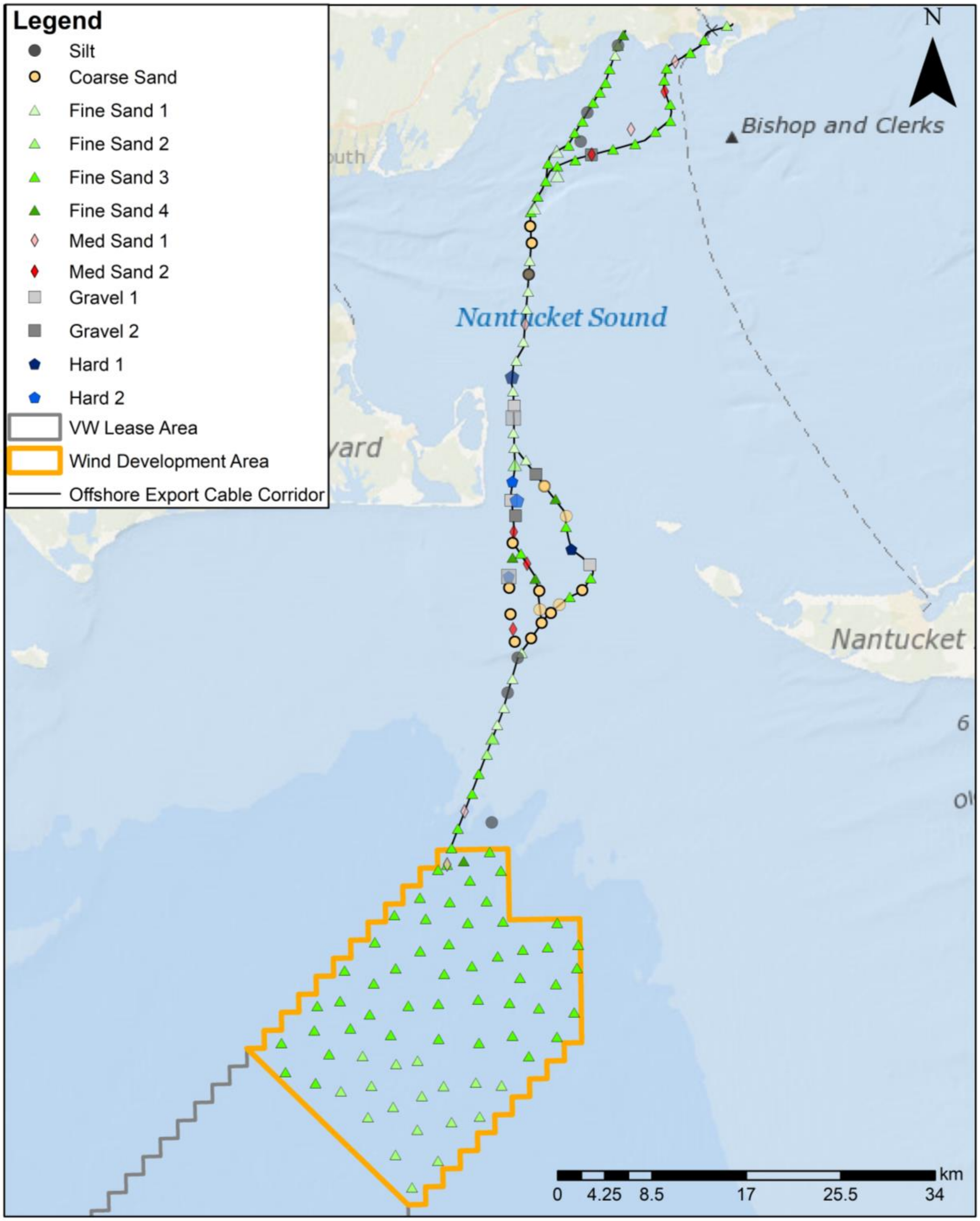


Figure 5. Benthic grab station locations for both the 2017 and 2018 surveys with symbology based on habitat type (2017 data points set at a slight transparency in order to show overlap of replicate samples).

## 2.2 Results

### 2.2.1 Taxa Composition

**2017**

The 31 grab samples collected in the updated OECC in 2017 yielded a total of 3,856 individual macroinfaunal organisms from 8 phyla and 90 families or lowest possible identification level (LPIL) taxa. The phyla Arthropoda (41%), Annelida (24%), Mollusca (19%), and Nematoda (14%) represented 99% of all organisms captured in the survey. The other phyla, including Cnidaria, Echinodermata, Nemertea, and Platyhelminthes, contributed less than 1% to the total abundance (

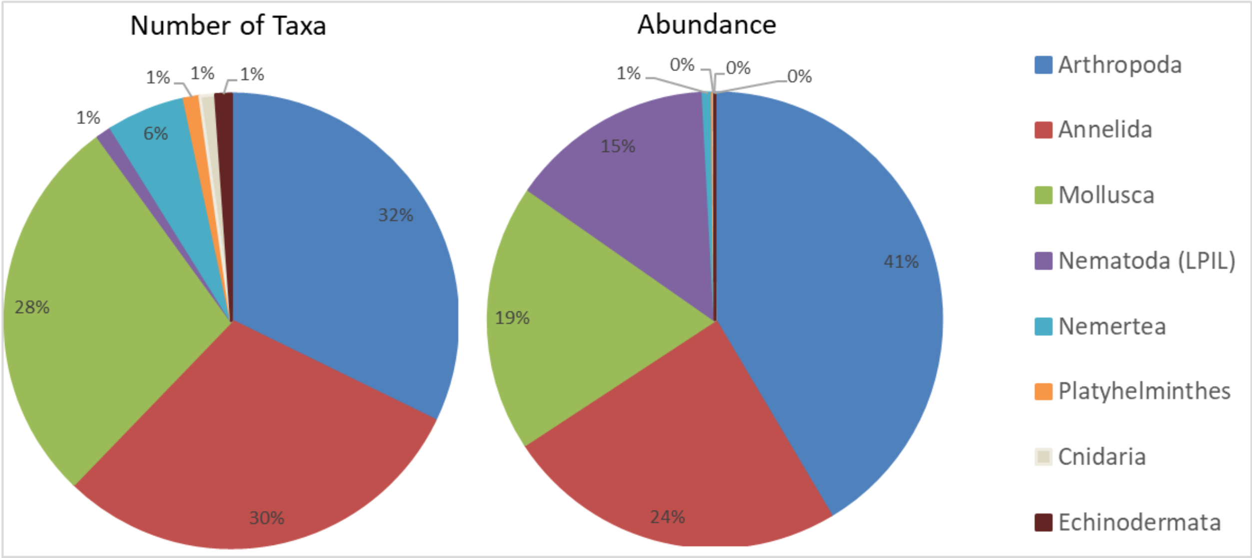


Figure 6). Four taxa, including Caprellidae (Arthropoda), Nematoda (Nematoda), Columbellidae (Mullusca), and Oligochaeta (Annelida), represented 59% of the abundance among all samples, with the remaining 86 taxa each contributing 0 - 2% to the total abundance (Table 3). The high proportion of Arthropoda in the overall survey abundance is due to a large number of organisms from the Caprellidae family (1,146 organisms) captured at station 23.

Arthropoda, Annelida, and Mollusca were represented by the greatest number of taxa with 29, 27, and 25 unique families (or LPIL) identified in each phylum, respectively. The remaining 5 phyla consisted of 1 - 5 unique taxa (Table

2;

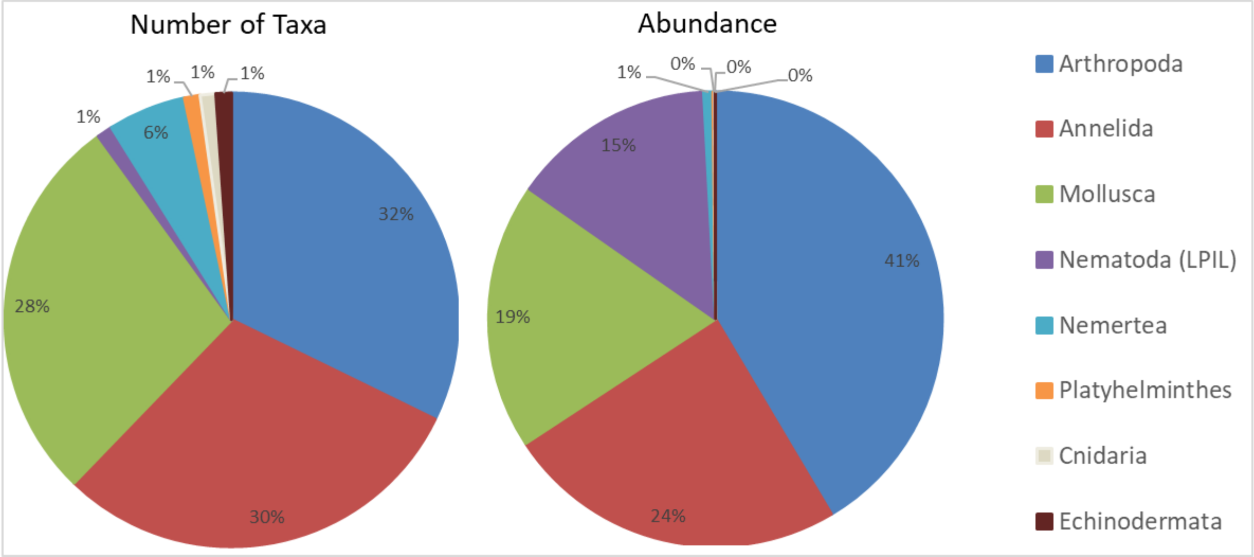


Figure 6).

Table 2. Phyla represented in the benthic grab samples along the Vineyard Wind OECC during the 2017 survey.

| Phyla | Number of Taxa (family or LPIL) | Abundance (# / 0.008 m$^2$) |
|---|---|---|
| Annelida | 27 | 937 |
| Arthropoda | 29 | 1,599 |
| Cnidaria | 1 | 2 |
| Echinodermata | 1 | 1 |
| Mollusca | 25 | 730 |
| Nematoda (LPIL) | 1 | 558 |
| Nemertea | 5 | 25 |
| Platyhelminthes | 1 | 4 |
| Total | 90 | 3,856 |

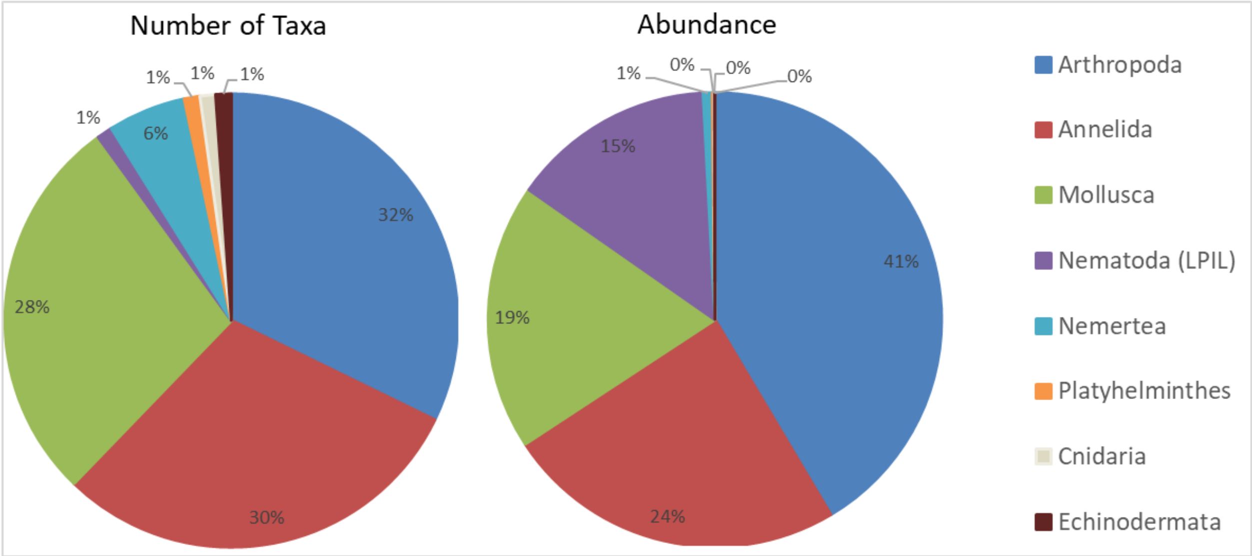


Figure 6. Percent of the number of taxa and abundance of each phyla collected in the benthic grab samples along the Vineyard Wind OECC during the 2017 survey.

Abundance across all 30 stations ranged from two organisms collected at station 43 to 1,588 organisms at station 23 with a mean abundance of 128 individuals per sample (0.008 $m^2$). Mean number of phyla representing each sample was 4 with no samples containing all eight of the identified phyla. The mean number of taxa across samples was 14 and ranged from 2 at station 43 and 34 at station 23. Overall, station 23 contained the most unique phyla (6) and taxa (34) and had the highest abundance of organisms (1,588) of all stations. Most of the organisms collected at station 23 (72%) were amphipods from the Caprellidae family (skeleton shrimp) in the Arthropoda phylum.

Samples with the greatest number of unique taxa and highest abundances were from stations composed of large grain or hard bottom habitat (i.e., station 23, 47, and 59). No taxa were present at all sample stations. Annelida worms were the most commonly present phylum, with the families Syllidae and Oligochaeta observed in 18 and 17 of the 30 samples, respectively (Table 3).

Table 3. Total abundance of each phyla and taxa collected in the benthic grab samples along the Vineyard Wind OECC during the 2017 survey.

| Phyla | Taxa | Abundance (# / 0.008 m$^2$) |
|---|---|---|
| Annelida | Onuphidae, Oenonidae, Magelonidae, Hesionidae, Pectinariidae, Oweniidae | 1 |
| | Dorvilleidae, Pilargidae | 2 |
| | Orbiniidae | 6 |
| | Paraonidae | 8 |
| | Polynoidae | 11 |
| | Opheliidae, Sigalionidae, Nephtyidae | 12 |
| | Glyceridae | 14 |
| | Ampharetidae, Maldanidae | 17 |
| | Phyllodocidae | 19 |
| | Lumbrineridae | 27 |
| | Terebellidae | 36 |
| | Cirratulidae | 42 |
| | Sabellaridae | 54 |
| | Capitellidae | 67 |
| | Archiannelida | 86 |
| | Syllidae | 111 |
| | Spionidae | 130 |
| | Oligochaeta | 246 |
| Total Annelida | | 937 |
| Arthropoda | Bodotriidae, Callianassidae, Argissidae, Cancridae, Idoteidae | 1 |
| | Inachoididae | 2 |
| | Mysidae, Bateidae | 3 |
| | Corophiidae, Liljeborgiidae, Oedicerotidae | 4 |
| | Janiridae | 5 |
| | Maeridae, Bathyporeiidae, Tanaissuidae | 6 |
| | Diastylidae, Pinnotheridae | 7 |
| | Xanthidae | 8 |
| | Haustoriidae | 9 |
| | Lysianassidae | 11 |
| | Aoridae | 12 |
| | Stenothoidae | 14 |
| | Ischyroceridae | 22 |
| | Photidae | 32 |
| | Unciolidae | 34 |
| | Phoxocephalidae | 48 |
| | Paguridae | 77 |

| Phyla | Taxa | Abundance (# / 0.008 m²) |
| --- | --- | --- |
| | Ampeliscidae | 96 |
| | Caprellidae | 1174 |
| Total Arthropoda | | 1599 |
| **Cnidaria** | Halcampidae | 2 |
| Total Cnidaria | | 2 |
| **Echinodermata** | Echinarachniidae | 1 |
| Total Echinodermata | | 1 |
| **Mollusca** | Naticidae, Pharidae, Myidae, Semelidae, Mangeliidae, Veneridae | 1 |
| | Margaritidae, Nassariidae, Muricidae | 2 |
| | Chaetopleuridae | 3 |
| | Crassatellidae | 4 |
| | Mytilidae, Yoldiidae | 5 |
| | Lyonsiidae, Corambidae | 6 |
| | Arcidae | 8 |
| | Cerithiopsidae | 13 |
| | Acteocinidae | 24 |
| | Tellinidae | 25 |
| | Mactridae | 29 |
| | Astartidae | 38 |
| | Nuculidae | 41 |
| | Pyramidellidae | 83 |
| | Calyptraeidae | 126 |
| | Columbellidae | 302 |
| Total Mollusca | | 730 |
| **Nematoda** | Nematoda | 558 |
| Total Nematoda | | 558 |
| **Nemertea** | Lineidae, Tubulanidae | 2 |
| | Tetrastemmatidae | 3 |
| | Carinomidae | 6 |
| | Amphiporidae | 12 |
| Total Nemertea | | 25 |
| **Platyhelminthes** | Turbellaria | 4 |
| Total Platyhelminthes | | 4 |
| **All Phyla Total** | | 3856 |

**2018**

In the 2018 field surveys conducted along the OECC and in the WDA, 131 successful grab samples were collected and contained a total of 27,287 individual macrofaunal organisms from 134 families (or LPIL) and 14 phyla. Samples from the OECC contained 7,706 organisms and samples from the WDA contained 19,581 organisms. The phyla Annelida (59%), Mollusca (22%), and Arthropoda (13%) represented 94% of all organisms captured in the survey. Other phyla captured in the survey included Chordata, Cnidaria, Echinodermata, Ectoprocta, Entoprocta, Hemichordata, Nemertea, Phoronida, Platyhelminthes, Sipuncula. The annelid worm taxa Polygordiidae (25%), Paraonidae (7%), Oligochaeta (5%), and Lumbrineridae (5%) made up 41% of the abundance among all samples. The second most abundant taxon, accounting for 18% of total across all stations, was the family Nuculidae, which consists of species of small marine clams known as nut clams. The remaining 129 taxa each contributed 4% or less to total abundance.

Arthropoda, Annelida, and Mollusca were also represented by the most unique taxa, with 40, 38, and 31 families (or LPIL) identified for each, respectively. The remaining 11 phyla were represented by 1 - 6 unique taxa.

Table 4. Phyla represented in the benthic grab samples in the Vineyard Wind Project Area during the 2018 survey.

| Phyla | Number of Taxa (family or LPIL) | Abundance (# / 0.008 m$^2$) |
|---|---|---|
| Annelida | 38 | 16,094 |
| Arthropoda | 40 | 3,552 |
| Chordata | 2 | 152 |
| Cnidaria | 4 | 152 |
| Echinodermata | 2 | 21 |
| Ectoprocta | 4 | 12 |
| Entoprocta | 1 | 1 |
| Hemichordata | 1 | 1 |
| Mollusca | 31 | 5,946 |
| Nematoda | 1 | 1,164 |
| Nemertea | 6 | 168 |
| Phoronida | 1 | 2 |
| Platyhelminthes | 1 | 16 |
| Sipuncula | 2 | 6 |
| Total | 134 | 27,287 |

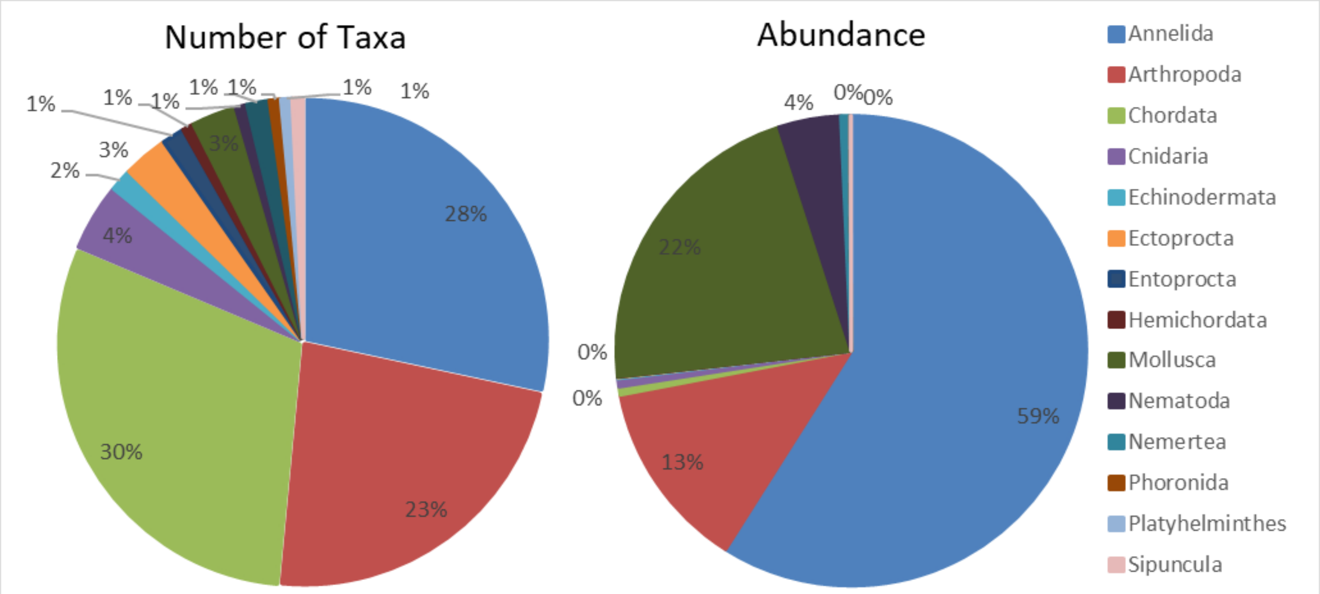


Figure 7. Percent of the number of taxa and abundance of each phyla collected in the benthic grab samples in the Vineyard Wind Project Area during the 2018 survey.

Abundance of organisms from all 131 stations ranged from three collected at station 140 (along the OECC) to 953 at station 210 (in the WDA) with a mean abundance of 208 organisms per sample (# / 0.008 m$^2$). For stations only within the WDA, mean abundance was 292, while mean abundance for stations along the OECC was 120. On average and most frequently, stations contained organisms from 5 of the 14 phyla identified across all stations. Number of phyla represented in the samples for each station ranged from 1 (station 140, OECC) to 8 (station 125 and 158, OECC). Unique taxa collected and identified at each station ranged from 2 at station 140 and 22 (OECC) to 35 at station 271 (WDA) and 164 (OECC) with a mean of 17 per station. The mean number of taxa in each sample also differed between stations in the WDA and OECC with 21 and 14 families or LPIL identified, respectively. Overall, stations within the WDA tended to have more unique taxa in individual samples than those collected in the OECC. However, when looking at the total number of taxa in each of the project areas, more unique taxa were identified along the OECC, with 110 taxa, than the WDA, with 86 taxa.

No family or LPIL was found in all 131 samples. Annelid worms had the highest presence across stations, with the families Syllidae, Oligochaeta, Cirratulidae, and Paraonidae present in 99, 95, 93, and 90 of the 131 stations, respectively. Extremely rare taxa, only observed at one station in the survey, made up 20% of all taxa (Table 5).

