New England Wind

AVANGRID RENEWABLES

Construction and Operations Plan

Lease Area OCS-A 0534

Volume II-A Appendices

February 2024

Submitted by
Park City Wind LLC

Submitted to
Bureau of Ocean Energy Management
45600 Woodland Rd
Sterling, VA 20166

Prepared by
Epsilon Associates, Inc.

New England Wind Construction and Operations Plan for Lease Area OCS-A 0534

Volume II-A Appendices

Marine Site Investigation Report

Submitted to:
BUREAU OF OCEAN ENERGY MANAGEMENT
45600 Woodland Rd
Sterling, VA 20166

Submitted by:
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Wood Thilsted Partners Ltd

February 2024

Appendix II-H

2016-2020 Benthic Reports

NOTE:

New England Wind will be developed immediately southwest of Vineyard Wind 1, which is located in Lease Area OCS-A 0501. New England Wind will occupy all of Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501 in the event that Vineyard Wind 1 does not develop "spare" or extra positions included in Lease Area OCS-A 0501 and Vineyard Wind 1 assigns those positions to Lease Area OCS-A 0534. For the purposes of the Construction and Operations Plan (COP), the area where New England Wind's offshore renewable generation facilities are located is referred to as the Southern Wind Development Area (SWDA), which is defined as all of Lease Area OCS-A 0534 and the southwest portion of Lease Area OCS-A 0501.

The southwest portion of Lease Area OCS-A 0501 that is included in the SWDA was previously analyzed as part of the Vineyard Wind 1 COP. Additionally, the Offshore Export Cable Corridor (OECC) for New England Wind is largely the same OECC proposed in the approved Vineyard Wind 1 COP, but it has been widened to the west along the entire corridor and to the east in portions of Muskeget Channel and the New England Wind OECC excludes the New Hampshire Avenue landfall site option that was included in the Vineyard Wind 1 COP. Accordingly, the following report contains some information from the overlap area in Lease Area OCS-A 0501 that is within the boundaries of the SWDA, as well as some information from the portion of Lease Area OCS-A 0501 that is not within the boundaries of New England Wind and thus is not relevant for the New England Wind COP. Likewise, the following report contains some information that is within the New England Wind OECC, as well as some information from the New Hampshire Avenue landfall site option that was included in the Vineyard Wind 1 OECC but is not included in the New England Wind OECC and thus is not relevant for the New England Wind COP. Additionally, the following report may include information regarding the Phase 2 OECC Western Muskeget Variant (Western Muskeget Variant) that was included as part of the Vineyard Wind 1 OECC and was thoroughly reviewed and approved for the Vineyard Wind 1 COP. One or two Phase 2 export cables may be installed within the Western Muskeget Variant if technical, logistical, grid interconnection, or other unforeseen issues arise with installing all New England Wind offshore export cables within the OECC that travels along the eastern side of Muskeget Channel. Please refer to the main body of Volume II of the New England Wind COP for full details on the precise data and limits of the site characterization and supporting information for New England Wind.

New England Wind was previously referred to as Vineyard Wind South; because the following reports were produced before the name change occurred, the original name is used. All references to Vineyard Wind South should now be considered references to New England Wind. Additionally, Park City Wind LLC, a wholly owned subsidiary of Avangrid Renewables, LLC, is the Proponent of New England Wind and therefore any references to Vineyard Wind LLC as the Proponent of Vineyard Wind South should now be considered references to Park City Wind LLC as the Proponent of New England Wind.

Data within this appendix that fall outside the boundaries of the New England Wind SWDA, OECC, and Western Muskeget Variant have been redacted to the fullest extent possible to remove extraneous data. As such, redactions are apparent on figures, tables, and text throughout this appendix. While a reasonable effort has been made to redact individual data points that are outside of the geographic limits of New England Wind, summary results of figures, tables, and text within this appendix have not been redacted and contain information from redacted samples that are outside the boundaries of New England Wind.

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. CR Environmental June/July 2018 Underwater Video Review
5. RPS/Alpine 2019 Benthic Report
6. RPS 2019 SWDA Benthic Report
7. RPS 2019 OECC Benthic Report
8. CR Environmental 2019 Underwater Video Review
9. RPS 2020 Benthic Report

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
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PREPARED BY:

ESS Group, Inc.
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Project No. O207-000

January 27, 2017

BENTHIC MACROINVERTEBRATE SAMPLE ANALYSIS REPORT
Vineyard Wind Project
Massachusetts

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January 27, 2017

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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.

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.

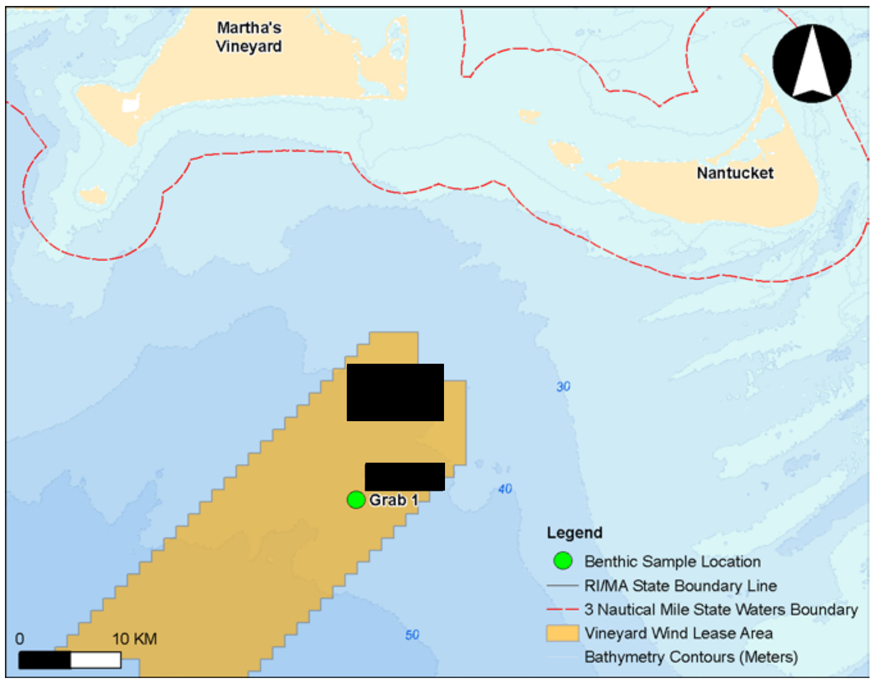

Figure 1. Benthic Grab Sample Locations

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:

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

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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).

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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.

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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.

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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

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Appendix A

Benthic Sample Taxonomy and Enumeration Results

	Organisms/m^3			
	Grab 1	**G**[redacted]	[redacted]	[redacted]
Conversion Factor (multiply by density to find raw sample abundance)	**0.00182**	[redacted]	[redacted]	[redacted]
Taxa				
Crustacea				
Amphipoda				
Ampelisca sp.	6,593	[redacted]	[redacted]	
Unidentified Amphipoda			[redacted]	
Byblis sp.			[redacted]	[redacted]
Cumacea	549			
Diastylis sp.	549			[redacted]
Harpinia sp.	549		[redacted]	
Leptocheirus pinguis		[redacted]		
Cumacea				
Unidentified Cumacea			[redacted]	
Diastylis sp.		[redacted]	[redacted]	
Isopoda				
Cyathura polita			[redacted]	
Ostracoda				
Unidentified Ostracoda	549			
Echinodermata				
Echinarachnius parma	549	[redacted]		
Mollusca				
Bivalvia				
Unidentified Bivalvia	1,648	[redacted]	[redacted]	
Lucinoma sp.	1,648		[redacted]	
Periploma papyratium	549			
Tellina sp.			[redacted]	
Nematoda				
Nematoda	21,978		[redacted]	[redacted]
Nemertea				
Cephalothrix sp.		[redacted]		
Cerebratulus luridus		[redacted]		
Unidentified Nemertea	1,099	[redacted]		[redacted]
Polychaeta				
Ampharetidae	1,099	[redacted]		[redacted]
Cirratulidae	1,099			
Clymenella sp.	7,692	[redacted]	[redacted]	
Drilonereis longa			[redacted]	
Exogone sp.	549			
Glycera sp.		[redacted]	[redacted]	
Nephtyidae	1,099			
Nephtys sp.		[redacted]		
Ninoe nigripes		[redacted]	[redacted]	
Paraonidae	23,077	[redacted]	[redacted]	
Pholoe minuta		[redacted]		
Unidentified Polychaeta	3,297			
Scoletoma sp.	25,824	[redacted]	[redacted]	[redacted]
Sigalionidae			[redacted]	
Total Density	**100,000**	[redacted]	[redacted]	[redacted]
Taxa Richness	**19**	[redacted]	[redacted]	[redacted]

2. Normandeau Associates 2017 Benthic Sample Processing Report

Benthic Sample Processing Results
Vineyard Wind Cable Route Survey
September 2017

Prepared by:
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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).

		Phyla		
QC	**Sample**	**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).

		Phyla		
QC	**Sample**	**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.

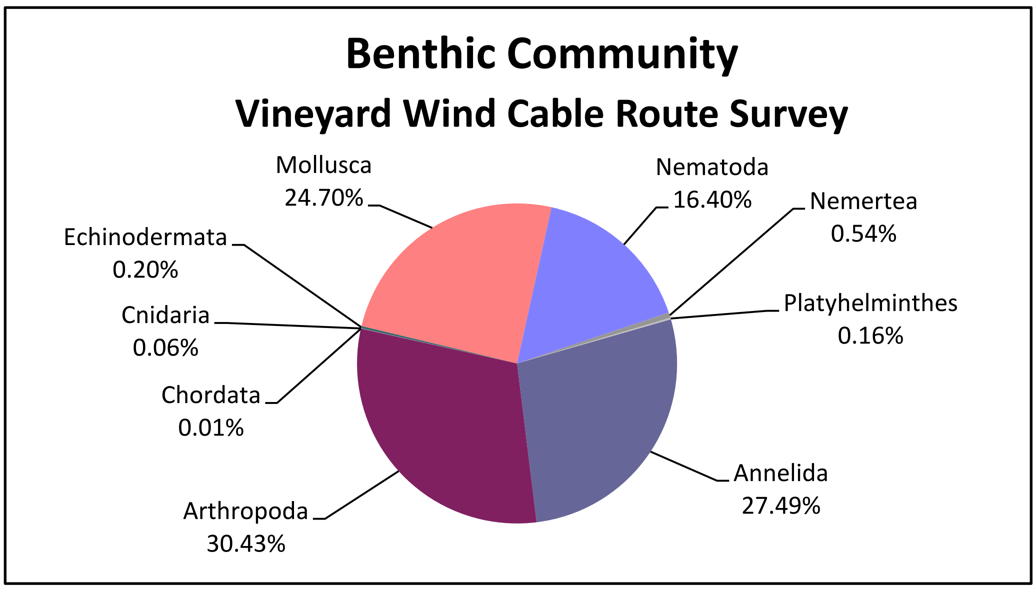


Figure 4-1. Percent contribution to total abundance by phyla in benthic samples collected during the Vineyard Wind cable route survey in September 2017.

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 m²)	Diversity (H')	Evenness (J')
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
4	11	37	1.84	0.77
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
11	16	32	2.58	0.93
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
15	10	20	1.99	0.86
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 4-2. Continued.

Station	Total Number of Taxa	Total Count (no. per 0.008 m^2)	Diversity (H')	Evenness (J')
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
49	10	41	1.79	0.78
50	18	89	2.30	0.80
51	11	80	1.65	0.69
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
58	7	30	1.42	0.73
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
61	15	55	2.32	0.86
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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 m²)
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 m²)
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

Clarke, KR and RN Gorley. 2006. Primer V6: User Manual-Tutorial. Plymouth Marine Laboratory.

Magurran, AE. 1988. Ecological Diversity and Its Measurement. Princeton University Press. Princeton, NJ. 179 pp.

USEPA 2016. National Coastal Condition Assessment 2015: Laboratory Operations Manual. EPA- 841-R-14-008. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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																		
		[redacted]	[redacted]	[redacted]	4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	11	[redacted]	[redacted]	[redacted]	15	[redacted]	17	18	19	20
Annelida	Ampharetidae		[redacted]		1		[redacted]						[redacted]					1	2	2
	Archiannelida		[redacted]	[redacted]						[redacted]	1									
	Capitellidae	[redacted]	[redacted]		6					[redacted]	5		[redacted]				2	24		
	Chaetopteridae																			
	Cirratulidae		[redacted]			[redacted]	[redacted]	[redacted]		[redacted]			[redacted]	[redacted]				5		14
	Dorvilleidae						[redacted]													
	Glyceridae			[redacted]			[redacted]											1		
	Hesionidae				1		[redacted]													
	Lumbrineridae		[redacted]										[redacted]							4
	Magelonidae										1									
	Maldanidae	[redacted]		[redacted]	1		[redacted]			[redacted]									1	
	Nephtyidae			[redacted]				[redacted]	[redacted]	[redacted]	1	[redacted]	[redacted]	[redacted]				2	2	
	Oenonidae																			
	Oligochaeta	[redacted]	[redacted]	[redacted]	14	[redacted]	[redacted]				3							93	1	
	Onuphidae													[redacted]						
	Opheliidae																			
	Orbiniidae		[redacted]																	
	Oweniidae																			
	Paraonidae		[redacted]				[redacted]			[redacted]	1									
	Pectinariidae				1															
	Phyllodocidae		[redacted]			[redacted]	[redacted]	[redacted]											2	1
	Pilargidae			[redacted]	1		[redacted]													
	Polynoidae					[redacted]	[redacted]	[redacted]												2
	Sabellaridae																			
	Sigalionidae									[redacted]						[redacted]				
	Sphaerodoridae																			
	Spionidae	[redacted]	[redacted]			[redacted]	[redacted]				1			[redacted]						2
	Syllidae	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]		[redacted]								6		6
	Terebellidae		[redacted]	[redacted]		[redacted]	[redacted]			[redacted]						[redacted]	2	2		

(continued)

Appendix Table A. (Continued)

		Station																		
		[redacted]	[redacted]	[redacted]	4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	11	[redacted]	[redacted]	[redacted]	15	[redacted]	17	18	19	20
Arthropoda	Ampeliscidae										4			[redacted]				5	4	1
	Anthuridae								[redacted]											
	Aoridae	[redacted]				[redacted]	[redacted]													3
	Argissidae																			
	Bateidae					[redacted]	[redacted]													1
	Bathyporeiidae			[redacted]						[redacted]										
	Bodotriidae							[redacted]			1		[redacted]							
	Callianassidae									[redacted]										
	Cancridae							[redacted]												
	Caprellidae	[redacted]	[redacted]	[redacted]		[redacted]		[redacted]											1	
	Corophiidae	[redacted]				[redacted]														
	Diastylidae			[redacted]	2			[redacted]	[redacted]			[redacted]	[redacted]						1	
	Epialtidae																			
	Haustoriidae										2	[redacted]			2					
	Idoteidae																			1
	Inachoididae																		1	
	Ischyroceridae		[redacted]																	
	Janiridae					[redacted]	[redacted]	[redacted]												1
	Leptocheliidae					[redacted]														
	Liljeborgiidae							[redacted]		[redacted]	1				1					
	Lysianassidae	[redacted]																		2
	Maeridae						[redacted]													2
	Mysidae					[redacted]	[redacted]													
	Oedicerotidae		[redacted]	[redacted]	1			[redacted]			1	[redacted]	[redacted]							
	Paguridae			[redacted]			[redacted]	[redacted]											1	2
	Parthenopidae						[redacted]													
	Photidae																			8
	Phoxocephalidae			[redacted]			[redacted]	[redacted]		[redacted]	4		[redacted]	[redacted]	1		3			2
	Pinnotheridae									[redacted]	3	[redacted]	[redacted]		1					

(continued)

Appendix Table A. (Continued)

		Station																		
		[redacted]	[redacted]	[redacted]	4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	11	[redacted]	[redacted]	[redacted]	15	[redacted]	17	18	19	20
Arthropoda (cont'd)	Stenothoidae							[redacted]												
	Tanaissuidae														5	[redacted]				
	Unciolidae		[redacted]	[redacted]			[redacted]								1				1	
	Upogebiidae																			
	Xanthidae	[redacted]				[redacted]	[redacted]	[redacted]										1		1
Chordata	Harrimaniidae						[redacted]													
Cnidaria	Alcyoniidae																			
	Edwardsiidae							[redacted]												
	Halcampidae		[redacted]																	
Echinodermata	Amphiuridae						[redacted]													
	Echinarachniidae																			
Mollusca	Acteocinidae		[redacted]																	
	Arcidae	[redacted]				[redacted]		[redacted]												
	Astartidae																			
	Busyconidae						[redacted]													
	Calyptraeidae	[redacted]				[redacted]	[redacted]	[redacted]											1	59
	Cerithiopsidae		[redacted]			[redacted]	[redacted]	[redacted]												
	Chaetopleuridae					[redacted]	[redacted]													1
	Columbellidae	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]											1	13
	Corambidae																			
	Crassatellidae			[redacted]			[redacted]												1	1
	Lyonsiidae			[redacted]															1	
	Mactridae																			
	Mangeliidae														1					
	Margaritidae																			
	Muricidae					[redacted]														
	Myidae																			
	Mytilidae																			
	Nassariidae														1					

(continued)

Appendix Table A. (Continued)

		Station																		
		[redacted]	[redacted]	[redacted]	4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	11	[redacted]	[redacted]	[redacted]	15	[redacted]	17	18	19	20
Mollusca (cont'd)	Naticidae																			1
	Nuculidae				1	[redacted]	[redacted]													
	Pandoridae																			
	Pectinidae					[redacted]	[redacted]													
	Pharidae							[redacted]												1
	Pyramidellidae	[redacted]	[redacted]	[redacted]		[redacted]		[redacted]		[redacted]	2			[redacted]					1	33
	Semelidae																			1
	Tellinidae		[redacted]	[redacted]				[redacted]	[redacted]	[redacted]	1	[redacted]	[redacted]	[redacted]	1				7	
	Veneridae																			
	Yoldiidae																			
Nematoda	Nematoda	[redacted]	[redacted]	[redacted]	8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	6	[redacted]	4	43	3	5
Nemertea	Amphiporidae						[redacted]			[redacted]										
	Carinomidae						[redacted]													
	Lineidae							[redacted]											1	
	Tetrastemmatidae						[redacted]													
	Tubulanidae																			
Platyhelminthes	Turbellaria					[redacted]	[redacted]			[redacted]										

(continued)

Appendix Table A. (Continued)

		Station																			
		21	22	23	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	40
Annelida	Ampharetidae	1		2									[redacted]						[redacted]	[redacted]	
	Archiannelida							[redacted]	[redacted]											[redacted]	1
	Capitellidae					[redacted]	[redacted]	[redacted]	[redacted]			[redacted]					[redacted]	[redacted]		[redacted]	
	Chaetopteridae											[redacted]	[redacted]								
	Cirratulidae	4		2			[redacted]	[redacted]	[redacted]			[redacted]					[redacted]		[redacted]		
	Dorvilleidae																				
	Glyceridae			1	[redacted]		[redacted]	[redacted]		[redacted]	[redacted]	[redacted]				[redacted]	[redacted]			[redacted]	
	Hesionidae																				
	Lumbrineridae	2		4			[redacted]		[redacted]	[redacted]		[redacted]					[redacted]	[redacted]		[redacted]	
	Magelonidae								[redacted]						[redacted]						
	Maldanidae						[redacted]			[redacted]	[redacted]		[redacted]					[redacted]	[redacted]	[redacted]	
	Nephtyidae				[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
	Oenonidae																				
	Oligochaeta	6		12			[redacted]	[redacted]	[redacted]			[redacted]	[redacted]				[redacted]	[redacted]	[redacted]	[redacted]	
	Onuphidae																				
	Opheliidae																				11
	Orbiniidae								[redacted]	[redacted]								[redacted]			
	Oweniidae			1			[redacted]														
	Paraonidae																				
	Pectinariidae																				
	Phyllodocidae	1		5				[redacted]		[redacted]		[redacted]	[redacted]				[redacted]	[redacted]		[redacted]	
	Pilargidae																				
	Polynoidae	3		1																	
	Sabellaridae	1		2																	
	Sigalionidae																			[redacted]	2
	Sphaerodoridae																				
	Spionidae	1	1	89				[redacted]	[redacted]							[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
	Syllidae	14		12				[redacted]				[redacted]							[redacted]	[redacted]	4
	Terebellidae	2		2															[redacted]	[redacted]	2

(continued)

Appendix Table A. (Continued)

		Station																			
		21	22	23	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	40
Arthropoda	Ampeliscidae	1					[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]			
	Anthuridae													[redacted]							
	Aoridae	2																			
	Argissidae																				
	Bateidae	2																			
	Bathyporeiidae								[redacted]												
	Bodotriidae																				
	Callianassidae							[redacted]	[redacted]												
	Cancridae			1																[redacted]	
	Caprellidae	6		1146		[redacted]		[redacted]													
	Corophiidae			2																	
	Diastylidae													[redacted]							
	Epialtidae				[redacted]																
	Haustoriidae								[redacted]					[redacted]	[redacted]	[redacted]		[redacted]			
	Idoteidae																				
	Inachoididae			1																	
	Ischyroceridae			20																	
	Janiridae			1																	
	Leptocheliidae																				
	Liljeborgiidae																				
	Lysianassidae	4																			
	Maeridae			4																	
	Mysidae																				
	Oedicerotidae							[redacted]													
	Paguridae	4		34						[redacted]			[redacted]								
	Parthenopidae																				
	Photidae	3		4																	
	Phoxocephalidae	5						[redacted]	[redacted]						[redacted]						
	Pinnotheridae											[redacted]		[redacted]			[redacted]				

(continued)

Appendix Table A. (Continued)

		Station																			
		21	22	23	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	40
Arthropoda (cont'd)	Stenothoidae	2		10																	
	Tanaissuidae															[redacted]					
	Unciolidae	2	1	3							[redacted]				[redacted]					[redacted]	
	Upogebiidae																[redacted]				
	Xanthidae			1							[redacted]									[redacted]	
Chordata	Harrimaniidae																				
Cnidaria	Alcyoniidae								[redacted]												
	Edwardsiidae																				
	Halcampidae			1																[redacted]	
Echinodermata	Amphiuridae						[redacted]		[redacted]		[redacted]										
	Echinarachniidae																				
Mollusca	Acteocinidae						[redacted]			[redacted]	[redacted]		[redacted]					[redacted]			
	Arcidae	6																		[redacted]	
	Astartidae																				6
	Busyconidae																				
	Calyptraeidae	13		3							[redacted]					[redacted]				[redacted]	
	Cerithiopsidae	1																			
	Chaetopleuridae	1																		[redacted]	
	Columbellidae	30		174	[redacted]		[redacted]	[redacted]	[redacted]		[redacted]										
	Corambidae	1																			
	Crassatellidae																				
	Lyonsiidae						[redacted]			[redacted]		[redacted]						[redacted]		[redacted]	1
	Mactridae															[redacted]					1
	Mangeliidae							[redacted]			[redacted]										
	Margaritidae			1																[redacted]	
	Muricidae																				
	Myidae																				
	Mytilidae			3																	
	Nassariidae						[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]								

(continued)

Appendix Table A. (Continued)

		Station																			
		21	**22**	**23**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**40**
Mollusca (cont'd)	Naticidae							[redacted]												[redacted]	
	Nuculidae												[redacted]								
	Pandoridae						[redacted]												[redacted]		
	Pectinidae																				
	Pharidae						[redacted]		[redacted]	[redacted]	[redacted]						[redacted]	[redacted]	[redacted]	[redacted]	
	Pyramidellidae			1			[redacted]			[redacted]	[redacted]		[redacted]	[redacted]						[redacted]	
	Semelidae																				
	Tellinidae	1		1	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
	Veneridae							[redacted]										[redacted]			
	Yoldiidae											[redacted]					[redacted]	[redacted]			
Nematoda	Nematoda	33	10	39	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	8
Nemertea	Amphiporidae	4			[redacted]													[redacted]			
	Carinomidae			2																	
	Lineidae	1			[redacted]			[redacted]		[redacted]											
	Tetrastemmatidae			3																	
	Tubulanidae						[redacted]										[redacted]	[redacted]			
Platyhelminthes	Turbellaria		1																	[redacted]	

(continued)

Appendix Table A. (Continued)

		Station																			
		43	44	45	46	[redacted]	[redacted]	49	50	51	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	58	[redacted]	[redacted]	61	62
Annelida	Ampharetidae					[redacted]		1	1										[redacted]	3	
	Archiannelida								14	15	[redacted]	[redacted]	[redacted]		[redacted]				[redacted]	11	
	Capitellidae	1					[redacted]		4				[redacted]	[redacted]		[redacted]		[redacted]	[redacted]		
	Chaetopteridae																				
	Cirratulidae		2			[redacted]			5	1		[redacted]		[redacted]	[redacted]	[redacted]					
	Dorvilleidae		2									[redacted]	[redacted]	[redacted]					[redacted]		
	Glyceridae		2	2			[redacted]				[redacted]						4				
	Hesionidae																				
	Lumbrineridae							3	1	2	[redacted]	[redacted]							[redacted]	5	
	Magelonidae													[redacted]							
	Maldanidae										[redacted]	[redacted]	[redacted]							9	
	Nephtyidae												[redacted]	[redacted]	[redacted]			[redacted]	[redacted]		
	Oenonidae																			1	
	Oligochaeta		4			[redacted]			2	2	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]		[redacted]	[redacted]	1	
	Onuphidae																				
	Opheliidae																1				
	Orbiniidae							1	2		[redacted]	[redacted]								1	
	Oweniidae																				
	Paraonidae								2	2		[redacted]	[redacted]			[redacted]			[redacted]		
	Pectinariidae																				
	Phyllodocidae					[redacted]			2							[redacted]		[redacted]			
	Pilargidae																				
	Polynoidae					[redacted]									[redacted]			[redacted]			
	Sabellaridae					[redacted]												[redacted]			
	Sigalionidae			1	5	[redacted]										[redacted]					
	Sphaerodoridae												[redacted]								
	Spionidae		4			[redacted]		1	1				[redacted]	[redacted]				[redacted]			
	Syllidae		10	9	4	[redacted]		5	2	2		[redacted]	[redacted]	[redacted]			1	[redacted]			
	Terebellidae		1	1		[redacted]			1												

(continued)

Appendix Table A. (Continued)

		Station																			
		43	44	45	46	[redacted]	[redacted]	49	50	51	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	58	[redacted]	[redacted]	61	62
Arthropoda	Ampeliscidae							16	19	11	[redacted]					[redacted]				4	
	Anthuridae																				
	Aoridae					[redacted]															
	Argissidae										[redacted]										
	Bateidae																				
	Bathyporeiidae													[redacted]							
	Bodotriidae																				
	Callianassidae																				
	Cancridae																				
	Caprellidae										[redacted]				[redacted]					1	
	Corophiidae					[redacted]															
	Diastylidae										[redacted]									1	
	Epialtidae																				
	Haustoriidae													[redacted]			5				
	Idoteidae																				
	Inachoididae																				
	Ischyroceridae					[redacted]															
	Janiridae					[redacted]												[redacted]			
	Leptocheliidae																				
	Liljeborgiidae														[redacted]						
	Lysianassidae					[redacted]															
	Maeridae																				
	Mysidae																	[redacted]			
	Oedicerotidae											[redacted]			[redacted]						
	Paguridae					[redacted]															
	Parthenopidae																				
	Photidae					[redacted]					[redacted]							[redacted]		3	
	Phoxocephalidae					[redacted]			1	5	[redacted]	[redacted]			[redacted]	[redacted]				1	
	Pinnotheridae																				

(continued)

Appendix Table A. (Continued)

		Station																			
		43	44	45	46	[redacted]	[redacted]	49	50	51	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	58	[redacted]	[redacted]	61	62
Arthropoda (cont'd)	Stenothoidae					[redacted]															
	Tanaissuidae												[redacted]	[redacted]							
	Unciolidae					[redacted]															
	Upogebiidae																				
	Xanthidae					[redacted]												[redacted]			
Chordata	Harrimaniidae																				
Cnidaria	Alcyoniidae																				
	Edwardsiidae																				
	Halcampidae																				
Echinodermata	Amphiuridae																				
	Echinarachniidae									1			[redacted]	[redacted]							
Mollusca	Acteocinidae																				
	Arcidae					[redacted]															
	Astartidae		2	15	15														[redacted]		
	Busyconidae																				
	Calyptraeidae					[redacted]												[redacted]			
	Cerithiopsidae																	[redacted]			
	Chaetopleuridae					[redacted]															
	Columbellidae		1			[redacted]												[redacted]			
	Corambidae			1		[redacted]															
	Crassatellidae			1																	
	Lyonsiidae													[redacted]							
	Mactridae			2	24				1		1			[redacted]							
	Mangeliidae																				
	Margaritidae					[redacted]															
	Muricidae																	[redacted]			
	Myidae						[redacted]														
	Mytilidae			1	1																
	Nassariidae								1												

(continued)

Appendix Table A. (Continued)

		Station																			
		43	44	45	46	[redacted]	[redacted]	49	50	51	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	58	[redacted]	[redacted]	61	62
Mollusca (cont'd)	Naticidae																				
	Nuculidae							3	17		[redacted]	[redacted]				[redacted]				10	2
	Pandoridae													[redacted]							
	Pectinidae																				
	Pharidae												[redacted]		[redacted]						
	Pyramidellidae			2		[redacted]					[redacted]					[redacted]	1	[redacted]			
	Semelidae																				
	Tellinidae		1			[redacted]		1		1			[redacted]	[redacted]	[redacted]	[redacted]	2		[redacted]		
	Veneridae										[redacted]										
	Yoldiidae																			1	4
Nematoda	Nematoda	1	9	3	4	[redacted]	[redacted]	9	13	38	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	16	[redacted]	[redacted]	3	1
Nemertea	Amphiporidae					[redacted]									[redacted]			[redacted]			
	Carinomidae							1			[redacted]										
	Lineidae																				
	Tetrastemmatidae																				
	Tubulanidae					[redacted]															
Platyhelminthes	Turbellaria											[redacted]		[redacted]							

3. CR Environmental 2018 Underwater Video Review

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.

Bottom Habitat Classification Results

- 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.

Biota Results

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>

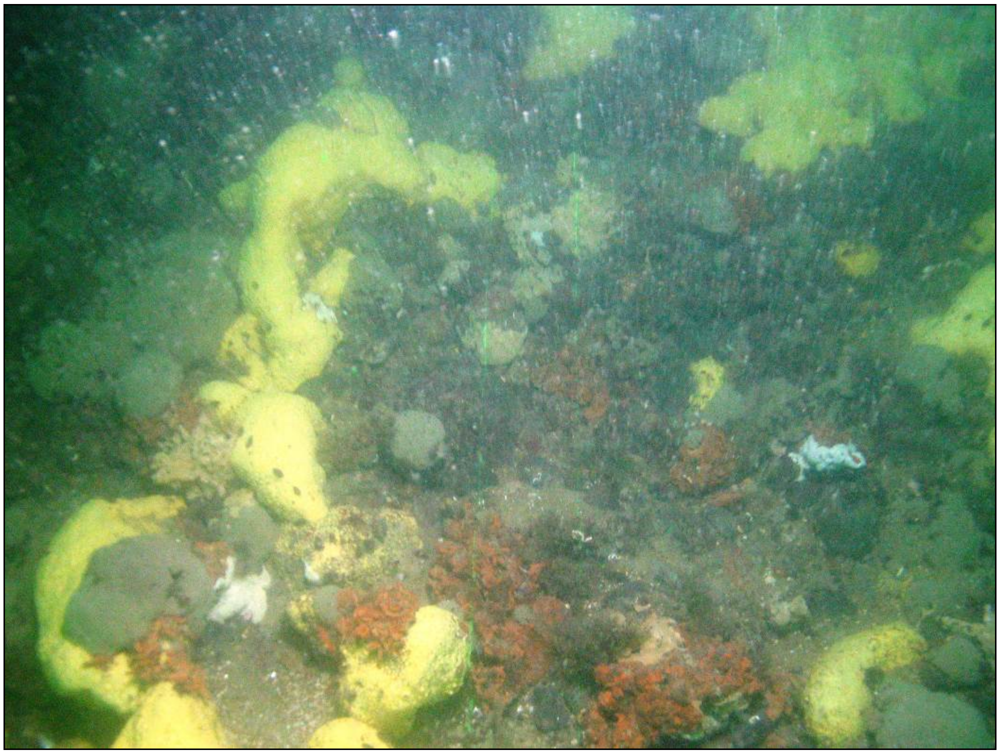
Auster, P.J. 1998. *The conceptual model of the impacts of fishing gear on the integrity of fish habitat.* Conservation Biology V12 (6): 1198-1203.

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.

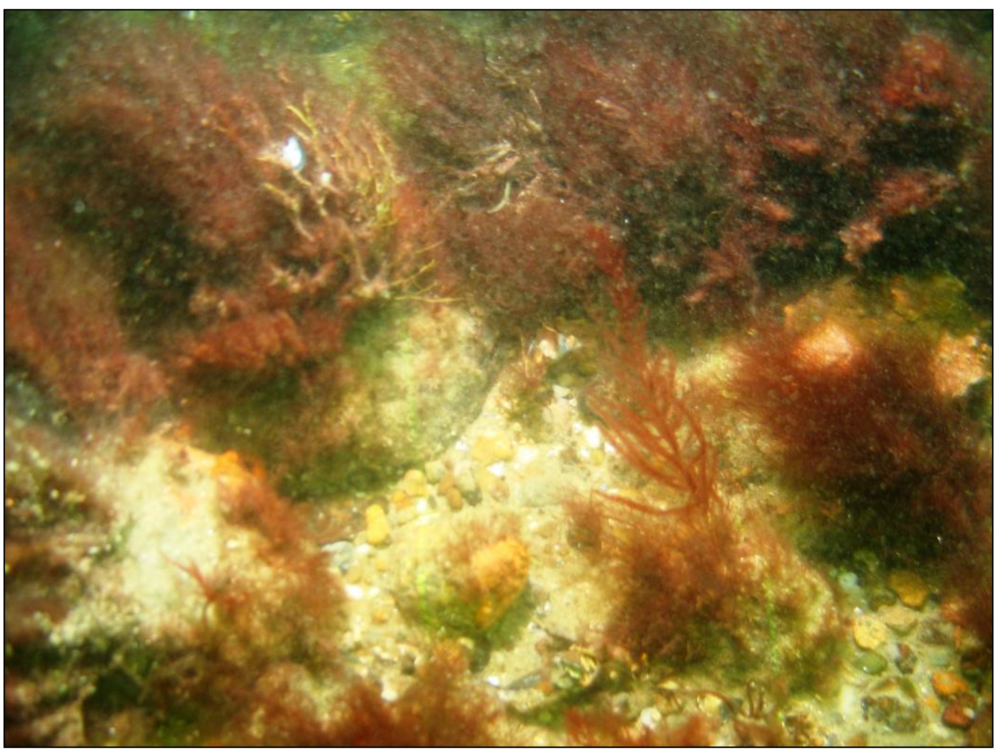
Screen Captures of Bottom Classifications (Auster, 1998) in Areas of Potential SSUs

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.



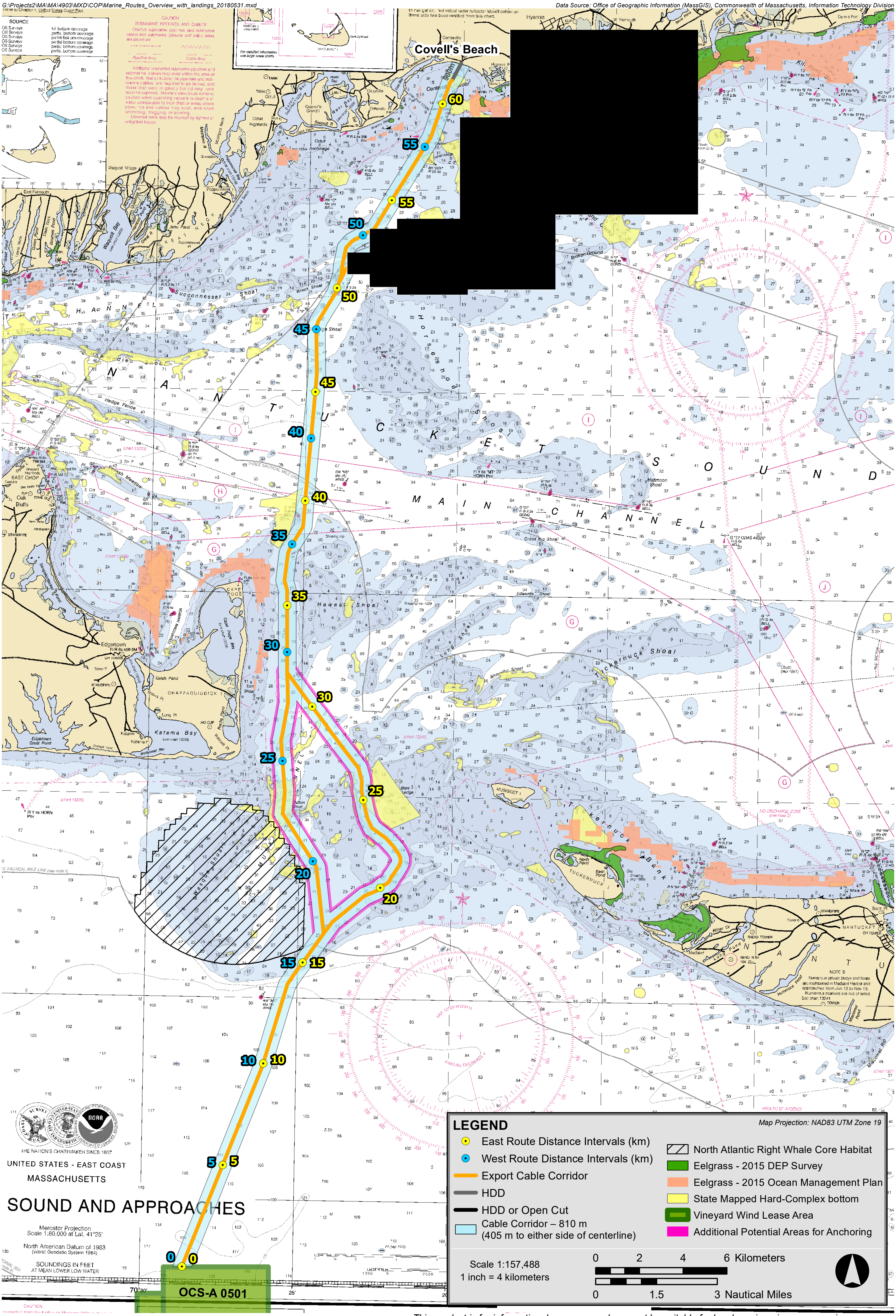
Transect 75 – The primary bottom classification was Flat sand, Mud/ Pebble cobble with a secondary classification of partially buried or dispersed boulders. Present were bread crumb and red beard sponges, bryozoans, hydroids, slipper limpets, hermit crabs, purple sea urchin, and branching red algae.

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

G:\Projects2\MA\MA\4903\MXD\COP\Marine_Routes_Overview_with_landings_20180531.mxd

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



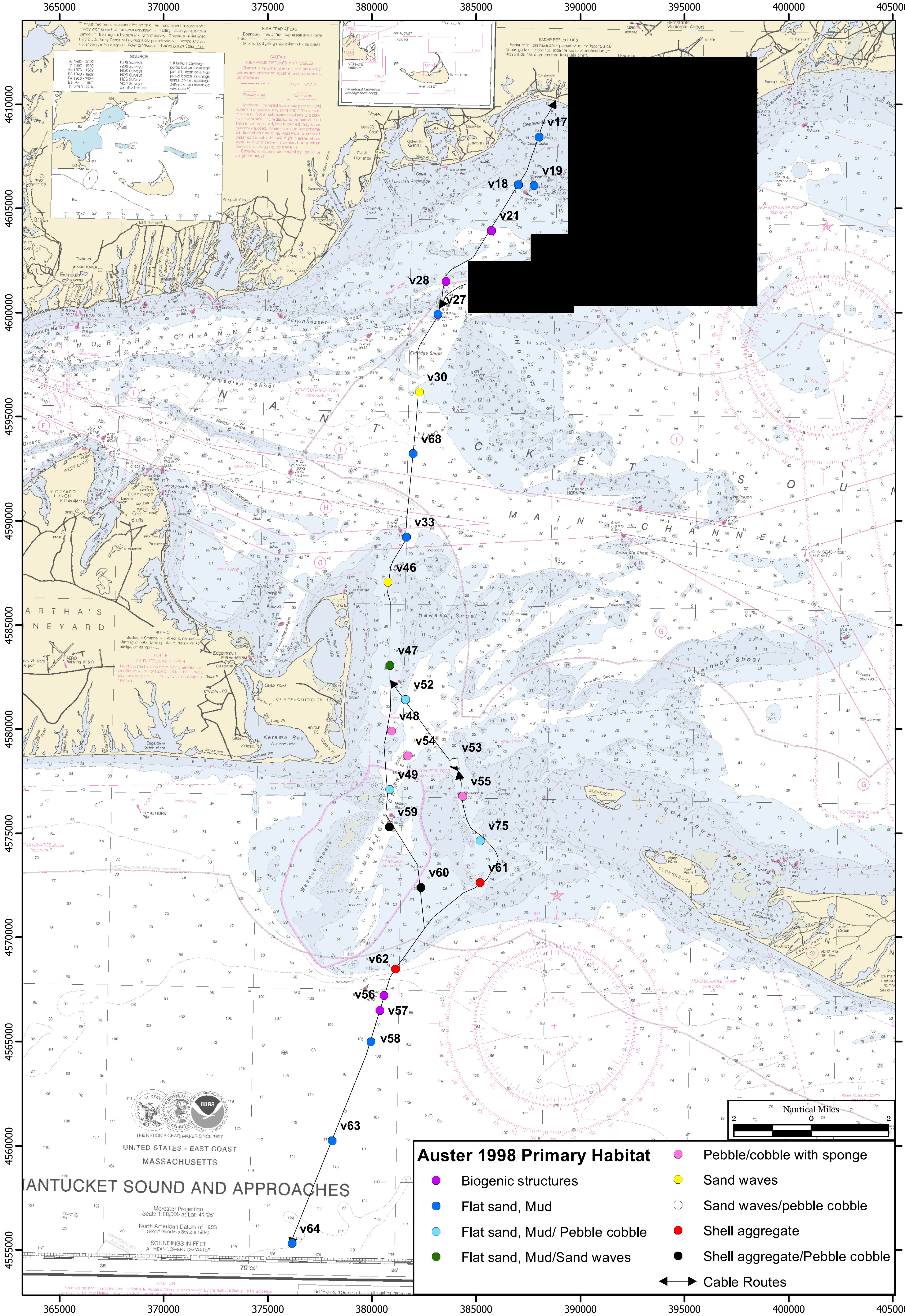
This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes.

Vineyard Wind Project

VINEYARD WIND

Figure 1

Export Cable Corridor



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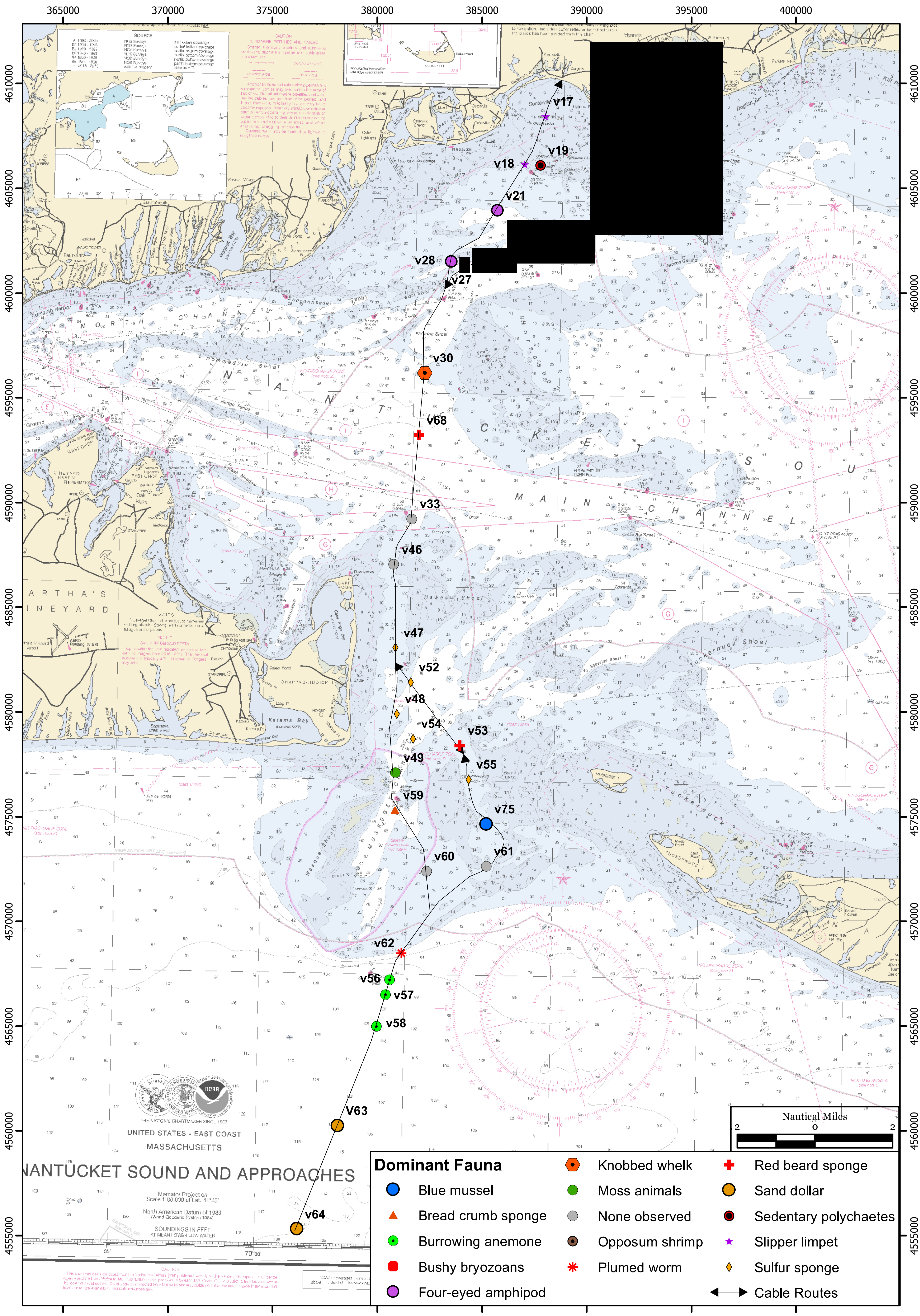
Transect Primary Habitat Classification (Auster, 1998)
Vineyard Wind Project
Nantucket Sound and Atlantic Ocean

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

Figure 2



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]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
21	385748	4603955	Four-eyed amphipod	*Ampelisca sp.*	Common	Biogenic structures		Fine	Absent	Absent	9.54
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	T-17	T-18
FAUNA											
PORIFERA											
Bread crumb sponge	*Halichondria panicea*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Red beard sponge[3]	*Microciona prolifera*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Sulfur sponge	*Cliona celata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
CNIDARIA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Bell shaped jellyfish		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Burrowing anemone	*Cerianthus borealis*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Star Coral	*Astrangia poculata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Hydroid	Hydrozoa	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
CTENOPHORA	Ctenophora	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
BRYOZOA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Bushy bryozoan	Bryozoa	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Encrusting bryozoan	*Schizoporella unicornis*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		X
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
MOLLUSCA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Bay Scallop	*Argopecten irradians*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	X	
Blue mussel	*Mytilis edulis*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Knobbed whelk*[1]	*Busycon carica*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Knobbed whelk egg case*	*Busycon carica*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Moon snail	Naticidae	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Slipper limpet	*Crepidula fornicata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Threeline Mudsnail	*Ilyanassa trivittata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
ANNELIDA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Polychaeta		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Lug worm	*Arenicola sp.*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		X
Plumed worm	*Diopatra cuprea*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	X	
Sedentary polychaetes	Polychaeta	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		X
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
ARTHROPODA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Crustacea		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Barnacle	*Balanus* sp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Four-eyed amphipod	*Ampelisca sp.*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Hermit crab	*Pagurus sp.*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		X
Jonah crab*	*Cancer borealis*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Mysid shrimp	Mysids	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Rock crab	*Cancer irroratus*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Spider crab	*Lubinia emarginata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Echinoderms		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Common sea star	*Asterias forbesi*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Sand dollar	*Echinarachnius parma*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Purple sea urchin	*Arbacia punctulata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
VERTEBRATA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Elasmobrachiomorphi		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Little Skate egg case*	*Raja erinacea*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Little Skate*	*Raja erinacea*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	X	
Osteichthyes		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Black sea bass*	*Centropristis striata*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Red Hake*	*Urophycis chuss*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Scup*	*Stenotomus chrysops*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
CHORDATA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Sand Sponge	*Amaroucium sp.*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
White invasive tunicate	*Didemnum candidum*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
SPECIES RICHNESS FAUNA[2]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3	4
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
FLORA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
CHLOROPHYTA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Dead Man's Fingers	*Codium fragile*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	X	X
Sea Lettuce	*Ulva lactuca*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
PHAEOPHYTA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Rockweed	*Fucus* sp.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		X
Sargassum	*Sargassum sp.*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	X	
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
RHODOPHYTA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
Branching red alga	Rhodophyta	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	X	X
SPECIES RICHNESS FLORA[2]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3	3
Water depth (m) below MLLW at transect centroid		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	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	[redacted]	T-21	[redacted]	[redacted]	T-27	T-28	T-30	T-33	T-47	T-48	T-49	T-52	T-53
FAUNA	[redacted]		[redacted]	[redacted]									
PORIFERA	[redacted]		[redacted]	[redacted]									
Bread crumb sponge	[redacted]		[redacted]	[redacted]							X		
Red beard sponge[3]	[redacted]		[redacted]	[redacted]			X				X		X
Sulfur sponge	[redacted]		[redacted]	[redacted]					X	X	X	X	
	[redacted]		[redacted]	[redacted]									
CNIDARIA	[redacted]		[redacted]	[redacted]									
Bell shaped jellyfish	[redacted]		[redacted]	[redacted]		X		X					
Burrowing anemone	[redacted]		[redacted]	[redacted]		X							
Star Coral	[redacted]		[redacted]	[redacted]									
Hydroid	[redacted]		[redacted]	[redacted]						X	X	X	X
	[redacted]		[redacted]	[redacted]									
CTENOPHORA	[redacted]		[redacted]	[redacted]				X		X		X	
	[redacted]		[redacted]	[redacted]									
BRYOZOA	[redacted]		[redacted]	[redacted]									
Bushy bryozoan	[redacted]		[redacted]	[redacted]							X		X
Encrusting bryozoan	[redacted]		[redacted]	[redacted]					X	X	X	X	X
	[redacted]		[redacted]	[redacted]									
MOLLUSCA	[redacted]		[redacted]	[redacted]									
Bay Scallop	[redacted]		[redacted]	[redacted]					X				
Blue mussel	[redacted]		[redacted]	[redacted]								X	
Knobbed whelk*[1]	[redacted]		[redacted]	[redacted]			X						
Knobbed whelk egg case*	[redacted]	X	[redacted]	[redacted]									
Moon snail	[redacted]		[redacted]	[redacted]									
Slipper limpet	[redacted]		[redacted]	[redacted]									
Threeline Mudsnail	[redacted]		[redacted]	[redacted]									
	[redacted]		[redacted]	[redacted]									
ANNELIDA	[redacted]		[redacted]	[redacted]									
Polychaeta	[redacted]		[redacted]	[redacted]									
Lug worm	[redacted]		[redacted]	[redacted]									
Plumed worm	[redacted]		[redacted]	[redacted]									
Sedentary polychaetes	[redacted]	X	[redacted]	[redacted]	X	X							
	[redacted]		[redacted]	[redacted]									
ARTHROPODA	[redacted]		[redacted]	[redacted]									
Crustacea	[redacted]		[redacted]	[redacted]									
Barnacle	[redacted]		[redacted]	[redacted]							X		X
Four-eyed amphipod	[redacted]		[redacted]	[redacted]	X								
Hermit crab	[redacted]		[redacted]	[redacted]								X	
Jonah crab*	[redacted]		[redacted]	[redacted]									
Mysid shrimp	[redacted]		[redacted]	[redacted]									
Rock crab	[redacted]		[redacted]	[redacted]									X
Spider crab	[redacted]		[redacted]	[redacted]	X								
Echinoderms	[redacted]		[redacted]	[redacted]									
Common sea star	[redacted]		[redacted]	[redacted]						X			
Sand dollar	[redacted]		[redacted]	[redacted]									
Purple sea urchin	[redacted]		[redacted]	[redacted]									
	[redacted]		[redacted]	[redacted]									
VERTEBRATA	[redacted]		[redacted]	[redacted]									
Elasmobrachiomorphi	[redacted]		[redacted]	[redacted]									
Little Skate egg case*	[redacted]		[redacted]	[redacted]									
Little Skate*	[redacted]		[redacted]	[redacted]	X								
Osteichthyes	[redacted]		[redacted]	[redacted]									
Black sea bass*	[redacted]		[redacted]	[redacted]									
Red Hake*	[redacted]		[redacted]	[redacted]									
Scup*	[redacted]		[redacted]	[redacted]	X		X						
	[redacted]		[redacted]	[redacted]									
CHORDATA	[redacted]		[redacted]	[redacted]									
Sand Sponge	[redacted]		[redacted]	[redacted]							X	X	
White invasive tunicate	[redacted]		[redacted]	[redacted]							X	X	
SPECIES RICHNESS FAUNA[2]	[redacted]	2	[redacted]	[redacted]	6	3	3	2	3	5	9	8	6
	[redacted]		[redacted]	[redacted]									
FLORA	[redacted]		[redacted]	[redacted]									
CHLOROPHYTA	[redacted]		[redacted]	[redacted]									
Dead Man's Fingers	[redacted]		[redacted]	[redacted]									
Sea Lettuce	[redacted]		[redacted]	[redacted]				X					
	[redacted]		[redacted]	[redacted]									
PHAEOPHYTA	[redacted]		[redacted]	[redacted]									
Rockweed	[redacted]		[redacted]	[redacted]									
Sargassum	[redacted]		[redacted]	[redacted]				X				X	
	[redacted]		[redacted]	[redacted]									
RHODOPHYTA	[redacted]		[redacted]	[redacted]									
Branching red alga	[redacted]		[redacted]	[redacted]				X	X	X		X	X
SPECIES RICHNESS FLORA[2]	[redacted]	0	[redacted]	[redacted]	0	0	0	3	1	1	0	2	1
Water depth (m) below MLLV	[redacted]	9.54	[redacted]	[redacted]	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. 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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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 [redacted] 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. [redacted] 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 ≥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).

[redacted]

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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 [redacted]. Secondary habitat of low relief *sand ripples* was observed at [redacted] -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). [redacted] 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). [redacted]

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 [redacted] and the Atlantic Ocean, southeast of

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Martha's Vineyard at V-137 (14 species), [redacted] [redacted] (Table 3). The only exceptions were V-122 [redacted] 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 [redacted] [redacted]-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, [redacted] 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]
[redacted]										
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]										
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

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
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
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
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
V-139	1211154.149	14918256.940	Common sand dollar	*Echinarachnius parma*	Occasional	Flat sand, Mud		Fine	Absent	Absent
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]

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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

[redacted]

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	[redacted]	V-117	V-118	V-119	V-120	V-121
FAUNA	[redacted]					
PORIFERA						
Bread crumb sponge						
Red beard sponge		X		X		
Sulfur sponge[3]		X				
CNIDARIA						
Burrowing anemone						
Star Coral						
Solitary Hydroid						
Sea Pens						
BRYOZOA						
Bushy bryozoan						
Encrusting bryozoan						
MOLLUSCA						
Bay Scallop					X	
Blue mussel						
Knobbed whelk*[1]		X	X	X	X	X
Long-Finned Squid						
Northen Moon snail						
Sea Scallop						
Slipper limpet					X	
Surf clam						
Threeline Mudsnail						
Parchment worm					X	
Plumed worm						
Tube worm					X	X
ARTHROPODA						
Merostomata						
Horshoe Crab						
Crustacea						
Barnacle						
Blue crab						
Four-eyed amphipod						
Green crab						
Hermit crab						
Lady crab						
Mysid shrimp						
Rock crab						
Spider crab					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						
Summer Flounder						
CHORDATA						
Sand Sponge						
White invasive tunicate						
SPECIES RICHNESS FAUNA[2]		3	2	2	6	3
FLORA						
ALISMATALES						
Zosteraceae						
Eelgrass*		X	X		X	
CHLOROPHYTA						
Dead Man's Fingers		X	X			X
Gutweed		X				
Sea Lettuce		X	X		X	X
PHAEOPHYTA						
Rockweed		X	X			
RHODOPHYTA						
Branching red alga		X	X	X	X	X
Purple laver					X	X
SPECIES RICHNESS FLORA2		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	[redacted]	[redacted]	[redacted]	V-130	V-131	V-132	V-133
FAUNA						[redacted]	[redacted]	[redacted]				
PORIFERA						[redacted]	[redacted]	[redacted]				
Bread crumb sponge	X				X	[redacted]	[redacted]	[redacted]				X
Red beard sponge	X			X		[redacted]	[redacted]	[redacted]				
Sulfur sponge[3]						[redacted]	[redacted]	[redacted]			X	
						[redacted]	[redacted]	[redacted]				
CNIDARIA						[redacted]	[redacted]	[redacted]				
Burrowing anemone						[redacted]	[redacted]	[redacted]				
Star Coral						[redacted]	[redacted]	[redacted]				X
Solitary Hydroid						[redacted]	[redacted]	[redacted]				
Sea Pens						[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
BRYOZOA						[redacted]	[redacted]	[redacted]				
Bushy bryozoan						[redacted]	[redacted]	[redacted]				
Encrusting bryozoan	X			X	X	[redacted]	[redacted]	[redacted]			X	X
						[redacted]	[redacted]	[redacted]				
MOLLUSCA						[redacted]	[redacted]	[redacted]				
Bay Scallop						[redacted]	[redacted]	[redacted]				
Blue mussel					X	[redacted]	[redacted]	[redacted]				
Knobbed whelk*[1]	X	X	X			[redacted]	[redacted]	[redacted]				
Long-Finned Squid						[redacted]	[redacted]	[redacted]				
Northen Moon snail						[redacted]	[redacted]	[redacted]	X			
Sea Scallop						[redacted]	[redacted]	[redacted]				
Slipper limpet	X			X		[redacted]	[redacted]	[redacted]				
Surf clam						[redacted]	[redacted]	[redacted]				
Threeline Mudsnail		X				[redacted]	[redacted]	[redacted]				
Parchment worm						[redacted]	[redacted]	[redacted]				
Plumed worm						[redacted]	[redacted]	[redacted]		X		
Tube worm				X	X	[redacted]	[redacted]	[redacted]			X	X
						[redacted]	[redacted]	[redacted]				
ARTHROPODA						[redacted]	[redacted]	[redacted]				
Merostomata						[redacted]	[redacted]	[redacted]				
Horshoe Crab						[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
Crustacea						[redacted]	[redacted]	[redacted]				
Barnacle				X	X	[redacted]	[redacted]	[redacted]			X	
Blue crab						[redacted]	[redacted]	[redacted]				
Four-eyed amphipod		X		X		[redacted]	[redacted]	[redacted]	X	X	X	
Green crab						[redacted]	[redacted]	[redacted]				
Hermit crab		X		X		[redacted]	[redacted]	[redacted]	X			
Lady crab						[redacted]	[redacted]	[redacted]				
Mysid shrimp						[redacted]	[redacted]	[redacted]				
Rock crab						[redacted]	[redacted]	[redacted]				
Spider crab		X	X			[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
Echinoderms						[redacted]	[redacted]	[redacted]				
Common sea star						[redacted]	[redacted]	[redacted]				
Norther sea star						[redacted]	[redacted]	[redacted]				
Sand dollar						[redacted]	[redacted]	[redacted]				
Purple sea urchin	X					[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
VERTEBRATA						[redacted]	[redacted]	[redacted]				
Elasmobrachiomorphi						[redacted]	[redacted]	[redacted]				
Little Skate*						[redacted]	[redacted]	[redacted]				X
Osteichthyes						[redacted]	[redacted]	[redacted]				
Black sea bass*				X		[redacted]	[redacted]	[redacted]		X		
Red Hake*						[redacted]	[redacted]	[redacted]				
Scup*						[redacted]	[redacted]	[redacted]				
Sea Robin	X		X		X	[redacted]	[redacted]	[redacted]		X	X	
Summer Flounder		X				[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
CHORDATA						[redacted]	[redacted]	[redacted]				
Sand Sponge						[redacted]	[redacted]	[redacted]			X	
White invasive tunicate	X				X	[redacted]	[redacted]	[redacted]			X	X
SPECIES RICHNESS FAUNA[2]	8	6	3	8	7	[redacted]	[redacted]	[redacted]	3	4	8	6
						[redacted]	[redacted]	[redacted]				
FLORA						[redacted]	[redacted]	[redacted]				
ALISMATALES						[redacted]	[redacted]	[redacted]				
Zosteraceae						[redacted]	[redacted]	[redacted]				
Eelgrass*						[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
CHLOROPHYTA						[redacted]	[redacted]	[redacted]				
Dead Man's Fingers						[redacted]	[redacted]	[redacted]				
Gutweed						[redacted]	[redacted]	[redacted]				
Sea Lettuce						[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
PHAEOPHYTA						[redacted]	[redacted]	[redacted]				
Rockweed					X	[redacted]	[redacted]	[redacted]				
						[redacted]	[redacted]	[redacted]				
RHODOPHYTA						[redacted]	[redacted]	[redacted]				
Branching red alga			X		X	[redacted]	[redacted]	[redacted]			X	X
Purple laver	X					[redacted]	[redacted]	[redacted]				
SPECIES RICHNESS FLORA2	1	0	1	0	2	[redacted]	[redacted]	[redacted]	0	0	1	1

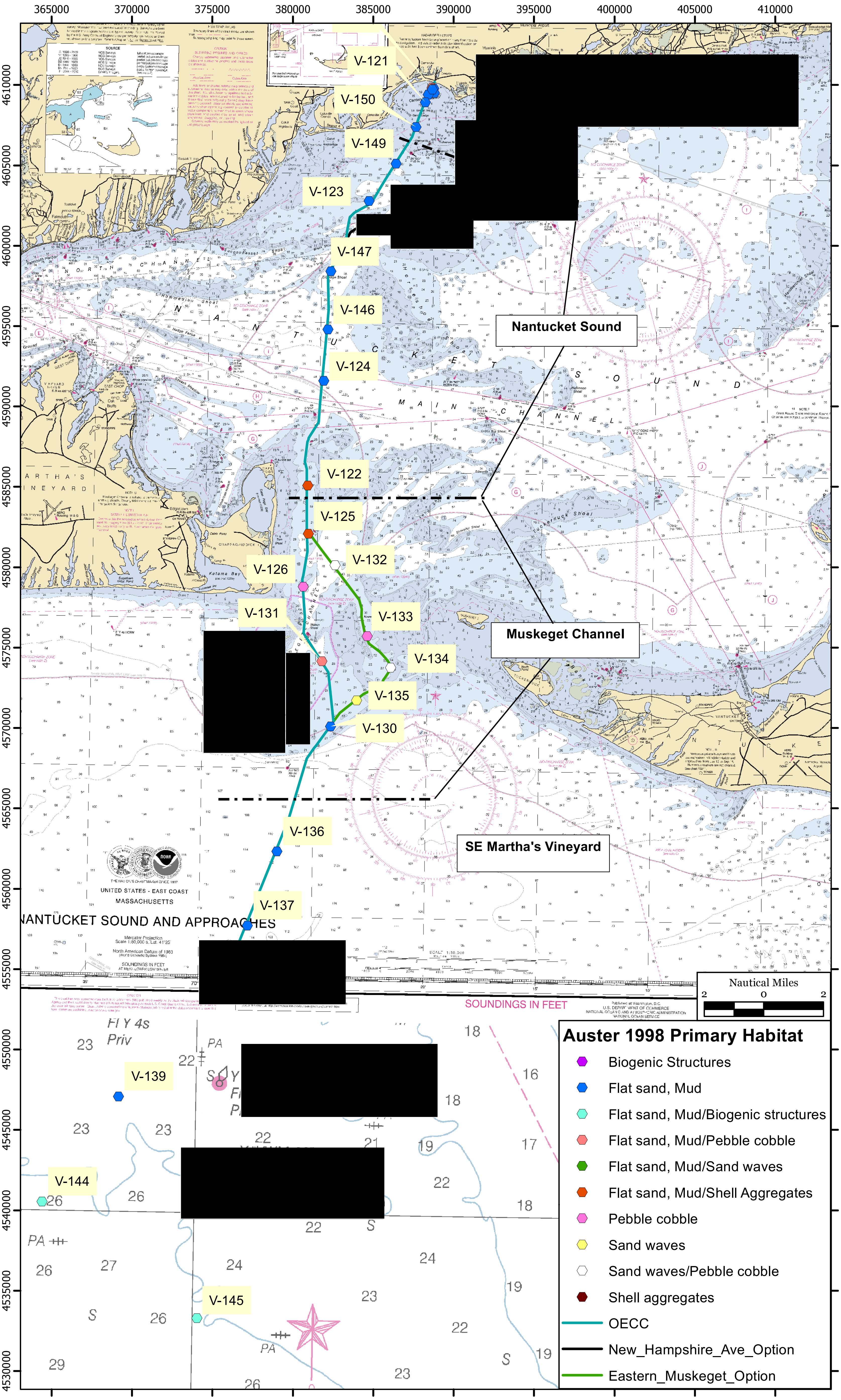
TABLE 3
SPECIES BY TRANSECT FROM UNDERWATER VIDEO JUNE 24 - JULY 3, 2018
VINEYARD WIND PROJECT - NANTUCKET SOUND AND ATLANTIC OCEAN

TRANSECT ID	V-134	V-135	V-136	V-137	[redacted]	V-139	[redacted]
FAUNA							
PORIFERA							
Bread crumb sponge							
Red beard sponge							
Sulfur sponge[3]				X			
CNIDARIA							
Burrowing anemone			X	X		X	
Star Coral							
Solitary Hydroid						X	
Sea Pens				X			
BRYOZOA							
Bushy bryozoan							
Encrusting bryozoan	X						
MOLLUSCA							
Bay Scallop							
Blue mussel							
Knobbed whelk*[1]							
Long-Finned Squid			X	X			
Northen Moon snail	X	X	X	X			
Sea Scallop							
Slipper limpet							
Surf clam	X	X					
Threeline Mudsnail				X			
Parchment worm							
Plumed worm	X						
Tube worm	X						
ARTHROPODA							
Merostomata							
Horshoe Crab							
Crustacea							
Barnacle	X						
Blue crab							
Four-eyed amphipod	X		X	X		X	
Green crab							
Hermit crab			X	X		X	
Lady crab							
Mysid shrimp				X			
Rock crab				X			
Spider crab							
Echinoderms							
Common sea star							
Norther sea star							
Sand dollar			X	X		X	
Purple sea urchin							
VERTEBRATA							
Elasmobrachiomorphi							
Little Skate*	X		X	X			
Osteichthyes							
Black sea bass*							
Red Hake*			X	X		X	
Scup*							
Sea Robin							
Summer Flounder			X	X			
CHORDATA							
Sand Sponge							
White invasive tunicate							
SPECIES RICHNESS FAUNA[2]	8	2	9	14		6	
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	

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	[redacted]	V-149	V-150	[redacted]	V-152	V-153	Freqency %
FAUNA									
PORIFERA									
Bread crumb sponge									9.43
Red beard sponge									7.55
Sulfur sponge[3]									**20.75**
CNIDARIA									
Burrowing anemone									18.87
Star Coral									5.66
Solitary Hydroid									11.32
Sea Pens									7.55
BRYOZOA									
Bushy bryozoan									1.89
Encrusting bryozoan		X		X					16.98
									1.89
MOLLUSCA									
Bay Scallop		X							**26.42**
Blue mussel									3.77
Knobbed whelk*[1]	X	X					X		**43.40**
Long-Finned Squid									5.66
Northen Moon snail								X	15.09
Sea Scallop									1.89
Slipper limpet				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					**39.62**
Green crab								X	1.89
Hermit crab		X		X					**26.42**
Lady crab									3.77
Mysid shrimp									5.66
Rock crab									9.43
Spider crab	X	X		X	X				**26.42**
Echinoderms									
Common sea star									1.89
Norther sea star									1.89
Sand dollar									15.09
Purple sea urchin									3.77
VERTEBRATA									
Elasmobrachiomorphi									
Little Skate*									18.87
Osteichthyes									
Black sea bass*									7.55
Red Hake*									18.87
Scup*									1.89
Sea Robin				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	1		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		2	2		4	4	

FIGURES



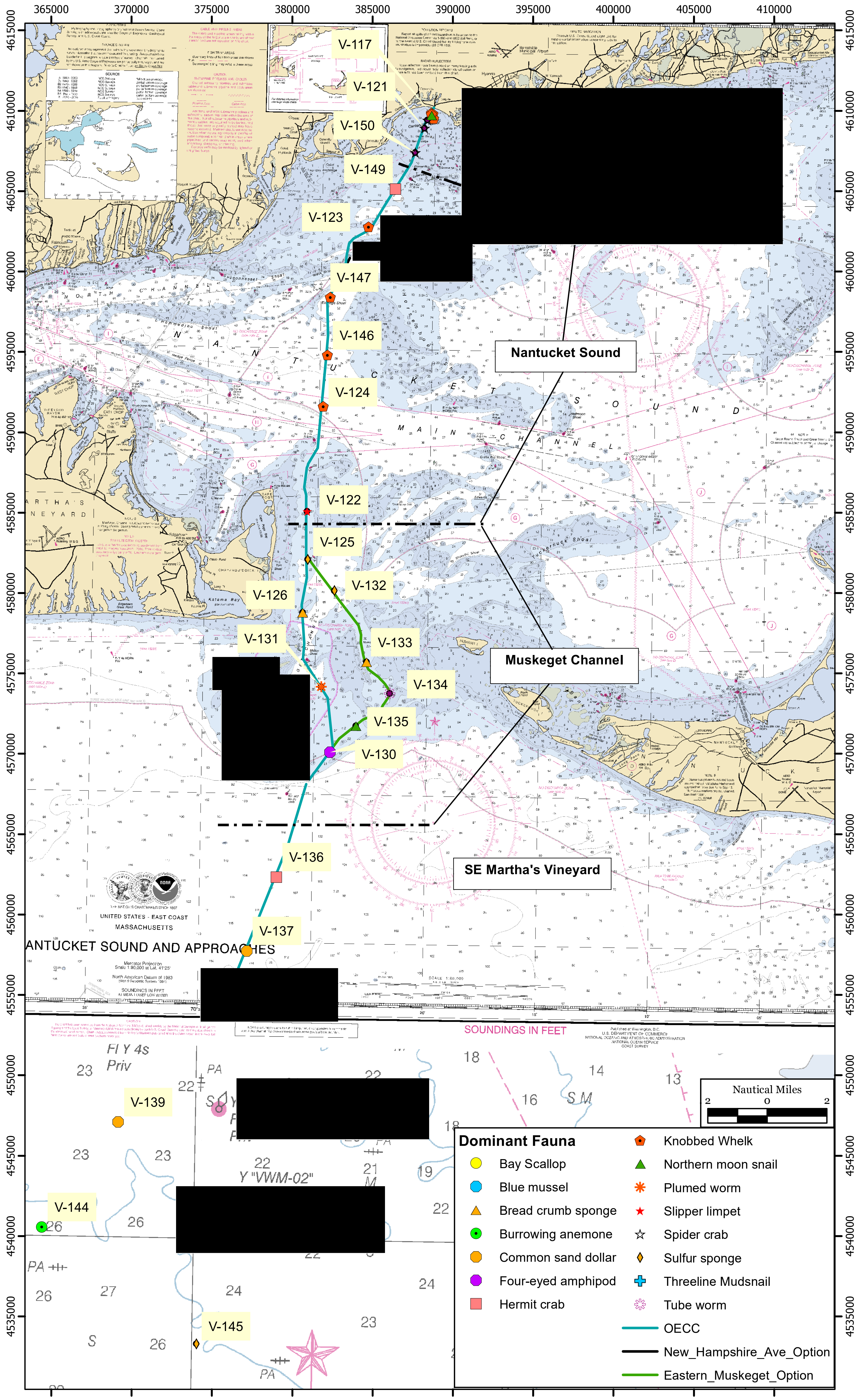
CR
www.crenvironmental.com

Video Transect Primary Habitat Classification
Vineyard Wind Project

N
W E
S

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

Figure 1



[redacted]

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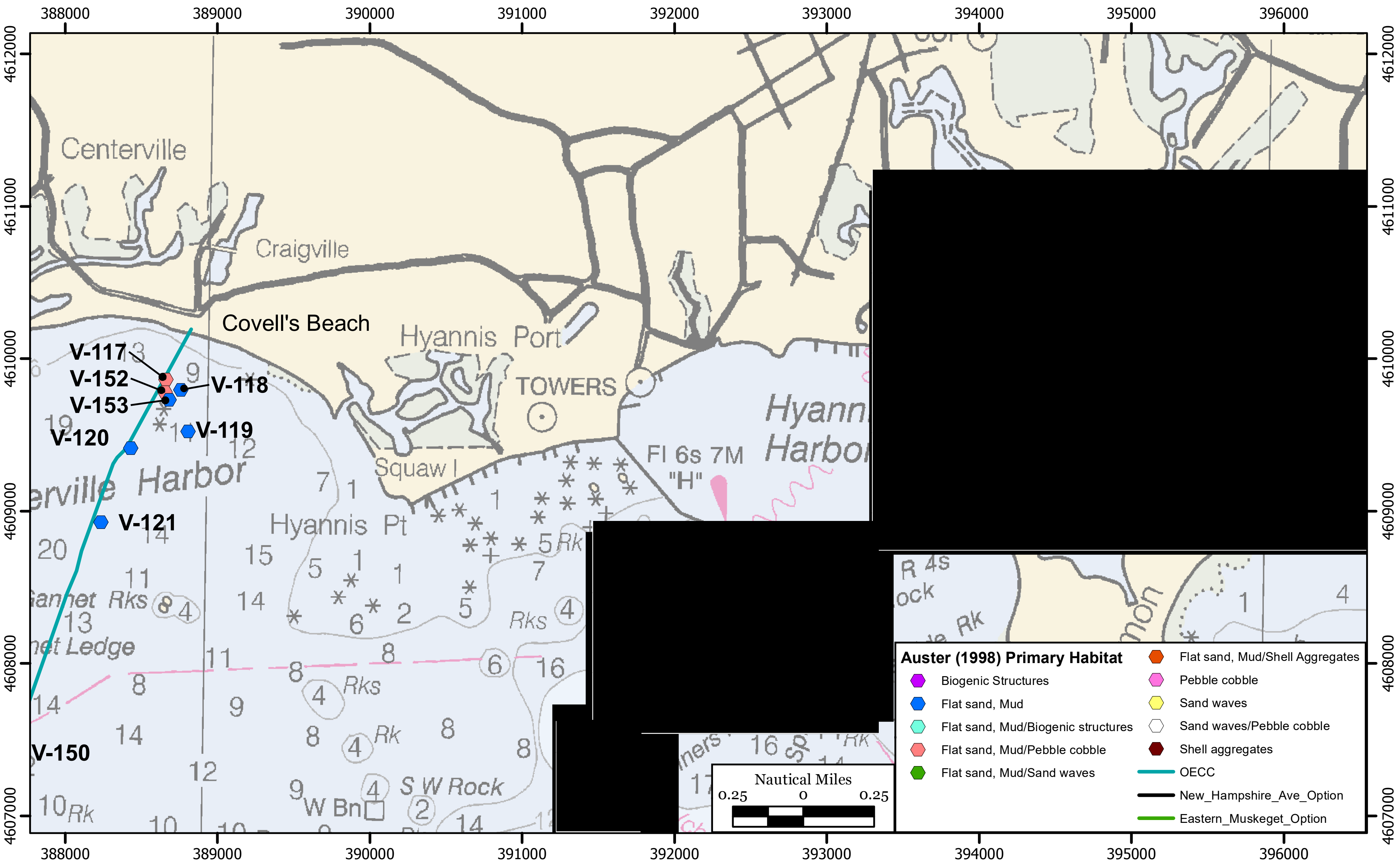
Video Transect Dominant Species
Vineyard Wind Project

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

Figure 2



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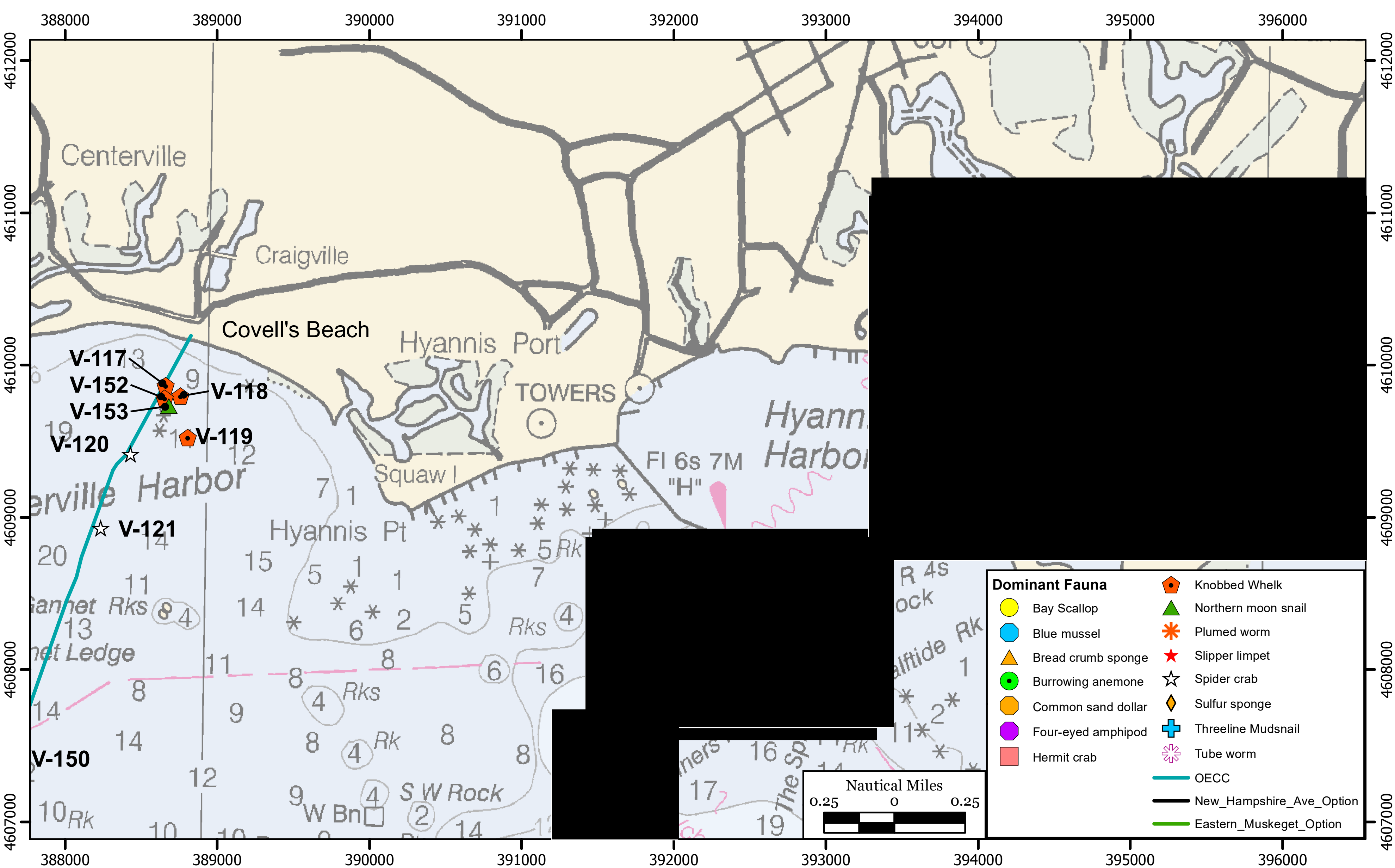
Video Transect Primary Habitat Classification
Centerville Harbor, Hyannis Harbor Entrance and Lewis Bay
Vineyard Wind Project

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

N W E S

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

[redacted]

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

V- 123 Summer flounder in Nantucket Sound

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

[redacted]

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

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

PLATE 4 Representative 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

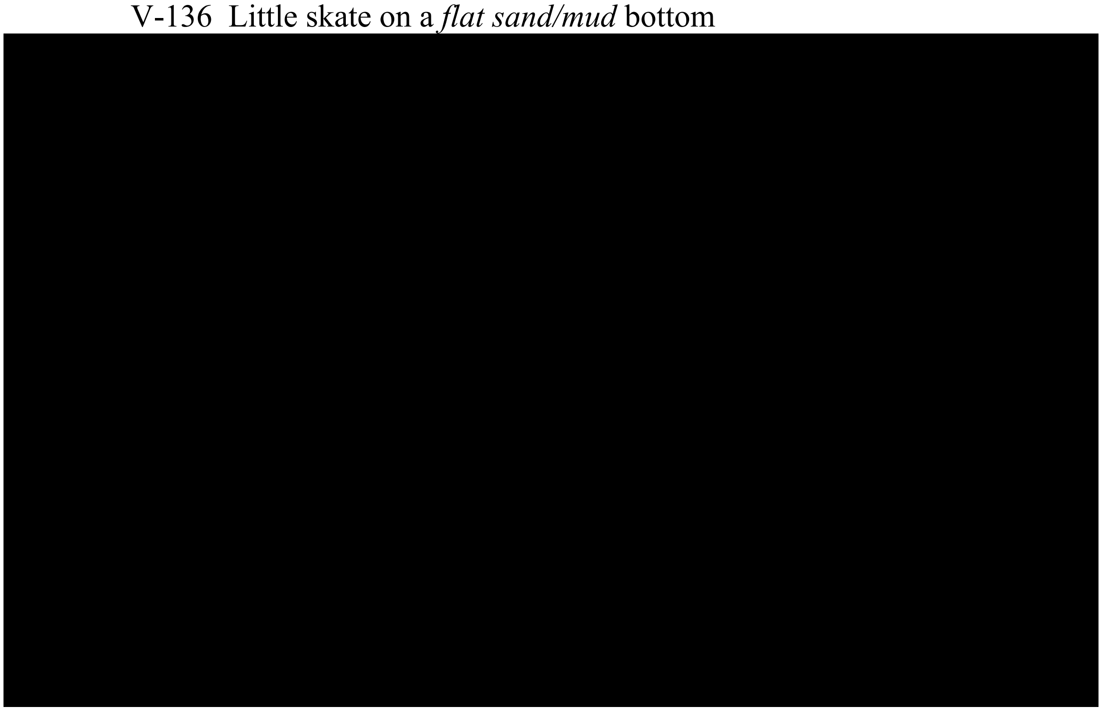
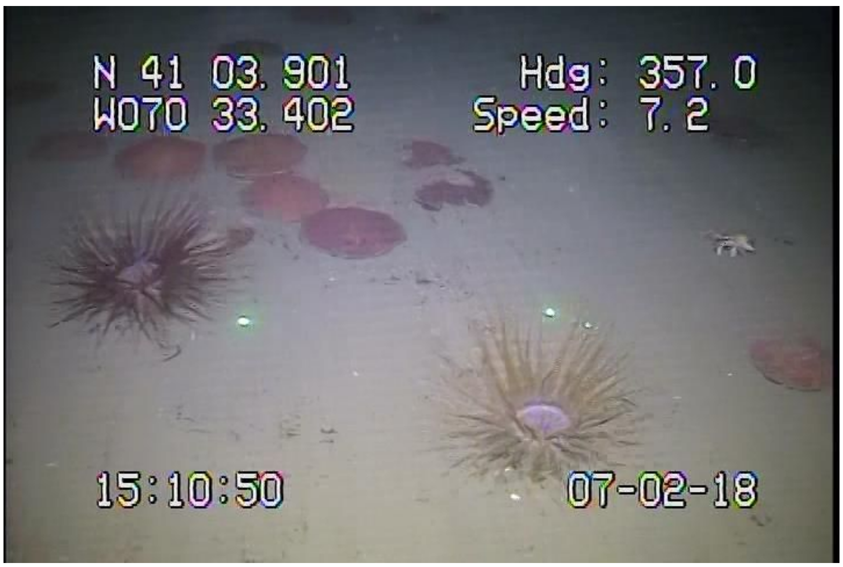


PLATE 5A   Representative video screen captures of Bottom Habitat and Biota
ATLANTIC OCEAN SOUTHEAST OF MARTHA'S VINEYARD

V-139 Red hake, and sand dollars



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

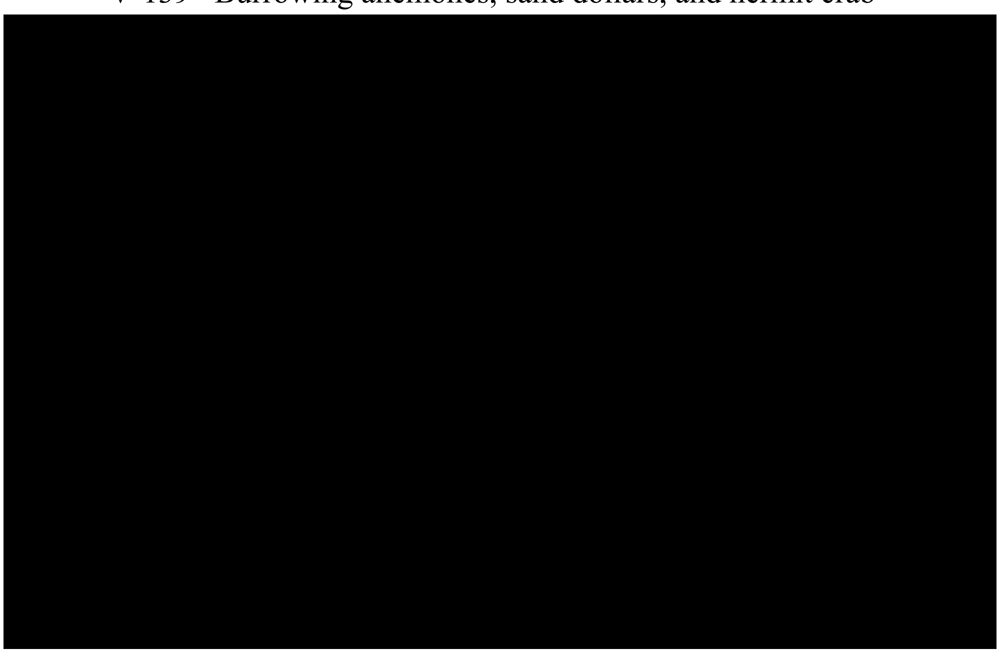


PLATE 5B Representative video screen captures of Bottom Habitat and Biota
ATLANTIC OCEAN SOUTHEAST OF MARTHA'S VINEYARD

5. RPS/Alpine 2019 Benthic Report

ALPINE VINEYARD WIND

Lease Area OCS-A 0501 South Benthic Report

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Alpine Ocean – Vineyard Wind

19-P-206028 Alpine Vineyard Wind Lease Areas OCS-A 0501 South Benthic Sampling Report V5

January 18, 2021

rpsgroup.com

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1 INTRODUCTION

RPS was contracted by Alpine Ocean to collect, process, analyze, and compile benthic data from a towed video sled and grab sampler for two lease areas offshore of Martha's Vineyard, Massachusetts (OCS-A 0501) intended for the construction of offshore wind turbines. The field program focused on environmental data acquisition in the southern portion of Lease OCS-A 0501 (501S). The grab samples and video imagery data conclusions presented here will support interpretation of geophysical data to characterize surficial sediment conditions and classify the benthic habitat in both lease areas according to the Coastal and Marine Ecological Classifications Standards (CMECS; FGDC, 2012) and recent guidance for mapping fish habitat from National Marine Fisheries Service (NMFS, 2020) for inclusion in permitting documentation required by Bureau of Ocean Energy Management (BOEM). This report provides:

- A description of the benthic grab sampling methods, results, and analysis;
- The analysis of benthic grab sampling results using key statistical analyses such as taxa richness, density per cubic meter, community composition, etc.;
- A description and analysis of the video data collected; and
- CMECS classifications of each sample site based on the video, grain size, and benthic community lab results.

2 METHODS

2.1 Field Survey

2.1.1 Towed Camera Sled

Underwater video transects were taken in conjunction with grab samples for visual classification of the seafloor in November and December 2019. The camera sled was equipped with an altimeter to record distance above sea floor, temperature probe, parallel-mounted lasers 7.5 centimeters (cm) apart, and a cable that transmitted real-time viewing of images to the vessel. The video sled was deployed from a side-oriented A-frame by the Alpine Ocean crew and lowered until positioned 0.5-1.5 meters (m) above the seafloor. Distance of camera to the seafloor varied along each transect due to differences in sediment type, vessel speed, swells, and low visibility/high turbidity.

Video transects were recorded in accordance with procedures approved by Alpine and Vineyard Wind and following BOEM's Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 (BOEM, 2019). Vessel speed was usually kept to 1 knot or lower to accommodate the tow sled and never exceeded 3 knots. Direction was given from the video operator to the winch operator to raise and lower the towed camera sled as needed to maintain proximity to the seafloor; however, a combination of difficult weather and the location of the tow sled off the side of the vessel instead of the stern created changes in deck height relative to the seafloor which frequently pulled the towed camera sled out of visible range of the seafloor. While recording, field notes were taken containing sample information (date, time, global positioning satellite [GPS] coordinates, station ID, depth, and video file name) and observations of sediment/seafloor characteristics of note to aid in post-processing of video data. Special notes were made for the beginning and end of the transect as well as any changes in weather or visibility conditions, sediment, or species. During video recording, attention was given to noting if potentially sensitive benthic habitats (e.g., exposed hard bottom, seagrass/kelp/algal beds, coral species) were present, as per BOEM's guidelines (BOEM, 2019). Video transects were roughly 200 m in length.

2.1.2 Grab Sampling

Benthic grab samples were acquired using a Harmon/Day Grab Sampler owned by Alpine Ocean. The standard sampler had been modified to improve penetration and reduce sample disturbance, contamination, and washout during retrieval by the addition of weights, the use of stainless-steel sample doors and bucket, and an extended bucket lip. An ultra-short baseline (USBL) beacon was fixed to the grab sampler to obtain GPS coordinates in conjunction with a pole-mounted USBL system. An attached video camera was intended to be used to collected additional information concerning the area surrounding the grab sample site but high turbidity/low visibility and rapid changes in grab sampler altitude due to weather and side deployment made it difficult to assess bottom type without contact.

Upon retrieval, the grab sampler was examined for sample acceptability. A sample was initially deemed acceptable only if the bucket was more than 50% full, the sample was not over penetrated (i.e., not full to the top), and sample surface structures were undisturbed and even (i.e., not slumped). However, due to the frequency of soft-bottom habitat comprised of mud and silt, RPS was authorized by onboard client representatives to accept over penetrated samples with disturbed surfaces (though discretion was used in cases of severely compromised samples).

If a sample did not fulfil these requirements, the contents were deposited into a clean bucket and another sample attempt was made. All subsequent failed samples (up to three attempts per station) were collected in the same bucket, contents mixed thoroughly, and core and sediment samples collected from the mixture to acquire the sample. If more than three failed sample attempts occurred at one station, sampling moved on to the next station (no more than three fails occurred in any one sampling station). The results of each attempted grab were recorded in field notes.

Once an acceptable sample was obtained, the following steps were taken:

1. A photograph was taken of the sample next to an identification label containing sample identification number.

2. Field notes included descriptions of physical features (depth of penetration, sediment color, texture, surface features) and surface macrofauna; large surface fauna were returned to the water (crabs and a skate were returned at different sites).

3. The grab sample was then divided into an “A” and backup “B” sample based on the bucket design which was accessed via two hinged doors divided by a central support bar. The “A” designation was assigned to the least disturbed side or arbitrarily when samples were of equal quality.

4. A four-inch diameter plexiglass tube was inserted and sediment cores were removed from each side of the grab sampler bucket and placed in sieving buckets.

5. A 100-mL sample was taken from the sediment surrounding the cores on both sides and placed in plastic bags for grain size analysis.

After collection, the “A” sample was then photographed and described more thoroughly (grain size and characteristics at depth) and both samples were then loaded onto a processing table and material washed through a 500-µm sieve using seawater under gentle pressure.

Organisms, shell fragments, and other remaining material was placed into a plastic container using stainless steel forceps as needed. The container was filled no more than two-thirds full of sample and seawater. If the quantity of sample exceeded this volume, it was placed in a second container. The sample was fixed/preserved with 10% buffered formalin solution dyed with Rose Bengal by filling the remaining space within the bottle with solution. Containers were tightly sealed with electrical tape and stored in a cooler at ambient temperature (not frozen or refrigerated). Prior to sieving the next sample, the sieve was cleaned by backwashing with pressurized water. The infaunal samples for OCS-A 0501 South were sent to ESS (Waltham, MA) and the grain size samples were sent to TerraSense (Totowa, NJ) for processing.

2.2 Lab Analysis

2.2.1 Grain Size and TOC Analysis

Grain size samples were analyzed by TerraSense using the American Society for Testing and Materials (ASTM) soil classification system standards D2487 and D2488 (ASTM, 2016a;b).

2.2.2 Benthic Infauna Analysis

The benthic infauna analysis was conducted by ESS according to the following steps:

1. Benthic infaunal samples were catalogued and verified against the Chain of Custody to ensure samples received match those listed in the shipment.

2. Samples were rinsed with freshwater to remove the formalin and transferred to ethanol for sorting and storage.

3. Organisms were identified to the lowest practical taxonomic level (LPTL) and counted by taxonomists using the most appropriate taxonomic references for the region.

4. Prior to performing the infaunal data analysis, the overall dataset was scanned for noninfaunal taxa (i.e., pelagic or planktonic organisms) that were excluded from all analyses; examples include chaetognaths, hyperiid amphipods, and decapod zoea/megalopae.

2.3 Video Data Post-Processing

2.3.1 Objectives

Post-processing and analysis of video transect data were conducted by RPS to provide:

- General characterization of substrate including bottom type, texture, micro-topography, and presence and approximate thickness (absent, light, moderate, or heavy) of sedimentation ("drape") covering hard substrates;
- Evidence of benthic activity by organisms (burrows, trails, biogenic reefs);
- Identification of epibenthic macroinvertebrates (decapod crustaceans, mollusks including squid mops], echinoderms) and benthic habitat;
- Presence/evidence and general characterization of submerged aquatic vegetation (macroalgae, sea grass);
- Identification of fish and fish habitat (where feasible) as classified by Auster (1998) to provide back compatibility with prior sampling work in the region;
- Identification of organisms to the lowest practical taxonomic level (generally to Order to Family) using standard taxonomic keys for the geographic area;
- Evidence of fishing activity, such as trawl scars, pots, and working nets; and
- Presence of derelict fishing gear, military expended materials, shipwrecks, cultural artifacts, or other marine debris.

All still images from videos were classified according to CMECS (FGDC, 2012), which focuses closely on details of grain size and composition to describe benthic habitats and is being used to define complex and otherwise valuable fish habitats. Auster (1998) classification is also included as it is indicative of overall habitat features that can be important to fish and has been historically used for habitat classification. The BOEM Benthic Habitat Survey guidelines (BOEM, 2019) also require that the developer characterize the benthic community composition which includes documentation of abundance, diversity, percent cover, and community structure. The following were recorded when present and identifiable:

- Characterization and delineation of any submerged aquatic vegetation (seagrass or macro-algae) that occurs within the area of potential adverse effect;
- Characterization and delineation of any hard-bottom gradients of low to high relief such as coral (heads/reefs), rock or clay outcroppings, or other shelter-forming features; and

- Identification of communities of sessile and slow-moving marine invertebrates (clams, quahogs, mussels, polychaete worms, anemones, sponges, echinoderms) that may be within the area of potential adverse effect.

2.3.2 Methods

The video data post-processing methods were developed based on relevant information presented in various peer-reviewed publications and technical guidelines, such as:

- "Northeast Atlantic Marine Biological Analytical Quality Control Scheme (NMBAQC) and Joint Nature Conservation Committee (JNCC): Epibiota remote monitoring from digital imagery: interpretation guidelines (Turner et al., 2016);
- "NMBAQC and JNCC: Epibiota remote monitoring from digital imagery: operational guidelines" (Hitchin et al., 2015).
- "Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects" (Judd, 2011);
- "Mapping European Seabed Habitats (MESH) Seafloor video mapping: collection, analysis, and interpretation of seafloor video footage for the purpose of habitat classification and mapping" (White et al., 2007);
- "Video analysis, experimental design, and database management of submersible-based habitat studies" (Tissot, 2008); and
- "Photographic evaluation of the impacts of bottom fishing on benthic epifauna" (Collie et al., 2000).

Videos were reviewed and analyzed in two separate steps. First, each video was reviewed in its entirety multiple times and any notable seafloor features or epifaunal/benthic/demersal species were recorded. When a feature or species was identified, the reviewer recorded the time, rated video visibility, categorized the bottom based on Auster (1998), and recorded the lowest possible taxon and abundance of organisms greater than ~4 cm in size (equal to roughly half the distance between the laser points). CMECS classification was applied to each individual still image during a later processing step using percent cover information. Most portions of the videos were reviewed multiple times using slower playback speeds and replay functions. After review, the taxonomic details of each macrofaunal observation were investigated and data were recorded at the lowest possible taxonomic level identifiable through the video.

Second, each video was subsampled to produce still images at 5-second intervals. Metadata were recorded for each still image including latitude and longitude, transect, and ID number. The quality of each image was assessed with a categorical scale from 0 to 4. Still images with quality scores of "moderate" (2 or greater) were analyzed with seabed image processing software photoQuad (Trygonis and Sini, 2012). Each image was calibrated using the reference laser points and the area of the visible portion was recorded. Poorly lighted or blurry edges of "passing" images were excluded from analysis.

The abundance of macrofauna was recorded along with presence/absence benthic biotic activity, submerged aquatic vegetation (macroalgae, sea grass), fishing activity, derelict gear, military expended materials, shipwrecks, coral heads/reefs, rock outcroppings, other shelter features, and other marine debris. A score for visibility, Auster (1998) fish habitat characterization, and rugosity (i.e., seafloor roughness or habitat complexity based on visual estimation) were assigned for each image as a whole (see definitions in Table 2).

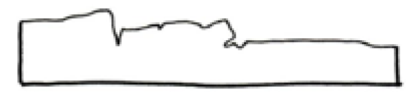
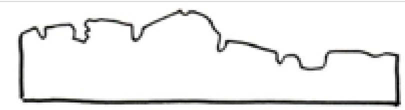
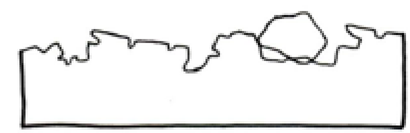
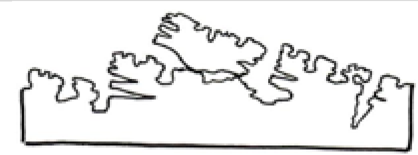
For CMECS classification, fifty points were distributed uniformly across the entire visible portion of each still image using photoQuad. Percent cover data were recorded as the number of points under which different substrate types or features were visible: boulder/cobble, pebble/granule, sand/mud, shells, infaunal structures (e.g., worm or amphipod tubes), burrows (e.g., crab depressions or clam siphon holes), mobile macrofauna, sessile macrofauna, algae, or encrusting organisms. These point counts were multiplied by two to approximate percent cover for the still image and used to assign the appropriate substrate classifications of the habitat to the furthest extent possible according to CMECS standards (FGSC, 2012). Biogenic shell substrate was characterized by the size and percent cover of the biogenic features (Table 1). Other biological elements were recorded (e.g., burrows, infaunal structures, macrofoauna) even though they are not part of the CMECS substrate categories.

Table 1. CMECS biogenic modifier size and percent cover categories.

Biogenic Size	Definition	Biogenic Cover	Definition*
Reef	> 4,096 mm	Trace	< 2%
Rubble	64 – 4,096 mm	Sparse	1 – 30%
Hash	2 – 64 mm	Moderate	30 – 70%
Sand	< 2 mm	Dense	70 – 90%
		Complete	> 90%

* Adapted from FGDC, 2012.

Table 2. Still image data analysis categories for visibility, Auster sediment class, and rugosity.

Visibility Score	Visibility Definition	Auster Category	Auster Definition*	Rugosity Score	Rugosity Definition**
0 – none	obscured or turbid, lasers not visible on seafloor	1 – flat sand/mud	areas with no vertical structure	0 – none	
1 – low	some visibility but still blurry, lasers may or may not be visible	2 – sand waves	troughs and waves in sand	1 – low	
2 – moderate	some features distinguishable, both lasers in view	3 – biogenic structures	burrows, depressions, and other features created or used by mobile fauna for shelter	2 – moderate	
3 – high	most features distinguishable, both lasers in view	4 – shell aggregates	shells create complex interstitial spaces for shelter and high-contrast background	3 – high	
4 - excellent	all features clearly visible, both lasers in view	5 – pebble-cobble	small interstitial spaces, less ephemeral than shell	4 - extreme	
		6 – pebble-cobble with sponge cover	attached fauna increase spatial complexity		
		7 – partially buried or dispersed boulders	partially buried boulders provide high vertical relief while dispersed boulders over cobble provide simple crevices		
		8 – piled boulders	provide deep interstitial spaces of variable sizes		

*Adapted from Auster, 1998. ** Adapted from Turner et al., 2016.

2.4 Benthic Infaunal Data Post-Processing

The benthic infaunal community analysis was based on the laboratory results provided by ESS for the 40 successful grab samples in OCS-A 0501 South. Infaunal community statistics were calculated using species and abundance estimates in each sample, which were reported as count per 0.008 m^2 (area of subsample core). Community composition parameters included: total abundance, number of phyla, number of taxa, Margalef's Richness Index, Shannon Diversity Index, and Pielou's Index of Evenness for each station and within each lease area.

2.4.1 Taxonomic Composition

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

2.4.2 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. Because some taxa were not identified to the species level, we used abundance data for organisms identified to the LPTL but no further than family, modifying the indices to be taxonomic richness, evenness, and diversity indices. Taxonomic richness is the number of unique species or taxonomic groups represented in an area of interest. In this assessment, taxonomic richness was calculated using Margalef's Richness Index (Formula 1) for each station and lease area to acquire sample and average richness indices.

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

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

Where:

S= the number of unique taxa

n= the total number of individuals in the sample

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

The diversity index for a community considers taxonomic richness and the proportion of each unique taxa. The Shannon Diversity Index (H'; Formula 2) was calculated using the number of each taxa, the proportional abundance of each taxa relative to the total number of individuals, and the sum of the proportions. This index was used to assess diversity of each station and lease area. The diversity index (H') increases with increasing taxonomic 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 = the proportion of individuals belonging to the taxa i

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

Evenness of a community refers to the similarity in abundances of different taxa comprising a population or sample. Pielou's Index of Evenness includes H' (Shannon-Weiner Diversity Index) in its calculation.

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

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

Where:

H' = the Shannon- Weiner Diversity Index

H_{Max} = the maximum possible value of H', where each taxon occurs in equal abundances.

$$H_{Max} = \ln(s)$$

Where: s = Number of taxa

Interpretation: J' is constrained between 0 and 1. The greater the value of J', the more evenness in the sample.

3 OCS-A 0501 SOUTH RESULTS

3.1 Video Analysis

The characteristics and locations of the 23 underwater video transects within OCS-A 0501 South are described in Table 3 and shown in Figure 1. Note that four transects collected near the beginning of the survey effort in November 2019 (VT05, VT07, VT08, and VT25_3) used a fiberglass tow sled frame that did not perform well under rough sea conditions. After three attempts at transect VT25_3, the fiberglass frame broke; thus, the same camera was transferred to a heavier metal tow sled frame that provided more stability to the tow system for the remaining transects and that transect was not analyzed in this report because it was not completed.

Table 3. Underwater video transect locations and characteristics in OCS-A 0501 South.

Transect	Date	Recorded Duration (min:sec)	Start Latitude	Start Longitude	End Latitude	End Longitude	Total # Stills	# Analyzed Stills
VT01	12-Dec-2019	10:40	40.899805	-70.643982	40.638867	-70.644450	121	18
VT02	13-Dec-2019	09:26	40.949775	-70.571958	40.949775	-70.568895	112	20
VT03	13-Dec-2019	08:52	40.985128	-70.577737	40.985432	-70.574645	102	33
VT04	12-Dec-2019	09:49	40.976193	-70.650150	40.976420	-70.647145	112	39
VT05	4-Nov-2019	08:22	40.952160	-70.621612	40.952967	-70.619345	92	13
VT06	13-Dec-2019	08:34	40.954183	-70.493593	40.954143	-70.490225	91	33
VT07	4-Nov-2019	14:17	40.934707	-70.641213	40.936673	-70.641215	150	3
VT08	3-Nov-2019	14:53	40.935785	-70.689365	40.936183	-70.689273	166	12
VT09	12-Dec-2019	08:04	40.928763	-70.531435	40.926548	-70.530512	92	32

Transect	Date	Recorded Duration (min:sec)	Start Latitude	Start Longitude	End Latitude	End Longitude	Total # Stills	# Analyzed Stills
VT10	12-Dec-2019	08:51	40.918977	-70.575940	40.920543	-70.573335	103	37
VT11	8-Dec-2019	10:35	40.901282	-70.771778	40.898950	-70.771205	122	40
VT12	12-Dec-2019	08:22	40.901242	-70.590480	40.903597	-70.592352	100	30
VT13	8-Dec-2019	10:48	40.885388	-70.705013	40.883172	-70.706458	120	29
VT14	8-Dec-2019	10:09	40.875468	-70.770185	40.874938	-70.767187	116	37
VT15	12-Dec-2019	10:35	40.870227	-70.640078	40.869065	-70.637275	122	29
VT16	8-Dec-2019	09:47	40.866407	-70.771490	40.867022	-70.768847	121	43
VT17	8-Dec-2019	08:27	40.849055	-70.798527	40.850658	-70.800392	92	26
VT18	8-Dec-2019	12:10	40.833607	-70.682203	40.835863	-70.682227	136	39
VT19	8-Dec-2019	09:51	40.832622	-70.745443	40.834423	-70.747260	109	15
VT20	8-Dec-2019	08:35	40.833700	-70.638287	40.835432	-70.637202	96	39
VT21	8-Dec-2019	10:14	40.791748	-70.701483	40.791748	-70.701007	113	28
VT22	8-Dec-2019	15:16	40.750033	-70.736123	40.751978	-70.735143	156	30
VT25_3*	4-Nov-2019	06:57	40.968617	-70.600275	40.968455	-70.599440	100	0

* Bad video overlay, rough sea conditions, only partial data collected so was not analyzed.

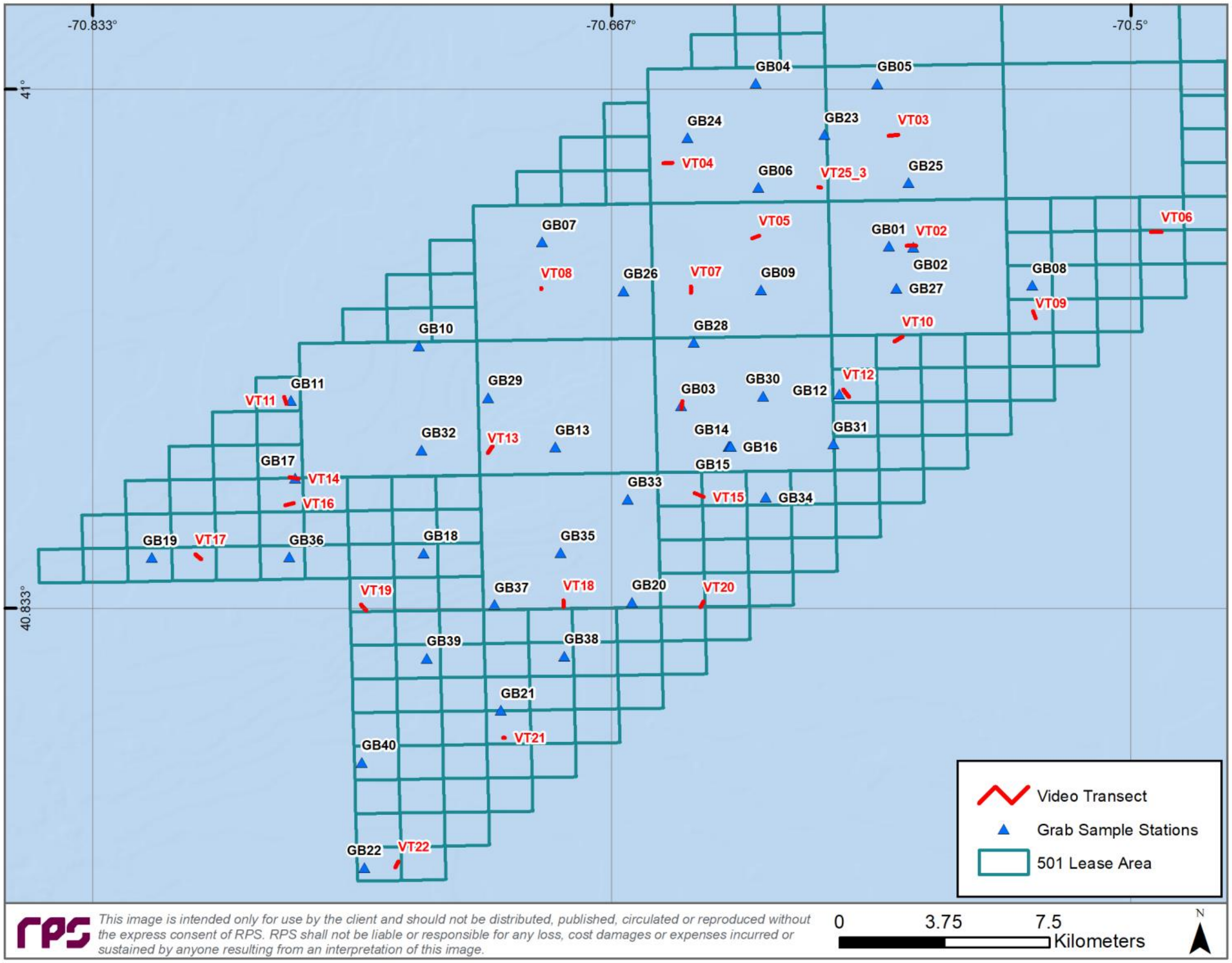


Figure 1. Map of OCS-A 0501 lease area video transects (red) and grab sample sites (blue).

3.1.1 Macrofauna Counts

The presence and abundance of macrofauna > 4 cm were recorded during the video review process (Table 4 and Figure 2). Organisms were identified to the LPTL, usually Order or Family. Seven fish taxa, ten invertebrate taxa, and two kinds of egg cases (skate and moon snail) were observed in the OCS-A 0501 South lease area. A total of 1632 individual macrofauna were counted, 80% of which (1311 individuals) were sea stars (*Asterias* spp.) counted in VT22. Other relatively numerous taxa across transects include hake (*Merluccius* spp.), moon snail (Naticidae), sea sponge (Porifera), and skate (Rajidae). Representative images of some of the macrofauna identified can be seen in Table 5.

Table 4. Macrofauna enumerated during review of the video transects in OCS-A 0501 South (continued on next page).