Table 5. Total abundance of each phyla and taxa collected in the benthic grab samples in the Vineyard Wind Project Area during the 2018 survey.

| Phyla | Taxa | Abundance (# / 0.008 $m^2$) |
|---|---|---|
| Annelida | Aphroditidae, Pilargidae | 1 |
| | Onuphidae, Sabellariidae, Serpulidae, Sphaerodoridae | 2 |
| | Piscicolidae | 3 |
| | Nereididae | 4 |
| | Magelonidae | 5 |
| | Hesionidae | 6 |
| | Cossuridae, Oweniidae | 10 |
| | Sigalionidae | 11 |
| | Goniadidae | 14 |
| | Flabelligeridae | 18 |
| | Polynoidae | 25 |
| | Scalibregmatidae | 26 |
| | Phyllodocidae | 29 |
| | Trichobranchidae | 34 |
| | Pisionidae | 38 |
| | Dorvilleidae | 43 |
| | Orbiniidae | 57 |
| | Oenonidae | 67 |
| | Glyceridae | 95 |
| | Opheliidae | 107 |
| | Spionidae | 121 |
| | Terebellidae | 127 |
| | Nephtyidae | 163 |
| | Maldanidae | 316 |
| | Ampharetidae | 332 |
| | Sabellidae | 500 |
| | Capitellidae | 689 |
| | Syllidae | 811 |
| | Cirratulidae | 1,104 |
| | Lumbrineridae | 1,337 |
| | Oligochaeta | 1,427 |
| | Paraonidae | 1,775 |
| | Polygordiidae | 6,780 |
| Total Annelida | | 16,094 |
| Arthropoda | Bateidae, Cancridae, Crangonidae, Lysianassidae, Microprotopidae, Paramunnidae, Pinnotheridae, Pleustidae, Stenothoidae | 1 |
| | Maeridae, Paguridae | 2 |
| | Bathyporeiidae, Harpacticoida | 3 |

| Phyla | Taxa | Abundance (# / 0.008 m$^2$) |
|---|---|---|
| | Cirolanidae | 4 |
| | Argissidae, Chaetiliidae | 5 |
| | Bodotriidae | 6 |
| | Anthuridae | 7 |
| | Idoteidae, Oedicerotidae, Tryphosidae | 8 |
| | Aoridae | 9 |
| | Panopeidae | 12 |
| | Tanaissuidae | 14 |
| | Sphaeromatidae | 15 |
| | Haustoriidae | 20 |
| | Halacaridae | 27 |
| | Caprellidae | 36 |
| | Photidae | 44 |
| | Phoxocephalidae | 71 |
| | Ischyroceridae, Leuconidae | 77 |
| | Dulichiidae | 101 |
| | Corophiidae | 105 |
| | Unciolidae | 170 |
| | Gammaridae | 249 |
| | Ostracoda | 340 |
| | Diastylidae | 601 |
| | Balanidae | 641 |
| | Ampeliscidae | 873 |
| Total Arthropoda | | 3,552 |
| **Chordata** | Styelidae | 14 |
| | Molgulidae | 138 |
| Total Chordata | | 152 |
| **Cnidaria** | Edwardsiidae | 2 |
| | Hydrozoa | 5 |
| | Actiniaria | 11 |
| | Rhizangiidae | 134 |
| Total Cnidaria | | 152 |
| **Echinodermata** | Synaptidae | 1 |
| | Echinarachniidae | 20 |
| Total Echinodermata | | 21 |
| **Ectoprocta** | Schizoporellidae | 2 |
| | Electridae, Hippothoidae | 3 |
| | Membraniporidae | 4 |
| Total Ectoprocta | | 12 |
| **Entoprocta** | Entoprocta | 1 |

| Phyla | Taxa | Abundance (# / 0.008 m$^2$) |
|---|---|---|
| Total Entoprocta | | 1 |
| **Hemichordata** | Enteropneusta | 1 |
| Total Hemichordata | | 1 |
| **Mollusca** | Buccinidae, Muricidae | 1 |
| | Lasaeidae, Naticidae, Pharidae | 2 |
| | Leptochitonidae, Solemyidae | 3 |
| | Crassatellidae, Nassariidae | 4 |
| | Arcticidae, Cerithiopsidae, Mytilidae, Thyasiridae | 6 |
| | Eulimidae, Gastropoda | 9 |
| | Arcidae, Yoldiidae | 13 |
| | Lucinidae | 15 |
| | Mactridae | 19 |
| | Caecidae, Cylichnidae | 20 |
| | Lyonsiidae | 22 |
| | Pyramidellidae | 34 |
| | Columbellidae | 41 |
| | Periplomatidae | 52 |
| | Veneridae | 57 |
| | Bivalvia | 67 |
| | Astartidae | 73 |
| | Calyptraeidae | 143 |
| | Tellinidae | 252 |
| | Nuculidae | 5,041 |
| Total Mollusca | | 5,946 |
| **Nematoda** | Nematoda | 1,164 |
| Nematoda | | 1,164 |
| **Nemertea** | Amphiporidae,Carinomidae, Emplectonematidae | 1 |
| | Lineidae | 23 |
| | Tubulanidae | 31 |
| | Nemertea | 111 |
| Total Nemertea | | 168 |
| **Phoronida** | Phoronida | 2 |
| Total Phoronida | | 2 |
| **Platyhelminthes** | Turbellaria | 16 |
| Total Platyhelminthes | | 16 |
| **Sipuncula** | Phascolionidae | 2 |
| | Sipuncula | 4 |
| Total Sipuncula | | 6 |
| **All Phyla Total** | | 27,287 |

### 2.2.2 Richness, Diversity, and Evenness

**2017**

Richness (Margalef's Richness Index) for all stations combined was 10.78 and the mean of all individual stations was 3.11. Richness scores ranged from 1.03 at station 62 (seven organisms from three taxa) to 6.13 at station 21 (157 organisms from 32 taxa;

Table 6). The Shannon diversity index for all stations combined was 2.87 and the mean across individual stations was 1.81. Diversity index scores ranged from 0.30 at station 17 to 2.73 at station 22. Evenness, calculated with Pielou's Index of Evenness, for all stations combined was 0.64 and the mean across individual stations was 0.75. The range of evenness scores was 0.22 at station 17 to 1.00 at stations 43 and 48.

Table 6. Community composition parameters of organisms collected in benthic grab samples for stations along the Vineyard Wind OECC during the 2017 survey. Parameters are color-coded to represent relatively high (red) and low (green) values within the dataset.

| Station | Total Number of Taxa | Total Number of Phyla | Abundance (# / 0.008 $m^2$) | Richness | Diversity | Evenness |
|---|---|---|---|---|---|---|
| 1 | 15 | 4 | 85 | 3.15 | 2.26 | 0.84 |
| 2 | 23 | 5 | 136 | 4.48 | 2.55 | 0.81 |
| 3 | 20 | 4 | 62 | 4.60 | 2.32 | 0.77 |
| 4 | 11 | 4 | 37 | 2.77 | 1.83 | 0.77 |
| 10 | 19 | 6 | 61 | 4.38 | 2.52 | 0.85 |
| 11 | 16 | 4 | 32 | 4.33 | 2.58 | 0.93 |
| 14 | 9 | 4 | 23 | 2.55 | 1.91 | 0.87 |
| 15 | 10 | 3 | 20 | 3.00 | 1.99 | 0.86 |
| 16 | 5 | 3 | 18 | 1.38 | 0.63 | 0.39 |
| 17 | 4 | 3 | 11 | 1.25 | 0.30 | 0.22 |
| 18 | 12 | 3 | 183 | 2.11 | 1.44 | 0.58 |
| 19 | 19 | 5 | 33 | 5.15 | 2.69 | 0.91 |
| 20 | 28 | 4 | 170 | 5.26 | 2.31 | 0.69 |
| 21 | 32 | 5 | 157 | 6.13 | 2.73 | 0.79 |
| 22 | 4 | 4 | 13 | 1.17 | 0.79 | 0.57 |
| 23 | 34 | 6 | 1588 | 4.48 | 1.19 | 0.34 |
| 40 | 10 | 3 | 38 | 2.47 | 1.97 | 0.85 |
| 43 | 2 | 2 | 2 | 1.44 | 0.69 | 1.00 |
| 44 | 11 | 3 | 38 | 2.75 | 2.07 | 0.86 |
| 45 | 11 | 3 | 38 | 2.75 | 1.85 | 0.77 |
| 46 | 6 | 3 | 53 | 1.26 | 1.40 | 0.78 |
| 47 | 32 | 5 | 323 | 5.37 | 2.67 | 0.77 |
| 48 | 4 | 3 | 4 | 2.16 | 1.39 | 1.00 |
| 49 | 10 | 5 | 41 | 2.42 | 1.79 | 0.78 |
| 50 | 18 | 4 | 89 | 3.79 | 2.30 | 0.80 |
| 51 | 11 | 5 | 80 | 2.28 | 1.65 | 0.69 |
| 52 | 18 | 5 | 86 | 3.82 | 2.07 | 0.72 |
| 58 | 7 | 4 | 30 | 1.76 | 1.42 | 0.73 |
| 59 | 19 | 5 | 343 | 3.08 | 1.56 | 0.53 |
| 61 | 15 | 4 | 55 | 3.49 | 2.32 | 0.86 |
| 62 | 3 | 2 | 7 | 1.03 | 0.96 | 0.87 |
| **Mean Values** | **14.16** | **4.03** | **124.39** | **3.10** | **1.81** | **0.75** |
| **Total Values (all stations)** | **90** | **8** | **3849** | **10.78** | **2.87** | **0.64** |

**2018**

Taxa richness across all stations was 13.02 and the mean for all stations individually was 3.38. The mean richness for the individual stations only in the WDA or OECC was 3.64 and 3.11, respectively. Richness for combined stations was higher in the OECC with a score of 12.18 compared to 8.60 in the WDA. Richness scores across all stations ranged from 0.62 at station 22 (5 organisms from 2 taxa) to 6.27 at station 271 (231 organisms from 35 taxa). The Shannon Diversity Index across all stations was 2.89 with a mean of 1.83 for individual stations. Shannon index scores ranged from 0.50 at station 22 to 2.82 at stations 268 and 271. Mean diversity of stations only in the WDA or OECC was similar with scores of 1.84 and 1.82, respectively. When taxa were combined and analyzed by project area, diversity was much higher in the OECC (3.13) than in the WDA (2.40). Across all stations, the evenness score was 0.59 and the mean of individual stations was 0.67. Scores ranged from 0.18 at station 234 to 0.96 at station 115. When comparing between project sites (WDA, OECC), evenness scores from stations along the OECC were more frequently above average than stations in the WDA, which had mean scores of 0.74 and 0.61, respectively.

Table 7. Community composition parameters of organisms collected in benthic grab samples for stations in the Vineyard Wind Project Area during the 2018 survey. Parameters are color-coded to represent relatively high (red) and low (green) values within the dataset.

| Station | Project Site | Total Number of Taxa | Total Number of Phyla | Abundance (# / 0.008 $m^2$) | Richness | Diversity | Evenness |
|---|---|---|---|---|---|---|---|
| GB 101 | OECC | 179 | 23 | 5 | 4.64 | 2.08 | 0.66 |
| GB 102 | OECC | 172 | 13 | 4 | 2.63 | 1.69 | 0.66 |
| GB 103 | OECC | 185 | 16 | 3 | 3.54 | 1.44 | 0.52 |
| GB 104 | OECC | 66 | 14 | 5 | 3.57 | 1.90 | 0.72 |
| GB 105 | OECC | 78 | 13 | 4 | 2.86 | 2.01 | 0.78 |
| GB 106 | OECC | 95 | 16 | 5 | 3.29 | 1.84 | 0.66 |
| GB 107 | OECC | 76 | 14 | 5 | 3.08 | 1.99 | 0.76 |
| GB 108 | OECC | 29 | 10 | 3 | 2.67 | 1.73 | 0.75 |
| GB 109 | OECC | 70 | 12 | 4 | 2.59 | 1.87 | 0.75 |
| GB 110 | OECC | 36 | 8 | 2 | 1.95 | 1.57 | 0.76 |
| GB 111 | OECC | 223 | 24 | 5 | 4.30 | 2.34 | 0.74 |
| GB 112 | OECC | 86 | 14 | 6 | 2.95 | 2.19 | 0.83 |
| GB 113 | OECC | 11 | 9 | 3 | 3.34 | 2.10 | 0.95 |
| GB 114 | OECC | 331 | 29 | 4 | 4.84 | 2.53 | 0.75 |
| GB 115 | OECC | 16 | 10 | 3 | 3.25 | 2.22 | 0.96 |
| GB 116 | OECC | 41 | 11 | 5 | 3.28 | 1.69 | 0.70 |
| GB 117 | OECC | 29 | 13 | 6 | 3.73 | 2.36 | 0.92 |
| GB 118 | OECC | 39 | 11 | 3 | 3.69 | 1.52 | 0.63 |
| GB 119 | OECC | 20 | 12 | 5 | 3.67 | 2.35 | 0.94 |
| GB 120 | OECC | 78 | 21 | 6 | 4.65 | 2.57 | 0.84 |
| GB 121 | OECC | 273 | 17 | 4 | 2.85 | 1.48 | 0.52 |
| GB 122A | OECC | 76 | 11 | 4 | 2.34 | 1.46 | 0.61 |
| GB 123 | OECC | 49 | 13 | 4 | 3.08 | 1.82 | 0.71 |
| GB 124 | OECC | 41 | 13 | 5 | 3.32 | 2.21 | 0.86 |
| GB 125A | OECC | 80 | 22 | 8 | 5.22 | 2.52 | 0.82 |
| GB 126 | OECC | 23 | 7 | 4 | 2.22 | 1.57 | 0.81 |
| GB 127 | OECC | 67 | 11 | 6 | 2.73 | 1.83 | 0.76 |
| GB 128 | OECC | 46 | 14 | 5 | 3.57 | 2.34 | 0.89 |
| GB 129 | OECC | 141 | 16 | 4 | 3.09 | 1.48 | 0.53 |
| GB 130 | OECC | 139 | 22 | 6 | 4.28 | 2.23 | 0.72 |
| GB 131 | OECC | 50 | 16 | 6 | 3.83 | 2.45 | 0.88 |
| GB 132 | OECC | 25 | 11 | 6 | 3.28 | 2.13 | 0.89 |
| GB 133A | OECC | 49 | 18 | 5 | 4.58 | 2.58 | 0.89 |
| GB 135 | OECC | 16 | 8 | 4 | 2.82 | 1.84 | 0.88 |
| GB 136 | OECC | 109 | 17 | 6 | 3.68 | 2.11 | 0.74 |
| GB 140 | OECC | 3 | 2 | 1 | 0.91 | 0.64 | 0.92 |

| Station | Project Site | Total Number of Taxa | Total Number of Phyla | Abundance (# / 0.008 $m^2$) | Richness | Diversity | Evenness |
|---|---|---|---|---|---|---|---|
| GB 141 | OECC | 34 | 6 | 4 | 2.79 | 0.74 | 0.41 |
| GB 142 | OECC | 108 | 19 | 6 | 4.16 | 2.07 | 0.70 |
| GB 143 | OECC | 46 | 5 | 5 | 1.52 | 0.92 | 0.57 |
| GB 145 | OECC | 12 | 7 | 5 | 2.89 | 1.75 | 0.90 |
| GB 146 | OECC | 10 | 4 | 4 | 1.30 | 1.28 | 0.92 |
| GB 147 | OECC | 12 | 6 | 5 | 2.40 | 1.49 | 0.83 |
| GB 148 | OECC | 94 | 22 | 7 | 4.88 | 2.39 | 0.77 |
| GB 151 | OECC | 42 | 15 | 6 | 3.85 | 2.36 | 0.87 |
| GB 154 | OECC | 76 | 7 | 6 | 1.52 | 1.32 | 0.68 |
| GB 155 | OECC | 48 | 9 | 5 | 2.11 | 1.86 | 0.85 |
| GB 156 | OECC | 33 | 11 | 7 | 3.11 | 2.07 | 0.86 |
| GB 157 | OECC | 94 | 10 | 6 | 2.00 | 1.59 | 0.69 |
| GB 158 | OECC | 88 | 16 | 8 | 3.61 | 2.14 | 0.77 |
| GB 159 | OECC | 8 | 4 | 3 | 1.44 | 1.07 | 0.77 |
| GB 160 | OECC | 11 | 5 | 5 | 1.67 | 1.41 | 0.88 |
| GB 161 | OECC | 377 | 21 | 5 | 3.38 | 1.52 | 0.50 |
| GB 162 | OECC | 232 | 14 | 4 | 2.51 | 1.45 | 0.55 |
| GB 163 | OECC | 465 | 18 | 4 | 2.78 | 1.83 | 0.63 |
| GB 164 | OECC | 717 | 35 | 6 | 5.18 | 2.00 | 0.56 |
| GB 165 | OECC | 246 | 15 | 3 | 2.54 | 1.48 | 0.55 |
| GB 166 | OECC | 154 | 14 | 4 | 2.64 | 1.90 | 0.72 |
| GB 167 | OECC | 245 | 18 | 4 | 3.09 | 1.59 | 0.55 |
| GB 168 | OECC | 177 | 18 | 5 | 3.33 | 1.70 | 0.59 |
| GB 201 | WDA | 507 | 15 | 3 | 2.25 | 1.23 | 0.45 |
| GB 202 | WDA | 929 | 23 | 6 | 3.22 | 1.13 | 0.36 |
| GB 203 | WDA | 376 | 16 | 3 | 2.53 | 1.37 | 0.49 |
| GB 204 | WDA | 727 | 19 | 6 | 2.75 | 1.09 | 0.37 |
| GB 205 | WDA | 119 | 9 | 4 | 1.69 | 0.95 | 0.43 |
| GB 206 | WDA | 227 | 21 | 5 | 3.70 | 2.27 | 0.75 |
| GB 207 | WDA | 280 | 12 | 4 | 1.95 | 0.78 | 0.31 |
| GB 208 | WDA | 274 | 20 | 5 | 3.40 | 1.60 | 0.53 |
| GB 209 | WDA | 529 | 28 | 4 | 4.31 | 1.96 | 0.59 |
| GB 211 | WDA | 505 | 20 | 6 | 3.06 | 1.04 | 0.35 |
| GB 212 | WDA | 392 | 23 | 5 | 3.69 | 1.58 | 0.50 |
| GB 213 | WDA | 146 | 18 | 6 | 3.43 | 1.80 | 0.62 |
| GB 214 | WDA | 874 | 23 | 5 | 3.25 | 1.20 | 0.38 |
| GB 215 | WDA | 231 | 12 | 5 | 2.03 | 0.93 | 0.38 |
| GB 216 | WDA | 261 | 12 | 3 | 1.98 | 0.97 | 0.39 |

| Station | Project Site | Total Number of Taxa | Total Number of Phyla | Abundance (# / 0.008 $m^2$) | Richness | Diversity | Evenness |
|---|---|---|---|---|---|---|---|
| GB 217 | WDA | 517 | 21 | 4 | 3.20 | 1.22 | 0.40 |
| GB 218 | WDA | 396 | 17 | 4 | 2.68 | 1.52 | 0.54 |
| GB 219 | WDA | 491 | 17 | 5 | 2.59 | 1.13 | 0.40 |
| GB 220 | WDA | 277 | 30 | 6 | 5.18 | 2.50 | 0.74 |
| GB 221 | WDA | 411 | 19 | 5 | 3.00 | 0.59 | 0.20 |
| GB 222 | WDA | 174 | 19 | 4 | 3.49 | 2.32 | 0.79 |
| GB 223 | WDA | 310 | 15 | 3 | 2.44 | 0.74 | 0.27 |
| GB 224 | WDA | 86 | 12 | 4 | 2.47 | 1.90 | 0.77 |
| GB 225 | WDA | 198 | 21 | 4 | 3.78 | 1.74 | 0.57 |
| GB 226 | WDA | 678 | 18 | 4 | 2.61 | 0.56 | 0.19 |
| GB 227 | WDA | 97 | 15 | 4 | 3.06 | 2.22 | 0.82 |
| GB 228 | WDA | 198 | 24 | 4 | 4.35 | 2.47 | 0.78 |
| GB 229 | WDA | 168 | 22 | 5 | 4.10 | 1.88 | 0.61 |
| GB 230 | WDA | 61 | 12 | 3 | 2.68 | 1.83 | 0.74 |
| GB 231 | WDA | 84 | 16 | 4 | 3.39 | 2.01 | 0.72 |
| GB 232 | WDA | 115 | 17 | 4 | 3.37 | 2.23 | 0.79 |
| GB 233 | WDA | 226 | 22 | 4 | 3.87 | 2.14 | 0.69 |
| GB 234 | WDA | 905 | 21 | 5 | 2.94 | 0.56 | 0.18 |
| GB 235 | WDA | 410 | 23 | 6 | 3.66 | 1.32 | 0.42 |
| GB 240 | WDA | 139 | 22 | 3 | 4.26 | 1.97 | 0.64 |
| GB 241 | WDA | 359 | 17 | 5 | 2.79 | 1.43 | 0.51 |
| GB 242 | WDA | 148 | 22 | 5 | 4.23 | 2.30 | 0.74 |
| GB 250 | WDA | 158 | 18 | 5 | 3.38 | 2.01 | 0.69 |
| GB 251 | WDA | 292 | 23 | 3 | 3.88 | 2.29 | 0.73 |
| GB 252 | WDA | 75 | 15 | 4 | 3.24 | 1.95 | 0.72 |
| GB 253 | WDA | 205 | 14 | 5 | 2.45 | 1.64 | 0.62 |
| GB 254 | WDA | 222 | 20 | 4 | 3.52 | 2.11 | 0.70 |
| GB 255 | WDA | 131 | 25 | 5 | 4.95 | 2.26 | 0.70 |
| GB 256 | WDA | 159 | 17 | 3 | 3.16 | 1.91 | 0.67 |
| GB 257 | WDA | 369 | 21 | 5 | 3.38 | 1.69 | 0.56 |
| GB 258 | WDA | 337 | 25 | 5 | 4.14 | 2.10 | 0.65 |
| GB 259 | WDA | 256 | 26 | 5 | 4.52 | 2.38 | 0.73 |
| GB 260 | WDA | 79 | 21 | 6 | 4.76 | 2.63 | 0.86 |
| GB 261 | WDA | 178 | 26 | 4 | 4.82 | 2.42 | 0.74 |
| GB 262 | WDA | 118 | 20 | 4 | 3.98 | 2.39 | 0.80 |
| GB 263 | WDA | 150 | 21 | 4 | 3.99 | 2.53 | 0.83 |
| GB 264 | WDA | 147 | 23 | 5 | 4.41 | 2.02 | 0.65 |
| GB 266 | WDA | 174 | 18 | 4 | 3.31 | 1.81 | 0.63 |

| Station | Project Site | Total Number of Taxa | Total Number of Phyla | Abundance (# / 0.008 m$^2$) | Richness | Diversity | Evenness |
|---|---|---|---|---|---|---|---|
| GB 267 | WDA | 202 | 22 | 3 | 3.96 | 2.23 | 0.72 |
| GB 268 | WDA | 199 | 31 | 5 | 5.69 | 2.82 | 0.82 |
| GB 269 | WDA | 332 | 29 | 6 | 4.83 | 2.58 | 0.77 |
| GB 270 | WDA | 174 | 25 | 3 | 4.65 | 2.35 | 0.73 |
| GB 271 | WDA | 231 | 35 | 7 | 6.27 | 2.82 | 0.79 |
| GB 272 | WDA | 126 | 22 | 4 | 4.34 | 2.43 | 0.79 |
| GB 273 | WDA | 119 | 22 | 4 | 4.39 | 2.35 | 0.76 |
| GB 274 | WDA | 168 | 21 | 4 | 3.90 | 2.32 | 0.76 |
| GB 275 | WDA | 171 | 30 | 5 | 5.67 | 2.81 | 0.83 |
| GB 276 | WDA | 141 | 27 | 6 | 5.28 | 2.46 | 0.75 |
| GB 277 | WDA | 187 | 32 | 5 | 5.93 | 2.65 | 0.77 |
| GB210 R16 | WDA | 953 | 22 | 5 | 3.08 | 1.12 | 0.36 |
| GB 61 R16 | WDA | 617 | 18 | 4 | 2.65 | 1.36 | 0.47 |
| GB 18 R17 | OECC | 255 | 16 | 5 | 2.72 | 1.59 | 0.57 |
| GB 22 R17 | OECC | 5 | 2 | 2 | 0.62 | 0.50 | 0.72 |
| GB 265 R16 | WDA | 90 | 19 | 4 | 4.00 | 2.29 | 0.78 |
| GB 4 R17 | OECC | 97 | 26 | 4 | 5.46 | 2.71 | 0.83 |
| GB 50 R17 | OECC | 204 | 13 | 4 | 2.31 | 1.83 | 0.71 |
| GB 59 R17 | OECC | 765 | 19 | 6 | 2.74 | 1.35 | 0.46 |
| **Mean Values** | **n/a** | **17** | **5** | **208** | **3.38** | **1.83** | **0.67** |
| **Total Values (all stations)** | **n/a** | **134** | **14** | **27,287** | **13.02** | **2.89** | **0.59** |
| R16 = Replicated sample stations in the WDA in 2016; R17 = Replicated sample stations along the OECC in 2017 | | | | | | | |

### 2.2.3 Multivariate Analyses

**2017**

Multivariate analyses distinguished infaunal assemblages in the 30 samples collected for the 2017 survey. Data from station 1 was left out of the subsequent analyses due to lack of environmental characterization data. Clear classification of samples based on habitat type or depth through the dendrogram was not possible (Figure 8). The lack of clear separation based on the two depth categories (nearshore and neritic) was also evident in the MDS plot depicting depth (Figure 10). This lack of clear, separate ordination based on depth may be due to the limited number of samples at deeper depths. There was also little clear separate ordination between samples based on habitat type (Figure 14). The only clear cluster of samples based on habitat, which showed both separation from other samples and Bray-Curtis similarity over 40%, were three samples with coarse sand (gray plus sign). Similarity of >40% was selected as a threshold and presented in the figures and results below because it represents medial similarity between samples. In other words, stations that fall within the same 40% threshold circle contained species assemblages that were 40% similar to each other.

ANOSIM was also used to test whether depth or habitat characterizations were useful in describing infaunal assemblages at sample stations (Clarke 1993). Based on global test results, the null hypothesis that infaunal assemblages do not change within depth classifications could not be rejected (R = 0, significance level = 48.5%). The null hypothesis that infaunal assemblages do not change within habitat type was rejected (Global Test: R = 0.28, significance level = 0.5%). However, the low R-statistic indicated overall similarity in assemblages with some potentially biologically significant differences between habitat types. SIMPER, used to explain similarities in infaunal composition due to specific taxa, identified Gravel 1 and Coarse Sand as the only habitat types having similarities of 40% or higher (Table 8).

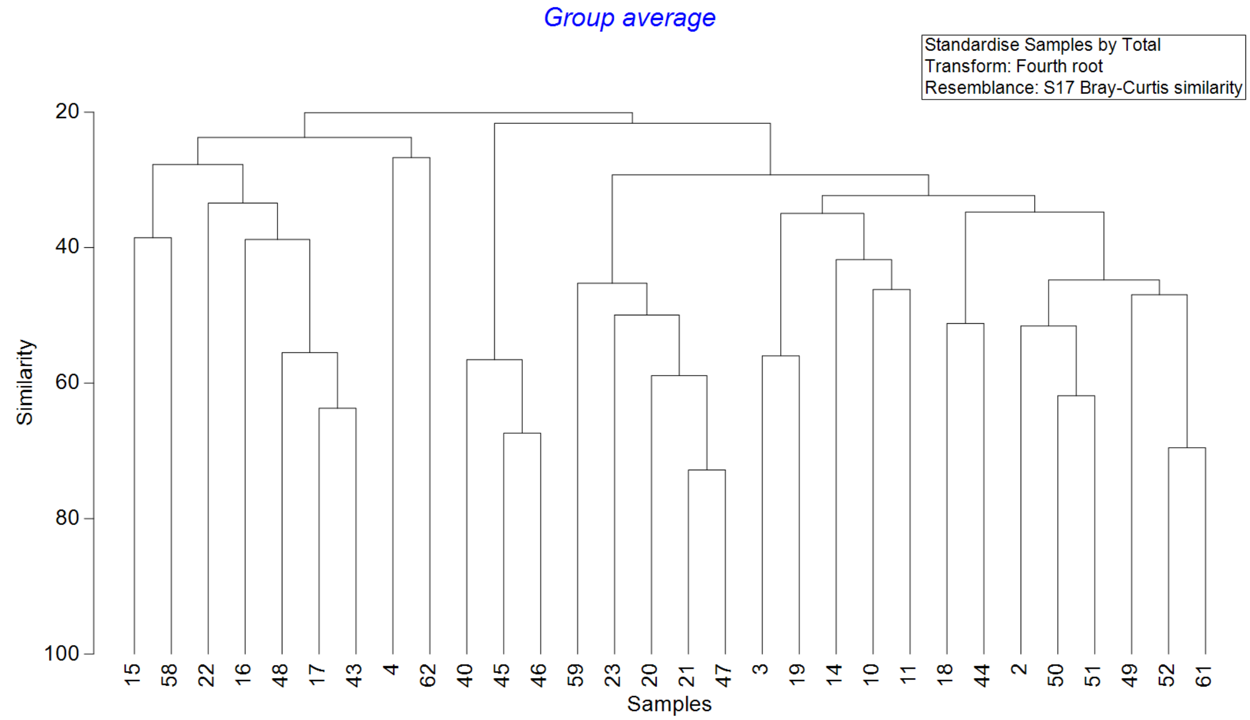


Figure 8. Dendrogram from cluster analysis based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 30 stations sampled along the Vineyard Wind OECC in the 2017 survey. Branches are based on the similarity between those clusters of samples, which is labeled on the y-axis.

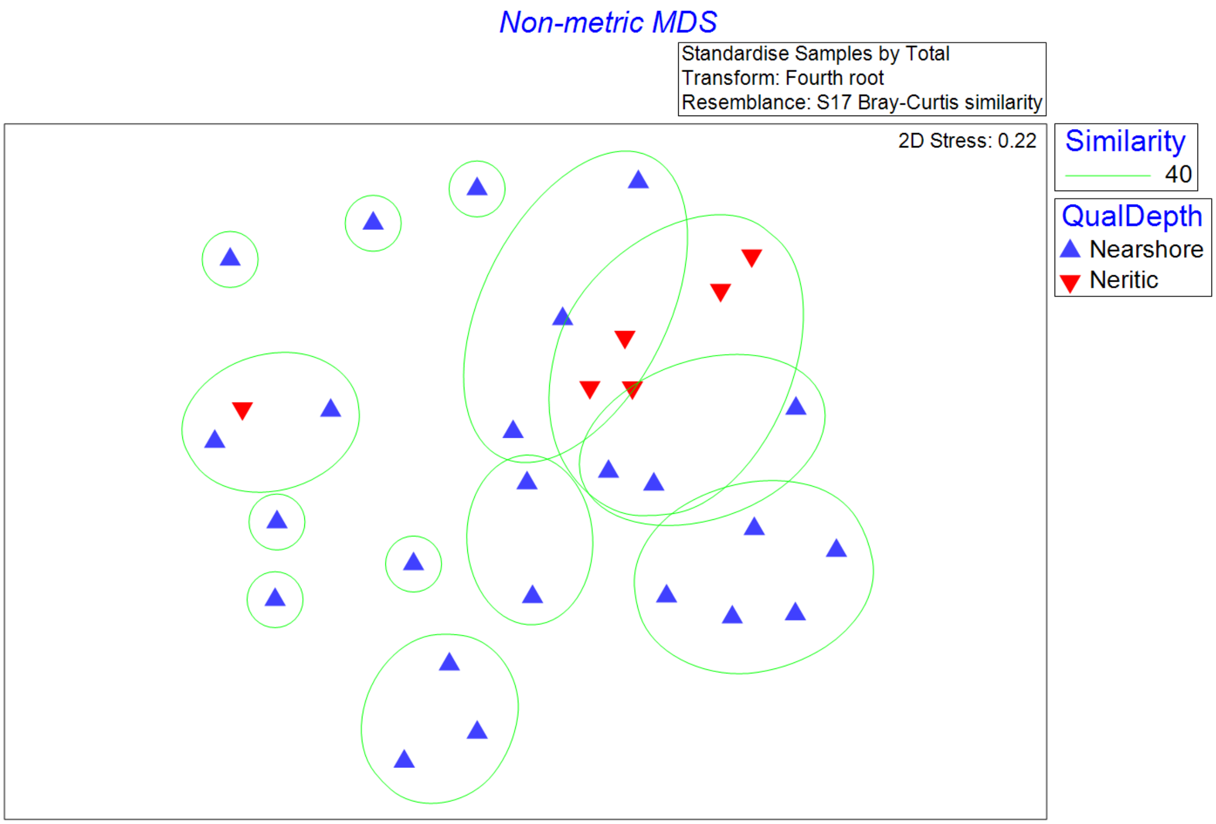


Figure 9. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 30 stations sampled along the Vineyard Wind OECC in the 2017 survey. Each symbol represents a station that is color-coded based on depth category. Green circles represent clusters of stations with Bray-Curtis similarity of 40%. For this dataset, stations did not clearly differ in community composition similarity by depth (i.e., 40% similarity circles overlapped for stations with different depth ranges).

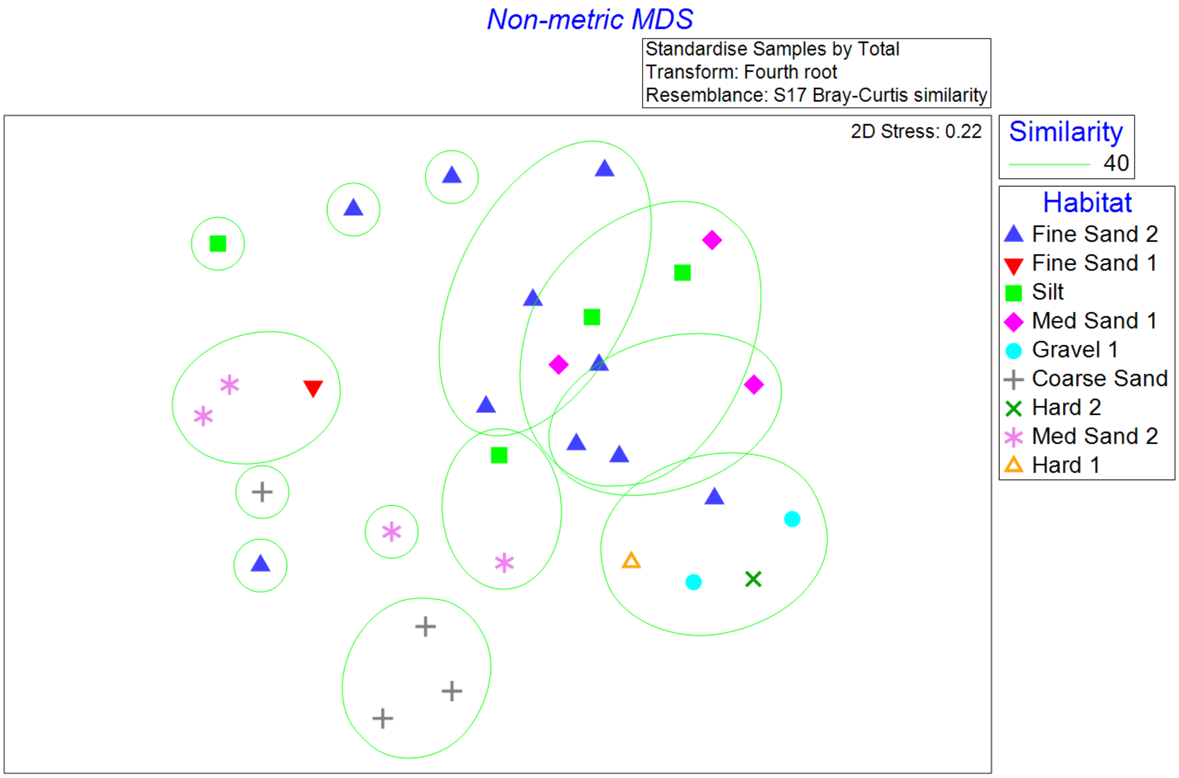


Figure 10. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 30 stations sampled along the Vineyard Wind OECC in the 2017 survey. Symbols represent stations by habitat type. Green circles represent clusters with Bray-Curtis similarity of 40%. For this dataset, stations with Coarse Sand (grey crosses) habitat type were clearly more similar to each other than to other habitat types (i.e., 40% similarity circle contained all stations with the same habitat type).

Table 8. SIMPER analysis of the 2017 samples showing taxa influential in the similarity of stations with Coarse Sand and Gravel 1 habitat (>40% similarity).

| Habitat Classification | Taxa | Average Abundance | Average Similarity | Contribution % | Cumulative % |
|---|---|---|---|---|---|
| Coarse Sand | Nematoda | 2.11 | 13.59 | 33.85 | 33.85 |
| | Astartidae | 1.7 | 7.06 | 17.57 | 51.43 |
| | Syllidae | 1.42 | 5.7 | 14.2 | 65.63 |
| | Sigalionidae | 1.14 | 4.56 | 11.37 | 77 |
| Gravel 1 | Columbellidae | 1.91 | 4.93 | 8.47 | 8.47 |
| | Pyramidellidae | 1.74 | 4.11 | 7.07 | 15.55 |
| | Syllidae | 1.47 | 4.06 | 6.98 | 22.53 |
| | Nematoda | 1.51 | 3.88 | 6.67 | 29.2 |
| | Calyptraeidae | 1.86 | 3.83 | 6.58 | 35.79 |
| | Cirratulidae | 1.43 | 3.46 | 5.95 | 41.74 |
| | Photidae | 1.29 | 3.31 | 5.68 | 47.42 |
| | LysiaNAssidae | 1.05 | 3.09 | 5.31 | 52.73 |
| | Paguridae | 1.43 | 3.09 | 5.31 | 58.03 |
| | Phoxocephalidae | 1.17 | 3.09 | 5.31 | 63.34 |
| | Polynoidae | 1.05 | 3.09 | 5.31 | 68.65 |
| | Spionidae | 1.08 | 3.09 | 5.31 | 73.95 |

**2018**

As for the 2017 survey data, multivariate analyses were used to distinguish infaunal assemblages in the 131 samples collected in the 2018 survey in the Vineyard Wind WDA and OECC. The dendrogram, which clusters based on the Bray-Curtis similarity of taxa, shows clear clustering of samples collected in the WDA (GB 201-277; Figure 11).

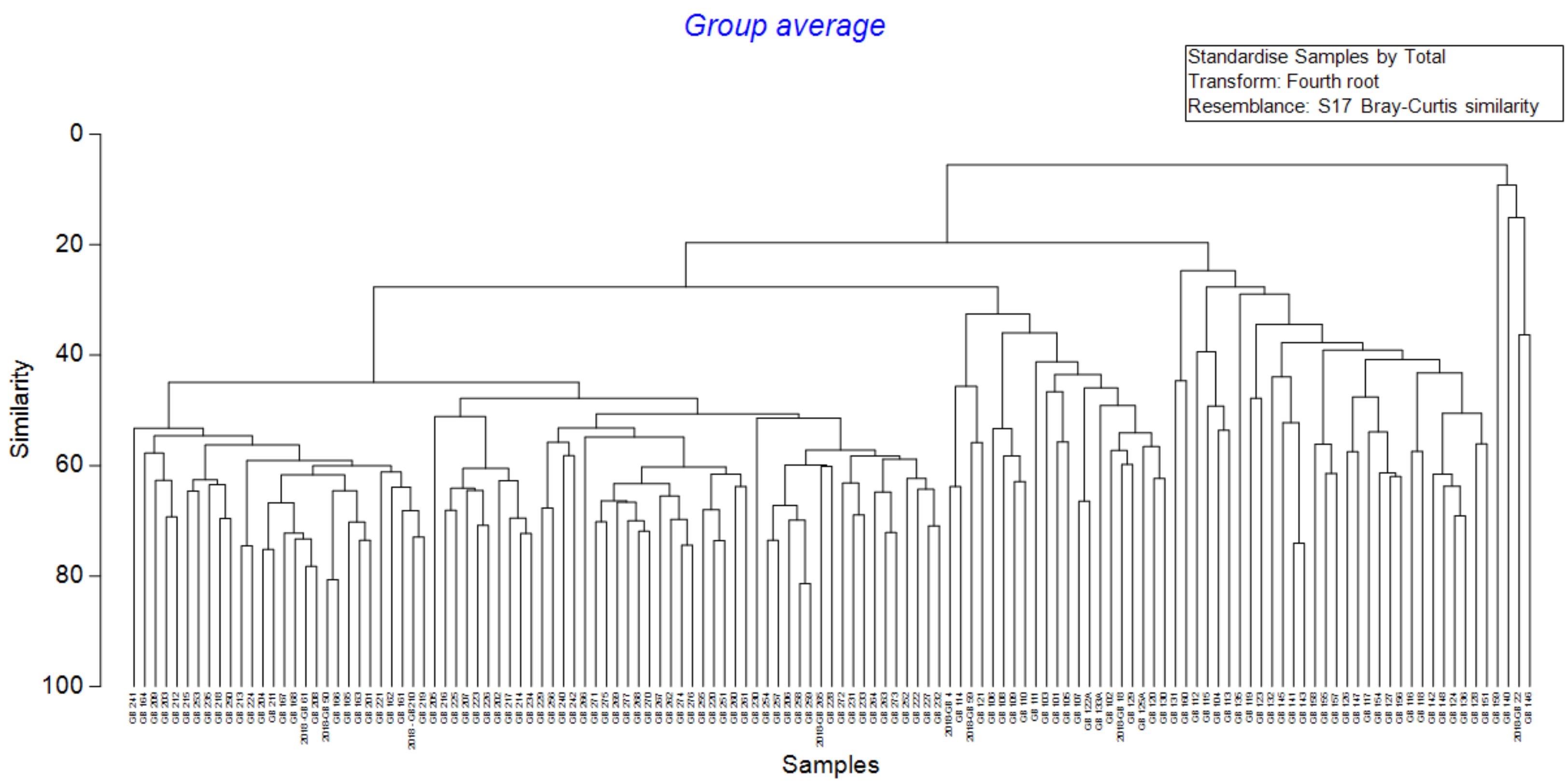


Figure 11. Dendrogram from cluster analysis based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 131 stations sampled in the Vineyard Wind Project Area in the 2018 survey. Branches are based on the similarity between those clusters of samples, which is labeled on the y-axis.

The MDS plots also show clear clustering of sample composition, which can be described by both depth and habitat type (Figure 12; Figure 13). Samples collected in neritic depths (>30 m), most of which were located in the WDA, were ordinated in a tight cluster, indicating similarity in taxonomic composition, while shallow, nearshore (<30 m) stations were spread throughout the plot (Figure 12). Clear clusters are also apparent for some samples with Fine Sand 3 and Fine Sand 2 habitat (Figure 13). To further assess the relationship between the clusters, depth and habitat type were combined in another MDS plot (Figure 14). Clear differences in the taxonomic composition between nearshore and neritic Find Sand 3 are evident, with clear clustering of samples collected in deeper, fine sand habitats. In addition, within the neritic fine sand cluster, there is further clustering and therefore taxonomic assemblage similarity between samples in Fine Sand 3 and Fine Sand 2.

Based on global test results for the ANOSIM analysis, the null hypothesis that infaunal assemblages do not change within depth classifications was rejected (R = .72 significance level = 0.1%). The null hypothesis that infaunal assemblages do not change within habitat type was also rejected (Global Test: R = 0.32, significance level = 0.1%). The low to medial R-statistic indicated that although there are differences in assemblages within habitat types, there may also be a high level of similarity between some groups. In order to further describe clusters, habitat type and depth were combined to test the null hypothesis that infaunal assemblages do not change within nearshore or neritic habitat types. The ANOSIM test results allowed for the rejection of the null hypothesis, indicating habitat and depth were good indicators of infaunal assemblage clusters (Global Test: R = 0.67, significance level = 0.1%). The SIMPER analysis identified Neritic Fine Sand 3, Neritic Fine Sand 2, Neritic Fine Sand 1, and Nearshore Fine Sand 4 as the habitat types having similarities of 40% or higher. Taxa that accounted for the similarity between samples are presented in Table 9.

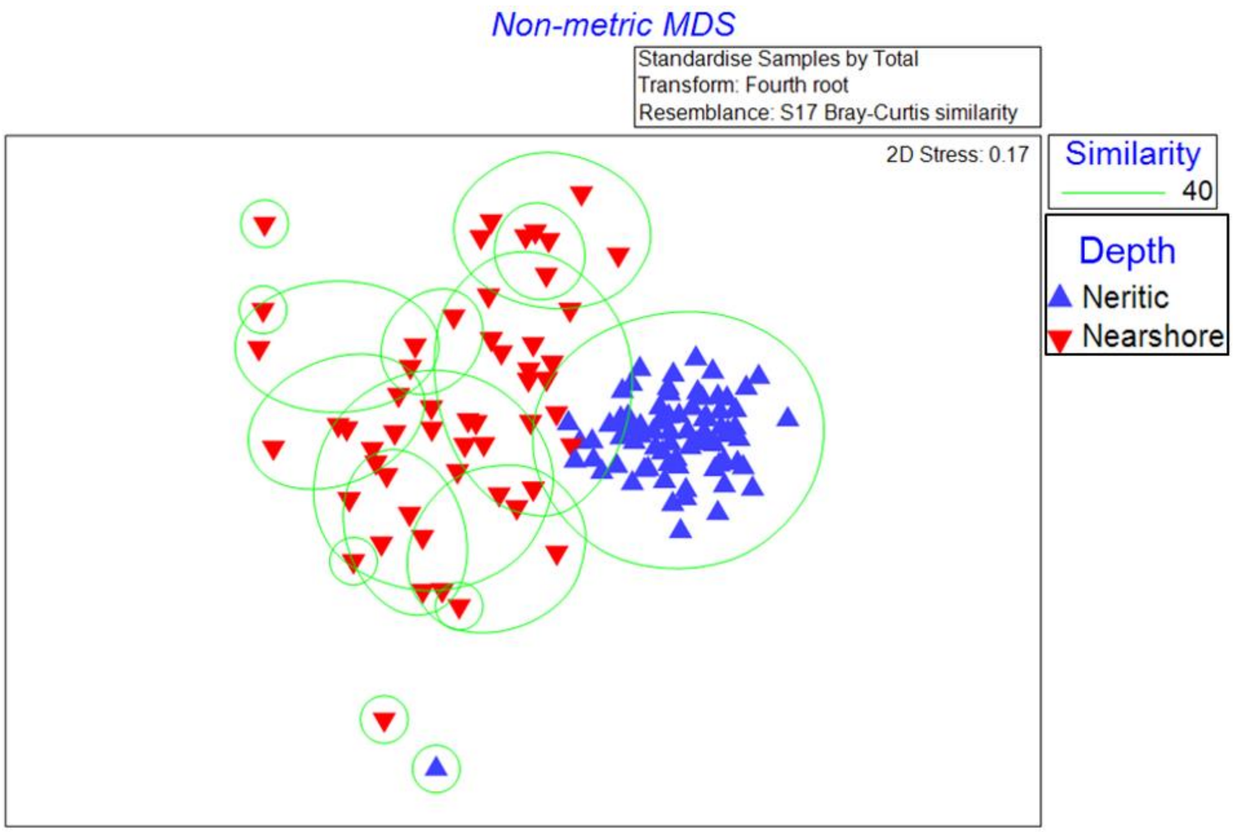


Figure 12. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 131 stations sampled in the Vineyard Wind Project Area in the 2018 survey. Each symbol represents a station that is color-coded based on depth category. Green circles represent clusters of stations with Bray-Curtis similarity of 40%. For this dataset, stations did show differences in community composition by depth (i.e., 40% similarity circles contained primarily sites with the same depth ranges).

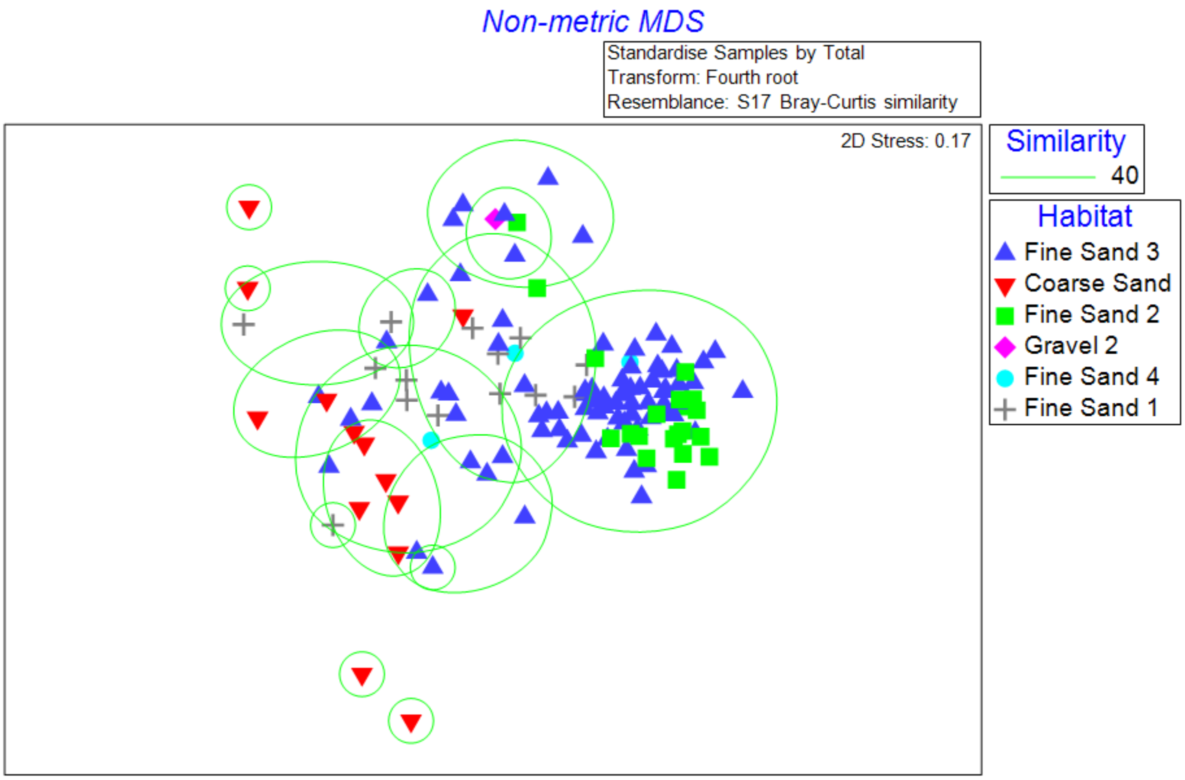


Figure 13. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 131 stations sampled in the Vineyard Wind Project Area in the 2018 survey. Symbols represent stations by habitat type. Green circles represent clusters with Bray-Curtis similarity of 40%. For this dataset, stations with Fine Sand 3 (blue triangles) and Fine Sand 2 (green squares) habitat types were clearly more similar to each other than to other habitat types (i.e., 40% similarity circles contained all stations with the same habitat type).