Common Name	Lowest Taxonomic Grouping	Counts per Transect										
		VT01	VT02	VT03	VT04	VT05	VT06	VT07	VT08	VT09	VT10	VT11
American Lobster	*Homarus americanus*	-	-	-	-	-	-	-	-	-	-	-
Cancer crab	Cancer	-	-	-	-	-	-	-	-	-	-	-
Flounder	Pleuronectiformes	-	-	-	-	-	-	-	-	1	-	1
Fourspot flounder	*Hippoglossina oblonga*	-	-	-	-	-	-	-	-	-	-	-
Hake	Merluccius	1	1	1	3	-	4	1	-	4	1	-
Hermit crab	Pagurus	-	-	-	2	1	1	-	1	-	-	2
Moon snail	Naticidae	1	-	11	9	-	31	-	-	1	-	3
Moon snail egg case	Naticidae egg case	1	-	-	-	1	-	-	-	-	-	-
Northern sea robin	Prionotus	-	-	-	-	-	-	-	1	-	-	-
Ray-finned Fish	Actinopterygii	-	-	1	-	-	-	-	-	-	-	-
Sea scallop	*Placoopecten meagellanicus*	-	-	-	-	-	-	-	-	-	-	4
Sea sponge	Porifera	1	3	4	1	1	6	-	-	2	3	6
Sea urchin	Echinoidea	-	-	-	-	-	-	-	-	-	-	-
Seastar	Asterias	3	2	-	-	-	-	-	-	2	1	-
Shrimp	Decapoda	-	-	-	-	-	-	-	-	-	-	-
Skate	Rajidae	1	2	3	4	2	1	3	1	2	-	2
Skate egg case	Rajidae egg case	-	-	2	-	-	-	-	-	-	-	2
Squid	Cephalopoda	-	-	-	-	-	-	-	-	-	-	-
Unidentified fish	Actinopterygii	-	-	1	-	-	1	-	-	-	-	-
Winter skate	*Leucoraja ocellata*	-	-	-	-	-	-	-	-	-	-	-
Totals	-	8	8	23	19	5	44	4	3	12	5	20

Lowest Taxonomic Grouping	Common Name	Counts per Transect											
		VT12	VT13	VT14	VT15	VT16	VT17	VT18	VT19	VT20	VT21	VT22	Total
American Lobster	*Homarus americanus*	-	-	2	-	-	-	-	-	-	-	-	2
Cancer crab	Cancer	-	-	1	-	-	-	2	-	-	1	10	14
Flounder	Pleuronectiformes	-	-	1	1	-	1	-	3	-	1	29	38
Fourspot flounder	*Hippoglossina oblonga*	-	1	-	-	-	-	-	-	-	-	-	1
Hake	Merluccius	3	2	2	4	1	3	1	-	3	1	3	39
Hermit crab	Pagurus	-	2	3	1	-	1	-	-	1	-	-	15
Moon snail	Naticidae	3	1	-	4	2	-	-	-	-	-	-	66
Moon snail egg case	Naticidae egg case	-	1	-	-	-	1	-	-	-	-	-	4
Northern sea robin	Prionotus	-	-	-	-	-	-	-	-	-	-	-	1
Ray-finned Fish	Actinopterygii	1	-	-	-	-	-	-	-	-	-	-	2
Sea scallop	*Placoopecten meagellanicus*	-	-	-	-	1	-	-	1	1	-	-	7
Sea sponge	Porifera	3	3	-	6	2	1	-	-	1	2	-	45
Sea urchin	Echinoidea	-	-	1	-	-	-	25	-	1	-	-	27
Seastar	Asterias	2	1	1	1	-	-	-	2	-	3	1293	1311
Shrimp	Decapoda	-	1	-	-	-	-	-	-	-	-	-	1
Skate	Rajidae	4	1	2	6	2	3	-	-	2	-	-	41
Skate egg case	Rajidae egg case	-	1	-	-	-	-	-	1	-	-	-	6
Squid	Cephalopoda	-	-	-	2	3	-	-	-	-	-	-	5
Unidentified fish	Actinopterygii	-	-	2	-	-	-	1	-	-	-	-	5
Winter skate	*Leucoraja ocellata*	-	-	2	-	-	-	-	-	-	-	-	2
Total	**-**	**16**	**14**	**17**	**25**	**11**	**10**	**29**	**7**	**9**	**8**	**1335**	**1632**

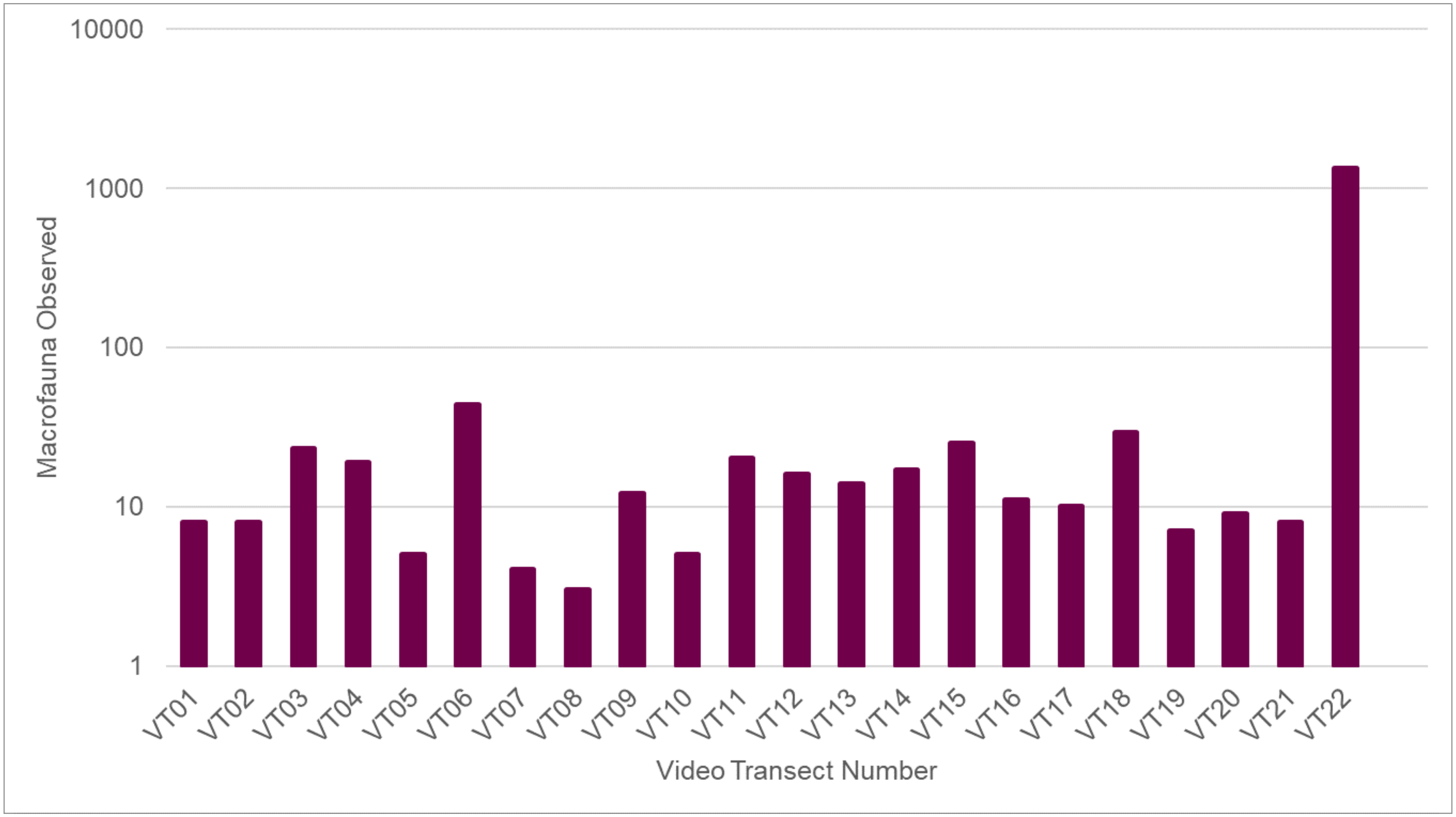


Figure 2. Counts of macrofauna enumerated in OCS-A 0501 South during video review for each transect, identified to lowest practical taxonomic level. Note that Logarithmic scale was used on y-axis to reconcile large range.

Table 5. Representative images of macrofauna observed and identified in transects within OCS-A 0501 South (continued on next two pages).

Sponge (*Porifera* spp.) VT01	
Cancer Crab (*Cancer* spp.) VT14	
Hake (*Merluccius* spp.) VT18	

<table>
<tr><td>Skate
(Leucoraja spp.)
VT14</td><td>
</td></tr>
<tr><td>Flounder
(Pleuronectiformes)
VT22</td><td>
</td></tr>
<tr><td>American Lobster
(Homarus americanus)
VT14</td><td>
</td></tr>
</table>

Sea Urchin (Echinoidea) VT18	
Sea Star (*Asterias* spp.) VT22	

3.1.2 Percent Cover

The following sections summarize the percent cover data obtained from still images taken throughout the underwater video transects in OCS-A 0501 South (Table 6). CMECS substrate categories were combined to the level detectable via visual analysis. Finer resolution classification into different subgroups requires grain size analysis of samples overlapping the video transect directly, which was done using grain size data in the CMECS classifications in Section 5. For these percent cover estimates, our grain size categories were sand/mud, pebble/granule, and boulder/cobble. Additional categories, included in CMECS as biotic or geoform classes, were included to assess the percent cover of anthropogenic debris and biological elements, such as infaunal structures (e.g., worm tubes, amphipod beds), shells, burrows (> 5 -100 mm width), sessile fauna, and macrofauna. Representative examples of habitat types detected in the still images are presented in Table 7.

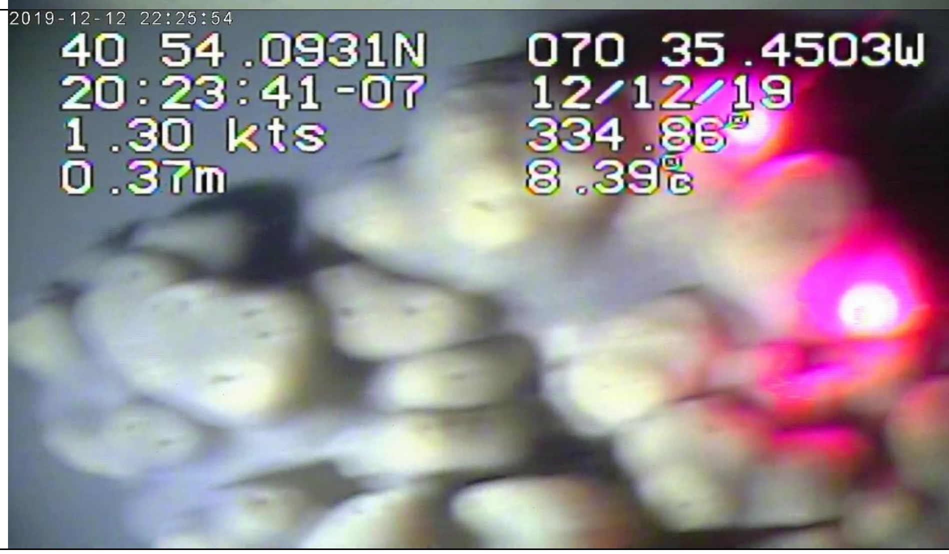
The substrate with the highest percent cover across all transects sampled in OCS-A 0501 South was fine sand/mud. There were no visual observations of boulder, cobble, pebble, or gravel substrates of geologic origin. Of the biological elements, infaunal structures had the highest percent cover and occurred in the most transects. Anthropogenic debris in the form of derelict fishing gear was observed in a single transect, VT14.

Table 6. Area and mean percent cover summarizing point count data across all stills in each of the 22 video transects in OCS-A 0501 South.

Transect	Total Area Analyzed (m^2)	Total # Stills Analyzed	Anthro-pogenic (%)	Biogenic	Geologic		Other Biological Elements				Primary CMECS Substrate Component
				Shells (%)	Gravel (%)	Sand/Mud (%)	Infaunal Structures (%)	Burrows (%)	Sessile (%)	Macrofauna (%)	
VT01	4.24	18	-	-	-	99.1	-	-	0.9	-	Geologic Unconsolidated Fine Sand / Mud
VT02	4.47	20	-	0.2	-	99.8	-	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT03	8.43	33	-	-	-	99.9	0.1	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT04	8.46	39	-	0.1	-	99.8	-	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT05	2.63	13	-	-	-	100.0	-	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT06	6.76	33	-	-	-	100.0	-	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT07	0.22	3	-	-	-	100.0	-	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT08	2.10	12	-	-	-	98.4	1.6	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT09	10.26	32	-	0.1	-	99.7	-	-	-	0.2	Geologic Unconsolidated Fine Sand / Mud
VT10	10.92	37	-	-	-	99.8	0.1	-	0.1	-	Geologic Unconsolidated Fine Sand / Mud
VT11	12.24	40	-	-	-	99.9	-	0.1	-	-	Geologic Unconsolidated Fine Sand / Mud
VT12	7.00	30	-	0.2	-	99.2	-	-	0.5	-	Geologic Unconsolidated Fine Sand / Mud
VT13	9.19	29	-	-	-	99.9	-	0.1	-	-	Geologic Unconsolidated Fine Sand / Mud
VT14	8.37	37	2.4	1.2	-	95.0	0.1	0.3	-	1.0	Geologic Unconsolidated Fine Sand / Mud
VT15	7.42	29	-	-	-	100.0	-	-	-	-	Geologic Unconsolidated Fine Sand / Mud
VT16	14.77	43	-	0.1	-	99.9	-	0.1	-	-	Geologic Unconsolidated Fine Sand / Mud
VT17	7.96	26	-	-	-	99.7	-	0.3	-	-	Geologic Unconsolidated Fine Sand / Mud
VT18	9.69	39	-	-	-	99.0	-	1.0	-	-	Geologic Unconsolidated Fine Sand / Mud
VT19	3.34	15	-	0.8	-	97.7	0.5	0.7	-	0.4	Geologic Unconsolidated Fine Sand / Mud
VT20	9.62	39	-	0.2	-	95.7	3.7	0.1	-	0.4	Geologic Unconsolidated Fine Sand / Mud
VT21	6.05	28	-	0.2	-	89.6	5.9	4.2	-	0.1	Geologic Unconsolidated Fine Sand / Mud
VT22	11.12	30	-	0.2	-	90.6	5.9	0.1	-	3.1	Geologic Unconsolidated Fine Sand / Mud

Table 7. Representative still images of various habitat types observed in 22 video transects in OCS-A 0501 South (continued on next page).

Fine sand/mud (VT11)	
Fine sand/mud with anthropogenic debris (derelict fishing pot with encrusting biota) (VT14)	
Fine sand/mud with shell debris (VT 12)	

Fine sand/mud with burrows (VT19)	
Fine sand/mud with sessile sponge (VT12)	

3.2 Grab Samples

The characteristics and locations of the grab sample stations within the OCS-A 0501 South lease area are described in Table 8 and shown in Figure 1 (in Section 3.1). The sample penetration depth is the depth of the sample within the grab equipment (i.e., the height of collected sediment from the center of the closed sampler to surface of sediment).

Table 8. Grab sample station locations and characteristics in OCS-A 0501 South (continued on next two pages).

Sample	Date	Time (EST)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth
GB01	3-Nov-19	2:10 PM	40.94953	70.57768	53.8	11 cm
GB02	3-Nov-19	1:57 PM	40.94932	70.56974	53.1	10 cm
GB03	4-Nov-19	10:50 AM	40.89828	70.64429	49.5	8 cm

Sample	Date	Time (EST)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth
GB04	3-Nov-19	4:05 PM	41.00187	70.62040	49.4	9 cm
GB05	3-Nov-19	3:34 PM	41.00173	70.58129	50.9	14 cm
GB06	3-Nov-19	4:54 PM	40.96840	70.61960	51.0	12 cm
GB07	4-Nov-19	9:27 AM	40.95088	70.68893	48.0	7 cm
GB08	3-Nov-19	1:27 PM	40.93701	70.53167	52.0	13 cm
GB09	3-Nov-19	6:04 PM	40.93551	70.61873	49.2	>12.5 cm
GB10	4-Nov-19	11:42 PM	40.91754	70.72855	59.2	12 cm
GB11	4-Nov-19	11:29 PM	40.89998	70.76969	56.5	11.5 cm
GB12	4-Nov-19	11:33 AM	40.90212	70.59356	52.8	13 cm
GB13	4-Nov-19	10:03 PM	40.88505	70.68481	56.7	12 cm
GB14	4-Nov-19	1:07 PM	40.88524	70.62909	53.1	14 cm
GB15	4-Nov-19	12:47 PM	40.88524	70.62879	53.5	16 cm
GB16	4-Nov-19	12:20 PM	40.88521	70.62842	57.9	6.5 cm
GB17	4-Nov-19	9:01 PM	40.87514	70.76828	58.1	14 cm
GB18	4-Nov-19	7:21 PM	40.85096	70.72698	57.6	12.5 cm
GB19	4-Nov-19	8:22 PM	40.84955	70.81424	53.5	15 cm
GB20	4-Nov-19	3:11 PM	40.83519	70.66011	58.6	13 cm
GB21	4-Nov-19	4:29 PM	40.80052	70.70225	60.5	13 cm
GB22	4-Nov-19	5:42 PM	40.74996	70.74610	66.5	15.5 cm
GB23	3-Nov-19	3:13 PM	40.98541	70.59835	51.9	12 cm
GB24	3-Nov-19	4:32 PM	40.98440	70.64234	50.2	9.5 cm
GB25	3-Nov-19	2:47 PM	40.96990	70.57137	51.0	10 cm
GB26	4-Nov-19	9:53 AM	40.93517	70.66285	49.4	11 cm
GB27	3-Nov-19	5:30 PM	40.93608	70.57521	51.9	>12.5 cm
GB28	4-Nov-19	10:29 AM	40.91863	70.64026	50.8	11 cm
GB29	4-Nov-19	10:25 PM	40.90093	70.70631	55.4	13.5 cm
GB30	4-Nov-19	11:14 AM	40.90139	70.61795	54.9	8 cm
GB31	4-Nov-19	11:53 AM	40.88602	70.59544	56.9	11 cm
GB32	4-Nov-19	9:32 PM	40.88412	70.72768	54.8	12 cm
GB33	4-Nov-19	2:21 PM	40.86828	70.66146	55.2	11.5 cm
GB34	4-Nov-19	1:33 PM	40.86892	70.61710	56.7	14 cm
GB35	4-Nov-19	2:48 PM	40.85109	70.68299	57.4	12 cm
GB36	4-Nov-19	7:52 PM	40.84974	70.77022	59.3	14 cm

Sample	Date	Time (EST)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth
GB37	4-Nov-19	6:56 PM	40.83445	70.70422	60.2	14 cm
GB38	4-Nov-19	3:36 PM	40.81792	70.68178	60.2	14 cm
GB39	4-Nov-19	6:33 PM	40.81724	70.72601	63.3	15 cm
GB40	4-Nov-19	5:02 PM	40.78373	70.74691	62.7	15 cm

3.2.1 Sediment Analysis

The following section presents grab sample grain size composition results from the TerraSense lab analysis. The grain size data in Section 3.2.1 conform to ASTM D6913, according to contractual agreement. During analysis, it was discovered that the grain sizes reported under this standard do not align exactly with CMECS grain size bins (see Table 9 for comparison). For the sake of applying NMFS (2020) modified CMECS, differences in the threshold for silt or clay (0.0625 mm vs. 0.075 mm) is the only significant factor and may impact classification of muddy sand vs. sand and sandy mud vs. muddy sand in rare instances. To simplify interpretation for CMECS habitat classification in future analyses, requesting CMECS-specific grain size bins from the lab is recommended.

Samples from the 40 grab sample stations in OCS-A 501 South were generally sandy comprised of 15% - 98% sand grains (0.075 mm – 2 mm) with a mean across samples of 73% (Table 10 and Figure 3). Eleven samples contained no CMECS-defined gravel-sized particles (> 2 mm) while 27 samples contained < 1% gravel. Just 2 samples (GB16 and GB24) were comprised of 2.3% gravel-sized particles, with maximum sieve sizes retaining gravel for these samples of 9.53 mm and 19.05 mm, respectively. Fines particles (<0.075 mm) comprised 1 – 84% of samples (mean of 27%), with 5 samples containing more than 50% silt and clay (GB14, GB15, GB22, GB39, and GB40). The fines component may be a slight overestimate because CMECS classifies silt/clay at a smaller scale (< 0.0625 mm) than the lab results (< 0.075 mm).

Table 9. Comparison of ASTM 6913 and CMECS (Wentworth) grain size bins.

Sediment Type	ASTM 6913	CMECS Bin Size
Gravel	> 4.75 mm	2 – < 4,096 mm
Very Coarse Sand	n/a	1 – < 2 mm
Coarse Sand	2 – < 4.75 mm	0.5 – < 1 mm
Medium Sand	0.41 – < 2 mm	0.25 – < 0.5 mm
Fine Sand	0.075 – < 0.41 mm	0.125 – < 0.25 mm
Very Fine Sand	n/a	0.0625 – < 0.125 mm
Silt or Clay	< 0.075 mm	< 0.0625 mm

Table 10. Grain size composition and moisture content from grab samples in OCS-A 0501 South (continued on next page).

Sample	% Grains > 4.75 mm	% Grains 2 – 4.75 mm	% Grains 0.41 – 2 mm	% Grains 0.075 – 0.41 mm	% Grains < 0.075 mm	% Moisture Content
GB01	0	0.1	82.7	15.4	1.8	15.8
GB02	0	0	2.1	65.3	32.6	40.8
GB03	0	0.2	77.0	20.9	1.9	20.1
GB04	0	0.1	6.1	83.7	10.1	36.6
GB05	0	0	1.5	80.4	18.1	35.5
GB06	0	0.1	1.8	84.1	14.0	27.8
GB07	0	0.2	49.9	47.6	2.3	26.0
GB08	0	0.2	9.4	66.8	23.6	41.3
GB09	0	0.1	1.9	78.7	19.3	34.9
GB10	0	0.1	2.2	77.0	20.7	40.5
GB11	0	0	5.2	84.4	10.4	28.2
GB12	0	0.1	12.8	50.7	36.4	44.3
GB13	0	0.1	54.4	44.0	1.5	21.6
GB14	0	0	9.0	13.9	77.1	100.1
GB15	0	0.2	3.1	12.6	84.1	119.8
GB16	0.4	1.9	84	9.8	3.9	19.3
GB17	0	0.1	5.3	82.9	11.7	34.4
GB18	0	0.2	19.7	57.2	22.9	38.7
GB19	0	0.1	5.2	74.1	20.6	37.4
GB20	0	0.1	10.1	54.3	35.5	44.3
GB21	0	0.1	10.9	58.2	30.8	40.5
GB22	0	0	6.0	26.7	67.3	65.4
GB23	0	0.1	5.6	70.9	23.4	38.0
GB24	0.3	2.0	76.8	19.3	1.6	17.4
GB25	0	0	18.5	80.2	1.3	24.1
GB26	0	0.1	2.2	86.0	11.7	30.3
GB27	0	0	7.9	69.8	22.3	28.3
GB28	0	0.1	4.0	73.8	19.1	34.3
GB29	0	0.1	2.4	57.3	40.2	48.9
GB30	0	0.2	64.8	30.3	4.7	21.7
GB31	0	0	1.6	49.2	49.2	60.3
GB32	0	0.1	3.5	54.8	41.6	66.0

Sample	% Grains > 4.75 mm	% Grains 2 – 4.75 mm	% Grains 0.41 – 2 mm	% Grains 0.075 – 0.41 mm	% Grains < 0.075 mm	% Moisture Content
GB33	0	0.1	75.7	22.7	1.5	19.7
GB34	0	0.8	15.9	48.3	35.0	40.7
GB35	0	0	3.2	59.3	37.5	43.8
GB36	0	0.1	3.1	73.7	23.1	38.3
GB37	0	0	8.2	61.5	30.3	44.5
GB38	0	0.1	2.5	48.0	49.4	45.3
GB39	0	0.1	2.1	37.5	60.3	71.9
GB40	0	0	4.6	32.2	63.2	74.1

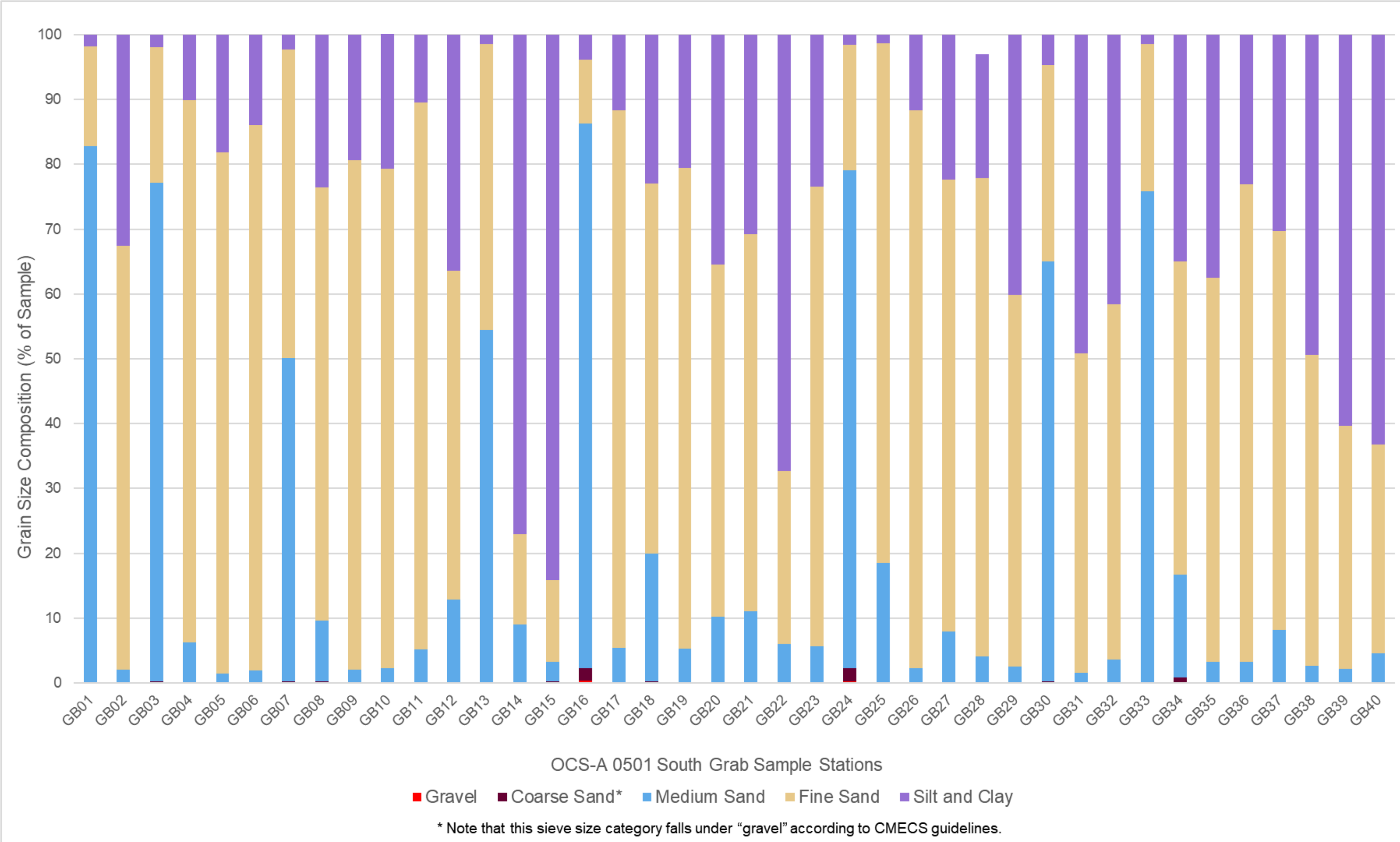


Figure 3. Grain size composition at each grab sample station in OCS-A 0501 South. Note that the size classifications do not exactly match those within the CMECS guidelines, see text for details.

3.2.2 Benthic Community Analysis

3.2.2.1 Taxonomic Composition

Benthic grab samples were collected for infaunal analysis at 40 sites throughout the OCS-A 0501 South lease area (501S-19-GB01 through -GB40). The grab samples yielded a total of 2,641 individual organisms (per all forty 0.008 m^2 core samples) from five (5) unique phyla and 54 families (or LPTL; Table 11). The phyla Arthropoda and Annelida dominated the samples in both abundance and diversity, representing 94% of all organisms and 85% of all unique taxa (Figure 4).

Table 11. Phyla present in the 40 benthic grab samples in OCS-A 0501 South.

Phyla	Abundant Taxonomic Groups (common names)	Density (Abundance per forty 0.008 m^2 samples)	Number of Taxa
Annelida	Polychaete worms	742	20
Arthropoda	Amphipods	1,735	24
Mollusca	Cleft clams, marine bivalve	56	8
Nematoda	Nematode	80	1
Nemertea	Nemertea	28	1
Totals		2,641	54

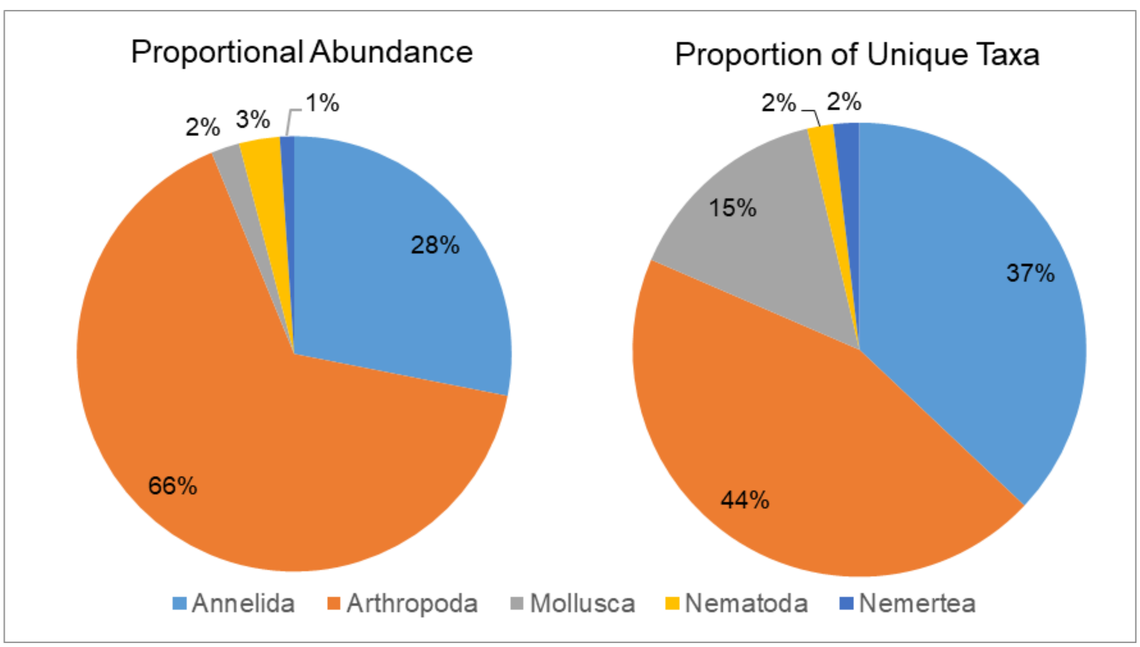


Figure 4. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum collected in all benthic grab samples in OCS-A 0501 South. Results presented as percentage of total.

Density across the 40 benthic grab sites ranged from 3 organisms per station at GB13 to 163 at GB05 (Table 12 and Figure 5). Most (118) of the organisms identified in GB05 were amphipods from the Ampeliscidae family. Taxa represented in each sample ranged from 3 families at GB13 to 26 unique families at GB39. Overall, just over half of all organisms identified across the 40 grab samples (51%, or 1,338 organisms/0.32 m^2 [i.e., total sampled area of the 40 grab sites]) were amphipods from a single taxon, the Ampeliscidae family. Abundance of each phyla and taxa are shown in Table 13.

Table 12. Density of each phylum at each station for OCS-A 0501 South (continued on next page).

Station	Annelida	Arthropoda	Mollusca	Nematoda	Nemertea	Density (Abundance per 0.008 m^2)
501S-19-GB01	3	2	0	1	0	6
501S-19-GB02	19	88	2	0	0	109
501S-19-GB03	10	4	0	4	0	18
501S-19-GB04	40	68	1	4	0	113
501S-19-GB05	23	132	5	2	1	163
501S-19-GB06	34	85	2	1	2	124
501S-19-GB07	1	2	1	3	1	8
501S-19-GB08	48	107	1	2	1	159
501S-19-GB09	20	102	0	0	1	123
501S-19-GB10	38	63	6	5	0	112
501S-19-GB11	41	50	3	0	1	95
501S-19-GB12	36	10	0	1	2	49
501S-19-GB13	2	1	0	0	0	3
501S-19-GB14	28	5	7	2	0	42
501S-19-GB15	14	0	0	0	0	14
501S-19-GB16	3	0	0	2	0	5
501S-19-GB17	23	65	0	0	1	89
501S-19-GB18	16	16	5	3	0	40
501S-19-GB19	24	132	0	0	4	160
501S-19-GB20	10	24	1	0	0	35
501S-19-GB21	18	18	2	0	0	38
501S-19-GB22	7	70	0	1	0	78
501S-19-GB23	12	57	0	0	4	73
501S-19-GB24	4	3	0	8	0	15
501S-19-GB25	6	29	0	11	0	46
501S-19-GB26	16	83	0	2	0	101
501S-19-GB27	26	66	6	3	1	102
501S-19-GB28	12	15	0	1	0	28
501S-19-GB29	43	84	1	0	1	129
501S-19-GB30	7	13	0	6	0	26
501S-19-GB31	12	2	1	0	1	16
501S-19-GB32	26	32	1	0	0	59

Station	Annelida	Arthropoda	Mollusca	Nematoda	Nemertea	Density (Abundance per 0.008 m^2)
501S-19-GB33	3	2	0	5	0	10
501S-19-GB34	15	34	3	0	0	52
501S-19-GB35	28	41	3	1	1	74
501S-19-GB36	12	33	2	0	2	49
501S-19-GB37	14	25	0	1	0	40
501S-19-GB38	20	69	3	6	3	101
501S-19-GB39	15	26	0	2	0	43
501S-19-GB40	14	79	0	3	1	97
Totals	**742**	**1735**	**56**	**80**	**28**	**2,641**

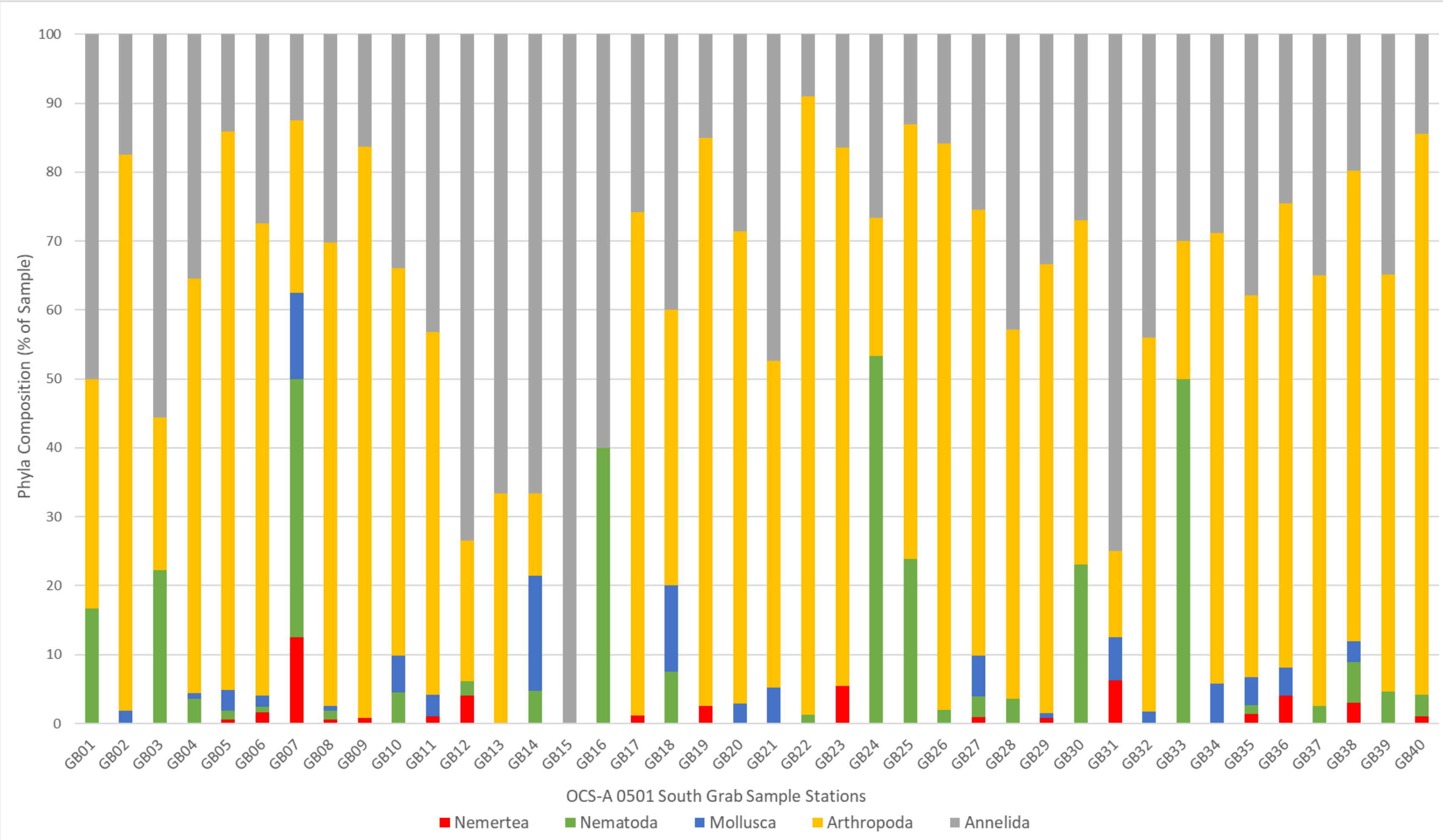


Figure 5. Percent composition of the 40 benthic grab samples in OCS-A 0501 South by phylum.

Table 13. Abundance of each phyla and taxa (family or LPTL) across all 40 samples for OCS-A 0501 South (continued on next page).

Phylum	Family or LPTL	Abundance Across All Samples	Median Abundance per 0.008 m^2	Frequency of Occurrence
Annelida	Lumbrineridae	241	6	37
	Paraonidae	184	5	27
	Maldanidae	75	2	22
	Cirratulidae	33	1	16
	Trichobranchidae	27	1	17
	Scalibregmatidae	24	1	12
	Flabelligeridae	23	1	8
	Oenonidae	21	1	14
	Naididae	18	0	12
	Nephtyidae	18	0	13
	Syllidae	16	0	8
	Opheliidae	15	0	10
	Goniadidae	13	0	7
	Ampharetidae	12	0	11
	Glyceridae	9	0	9
	Sabellidae	7	0	6
	Cossuridae	3	0	3
	Spionidae	2	0	2
	Capitellidae	1	0	1
	Phyllodocidae	1	0	1
Total Annelida		742	1	38
Arthropoda	Ampeliscidae	1338	33	35
	Corophiidae	72	2	19
	Unciolidae	67	2	25
	Hyperiidae	54	1	4
	Leuconidae	38	1	19
	Phoxocephalidae	35	1	22
	Ischyroceridae	31	1	11
	Calanoida (LPTI)	20	0	13
	Lysianassidae	18	0	7
	Diastylidae	11	0	10
	Axiidae	8	0	8
	Cheirocratidae	6	0	5
	Amphipoda (LPTI)	6	0	5
	Gammaridae	5	0	4
	Idoteidae	4	0	3
	Ostracoda (LPTI)	4	0	1

Phylum	Family or LPTL	Abundance Across All Samples	Median Abundance per 0.008 m^2	Frequency of Occurrence
	Pleustidae	4	0	2
	Anthuridae	3	0	3
	Cyclopoida (LPTI)	3	0	3
	Cancridae	2	0	1
	Melitidae	2	0	1
	Photidae	2	0	2
	Brachyura (LPTI)	1	0	1
	Tryphosidae	1	0	1
Total Arthropoda		1,735	7	40
Mollusca	Thyasiridae	21	1	12
	Thraciidae	19	1	10
	Nuculidae	7	1	2
	Bivalvia (LPTL)	3	0	3
	Yoldiidae	3	0	3
	Tellinidae	1	0	1
	Chaetodermatidae	1	0	1
	Pleurobranchaeidae	1	0	1
Total Mollusca		56	0	20
Nematoda	Nematoda (LPTL)	80	3	25
Total Nematoda		80	3	25
Nemertea	Nemertea (LPTL)	28	1	17
Total Nemertea		28	1	17

3.2.2.2 Richness, Diversity, and Evenness

Mean density was 66 organisms per station, averaged across the 40 samples. Taxonomic richness across all grab samples collected in OCS-A 0501 South was 6.7 (Table 14). The richness of organisms collected in each of the benthic grab samples ranged from 0.87 at GB33 to 5.42 at GB39, with an average richness across samples of 2.96. Diversity was higher and evenness lower across all grab samples (2.23 and 0.56, respectively) than the average of individual samples (1.70 and 0.72, respectively). The low evenness in organisms across all stations was a result of the high proportion of organisms from three families, including Ampeliscidae (1,338 organisms), Lumbrineridae (241 organisms), and Paradonidae (184 organisms). Diversity of the 40 grab samples ranged from 1.03 at GB33 to 2.36 at GB39 and evenness ranged from 0.39 at GB19 to 1.00 at GB13. Although evenness was high at GB13, both richness and diversity were low as this sample contained only three organisms from three families (Lumbrineridae, Goniadidae, and Ampeliscidae). Richness, diversity, and evenness are indices that do not have units; however, higher values indicate greater amounts of richness, diversity, or evenness in each sample.

Table 14. Community composition parameters calculated for each grab sample station in OSC-A 0501 South (continued on next page).

Station	Density (Community Abundance per 0.008 m^2)	# of Taxa	Ecological Indices		
			Richness	Diversity	Evenness
GB01	6	4	1.67	1.24	0.90
GB02	109	16	3.20	1.39	0.50
GB03	18	10	3.11	2.12	0.92
GB04	113	18	3.60	1.81	0.63
GB05	163	19	3.53	1.32	0.45
GB06	124	21	4.15	1.70	0.56
GB07	8	6	2.40	1.67	0.93
GB08	159	25	4.73	2.01	0.63
GB09	123	16	3.12	1.36	0.49
GB10	112	20	4.03	2.22	0.74
GB11	95	14	2.85	1.74	0.66
GB12	49	15	3.60	2.27	0.84
GB13	3	3	1.82	1.10	1.00
GB14	42	5	1.52	1.30	0.81
GB15	14	10	2.41	1.76	0.77
GB16	5	4	1.86	1.33	0.96
GB17	89	12	2.45	1.62	0.65
GB18	40	14	3.52	2.20	0.83
GB19	160	17	3.15	1.08	0.38
GB20	38	11	2.75	1.92	0.80
GB21	35	9	2.25	1.34	0.61
GB22	78	11	2.33	1.32	0.55
GB23	73	11	2.30	1.23	0.51

Station	Density (Community Abundance per 0.008 m^2)	# of Taxa	Ecological Indices		
			Richness	Diversity	Evenness
GB24	15	5	1.48	1.32	0.82
GB25	46	7	1.57	1.23	0.63
GB26	101	13	2.60	1.65	0.65
GB27	102	21	4.32	2.28	0.75
GB28	28	10	2.70	2.03	0.88
GB29	129	21	4.12	1.84	0.60
GB30	26	9	2.89	1.98	0.90
GB31	16	11	3.07	2.02	0.84
GB32	59	15	3.43	1.97	0.73
GB33	10	3	0.87	1.03	0.94
GB34	52	15	3.54	1.76	0.65
GB35	74	15	3.25	1.99	0.73
GB36	49	15	3.60	1.83	0.68
GB37	40	13	3.25	2.14	0.83
GB38	43	12	2.92	1.81	0.73
GB39	101	26	5.42	2.36	0.73
GB40	97	14	2.84	1.58	0.60
Average	**66**	**13**	**2.96**	**1.70**	**0.72**
Total	**2,641**	**54**	**6.73**	**2.23**	**0.56**

4 CMECS CLASSIFICATIONS

We assigned NMFS (2020) modified CMECS classifications to each grab sample station based on visual inspection of the sample on board the ship, as well as laboratory analysis of grain size. We also assigned a CMECS substrate classification for each still image from the underwater video transects that were analyzed for percent cover.

4.1 CMECS OCS-A 0501 South

Substrate classification results are presented as a hierarchy in Table 15 for grab samples stations in the OCS-A 0501 South lease area. Table 16 shows the images of each grab sample and core after retrieval along with the CMECS classifications for sample. All samples in OCS-A 0501 South were dominated by fine unconsolidated substrate of geologic origin. All samples belonged to the sand, muddy sand, or sandy mud groups. The majority of samples contained small (0.1% - 2.3%) fractions of gravel. The gravel portions of these samples may have been comprised of shell fragments rather than substrate of geologic origin but the grain size analysis did not differentiate between substrate origins and images of the cores are insufficient for determining the composition of the gravel at such a fine scale. Therefore, it is possible that the samples would be more appropriately classified as sand with trace shell hash, muddy sand with trace shell hash, or sandy mud with trace shell hash.

Maps displaying the location and CMECS classification of each individual still image analyzed for the video transects in OCS-A 0501 South are provided in Appendix A, Section 1.

Table 15. CMECS hierarchical classification of substrates collected at each grab sample or video transect within OCS-A 0501 South.

Origin	Class	Subclass	Group	Subgroup	Modifier	Grab Sample

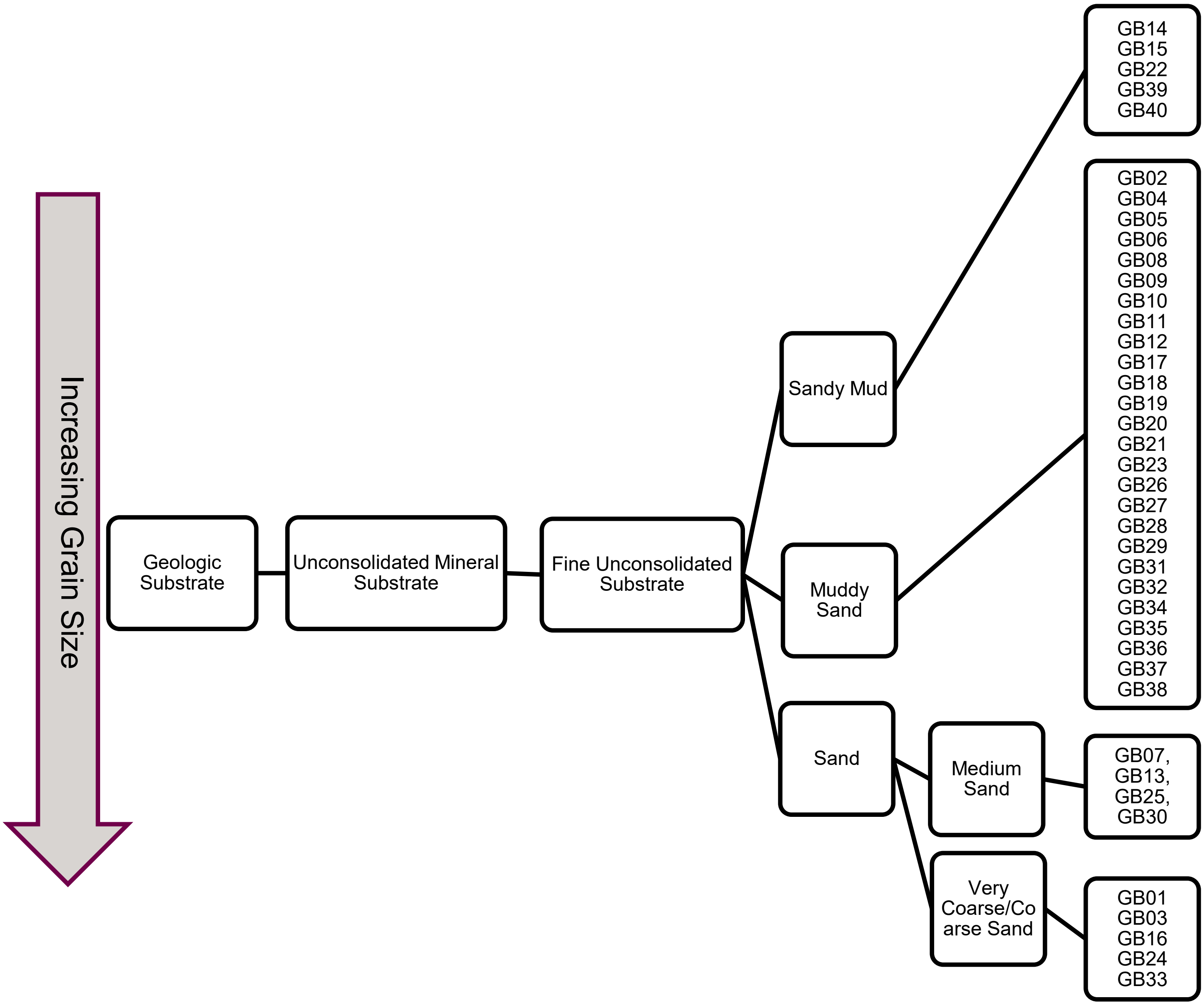


Table 16. Images of grab and subsequent core samples prior to processing from OCS-A 0501 South, along with CMECS classifications (continued on next page).

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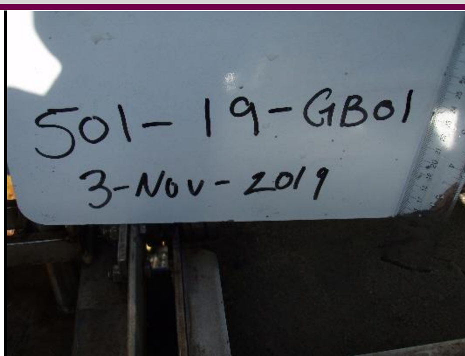
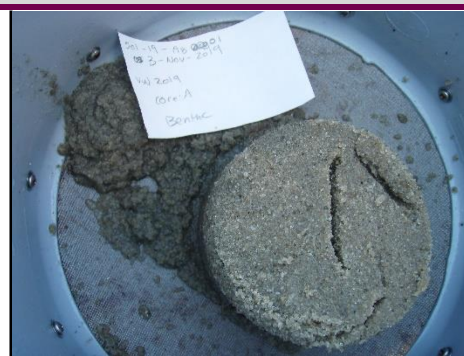
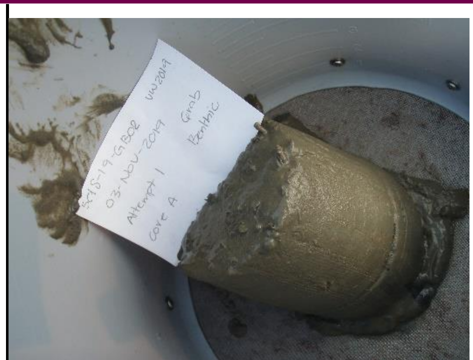
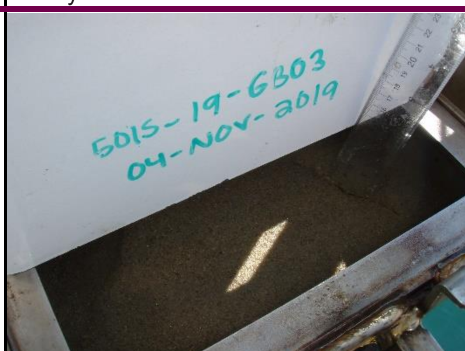
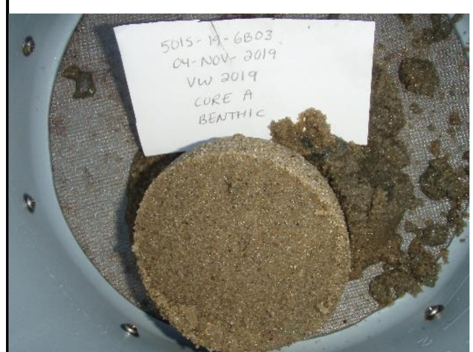
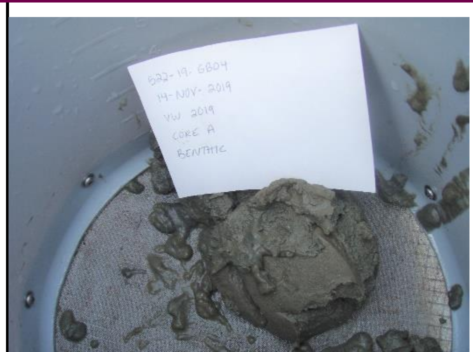
<tr><th>Station</th><th>Grab Sample</th><th>Core Sample</th></tr>
<tr><td>GB01</td><td>

Very coarse/coarse sand</td><td></td></tr>
<tr><td>GB02</td><td>

Muddy sand</td><td></td></tr>
<tr><td>GB03</td><td>

Very coarse/coarse sand</td><td>
</td></tr>
<tr><td>GB04</td><td>

Muddy sand</td><td></td></tr>
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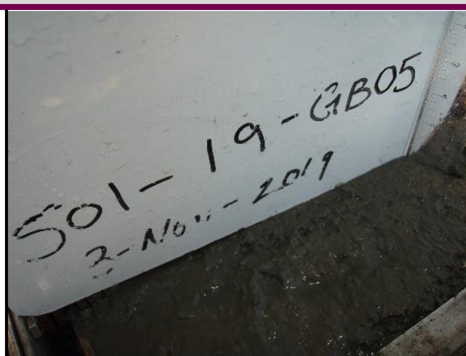
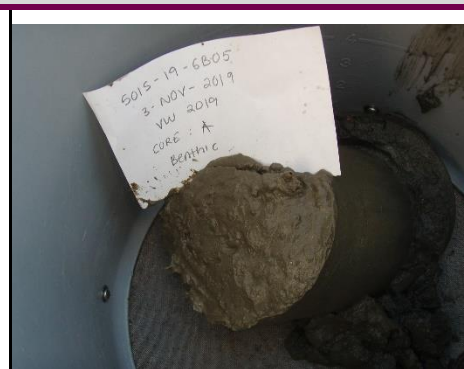
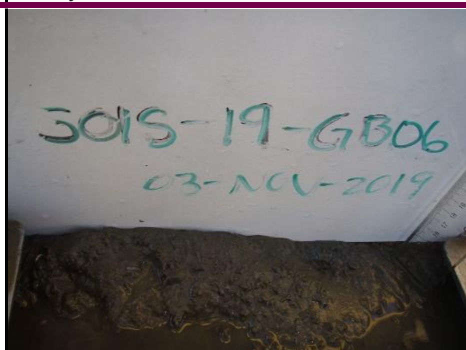
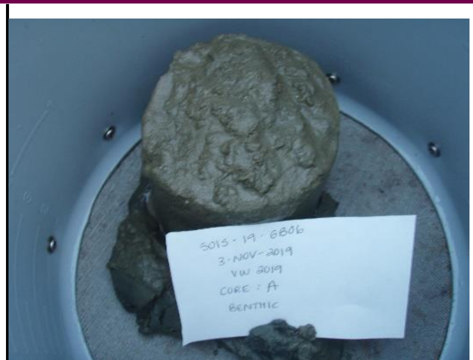
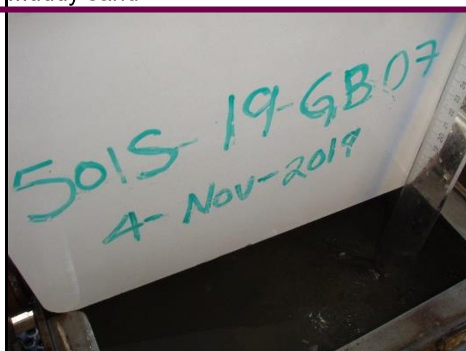
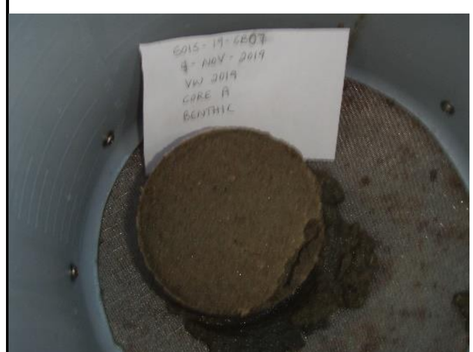
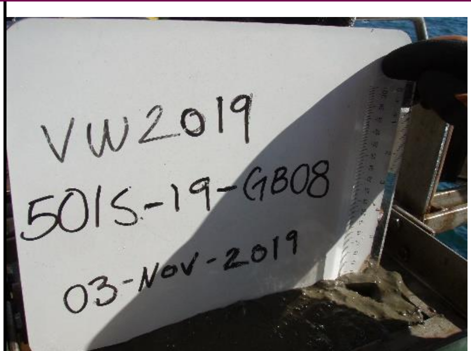
<tr><td>GB05</td><td>

Muddy sand</td><td></td></tr>
<tr><td>GB06</td><td>

Muddy sand</td><td></td></tr>
<tr><td>GB07</td><td>

Medium sand</td><td></td></tr>
<tr><td>GB08</td><td>

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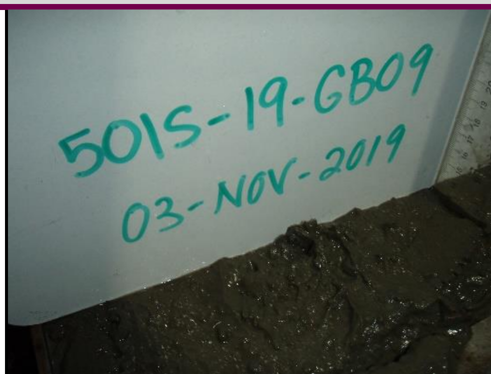
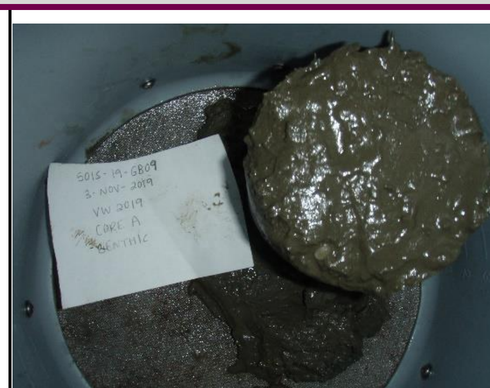
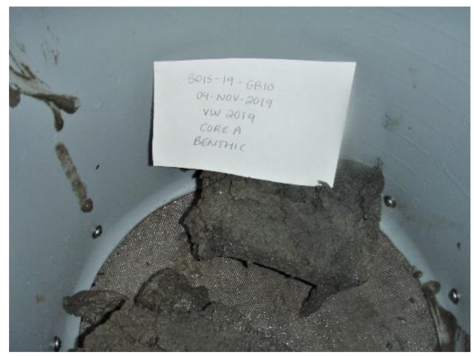
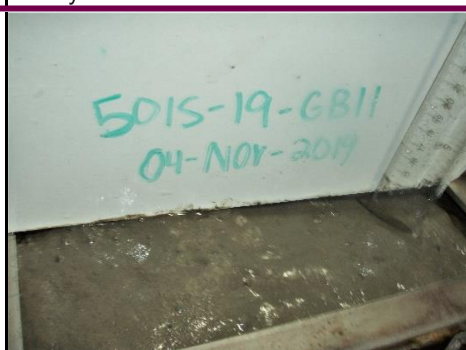
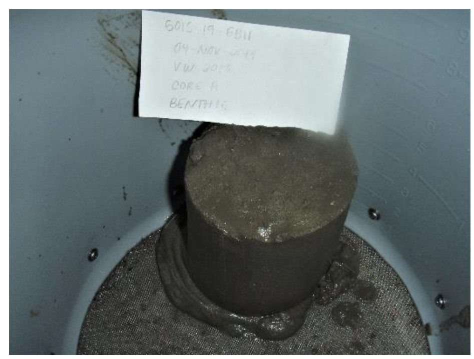
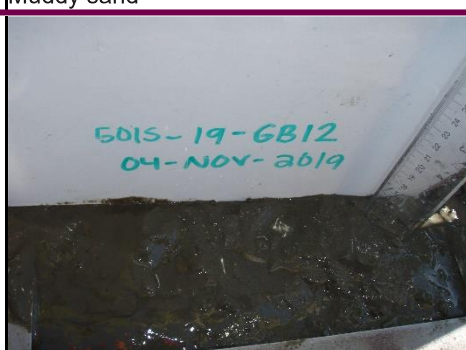
GB09	 Muddy sand	
GB10	 Muddy sand	
GB11	 Muddy sand	
GB12	 Muddy sand	

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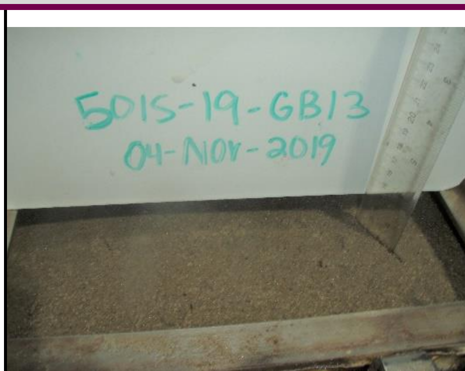
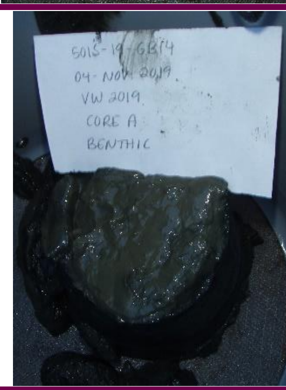
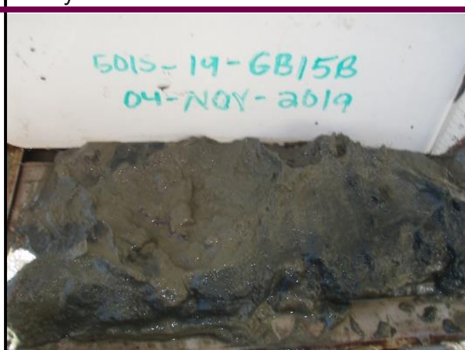
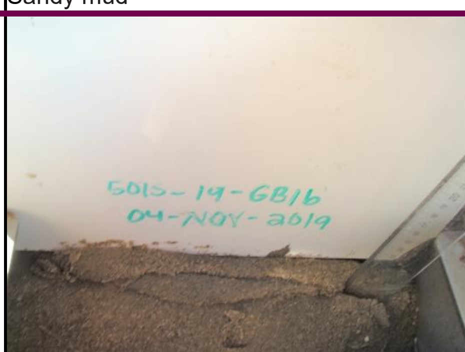
GB13	 Medium sand	
GB14	 Sandy mud	
GB15	 Sandy mud	
GB16	 Very coarse/coarse sand	

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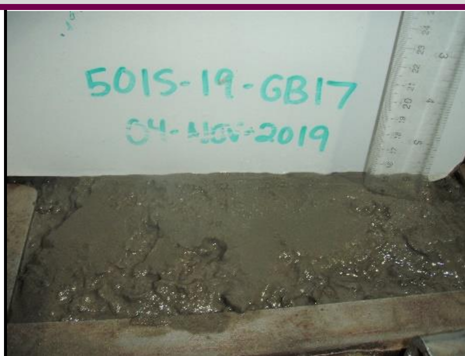
GB17	Muddy sand	
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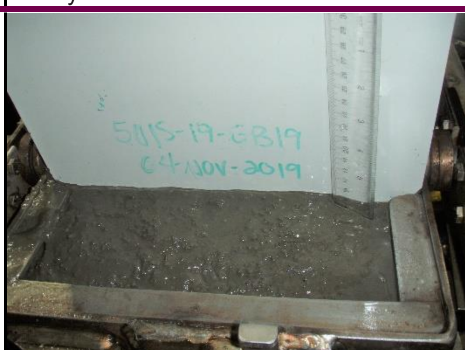
GB19	Muddy sand	
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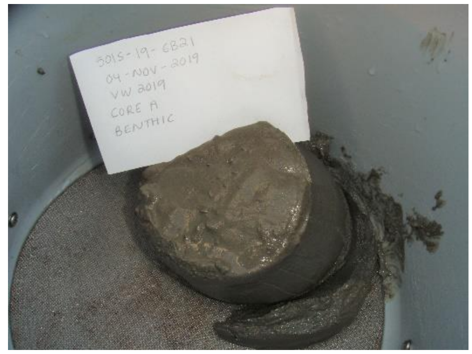
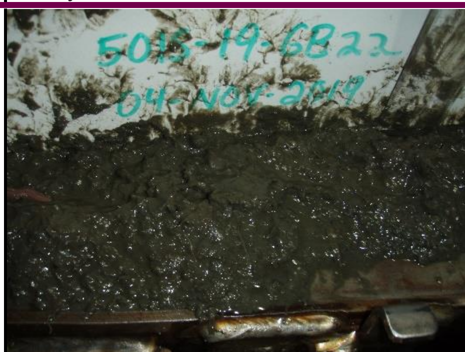
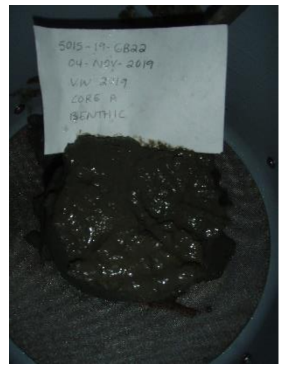
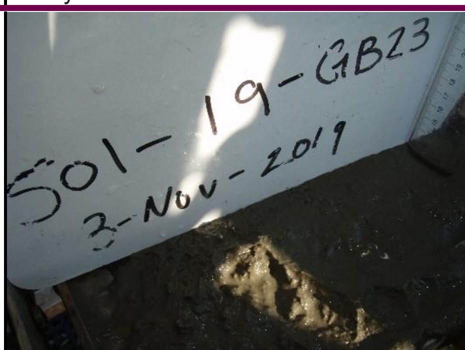
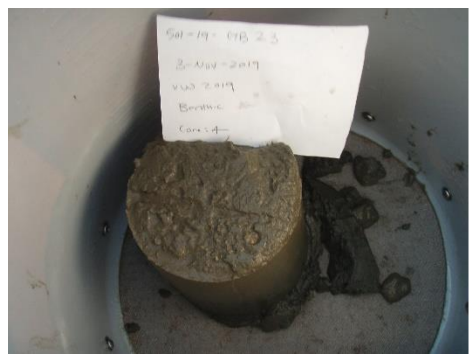
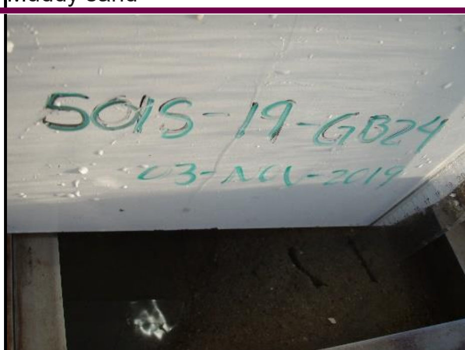
Station	Grab Sample	Core Sample
GB21	 Muddy sand	
GB22	 Sandy mud	
GB23	 Muddy sand	
GB24	 Very coarse/coarse sand	

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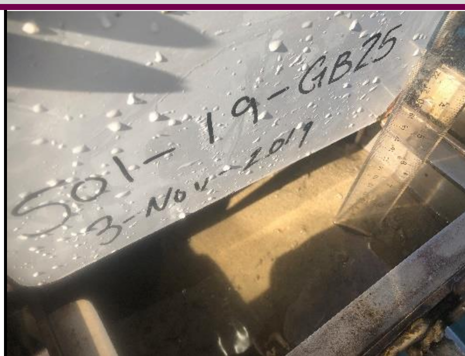
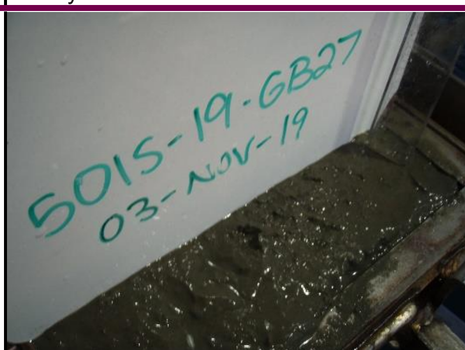
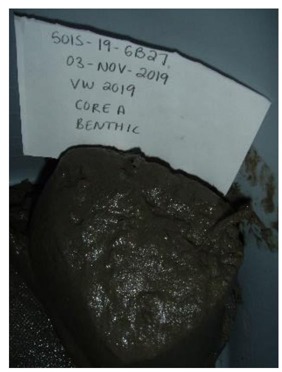
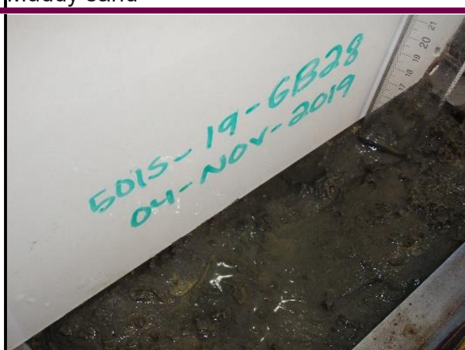
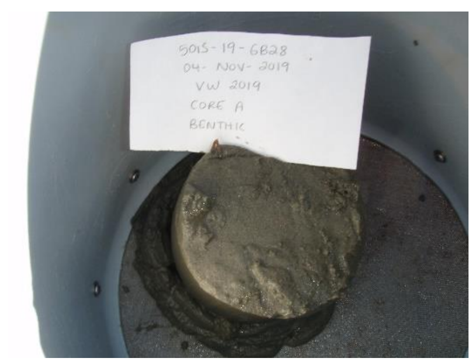
GB25	 Medium sand	
GB26	 Muddy sand	
GB27	 Muddy sand	
GB28	 Muddy sand	

Station	Grab Sample	Core Sample
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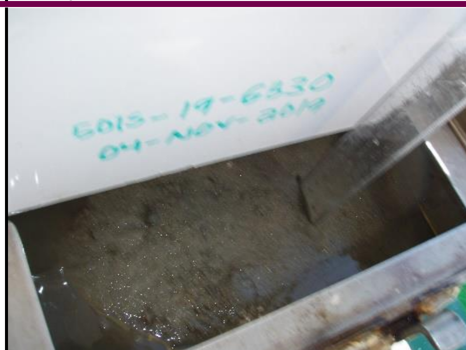
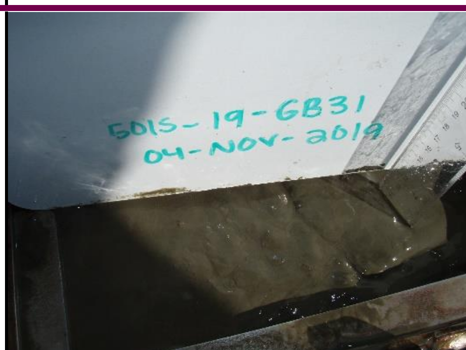
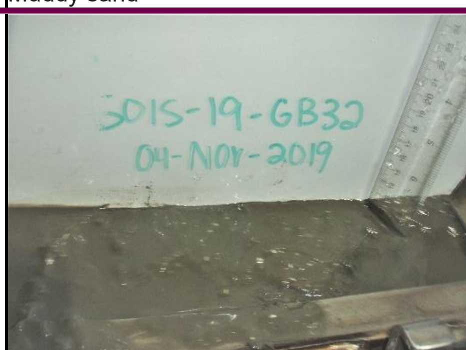
GB30	 Medium sand	
GB31	 Muddy sand	
GB32	 Muddy sand	

Station	Grab Sample	Core Sample
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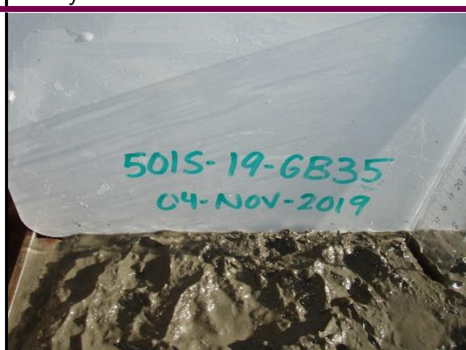
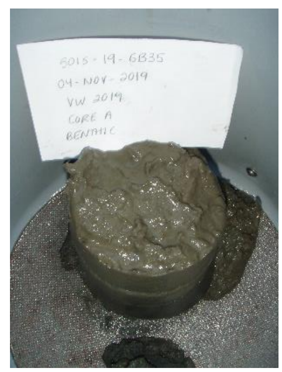
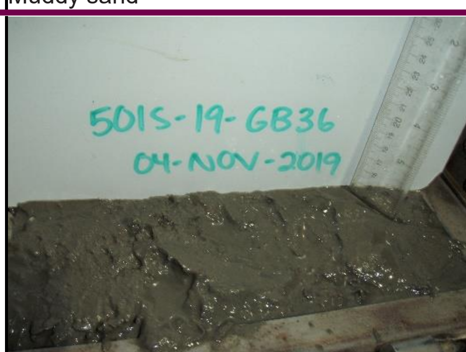
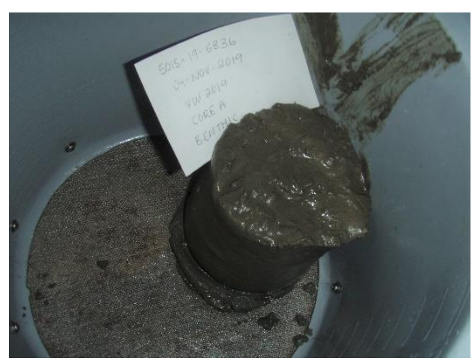
GB35	 Muddy sand	
GB36	 Muddy sand	

Station	Grab Sample	Core Sample
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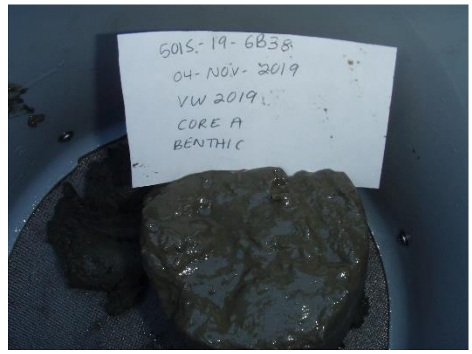
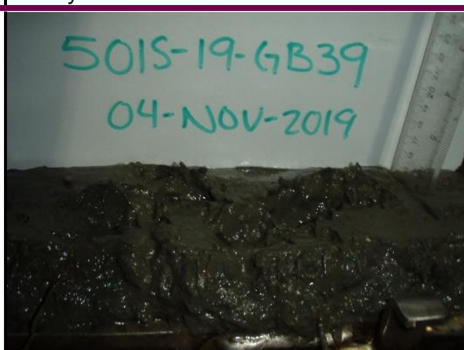
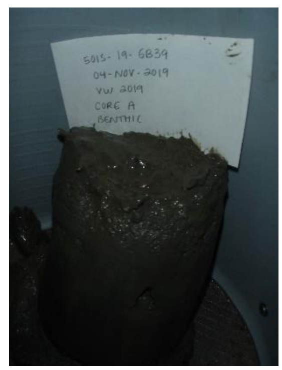
GB38	 Muddy sand	
GB39	 Sandy mud	
GB40	 Sandy mud	

5 SUMMARY

OCS-A 0501 South sampling locations consisted of muddy sand, sand, or sandy mud with no evidence of consolidated substrate. Bottom complexity was low with some evidence of sand ripples to small sand waves. Video revealed that >89.6% of bottom in all transects was comprised of sand/mud with most transects revealing >99% sand/mud. Infaunal structures (seemingly small worm tubes and amphipod structures), burrows, macrofauna, and shells made up most of the remaining surface area. Sea stars were the dominant benthic macrofauna, but were not observed in roughly half of the video transects. Infauna was dominated by the Arthropoda phylum followed by the Annelida phylum. One instance of anthropogenic debris was observed in the form of a derelict fishing pot.

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ALPINE VINEYARD WIND BENTHIC SAMPLING

APPENDIX A – LEASE AREA OCS-A 0501 CMECS MAPS

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Alpine Ocean – Vineyard Wind

19-P-206028 Alpine Vineyard Wind Lease Areas OCS-A 0501 South Benthic Sampling Appendix A

January 18, 2021

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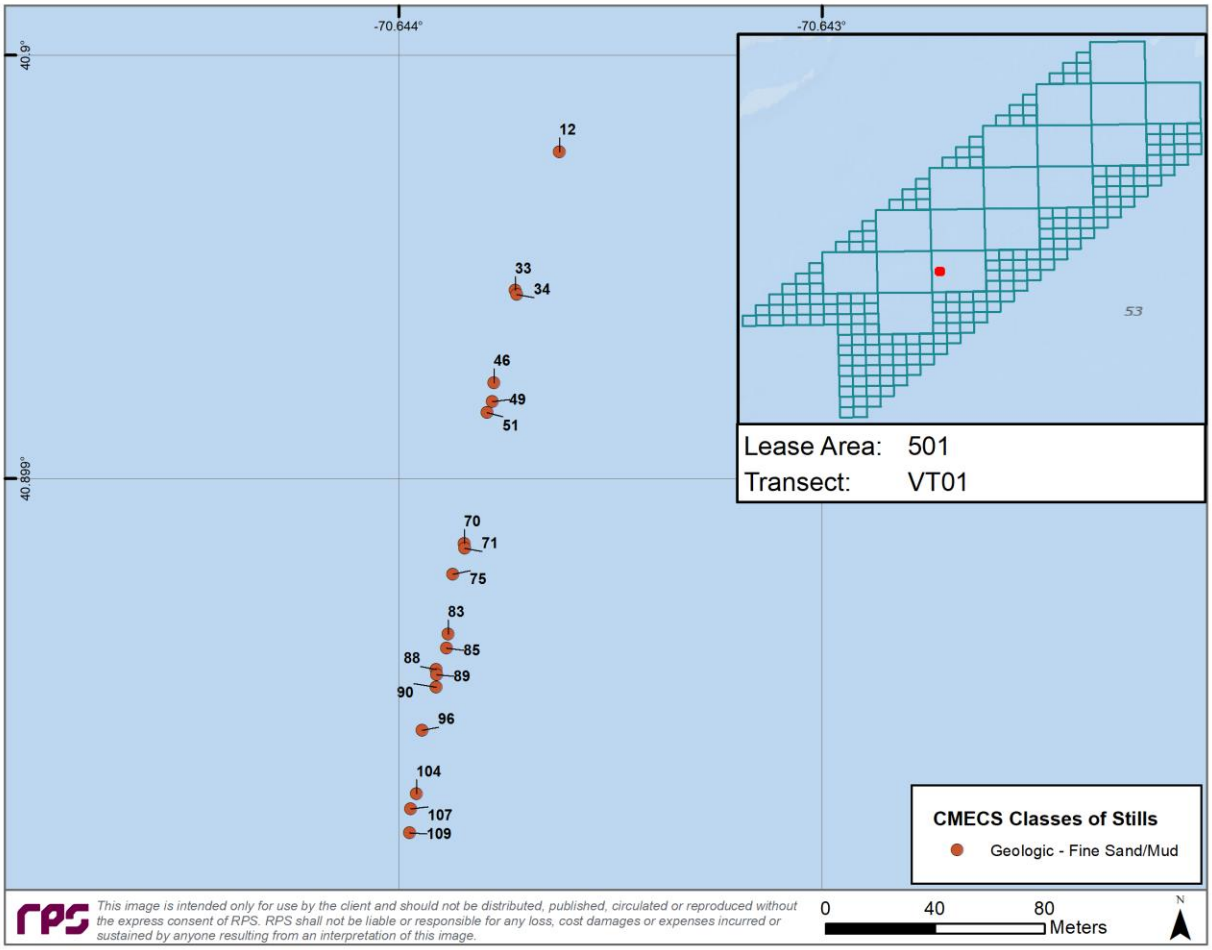


Figure 1 CMECS substrate classification for all viable still images in VT01 (numbers indicate still image ID).

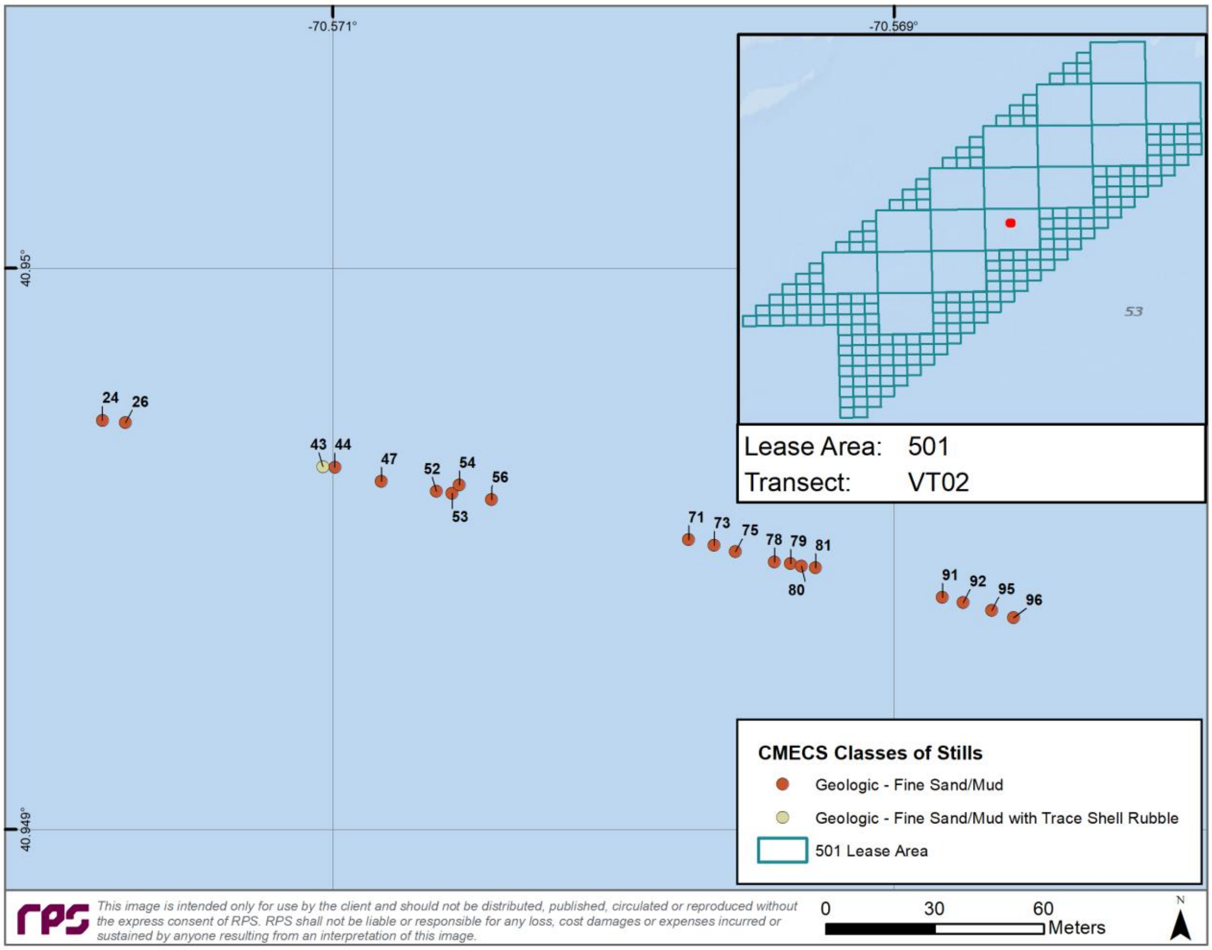


Figure 2 CMECS substrate classification for all viable still images in VT02 (numbers indicate still image ID).

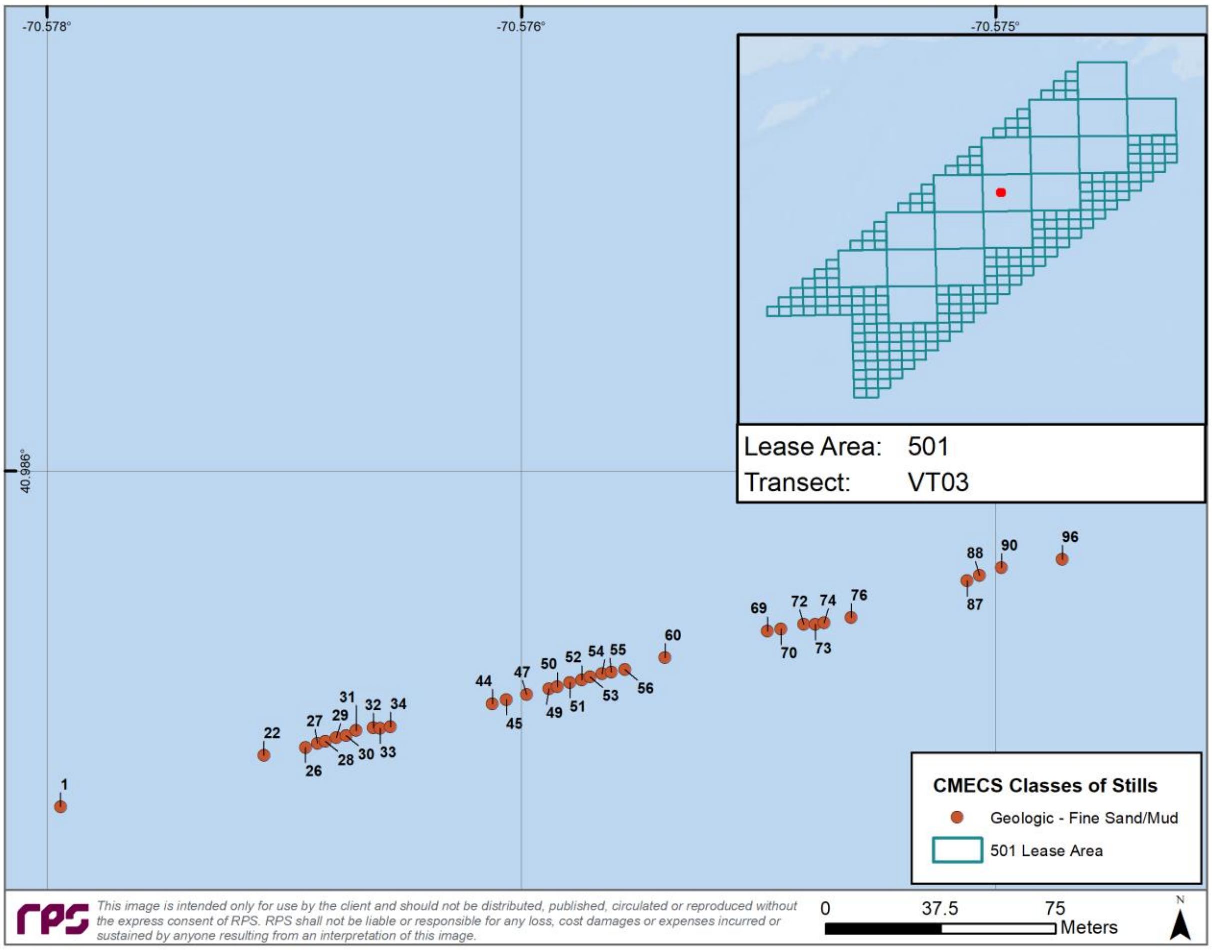


Figure 3 CMECS substrate classification for all viable still images in VT03 (numbers indicate still image ID).

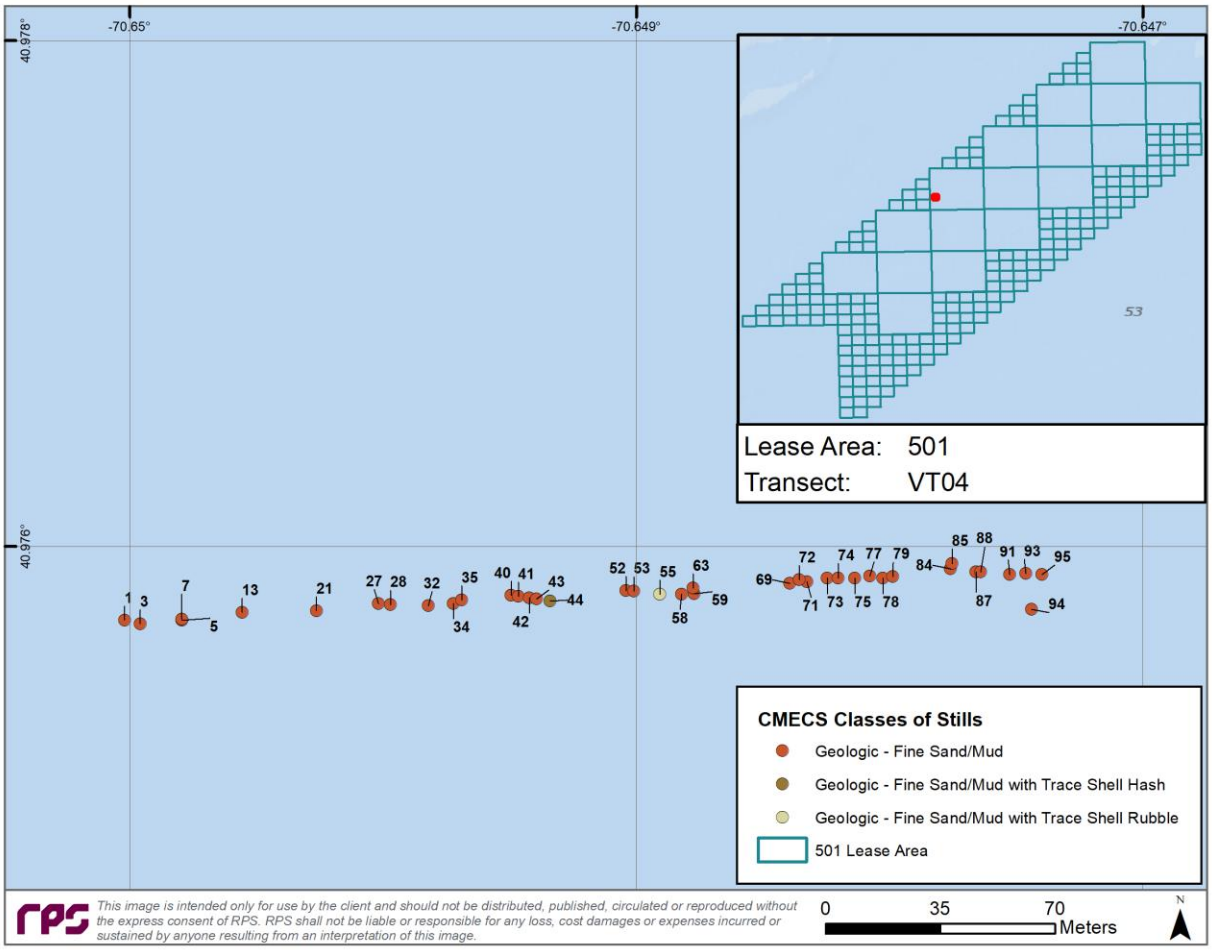


Figure 4 CMECS substrate classification for all viable still images in VT04 (numbers indicate still image ID).

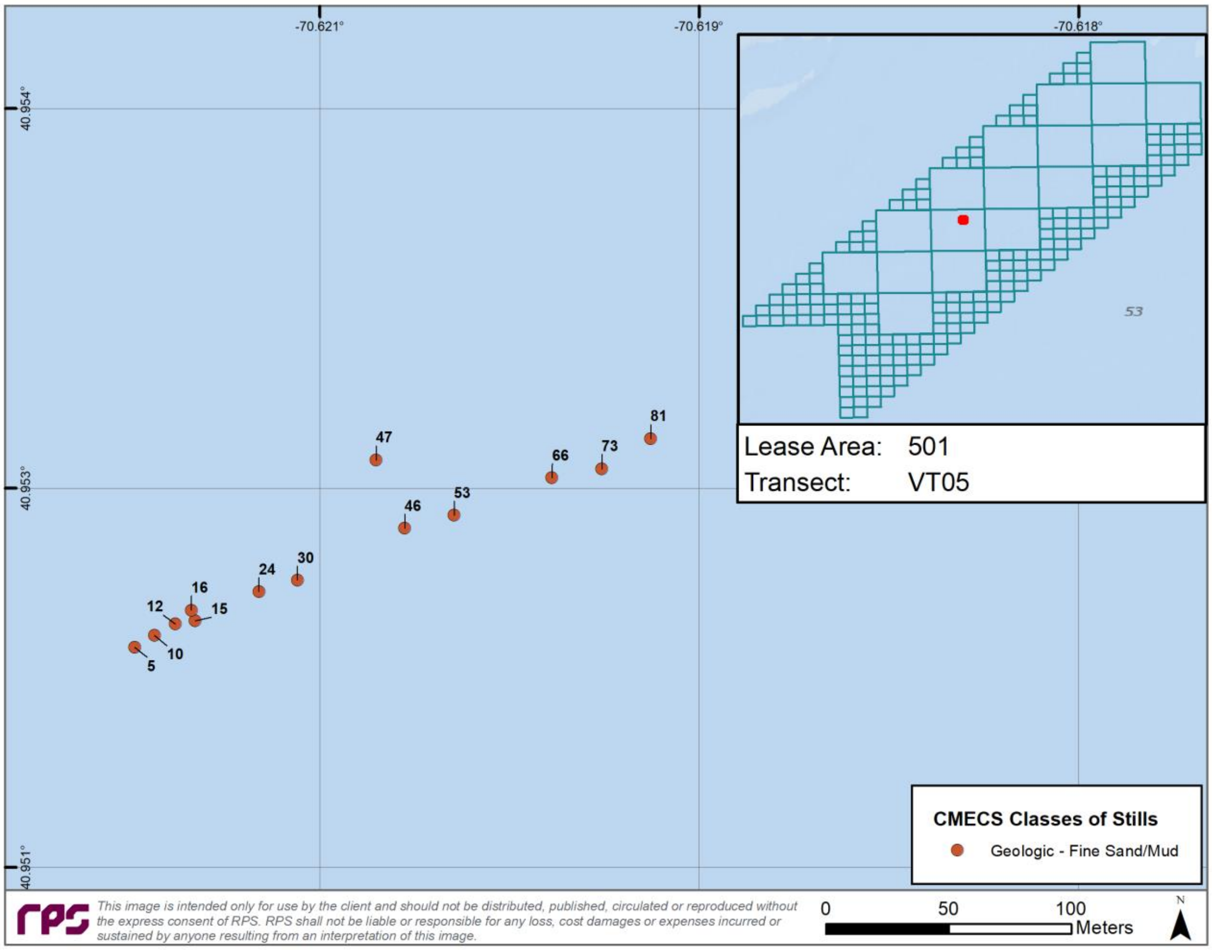


Figure 5 CMECS substrate classification for all viable still images in VT05 (numbers indicate still image ID).

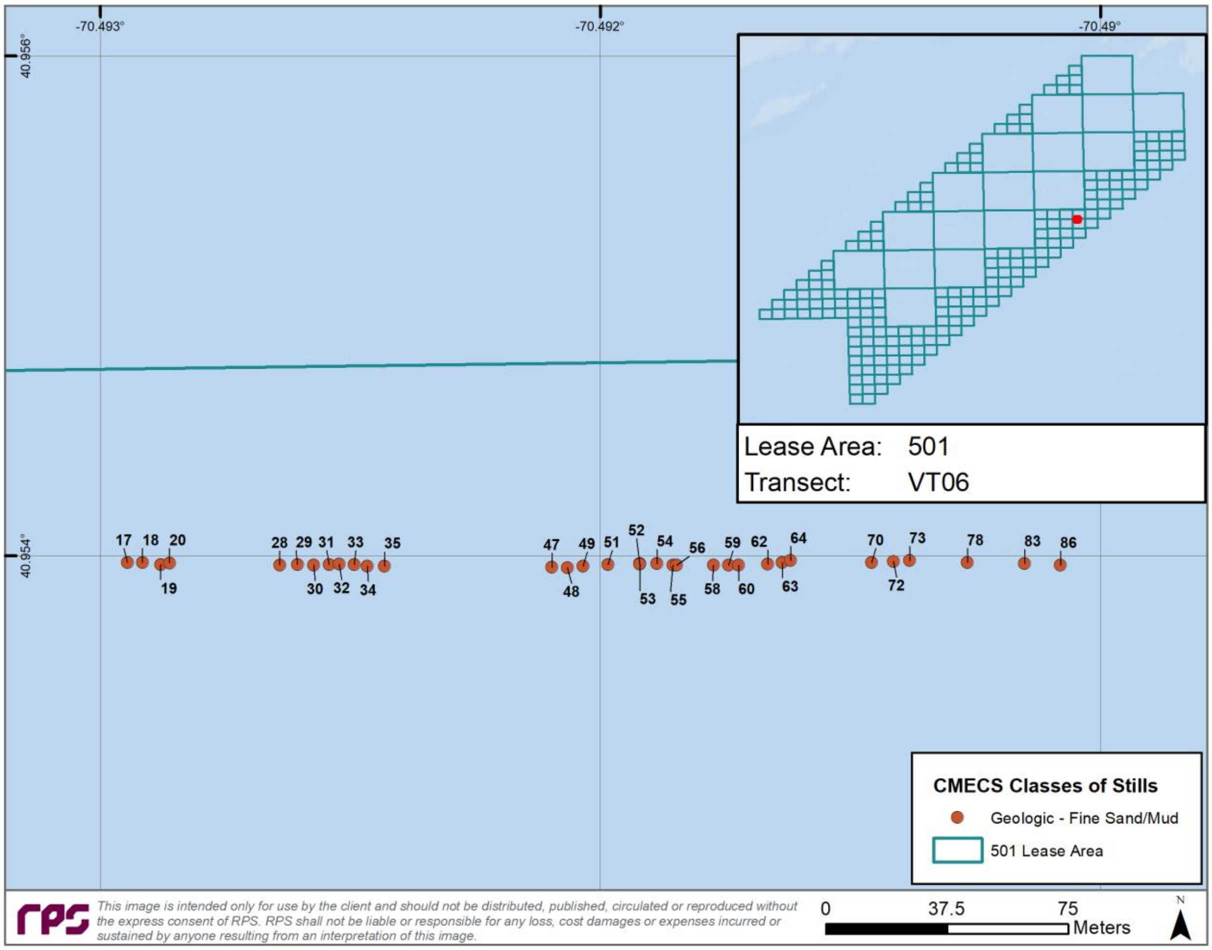


Figure 6 CMECS substrate classification for all viable still images in VT06 (numbers indicate still image ID).

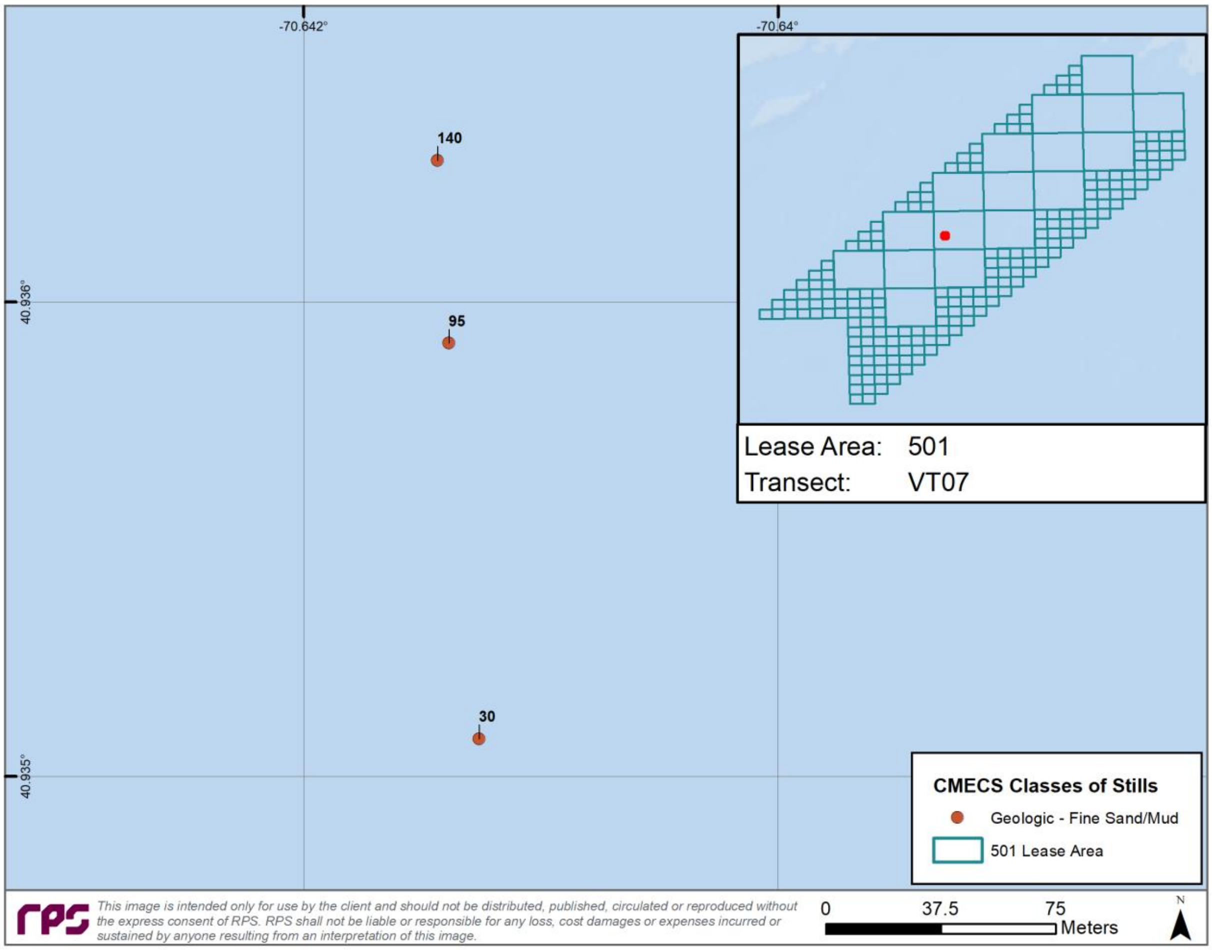
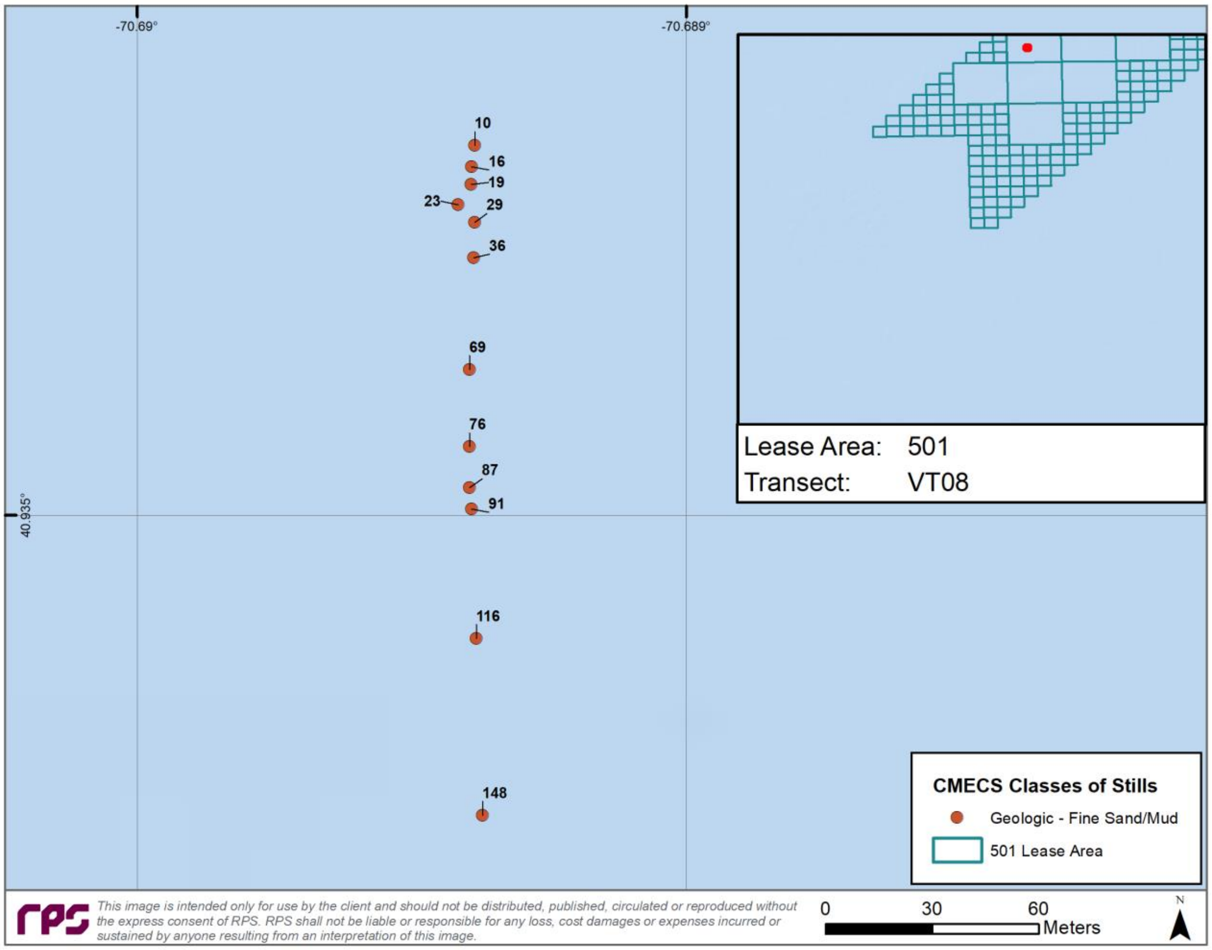


Figure 7 CMECS substrate classification for all viable still images in VT07 (numbers indicate still image ID).



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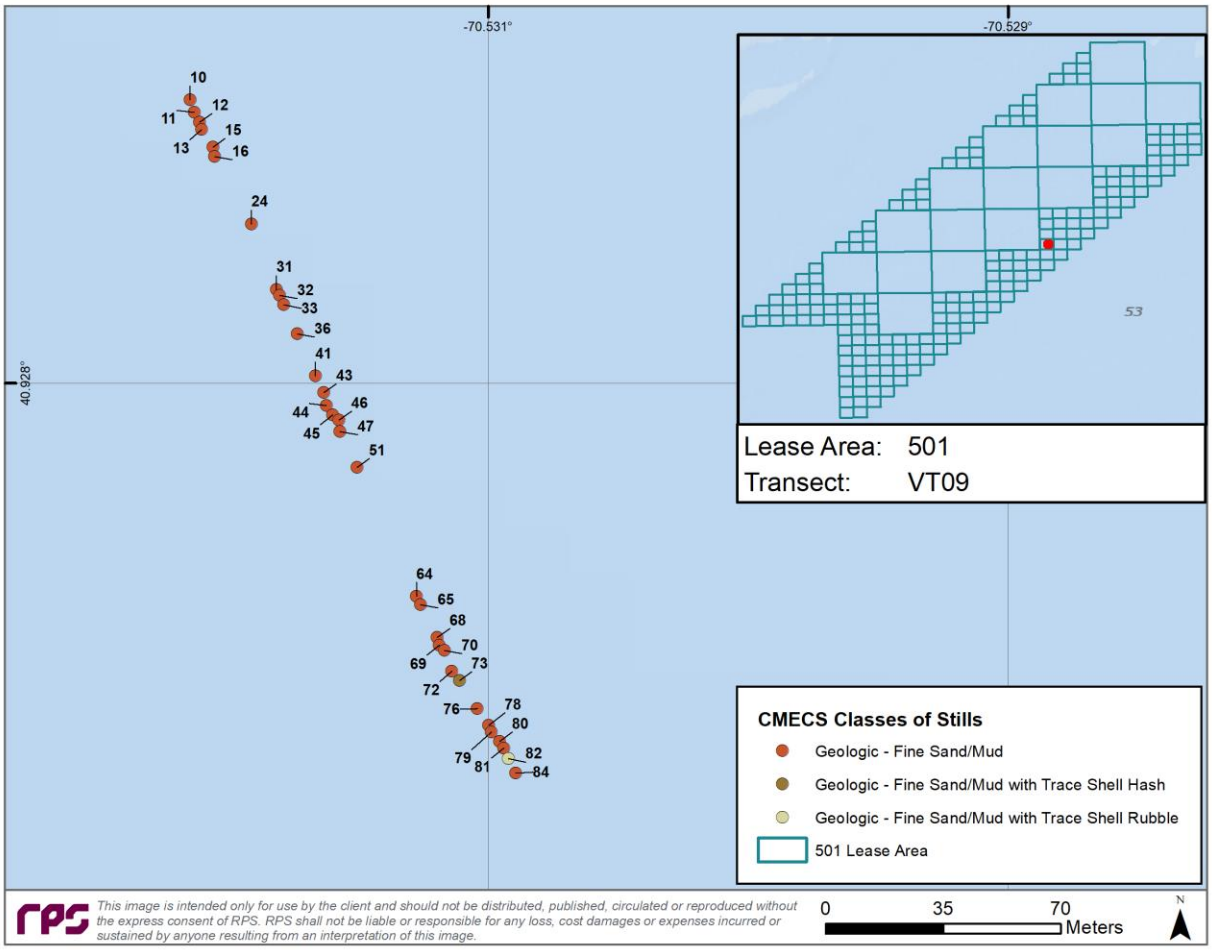

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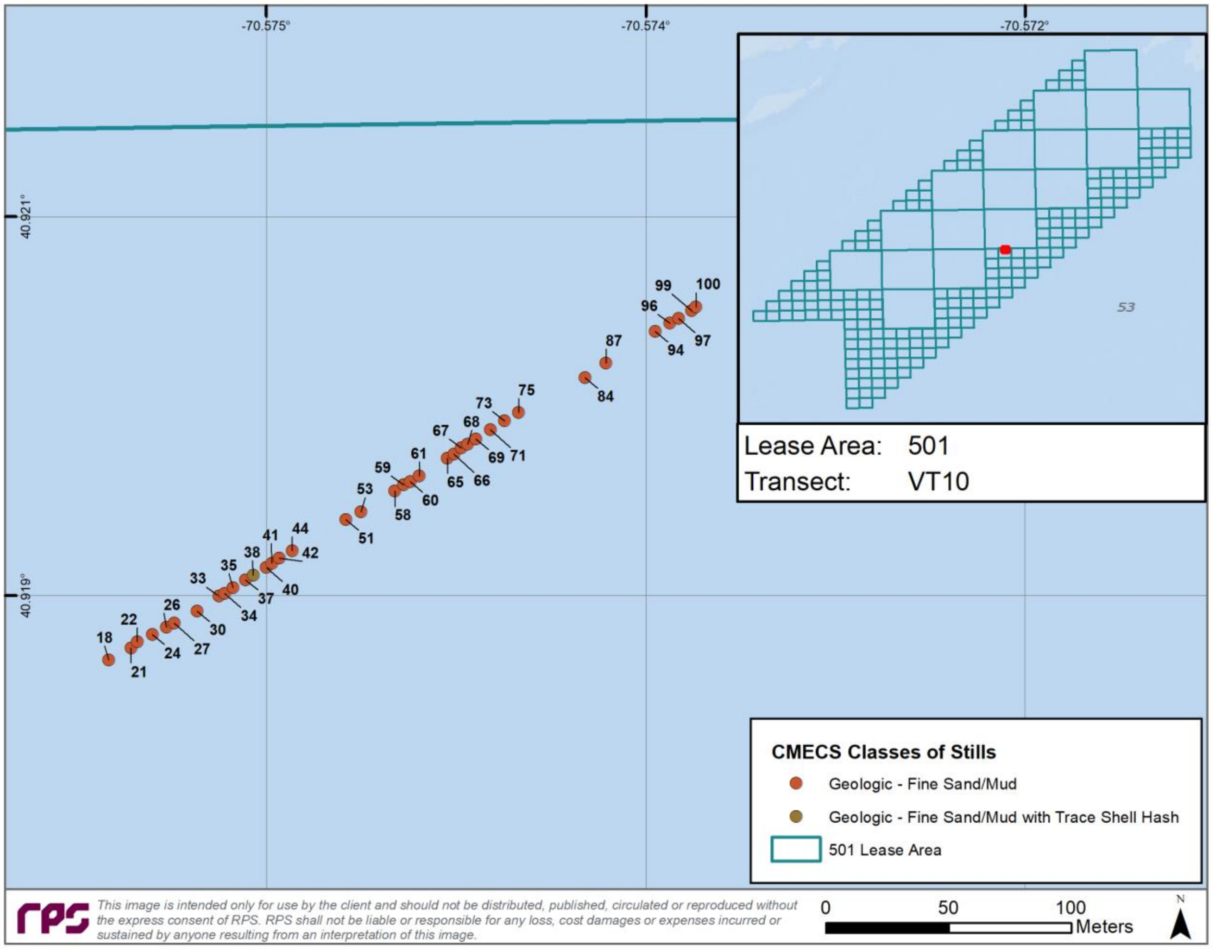

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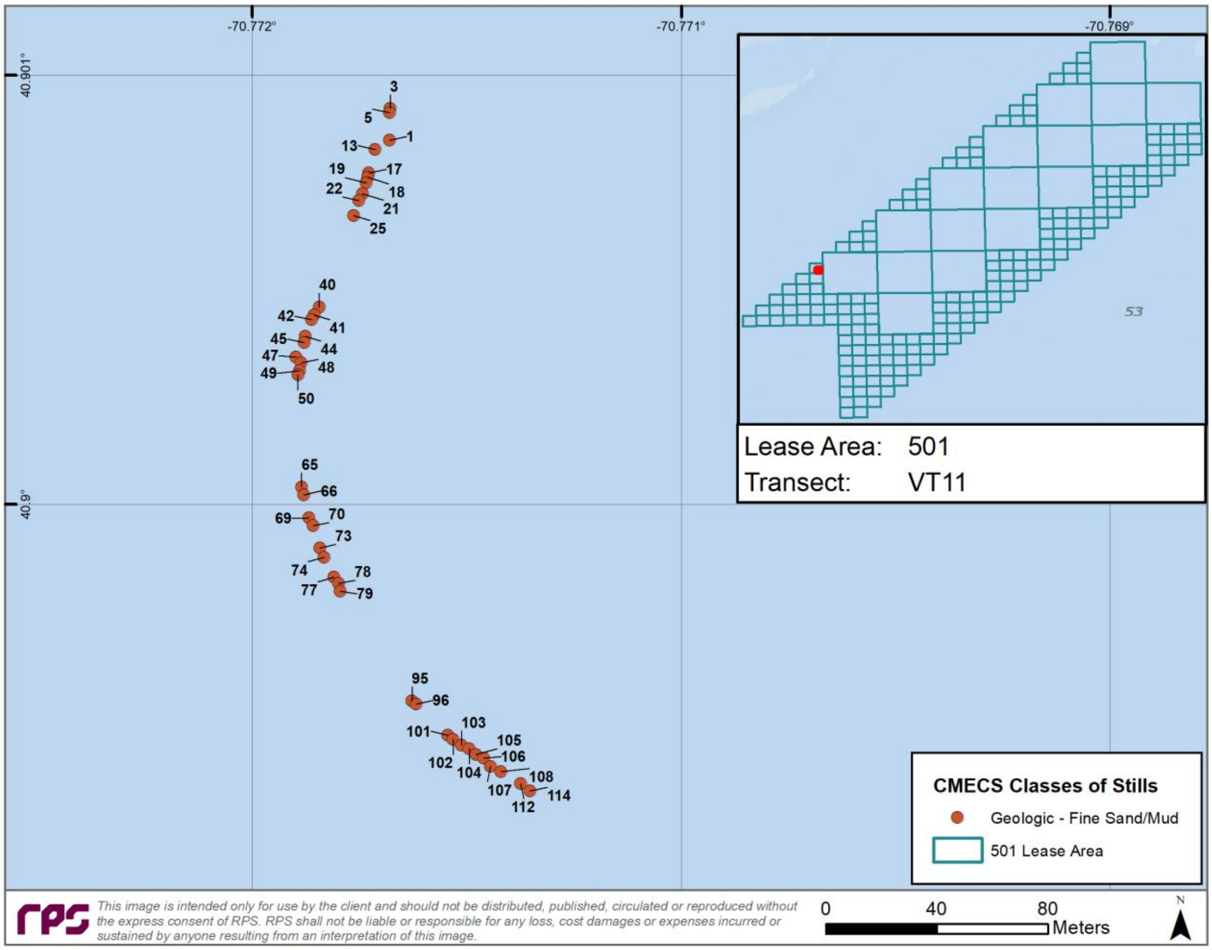

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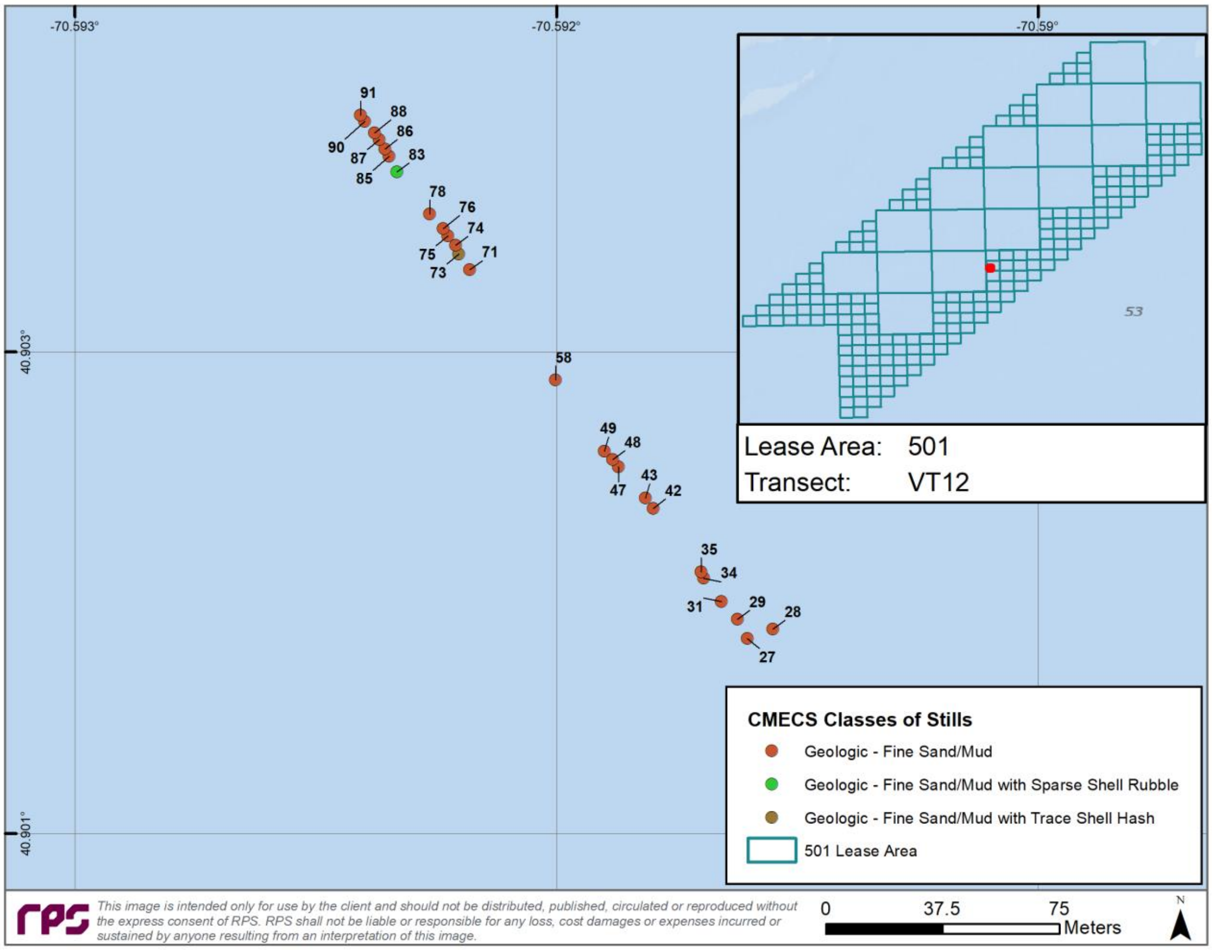

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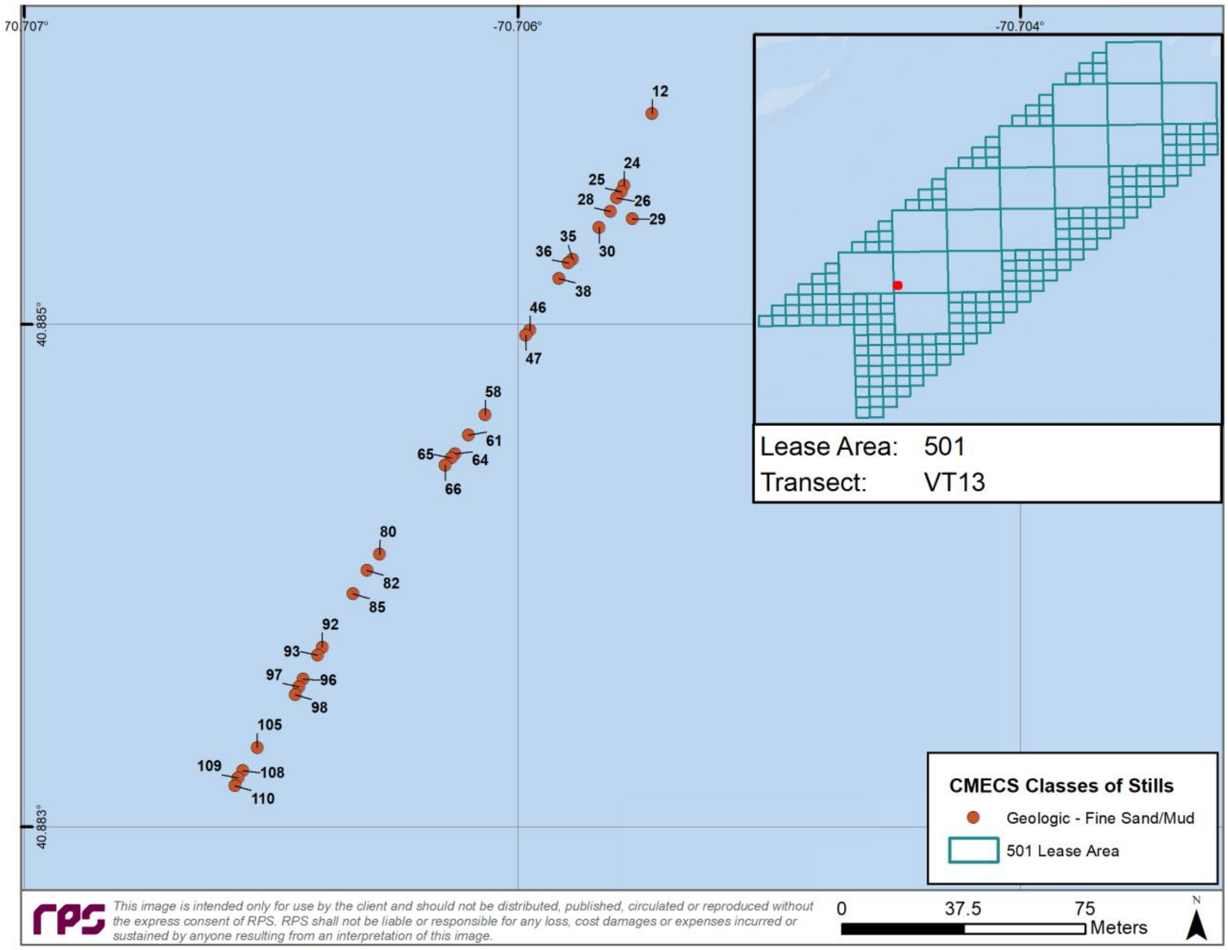

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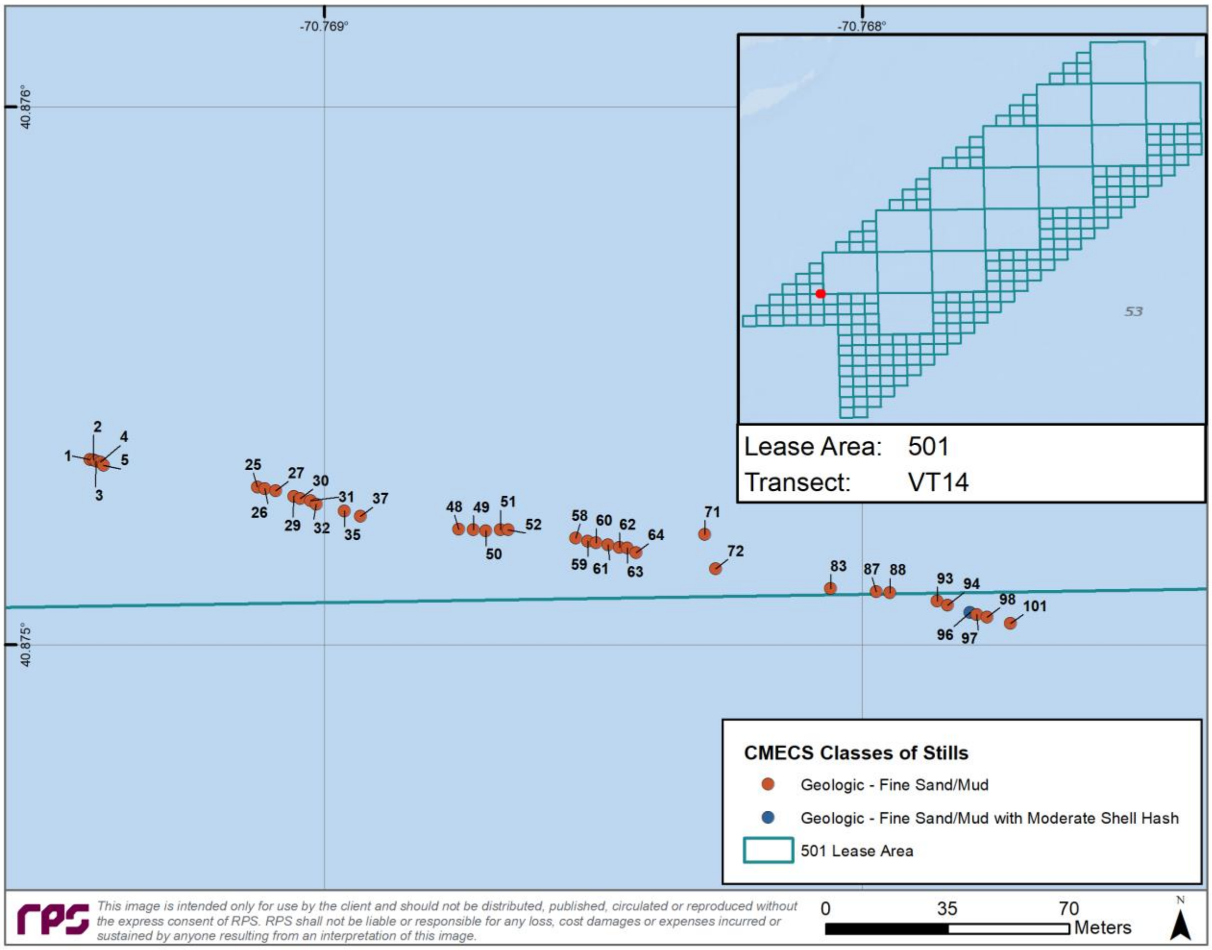

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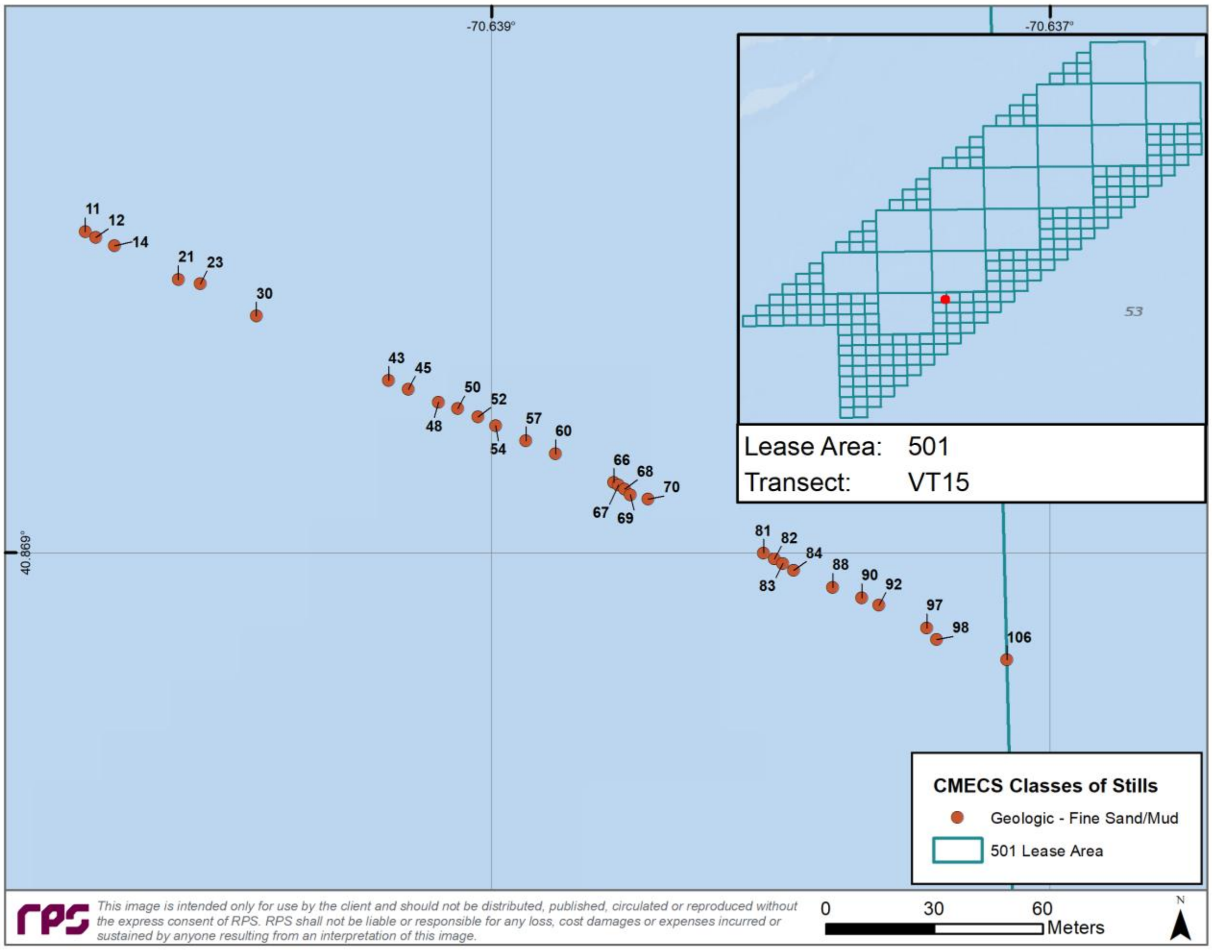

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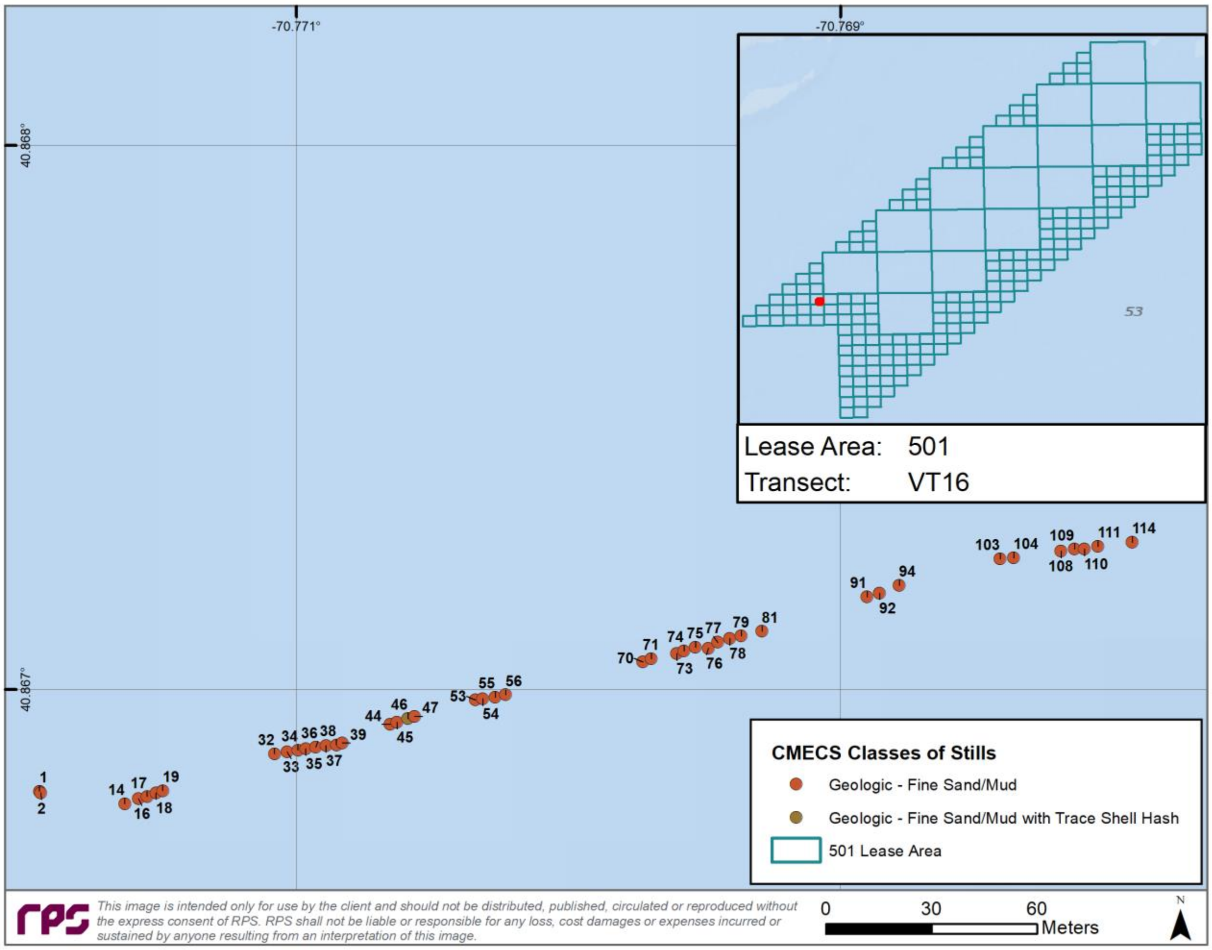

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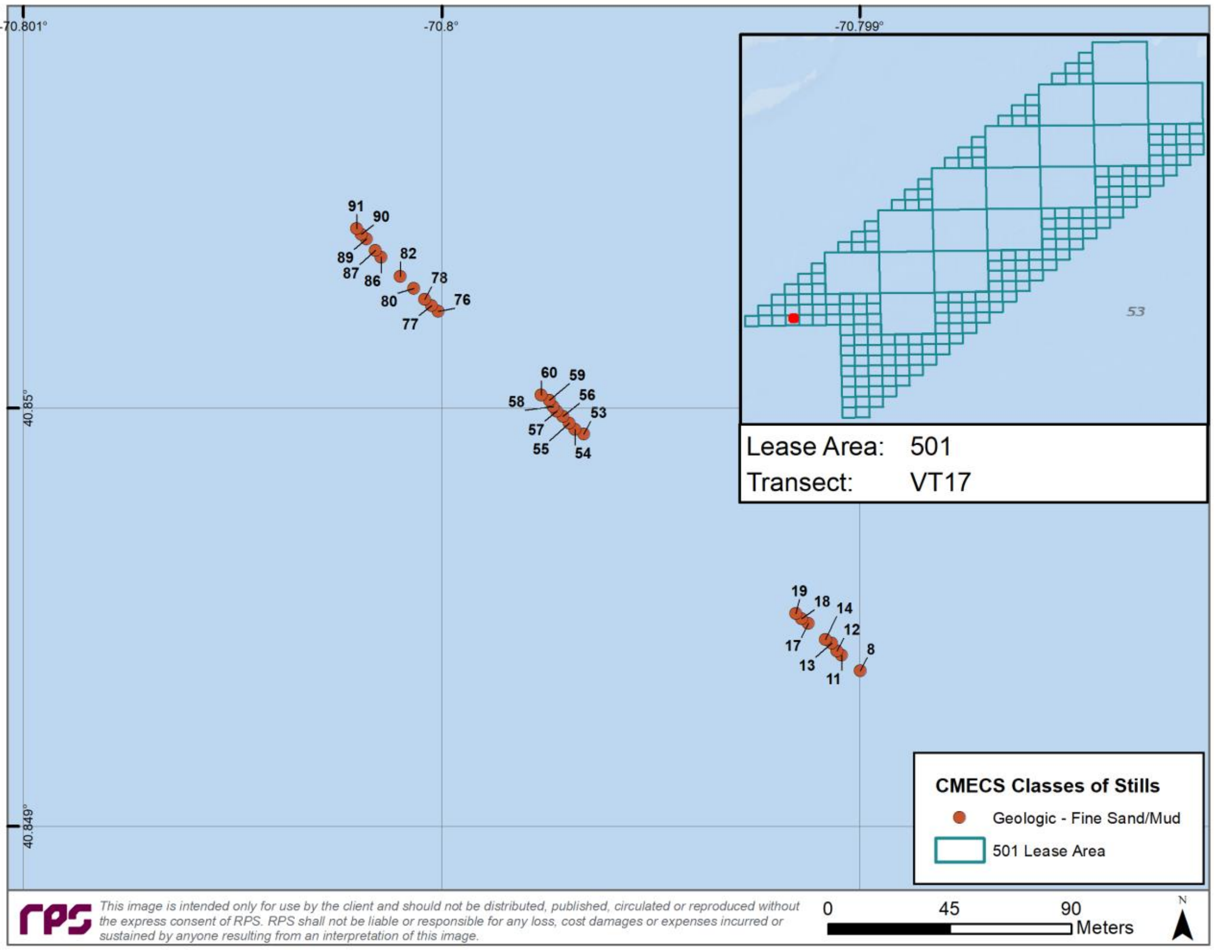

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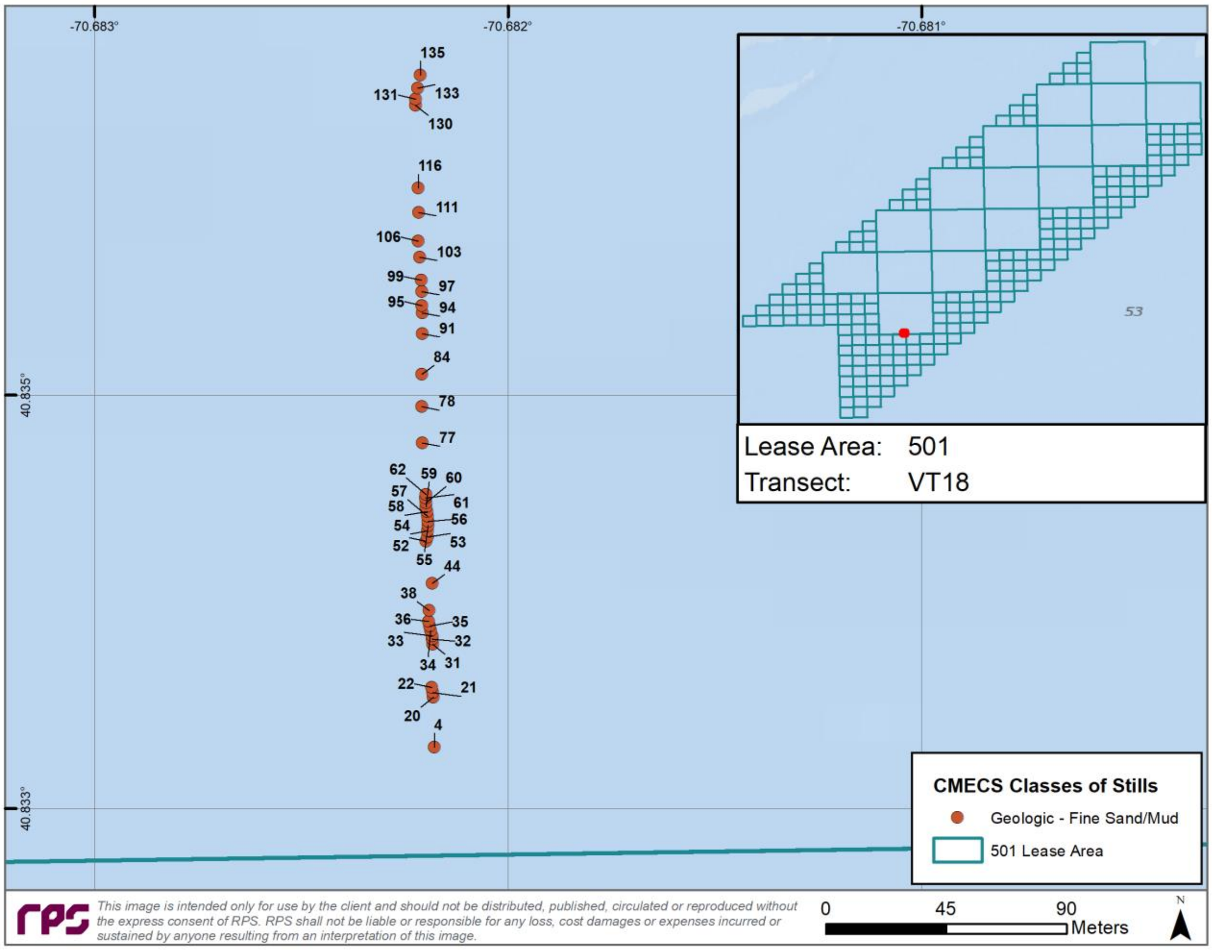

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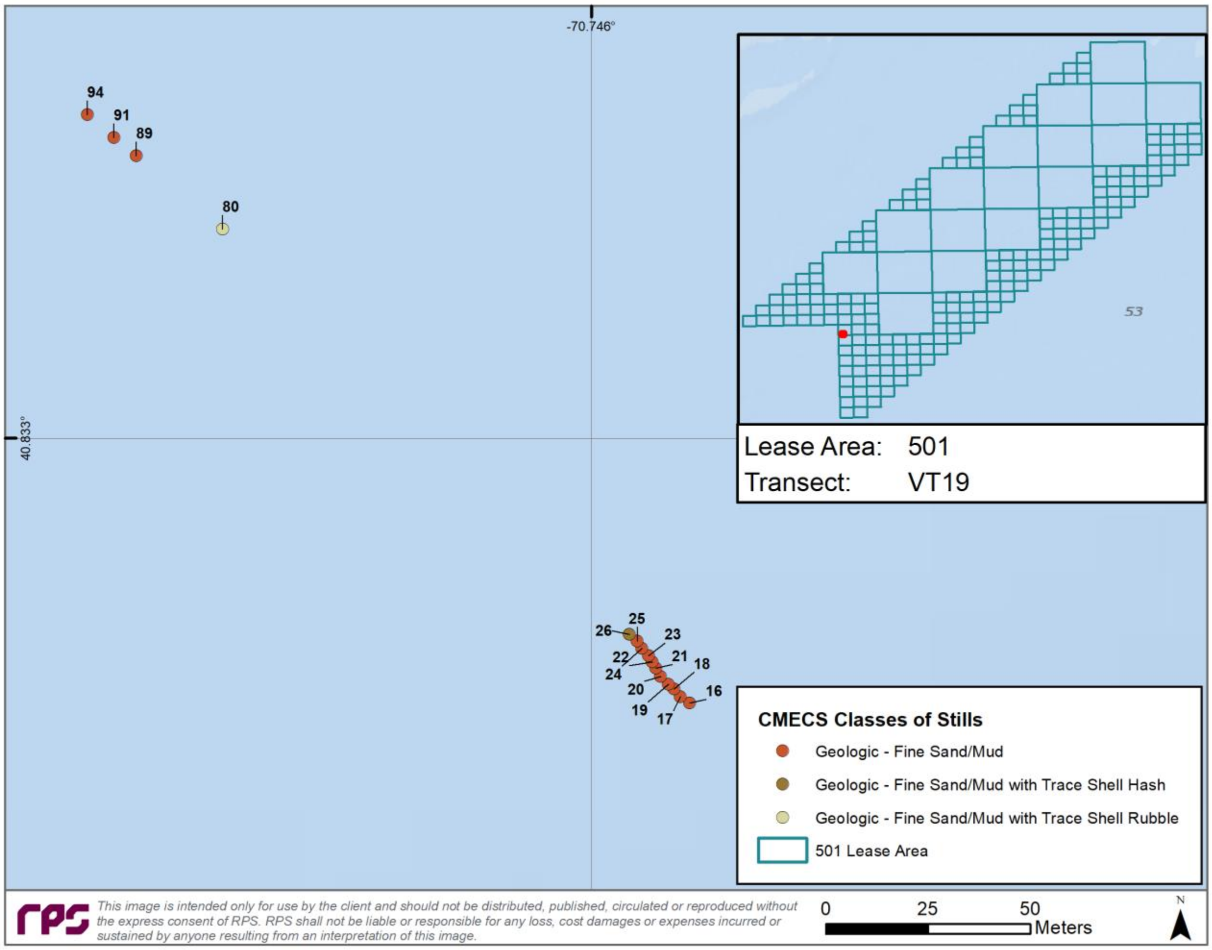

Figure 19 CMECS substrate classification for all viable still images in VT19 (numbers indicate still image ID).

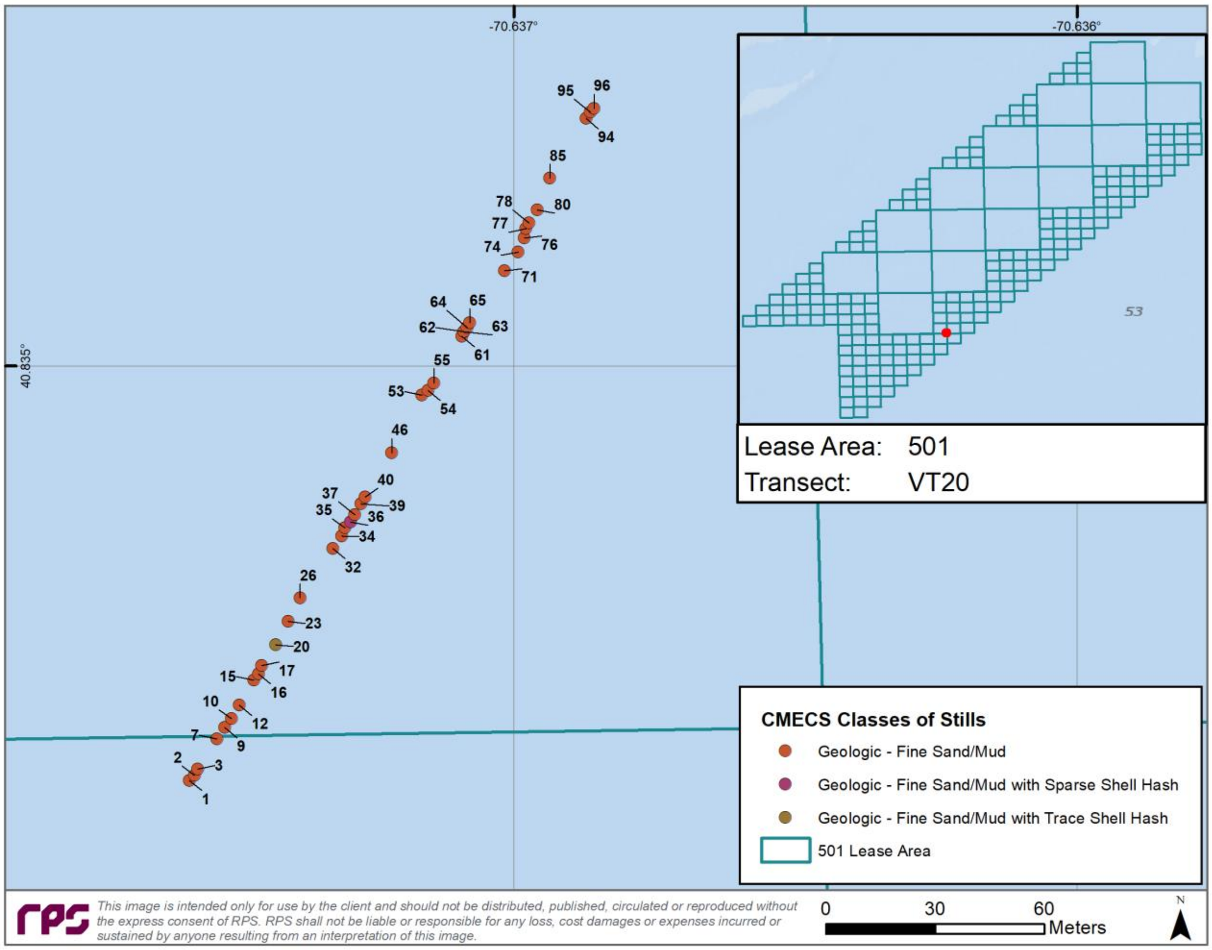

Figure 20 CMECS substrate classification for all viable still images in VT20 (numbers indicate still image ID).

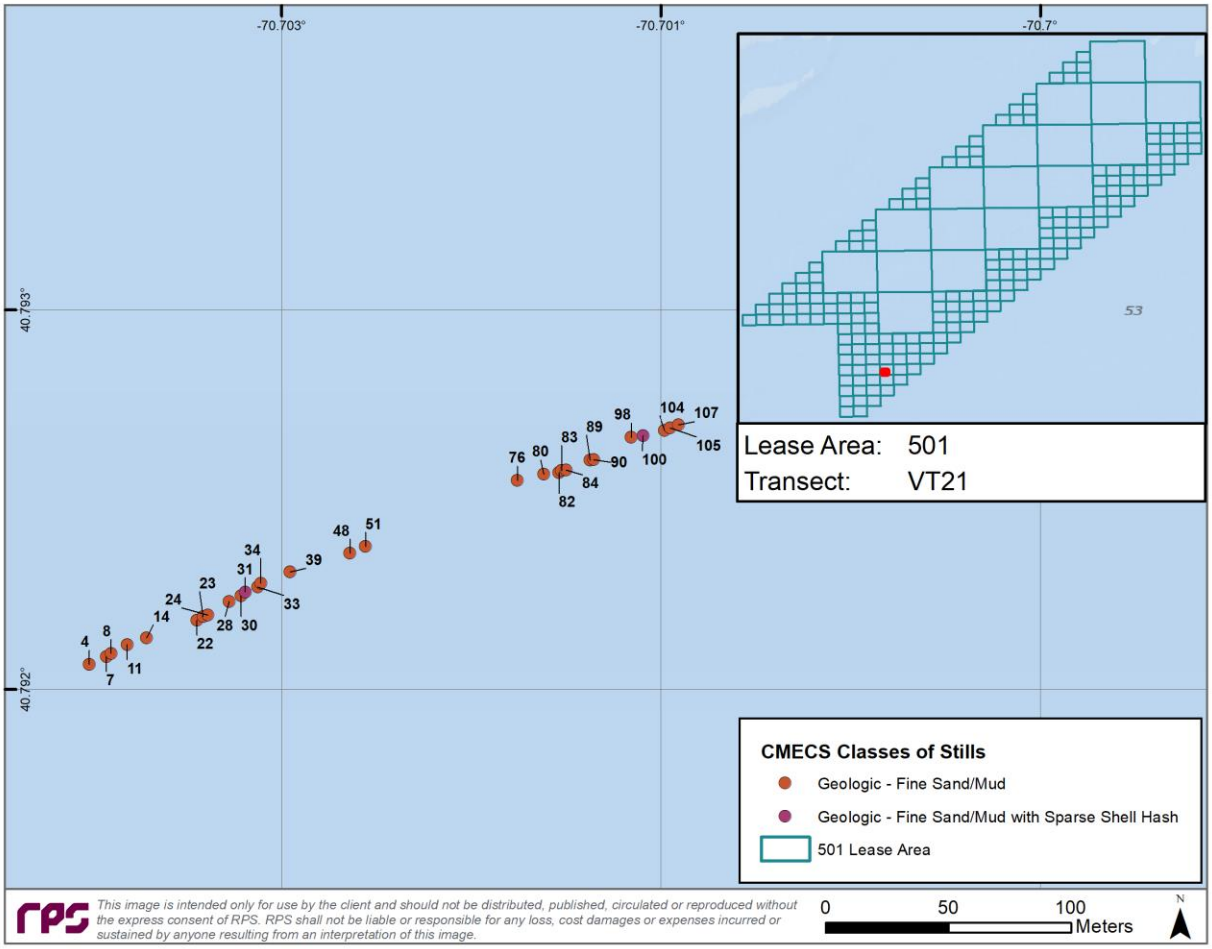

Figure 21 CMECS substrate classification for all viable still images in VT21 (numbers indicate still image ID).

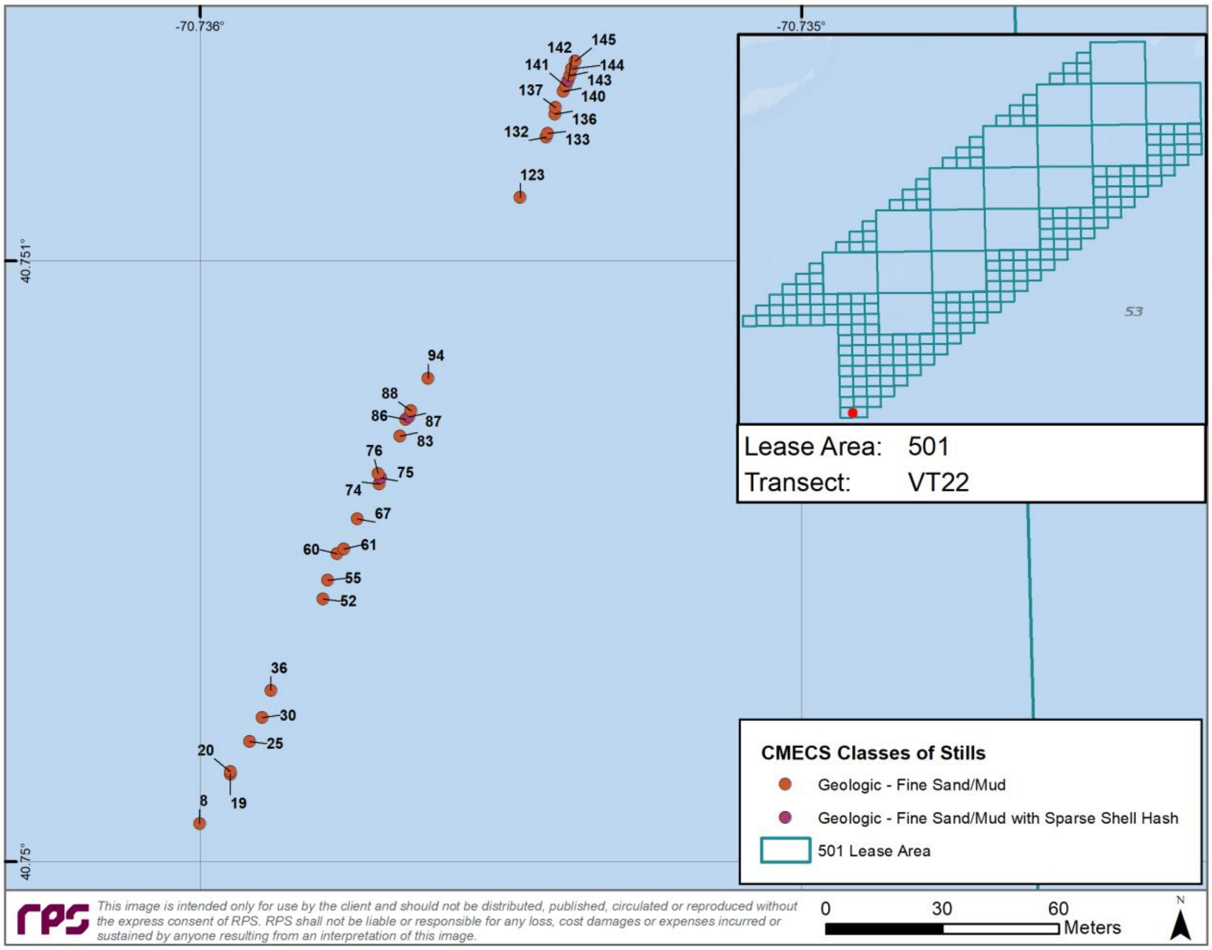

Figure 22 CMECS substrate classification for all viable still images in VT22 (numbers indicate still image ID).

6. RPS 2019 SWDA Benthic Report

BENTHIC INFAUNAL DATA ANALYSIS

Lease Area OCS-A 0501 South Benthic Report

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20-P-208319 Geo SubSea-
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OCS-A 0501 South
Benthic Infaunal Data Analysis

May 22, 2020

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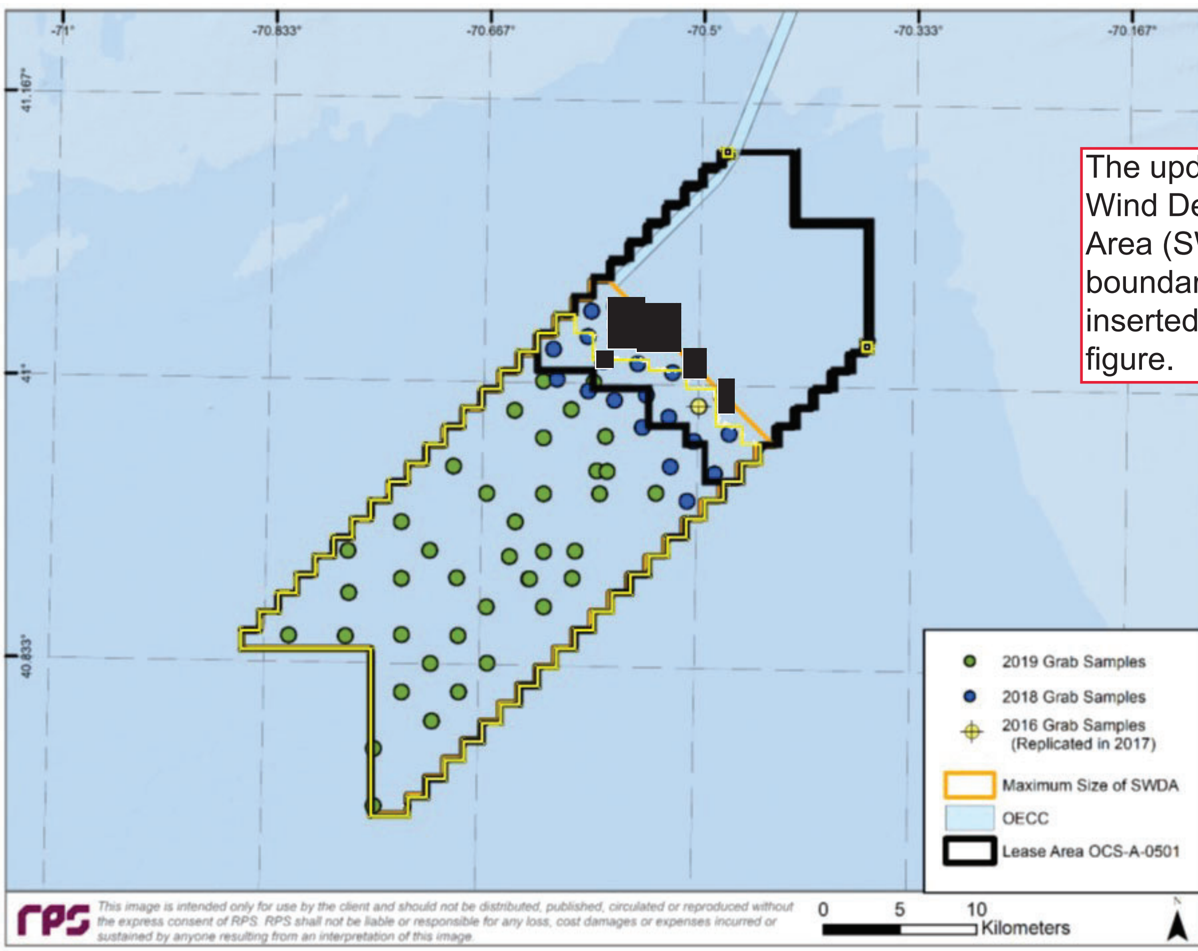
1 INTRODUCTION

RPS was contracted by Geo SubSea LLC to conduct a statistical analysis of benthic macroinfauna grab sample data from the southern portion of Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0501 known as the Southern Wind Development Area (SWDA), offshore of Martha's Vineyard, Massachusetts. 501 South is intended for the generation of renewable energy from offshore wind in two phases comprised of up to 140 total wind turbine generator (WTG) and electrical service platform (ESP) positions. Samples included in this assessment were collected in the fall of 2016 and summer of 2018 as part of Vineyard Wind's first 800 MW project, Vineyard Wind 1 (also known as 501 North) and in the fall of 2019 as part of 501 South in order to characterize the benthic habitat and infaunal communities throughout the SWDA (Figure 1). Habitat classifications for all samples were completed in accordance with the Coastal and Marine Ecological Classifications Standards (CMECS; FGDC, 2012) and recent guidance for mapping fish habitat from National Marine Fisheries Service (NMFS, 2020).



The updated Southern Wind Development Area (SWDA) boundaries have been inserted onto this figure.

Figure 1. Benthic grab locations in the SWDA. Samples were collected in the fall of 2016 and 2019 and the summer of 2018. The 2016 sample was replicated in 2018 and indicated in the map as an orange point overlaid on a blue point to represent the 2018 sample.

1.1 2016 Field Survey

Benthic macroinfaunal sampling was conducted on November 10, 2016 by Geo Subsea LLC in the Vineyard Wind 1 Wind Development Area (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). However, only one sample from this survey overlapped with the SWDA and was included in these analyses. This location (GB1) was also replicated in the 2018 survey (GB265). Additional information on the 2016 survey can be found in ESS (2017) and RPS (2018).

1.2 2018 Field Survey

Marine benthic habitat sampling was conducted in the OCS-A 0501 lease area by CSA Ocean Sciences, Inc. (CSA) and Alpine Ocean Seismic Survey, Inc. (Alpine) between June 21 and July 5, 2018. Infaunal and grain-size samples were collected at 67 sites in the WDA with a 0.1 m^2 Day Grab Sampler (CSA, 2018). Lab processing and taxonomic identification of all infaunal samples were conducted by EcoAnalysts, Inc. (EcoAnalysts) while grain size samples were analyzed by TerraSense. The abundance of taxa collected and identified in the samples was reported as number of organisms per 0.008 m^2, corresponding to the surface area of the subsample corer used. Of the 67 samples collected in the WDA during the 2018 survey, 24 occurred within the SWDA and were included in these analyses. For the full report on the 2018 survey and data analysis refer to CSA (2018) and RPS (2018).

1.3 2019 Field Survey

Benthic sampling was conducted at 40 stations within the SWDA by Alpine and RPS from November 3-4, 2019. Benthic grab samples were acquired using a 0.1 m^2 Day Grab Sampler owned by Alpine Ocean. Lab processing and taxonomic identification of all infaunal samples was conducted by ESS Group, Inc. As in the 2018 survey, the abundance of taxa collected and identified in the samples was reported as number of organisms per 0.008 m^2, corresponding to the surface area of the subsample plexiglass corer used. Grain size samples were analyzed by TerraSense using the American Society for Testing and Materials (ASTM) soil classification system standards D2487 and D2488 (ASTM, 2017 a;b). For the full survey and benthic data analysis report for the 2019 benthic survey refer to RPS (2020).

2 BENTHIC DATA ANALYSIS METHODS AND RESULTS

2.1 Benthic Infaunal Data Post-Processing

The benthic infaunal community analysis was based on the laboratory results provided by EcoAnalysts (2018) and ESS (2016, 2019) for the 65 grab samples collected in the SWDA. Infaunal community statistics were calculated using species and abundance estimates in each sample, which were reported as count per 0.008 m^2 (area of subsample core). Community composition parameters included: total abundance, number of phyla, number of taxa, Margalef's Richness Index, Shannon Diversity Index, and Pielou's Index of Evenness for each station and within the lease area.

2.1.1 Taxonomic Composition

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

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. Because some taxa were not identified to the species level, we used abundance data for organisms identified to the LPTL but no further than family. Therefore, this modified the indices to be taxonomic richness, evenness, and diversity indices. Taxonomic richness is the number of unique species or taxonomic groups represented in an area of interest. In this assessment, taxonomic richness was calculated using Margalef's Richness Index (Formula 1) for each station and lease area to acquire sample and average richness indices.

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

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

Where:

S= the number of unique taxa

n= the total number of individuals in the sample

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

The diversity index for a community further refines taxonomic richness by considering the proportion of each unique taxa. The Shannon Diversity Index (H'; Formula 2) is calculated using the number of each taxa, the proportional abundance of each taxa relative to the total number of individuals, and the sum of the proportions. This index was used to assess diversity of each station and lease area. The diversity index (H') increases with increasing taxonomic richness and evenness.

Formula 2. H'- Shannon Diversity Index.

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

Where:

p_i = the proportion of individuals belonging to the taxa i

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

Evenness of a community refers to the similarity in abundances of different taxa comprising a population or sample. Pielou's Index of Evenness includes H' (Shannon-Weiner Diversity Index) in its calculation.

Formula 3. J'- Pielou's Index of Evenness.

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

Where:

H' = the Shannon- Weiner Diversity Index

H_{Max} = the maximum possible value of H', where each taxon occurs in equal abundances.

$$H_{Max} = \ln(s)$$

Where: s = Number of taxa

Interpretation: J' is constrained between 0 and 1. The greater the value of J', the more evenness in the sample.

2.1.3 Substrate Classification

Sediment samples for grain-size analyses were collected in 2018 and 2019. Grain size samples were analyzed by TerraSense using the American Society for Testing and Materials (ASTM) soil classification system standards D2487 and D2488 (ASTM, 2016a;b). Substrates at each grab site were classified in accordance with the Coastal and Marine Ecological Classifications Standards (CMECS; FGDC, 2012) and recent guidance for mapping fish habitat from National Marine Fisheries Service (NMFS, 2020;Table 1; Table 2; Figure 2). No sediment samples for grain-size analysis were collected in 2016; therefore, substrate classification was determined using field notes and visual assessment of the collected grab sample (see COP Appendix II-M). Five substrate types were observed in the SWDA and included: Muddy Sand, Fine/Very Fine Sand, Sandy Mud, Medium Sand, and Very Coarse/Coarse Sand; Figure 3).

Table 1. Benthic grab substrate classifications under CMECS/NMFS guidelines.

Substrate Group	Substrate Subgroup	CMECS Bin Size
Muddy Sand	None	**50 to <90% Sand, <5% Gravel**
Sandy Mud	None	**10 to <50% Sand, <5% Gravel**
Sand:		**>90% Sand**
	Very Coarse/Coarse Sand	0.5 – < 2 mm
	Medium Sand	0.25 – < 0.5 mm
	Fine/Very Fine Sand	0.0625 – < 0.25 mm

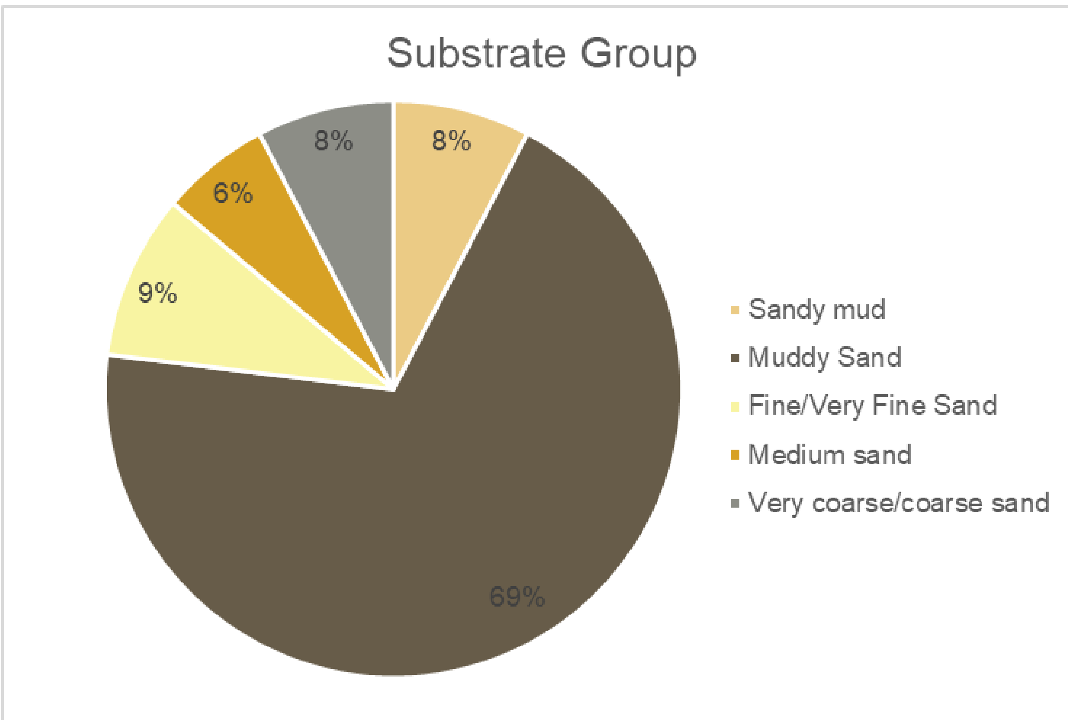


Figure 2. Percent of each substrate group represented in the 65 benthic grab samples located in the SWDA.

The updated Southern Wind Development Area (SWDA) boundaries have been inserted onto this figure.

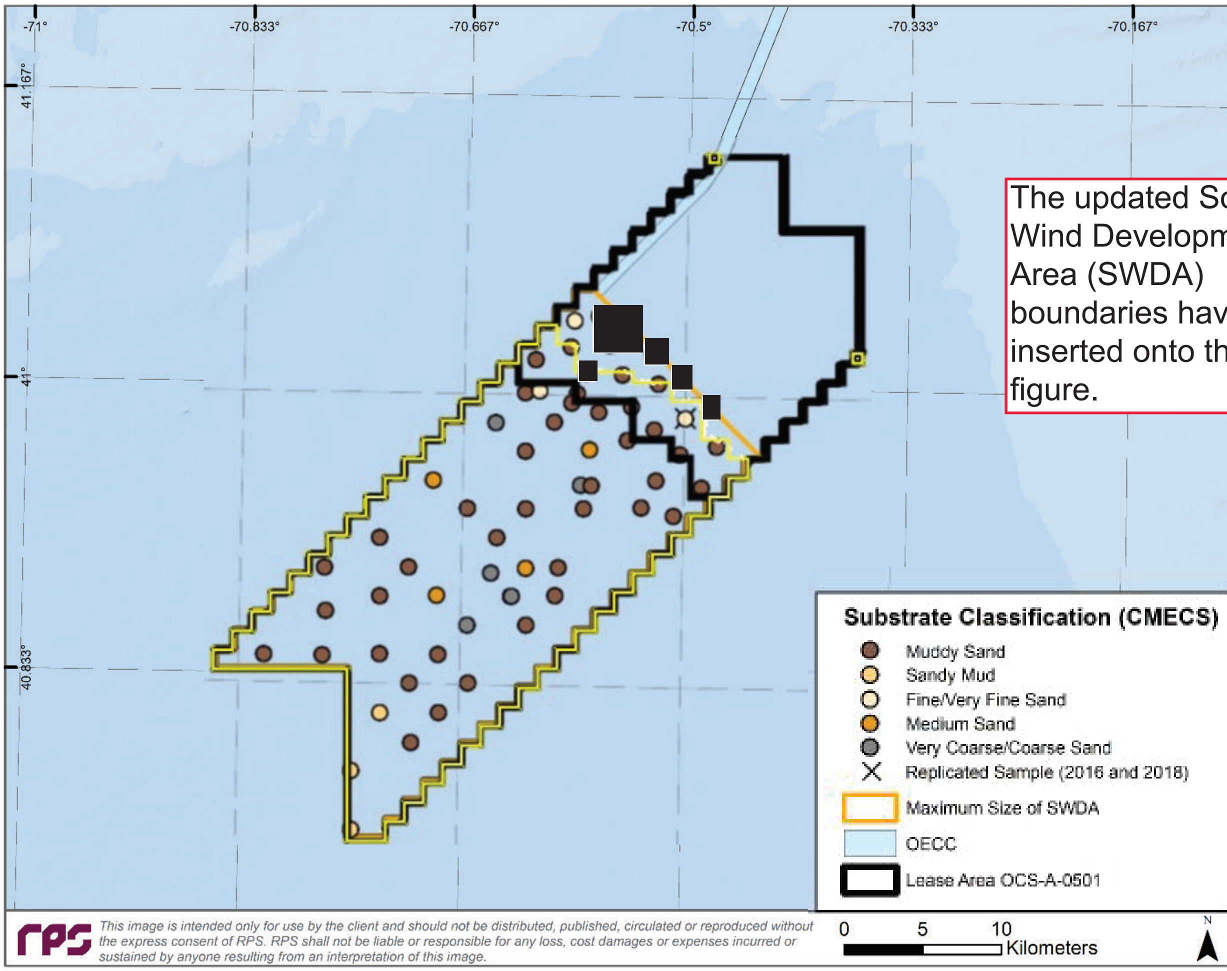


Figure 3. Map of the Southern Wind Development Area with sample points color coded based on substrate type. The station sampled in both 2016 and 2018 is deliniated with a X. The substrate was classified as Fine/Very Fine Sand in both years.

Table 2. Substrate classifications for benthic grab samples collected in the SWDA.

2016		2018		2019	
Site	**Substrate**	**Site**	**Substrate**	**Site**	**Substrate**
16-GB1	Fine/Very Fine Sand	18-GB252	Fine/Very Fine Sand	19-GB01	Very Coarse/Coarse Sand
		[redacted]	[redacted]	19-GB02	Muddy Sand
		[redacted]	[redacted]	19-GB03	Very Coarse/Coarse Sand
		[redacted]	[redacted]	19-GB04	Muddy Sand
		[redacted]	[redacted]	19-GB05	Muddy Sand
		18-GB257	Muddy Sand	19-GB06	Muddy Sand
		18-GB258	Muddy Sand	19-GB07	Medium sand
		[redacted]	[redacted]	19-GB08	Muddy Sand
		18-GB260	Muddy Sand	19-GB09	Muddy Sand
		18-GB261	Muddy Sand	19-GB10	Muddy Sand
		[redacted]	[redacted]	19-GB11	Muddy Sand
		[redacted]	[redacted]	19-GB12	Muddy Sand
		18-GB265	Fine/Very Fine Sand	19-GB13	Medium Sand
		18-GB266	Muddy Sand	19-GB14	Sandy Mud
		18-GB267	Muddy Sand	19-GB15	Sandy Mud
		18-GB268	Muddy Sand	19-GB16	Very Coarse/Coarse Sand
		18-GB269	Fine/Very Fine Sand	19-GB17	Muddy Sand
		18-GB270	Muddy Sand	19-GB18	Muddy Sand
		18-GB271	Muddy Sand	19-GB19	Muddy Sand
		18-GB273	Muddy Sand	19-GB20	Muddy Sand
		18-GB274	Muddy Sand	19-GB21	Muddy Sand
		18-GB275	Muddy Sand	19-GB22	Sandy Mud
		18-GB276	Muddy Sand	19-GB23	Muddy Sand
				19-GB24	Very Coarse/Coarse Sand
				19-GB25	Medium Sand
				19-GB26	Muddy Sand
				19-GB27	Muddy Sand
				19-GB28	Muddy Sand
				19-GB29	Muddy Sand
				19-GB30	Medium Sand
				19-GB31	Muddy Sand
				19-GB32	Muddy Sand
				19-GB33	Very Coarse/Coarse Sand
				19-GB34	Muddy Sand
				19-GB35	Muddy Sand
				19-GB36	Muddy Sand
				19-GB37	Muddy Sand
				19-GB38	Muddy Sand
				19-GB39	Sandy Mud
				19-GB40	Sandy Mud

2.1.4 Results

A single sample collected for Vineyard Wind 1 in the fall of 2016 falls within the SWDA and was included in these analyses. Within the grab sample (16-GB1) there were 85 individual organisms (per 0.008 m^2) from 19 unique taxa and 6 phyla (Table 3). Most of the organisms collected belonged to the phyla Annelida (62%) and Nematoda (21%), while the most unique taxa were from Annelida (42%) and Arthropoda (27%; Figure 4).

In the field survey conducted in the summer of 2018, 24 benthic grab samples were collected in the SWDA (18-GB252 through -GB277) and contained a total of 4,464 individual infaunal organisms (per all 0.008 m^2 core samples) from 68 unique taxa (family or LPTL) and nine plyla (Table 3). Organisms from the phyla Annelida and Arthropoda accounted for 90% of the total abundance and 65% of all unique taxa (Figure 54).

Benthic grab samples were collected for infaunal analysis at 40 sites throughout the SWDA (19-GB01 through -GB40) in the fall of 2019. The grab samples yielded a total of 2,641 individual organisms (per all forty 0.008 m^2 core samples) from five (5) unique phyla and 54 families (or LPTL; Table 3). The phyla Arthropoda and Annelida dominated the samples in both abundance and diversity, representing 94% of all organisms and 85% of all unique taxa (Figure 6).

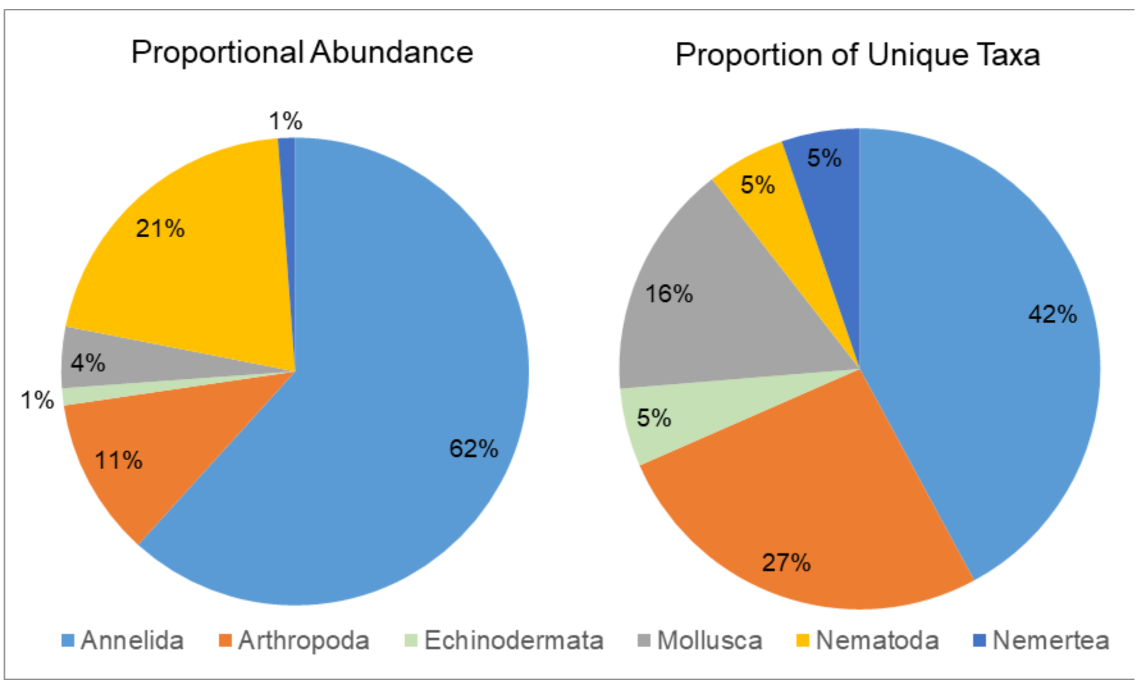


Figure 4. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum collected in the benthic grab sample (16-GB1) collected in 2016 in SWDA . Results presented as percentage of total.

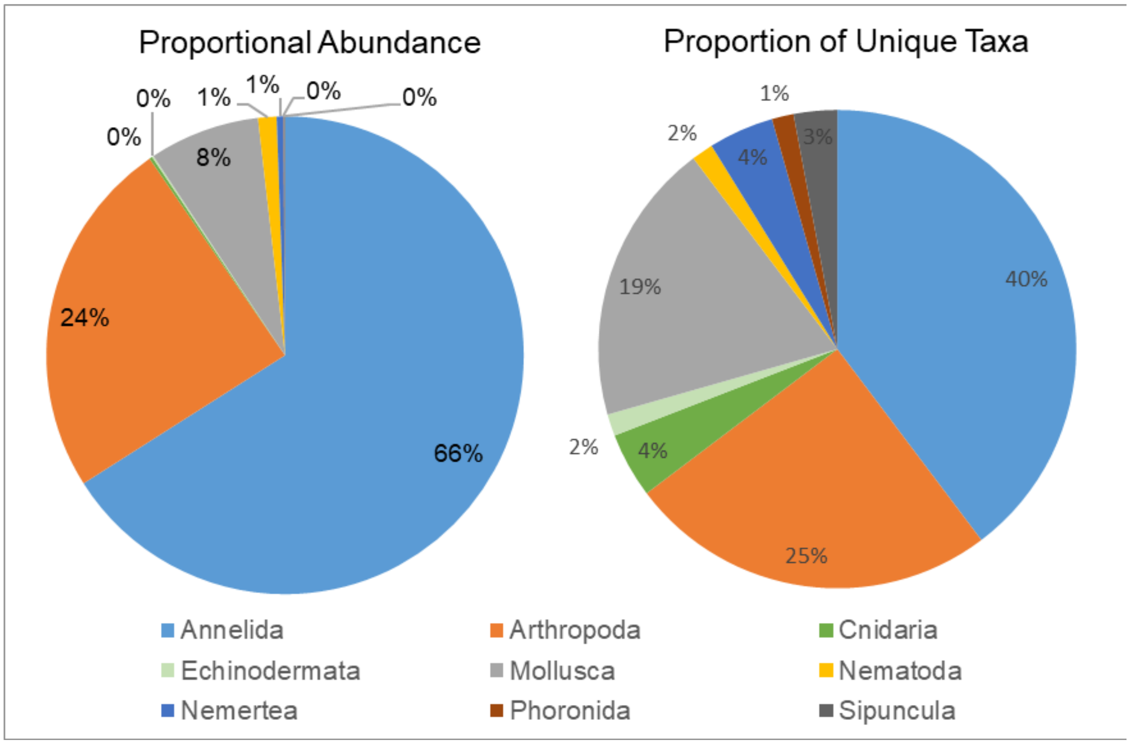


Figure 5. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum collected in all (24) benthic grab samples collected in 2018 in SWDA . Results presented as percentage of total.

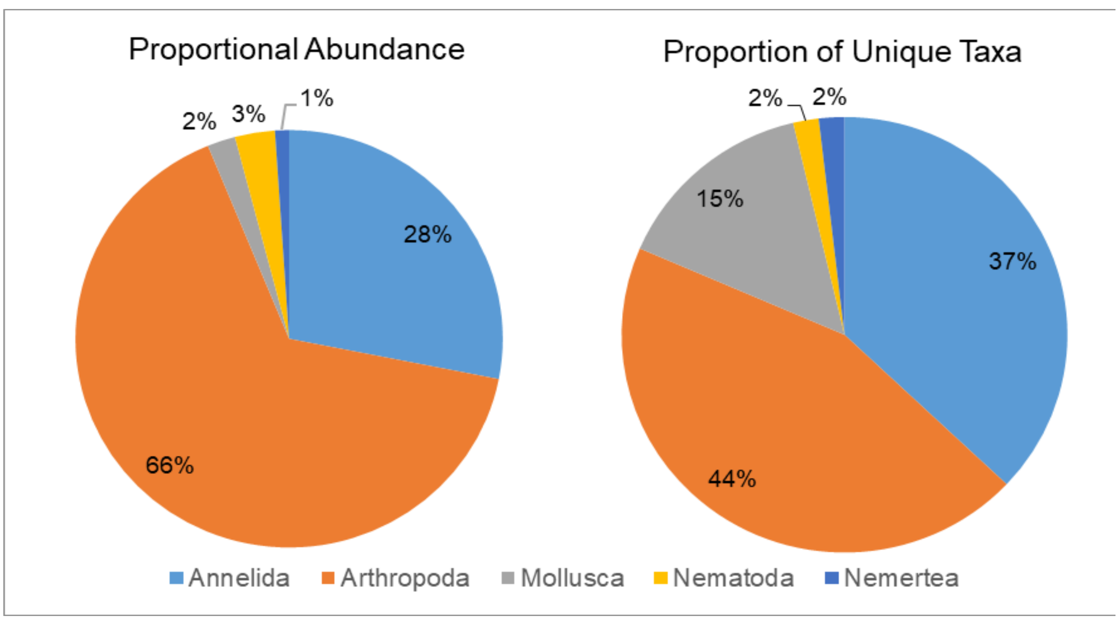


Figure 6. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum collected in all (40) benthic grab samples collected in 2019 in SWDA. Results presented as percentage of total.

Table 3. Phyla present in the benthic grab samples collected in the SWDA during the 2016, 2018, and 2019 benthic surveys.

Sample Year	Phyla	Abundant Taxonomic Groups (common names)	Density (Abundance per 0.008 m^2 samples)	Number of Taxa
2016 1 sample	Annelida	Polychaete worms	52	8
	Arthropoda	Amphipods	9	5
	Echinodermata	Sand dollars	1	1
	Mollusca	Marine clams	4	3
	Nematoda	Nematode worms	18	1
	Nemertea	Ribbon worms	1	1
	Total		85	19
2018 24 samples	Annelida	Polychaete worms	2,946	27
	Arthropoda	Amphipods	1,089	17
	Cnidaria	Sea anemones	9	3
	Echinodermata	Sand dollars	5	1
	Mollusca	Nut clams	334	13
	Nematoda	Nematode worms	56	1
	Nemertea	Ribbon worms	20	3
	Phoronida	Horseshoe worms	1	1
	Sipuncula	Sipunculid worms	4	2
	2018 Total		4,464	68
2019 40 samples	Annelida	Polychaete worms	742	20
	Arthropoda	Amphipods	1,735	24
	Mollusca	Cleft clams, marine bivalve	56	8
	Nematoda	Nematode worms	80	1
	Nemertea	Ribbon worms	28	1
	2019 Total		2,641	54

Samples collected in 2018 averaged higher in abundance, unique taxa, richness, and diversity than those collected in 2019 (Table 4; Figure 7). Sample abundance ranged from 75 to 369 individuals in 2018 and from 3 to 163 individuals in 2019. The number of unique taxa in each sample ranged from 14 to 35 taxa in 2018 and from 3 to 26 taxa in 2019. Richness and diversity ranged from 2.45 to 6.27 and 1.64 to 2.82 in 2018, respectively, and from 0.87 to 5.42 and 1.03 to 2.27 in 2019, respectively. Evenness between sample years was similar and ranged from 0.56 to 0.87 in 2018 and 0.38 to 1.00 in 2019 (Table 5).

Table 4. Summary of community composition parameters calculated for the 2018 and 2019 benthic grab samples collected in the SWDA.

Survey	Avg. Density (Abundance per 0.008 m^2)	Avg. # of Taxa	Ecological Indices (Avg.)		
			Richness	Diversity	Evenness
2018	186	24	4.38	2.29	0.73
2019	66	13	2.96	1.70	0.72

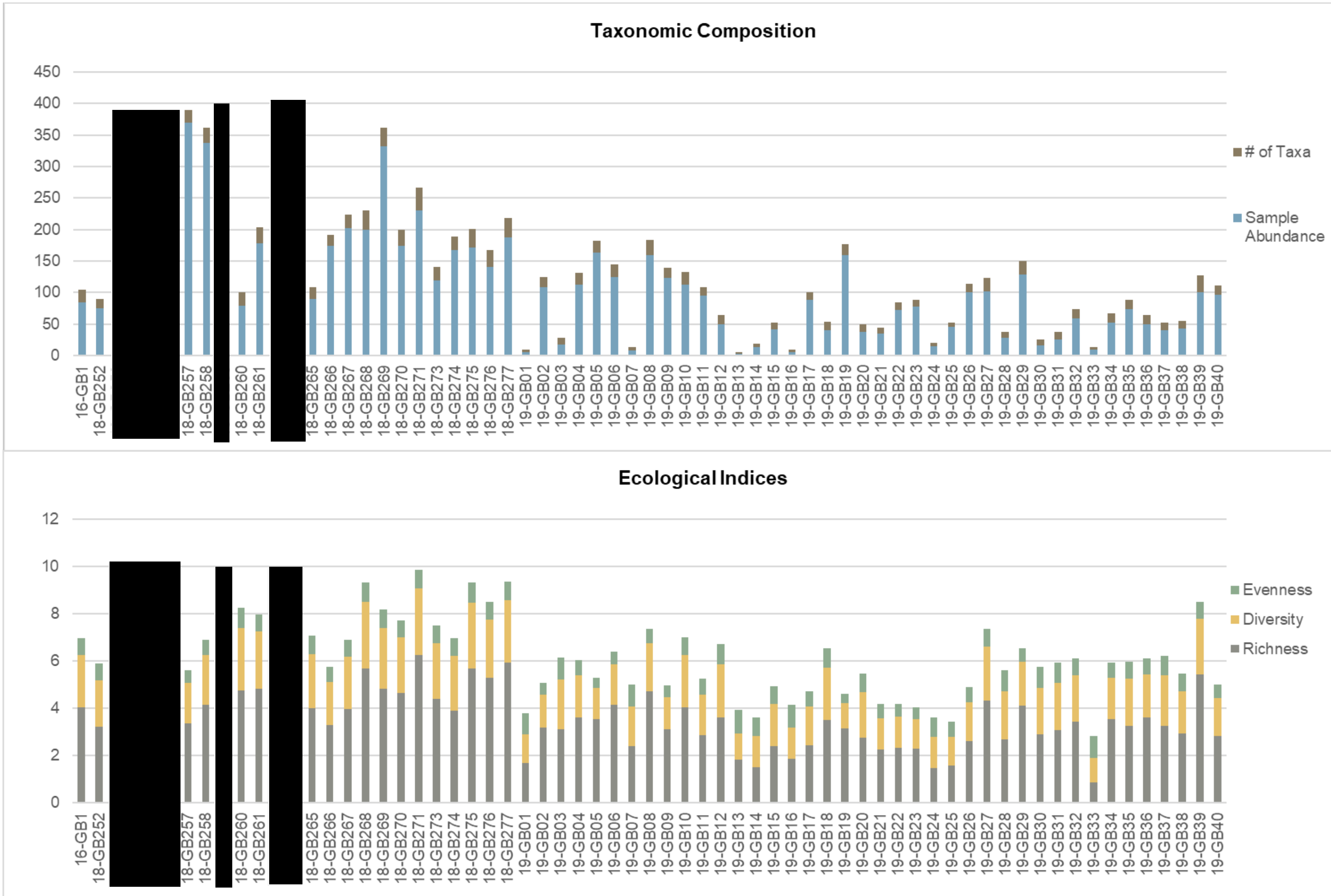


Figure 7. Bar chart representing taxonomic composition (top; # of unique taxa and sample abundance) and ecological indices (bottom; richness, diversity, evenness) for grab sample stations in the SWDA.

Table 5. Community composition parameters calculated for each grab sample station in the SWDA. The first two numbers in the station name indicate year sample was taken (e.g., 16-GB1 represents grab station 1 from the 2016 survey).

Station	Density (Abundance per 0.008 m^2)	# of Taxa	Ecological Indices		
			Richness	Diversity	Evenness
16-GB1	85	19	4.05	2.19	0.74
18-GB252	75	15	3.24	1.95	0.72
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18-GB257	369	21	3.38	1.69	0.56
18-GB258	337	25	4.14	2.1	0.65
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18-GB260	79	21	4.76	2.63	0.86
18-GB261	178	26	4.82	2.42	0.74
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
18-GB265	90	19	4	2.29	0.78
18-GB266	174	18	3.31	1.81	0.63
18-GB267	202	22	3.96	2.23	0.72
18-GB268	199	31	5.69	2.82	0.82
18-GB269	332	29	4.83	2.58	0.77
18-GB270	174	25	4.65	2.35	0.73
18-GB271	231	35	6.27	2.82	0.79
18-GB273	119	22	4.39	2.35	0.76
18-GB274	168	21	3.9	2.32	0.76
18-GB275	171	30	5.67	2.81	0.83
18-GB276	141	27	5.28	2.46	0.75
18-GB277	187	32	5.93	2.65	0.77
19-GB01	6	4	1.67	1.24	0.90
19-GB02	109	16	3.20	1.39	0.50
19-GB03	18	10	3.11	2.12	0.92
19-GB04	113	18	3.60	1.81	0.63
19-GB05	163	19	3.53	1.32	0.45
19-GB06	124	21	4.15	1.70	0.56
19-GB07	8	6	2.40	1.67	0.93
19-GB08	159	25	4.73	2.01	0.63
19-GB09	123	16	3.12	1.36	0.49
19-GB10	112	20	4.03	2.22	0.74
19-GB11	95	14	2.85	1.74	0.66
19-GB12	49	15	3.60	2.27	0.84
19-GB13	3	3	1.82	1.10	1.00
19-GB14	14	5	1.52	1.30	0.81
19-GB15	42	10	2.41	1.76	0.77
19-GB16	5	4	1.86	1.33	0.96
19-GB17	89	12	2.45	1.62	0.65
19-GB18	40	14	3.52	2.20	0.83
19-GB19	160	17	3.15	1.08	0.38
19-GB20	38	11	2.75	1.92	0.80

19-GB21	35	9	2.25	1.34	0.61
19-GB22	73	11	2.33	1.32	0.55
19-GB23	78	11	2.30	1.23	0.51
19-GB24	15	5	1.48	1.32	0.82
19-GB25	46	7	1.57	1.23	0.63
19-GB26	101	13	2.60	1.65	0.65
19-GB27	102	21	4.32	2.28	0.75
19-GB28	28	10	2.70	2.03	0.88
19-GB29	129	21	4.12	1.84	0.60
19-GB30	16	9	2.89	1.98	0.90
19-GB31	26	11	3.07	2.02	0.84
19-GB32	59	15	3.43	1.97	0.73
19-GB33	10	3	0.87	1.03	0.94
19-GB34	52	15	3.54	1.76	0.65
19-GB35	74	15	3.25	1.99	0.73
19-GB36	49	15	3.60	1.83	0.68
19-GB37	40	13	3.25	2.14	0.83
19-GB38	43	12	2.92	1.81	0.73
19-GB39	101	26	5.42	2.36	0.73
19-GB40	97	14	2.84	1.58	0.60

When combining samples from the three surveys, all community composition parameters, other than evenness, were higher in the finer substrates (Muddy Sand, Fine/Very Fine Sand, Sandy Mud) than the coarser substrates (Medium Sand, Very Coarse/Coarse Sand; Table 6).

Table 6. Summary of community composition parameters calculated by CMECS substrate type for benthic grab samples collected in the SWDA.

Survey	Avg. Density (Abundance per 0.008 m^2)	Avg. # of Taxa	Ecological Indices (Avg.)		
			Richness	Diversity	Evenness
Sandy Mud	65	13	2.90	1.66	0.69
Muddy Sand	127	19	3.83	2.02	0.69
Fine/Very Fine Sand	174	20	3.85	2.17	0.73
Medium Sand	18	6	2.17	1.50	0.87
Very Coarse/Coarse Sand	11	5	1.80	1.41	0.91

2.2 Statistical Analyses

2.2.1 Methods

A two-way analysis of variance (ANOVA) following the Type III sums of squares approach in R (Fox and Weisberg, 2019; R Core Team, 2020) was used to test for relationships between sample season, substrate type, and infauna diversity. The Shannon Diversity Index was used to calculate the response variable as it is widely used and an universally accepted ecological index that accounts for both richness and evenness in its estimation. Sample season included two levels, summer and fall. “Fall” samples are defined as those collected from November 2016 and 2019 whereas samples collected from June and July of 2018 are classified as “summer”. Although termed here as “seasons”, these data do not allow for conclusive assessment of seasonal differences due to variation in year and sample location across surveys within the SWDA. The seasonal categorization used here allowed for the sample collected in 2016 to be combined with the 2019 data. Substrate type (based on CMECS) included five levels: Fine/Very Fine Sand, Medium Sand, Muddy Sand, Sandy Mud, and Very Coarse/Coarse Sand. The two null hypotheses tested with the ANOVA included:

$H_0 1$: There is no difference in mean diversity for different seasons.

$H_0 2$: There is no difference in mean diversity for different substrate types.

Multivariate analyses were conducted in R (Oksanen et al., 2019; R Core Team, 2020) to examine dissimilarity/similarity of stations based on the infaunal assemblages (composition of all species and their abundances). These analyses included nonmetric multidimensional scaling (NMDS), analysis of similarities (ANOSIM), and analysis of similarity percentages (SIMPER; Clarke, 1993). All analyses were built on a Bray-Curtis Similarity Index, using a square-root transformation of the data to ensure all taxa (not just those that dominated samples) would contribute to similarity measures. Differences in the infaunal assemblages between stations were assessed using substrate classification, depth, and sample season.

NMDS was used to compare the distance (difference) between data points and visually evaluate clusters of similarity in the data. Dendrograms present the discrete groupings of samples with similar community structures while NMDS plots present data and groupings spatially, with samples ordinating based on similarity to one another. Samples of high similarity plot in close proximity to one another in NMDS plots.

SIMPER was used to identify the percent dissimilarity between substrate types and taxa that were most responsible for that dissimilarity, i.e., the taxa with the largest difference in mean abundance. ANOSIM was used to help determine if season, depth, or substrate classifications were predictive of the infaunal assemblage clusters. The test statistic (R) calculated in the Global ANOSIM indicates whether samples within classification groups were more similar than samples between groups. R values closer to 1 than 0 and significance levels of $p < 0.05$ indicate that samples within a classification group are more similar to each other than to those in different groups. Specifically, ANOSIM was used to test three null hypotheses:

$H_0$1: Infaunal assemblages do not change within depth classifications.

$H_0$2: Infaunal assemblages do not change within seasons.

$H_0$3: Infaunal assemblages do not change within habitat types.

2.2.2 Results

The two-way ANOVA using Type III sums of squares testing for associations of season and substrate type with infanual diversity found a highly significant ($p < 0.001$) relationship for season, but not for substrate type ($p = 0.15$). These results demonstrated that the mean diversity was significantly higher in the summer season/survey than in the fall season/surveys (Figure 8). The lack of significant interaction between infaunal diversity and substrate indicated high levels of variability between samples (Figure 9).

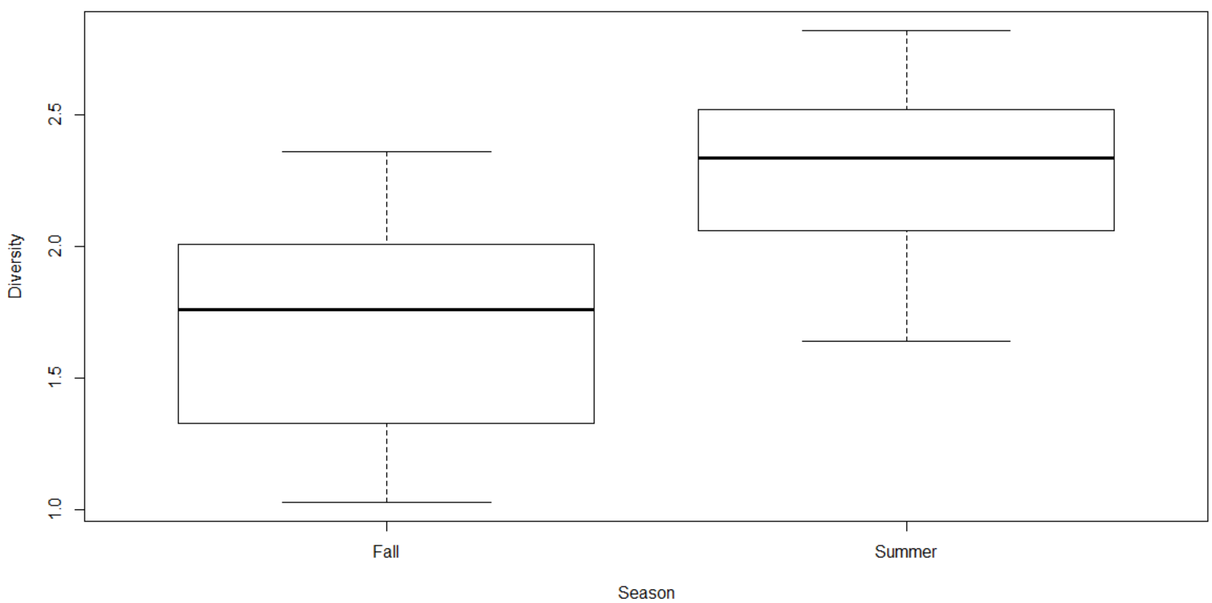


Figure 8. Boxplot presenting the range of diversity values within each season. The bold horizontal line represents the mean value.

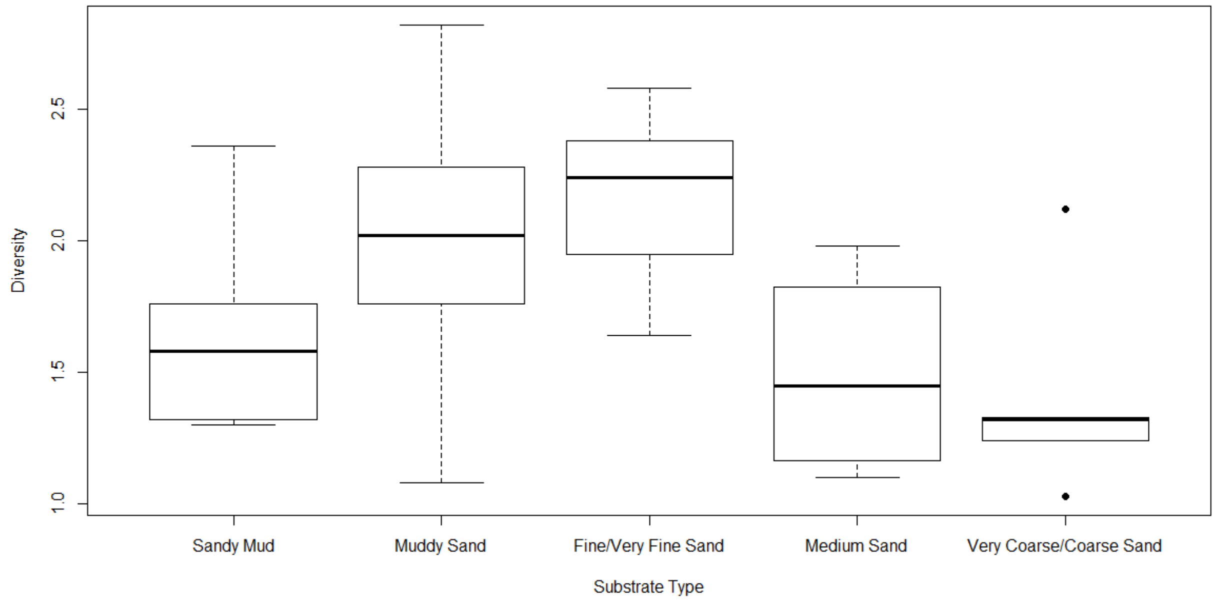


Figure 9. Boxplot presenting the range of diversity values within the CMECS substrate types. The bold horizontal line represents the mean value.

Multivariate analyses distinguished infaunal assemblages in the 65 samples from the 2016, 2018, and 2019 SWDA surveys. Results from the cluster analysis and NMDS based on the Bray-Curtis dissimilarity of infaunal assemblages are presented below in a series of figures including a dendrogram and multiple MDS plots (Figure 10 - Figure 13). Overall, results from the NMDS analysis indicated that the ordination summarized the distance of data points well with a stress value of 0.16. The dendrogram (Figure 10) displays distinct clustering of all samples collected in the summer or 2018 survey, while the fall samples, collected in 2016 and 2019, are dispersed into four distinct clusters.

The NMDS plots were spatially ordinated based on their Bray-Curtis dissimilarity and color-coded based on variables including season, depth, and CMECS substrate type. As displayed in the dendrogram, samples formed distinct clusters based on whether sampling occurred in the summer (2018) or fall (2019 and 2016), however, the wide spread of points within the cluster indicated high variability in infaunal assemblages within each season (Figure 11). The NMDS plot coded by depth showed clusters of shallower sites (right) and deeper sites (left), with higher variability among the deeper sites (Figure 12). The clusters presented in this plot may represent this difference in sampling season in addition to depth, as the summer 2018 survey occurred in the northern, shallower, portion of the WDA, however, as mentioned above, these data are limited in their ability to draw such conclusions due to variation in year and sample location across surveys within the SWDA. Muddy Sand represented most of the samples collected in the SWDA and formed a clear cluster in the NMDS plot coded by substrate type (Figure 13). In general, finer grain size substrates were more similar to one another, forming tighter clusters than the coarse grain sizes, which had higher variability and space between points.

Based on ANOSIM global test results, the null hypothesis that infaunal assemblages do not change within depth classifications was rejected ($R = 0.28$, significance level $p < 0.01$). Although the model showed there was a significant difference between infaunal assemblages at different depths, the low R statistic indicated depth only characterized a small portion of the differences between the infaunal communities at each site. The R value from the ANOSIM of season was 0.37, with a significance level of $p < 0.01$, demonstrating that the overall model was significant; however, infaunal assemblages were only marginally similar within each season, as variability was high within the seasons. The null hypothesis that infaunal assemblages do not change within substrate type was also rejected ($R = 0.58$, significance level $p < 0.01$). The higher R-value indicated that infaunal assemblages are more similar within each substrate type than outside or between the substrate groupings.

The SIMPER analysis was conducted on the substrate factor as the ANOSIM demonstrated significant relationships between the infaunal assemblages within the substrate types. Results from the SIMPER analysis, listed in Table 7, present the percent of dissimilarity between two substrates and the three taxa that contributed the most to that dissimilarity. The substrates with the most dissimilar infaunal assemblages were Very Coarse/Coarse Sand and Fine/Very Fine Sand. Infaunal assemblages in Muddy Sand and Sandy Mud substrates had the highest similarity with Ampeliscidae, Paraonidae, and Maldanidae accounting for 22% of the dissimilarity between substrates. In general, substrates of similar grain size (e.g., Very Coarse/Coarse Sand and Medium Sand) had greater similarities of infaunal assemblages.

Table 7. SIMPER results of the dissimilarity of infaunal compositions between substrate types.

Substrate Type (A)	Substrate Type (B)	Bray-Curtis Dissimilarity	Dissimilar Taxa[1]	% Contribution	Av. Abundance[2] (A)	Av. Abundance[2] (B)
Very Coarse/Coarse Sand	Fine/Very Fine Sand	88%	Polygordiidae	12%	0	5.39
			Lumbrineridae	11%	0.68	5.21
			Paraonidae	8%	0.20	4.25
Fine/Very Fine Sand	Medium Sand	85%	Ampeliscidae	12%	0	5.39
			Paraonidae	10%	0.96	5.21
			Lumbrineridae	8%	0.56	4.25
Very Coarse/Coarse Sand	Muddy Sand	85%	Ampeliscidae	14%	0.77	5.74
			Paraonidae	8%	0.20	3.52
			Lumbrineridae	7%	0.68	3.32
Very Coarse/Coarse Sand	Sandy Mud	82%	Ampeliscidae	15%	0.77	4.25
			Paraonidae	10%	0.20	2.13
			Lumbrineridae	8%	0.68	2.24
Muddy Sand	Medium Sand	77%	Ampeliscidae	13%	5.74	1.80
			Paraonidae	8%	3.52	0.56
			Lumbrineridae	7%	3.32	0.96
Medium Sand	Sandy Mud	76%	Ampeliscidae	16%	1.80	4.25
			Paraonidae	10%	0.56	2.13
			Lumbrineridae	6%	0.96	2.24
Fine/Very Fine Sand	Sandy Mud	73%	Polygordiidae	11%	0	5.39
			Ampeliscidae	8%	4.25	2.39
			Cirratulidae	7%	0.35	3.71
Very Coarse/Coarse Sand	Medium Sand	72%	Nematoda	14%	1.90	1.26
			Ampeliscidae	13%	0.77	1.80
			Scalibregmatidae	8%	0.83	0
Muddy Sand	Fine/Very Fine Sand	62%	Polygordiidae	10%	1.10	5.39
			Ampeliscidae	8%	5.74	2.39
			Paraonidae	6%	3.52	4.25
Muddy Sand	Sandy Mud	62%	Ampeliscidae	12%	5.74	4.25
			Paraonidae	6%	3.52	2.13
			Maldanidae	4%	1.78	0.48

[1] Includes taxa contributing highest percentage to the dissimilarity between substrate types
[2] Average square-root transformed abundance

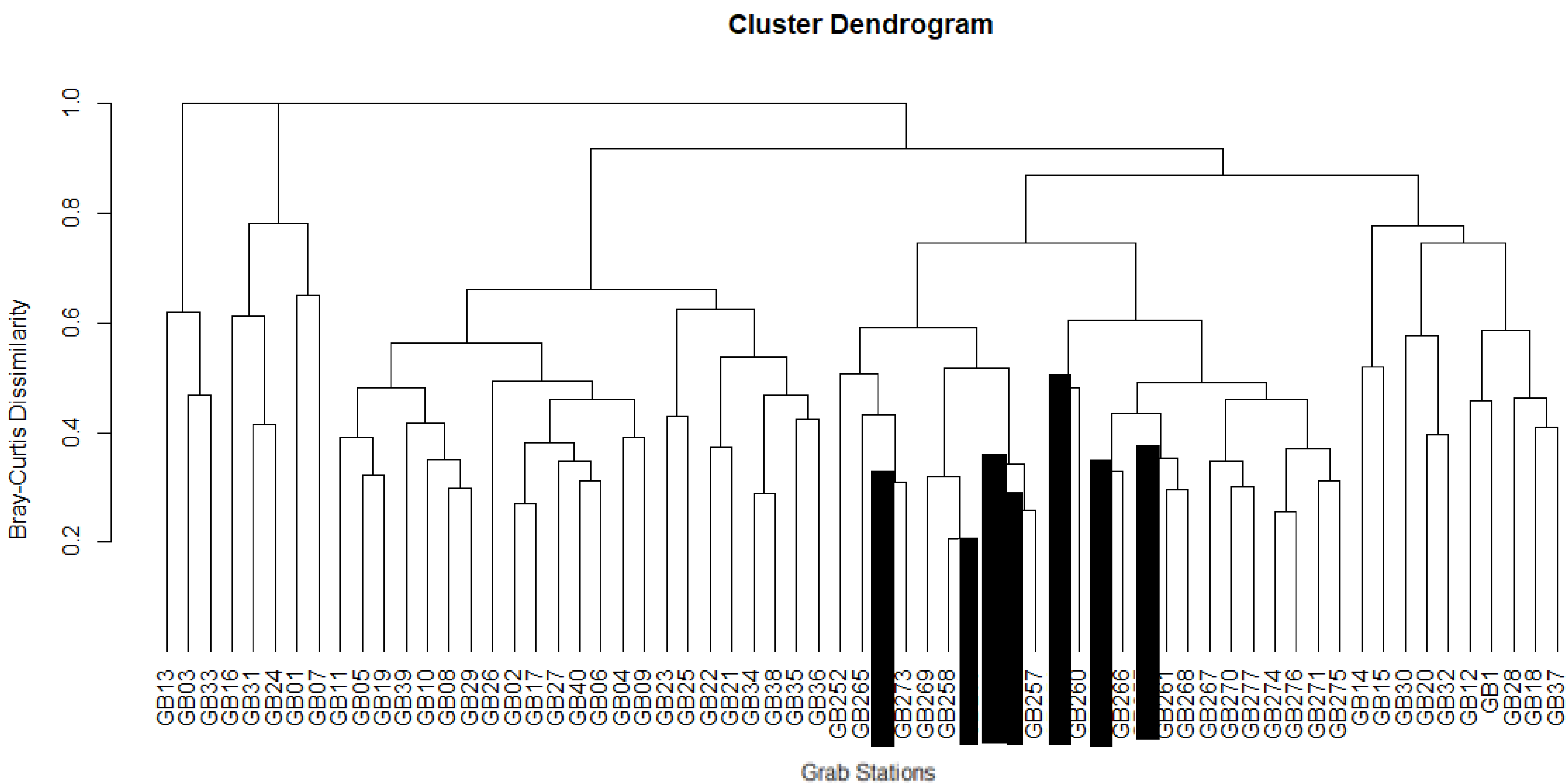


Figure 10. Dendrogram from cluster analysis based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 65 stations sampled in the SWDA. Branches are based on the dissimilarities between those clusters of samples (i.e., samples with lower level clusters are more similar to one another than other samples outside of the cluster), which is labelled on the y-axis. Grab samples labeled GB252-GB277 were collected in the 2018 survey, and sampled labeled GB01-GB40 were sampled in the 2019 survey. The grab sample labeled GB1 was collected in the 2016 survey.

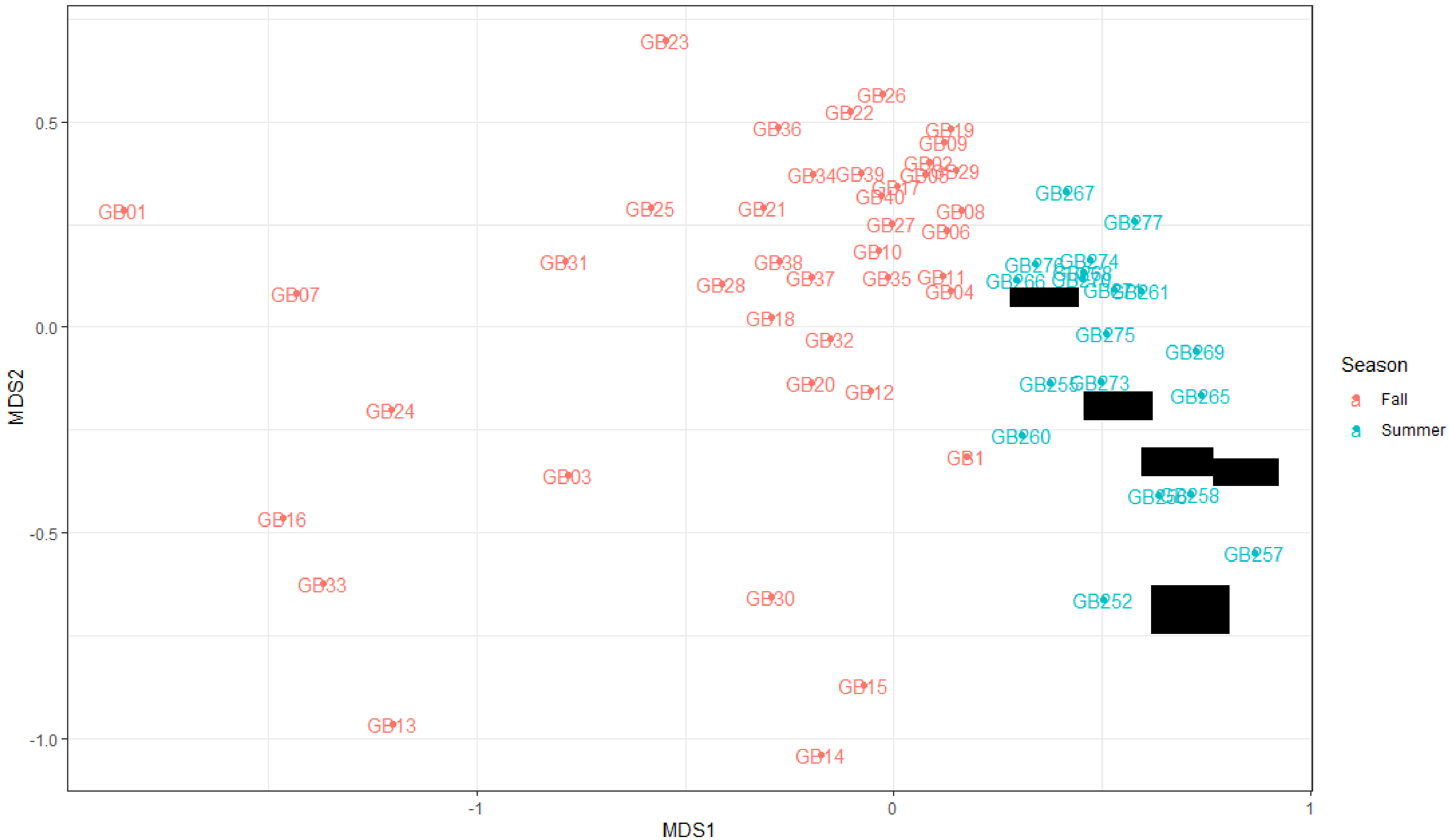


Figure 11. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 65 stations sampled in the SWDA in the 2016, 2018, and 2019. Each symbol represents a station that is color-coded based on season sampled. Red points represent samples collected in the fall (November 2016 and 2019), while blue points represent those collected in the summer (June/July 2018).

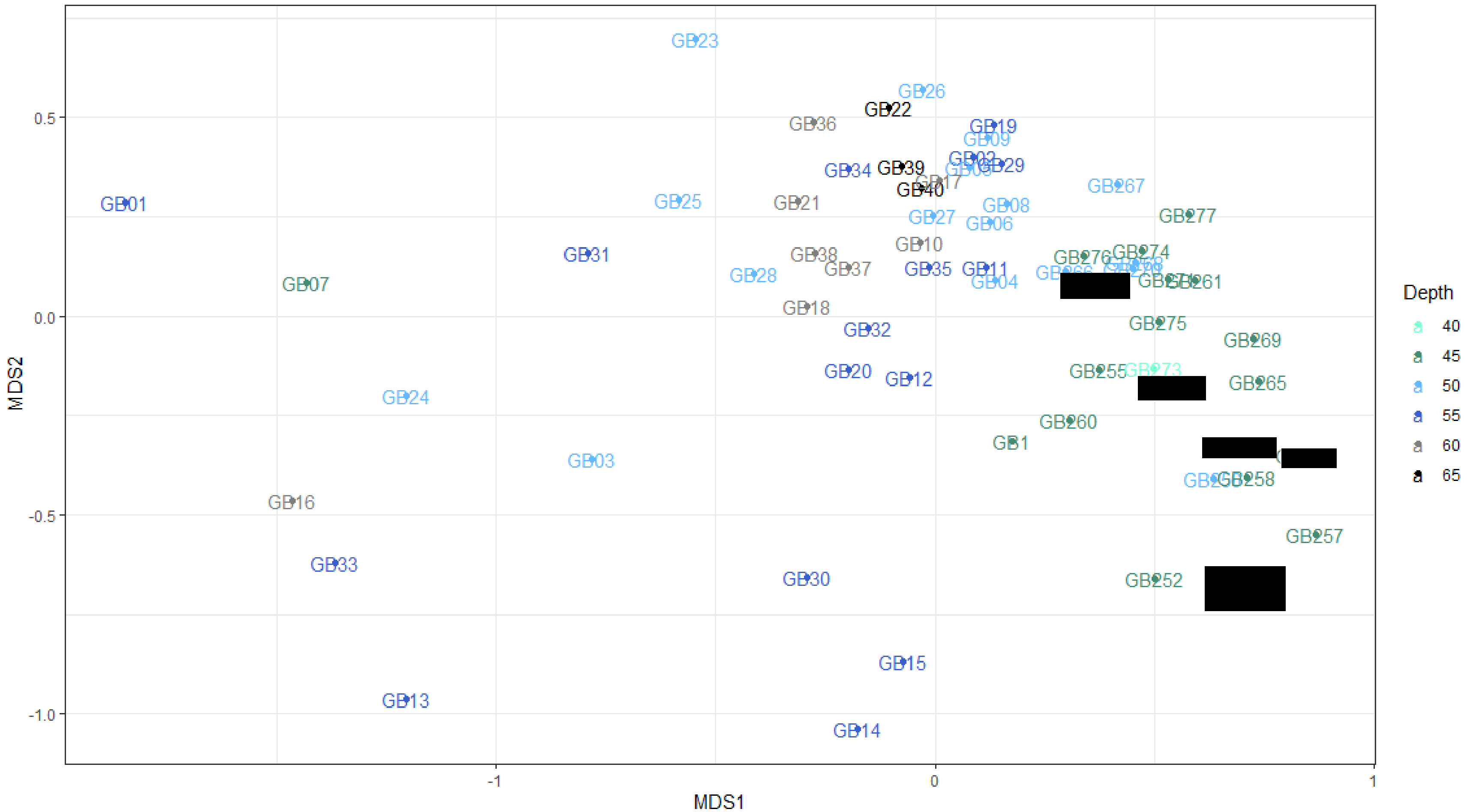


Figure 12. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 65 stations sampled in the SWDA in the 2016, 2018, and 2019. Each symbol represents a station that is color-coded in a gradient based on depth.

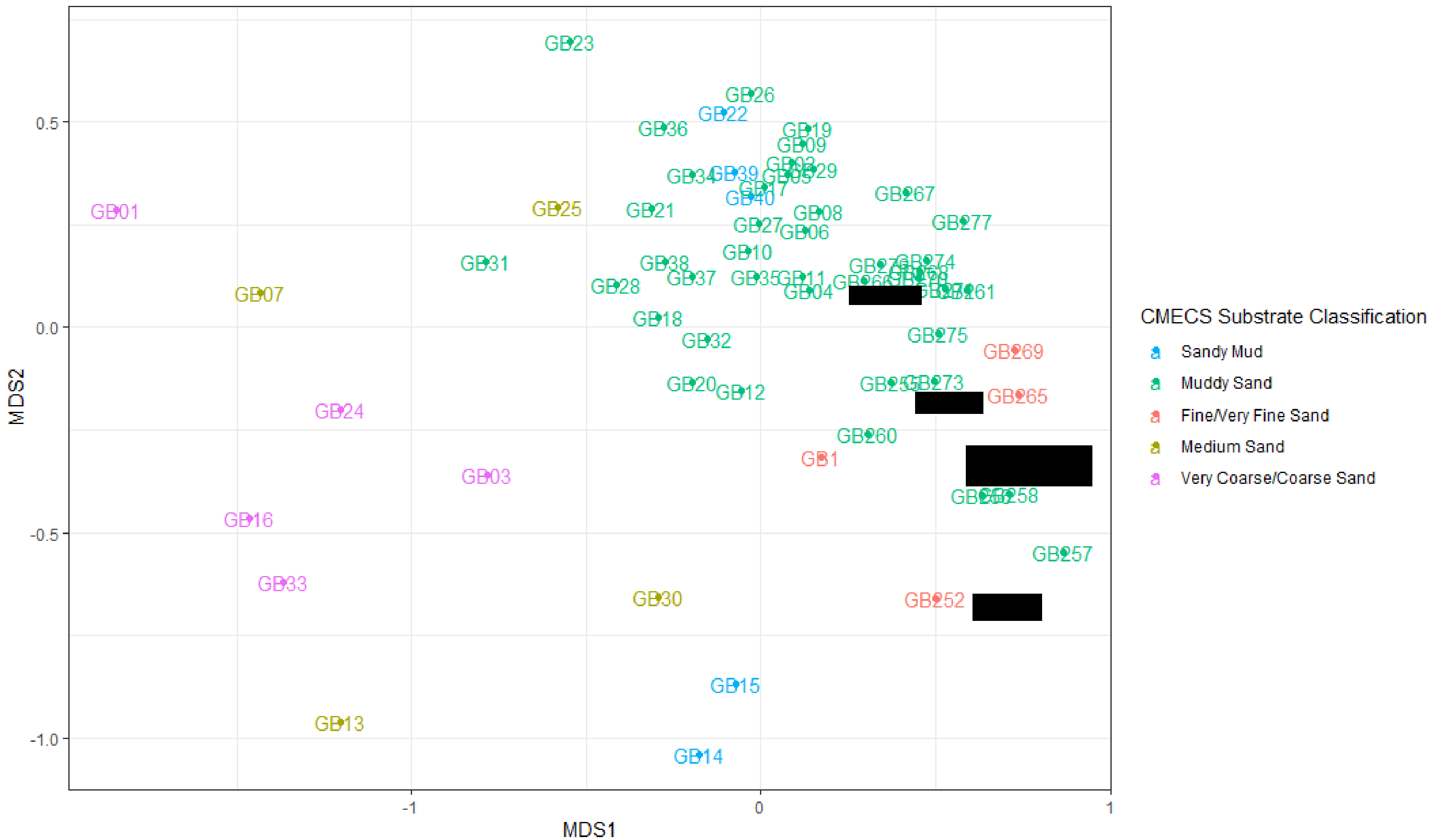


Figure 13. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 65 stations sampled in the SWDA in the 2016, 2018, and 2019. Each symbol represents a station that is color-coded based on CMECS substrate type. Blue points represent samples in Sandy Mud, green points represent samples in Muddy Sand, red points represent samples in Fine/Very Fine Sand, yellow points represent samples in Medium Sand, and pink points represent samples in Very Coarse/Coarse Sand.

3 DISCUSSION

Across the surveys and benthic grab data included in this analysis, organisms from the phyla Annelida and Arthropoda were consistently dominant in samples throughout the SWDA. Nut clams from the Mollusca phylum were also abundant in 2018 samples, but not in the 2016 sample or 2019 samples. Overall, abundance, number of unique taxa and phyla, richness, and diversity were higher across samples collected in the summer 2018 survey than the fall 2016/2019 surveys. Almost twice as many individual organisms were captured in the 24 samples collected in 2018 than the 40 samples collected in 2019.

Results from the ANOVA and dissimilarity analyses also indicated possible differences in the ecological indices and infaunal assemblages of samples collected in the summer (2018) and fall (2016 and 2019). Many of the ecological indices calculated for samples collected in the summer, other than evenness, were almost double of those from the fall samples. Seasonal differences, related to primary and corresponding secondary production in New England, could explain some of the seasonal trends observed in the data and results. However, the effect of season cannot be conclusively shown by analyses of these data due to changes in season, year, and location within the SWDA over the three years of sampling, as explained below.

Interannual variability could also explain the differences observed within the summer and fall seasons, as summer sampling only occurred in 2018 and fall sampling occurred primarily only in 2019. Interannual variability can be introduced through large-scale climatic events such as storms or shifts in sea temperature, or hydrograhic fronts. Although fall sampling occurred in 2016 and 2019, only one data point from the 2016 survey was included in the dataset; an insufficient number for comparative analyses between the years.

Spatial variability could also contribute to these differences as samples in 2018 were collected in the northern most region of the SWDA, which is closer to shore and in shallower waters. Although statistical results indicate that depth was a poor indicator of infaunal abundance, the variation in depth between the surveys can be observed in the NMDS plot color-coded by depth, which shows loose clustering of the shallow water samples (40-45 m) from the 2018 survey. The NMDS plot also displayed loose clustering of sites at the deepest depths (60-65 m), which may indicate distinct shifts in the infanual assemblages as water depth increases. However, it remains difficult to draw inferences on infaunal assemblages based on depth as it is unclear whether the clustering is an artefact of differences in sample season and year.

Although the diversity scores of infauna collected at each grab site were not significantly different across the substrate types, infaunal assemblages formed several clusters based on the classified substrate. Muddy Sand represented the most samples and formed a loose cluster in the NMDS plot. Although variability was high in the infaunal assemblages within Muddy Sand substrates, these samples were more similar to each other on average than to other samples outside of this group. This is also apparent for samples collected in Fine/Very Fine Sand, which also ordinated in a loose cluster. The coarser substrates, Medium Sand and Very Coarse/Coarse Sand, had the highest variability within the infaunal assemblages, as represented in the wide spread of points in the NMDS plot. This high level of variability may indicate increased heterogenetity within the substrate types that allows for a wider array of taxa.

The SIMPER results found that finer substrates (Muddy Sand, Fine/Very Fine Sand, Sandy Mud) both contained more similar infaunal assemblages within each substrate group and were more similar to each other than the coarse substrates. Infaunal assemblages associated with Muddy Sand were most similar to those within Fine/Very Fine Sand and Sandy Mud and most dissimilar to those associated with Very Coarse/Coarse Sand. Fine/Very Fine Sand and Very Coarse/Coarse Sand had the highest percentage of dissimilarity of any other two substrates. Three families of polychaete worms were most important in distinguishing the infaunal abundances within these substrate types and all occurred in higher abundances on average in Fine/Very Fine Sand than in Very Coarse/Coarse Sand. Although this could describe the natural relationship between infaunal assemblages within these substrates, it should be noted that Fine/Very Fine Sand was only observed in the summer survey in 2018 and at the single site in 2016; whereas Very Coarse/Coarse Sand was only observed in the fall survey in 2019. Therefore, this relationship could be a consequence of the variability between surveys. In general, SIMPER was useful in presenting taxa that contributed the most to the dissimilarity between substrates and highlighted few taxa consistently contributing large percentages to that dissimilarity, including Lumbrineridae, Paraonidae, Ampeliscidae and Polygordiidae. However, SIMPER is sensitive to abundance and highlights the larger-scale variance of individual common taxa, rather than differences in rare or unique taxa.