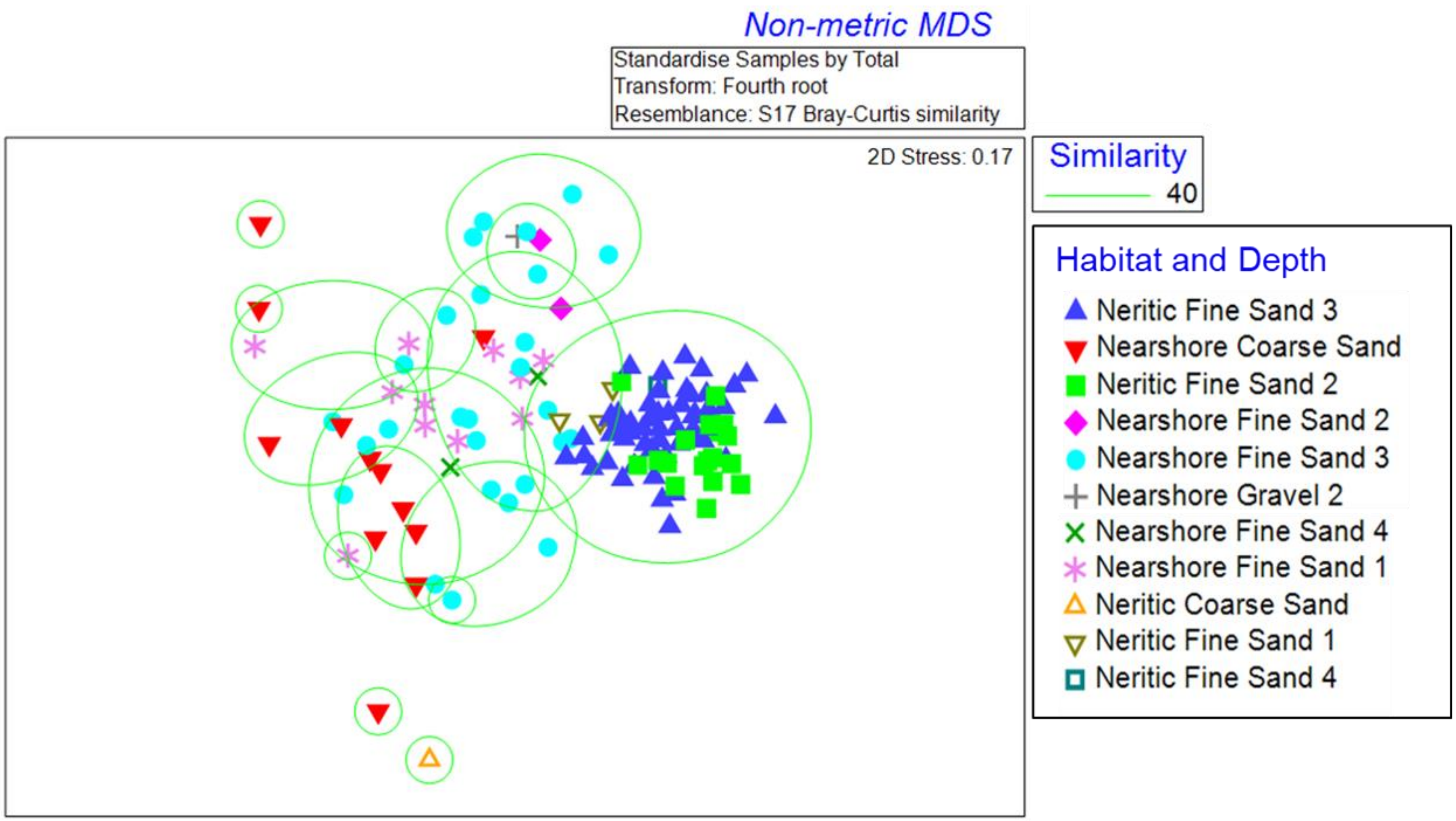


Figure 14. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the 131 stations sampled in the Vineyard Wind Project Area in the 2018 survey. Symbols represent stations by habitat type and depth zone. Green circles represent clusters with Bray-Curtis similarity of 40%. This MDS plot shows clear clustering of samples in neritic depths, with further clustering by habitat type also apparent with Fine Sand 3 (blue triangles), Fine Sand 2 (green squares), and Fine Sand 1 habitat types.

Table 9. SIMPER analysis of the 2018 samples showing taxa influential in the similarity of stations with habitat types that have an average similarity of >40%.

| Habitat Classification | Species | Average Abundance | Average Similarity | Contribution % | Cumulative % |
|---|---|---|---|---|---|
| Neritic Fine Sand 3 | Polygordiidae | 1.87 | 5.95 | 11.52 | 11.52 |
| | Lumbrineridae | 1.55 | 5.83 | 11.29 | 22.8 |
| | Nuculidae | 1.66 | 5.59 | 10.82 | 33.62 |
| | Paraonidae | 1.57 | 5.54 | 10.72 | 44.34 |
| | Cirratulidae | 1.4 | 5.2 | 10.06 | 54.4 |
| | Oligochaeta | 1.01 | 3.04 | 5.89 | 60.29 |
| | Ampeliscidae | 0.91 | 2.61 | 5.05 | 65.34 |
| | Ostracoda | 0.89 | 2.57 | 4.97 | 70.31 |
| Neritic Fine Sand 2 | Ampeliscidae | 1.98 | 5.88 | 10.63 | 10.63 |
| | Lumbrineridae | 1.8 | 5.5 | 9.95 | 20.58 |
| | Paraonidae | 1.82 | 5.39 | 9.74 | 30.33 |
| | Nuculidae | 1.39 | 3.72 | 6.73 | 37.06 |
| | Cirratulidae | 1.28 | 3.41 | 6.16 | 43.22 |
| | Maldanidae | 1.2 | 3.06 | 5.54 | 48.76 |
| | Leuconidae | 1.07 | 2.93 | 5.3 | 54.06 |
| | Nephtyidae | 0.97 | 2.33 | 4.21 | 58.27 |
| | Diastylidae | 0.91 | 2.1 | 3.79 | 62.06 |
| | Polygordiidae | 1.03 | 1.77 | 3.21 | 65.27 |
| | Opheliidae | 0.81 | 1.73 | 3.12 | 68.39 |
| | Syllidae | 0.76 | 1.58 | 2.86 | 71.25 |
| Nearshore Fine Sand 4 | Nematoda | 2.39 | 9.07 | 20.89 | 20.89 |
| | Syllidae | 2.17 | 7.8 | 17.97 | 38.86 |
| | Oligochaeta | 1.71 | 5.02 | 11.56 | 50.42 |
| | Caecidae | 1.1 | 3.81 | 8.78 | 59.2 |
| | Cirratulidae | 1.14 | 3.81 | 8.78 | 67.99 |
| | Tellinidae | 1 | 3.81 | 8.78 | 76.77 |
| Neritic Fine Sand 1 | Polygordiidae | 2.55 | 12.12 | 18.38 | 18.38 |
| | Oligochaeta | 2.2 | 9.43 | 14.3 | 32.68 |
| | Nematoda | 1.53 | 5.55 | 8.42 | 41.1 |
| | Ampharetidae | 1.23 | 5.48 | 8.32 | 49.42 |
| | Syllidae | 1.17 | 4.54 | 6.88 | 56.3 |
| | Cirratulidae | 0.99 | 4.27 | 6.48 | 62.78 |
| | Maldanidae | 0.91 | 4.09 | 6.21 | 68.98 |
| | Paraonidae | 0.92 | 3.93 | 5.96 | 74.94 |

# 3 Comparative Analyses

### 3.1.1 Methods

In order to compare samples from multiple surveys across different years, all data must be in the same unit. The 2017 and 2018 samples were conducted using the same methods and equipment and the unit of abundance data was assumed to be number of individuals per 0.008 $m^2$ for both. Sub-sampling for the 2016 survey was not conducted using the same methods and grab samples were assessed as a volume rather than area, as typical in benthic grab analyses. Therefore, the 2016 data used in the subsequent analyses was recalculated and standardized to acquire number of individuals per 0.008 $m^2$. The multivariate analysis described in Section 2.1 was repeated to compare the infaunal assemblages from samples taken at stations replicated in different years (2016 and 2018 or 2017 and 2018). In addition, comparative analyses were also conducted with all samples from all surveys to detect any overall inter-survey or regional patterns in the taxonomic assemblages. Bray-Curtis similarity was calculated to understand how different or similar sample assemblages were from one another. These scores were then used to show the ordination of points, which allowed for the visual assessment of similarity between replicated sample stations. SIMPER analysis was also conducted to describe species that were most influential in the similarity scores between the samples.

### 3.1.2 Results

An MDS plot presenting the ordination of replicated sample stations that were collected in the 2016 and 2018 or 2017 and 2018 surveys indicated similarity in the infaunal assemblages across surveys for some stations, but overall replicated station was not a good indicator of infaunal assemblage clusters (Global Test: R = 0.37, significance level = 0.3%; Figure 15; Figure 16). The low to medial R-statistic indicated that although there are some similarities between the assemblages at replicated samples, there may also be a high level of similarity between the other samples as well. If species assemblages for the replicated samples were highly similar, the MDS plot would have shown clear clusters of similar symbols ordinated near each other. The Bray-Curtis similarity percentages are presented in Table 10 and indicated some medial overlap in taxonomic assemblage at replicated stations across years. Sample stations which had infaunal assemblages with >40% similarity between surveys included station 18 (57% similar), 59 (48% similar), 50 (45% similar), and 61 (45% similar). The SIMPER analysis identified taxa responsible for similarity of assemblages between the two replicated samples. Station 59 and 18 are along the OECC relatively nearshore within Nantucket Sound, and station 50 and 61 are located farther offshore, near or within the WDA.

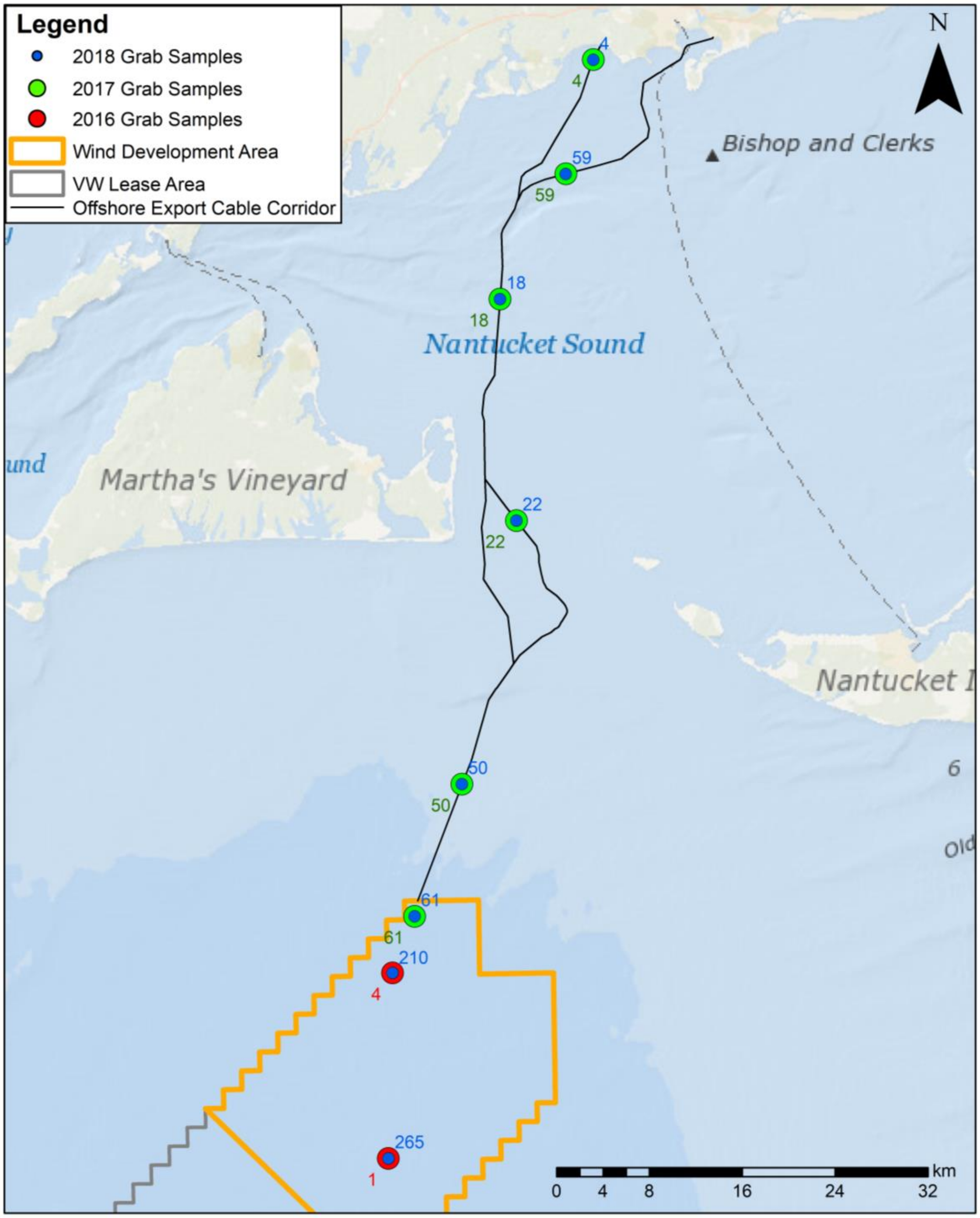


Figure 15. Map of the replicated samples taken in the 2016 (red) and 2018 (blue) or 2017 (green) and 2018 (blue) surveys. Number next to station point on the map indicates the station number as described in the survey technical documents and referred to in this report unless otherwise noted.

Table 10. Summary of ecological parameters and Bray-Curtis dissimilarity for stations sampled in two surveys.

| Station | Sample Year | Richness | Diversity | Evenness | Bray-Curtis Similarity |
|---|---|---|---|---|---|
| 61 | 2017 | 3.49 | 2.32 | 0.86 | 45% |
| | 2018 | 2.65 | 1.36 | 0.47 | |
| 18 | 2017 | 2.11 | 1.44 | 0.58 | 57% |
| | 2018 | 2.72 | 1.59 | 0.57 | |
| 22 | 2017 | 1.17 | 0.79 | 0.57 | 0% |
| | 2018 | 0.62 | 0.50 | 0.72 | |
| 4 | 2017 | 2.77 | 1.83 | 0.77 | 26% |
| | 2018 | 5.46 | 2.71 | 0.83 | |
| 50 | 2017 | 3.79 | 2.30 | 0.80 | 45% |
| | 2018 | 2.31 | 1.83 | 0.71 | |
| 59 | 2017 | 3.08 | 1.56 | 0.53 | 48% |
| | 2018 | 2.74 | 1.35 | 0.46 | |
| 4* (4.1)<br>210 (4.1) | 2016 | 1.07 | 1.03 | 0.58 | 31% |
| | 2018 | 3.08 | 1.12 | 0.36 | |
| 1 (1.1)<br>265 (1.1) | 2016 | 3.46 | 2.04 | 0.69 | 39% |
| | 2018 | 4.00 | 2.29 | 0.78 | |

*This station #4 surveyed in 2016 is not in the same location as the station #4 surveyed in 2017 and 2018. Station nomenclature was inconsistent between survey years. The numbers in parentheses indicate the station names used in subsequent plots for this analysis in order to reduce confusion (e.g., station #4.1 is the name we applied to the location called station #4 in the 2016 analysis and station #210 in the 2018 analysis).

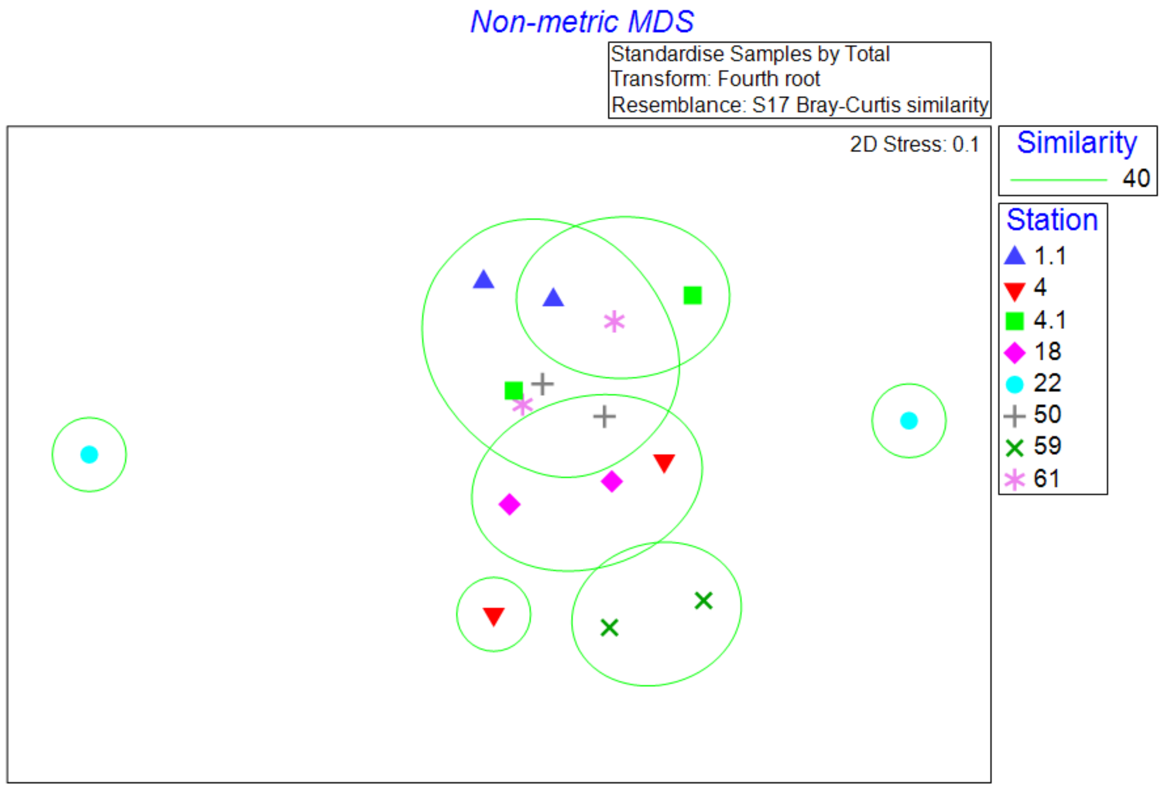


Figure 16. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at the eight stations sampled in two surveys in the Vineyard Wind Project Area. Color and symbology is based on sample station number. Green circles represent clusters with Bray-Curtis similarity of 40%.

Table 11. SIMPER analysis of the replicated samples showing taxa influential in the similarity of stations with habitat types that have an average similarity of >40%.

| Habitat Classification | Species | Average Abundance | Average Similarity | Contribution % | Cumulative % |
|---|---|---|---|---|---|
| Station 18 | Oligochaeta | 2.37 | 11.75 | 20.47 | 20.47 |
| | Capitellidae | 2.3 | 10.85 | 18.91 | 39.38 |
| | Nematoda | 1.77 | 7.59 | 13.22 | 52.6 |
| | Syllidae | 1.32 | 7.34 | 12.79 | 65.39 |
| | Ampeliscidae | 1.16 | 5.94 | 10.35 | 75.74 |
| Station 50 | Nematoda | 1.9 | 8.68 | 19.46 | 19.46 |
| | Oligochaeta | 1.74 | 5.74 | 12.86 | 32.32 |
| | Syllidae | 1.47 | 5.74 | 12.86 | 45.18 |
| | Cirratulidae | 1.36 | 5.55 | 12.43 | 57.62 |
| | Ampeliscidae | 1.63 | 5.16 | 11.57 | 69.19 |
| | Paraonidae | 1.16 | 5.16 | 11.57 | 80.75 |
| Station 59 | Nematoda | 2.18 | 8.19 | 17.12 | 17.12 |
| | Calyptraeidae | 1.61 | 7.16 | 14.96 | 32.08 |
| | Oligochaeta | 1.8 | 6.95 | 14.52 | 46.6 |
| | Columbellidae | 1.17 | 5.1 | 10.66 | 57.25 |
| | Syllidae | 0.93 | 4.4 | 9.2 | 66.45 |
| | Capitellidae | 0.94 | 4.28 | 8.94 | 75.39 |
| Station 61 | Nuculidae | 1.81 | 7.36 | 16.27 | 16.27 |
| | Ampharetidae | 1.48 | 6.74 | 14.9 | 31.17 |
| | Oligochaeta | 1.46 | 5.46 | 12.07 | 43.24 |
| | Lumbrineridae | 1.4 | 5.02 | 11.09 | 54.34 |
| | Diastylidae | 1.1 | 4.85 | 10.73 | 65.07 |
| | Ampeliscidae | 1.32 | 4.67 | 10.32 | 75.39 |

Both regional and inter-survey patterns in the taxonomic assemblages of benthic infauna between all samples from the 2016-2018 surveys were observed (Figure 17; Figure 18). As discussed above in Section 2.2.3, the infaunal assemblages were similar among stations located in the neritic sand habitats in the WDA, while there was high scatter and variability among samples in the OECC. These relationships were maintained when assessing the samples from all three surveys. Taxa contributing to the differences between project areas include, Nuculidae, Lumbrineridae, Polygordiidae, and Nematoda (

Table 12). In addition, inter-survey differences were also apparent between the 2018 and 2016 assemblages in the WDA (Figure 18).