Overall, these results demonstrated significant interannual, seasonal, and or spatial variability between the summer 2018 and fall 2016/2019 surveys. Higher productivity, richness, and diversity were observed in the infanal assemblages of sampled collected in the summer of 2018, possibly driven by spring production booms and favorable conditions. Additionally, these analyses indicate that infaunal assemblages can be distinguished by substrate type. Muddy Sand substrate represented almost 70% of the total samples collected in 2016, 2018 and 2019, demonstrating largely homogenous habitats within the SWDA. Other substrate types regularly occurred in patches, demonstrating smaller-scale habitat heterogeneity within the SWDA.

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7. RPS 2019 OECC Benthic Report

BENTHIC INFAUNAL DATA ANALYSIS

Lease Area OCS-A 0501 South Offshore Cable Corridor Benthic Report

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20-P-208319 Geo SubSea-Vineyard Wind
OCS-A 0501 South
Benthic Infaunal Data Analysis

May 22, 2020

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1 INTRODUCTION

RPS was contracted by Geo SubSea LLC to conduct a statistical analysis of benthic macroinfauna (referred to as infauna or macroinfauna) grab data sampled along the Offshore Export Cable Corridor (OECC) of 501 South, Vineyard Wind's proposal to develop the southern portion of Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0501 known as the Southern Wind Development Area (SWDA), offshore of Martha's Vineyard, Massachusetts. 501 South is intended for the generation of renewable energy from offshore wind in two phases comprised of up to 140 total wind turbine generator (WTG) and electrical service platform (ESP) positions. Samples included in this assessment were collected in 2017 and 2018 as part of Vineyard Wind's first 800 MW project, Vineyard Wind 1 (also known as 501 North), and in 2019 as part of 501 South in order to characterize the benthic habitat and macroinfaunal communities throughout Offshore Development Area (Figure 1). Habitats at each grab site were classified using field survey notes and the Coastal and Marine Ecological Classifications Standards (CMECS; FGDC 2012) as guidance. The OECC was broken down into four regions or locations, including the nearshore landfall area, the northern OECC, Muskeget channel, and southern OECC (Figure 1).

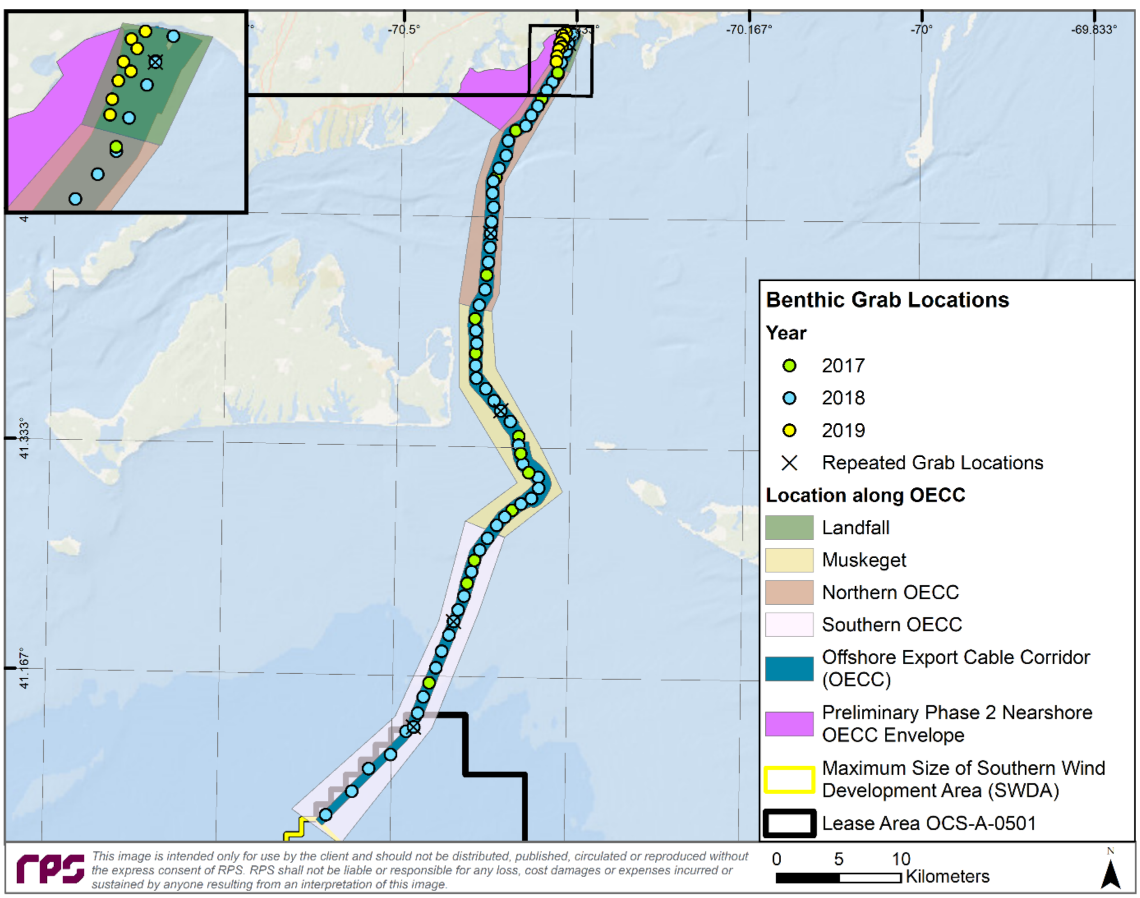


Figure 1. Benthic grab locations along the 501 South Offshore Export Cable Corridor. Samples were collected in 2017, 2018, and 2019. The stations sampled in both 2017 and 2018 are delineated with an X.

1.1 2017 Field Survey

Benthic macroinfaunal sampling was conducted between August 31 and September 4, 2017 by Alpine Ocean Seismic Survey, Inc. (Alpine). Grab samples were collected using a 0.1 m^2 modified Day Grab Sampler and infaunal samples were collected from the grab using a 4-inch diameter handheld core. Samples were processed and analyzed by Normandeau Associates, Inc. (Normandeau 2017). The abundance of taxa collected and identified in the samples was reported as number of organisms per 0.008 m^2, corresponding to the surface area of the subsample corer used. Of the 59 successful grab samples collected during this survey, 16 of the stations are along the currently proposed OECC and included in this analysis. Additional information on the 2017 survey can be found in Normandeau (2017).

1.2 2018 Field Survey

Marine benthic habitat sampling was conducted in the Vineyard Wind I Offshore Development Area by CSA Ocean Sciences, Inc. (CSA) and Alpine Ocean Seismic Survey, Inc. (Alpine) between May 28 and July 5, 2018. Infaunal and grain-size samples were successfully collected at a total of 141 stations (67 sites in the Vineyard Wind I Wind Development Area (WDA) and 74 along the OECC) with a 0.1 m^2 Day Grab Sampler and infaunal samples collected from the grab using a 4-inch diameter handheld core (CSA 2018). Five stations sampled along the OECC in 2017 were replicated in 2018. Lab processing and taxonomic identification of all infaunal samples were conducted by EcoAnalysts, Inc. (EcoAnalysts) while grain size samples were analyzed by TerraSense. The abundance of taxa collected and identified in the samples was reported as number of organisms per 0.008 m^2, corresponding to the surface area of the subsample corer used. Of the 141 samples collected in the Vineyard Wind I Offshore Development Area during the 2018 survey, 50 occurred within the 501 South OECC and were included in these analyses. For the full report on the 2018 survey and data analysis refer to CSA (2018) and RPS (2018).

1.3 2019 Field Survey

Benthic sampling was conducted at 11 stations within the nearshore area of the 501 South OECC by Horizon Geosciences and Seaforth Geosurveys in the summer of 2019. Benthic grab samples were acquired using a Ted Young benthic grab sampler and infaunal subsamples were taken using a 4-inch diameter hand core. Lab processing and taxonomic identification of all infaunal samples were conducted by ESS Group, Inc. As in the 2017 and 2018 surveys, the abundance of taxa collected and identified in the samples was reported as number of organisms per 0.008 m^2, corresponding to the surface area of the subsample plexiglass corer used. Grain size samples were analyzed by TerraSense using the American Society for Testing and Materials (ASTM) soil classification system standards D2487 and D2488 (ASTM 2017 a;b). Of the 11 samples collected in 2019 during the nearshore survey, eight occurred within the currently proposed 501 South OECC and were included in these analyses.

2 BENTHIC DATA ANALYSIS METHODS AND RESULTS

2.1 Benthic Infaunal Data Post-Processing

The benthic macroinfaunal community analysis was based on the laboratory results provided by Normandeau (2017), EcoAnalysts (2018), and ESS Group (2019) for the 74 grab samples collected along the 501 South OECC. Infaunal community statistics were calculated using species and abundance estimates in each sample, which were reported as count per 0.008 m^2 (area of subsample core). Community composition parameters included: total abundance, number of phyla, number of taxa, Margalef's Richness Index, Shannon Diversity Index, and Pielou's Index of Evenness for each station and within the lease area.

2.1.1 Community Composition

Taxonomic data was assessed to characterize the high-level trends in community composition. Community composition includes the relative proportions of taxonomic groups aggregated by the number of identifiable taxa and number of individuals which was used to evaluate dominance of common phyla across all samples. Community composition was also summarized for individual samples.

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. Because some taxa were not identified to the species level, we used abundance data for organisms identified to the Lowest Practical Taxonomic Level (LPTL) but no further than family-level. Therefore, this modified the indices to be taxonomic richness, evenness, and diversity indices. In addition, ostracods and copepod taxa were excluded from the analyses as one lab did not include enumeration of these organisms in their infaunal processing. Taxonomic richness is the number of unique species or taxonomic groups represented in an area of interest. In this assessment, taxonomic richness was calculated using Margalef's Richness Index (Formula 1) for each station and lease area to acquire sample and average richness indices.

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

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

Where:

S= the number of unique taxa

n= the total number of individuals in the sample

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

The diversity index for a community further refines taxonomic richness by considering the proportion of each unique taxa. The Shannon Diversity Index (H'; Formula 2) is calculated using the number of each taxa, the proportional abundance of each taxa relative to the total number of individuals, and the sum of the proportions. This index was used to assess diversity of each station and lease area. The diversity index (H') increases with increasing taxonomic richness and evenness.

Formula 2. H'- Shannon Diversity Index.

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

Where:

p_i = the proportion of individuals belonging to the taxa i

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

Evenness of a community refers to the similarity in abundances of different taxa comprising a population or sample. Pielou's Index of Evenness includes H' (Shannon-Weiner Diversity Index) in its calculation.

Formula 3. J'- Pielou's Index of Evenness.

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

Where:

H' = the Shannon- Weiner Diversity Index

H_{Max} = the maximum possible value of H', where each taxon occurs in equal abundances.

$$H_{Max} = \ln(s)$$

Where: s = Number of taxa

Interpretation: J' is constrained between 0 and 1. The greater the value of J', the more evenness in the sample.

2.1.3 Habitat Classification

Habitat at each grab site was classified using field survey notes and the Coastal and Marine Ecological Classifications Standards (CMECS; FGDC 2012) as guidance (Table 1; Table 2; Figure 2). Both substrate and biogenic components were noted and combined into a single habitat classification. Five habitat types were observed along the 501 South OECC and included: Silt, Fine Sand 1, Fine Sand 2, Coarse Sand and Gravel; Figure 3). Habitat classifications for eight additional sites (three from 2017 and five from 2018), which were sampled but failed to collect infaunal samples due to improper closure of sampler, were included in Figure 2 and Figure 3. Habitat at all eight sites was classified as Gravel.

Table 1. Habitat classifications used to describe 2017, 2018, and 2019 benthic grab survey stations.

Classification	Description
Fine Sand 1	Fine sand with some shell hash
Fine Sand 2	Plain fine sand
Coarse Sand	Medium to coarse sand with some shell hash
Silt	Silty sand or mud
Gravel	Gravel or large rocks

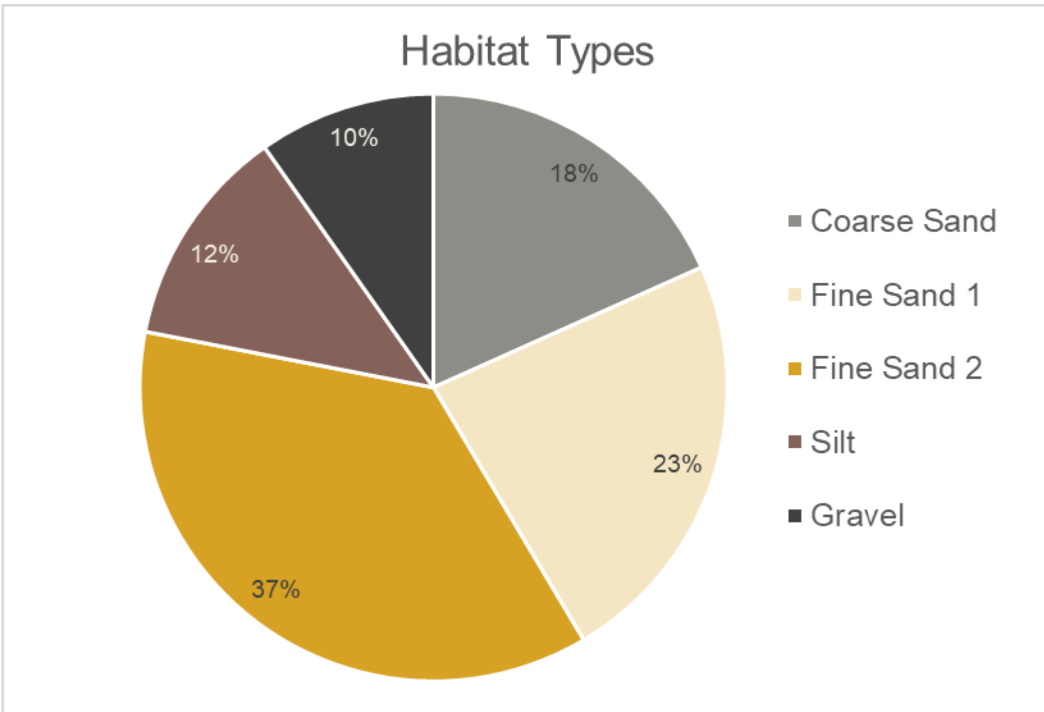


Figure 2. Percent of each habitat type represented in the 82 benthic grab samples located in the 501 South Offshore Export Cable Corridor.

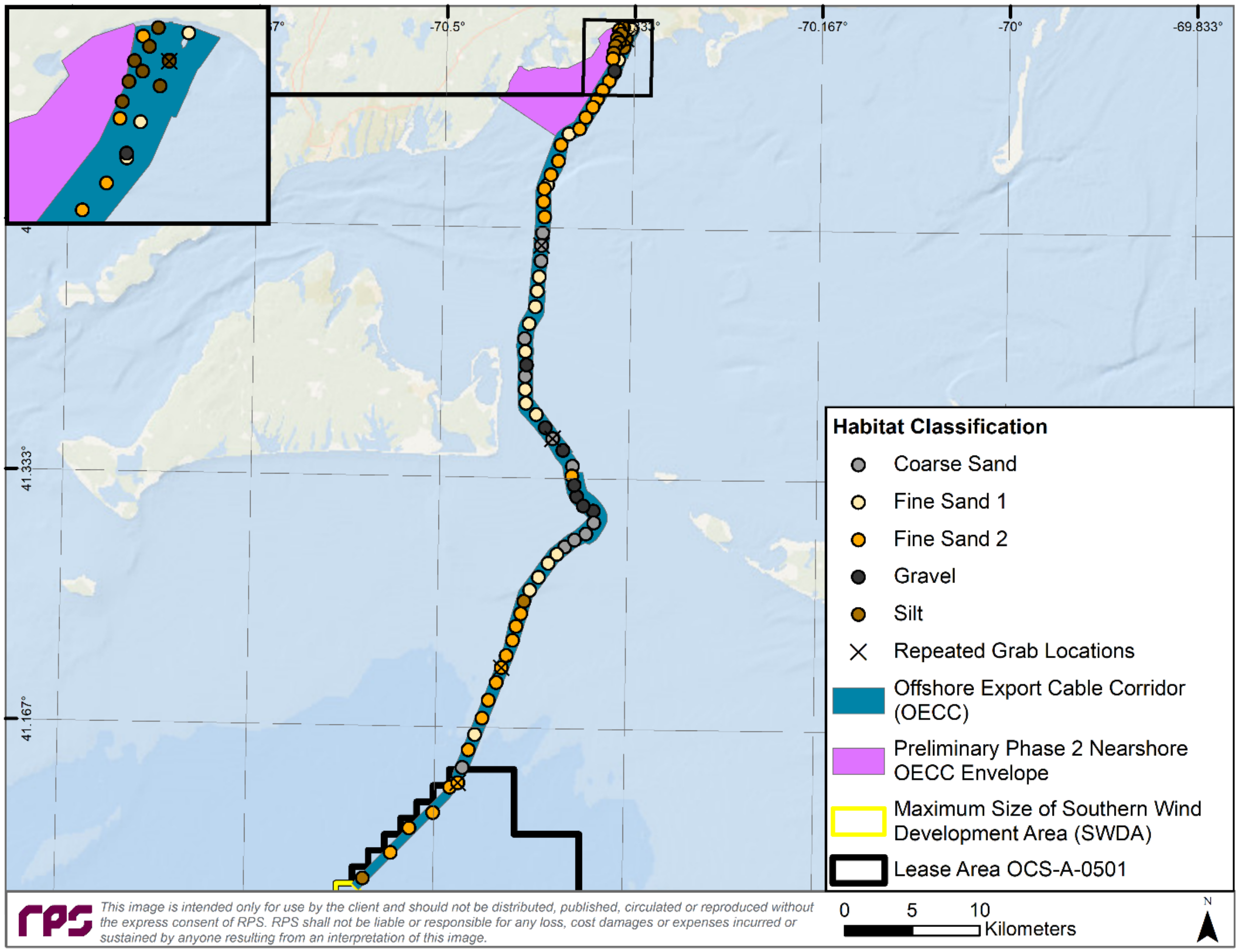


Figure 3. Map of 501 South Offshore Export Cable Corridor with sample points color coded based on habitat type. The stations sampled in both 2017 and 2018 are delineated with an X.

Table 2. Habitat classifications for benthic grab samples collected in the 501 South Offshore Export Cable Corridor.

2017		2018		2019	
Site	**Habitat**	**Site**	**Habitat**	**Site**	**Habitat**
17-GB04	Silt	18-GB04	Silt	19-GB01	Silt
17-GB05	Gravel	18-GB101	Fine Sand 1	19-GB02	Fine Sand 2
17-GB11	Fine Sand 2	18-GB102	Fine Sand 1	19-GB03	Silt
17-GB15	Fine Sand 1	18-GB103	Fine Sand 2	19-GB04	Silt
17-GB17	Fine Sand 1	18-GB104	Fine Sand 2	19-GB05	Silt
17-GB18	Silt	18-GB105	Fine Sand 2	19-GB06	Silt
17-GB19	Fine Sand 1	18-GB106	Fine Sand 2	19-GB09	Silt
17-GB20	Coarse Sand	18-GB107	Fine Sand 2	19-GB11	Fine Sand 2
17-GB22	Coarse Sand	18-GB108	Fine Sand 2		
17-GB40	Coarse Sand	18-GB109	Fine Sand 2		
17-GB41	Gravel	18-GB110	Fine Sand 2		
17-GB42	Gravel	18-GB123	Fine Sand 2		
17-GB46	Coarse Sand	18-GB124	Fine Sand 2		
17-GB49	Fine Sand 2	18-GB125	Fine Sand 2		
17-GB50	Coarse Sand	18-GB126	Coarse Sand		
17-GB51	Fine Sand 1	18-GB127	Coarse Sand		
17-GB58	Coarse Sand	18-GB128	Fine Sand 1		
17-GB61	Coarse Sand	18-GB129	Fine Sand 1		
17-GB62	Silt	18-GB130	Fine Sand 1		
		18-GB131	Fine Sand 1		
		18-GB132	Fine Sand 1		
		18-GB133	Fine Sand 1		
		18-GB134	Gravel		
		18-GB135	Fine Sand 1		
		18-GB136	Fine Sand 1		
		18-GB148	Fine Sand 1		
		18-GB149	Gravel		
		18-GB150	Gravel		
		18-GB151	Fine Sand 2		
		18-GB152	Gravel		
		18-GB153	Gravel		
		18-GB154	Fine Sand 2		
		18-GB155	Coarse Sand		
		18-GB156	Fine Sand 2		
		18-GB157	Coarse Sand		
		18-GB158	Coarse Sand		
		18-GB159	Coarse Sand		
		18-GB160	Fine Sand 1		
		18-GB161	Fine Sand 1		
		18-GB162	Fine Sand 1		
		18-GB163	Fine Sand 1		
		18-GB164	Fine Sand 2		
		18-GB165	Fine Sand 2		
		18-GB166	Fine Sand 2		
		18-GB167	Fine Sand 2		
		18-GB168	Fine Sand 2		
		18-GB18	Coarse Sand		
		18-GB203	Fine Sand 2		
		18-GB206	Fine Sand 2		
		18-GB209	Fine Sand 2		
		18-GB22	Coarse Sand		
		18-GB220	Fine Sand 2		
		18-GB250	Fine Sand 2		
		18-GB50	Fine Sand 2		
		18-GB61	Fine Sand 2		

2.1.4 Results

Within the 16 grab samples collected along the OECC in 2017, there were 892 individual organisms (per all 0.008 m^2 samples) from 66 unique taxa (family or LPTL and 7 phyla (Table 3). Organisms belonging to the phyla Annelida accounted for 40% of all individuals captured in the samples. Organisms from Mollusca (221 organisms), Nematoda (171 organisms), and Arthropoda (140 organisms) were similarly abundant and accounted for 25%, 19%, and 16% of the total abundance, respectively. A similar number of unique taxa represented Annelida (23 unique taxa), Arthropoda (21 unique taxa), and Mollusca (17 unique taxa) phyla, which all accounted for 93% of total unique taxa observed in the samples (Figure 4).

During the field survey conducted in the summer of 2018, 50 benthic grab samples were collected along the OECC (18-GB04 through -GB250) that contained a total of 7,574 individual infaunal organisms (per all 0.008 m^2 core samples) from 104 unique taxa (family or LPTL) and 11 phlyla (Figure 5). Organisms from the phyla Annelida dominated the total abundance of organisms, accounting for 66% of the observed individuals. Unique taxa were primarily from the Annelida (30%), Arthropods (29%), and Mollusca (24%) phyla (Figure 5).

Benthic grab samples were collected for infaunal analysis at eight stations along the OECC (19-GB01 through -GB11) in the summer of 2019. The grab samples yielded a total of 1,151 individual organisms (per all 0.008 m^2 core samples) from five (5) unique phyla and 28 families (or LPTL; Figure 6). Nematode worms dominated the samples in terms of abundance, accounting for 68% of all organisms observed. The Annelida and Mollusca phyla were the most diverse, accounting for 39% and 36% of all unique taxa identified (Figure 6).

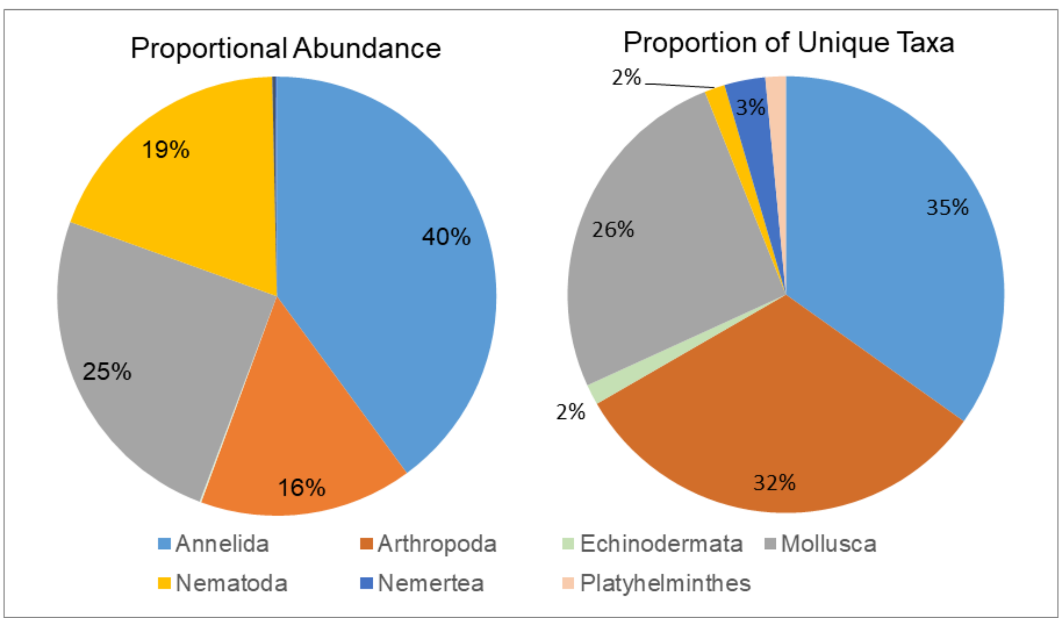


Figure 4. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum observed in all (16) benthic grab samples collected in 2017 along the 501 South Offshore Export Cable Corridor. Results presented as percentage of total ≥1%.

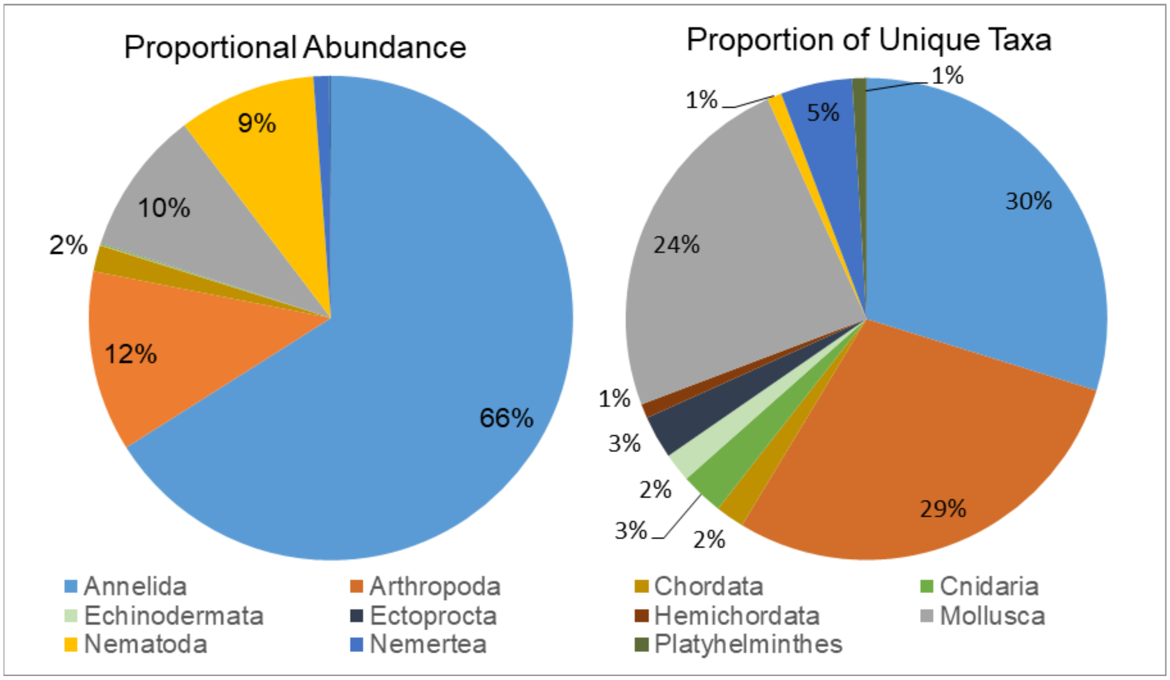


Figure 5. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum collected in all (50) benthic grab samples collected in 2018 along the 501 South Offshore Export Cable Corridor. Results presented as percentage of total ≥1%.

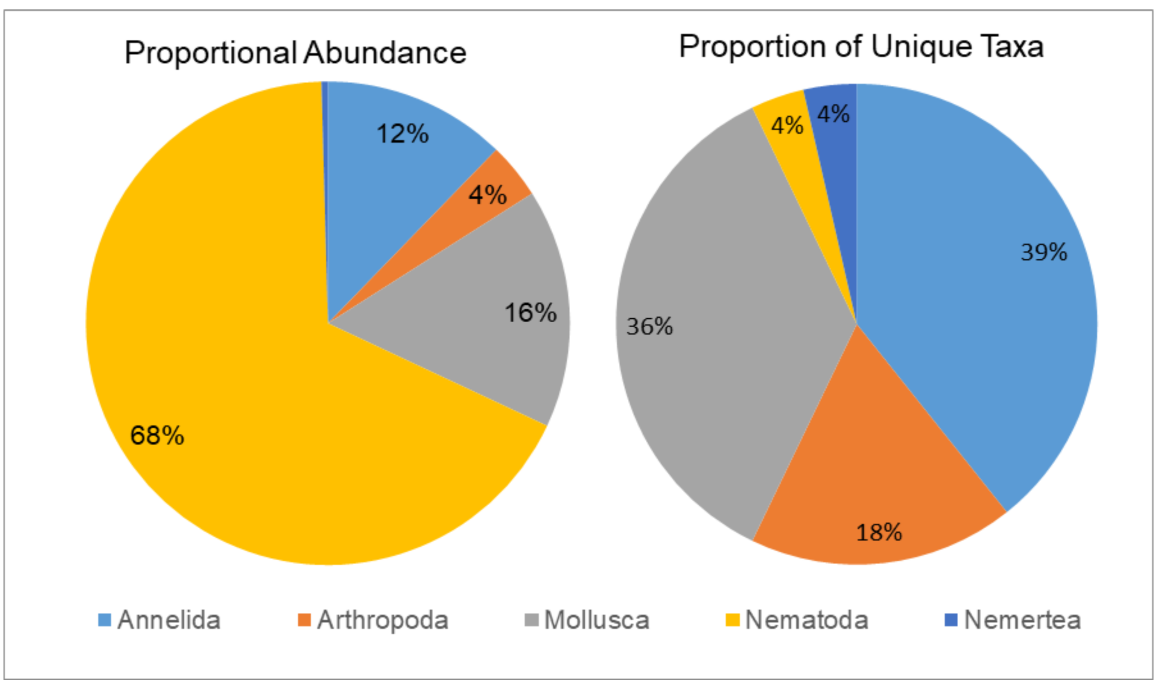


Figure 6. Proportional abundance and proportion of unique taxa (Family or LPTL) for each phylum collected in all (8) benthic grab samples collected in 2019 along the 501 South Offshore Export Cable Corridor. Results presented as percentage of total >1%.

Table 3. Phyla present in the benthic grab samples collected in the 501 South Offshore Export Cable Corridor during the 2017, 2018, and 2019 benthic surveys.

Sample Year and Number	Phyla	Abundant Taxonomic Groups (common names)	Density (Abundance per all 0.008 m^2 samples)	Number of Taxa (Unique family or LPTL)
2017 16 samples	Annelida	Polychaete and oligochaete worms	356	23
	Arthropoda	Amphipods	140	21
	Echinodermata	Sand dollars	1	1
	Mollusca	Sea snails, surf clams, nut clams	221	17
	Nematoda	Nematode worms	171	1
	Nemertea	Ribbon worms	2	2
	Platyhelminthes	Flatworms	1	1
	Total		892	66
2018 50 samples	Annelida	Polychaete worms	5,001	31
	Arthropoda	Amphipods, hooded shrimp	914	30
	Chordata	Tunicates	133	2
	Cnidaria	Sea anemones	3	3
	Echinodermata	Sand dollars, sea cucumbers	3	2
	Ectoprocta	Bryzoans	6	3
	Hemichordata	Acorn worms	1	1
	Mollusca	Nut clams, tellins	729	25
	Nematoda	Nematode worms	696	1
	Nemertea	Ribbon worms	80	5
	Platyhelminthes	Flatworms	8	1
	2018 Total		7,574	104
2019 8 samples	Annelida	Polychaete worms	141	11
	Arthropoda	Barnacles	43	5
	Mollusca	Sea snails, tellins	184	10
	Nematoda	Nematode worms	778	1
	Nemertea	Ribbon worms	5	1
	2019 Total		1,151	28

Samples collected in 2018 had higher average abundance, unique taxa, richness, and diversity than those collected in 2017 and 2019 (Table 4; Figure 7). Sample abundance ranged from 7 to 183 individuals in 2017, 5 to 691 individuals in 2018, and from 2 to 314 individuals in 2019. The number of unique taxa in each sample ranged from 3 to 27 in 2017, 2 to 33 taxa in 2018, and from 2 to 13 taxa in 2019. Richness and diversity ranged from 1.03 to 5.15 and 0.79 to 2.69 in 2017, respectively, and from 0.62 to 5.28 and 0.50 to 2.66 in 2018, and from 0 to 1.41 and 0 to 1.40 in 2019 (Table 5). Evenness between sampled collected in 2017 and 2018 was similar with mean evenness values of 0.79 in 2017 and 0.72 in 2018, while the evenness of samples from 2019 was consistently lower with a mean of 0.53.

Table 4. Summary of community composition parameters calculated for the 2017 (16 samples), 2018 (50 samples), and 2019 (8 samples) benthic grab samples collected in the 501 South Offshore Export Cable Corridor.

Survey	Avg. Density (Abundance per 0.008 m^2)	Avg. # of Taxa (family or LPTL	Ecological Indices (Avg.)		
			Richness	Diversity	Evenness
2017	56	11	2.70	1.80	0.79
2018	151	15	3.00	1.85	0.72
2019	143	7	1.16	0.91	0.53

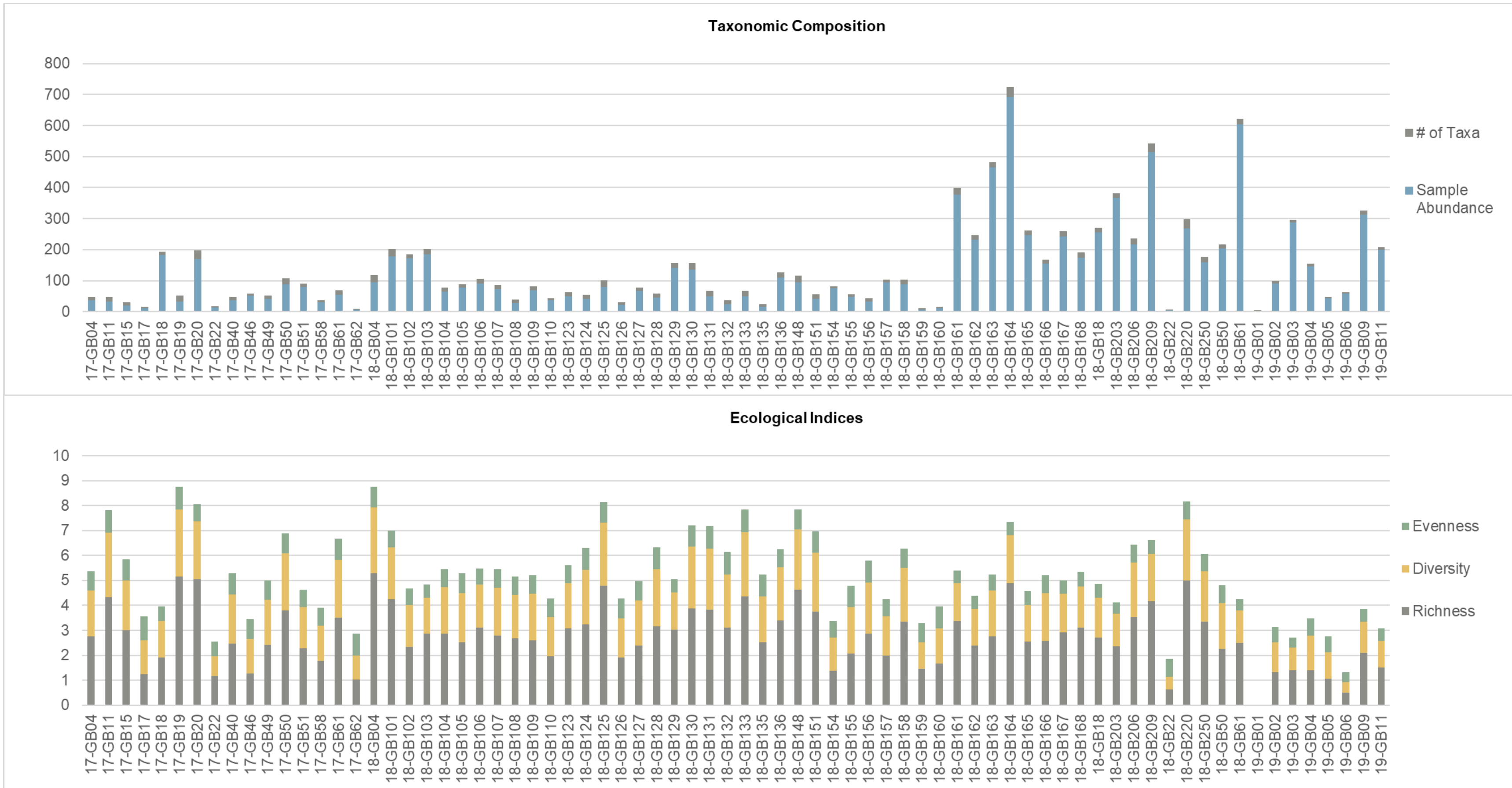


Figure 7. Taxonomic composition (top; # of unique taxa (family or LPTL) and total abundance per sample) and ecological indices (bottom; richness, diversity, and evenness per sample) for grab sample stations along the 501 South Offshore Export Cable Corridor.

Table 5. Community composition parameters calculated for each grab sample station along the 501 South Offshore Export Cable Corridor. The first two numbers in the station name indicate year sample was taken (e.g., 17-GB04 represents grab station 04 from the 2017 survey).

Station	Density (Abundance per 0.008 m^2)	# of Taxa (family or LPTL)	Ecological Indices		
			Richness	Diversity	Evenness
17-GB04	37	11	2.77	1.83	0.77
17-GB11	32	16	4.33	2.58	0.93
17-GB15	20	10	3.00	1.99	0.86
17-GB17	11	4	1.25	1.34	0.97
17-GB18	183	11	1.92	1.44	0.60
17-GB19	33	19	5.15	2.69	0.91
17-GB20	170	27	5.06	2.31	0.70
17-GB22	13	4	1.17	0.79	0.57
17-GB40	38	10	2.47	1.97	0.85
17-GB46	53	6	1.26	1.40	0.78
17-GB49	41	10	2.42	1.79	0.78
17-GB50	89	18	3.79	2.30	0.80
17-GB51	80	11	2.28	1.65	0.69
17-GB58	30	7	1.76	1.42	0.73
17-GB61	55	15	3.49	2.32	0.86
17-GB62	7	3	1.03	0.96	0.87
18-GB04	94	25	5.28	2.66	0.83
18-GB18	255	16	2.71	1.59	0.57
18-GB22	5	2	0.62	0.50	0.72
18-GB50	204	13	2.26	1.83	0.71
18-GB61	605	17	2.50	1.29	0.46
18-GB101	179	23	4.24	2.08	0.66
18-GB102	172	13	2.33	1.69	0.66
18-GB103	185	16	2.87	1.44	0.52
18-GB104	65	13	2.87	1.85	0.72
18-GB105	77	12	2.53	1.96	0.79
18-GB106	91	15	3.10	1.74	0.64
18-GB107	74	13	2.79	1.92	0.75
18-GB108	29	10	2.67	1.73	0.75
18-GB109	70	12	2.59	1.87	0.75
18-GB110	36	8	1.95	1.57	0.76
18-GB123	49	13	3.08	1.82	0.71
18-GB124	41	13	3.23	2.21	0.86
18-GB125	80	22	4.79	2.52	0.82
18-GB126	23	7	1.91	1.57	0.81
18-GB127	67	11	2.38	1.83	0.76
18-GB128	45	13	3.15	2.29	0.89
18-GB129	141	16	3.03	1.48	0.53
18-GB130	136	20	3.87	2.50	0.83
18-GB131	50	16	3.83	2.45	0.88
18-GB132	25	11	3.11	2.13	0.89
18-GB133	49	18	4.37	2.58	0.89
18-GB135	16	8	2.52	1.84	0.88
18-GB136	109	17	3.41	2.11	0.74

Station	Density (Abundance per 0.008 m^2)	# of Taxa (family or LPTL)	Ecological Indices		
			Richness	Diversity	Evenness
18-GB148	94	22	4.62	2.44	0.79
18-GB151	42	15	3.75	2.36	0.87
18-GB154	76	7	1.39	1.32	0.68
18-GB155	48	9	2.07	1.86	0.85
18-GB156	33	11	2.86	2.07	0.86
18-GB157	94	10	1.98	1.59	0.69
18-GB158	88	16	3.35	2.14	0.77
18-GB159	8	4	1.44	1.07	0.77
18-GB160	11	5	1.67	1.41	0.88
18-GB161	377	21	3.37	1.52	0.50
18-GB162	232	14	2.39	1.45	0.55
18-GB163	465	18	2.77	1.83	0.63
18-GB164	691	33	4.89	1.91	0.55
18-GB165	246	15	2.54	1.48	0.55
18-GB166	154	14	2.58	1.90	0.72
18-GB167	242	17	2.91	1.54	0.55
18-GB168	175	17	3.10	1.66	0.59
18-GB203	367	15	2.37	1.28	0.47
18-GB206	217	20	3.53	2.19	0.73
18-GB209	515	27	4.16	1.89	0.57
18-GB220	269	29	5.00	2.44	0.73
18-GB250	158	18	3.36	2.01	0.69
19-GB01	2	1	0.00	0.00	NA
19-GB02	91	7	1.33	1.18	0.61
19-GB03	288	9	1.41	0.89	0.40
19-GB04	147	8	1.40	1.40	0.67
19-GB05	43	5	1.06	1.05	0.65
19-GB06	59	3	0.49	0.44	0.40
19-GB09	314	13	2.09	1.27	0.50
19-GB11	200	9	1.51	1.07	0.49

When combining samples from the three surveys, samples collected in Fine Sand 2 habitat had the highest average densities, while samples in Fine Sand 1 had highest average scores for the three ecological indices (Table 6). Although average density was relatively high, samples from silt habitats, most of which were from the nearshore 2019 sampling, had low average values of richness, diversity, and evenness.

Table 6. Summary of community composition parameters calculated by habitat type for benthic grab samples collected in the 501 South Offshore Cable Corridor.

Survey	Avg. Density (Abundance per 0.008 m^2 sample)	Avg. # of Taxa	Ecological Indices (Avg.)		
			Richness	Diversity	Evenness
Silt	130	7	1.18	0.93	0.58
Fine Sand 1	130	15	3.21	1.96	0.76
Fine Sand 2	164	15	2.99	1.84	0.69
Coarse Sand	65	13	2.26	1.60	0.75

2.2 Statistical Analyses

2.2.1 Methods

One- and two-way analysis of variance (ANOVA) following the Type III sums of squares approach in R (Fox and Weisberg 2019; R Core Team 2020) was used to test for relationships between sample year, habitat type, and infauna diversity. The Shannon Diversity Index was used to calculate the response variable as it is widely used and is a universally accepted ecological index that accounts for both richness and evenness in its estimation. Due to the difference in spatial scales between samples collected in 2017/2018 and 2019, two separate tests were conducted. The first analysis tested whether there was a difference between the infaunal diversity of samples collected in different years and in different habitats. Sample year included two levels, 2017 and 2018. Habitat type included four levels: Silt, Fine Sand 1, Fine Sand 2, and Coarse Sand. The two null hypotheses tested with the two-way ANOVA included:

$H_0$1: There is no difference in mean diversity for different year.

$H_0$2: There is no difference in mean diversity for different habitat types.

As mentioned above, only the landfall region of the OECC was sampled in 2019, therefore, for the second analysis, samples collected within the landfall region were used to test differences in infanual diversity between sampling years. Due to the small sample size (1 sample in 2017 and 4 samples in 2018) and non-significant year effect (described below) between the infaunal diversity of samples collected in 2017 and 2018, they were combined into a single sampling year (2018) for this test. The null hypothesis tested with the one-way ANOVA was:

$H_0$1: There is no difference in mean diversity between years.

Multivariate analyses were conducted in R (Oksanen et al. 2019; R Core Team 2020) to examine dissimilarity/similarity of stations based on the infaunal assemblages (composition of all species and their abundances). These analyses included nonmetric multidimensional scaling (NMDS), analysis of similarities (ANOSIM), and analysis of similarity percentages (SIMPER; Clarke 1993). All analyses were built on a Bray-Curtis Similarity Index, which used square-root transformed data to ensure all taxa (not just those that dominated samples) would contribute to similarity measures. Differences in the infaunal assemblages between stations were assessed using sample year, depth (shallow [<30 m] and deep [>30m]), location, and habitat classification.

NMDS with two dimensions was used to compare the distance (difference) between data points and visually evaluate patterns of similarity in the data. Dendrograms present the discrete groupings of samples with similar community structures while NMDS plots present data and groupings spatially, with samples ordinating based on similarity to one another. Samples of high similarity are plotted in proximity to one another in NMDS plots.

SIMPER was used to identify the percent dissimilarity between location and taxa that were most responsible for dissimilarity (i.e., the taxa with the largest difference in mean abundance). ANOSIM was used to help determine if year, depth (shallow or deep), location, or habitat classifications were predictive of the infaunal assemblage clusters. The test statistic “R” calculated in the Global ANOSIM indicates whether samples within classification groups were more similar than samples between groups. R values closer to 1 than 0 and significance levels of $p < 0.05$ indicate that samples within a classification group are more similar to each other than to those in different groups. Specifically, ANOSIM was used to test four null hypotheses:

$H_0$1: Infaunal assemblages do not change within years.

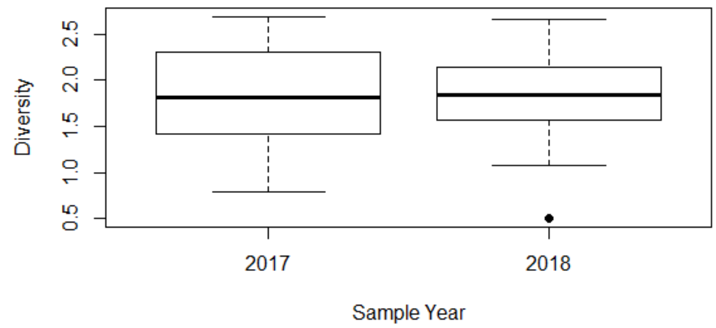
$H_0$2: Infaunal assemblages do not change within sampled collected in shallow or deep waters.

$H_0$3: Infaunal assemblages do not change within locations.

$H_0$4: Infaunal assemblages do not change within habitat types.

2.2.2 Results

The two-way ANOVA using Type III sums of squares testing for associations of year (2017 and 2018 only) and habitat type with infaunal diversity found that there was no significant difference in mean diversity between years or habitat types (P = 0.73 and P = 0.21, respectively). The lack of significant interaction between infaunal diversity and the two response variables (year and habitat) was likely due to high variability within the dataset (Figure 8) in addition to the difficulties of trying to assess communities based on a metric (e.g. in this case: diversity index).



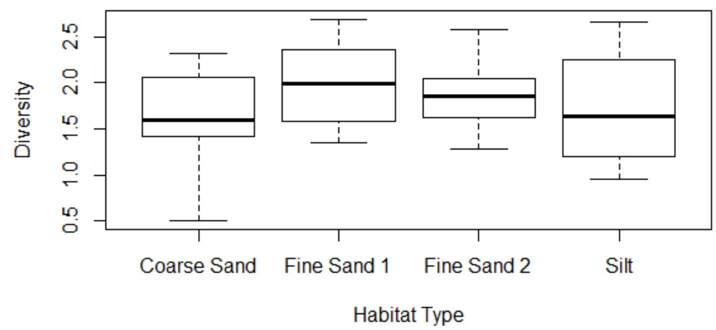


Figure 8. Boxplot presenting the range of diversity values within each sample year (top) and habitat type (bottom) for samples collected in 2017 and 2018. The bold horizontal line represents the median value.

The results for the one-way ANOVA indicated that mean diversity of infaunal samples was significantly different between years (P = 0.003). As can be seen in Figure 9, diversity was higher in landfall samples collected during the 2017 and 2018 surveys than in the 2019 survey.

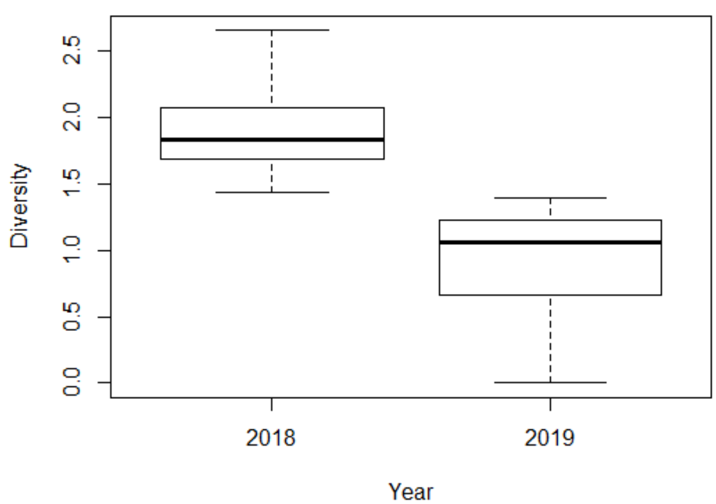


Figure 9. Boxplot presenting the range of diversity values within survey year for samples collected in the landfall area. The bold horizontal line represents the median value.

Multivariate analyses distinguished infaunal assemblages in the 74 samples from the 2017, 2018, and 2019 surveys within the 501 South OECC. Results from the cluster analysis and NMDS based on the Bray-Curtis dissimilarity of infaunal assemblages are presented below in a series of figures including a dendrogram and multiple MDS plots (Figure 10 - Figure 14). Overall, results from the NMDS analysis indicated that ordination summarized the distance of data points only moderately well with a stress value of 0.22. The dendrogram (Figure 10) displays seven higher level clusters, which include a mix of samples from all sample years.

The NMDS plots were spatially ordinated based on their Bray-Curtis dissimilarity and color-coded based on variables including sample year, depth (shallow [<30 m] or deep [>30 m]), location, and habitat type. As observed in the dendrogram (Figure 10), there was no clear clustering across samples collected in different years. As seen in the NMDS plot color-coded by sample year (Figure 11), there is much overlap in grabs from 2017 and 2018, but seven of the eight samples collected in 2019 are ordinated in a loose cluster, indicating increased interannual similarity in grabs collected in 2019 relative to the previous years. The NMDS plot coded by depth showed deeper sites were generally more-similar to each other (ordinated near the bottom of the plot), with higher variability and dissimilarity among sites in the shallower depths (Figure 12). In general, similarity in sample assemblages is greater within sampling locations then they are across sampling locations indicating regional similarity of habitats (Figure 13). Samples collected in the southern OECC produced a clear cluster, indicating that the infaunal assemblage of samples in this area is more homogenous when the NMDS ordination was color-coded based on sample location (Figure 13). Although there is some clustering of samples collected near the landfall, these data are potentially biased because these clustered samples were all collected in 2019 (Figure 11) and therefore the grouping could be a result of missing interannual variability captured at the other sample locations. Samples from the northern OECC region were spread throughout the plot, indicating highest variability in the infaunal assemblages in this region. Loose clustering of samples from the Muskeget channel can also be observed, as they primarily ordinated in a single quadrat of the plot, indicating similarities between infaunal assemblages. As displayed in Figure 14, samples collected in each of the habitat types were spread throughout the ordination plot with comparable inter- and intra-group similarities when the plot was color-coded by habitat type.

The ANOSIM results of the individually analysed categorical variables year, depth (shallow or deep), location, and habitat type all rejected the null hypothesis that infaunal community assemblages do not change within categorical levels (significance value of $p = 0.001$). However, the R statistic for the ANOSIM of year, depth, and habitat type was low (0.10 to 0.26) indicating each variable only weakly accounted for the similarities/differences between the infaunal communities at each site (Table 7). The R statistic for the ANOSIM of location was 0.40, indicating that infaunal assemblages are likely similar within each location group, however variability is high between groupings.

Table 7. Results from the ANOSIM conducted on the four classification groups.

Test Variable	R Statistic	P-Value
Year	0.26	0.001
Depth	0.26	0.001
Location	0.40	0.001
Habitat Type	0.17	0.001

The SIMPER analysis was conducted on the location factor because the ANOSIM demonstrated significant relationships between the infaunal assemblages within this classification. Results from the SIMPER analysis, listed in Table 8, present the percent of dissimilarity between two sampling locations and the three taxa that contributed the most to the dissimilarity. The location pair with the most dissimilar infaunal assemblages was Muskeget and the southern OECC, which were 83% dissimilar. Infaunal assemblages in the northern OECC and the landfall had the lowest dissimilarity (75%) with Nematoda, Capitellidae, and Oligochaeta accounting for 29% of the dissimilarity between assemblages from samples collected in each location. Nematoda consistently accounted for high proportions of the dissimilarity between samples in the different locations and was typically one of the three most influential taxa (Table 8).

Table 8. SIMPER results of the dissimilarity of infaunal assemblages between grab locations and depth categories.

Location (A)	Location (B)	Bray-Curtis Dissimilarity	Dissimilar Taxa[a]	% Contribution	Av. Abundance[b] (A)	Av. Abundance[b] (B)
Muskeget	Southern OECC	83%	Polygordiidae	12%	0.00	7.10
			Oligochaeta	6%	0.95	3.88
			Nematoda	5%	2.99	2.50
Landfall	Southern OECC	81%	Nematoda	12%	7.81	2.50
			Polygordiidae	11%	0.23	7.10
			Oligochaeta	6%	2.06	3.88
Northern OECC	Southern OECC	80%	Polygordiidae	12%	0.49	7.10
			Oligochaeta	6%	1.78	3.88
			Capitellidae	5%	2.71	0.63
Landfall	Muskeget	80%	Nematoda	15%	7.81	2.99
			Capitellidae	7%	2.62	0.00
			Syllidae	6%	1.56	2.31
Northern OECC	Muskeget	77%	Capitellidae	7%	2.71	0.00
			Nematoda	6%	2.28	2.99
			Tellinidae	6%	2.25	0.65
Landfall	Northern OECC	75%	Nematoda	16%	7.81	2.28
			Capitellidae	8%	2.62	2.71
			Oligochaeta	6%	2.06	1.78

[a] Includes taxa contributing highest percentage to the dissimilarity between location
[b] Average square-root transformed abundance

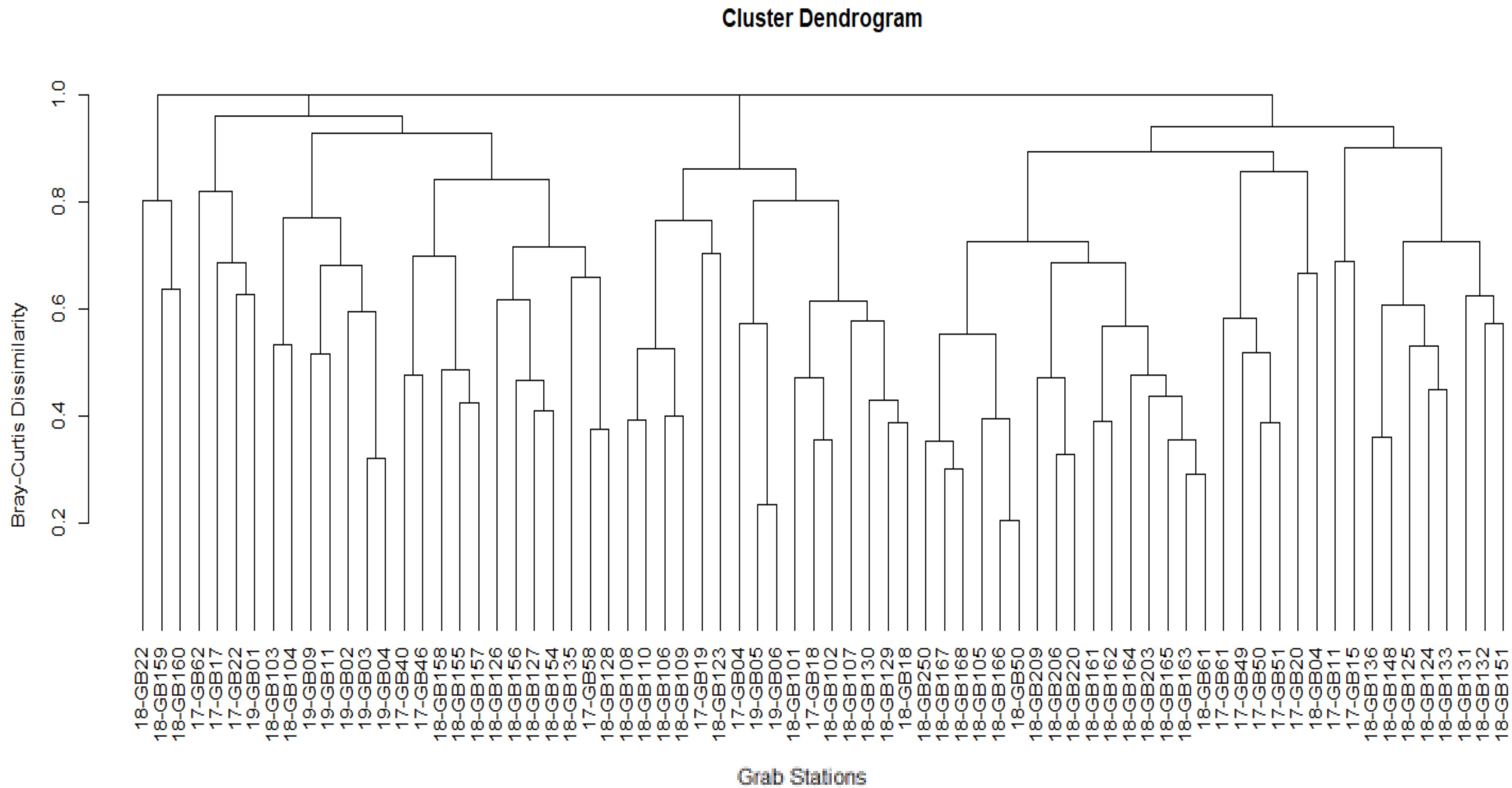


Figure 10. Dendrogram from cluster analysis based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 74 stations sampled in the 501 South Offshore Export Cable Corridor. Branches are based on the dissimilarities between those clusters of samples (i.e., samples with lower level clusters are more similar to one another than other samples outside of the cluster), which is labelled on the y-axis. The number before the grab site (GB) indicates sample year (i.e., 18-GB110 represents grab sample 110 collected in 2018).

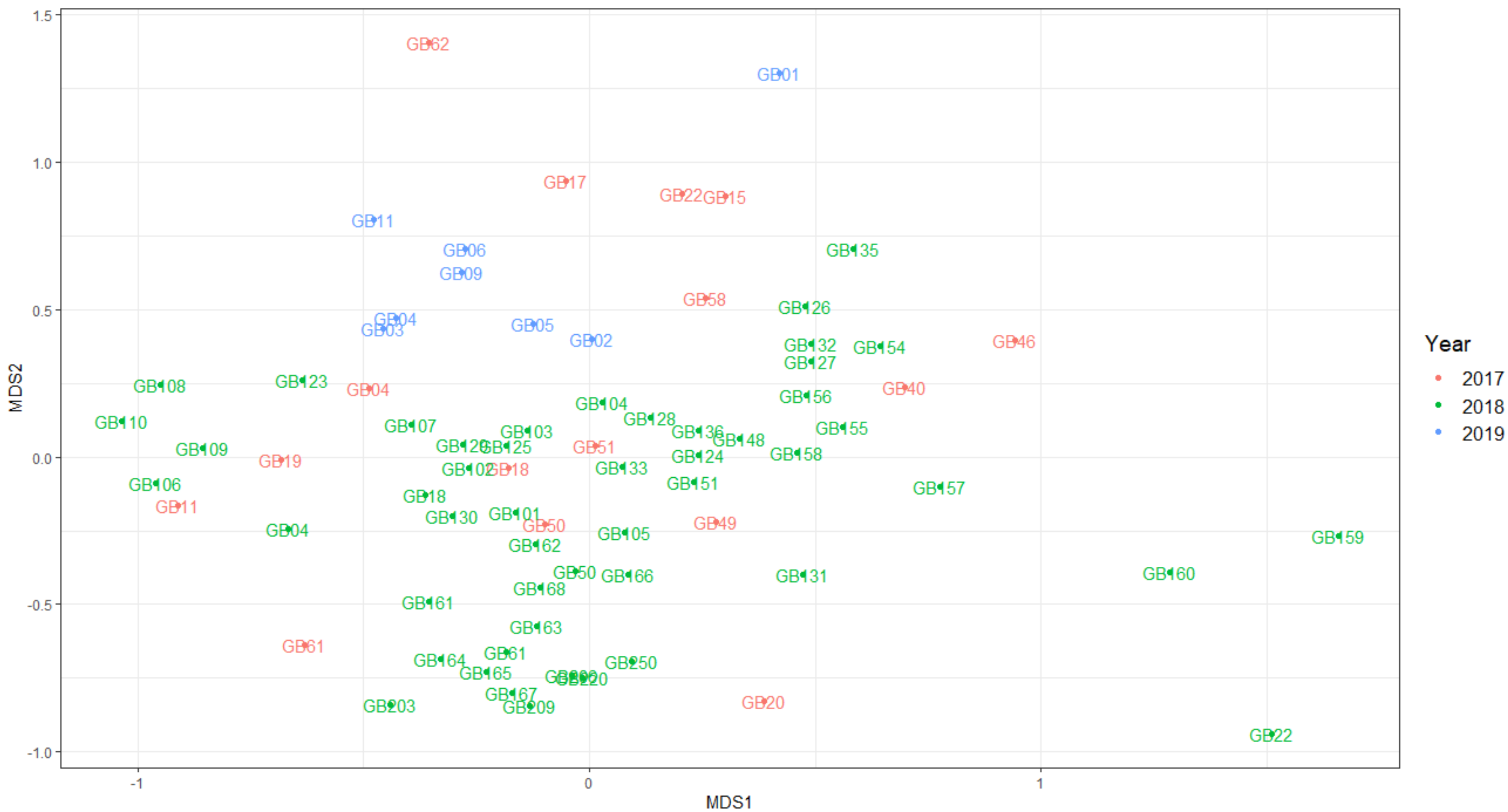


Figure 11. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 74 stations sampled along the 501 South Offshore Export Cable Corridor in the 2017, 2018, and 2019. Red points represent samples collected in 2017, green points represent samples collected in 2018, and blue points represent samples collected in the 2019.

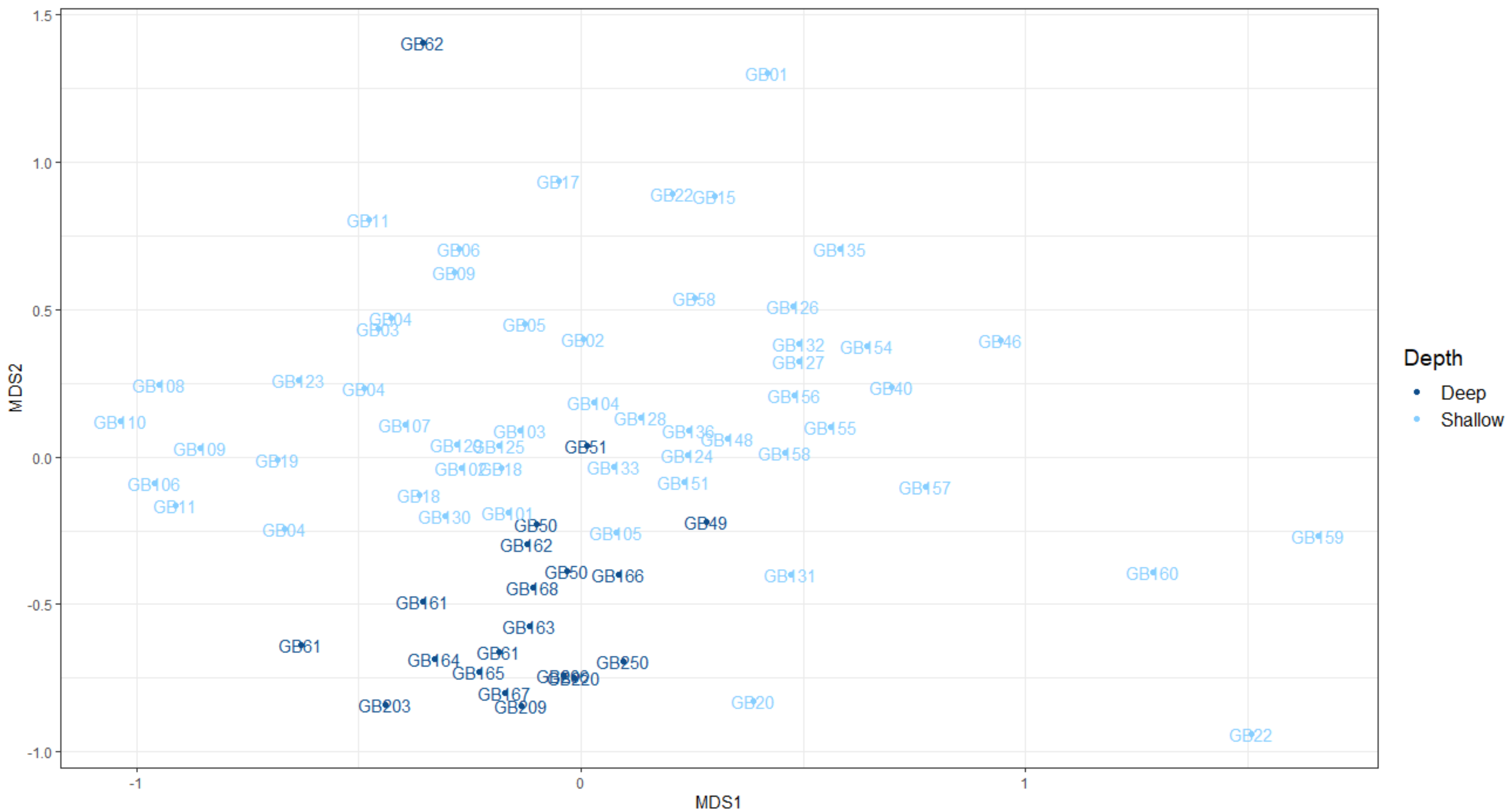


Figure 12. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 74 stations sampled along the 501 South Offshore Export Cable Corridor in the 2017, 2018, and 2019. Light blue points represent samples located in shallow waters (<30 m depth) and dark blue points represent samples located in deep waters (>30 m depth).

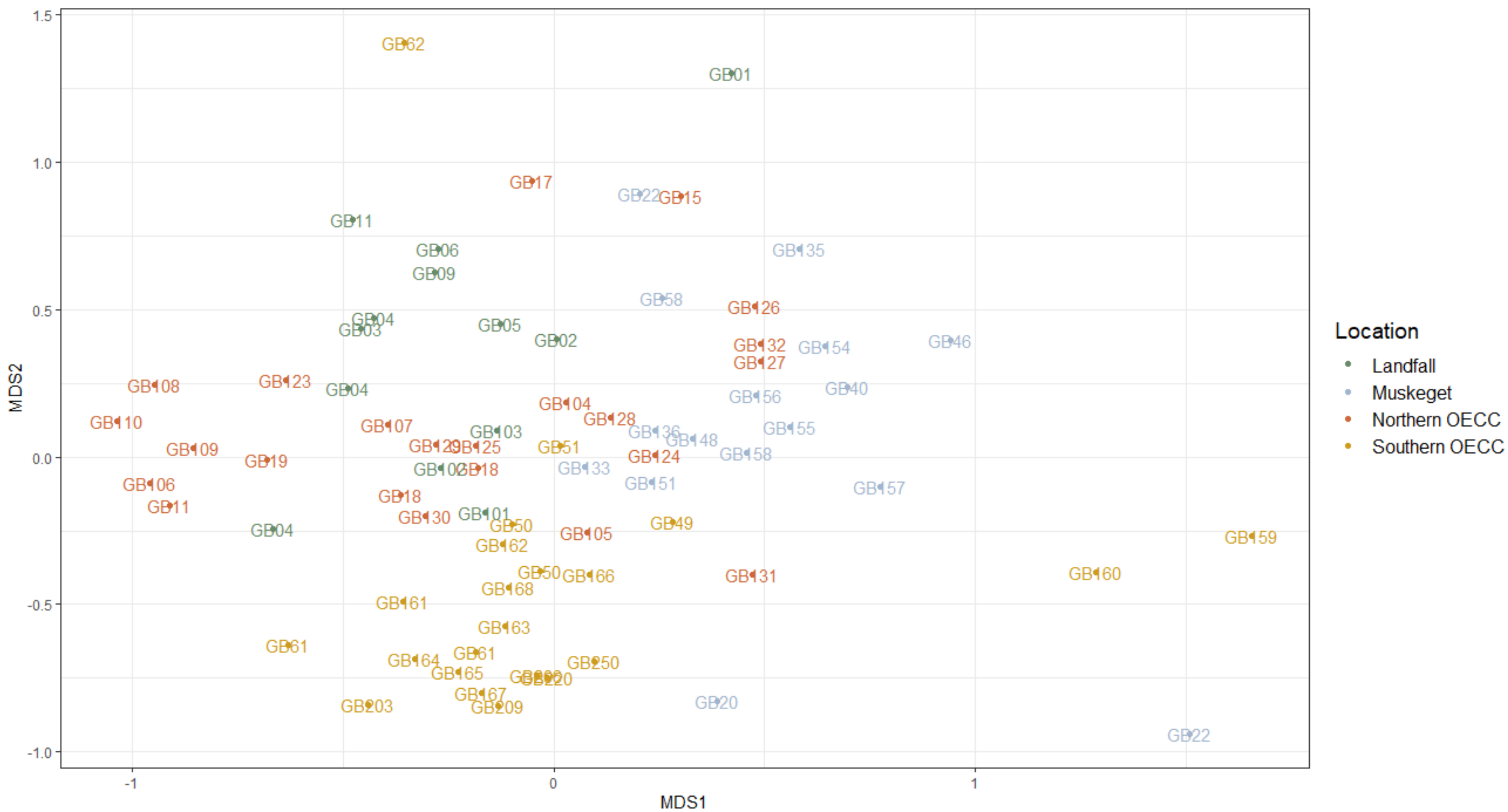


Figure 13. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 74 stations sampled along the 501 South Offshore Export Cable Corridor in the 2017, 2018, and 2019. Each symbol represents a station that is color-coded based on sample location.

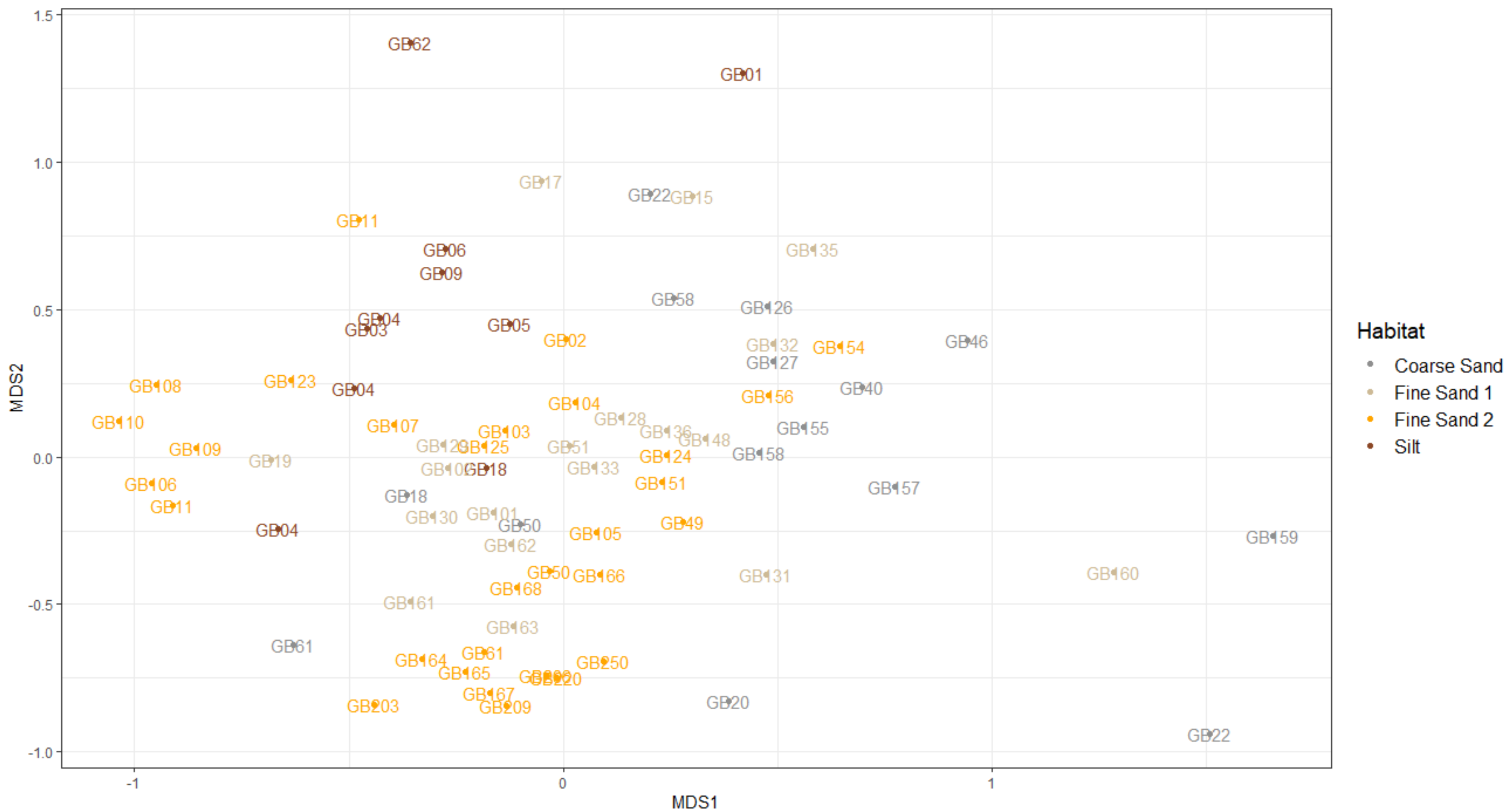


Figure 14. NMDS plot based on Bray-Curtis similarities of square-root transformed infaunal abundances at the 74 stations sampled along the 501 South Offshore Export Cable Corridor in the 2017, 2018, and 2019. Each symbol represents a station that is color-coded based on habitat type.

3 DISCUSSION

Across the three surveys included in this analysis, organisms from the phyla Annelida, Nematoda, and Mollusca were consistently dominant in benthic grab samples throughout the OECC. Polychaete worms were particularly abundant in the samples collected in 2018, accounting for over 60% of the total abundance. Nematode worms dominated the samples in 2019, occurring in all eight samples with 778 nematodes identified. Overall, abundance, number of unique taxa and phyla, richness, and diversity were higher across samples collected in the summer 2018 survey than the 2017 and 2019 surveys.

Results from the ANOVA and dissimilarity analyses also indicated significant differences in the ecological indices and infaunal assemblages of samples collected in the landfall areas during the 2017/2018 and 2019 surveys, with samples collected in 2019 being significantly different from those collected in other years. Alternatively, no significant difference in mean diversity was observed between all samples collected during the 2017 or 2018 surveys. These results may indicate that interannual variability can be distinguished at smaller spatial scales, while these relationships are not apparent when testing across the entire OECC.

Dissimilarities between infaunal sample assemblages could be significantly explained by sediment-based habitat type as found in both the ANOSIM and NMDS ordination. However, the R value for the ANOSIM was small (weak) and no strong clustering based on habitat type is apparent in the NMDS plot, with samples exhibiting comparable inter- and intra-group similarities. The low intra-habitat similarity of infaunal assemblages relative to inter-habitat similarity indicates high variability between sampling sites regardless of habitat. In other words, two samples from the same habitat types were likely to be about equally dissimilar as two samples from different habitat types. In addition, habitat classifications, which were based on CMECS using field notes, are limited in their ability to explain other important habitat features, such as the composition of more complex substrates (e.g., gravel), biogenic materials (e.g., algae, worm tubes, amphipod bed structures), that are also likely important indicators of macroinfaunal community composition.

Spatial variability and offshore conditions could also explain the similarities between infaunal assemblages observed along the OECC. Although ANOSIM results indicated that infaunal assemblages were weakly similar within depth categories (shallow vs deep), the respective NMDS plots show noticeable clustering of the deeper water samples. In addition, plain fine sand (Fine Sand 2) habitat was common in samples from deeper waters, which may indicate increased similarity of infaunal assemblages within these offshore homogenous sand habitats.

Results from the ANOSIM of the variable “sample location” indicated that this classification described differences between infaunal assemblages moderately well, however, there is likely large overlap between the groups. This is apparent in the NMDS plot, which shows a high level of overlap between some location groupings. Samples from the southern OECC formed the tightest cluster, while those from the northern OECC spread across the ordination plot. Samples from Muskeget and the landfall area did not form tight clusters but are primarily ordinated together with increased distance between points. In other words, as expected, it appears that the general sampling location within the OECC can be an indicator of the species present.

The SIMPER results found that in general, samples located closer together were more similar to each other than other locations along OECC. Infaunal assemblages in samples collected in the landfall areas and the northern OECC were the least dissimilar to each other (75%), while assemblages from the landfall area and northern OECC were most dissimilar to those from the southern OECC. This pattern was not observed further offshore as the infaunal assemblages from samples collected in the southern OECC and Muskeget channel were the most dissimilar (83%) of all locations. This dissimilarity could be related to the homogenous vs heterogenous habitats observed in each location as samples from the southern OECC were primarily plain fine sand habitat (Fine Sand 2), while those in Muskeget included both fine sand classifications and coarse sand. The SIMPER was useful in determining taxa that contributed the most to the dissimilarity in infaunal abundances between locations and demonstrated that a few taxa consistently contribute large percentages to that dissimilarity, including Nematoda, Oligochaeta, and Polygordiidae and Capitellidae. However, SIMPER is sensitive to abundance and reflects the larger-scale variability of individual common taxa, rather than differences in rare or unique taxa. In general, the SIMPER results supported that benthic communities change along a gradient moving offshore, with nearshore and offshore sampling detecting different communities as would be expected.

Overall, with the current data available, identifying a single variable, or multiple very strong variables for predicting similarity/dissimilarity between infaunal communities of samples is not possible. There is evidence that samples taken from within the same general location, year, or depth are more likely to be similar within categories than across categories, but there is too much variability or other confounding influences preventing the establishment of strong relationships. Some of these potential influences include interannual, seasonal, and or spatial variability. However, there is support that there is greater similarity between sample community assemblages offshore than in nearshore locations.

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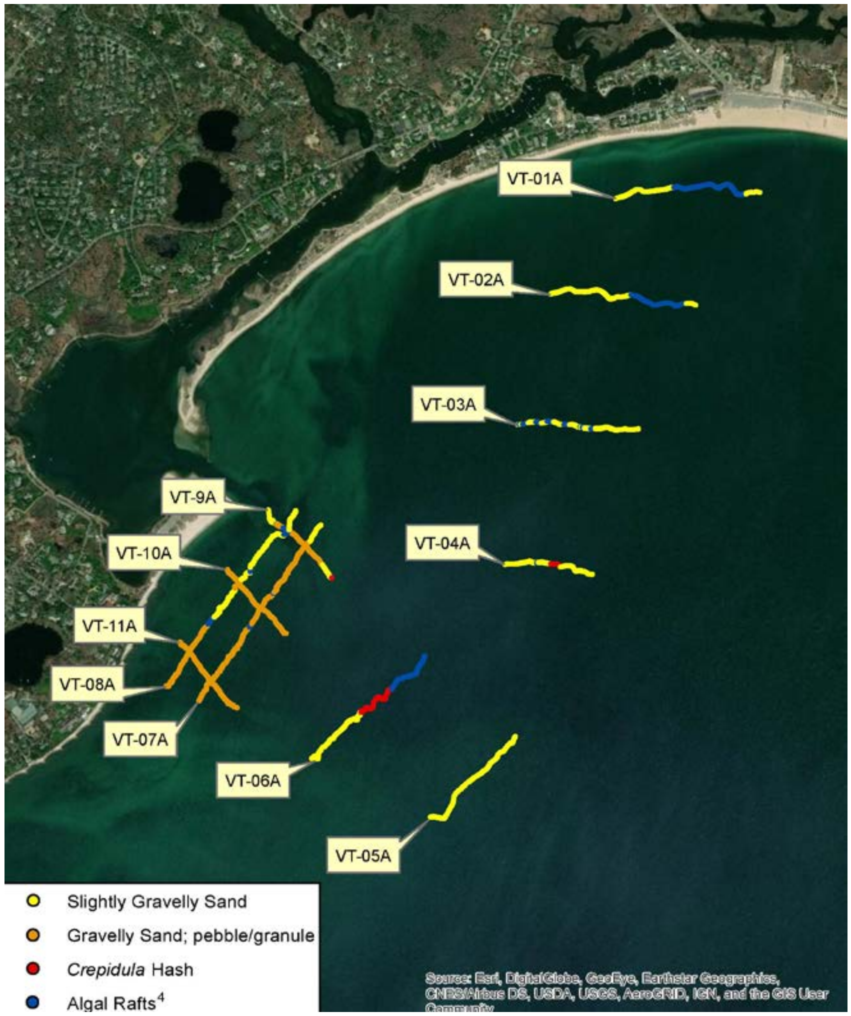
8. CR Environmental 2019 Underwater Video Review

NOVEMBER 2019 UNDERWATER VIDEO SURVEY
Vineyard Wind Project
Barnstable Landing Sites Centerville Harbor
Barnstable, MA



Substrate Classification Barnstable Landing Sites

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January 2020

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1.0 INTRODUCTION

On November 5 and 6, 2019 CR Environmental, Inc. (CR) performed underwater video surveys for Seaforth Geosurveys, Inc. (Seaforth) to document bottom substrate and biota, and identify any potential SSU's at the two proposed Vineyard Wind Barnstable landing sites in Centerville Harbor, Centerville, MA. Underwater video data were collected along 11 video transects, and at 11 sediment grab stations as directed by Seaforth and Geo SubSea LLC.

The collected sediment grabs were provided by Seaforth to ESS Group, Inc. for benthic enumeration and Geotesting Express for grain size analysis. The results of these analyses are discussed elsewhere.

2.0 METHODS

2.1 Vessel and Navigation

Vessel operations were performed from CR's 26-foot custom built aluminum landing craft style vessel, *Lophius.* The vessel has a large enclosed pilothouse, benches for survey equipment, stern mounted davit and hauler, bow mounted A-frame and hydraulic winch. Operations were staged out of the Hyannis Marina in Hyannis Harbor.

Navigation for the surveys was accomplished using a Hemisphere V104 Sub-meter GPS and Heading Sensor that was serially interfaced to a shipboard computer running HYPACK 2015 hydrographic surveying software. This system calculated X and Y positions in the desired grid system (UTM North, Zone 19 (72W-66W), Meters), recorded navigation data, and provided a steering display for the vessel captain.

Progress of the video survey along the proposed transects and grab sampling operations was followed in HYPACK using georeferenced imagery (e.g. orthophotos) as a background file by the vessel captain thus ensuring transect coverage and collection of the grab samples and video at the designated positions.

GPS offsets to the bow mounted A-frame on *Lophius* were input into the HYPACK software. A layback was not entered as the grab sampler and video sled were one to three meters from the A-frame at all time due to the shallow water conditions.

2.2 Underwater Video Methods

2.2.1 Grab video and sediment sampling methods

Grab video and sediment samples were collected at 11 stations (GB-01A through GB-11A) in Centerville Harbor in the vicinity of the proposed landing alignments on November 5, 2019. Proposed sampling locations were provided by Seaforth. CR's Outland Technologies cabled underwater video system and lights were mounted on the grab sampler facing downward and one to two minutes of video footage was recorded prior to collecting each sediment grab. One grab was taken at each station using a Ted Young $0.1m^2$ modified Van Veen grab sampler.

Due rough sea conditions and abundant rafting algae and benthic macroalgae it was often necessary to land the grab sampler on the bottom and wait for the visibility to improve in order to obtain a clearer image of the bottom. Rafting algae at GB-09A required that a second video and grab attempt be made (GB-09B). One or two video screen captures were created for each sediment grab station from the Outland camera footage and notes on visible substrate recorded. Collected sediment grabs were split by subsampling each grab using clean CAB core liner. Seaforth transferred sediment to Geotesting Express for grain size analysis and ESS Group for benthic enumeration.

2.2.2 Video methods along planned transects

Underwater video data were collected on November 6, 2019 along 11 transects with CR's portable towed video sled consisting of a lightweight aluminum frame, Outland Technologies' (OTI) high-definition color video camera, and two wide-angle LED video lights with variable output control. The OTI video camera was cabled to an OTI-1080 HD DVR recorder and high resolution daylight monitor at the surface. As a back-up video system, a GoPro Hero 4+ Black video camera in a Golem Gear deep water housing was mounted below the OTI camera and programmed to record full HD video at 1080P, 30 frames per second, and take 12 megapixel still frames every 10 seconds. Prior to deploying the video sled the OTI camera time was synced to the time on the navigation system. The start time of the video transect for the OTI and GoPro cameras were synced by videotaping the transect number and date on a white board prior to deployment.

The video sled was operated in drift and towed mode. The sled was raised and lowered using the bow mounted A-frame and hydraulic winch on *Lophius*, and the height of the system off the bottom was continually adjusted to achieve the best bottom coverage and video quality. When the video camera was one foot off the bottom, the viewing area of the camera was approximately 1.5 feet x 1.5 feet (18 inches x 18 inches), and the video quality was optimal for bottom sediment characterizations and biota identifications. For scaling purposes, lasers were set 8 inches (20 cm) apart and a calibration check was performed prior to survey operations.

Camera footage was backed up on an external hard drive at the end of the underwater video operation. The video transect data from the OTI camera video footage that displayed time from the GPS was reviewed first. A minimum of every 30 seconds, detailed notes of biota or changes in substrate, actual time, and video screen captures were created by a CR marine biologist. Subsequently, the higher resolution GoPro camera footage was reviewed to confirm species identifications and bottom substrate characterization and to create a series of three representative video screen captures for each transect.

All raw navigation and underwater video data has been furnished to Seaforth. Additionally, 40 to 80 underwater video footage screen captures from the OTI camera, and 15 to 30 screen captures from the Go Pro camera are archived at CR, and can be made available.

Data compiled for each transect includes:

- The CMECS (FGDC-STD, 2012) substrate and biotic components,
- The MA CZM modified Barnhardt et al. (1998) substrate classification,
- Identification of the dominant fauna and its relative abundance,
- Presence/absence data for biota (fauna, seagrass and macroalgae) observed, and
- The presence of MA CZM Special, Sensitive or Unique Resources.

The Coastal and Marine Ecological Classification Standard (CMECS) is a hierarchical arrangement of biogeographic and aquatic setting units and components (water column, geoform, substrate and biotic) that were used to describe ecosystem features within Centerville Harbor in the vicinity of the proposed landing sites (FGDC, 2012).

Also provided are MACZM's modified Barnhardt et al. (1998) substrate classifications (Fine, Fine with Gravel, Fine with Rock, Gravel with Fine, Gravel, Gravel with Rock, Rock with Fine, and Rock); and the observation of any Massachusetts CZM Special, Sensitive or Unique Resources (SSUs) such as, eelgrass beds, hard complex substrate, or commercially important species.

3.0 RESULTS

3.1 Video Sled Transect Results

The underwater video transects as for the two proposed Barnstable landing sites included eight shore parallel transects and three shorter transects perpendicular to the two most westerly transects off Dowses Beach (Figure 1). Table 1 provides the bottom substrate and biotic components observed at each video transect based on the Coastal and Marine Ecological Classification System (CMECS) (FDGC, 2012). Also listed are MACZM's modified Barnhardt et al. (1998) sediment classes, and dominant faunal species observed. Substrate components and areas of algal rafts that partially obscured the substrate are mapped on Figure 1.

A list of flora and fauna observed by transect along with summary statistics of species observations by transect and frequency of observation across transects are provided on Table 2. Plates 1-11 provide screen captures of bottom substrate and biota.

3.1.1 CMECS interpretation from video footage

The CMECS biogeographic setting for the Barnstable landing site was identified as the Virginian ecoregion, the cold temperate Northwest Atlantic province, and the temperate North America realm (Table 4). Water column components were not directly measured within the landing sites marine nearshore subtidal waters however it is estimated that lower water column waters were likely polyhaline. Raw depths on underwater video transects ranged from 2.2 meters (7.2 feet) to 6.3 meters (20.6 feet) at the time of the survey. The geoform component tectonic setting is a passive continental margin and the physiographic setting is an embayment/bay. The main type of unconsolidated bottom substrate geoform encountered was low relief ripples. Visually estimated surficial substrates were primarily of geologic origin and consisted of coarse unconsolidated gravelly sand, and fine unconsolidated slightly gravelly sand. Biogenic substrate was often present in the form of shell mixed with or overlying the sand, and on portions of transects VT-04A, 06A, and 09A formed *Crepidula* hash (Figure 1). Gravelly sand was the predominant substrate component on inshore transects near the entrance to East Bay (VT-11A, 10A, 09A, 08A, and 07A) (Figure 1, Table 1). Finer slightly gravelly sand was observed at the offshore transects (VT-06A, 05A, 04A, and 03A) and the eastern inshore transects off Craigville Beach (VT-02A, and 01A). Most of the gravelly sand bottom was comprised of sand ripples with gravel found in the sand ripple troughs. Only a few isolated cobbles particularly on inshore transects near the entrance to East Bay, and no boulders were observed during the survey operation.

The biotic components consisted of algal rafts of branching red algae, and aquatic vegetation bed subclass benthic macroalgae including *Codium* and *Sargassum*. Rafting algae floated above the seabed at times obscuring the bottom (Figure 1). Co-occurring biotic units included benthic/attached biota: live *Crepidula* that were not substantial reef builders, so the biotic class was assigned to faunal bed/attached *Crepidula*; soft sediment fauna, the tube building plumed worm *Diopatra*; and mobile crustaceans, hermit crabs *Pagurus* spp. on soft sediment. Associated taxa included mobile mollusks *Busycon*, and crustaceans particularly spider crabs *Libinia* that feed on *Crepidula*. Aquatic vascular vegetation, *Zostera marina*, was only observed as bed forming at the very southwestern extDnt of inshore transect, VT-08A (Plate 8). The eelgrass may extend further south or inshore outside the survey area.

A total of 15 invertebrate, two fish, five algal species, and eelgrass were observed. Frequently observed invertebrates (>70%) across transects included knobbed whelks, slipper limpets, plume worms, flat-clawed and long-clawed hermit crabs, and spider crabs. This assemblage of species appeared more abundant along the western inshore transects where the substrate was more complex including a mixture of slightly gravelly sand with ripples, gravelly sand and shell hash or in areas of *Crepidula* hash (e.g. on VT-04A, 06A, 09A). Only two fish were observed during the entire survey, one winter flounder and one northern pipefish most likely due to the late season survey period and lack of hard bottom within the survey area. Dense floating red branching algae (algal rafts) were observed in portions of seven of the 11 transects (Figure 1). In these areas, substrate observations were limited and counts of biota may have been underestimated due to the dense floating algae that obscured the bottom.

The algal cover was comprised of dead man's fingers (*Codium*), sea lettuce (*Ulva*), *Sargassum*, purple laver (*Porphyra*), and branching red algae. Although a few observations of attached branching red algae were noted, the majority of the red algae observed were floating and possibly the invasive species *Heterosiphonia japonica*. Algal blooms of this species were reported at other Cape Cod Beaches in November 2019. Trace eelgrass cover, consisting of a few individual plants were observed at eight of the 11 transects. The only observation of eelgrass with moderate cover was at the start of inshore transect VT-08A.

3.1.2 Commercial species

The dominant mobile mollusk, knobbed whelks *Busycon* were found in low numbers on 91% of transects. Knobbed whelks were the only commercial invertebrate species recorded in significant numbers (Table 2). Single observations of blue crabs and horseshoe crabs were made on two and five of the 11 transects, respectively. No bay scallops were observed during the November 2019 survey, and of the commercial fish species, only one winter flounder was observed.

3.1.3 SSUs

No boulder substrate was encountered during the 2019 video survey and the intermittent observations of slipper limpet hash bottom do not meet the designation of potential Special, Sensitive, or Unique Areas (SSUs) based on the complexity of the bottom habitat and the abundance of biota. Although sparse eelgrass, consisting of isolated rooted plants were observed on multiple transects in Centerville Harbor, only one patch of eelgrass with moderate coverage at the very southwestern end of VT-08A south of Dowses Beach could be designated as an SSU. This *Zostera marina* patch may indicate the edge of a bed that extends to the south or inshore but outside the landing site study area.

3.2 Video Grab Results

The video grab sampling locations are presented on Figure 2, and sample station coordinates on Table 3. One or two video screen captures were created for each of the 11 sediment grab stations at the proposed Centerville Harbor landing sites (Figure 2, Plates GB-1 through GB-3). Basic substrate classifications were obtained despite at times poor visibility due to turbidity and floating algae. Visual estimates of the surficial substrate component were slightly gravelly sand with trace shell hash, ripples; gravelly sand, and gravelly sand with *Crepidula* hash. The dominant substrate was slightly gravelly sand with shell hash. Gravelly sand was observed at GB-09A and 09B along with *Crepidula* hash. Grain size analyses of sediment grabs reported elsewhere by Seaforth indicate that a finer component may be present below the visible sand and shell hash veneer.

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TABLES

TABLE 1
CMECS CLASSIFICATION, DOMINANT SPECIES, AND SPECIAL, SENSITIVE OR UNIQUE AREAS
UNDERWATER VIDEO DATA
VINEYARD WIND - CENTERVILLE HARBOR, BARNSTABLE, MA
November 6, 2019

Video Transect ID	Transect Start_X[1]	Start_Y	Transect End_X	End_Y	Measured Water Depths[5] (ft)	Dominant Fauna	Latin Name	CMECS Substrate Component[2, 6]	CMECS Biotic Component[2]	Biotic Co-occurring and Associated Taxa[6]	CZM - Barnhardt et. al (1998)
CENTERVILLE HARBOR PROPOSED LANDING SITES											
VT-01A	387806.0	4609984.5	388337.0	4610008.5	9.0 to 18.8	Slipper limpet	*Crepidula fornicata*	Slightly gravelly sand with ripples trace *Crepidula* hash	algal rafts[3] , benthic macroalgae	sparse attached *Crepidula* ; mobile mollusks and crustaceans	Fine
VT-02A	387565.1	4609632.8	388100.1	4609590.8	12.6 to 20.5	Long-clawed hermit crab	*Pagurus longicarpus*	Slightly gravelly sand with ripples co-occurring sparse *Crepidula* hash	algal rafts[3] , benthic macroalgae	sparse mobile crustaceans	Fine
VT-03A	387443.8	4609148.5	387890.4	4609133.3	19.6 to 21	Slipper limpet	*Crepidula fornicata*	Slightly gravelly sand with co-occurring moderate *Crepidula* hash	algal rafts[3] , benthic macroalgae	sparse attached *Crepidula* ; mobile crustaceans	Fine
VT-04A	387397.4	4608630.3	387720.4	4608594.1	17.6 to 20.6	Long-clawed hermit crab	*Pagurus longicarpus*	Slightly gravelly sand/ moderate *Crepidula* hash	algal rafts[3,] benthic macroalgae	sparse mobile crustaceans	Fine
VT-05A	387122.0	4607694.9	387434.9	4607993.7	10.6 to 12.0	Spider crab	*Libinia emarginata*	Slightly gravelly sand with ripples, co-occuring *Crepidula* hash	sparse benthic macroalgae	moderate mobile crustaceans	Fine
VT-06A	386683.0	4607913.2	387099.2	4608292.2	8.5 to 19.7	Slipper limpet/ Spider crab	*Crepidula fornicata/ Libinia emarginata*	Slightly gravelly sand with ripples/*Crepidula* hash	algal rafts[3] , benthic macroalgae	moderate attached *Crepidula* and mobile crustaceans; sparse mobile mollusks and larger tube building fauna (*Diopatra*)	Fine

TABLE 1
CMECS CLASSIFICATION, DOMINANT SPECIES, AND SPECIAL, SENSITIVE OR UNIQUE AREAS
UNDERWATER VIDEO DATA
VINEYARD WIND - CENTERVILLE HARBOR, BARNSTABLE, MA
November 6, 2019

Video Transect ID	Transect Start_X[1]	Start_Y	Transect End_X	End_Y	Range of Measured Water Depths[5] (ft)	Dominant Fauna	Latin Name	CMECS Substrate Component[2]	CMECS Biotic Component[2]	Co-occurring and Associated Taxa	CZM - Barnhardt et. al (1998)
VT-07A	386267.3	4608124.5	386716.6	4608776.4	7.7	Spider crab	*Libinia emarginata*	Gravelly sand and sparse slightly gravelly sand	patchy sparse algal rafts[3], benthic macroalgae	sparse attached *Crepidula,* mobile mollusks and larger tube building fauna (*Diopatra*); and moderate mobile crustaceans	Fine with gravel
VT-08A	386154.2	4608181.8	386623.4	4608829.4	7.7 to 8.3	Plumed worm	*Diopatra cuprea*	Slightly gravelly sand with ripples/gravelly sand	algal rafts, benthic macroalgae, trace *Zostera marina* [4]	sparse attached *Crepidula,* larger tube building fauna (*Diopatra*); and mobile crustaceans	Fine with gravel
VT-09A	386523.8	4608832.8	386757.3	4608581.3	9.1	Slipper limpet	*Crepidula fornicata*	Gravelly sand/slightly gravelly sand with ripples/*Crepidula* hash	patchy algal rafts[3] , benthic macroalgae	sparse attached *Crepidula,* mobile mollusks; larger tube building fauna (*Diopatra*); and mobile crustaceans	Fine with gravel
VT-10A	386371.9	4608612.5	386588.0	4608374.5	9.2	Spider crab	*Libinia emarginata*	Gravelly sand with ripples sparse shell hash; pebble/granule trace cobble	benthic macroalgae	moderate mobile crustaceans; sparse mobile mollusks and larger tube building fauna (*Diopatra*)	Fine with gravel
VT-11A	386195.5	4608343.2	386407.9	4608099.5	7.2	Spider crab	*Libinia emarginata*	Gravelly sand / slightly gravelly sand; pebble/granule trace cobble	benthic macroalgae	moderate mobile crustaceans and attached *Crepidula* ; sparse barnacles, mobile mollusks and larger tube building fauna (Diopatra)	Fine with gravel

TABLE 1
CMECS CLASSIFICATION, DOMINANT SPECIES, AND SPECIAL, SENSITIVE OR UNIQUE AREAS
UNDERWATER VIDEO DATA
VINEYARD WIND - CENTERVILLE HARBOR, BARNSTABLE, MA
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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 Coastal Research 14(2) 646-59.

Notes:

[1] Coordinates for the video transect start and end points in Grid: UTM North, Ellipsoid: WGS-84, Zone: Zone 19 (72W-66W), Distance: Meters

[2] Figure 1 illustrates the major CMECS substate components identified along the video transects

[3] When present dense rafts of red macroalgae floating below the surface of the water often obscured a view of the bottom substrate.The algal rafts were estimated to overlay slightly gravelly sand or gravelly sand substrate.

[4] Possible eelgrass SSU identified at southwestern end of video transect 8 (Figure 1)

[5] Water depths from vessel echosounder - not corrected for tides

[6] CMECS modifiers were used to relay relative frequency within a transect
(number of screen captures in which element was observed / total screen capture observation points, taken ~ every 30 seconds)

- Trace (<1%)
- Sparse (1 to <30%)
- Moderate (30 to 70%)
- Dense (70 to 90%)
- Complete (90 to 100%)

TABLE 2
SPECIES OBSERVATIONS BY TRANSECT
UNDERWATER VIDEO DATA
VINEYARD WIND - CENTERVILLE HARBOR, BARNSTABLE, MA
November 6, 2019

TRANSECT ID	Latin Name	VT-01A	VT-02A	VT-03A	VT-04A	VT-05A	VT-06A	VT-07A	VT-08A	VT-09A	VT-10A	VT-11A	Freqency %
FAUNA													
PORIFERA													
Red beard sponge	*Microciona prolifera*	X (1)						X (2)		X (1)	X (1)	X (2)	45.45
CNIDARIA													
Snail fur	*Hydractinia echinata*		X (1)							X (1)	X (1)		27.27
BRYOZOA													
Bushy bryozoan	Bryozoa		X (1)							X (1)			18.18
MOLLUSCA													
Knobbed whelk*[1]	*Busycon carica*	X (3)	(1eggcase)	X (2)	X (1)		X (3)	X (5)	X (1)	X (4)	X (2)	X (2)	**90.91**
Slipper limpet[6]	*Crepidula fornicata*	X (4)	X (2)	X (9)	X (3)	X (5)	X (18)	X (11)	X (6)	X (10)	X (1)	X (19)	**100.00**
ANNELIDA													
Plumed worm	*Diopatra cuprea*		X (1)	X (2)	X (1)		X (5)	X (10)	X (12)	X (7)	X (8)	X (11)	**81.82**
Tube worm	*Hydroides dianthus*		X (1)							X (1)			18.18
ARTHROPODA													
Merostomata													
Horseshoe Crab	*Limulus polyphemus*	X (1)	X (1)	X (1)	X (1)	X (1)							45.45
Crustacea													
Barnacle	*Balanus* sp.					X (2)		X (2)	X (5)	X (8)	X (6)	X (18)	54.55
Blue crab	*Callinectes sapidus*			X (1)	X (1)								18.18
Flat-Clawed Hermit Crab	*Pagurus pollicaris*	X (1)	X (1)			X (6)	X (5)	X (2)	X (1)	X (2)	X(1)	X (2)	**90.91**
Long-Clawed Hermit Crab	*Pagurus longicarpus*	X (3)	X (10)	X (1)	X (5)	X (5)		X (3)		X (1)	X (2)		**72.73**
Lady crab	*Ovalipes occellatus*									X (1)			9.09
Sand shrimp	*Crangon septemspinosa*								X (4)	X (3)			18.18
Spider crab	*Libinia emarginata*		X (3)		X (4)	X (15)	X (33)	X (52)	X (7)	X (5)	X (22)	X (34)	**81.82**
VERTEBRATA													
Osteichthyes													
Northern pipefish	*Syngnathus fuscus*											X (1)	9.09
Winter flounder	*Pleuronectes americanus*										X (1)		9.09

TABLE 2
SPECIES OBSERVATIONS BY TRANSECT
UNDERWATER VIDEO DATA
VINEYARD WIND - CENTERVILLE HARBOR, BARNSTABLE, MA
November 6, 2019

TRANSECT ID	Latin Name	VT-01A	VT-02A	VT-03A	VT-04A	VT-05A	VT-06A	VT-07A	VT-08A	VT-09A	VT-10A	VT-11A	Freqency %
SPECIES RICHNESS FAUNA[2]		6	10	6	8	6	5	8	7	13	10	8	
FLORA													
ALISMATALES													
Zosteraceae													
Eelgrass*[5]	*Zostera marina*	X (9)[5]	X (6)[5]	X (9)[5]	X (16)[5]		X (7)[5]	X (2)[5]	X (5)[5] bed (1)*		X (2)[5]		**72.73**
CHLOROPHYTA													
Dead Man's Fingers	*Codium fragile*	X (8)	X (2)	X (9)	X (15)	X (1)	X (12)	X (28)	X (28)	X (9)	X (2)	X (17)	**100.00**
Sea Lettuce	*Ulva lactuca*							X (1)		X (1)			18.18
PHAEOPHYTA													
Wire weed	*Sargassum filipendula*	X (3)	X (5)	X (6)	X (5)	X (1)	X (3)	X (6)	X (7)	X (4)	X (2)	X (5)	**100.00**
RHODOPHYTA													
Branching red alga[6]	Rhodophyta	X (28)	X (26)	X (41)	X (28)	X (6)	X (38)	X (55)	X (50)	X (28)	X (13)	X (15)	**100.00**
Purple laver	*Porphyra umbilicalis*		X (1)		X (2)	X (1)	X (3)	X (1)		X (2)		X (3)	63.64
Total # of screen capture observation points		50	45	56	35	27	63	95	82	43	41	56	
SPECIES RICHNESS FLORA[2]		4	5	4	5	4	5	6	4	5	4	4	

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

2) Species Richness = the total number of species observed - not normalized for length of transect

3) Species with a frequency across all transects greater than 70% are bolded and shaded

4) X designates presence on a transect; (#) designates the number of individuals observed. Data not normalized for length of transect. For *Crepidula, barnacles* and algae - individuals were too numerous to count

5) Only single strands of eelgrass observed (e.g., Plate 3) - no sign of an eelgrass bed SSU excluding southwestern end of VT-08A (Plate 8).

6) The majority of the branching red algae was rafting above the bottom and may be the invasive *Heterosiphonia japonica*

TABLE 3
VIDEO GRAB STATION COORDINATES
BARNSTABLE LANDING SITES, CENTERVILLE HARBOR, MA
November 2019

STATION ID[1]	X (Eastings)[2]	Y (Northings)	LAT	LONG	TIME	DATE	WATER DEPTH[3]
wb19-gb-01a	388115.51	4610071	41.63452761	70.3433007	11:57:12	11/5/2019	19.4
wb19-gb-02a	387816.11	4609854.79	41.63253864	70.34685385	11:42:27	11/5/2019	11.6
wb19-gb-03a	387932.91	4609588.83	41.63016015	70.34540214	11:21:45	11/5/2019	20.5
wb19-gb-04a	387639.75	4609233.58	41.62691997	70.34885399	10:59:39	11/5/2019	21
wb19-gb-05a	387790.12	4608959.4	41.62447221	70.34699793	10:33:17	11/5/2019	22.5
wb19-gb-06a	387526.59	4608696.75	41.62207001	70.35011122	10:17:15	11/5/2019	22
wb19-gb-07a	386495.79	4608478.91	41.61996245	70.36244012	7:38:43	11/5/2019	9.6
wb19-gb-08a	386912.63	4608458.9	41.61984145	70.35743418	8:33:44	11/5/2019	18
wb19-gb-09a	387389.73	4608185.27	41.61744495	70.35165743	8:48:12	11/5/2019	22.5
wb19-gb-09b	387387.92	4608183.84	41.61743182	70.35167888	9:31:21	11/5/2019	22.5
wb19-gb-10a	386914.58	4607804.49	41.61394894	70.35728721	8:14:18	11/5/2019	11.5
wb19-gb-11a	387334	4607752.79	41.61354271	70.35224482	10:00:10	11/5/2019	12

NOTES:
1) Grid: UTM North, Ellipsoid: WGS-84, Zone: Zone 19 (72W-66W), Distance: Meter
2) Grab attempts are identified by the number at the end of Station ID(1ST attempt="a",2ND attempt="b",3RD attempt="c")
Highlighted cells separate each grab station. See Figure 2 for mapped positions.
3) Water depths are in decimal feet, and are raw, not corrected for tides
4) Navigation Used- Hemisphere Vector V104 Submeter Differential GPS and Hypack Survey Software
5) Grab System- 0.1 m^2 Ted Young Grab Sampler
6) Vessel Used- R/V Lophius 26' Aluminum Workboat

TABLE 4

CMECS CLASSIFICATION OF THE BOTTOM HABITAT PROPOSED CENTERVILLE HARBOR LANDING SITES

Biogeographic Setting

Realm: Temperate North America

Province: Cold Temperate Northwest Atlantic

Ecoregion: Virginian

Aquatic Setting

System: Marine

Subsystem: Nearshore

Tidal Zone: Subtidal

Water Column Component

Water Column Layer: Marine Nearshore Lower Water Column

Salinity Regime: Polyhaline

Temperature Regime: Cool Water

Geoform Component

Tectonic Setting: Passive Continental Margin

Physiographic Setting: Embayment/Bay

Geoform Origin: Geologic

Level 2 Geoform: Ripples

Substrate Component

Substrate Origin: Geologic Substrate

Substrate Class: Unconsolidated Mineral Substrate

Substrate Subclass: Coarse Unconsolidated Substrate

Substrate Subgroup: Gravelly Sand

Substrate Subclass: Fine Unconsolidated Substrate

Substrate Group: Slightly Gravelly

Substrate Subgroup: Slightly Gravelly Sand

Substrate Origin: Biogenic Substrate

Substrate Class: Shell Substrate

Substrate Subclass: Shell Hash

Substrate Group: *Crepidula* Hash

Biotic Component

Biotic Setting: Plantonic Biota

Biotic Class: Floating/Suspended Plants and Macroalgae

Biotic Subclass: Floating/Suspended Macroalgae

Biotic Group: Algal Rafts

Biotic Setting: Benthic/Attached Biota

Biotic Class: Aquatic Vegetation Bed

Biotic Subclass: Benthic Macroalgae

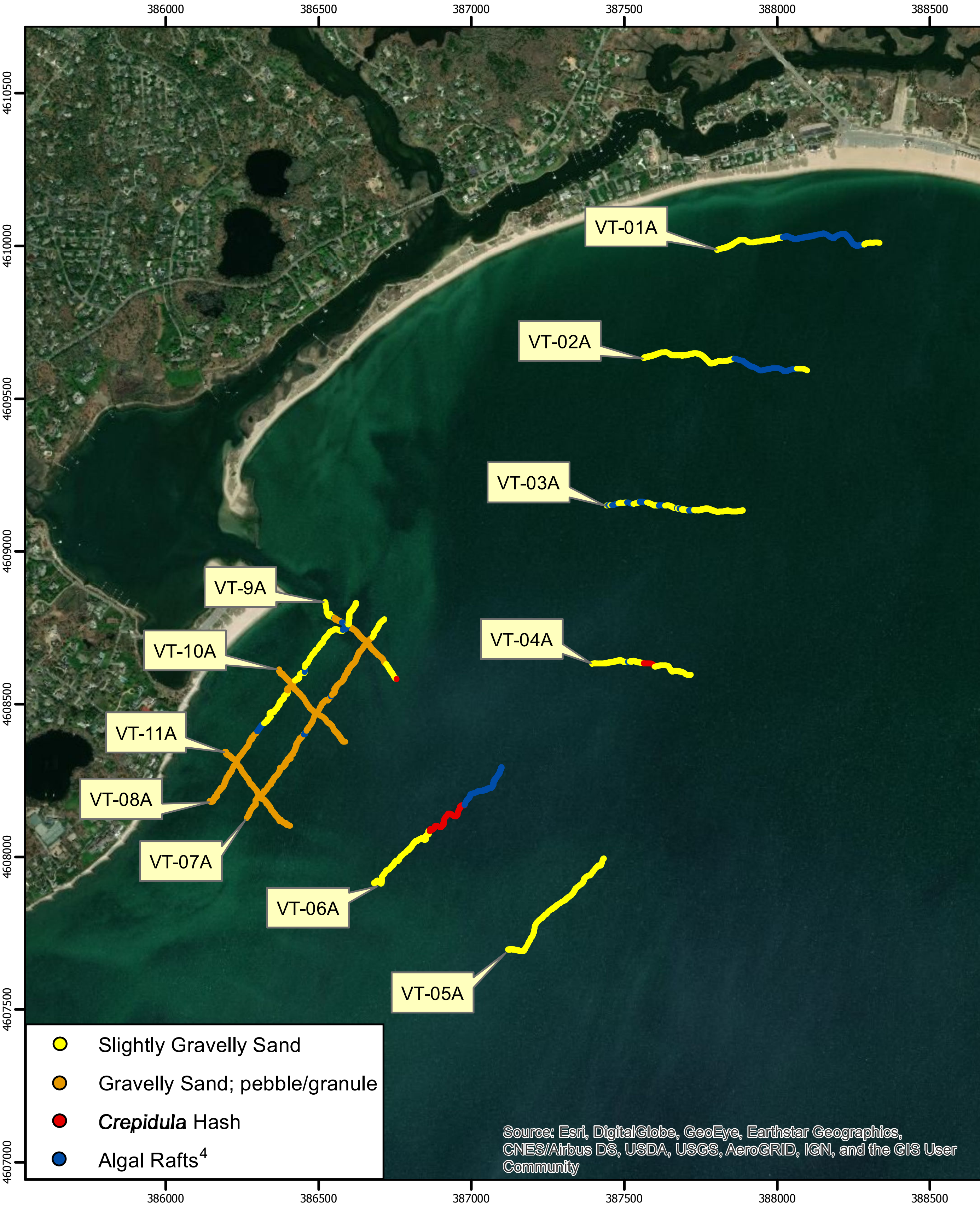
Co-occuring elements: *Codium and Sargassum* Communities *Zostera marina* Community

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Co-occurring elements: Attached *Crepidula* and Mobile Mollusks *Busycon;* Soft Sediment Tube Building Fauna *Diopatra* and Associated Taxa: Mobile Crustaceans *Pagurus* and *Lubinia*

FIGURES



www.crenvironmental.com

UNDERWATER VIDEO CMECS SUBSTRATE COMPONENTS
Centerville Harbor, Barnstable, Massachusetts

NOTES:
1) Survey conducted November 6, 2019.
2) UTM Zone 19N, NAD 83, Meters
3) Video transects labeled at start of file.
4) Algal rafts obscured substrate - estimated to be over slightly gravelly sand or gravelly sand

Meters
0 200 400

N W E S

Figure 1

www.crenvironmental.com

SEDIMENT GRAB SAMPLE LOCATIONS
Centerville Harbor
Barnstable, Massachusetts

NOTES:
1) Samples collected November 5, 2019.
2) UTM Zone 19N, NAD 83, Meters

Meters
0 200 400

N W E S

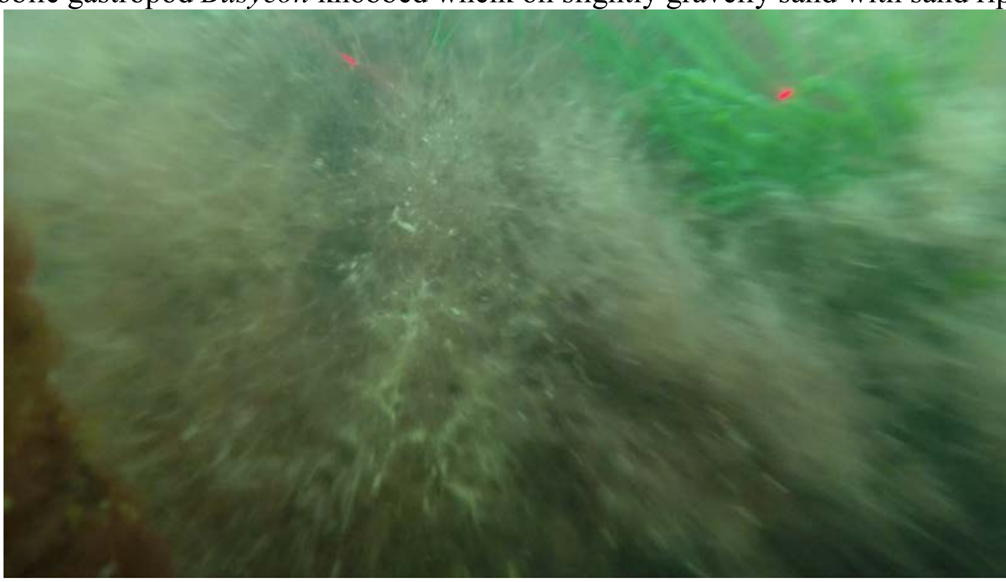
Figure 2

PLATES

PLATES 1-11 UNDERWATER VIDEO SLED TRANSECTS SCREEN CAPTURES

PLATES GB-1-GB-3 VIDEO GRAB SCREEN CAPTURES

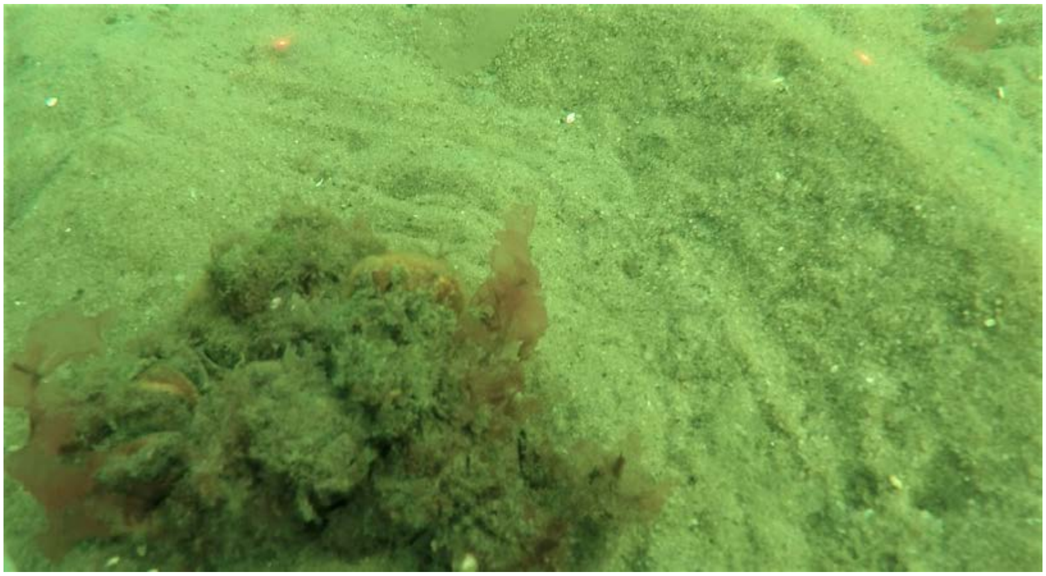
Mobile gastropod *Busycon* knobbed whelk on slightly gravelly sand with sand ripples



Dense rafting red algae and benthic macroalgae (*Sargassum, Codium*)

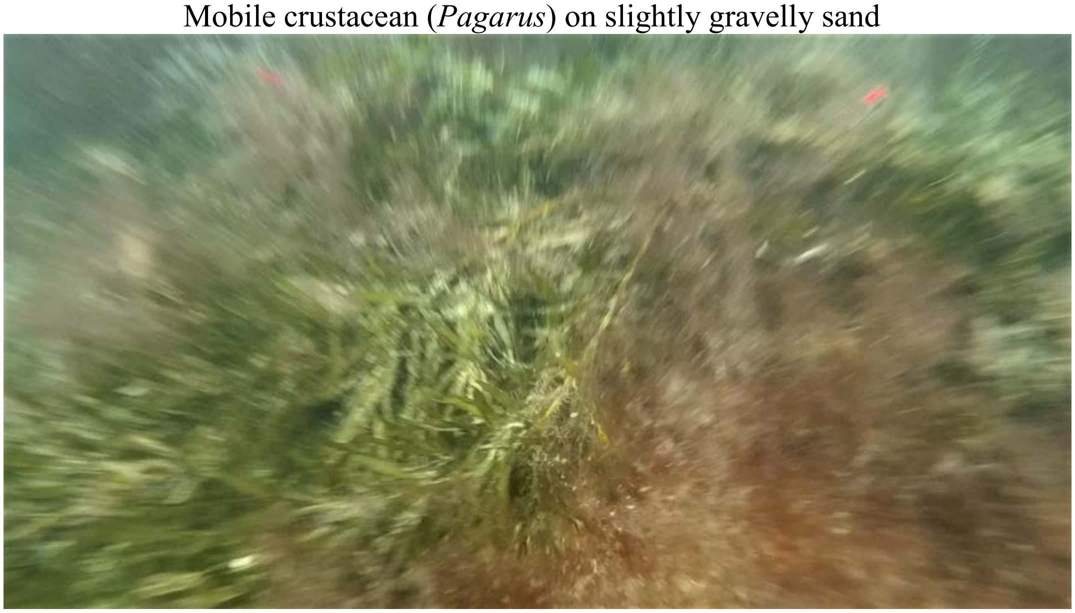
Slightly gravelly sand with trace *Crepidula* shell hash plus attached *Crepidula* and benthic macroalgae *Sargassum*

Plate 1 Video Screen Captures of Substrate and Biota Components at VT-01A



Slightly gravelly sand with trace gravel and shell hash in troughs of sand ripples plus benthic macroalgae (*Porphyra*) on attached *Crepidula*

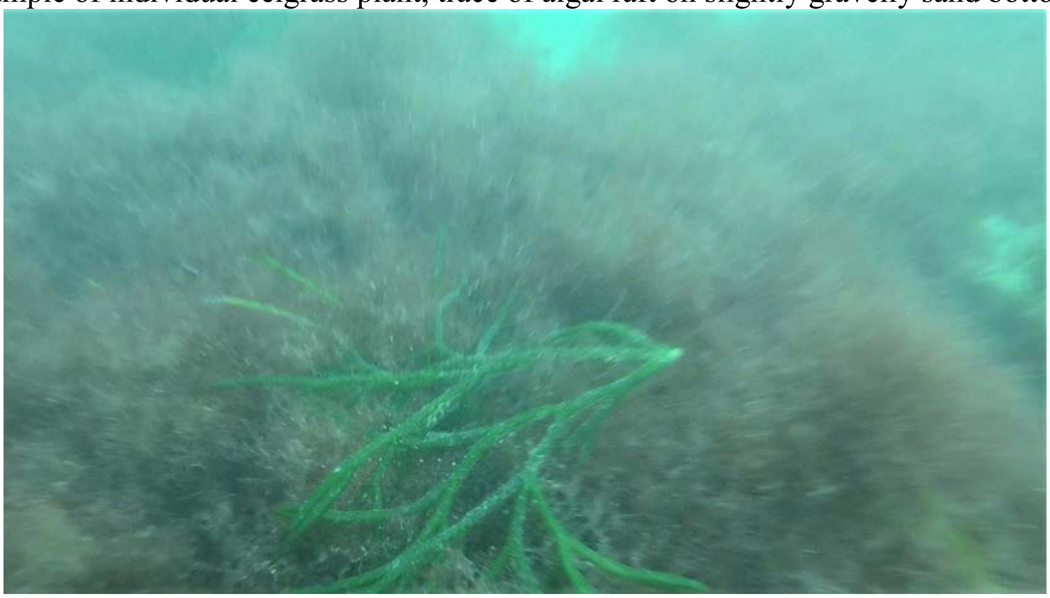
Mobile crustacean (*Pagarus*) on slightly gravelly sand



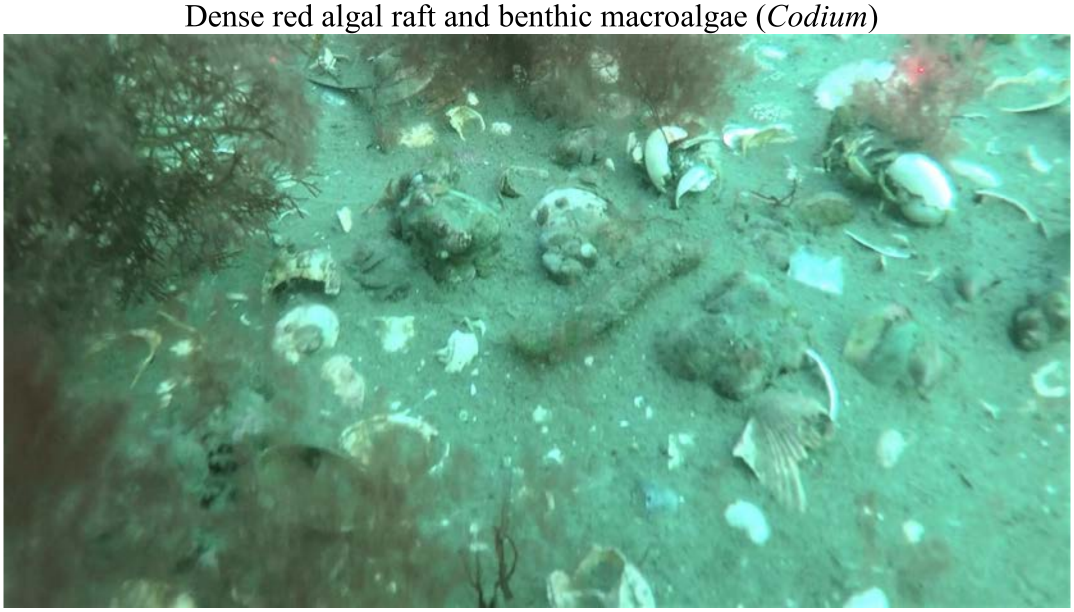
Dense rafting red algae and benthic macroalgae (*Sargassum*)

Plate 2 Video Screen Captures of Substrate and Biota Components at VT-02A

Example of individual eelgrass plant, trace of algal raft on slightly gravelly sand bottom



Dense red algal raft and benthic macroalgae (*Codium*)

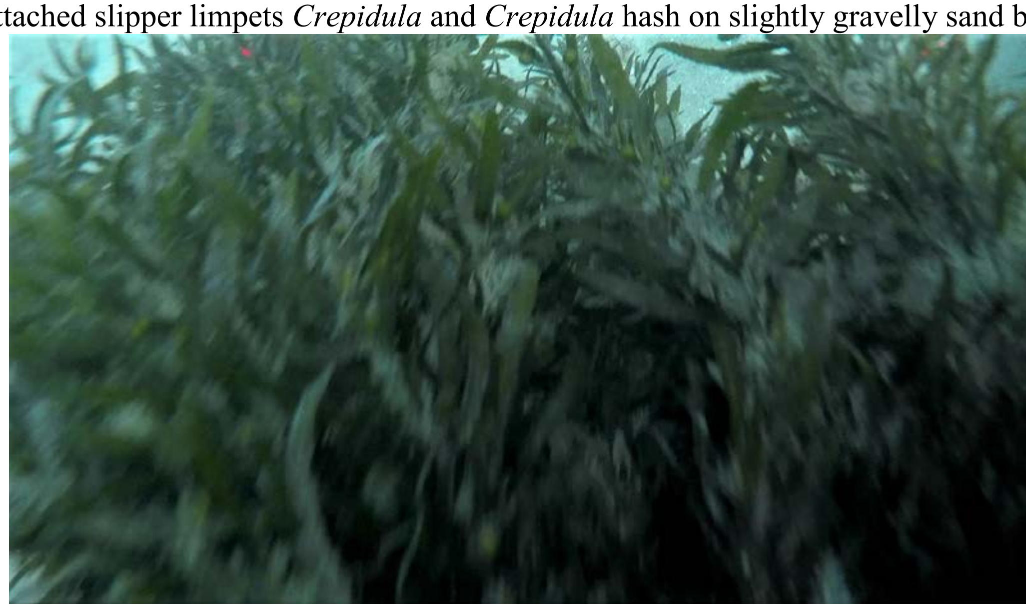


Slightly gravelly sand bottom with co-occurring *Crepidula* shell hash and trace red algal raft

Plate 3 Video Screen Captures of Bottom Substrate and Biota at VT-03A

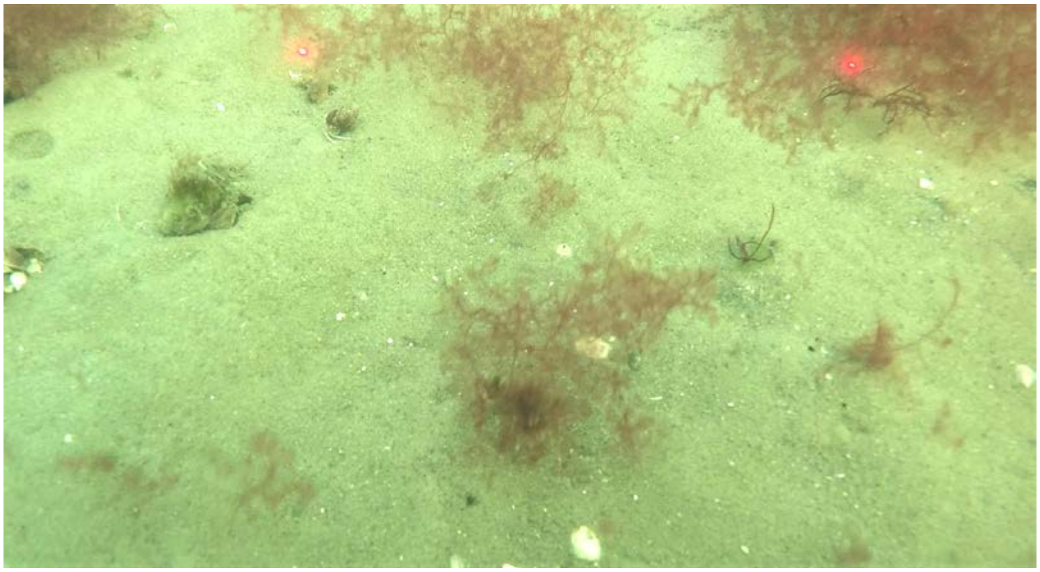
Slightly gravelly sand ripple bottom and associated mobile crustacean spider crab (*Libinia*)

Attached slipper limpets *Crepidula* and *Crepidula* hash on slightly gravelly sand bottom



Dense *Sargassum* benthic macroalgae on slightly gravelly sand bottom

Plate 4. Video Screen Captures of Bottom Substrate and Biota at VT-04A



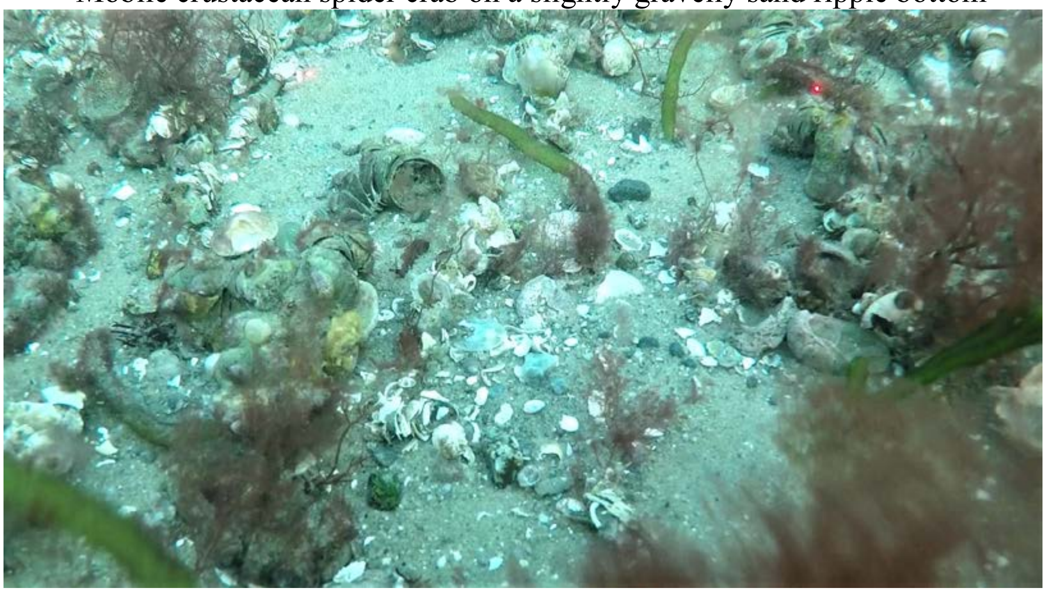
Patchy branching algal raft and mobile crustacean long-clawed hermit crab (*Pagurus*) on slightly gravelly sand

Localized dense branching red algal raft and purple laver (*Porphyra*) and *Sargassum* macroalgae

Mobile crustacean spider crab (*Libinia*) on slightly gravelly sand bottom

Plate 5. Video Screen Captures of Bottom Substrate and Biota at VT-05A

Mobile crustacean spider crab on a slightly gravelly sand ripple bottom

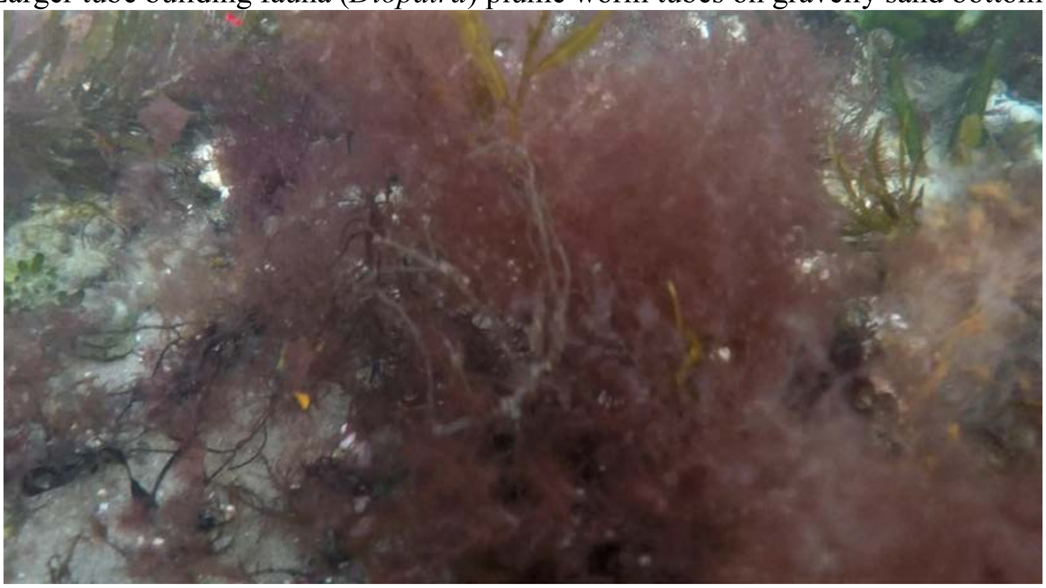


Attached slipper limpets and *Crepidula* hash on gravelly sand bottom

Dense red branching algal raft and benthic macroalgae *Sargassum*

Plate 6. Video Screen Captures of Bottom Substrate and Biota at VT-06A

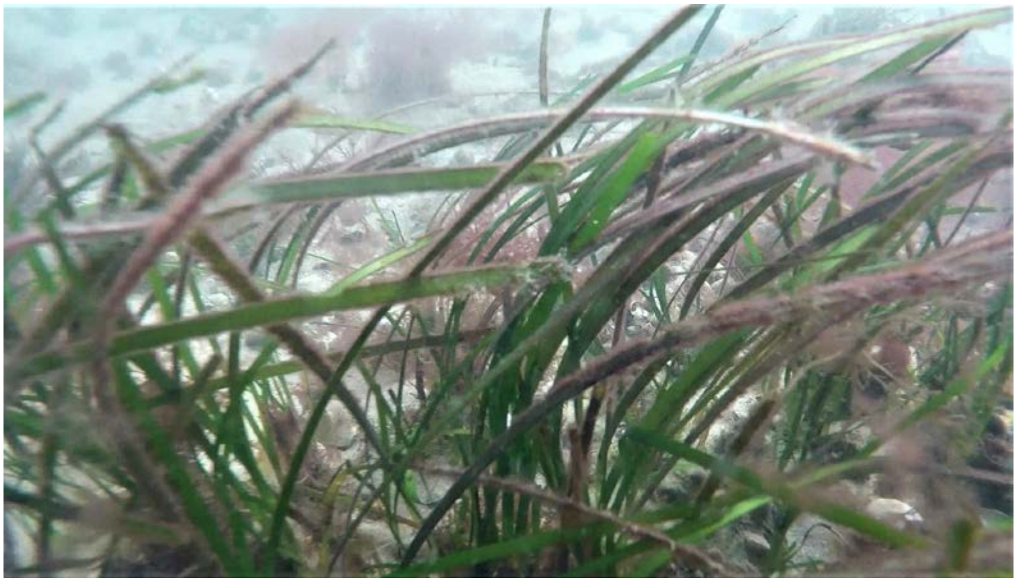
Larger tube building fauna (*Diopatra*) plume worm tubes on gravelly sand bottom



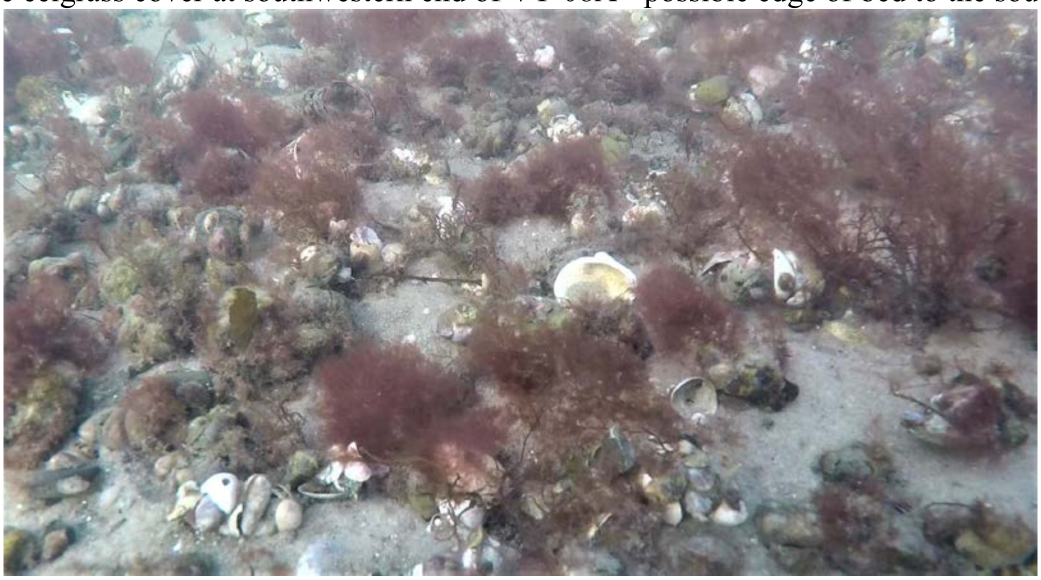
Patchy sparse red branching algal rafts and benthic macroalgae *Sargassum*

Benthic macroalgae dead man fingers (*Codium*) on gravelly sand bottom

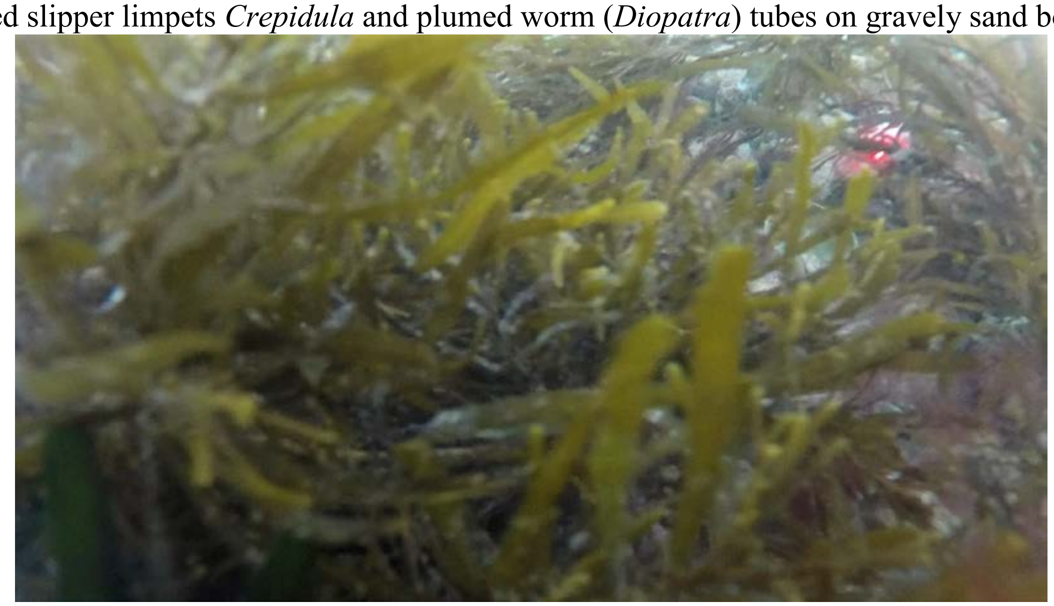
Plate 7. Video Screen Captures of Bottom Substrate and Biota at VT-07A



Moderate eelgrass cover at southwestern end of VT-08A - possible edge of bed to the south



Attached slipper limpets *Crepidula* and plumed worm (*Diopatra*) tubes on gravely sand bottom



Benthic macroalgae *Sargassum* on gravelly sand

Plate 8. Video Screen Captures of Bottom Substrate and Biota at VT-08A

Attached slipper limpets (*Crepidula*) and plumed worm (*Diopatra*) tubes, sea lettuce (*Ulva*), *Sargassum*, and red branching macroalgae

Mobile crustacean spider crab (*Libinia*) on a gravelly sand bottom

Tube worm, slipper limpets, red branching benthic macroalgae on gravelly sand bottom

Plate 9. Video Screen Captures of Bottom Substrate and Biota at VT-09A

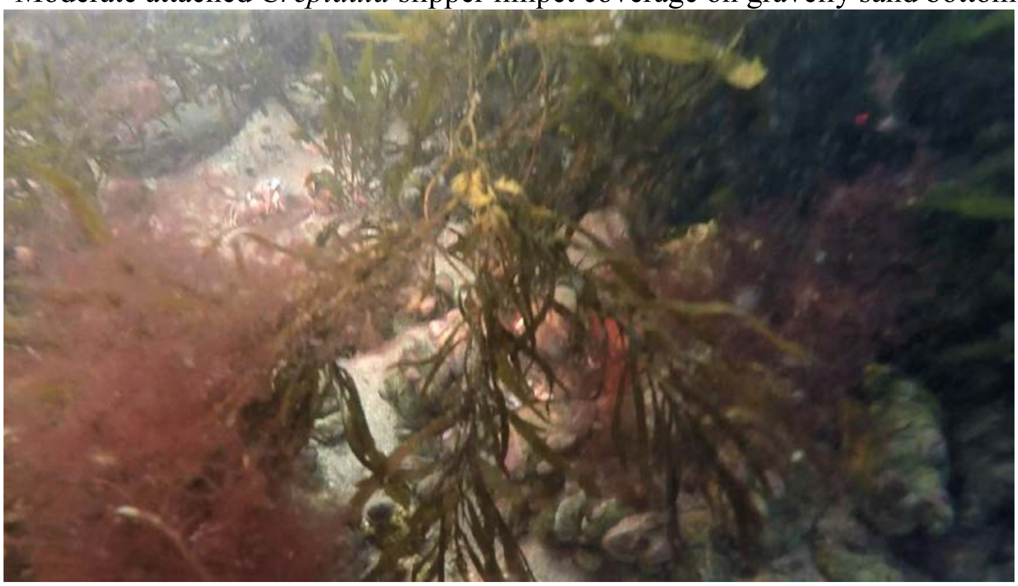
Mobile crustacean flat-clawed hermit (*Pagurus*) with sea fur hydroids and plumed worm (*Diopatra*) tubes on gravelly sand bottom

Mobile gastropod, knobbed whelk, feeding on slipper limpets

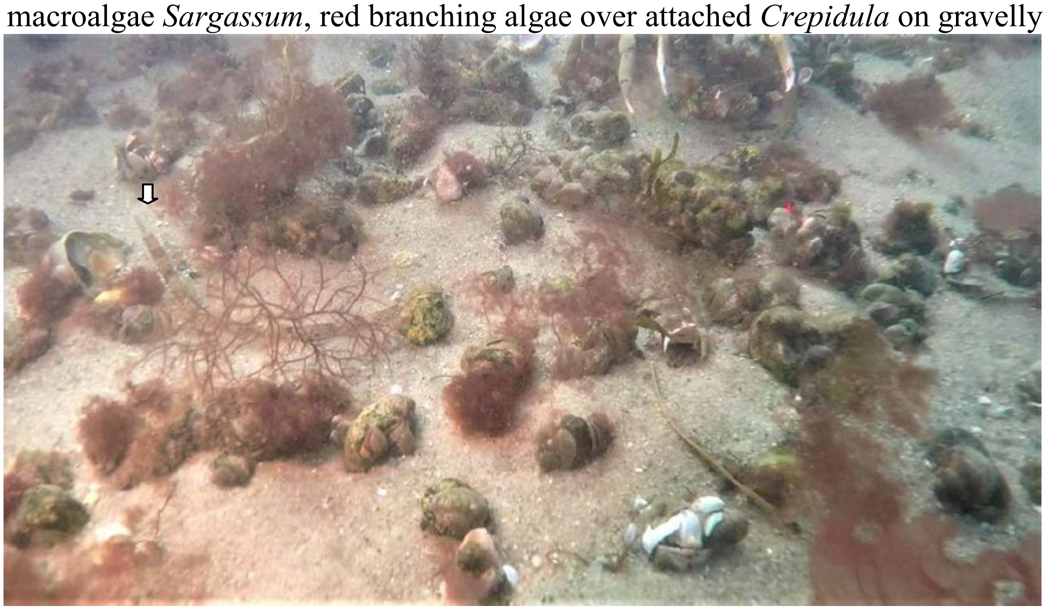
Barnacles, plumed worm tubes and red branching benthic macroalgae on gravelly sand

Plate 10. Video Screen Captures of Bottom Substrate and Biota at VT-10A

Moderate attached *Crepidula* slipper limpet coverage on gravelly sand bottom



Benthic macroalgae *Sargassum*, red branching algae over attached *Crepidula* on gravelly sand



Northern pipefish, and slipper limpets on a gravelly sand bottom

Plate 11. Video Screen Captures of Bottom Substrate and Biota at VT-11A


GB-01A Abundant *Sargassum* macroalgae

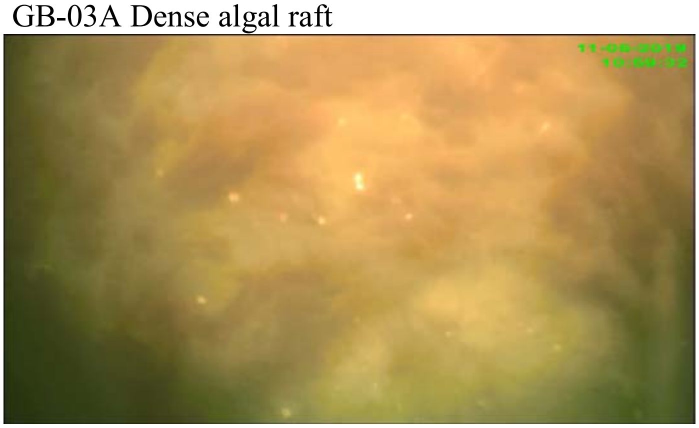
GB-01A Slightly gravelly sand


GB-02A Sand ripples

GB-02A Slightly gravelly sand ripples trace shell hash

GB-03A Dense algal raft

GB-03A Slightly gravelly sand trace shell hash


GB-04A Moderate algal raft over sand


GB-04A Slightly gravelly sand trace shell hash

Plate GB1. Grab Sample Video Screen Captures (reference Figure 2 for video grab station locations)

GB-01A Abundant *Sargassum* macroalgae

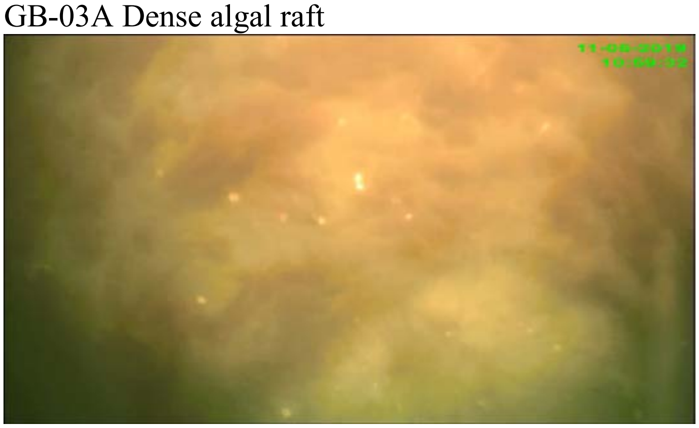
GB-01A Slightly gravelly sand

GB-02A Sand ripples

GB-02A Slightly gravelly sand ripples trace shell hash

GB-03A Dense algal raft

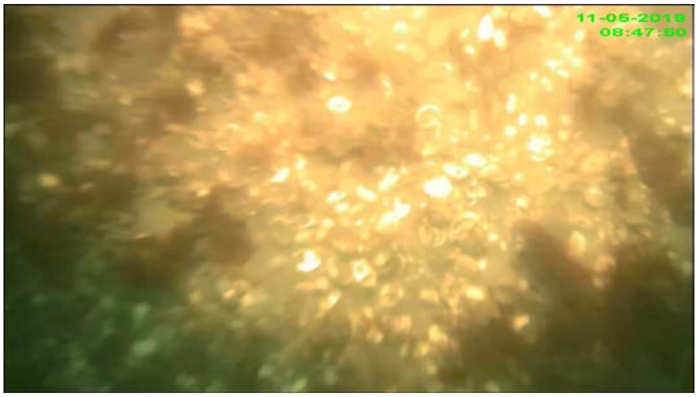
GB-03A Slightly gravelly sand trace shell hash



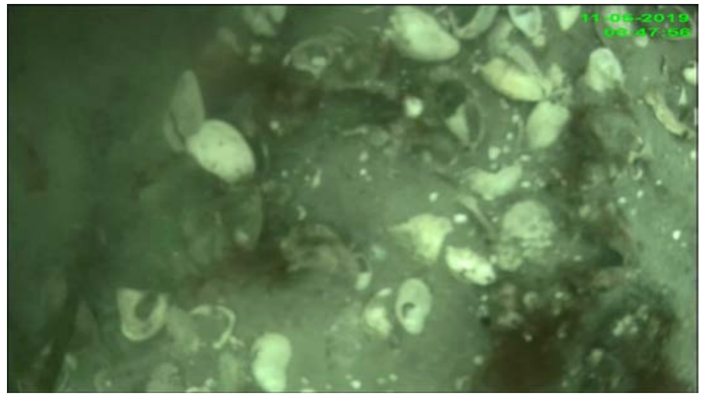
GB-04A Moderate algal raft over sand

GB-04A Slightly gravelly sand trace shell hash

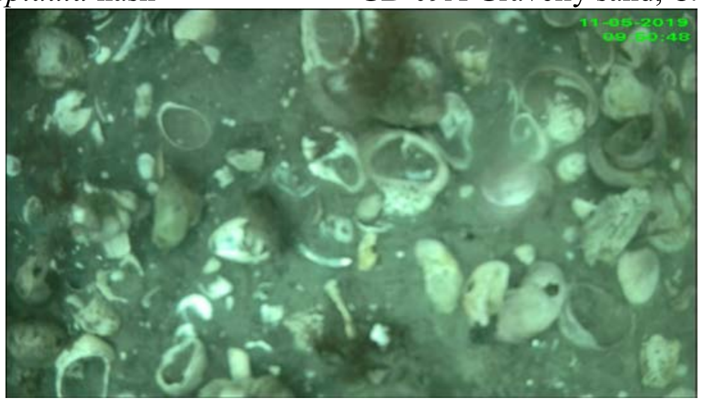
Plate GB1. Grab Sample Video Screen Captures (reference Figure 2 for video grab station locations)



GB-09A Gravelly sand, *Crepidula* hash



GB-09A Gravelly sand, *Crepidula* hash



GB-9B Gravelly sand, *Crepidula* hash

GB-10A Sand ripples, sparse red branching algae

GB-10A Slightly gravelly sand, ripples

GB-11A Sand ripples

GB-11A Slightly gravelly sand, ripples

Plate GB-3. Grab Sample Video Screen Captures (reference Figure 2 for grab station locations)

9. RPS 2020 Benthic Report

EGS VINEYARD WIND

Lease Area SWDA and OECC Benthic Report

Prepared by:

RPS Ocean Science

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Prepared for:

EGS – Vineyard Wind

20-P-209243 Vineyard Wind 2020 G&G Survey – EGS
Lease Areas SWDA and OECC Benthic Sampling Report

June 8, 2021

rpsgroup.com

Contents

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1 INTRODUCTION

RPS was contracted by EGS to collect, process, analyze, and compile benthic data collected with a towed video sled and grab sampler in the project area associated with Vineyard Wind's proposed Offshore Wind Development Area located in the southern portion of Lease Area OCS-A 0501, offshore of Martha's Vineyard, Massachusetts. The survey area included the southern wind development area (SWDA) and the offshore export cable corridor (OECC), which extends north toward shore from the SWDA. The OECC is described in four sections: Landfall, Northern OECC, Muskeget Channel, and Southern OECC (Figure 1-1), with grab samples in all four sections and video transects in all but the Landfall section. Sampling occurred over two events on two separate vessels to allow for sampling in shallow waters. The grab samples and video imagery data conclusions presented in this document will support interpretation of geophysical data to characterize surficial sediment conditions and classify the benthic habitat in both the SWDA and OECC according to the Coastal and Marine Ecological Classifications Standards (CMECS; FGDC, 2012) and recent guidance for mapping fish habitat from National Marine Fisheries Service (NMFS, 2020) for inclusion in permitting documentation required by Bureau of Ocean Energy Management (BOEM). This report provides:

- A description of the benthic grab sampling methods, results, and analysis;
- The analysis of benthic grab sampling results using key statistical analyses such as taxa richness, density per cubic meter, community composition, etc.;
- A description and analysis of the video data collected; and
- CMECS classifications of each sample site based on the video, grain size, and benthic community lab results.

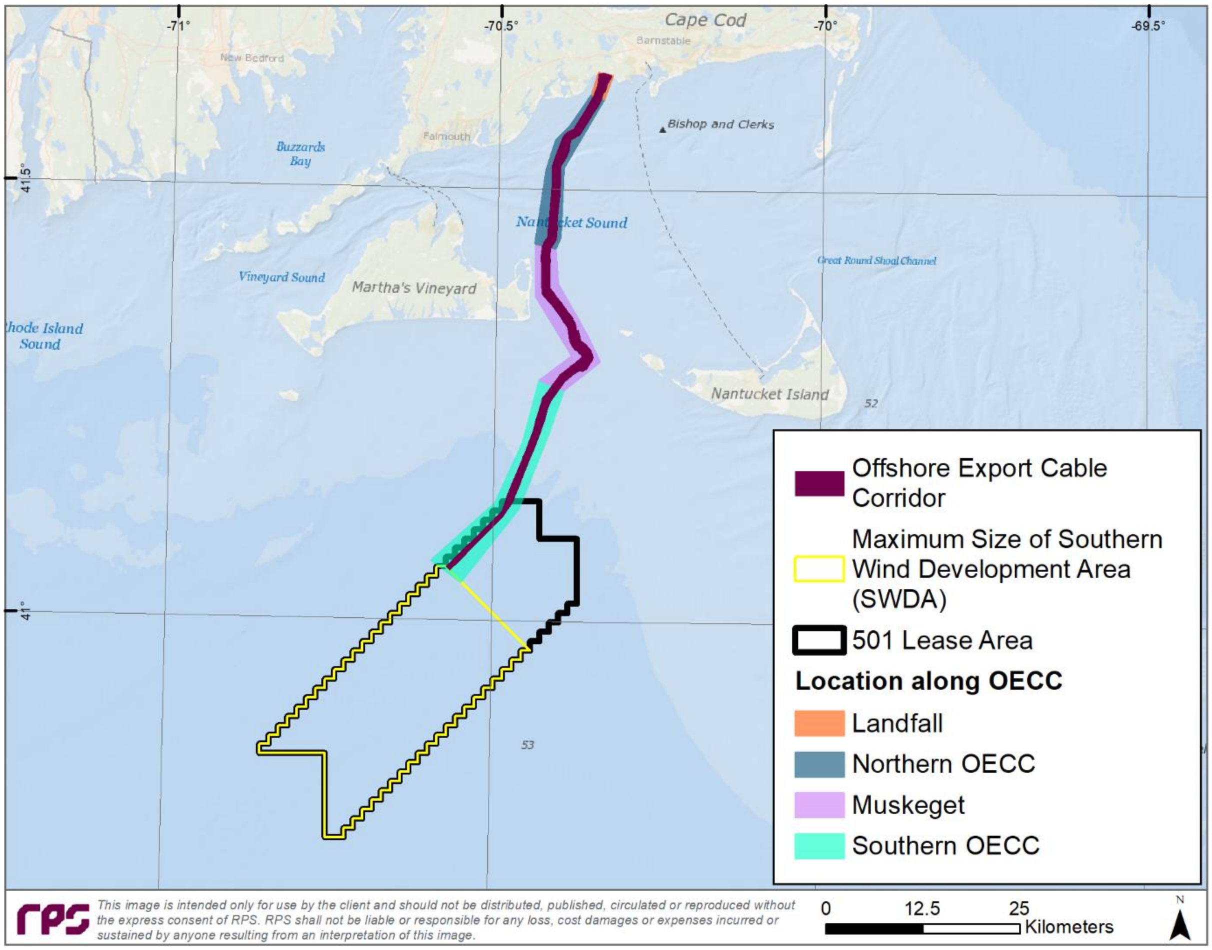


Figure 1-1. Location of sampling for 2020 Benthic Campaign within the SWDA and along the OECC.

2 METHODS

2.1 Field Survey

2.1.1 Towed Camera Sled

Underwater video transects were taken in conjunction with grab samples for visual classification of the seafloor in the summer (July-August) and fall (October) of 2020. The survey was completed on two research vessels: R/V Danielle Miller, which sampled the offshore SWDA and the deeper waters within the OECC in the summer, and R/V Jamie Hanna, which sampled the nearshore and shallow, shoal waters within the OECC in the fall. The camera sled was equipped with parallel-mounted lasers 3.5 centimeters (cm) apart and a cable that transmitted real-time viewing of images to the vessel. For sampling aboard the Danielle Miller, an ultra-short baseline (USBL) beacon was fixed to the camera sled to obtain GPS coordinates in conjunction with a pole-mounted USBL system. Because the Jamie Hanna sampled in only shallow water, a USBL was not necessary and position of the camera sled was recorded as an offset from the vessel. The video sled was deployed from a stern A-frame by the RPS, Danielle Miller/Jamie Hanna, and EGS crews and lowered until positioned 0.5-1 meters (m) above the seafloor. Distance of the camera to the seafloor varied along each transect due to differences in sediment type, vessel speed, swells, and low visibility/high turbidity.

Video transects were recorded in accordance with procedures following BOEM's Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 (BOEM, 2019) and approved by EGS, Geo SubSea LLC, and Vineyard Wind. Vessel speed was usually kept to 1 knot or lower to accommodate the tow sled and never exceeded 3 knots. Direction was given from the video operator to the winch operator to raise and lower the towed camera sled as needed to maintain proximity to the seafloor. While recording, field notes were taken containing sample information (date, time, global positioning satellite [GPS] coordinates, station ID, depth, and video file name) and observations of sediment/seafloor characteristics of note to aid in post-processing of video data. Special notes were made for the beginning and end of the transect as well as any changes in weather or visibility conditions, sediment, or species. During video recording, attention was given to note if potentially sensitive benthic habitats (e.g., exposed hard bottom, seagrass/kelp/algal beds, coral species) were present, as per BOEM's guidelines (BOEM, 2019). In the SWDA, 12 video transects were completed, while 63 video transects were completed in the OECC. Video transects varied in length with most between 200 m and 700 m.

2.1.2 Grab Sampling

Benthic grab samples were acquired using an Ocean Instruments Salish Grab Standard SG-20 sampler. This grab is a modified version of a standard Van Veen sampler with a stainless-steel weighted frame and release system ideal for collection of sediments in soft to hard substrates with a penetration depth up to 20 centimeters (cm) and sampling area of 0.10 square meters (m^2). For sampling aboard the Danielle Miller, an ultra-short baseline (USBL) beacon was fixed to the grab sampler to obtain GPS coordinates in conjunction with a pole-mounted USBL transceiver. Because the Jamie Hanna sampled in only shallow water, a USBL system was not necessary and position of the grab sampler was recorded as an offset from the vessel. An attached video camera was equipped with an altimeter to record distance above sea floor, temperature probe, parallel-mounted scale lasers, and lights provided real-time viewing of the bottom from the vessel. This video was recorded and used to collect additional information concerning the area surrounding the grab sample site.

Upon retrieval, the grab sampler was examined for sample acceptability. A sample was initially deemed acceptable only if the bucket was more than 50% full, the sample was not over penetrated (i.e., not full to the top), and sample surface structures were undisturbed and even (i.e., not slumped). If a sample did not fulfil these requirements, the entire contents were returned to the water and another sample attempt was made. A photograph and/or results from each attempt were collected as the grab was brought on board. If more than three failed sample attempts (insufficient sediment recovery) occurred at one station, sampling moved on to the next station, and no sediment samples were sent for further analyses. Failed attempts due to grab sampler malfunction (not habitat/sediment related), were not included in the total count of attempts or the decision to move on from a station. The results of each attempted grab were recorded in field notes. Forty sediment grabs samples were collected in the SWDA. Grab samples were attempted at 80 sample locations along the OECC, of those 66 were successful, and 14 stations had insufficient recovery after multiple attempts were made to collect a sediment sample.

Once an acceptable sample was obtained, the following steps were taken:

1. Overlying water was drained using a siphon.
2. A photograph was taken of the sample next to an identification label containing sample identification number and date.
3. Field notes were taken, including descriptions of physical features (depth of penetration, sediment color, texture, surface features) and surface megafauna; large surface fauna were returned to the water immediately.
4. The grab sample was then divided into an “A” and “B” sample based on the bucket design which was accessed via two hinged doors divided by a central support bar.
5. A four-inch diameter plexiglass tube was inserted, and sediment cores were removed from each side of the grab sampler bucket and placed in sieving buckets.
6. A 100-mL sample was taken from the sediment surrounding the cores on both sides and placed in plastic bags for grain size analysis.

After collection, both sediment core samples were photographed, described more thoroughly (grain size and characteristics at depth), and loaded onto a processing table and material washed through a 500-µm sieve using seawater under gentle pressure.

Organisms, shell fragments, and other remaining material were placed into a plastic container using stainless steel forceps, as needed. The container was filled no more than two-thirds full of sample and seawater. If the quantity of sample exceeded this volume, it was placed in a second container. The sample was fixed/preserved with 10% buffered formalin solution by filling the remaining space within the bottle with solution. Containers were tightly sealed with electrical tape and stored in a cooler at ambient temperature (not frozen or refrigerated). Prior to sieving the next sample, the sieve was cleaned by backwashing with pressurized water. The macroinvertebrate benthic community samples for the project were sent to Normandeau Associates, Inc. (Bedford, NH). The grain size samples were sent to GZA GeoEnvironmental, Inc. (Providence, RI) and processed by GeoTesting Express (Acton, MA).

2.2 Lab Analysis

2.2.1 Grain Size Analysis

Grain size samples were analyzed by GZA GeoEnvironmental, Inc./GeoTesting Express using the American Society for Testing and Materials (ASTM) soil classification system standards D6913/D7928 (sieve and hydrometer) to obtain particle size distributions by weight (ASTM, 2017a;b). A total of 106 sediment samples were sent for grain size analysis.

2.2.1.1 Image Analysis

For grab samples that had insufficient recovery three times, and therefore did not have sediment for lab analyses, RPS captured a still image from the underwater video directly before the sampler hit the substrate and disturbed the bottom, which can be seen in Table C-1 and C-2, Column A. A quadrat was drawn in the image processing software PhotoQuad (Trygonis and Sini, 2012) and one hundred points were analyzed to provide an estimate of the sediment classification of each station with insufficient recovery. In addition, because GZA GeoEnvironmental/Geotesting Express did not discern between biogenic and geologic origin of the substrate samples that were sieved, all underwater video and associated bottom images were reviewed to determine origin of substrate. If the bottom substrate at a grab sample location appeared to have ~50% or more shell, a bottom image was also analyzed in PhotoQuad and classified as biogenic shell habitats if over 50% of the points were confirmed as shell, instead of the gravel/gravel mix that the lab data would show.

2.2.2 Benthic Macroinvertebrate Lab Analysis

The benthic macroinvertebrate lab analysis was conducted by Normandeau Associates, Inc. (Normandeau; Bedford, NH) for processing and identification of organisms to lowest practical taxonomic level according to the following steps:

1. Upon arrival at the laboratory, Normandeau conducted sample inventory, checking samples for proper preservation, labeling and condition and for Chain of Custody accuracy.
2. Samples were rinsed with freshwater to remove the formalin and transferred to 70 percent ethanol alcohol for sorting and storage.
3. One randomly selected sub-sample from each station was gently rinsed through a 0.5 mm mesh screen, elutriated into 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. Macroinvertebrates were sorted from the debris into major taxonomic groups using a dissecting microscope.
4. All organisms were identified to the lowest practical taxon level (LPTL) and enumerated, with the following exceptions: nemerteans, nematodes, and sipunculids were identified to phylum; oligochaetes, platyhelminthes, and anthozoans 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. To ensure consistency for assessment of the soft-bottom megafaunal community, any incidental pelagic organisms or fauna attached to hard-substrates were not identified.

5. Calculations of abundance included all taxa occurring in each sample whether identified to species level or not.

2.3 Video Data Post-Processing

2.3.1 Objectives

Post-processing and analysis of video transect data were conducted by RPS to provide:

- General characterization of substrate including bottom type, texture, micro-topography.
- Evidence of benthic activity by organisms (burrows, trails, biogenic reefs);
- Identification of epibenthic macroinvertebrates (decapod crustaceans, mollusks [including squid mops], echinoderms) and benthic habitat;
- Presence/evidence and general characterization of submerged aquatic vegetation (macroalgae, sea grass);
- Identification of fish and fish habitat (where feasible) as classified by Auster (1998) to provide back compatibility with prior sampling work in the region if needed;
- Identification of organisms to the lowest practical taxonomic level (generally to Order to Family) using standard taxonomic keys for the geographic area;
- Evidence of fishing activity, such as trawl scars, pots, and working nets; and
- Presence of derelict fishing gear, military expended materials, shipwrecks, cultural artifacts, or other anthropogenic marine debris.

All still images from videos were classified according to NMFS-modified CMECS substrate component categories (FGDC, 2012; NMFS, 2020), which focuses closely on details of grain size and composition to describe benthic habitats and is being used to define complex and potentially valuable fish habitats. The BOEM Benthic Habitat Survey guidelines (BOEM, 2019) also require that the developer characterize the benthic community composition which includes documentation of abundance, diversity, percent cover, and community structure. The following were recorded when present and identifiable:

- Characterization and delineation of any submerged aquatic vegetation (seagrass or macroalgae) that occurs within the area of potential adverse effect;
- Characterization and delineation of any hard-bottom gradients of low to high relief such as coral (heads/reefs), rock or clay outcroppings, or other shelter-forming features; and
- Identification of communities of sessile and slow-moving marine invertebrates (clams, mussels, polychaete worms, anemones, sponges, echinoderms) that may be within the area of potential adverse effect.

2.3.2 Methods

The video data post-processing methods were developed according to relevant information presented in peer-reviewed publications and technical guidelines (Collie et al., 2000; Tissot, 2006; White et al., 2007; Judd. 2012; Hitchin et al., 2015; Turner et al., 2016). Videos were reviewed and analyzed in two separate steps. First, each video was reviewed in its entirety and any notable seafloor features or epifaunal/benthic/demersal species greater than 4 cm in size (roughly equal to the distance between the laser points) were recorded. When a feature or species was identified, the reviewer recorded the time, rated video visibility at that time, categorized the bottom based on Auster (1998; Table 2-1), and recorded the lowest possible taxon and abundance of organisms. The Auster bottom type was not used in any of the data analyses presented in the report but was provided in the data delivered for back compatibility with previous sampling, if needed. Most portions of the videos were reviewed multiple times using slower playback speeds and replay functions.

The abundance of megafauna was recorded along with presence/absence of biotic activity, submerged aquatic vegetation (macroalgae, sea grass), fishing activity, derelict gear, military expended materials, shipwrecks, coral heads/reefs, rock outcroppings, other shelter features, and other marine debris. After review, the taxonomic details of each megafaunal observation were investigated and data were recorded at the lowest possible taxonomic level identifiable through the video.

Encrusting sponges are by nature amorphous and difficult to discern as individuals; thus, they were not individually counted in the megafauna video review. In addition, sponges are known to be difficult to identify to species, particularly through imagery recorded at a distance, and there are multiple ways of characterizing their abundance for monitoring based on morphology (Bell et al., 2017). Many species need to be physically sampled and analyzed in a lab for taxonomic identification. For this work, sponge presence was recorded during megafauna review, and the area of substrate occupied by encrusting organisms was calculated during the percent cover analysis as one group that was not further identified to species.

Table 2-1. Categories for video or image quality/visibility, and Auster sediment class.

Quality Score	Visibility Definition	Auster Category	Auster Definition*
0 – none	obscured or turbid, lasers not visible on seafloor	1 – flat sand/mud	areas with no vertical structure
1 – low	lasers are visible but image still too blurry or dark	2 – sand waves	troughs and waves in sand
2 – moderate	most features distinguishable, both lasers in view	3 – biogenic structures	burrows, depressions, and other features created or used by mobile fauna for shelter
3 – high	features easily distinguishable, both lasers in view	4 – shell aggregates	shells create complex interstitial spaces for shelter and high-contrast background
		5 – pebble-cobble	small interstitial spaces, less ephemeral than shell
		6 – pebble-cobble with sponge cover	attached fauna increase spatial complexity
		7 – partially buried or dispersed boulders	partially buried boulders provide high vertical relief while dispersed boulders over cobble provide simple crevices
		8 – piled boulders	provide deep interstitial spaces of variable sizes

* Adapted from Auster, 1998.

Second, each video was subsampled to still images at 8-14 second intervals. Metadata were recorded for each still image including latitude and longitude, time, transect, and ID number. The quality of each image was assessed with a categorical scale from 0 to 3 based on clarity, perceived height above the seafloor, lighting, and turbidity. Still images with quality scores of "moderate" (2 or greater) were analyzed with seabed image processing software PhotoQuad (Trygonis and Sini, 2012). Each image was calibrated for scale using the reference laser points and the area (cm^2) of the visible portion was recorded, with poorly lit or blurry edges of "passing" images excluded from analysis.

To inform CMECS classification of bottom habitat, 100 points were distributed uniformly by the PhotoQuad software across the entire visible portion of each passing still image. Percent cover data were recorded as the number of points under which different substrate types were visible: boulder, cobble, pebble/granule, sand/mud, or biogenic-origin shells or large worm tube structures (see size definitions in Table 2-2). In addition, other "biological elements" were recorded if visible in each image, including infaunal structures (e.g., small worm or amphipod tubes), burrows (e.g., crab depressions or clam siphon holes), mobile megafauna (e.g., fish, crabs, moon snails), Codium or other green algae, encrusting organisms (e.g., sponges, corals), sand dollars, mussel beds, eelgrass, and bushy plant-like organisms that were grouped together for identification purposes (e.g., hydrozoa, bryozoa, branching red algae).

These point counts approximated percent cover of each substrate type in the still image and was used to assign the appropriate substrate classifications of the habitat to the furthest extent possible under a NMFS-modified (NMFS, 2020) version of CMECS (FGDC, 2012). This system discerns substrate components by origin (e.g., geologic mineral or biogenic shell) and groups, based primarily on the percent cover of coarse, gravel-sized particles (pebble/granule, cobble, and boulder) versus fine sand/mud, or the size category of shells (reef, rubble, and hash). For some images, a substantial amount of cover from biological elements made the percent cover thresholds of different gravel-sized particles less informative/appropriate for classification. In these cases, additional decision rules were developed that informed whether the image should be classified as NMFS-defined categories based primarily on gravel percent cover, or if the image should bump up to a higher threshold gravel category assuming that the substrate under the biological elements was also comprised of gravel. Additional details on the still image analysis and classification methods can be found in Appendix A.

Table 2-2. CMECS geologic sediment size, biogenic size, and percent cover categories (from FGDC, 2012).

Geologic Sediment	Definition	Biogenic Size	Definition	Biogenic Cover	Definition
Bedrock	> 4,096 mm	Reef	> 4,096 mm	Trace	< 2%
Boulder	256 – 4,096 mm	Rubble	64 – 4,096 mm	Sparse	2 – 30%
Cobble	64 – 256 mm			Moderate	30 – 70%
Pebble / Granule	2 – 64 mm	Hash	2 – 64 mm	Dense	70 – 90%
Sand / Mud	< 2 mm	Sand	< 2 mm	Complete	> 90%

2.4 Benthic Macroinvertebrate Data Post-Processing

The benthic macroinvertebrate community analysis was based on the laboratory results provided by Normandeau Associates for the 40 successful grab samples collected in the SWDA and 66 successful grab samples collected along the OECC, respectively. Benthic macroinvertebrate community statistics were calculated using family (or next lowest taxonomic level possible based on LPTL) abundance estimates in each sample, which were reported as count per 0.008 m^2 (area of subsample core). Community composition parameters included: total abundance, number of phyla, number of taxa, Margalef's Richness Index, Shannon Diversity Index, and Pielou's Index of Evenness for each station and within each lease area. A multivariate analysis was conducted examine dissimilarity/similarity of samples based on the invertebrate assemblages (composition of all taxa and their abundances).

2.4.1 Taxonomic Composition

Benthic macroinvertebrate taxonomic composition was assessed to characterize the high-level trends in taxa data. Community composition includes the relative proportions of taxonomic groups by number of identifiable taxa and number of individuals and was used to evaluate dominance of common phyla across all samples. Taxonomic composition was summarized for each station and across the project area (SWDA or OECC), aggregated at both phylum-level and family or LPTL.

2.4.2 Richness, Diversity, and Evenness

Taxonomic richness, evenness, and diversity are common ecological parameters used to measure the overall biodiversity of a community or discrete unit. Because some taxa were not identified to the species level, we used abundance data for organisms identified to the LPTL but no further than family, modifying the indices to be taxonomic richness, evenness, and diversity indices. Taxonomic richness is the number of unique species or taxonomic groups represented in an area of interest. In this assessment, taxonomic richness was calculated using Margalef's Richness Index (Formula 1) for each station and survey area to acquire sample and average richness indices.

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

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

Where:

S= the number of unique taxa

N= the total number of individuals in the sample

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

The diversity index for a community considers taxonomic richness and the proportion of each unique taxa. The Shannon Diversity Index (H'; Formula 2) was calculated using the number of each taxa (family or LPTL), the proportional abundance of each taxa relative to the total number of individuals, and the sum of the proportions. This index was used to assess diversity of each station within the SWDA and OECC. The diversity index (H') increases with increasing taxonomic richness and evenness.

Formula 2. H'- Shannon Diversity Index.

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

Where:

p_i = the proportion of individuals belonging to the taxa I 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 taxa comprising a population or sample. Pielou's Index of Evenness (J'; Formula 3) includes H' (Shannon-Weiner Diversity Index) in its calculation.

Formula 3. J'- Pielou's Index of Evenness.

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

Where:

H' = the Shannon- Weiner Diversity Index

H_{Max} = the maximum possible value of H', where each taxon occurs in equal abundances.

$$H_{Max} = \ln(s)$$

Where: s = Number of taxa

Interpretation: J' is constrained between 0 and 1. The greater the value of J', the more evenness in the sample.

2.4.3 Multivariate Analysis

Multivariate analyses were conducted with R software (Oksanen et al., 2019; R Core Team, 2020) to examine dissimilarity/similarity of samples based on the invertebrate assemblages (composition of all taxa and their abundances). These analyses included nonmetric multidimensional scaling (NMDS), analysis of similarities (ANOSIM), and analysis of similarity percentages (SIMPER; Clarke, 1993). All analyses were built on a Bray-Curtis Similarity Index, using a square-root transformation of the data to ensure all taxa (not just those that dominated samples) would contribute to similarity measures. As with the community indices, invertebrate data were limited to the family level or next LPTL. Differences in assemblages between stations were compared and assessed using NMFS (2020) modified CMECS substrate classifications, complex (>5% gravel or shell) designation, and location of sample in the SWDA and along the OECC.

Three-dimensional NMDS was used to visually compare the ordinate distance (difference) between samples and evaluate the similarity of community assemblages. Samples were ordinated based on similarity to one another with samples of higher similarity appearing in closer proximity to one another in NMDS plots. Samples were also colored according to assigned NMFS (2020) modified CMECS classifications, complex or non-complex habitat, and sample location.

SIMPER was used to identify the percent dissimilarity between assemblages within NMFS (2020) modified CMECS substrate components, complex and non-complex habitats, and sample location and to identify taxa that were most responsible for that dissimilarity (i.e., the taxa with the largest differences in mean abundance). ANOSIM was used to help determine if substrate classifications or location were predictive of the invertebrate assemblage clusters. The test statistic (R values) calculated in the Global ANOSIM indicates whether samples within classification groups were more similar than samples between groups. R values closer to 1 with significance levels of $p < 0.05$ indicate that samples within a classification group are more similar to each other than to those in different groups. R values closer to 0 indicate samples are equally similar within a classification group as they are between different groups. Specifically, ANOSIM was used to test the null hypotheses:

$H_0 1$: The similarity of invertebrate assemblages between NMFS CMECS groups is greater than or equal to the similarity within NMFS CMECS groups;

$H_0 2$: The similarity of invertebrate assemblages between NMFS CMECS complex designations (complex and non-complex) is greater than or equal to the similarity within the designation groups;

$H_0 3$: The similarity of invertebrate assemblages between sample location groups is greater than or equal to the similarity within location groups.

3 RESULTS

3.1 Video Analysis

3.1.1 SWDA Analysis

The characteristics and locations of the 12 underwater video transects within the SWDA in 2020 are described in Table 3-1 and locations are shown in Figure 3-1. Abundance data are displayed in Table 3-2 and visualized in Figure 3-2 through Figure 3-7. Example stills of important megafauna are displayed in Table 3-5. Percent cover can be found in Table 3-6 and, due to the low habitat variance of the SWDA, representative habitat stills can be found alongside OECC images in Table 3-13.

Table 3-1. Underwater video transect locations in SWDA area.

Transect	Date	Recorded Duration (min:sec)	Transect Length (m)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Total # Stills	# Analyzed Stills
SWDA20-VT-01	8/14/20	11:23	297.0	-70.528005	40.985458	-70.530479	40.987319	66	49
SWDA20-VT-02	8/14/20	14:55	267.4	-70.533086	40.953018	-70.530076	40.953044	96	57
SWDA20-VT-03	8/9/20	06:46	224.9	-70.597813	40.962494	-70.598022	40.960482	43	19
SWDA20-VT-04	8/14/20	07:11	160.6	-70.636321	41.001383	-70.635398	41.002609	44	41
SWDA20-VT-05	8/10/20	15:57	339.0	-70.663536	40.963598	-70.663582	40.961432	102	78
SWDA20-VT-06	8/9/20	06:48	245.3	-70.552181	40.905101	-70.551725	40.903031	42	37
SWDA20-VT-07	8/14/20	12:58	282.0	-70.636816	40.902234	-70.633584	40.902254	83	72
SWDA20-VT-08	8/14/20	15:10	229.9	-70.64064	40.885741	-70.638052	40.885846	90	58
SWDA20-VT-09	8/10/20	10:21	269.4	-70.727808	40.901996	-70.727879	40.899611	66	43
SWDA20-VT-10	8/10/20	09:58	280.3	-70.710879	40.867186	-70.707616	40.867249	63	48
SWDA20-VT-11	8/10/20	09:59	272.6	-70.815065	40.865884	-70.814829	40.863529	62	40
SWDA20-VT-12	8/14/20	09:52	237.2	-70.725442	40.799547	-70.72565	40.801644	62	58

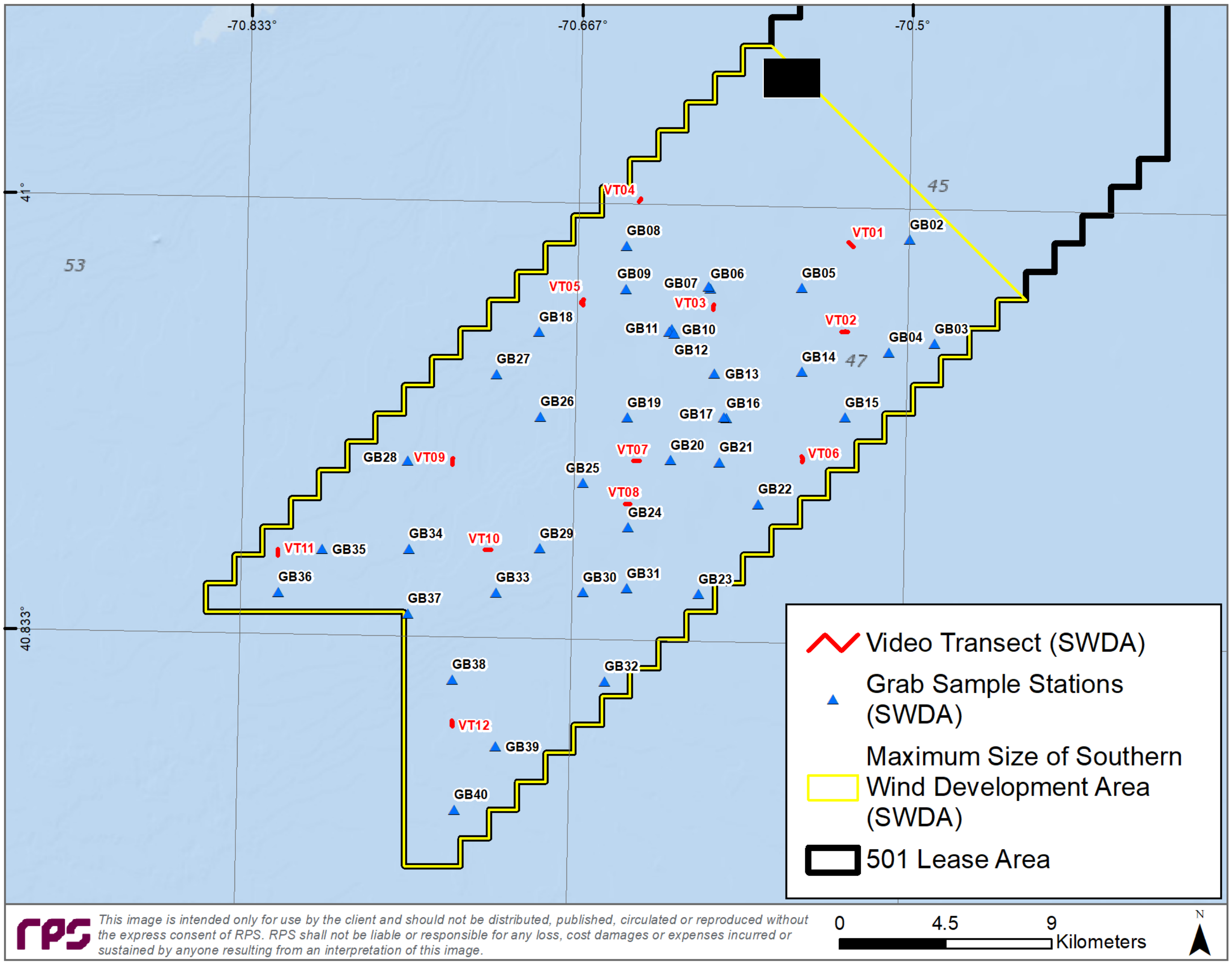


Figure 3-1. Map of sampling locations in SWDA video transects (red) and grab sample sites (blue).

3.1.1.1 Megafauna Counts

The presence and abundance of megafauna greater than 4 cm were recorded during the video review process in Table 3-2 and visualized in Figure 3-2, Figure 3-4, Figure 3-5, Figure 3-6, and Figure 3-7. Organisms were identified to the LPTL, which ranged from a binomial scientific name to phyla. A total of 1,347 organisms were identified across the 12 transects that make up the SWDA area. One hundred and fifty-seven vertebrates composed of 7 taxa were identified (all of which were species of fish; Table 3-3, Table 3-4, and Figure 3-6), 1,190 invertebrates composed of 15 taxa (Figure 3-7), and two kinds of egg cases (skate and moon snail) were identified. An additional 34 unidentified observations were recorded, of which one observation may have been a living organism with the remaining 33 suspected to be non-living.

Vertebrates composed approximately 12% of all organisms observed in the SWDA (157 of 1,348) and most numerous amongst them were varieties of hake which comprised approximately 64% of all observed vertebrates (Figure 3-6). Accordingly, invertebrates made up the remaining 88% of organisms observed (1,190 of 1,348; Figure 3-5). However, >90% of invertebrates (782 observations) were of *Cerianthus borealis* (northern cerianthid anemone) of which >90% were found in VT-12 (734 of 782). The next most numerous enumerated invertebrate taxa were varieties of crab, and sea stars with 275 and 99 observation respectively (Figure 3-7). Representative images of some of the megafauna identified are provided in Table 3-5.

Due to the high abundance of Cerianthid anemones (Phylum Cnidaria), VT-12 contained the most observed organisms with a total abundance of 776 individuals (Figure 3-2). However, it should be noted that in the absence of these anemones, VT-12 would register as one of the lower total abundance overall, and transects VT-02, VT-10, and VT-11 then become the transects with the first, second, and third highest abundance totals, respectively, primarily due to the number of crabs (Phylum Arthropoda) observed.

Table 3-2. Megafauna enumerated during review of the video transects in SWDA.

Common Name	Lowest Taxonomic Level	Counts per Transect												
		VT01	VT02	VT03	VT04	VT05	VT06	VT07	VT08	VT09	VT10	VT11	VT12	Total
Vertebrate														
Hake, Unidentified	Gadidae	14	20	3	3	8	1	9	14	7	7	10	3	99
Skate, Little or Winter	Leucoraja	-	-	-	-	1	-	-	-	-	-	-	-	1
Monkfish	*Lophius americanus*	-	-	-	-	-	-	-	-	-	-	-	1	1
Hake, Silver	*Merluccius bilinearis*	-	-	-	2	-	-	-	-	-	-	-	-	2
Flounder	Pleuronectiformes	1	2	-	1	2	-	4	-	2	-	2	-	14
Skate	Rajidae	-	2	1	-	4	1	-	4	-	-	-	1	13
Skate, Egg Case	Rajidae	-	2	-	1	1	-	-	-	-	-	-	-	4
Fish, Unidentified (Bony)	Teleostei	-	-	-	-	-	-	-	-	-	-	5	-	5
Flatfish, Unidentified	Teleostei	1	-	-	-	-	-	-	-	-	-	-	-	1
Roundfish, Unidentified	Teleostei	2	4	2	2	-	-	3	-	-	-	4	-	17
Total Vertebrates		18	30	6	9	16	2	16	18	9	7	21	5	157
Invertebrates														
Sea Star	Asterias	-	3	2	1	2	37	2	11	2	26	4	3	93
Crab, Cancer	Cancer	4	13	5	5	4	1	7	2	2	4	5	33	85
Squid	Cephalopoda	-	-	-	-	-	-	1	-	-	-	-	-	1
Cerianthid, Northern	*Cerianthus borealis*	1	7	-	10	-	1	1	2	8	-	18	734	782
Shrimp	Decapoda	9	36	-	1	24	-	35	-	3	42	28	-	178
Sea Urchin	Echinoidea	-	-	-	-	-	-	-	-	1	1	-	-	2
Sea Star, Blood	*Henricia sanguinolenta*	-	-	-	-	-	-	-	-	-	-	-	6	6
Solitary Hydroid	Hydrozoa	-	4	-	-	-	-	1	-	-	-	-	-	5
Whelk (Knobbed, Channeled)	Melongenidae	1	-	-	-	-	-	-	-	-	-	-	-	1
Moon Snail	Naticidae	-	-	-	-	-	-	3	-	-	1	1	1	6
Moon Snail, Egg Case	Naticidae	-	-	-	-	-	-	-	1	-	-	-	-	1
Crab, Hermit	Pagurus	-	4	-	1	-	-	1	5	-	-	1	-	12
Scallop, Sea	*Placopecten magellanicus*	-	1	-	5	1	-	2	-	-	2	3	-	14
Worm, Polychaete	Polychaeta	-	-	-	-	-	-	1	-	-	-	-	-	1
Worm, Unidentified	Polychaeta	-	-	-	-	-	-	-	-	1	-	-	-	1
Worm, Scale	Polynoidae	-	-	-	-	-	1	-	-	-	-	-	-	1
Worm, Sabellid	Sabellida	-	-	-	-	1	-	-	-	-	-	-	-	1
Total Invertebrates		15	68	7	23	32	40	54	21	17	76	60	777	1190
Other														
Unidentified		-	-	-	-	-	-	-	1	2	-	-	-	3
Unidentified Object		3	3	3	-	6	-	9	-	-	-	6	-	30
Unidentified Organisms		-	-	-	-	1	-	-	-	-	-	-	-	1
Total Organisms		33	98	13	32	48	42	70	39	26	83	81	782	1348
Total Observations		36	101	16	32	55	42	79	40	28	83	87	782	1381

Table 3-3. Total abundance of organisms by class per 300m in the SWDA.[1]

Common Name	Taxonomic Class or higher	Organisms per 300 meters in Sample Area
		SWDA (4,497 m)
Vertebrates		
Bony Fish	Teleostei	13
Skates	Chondrichthyes	1
Total Vertebrates		15
Invertebrates		
Bivalves	Bivalvia	1
Crabs	Malacostraca	26
Hydrozoans	Hydrozoa	0.48
Marine Worms	Polychaeta	0.38
Sea Anemones	Anthozoa	75
Sea Stars	Asteroidea	9
Sea Urchins	Echinoidea	0.19
Squid	Cephalopoda	0.09
Whelk	Gastropoda	0.77
Total Invertebrates		114
Other		
Unidentified	unidentified	0.28
Unidentified Object	unidentified object	2
Unidentified Organisms	unidentified species	0.09
Total Organisms		130
Total Observations		133

[1] "Total Organisms" does not include anthropogenic debris or unidentified object. Summed transect length (m) in parenthesis below area. Dashes indicate that no organisms of that classification were enumerated.

Table 3-4. Common taxonomic clades and common name equivalents. For clarity, taxonomy beyond the class level was not used in figures for invertebrates.

Common Name	Phylum	Class	Order
Vertebrates			
Bony Fish	Chordata	**Teleostei**	*N/A*
Perch-like fish	Chordata	Teleostei	**Perciformes**
Flounder	Chordata	Teleostei	**Pleuronectiformes**
Hake	Chordata	Teleostei	**Gadiformes**
Monkfish	Chordata	Teleostei	**Lophiiformes**
Sea Robin	Chordata	Teleostei	**Scorpaeniformes**
Skate	Chordata	Chondrichthyes	**Rajiformes**
Invertebrates			
Sea Anemones	Cnidaria	**Anthozoa**	*N/A*
Clams and other shellfish	Mollusca	**Bivalvia**	*N/A*
Crabs	Arthropoda	**Malacostraca**	*N/A*
Horseshoe Crabs	Arthropoda	**Euchelicerata**	*N/A*
Snails	Mollusca	**Gastropoda**	*N/A*
Sea Stars	Echinodermata	**Asteroidea**	*N/A*
Sea Urchins	Echinodermata	**Echinoidea**	*N/A*
Hydrozoans	Cnidaria	**Hydrozoa**	*N/A*
Squid	Mollusca	**Cephalopoda**	*N/A*
Worms	Annelida	**Polychaeta**	*N/A*

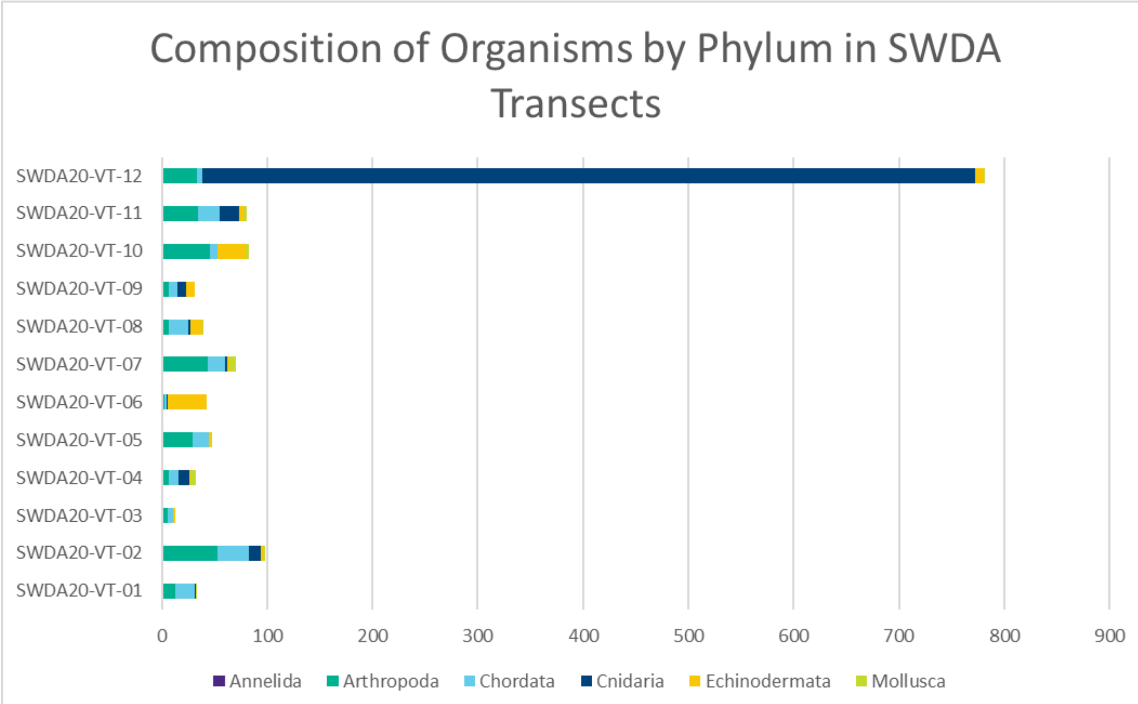


Figure 3-2. Comparative abundance by Phylum throughout SWDA transects. For common name equivalents of taxonomy, refer to Table 3-4.

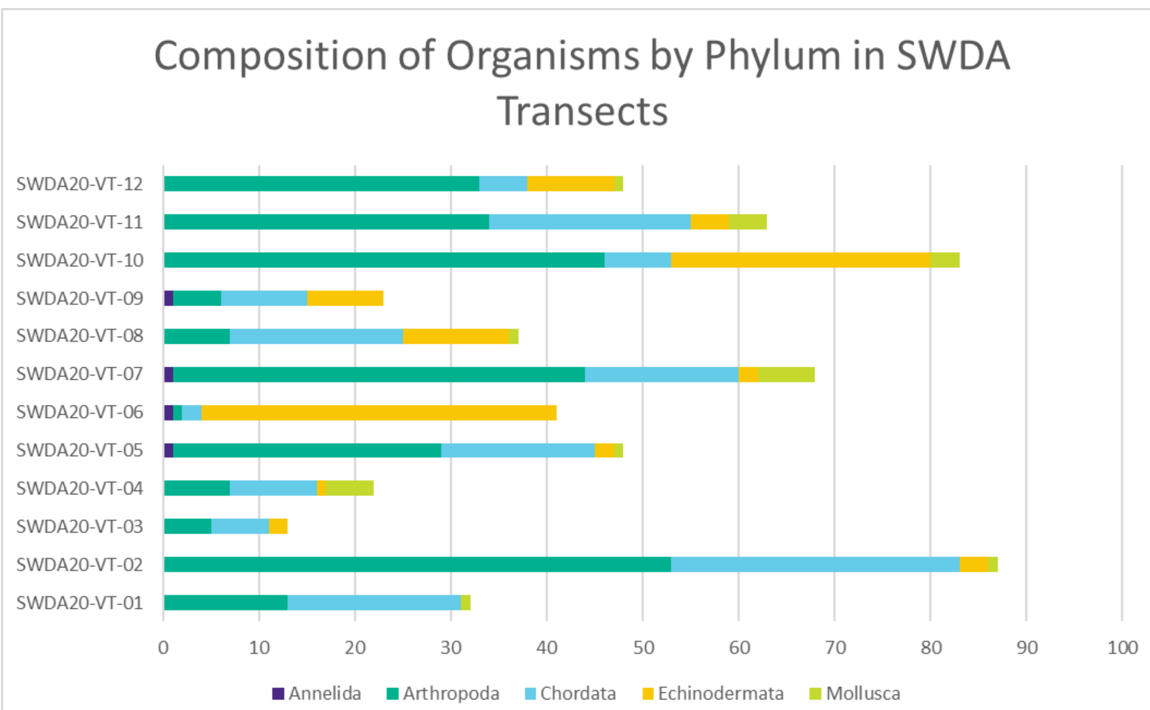


Figure 3-3 Comparative abundance by Phylum throughout SWDA transects with the Phylum Cnidaria removed for clarity. For common name equivalents of taxonomy, refer to Table 3-4.

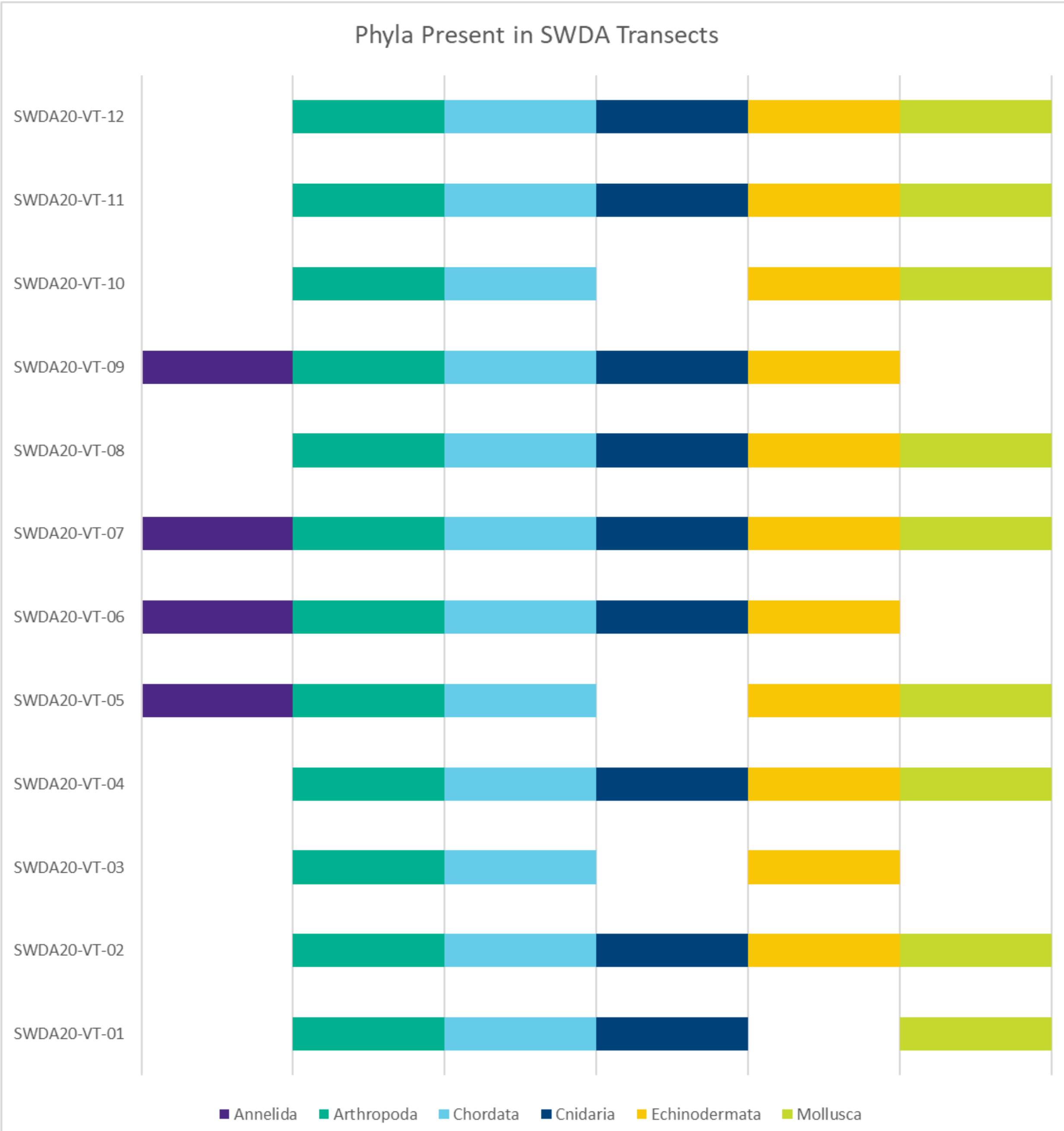


Figure 3-4. Presence or absence of Phyla throughout SWDA transects. For common name equivalents of taxonomy, refer to Table 3-4.

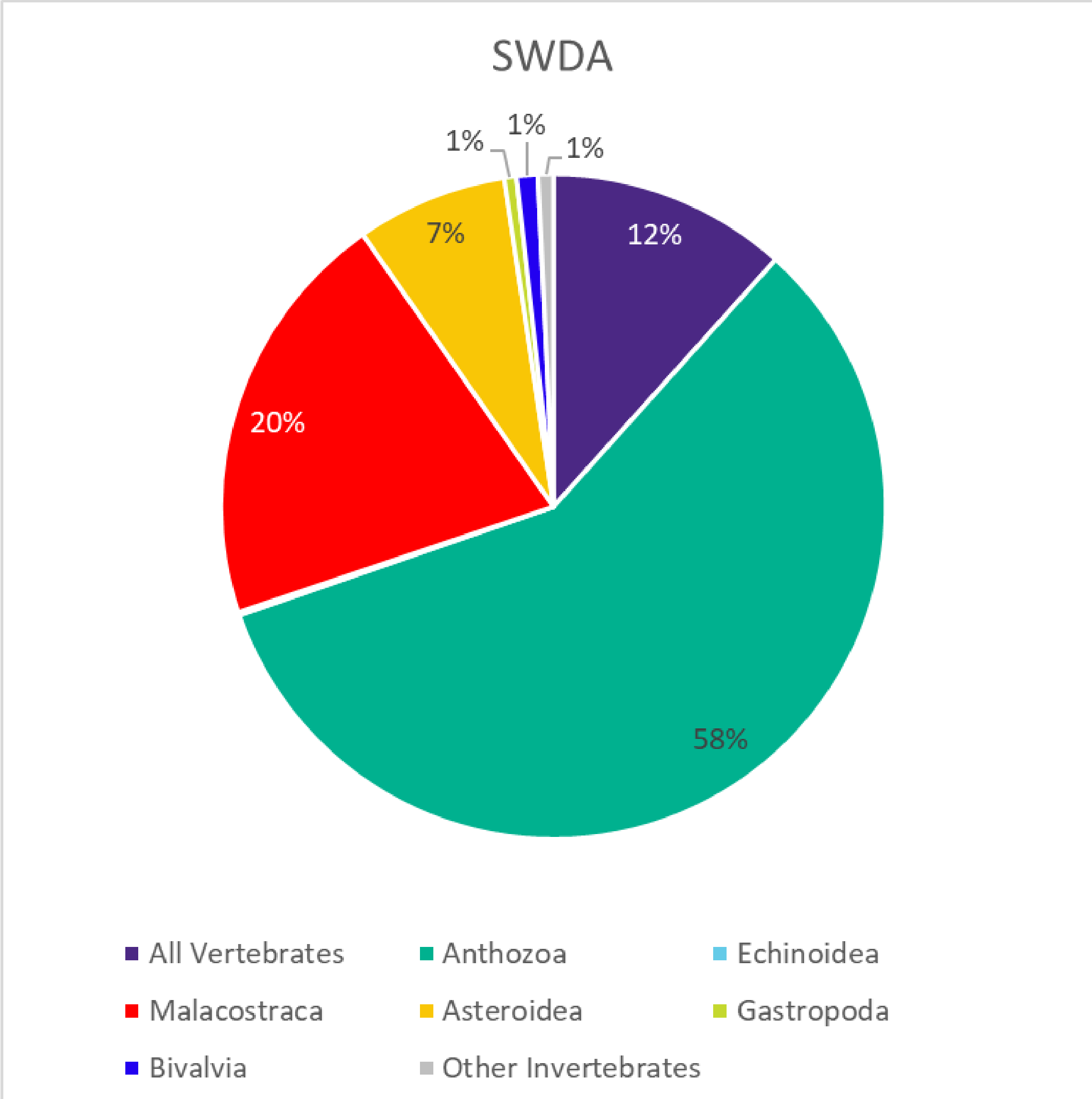


Figure 3-5. Percent composition of organisms enumerated throughout SWDA transects. Organisms contained in “Other Invertebrates” category constitute less than 1% of all observations and are composed of Cephalopods (squid), Hydrozoans, Euchelicerata (horseshoe crabs) and Polychaetes (worms).

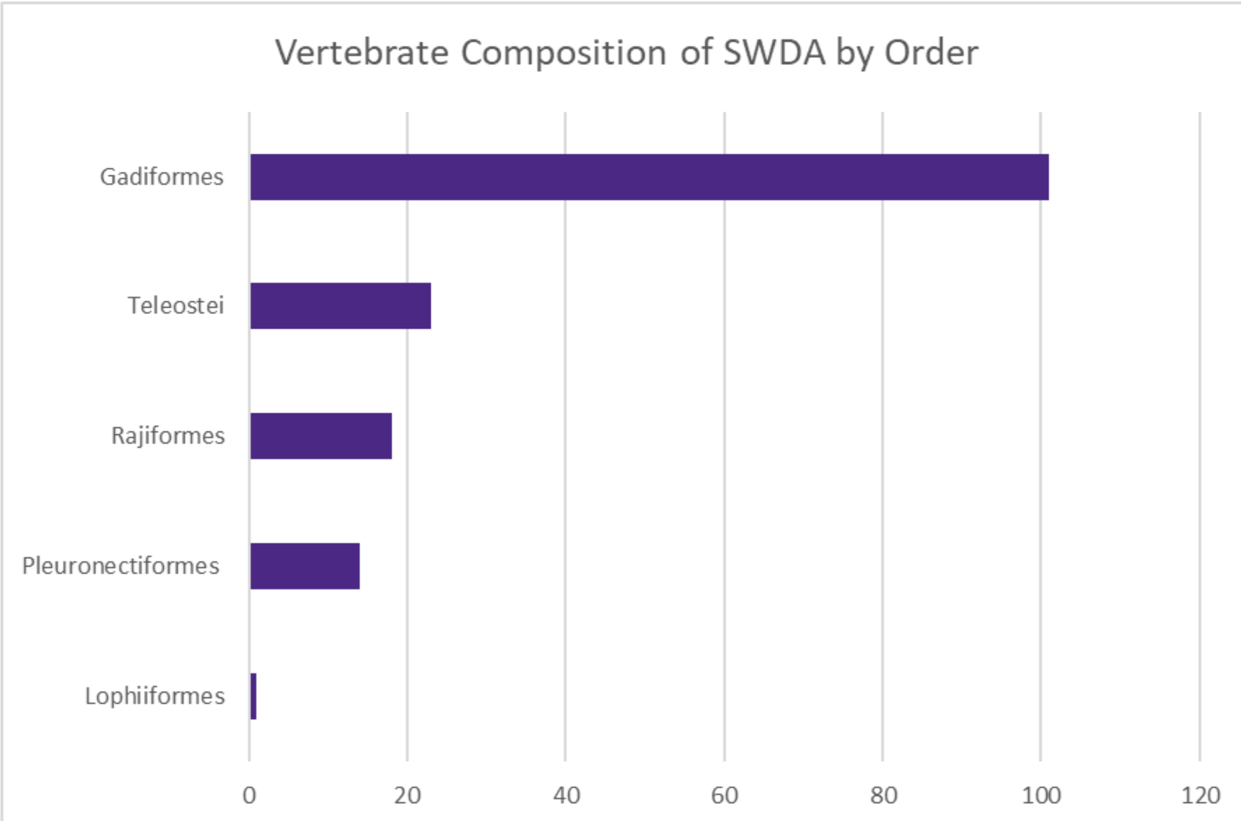


Figure 3-6. Relative abundance of vertebrates (members of the Phylum Chordata) throughout the SWDA transects summed by Order when possible. For common name equivalents of taxonomy, refer to Table 3-4.

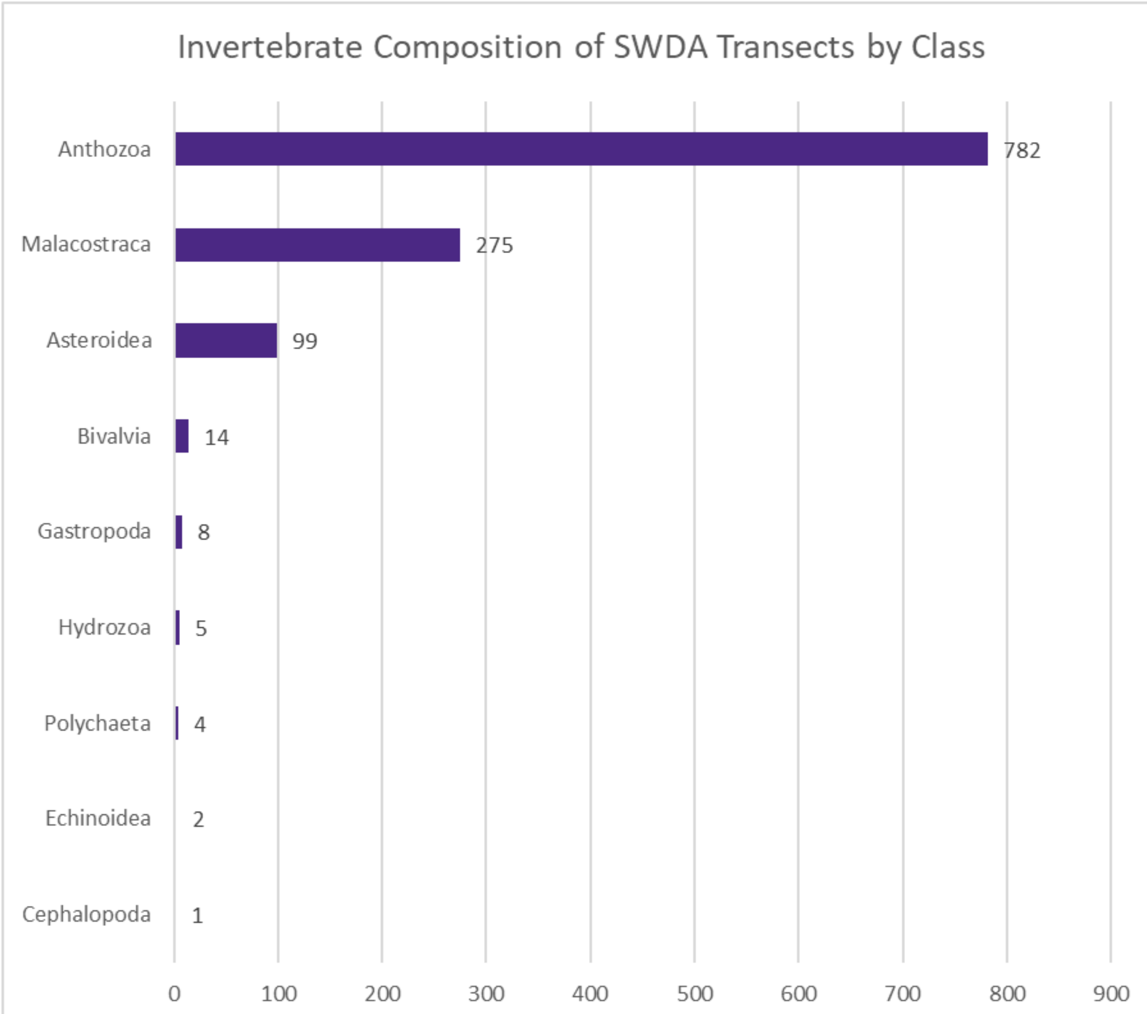


Figure 3-7. Relative abundance of invertebrates (species not contained within the Phylum Chordata) throughout the SWDA transects summed by Class. For common name equivalents of taxonomy, refer to Table 3-4.

Table 3-5. Representative images of megafauna observed and identified within the 12 transects of the SWDA area (continued on next page).

Cancer crab *(Cancer)* and Northern Cerianthid *(Cerianthus borealis)* SWDA-VT-12B	
Blood Star *(Henricia sanguinolenta)* SWDA-VT-02	
Silver Hake *(Merluccius bilinearis)* SWDA-VT-01	

Hake (Gaddidae likely *Merluccius*) SWDA-VT-02	
Skate (Rajidae) SWDA-VT-02	

3.1.1.2 Percent Cover

The following section summarizes the results of the percent cover analysis of still images derived from underwater video transects in the SWDA project region. Percent cover of various bottom substrates and features within a measured surface area of each image were recorded and used to define the NMFS-modified (NMFS, 2020) CMECS substrate classification that was most suitable for the sampled area. In addition to percent cover of different sediment grain sizes (boulder, cobble, pebble/granule, or sand/mud), the presence of biogenic shell substrate and other biological elements were also recorded. Examples of biological elements include flora (e.g., algae or seagrass), fauna (e.g., mobile megafauna, encrusting species, sand dollars, mussel beds), and evidence of biological activity (e.g., burrows, infaunal structures). Thus, in addition to CMECS classification of substrate, the density of shell and flora/fauna cover were calculated and included as additional indicators of habitat complexity. Visual examples of habitat types defined using the still images are presented in the CMECS Classifications section (Section 4).

The substrate group with the highest percent cover across all transects sampled in the SWDA was sand/mud, comprising over 99% of the surface area analyzed through still images for each transect (Table 3-6). Sand and mud were combined into one category while pebble and granule were combined into another as the size differences between there categories were not discernable from each other in a video analysis. There were no visual observations of boulder, cobble, or pebble/granule substrates of geologic origin. Very small deposits of biogenic origin substrates (i.e., shell hash) and flora/fauna cover were observed in most of the transects but totaled less than 3 m^2 (0.3%) of the 810 m^2 analyzed for the SWDA.

Of the biological elements, infaunal structures and megafauna had the highest percent cover (0.07% and 0.06%, respectively) and occurrence (occurred in 8 and 9 transects, respectively) across the 12 SWDA transects (Table 3-7). The only other biological elements encountered were burrows observed in two transects (0.04% of area) and encrusting organisms observed in one transect (0.02% of area). All flora/fauna combined covered 1.6 m^2 of the bottom.

Table 3-6. Area and percent coverage of different substrates summarized from still images taken from each of the 12 video transects in the SWDA.

Transect	Total Area Analyzed (m^2)	Percent of Area - Gravel Substrates				Sand / Mud Substrate (%)	Biogenic Shell Cover (%)	Flora / Fauna Cover (%)
		Boulder (%)	Cobble (%)	Pebble/ Granule (%)	All Gravel Combined (%)			
SWDA20-VT-01	39.2	0.0	0.0	0.0	0.0	99.6	0.1	0.2
SWDA20-VT-02	39.1	0.0	0.0	0.0	0.0	99.1	0.0	0.9
SWDA20-VT-03	29.8	0.0	0.0	0.0	0.0	100.0	0.0	0.0
SWDA20-VT-04	94.8	0.0	0.0	0.0	0.0	99.7	0.3	0.0
SWDA20-VT-05	105.1	0.0	0.0	0.0	0.0	99.6	0.3	0.1
SWDA20-VT-06	66.1	0.0	0.0	0.0	0.0	99.8	0.1	0.2
SWDA20-VT-07	99.7	0.0	0.0	0.0	0.0	99.7	0.2	0.1
SWDA20-VT-08	45.4	0.0	0.0	0.0	0.0	99.7	0.1	0.3
SWDA20-VT-09	31.6	0.0	0.0	0.0	0.0	99.4	0.1	0.5
SWDA20-VT-10	48.6	0.0	0.0	0.0	0.0	99.6	0.1	0.3
SWDA20-VT-11	78.6	0.0	0.0	0.0	0.0	99.8	0.0	0.2
SWDA20-VT-12	131.7	0.0	0.0	0.0	0.0	99.8	0.0	0.2
SWDA Total Area (m^2)	**809.6**	**0.0**	**0.0**	**0.0**	**0.0**	**807.0**	**1.0**	**1.6**

Table 3-7. Area and percent coverage of different biological elements (i.e., flora/fauna) observed within still images taken from each of the 12 video transects in the SWDA.

Transect	Flora/ Fauna Area (m^2)	Burrows (%)	Infaunal Structures (%)	Megafauna (%)	Encrusting Orgs. (%)	Sand Dollars (%)	Mussel Beds (%)	Eelgrass (%)	Algae – Codium (%)	Bushy Plant-like Orgs. (%)
SWDA20-VT-01	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-02	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-05	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-06	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-07	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-08	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-09	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-10	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-11	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
SWDA20-VT-12	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
SWDA Total Flora/Fauna Area (m^2)	**1.6**	**0.4**	**0.6**	**0.5**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

3.1.2 OECC Analysis

The characteristics and locations of the 63 underwater video transects within OECC are described in Table 3-8 and locations are shown in Figure 3-8. Abundance data are displayed in three sets of tables separated by region; Table 3-9 displays abundance data for the Northern OECC; Table 3-10 contains Southern OECC data; and Table 3-11 contains data from Muskeget channel. There were no video transect located within the Landfall region. Table 3-12 enables more meaningful comparisons between regions of the OECC by normalizing the total number of organisms by the total length of transects within a given region. Data is further visualized in Figure 3-9 through Figure 3-15. Example stills of important megafauna are displayed in Table 3-13.

Table 3-8. Underwater video transect locations along the OECC.

Transect	Date	Recorded Duration (min:sec)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Total # Stills	# Analyzed Stills
OECC20-VT-01	10/11/20	12:32	-70.354852	41.607991	-70.355866	41.605668	54	21
OECC20-VT-02	10/11/20	15:33	-70.351108	41.597494	-70.353522	41.595643	65	39
OECC20-VT-03	8/12/20	10:00	-70.36348	41.595555	-70.362056	41.593752	56	47
OECC20-VT-04	8/12/20	12:23	-70.372349	41.586257	-70.37398	41.584021	73	33
OECC20-VT-05	8/12/20	09:56	-70.384156	41.561757	-70.386859	41.560944	55	28
OECC20-VT-06	10/11/20	19:03	-70.401214	41.558941	-70.402136	41.556094	80	53
OECC20-VT-07	8/12/20	09:15	-70.393743	41.543015	-70.396749	41.543281	59	47
OECC20-VT-08	10/11/20	14:07	-70.408383	41.544561	-70.407442	41.542852	58	20
OECC20-VT-09	8/12/20	07:38	-70.411707	41.530526	-70.413677	41.531489	48	41
OECC20-VT-10	8/12/20	09:51	-70.40622	41.514718	-70.408654	41.515809	60	41
OECC20-VT-11	8/12/20	10:37	-70.413874	41.512532	-70.416624	41.511656	68	49
OECC20-VT-12	8/12/20	11:35	-70.416312	41.499716	-70.418099	41.502169	70	58
OECC20-VT-13	8/23/20	11:48	-70.420724	41.473859	-70.418489	41.475576	73	41
OECC20-VT-14	8/22/20	14:18	-70.419492	41.453846	-70.422445	41.455626	89	55
OECC20-VT-15	8/23/20	13:01	-70.422387	41.441657	-70.424833	41.442719	82	61
OECC20-VT-16	10/14/20	12:37	-70.429909	41.436439	-70.428994	41.433507	52	32
OECC20-VT-17	10/15/20	20:33	-70.422399	41.422156	-70.422046	41.419263	87	65
OECC20-VT-18	8/23/20	11:15	-70.424596	41.414741	-70.422868	41.412699	74	33
OECC20-VT-19	10/14/20	06:56	-70.430777	41.412211	-70.430373	41.414465	31	18
OECC20-VT-20	10/15/20	23:33	-70.431595	41.40417	-70.430135	41.401095	102	77
OECC20-VT-21	10/14/20	12:55	-70.419538	41.398598	-70.423297	41.399058	53	22
OECC20-VT-22	8/22/20	21:38	-70.430643	41.385977	-70.428396	41.382573	133	96
OECC20-VT-23	8/22/20	13:41	-70.422614	41.376628	-70.425144	41.374879	80	74
OECC20-VT-24	8/22/20	12:51	-70.413282	41.372417	-70.413865	41.375361	65	45
OECC20-VT-25	8/22/20	11:41	-70.410793	41.370394	-70.407357	41.371395	68	42
OECC20-VT-26	8/22/20	11:06	-70.413894	41.365677	-70.415209	41.367141	70	26
OECC20-VT-27	8/22/20	10:52	-70.405611	41.367027	-70.407554	41.368405	69	27
OECC20-VT-28	8/24/20	17:14	-70.39626	41.359835	-70.396187	41.356142	111	83
OECC20-VT-29	10/15/20	32:10	-70.401398	41.354415	-70.398463	41.350038	137	102
OECC20-VT-30	8/22/20	20:25	-70.393228	41.354607	-70.388971	41.355089	130	69
OECC20-VT-31	8/22/20	14:23	-70.391789	41.346238	-70.388442	41.346632	91	80
OECC20-VT-32	10/19/20	22:03	-70.390052	41.341824	-70.388657	41.33869	94	75

Transect	Date	Recorded Duration (min:sec)	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Total # Stills	# Analyzed Stills
OECC20-VT-33	8/18/20	15:11	-70.385182	41.341635	-70.384109	41.339346	71	24
OECC20-VT-34	10/14/20	08:22	-70.381842	41.343751	-70.378898	41.343865	34	18
OECC20-VT-35	8/18/20	10:37	-70.380583	41.338439	-70.380558	41.340683	64	31
OECC20-VT-36	10/15/20	19:25	-70.385145	41.338062	-70.388089	41.334829	82	66
OECC20-VT-37	10/19/20	23:04	-70.38594	41.332966	-70.385062	41.329557	102	54
OECC20-VT-38	10/14/20	19:17	-70.379193	41.336461	-70.373149	41.335957	82	42
OECC20-VT-39	10/19/20	22:51	-70.381334	41.327988	-70.379078	41.325255	98	66
OECC20-VT-40	10/19/20	39:45	-70.372731	41.330888	-70.372796	41.327299	173	79
OECC20-VT-41	10/15/20	21:25	-70.380306	41.318703	-70.376454	41.31979	94	40
OECC20-VT-42	10/19/20	20:36	-70.373102	41.322774	-70.370941	41.321375	90	36
OECC20-VT-43	10/15/20	21:27	-70.375146	41.31473	-70.37873	41.316697	89	36
OECC20-VT-44	10/14/20	30:23	-70.36823	41.313813	-70.364883	41.316008	129	67
OECC20-VT-45	10/15/20	14:12	-70.355863	41.313862	-70.358114	41.31644	58	23
OECC20-VT-46	10/15/20	23:55	-70.355286	41.307744	-70.357174	41.311931	102	69
OECC20-VT-47	10/14/20	15:20	-70.369904	41.304607	-70.366757	41.306399	63	35
OECC20-VT-48	10/15/20	15:31	-70.358214	41.297783	-70.360759	41.299916	63	32
OECC20-VT-49	8/18/20	14:57	-70.382982	41.296046	-70.377736	41.295514	77	73
OECC20-VT-50	8/18/20	17:08	-70.39249	41.290468	-70.395536	41.288674	100	81
OECC20-VT-51	8/18/20	09:57	-70.410675	41.271997	-70.409475	41.270967	53	20
OECC20-VT-52	8/21/20	14:42	-70.418662	41.255968	-70.422115	41.255746	86	58
OECC20-VT-53	8/21/20	12:19	-70.426689	41.256161	-70.427813	41.253425	77	34
OECC20-VT-54	8/21/20	14:45	-70.431966	41.244845	-70.432539	41.242233	86	33
OECC20-VT-55	8/15/20	12:27	-70.435809	41.230335	-70.432531	41.231588	75	57
OECC20-VT-56	8/15/20	12:17	-70.433441	41.216785	-70.430675	41.217688	78	70
OECC20-VT-57	8/15/20	06:39	-70.44221	41.211986	-70.444331	41.21249	42	32
OECC20-VT-58	8/15/20	06:43	-70.453813	41.194051	-70.451742	41.192824	43	35
OECC20-VT-59	8/15/20	15:39	-70.461722	41.177799	-70.459932	41.180676	98	59
OECC20-VT-60	8/15/20	15:00	-70.473223	41.155955	-70.471328	41.159101	95	90
OECC20-VT-61	8/15/20	27:51	-70.495788	41.118778	-70.489787	41.120517	167	64
OECC20-VT-62	8/15/20	26:15	-70.513162	41.100837	-70.512924	41.105832	166	103
OECC20-VT-63	8/14/20	09:54	-70.544131	41.080931	-70.542631	41.079974	61	29

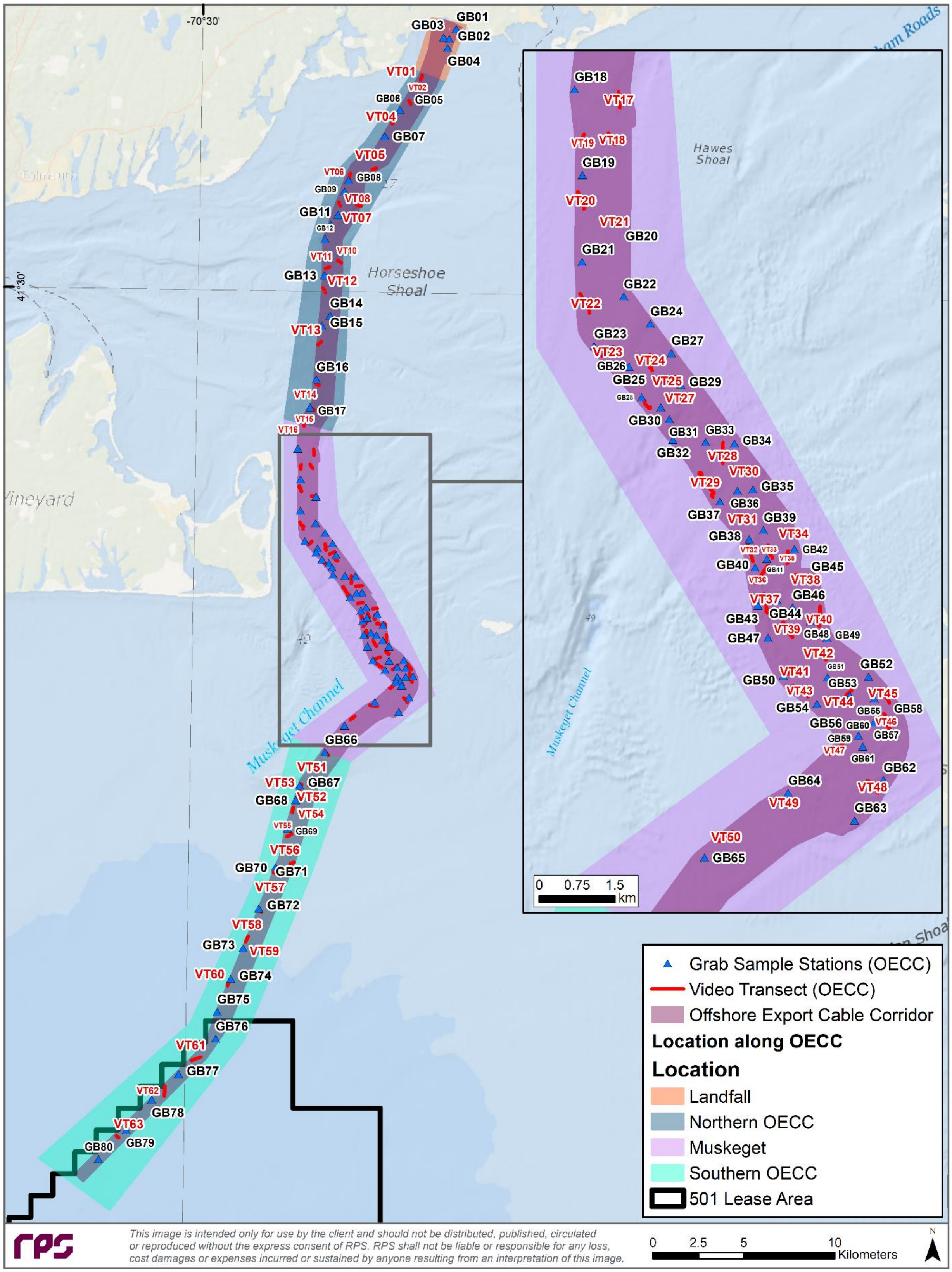


Figure 3-8. Map of video transects (red) and grab sample sites (blue) along the OECC. Note that there were no video transects in the Landfall area.