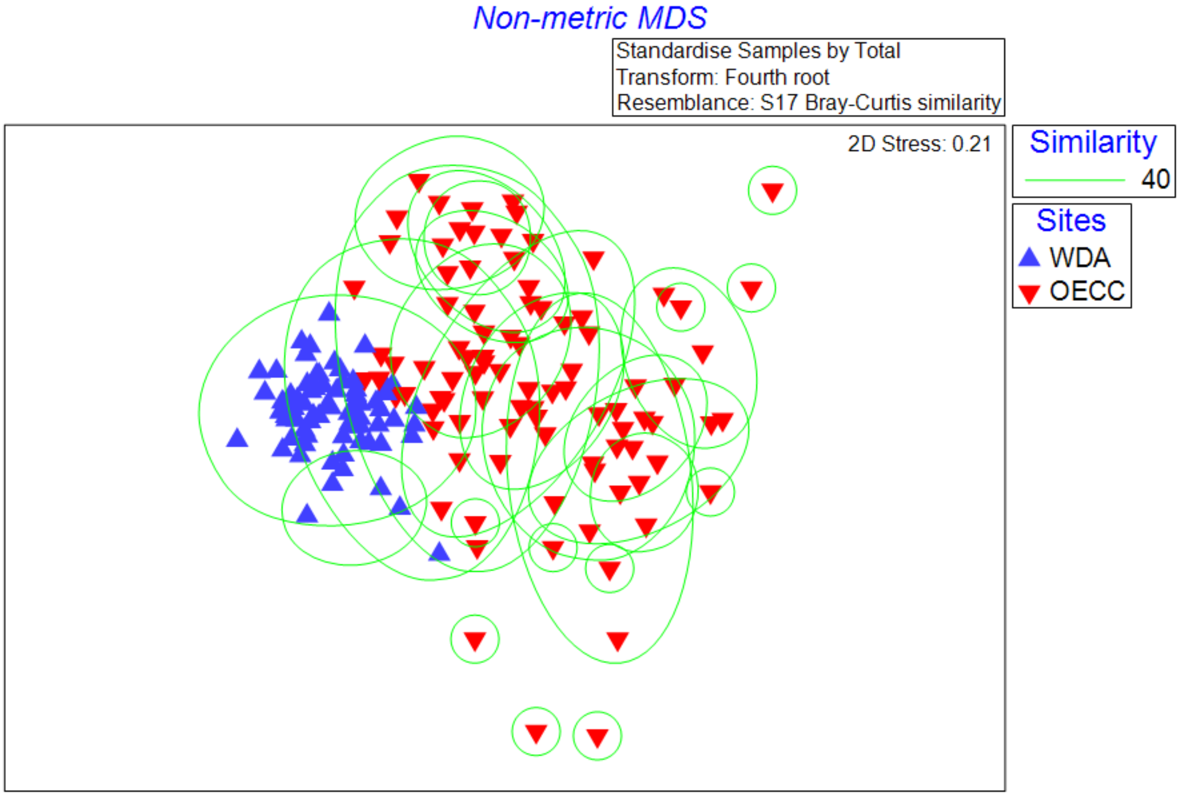


Figure 17. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at all stations sampled in the three surveys in the Vineyard Wind Project Area. Color and symbology is based on project region. Green circles represent clusters with Bray-Curtis similarity of 40%.

Table 12. SIMPER analysis showing taxa most influential in the dissimilarity between stations in the WDA and OECC (including all samples from the three surveys). Average abundances are the 4th root transformed infaunal abundances.

| Species | Average Abundance WDA | Average Abundance OECC | Average Dissimilarity | Contribution % | Cumulative % |
|---|---|---|---|---|---|
| Nuculidae | 1.57 | 0.23 | 3.56 | 4.55 | 4.55 |
| Lumbrineridae | 1.67 | 0.31 | 3.44 | 4.40 | 8.95 |
| Polygordiidae | 1.48 | 0.46 | 3.40 | 4.34 | 13.29 |
| Nematoda | 0.64 | 1.64 | 3.21 | 4.10 | 17.39 |
| Paraonidae | 1.62 | 0.40 | 3.17 | 4.05 | 21.45 |
| Ampeliscidae | 1.26 | 0.29 | 2.76 | 3.52 | 24.97 |
| Cirratulidae | 1.31 | 0.52 | 2.40 | 3.07 | 28.03 |
| Syllidae | 0.71 | 1.21 | 2.19 | 2.80 | 30.83 |
| Oligochaeta | 0.85 | 1.02 | 2.10 | 2.68 | 33.51 |
| Tellinidae | 0.10 | 0.86 | 1.98 | 2.53 | 36.05 |
| Ostracoda | 0.77 | 0.13 | 1.87 | 2.39 | 38.43 |
| Maldanidae | 0.76 | 0.33 | 1.73 | 2.21 | 40.65 |
| Capitellidae | 0.14 | 0.67 | 1.70 | 2.17 | 42.81 |
| Diastylidae | 0.67 | 0.18 | 1.65 | 2.11 | 44.93 |
| Sabellariidae | 0.70 | 0.08 | 1.59 | 2.03 | 46.96 |
| Nephtyidae | 0.61 | 0.44 | 1.57 | 2.01 | 48.97 |
| Ampharetidae | 0.56 | 0.51 | 1.54 | 1.96 | 50.93 |
| Glyceridae | 0.23 | 0.55 | 1.54 | 1.96 | 52.89 |

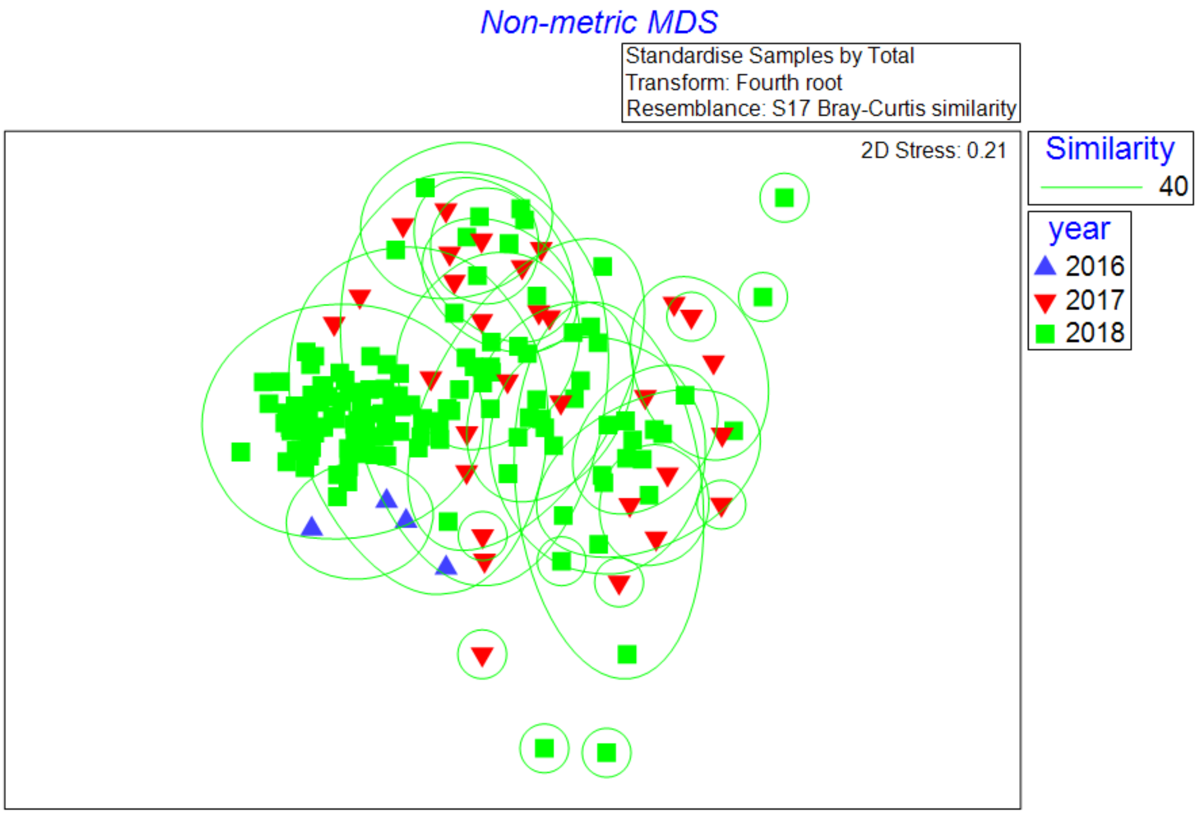


Figure 18. MDS plot based on Bray-Curtis similarities of 4th root transformed infaunal abundances at all stations sampled in the three surveys in the Vineyard Wind Project Area. Color and symbology is based on sample/survey year. Green circles represent clusters with Bray-Curtis similarity of 40%.

# 4 Discussion

Across all surveys and both sections of the Vineyard Wind Project Area (WDA and OECC), infaunal community abundance and taxonomic diversity were dominated by taxa in the Annelida, Mollusca, Nematoda, and Arthropoda phyla. Totals of 488, 3,856, and 27,287 organisms were identified through lab processing in the 2016, 2017, and 2018 benthic surveys, respectively. Across all three surveys, 155 unique taxa from 14 phyla were identified in the benthic grab samples.

Comparison between samples collected in the WDA (67) and the OECC (64) in the 2018 survey indicated overall higher abundances of organisms in the WDA, with 19,581 and 7,706 organisms collected in the WDA and OECC, respectively. Organisms from the Annelida phylum dominated abundance in both areas with those from the Polygordiidae family having the highest abundances of a single taxon. In the WDA, organisms from the Mollusca phylum and Nuculidae family were also abundant.

Richness, which is based on the number of taxa in a sample or area, was lower in the individual samples along the OECC than those collected in the WDA. However, across all stations in the project areas, more unique taxa were observed along the OECC with 110 taxa identified compared to 86 identified in the WDA. Evenness, which is based on the similarity of abundances of taxa, was higher in stations along the OECC, indicating less samples with singularly dominating taxa. Mean diversity for stations only in the WDA or OECC was similar, however, when taxa were combined and analyzed by project area, diversity was higher in the OECC (3.13) than in the WDA (2.40). The higher richness, diversity, and evenness in the OECC may, in part, be a result of the increased habitat heterogeneity along the route, which supports more niches and resultant diversity in taxonomic assemblages (Tews et al., 2004). In addition, the relatively homogenous fine sand habitat in the WDA may favor certain taxa and could explain the lower richness and few dominating species (i.e., Polygordiidae and Nuculidae) observed in these samples (Rosenzweig & Abramsky 1993). These trends can be seen in the MDS plots with high similarity (close ordination) of infaunal species assemblages (Bray-Curtis similarity) in the neritic fine sand habitats (located in the WDA) and more dissimilarity or scatter in the other habitat types (located along the OECC).

Results from the multivariate analyses also indicated differences in the taxonomic assemblages in the WDA and the OECC. These relationships were apparent when comparing taxonomic assemblages of samples across all surveys and in only 2018. Samples collected in the WDA were all in neritic water depths (>30 m) and consisted of only two habitat types, Fine Sand 2 and Fine Sand 3. MDS plots presenting Bray-

Curtis similarity between the taxonomic assemblages at each station in the 2018 survey ordinated stations with these habitats very closely, indicating similarity in those assemblages, and an overall difference between benthic communities within the WDA compared to those along the OECC. Habitat type and bottom depth category were much more variable along the OECC with all the unique and hard bottom habitats occurring in this area. The MDS plots for both the 2017 and 2018 surveys showed little evidence of conclusive clustering based on the other habitat types and depth descriptor, indicating little similarity between stations outside of the WDA. Overall, these results demonstrated that habitat type and depth were good predictors of taxonomic assemblages of stations within the WDA but not for those along the OECC. In addition, is it evident that the composition of taxa in the WDA is homogenous, with slight variations occurring between the fine sand habitat types.

Comparisons of the taxonomic assemblages at stations that were sampled in two survey years indicated medial to low similarity between the samples. The level of similarity/dissimilarity between samples could be the result of a variety of differing conditions between surveys, such as season, exact grab sample location, or natural environmental turnover. With the current data, identifying cause for the dissimilarity is not possible. However, from these results it is evident that although there is some dissimilarity between individual stations across years, overall taxonomic assemblages show similar patterns of heterogeneity along the OECC and homogeneity in the WDA.

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## Appendix A

# Standard Operating Procedure
# Laboratory Analysis: Marine Benthic Infauna

May 15, 2018

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**TABLE OF CONTENTS**



**LIST OF EQUATIONS**

This SOP addresses the laboratory operations and analyses for marine benthic infauna samples. This plan describes data quality objectives, measurement and data acquisition, and information management for processing marine benthic infauna samples.

## QUALITY OBJECTIVES AND CRITERIA

Sorting Efficacy – Aliquot Method

At least 20% of each sample is re-sorted by a quality control technician, who did not originally sort the sample, to ensure at least 90% of the organisms have been removed. The QCs are performed by technicians who have shown to achieve 90% efficacy on a minimum of 90% of samples they process. QC technicians are trained in the QC process by the sorting lab manager. The QC technician QCs a minimum of 20% of the sorted material from a given sample to ensure at least 90% of the organisms have been removed. The estimated percent efficacy is calculated, using the following equation:

**Equation 1. Sorting Efficacy**

$$\underline{\text{Sorting Efficacy }}\%=\left(\frac{Original\ Count}{Origianl\ count+\left(\left(\frac{QC\ count}{QC'd\ Grids}\right)*QC\ total\ girds\right)}\right)*100$$

Where:
OriginalCount = the number of organisms picked by the first sorter
QCCount = the number of organisms found in the Quality Control sort
QC'd grids = the number of grids sorted during the QC process
QC Total grids = the total number of grids in the QC Caton

Sorting efficacy is measured as the estimated percent of the total organisms found during the original sorting process. If the estimated percent sorting efficacy is 90% or greater, the sample passes the quality control check. If the estimate is less than 90%, the sample is re-sorted. When this happens, the sample undergoes the quality control process again until it passes the 90% efficacy requirement.

## SAMPLE HANDLING AND CUSTODY

Immediately upon receipt of samples, all containers are inspected for damage or leakage. Sample labels are checked against chain of custody forms and/or packing slips and any discrepancies are noted. Receipt records are reported to the client within one business day of sample receipt. Chain of custody logs are reported, throughout the project, according to timelines and methods requested by the client. Samples are logged into the EcoAnalysts, Inc. custom LIMS database and assigned a unique sample tracking number.

Sample components will be stored for 30 days. After 30 days, upon direction of the client, sample components will be returned to the client or a client provided location for long term storage or disposed of. Sample material will be stored in 95% ethanol/5% glycerol at room temperature.

## ANALYTICAL METHODS

### Sorting Marine Benthic Infauna Samples

A sample is checked out by a sorting technician via the LIMS. A sorting bench sheet is printed that contains the EcoAnalysts sample identification information and sorting protocols assigned to it. The sorter records the primary matrix type and approximates the volume of detritus prior to sieving.

The sample is prepped for subsampling by rinsing the matrix into a 500 mm or 1000 mm mesh sieve as directed by the client. If the sample matrix is made up of a significant percentage of inorganic material, the organic material will be elutriated from the inorganic material prior to sorting.

For elutriation, the whole sample is washed into a shallow pan of water. At this time any large pieces of organic material can be rinsed and inspected thoroughly by the original technician and a secondary technician for attached and burrowing aquatic invertebrates. If large organic matter is deemed removable from the sample, it is retained separately as sample residues. The sample is agitated with water to separate any organic matter from inorganic sediments. After agitating the sample in water, the lighter organic material is poured back into the sieve. The inorganic portion of the sample remaining in the pan is repeatedly washed and decanted into the sieve until no more organic matter remains in the pan with the inorganic material.

The remaining inorganic sediments are inspected under a magnifying lamp (3X) to look for any invertebrates too heavy to have been elutriated. If there are significant numbers of heavy invertebrates in the inorganic material – too many to easily remove under the magnifying lamp – the inorganic and organic matrix is recombined into the sieve and entire sample matrix will be prepared for subsample. If there are not significant numbers of heavy invertebrates in the inorganic material, they are removed under the magnifying lamp and placed with the organic matrix. A second technician inspects the inorganic material for organisms until it is determined there are no more invertebrates in the inorganic fraction of the sample. Unless otherwise requested, the inorganic elutriate is discarded.

The organic material and other contents of the sieve are then evenly distributed into the bottom of a Caton-style tray. These are trays of various sizes consisting of uniform grids, each grid being 2 inches per side and the bottom is constructed of 250-micron mesh. A grid (or a standardized portion of a grid) is randomly selected and its contents transferred to a Petri dish. The material in the Petri dish is sorted under a dissecting microscope (minimum magnification = 10X). The benthic infauna are counted as they are placed into vials containing 70% ethanol. Sorters are trained to pick and count only invertebrates that were alive during sampling and contain the attributes required for taxonomic identification.

Laser-printed labels containing the appropriate sample tracking information are placed in the vial(s). The total number of organisms removed (not including large and rare organisms), the number of grids sorted out of the total, the time spent sorting, and the final volume of the remaining sample volume are all recorded on the sorting bench sheet, as well as comments significant to the preparation, sorting, and/or condition of the sample.

To ensure every sample meets a standard minimum level of sorting efficacy, standard sorting quality assurance is maintained by re-sorting a portion of the sorted material of every sample that is processed in the lab, and ensuring a minimum efficacy is reached. If a technician is continually not meeting the efficacy requirements of the project, they will be removed from the project. Supplemental project specific guidance that may be provided by the lab manager, such as photo reference guides for rejects.

### Taxonomic Identification of Marine Benthic Infauna

A taxonomist selects a sample for identification via the LIMS and empties it into a Petri dish. Under a dissecting and/or compound microscope, the invertebrates are identified to the lowest practical level, generally genus/species. The taxonomist enters each taxon directly into the project database using a unique taxonomic code (this is done while at the microscope). The number of individuals of each taxon is counted and entered into the database. As the sample is being identified, the taxonomist enters data directly into the LIMS database and user interface.

The taxonomist measures size class to the nearest whole mm. Size class is measured from the tip of the head to the end of the abdomen. Size class may be extrapolated if the individual is damaged or may be recorded as “Sample condition” = “Damaged, affecting measurement”.

If requested, a synoptic reference collection will be prepared, where at least one specimen (preferably 3-5 specimens) of each taxon encountered is placed into a 1-dram vial containing 70% ethanol and is properly labeled with identity and sample number.

## DATA MANAGEMENT

Data is directly entered into the LIMS database. Throughout the project and sample analysis, data entry is double checked for accuracy, and validated by the laboratory managers. The appropriate data are combined for each sample to obtain the sorting statistics and comprehensive taxa lists and counts.

Quality assurance data sheet checks are part of the sample validation process, and include scanning for apparent entry errors, measurement errors, omissions, and anomalies. Suspect data are flagged and/or excluded from use. Data may be presented in table, graph, and chart format. Unusual data are rechecked to verify their accuracy.

Data is formatted on client data ingest sheets and returned by uploading directly to the client project data portal or returning to a filesharing folder.

5. CR Environmental June/July 2018 Underwater Video Review

# JUNE/JULY 2018 UNDERWATER VIDEO SURVEY DATA REVIEW
# Vineyard Wind Project
# Lewis Bay, Centerville Harbor, Nantucket Sound & Atlantic Ocean


*Spider crab feeding on a slipper limpet reef*

***Prepared By:***

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**October 2018**

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## FIGURES



## PLATES of Representative Video Screen Captures of Bottom Habitat and Biota

## 1.0 INTRODUCTION

CR Environmental, Inc. (CR) reviewed benthic underwater video data collected along the proposed Vineyard Wind Offshore Export Cable Corridor (OECC), and the Eastern Muskeget and New Hampshire Avenue optional corridors within Nantucket Sound and the Atlantic Ocean under contract to GeoSubsea. The proposed OECC runs approximately 78 kilometers from the Atlantic Ocean southeast of Martha's Vineyard north through Nantucket Sound including Muskeget Channel and makes landfall at Covell's Beach, Centerville Harbor. The New Hampshire Avenue Optional Corridor goes through the entrance to Hyannis Harbor and Lewis Bay and makes landfall at New Hampshire Avenue. Water depths were shallowest nearshore ranging from 1 to 7 meters in Centerville Harbor, Lewis Bay and the Hyannis Harbor entrance channel, and deepest 34 to 47 meters offshore southeast of Martha's Vineyard in the Atlantic. Underwater video footage along fifty three transects was collected and initially reviewed by CSA Ocean Sciences, Inc. (CSA) and Epsilon Associates aboard the M/V Theory using a towed video sled from June 24 to July 3, 2018 (CSA, 2018).

## 2.0 METHODS

A marine biologist from CR reviewed the underwater video footage to further describe and verify bottom habitat types and identify associated biota for each of the transects along the OECC and optional routes. Review methods included freezing frames and collecting screen captures approximately every minute to allow for the confirmation of species identifications and bottom substrate characterization along each transect.

Specifically the underwater video review included the following for each transect:

- Identification of the dominant fauna and its relative abundance,
- Presence/absence data for biota observed and their commercial importance
- Bottom habitat classification based on Auster (1998),
- Massachusetts Coastal Zone Management's (MACZM) modified Barnhardt et al. (1998) bottom sediment classification, and



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- The presence of MACZM Special, Sensitive or Unique Resources (e.g., eelgrass beds, and hard bottom).

Auster (1998) developed a hierarchical approach for classifying marine bottom habitats in the outer continental shelf of the northwest Atlantic. Sediments are classified along a gradient of grain sizes from mud to boulders (Table 1). The eight general habitat categories are ranked by Auster (1998) based on their complexity and effectiveness in providing habitat, attachment surfaces, and shelter for a variety of marine plants and animals. Those with the highest habitat rankings are for *pebble-cobble with sponge*, *partially buried or dispersed boulders*, and *piled boulder* substrates. The various forms these bottom habitats take and the infauna and epifauna associated with the sediments produce a wide diversity of habitat types for fish and associated fauna. Seafloor substrates based on the MACZM modified Barnhardt et al. (1998) sediment classification scheme are: Fine, Fine with Gravel, Fine with Rock, Gravel with Fine, Gravel, Gravel with Rock, Rock with Fine, and Rock. Identification of flora and fauna was made to the lowest taxonomic level possible using references by Weiss (1995), Martinez (1994), Miner (1950), and Bigelow and Schroeder (1953).

## 3.0 RESULTS

The underwater video transects ranged from approximately ten to thirty minutes in length. Table 2 provides the primary bottom habitat classification based on Auster (1998) observed at each video transect grouped by area. A secondary bottom classification is provided for alternate bottom types observed on $\geq$10% of the video based on elapsed time. Otherwise no secondary bottom class is reported. In addition, Table 2 provides MACZM's modified Barnhardt et al. (1998) sediment classification scheme, the dominant faunal species observed, and identifies transects where Special, Sensitive or Unique Areas (SSUs) were observed. The centroid coordinates for each transect is also provided.

The primary bottom classification (Auster 1998) for video transects along the proposed OECC and optional corridors is graphically represented on Figure 1. Dominant fauna observed on each transect is graphically represented on Figure 2. Figures 3 and 4, respectively, provide a detail of the substrate and dominant fauna at the nearshore portion of the proposed OECC through



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Centerville Harbor landing at Covell's Beach, and the New Hampshire Avenue Option through the entrance to Hyannis Harbor and Lewis Bay.

A list of flora and fauna observed by transect along with summary statistics of species richness by transect and frequency across transects are provided on Table 3.

## 3.1 Bottom Habitat Classification and Dominant Biota

### 3.1.1 Nearshore areas - Centerville Harbor (OECC), Lewis Bay and the Hyannis Harbor entrance channel (New Hampshire Avenue Option)

**Centerville Harbor Covell's Beach (proposed OECC)**

Water depths during the underwater video survey in Centerville Harbor ranged from 3.3 to 6.9 meters. The primary habitats along the OECC in Centerville Harbor were of low complexity and included *flat sand, mud* (6 of 8 transects) and *flat sand, mud / pebble-cobble* (2 of 8 transects). Secondary habitat of *pebble-cobble* (i.e. observed over at least 10% of the elapsed footage) was noted for half of the Centerville Harbor video transects (V-119, -120, -121, and -153) (Table 2, Figure 3). Occasional boulders (*partially buried or dispersed boulder*) were identified as secondary habitat at V-117, -118, and -152 at the shoreward end of the proposed OECC in Centerville Harbor.

Eelgrass a Special, Sensitive or Unique Resource (SSU) was observed at 3 of the 8 transects along the OECC in Centerville Harbor. At transect V-117, a bed with moderate to dense eelgrass was observed (Plate 1), however, only sparse eelgrass strands were observed at V-118 and V-120.

The majority of dominant fauna along transects in Centerville Harbor were rarely observed on the video footage (Table 2, Figure 4). These species included bay scallops, knobbed whelks, spider crabs, and moon snails (Plate 1).



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Dense to moderate macro algae coverage was observed at the majority of the Centerville Harbor transects. The algal cover was predominantly comprised of dead man's fingers, sea lettuce, purple laver, and several species of branching red algae. Gutweed, and rockweed were occasionally observed (Table 3).

**Lewis Bay and the Hyannis Harbor Entrance Channel (New Hampshire Avenue Option)**

Water depths during the underwater video survey along the New Hampshire Avenue Option ranged from 1 to 6.2 meters. The primary habitat type for all 15 of the underwater video transects in the Hyannis Harbor entrance channel and Lewis Bay was the low complexity *flat sand, mud* bottom (Table 2, Figure 3). A secondary bottom habitat of *pebble-cobble* (i.e. covering at least 10% of a transect) was recorded for the 4 entrance channel transects V-110, -111, -114, and -115; and one Lewis Bay transect, V-103.

No eelgrass was observed along the Hyannis Harbor entrance portion of the optional corridor. Sparse eelgrass, consisting of a few isolated plants was observed at V-109 in Lewis Bay.

Similar to Centerville Harbor, dense to moderate macro algae was observed at the majority of the Lewis Bay video transects. The algal cover was similarly comprised of dead man's fingers, sea lettuce, purple laver, and several species of branching red algae. Gutweed, and rockweed were occasionally observed (Table 3).

The majority of dominant fauna were rarely observed along the transects in Lewis Bay and the Hyannis Harbor entrance channel (Tables 2 and 3, Figure 4). These species included bay scallops, knobbed whelks, spider crabs, and moon snails (Plate 2). The only dominant fauna that was common or abundant was slipper limpets at transects V-103 and V-104 in Lewis Bay, and V-114 in the Hyannis Harbor entrance channel. At V-113, in Lewis Bay a bacterial mat (*Beggiatoa* sp.) was present which can be indicative of anoxic sediment and elevated nutrients.



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### 3.1.2 Nantucket Sound (OECC)

The Nantucket Sound transects were in water depths of 5.5 to 20 meters. Similar to the harbor video transects, the primary habitat in Nantucket Sound was *flat sand/mud* (Table 2, Figure 2), however, overall there was increased bottom habitat complexity. A *shell aggregate* substrate was observed as the primary habitat type at V-122 and V-148. Secondary habitat of low relief *sand ripples* was observed at V-116, -123, and -124, secondary habitat of *pebble-cobble* was observed at V-146 and -149, and *partially buried or dispersed boulders* at V-122.

Mollusks were the dominant biota in Nantucket Sound including: knobbed whelks, slipper limpets, and mud snails (Tables 2 and 3, Figure 3). At transect V-148, a productive slipper limpet reef with 50-100% coverage was observed. Multiple observations of star coral, spider crabs, knobbed whelks, purple sea urchins, black sea bass, and sea robins were noted at this transect. The spider crabs and knobbed whelks were observed feeding on the slipper limpets (Plate 3).

### 3.1.3 Muskeget Channel (OECC) and the Eastern Muskeget Option

Water depths in Muskeget Channel during the video survey ranged from 6 to 20 meters. The strong currents of the Muskeget Channel have shaped the bottom habitat. The primary habitat observed on the video transects was *sand waves* often combined with *pebbles-cobble* habitat observed in the troughs. Secondary bottom habitat at 2 of the 11 transects (V-125 and -126) was the higher complexity *partially buried or dispersed boulder* (Table 2, Figure 1).

Rare observations of bread crumb sponge, amphipods, moon snails, tube worms, and plume worms were observed along the OECC and Eastern Muskeget Option (Table 2, Plate 4). Blue mussels were observed within the Muskeget Channel at V-127 west of the OECC (Table 3, Figure 2).

Dominant biota observed included abundant observations of sulfur sponge at V-125, and V-132 on the Eastern Muskeget Option. Other biota associated with the sulfur sponge bottom included



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orange encrusting bryozoans, sand sponge, invasive white tunicate, tube worms, barnacles, sea robins, and black sea bass (Table 3).

### 3.1.4 Atlantic Ocean southeast of Martha's Vineyard (OECC)

In waters southeast of Martha's Vineyard at depths ranging from 34 to 47 meters the primary habitats along the OECC video transects were the relatively low complexity, *flat sand*, *mud* and *biogenic structure*s. The bottom habitat classification, *biogenic structures,* is characterized by burrows and depressions that are used by mobile fauna for shelter (Table 1, Auster, 1998).

Dominant biota included common sand dollars, sulfur sponge, and burrowing anemones (Plates 5A and 5B). Hermit crabs were the dominant biota at V-136, however, in low numbers. Other biota observed only at these deeper water video transects included solitary hydroids, sea pens, and mysid shrimp. Multiple observations of red hake in burrows, skate, summer flounder, and long-finned squid were also noted.

## 3.2 General Observations along the Proposed Offshore Export Cable Corridor

### 3.2.1 Bottom substrate classification

Bottom substrate classification along the cable corridor, based on the MACZM modified Barnhardt classification scheme included 57% fines, 28% fines with gravel, 11% fines with rock, 2 % gravel, and 2% gravel with rock (Table 2). With the exception of a few isolated boulders and areas of gravel bottom, much of the hard bottom encountered during the survey was to limited gravel found within sand wave troughs.

### 3.2.2 Bottom Habitat and Biota

The video transects with the highest species richness, eight or more invertebrate and fish species, were in the Muskeget Channel at V-127 (10 species), and the Atlantic Ocean, southeast of



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Martha's Vineyard at V-137 (14 species), V-138 (11 species), and V-151 (11 species) (Table 3). The only exceptions were V-122 and V-148 in Nantucket Sound. The lowest species counts, six or fewer, were on the inshore *flat sand, mud* habitat of Centerville Harbor and Lewis Bay, and in the *sand wave* habitat of Muskeget Channel at V-128, -129, -130, and -131.

The most frequently observed biota on all 53 video transects were knobbed whelk (43%), four eyed amphipod (40%), slipper limpet (36%), bay scallop (26%), hermit crabs (26%), and sulfur sponge (21%). A total of 39 invertebrates, 6 fish, and approximately 7 algal species were observed during the video review. Red branching algae was observed at 55% of the transects and this general classification represents 4 to 5 different species of bushy red seaweeds 1-2 feet in length and 2 to 3 species of tuft-like algae 3-4 inches in height that were attached to pebble, cobbles and shell.

### 3.2.3 Commercial species

Knobbed whelks were the only commercial invertebrate species recorded in significant numbers. Bay scallops, sea scallops, surf clams, blue mussels, rock crabs, blue crabs, and horseshoe crabs were observed in low numbers. Of the commercial fish species observed: scup, black sea bass, skate, and red hake; only red hake and skate were noted at a significant number of transects primarily in the deeper waters southeast of Martha's Vineyard (19%) (Table 3).

### 3.2.4 Special, Sensitive or Unique Areas

The presence of obvious Special, Sensitive or Unique Areas (SSUs) such as areas of hard/complex bottom or eelgrass beds along the OECC and optional corridors was very limited. Of the 53 video transects, only a small amount of *partially buried or dispersed boulder* habitat was recorded at V-125 and -126 in the Muskeget Channel, at V-122 in Nantucket Sound, and V-117, -118, and -152 in Centerville Harbor. No *piled boulders* or rock ledge bottom habitat was observed along any of the video transects. The moderate to dense eelgrass bed off Covell's Beach at V-117 in Centerville Harbor and areas of isolated rooted plants observed at V-118 and



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V-120 in Centerville Harbor, and V-103 in Lewis Bay should be further evaluated to determine the extent of this SSU along the proposed OECC and if needed New Hampshire Avenue optional corridor.

## 4.0 LIMITATIONS

In the months of June and July, water column visibility in the shallow bays of Cape Cod is often poor due to diatom blooms. The low water column visibility during the 2018 video survey and the presence of dense macro algae nearshore often obscured the bottom, and observations of biota in Lewis Bay and Centerville Harbor may have been underestimated. The ideal time to conduct underwater video surveys in these shallow embayments would be in spring or late fall. Additionally, for segments of the video footage the sled was too high off the bottom to make all but very general biota and bottom habitat observations. The number of transects identified as having sand waves may have been underestimated as they are difficult to detect with underwater video alone due to the camera angle. Project side scan sonar or multibeam backscatter may more accurately detect their presence.

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# TABLES

**TABLE 1**

**Bottom Habitat Classification (Auster, 1998)**

| **Habitat Description** | **Rationale** | **Complexity Score** |
|---|---|---|
| Flat sand, mud | Areas with no vertical structure such as depressions, ripples or epifauna | 1 |
| Sand waves | Troughs provide shelter from current; previous observations indicate that species such as red hake hold position on the downcurrent sides of sand waves and ambush drifting demersal zooplankton and shrimp | 2 |
| Biogenic structures | Burrows, depressions, cerianthid anemones, hydroid patches; features that are created or used by mobile fauna for shelter | 3 |
| Shell aggregates | Provide complex interstitial spaces for shelter; also provide a complex, high-contrast background that may confuse visual predators | 4 |
| Pebble-cobble | Provide small interstitial spaces and may be equivalent in shelter value to shell aggregate, but less ephemeral than shell | 5 |
| Pebble-cobble with sponge cover | Attached fauna such as sponges provide additional spatial complexity for a wider range of size classes of mobile organisms | 10 |
| Partially buried or dispersed boulders | Partially buried boulders exhibit high vertical relief; dispersed boulders on cobble pavement provide simple crevices; the shelter value of this type of habitat may be less or greater than previous types based on the size class and behavior of associated species | 12 |
| Piled boulders | Provide deep interstitial spaces of variable sizes | 15 |

# TABLE 2
# TRANSECT HABITAT CLASSIFICATION, DOMINANT SPECIES, AND SPECIAL, SENSITIVE OR UNIQUE AREAS
# VIDEO DATA June 24 - July 3, 2018
# VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN

| Video Transect ID | POINT_X[1] | POINT_Y[1] | Dominant_Fauna | Latin Name | Abundance of Dominant Spp. | Auster (1998) - primary | Auster (1998) -secondary[2] | CZM - Barnhardt et. al (1998) | Eelgrass | SSUs[4] |
|---|---|---|---|---|---|---|---|---|---|---|
| LEWIS BAY [NEW HAMPSHIRE AVENUE OPTION] | | | | | | | | | | |
| V-101 | 1297669.609 | 15125944.842 | Bay Scallop | *Aequipecten irradians* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-102 | 1298201.919 | 15126109.605 | Bay Scallop | *Aequipecten irradians* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-103 | 1297790.540 | 15125972.319 | Slipper limpet | *Crepidula fornicata* | Common | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-104 | 1297353.192 | 15125846.904 | Slipper limpet | *Crepidula fornicata* | Common | Flat sand, Mud | | Fine | Absent | Absent |
| V-105 | 1294868.117 | 15124420.129 | Knobbed Whelk | Busycon carica | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-106 | 1294677.254 | 15124660.158 | Bay Scallop | *Aequipecten irradians* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-107 | 1294445.845 | 15124781.971 | Knobbed Whelk | *Busycon carica* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-108 | 1294051.616 | 15124641.095 | Slipper limpet | *Crepidula fornicata* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-109 | 1293818.958 | 15124349.547 | Spider crab | *Lubinia emarginata* | Rare | Flat sand, Mud | | Fine | EG (Rare) | Possible |
| V-112 | 1296639.041 | 15124341.762 | Knobbed Whelk | *Busycon carica* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-113 | 1295378.377 | 15126966.244 | Spider crab | *Lubinia emarginata* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| HYANNIS HARBOR ENTRANCE CHANNEL [NEW HAMPSHIRE AVENUE OPTION] | | | | | | | | | | |
| V-110 | 1293663.513 | 15123881.024 | Knobbed Whelk | *Busycon carica* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-111 | 1293558.679 | 15123037.523 | Knobbed Whelk | *Busycon carica* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-114 | 1291794.577 | 15121395.966 | Slipper limpet | *Crepidula fornicata* | Abundant | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-115 | 1284904.003 | 15110384.345 | Spider crab | *Lubinia emarginata* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| CENTERVILLE HARBOR [PROPOSED OECC] | | | | | | | | | | |
| V-117 | 1275134.210 | 15124196.247 | Knobbed whelk | *Busycon carica* | Rare | Flat sand, Mud/Pebble-cobble | Dispersed Boulders | Fine with rock | EG (Common) | Yes |
| V-118 | 1275452.306 | 15123976.711 | Knobbed whelk | *Busycon carica* | Rare | Flat sand, Mud | Dispersed Boulders | Fine with rock | EG (Rare) | Possible |
| V-119 | 1275610.561 | 15123078.997 | Knobbed whelk | *Busycon carica* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-120 | 1274370.835 | 15122716.977 | Spider crab | Lubinia emarginata | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | EG (Rare) | Possible |
| V-121 | 1273735.319 | 15121125.909 | Spider crab | *Lubinia emarginata* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-150 | 1271852.489 | 15116107.374 | Spider crab | *Lubinia emarginata* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-152 | 1275113.492 | 15123924.839 | Knobbed whelk | *Busycon carica* | Rare | Flat sand, Mud/Pebble-cobble | Dispersed Boulders | Fine with rock | Absent | Absent |
| V-153 | 1275201.376 | 15123753.536 | Northern moon snail | *Lunatia heros* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| NANTUCKET SOUND [PROPOSED OECC] | | | | | | | | | | |
| V-116 | 1279987.961 | 15101394.422 | Threeline Mudsnail | *Ilyanassa trivittata* | Occasional | Flat sand, Mud | Sand Ripples | Fine | Absent | Absent |
| V-122 | 1253037.049 | 15064306.103 | Slipper limpet | *Crepidula fornicata* | Common | Flat sand, Mud/Shell Aggregates | Dispersed Boulders | Fine with rock | Absent | Absent |
| V-123 | 1249779.636 | 15042913.535 | Knobbed whelk | *Busycon carica* | Common | Flat sand,Mud | Sand Ripples | Fine | Absent | Absent |
| V-124 | 1262315.168 | 15100997.145 | Knobbed whelk | *Busycon carica* | Rare | Flat sand, Mud | Sand Ripples | Fine | Absent | Absent |
| V-146 | 1253898.044 | 15074808.233 | Knobbed Whelk | *Busycon carica* | Occasional | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-147 | 1254468.880 | 15086640.387 | Knobbed Whelk | *Busycon carica* | Occasional | Flat sand, Mud | Shell aggregates | Fine | Absent | Absent |
| V-148 | 1269193.122 | 15098303.040 | Slipper limpet | *Crepidula fornicata* | Abundant | Shell aggregates | | Fine | Absent | Absent |
| V-149 | 1267791.878 | 15108639.220 | Hermit crab | *Lunatia heros* | Rare | Flat sand, Mud | Pebble-cobble | Fine with gravel | Absent | Absent |

# TABLE 2
# TRANSECT HABITAT CLASSIFICATION, DOMINANT SPECIES, AND SPECIAL, SENSITIVE OR UNIQUE AREAS
# VIDEO DATA June 24 - July 3, 2018
# VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN

| Transect ID | POINT_X[1] | POINT_Y[1] | Dominant_Fauna | Latin Name | Abundance of Dominant Spp. | Auster (1998) - primary | Auster (1998) -secondary[2] | CZM - Barnhardt et. al (1998) | Eelgrass | SSUs[5] |
|---|---|---|---|---|---|---|---|---|---|---|
| MUSKEGET | CHANNEL [PROPOSED OECC] | | | | | | | | | |
| V-125 | 1249908.785 | 15033083.937 | Sulfur sponge | *Cliona celeta* | Abundant | Flat sand, Mud/Shell Aggregates | Pebble-cobble/Dispersed Boulders | Fine with rock | Absent | Absent |
| V-126 | 1248871.299 | 15022268.473 | Bread crumb sponge | *Halichodria panicea* | Rare | Pebble-cobble | Dispersed Boulders | Gravel with rock | Absent | Absent |
| V-127 | 1248365.801 | 15006785.021 | Blue mussel | *Mytilus edulis* | Common | Sand waves/Pebble-cobble | | Fine with gravel | Absent | Absent |
| V-128 | 1247896.687 | 14999759.423 | Four-eyed amphipod | *Ampelisca sp.* | Rare | Sand waves[3] | Pebble-cobble | Fine with gravel | Absent | Absent |
| V-129 | 1248708.605 | 14993413.622 | Four-eyed amphipod | *Ampelisca sp.* | Rare | Sand waves | | Fine | Absent | Absent |
| V-130 | 1254440.272 | 14993764.100 | Four-eyed amphipod | *Ampelisca sp.* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-131 | 1252647.503 | 15007098.411 | Plumed worm | *Diopatra cuprea* | Rare | Flat sand, Mud/Pebble-cobble | | Fine with gravel | Absent | Absent |
| [EASTERN MUSKEGET CHANNEL OPTION] | | | | | | | | | | |
| V-132 | 1255338.761 | 15026684.526 | Sulfur sponge | *Cliona celeta* | Abundant | Sand waves/Pebble-cobble | | Fine with gravel | Absent | Absent |
| V-133 | 1261890.846 | 15012177.745 | Bread crumb sponge | *Halichodria panicea* | Rare | Pebble-cobble | | Gravel | Absent | Absent |
| V-134 | 1266653.457 | 15005749.232 | Tube worm | *Hydrodes dianthus* | Rare | Sand waves/Pebble-cobble | Flat sand, Mud | Fine | Absent | Absent |
| V-135 | 1259706.399 | 14999114.078 | Northern Moon snail | *Lunatia heros* | Rare | Sand waves | | Fine | Absent | Absent |
| ATLANTIC OCEAN SOUTHEAST OF MARTHAS VINEYARD [PROPOSED OECC] | | | | | | | | | | |
| V-136 | 1243499.539 | 14968260.936 | Hermit crab | *Pagurus acadianus* | Rare | Flat sand, Mud | | Fine | Absent | Absent |
| V-137 | 1237426.172 | 14953150.297 | Common sand dollar | *Echinarachnius parma* | Occasional | Flat sand, Mud | | Fine | Absent | Absent |
| V-138 | 1235714.492 | 14942804.298 | Sulfur sponge | *Cliona* | Occasional | Flat sand, Mud/Biogenic structures | | Fine | Absent | Absent |
| V-139 | 1211154.149 | 14918256.940 | Common sand dollar | *Echinarachnius parma* | Occasional | Flat sand, Mud | | Fine | Absent | Absent |
| V-140 | 1261963.685 | 14918446.274 | Sulfur sponge | *Cliona celata* | Occasional | Flat sand,Mud/Biogenic structures | | Fine | Absent | Absent |
| V-141 | 1238001.002 | 14919211.989 | Common sand dollar | *Echinarachnius parma* | Occasional | Flat sand, Mud | | Fine | Absent | Absent |
| V-142 | 1251717.183 | 14897571.855 | Common sand dollar | *Echinarachnius parma* | Occasional | Flat sand, Mud/Pebble-cobble | | Fine with gravel | Absent | Absent |
| V-143 | 1226083.330 | 14897854.844 | Burrowing anemone | *Cerianthus borealis* | Common | Biogenic Structures | | Fine | Absent | Absent |
| V-144 | 1195563.570 | 14896825.594 | Burrowing anemone | *Cerianthus borealis* | Common | Flat sand, Mud/Biogenic structures | | Fine | Absent | Absent |
| V-145 | 1227150.600 | 14873005.838 | Sulfur sponge | *Cliona celata* | Common | Flat sand, Mud/Biogenic Structures | | Fine | Absent | Absent |
| V-151 | 1243903.061 | 14941115.837 | Common sand dollar | *Echinarachnius parma* | Common | Flat sand, Mud/Sand waves | | Fine | Absent | Absent |


Auster, P.J. 1998. The conceptual model of the impacts of fishing gear on the integrity of fish habitat. Conservation Biology V12 (6): 1198-1203.

Barnhardt, W.A., J.T. Kelley, S.M. Dickson, and D.F. Belknap. 1998. Mapping the Gulf of Maine with Side-Scan Sonar: A New Bottom-Type Classification for Complex Seafloors. Journal of Coastal Research.14(2): 646-659.


**Notes:**

1) Centroid coordinates for the video transect
2) A secondary bottom classification for transects is provided for alternate bottom types observed over at least ~10% of the video based on time lapse. Otherwise none is reported.
3) Sand waves were not always able to be detected on video segments refer to side scan record
4) Designation of possible SSUs

**TABLE 3**
**SPECIES BY TRANSECT FROM UNDERWATER VIDEO JUNE 24 - JULY 3, 2018**
**VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN**

| TRANSECT ID | Latin Name | V-101 | V-102 | V-103 | V-104 | V-105 | V-106 | V-107 | V-108 | V-109 |
|---|---|---|---|---|---|---|---|---|---|---|
| **FAUNA** | | | | | | | | | | |
| **PORIFERA** | | | | | | | | | | |
| Bread crumb sponge | *Halichondria panicea* | | | | | | | | | |
| Red beard sponge | *Microciona prolifera* | | | | | | | | | |
| **Sulfur sponge**[3] | *Cliona celata* | | | | | | | | | |
| | | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | | |
| Burrowing anemone | *Cerianthus borealis* | | | | | | | | | |
| Star Coral | *Astrangia poculata* | | | | | | | | | |
| Solitary Hydroid | Hybocodon pendula | | | | | | | | | |
| Sea Pens | Pennatulacea | | | | | | | | | |
| | | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | | |
| Bushy bryozoan | Bryozoa | | | | | | | | | |
| Encrusting bryozoan | *Schizoporella unicornis* | | | | | | | | | |
| | | | | | | | | | | |
| **MOLLUSCA** | | | | | | | | | | |
| **Bay Scallop** | *Argopecten irradians* | X | X | X | X | X | X | X | | X |
| Blue mussel | *Mytilis edulis* | | | | | | | | | |
| **Knobbed whelk***[1] | *Busycon carica* | | | X | X | X | | X | | |
| Long-Finned Squid | *Loligo pealei* | | | | | | | | | |
| Northen Moon snail | Lunatia heros | | | | | | | | | |
| Sea Scallop | Placopecten magellanicus | | | | | | | | | |
| **Slipper limpet** | *Crepidula fornicata* | X | | | X | X | X | X | X | X |
| Surf clam | *Spisula solidissima* | | | | | | | | | |
| Threeline Mudsnail | *Ilyanassa trivittata* | | | | | | | | | |
| Parchment worm | *Chaetopterus pergamentaceus* | | | | | | | | | |
| Plumed worm | *Diopatra cuprea* | | | | | | | | | X |
| **Tube worm** | Hydroides dianthus | X | | | | | X | | | |
| | | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | | |
| **Merostomata** | | | | | | | | | | |
| Horshoe Crab | Limulus polyphemus | | | | | | | | | |
| | | | | | | | | | | |
| **Crustacea** | | | | | | | | | | |
| Barnacle | *Balanus* sp. | | | | | | | | | X |
| Blue crab | Callinectes sapidus | | | | | | | X | | |
| **Four-eyed amphipod** | *Ampelisca sp.* | | | | | | | | | |
| Green crab | *Carcinus maenas* | | | | | | | | | |
| **Hermit crab** | *Pagurus sp.* | | | | | | | | | |
| Lady crab | *Ovalipes occellatus* | | | | | | | | X | |
| Mysid shrimp | Mysids | | | | | | | | | |
| Rock crab | *Cancer irroratus* | | | | | | | | | |
| **Spider crab** | *Lubinia emarginata* | | | | | | X | X | | X |
| | | | | | | | | | | |
| **Echinoderms** | | | | | | | | | | |
| Common sea star | *Asterias forbesi* | | | | | | | | | |
| Norther sea star | *Asterias vulgaris* | | | | | | | | | |
| Sand dollar | *Echinarachnius parma* | | | | | | | | | |
| Purple sea urchin | *Arbacia punctulata* | | | | | | | | | |
| | | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | | |
| Little Skate* | *Raja erinacea* | | | | | | | | | |
| **Osteichthyes** | | | | | | | | | | |
| Black sea bass* | *Centropristis striata* | | | | | | | | | |
| Red Hake* | *Urophycis chuss* | | | | | | | | | |
| Scup* | *Stenotomus chrysops* | | | | | | | | | |
| Sea Robin | *Prionotus carolinus* | | | | | | | | | |
| Summer Flounder | *Paralichthys dentatus* | | | | | | | | | |
| | | | | | | | | | | |
| **CHORDATA** | | | | | | | | | | |
| Sand Sponge | *Amaroucium sp.* | | | | | | | | | |
| White invasive tunicate | *Didemnum candidum* | | | | | | | | | |
| **SPECIES RICHNESS FAUNA**[2] | | 3 | 1 | 2 | 3 | 3 | 4 | 5 | 2 | 5 |
| | | | | | | | | | | |
| **FLORA** | | | | | | | | | | |
| **ALISMATALES** | | | | | | | | | | |
| **Zosteraceae** | | | | | | | | | | |
| Eelgrass* | *Zostera marina* | | | | | | | | | X |
| | | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | | |
| **Dead Man's Fingers** | *Codium fragile* | X | X | X | X | X | X | X | X | X |
| Gutweed | *Enteromorpha sp.* | | | X | | | | | | |
| **Sea Lettuce** | *Ulva lactuca* | X | | X | | | | X | X | X |
| | | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | | |
| Rockweed | *Fucus* sp. | X | | | | | | | | |
| | | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | | |
| **Branching red alga** | Rhodophyta | X | | X | | X | X | X | X | X |
| **Purple laver** | Porphyra umbilicalis | X | | X | X | X | X | X | X | X |
| **SPECIES RICHNESS FLORA2** | | 5 | 1 | 5 | 2 | 3 | 3 | 4 | 4 | 4 |