3.1.2.1 Megafauna Counts

The presence and abundance of megafauna greater than 4 cm in length were recorded during the video review process (Table 3-9, Table 3-10, Table 3-11, Figure 3-9, Figure 3-10, Figure 3-11, Figure 3-12, Figure 3-13, Figure 3-14, and Figure 3-15). Organisms were identified to the LPTL, usually to Order or Family. A total of 3,329 organisms were identified and recorded within the 63 transects that make up the three OECC areas. The Northern OECC (Table 3-9) contained 163 organisms, Southern OECC (Table 3-10) contained 1,228 organisms, and Muskeget (Table 3-11) contained 1,939 organisms. A total length of 23,130 m was surveyed with 4,497 m (24%), 4,196 m (21%), and 14,436 m (62%) belonging to the Northern OECC, Southern OECC, and Muskeget regions, respectively. Identifications were made of 313 vertebrates composed of 20 taxa (all of which were species of fish), 3,016 invertebrates composed of 21 different taxa, and three kinds of egg cases (skate, whelk, and moon snail). An additional 51 other observations were recorded: 11 instances of anthropogenic debris including three instances of fishing gear (VT-07, VT-58, and VT-61), 32 other non-living objects, and 8 potentially living organisms which could not be identified further.

Vertebrates composed approximately 9% (313 of 3,330 individuals) of all organisms identified (Figure 3-12) and most numerous amongst them were varieties of unidentified bony fish (97 of 313 individuals) followed by varieties of skate (80 of 313 individuals). Together these groups comprised >50% of vertebrate observations (Figure 3-13). Invertebrates made up the remaining 90% of observed organisms (3,016 of 3,330 individuals). With sea urchins comprising over 50% (1,593 of 3,330 individuals) and Cerianthid anemones comprising more than 30% (969 of 3,330 individuals; Figure 3-14 and Figure 3-15). Despite their abundance, sea urchins were almost entirely contained within the Muskeget area, in which over 70% (1,167 of 1,584 individuals) of their abundance was found within four transects: VT-24, VT-38, VT-39, and VT-41 (Table 3-11 and Figure 3-9). A similar pattern is observed with Cerianthid anemones, which are almost entirely contained within the Southern OECC area within which VT-55, VT-60, and VT-63 (Table 3-10) contain over 80% of individuals (803 of 968 individuals). The next most plentiful invertebrates are species of crabs and sea stars which make up 5% (184 of 3,330 individuals) and 3% (98 of 3,330 individuals) of all observations, respectively. However, in the absence of sea urchins and Cerianthid anemones, crabs and sea stars make up 52% and 28% of all invertebrate observations, respectively (Figure 3-14 and Figure 3-15).

Table 3-11 demonstrates that the highest abundances per meter for both vertebrates and invertebrates were found in the Southern OECC: 10 individuals and 77 individuals per 300 m, respectively; more organisms per meter than the other two areas combined. In the case of vertebrates, this was primarily due to a comparatively even spread of bony and cartilaginous fish. In the case of invertebrates, Cerianthid anemones dominated the observed organisms with a per meter abundance of 69 organisms per 300 m within the Southern OECC and 12 organisms per 300 m across all OECC regions. However, if Cerianthids are factored out, the Muskeget channel contains the highest number of organisms per meter, primarily due to the high abundance of sea urchins.

Due to the high abundance of Cerianthid anemones, VT-63 of the Southern OECC contained the highest number of enumerated organisms, with a total organismal abundance of 465 individuals. Similarly, the second and third most populated transects are VT38 (431 individuals) and VT-41 (391 individuals) of the Muskeget region, due to their density of sea urchins. Thus, Cerianthid anemones, sea urchins, and sand dollars comprise the majority of organisms enumerated. Representative images of some of the megafauna identified can be seen in Table 3-13. It should also be noted that the most abundant organisms were sand dollars but their abundance was so high (thousands of organisms) in some transects (i.e., VT-59, VT-61, VT-62, and VT-63) that sand dollars were instead quantified via percent cover in the point count analysis portion of the video processing.

Although the Northern OECC contained the most (five pieces) anthropogenic debris, the Southern OECC contained the highest quantity of debris on a per meter basis (0.35 pieces/300 m; Table 3-12). The Southern OECC also included a particularly large piece of anthropogenic debris in VT-55 which may warrant further investigation.

Table 3-9. Megafauna enumerated during review of the video transects in Northern OECC.

Common Name	Lowest Taxonomic Level	Counts per Transect In Northern OECC															
		VT 01	VT 02	VT 03	VT 04	VT 05	VT 06	VT 07	VT 08	VT 09	VT 10	VT 11	VT 12	VT 13	VT 14	VT 15	Total
Vertebrates																	
Fish, Unidentified	Chordata	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Fish, Unidentified (Demersal)	Chordata	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Flounder	Pleuronectiformes	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Roundfish, Unidentified	Teleostei	-	1	-	-	-	-	4	-	-	2	2	-	26	-	7	42
Scup	*Stenotomus chrysops*	-	-	-	-	-	-	1	-	-	-	5	-	8	-	1	15
Sea Robin, Unidentified	Prionotus	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Tautog	*Tautoga onitis*	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Total Vertebrates		-	8	-	1	1	-	5	-	-	3	8	-	34	-	8	68
Invertebrates		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerianthid, Northern	*Cerianthus borealis*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Crab, Blue	*Callinectes sapidus*	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Crab, Cancer	Cancer	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	2
Crab, Hermit	Pagurus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	2
Crab, Horseshoe	*Limulus polyphemus*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	2
Crab, Portunid	Portunidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Crab, Spider (Portly)	*Libinia emarginata*	-	-	6	-	3	-	5	-	4	3	2	-	1	1	-	25
Crab, Unidentified	Decapoda	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	2
Large Whelk (Knobbed, Channeled)	Melongenidae	-	-	-	-	-	-	2	-	-	6	5	-	-	-	6	19
Moon Snail	Naticidae	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	3
Scallop, Bay	*Argopecten irradians*	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	5
Sea Star	Asterias	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Sea Urchin	Echinoidea	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	4
Shrimp	Decapoda	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Squid	Cephalopoda	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Whelk Eggs	Melongenidae	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Whelk, Channeled	*Busycotypus canaliculatus*	-	-	-	-	-	-	-	-	-	-	-	-	10	2	-	12
Whelk, Unidentified	Melongenidae	-	1	-	1	-	8	-	-	-	-	-	-	-	-	-	10
Total Invertebrates		4	1	8	8	10	8	10	-	4	9	8	1	14	3	7	95
Other		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified		-	-	-	2	3	-	-	-	-	-	-	-	1	-	-	6
Unidentified Object		-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2
Debris, Anthropogenic		-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Debris, Anthropogenic (Fishing Gear)		-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Debris, Anthropogenic (Trash)		-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	2
Total Organisms		4	9	8	9	11	8	15	0	4	12	16	1	48	3	15	163
Total Observations		4	11	8	11	14	8	16	1	5	12	16	2	49	3	16	176

Table 3-10. Megafauna enumerated during review of the video transects in Southern OECC.

Common Name	Lowest Taxonomic Level	Counts per Transect In Southern OECC													
		VT51	VT52	VT53	VT54	VT55	VT56	VT57	VT58	VT59	VT60	VT61	VT62	VT63	Total
Vertebrates															
Butterfish	*Peprilus triacanthus*	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Fish, Unidentified	Chordata	1	-	-	1	-	-	-	-	-	-	-	-	-	2
Fish, Unidentified (Bony)	Teleostei	-	-	-	-	-	1	1	-	-	-	-	-	-	2
Flatfish, Unidentified	Teleostei	-	-	-	-	-	2	-	1	-	-	1	-	-	4
Flounder	Pleuronectiformes	-	-	-	1	-	-	1	3	-	1	1	2	-	9
Flounder, Fourspot	*Hippoglossina oblongus*	-	-	-	-	-	-	-	-	-	-	1	2	-	3
Flounder, Windowpane	*Scopthalmus aquosas*	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Hake, Silver	*Merluccius bilinearis*	-	-	-	-	-	-	-	-	-	-	6	-	-	6
Hake, Spotted	*Urophycis regia*	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Hake, Unidentified	Gadidae	-	-	-	-	-	-	1	-	7	5	7	15	2	37
Roundfish, Unidentified	Teleostei	-	-	1	1	-	-	3	1	1	3	5	8	1	24
Sea Robin, Northern	*Prionotus carolinus*	-	1	-	-	-	-	-	1	-	-	-	-	-	2
Sea Robin, Unidentified	*Prionotus*	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Skate	Rajidae	-	-	-	1	-	1	2	1	3	-	7	4	2	21
Skate, Egg Case	Rajidae	-	-	1	-	-	2	1	1	-	-	3	5	2	15
Skate, Little	*Leucoraja erinacea*	-	-	-	-	-	-	-	-	-	-	1	-	1	2
Skate, Little or Winter	*Leucoraja*	-	-	-	-	-	-	-	2	-	6	8	-	-	16
Skate, Winter	*Leucoraja ocellata*	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Total Vertebrates		1	1	2	4	-	7	9	9	12	9	33	36	8	131
Invertebrates															
Cerianthid, Northern	*Cerianthus borealis*	-	1	-	-	214	26	7	36	92	142	1	2	447	968
Crab, Cancer	Cancer	-	-	-	-	-	-	-	-	1	23	17	19	1	61
Crab, Hermit	Pagurus	1	1	-	-	-	-	-	-	-	-	5	-	-	7
Large Whelk (Knobbed, Channeled)	Melongenidae	-	-	-	-	-	-	-	-	-	-	-	-	4	4
Moon Snail	Naticidae	-	-	-	-	-	1	-	-	1	-	2	-	-	4
Moon Snail, Egg Case	Naticidae	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Scallop, Sea	*Placopecten magellanicus*	-	-	-	-	-	-	-	-	-	-	-	1	1	2
Sea Pen	Pennatulacea	-	-	-	-	-	-	-	-	1	-	-	1	4	6
Sea Star	Asterias	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Sea Urchin	Echinoidea	-	-	-	-	5	-	-	-	-	-	-	-	-	5
Shrimp	Decapoda	-	-	-	-	-	-	-	-	-	-	6	-	0	6
Solitary Hydroid	Hydrozoa	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Squid	Cephalopoda	-	-	-	-	-	-	-	-	1	2	-	-	-	3
Squid, Egg Mop	Cephalopoda	-	-	-	-	1	-	-	2	-	-	-	-	-	3
Whelk, Unidentified	Melongenidae	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Worm, Polychaete	Polychaeta	-	-	-	-	-	-	-	-	1	-	5	-	-	6
Total Invertebrates		1	2	-	1	221	27	7	38	97	167	37	24	457	1079
Other															
Unidentified Object		-	-	-	-	-	3	6	4	1	1	6	7	-	28
Debris, Anthropogenic (Fishing Gear)		-	-	-	-	-	-	-	1	-	-	1	-	-	2
Debris, Anthropogenic (Trash)		-	-	1	-	-	-	1	-	-	-	-	-	-	2
Debris, Anthropogenic		-	-	-	-	-	1	-	-	-	-	-	-	-	1
Total Organisms		2	3	2	5	221	34	16	49	109	182	80	60	465	1228
Total Observations		2	3	3	5	221	38	23	54	110	183	87	67	465	1261

Table 3-11. Megafauna enumerated during review of the video transects in Muskeget (continued on next two pages). No megafauna over the size cut-off (4 cm) were observed in OECC20-VT-50, therefore, it is not displayed in this table.

Common Name	Lowest Taxonomic Level	Counts per Transect in Muskeget											
		VT16	VT17	VT18	VT19	VT20	VT21	VT22	VT23	VT24	VT25	VT26	VT27
Vertebrates													
Black Sea Bass	*Centropristis striata*	7	-	1	-	-	-	-	-	-	-	-	-
Cunner	*Tautoglabrus adspersus*	-	-	-	-	-	-	-	-	-	-	-	-
Fish, Unidentified (Demersal)	Chordata	-	-	-	-	-	-	-	-	1	-	-	-
Flounder	Pleuronectiformes	-	-	-	-	-	-	-	-	-	-	-	-
Flounder, Summer	*Paralichthys dentatus*	-	-	-	-	-	-	-	-	-	-	-	-
Goby	Gadidae	-	-	-	-	-	-	-	-	-	-	-	-
Roundfish, Unidentified	Teleostei	4	-	3	-	4	-	-	-	1	-	-	-
Scup	*Stenotomus chrysops*	-	-	3	-	-	-	-	-	-	-	-	1
Skate	Rajidae	-	-	-	-	-	-	-	-	-	-	-	1
Skate, Egg Case	Rajidae	-	1	-	-	-	-	1	-	4	2	-	-
Skate, Little or Winter	Leucoraja	1	-	-	-	-	-	-	-	-	-	-	-
Tautog	*Tautoga onitis*	8	-	-	-	-	-	-	-	-	-	-	-
Total Vertebrates		20	1	7	-	4	-	1	-	6	2	-	2
Invertebrates													
Clam, Surf	*Spisula solidissima*	-	-	-	-	-	-	-	-	-	-	-	-
Crab, Cancer	Cancer	-	-	-	-	2	-	-	-	-	-	-	-
Crab, Hermit	Pagurus	2	-	-	-	1	-	-	-	-	-	-	-
Crab, Horseshoe	*Limulus polyphemus*	1	-	-	1	1	-	-	-	-	1	-	-
Crab, Lady	*Ovalipes ocellatus*	-	-	-	-	-	-	-	-	-	-	-	-
Crab, Spider (Portly)	*Libinia emarginata*	-	2	1	-	-	-	-	-	-	-	-	-
Crab, Unidentified	Decapoda	-	-	-	-	-	-	-	-	-	-	-	1
Whelk (Knobbed, Channeled)	Melongenidae	-	17	4	-	1	-	-	-	-	-	-	-
Moon Snail	Naticidae	-	-	-	-	-	-	-	-	-	-	-	-
Scallop, Bay	*Argopecten irradians*	-	4	-	-	1	-	19	1	-	-	-	-
Sea Star	Asterias	-	1	-	-	1	-	-	-	-	-	-	-
Sea Urchin	Echinoidea	-	7	-	-	2	1	47	-	133	127	3	11
Squid	Cephalopoda	-	-	-	-	-	-	-	-	-	-	-	-
Whelk Eggs	Melongenidae	2	-	-	-	-	-	-	-	-	-	-	-
Whelk, Unidentified	Melongenidae	-	-	-	3	-	-	-	-	-	-	-	-
Worm, Unidentified	Polychaeta	-	-	-	-	-	-	-	-	-	1	-	-
Total Invertebrates		5	31	5	4	9	1	66	1	133	129	3	12
Other													
Unidentified		-	-	-	-	-	-	-	-	-	1	-	-
Unidentified Object		-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Species		-	-	-	-	-	-	-	-	-	-	-	-
Debris, Anthropogenic		-	-	-	-	-	-	-	-	-	-	-	-
Total Organisms		25	32	12	4	13	1	67	1	139	131	3	14
Total Observations		25	32	12	4	13	1	67	1	139	131	3	14

Common Name	Lowest Taxonomic Level	Counts per Transect in Muskeget											
		VT28	VT29	VT30	VT31	VT32	VT33	VT34	VT35	VT36	VT37	VT38	VT39
Vertebrates													
Black Sea Bass	*Centropristis striata*	-	-	-	-	-	-	-	-	-	5	4	-
Cunner	*Tautoglabrus adspersus*	-	-	-	-	-	-	-	-	-	-	4	-
Fish, Unidentified (Demersal)	Chordata	-	-	-	-	-	-	-	-	-	-	-	-
Flounder	Pleuronectiformes	1	-	-	-	-	-	-	-	-	-	-	-
Flounder, Summer	*Paralichthys dentatus*	1	-	-	-	-	-	-	-	-	-	-	-
Goby	Gadidae	-	-	-	-	-	-	-	-	1	-	-	-
Roundfish, Unidentified	Teleostei	2	-	1	-	-	1	-	-	1	-	-	-
Scup	*Stenotomus chrysops*	-	-	1	1	-	4	-	4	-	-	-	-
Skate	Rajidae	-	-	-	-	-	-	-	-	1	-	-	-
Skate, Egg Case	Rajidae	-	1	-	-	-	-	-	-	1	-	-	-
Skate, Little Or Winter	Leucoraja	-	-	-	-	2	-	-	-	-	1	-	-
Tautog	*Tautoga onitis*	-	-	-	-	-	-	-	-	-	-	-	-
Total Vertebrates		4	1	2	1	2	5	-	4	4	6	8	-
Invertebrates													
Clam, Surf	*Spisula solidissima*	1	2	1	-	-	-	-	-	-	-	-	-
Crab, Cancer	Cancer	-	1	-	-	1	-	-	-	1	4	4	5
Crab, Hermit	Pagurus	-	1	1	-	3	-	-	-	-	-	-	-
Crab, Horseshoe	*Limulus polyphemus*	-	-	-	-	-	-	-	-	-	-	-	-
Crab, Lady	*Ovalipes ocellatus*	-	1	-	-	-	-	-	-	-	-	-	-
Crab, Spider (Portly)	*Libinia emarginata*	-	-	-	-	-	-	-	-	-	-	-	-
Crab, Unidentified	Decapoda	-	-	-	-	-	-	-	-	-	2	1	-
Whelk (Knobbed, Channeled)	Melongenidae	3	-	1	-	1	-	-	-	-	-	2	-
Moon Snail	Naticidae	1	-	1	-	-	-	2	-	1	-	-	-
Scallop, Bay	*Argopecten irradians*	-	-	-	-	-	-	-	-	-	-	-	-
Sea Star	Asterias	-	-	-	-	-	-	-	-	3	-	3	1
Sea Urchin	Echinoidea	-	-	-	-	11	-	-	4	47	2	413	256
Squid	Cephalopoda	5	-	-	-	-	-	-	-	-	-	-	-
Whelk Eggs	Melongenidae	-	-	-	-	-	-	-	-	-	-	-	-
Whelk, Unidentified	Melongenidae	-	1	-	-	-	1	-	-	-	-	-	-
Worm, Unidentified	Polychaeta												
Total Invertebrates		10	6	4	-	16	1	2	4	52	8	423	262
Other													
Unidentified		-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Object		-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Species		-	-	-	2	-	-	-	-	-	-	-	-
Debris, Anthropogenic		-	1	-	-	-	-	-	-	-	-	-	-
Total Organisms		14	7	6	1	18	6	2	8	56	14	431	262
Total Observations		14	9	6	3	18	6	2	8	56	14	431	262

Common Name	Lowest Taxonomic Level	Counts per Transect in Muskeget										
		VT40	VT41	VT42	VT43	VT44	VT45	VT46	VT47	VT48	VT49	Total
Vertebrates												
Black Sea Bass	*Centropristis striata*	-	-	-	-	-	-	-	-	-	-	17
Cunner	*Tautoglabrus adspersus*	-	-	-	-	-	-	-	-	-	-	4
Fish, Unidentified (Demersal)	Chordata	-	-	-	-	-	-	-	-	-	-	1
Flounder	Pleuronectiformes	-	-	-	-	-	-	-	-	-	-	1
Flounder, Summer	*Paralichthys dentatus*	-	-	-	-	-	-	-	-	-	-	1
Goby	Gadidae	-	-	-	-	-	-	-	-	-	-	1
Roundfish, Unidentified	Teleostei	-	2	-	-	6	-	-	-	-	-	25
Scup	*Stenotomus chrysops*	-	-	-	-	-	-	-	-	-	-	14
Skate	Rajidae	-	-	-	-	-	-	1	-	-	-	3
Skate, Egg Case	Rajidae	-	-	-	-	-	-	-	-	-	-	10
Skate, Little Or Winter	Leucoraja	-	-	-	-	-	1	-	1	5	-	11
Tautog	*Tautoga onitis*	-	-	-	-	-	-	-	-	-	-	8
Total Vertebrates		-	2	-	-	6	1	1	1	5	-	96
Invertebrates												
Clam, Surf	*Spisula solidissima*	-	-	-	-	-	-	-	-	-	-	4
Crab, Cancer	Cancer	3	6	1	5	9	3	3	1	2	-	51
Crab, Hermit	Pagurus	-	-	-	-	1	-	-	-	-	1	10
Crab, Horseshoe	*Limulus polyphemus*	-	-	-	-	-	-	-	-	-	-	4
Crab, Lady	*Ovalipes ocellatus*	-	-	-	-	-	-	-	-	-	-	1
Crab, Spider (Portly)	*Libinia emarginata*	-	-	-	-	-	-	-	-	-	-	3
Crab, Unidentified	Decapoda	1	-	2	-	2	-	-	-	-	-	9
Large Whelk (Knobbed, Channeled)	Melongenidae	1	-	-	-	1	-	-	-	-	-	31
Moon Snail	Naticidae	-	-	-	2	-	-	-	-	-	-	7
Scallop, Bay	*Argopecten irradians*	4	-	-	-	-	-	-	-	-	-	29
Sea Star	Asterias	64	18	-	4	1	-	-	-	-	-	96
Sea Urchin	Echinoidea	10	365	3	127	15	-	-	-	-	-	1584
Squid	Cephalopoda	-	-	-	-	-	-	-	-	-	-	5
Whelk Eggs	Melongenidae	-	-	-	-	-	-	-	-	-	-	2
Whelk, Unidentified	Melongenidae	-	-	-	-	-	-	-	-	-	-	5
Worm, Unidentified	Polychaeta	-	-	-	-	-	-	-	-	-	-	1
Total Invertebrates		83	389	6	138	29	3	3	1	2	1	1842
Other												
Unidentified		-	-	-	-	-	-	-	-	-	-	1
Unidentified Object		-	-	-	-	-	-	-	-	-	1	1
Unidentified Species		-	-	-	-	-	-	-	-	-	-	2
Debris, Anthropogenic		-	-	-	-	-	-	-	-	-	-	1
Total Organisms		83	391	6	138	35	4	4	2	7	1	1938
Total Observations		83	391	6	138	35	4	4	2	7	2	1943

Table 3-12. Total abundance of organisms by class per 300m in the OECC regions[2].

Common Name	Taxonomic Class or higher	Organisms per 300 meters in Sample Area			
		Northern OECC (4,497 m)	Southern OECC (4,196 m)	Muskeget (14,436 m)	All OECC Areas (23,130 m)
Vertebrates					
Bony Fish	Teleostei	4	1	6	2
Skates	Chondrichthyes	-	0.49	4	1
Unidetified Vertebrates	Chordata	0.13	0.02	0.14	0.06
Total Vertebrates		4	1	10	4
Invertebrates					
Bivalves	Bivalvia	0.33	0.68	0.14	0.51
Crabs	Malacostraca	2	1	5	2
Horseshoe Crabs	Euchelicerata	0.13	0.08	-	0.07
Hydrozoans	Hydrozoa	-	-	0.07	0.01
Marine Worms	Polychaeta	-	0.02	0.42	0.09
Sea Anenomes	Anthozoa	0.06	-	69	12
Sea Stars	Asteroidea	0.06	1	0.07	1
Sea Urchins	Echinoidea	0.26	32	0.35	20
Squid	Cephalopoda	0.06	0.10	0.42	0.15
Whelk	Gastropoda	3	0.93	0.71	1
Total Invertebrates		6	38	77	39
Other					
Anthropogenic Debris	Anthropogenic Debris	0.33	0.02	0.35	0.71
Unidentified	unidentified	0.40	0.02	-	0.09
Unidentified object	unidentified object	0.13	0.04	2	0.41
Unidentified Organisms	unidentified species	-	0.02	-	0.01
Total Organisms		10	40	87	43
Total Observations		11	40	90	44

[2] "Total Organisms" does not include anthropogenic debris or unidentified object. Summed transect length (m) in parenthesis below area.

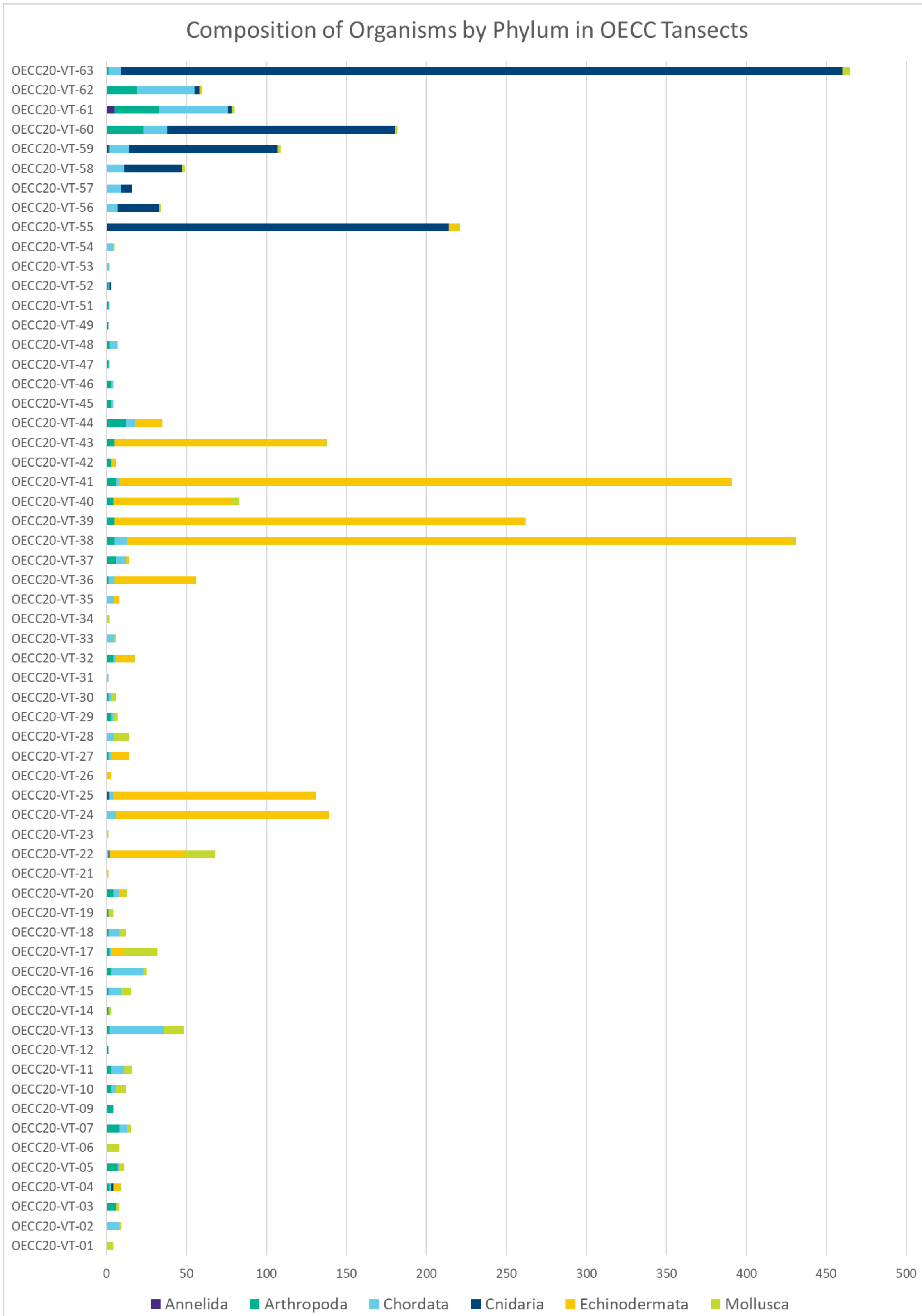


Figure 3-9. Comparative abundance by Phylum throughout OECC transects. For common name equivalents of taxonomy, refer to Table 3-4. No organisms were enumerated in transects VT-08 and VT-50, and therefore they are not presented in this figure.

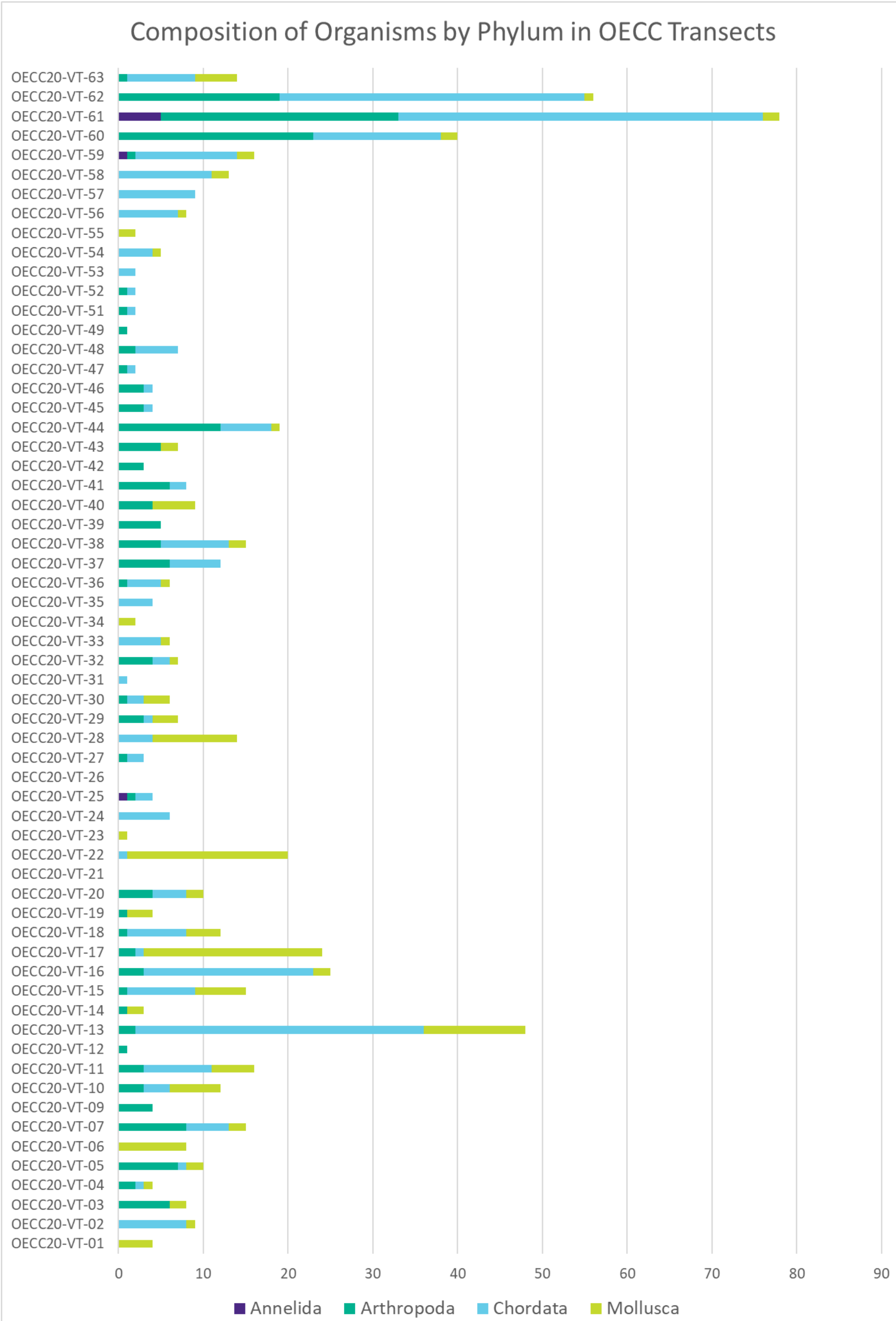


Figure 3-10. Comparative abundance by Phylum throughout OECC transect with Echinodermata and Cnidaria removed for clarity. For common name equivalents of taxonomy, refer to Table 3-4. No organisms were enumerated in transects VT-08 and VT-50, and therefore they are not presented in this figure.

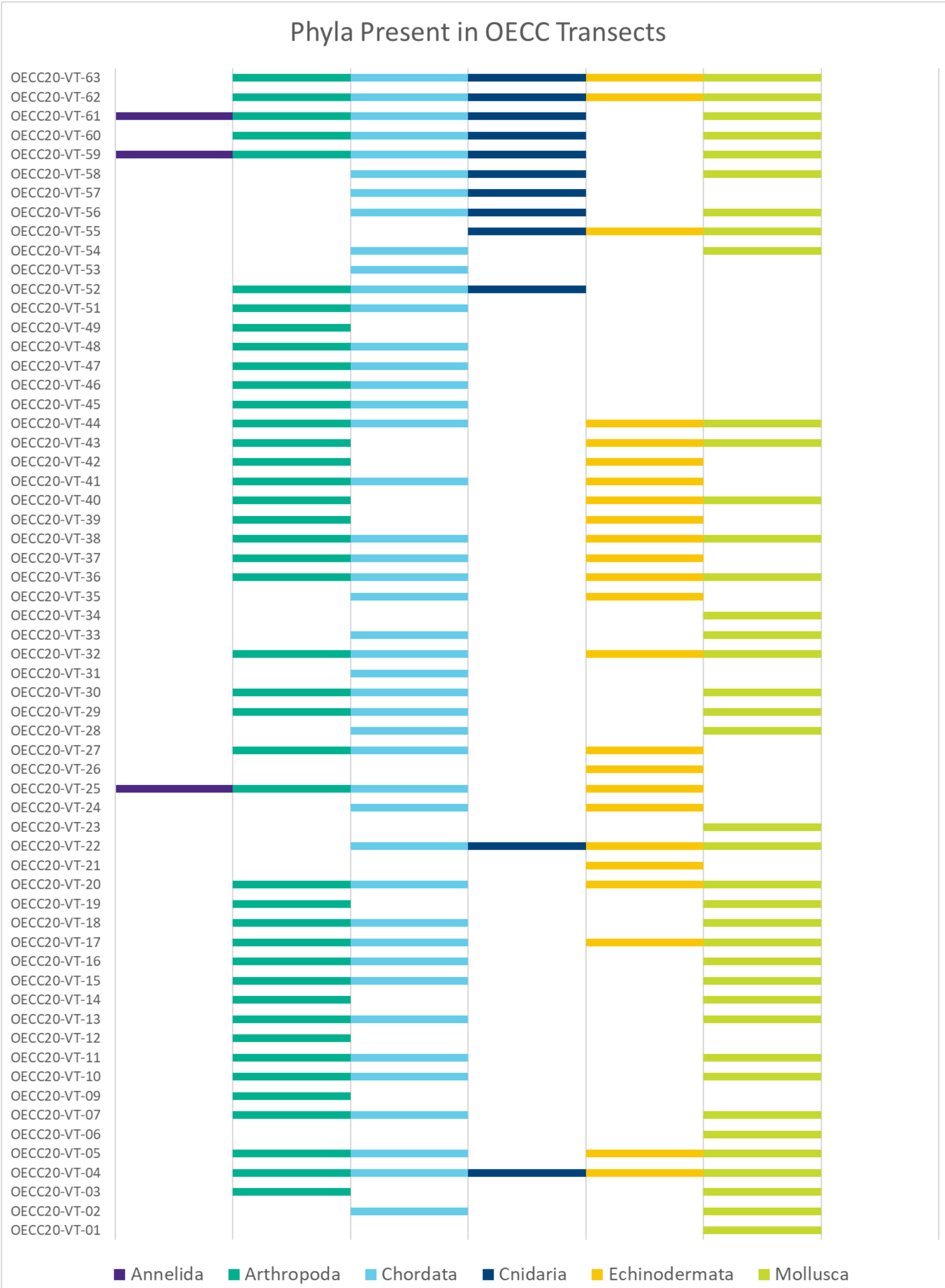


Figure 3-11. Presence or absence of Phyla throughout OECC transects. For common name equivalents of taxonomy, refer to Table 3-4. No organisms were enumerated in transects VT-08 and VT-50, and therefore they are not included in this figure.

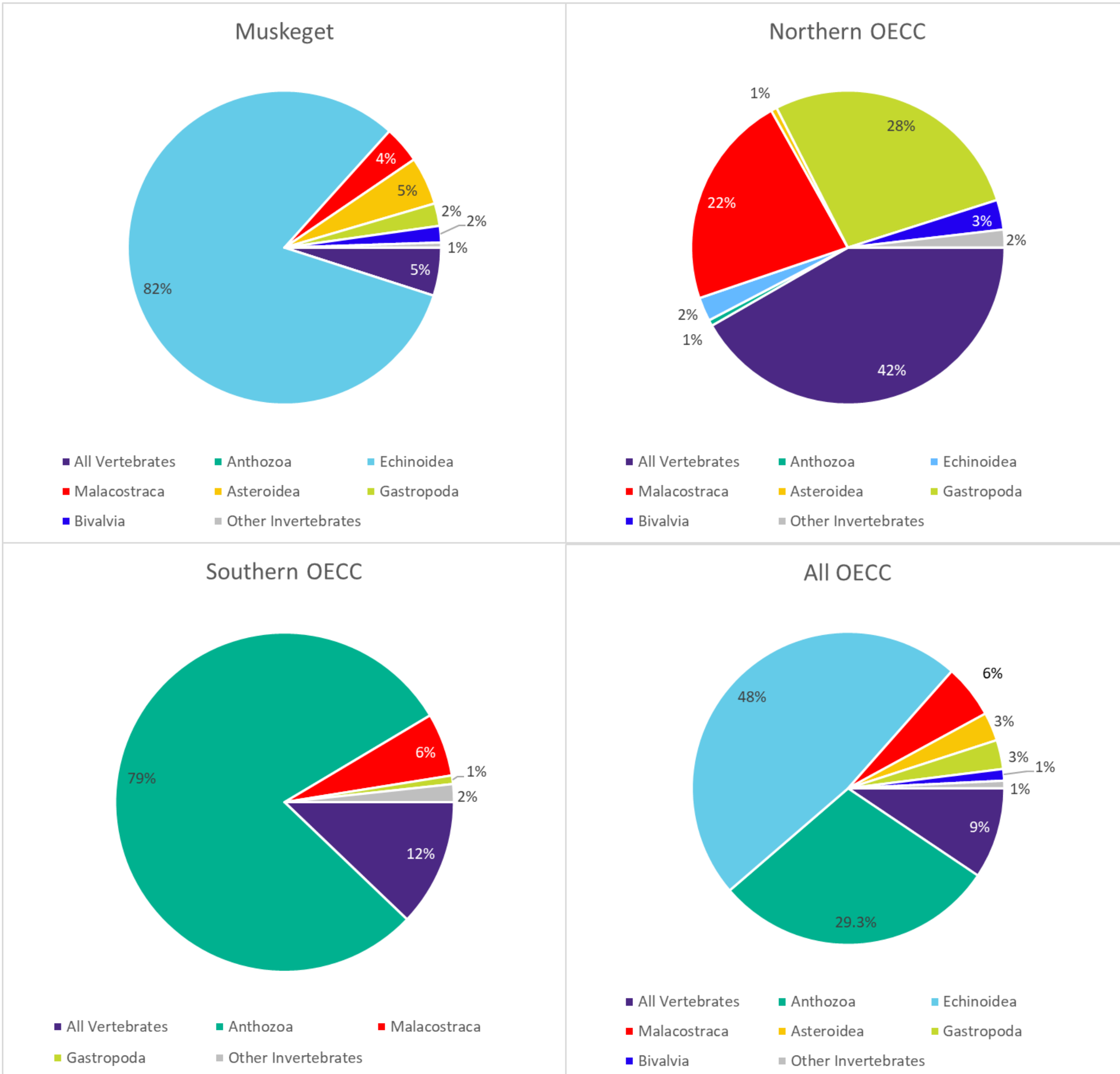


Figure 3-12. Percent composition of organisms by taxonomic class. Organisms contained in “Other Invertebrates” category include Cephalopoda, Polychaeta, Euchelicerata, and Hydrozoa, all of which compose less than 1% of total observations individually. In the Southern OECC, Echinoidea, Asteroidea, and Bivalvia are also included as “Other invertebrates” due to their low abundance (<1%). For common name equivalents of taxonomy, refer to Table 3-4.

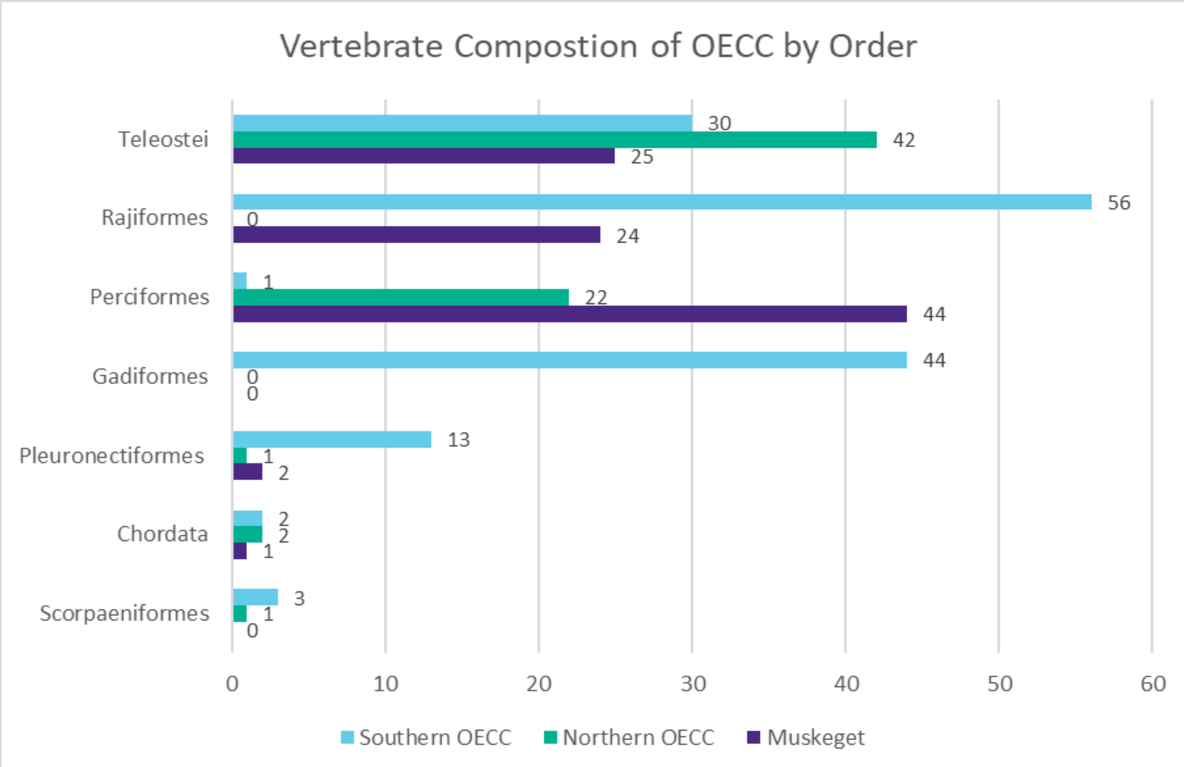


Figure 3-13. Relative abundance of vertebrates (members of the Phylum Chordata) throughout the OECC transects summed by Order when possible. For common name equivalents of taxonomy, refer to Table 3-4.

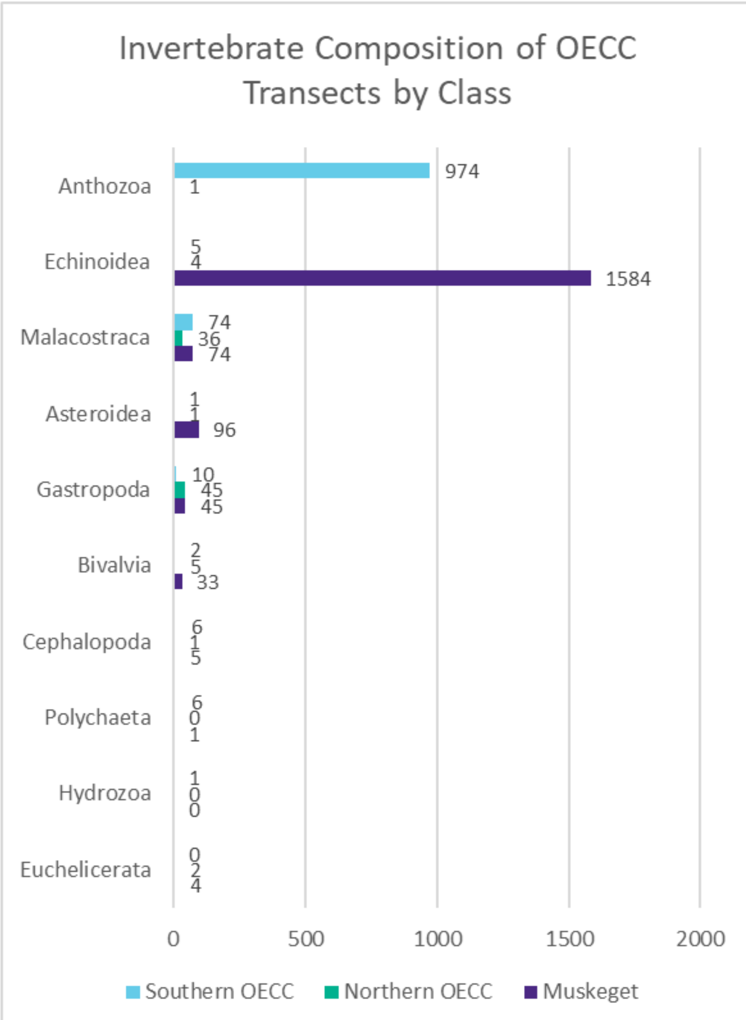


Figure 3-14. Relative abundance of invertebrates (species not contained within the phylum Chordata) throughout the OECC transects summed by Class when possible. For common name equivalents of taxonomy, refer to Table 3-4.

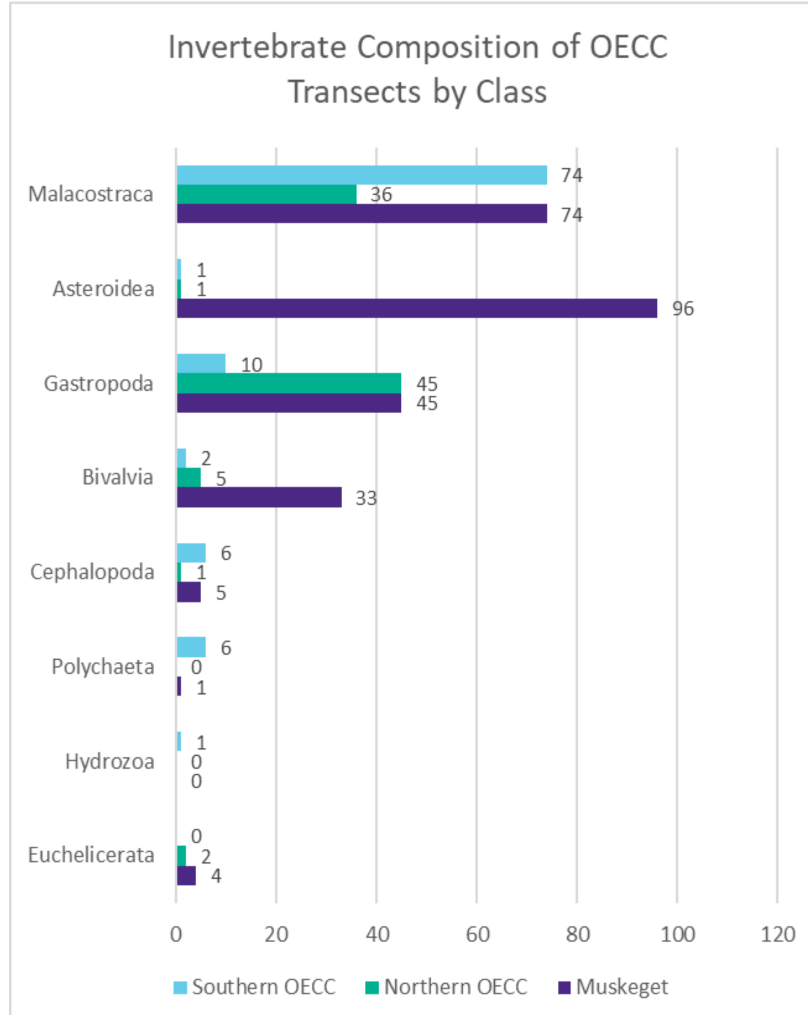
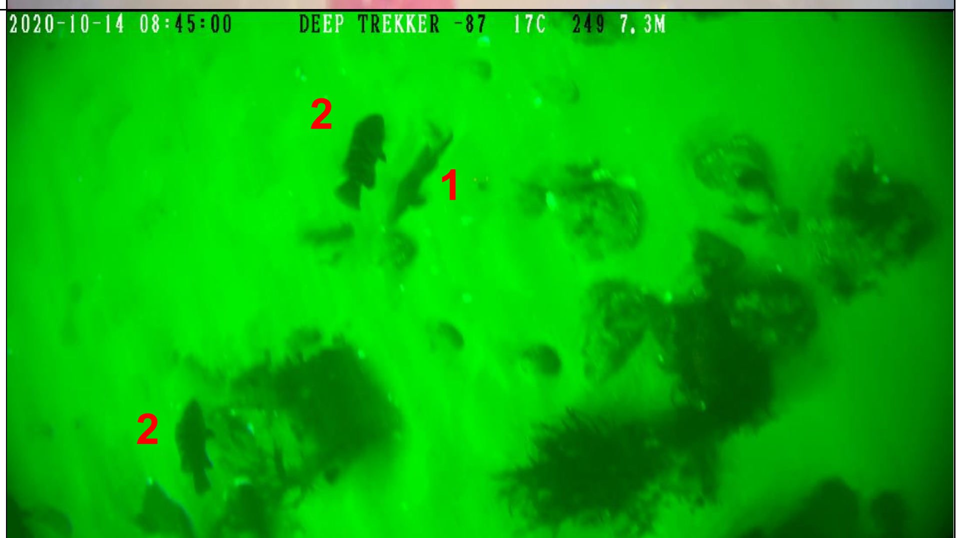


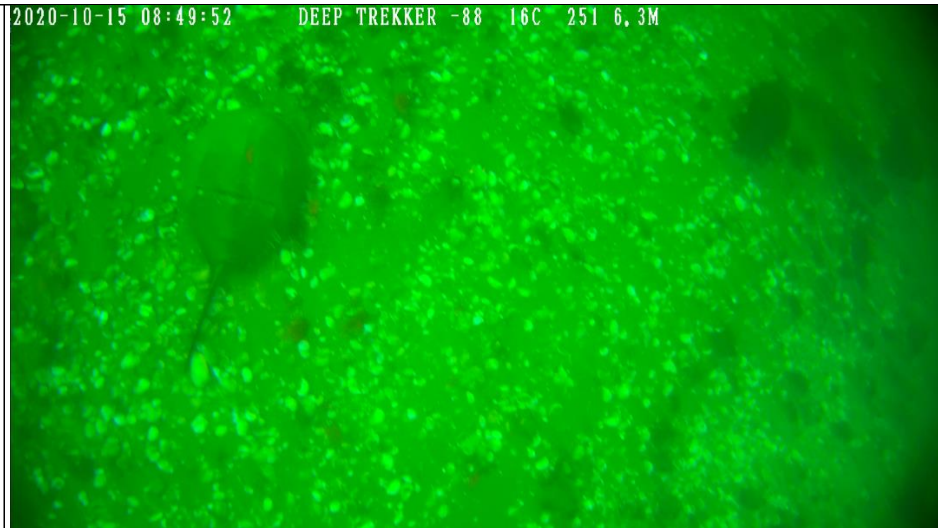
Figure 3-15. Relative abundance of invertebrates (species not contained within the Phylum Chordata) throughout the OECC transects summed by Class when possible. Echinoidea and Anthozoa were excluded for clarity. For common name equivalents of taxonomy, refer to Table 3-4.

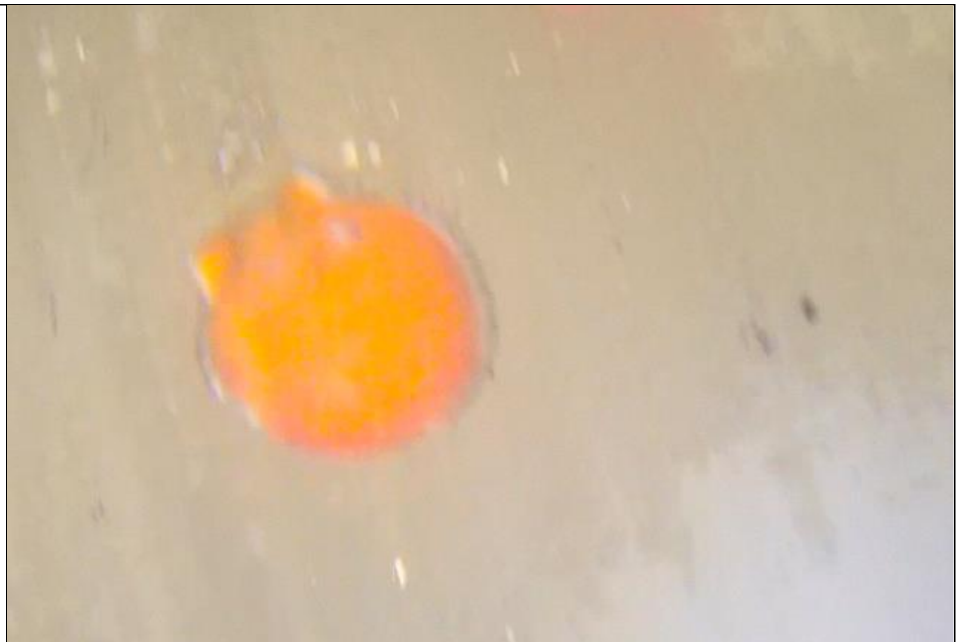
Table 3-13. Representative images of megafauna observed and identified in transects within the 63 OECC transects (continued on next pages).

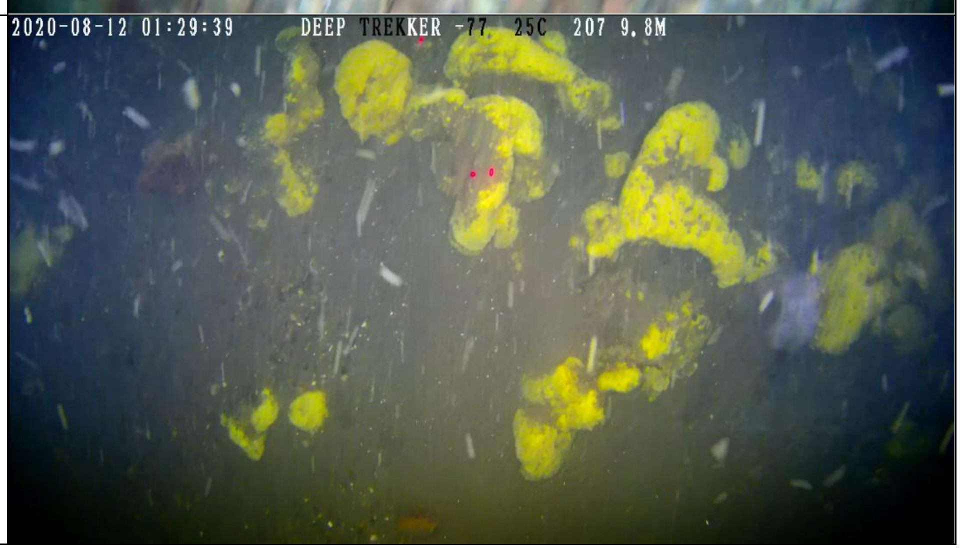
Sand Dollar (*Echinarachnius parma)* and Ceriantid Anenomes (*Cerainthus borealis*) OECC20-VT-63	
Black Sea Bass (1: center, *Centropristis striata*) and Tautog (2: center left and bottom left, *Tautoglabrus adspersus*) OECC20-VT-16	
Hake (Gadidae likely *Merluccius*) and sand dollar (*Echinarachnius parma)* OECC20-VT-59	

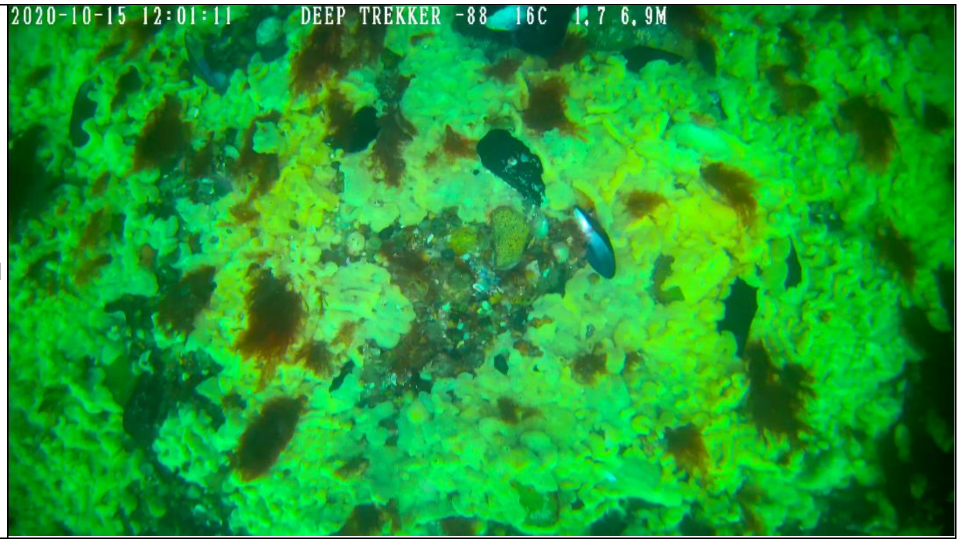
Scup (*Stenotomus chrysops*) OECC20-VT-33	
Little skate (*Leucoraja erinacea*) OECC20-VT-61	
Fourspot Flounder (*Hippoglossina oblongus*) OECC20-VT-62	

Squid (Teuthida) OECC20-VT-60	
Sea Star (*Asterias*) OECC20-VT-36	
Portly Spider Crab (*Libinia emarginata*) OECC20-VT-09	

Horseshoe Crab (*Limulus polyphemus*) OECC20-VT-20	
Cancer Crab (Cancer) OECC20-VT-37	
Sea Urchin (Echinoidea) OECC20-VT-24	

Sea Scallop (*Placopecten magellanicus*) OECC20-VT-62	
Squid Egg Mop (Cephalopoda) OECC20-VT-58	
Whelk Egg Case (Melongenidae) OECC20-VT-16	

Blue Mussel (*Mytilus edulis*) OECC20-VT-40	
Red beard sponge (Porifera) OECC20-VT-03	
Sulphur sponge (Porifera) OECC20-VT-11	

Encrusting organism (Potential breadcrumb sponge *Halichondria panicea* or invasive colonial tunicate *Didemnum*) OECC20-VT-43	

3.1.2.2 Percent Cover

The following section summarizes the results of the percent cover analysis of still images derived from underwater video transects in the OECC project region. Percent cover of various bottom substrates and features within a measured surface area of each image were recorded and used to define the NMFS-modified (NMFS, 2020) CMECS substrate classification that was most suitable for the sampled area. In addition to percent cover of different sediment grain sizes (boulder, cobble, pebble/granule, or sand/mud), the presence of biogenic shell substrate and other biological elements were also recorded. Examples of biological elements include flora (e.g., algae or seagrass), fauna (e.g., mobile megafauna, encrusting species [sponges, corals, bryozoans, tunicates, etc], sand dollars, mussel beds), and evidence of biological activity (e.g., burrows, infaunal structures). Thus, in addition to CMECS classification of substrate, the density of shell and flora/fauna cover were calculated and included as additional indicators of habitat complexity. Visual examples of habitat types defined using the still images are presented in the CMECS Classifications section (Section 4).

The substrate group with the highest percent cover across all transects sampled in the OECC was fine sand/mud, comprising 74% of the surface area analyzed through still images for each transect (Table 3-14). However, gravel substrates (> 2 mm) were present in 65% of the OECC transects, comprising nearly 9% of the analyzed surface area. Biogenic origin substrates (i.e., shell hash or rubble) were observed to some extent in all transects and totaled 282 m^2 (9%) of the surface area analyzed in the OECC transects. Some amount of flora/fauna cover was observed in all but three of the transects (OECC20-VT-12, OECC20-VT-34, and OECC-VT-51) and, similar to the biogenic shell cover, comprised 261 m^2 (8%) of the 3,224 m^2 analyzed for the OECC.

Of the biological elements, bushy "plant-like" organisms had the highest percent cover (7%) and occurrence, appearing in 52 of the 63 OECC transects and comprising 216 m^2 of the area analyzed for the

OECC (Table 3-15). This category included sessile, branching structures that could have been a type of red algae or a branching hydrozoan species. They were counted together due to the difficulty of identification via video or stills. The next most prevalent biological element was encrusting organisms, which included sponges and tunicates, with 0.8% percent cover, occurring in 29 of the 63 transects and comprising 26 m^2 of the area. Sand dollars and mobile megafauna made up most of the rest of the percent cover for biological elements (0.3% and 0.1%, respectively) and with sand dollar area (11 m^2) concentrated in just 7 transects while megafauna (3 m^2) were observed in 29 of the 63 transects in the OECC.

Table 3-14. Total area analyzed and percent coverage of different substrates summarized from still images taken from each of the 63 video transects in the OECC.

Transect	Total Area Analyzed (m^2)	Percent of Area – Gravel Substrates				Fine Sand/Mud Substrate (%)	Biogenic Shell Cover (%)	Flora/Fauna Cover (%)
		Boulder (%)	Cobble (%)	Pebble/ Granule (%)	All Gravel Combined (%)			
OECC20-VT-01	8.7	0	0.3	1.5	1.8	92.0	1.7	4.5
OECC20-VT-02	37.8	0	0	4.4	4.4	34.2	33.9	27.5
OECC20-VT-03	54.2	0	0	0	0	60.8	33.5	5.7
OECC20-VT-04	27.1	0	0	0	0	99.4	0.1	0.5
OECC20-VT-05	32.0	0	0.1	< 0.1	0.1	99.4	0.5	0.1
OECC20-VT-06	38.4	0	0	< 0.1	< 0.1	98.7	0.2	1.0
OECC20-VT-07	82.2	0	0	3.4	3.4	74.3	18.2	4.1
OECC20-VT-08	18.7	0	0	0.1	0.1	88.0	10.9	1.0
OECC20-VT-09	58.6	0	0	0	0	84.7	15.2	0.1
OECC20-VT-10	46.6	0	0	0.3	0.3	88.8	10.0	0.8
OECC20-VT-11	54.7	0	0	0.9	0.9	92.5	2.8	3.8
OECC20-VT-12	75.6	0	0	0	0	99.2	0.8	0
OECC20-VT-13	26.7	0	0	0	0	99.3	0.5	0.2
OECC20-VT-14	59.0	0	0	0	0	81.6	16.5	1.9
OECC20-VT-15	50.2	0	0.1	0.3	0.4	98.5	0.7	0.3
OECC20-VT-16	82.4	0	0	0	0	98.6	0.1	1.3
OECC20-VT-17	66.3	0	0	4.2	4.2	12.9	63.4	19.5
OECC20-VT-18	41.0	0	0	9.2	9.2	27.7	47.0	16.1
OECC20-VT-19	25.9	0	0	43.9	43.9	25.4	7.2	23.5
OECC20-VT-20	108.6	0	0	2.5	2.5	35.1	46.2	16.1
OECC20-VT-21	17.4	0	0	15.2	15.2	60.1	3.1	21.6
OECC20-VT-22	69.8	0	< 0.1	12.6	12.6	55.2	15.9	16.3
OECC20-VT-23	95.0	0	0.1	1.1	1.1	89.9	6.0	2.9
OECC20-VT-24	52.8	0	0	0	0	49.3	47.1	3.6
OECC20-VT-25	35.7	0	0	81.4	81.4	9.4	6.6	2.6
OECC20-VT-26	13.0	0	0.3	27.9	28.2	35.3	8.9	27.5
OECC20-VT-27	15.6	0	7.0	37.7	44.7	34.5	7.2	13.6
OECC20-VT-28	102.9	0	0	3.1	3.1	94.9	1.7	0.3
OECC20-VT-29	121.2	0	0	7.5	7.5	86.3	4.9	1.3
OECC20-VT-30	47.6	0	0	17.0	17.0	39.3	5.4	38.3
OECC20-VT-31	130.8	0	0	0.2	0.2	98.0	0.9	0.9
OECC20-VT-32	76.3	0	0	35.2	35.2	57.4	2.3	5.0
OECC20-VT-33	8.7	0	0	0	0	86.7	0.2	13.0
OECC20-VT-34	11.4	0	0	24.6	24.6	72.2	3.2	0
OECC20-VT-35	7.8	0	0	7.3	7.3	80.3	4.4	7.9
OECC20-VT-36	51.0	0	< 0.1	5.4	5.5	70.5	9.7	14.4
OECC20-VT-37	52.1	1.1	0.4	34.5	36.0	55.0	7.5	1.5
OECC20-VT-38	17.5	0.6	0	25.5	26.2	51.6	14.9	7.4
OECC20-VT-39	65.8	0	0	58.0	58.0	< 0.1	2.1	39.9
OECC20-VT-40	104.0	0	0	32.7	32.7	33.3	8.2	25.8

Transect	Total Area Analyzed (m^2)	Percent of Area – Gravel Substrates				Fine Sand/Mud Substrate (%)	Biogenic Shell Cover (%)	Flora/Fauna Cover (%)
		Boulder (%)	Cobble (%)	Pebble/ Granule (%)	All Gravel Combined (%)			
OECC20-VT-41	24.8	0.6	1.3	51.5	53.3	2.0	1.0	43.7
OECC20-VT-42	39.0	0	< 0.1	36.4	36.4	7.7	7.1	48.7
OECC20-VT-43	22.4	0	0	47.8	47.8	0.2	1.7	50.2
OECC20-VT-44	71.2	0.6	0.2	24.7	25.4	49.5	4.8	20.3
OECC20-VT-45	10.6	0.1	0	0.4	0.6	81.5	0.7	17.3
OECC20-VT-46	75.5	0.1	0	2.0	2.1	86.7	2.0	9.2
OECC20-VT-47	32.8	0	0	0	0	99.4	0.1	0.5
OECC20-VT-48	29.3	0	0	0	0	99.9	0.1	< 0.1
OECC20-VT-49	62.6	0	0	< 0.1	< 0.1	98.7	0.8	0.5
OECC20-VT-50	93.7	0	0	1.0	1.0	97.0	2.0	< 0.1
OECC20-VT-51	21.3	0	0	8.0	8.0	91.5	0.5	0
OECC20-VT-52	22.1	0	0	0	0	96.1	0.3	3.6
OECC20-VT-53	11.6	0	0	0	0	86.9	0.9	12.2
OECC20-VT-54	14.7	0	0	0	0	99.4	< 0.1	0.5
OECC20-VT-55	66.9	0	0	0	0	99.3	0.2	0.5
OECC20-VT-56	106.0	0	0	< 0.1	< 0.1	99.5	0.3	0.2
OECC20-VT-57	26.7	0	0	0	0	99.9	< 0.1	0.1
OECC20-VT-58	43.1	0	0	0	0	99.6	0.3	0.1
OECC20-VT-59	53.9	0	0	0	0	97.3	0.2	2.5
OECC20-VT-60	158.8	0	0	0	0	98.1	0.1	1.9
OECC20-VT-61	45.8	0	0	0	0	93.7	0.1	6.2
OECC20-VT-62	75.6	0	0	0	0	96.9	0.1	3.0
OECC20-VT-63	25.2	0	0	0	0	92.4	0.2	7.5
OECC Total Area (m^2)	**3,224.3**	**1.3**	**2.0**	**284.5**	**287.8**	**2,393.5**	**282.1**	**260.9**

Table 3-15. Area and percent coverage of different biological elements (i.e., flora/fauna) observed within still images taken from each of the 63 video transects in the OECC.

Transect	Flora/ Fauna Area (m^2)	Burrows (%)	Infaunal Structures (%)	Megafauna (%)	Encrusting Orgs. (%)	Sand Dollars (%)	Mussel Beds (%)	Eelgrass (%)	Algae – Codium (%)	Bushy Plant-like Orgs. (%)
OECC20-VT-01	0.4	0.1	0	0	0	0	0	0	0.8	3.6
OECC20-VT-02	10.4	< 0.1	0	1.0	0	0	0	0	0.4	26.1
OECC20-VT-03	3.1	0	0	0.1	< 0.1	0	0	0	0	5.6
OECC20-VT-04	0.1	0	0.1	0	0	0	0	0	0	0.5
OECC20-VT-05	< 0.1	< 0.1	0	< 0.1	0	0	0	0	0	< 0.1
OECC20-VT-06	0.4	0.2	0.6	< 0.1	< 0.1	0	0	0	0	0.2
OECC20-VT-07	3.4	0	0	1.3	0.1	0	0	0	0	2.7
OECC20-VT-08	0.2	0	0	< 0.1	0	0	0	0	0	0.9
OECC20-VT-09	0.1	0	0	0	0	0	0	0	0	0.1
OECC20-VT-10	0.4	0	0	0	0.5	0	0	0	0	0.3
OECC20-VT-11	2.1	0	0	< 0.1	3.7	0	0	0	0	0.1
OECC20-VT-12	0	0	0	0	0	0	0	0	0	0
OECC20-VT-13	0.1	0	0	< 0.1	0	0	0	0	0	0.2
OECC20-VT-14	1.1	0	0	0	0	0	0	0	0	1.9
OECC20-VT-15	0.2	0	0	0	0	0	0	0	0	0.3
OECC20-VT-16	1.1	< 0.1	0	< 0.1	0	0	0	0	0.8	0.4
OECC20-VT-17	12.9	0	0	< 0.1	< 0.1	0	0	< 0.1	0	19.5
OECC20-VT-18	6.6	0	0	0	0	0	0	0	0	16.1
OECC20-VT-19	6.0	0	0	0	0.1	0	0	0	0.8	22.5
OECC20-VT-20	17.5	0	0	0	< 0.1	0	0	0	0.9	15.2
OECC20-VT-21	3.8	0	0	0	< 0.1	0	0	0	0.2	21.4
OECC20-VT-22	11.4	< 0.1	0	0.1	1.5	0	0	0	0.3	14.4
OECC20-VT-23	2.8	0	0	0	0	0	0	0	0	2.9
OECC20-VT-24	1.9	0	0	0.2	1.5	0	0	0	0	2.0
OECC20-VT-25	0.9	0	0	0.1	1.7	0	0	0	0	0.8
OECC20-VT-26	3.6	< 0.1	0	0	7.3	0	0	0	0	20.2
OECC20-VT-27	2.1	0	0	0	13.4	0	0	0	0	0.2
OECC20-VT-28	0.3	0	0	0	0	0	0	< 0.1	0	0.3
OECC20-VT-29	1.6	0	0	0	0	0	0	0	0	1.3
OECC20-VT-30	18.2	0	0	0	0	0	0	0	0	38.3
OECC20-VT-31	1.1	0	0	< 0.1	0	0	0	< 0.1	0	0.8
OECC20-VT-32	3.8	0	0.9	0	0.1	0	0	0	0	4.1
OECC20-VT-33	1.1	< 0.1	0	0	5.6	0	0	0	0	7.4
OECC20-VT-34	0	0	0	0	0	0	0	0	0	0
OECC20-VT-35	0.6	0	0	0	< 0.1	0.6	0	0	0	7.3
OECC20-VT-36	7.3	0	0	0	0.3	0	0	0	< 0.1	14.1
OECC20-VT-37	0.8	0	0	0.5	0	0	0	0	0	1.0
OECC20-VT-38	1.3	0	0	0.2	3.4	0	0	< 0.1	0	3.8
OECC20-VT-39	26.3	0	0	0.1	4.6	0	0.4	< 0.1	0	34.9
OECC20-VT-40	26.8	0	0	0.1	0	0	0.2	0.6	0.1	24.9
OECC20-VT-41	10.8	0	0	0.2	19.9	0	0.1	0	0.2	23.3
OECC20-VT-42	19.0	0	0	0.1	1.2	0	0	0	< 0.1	47.4
OECC20-VT-43	11.2	0	0	0.2	33.2	0	0.6	0	0	16.3
OECC20-VT-44	14.4	0	0	0	0.6	0	0.7	0	0.2	18.7
OECC20-VT-45	1.8	0	0	0	0.1	0	0	0	0	17.2
OECC20-VT-46	6.9	0	0	0	0	0	0	0	< 0.1	9.1
OECC20-VT-47	0.2	0	0	0	0	0	0	< 0.1	0	0.5
OECC20-VT-48	< 0.1	0	0	0	0	0	0	0	0	< 0.1
OECC20-VT-49	0.3	0	0	0	0	0	0	< 0.1	0	0.5

Transect	Flora/ Fauna Area (m^2)	Burrows (%)	Infaunal Structures (%)	Megafauna (%)	Encrusting Orgs. (%)	Sand Dollars (%)	Mussel Beds (%)	Eelgrass (%)	Algae – Codium (%)	Bushy Plant-like Orgs. (%)
OECC20-VT-50	< 0.1	0	0	0	0	0	0	0	0	< 0.1
OECC20-VT-51	0	0	0	0	0	0	0	0	0	0
OECC20-VT-52	0.8	0	0.1	0	0	0.1	0	0.1	0	3.3
OECC20-VT-53	1.4	0	0.2	0	0	0	0	< 0.1	0.1	11.9
OECC20-VT-54	0.1	0.5	0	0	0	0	0	0	0	0
OECC20-VT-55	0.3	0	0	< 0.1	0	0	0	0	0	0.5
OECC20-VT-56	0.2	< 0.1	0	< 0.1	< 0.1	0	0	0	0	0.1
OECC20-VT-57	< 0.1	0.1	0	0	0	0	0	0	0	0
OECC20-VT-58	< 0.1	0.1	0	< 0.1	0	0	0	0	0	0
OECC20-VT-59	1.3	< 0.1	0	0.1	< 0.1	2.3	0	0	0	0
OECC20-VT-60	3.0	0	0	0.2	< 0.1	1.7	0	0	0	0
OECC20-VT-61	2.9	0	< 0.1	0.5	0	5.7	0	0	0	0
OECC20-VT-62	2.3	0	0	0.1	0.1	2.8	0	0	0	0
OECC20-VT-63	1.9	0	0	0.1	0	7.3	0	0	0	0
OECC Total Flora/Fauna Area (m^2)	**260.9**	**0.3**	**1.0**	**3.0**	**25.6**	**10.5**	**1.1**	**0.7**	**2.6**	**216.0**

3.2 Grab Sample Analysis

3.2.1 Grab Locations

3.2.1.1 SWDA Sampling

The characteristics and locations of the 40 stations at which grab samples were obtained within the SWDA in 2020 are described in Table 3-16 and shown in Figure 3-1. It should be noted that the latitude and longitude coordinates in Table 3-16 will be slightly different by a couple of meters from the coordinates represented on the grab sample screen image prior to sampling as the vessel is moving while the grab sampler is lowered to the bottom. Field notes from grab sampling are presented in Appendix B.

Table 3-16. Location and characteristics of grab samples collected in the SWDA (continued on next page).

Sample	Date	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth (mm)
[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SWDA20-GB-02	14-Aug-20	18:37	40.98856	-70.4995	45	90
SWDA20-GB-03	10-Aug-20	8:14	40.94884	-70.486	43	110
SWDA20-GB-04	10-Aug-20	7:49	40.94529	-70.5089	44	80
SWDA20-GB-05	10-Aug-20	9:17	40.96937	-70.5535	46	110
SWDA20-GB-06	14-Aug-20	20:52	40.96845	-70.5994	47	95
SWDA20-GB-07	14-Aug-20	21:16	40.96938	-70.6004	45	100
SWDA20-GB-08	15-Aug-20	0:12	40.98429	-70.6423	48	75
SWDA20-GB-09	14-Aug-20	22:01	40.96772	-70.6421	49	105
SWDA20-GB-10	11-Aug-20	6:48	40.95276	-70.6187	50	72
SWDA20-GB-11	11-Aug-20	6:38	40.95171	-70.6198	50	120

Sample	Date	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth (mm)
SWDA20-GB-12	9-Aug-20	9:34	40.95101	-70.6173	49	50
SWDA20-GB-13	9-Aug-20	9:00	40.93598	-70.5967	46	78
SWDA20-GB-14	10-Aug-20	7:10	40.93738	-70.5527	52	130
SWDA20-GB-15	10-Aug-20	6:36	40.92022	-70.5306	46	112
SWDA20-GB-16	9-Aug-20	7:48	40.91908	-70.5903	48	75
SWDA20-GB-17	9-Aug-20	8:21	40.91936	-70.5915	43	110
SWDA20-GB-18	11-Aug-20	5:37	40.95071	-70.6856	56	73
SWDA20-GB-19	11-Aug-20	3:50	40.91872	-70.6402	50	85
SWDA20-GB-20	10-Aug-20	4:48	40.90275	-70.6179	50	50
SWDA20-GB-21	10-Aug-20	5:15	40.90218	-70.5935	49	72
SWDA20-GB-22	10-Aug-20	5:45	40.88644	-70.5735	53	110
SWDA20-GB-23	10-Aug-20	3:23	40.85168	-70.6029	49	90
SWDA20-GB-24	10-Aug-20	4:09	40.87674	-70.6389	51	80
SWDA20-GB-25	11-Aug-20	3:12	40.89338	-70.662	50	85
SWDA20-GB-26	11-Aug-20	4:36	40.91842	-70.6841	52	120
SWDA20-GB-27	11-Aug-20	5:08	40.93436	-70.7064	46	110
SWDA20-GB-28	11-Aug-20	1:51	40.90053	-70.7503	52	82
SWDA20-GB-29	11-Aug-20	0:43	40.86809	-70.6832	51	70
SWDA20-GB-30	10-Aug-20	2:15	40.85163	-70.6608	52	108
SWDA20-GB-31	10-Aug-20	2:42	40.85343	-70.6388	50	85
SWDA20-GB-32	9-Aug-20	1:31	40.81772	-70.6491	52	58
SWDA20-GB-33	11-Aug-20	0:06	40.85092	-70.7047	50	78
SWDA20-GB-34	10-Aug-20	23:22	40.86699	-70.7488	51	120
SWDA20-GB-35	10-Aug-20	22:44	40.86613	-70.7926	51	90
SWDA20-GB-36	10-Aug-20	22:06	40.84942	-70.8142	51	100
SWDA20-GB-37	10-Aug-20	20:39	40.84217	-70.7489	52	75
SWDA20-GB-38	9-Aug-20	0:31	40.81734	-70.726	55	115
SWDA20-GB-39	9-Aug-20	23:42	40.7921	-70.7036	54	89
SWDA20-GB-40	9-Aug-20	23:04	40.76757	-70.7237	56	125

3.2.1.2 OECC Sampling

The characteristics and locations of the 66 stations at which grab samples were obtained within the OECC are described in Table 3-17 and shown in Figure 3-8. Fourteen stations retrieved insufficient sediment after three attempts, and therefore show N/A for sample penetration in the table below. Gravel, shell, algae, or hard bottom blocked the complete closing of the sampler jaws and caused the retrieval of insufficient sediment levels in grabs OECC20-GB-27, OECC20-GB-29, OECC20-GB-31, OECC20-GB-32, OECC20-GB-36, OECC20-GB-38, OECC20-GB-40, OECC20-GB-46, OECC20-GB-47, OECC20-GB-48, OECC20-GB-49, OECC20-GB-50, OECC20-GB-51, and OECC20-GB-61. Sample OECC20-GB-36 retrieved insufficient sediment due to hard bottom twice and the third attempt was aborted due to strong current/weather. Field notes from grab sampling are presented in Appendix B.

Table 3-17. Location and characteristics of grab samples collected along the OECC (continued on next page).

Sample	Date	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth (mm)
OECC20-GB-01	11-Oct-20	11:37	41.63117	-70.3328	3	95
OECC20-GB-02	11-Oct-20	12:17	41.62619	-70.3372	6	80
OECC20-GB-03	11-Oct-20	13:04	41.62698	-70.341	4	135
OECC20-GB-04	11-Oct-20	3:52	41.62181	-70.3383	4	110
OECC20-GB-05	11-Oct-20	14:58	41.60217	-70.3596	5	60
OECC20-GB-06	12-Aug-20	0:00	41.59071	-70.369	6	90
OECC20-GB-07	12-Aug-20	0:26	41.5777	-70.3789	7	70
OECC20-GB-08	12-Aug-20	0:58	41.55562	-70.4022	5	90
OECC20-GB-09	12-Aug-20	1:39	41.54995	-70.4048	7	100
OECC20-GB-10	12-Aug-20	2:10	41.53841	-70.4087	12	65
OECC20-GB-11	12-Aug-20	2:30	41.53361	-70.4134	6	78
OECC20-GB-12	12-Aug-20	2:57	41.52634	-70.417	8	110
OECC20-GB-13	12-Aug-20	3:24	41.50847	-70.417	8	70
OECC20-GB-14	12-Aug-20	17:08	41.48839	-70.4129	17	70
OECC20-GB-15	12-Aug-20	18:00	41.48341	-70.4183	12	70
OECC20-GB-16	12-Aug-20	19:13	41.45681	-70.4213	20	100
OECC20-GB-17	12-Aug-20	19:53	41.44293	-70.4252	6	100
OECC20-GB-18	12-Aug-20	20:40	41.42242	-70.4328	4	80
OECC20-GB-19	12-Aug-20	21:18	41.40716	-70.4306	4	70
OECC20-GB-20	12-Aug-20	21:55	41.39876	-70.4202	5	100
OECC20-GB-21	12-Aug-20	22:26	41.39167	-70.4303	5	58
OECC20-GB-22	12-Aug-20	22:47	41.38561	-70.4203	8	70
OECC20-GB-23	12-Aug-20	23:02	41.37666	-70.4271	9	65
OECC20-GB-24	12-Aug-20	23:28	41.38081	-70.4139	10	65
OECC20-GB-25	12-Aug-20	0:10	41.37313	-70.4188	11	65
OECC20-GB-26	13-Aug-20	0:30	41.37103	-70.4196	9	70
OECC20-GB-27	13-Aug-20	1:19	41.37566	-70.4088	11	N/A
OECC20-GB-28	13-Aug-20	1:45	41.36768	-70.4157	9	55
OECC20-GB-29	13-Aug-20	2:21	41.36998	-70.4064	12	N/A
OECC20-GB-30	18-Aug-20	1:13	41.36594	-70.4111	11	60
OECC20-GB-31	18-Aug-20	1:42	41.36385	-70.409	9.5	N/A
OECC20-GB-32	18-Aug-20	2:04	41.36019	-70.4081	16.5	N/A
OECC20-GB-33	18-Aug-20	2:25	41.35988	-70.4004	5	122
OECC20-GB-34	18-Aug-20	2:44	41.35972	-70.3935	11	119
OECC20-GB-35	18-Aug-20	3:03	41.35158	-70.389	6	70
OECC20-GB-36	22-Aug-20	5:44	41.35129	-70.3926	5	N/A
OECC20-GB-37	18-Aug-20	21:05	41.34931	-70.3967	10	120
OECC20-GB-38	20-Oct-20	15:15	41.34267	-70.3896	10	N/A
OECC20-GB-39	18-Aug-20	20:21	41.34436	-70.3863	7	30
OECC20-GB-40	20-Oct-20	16:58	41.33762	-70.3882	8	N/A
OECC20-GB-41	20-Oct-20	15:39	41.33922	-70.3854	9	75
OECC20-GB-42	18-Aug-20	19:38	41.34103	-70.3789	7	80
OECC20-GB-43	20-Oct-20	17:10	41.33084	-70.3873	8	70
OECC20-GB-44	18-Aug-20	19:04	41.33182	-70.3828	10	65
OECC20-GB-45	20-Oct-20	14:22	41.33573	-70.3748	11	60
OECC20-GB-46	18-Aug-20	18:38	41.33063	-70.3791	6	N/A
OECC20-GB-47	20-Oct-20	13:21	41.32514	-70.3848	7	N/A

Sample	Date	Time (UTC)	Latitude (°N)	Longitude (°W)	Water Depth (m)	Sample Penetration Depth (mm)
OECC20-GB-48	18-Aug-20	17:57	41.32815	-70.3749	8	N/A
OECC20-GB-49	20-Oct-20	14:00	41.32532	-70.3709	6	N/A
OECC20-GB-50	20-Oct-20	13:01	41.31832	-70.381	8	N/A
OECC20-GB-51	19-Oct-20	18:52	41.31827	-70.3706	6	N/A
OECC20-GB-52	19-Oct-20	19:06	41.3185	-70.3609	8	N/A
OECC20-GB-53	18-Oct-20	19:40	41.31507	-70.3652	6	60
OECC20-GB-54	18-Aug-20	17:02	41.31348	-70.373	9	80
OECC20-GB-55	19-Oct-20	18:12	41.31457	-70.3594	5	130
OECC20-GB-56	18-Aug-20	16:35	41.31019	-70.3651	7	90
OECC20-GB-57	19-Oct-20	17:23	41.31033	-70.3594	7	85
OECC20-GB-58	19-Oct-20	17:44	41.31068	-70.3547	6	125
OECC20-GB-59	19-Oct-20	16:55	41.30797	-70.363	6	145
OECC20-GB-60	19-Oct-20	16:33	41.30766	-70.366	5	160
OECC20-GB-61	18-Oct-20	18:57	41.306	-70.362	7	N/A
OECC20-GB-62	18-Oct-20	18:05	41.30011	-70.357	6	100
OECC20-GB-63	18-Oct-20	16:32	41.29283	-70.3636	8	70
OECC20-GB-64	18-Oct-20	17:23	41.29753	-70.3795	7	115
OECC20-GB-65	18-Aug-20	15:29	41.28575	-70.399	6	120
OECC20-GB-66	18-Aug-20	15:05	41.27242	-70.4117	7	95
OECC20-GB-67	21-Aug-20	18:22	41.25568	-70.4279	21	85
OECC20-GB-68	21-Aug-20	19:26	41.24852	-70.4303	25	160
OECC20-GB-69	21-Aug-20	19:57	41.23437	-70.4354	27	90
OECC20-GB-70	21-Aug-20	20:29	41.21505	-70.4429	30	80
OECC20-GB-71	21-Aug-20	20:53	41.20669	-70.4425	30	75
OECC20-GB-72	21-Aug-20	21:27	41.19461	-70.4533	31	110
OECC20-GB-73	21-Aug-20	22:22	41.17474	-70.4632	31	73
OECC20-GB-74	21-Aug-20	22:55	41.15955	-70.4709	36	105
OECC20-GB-75	21-Aug-20	23:30	41.14312	-70.4795	34	53
OECC20-GB-76	22-Aug-20	0:06	41.12975	-70.4802	35	75
OECC20-GB-77	18-Oct-20	14:23	41.11188	-70.5041	40	95
OECC20-GB-78	22-Aug-20	1:21	41.09912	-70.5213	37	70
OECC20-GB-79	22-Aug-20	1:58	41.08377	-70.5377	39	95
OECC20-GB-80	15-Aug-20	3:30	41.06926	-70.5554	40	98

3.2.2 Sediment Analysis

The following section presents grab sample grain size composition results from the GeoTesting lab analysis. The grain size data in Section 3.2.2 conform to ASTM D6913 (equivalent to the Unified Soils Classification System [USCS]), according to contractual agreement. This system is the standard for engineering projects worldwide. Grain size boundaries differ slightly from the Wentworth System referenced for CMECS and these differences apply throughout the tables and figures in this sediment analysis. For the sake of applying NMFS (2020) modified CMECS, a slight difference in the threshold for silt or clay (0.0625 mm for Wentworth vs. 0.075 mm for USCS) is the only factor that may affect the classification of muddy sand vs. sand and sandy mud vs. muddy sand in rare instances. The threshold distinguishing sand from gravel for CMECS (Wentworth 2 mm sieve size) is the same between the two sets of sieve standards so that threshold is captured in the grain size analysis.

3.2.2.1 SWDA Analysis

Samples from all 40 grab sample stations in the SWDA were almost exclusively sandy, with all samples having a CMECS classification of Very Coarse/Coarse Sand or finer (Table 3-18; Figure 3-16). Twenty-six samples contained no gravel-sized particles (> 2 mm) while no samples contained > 5% gravel to place them into a NMFS complex habitat classification. Only two samples (SWDA20-GB-21 and SWDA20-GB-30) had more than 1% gravel larger than 2 mm. Fine silt and clay particles (< 0.075 mm) comprised < 1 – 92% of each sample (mean of 19%), with three samples containing 50% or more silt and clay (SWDA20-GB-14, SWDA20-GB-38, and SWDA20-GB-40). The fines component may be a slight overestimate because CMECS classifies silt/clay at a smaller scale (< 0.0625 mm) than the lab results (< 0.075 mm). Field notes from grab sampling are presented in Appendix B.

Table 3-18. Grain size composition from grab samples collected in the SWDA (continued on next page).

Station	> 2 mm (%)	2 – 0.42 mm (%)	0.42 – 0.25 mm (%)	0.075 – 0.42 mm (%)	< 0.075 mm (%)
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SWDA20-GB-02	0	5	12	72	11
SWDA20-GB-03	1	2	6	75	16
SWDA20-GB-04	0	40	48	8	4
SWDA20-GB-05	1	1	2	63	33
SWDA20-GB-06	0	38	42	17	3
SWDA20-GB-07	0	6	21	66	7
SWDA20-GB-08	1	77	15	5	2
SWDA20-GB-09	1	2	9	76	12
SWDA20-GB-10	0	5	39	48	8
SWDA20-GB-11	0	10	18	50	22
SWDA20-GB-12	0	51	30	11	8
SWDA20-GB-13	0	26	49	21	4
SWDA20-GB-14	0	1	0	7	92
SWDA20-GB-15	1	4	10	61	24
SWDA20-GB-16	0	44	38	9	9
SWDA20-GB-17	0	13	14	50	23
SWDA20-GB-18	0	6	42	48	4
SWDA20-GB-19	1	3	8	63	25
SWDA20-GB-20	0	2	4	49	45
SWDA20-GB-21	3	59	14	3	21
SWDA20-GB-22	0	12	22	35	31
SWDA20-GB-23	0	9	35	50	6
SWDA20-GB-24	0	74	21	3	2
SWDA20-GB-25	0	13	23	42	22
SWDA20-GB-26	1	5	5	57	32
SWDA20-GB-27	0	6	23	61	10
SWDA20-GB-28	1	3	12	68	16
SWDA20-GB-29	1	61	28	4	6
SWDA20-GB-30	2	2	3	49	44

SWDA20-GB-31	0	68	26	4	2
SWDA20-GB-32	0	71	22	3	4
SWDA20-GB-33	0	71	26	2	1
SWDA20-GB-34	1	5	16	56	22
SWDA20-GB-35	1	4	16	64	15
SWDA20-GB-36	1	7	14	57	21
SWDA20-GB-37	0	43	50	5.5	1.5
SWDA20-GB-38	0	4	5	41	50
SWDA20-GB-39	0	54	36	4	6
SWDA20-GB-40	1	3	2	20	74

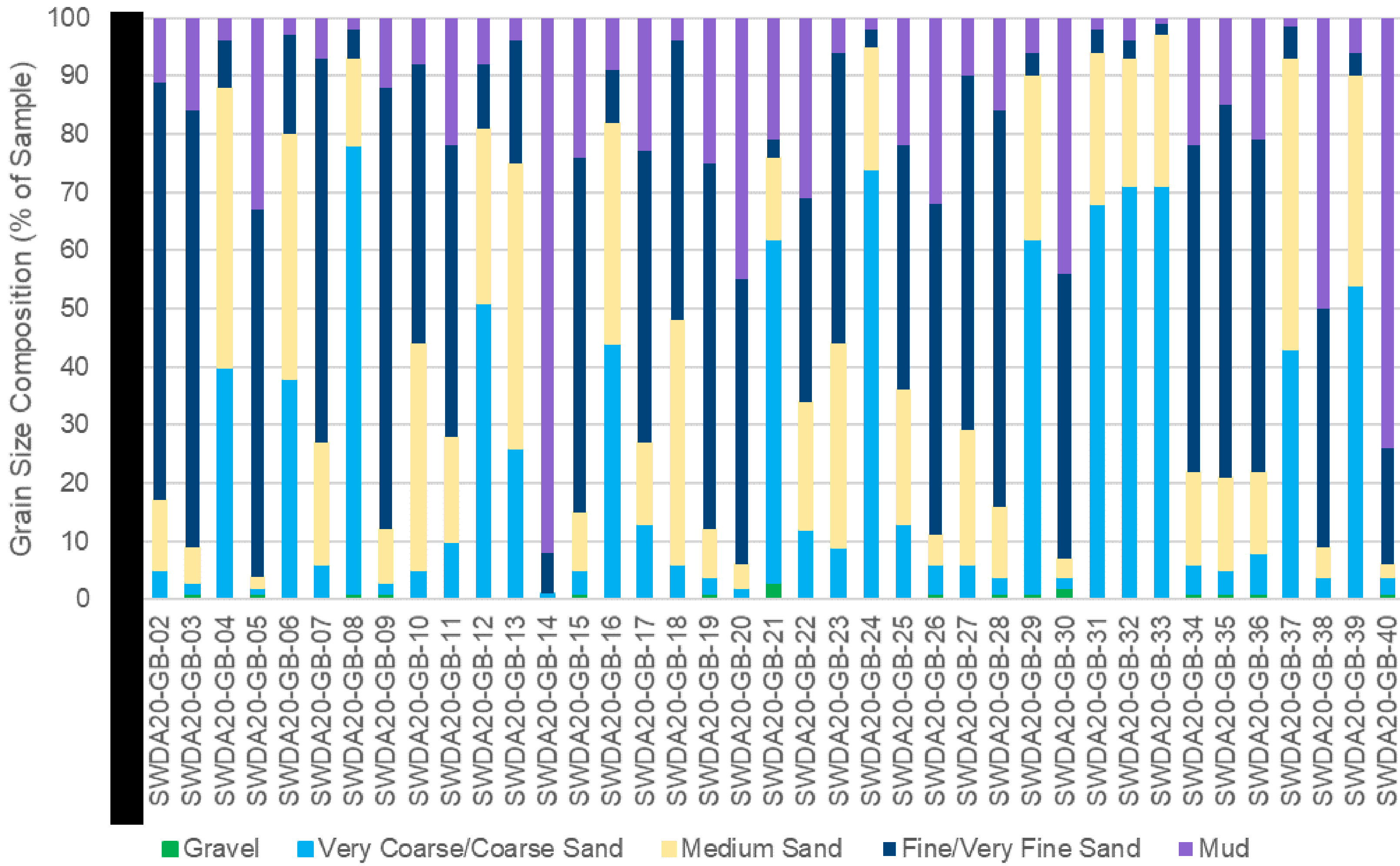


Figure 3-16. Grain size composition at each grab sample station collected in the SWDA.

3.2.2.2 OECC Analysis

Samples from all 66 grab sample stations along the OECC at which sufficient sediment was obtained were mostly sandy/muddy with 61% of samples classified as fine unconsolidated substrate (Table 3-19). Seventeen samples contained ≥ 5% gravel (> 2 mm), which classifies them into a NOAA complex habitat classification. Of the samples designated as complex, 10 had ≥ 30% gravel. Nine samples were classified as biogenic Shell Hash, as over 50% of the substrate was designated shell hash of biogenic origin upon further review of sample and bottom imagery. Fine silt and clay particles (< 0.075 mm) comprised 0 – 80% of each sample (mean of 7.5%), with only six samples containing ≥ 30% silt and clay (OECC20-GB-01, OECC20-GB-02, OECC20-GB-03, OECC20-GB-68, OECC20-GB-74, and OECC20-GB-80). The fines component may be a slight overestimate because CMECS classifies silt/clay at a smaller scale (< 0.0625 mm) than the lab results (<0.075 mm). Of the 14 sample stations that had three insufficient recovery grab attempts, percent gravel ranged from 21 – 86% with four sites classified as gravel (> 80% gravel) and the remaining ten stations classified as gravel mixes from still image point count analyses.

Table 3-19. Grain size composition from grab samples collected along the OECC (continued on next page).

Station	> 2 mm (%)	2 – 0.42 mm (%)	0.42 – 0.25 mm (%)	0.075 – 0.42 mm (%)	< 0.075 mm (%)
OECC20-GB-01	3	6	5	44	42
OECC20-GB-02*	38	7	2	21	32
OECC20-GB-03	7	2	2	32	57
OECC20-GB-04	0	28	49	22	1
OECC20-GB-05*	41	21	7	20	11
OECC20-GB-06	0	18	39	41	2
OECC20-GB-07	0	3	11	83	3
OECC20-GB-08	0	2	18	77	3
OECC20-GB-09	0	31	33	33	3
OECC20-GB-10*	27	29	26	17	1
OECC20-GB-11	0	86	13	0	1
OECC20-GB-12*	17	41	24	17	1
OECC20-GB-13	5	61	29	4	1
OECC20-GB-14	0	36	31	28	5
OECC20-GB-15	0	38	33	25	4
OECC20-GB-16	9	45	40	4.5	1.5
OECC20-GB-17	1	70	20	8	1
OECC20-GB-18	0	53	29	17	1
OECC20-GB-19*	52	28	15	3.5	1.5
OECC20-GB-20	1	36	53	9	1
OECC20-GB-21*	36	42	7	11	4
OECC20-GB-22	3	25	55	16	1
OECC20-GB-23	9	11	14	63	3
OECC20-GB-24*	30	29	23	16	2
OECC20-GB-25*	21	37	28	12	2
OECC20-GB-26	5	67	24	3	1
OECC20-GB-28	54	27	13	5	1
OECC20-GB-30	74	21	4	0	1

Station	> 2 mm (%)	2 – 0.42 mm (%)	0.42 – 0.25 mm (%)	0.075 – 0.42 mm (%)	< 0.075 mm (%)
OECC20-GB-33	0	77	22	0	1
OECC20-GB-34	1	94	5	0	0
OECC20-GB-35	49	13	23	14	1
OECC20-GB-37	2	65	31	1	1
OECC20-GB-39	34	4	23	38	1
OECC20-GB-41	1	6	44	47	2
OECC20-GB-42	46	28	23	2	1
OECC20-GB-43	37	3	25	34	1
OECC20-GB-44	30	37	22	10	1
OECC20-GB-45*	69	12	13	5	1
OECC20-GB-52	0	66	33	0	1
OECC20-GB-53	51	24	21	4	0
OECC20-GB-54	43	20	23	13	1
OECC20-GB-55	1	98	1	0	0
OECC20-GB-56	35	24	28	12	1
OECC20-GB-57	0	71	23	1	5
OECC20-GB-58	0	78	20	1	1
OECC20-GB-59	2	97	1	0	0
OECC20-GB-60	0	98	2	0	0
OECC20-GB-62	2	77	20	0	1
OECC20-GB-63	0	97	1	0	2
OECC20-GB-64	0	95	5	0	0
OECC20-GB-65	17	79	4	0	0
OECC20-GB-66	9	85	5	1	0
OECC20-GB-67	0	1	11	77	11
OECC20-GB-68	0	1	1	18	80
OECC20-GB-69	1	81	5	2	11
OECC20-GB-70	0	40	45	8	7
OECC20-GB-71	0	49	39	7	5
OECC20-GB-72	0	7	21	54	18
OECC20-GB-73	0	32	55	11	2
OECC20-GB-74	0	4	10	21	65
OECC20-GB-75	0	12	51	30	7
OECC20-GB-76	0	7	34	55	4
OECC20-GB-77	0	7	44	47	2
OECC20-GB-78	0	2	24	69	5
OECC20-GB-79	0	11	19	51	19
OECC20-GB-80	1	1	6	44	48

* CMECS classification determined through still imagery of bottom, rather than grain size data due to presence of dense shell or gravel that caused insufficient sediment recovery.

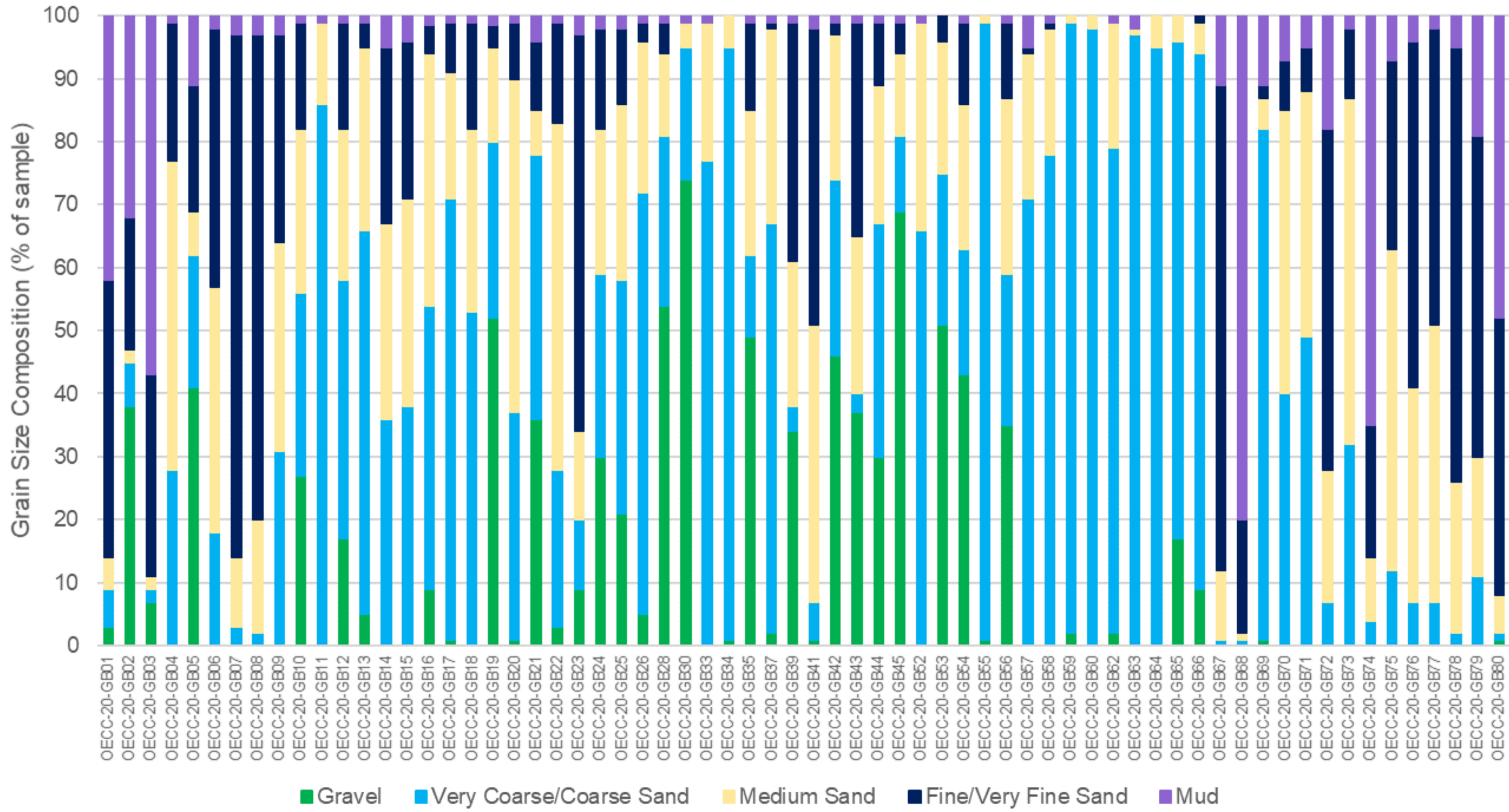


Figure 3-17. Grain size composition at each grab sample station collected in the SWDA.

3.2.3 Benthic Community Analysis

3.2.3.1 SWDA

3.2.3.1.1 Taxonomic Composition

Grab samples were collected for benthic macroinvertebrate analysis from 40 sites in the SWDA. The grab samples yielded a total of 2,632 individual megafaunal organisms (per all forty 0.008 m^2 core samples, Table 3-20). Organisms identified from samples collected in the SWDA were from 8 unique phyla, 68 families (or LPTL), and 121 species (or LPTL; Table 3-20). The phyla Arthropoda, Annelida, and Mollusca dominated samples in both abundance and unique taxa, representing 90% of all organisms and 93% of the unique taxa (family or LPTL; Figure 3-18).

Table 3-20. Phyla present in the 39 benthic grab samples in SWDA.

Phyla	Abundant Taxonomic Groups (common names)	Density (Abundance per forty 0.008 m^2 samples)	Number of Families (or LPTL)	Number of Species (or LPTL)
Annelida	Polychaete worms (segmented and bamboo worms)	1,019	26	62
Arthropoda	Amphipods, hooded shrimp	1,040	19	31
Cnidaria	Sea anemone	2	1	1
Echinodermata	Sand dollars	3	1	1
Hemichordata	Acorn worms	1	1	1
Mollusca	Nut clams, spoonclams, false quahogs	335	18	23
Nematoda	Nematodes	206	1	1
Nemertea	Ribbon worms	26	1	1
Totals		2,632	68	121

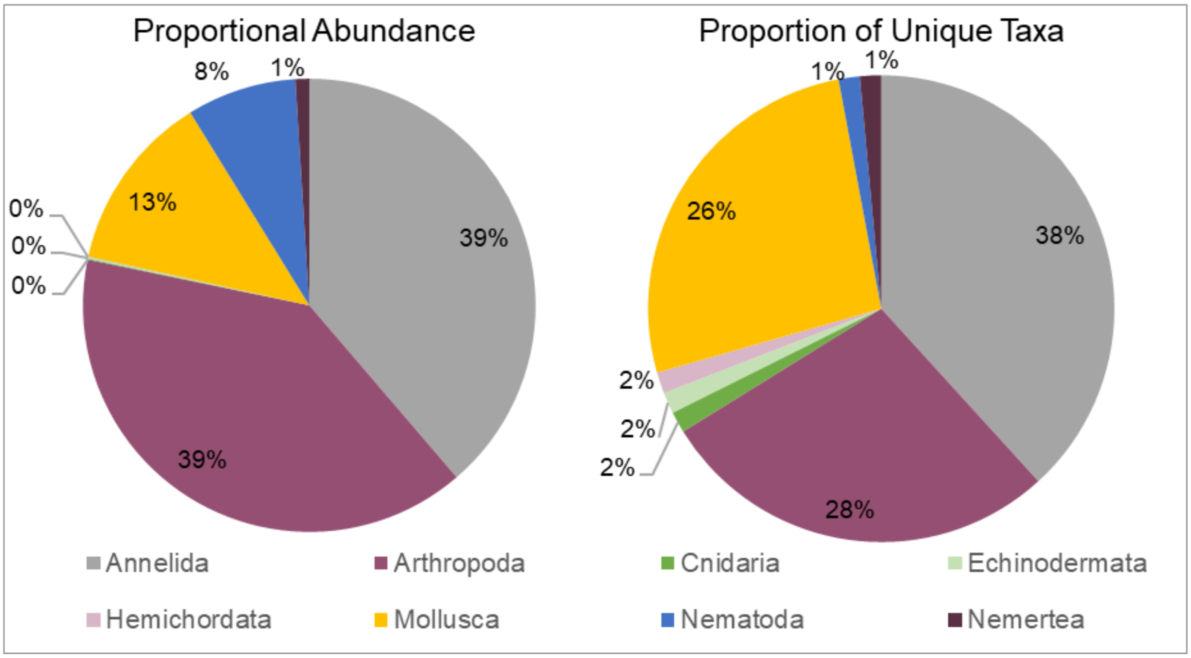


Figure 3-18. Proportional abundance and proportion of unique taxa (family or LPTL) for each phylum represented in all benthic grab samples collected in the SWDA. Results presented as percentage of total.

Density across the 40 benthic grab sites ranged from nine organisms in SWDA20-GB-39 to 215 in SWDA20-GB-03 (Table 3-21). Amphipods from the Ampeliscidae family were the single most abundant taxa, accounting for 30% of total abundance, and were identified in 31 of the 40 samples collected in the SWDA. A majority (>50%) of the organisms identified in the sample collected at stations SWDA20-GB-03, SWDA20-GB-04, and SWDA20-GB-15 were amphipods from the Ampeliscidae family. The number of unique families represented in each sample ranged from 6 families at SWDA20-GB-39 to 25 families at SWDA20-GB-19. No taxa (family or LPTL) were observed in all samples; however, Nematoda occurred most frequently, identified in 34 of the 40 samples. The percent composition of each sample by Phyla is shown in Figure 3-19 and abundance of unique taxa is presented in Table 3-22.

Table 3-21. Abundance of organisms identified in each Phylum counted within each grab sample collected in the SWDA (continued on next page).

Station	Annelida	Arthropoda	Cnidaria	Echinodermata	Hemichordata	Mollusca	Nematoda	Nemertea	Density (Abundance per 0.008 m^2)
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SWDA20-GB-02	39	33	0	0	1	9	1	1	84
SWDA20-GB-03	36	165	0	0	0	12	1	1	215
SWDA20-GB-04	4	24	0	0	0	0	1	0	29
SWDA20-GB-05	38	28	0	0	0	29	1	0	96
SWDA20-GB-06	29	12	0	0	0	3	13	0	57
SWDA20-GB-07	52	9	0	0	0	2	16	0	79
SWDA20-GB-08	32	3	0	0	0	0	12	0	47
SWDA20-GB-09	41	38	0	0	0	23	5	0	107
SWDA20-GB-10	34	5	0	0	0	7	2	0	48
SWDA20-GB-11	29	43	0	0	0	16	2	1	91
SWDA20-GB-12	18	9	0	0	0	2	0	0	29
SWDA20-GB-13	18	4	0	0	0	0	21	0	43
SWDA20-GB-14	28	0	0	0	0	12	5	0	45
SWDA20-GB-15	27	128	0	0	0	26	0	0	181
SWDA20-GB-16	19	24	0	0	0	2	8	0	53
SWDA20-GB-17	21	45	0	0	0	16	12	8	102
SWDA20-GB-18	20	6	0	0	0	2	2	1	31
SWDA20-GB-19	39	39	0	1	0	12	2	0	93
SWDA20-GB-20	23	29	0	0	0	7	1	0	60
SWDA20-GB-21	11	5	0	0	0	8	0	0	24
SWDA20-GB-22	16	40	0	0	0	23	3	0	82
SWDA20-GB-23	12	7	0	0	0	1	0	1	21
SWDA20-GB-24	11	2	0	0	0	1	2	0	16
SWDA20-GB-25	11	2	0	0	0	4	3	0	20
SWDA20-GB-26	28	55	0	0	0	17	5	0	105
SWDA20-GB-27	16	52	1	0	0	19	1	0	89
SWDA20-GB-28	24	36	0	0	0	16	1	1	78
SWDA20-GB-29	19	2	0	0	0	2	1	0	24
SWDA20-GB-30	16	18	0	0	0	8	1	3	46
SWDA20-GB-31	11	0	0	1	0	0	4	0	16
SWDA20-GB-32	7	3	0	0	0	9	4	0	23
SWDA20-GB-33	56	5	0	0	0	1	54	1	117
SWDA20-GB-34	31	14	0	0	0	13	1	2	61
SWDA20-GB-35	43	46	1	0	0	13	0	0	103
SWDA20-GB-36	38	41	0	0	0	7	0	3	89
SWDA20-GB-37	32	4	0	0	0	0	13	1	50
SWDA20-GB-38	22	26	0	0	0	7	2	1	58

Station	Annelida	Arthropoda	Cnidaria	Echinodermata	Hemichordata	Mollusca	Nematoda	Nemertea	Density (Abundance per 0.008 m^2)
SWDA20-GB-39	6	1	0	0	0	0	2	0	9
SWDA20-GB-40	13	32	0	0	0	4	1	1	51
Totals	1,019	1,040	2	3	1	335	206	26	2,632

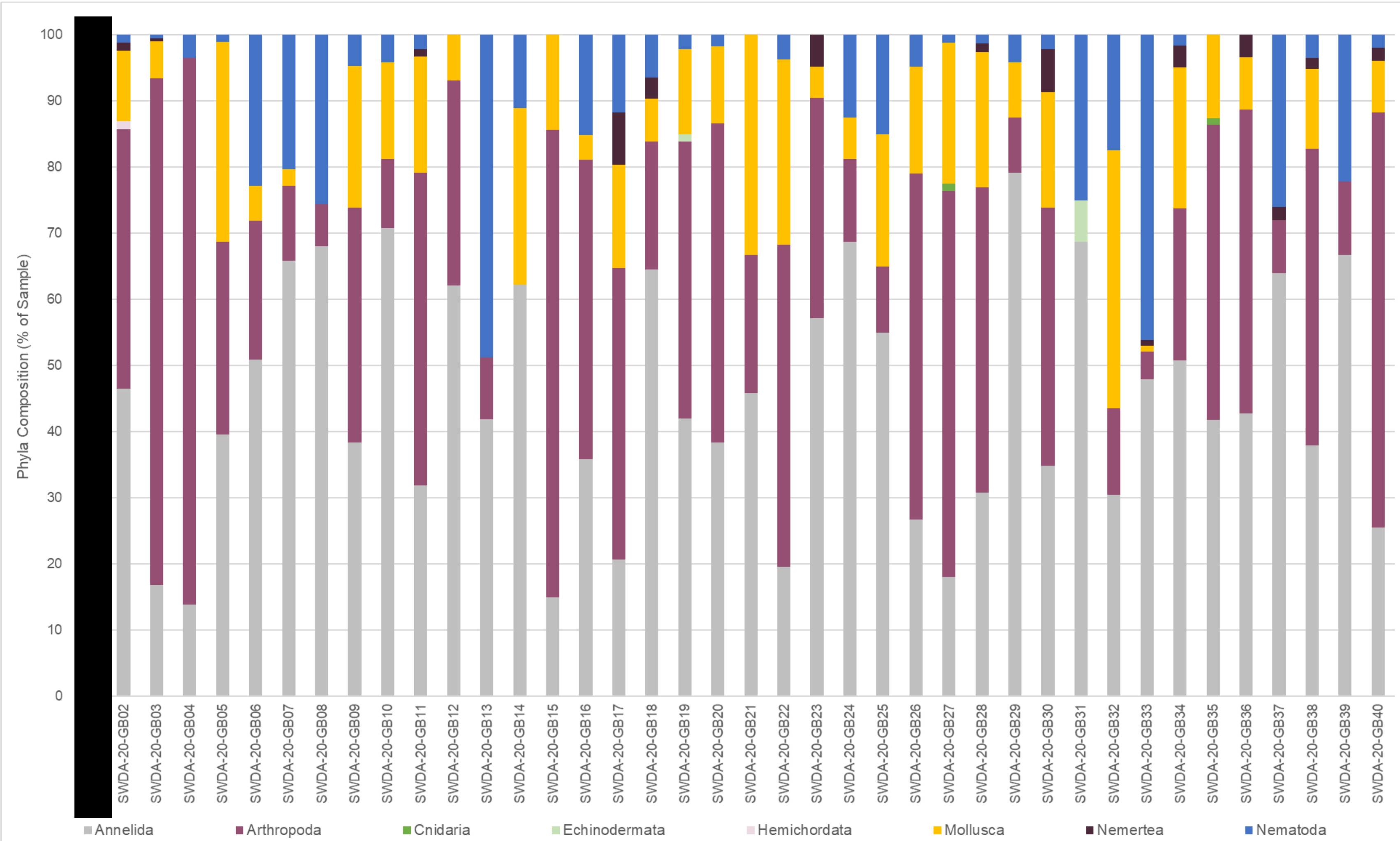


Figure 3-19. Percent composition of organisms in each represented phylum for the 40 benthic grab samples collected in the SWDA.