**1) An * designates species selected for assessment of 'important fish resource areas' an SSU under the Mass. Ocean Management Plan**
**2) Species Richness = the total number of species observed**
**3) Species with a frequency across all transects greater than 20% are bolded and shaded**

**TABLE 3**
**SPECIES BY TRANSECT FROM UNDERWATER VIDEO JUNE 24 - JULY 3, 2018**
**VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN**

| **TRANSECT ID** | **V-110** | **V-111** | **V-112** | **V-113** | **V-114** | **V-115** | **V-116** | **V-117** | **V-118** | **V-119** | **V-120** | **V-121** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAUNA** | | | | | | | | | | | | |
| **PORIFERA** | | | | | | | | | | | | |
| Bread crumb sponge | | | | | | | | | | | | |
| Red beard sponge | | | | | | | | X | | X | | |
| **Sulfur sponge[3]** | | | | | | | | X | | | | |
| | | | | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | | | | |
| Burrowing anemone | | | | | | | X | | | | | |
| Star Coral | | | | | | | | | | | | |
| Solitary Hydroid | | | | | | | | | | | | |
| Sea Pens | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | | | | |
| Bushy bryozoan | | | | | | | | | | | | |
| Encrusting bryozoan | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **MOLLUSCA** | | | | | | | | | | | | |
| **Bay Scallop** | | X | X | X | X | | | | | | X | |
| Blue mussel | | | | | | | | | | | | |
| **Knobbed whelk*[1]** | X | X | X | X | X | X | X | X | X | X | X | X |
| Long-Finned Squid | | | | | | | | | | | | |
| Northen Moon snail | | | | | | | | | | | | |
| Sea Scallop | | | | | | | | | | | | |
| **Slipper limpet** | | X | X | X | X | X | | | | | X | |
| Surf clam | | | | | | | | | | | | |
| Threeline Mudsnail | | | | | | | X | | | | | |
| Parchment worm | | | | | | | | | | | X | |
| Plumed worm | | | | | X | | | | | | | |
| **Tube worm** | | | | | | | X | | | | X | X |
| | | | | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | | | | |
| **Merostomata** | | | | | | | | | | | | |
| Horshoe Crab | | | | X | X | | | | | | | |
| | | | | | | | | | | | | |
| **Crustacea** | | | | | | | | | | | | |
| Barnacle | | | | | | | | | | | | |
| Blue crab | | | | | | | | | | | | |
| **Four-eyed amphipod** | | | | | | | X | | | | | |
| Green crab | | | | | | | | | | | | |
| **Hermit crab** | | | | X | | | X | | | | | |
| Lady crab | | X | | | | | | | | | | |
| Mysid shrimp | | | | | | | | | | | | |
| Rock crab | | | | | | | | | | | | |
| **Spider crab** | | | | X | | X | | | | | X | X |
| | | | | | | | | | | | | |
| **Echinoderms** | | | | | | | | | | | | |
| Common sea star | | | | | | | | | | | | |
| Norther sea star | | | | | | | | | | | | |
| Sand dollar | | | | | | | | | | | | |
| Purple sea urchin | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | | | | |
| Little Skate* | | | | | | | | | | | | |
| **Osteichthyes** | | | | | | | | | | | | |
| Black sea bass* | | | | | | | | | | | | |
| Red Hake* | | | | | | | | | | | | |
| Scup* | | | | | | | | | X | | | |
| Sea Robin | | | | | | | X | | | | | |
| Summer Flounder | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **CHORDATA** | | | | | | | | | | | | |
| Sand Sponge | | | | | | | | | | | | |
| White invasive tunicate | | | | | | | | | | | | |
| **SPECIES RICHNESS FAUNA[2]** | 1 | 4 | 3 | 6 | 5 | 3 | 7 | 3 | 2 | 2 | 6 | 3 |
| | | | | | | | | | | | | |
| **FLORA** | | | | | | | | | | | | |
| **ALISMATALES** | | | | | | | | | | | | |
| **Zosteraceae** | | | | | | | | | | | | |
| Eelgrass* | | | | | | | | X | X | | X | |
| | | | | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | | | | |
| **Dead Man's Fingers** | X | X | X | X | X | X | | X | X | | | X |
| Gutweed | | | | | | | | X | | | | |
| **Sea Lettuce** | | X | | X | X | X | | X | X | | X | X |
| | | | | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | | | | |
| Rockweed | | | | | | | | X | X | | | |
| | | | | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | | | | |
| **Branching red alga** | | X | X | X | X | X | X | X | X | X | X | X |
| **Purple laver** | | | | X | X | | | | | | X | X |
| **SPECIES RICHNESS FLORA2** | 1 | 3 | 2 | 4 | 4 | 3 | 1 | 5 | 4 | 1 | 3 | 4 |

**TABLE 3**
**SPECIES BY TRANSECT FROM UNDERWATER VIDEO JUNE 24 - JULY 3, 2018**
**VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN**

| TRANSECT ID | V-122 | V-123 | V-124 | V-125 | V-126 | V-127 | V-128 | V-129 | V-130 | V-131 | V-132 | V-133 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FAUNA | | | | | | | | | | | | |
| PORIFERA | | | | | | | | | | | | |
| Bread crumb sponge | X | | | | X | X | | | | | | X |
| Red beard sponge | X | | | X | | | | | | | | |
| Sulfur sponge[3] | | | | | | | | | | | X | |
| | | | | | | | | | | | | |
| CNIDARIA | | | | | | | | | | | | |
| Burrowing anemone | | | | | | | | | | | | |
| Star Coral | | | | | | X | | | | | | X |
| Solitary Hydroid | | | | | | | | | | | | |
| Sea Pens | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| BRYOZOA | | | | | | | | | | | | |
| Bushy bryozoan | | | | | | | | | | | | |
| Encrusting bryozoan | X | | | X | X | X | | | | | X | X |
| | | | | | | | | | | | | |
| MOLLUSCA | | | | | | | | | | | | |
| Bay Scallop | | | | | | | | | | | | |
| Blue mussel | | | | | X | X | | | | | | |
| Knobbed whelk*[1] | X | X | X | | | | | | | | | |
| Long-Finned Squid | | | | | | | | | | | | |
| Northen Moon snail | | | | | | | | | X | | | |
| Sea Scallop | | | | | | | | | | | | |
| Slipper limpet | X | | | X | | X | | | | | | |
| Surf clam | | | | | | X | | | | | | |
| Threeline Mudsnail | | X | | | | | | | | | | |
| Parchment worm | | | | | | | | | | | | |
| Plumed worm | | | | | | X | | | | X | | |
| Tube worm | | | | X | X | X | | | | | X | X |
| | | | | | | | | | | | | |
| ARTHROPODA | | | | | | | | | | | | |
| Merostomata | | | | | | | | | | | | |
| Horshoe Crab | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Crustacea | | | | | | | | | | | | |
| Barnacle | | | | X | X | | | | | | X | |
| Blue crab | | | | | | | | | | | | |
| Four-eyed amphipod | | X | | X | | | X | X | X | X | X | |
| Green crab | | | | | | | | | | | | |
| Hermit crab | | X | | X | | | | | X | | | |
| Lady crab | | | | | | | | | | | | |
| Mysid shrimp | | | | | | | | | | | | |
| Rock crab | | | | | | | | | | | | |
| Spider crab | | X | X | | | | | | | | | |
| | | | | | | | | | | | | |
| Echinoderms | | | | | | | | | | | | |
| Common sea star | | | | | | | | | | | | |
| Norther sea star | | | | | | | | | | | | |
| Sand dollar | | | | | | | | | | | | |
| Purple sea urchin | X | | | | | | | | | | | |
| | | | | | | | | | | | | |
| VERTEBRATA | | | | | | | | | | | | |
| Elasmobrachiomorphi | | | | | | | | | | | | |
| Little Skate* | | | | | | | | | | | | X |
| Osteichthyes | | | | | | | | | | | | |
| Black sea bass* | | | | X | | X | | | | X | | |
| Red Hake* | | | | | | | | | | | | |
| Scup* | | | | | | | | | | | | |
| Sea Robin | X | | X | | X | X | X | | | X | X | |
| Summer Flounder | | X | | | | | | X | | | | |
| | | | | | | | | | | | | |
| CHORDATA | | | | | | | | | | | | |
| Sand Sponge | | | | | | | | | | | X | |
| White invasive tunicate | X | | | | X | | | | | | X | X |
| SPECIES RICHNESS FAUNA[2] | 8 | 6 | 3 | 8 | 7 | 10 | 2 | 2 | 3 | 4 | 8 | 6 |
| | | | | | | | | | | | | |
| FLORA | | | | | | | | | | | | |
| ALISMATALES | | | | | | | | | | | | |
| Zosteraceae | | | | | | | | | | | | |
| Eelgrass* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| CHLOROPHYTA | | | | | | | | | | | | |
| Dead Man's Fingers | | | | | | | | | | | | |
| Gutweed | | | | | | | | | | | | |
| Sea Lettuce | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| PHAEOPHYTA | | | | | | | | | | | | |
| Rockweed | | | | | X | | | | | | | |
| | | | | | | | | | | | | |
| RHODOPHYTA | | | | | | | | | | | | |
| Branching red alga | | | X | | X | X | X | | | | X | X |
| Purple laver | X | | | | | | | | | | | |
| SPECIES RICHNESS FLORA2 | 1 | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

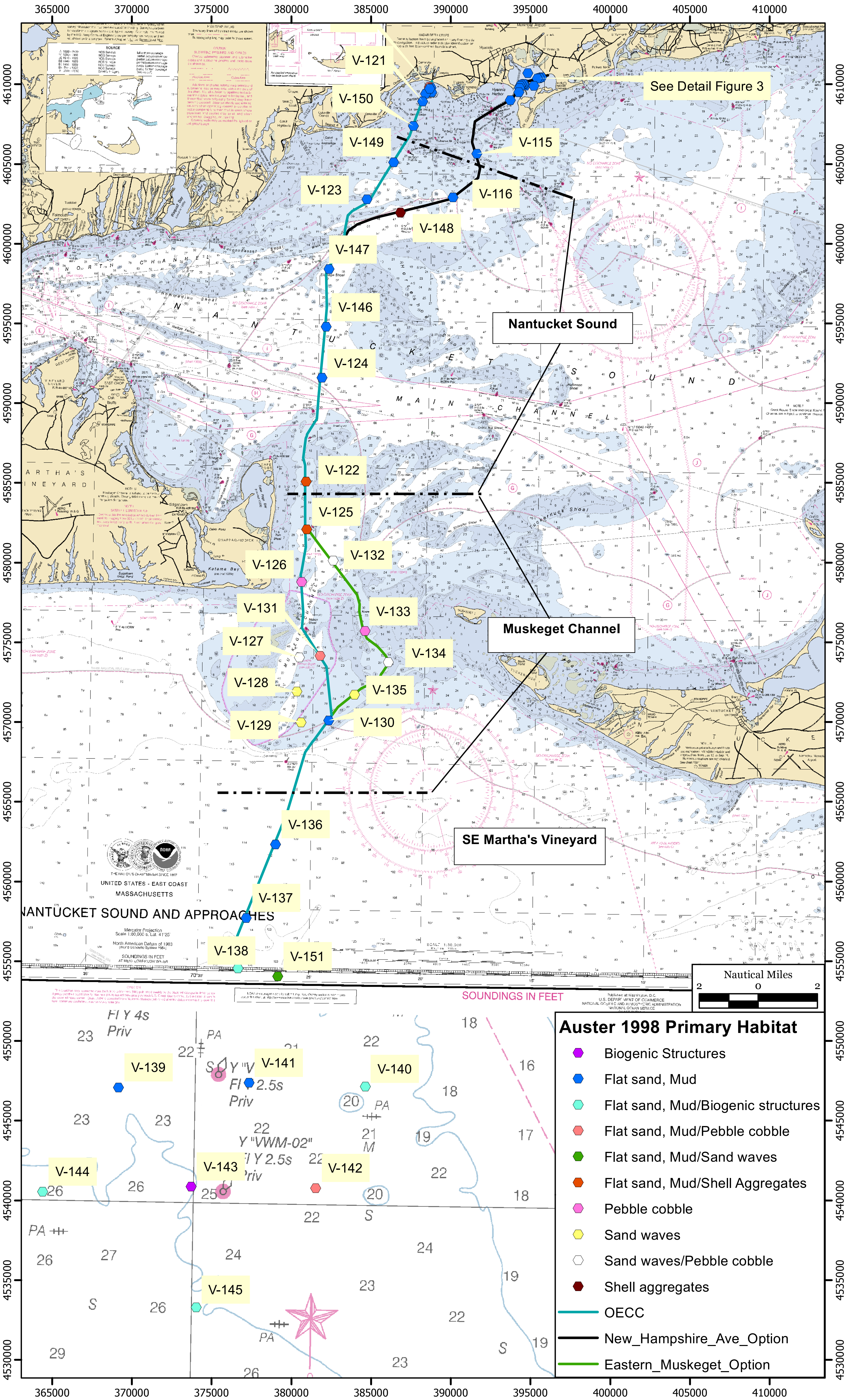
## TABLE 3
## SPECIES BY TRANSECT FROM UNDERWATER VIDEO JUNE 24 - JULY 3, 2018
## VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN

| TRANSECT ID | V-134 | V-135 | V-136 | V-137 | V-138 | V-139 | V-140 | V-141 | V-142 | V-143 | V-144 | V-145 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FAUNA | | | | | | | | | | | | |
| **PORIFERA** | | | | | | | | | | | | |
| Bread crumb sponge | | | | | | | | X | | | | |
| Red beard sponge | | | | | | | | | | | | |
| **Sulfur sponge[3]** | | | | X | X | | X | X | X | X | X | X |
| | | | | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | | | | |
| Burrowing anemone | | | X | X | X | X | | X | | X | X | X |
| Star Coral | | | | | | | | | | | | |
| Solitary Hydroid | | | | | | X | | X | X | X | | x |
| Sea Pens | | | | X | X | | `X | X | | | | |
| | | | | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | | | | |
| Bushy bryozoan | | | | | | | | | | X | | |
| Encrusting bryozoan | X | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **MOLLUSCA** | | | | | | | | | | | | |
| **Bay Scallop** | | | | | | | | | | | | |
| Blue mussel | | | | | | | | | | | | |
| **Knobbed whelk*[1]** | | | | | | | | | | | | |
| Long-Finned Squid | | | X | X | | | | | | | | |
| Northen Moon snail | X | X | X | X | X | | | X | | | | |
| Sea Scallop | | | | | | | | X | | | | |
| **Slipper limpet** | | | | | | | | | | | | |
| Surf clam | X | X | | | | | | | | | | |
| Threeline Mudsnail | | | | X | | | | | | | | |
| Parchment worm | | | | | | | | | X | | | |
| Plumed worm | X | | | | | | | | | | | |
| **Tube worm** | X | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | | | | |
| **Merostomata** | | | | | | | | | | | | |
| Horshoe Crab | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Crustacea** | | | | | | | | | | | | |
| Barnacle | X | | | | | | | | | | | |
| Blue crab | | | | | | | | | | | | |
| **Four-eyed amphipod** | X | | X | X | X | X | | | X | X | X | X |
| Green crab | | | | | | | | | | | | |
| **Hermit crab** | | | X | X | | X | X | X | | | | X |
| Lady crab | | | | | | | | | | | | |
| Mysid shrimp | | | | X | X | | | | | | | |
| Rock crab | | | | X | X | | X | X | | | | |
| **Spider crab** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Echinoderms** | | | | | | | | | | | | |
| Common sea star | | | | | | | | | | | X | |
| Norther sea star | | | | | | | | | X | | | |
| Sand dollar | | | X | X | X | X | X | X | X | | | |
| Purple sea urchin | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | | | | |
| Little Skate* | X | | X | X | X | | X | | X | | X | X |
| **Osteichthyes** | | | | | | | | | | | | |
| Black sea bass* | | | | | | | | | | | | |
| Red Hake* | | | X | X | X | X | X | | X | X | X | X |
| Scup* | | | | | | | | | | | | |
| Sea Robin | | | | | | | | | | | | |
| Summer Flounder | | | X | X | X | | | | X | | | |
| | | | | | | | | | | | | |
| **CHORDATA** | | | | | | | | | | | | |
| Sand Sponge | | | | | | | | | | | | |
| White invasive tunicate | | | | | | | | | | | | |
| **SPECIES RICHNESS FAUNA[2]** | 8 | 2 | 9 | 14 | 11 | 6 | 7 | 10 | 9 | 6 | 6 | 7 |
| | | | | | | | | | | | | |
| **FLORA** | | | | | | | | | | | | |
| **ALISMATALES** | | | | | | | | | | | | |
| **Zosteraceae** | | | | | | | | | | | | |
| Eelgrass* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | | | | |
| **Dead Man's Fingers** | | | | | | | | | | | | |
| Gutweed | | | | | | | | | | | | |
| **Sea Lettuce** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | | | | |
| Rockweed | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | | | | |
| **Branching red alga** | X | X | | | | | | | | | | |
| **Purple laver** | X | | | | | | | | | | | |
| **SPECIES RICHNESS FLORA2** | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

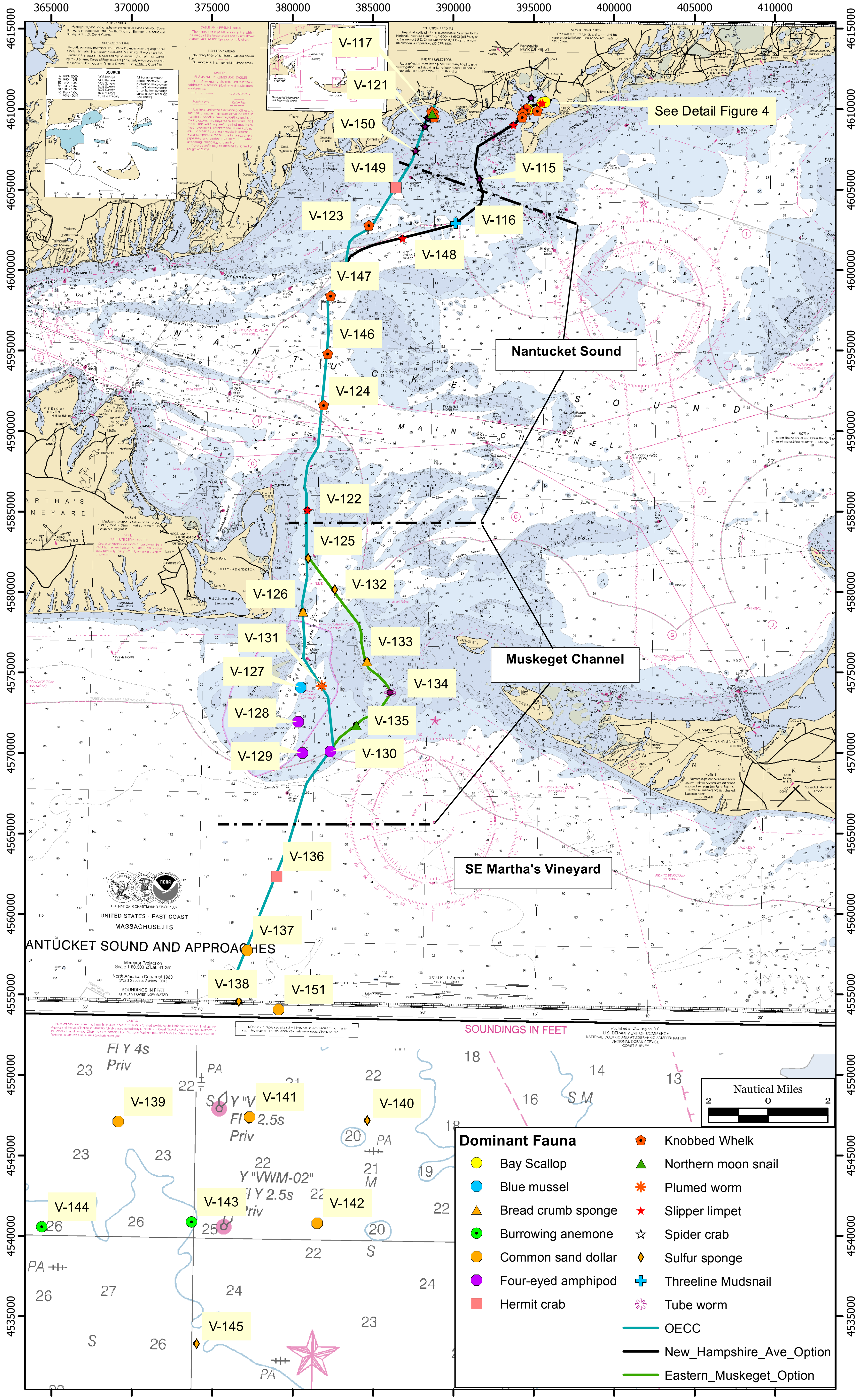
**TABLE 3**
**SPECIES BY TRANSECT FROM UNDERWATER VIDEO JUNE 24 - JULY 3, 2018**
**VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN**

| TRANSECT ID | V-146 | V-147 | V-148 | V-149 | V-150 | V-151 | V-152 | V-153 | Freqency % |
|---|---|---|---|---|---|---|---|---|---|
| **FAUNA** | | | | | | | | | |
| **PORIFERA** | | | | | | | | | |
| Bread crumb sponge | | | | | | | | | 9.43 |
| Red beard sponge | | | | | | | | | 7.55 |
| **Sulfur sponge[3]** | | | | | | X | | | **20.75** |
| | | | | | | | | | |
| **CNIDARIA** | | | | | | | | | |
| Burrowing anemone | | | | | | X | | | 18.87 |
| Star Coral | | | X | | | | | | 5.66 |
| Solitary Hydroid | | | | | | X | | | 11.32 |
| Sea Pens | | | | | | | | | 7.55 |
| | | | | | | | | | |
| **BRYOZOA** | | | | | | | | | |
| Bushy bryozoan | | | | | | | | | 1.89 |
| Encrusting bryozoan | | X | | X | | | | | 16.98 |
| | | | X | | | | | | 1.89 |
| **MOLLUSCA** | | | | | | | | | |
| **Bay Scallop** | | X | | | | | | | **26.42** |
| Blue mussel | | | | | | | | | 3.77 |
| **Knobbed whelk*[1]** | X | X | X | | | | X | | **43.40** |
| Long-Finned Squid | | | | | | X | | | 5.66 |
| Northen Moon snail | | | | | | | | X | 15.09 |
| Sea Scallop | | | | | | | | | 1.89 |
| **Slipper limpet** | | | X | X | | | X | | **35.85** |
| Surf clam | X | | | | | | | | 7.55 |
| Threeline Mudsnail | | | | | | | | | 5.66 |
| Parchment worm | | | | | | | | | 3.77 |
| Plumed worm | | | | | | | | | 9.43 |
| **Tube worm** | X | | | X | | | X | X | **28.30** |
| | | | | | | | | | |
| **ARTHROPODA** | | | | | | | | | |
| **Merostomata** | | | | | | | | | |
| Horshoe Crab | | | | | | | | | 3.77 |
| | | | | | | | | | |
| **Crustacea** | | | | | | | | | |
| Barnacle | | | | X | | | | X | 13.21 |
| Blue crab | | | | | | | | | 1.89 |
| **Four-eyed amphipod** | X | X | | X | | X | | | **39.62** |
| Green crab | | | | | | | | X | 1.89 |
| **Hermit crab** | | X | | X | | X | | | **26.42** |
| Lady crab | | | | | | | | | 3.77 |
| Mysid shrimp | | | | | | X | | | 5.66 |
| Rock crab | | | | | | X | | | 9.43 |
| **Spider crab** | X | X | X | X | X | | | | **26.42** |
| | | | | | | | | | |
| **Echinoderms** | | | | | | | | | |
| Common sea star | | | | | | | | | 1.89 |
| Norther sea star | | | | | | | | | 1.89 |
| Sand dollar | | | | | | X | | | 15.09 |
| Purple sea urchin | | | X | | | | | | 3.77 |
| | | | | | | | | | |
| **VERTEBRATA** | | | | | | | | | |
| **Elasmobrachiomorphi** | | | | | | | | | |
| Little Skate* | | | | | | X | | | 18.87 |
| **Osteichthyes** | | | | | | | | | |
| Black sea bass* | | | X | | | | | | 7.55 |
| Red Hake* | | | | | | X | | | 18.87 |
| Scup* | | | | | | | | | 1.89 |
| Sea Robin | | | X | X | | | | | 18.87 |
| Summer Flounder | | | | | | | | | 11.32 |
| | | | | | | | | | |
| **CHORDATA** | | | | | | | | | |
| Sand Sponge | | | | | | | | | 1.89 |
| White invasive tunicate | | | | | | | X | | 9.43 |
| **SPECIES RICHNESS FAUNA[2]** | 5 | 6 | 8 | 8 | 1 | 11 | 4 | 4 | |
| | | | | | | | | | |
| **FLORA** | | | | | | | | | |
| **ALISMATALES** | | | | | | | | | |
| **Zosteraceae** | | | | | | | | | |
| Eelgrass* | | | | | | | | | |
| | | | | | | | | | |
| **CHLOROPHYTA** | | | | | | | | | |
| **Dead Man's Fingers** | | | | | X | | X | X | **39.62** |
| Gutweed | | | | | | | X | X | 7.55 |
| **Sea Lettuce** | | | | | | | | X | **26.42** |
| | | | | | | | | | |
| **PHAEOPHYTA** | | | | | | | | | |
| Rockweed | | | | | | | X | X | 11.32 |
| | | | | | | | | | |
| **RHODOPHYTA** | | | | | | | | | |
| **Branching red alga** | | | | X | X | | X | | **54.72** |
| **Purple laver** | | | | X | | | | | **28.30** |
| **SPECIES RICHNESS FLORA2** | 0 | 0 | 0 | 2 | 2 | 0 | 4 | 4 | |