Table 3-22. Abundance of each phylum and taxon (family or LPTL) across all samples collected in the SWDA (continued on next page).

Phylum	Family or LPTL	Abundance Across All Samples	Mean Abundance per 0.008 m^2	Median Abundance per 0.008 m^2	Frequency of Occurrence
Annelida	Ampharetidae	24	0.6	0	17
	Capitellidae	6	0.2	0	4
	Cirratulidae	47	1.2	0	18
	Cossuridae	11	0.3	0	4
	Dorvilleidae	1	0	0	1
	Flabelligeridae	10	0.2	0	5
	Glyceridae	18	0.4	0	15
	Goniadidae	56	1.4	0	5
	Lumbrineridae	153	3.8	3	32
	Maldanidae	100	2.5	1.5	25
	Nephtyidae	36	0.9	0	19
	Oenonidae	7	0.2	0	7
	Oligochaeta	20	0.5	0	14
	Opheliidae	8	0.2	0	7
	Oweniidae	4	0.1	0	3
	Paraonidae	148	3.7	2	29
	Phyllodocidae	2	0	0	2
	Polygordiidae	55	1.4	0	17
	Polynoidae	3	0.1	0	3
	Sabellidae	63	1.6	0.5	20
	Scalibregmatidae	19	0.5	0	15
	Sigalionidae	4	0.1	0	2
	Spionidae	162	4	1	24
	Syllidae	22	0.6	0	10
	Terebellidae	5	0.1	0	3
	Trichobranchidae	35	0.9	0	15
Arthropoda	Ampeliscidae	792	19.8	14	31
	Anthuridae	1	0	0	1
	Axiidae	1	0	0	1
	Caprellidae	1	0	0	1
	Cheirocratidae	1	0	0	1
	Cirolanidae	1	0	0	1
	Corophiidae	98	2.5	0	14
	Diastylidae	14	0.4	0	12
	Eriopisidae	1	0	0	1
	Idoteidae	1	0	0	1
	Ischyroceridae	4	0.1	0	4
	Leuconidae	21	0.5	0	14
	Photidae	7	0.2	0	4
	Phoxocephalidae	47	1.2	1	23
	Pleustidae	2	0	0	2
	Tanaissuidae	2	0	0	1
	Tryphosidae	26	0.6	0	9
	Unciolidae	19	0.5	0	11
	Uristidae	1	0	0	1
Cnidaria	Anthozoa	2	0	0	2
Echinodermata	Echinarachniidae	3	0.1	0	3
Hemichordata	Harrimaniidae	1	0	0	1
Mollusca	Arcticidae	3	0.1	0	2
	Astartidae	5	0.1	0	5
	Cardiidae	10	0.2	0	6
	Carditidae	4	0.1	0	3
	Columbellidae	2	0	0	2

Phylum	Family or LPTL	Abundance Across All Samples	Mean Abundance per 0.008 m^2	Median Abundance per 0.008 m^2	Frequency of Occurrence
	Gastropoda	1	0	0	1
	Lasaeidae	2	0	0	2
	Lysoniidae	2	0	0	2
	Mactridae	1	0	0	1
	Mytilidae	11	0.3	0	8
	Nassariidae	1	0	0	1
	Nuculidae	202	5	3.5	27
	Periplomatidae	39	1	0	17
	Rissoidae	5	0.1	0	4
	Thraciidae	11	0.3	0	8
	Thyasiridae	14	0.4	0	7
	Veneridae	12	0.3	0	10
	Yoldiidae	10	0.2	0	6
Nematoda	Nematoda	206	5.2	2	34
Nemertea	Nemertea	26	0.6	0	14

3.2.3.1.2 Richness, Diversity, and Evenness

Mean density was 66 organisms per station, averaged across the 40 benthic grab stations in the SWDA (Table 3-23). The richness of organisms collected at each grab sample location ranged from 1.44 at SWDA20-GB-31, which contained 16 organisms from five families (or LPTL) to 5.29 at SWDA20-GB-19, which contained 93 organisms from 29 families (or LPTL; Figure 3-20). Average diversity across the individual grab samples was 2.06 and ranged from 1.1 at SWDA20-GB-31 to 2.63 at SWDA20-GB-34. Evenness across the samples ranged from 0.54 at SWDA20-GB-33 to 0.96 at SWDA20-GB-21 and SWDA20-GB-25. Richness, diversity, and evenness are indices that do not have units; however, higher values indicate greater amounts of richness, diversity, or evenness in each sample.

Table 3-23. Community composition parameters calculated for each station in the SWDA (continued on next page).

Station	Density (Abundance per 0.008 m^2)	Number of LPTLs	Number of Families (or LPTL)	Ecological Indices		
				Richness	Diversity	Evenness
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SWDA20-GB-02	84	27	22	4.74	2.43	0.79
SWDA20-GB-03	215	24	20	3.54	1.76	0.59
SWDA20-GB-04	29	9	8	2.08	1.29	0.62
SWDA20-GB-05	96	22	18	3.72	2.17	0.75
SWDA20-GB-06	57	15	13	2.97	1.99	0.78
SWDA20-GB-07	79	25	20	4.35	2.22	0.74
SWDA20-GB-08	47	13	12	2.86	1.83	0.74
SWDA20-GB-09	107	30	24	4.92	2.45	0.77
SWDA20-GB-10	48	19	15	3.62	2.21	0.81
SWDA20-GB-11	91	22	20	4.21	2.09	0.70
SWDA20-GB-12	29	14	11	2.97	2.02	0.84
SWDA20-GB-13	43	11	10	2.39	1.69	0.73
SWDA20-GB-14	45	8	7	1.58	1.64	0.84
SWDA20-GB-15	181	25	24	4.42	1.93	0.61
SWDA20-GB-16	53	18	15	3.53	2.21	0.82
SWDA20-GB-17	102	23	21	4.32	2.29	0.75
SWDA20-GB-18	31	12	12	3.20	1.75	0.70
SWDA20-GB-19	93	29	25	5.29	2.40	0.75
SWDA20-GB-20	60	14	12	2.69	1.78	0.72
SWDA20-GB-21	24	16	15	4.41	2.59	0.96
SWDA20-GB-22	82	22	17	3.63	2.07	0.73
SWDA20-GB-23	21	15	12	3.61	2.36	0.95
SWDA20-GB-24	16	8	8	2.52	1.81	0.87
SWDA20-GB-25	20	9	8	2.34	1.99	0.96
SWDA20-GB-26	105	18	16	3.22	1.85	0.67
SWDA20-GB-27	89	23	19	4.01	2.10	0.71
SWDA20-GB-28	78	27	22	4.82	2.47	0.80
SWDA20-GB-29	24	13	11	3.15	2.24	0.94
SWDA20-GB-30	46	20	17	4.18	2.40	0.85
SWDA20-GB-31	16	5	5	1.44	1.19	0.74
SWDA20-GB-32	23	14	13	3.83	2.39	0.93
SWDA20-GB-33	117	14	14	2.73	1.42	0.54
SWDA20-GB-34	61	25	22	5.11	2.63	0.85
SWDA20-GB-35	103	25	20	4.10	2.19	0.73
SWDA20-GB-36	89	28	22	4.68	2.24	0.73
SWDA20-GB-37	50	15	14	3.32	2.18	0.83
SWDA20-GB-38	58	16	14	3.20	2.01	0.76
SWDA20-GB-39	9	6	6	2.28	1.68	0.94

Station	Density (Abundance per 0.008 m^2)	Number of LPTLs	Number of Families (or LPTL)	Ecological Indices		
				Richness	Diversity	Evenness
SWDA20-GB-40	51	18	15	3.56	2.05	0.76
Average	**66**	**18**	**15**	**3.53**	**2.06**	**0.78**

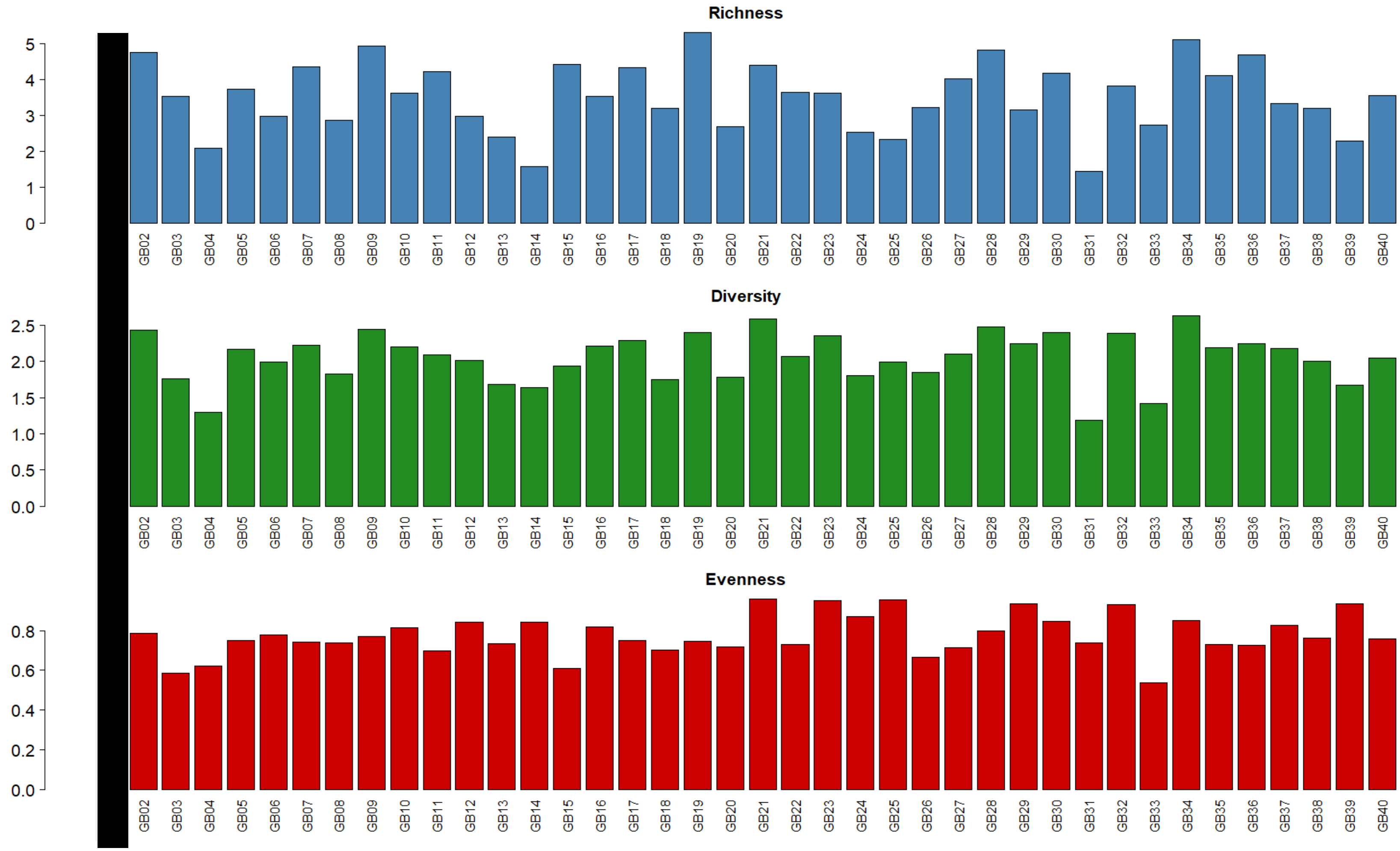


Figure 3-20. Ecological index values calculated for each sample station collected in the SWDA.

3.2.3.2 OECC

3.2.3.2.1 Taxonomic Composition

Grab samples were attempted at 80 sample locations along the OECC for infaunal analysis. Of the 80 stations, 66 had successful benthic grab samples collected. All 14 grab stations where insufficient amounts of sediment were obtained were a result of coarse/hard bottom sediments preventing full closure of grab sampler bucket. The 66 successful grab samples yielded a total of 6,723 individual megafaunal organisms (per all 66 0.008 m^2 core samples). Organisms collected in this survey area were from 8 unique phyla, 109 families or LPTL, and 238 species or LPTL (Table 3-24). The Phyla Annelida, Mollusca, and Nematoda dominated the abundance in samples, representing 84% of all organisms, while Arthropoda, Annelida, and Mollusca dominated in unique taxa, representing 94% of the taxa identified (Figure 3-21).

Table 3-24. Phyla present in the 66 benthic grab samples collected along the OECC.

Phylum	Abundant Taxonomic Groups (common names)	Density (Abundance per forty 0.008 m^2 samples)	Number of Families (or LPTL)	Number of Species (or LPTL)
Annelida	Polychaete worms (segmented and bamboo worms)	2,153	35	117
Arthropoda	Amphipods, calanoid copepods, ostracods	819	27	42
Chordata	Tunicate	234	1	1
Cnidaria	Hydroid	5	41	73
Echinodermata	Sand dollars, sea cucumbers	2	1	1
Mollusca	Nut clams	2,023	1	1
Nematoda	Nematodes	1,447	1	1
Nemertea	Ribbon worms	40	2	2
Totals		6,723	109	238

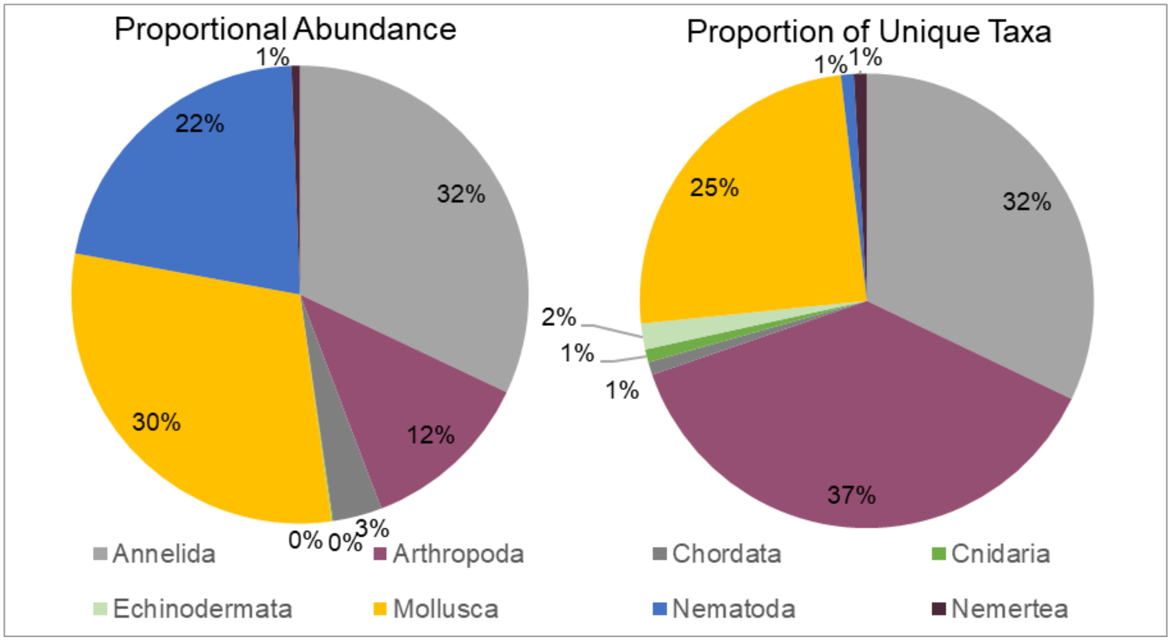


Figure 3-21. Proportional abundance and proportion of unique taxa (family or LPTL) for each phylum collected in all benthic grab samples along the OECC. Results presented as percentage of total.

Density across the 66 benthic grab samples collected along the OECC ranged from 2 organisms in OECC20-GB-68 to 645 in OECC20-GB-05 (Table 3-25). A large quantity of macroinvertebrate organisms (58%) identified in the sample collected at OECC20-GB-05 were from the Oligochaeta family (oligochaete worm) and Nematoda phylum (roundworm). The number of unique taxa represented in each sample ranged from 1 at OECC20-GB-11 and OECC20-GB-34 to 42 at OECC20-GB-23. Nematode roundworms and nut clams from the Nuculidae family were the most abundant taxa identified across all samples, while nematodes occurred most frequently, identified in 55 of the 66 grab samples. Although no one phylum was represented in all samples, organisms from the Annelida phylum occurred in 62 of the 66 samples. The percent composition of each sample by phyla is shown in Figure 3-22 and abundance of unique taxa is presented in Table 3-26.

Table 3-25. Abundance of each Phylum counted within each grab sample collected along the OECC (continued on next page).

Station	Annelida	Arthropoda	Chordata	Cnidaria	Echinodermata	Mollusca	Nematoda	Nemertea	Density (Abundance per 0.008 m^2)
OECC20-GB-01	56	41	0	0	0	8	37	0	142
OECC20-GB-02	47	21	0	0	0	18	11	0	97
OECC20-GB-03	50	10	0	0	0	11	22	2	95
OECC20-GB-04	33	2	0	0	0	26	35	3	99
OECC20-GB-05	285	83	0	0	0	69	204	4	645
OECC20-GB-06	13	4	0	0	0	0	1	0	18
OECC20-GB-07	15	16	0	0	0	2	0	0	33
OECC20-GB-08	15	8	0	0	0	3	0	0	26
OECC20-GB-09	11	2	0	0	0	2	6	0	21
OECC20-GB-10	15	4	0	0	0	1	2	1	23
OECC20-GB-11	0	0	0	0	0	0	11	0	11
OECC20-GB-12	17	2	0	0	0	0	7	0	26
OECC20-GB-13	26	1	0	0	0	2	21	0	50
OECC20-GB-14	8	21	0	0	0	2	3	2	36
OECC20-GB-15	24	0	0	0	0	3	5	0	32
OECC20-GB-16	21	6	0	0	0	15	9	0	51
OECC20-GB-17	9	4	0	0	0	1	22	0	36
OECC20-GB-18	14	3	0	0	0	0	43	0	60
OECC20-GB-19	55	37	0	0	0	108	52	3	255
OECC20-GB-20	10	3	0	0	0	0	7	0	20
OECC20-GB-21	14	19	2	0	0	99	31	0	165
OECC20-GB-22	22	2	0	0	0	3	8	1	36
OECC20-GB-23	80	89	0	0	1	67	130	7	374
OECC20-GB-24	28	19	0	0	0	28	6	0	81
OECC20-GB-25	58	30	0	0	0	28	13	0	129
OECC20-GB-26	39	2	0	1	0	7	11	0	60
OECC20-GB-28	71	22	0	1	0	14	46	2	156
OECC20-GB-30	54	70	0	1	0	69	175	2	371
OECC20-GB-33	0	0	1	0	0	1	3	0	5
OECC20-GB-34	0	0	0	0	0	0	3	0	3
OECC20-GB-35	33	12	0	0	0	22	2	1	70
OECC20-GB-37	2	3	0	0	0	0	1	0	6
OECC20-GB-39	25	22	0	0	0	22	0	1	70
OECC20-GB-41	29	15	0	0	0	4	16	0	64
OECC20-GB-42	16	2	0	0	0	0	1	0	19
OECC20-GB-43	32	27	4	0	0	21	16	1	101
OECC20-GB-44	97	33	0	0	0	53	13	1	197
OECC20-GB-45	104	56	0	0	0	19	144	0	323

Station	Annelida	Arthropoda	Chordata	Cnidaria	Echinodermata	Mollusca	Nematoda	Nemertea	Density (Abundance per 0.008 m^2)
OECC20-GB-52	46	6	0	0	0	42	39	0	133
OECC20-GB-53	128	55	0	0	0	6	117	1	307
OECC20-GB-54	10	4	0	0	0	39	2	0	55
OECC20-GB-55	11	0	3	0	0	1	10	0	25
OECC20-GB-56	9	1	0	0	0	44	0	0	54
OECC20-GB-57	29	2	6	0	0	30	9	0	76
OECC20-GB-58	5	5	5	0	0	5	18	0	38
OECC20-GB-59	12	7	53	0	0	83	1	0	156
OECC20-GB-60	2	1	7	0	0	139	7	0	156
OECC20-GB-62	13	2	39	0	0	9	18	0	81
OECC20-GB-63	1	2	10	0	0	36	4	0	53
OECC20-GB-64	40	8	13	0	0	23	22	0	106
OECC20-GB-65	99	7	46	0	0	33	6	0	191
OECC20-GB-66	22	0	45	2	0	61	34	0	164
OECC20-GB-67	34	6	0	0	0	25	0	0	65
OECC20-GB-68	0	0	0	0	0	2	0	0	2
OECC20-GB-69	8	1	0	0	0	12	0	0	21
OECC20-GB-70	56	0	0	0	0	6	12	0	74
OECC20-GB-71	23	1	0	0	0	4	11	0	39
OECC20-GB-72	11	0	0	0	0	437	3	0	451
OECC20-GB-73	22	13	0	0	0	2	2	0	39
OECC20-GB-74	4	0	0	0	0	136	1	2	143
OECC20-GB-75	16	2	0	0	0	23	0	0	41
OECC20-GB-76	15	2	0	0	0	5	0	3	25
OECC20-GB-77	33	0	0	0	0	1	13	1	48
OECC20-GB-78	9	2	0	0	0	1	0	0	12
OECC20-GB-79	21	1	0	0	0	79	0	1	102
OECC20-GB-80	46	0	0	0	1	11	1	1	60
Totals	2,153	819	234	5	2	2,023	1,447	40	6,723

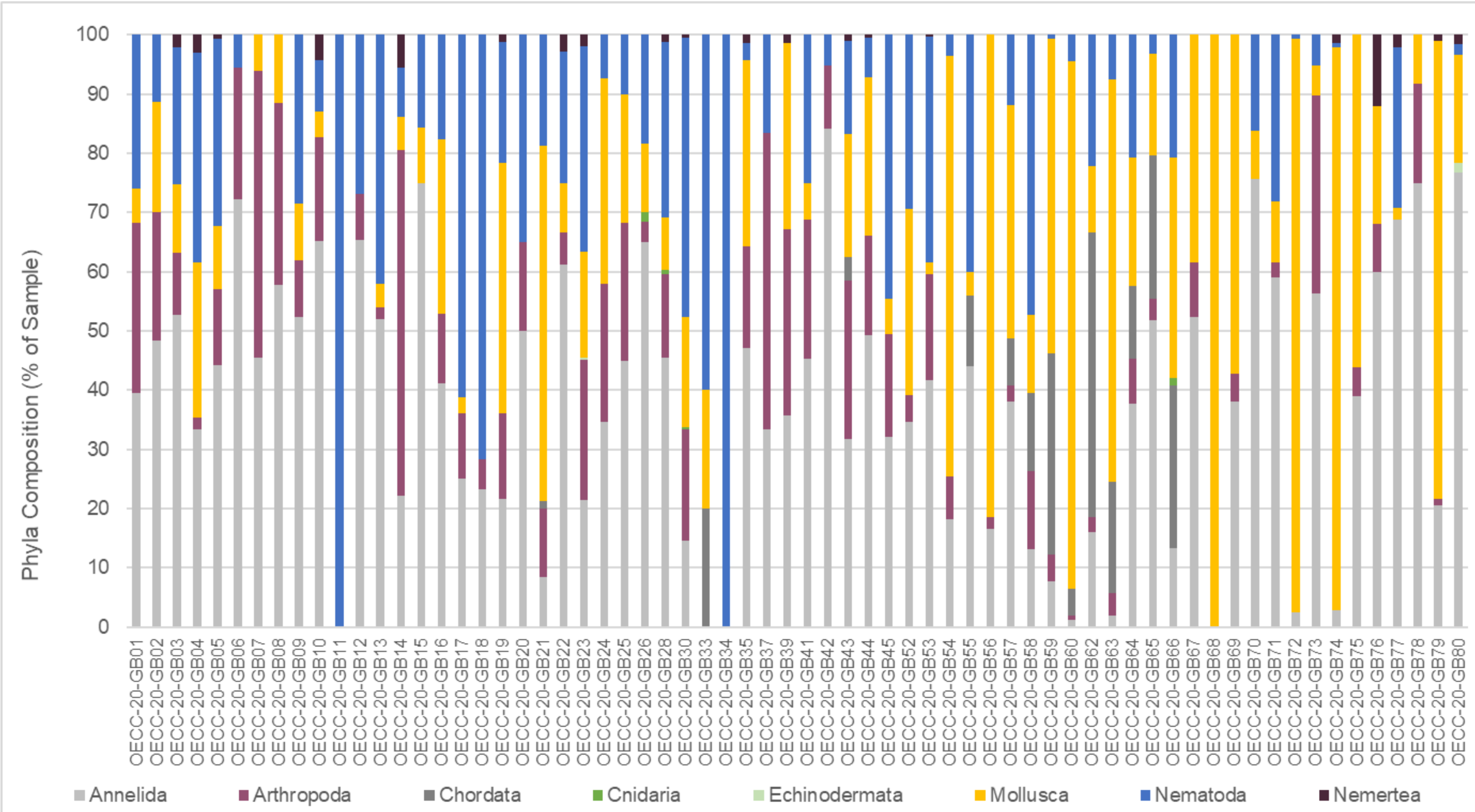


Figure 3-22. Percent composition of organisms in each represented phylum for the 66 benthic grab samples collected along the OECC.

Table 3-26. Abundance of each phylum and taxon (family or LPTL) across all samples along the OECC (continued on next page).

Phylum	Family or LPTL	Abundance Across All Samples	Mean Abundance per 0.008 m^2	Median Abundance per 0.008 m^2	Frequency of Occurrence
Annelida	Ampharetidae	50	0.8	0	22
	Capitellidae	120	1.8	0	15
	Cirratulidae	134	2	0	32
	Ctenodrilidae	2	0	0	2
	Dorvilleidae	42	0.6	0	12
	Flabelligeridae	4	0.1	0	4
	Glyceridae	46	0.7	0	20
	Goniadidae	2	0	0	2
	Hesionidae	4	0.1	0	3
	Lumbrineridae	48	0.7	0	12
	Magelonidae	8	0.1	0	3
	Maldanidae	31	0.5	0	21
	Microphthalmidae	1	0	0	1
	Nephtyidae	37	0.6	0	19
	Nereididae	47	0.7	0	14
	Oenonidae	15	0.2	0	9
	Oligochaeta	431	6.5	0	31
	Onuphidae	5	0.1	0	3
	Opheliidae	36	0.5	0	5
	Orbiniidae	11	0.2	0	7
	Oweniidae	1	0	0	1
	Paraonidae	35	0.5	0	13
	Pectinariidae	6	0.1	0	2
	Phyllodocidae	33	0.5	0	16
	Polygordiidae	99	1.5	0	21
	Polynoidae	12	0.2	0	7
	Sabellaridae	27	0.4	0	9
	Sabellidae	2	0	0	1
	Serpulidae	19	0.3	0	6
	Sigalionidae	16	0.2	0	7
	Spionidae	178	2.7	1	36
	Spirorbidae	6	0.1	0	1
	Syllidae	453	6.9	1.5	45
	Terebellidae	182	2.8	0	25
	Travisiidae	10	0.2	0	3
Arthropoda	Ampeliscidae	39	0.6	0	8
	Ampithoidae	4	0.1	0	2
	Anthuridae	2	0	0	2
	Aoridae	68	1	0	10
	Balanidae	1	0	0	1
	Bateidae	2	0	0	2
	Bathyporeiidae	7	0.1	0	4
	Bodotriidae	12	0.2	0	10
	Callipallenidae	3	0	0	2
	Cancridae	1	0	0	1
	Caprellidae	87	1.3	0	11
	Chaetiliidae	13	0.2	0	6
	Cirolanidae	2	0	0	1
	Corophiidae	14	0.2	0	8
	Cragonidae	3	0	0	3
	Diastylidae	7	0.1	0	5
	Epialtidae	2	0	0	2
	Haustoriidae	7	0.1	0	3

Phylum	Family or LPTL	Abundance Across All Samples	Mean Abundance per 0.008 m^2	Median Abundance per 0.008 m^2	Frequency of Occurrence
	Hippolytidae	1	0	0	1
	Hutchinsoniellidae	1	0	0	1
	Idoteidae	3	0	0	2
	Ischyroceridae	18	0.3	0	6
	Janiridae	31	0.5	0	5
	Leptocheliidae	4	0.1	0	2
	Liljeborgiidae	7	0.1	0	6
	Lysianassidae	50	0.8	0	10
	Maeridae	55	0.8	0	13
	Microprotopidae	35	0.5	0	1
	Mysidae	5	0.1	0	1
	Nannosquillidae	1	0	0	1
	Oedicerotidae	8	0.1	0	6
	Paguridae	52	0.8	0	16
	Panopeidae	35	0.5	0	11
	Photidae	40	0.6	0	8
	Phoxocephalidae	103	1.6	0	24
	Pinnotheridae	8	0.1	0	6
	Sphaeromatidae	2	0	0	2
	Stenothoidae	11	0.2	0	8
	Tanaissuidae	40	0.6	0	12
	Unciolidae	33	0.5	0	16
	Upogebiidae	2	0	0	2
Chordata	Molgulidae	234	3.5	0	13
Cnidaria	Anthozoa	5	0.1	0	4
Echinodermata	Amphiuridae	1	0	0	1
	Echinarachniidae	1	0	0	1
Mollusca	Anomiidae	37	0.6	0	10
	Arcidae	9	0.1	0	5
	Arcticidae	4	0.1	0	2
	Astartidae	28	0.4	0	9
	Bivalvia	3	0	0	3
	Calyptraeidae	237	3.6	0	21
	Cerithiopsidae	3	0	0	1
	Chaetopleuridae	14	0.2	0	8
	Columbellidae	335	5.1	0	19
	Corambidae	3	0	0	3
	Crassatellidae	2	0	0	1
	Cylichnidae	1	0	0	1
	Gastropoda	1	0	0	1
	Lysoniidae	7	0.1	0	5
	Mactridae	259	3.9	0	25
	Margaritidae	7	0.1	0	3
	Mytilidae	208	3.2	0	10
	Nassariidae	7	0.1	0	6
	Nuculidae	713	10.8	0	17
	Pandoridae	4	0.1	0	4
	Periplomatidae	10	0.2	0	6
	Pyramidellidae	43	0.7	0	6
	Tellinidae	46	0.7	0	25
	Thraciidae	3	0	0	1
	Tornatinidae	26	0.4	0	5
	Veneridae	9	0.1	0	6
	Yoldiidae	4	0.1	0	3
Nematoda	Nematoda	1,447	21.9	7.5	55
Nemertea	Nemertea	40	0.6	0	20

3.2.3.2.2 Richness, Diversity, and Evenness

Mean density was 102 organisms per sample, averaged across 66 stations along the OECC (Table 3-27). Taxonomic richness for grab samples collected along the OECC was 3.15, on average, with individual samples ranging from 0 at OECC20-GB-11 and OECC20-GB-34, which contained 11 and 3 organisms, respectively, all from a single family (or LPTL), to 6.92 at OECC20-GB-23, which contained 374 organisms from 42 families (or LPTL; Figure 3-23). Average diversity across the individual grab samples was 1.85 with a range from 0 at OECC20-GB-11 and OECC20-GB-34 to 2.88 OECC20-GB-24, which contained 81 organisms from 28 families. Evenness across the samples ranged from 0 at OECC20-GB-11 and OECC20-GB-34 to 1 at OECC20-GB37 and OECC20-GB-68, which contained 6 organisms from 6 families and 2 organisms from 2 families, respectively. Richness, diversity, and evenness are indices that do not have units; however, higher values indicate greater amounts of richness, diversity, or evenness in each sample.

Table 3-27. Community composition parameters calculated for each grab sample station along the OECC (continued on next page).

Station	Density (Abundance per 0.008 m^2)	Number of LPTLs	Number of Families (or LPTL)	Ecological Indices		
				Richness	Diversity	Evenness
OECC20-GB-01	142	21	25	4.04	1.99	0.65
OECC20-GB-02	97	18	21	3.72	2.28	0.79
OECC20-GB-03	95	22	30	4.61	2.49	0.81
OECC20-GB-04	99	19	23	3.92	2.14	0.73
OECC20-GB-05	645	31	44	4.64	2.28	0.66
OECC20-GB-06	18	10	10	3.11	1.79	0.78
OECC20-GB-07	33	9	9	2.29	1.65	0.75
OECC20-GB-08	26	11	11	3.07	1.91	0.79
OECC20-GB-09	21	10	10	2.96	1.95	0.85
OECC20-GB-10	23	13	14	3.83	2.28	0.89
OECC20-GB-11	11	1	1	0	0	0
OECC20-GB-12	26	9	9	2.46	1.93	0.88
OECC20-GB-13	50	10	11	2.30	1.67	0.72
OECC20-GB-14	36	9	12	2.23	1.58	0.72
OECC20-GB-15	32	13	14	3.46	2.38	0.93
OECC20-GB-16	51	12	18	2.80	2.12	0.85
OECC20-GB-17	36	10	11	2.51	1.49	0.65
OECC20-GB-18	60	7	8	1.47	1.05	0.54
OECC20-GB-19	255	35	45	6.14	2.66	0.75
OECC20-GB-20	20	6	7	1.67	1.54	0.86
OECC20-GB-21	165	22	26	4.11	2.00	0.65
OECC20-GB-22	36	11	11	2.79	1.92	0.80
OECC20-GB-23	374	42	55	6.92	2.64	0.71
OECC20-GB-24	81	28	39	6.14	2.88	0.87
OECC20-GB-25	129	29	36	5.76	2.64	0.78
OECC20-GB-26	60	20	21	4.64	2.55	0.85
OECC20-GB-28	156	35	40	6.73	2.64	0.74
OECC20-GB-30	371	26	33	4.23	1.98	0.61
OECC20-GB-33	5	3	3	1.24	0.95	0.86
OECC20-GB-34	3	1	1	0	0	0
OECC20-GB-35	70	22	30	4.94	2.69	0.87
OECC20-GB-37	6	6	6	2.79	1.79	1.00
OECC20-GB-39	70	17	23	3.77	2.43	0.86
OECC20-GB-41	64	18	24	4.09	2.48	0.86

Station	Density (Abundance per 0.008 m^2)	Number of LPTLs	Number of Families (or LPTL)	Ecological Indices		
				Richness	Diversity	Evenness
OECC20-GB-42	19	10	12	3.06	1.73	0.75
OECC20-GB-43	101	27	34	5.63	2.78	0.84
OECC20-GB-44	197	36	46	6.62	2.87	0.80
OECC20-GB-45	323	34	41	5.71	2.25	0.64
OECC20-GB-52	133	14	21	2.66	2.02	0.76
OECC20-GB-53	307	23	25	3.84	1.99	0.63
OECC20-GB-54	55	19	21	4.49	2.40	0.81
OECC20-GB-55	25	6	6	1.55	1.45	0.81
OECC20-GB-56	54	12	14	2.76	1.54	0.62
OECC20-GB-57	76	12	12	2.54	1.91	0.77
OECC20-GB-58	38	8	9	1.92	1.64	0.79
OECC20-GB-59	156	11	11	1.98	1.56	0.65
OECC20-GB-60	156	9	9	1.58	1.18	0.54
OECC20-GB-62	81	13	16	2.73	1.68	0.66
OECC20-GB-63	53	10	10	2.27	1.69	0.73
OECC20-GB-64	106	12	16	2.36	2.20	0.88
OECC20-GB-65	191	12	15	2.09	1.74	0.70
OECC20-GB-66	164	8	11	1.37	1.53	0.73
OECC20-GB-67	65	19	20	4.31	2.49	0.85
OECC20-GB-68	2	2	2	1.44	0.69	1.00
OECC20-GB-69	21	7	8	1.97	1.46	0.75
OECC20-GB-70	74	11	11	2.32	1.86	0.77
OECC20-GB-71	39	12	12	3.00	2.07	0.83
OECC20-GB-72	451	8	10	1.15	0.22	0.10
OECC20-GB-73	39	12	12	3.00	2.09	0.84
OECC20-GB-74	143	6	7	1.01	0.27	0.15
OECC20-GB-75	41	10	11	2.42	1.65	0.72
OECC20-GB-76	25	7	9	1.86	1.66	0.85
OECC20-GB-77	48	9	10	2.07	1.48	0.67
OECC20-GB-78	12	7	8	2.41	1.82	0.94
OECC20-GB-79	102	14	16	2.81	1.27	0.48
OECC20-GB-80	60	15	18	3.42	2.19	0.81
Average	**102**	**18**	**15**	**3.15**	**1.85**	**0.73**

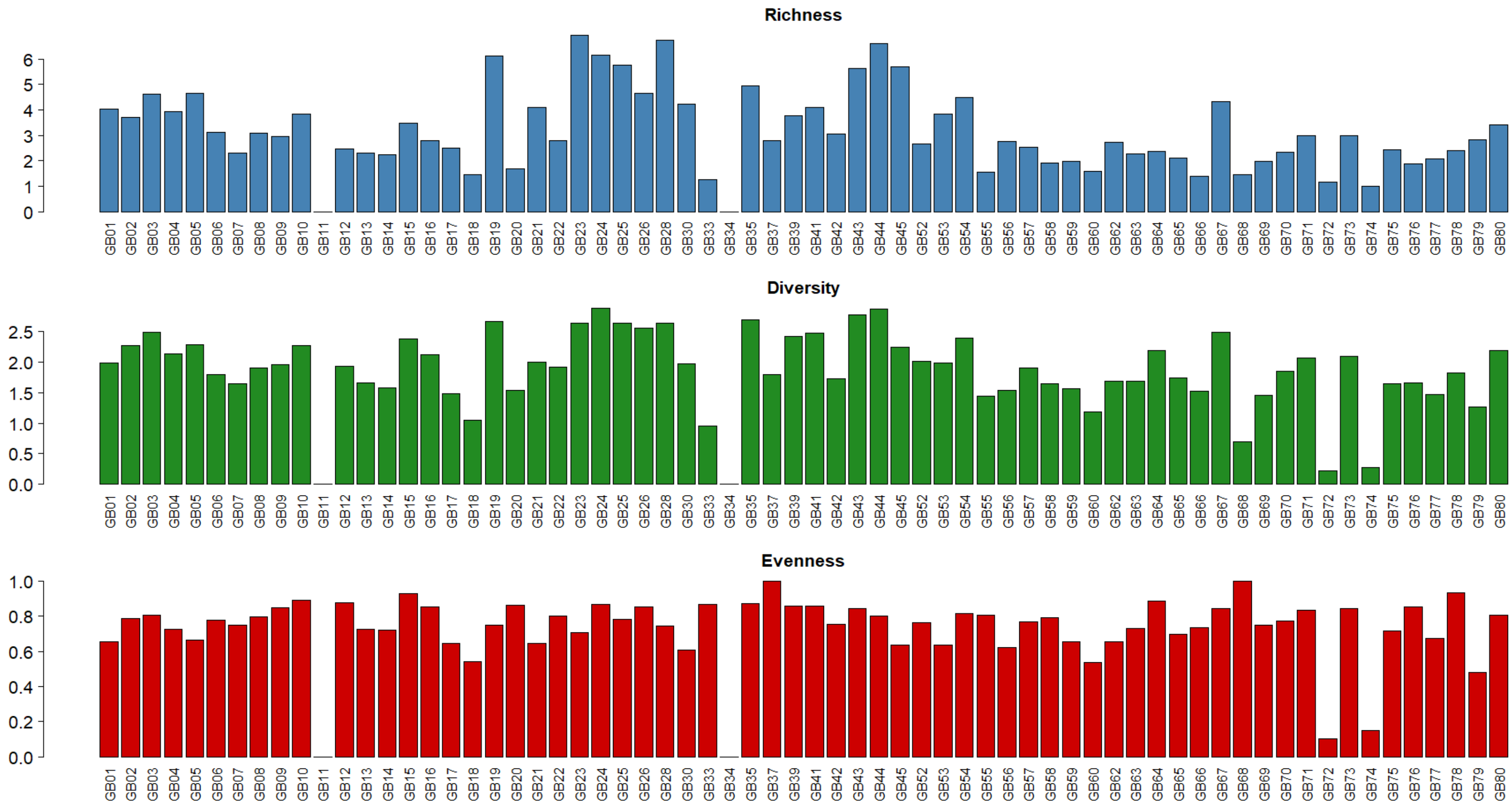


Figure 3-23. Ecological index values calculated for each sample station collected along the OECC

3.2.4 Multivariate Analysis

The NMDS analysis and Bray-Curtis Similarity Index fit with three dimensions produced a stress value of 0.16, indicating a moderately good fit of the data in the ordination. Results from the cluster analysis and NMDS based on the Bray-Curtis dissimilarity of macroinvertebrate assemblages are presented below in a series of figures and tables including a dendrogram and multiple MDS plots (Figure 3-24 to Figure 3-27; Table 3-28 to Table 3-30). After color-coding sample stations based on their NMFS (2020) modified CMECS classifications, sample stations formed loose apparent groupings corresponding to some of the CMECS classifications, including muddy sand and very coarse/coarse sand (Figure 3-25.). The NMDS ordination plot color-coded by sample location in the Project Area indicated that the invertebrate assemblages of samples located in Muskeget Channel are highly dissimilar to those located in the SWDA and the Southern OECC, represented by the wide spacing and loose clustering of sample points with each group (Figure 3-26.). Although there is apparent overlap in the center of the ordination plot, the invertebrate assemblages of samples collected in the SWDA, Southern OECC, Landfall, and Muskeget Channel appear loosely clustered, indicating that samples within these location groupings are generally more similar to other samples collected in that area than to samples collected in other areas. There were no clear clustering in the invertebrate assemblages from samples collected in complex versus not complex habitat (as designated by NMFS [2020] modified CMECS classifications), with high overlap among samples in the ordination (Figure 3-27).

Samples from stations OECC20-GB-03, OECC20-GB-68, OECC20-GB-74, SWDA20-GB-14, and SWDA20-GB-40 from three substrate types (mud, gravelly mud, and sandy mud) were removed from SIMPER and ANOSIM analyses and results because of limited intragroup variability between samples (<3 samples per substrate type). Based on ANOSIM global test results, the null hypothesis that similarity of invertebrate assemblages between NMFS (2020) modified CMECS groups is greater than or equal to the similarity within CMECS groups was rejected (R value = 0.51 and significance level p = 0.001; Table 3-28). Similarly, the second null hypothesis that benthic invertebrate assemblages between sample location groups is greater than or equal to the similarity within location groups was rejected (R value = 0.49 and significance level p = 0.001; Table 3-28). The third null hypothesis that benthic invertebrate assemblages between samples with complex habitat is greater than or equal to the similarity within the groups was also rejected (R value = 0.26 and significance level p =0.001; Table 3-28). The medial R statistic results for the ANOSIM of CMECS group and sample location indicate that the invertebrate assemblages within samples are more similar to other samples with the same CMECS substrate type or sample location than to other substrate types and locations; however. variability between groupings is also relatively high. The low R statistic for the ANOSIM of complex habitat indicated that the presence or absence of complex habitat only weakly accounted for the similarities/differences between the invertebrate communities within each sample.

The SIMPER analysis was conducted on the CMECS and location factors because the ANOSIM demonstrated significant relationships between the invertebrate assemblages within these classifications. The SIMPER analysis provided pairwise insight as to which NMFS (2020) modified CMECS substrate classifications and sample locations are more dissimilar to each other. According to the SIMPER results for CMECS groups, muddy sand and gravelly sand, fine/very fine sand and gravelly sand, and muddy sand and very coarse/coarse sand were the substrate component pairs with the least similar invertebrate assemblages (87% dissimilar). Differences in the abundances of Nematoda, Ampeliscidae, Nuculidae, Syllidae, and Spionidae contributed the most to dissimilarity between pairs of CMECS substrate classifications (Table 3-29). Macroinvertebrate assemblages were most similar between samples collected in substrates considered complex by the NMFS (2020) modified CMECS guidelines, with assemblages from shell hash and sandy gravel, shell hash and gravelly sand, and gravelly sand and sandy gravel showing the lowest dissimilarity percentages. Results from the SIMPER analysis based on sample location indicated that benthic invertebrate assemblages from samples collected in Muskeget Channel and the Southern OECC (86%) and Muskeget Channel and the SWDA (85%) were most dissimilar to each other, with abundances of organisms in the families (or LPTL) Nuculidae, Nematoda, Ampeliscidae, and Syllidae driving much of the dissimilarity (Table 3-30).

Table 3-28. Results from the ANOSIM conducted on the three classification groups: CMECS substrate classification, sample location within the Project Area, and complex habitat designation.

Test Variable	R Statistic	P-Value
CMECS	0.51	0.001
Sample Location	0.49	0.001
Complex Habitat	0.26	0.001

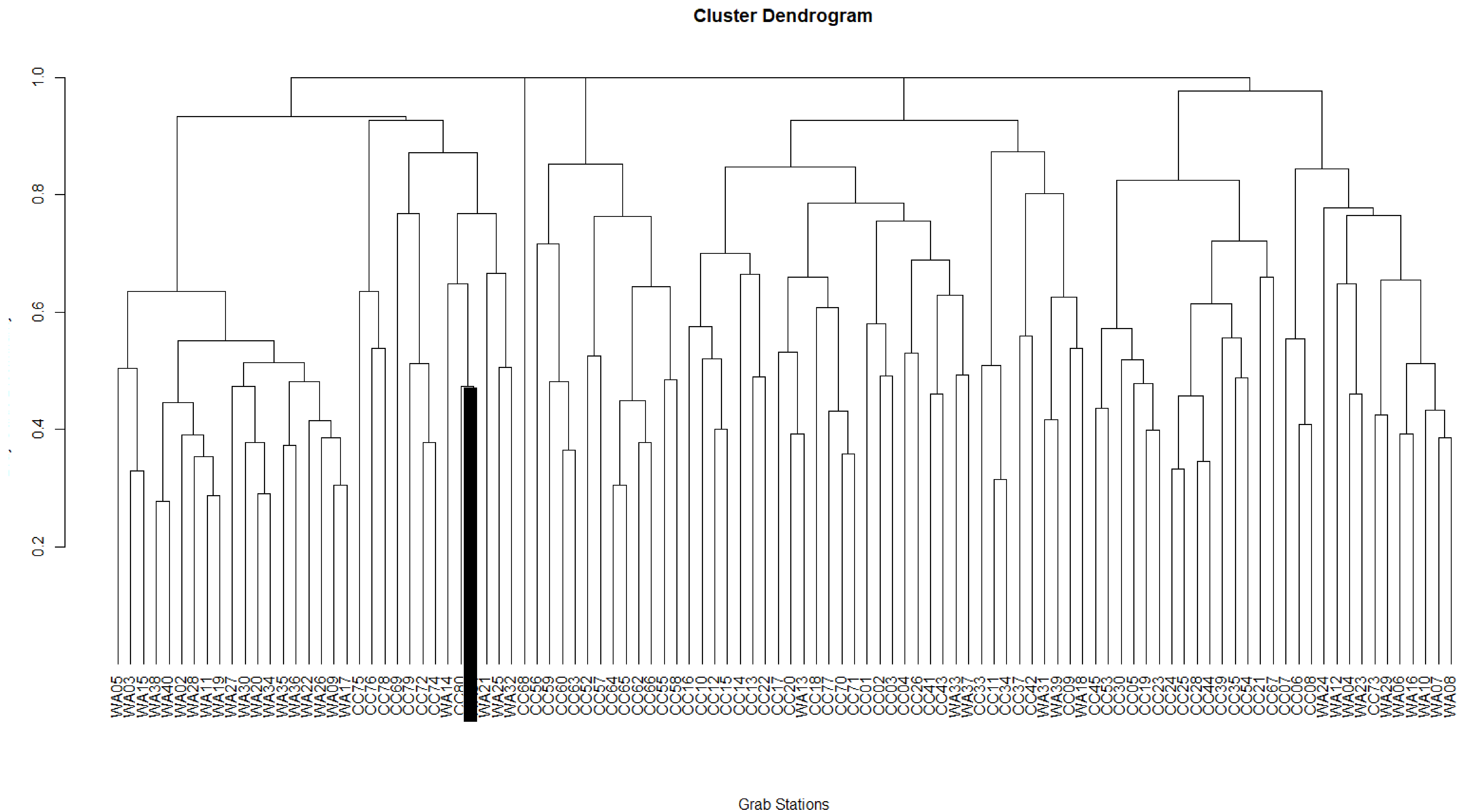


Figure 3-24. Dendrogram from cluster analysis based on Bray-Curtis similarities of square-root transformed macroinvertebrate abundances at the 106 stations sampled in the SWDA and OECC. Branches are based on the dissimilarities between those clusters of samples (i.e., samples with lower level clusters are more similar to one another than other samples outside of the cluster), which is labelled on the y-axis. For clarity, grab sample station names were hyphenated to WA for samples collected in the SWDA and CC for samples collected in the OECC.

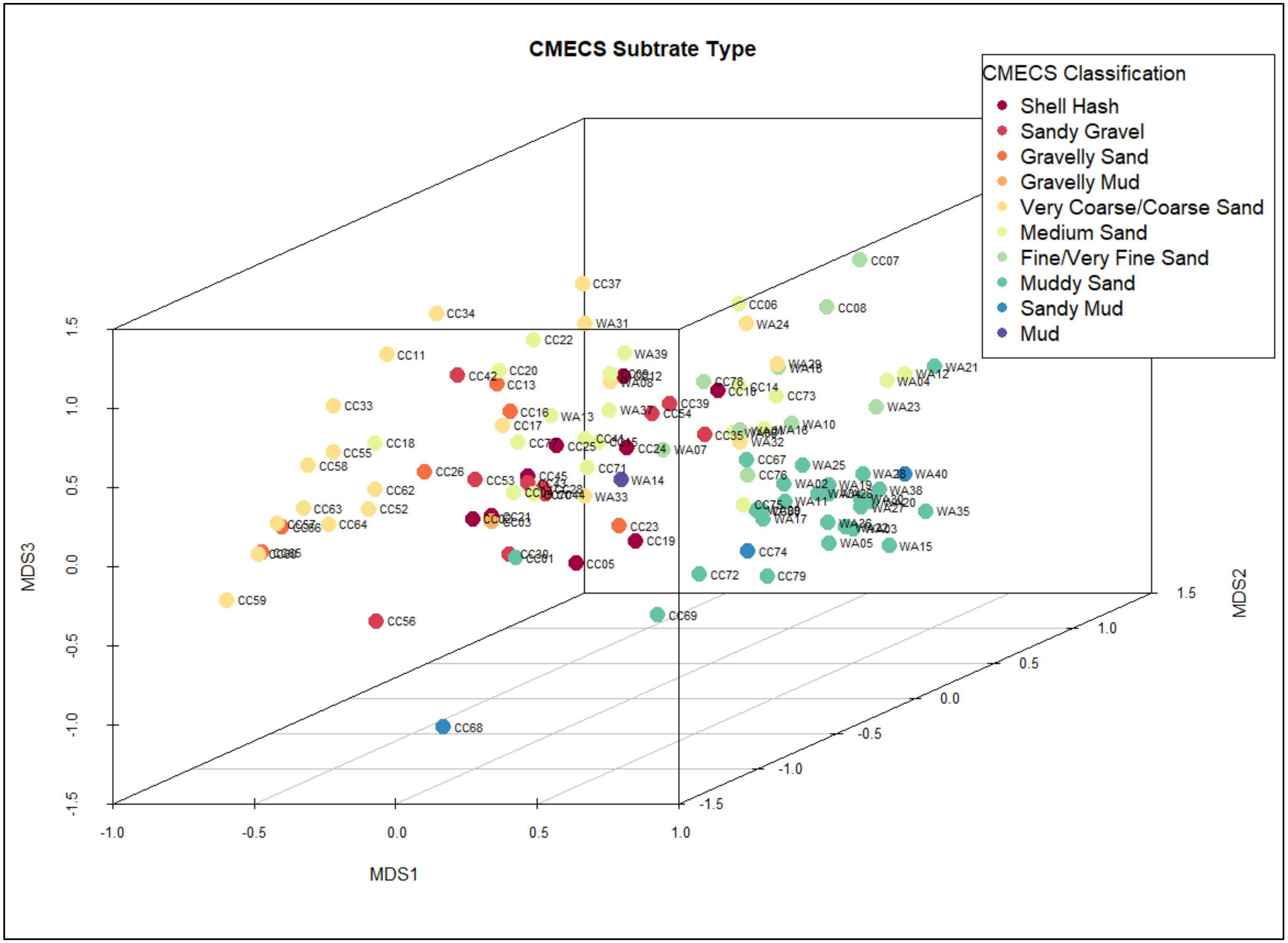


Figure 3-25. NMDS plot of Bray-Curtis similarities of square-root transformed taxonomic abundances at each sample station. Points are color-coded based on NMFS (2020) modified CMECS substrate component types.

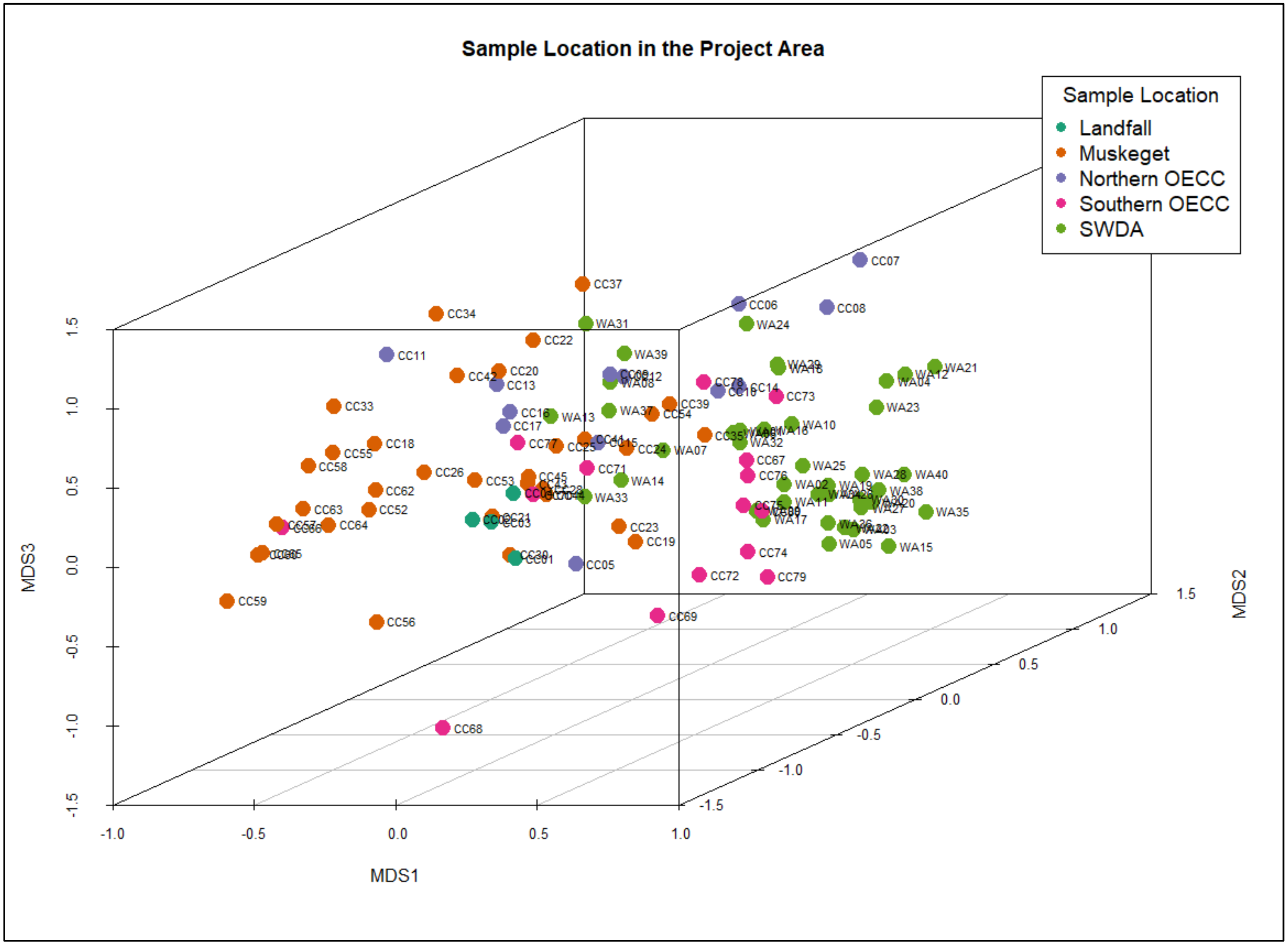


Figure 3-26. NMDS plot of Bray-Curtis similarities of square-root transformed taxonomic abundances at each sample station. Points are color-coded based on sample station location: SWDA, Southern OECC, Muskeget Channel, Northern OECC, and Landfall.

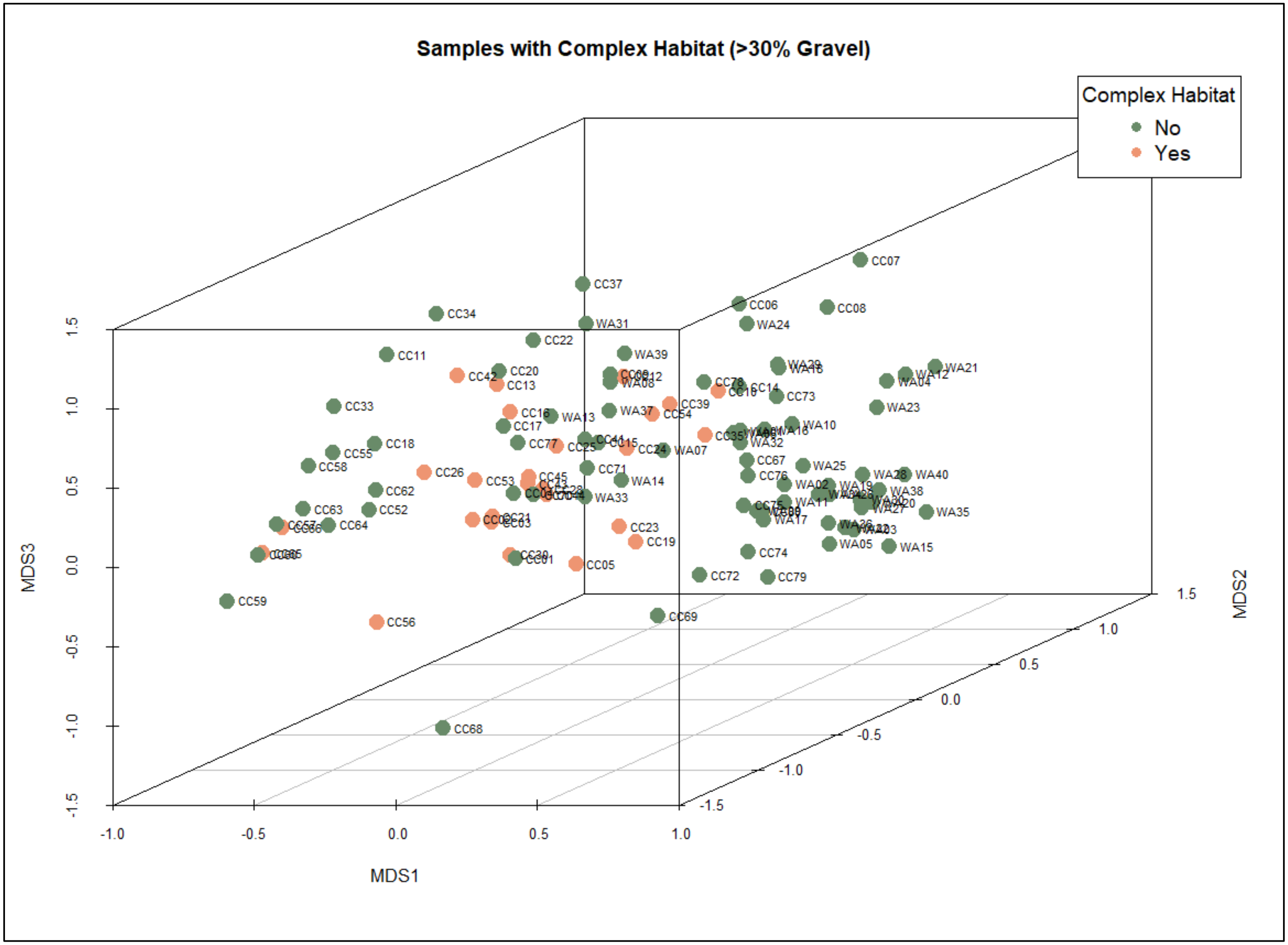


Figure 3-27. NMDS plot of Bray-Curtis similarities of square-root transformed taxonomic abundances at each sample station. Points are color-coded based on whether substrate identified at that station fell under the complex habitat designation defined by NMFS (2020).

Table 3-29. SIMPER results presenting the dissimilarity of community compositions between NMFS (2020) modified CMECS substrate types.

Substrate Type (A)	Substrate Type (B)	Bray-Curtis Dissimilarity	Dissimilar Taxa[1]	% Contribution
Muddy Sand	Gravelly Sand	87%	Ampeliscidae	7%
			Nematoda	6%
			Nuculidae	6%
Fine Very / Fine Sand	Gravelly Sand	87%	Nematoda	9%
			Syllidae	8%
			Spionidae	5%
Muddy Sand	Very Coarse / Coarse Sand	87%	Ampeliscidae	10%
			Nuculidae	9%
			Nematoda	5%
Muddy Sand	Sandy Gravel	86%	Ampeliscidae	7%
			Nuculidae	6%
			Nematoda	5%
Fine Very / Fine Sand	Very Coarse / Coarse Sand	85%	Nematoda	9%
			Spionidae	8%
			Polygordiidae	5%
Fine Very Fine Sand	Sandy Gravel	84%	Nematoda	6%
			Syllidae	5%
			Columbellidae	5%
Very Coarse / Coarse Sand	Sandy Gravel	84%	Nematoda	7%
			Columbellidae	5%
			Syllidae	5%
Muddy Sand	Shell Hash	83%	Ampeliscidae	6%
			Nematoda	6%
			Nuculidae	5%
Shell Hash	Very Coarse / Coarse Sand	83%	Nematoda	6%
			Calyptraeidae	5%
			Terebellidae	5%
Shell Hash	Fine / Very Fine Sand	82%	Nematoda	8%
			Calyptraeidae	5%
			Terebellidae	5%
Medium Sand	Sandy Gravel	79%	Nematoda	7%
			Columbellidae	6%
			Syllidae	5%
Medium Sand	Very Coarse / Coarse Sand	77%	Nematoda	7%
			Spionidae	6%
			Polygordiidae	5%
Muddy Sand	Medium Sand	77%	Ampeliscidae	9%
			Nuculidae	9%
			Nematoda	5%
Very Coarse / Coarse Sand	Gravelly Sand	76%	Syllidae	8%
			Molgulidae	7%
			Mactridae	7%
Medium Sand	Gravelly Sand	76%	Syllidae	7%
			Nematoda	6%
			Mactridae	6%
Shell Hash	Medium Sand	76%	Nematoda	7%
			Calyptraeidae	6%
			Terebellidae	5%
Muddy Sand	Fine / Very Fine Sand	75%	Ampeliscidae	10%
			Nuculidae	8%
			Spionidae	6%
Medium Sand	Fine / Very Fine Sand	73%	Nematoda	9%
			Spionidae	7%
			Polygordiidae	6%

Substrate Type (A)	Substrate Type (B)	Bray-Curtis Dissimilarity	Dissimilar Taxa[1]	% Contribution
Gravelly Sand	Sandy Gravel	72%	Nematoda	8%
			Mactridae	5%
			Columbellidae	5%
Shell Hash	Gravelly Sand	71%	Nematoda	6%
			Calyptraeidae	5%
			Oligochaeta	4%
Shell Hash	Sandy Gravel	66%	Nematoda	8%
			Columbellidae	5%
			Oligochaeta	5%

[1] Includes taxa contributing highest percentage to the dissimilarity between location.

Table 3-30. SIMPER results of the dissimilarity of macroinvertebrate assemblages between benthic grab locations.

Location (A)	Location (B)	Bray-Curtis Dissimilarity	Dissimilar Taxa[1]	% Contribution
Muskeget	Southern OECC	86%	Nuculidae	9%
			Nematoda	8%
			Syllidae	5%
Muskeget	SWDA	85%	Ampeliscidae	7%
			Nematoda	6%
			Syllidae	4%
Landfall	Southern OECC	82%	Capitellidae	8%
			Nematoda	8%
			Nuculidae	8%
Northern OECC	Southern OECC	82%	Nuculidae	13%
			Nematoda	8%
			Spionidae	6%
Landfall	SWDA	81%	Capitellidae	8%
			Nematoda	7%
			Ampeliscidae	6%
Northern OECC	SWDA	79%	Ampeliscidae	9%
			Nematoda	6%
			Spionidae	5%
Northern OECC	Muskeget	78%	Nematoda	8%
			Syllidae	5%
			Spionidae	4%
Southern OECC	SWDA	78%	Nuculidae	10%
			Ampeliscidae	9%
			Nematoda	5%
Landfall	Northern OECC	75%	Capitellidae	9%
			Nematoda	7%
			Oligochaeta	6%
Landfall	Muskeget	74%	Capitellidae	8%
			Nematoda	6%
			Oligochaeta	4%

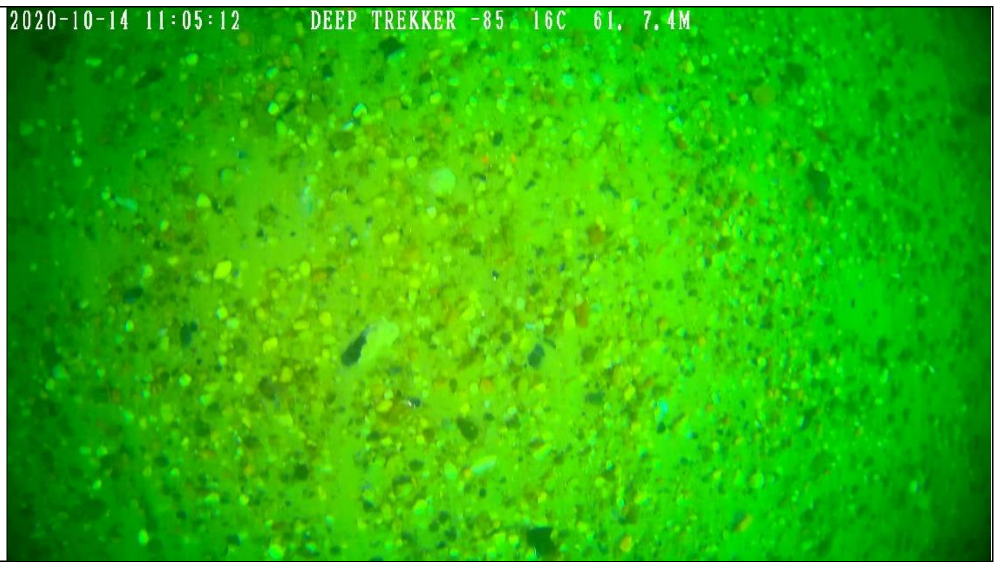
[1] Includes taxa contributing highest percentage to the dissimilarity between location

4 CMECS CLASSIFICATIONS

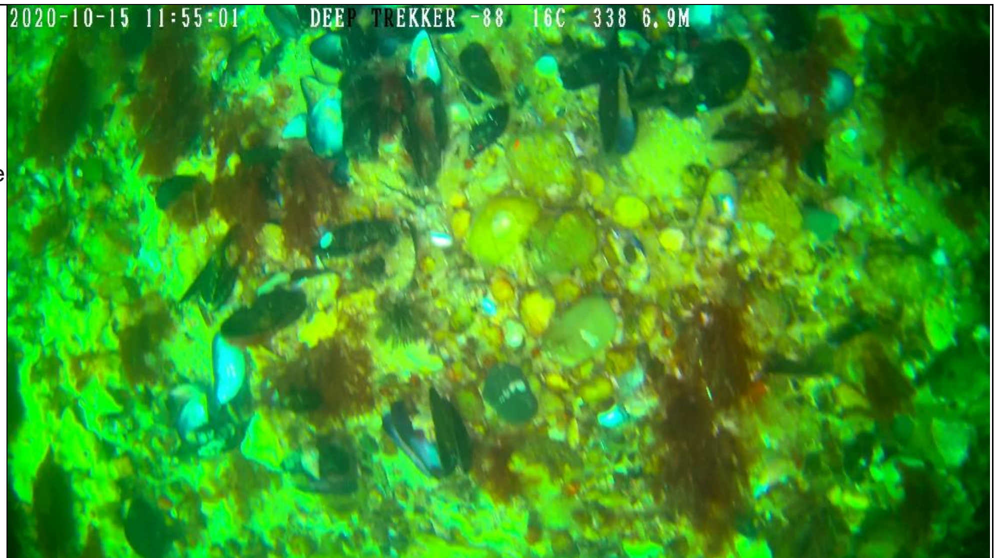
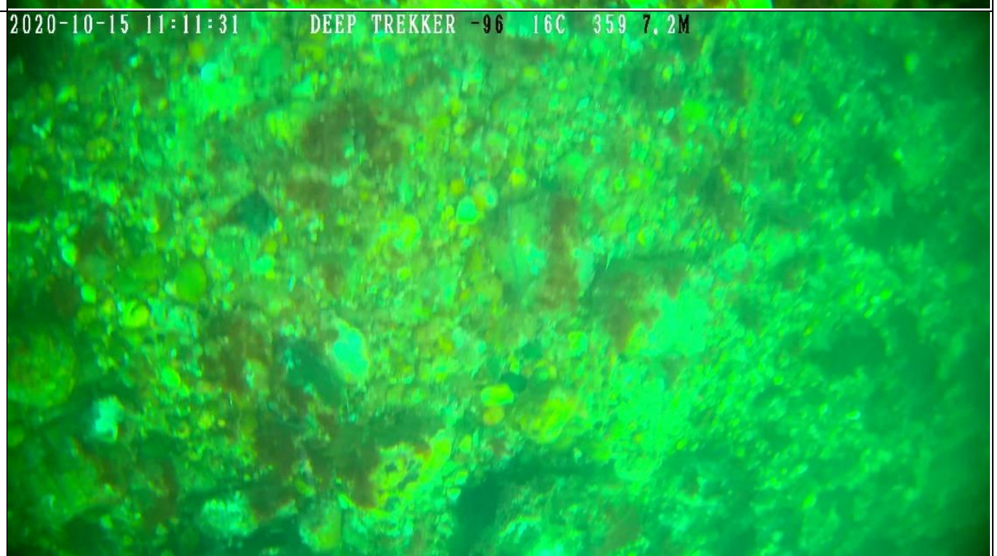
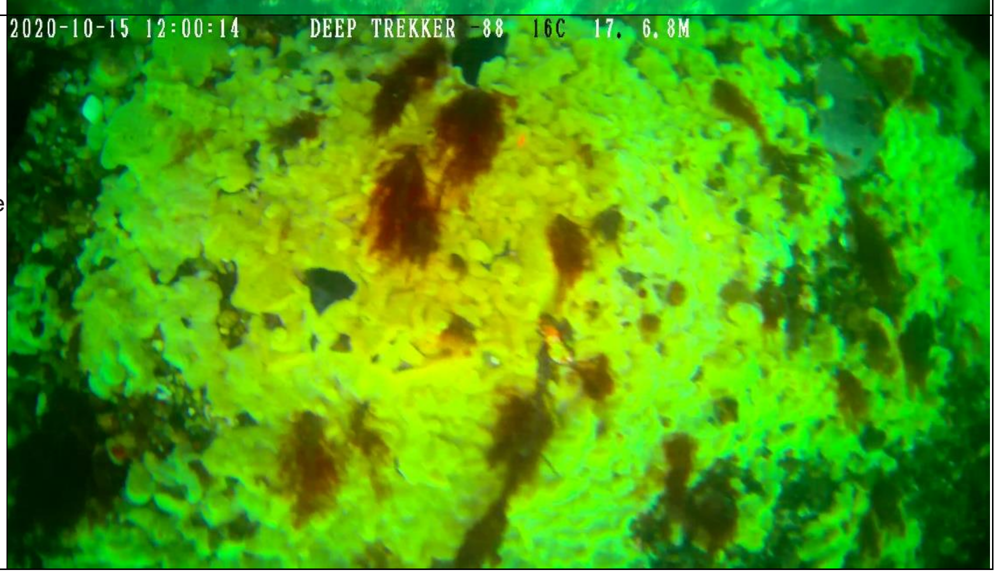
4.1 Video Transects

For underwater video transects, each still image taken along the transect during the percent cover analysis was assigned a CMECS substrate classification following NMFS modifications (NMFS, 2020). These results are discussed in separate sections for the SWDA and OECC. In addition to substrate classes, the density of shell and flora/fauna cover were calculated for each still image and summarized at the transect level. Finally, CMECS classifications were applied at the transect level by listing one to four dominant classifications if they occurred in >10% of the transect by area. Representative images of different CMECS classifications are presented in Table 4-1. Maps displaying the location and CMECS classification of each still image analyzed from the video transects are provided in Appendix D.

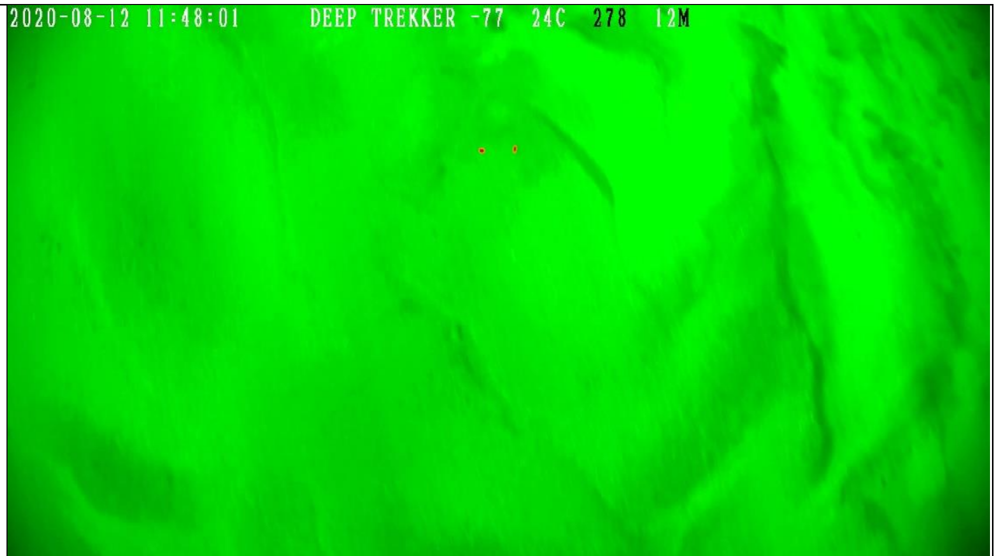
Table 4-1. Representative still images of various habitat types observed in 75 video transects across OECC and SWDA areas. Still number in parenthesis. Abbreviations are as follows: S/M = Sand/Mud, B = Boulder, C = Cobble, and P/G = Pebble/Granule.

Gravel Mixes-Pebble/Granule with S/M Sparse shell OECC20-VT-34 (still 15)	

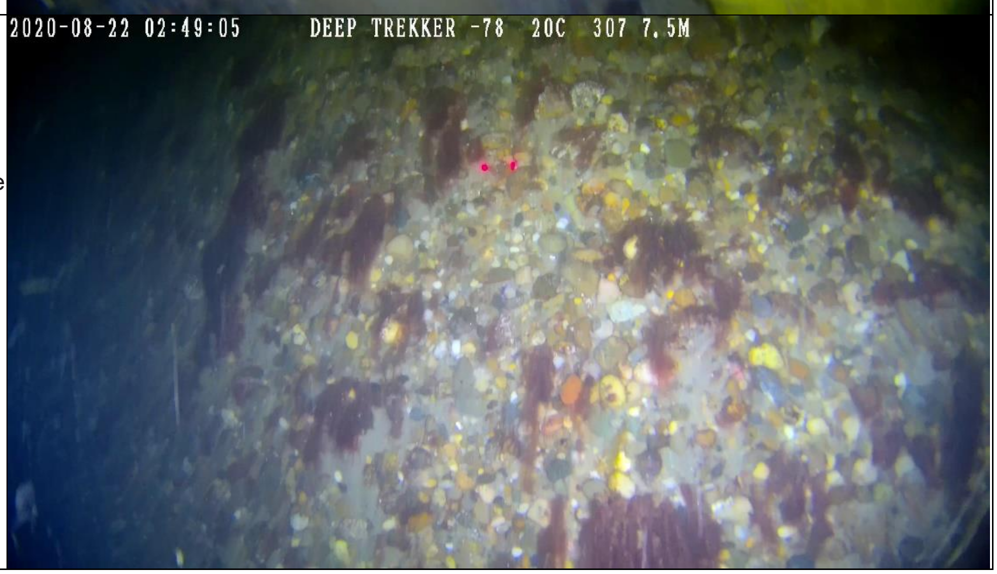
Sand/Mud Sparse Shell Trace Flora/Fauna OECC20-VT-02 (25)	
Biogenic Shell Hash Moderate Shell Sparse Flora/Fauna OECC20-VT-02 (62)	
Biogenic Shell Rubble Moderate Shell Moderate Flora/Fauna OECC20-VT-40 (103)	

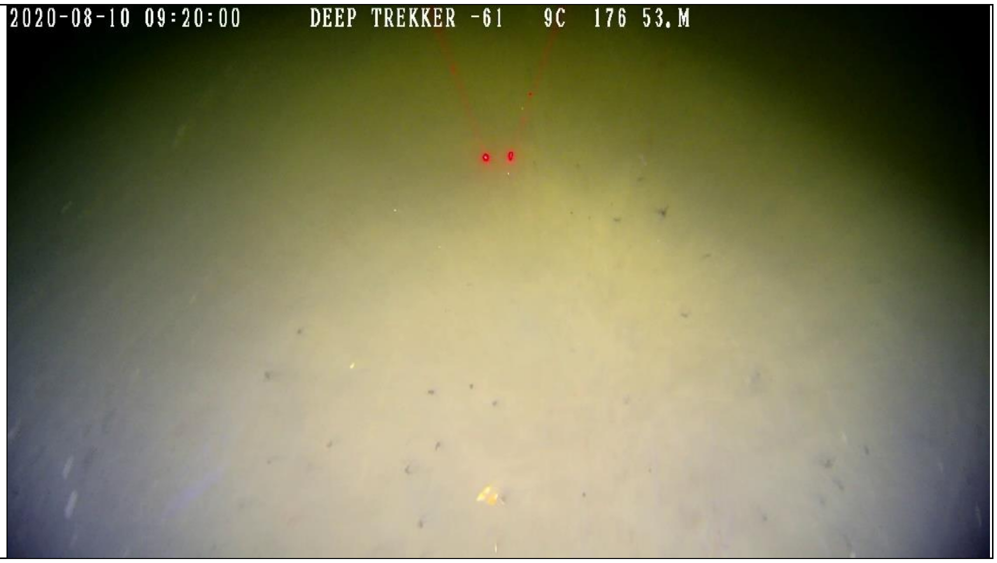
Gravel - Pebble/Granule Sparse Shell Moderate Flora/Fauna OECC20-VT-43 (38)	
Gravel - Gravel Pavement Sparse Flora/Fauna OECC20-VT-41 (37)	
Gravel - Pebble/Granule Dense Flora/Fauna OECC2020-VT-43 (59)	

<table>
<tr><td>Sand/Mud

OECC20-VT-12 (41)</td><td>
</td></tr>
<tr><td>Gravel – Cobble
Moderate Flora/Fauna

OECC20-VT-27 (22)</td><td>
</td></tr>
<tr><td>Gravel - Pebble/Granule
Sparse Flora/Fauna

OECC20-VT-30 (44)</td><td>
</td></tr>
</table>

Sand/Mud SWDA20-VT-09 (61)	

4.1.1 SWDA

The area (m^2) classified for transects within the SWDA ranged from 29.8 m^2 to 131.7 m^2 (Table 4-2). Differences in the area classified for each transect were a result of varying total transect lengths and visibility throughout the video. All twelve video transects were classified as geologic origin with unconsolidated fine sand/mud (Table 4-3). No other CMECS substrate group was identified across all classified stills from the transects (Figure 4-1). Various densities of shell cover were classified in nine of the twelve transects, with trace shell hash (<2% cover) most commonly observed across stills (Figure 4-2). Overall shell cover in the SWDA was low, with little to no rubble identified in the stills. Some density of flora/fauna, which included flora (e.g., algae or seagrass), fauna (e.g., mobile megafauna, encrusting species, sand dollars, mussel beds), and evidence of biological activity (e.g., burrows, infaunal structures) was identified in stills from all transects in the SWDA (Figure 4-3). Flora/fauna density varied from trace (<2% cover) to sparse (2 to <30% cover) and was present in a low number of stills per transect. However, flora/fauna was classified in over half of the stills from SWDA20-VT-02 and SWDA20-VT-09, with megafauna representing much of this cover.

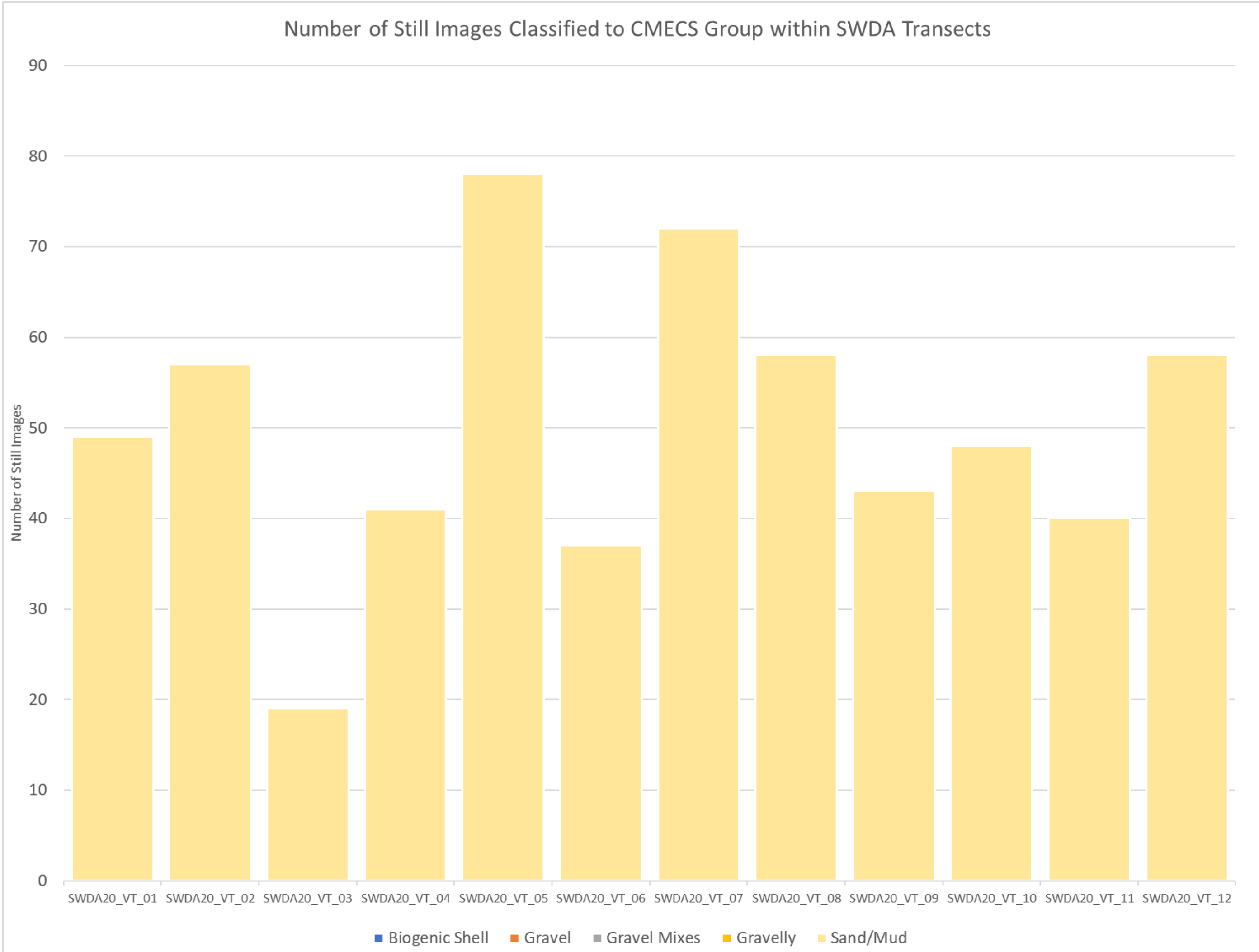


Figure 4-1. The number of still images classified to CMECS substrate component groups within each SWDA transect.

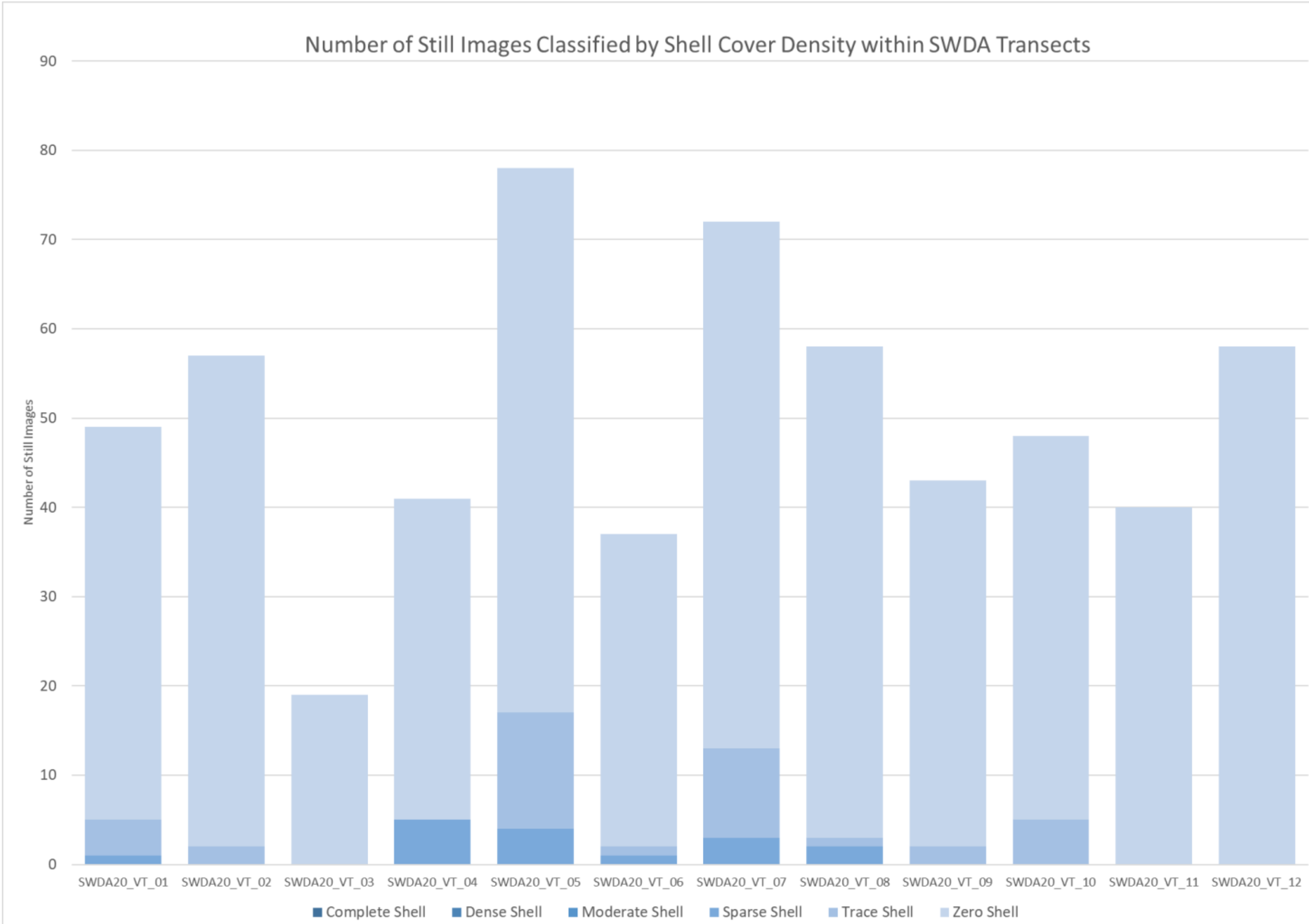


Figure 4-2. The number of still images classified to each shell cover density category within each SWDA transect. Trace is < 2%, Sparse is 2 to < 30%, Moderate is 30 to < 70%, Dense is 70 to < 90%, and Complete is 90 to 100% cover.

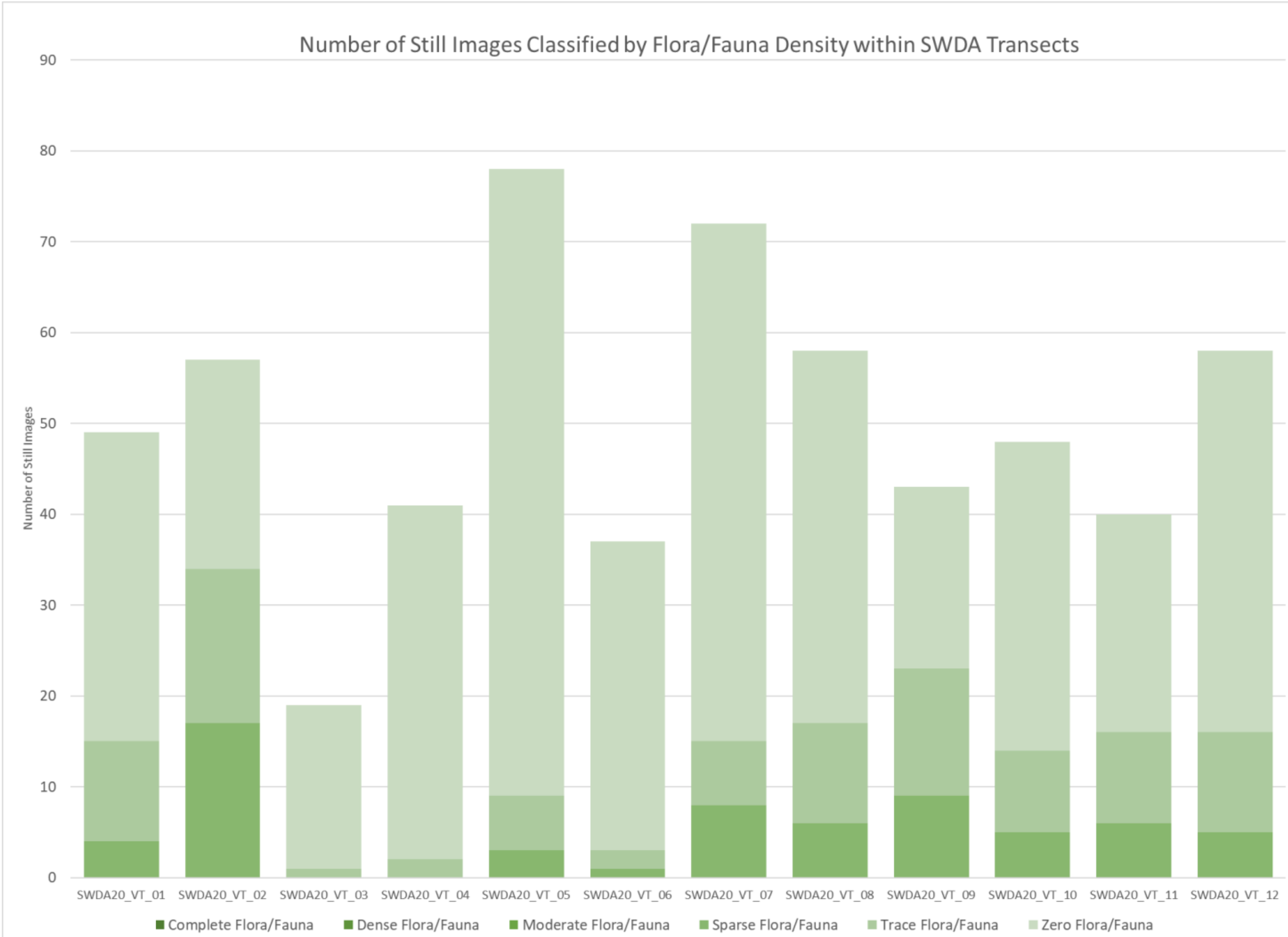


Figure 4-3. The number of still images classified to each flora/fauna density category within each SWDA transect. Trace is < 2%, Sparse is 2 to < 30%, Moderate is 30 to < 70%, Dense is 70 to < 90%, and Complete is 90 to 100% cover.

Table 4-2. Area (m^2) classified to CMECS substrate component groups for each of the 12 transects in the SWDA.

Transect	Sand/Mud
SWDA20-VT-01	39.2
SWDA20-VT-02	39.1
SWDA20-VT-03	29.8
SWDA20-VT-04	94.8
SWDA20-VT-05	105.0
SWDA20-VT-06	66.1
SWDA20-VT-07	99.7
SWDA20-VT-08	45.4
SWDA20-VT-09	31.6
SWDA20-VT-10	48.6
SWDA20-VT-11	78.6
SWDA20-VT-12	131.7
SWDA Total Area per CMECS (m^2)	**809.6**

Table 4-3. Dominant CMECS classifications for each video transect based on surface area of stills classified to each CMECS category. Second, third, and fourth classifications were included if that substrate type covered ≥10% of the sampled area for that transect.

Transect ID	Primary CMECS by Area	Secondary CMECS By Area (if ≥10%)
SWDA20_VT_01	Sand/Mud	--
SWDA20_VT_02	Sand/Mud	--
SWDA20_VT_03	Sand/Mud	--
SWDA20_VT_04	Sand/Mud	--
SWDA20_VT_05	Sand/Mud	--
SWDA20_VT_06	Sand/Mud	--
SWDA20_VT_07	Sand/Mud	--
SWDA20_VT_08	Sand/Mud	--
SWDA20_VT_09	Sand/Mud	--
SWDA20_VT_10	Sand/Mud	--
SWDA20_VT_11	Sand/Mud	--
SWDA20_VT_12	Sand/Mud	--

4.1.2 OECC

For video transects along the OECC, the area classified as sand/mud was far greater than any other substrate type (2,198 m^2; Table 4-4). Biogenic shell hash, gravel (pebble/granule), gravel mixes (pebble/granule with sand/mud), and gravelly sand/mud with pebble/granule substrate types covered a similarly large area across stills (179.2-318.1 m^2), and occurred primarily within transects located in Muskeget Channel (Figure 3-8; Figure 4-4). The area across all 63 transects in the OECC classified as complex by NMFS guidelines (2020), which include all coarse substrate components groups with gravel content ≥ 5% and biogenic shell, was 1,014 m^2, or 31% of the total area classified in the OECC. Differences in the total area classified for each individual transect were a result of varying total transect lengths and visibility throughout the video.

The CMECS classifications were summarized at the transect level by listing the dominant classifications that occurred in >10% of the transect by area. This resulted in one to four dominant CMECS classifications identified for each transect. The majority (45 of 63 transects) of the video transects collected along the OECC were primarily classified as geologic origin with unconsolidated fine sand/mud based on the dominant spatial area of still images processed (Table 4-5; Figure 3-8; Figure 4-4). Transects from Muskeget Channel frequently had more than two dominant substrate types, as this area comprises diverse, heterogeneous habitats, with 15 unique substrate classifications identified across stills in the 35 video transects. Fourteen of the Muskeget Channel transects were dominated by coarse gravels, gravel mixes, or gravelly sand substrates containing pebble/granule-sized particles.

Three transects (OECC20-VT-17, OECC20-VT-18, and OECC20-VT-20) were predominantly classified as biogenic-origin shell hash with moderate to dense cover of *Crepidula* spp. shells (Figure 4-5). Various densities of shell cover were classified in all transects in the OECC, with sparce shall hash (2% to < 30% cover) most commonly observed across stills (Figure 4-5). In general, shell cover was lower in transects located in the southern OECC than those in the northern OECC or Muskeget Channel. Some density of flora/fauna cover, which included, flora (e.g., algae or seagrass), fauna (e.g., mobile megafauna, encrusting species, sand dollars, mussel beds), and evidence of biological activity (e.g., burrows, infaunal structures) was identified in stills from all but two transects along the OECC (Figure 4-6). Higher densities of flora/fauna occurred in transects throughout the OECC but were not concentrated in a single region.

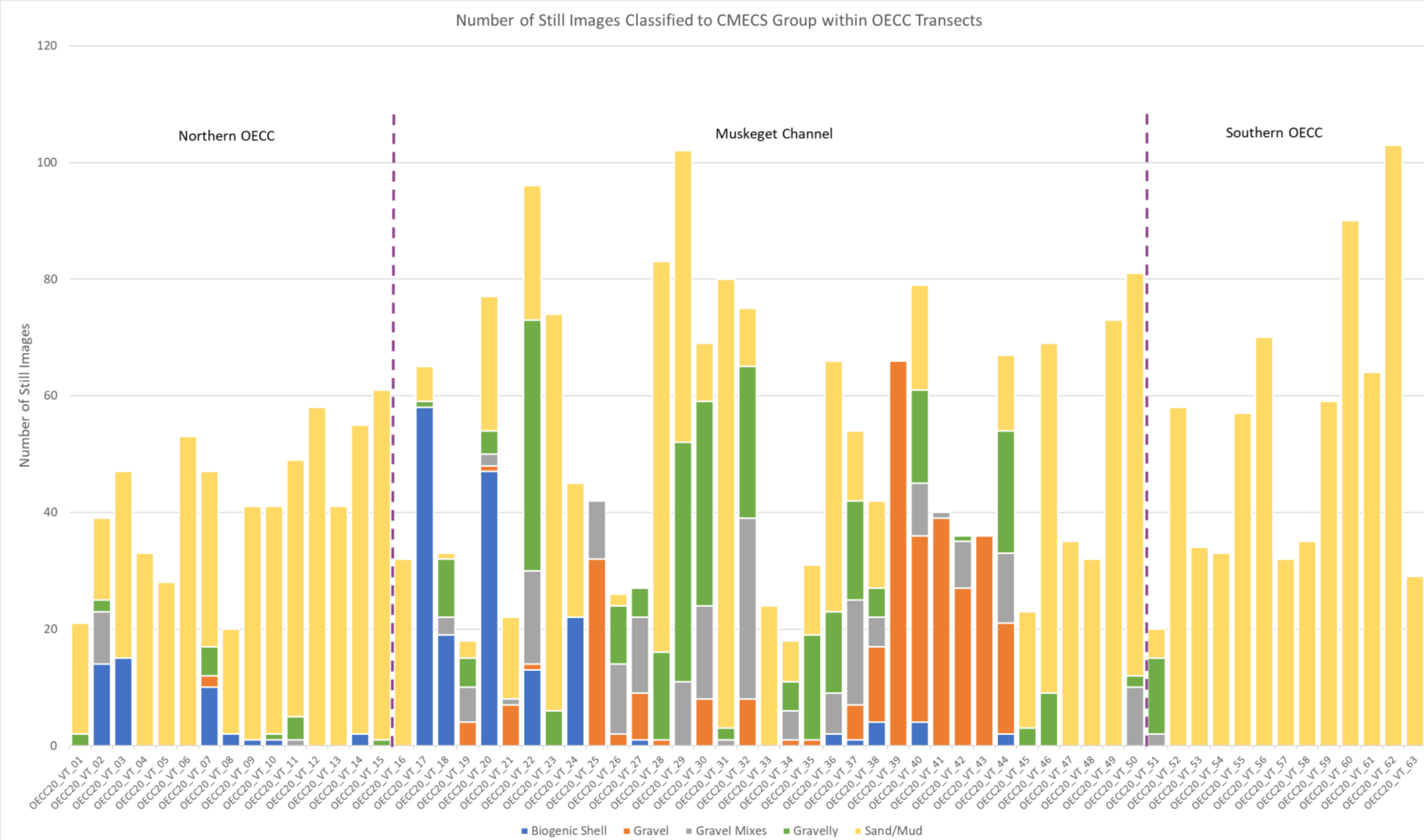


Figure 4-4. The number of still images classified to CMECS substrate component groups within each OECC transect.

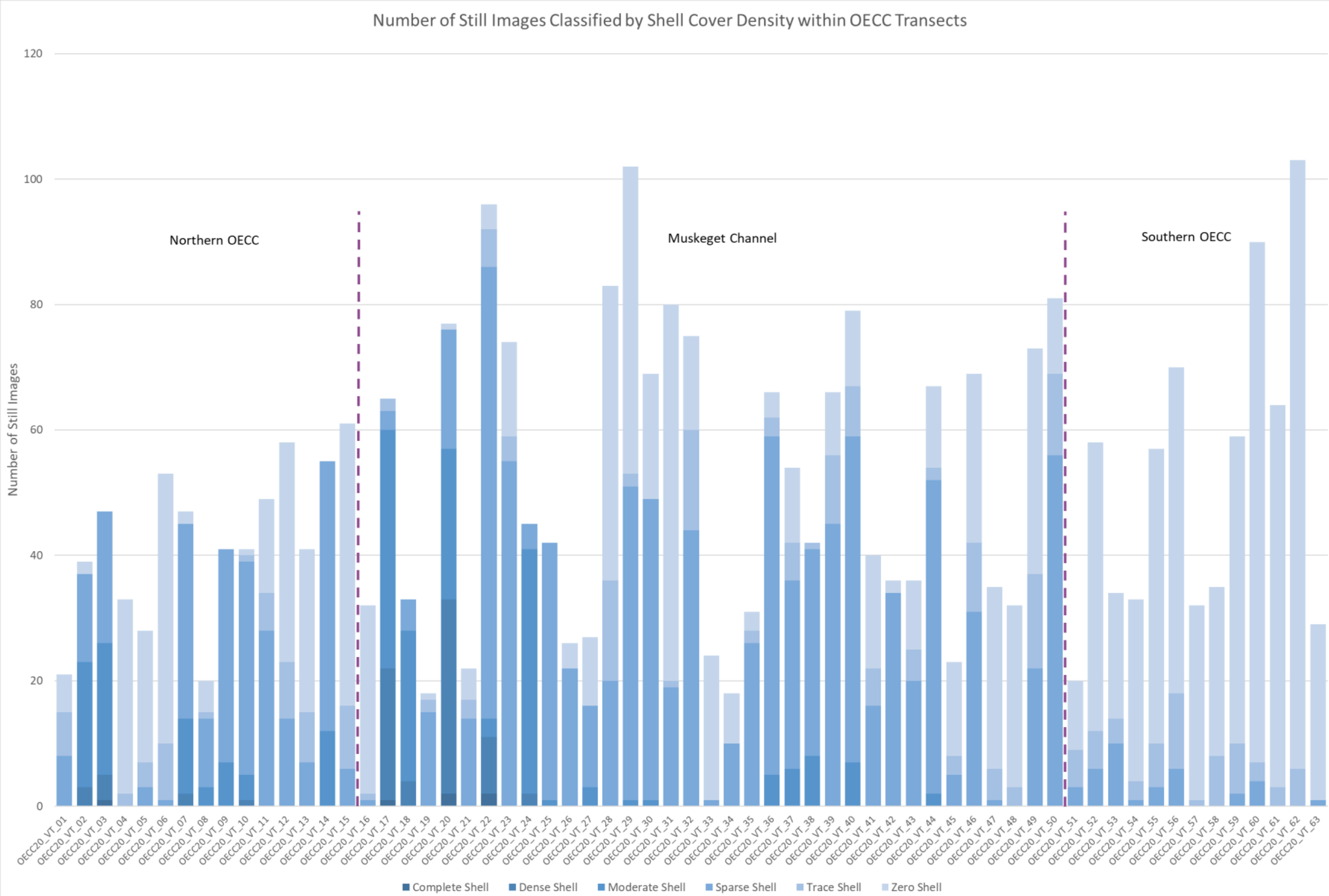


Figure 4-5. The number of still images classified to each shell cover density category within each OECC transect. Trace is < 2%, Sparse is 2 to < 30%, Moderate is 30 to < 70%, Dense is 70 to < 90%, and Complete is 90 to 100% cover.

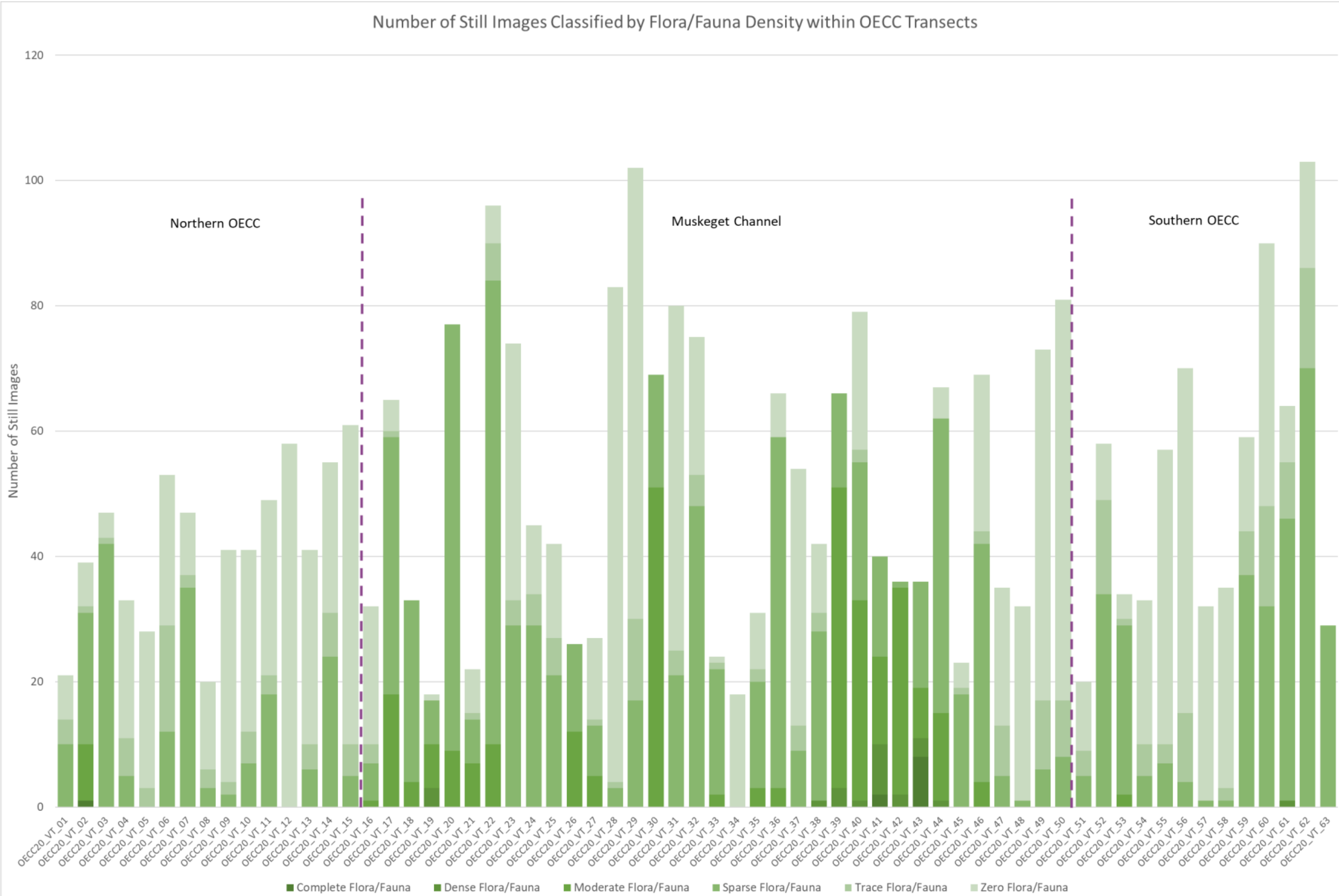


Figure 4-6. The number of still images classified to each flora/fauna density category within each OECC transect. Trace is < 2%, Sparse is 2 to < 30%, Moderate is 30 to < 70%, Dense is 70 to < 90%, and Complete is 90 to 100% cover.

Table 4-4. Area (m^2) classified to CMECS substrate component groups for each of the 63 transects in the OECC. Abbreviations are as follows: S/M = Sand/Mud, B = Boulder, C = Cobble, and P/G = Pebble/Granule. All substrate component groups except sand/mud/shell mix and sand/mud are considered 'complex' habitat by NMFS (2020).