# FIGURES




| www.crenvironmental.com | Video Transect Primary Habitat Classification<br>Vineyard Wind Project | N W E S |
|---|---|---|
| | NOTES:<br>1) Underwater video data collected in June and July 2018.<br>2) Grid: UTM, Zone 19N, NAD83, metric. | Figure 1 |



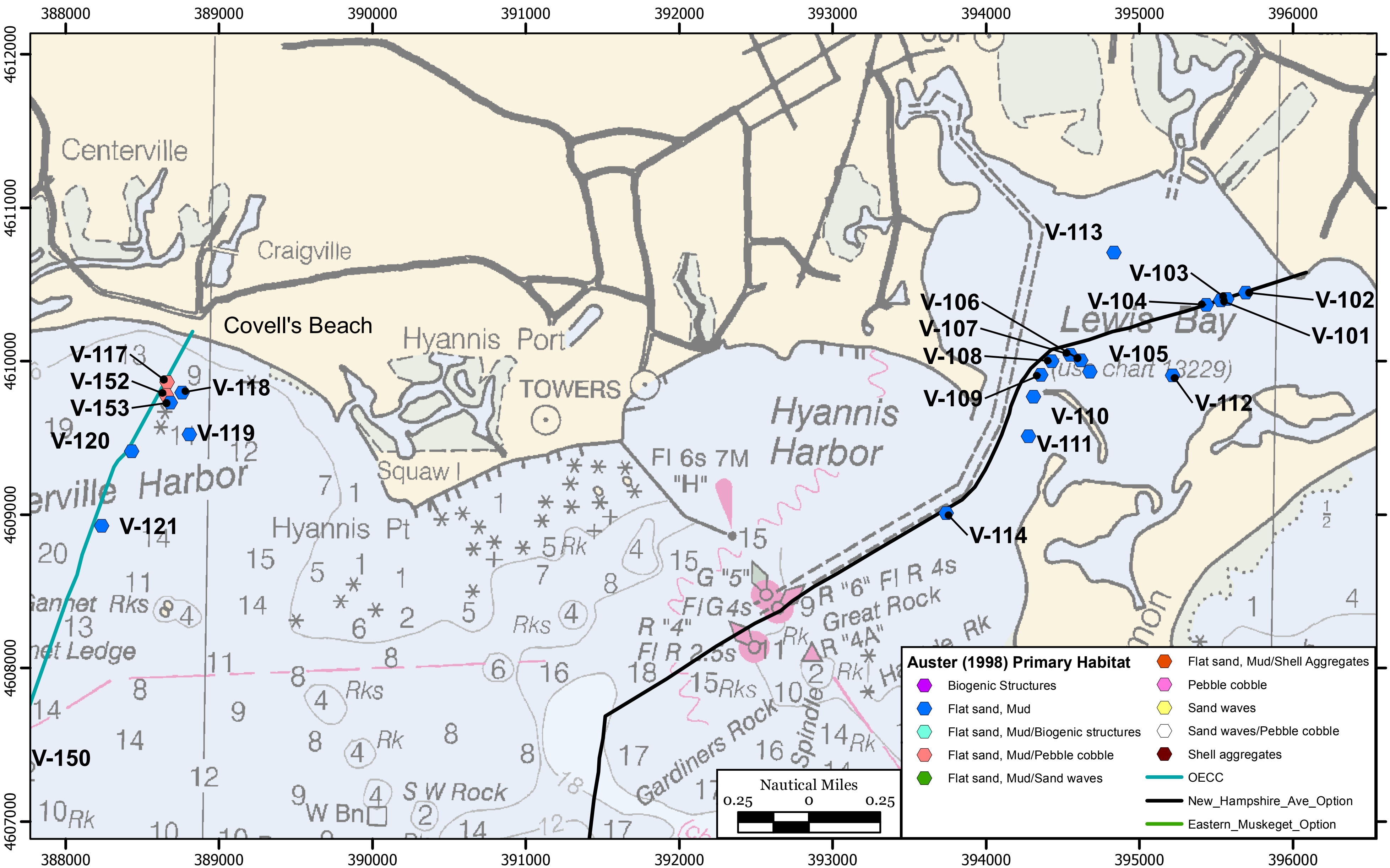

www.crenvironmental.com

Video Transect Dominant Species
Vineyard Wind Project

NOTES:
1) Underwater video data collected in June and July 2018.
2) Grid: UTM, Zone 19N, NAD83, metric.

N W E S

Figure 2

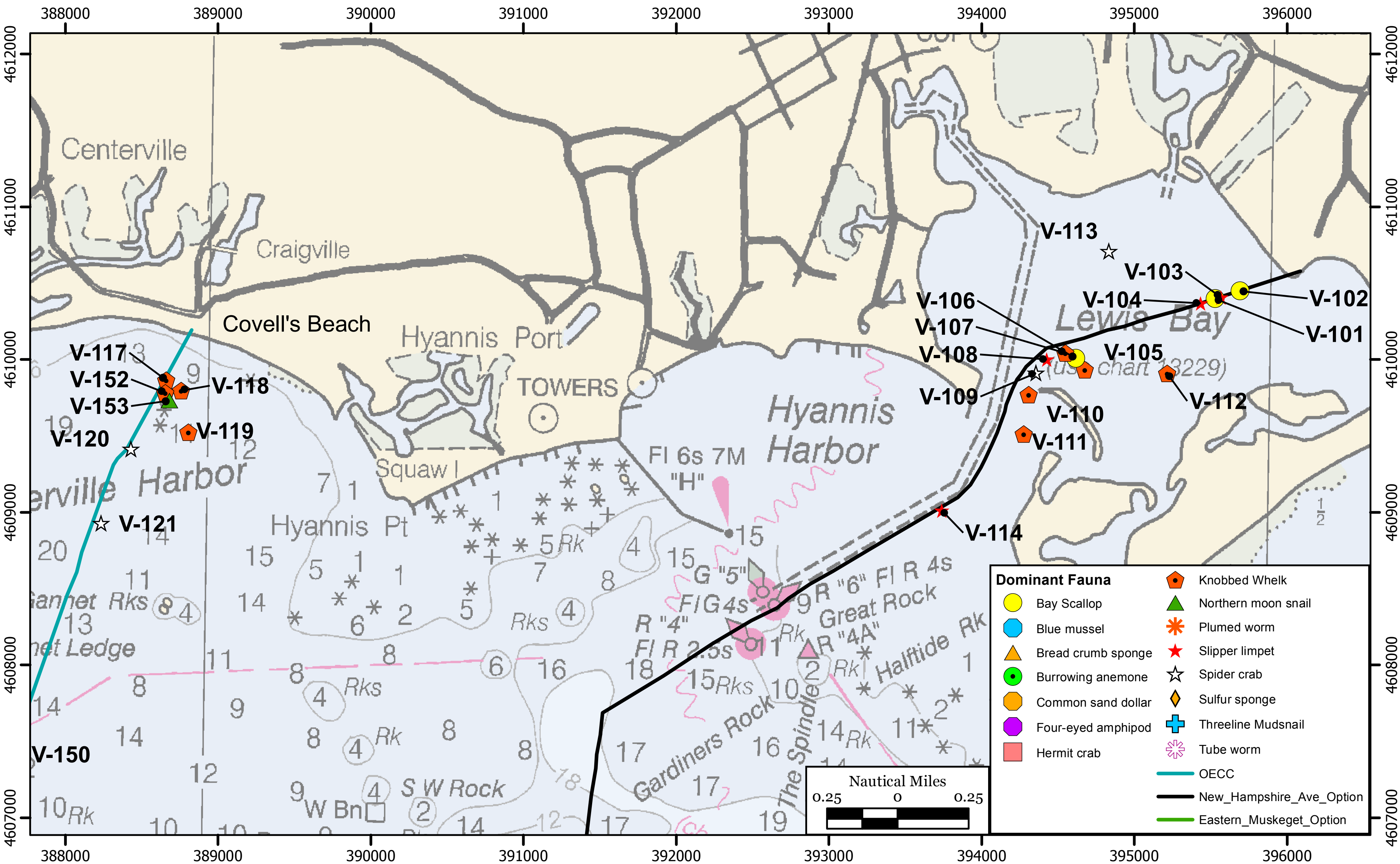



Video Transect Primary Habitat Classification
Centerville Harbor, Hyannis Harbor Entrance and Lewis Bay
Vineyard Wind Project

NOTES:
1) Underwater video data collected in June and July 2018.
2) Grid: UTM, Zone 19N, NAD83, metric.

www.crenvironmental.com

Figure 3

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Transect Dominant Species
Centerville Harbor, Hyannis Harbor Entrance and Lewis Bay
Vineyard Wind Project

NOTES:
1) Underwater video data collected in June and July 2018.
2) Grid: UTM, Zone 19N, NAD83, metric.

N
W E
S

Figure 4

# PLATES

V-117 Dense to moderate coverage eelgrass bed in Centerville Harbor

V-120 Knobbed whelk and Dead Man's Fingers (*Codium fragile*)

V-152 Boulder with bushy bryozoan and attached algae

**PLATE 1** Representative video screen captures of Bottom Habitat and Biota
**CENTERVILLE HARBOR, Hyannis Harbor Entrance Channel**

V-104 Bay Scallop in dense branching red algae in Lewis Bay

V-113 Horseshoe crab in Lewis Bay

V-107 Blue crab, scallop shell, branching red algae in Lewis Bay

**PLATE 2** Representative video screen captures of Bottom Habitat and Biota
**LEWIS BAY (NEW HAMPSHIRE AVENUE OPTION)**

V-146 Surf clam in a s*and ripple* bottom

V-148 Spider crab feeding on slipper limpets

V- 123 Summer flounder in Nantucket Sound

**PLATE 3 Representative video screen captures of Bottom Habitat and Biota NANTUCKET SOUND**


V-127 Blue mussels in a *sand waves/pebble-cobble* bottom (OECC)


V-132 Sulfur sponge, sand sponge, invasive white tunicate (Eastern Option)


V-133 Bread crumb sponge and red tufted algae (Eastern Option)

**PLATE 4** R**epresentative video screen captures of Bottom Habitat and Biota**
**MUSKEGET CHANNEL**


V-136 Long-finned squid at a *flat sand/mud* bottom

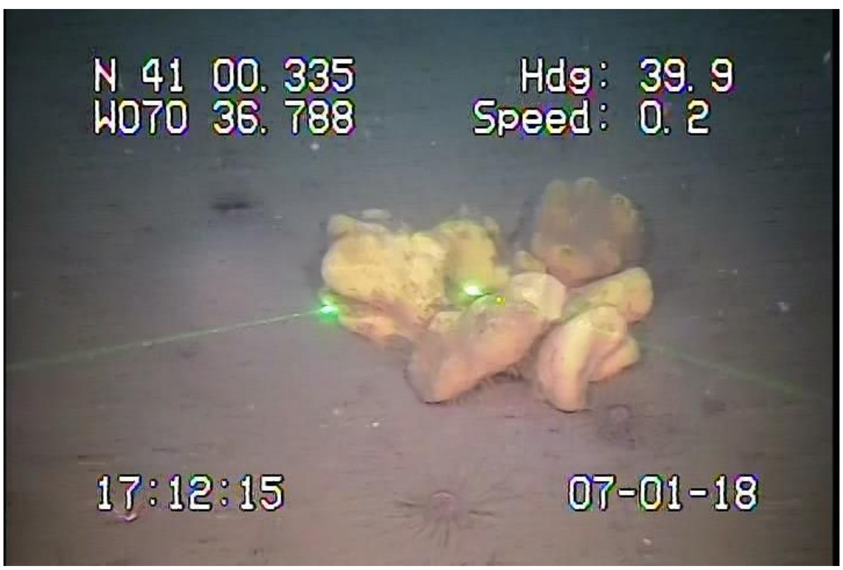

V-136 Little skate on a *flat sand/mud* bottom


V-138 Rock crab, moon snail on a *flat sand/mud* and *biogenic structures* combination bottom habitat

**PLATE 5A Representative video screen captures of Bottom Habitat and Biota**
**ATLANTIC OCEAN SOUTHEAST OF MARTHA'S VINEYARD**

V-139 Red hake, and sand dollars

V-139 Burrowing anemones, sand dollars, and hermit crab



V-144 Sulfur sponge, burrowing anemones

**PLATE 5B Representative video screen captures of Bottom Habitat and Biota**
**ATLANTIC OCEAN SOUTHEAST OF MARTHA'S VINEYARD**

# Appendix II-I

Project Drawings

Appendix II-I is redacted in its entirety.

OCS-A 0501 MASS USA

# VINEYARD WIND

# Draft
# Construction and Operations Plan

## Volume II-B

## Vineyard Wind Project

October 22, 2018

**Submitted by**
**Vineyard Wind LLC**
**700 Pleasant Street, Suite 510**
**New Bedford, Massachusetts 02740**

**Submitted to**
**Bureau of Ocean Energy Management**
**45600 Woodland Road**
**Sterling, Virginia 20166**

**Prepared by**
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**3 Mill & Main Place, Suite 250**
**Maynard, Massachusetts 01754**

Epsilon ASSOCIATES INC.

# Appendix II-J

Route Position Listings for Cable Corridors

Appendix II-J is redacted in its entirety.

# Appendix II-K

## Side Scan Sonar Contact Listings

Appendix II-K is redacted in its entirety.

Appendix K1 – Extracted from Alpine OECC Factual Report Appendix C

Appendix K2 – Extracted from Seaforth Geophys. Factual Report Appendix A

Appendix K3 – Extracted from Seaforth Geophys. Factual Report Appendix A

Appendix K4 – Extracted from Seaforth Geophys. Factual Report Appendix A

Appendix K5 – Extracted from Alpine IACC Factual Report Appendix C

# Appendix II-L

## Magnetic Anomaly Listings

Appendix II-L is redacted in its entirety.

Appendix L1 – Extracted from Alpine OECC Factual Report Appendix D

Appendix L2 - Extracted from Alpine IACC Factual Report Appendix D

Appendix L3 - Extracted from Seaforth Geophys. Factual Report Appendix B

# Appendix II-M

2016 Grab Samples Results

Appendix II-M is redacted in its entirety.

# Appendix II-N

2016 CPT and Borehole Logs and Lab Resutls

Appendix II-N is redacted in its entirety.

# Appendix II-O

2017 Grab Sample Photographs and Grain Size Results

Appendix II-O is redacted in its entirety.

# Appendix II-P

2017 Vibracore Grain Size and Geotechnical Test Results

Appendix II-P is redacted in its entirety.

# Appendix II-Q

2018 Geophysical Operations Report - Alpine

Appendix II-Q is redacted in its entirety.

Appendix II-R is redacted in its entirety.

# Appendix II-S

2018 Geotechnical Operations Report – Horizon, Boreholes

Appendix II-S is redacted in its entirety.

# Appendix II-T

2018 Geotechnical Operations Report – Geoquip, CPTs

Appendix II-T is redacted in its entirety.

# Appendix II-U

2016 Borehole Lab Testing - Fugro

Appendix II-U is redacted in its entirety.

# Appendix II-V

2018 Geotechnical Factual Report - Horizon, Boreholes

Appendix II-V is redacted in its entirety.

# Appendix II-W

2018 Geotechnical Factual Report – Geoquip, CPTs

Appendix II-W is redacted in its entirety.

## Appendix II-X

2018 Vibracore Logging and Lab Results

Appendix II-X is redacted in its entirety.

Appendix X1 – Extracted from Alpine OECC Factual Report Appendix F

Appendix X2 – Extracted from Alpine OECC Factual Report Appendix I

Appendix X3 – Extracted from Alpine OECC Factual Report Appendix K

Appendix X4 – Extracted from Alpine OECC Factual Report Appendix L

Appendix X5 – Extracted from Alpine OECC Factual Report Appendix M

Appendix X6 – Extracted from Alpine OECC Factual Report Appendix N

Appendix X7 – Lewis Bay Sediment Chemistry

Appendix X8 – Extracted from Alpine IACC Factual Report Appendix F

Appendix X9 – Extracted from Alpine IACC Factual Report Appendix G

Appendix X10 – Extracted from Alpine IACC Factual Report Appendix I

Appendix X11 – Extracted from Alpine IACC Factual Report Appendix J

Appendix X12 – Extracted from Alpine IACC Factual Report Appendix K

Appendix X21 – Extracted from SEAFORTH GEOTECH Factual Report Appendix B

Appendix X23 – Extracted from SEAFORTH GEOTECH Factual Report Appendix B

Appendix X24 – Extracted from SEAFORTH GEOTECH Factual Report Appendix C

Appendix X25 – Extracted from SEAFORTH GEOTECH Factual Report Appendix C

# Appendix II-Y

2018 Grab Sample Grain Size Results

Appendix II-Y is redacted in its entirety.

Appendix Y1 – Extracted from Alpine OECC Factual Report Appendix F & P

Appendix Y2 – Extracted from SEAFORTH GEOTECH. Factual Report Appendix A

# Appendix II-Z

2018 Grab Sample Results

Appendix II-Z is redacted in its entirety.

Appendix Z1 – Extracted from ALPINE OECC Factual Report Appendix F & H

Appendix Z2 – Extracted from ALPINE OECC Factual Report Appendix G

# Appendix II-AA

2018 Ground Model Report - Reynolds

Appendix II-AA is redacted in its entirety.

OCS-A 0501

MASS USA

VINEYARD WIND

# Draft Construction and Operations Plan

## Volume II-C

## Vineyard Wind Project

October 22, 2018

**Submitted by**
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**Submitted to**
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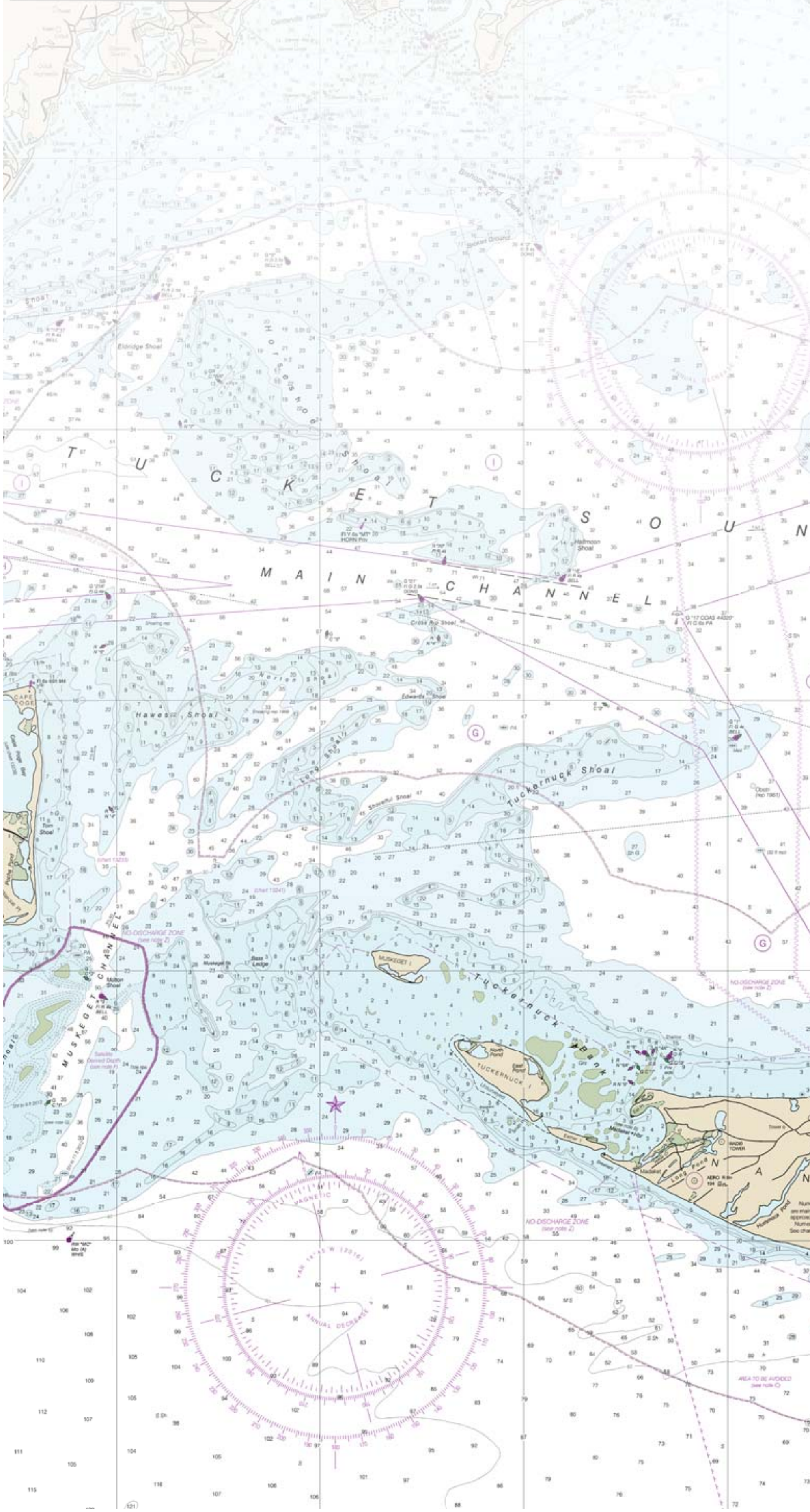
GRAY & PAPE
HERITAGE MANAGEMENT




# *Marine Archaeological Services in Support of the Vineyard Wind Offshore Wind Energy Project Construction and Operations Plan OCS-A 0501 Lease Area and Offshore Export Cable Corridors Offshore Massachusetts*

**Lead Federal Agency:**
Bureau of Ocean Energy Management

**Prepared for:**
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New Bedford, Massachusetts 02740

**Prepared by:**

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60 Valley Street, Suite 103
Providence, Rhode Island 02909


16-73901.002

GRAY & PAPE
HERITAGE MANAGEMENT

Project No. 16-73901.002

# Marine Archaeological Services in Support of the Vineyard Wind Offshore Wind Energy Project Construction and Operations Plan OCS-A 0501 Lease Area and Offshore Export Cable Corridor Offshore Massachusetts

Lead Federal Agency:
Bureau of Ocean Energy Management

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Principal Investigator
October 22, 2018

Volume II-C is redacted in its entirety.