Transect	Biogenic Shell Hash	Biogenic Shell Rubble	Gravel - Cobble	Gravel - Gravel Pavement	Gravel - Pebble/ Granule	Gravel Mixes - Boulder with S/M	Gravel Mixes - Cobble with S/M	Gravel Mixes - Cobble/ Pebble/ Granule with S/M	Gravel Mixes - Pebble/ Granule with S/M	Gravelly Sand/ Mud with B	Gravelly Sand/Mud with B/C/P/G	Gravelly Sand/ Mud with B/P/G	Gravelly Sand/ Mud with C/P/G	Gravelly Sand/ Mud with P/G	Sand/ Mud	Sand/ Mud/ Shell Mix
OECC20-VT-01														1.1	7.6	
OECC20-VT-02	12.3								3.7					0.4	18.1	3.4
OECC20-VT-03	16.7														35.5	2.0
OECC20-VT-04															27.1	
OECC20-VT-05															32.0	
OECC20-VT-06															38.4	
OECC20-VT-07	13.7				3.0									7.6	57.0	0.8
OECC20-VT-08	0.3	0.3													18.1	
OECC20-VT-09	1.2														57.4	
OECC20-VT-10	0.6													0.2	45.7	
OECC20-VT-11									0.5					2.1	52.1	
OECC20-VT-12															75.6	
OECC20-VT-13															26.7	
OECC20-VT-14	1.4														57.6	
OECC20-VT-15													0.9		49.3	
OECC20-VT-16															82.4	

Transect	Biogenic Shell Hash	Biogenic Shell Rubble	Gravel - Cobble	Gravel - Gravel Pavement	Gravel - Pebble/ Granule	Gravel Mixes - Boulder with S/M	Gravel Mixes - Cobble with S/M	Gravel Mixes - Cobble/ Pebble/ Granule with S/M	Gravel Mixes - Pebble/ Granule with S/M	Gravelly Sand/ Mud with B	Gravelly Sand/Mud with B/C/P/G	Gravelly Sand/ Mud with B/P/G	Gravelly Sand/ Mud with C/P/G	Gravelly Sand/ Mud with P/G	Sand/ Mud	Sand/ Mud/ Shell Mix
OECC20-VT-17	59.1													0.6	6.5	
OECC20-VT-18	22.4								4.6					12.9		1.1
OECC20-VT-19					7.9				10.0					5.2	2.5	
OECC20-VT-20	55.1				0.1				2.8					9.4	36.9	4.4
OECC20-VT-21					3.4				2.8						11.1	
OECC20-VT-22	8.2				0.3				9.1				0.6	32.5	19.0	
OECC20-VT-23														9.5	85.5	
OECC20-VT-24	25.8														27.0	
OECC20-VT-25					27.9				7.8							
OECC20-VT-26					0.3			0.7	5.3					5.5	1.2	
OECC20-VT-27		0.1	0.3	1.1	1.3		0.1	2.4	7.0					3.4		
OECC20-VT-28					0.7									23.5	78.8	
OECC20-VT-29									4.9					46.9	69.5	
OECC20-VT-30					4.3				8.8					27.2	7.3	
OECC20-VT-31									0.3					0.4	130.1	
OECC20-VT-32					11.3				28.9					27.7	8.5	
OECC20-VT-33															8.7	
OECC20-VT-34					0.4				3.2					3.7	4.2	

Transect	Biogenic Shell Hash	Biogenic Shell Rubble	Gravel - Cobble	Gravel - Gravel Pavement	Gravel - Pebble/ Granule	Gravel Mixes - Boulder with S/M	Gravel Mixes - Cobble with S/M	Gravel Mixes - Cobble/ Pebble/ Granule with S/M	Gravel Mixes - Pebble/ Granule with S/M	Gravelly Sand/ Mud with B	Gravelly Sand/Mud with B/C/P/G	Gravelly Sand/ Mud with B/P/G	Gravelly Sand/ Mud with C/P/G	Gravelly Sand/ Mud with P/G	Sand/ Mud	Sand/ Mud/ Shell Mix
OECC20-VT-35					0.1									3.7	4.0	
OECC20-VT-36	1.9								3.7				0.4	6.6	37.9	0.5
OECC20-VT-37	0.9				4.9				24.7	1.9	2.5			10.5	6.2	0.4
OECC20-VT-38	0.9				4.0	0.2			2.3					4.2	5.9	
OECC20-VT-39					65.8											
OECC20-VT-40	2.0	1.3			48.0				15.8					18.1	18.7	
OECC20-VT-41				3.2	20.5			1.0								
OECC20-VT-42				0.3	26.5				8.6					3.6		
OECC20-VT-43					22.4											
OECC20-VT-44	1.8			0.1	17.6			0.9	7.2			2.3		26.5	14.8	
OECC20-VT-45										0.1				0.2	10.2	
OECC20-VT-46										0.8				12.0	62.7	
OECC20-VT-47															32.8	
OECC20-VT-48															29.3	
OECC20-VT-49															62.6	
OECC20-VT-50									15.9					0.9	76.9	
OECC20-VT-51									1.5					12.0	7.9	
OECC20-VT-52															22.1	

Transect	Biogenic Shell Hash	Biogenic Shell Rubble	Gravel - Cobble	Gravel - Gravel Pavement	Gravel - Pebble/ Granule	Gravel Mixes - Boulder with S/M	Gravel Mixes - Cobble with S/M	Gravel Mixes - Cobble/ Pebble/ Granule with S/M	Gravel Mixes - Pebble/ Granule with S/M	Gravelly Sand/ Mud with B	Gravelly Sand/Mud with B/C/P/G	Gravelly Sand/ Mud with B/P/G	Gravelly Sand/ Mud with C/P/G	Gravelly Sand/ Mud with P/G	Sand/ Mud	Sand/ Mud/ Shell Mix
OECC20-VT-53															11.6	
OECC20-VT-54															14.7	
OECC20-VT-55															66.9	
OECC20-VT-56															106.0	
OECC20-VT-57															26.7	
OECC20-VT-58															43.1	
OECC20-VT-59															53.9	
OECC20-VT-60															158.8	
OECC20-VT-61															45.8	
OECC20-VT-62															75.6	
OECC20-VT-63															25.2	
OECC Total Area per CMECS (m^2)	**224.3**	**1.7**	**0.3**	**4.7**	**270.7**	**0.2**	**0.1**	**5.1**	**179.2**	**2.8**	**2.5**	**2.3**	**1.9**	**318.1**	**2,197.8**	**12.7**

Table 4-5. Dominant CMECS classifications for each video transect based on surface area of stills classified to each CMECS category. Second, third, and fourth classifications were included if that substrate type covered ≥10% of the sampled area for that transect.

Transect ID	Primary CMECS by Area	Second CMECS by Area (if ≥ 10%)	Third CMECS by Area (if ≥ 10%)	Fourth CMECS by Area (if ≥ 10%)
OECC20_VT_01	Sand/Mud	Gravelly Sand/Mud with P/G	--	--
OECC20_VT_02	Sand/Mud	Biogenic Shell Hash	--	--
OECC20_VT_03	Sand/Mud	Biogenic Shell Hash	--	--
OECC20_VT_04	Sand/Mud	--	--	--
OECC20_VT_05	Sand/Mud	--	--	--
OECC20_VT_06	Sand/Mud	--	--	--
OECC20_VT_07	Sand/Mud	Biogenic Shell Hash	--	--
OECC20_VT_08	Sand/Mud	--	--	--
OECC20_VT_09	Sand/Mud	--	--	--
OECC20_VT_10	Sand/Mud	--	--	--
OECC20_VT_11	Sand/Mud	--	--	--
OECC20_VT_12	Sand/Mud	--	--	--
OECC20_VT_13	Sand/Mud	--	--	--
OECC20_VT_14	Sand/Mud	--	--	--
OECC20_VT_15	Sand/Mud	--	--	--
OECC20_VT_16	Sand/Mud	--	--	--
OECC20_VT_17	Biogenic Shell Hash	--	--	--
OECC20_VT_18	Biogenic Shell Hash	Gravelly Sand/Mud with P/G	Gravel Mixes - Pebble/Granule with S/M	--
OECC20_VT_19	Gravel Mixes - Pebble/Granule with S/M	Gravel - Pebble/Granule	Gravelly Sand/Mud with P/G	--
OECC20_VT_20	Biogenic Shell Hash	Sand/Mud	--	--
OECC20_VT_21	Sand/Mud	Gravel - Pebble/Granule	Gravel Mixes - Pebble/Granule with S/M	--
OECC20_VT_22	Gravelly Sand/Mud with P/G	Sand/Mud	Gravel Mixes - Pebble/Granule with S/M	Biogenic Shell Hash
OECC20_VT_23	Sand/Mud	--	--	--
OECC20_VT_24	Sand/Mud	Biogenic Shell Hash	--	--
OECC20_VT_25	Gravel - Pebble/Granule	Gravel Mixes - Pebble/Granule with S/M	--	--
OECC20_VT_26	Gravelly Sand/Mud with P/G	Gravel Mixes - Pebble/Granule with S/M	--	--
OECC20_VT_27	Gravel Mixes - Pebble/Granule with S/M	Gravelly Sand/Mud with P/G	Gravel Mixes - Cobble/Pebble/Granule with S/M	--
OECC20_VT_28	Sand/Mud	Gravelly Sand/Mud with P/G	--	--
OECC20_VT_29	Sand/Mud	Gravelly Sand/Mud with P/G	--	--
OECC20_VT_30	Gravelly Sand/Mud with P/G	Gravel Mixes - Pebble/Granule with S/M	Sand/Mud	--
OECC20_VT_31	Sand/Mud	--	--	--
OECC20_VT_32	Gravel Mixes - Pebble/Granule with S/M	Gravelly Sand/Mud with P/G	Gravel - Pebble/Granule	Sand/Mud
OECC20_VT_33	Sand/Mud	--	--	--

Transect ID	Primary CMECS by Area	Second CMECS by Area (if ≥ 10%)	Third CMECS by Area (if ≥ 10%)	Fourth CMECS by Area (if ≥ 10%)
OECC20_VT_34	Sand/Mud	Gravelly Sand/Mud with P/G	Gravel Mixes - Pebble/Granule with S/M	--
OECC20_VT_35	Sand/Mud	Gravelly Sand/Mud with P/G	--	--
OECC20_VT_36	Sand/Mud	Gravelly Sand/Mud with P/G	--	--
OECC20_VT_37	Gravel Mixes - Pebble/Granule with S/M	Gravelly Sand/Mud with P/G	Sand/Mud	--
OECC20_VT_38	Sand/Mud	Gravelly Sand/Mud with P/G	Gravel - Pebble/Granule	Gravel Mixes - Pebble/Granule with S/M
OECC20_VT_39	Gravel - Pebble/Granule	--	--	--
OECC20_VT_40	Gravel - Pebble/Granule	Sand/Mud	Gravelly Sand/Mud with P/G	Gravel Mixes - Pebble/Granule with S/M
OECC20_VT_41	Gravel - Pebble/Granule	Gravel - Gravel Pavement	--	--
OECC20_VT_42	Gravel - Pebble/Granule	Gravel Mixes - Pebble/Granule with S/M	--	--
OECC20_VT_43	Gravel - Pebble/Granule	--	--	--
OECC20_VT_44	Gravelly Sand/Mud with P/G	Gravel - Pebble/Granule	Sand/Mud	Gravel Mixes - Pebble/Granule with S/M
OECC20_VT_45	Sand/Mud	--	--	--
OECC20_VT_46	Sand/Mud	Gravelly Sand/Mud with P/G	--	--
OECC20_VT_47	Sand/Mud	--	--	--
OECC20_VT_48	Sand/Mud	--	--	--
OECC20_VT_49	Sand/Mud	--	--	--
OECC20_VT_50	Sand/Mud	Gravel Mixes - Pebble/Granule with S/M	--	--
OECC20_VT_51	Gravelly Sand/Mud with P/G	Sand/Mud	--	--
OECC20_VT_52	Sand/Mud	--	--	--
OECC20_VT_53	Sand/Mud	--	--	--
OECC20_VT_54	Sand/Mud	--	--	--
OECC20_VT_55	Sand/Mud	--	--	--
OECC20_VT_56	Sand/Mud	--	--	--
OECC20_VT_57	Sand/Mud	--	--	--
OECC20_VT_58	Sand/Mud	--	--	--
OECC20_VT_59	Sand/Mud	--	--	--
OECC20_VT_60	Sand/Mud	--	--	--
OECC20_VT_61	Sand/Mud	--	--	--
OECC20_VT_62	Sand/Mud	--	--	--
OECC20_VT_63	Sand/Mud	--	--	--

4.2 Grab Sample Stations

We assigned NMFS (2020) modified CMECS classifications to each benthic grab sample station based on visual inspection of the sample once on board the survey vessel, laboratory analysis of grain size, and still image point count analysis for grabs with insufficient sediment recovery and those with substantial amounts of shell cover based on the imagery collected prior to grab deployment. Substrate classification results are presented as a hierarchy in Table 4-6 and

Table 4-7 for grab sample stations in the SWDA and OECC, respectively. Maps displaying the location and CMECS classification of the grab samples are provided in Appendix D.

Tables in Appendices C-1and C-2 show the images of each grab sample and core after retrieval along with the CMECS classifications for each sample. All samples in SWDA were dominated by fine unconsolidated substrate of geologic origin. Seventeen OECC samples contained ≥ 5% gravel that classified them as complex habitat according to the NMFS (2020) modified CMECS classifications. Nine samples were classified as biogenic origin with ≥ 50% shell hash.

Table 4-6. CMECS hierarchical classification of substrates collected at each grab sample within the SWDA.

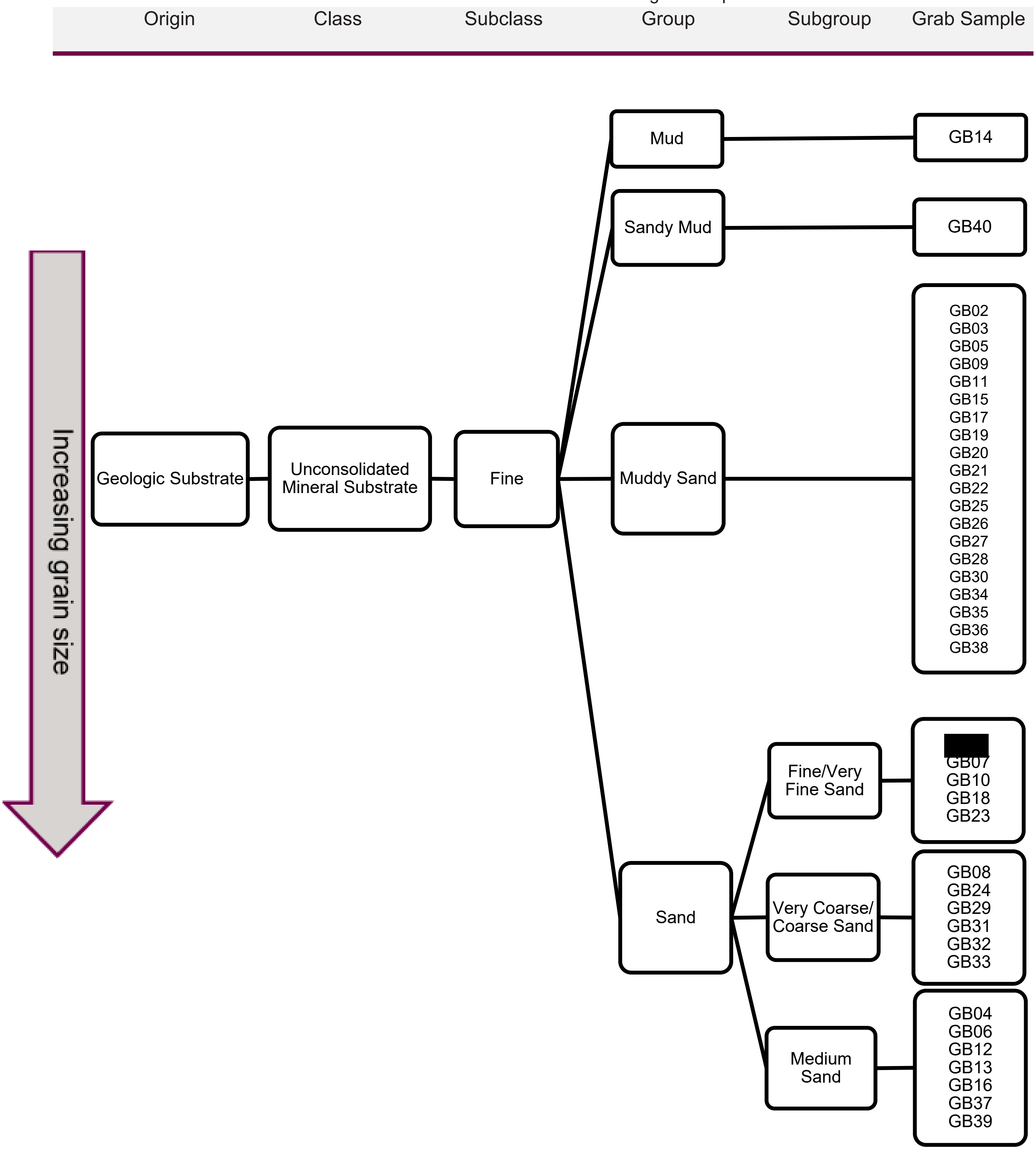


Table 4-7. CMECS hierarchical classification of substrates collected at each grab sample along the OECC.

Origin	Class	Subclass	Group	Subgroup	Grab Sample
Geologic Substrate	Unconsolidated Mineral Substrate	Fine	Muddy Sand		GB01, GB67, GB69, GB72, GB79, GB80
			Sandy Mud		GB68, GB74
			Sand	Fine/Very Fine Sand	GB07, GB08, GB76, GB78
				Medium Sand	GB04, GB22, GB06, GB41, GB09, GB70, GB14, GB71, GB15, GB73, GB18, GB75, GB20, GB77
				Very Coarse/ Coarse Sand	GB11, GB57, GB17, GB58, GB33, GB59, GB34, GB60, GB37, GB62, GB52, GB63, GB55, GB64
		Coarse	Gravelly	Gravelly Mud	GB03
				Gravelly Sand	GB13, GB16, GB23, GB26, GB65, GB66
			Gravel Mixes	Sandy Gravel	GB42, GB43, GB44, GB28, GB30, GB53, GB35, GB54, GB39, GB56
Biogenic Substrate	Shell	Shell Hash			GB02, GB05, GB10, GB12, GB19, GB21, GB24, GB25, GB45

Increasing grain size

5 SUMMARY

CMECS is a hierarchical system with classification thresholds based primarily on the percent and composition of gravel particles (> 2 mm) to identify substrates that may be considered “complex” by NMFS for the purposes of essential fish habitat mapping. All grab samples and video transects in the SWDA were dominated by fine unconsolidated substrate of geologic origin, and no samples contained ≥ 5% gravel, meaning none of the grab sample stations or video transects were classified as complex habitat as defined by NMFS (2020). The video transects in the SWDA were similarly comprised of very little shell or flora and fauna cover.

The grab samples in the OECC consisted of more gravel, with 26 of the 66 grab samples composed of ≥ 5% gravel and classified as complex habitat. Of these 26 samples, 7 were gravelly (5% - 30% gravel), 10 were gravel mixes (≥ 30% gravel), and 9 were classified as biogenic shell habitat with over 50% of the substrate (visible through grab camera imagery) composed of shell cover of biogenic origin. Mud comprised ≥ 5% of the substrate sample in 16 of the 66 OECC grab samples, with 6 of those samples being mud dominant (≥ 30% mud). Samples obtained in the Muskeget Channel area contained the most gravel overall with 13 of all 17 samples classified as gravel (≥ 30% gravel) or gravelly (5% - 30% gravel) collected in this area. Most samples in Muskeget Channel area were classified as sandy gravel (complex) or coarse sand (not complex); however, the Muskeget Channel area contains more variation in grain size than either the northern or southern OECC as demonstrated by variability in the percent composition of sediment samples.

Both the NMFS CMECS substrate component type and sample location classifications are reasonable grouping systems for predicting which invertebrate assemblages may be present at a given station. However, the predictive power varied by grouping, as displayed by cluster patterns in the NMDS plots. For instance, although the results displayed clear evidence of dissimilarity (opposite ordination of points in NMDS plot) in the invertebrate assemblages in samples from substrates classified as muddy sand and very coarse/coarse sand, this pattern is not clear for most of the other substrate types (Figure 3-25.; Table 3-29). Dissimilarity between sample locations was more apparent in both the NMDS plot and SIMPER results as each location was highly dissimilar to the others (> 74% dissimilar; Figure 3-26.; Table 3-30). The clearest distinction between the invertebrate assemblages was between Muskeget Channel and the two most offshore sampling locations, the Southern OECC, and SWDA. Whether a sample was collected in complex or not complex habitat had very little predictive power as this grouping, although significant, only explained a small proportion of the variability between invertebrate assemblages and showed high overlap in points ordinated in the NMDS plot (Figure 3-27).

The most abundant organisms observed by the megafauna video review across the SWDA region were Cerianthid anemones (782 of 1348 individuals) and the most abundant organisms across the OECC regions were again Cerianthid anemones (969 of 3330 individuals) in addition to sea urchins (1593 of 3330 individuals). In both cases, the most abundant organisms were higher in abundance than all other organisms combined. In SWDA transects, the next most abundant organisms were varieties of crab (275 individuals), followed by fish species (139 organisms). In OECC transects, more fish (228 individuals) were observed and varieties of crab (184 individuals) were the next most abundant species. It should be noted that sand dollars were so numerous in some transects (primarily in the Southern OECC where there were thousands of individuals per transect) that they were analyzed via point count methods instead of enumerated individually.

When abundances were normalized by transect lengths, the SWDA region contained 130 organisms per 300 m with over 100 of those organisms comprised of Cerianthid anemones and crabs. Within the SWDA, fish species were observed at a density of 15 individuals per 300 m. Within the OECC regions, there were 43 organisms per 300 m with 32 of those organisms comprising sea urchins and Cerianthid anemones. Within the OECC regions, fish species were observed at a density of 4 individuals per 300 m.

Mean density of identified infaunal invertebrates was higher (almost double) in samples collected along the OECC than those from the SWDA. The organisms from the phyla Arthropoda, Annelida, and Mollusca were represented by the largest numbers of unique taxa across samples collected in both the SWDA and OECC. Abundance was highest for organisms in the phyla Annelida and Arthropoda from samples collected in the SWDA, while Annelida, Nematoda, and Mollusca, dominated density in sampled from the OECC. Although density was higher, on average, in samples collected along the OECC, mean richness, diversity, and evenness were higher across samples collected in the SWDA.

The video transects in the OECC were variable in CMECS classification, shell cover, and flora/fauna cover throughout their lengths and between transects. Fine sand/mud habitats were the primary classification (by area) for the majority of the video transects sampled in the northern and southern OECC. The Muskeget Channel region showed the greatest variety in CMECS classifications and had the most still images classified to biogenic shell or coarse gravel, gravel mix, or gravelly (i.e., NFMS-defined complex) substrate types. Forty-six percent of stills from Muskeget are classified as sand/mud, 45% as coarse substrates (gravels, gravel mixes, or gravelly sands), and 9% as shell hash and rubble. In contrast, 88% of stills from Northern OECC and 98% of stills from the Southern OECC are classified as sand/mud. Muskeget Channel is a high energy environment known for shifting sand shoals due to the presence of exceptional tidal energy, which frequently exceeds 4 knots. As a result, the benthos of the channel is dynamic and heterogeneous as observed in these data. The densest shell and flora/fauna cover also occurred in Muskeget Channel, but more moderate densities were spread throughout the other OECC transects as well. The high proportion of hard bottom substrate provides complex habitat and structure that attracts species to the area.

Grab samples are point samples which offer highly detailed data for a small area of the seafloor, whereas transects cover a large swathe of area but only view the surficial material; thus, comparisons between the datasets should be performed with these differences in mind. However, comparing results from the closest grab-transect pairs can demonstrate the area's heterogeneity: grab sample GB45 was classified as biogenic shell hash but only 3% (0.9 m^2) of still images taken from transect VT38 (only 29 m away) were classified primarily as shell hash. In addition, grab sample GB28 was classified as sandy gravel with over 50% gravel while the VT26 (70 m away) was primarily classified as gravelly sand/mud with pebble/granule and secondarily as gravel mixes (pebble granule with sand/mud), which highlights the patchy distribution of hard bottom substrates in this area.

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APPENDIX A: STILL IMAGE ANALYSIS METHODS

Visibility Scoring

One biologist was assigned to each transect for point count analysis after stills were created via an automated process every 8 to 14 seconds through the duration of each video. Two longer transects (OECC20-VT-22 and OECC20-VT-41) were split between two biologists when finishing up final transects. Each still image was reviewed for visibility following the quality criteria in Table A-1. Images which scored 0 or 1 were failed and not included in further analyses. Some images scored 2 were highlighted as "borderline" passing. These images were reviewed a second time by a different biologist during the point count analysis and they ultimately decided whether the image passed for further analysis. This two-step quality review increased confidence in the results while maximizing the number of better quality still images for analysis.

Table A-1. Quality criteria for assigning visibility scores. Scores of 2 or higher "passed" for further analysis.

Visibility Score	Definition
0 – none	Lasers not visible or measurable, thus image is unusable.
1 – low	Lasers visible or measurable, but quality clearly poor because too blurry, moving too fast, not angled at the bottom, too much marine snow, too dark, too green, features not discernable.
2 – moderate	Lasers visible and measurable, quality is good enough to review at least 40% of the image. The measurable area appears not too blurry, bottom is visible, most features are discernable. Green tint or some marine snow is ok if they do not obscure bottom.
3 – high	Lasers visible and measurable, usually nice and bright. Quality is clearly good: bottom is visible, features are crisp and clear, camera seems nearer the seafloor and not moving too fast, and there is minimal marine snow.

Point Count Analysis

A point count analysis was conducted on every passing still image. One hundred points were distributed uniformly across each image by the PhotoQuad image analysis software (Figure A-1). This distribution of points was the only automated part of the image analysis process. Points were distributed within a stratification grid (black lines) created by PhotoQuad after a biologist drew the quadrat perimeter (red outline) around the visible portion of the image. A biologist manually classified the substrate type or biological element that occurred directly underneath the crosshairs and recorded the point count in an Excel spreadsheet. Each point fell within one pixel. Gravel-sized particles (> 0.2 cm [2 mm] in CMECS) would occupy 6 pixels of space, as demonstrated in Figure A-2, where 3 pixels measure 0.1 cm. The biologist zoomed in and out as needed to confirm the location of the crosshairs with respect to substrates and features on the seafloor. In situations where features were difficult to discern, the video was reviewed in the seconds before and after the frame of the still image to better understand the shape/color of the substrate or features.

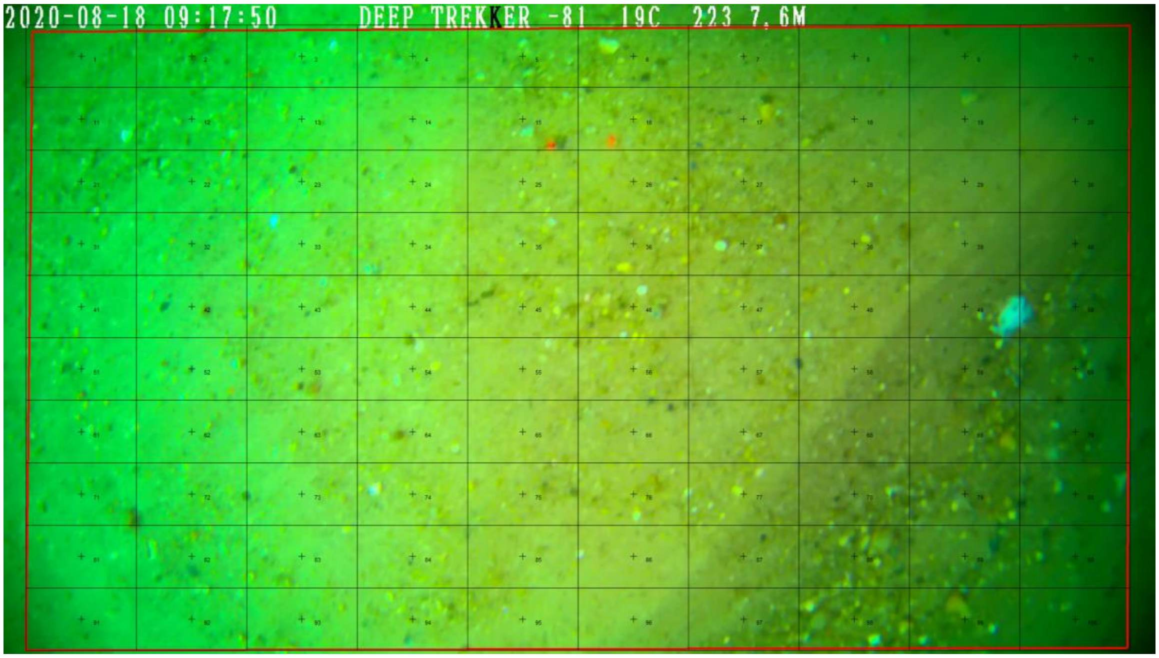


Figure A-1. Stratification grid and 100 uniform points created in PhotoQuad.

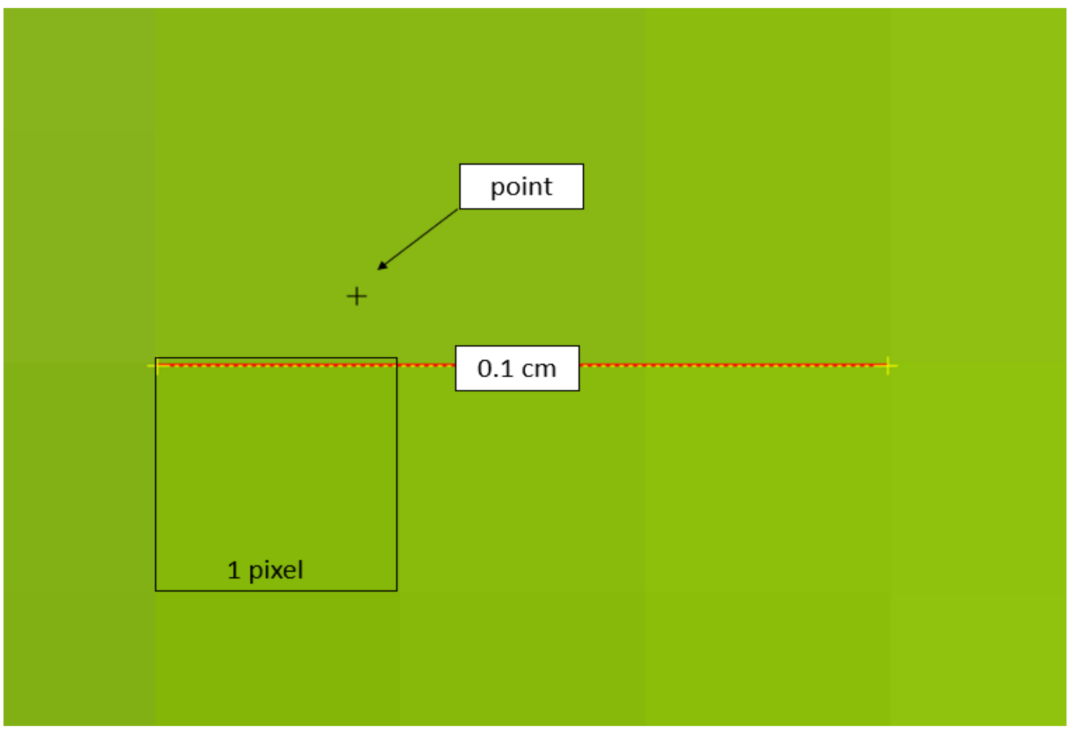


Figure A-2. The crosshairs of each point falls within one pixel, with scale bar showing 3 pixels as 0.1 cm in this reference image. The minimum threshold for gravel would occupy six pixels of space.

Substrate Identification Guidelines

Sand/mud was the default substrate classification wherever points fell on brown, flat, and apparently featureless space. However, more complex substrates were common in many of the heterogenous transects in Muskeget channel, and the distinction between gravel (geologic-origin) and shell (biogenic-origin) particles required careful definition. These substrates were discerned according to the following guidelines.

Shell was classified when a feature under the point appeared primarily as:

1. White or reflective in a compact, not transparent shape (vs. marine snow which appeared as a longer white streak and partially transparent);
2. Sharper edges and angles;
3. If larger mussel shells are present and color matches; or
4. If over 30% points already identified as shell and no gravel present, more likely to default to shell.

Gravel was classified when a feature under the point appeared primarily as:

1. Darker and no other mussel shells nearby;
2. More rounded edges and three-dimensional; or
3. Clearly not sand/mud or a biological element but unsure if shell; defaulted to gravel following the logic of the CMECS guidelines which assumes geologic-origin substrate when biogenic shell cannot be confirmed.

For both shell and gravel, the types (rubble or hash for shell, or boulder, cobble, or pebble/granule for gravel) identified were based on the size of the feature being counted under the point relative to scaling lasers, with measurements taken through PhotoQuad software to confirm the size of larger particles.

Many images contained a variety of biological elements that covered the seafloor substrate. Since it was not possible to see the underlying substrate if a point fell on a biological element, the biological element itself was counted and included in the percent cover analysis. Some images contained very dense algae or sponge cover with little of the underlying substrate visible, but the substrate that was visible under a point was still counted as appropriate.

CMECS Classification

After the percent cover analysis was complete, CMECS classifications were assigned en masse to the data recorded in the Excel spreadsheet. This means that CMECS classifications were not applied with each image in view but were assigned during data analysis, once percent cover data were captured for all stills. CMECS classes were based on the percent composition of different cover types as defined in the CMECS guidelines. However, the presence of substantial amounts of biological element cover necessitated the development of a decision matrix for “edge cases” where the NMFS-modified CMECS classifications rules could not apply (Table A-2).

For example, an image might contain 80 points that fell on biological elements, 10 points that fell on sand/mud, 6 points fell on shell, and 4 points that fell on gravel of pebble/granule size. If following the guidelines as written, this image contained more geologic-origin substrates but less than 5% gravel so it would not be considered a coarse substrate and would receive the classification of Sand/Mud overall. However, 25% of the geologic-origin substrate that was visible was composed of gravel [4 gravel points out of 16 total geologic-origin substrate points (gravel + sand/mud), and 25% gravel content is enough to classify the image as Gravelly Sand/Mud (with co-occurring sparse biogenic shell and dense flora/fauna)]. Plus, biological elements like algae or bushy-plant-like organisms tend to attach to coarser substrates, so it is probable that there is additional gravel substrate under the biological elements in the image. Thus, through multiple iterations of analysis of the percent cover data and additional review of approximately 200 "edge case" images, we modified classification rules regarding gravel and shell content where there is a substantial amount of biological element cover to better represent the complexity of the seafloor in such images. These decision rules are explained in Table A-2.

Table A-2. Decision matrix for CMECS classification assignment to percent cover data for each image.

CMECS Classification Assigned	Standard (as NMFS defined) Classification Metric	'Edge Case' Decision Metric
Biogenic Shell Hash	More points fell on shells than geologic substrates, most of which were hash size	< 50% points fell on shell, but remaining cover was entirely flora/fauna
Biogenic Shell Rubble	More points fell on shells than geologic substrates, most of which were rubble size	
Gravel - Cobble	≥ 80% points fell on gravel of cobble size	< 80% gravel overall but: • gravel was ≥ 80% of the geologic component (i.e., after subtracting cover of shell and flora/fauna); • gravel+flora/fauna was ≥ 80% and sand/mud was < 10%; • gravel was 100% of geologic component (i.e., no sand/mud) and gravel+flora/fauna was 40-80%; or • sand/mud 10-20% but gravel was ≥ 70% geologic component AND gravel+flora/fauna ≥ 70%
Gravel - Gravel Pavement	≥ 80% points fell on gravel of mixed sizes (pebble/granule [2 – 64 m], cobble [64 – 256 mm], and boulder [256 – 4,096 mm])	
Gravel - Pebble/Granule	≥ 80% points fell on gravel of pebble/granule size	
Gravel Mixes - Boulder with S/M	30% to < 80% of points fell on gravel of the described size categories, with at least 10% of points on sand/mud	< 30% gravel overall but: • gravel ≥ 50% of the geologic component. gravel+flora/fauna+ shell ≥ 75%, and gravel > sand/mud
Gravel Mixes - Cobble with S/M		
Gravel Mixes - Cobble/Pebble/Granule with S/M		
Gravel Mixes - Pebble/Granule with S/M		
Gravelly Sand/Mud with B	5% to < 30% of points fell on gravel of the described size categories	< 5% gravel overall but: • gravel was ≥ 5% of the geologic component and gravel+flora/fauna +shell cover was ≥ 50% (sand/mud was < 50%)
Gravelly Sand/Mud with B/C/P/G		
Gravelly Sand/Mud with C/P/G		
Gravelly Sand/Mud with P/G		
Sand/Mud	< 5% of points fell on gravel	none needed
Sand/Mud/Shell Mix	n/a	< 5% of points fell on gravel, with 30% to < 50% biogenic shell and ≥ 10% sand/mud

Analysis and QA/QC Summary

A photo library of reference images from all projects is available to biologists for training and calibration. Any still images that are noted to be referred back to are marked in the spreadsheet, and a copy of the image is saved in the reference image folder for further group analysis by biologists to reach a consensus.

Data from each video transect were reviewed at least three times, often by different biologists:

1. during full video review for megafauna enumeration;
2. during still image visibility scoring;
3. during point count / percent cover analysis;
4. a subset of images from a subset of transects were reviewed again to develop edge case decision matrix; and
5. all stills from a subset of transects, selected based on further quality review, were reprocessed if initial results and CMECS classifications did not appear to match the visible substrate in the still image.

The percent cover method is designed to remove observer bias by identifying the cover type that falls exactly under each point. Bias has been demonstrated when reviewers try to estimate percent cover by eye without an objective points-based analysis (i.e., the minority components always seem to cover more area than they actually do). The points-based method used in these analyses assumes that any interesting feature that is missed for a particular still will be captured in another still (law of large numbers) and in aggregate they will be an accurate representation of the percent cover of different substrates present throughout the transect, which is itself a subsampling of the project area as a whole.

Reference Images of Point Count Analysis

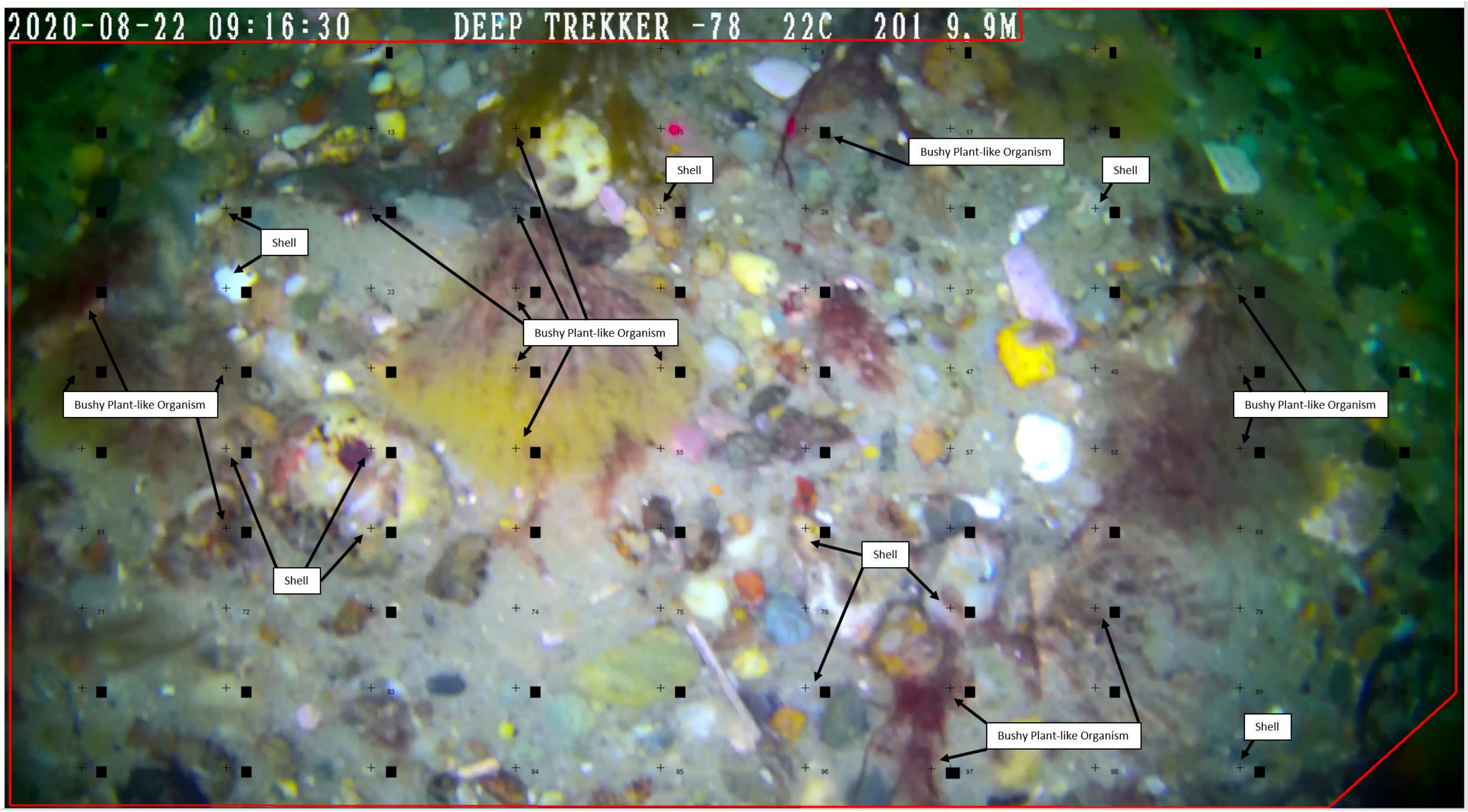


Figure A-3. VT22_133 CMECS classification: Geologic Unconsolidated Coarse Gravel Mixes Pebble/Granule with Sand/Mud (41% Sand, 30% Pebble/Granule, 11% Biogenic Shell, 18% Bushy Plant-like Organism). Points landing on shell and bushy plant-like organisms are annotated above, with the other assigned points (black squares) indicating pebble/granule.

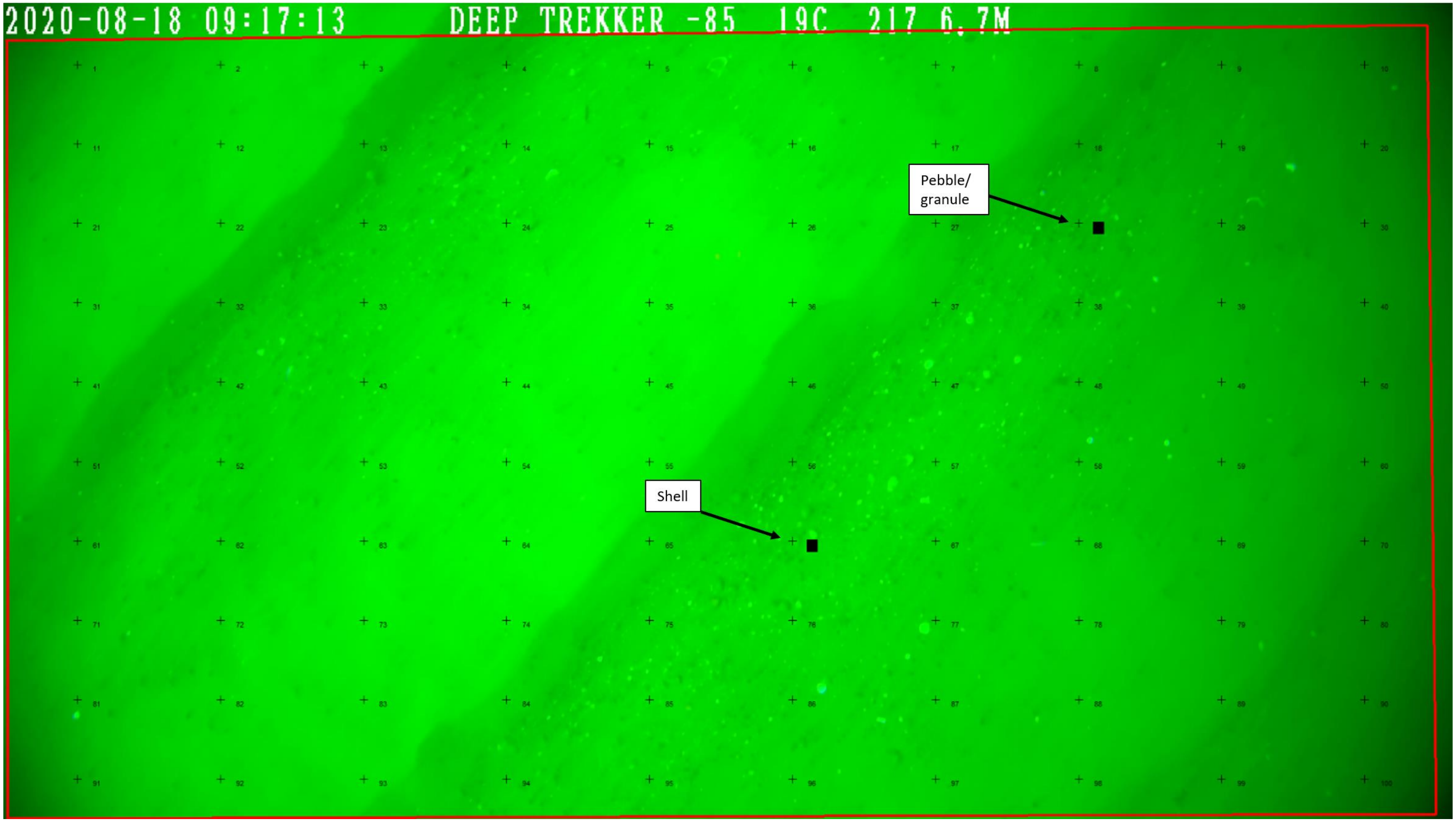


Figure A-4. VT50_35 CMECS classification: Geologic Unconsolidated Fine Sand/Mud (98% Sand, 1% Pebble/Granule, 1% Biogenic Shell).

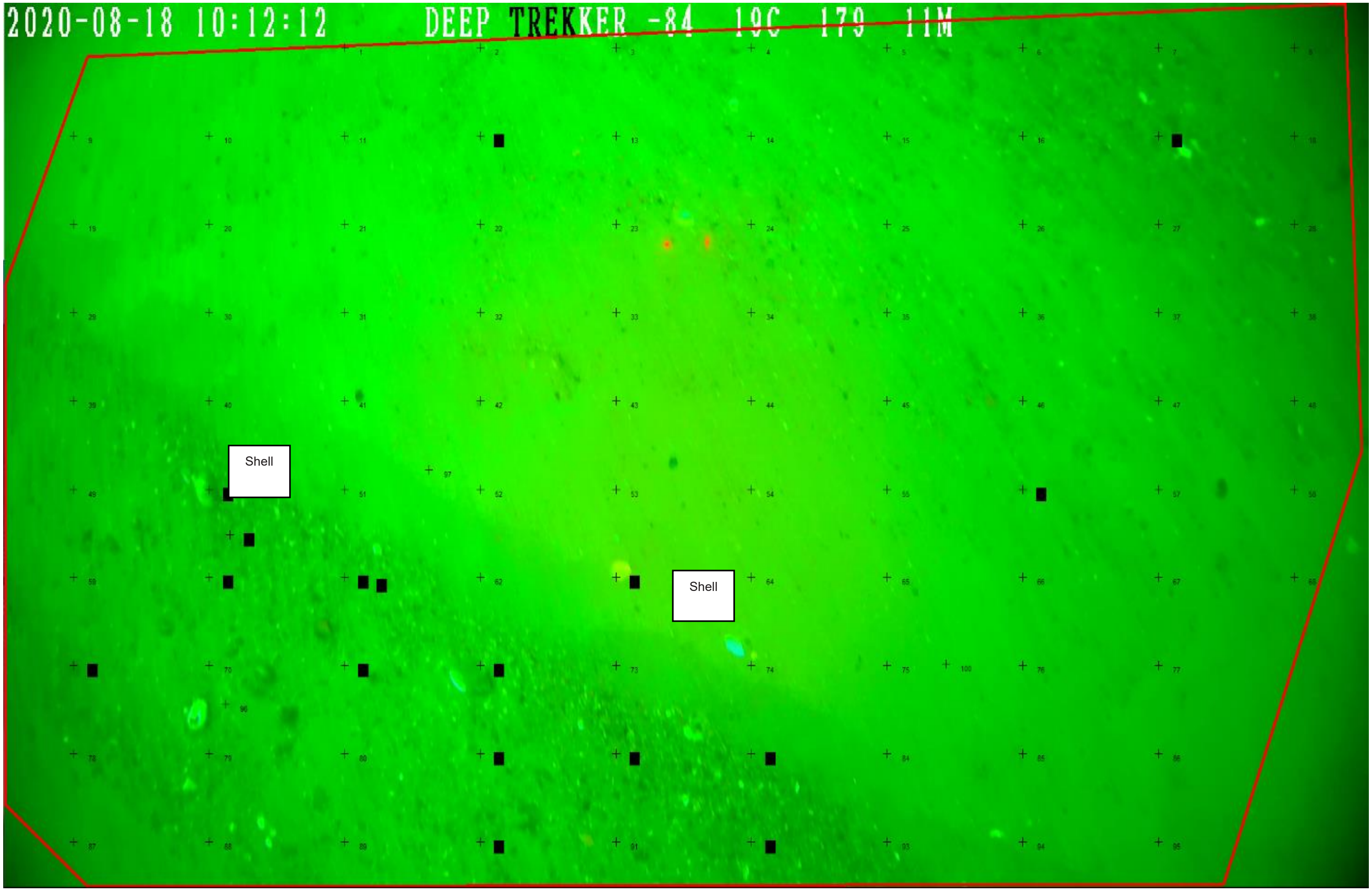


Figure A-5. VT51_18 CMECS classification: Geologic Unconsolidated Coarse Gravelly Sand/Mud with Pebble/Granule (83% Sand, 15% Pebble/Granule, 2% Biogenic Shell). Points on shell are annotated above, with the other assigned points (black squares) indicating pebble/granule.

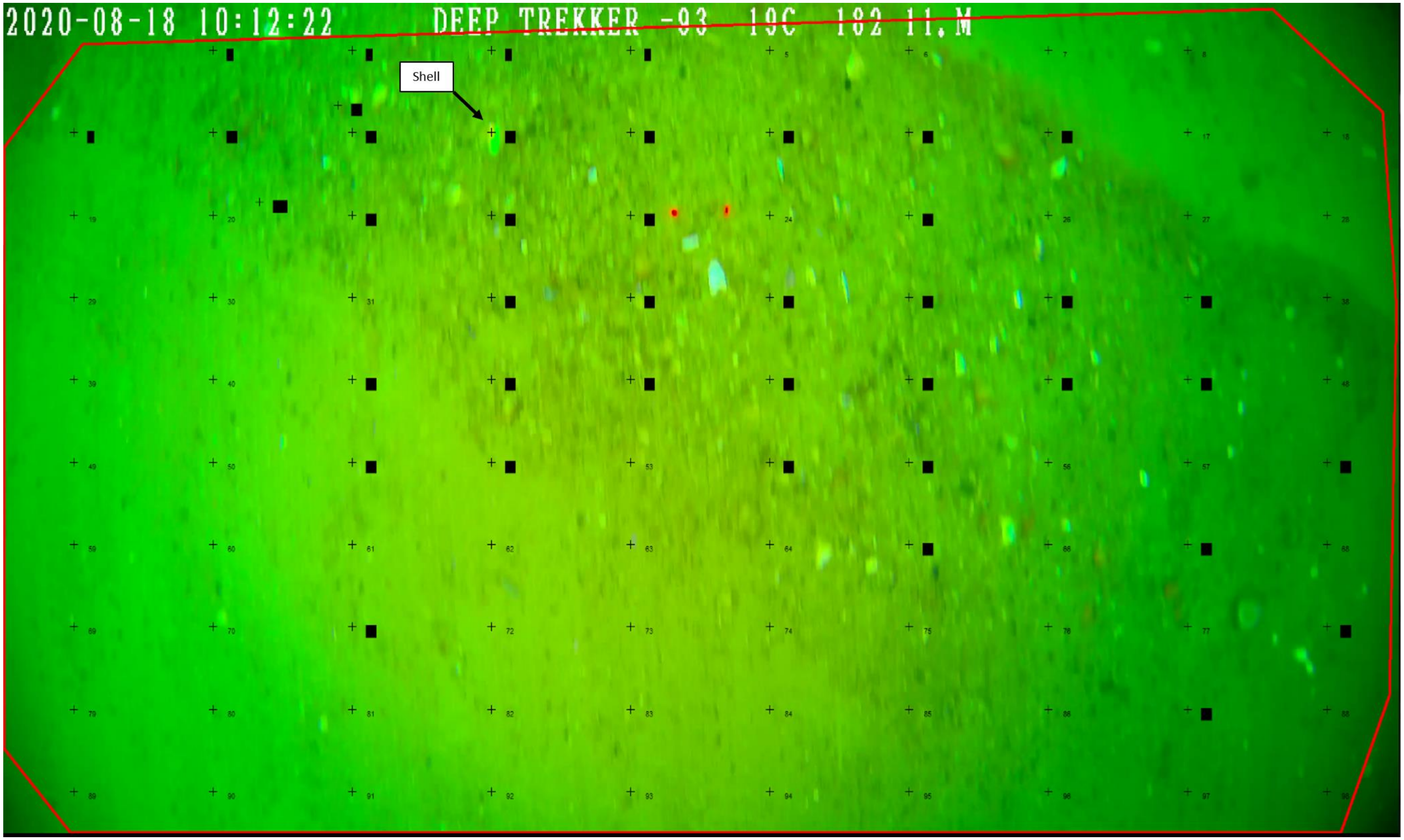


Figure A-6. VT51_19 CMECS classification: Geologic Unconsolidated Coarse Gravel Mixes Pebble/Granule with Sand/Mud (59% Sand, 40% Pebble/Granule, 1% Biogenic Shell). Points on shell are annotated above, with the other assigned points (black squares) indicating pebble/granule.

APPENDIX B: BENTHIC GRAB FIELD NOTES

Table B - 1. Field notes and biologic information for each grab station.

Station	Characteristics	Biotic Benthic Activity	Aquatic Vegetation	Anthropogenic Debris/Fishing Activity
OECC-20-GB01	Fine gray sand with shell hash	None present	Red algae and *Codium fragile* macroalgae	None present
OECC-20-GB02	Fine gray sand with dense shell hash (Crepidula/surf clam)	None present	None present	None present
OECC-20-GB03	Fine gray sand over dark silt with shell hash	Worm tubes	Red algae and *Codium fragile* macroalgae	None present
OECC-20-GB04	Fine brown sand and gravel with trace shell hash	None present	None present	None present
OECC-20-GB05	Dark gray silt with dense Crepidula shell hash	None present	None present	None present
OECC-20-GB06	Yellow-brown anoxic layer, 2 cm down dark gray anoxic	None present	Floating macroalgae	None present
OECC-20-GB07	Tan sand top 2 cm, gray sand bottom	None present	Floating macroalgae	None present
OECC-20-GB08	Tan surface layer 2 cm gray anoxic	Some small tube worms	None present	None present
OECC-20-GB09	Tan, 3 cm gray anoxic	Small worm tubes, fecal deposits visible on sea floor	None present	None present
OECC-20-GB10	Sand with shell debris (Crepidula)	Jelly on grab on way down, 1 colonial tunicate mass	None present	None present
OECC-20-GB11	Tan sand	None present	None present	None present
OECC-20-GB12	Sand with shells of >5 species	Hydrozoa colonies, hermit crabs	None present	None present
OECC-20-GB13	Beach sand w/ some small shell debris. Anoxic layer below 3 cm	None present	None present	None present
OECC-20-GB14	Brown to med sand w/ dark gray mud layer	None present	None present	None present
OECC-20-GB15	Brown sand with trace shall hash. Dark coarser sand underneath	Small whelk sp. present	None present	None present
OECC-20-GB16	Brown medium sand with trace shell hash	Small whelks in sampler	None present	None present
OECC-20-GB17	Brown medium sand with trace shell hash	None present	None present	None present
OECC-20-GB18	Brown coarse to medium sand with shell rubble on surface. Dark layer few cm under brown sand	None present	Floating macroalgae	None present
OECC-20-GB19	Brown sand with dense shell hash	Crepidula shells abundant	Red branching macroalgae and brown macroalgae attached	None present

Station	Characteristics	Biotic Benthic Activity	Aquatic Vegetation	Anthropogenic Debris/Fishing Activity
OECC-20-GB20	Brown medium sand with trace shell hash and dark subsurface layer	None present	None present	None present
OECC-20-GB21	Sand/gravel under dominant shell cover	Crepidula shells with encrusting organisms	Attached red, brown, and *Codium fragile* macroalgae	None present
OECC-20-GB22	Tan/brown to yellow sand with trace shell hash	None present	None present	None present
OECC-20-GB23	Brown/tan sand w/ gray anoxic layer 2 cm down	Crepidula covered in hydrozoans/bryozoans	Green and red macroalgae	None present
OECC-20-GB24	Tan/brown sand with shell debris	Coral, chitons, hydrozoa	Green macroalgae	None present
OECC-20-GB25	Tan-brown with shell debris, anoxic at 3 cm	Mussels, crepidula, hydrozoa	Some macroalgae	None present
OECC-20-GB26	Yellow/brown sand with shell hash	Yellow sponges	None present	None present
OECC-20-GB27	Failed three times, sandy gravel	None observed	Some macroalgae	None present
OECC-20-GB28	Sandy gravel with shell hash	Worm tubes, hydrozoa	None present	None present
OECC-20-GB29	Failed three times, gravel with some shell	Encrusting organisms	Attached red macroalgae	None present
OECC-20-GB30	Sandy gravel/cobble	Yellow sponges	Some macroalgae	None present
OECC-20-GB31	Failed three times, large cobble, too rocky to close	Encrusting organisms	Attached red macroalgae	None present
OECC-20-GB32	Failed three times, large cobble	Yellow sponge, encrusting organisms	Attached red macroalgae	None present
OECC-20-GB33	Tan-yellow sand, well-aerated	Little to no life present	None present	None present
OECC-20-GB34	Yellow large grain sand	None present	None present	None present
OECC-20-GB35	Sandy gravel w/ trace shells. Anoxic below 3 cm	Gobies, worm tubes, hydrozia/bryozoa	None present	None present
OECC-20-GB36	Failed three times, hard bottom	None present	Attached red macroalgae	None present
OECC-20-GB37	Coarse to medium brown sand	None present	None present	None present
OECC-20-GB38	Failed three times, mix of sand, cobble and shell	None observed	Some macroalgae	None present
OECC-20-GB39	Large cobble/gravel w/ fine sand	Encrusting organisms on gravel	Attached red branching macroalgae	None present
OECC-20-GB40	Failed three times. Mix of sand, cobble and shell	None observed	Attached red macroalgae	None present
OECC-20-GB41	Fine brown sand with dark surficial sand layer and shell hash	None present	Red macroalgae	None present
OECC-20-GB42	Coarse sand with large gravel and some shells	Encrusting organisms on larger grains/barnacles	None present	None present
OECC-20-GB43	Brown sand with gravel	Hermit crab	Macroalgae	None present
OECC-20-GB44	Fine brown sand with large shell hash	Large surf clam shell and crepidula hash	None present	None present

Station	Characteristics	Biotic Benthic Activity	Aquatic Vegetation	Anthropogenic Debris/Fishing Activity
OECC-20-GB45	Fine to medium sand with dense gravel and cobble. Dark surficial layer under fine sand	Crabs and hermit crabs on surface	None present	None present
OECC-20-GB46	Failed three times, large gravel/cobble prevented closure	Yellow sponge	Attached red macroalgae	None present
OECC-20-GB47	Failed three times, rock and algae in jaw	None observed	Some macroalgae	None present
OECC-20-GB48	Failed three times	None observed	Attached red macroalgae	None present
OECC-20-GB49	Failed three times, rock in jaw with sand/cobble and mussel shells and hermit crabs in sample bucket	None observed	Attached red macroalgae	None present
OECC-20-GB50	Failed three times from gravel in jaw. Partial sample of medium sand, gravel/cobble and hermit crabs	None observed	Attached red macroalgae	None present
OECC-20-GB51	Failed three times, gravel and algae stuck in jaws	Mussels	Attached red macroalgae	None present
OECC-20-GB52	Medium brown sand	Mussel bed	Red macroalgae	None present
OECC-20-GB53	Gravelly sand with shell hash	None present	Red macroalgae	None present
OECC-20-GB54	Coarse sand/gravel/shell hash over fine brown and gray sand very dark anoxic layer over coarse surface	None present	Floating red macroalgae	None present
OECC-20-GB55	Medium to coarse brown sand with trace shell hash	None present	None present	None present
OECC-20-GB56	Coarse sand with gravel and fine sand, gray to brown in color, dark anoxic layer under surface with dense mussel shells	Dense mussel shells, whelk on surface	Floating red macroalgae	None present
OECC-20-GB57	Medium brown sand	None present	Red macroalgae	None present
OECC-20-GB58	Medium brown sand	None present	None present	None present
OECC-20-GB59	Coarse sand with trace shell hash	None present	None present	None present
OECC-20-GB60	Coarse sand with trace shell hash	None present	None present	None present
OECC-20-GB61	Failed three times, gravel in jaws. Coarse sand with gravel/cobble in partial sample	None observed	Some macroalgae	None present
OECC-20-GB62	Medium brown sand	None present	None present	None present
OECC-20-GB63	Medium sand	None present	None present	None present
OECC-20-GB64	Medium brown sand	None present	None present	None present
OECC-20-GB65	Coarse sand with trace shell hash	None present	None present	None present
OECC-20-GB66	Yellow/orange coarse sand	None present	None present	None present

Station	Characteristics	Biotic Benthic Activity	Aquatic Vegetation	Anthropogenic Debris/Fishing Activity
OECC-20-GB67	Brown fine sand over dark mud, strong sulphur smell	Worm tubes on surface, many hermit crabs in sampler	None present	None present
OECC-20-GB68	Olive gray fine sand over dark gray mud with coarse sand and fine shell hash, strong anoxic smell	None present	None present	None present
OECC-20-GB69	Brown sandy mud over dark gray/black mud	None present	None present	None present
OECC-20-GB70	Brown fine sand with dark muddy subsurface	Fecal or burrowing deposits present	None present	None present
OECC-20-GB71	Brown sand with dark sublayer	Trace tube presence, hermit crab on surface, sand dollars	None present	None present
OECC-20-GB72	Olive gray fine sand with dark mud subsurface layer	Worm tubes and suspension feeding worms	None present	None present
OECC-20-GB73	Brown/yellow sand	Small filamentous worm tubes exposed	None present	None present
OECC-20-GB74	Black/brown anoxic mud below 1 cm, tan surface, strong sulphur smell	None present	None present	None present
OECC-20-GB75	Brown muddy sand	Some small filamentous worm tubes	None present	None present
OECC-20-GB76	Yellow/gray fine sand	Little to no life present	None present	None present
OECC-20-GB77	Medium to fine brown sand with trace shell hash	None present	None present	None present
OECC-20-GB78	Muddy tan/brown sand	Sand dollars on surface	None present	None present
OECC-20-GB79	Yellow/tan sand surface with gray anoxic sublayer	Sand dollars on surface, smallmouth flounder in grab	None present	None present
OECC-20-GB80	Tan very fine sand with shallow anoxic layer ~1cm down	Sand dollars on surface, some worm tubes	None present	None present
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SWDA-20-GB02	Olive gray muddy sand	Dense amphipod bed and worm tubes	None present	None present
SWDA-20-GB03	Gray/brown muddy sand	Amphipod burrows	None present	None present
SWDA-20-GB04	Yellow/brown sand	Fish in camera view, amphipod tubes	None present	None present
SWDA-20-GB05	2cm surface aerobic layer, tan/gray anoxic layer	Amphipod bed	None present	None present
SWDA-20-GB06	Brown fine sand with trace shell hash	Trace amphipod bed	None present	None present
SWDA-20-GB07	Olive gray sand	Worm tubes	None present	None present
SWDA-20-GB08	Brown/tan sand	Surf clam shell on surface	None present	None present

Station	Characteristics	Biotic Benthic Activity	Aquatic Vegetation	Anthropogenic Debris/Fishing Activity
SWDA-20-GB09	Olive gray muddy sand	Dense amphipod bed	None present	None present
SWDA-20-GB10	Yellow/brown/gray muddy sand	Some small worm tubes	None present	None present
SWDA-20-GB11	Gray/brown muddy sand	Sponge, amphipod and worm tube	None present	None present
SWDA-20-GB12	Gray/brown sand	Few small worm tubes	None present	None present
SWDA-20-GB13	Yellow/brown sand	None present	None present	None present
SWDA-20-GB14	Tan sand on surface, anoxic layer with black sulphur/decaying smell	None present	None present	None present
SWDA-20-GB15	Dark brown mud	Amphipod bed in mud	None present	None present
SWDA-20-GB16	Gray/brown muddy sand	None present	None present	None present
SWDA-20-GB17	Gray/brown sand with trace shell hash	Amphipod bed	None present	None present
SWDA-20-GB18	Yellow/brown sand with trace shell hash and darker anoxic layer 2 cm below	Small worm tubes	None present	None present
SWDA-20-GB19	Tan/gray sand on surface, gray anoxic layer below 3 cm	Worm and amphipod tubes	None present	None present
SWDA-20-GB20	Dark streaks below surface, sulphur smell	Sea stars, amphipods	None present	None present
SWDA-20-GB21	Shallow anoxic layer ~1 cm	Some small tubes	None present	None present
SWDA-20-GB22	Slight sulphur smell	Amphipod beds, worm tubes	None present	None present
SWDA-20-GB23	Yellow/gray sand	Amphipods, some worm tubes	None present	None present
SWDA-20-GB24	Yellow/brown sand	Fish on video looks to be silver hake	None present	None present
SWDA-20-GB25	Gray/brown sand	Amphipod beds	None present	None present
SWDA-20-GB26	Brown-gray top, gray anoxic layer 3 cm down	Amphipod bed	None present	None present
SWDA-20-GB27	Brown/gray mud	Amphipod and worm tubes	None present	None present
SWDA-20-GB28	Brown sand	Amphipod bed	None present	None present
SWDA-20-GB29	Brown sand, anoxic below ~4 cm	Sea stars and crab	None present	None present
SWDA-20-GB30	Gray sand	Some tubes	None present	None present
SWDA-20-GB31	Yellow/brown sand	Few small worm tubes	None present	None present
SWDA-20-GB32	Brown/gray sand	Few signs of life	None present	None present
SWDA-20-GB33	Yellow/tan sand, signs of anoxia 6-8cm down	Some small sand worm tubes	None present	None present
SWDA-20-GB34	Gray/brown sand	Amphipod tubes	None present	None present
SWDA-20-GB35	Gray/brown sand	Amphipod tube, 2 adult ocean quahogs (1 in core)	None present	None present
SWDA-20-GB36	Olive/gray silty mud	Worm tube and amphipod beds	None present	None present

Station	Characteristics	Biotic Benthic Activity	Aquatic Vegetation	Anthropogenic Debris/Fishing Activity
SWDA-20-GB37	Brown sand	Worms present on surface	None present	None present
SWDA-20-GB38	Gray/brown sand	Some amphipod tubes, some worm tubes	None present	None present
SWDA-20-GB39	Brown sand	Bioturbidity and structures	None present	None present
SWDA-20-GB40	Gray/brown sand	Some small worm tubes, sea star	None present	None present

APPENDIX C-1: GRAB SAMPLE IMAGES: SWDA

Table C-1. Images of SWDA grab samples A.) prior to sampling B.) immediately after recovery/draining, and C.) core sample for sediment grain size percent composition analysis. NMFS Modified CMECS (2020), NMFS Complex Habitat classification, and d50 (median grain size, or closest reported such as d60 or d85 for muddy samples) reported below images.

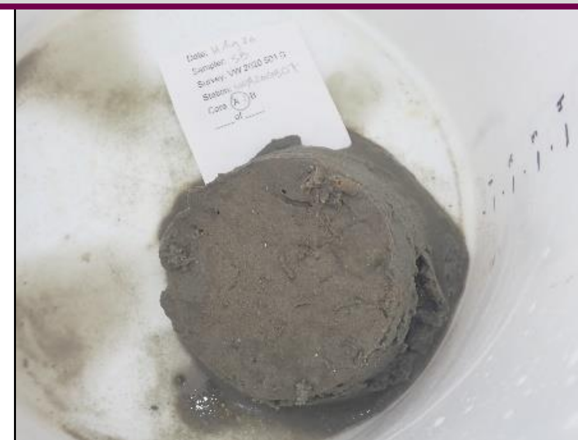
Station	A.	B.	C.
[redacted]			
SWDA20-GB-02	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1792 mm

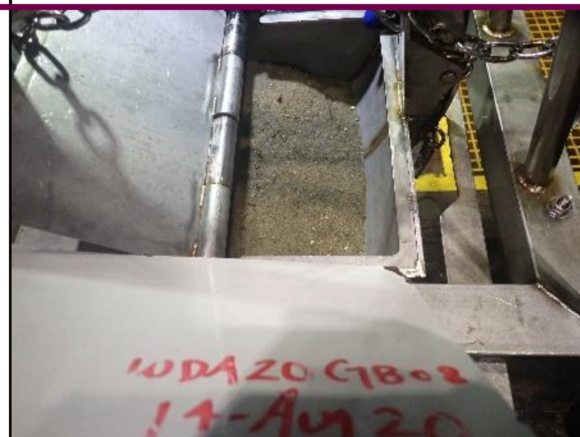
Station	A.	B.	C.
SWDA20-GB-03	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1603 mm
SWDA20-GB-04	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3803 mm

Station	A.	B.	C.
SWDA20-GB-05	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1064 mm
SWDA20-GB-06	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3656 mm

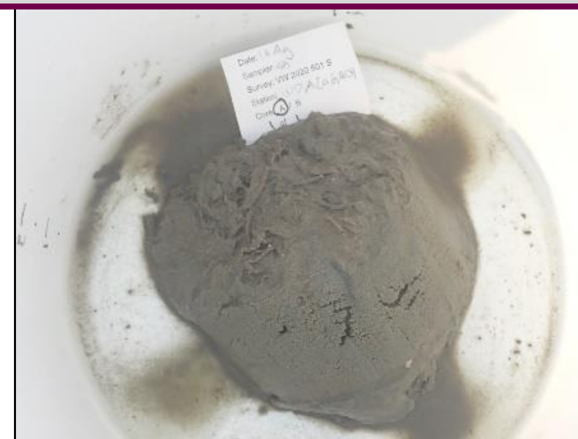
<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>SWDA20-
GB-07</td><td>

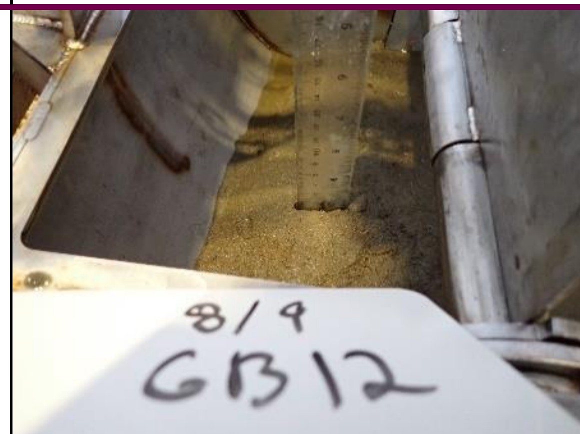
NMFS CMECS (modified):
Fine/Very Fine Sand</td><td>

NMFS Complex Habitat: No</td><td>
d50 = 0.2071 mm</td></tr>
<tr><td>SWDA20-
GB-08</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>

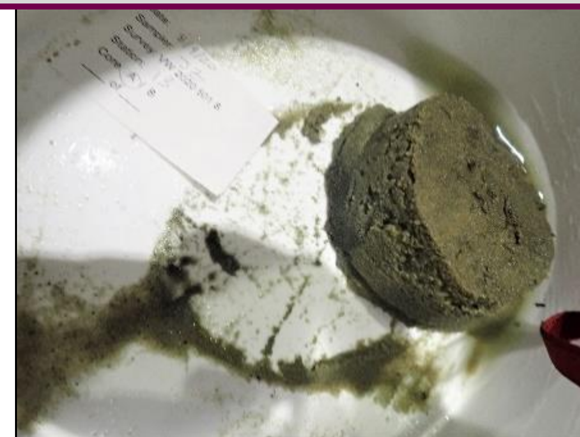
NMFS Complex Habitat: No</td><td>
d50 = 0.6455 mm</td></tr>
</table>

Station	A.	B.	C.
SWDA20-GB-09	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1815 mm
SWDA20-GB-10	 NMFS CMECS (modified): Fine/Very Fine Sand	 NMFS Complex Habitat: No	 d50 = 0.2316 mm

Station	A.	B.	C.
SWDA20-GB-11	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1821 mm
SWDA20-GB-12	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.4340 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>SWDA20-GB-13</td><td>

NMFS CMECS (modified):
Medium Sand</td><td>

NMFS Complex Habitat: No</td><td>
d50 = 0.3271 mm</td></tr>
<tr><td>SWDA20-GB-14</td><td>

NMFS CMECS (modified):
Mud</td><td>

NMFS Complex Habitat: No</td><td>
d50 = N/A mm</td></tr>
</table>

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>SWDA20-GB-15</td><td>

NMFS CMECS (modified):
Muddy Sand</td><td>

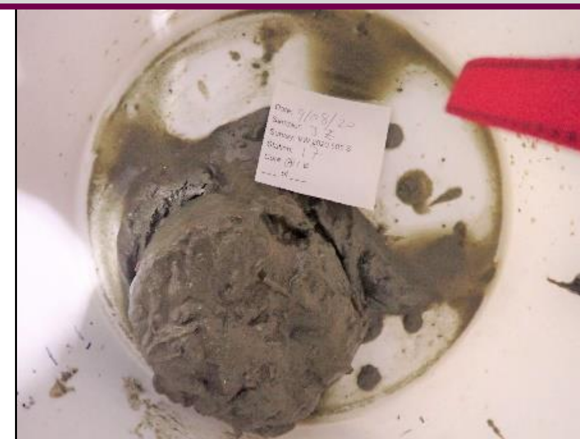
NMFS Complex Habitat: No</td><td>
d50 = 0.1440 mm</td></tr>
<tr><td>SWDA20-GB-16</td><td>

NMFS CMECS (modified):
Medium Sand</td><td>

NMFS Complex Habitat: No</td><td>
d50 = 0.3887 mm</td></tr>
</table>

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>SWDA20-
GB-17</td><td>

NMFS CMECS (modified):
Muddy Sand</td><td>

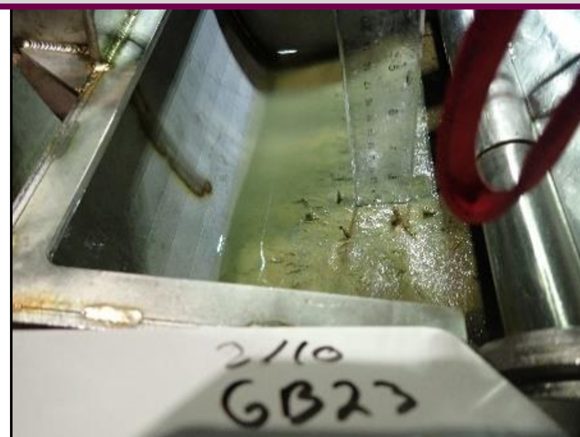
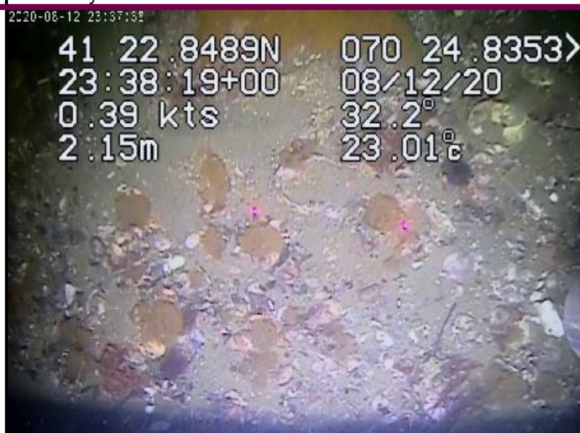
NMFS Complex Habitat: No</td><td>
d50 = 0.1585 mm</td></tr>
<tr><td>SWDA20-
GB-18</td><td>

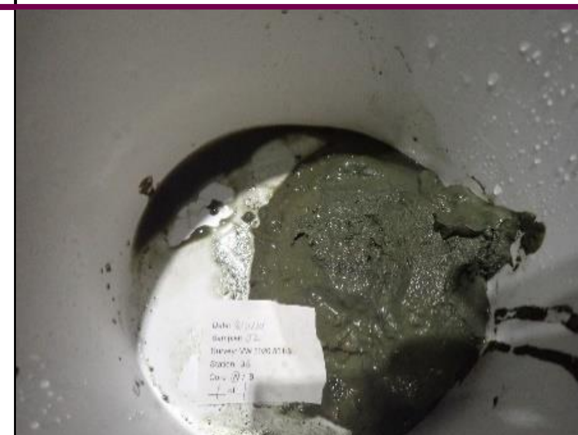
NMFS CMECS (modified):
Fine/Very Fine Sand</td><td>

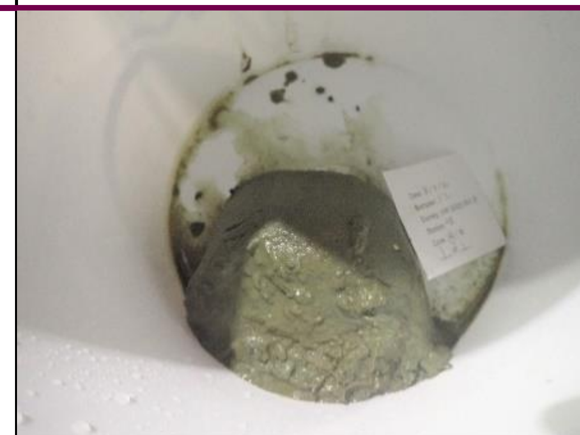
NMFS Complex Habitat: No</td><td>
d50 = 0.2431 mm</td></tr>
</table>

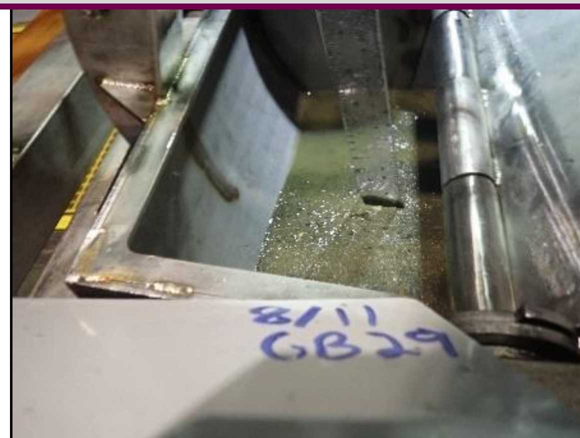
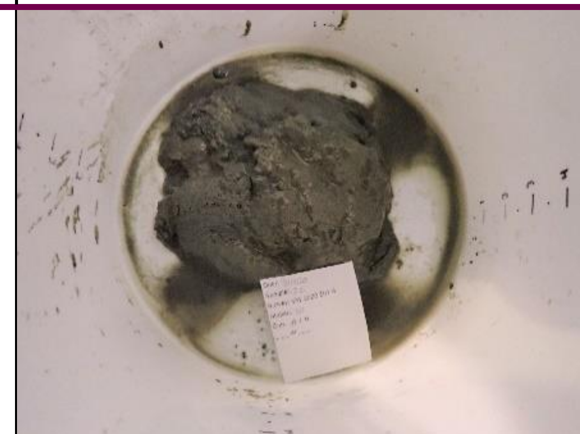
Station	A.	B.	C.
SWDA20-GB-19	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1630 mm
SWDA20-GB-20	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.0859 mm

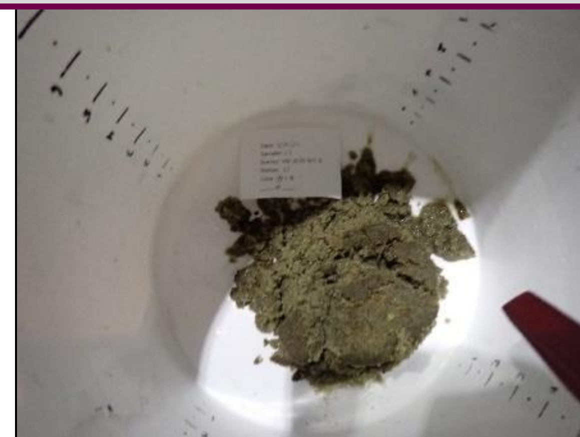
Station	A.	B.	C.
SWDA20-GB-21	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.5725 mm
SWDA20-GB-22	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1475 mm

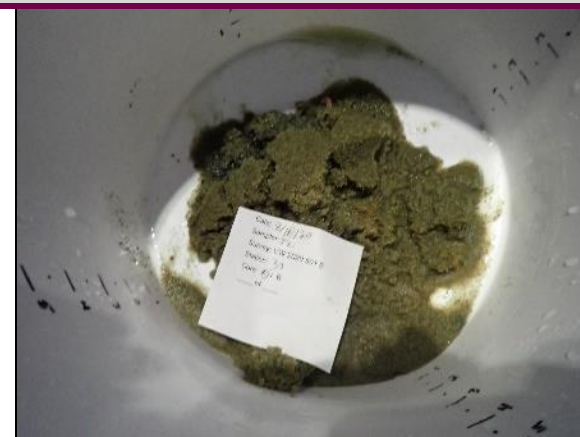
Station	A.	B.	C.
SWDA20-GB-23	 NMFS CMECS (modified): Fine/Very Fine Sand	 NMFS Complex Habitat: No	 d50 = 0.2340 mm
SWDA20-GB-24	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5627 mm

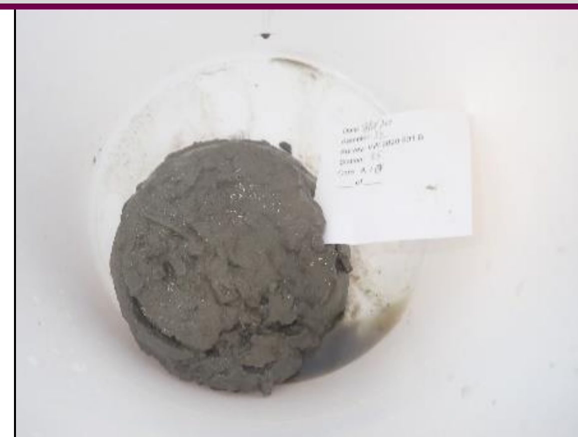
Station	A.	B.	C.
SWDA20-GB-25	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.2008 mm
SWDA20-GB-26	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1097 mm

Station	A.	B.	C.
SWDA20-GB-27	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.2000 mm
SWDA20-GB-28	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1833 mm

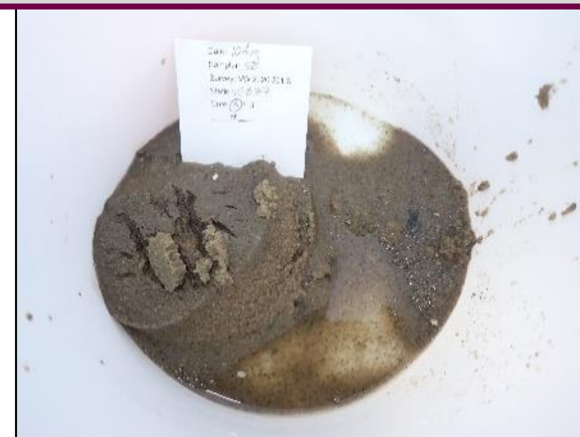
Station	A.	B.	C.
SWDA20-GB-29	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5031 mm
SWDA20-GB-30	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.0882 mm

Station	A.	B.	C.
SWDA20-GB-31	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5118 mm
SWDA20-GB-32	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5398 mm

Station	A.	B.	C.
SWDA20-GB-33	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5440 mm
SWDA20-GB-34	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1838 mm

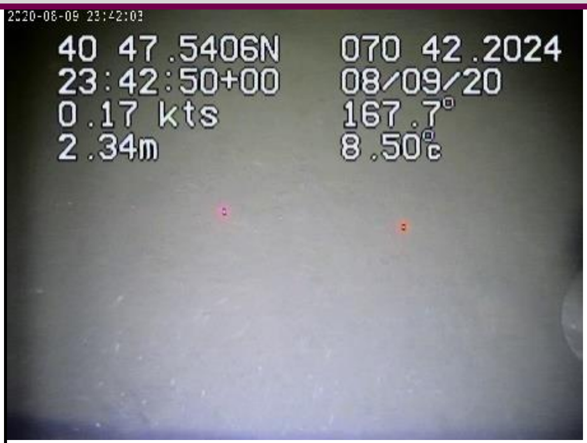
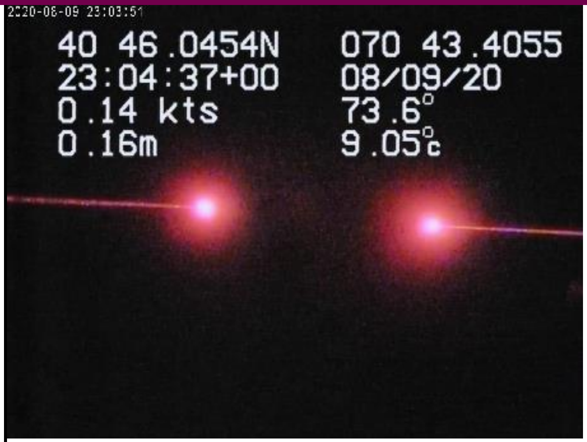
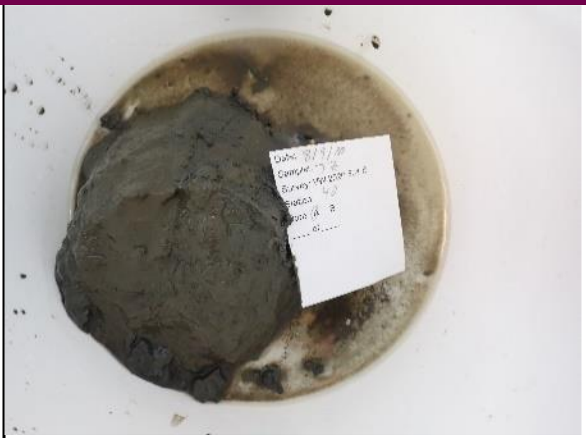
Station	A.	B.	C.
SWDA20-GB-35	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1892 mm
SWDA20-GB-36	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1839 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr>
<td>SWDA20-GB-37</td>
<td>

NMFS CMECS (modified):
Medium Sand</td>
<td>
NMFS Complex Habitat: No</td>
<td>
d50 = 0.3931 mm</td>
</tr>
<tr>
<td>SWDA20-GB-38</td>
<td>

NMFS CMECS (modified):
Muddy Sand</td>
<td>

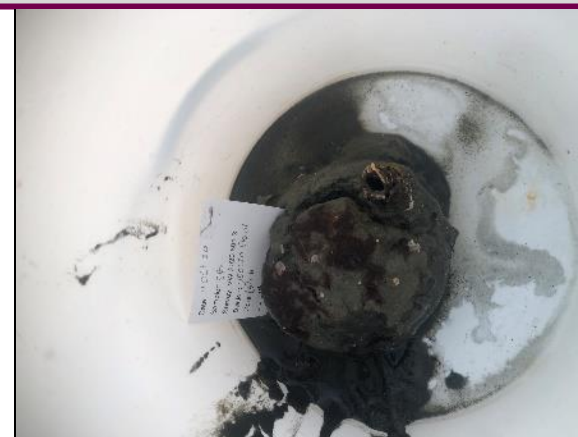
NMFS Complex Habitat: No</td>
<td>
d50 = 0.0753 mm</td>
</tr>
</table>

Station	A.	B.	C.
SWDA20-GB-39	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.4496 mm
SWDA20-GB-40	 NMFS CMECS (modified): Sandy Mud	 NMFS Complex Habitat: No	 d85 = 0.1281 mm

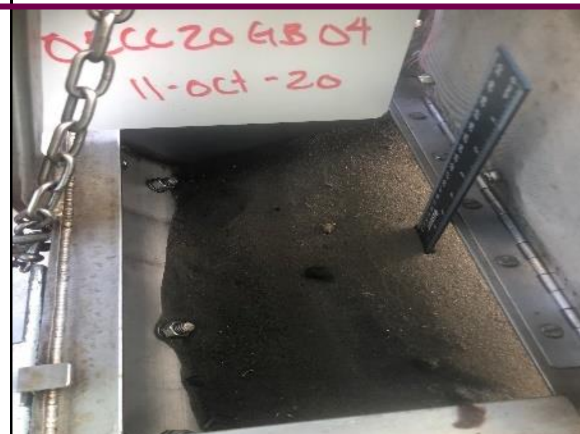
APPENDIX C-2: GRAB SAMPLE IMAGES: OECC

Table C-2. Images of OECC grab samples A.) prior to sampling B.) immediately after recovery/draining, and C.) core sample for sediment grain size percent composition analysis. NMFS Modified CMECS (2020), NMFS Complex Habitat classification, and d50 (median grain size, or closest reported such as d60 or d85 for muddy samples) reported below images.

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-01</td><td>

NMFS CMECS (modified): Muddy Sand</td><td>
NMFS Complex Habitat: No</td><td>
d50 = 0.0963 mm</td></tr>
<tr><td>OECC20-GB-02</td><td>

NMFS CMECS (modified): Shell Hash</td><td>
NMFS Complex Habitat: Yes</td><td>
d50 = 0.1778 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-03	 NMFS CMECS (modified): Gravelly Mud (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d60 = 0.0784 mm
OECC20-GB-04	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3343 mm

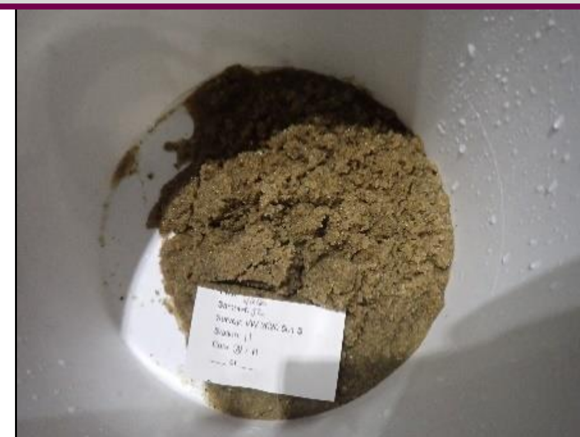
Station	A.	B.	C.
OECC20-GB-05	 NMFS CMECS (modified): Shell Hash (Crepidula)	 NMFS Complex Habitat: Yes	 d50 = 0.7344 mm
OECC20-GB-06	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.2733 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-07</td><td>
NMFS CMECS (modified): Fine/Very Fine Sand</td><td>
NMFS Complex Habitat: No</td><td>
d50 = 0.1755 mm</td></tr>
<tr><td>OECC20-GB-08</td><td>
NMFS CMECS (modified): Fine/Very Fine Sand</td><td>
NMFS Complex Habitat: No</td><td>
d50 = 0.1983 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-09	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3131 mm
OECC20-GB-10	 NMFS CMECS (modified): Shell Hash (Crepidula)	 NMFS Complex Habitat: Yes	 d50 = 0.5319 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr>
<td>OECC20-GB-11</td>
<td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td>
<td>

NMFS Complex Habitat: No</td>
<td>
d50 = 0.5732 mm</td>
</tr>
<tr>
<td>OECC20-GB-12</td>
<td>

NMFS CMECS (modified):
Shell Hash</td>
<td>

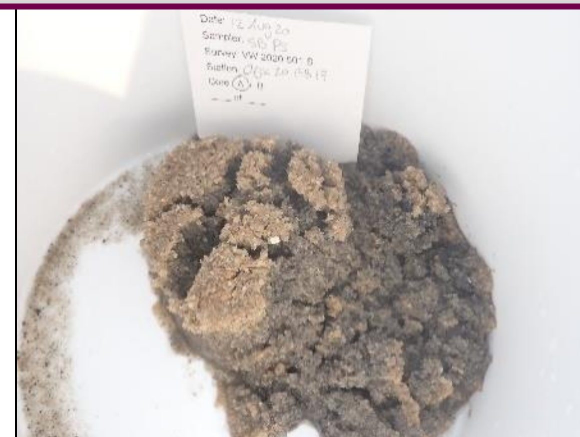
NMFS Complex Habitat: Yes</td>
<td>
d50 = 0.5444 mm</td>
</tr>
</table>

Station	A.	B.	C.
OECC20-GB-13	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.5616 mm
OECC20-GB-14	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3344 mm

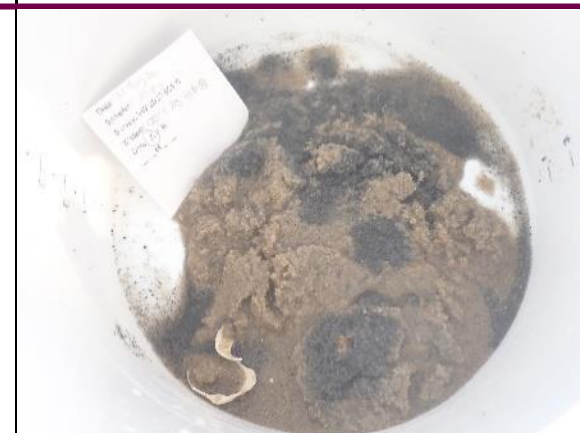
Station	A.	B.	C.
OECC20-GB-15	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3517 mm
OECC20-GB-16	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.4656 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-17</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>

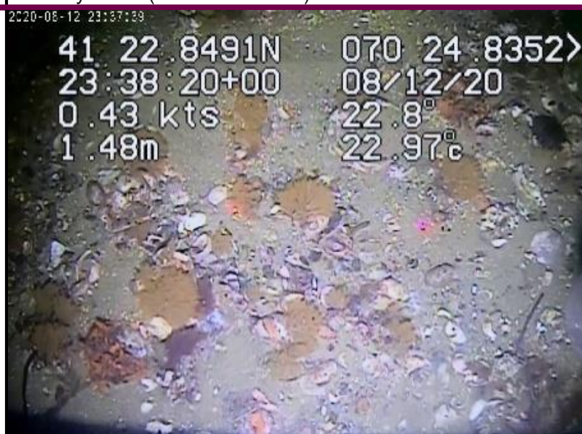
NMFS Complex Habitat: No</td><td>
d50 = 0.5831 mm</td></tr>
<tr><td>OECC20-GB-18</td><td>

NMFS CMECS (modified):
Medium Sand</td><td>

NMFS Complex Habitat: No</td><td>
d50 = 0.4476 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-19	 NMFS CMECS (modified): Shell Hash (Crepidula)	 NMFS Complex Habitat: Yes	 d50 = 2.2023 mm
OECC20-GB-20	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3724 mm

Station	A.	B.	C.
OECC20-GB-21	 NMFS CMECS (modified): Shell Hash (Crepidula)	 NMFS Complex Habitat: Yes	 d50 = 1.1906 mm
OECC20-GB-22	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3444 mm

Station	A.	B.	C.
OECC20-GB-23	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.214 mm
OECC20-GB-24	 NMFS CMECS (modified): Shell Hash (Crepidula)	 NMFS Complex Habitat: Yes	 d50 = 0.6071 mm

Station	A.	B.	C.
OECC20-GB-25	 NMFS CMECS (modified): Shell Hash	 NMFS Complex Habitat: Yes	 d50 = 0.5533 mm
OECC20-GB-26	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.5878 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-
GB-27</td><td>

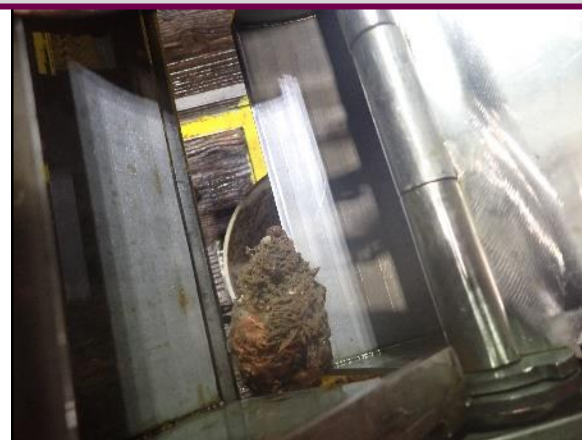
NMFS CMECS (modified):
Sandy Gravel (Pebble/Granule)</td><td>

NMFS Complex Habitat: Yes</td><td>Insufficient sediment recovery</td></tr>
<tr><td>OECC20-
GB-28</td><td>

NMFS CMECS (modified):
Sandy Gravel (Pebble/Granule)</td><td>

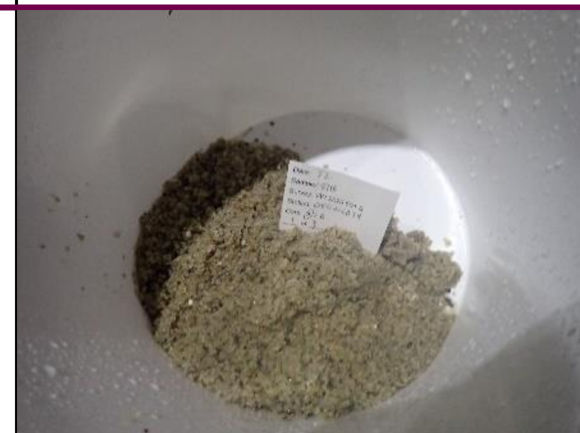
NMFS Complex Habitat: Yes</td><td>
d50 = 3.0847 mm</td></tr>
</table>

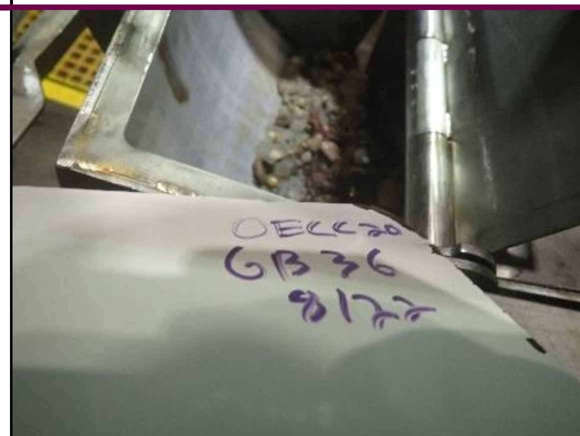
Station	A.	B.	C.
OECC20-GB-29	 NMFS CMECS (modified): Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery
OECC20-GB-30	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 13.1747 mm

Station	A.	B.	C.
OECC20-GB-31	 NMFS CMECS (modified): Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery
OECC20-GB-32	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery

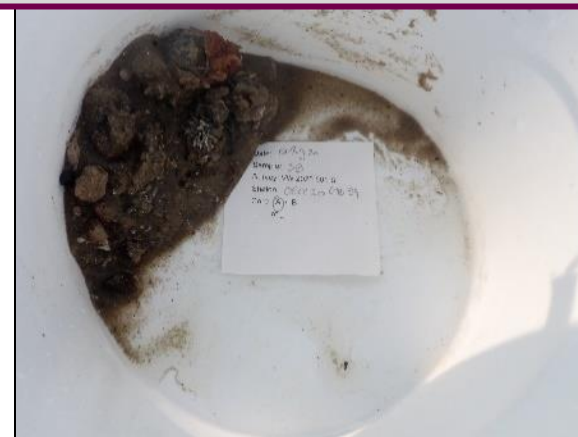
<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-
GB-33</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>
NMFS Complex Habitat: No</td><td>
d50 = 0.5554 mm</td></tr>
<tr><td>OECC20-
GB-34</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>
NMFS Complex Habitat: No</td><td>
d50 = 0.6703 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-35	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 1.8059 mm
OECC20-GB-36	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat:	Insufficient sediment recovery

Station	A.	B.	C.
OECC20-GB-37	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5416 mm
OECC20-GB-38	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery

Station	A.	B.	C.
OECC20-GB-39	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.3213 mm
OECC20-GB-40	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-41</td><td>

NMFS CMECS (modified): Medium Sand</td><td>

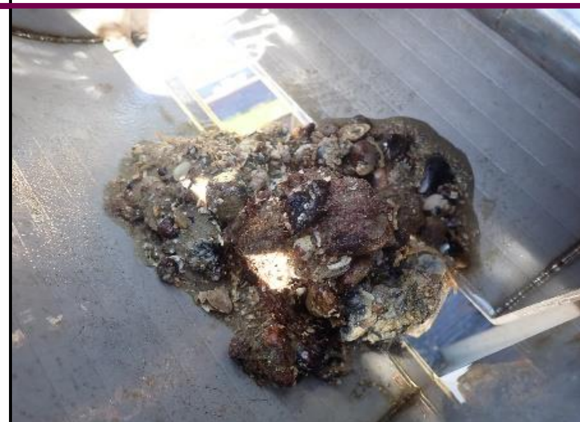
NMFS Complex Habitat: No</td><td>
d50 = 0.2533 mm</td></tr>
<tr><td>OECC20-GB-42</td><td>

NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)</td><td>

NMFS Complex Habitat: Yes</td><td>
d50 = 1.506 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-43	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.3419 mm
OECC20-GB-44	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.8095 mm

Station	A.	B.	C.
OECC20-GB-45	 NMFS CMECS (modified): Shell Hash	 NMFS Complex Habitat: Yes	 d50 = 7.7342 mm
OECC20-GB-46	 NMFS CMECS (modified): Gravel	 NMFS Complex Habitat: Yes	Insufficient sediment recovery

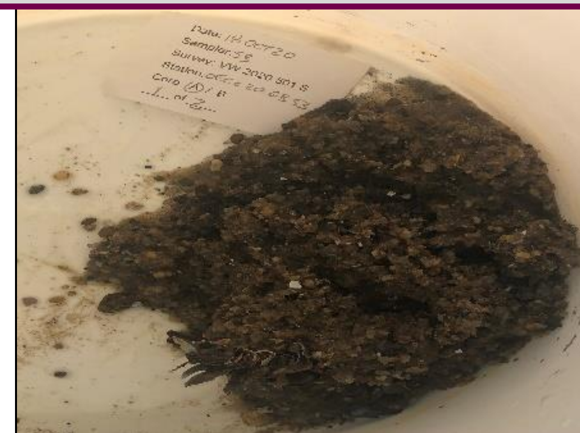
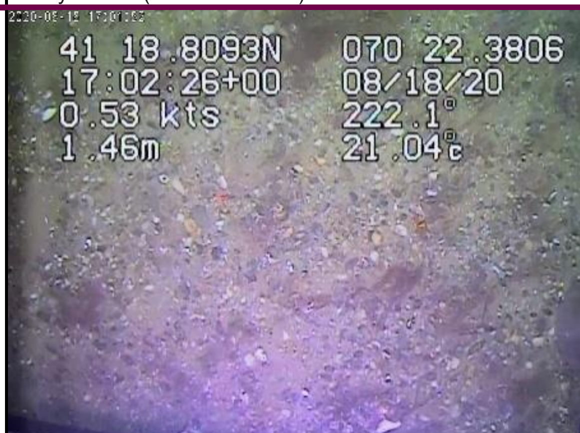
Station	A.	B.	C.
OECC20-GB-47	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery
OECC20-GB-48	 NMFS CMECS (modified): Gravel Pavement	 NMFS Complex Habitat: Yes	Insufficient sediment recovery

Station	A.	B.	C.
OECC20-GB-49	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery
OECC20-GB-50	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery

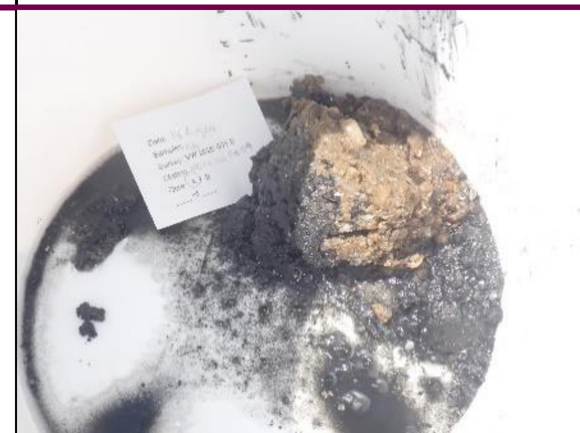
Station	A.	B.	C.
OECC20-GB-51	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	Insufficient sediment recovery
OECC20-GB-52	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.5092 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-53</td><td>

NMFS CMECS (modified):
Sandy Gravel (Pebble/Granule)</td><td>

NMFS Complex Habitat: Yes</td><td>
d50 = 2.0796 mm</td></tr>
<tr><td>OECC20-GB-54</td><td>

NMFS CMECS (modified):
Sandy Gravel (Pebble/Granule)</td><td>

NMFS Complex Habitat: Yes</td><td>
d50 = 1.2124 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-55	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: Yes	 d50 = 0.7813 mm
OECC20-GB-56	 NMFS CMECS (modified): Sandy Gravel (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 0.909 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-57</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>
NMFS Complex Habitat: No</td><td>
d50 = 0.562 mm</td></tr>
<tr><td>OECC20-GB-58</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>

NMFS Complex Habitat: No</td><td>
d50 = 0.5596 mm</td></tr>
</table>

Station	A.	B.	C.
OECC20-GB-59	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 1.1793 mm
OECC20-GB-60	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.8325 mm

<table>
<tr><th>Station</th><th>A.</th><th>B.</th><th>C.</th></tr>
<tr><td>OECC20-GB-61</td><td>

NMFS CMECS (modified):
Sandy Gravel (Pebble/Granule)</td><td>

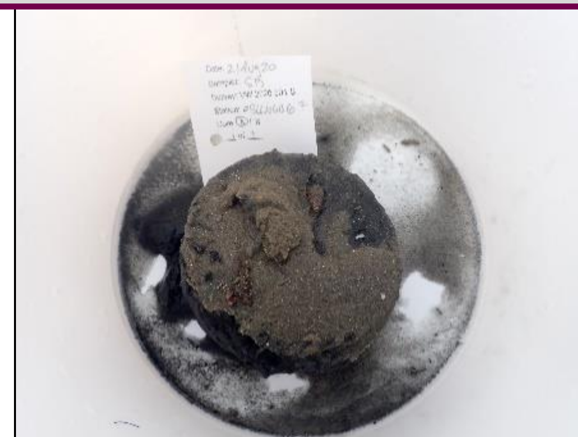
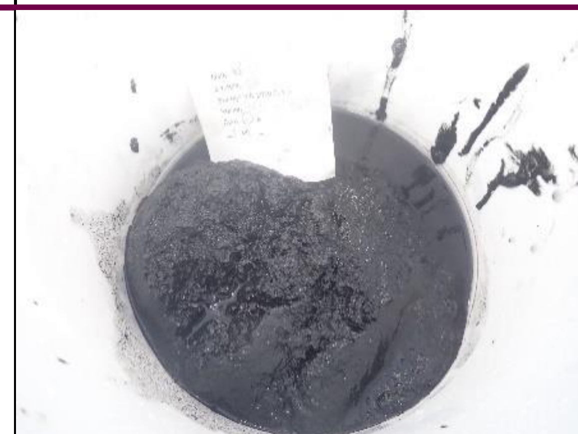
NMFS Complex Habitat: Yes</td><td>Insufficient sediment recovery</td></tr>
<tr><td>OECC20-GB-62</td><td>

NMFS CMECS (modified):
Very Coarse/Coarse Sand</td><td>

NMFS Complex Habitat: No</td><td>
d50 = 0.6185 mm</td></tr>
</table>

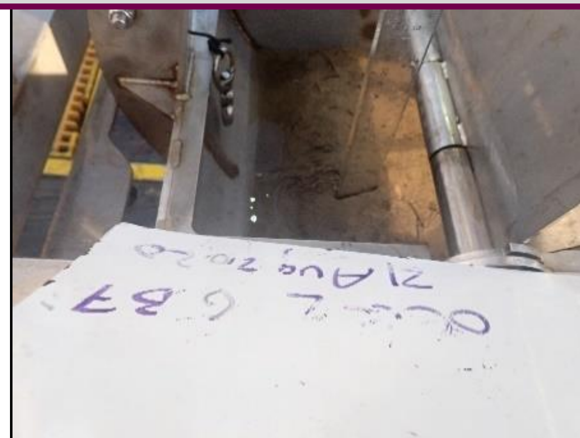
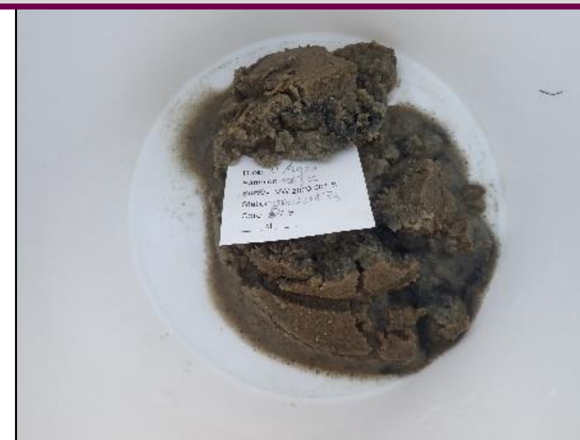
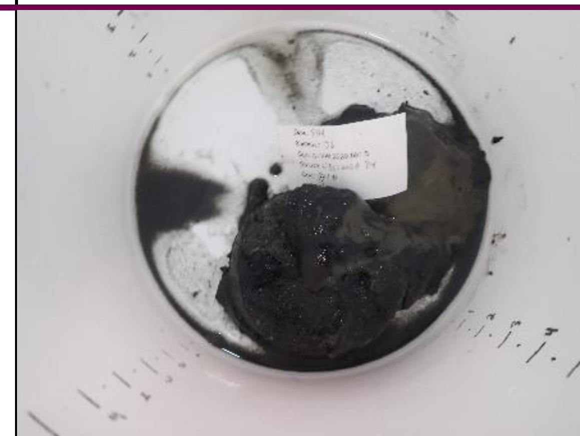
Station	A.	B.	C.
OECC20-GB-63	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.6387 mm
OECC20-GB-64	 NMFS CMECS (modified): Very Coarse/Coarse Sand	 NMFS Complex Habitat: No	 d50 = 0.696 mm

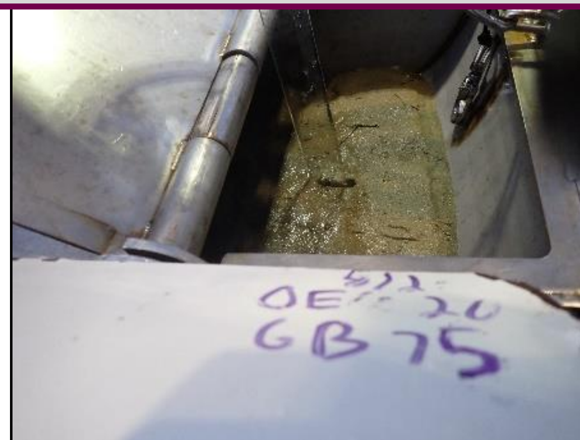
Station	A.	B.	C.
OECC20-GB-65	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 1.1794 mm
OECC20-GB-66	 NMFS CMECS (modified): Gravelly Sand (Pebble/Granule)	 NMFS Complex Habitat: Yes	 d50 = 1.053 mm

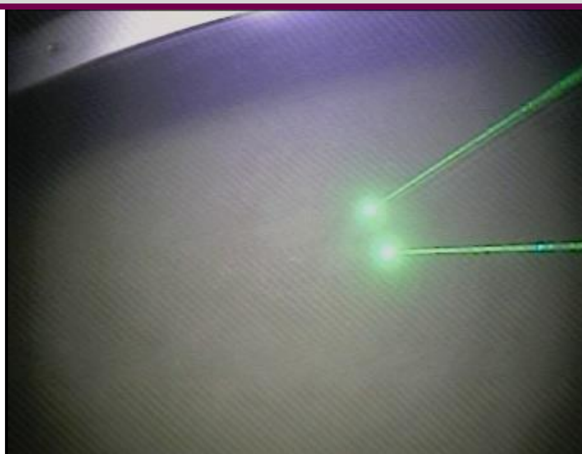
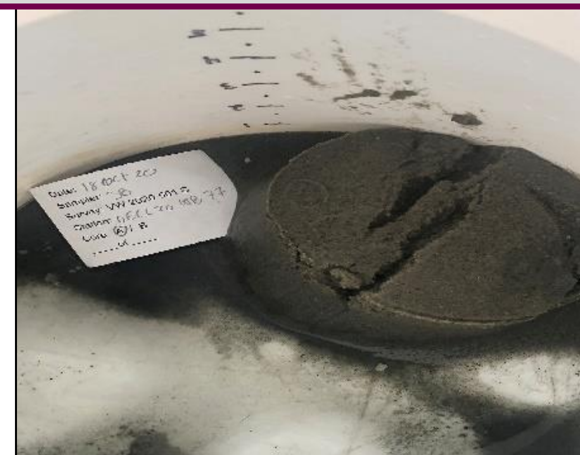
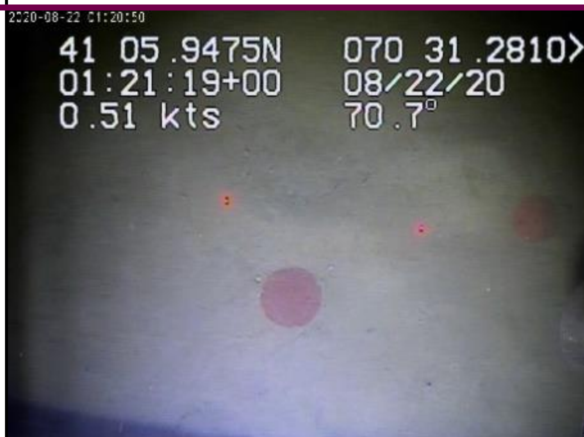
Station	A.	B.	C.
OECC20-GB-67	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 1.1826 mm
OECC20-GB-68	 NMFS CMECS (modified): Sandy Mud	 NMFS Complex Habitat: No	 d85 = 0.0934 mm

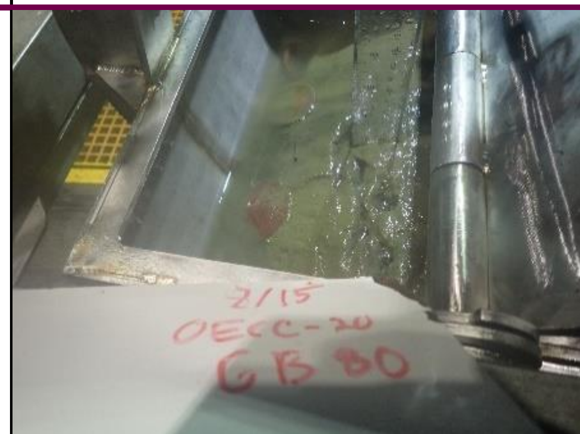
Station	A.	B.	C.
OECC20-GB-69	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.7454 mm
OECC20-GB-70	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3785 mm

Station	A.	B.	C.
OECC20-GB-71	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.4197 mm
OECC20-GB-72	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1833 mm

Station	A.	B.	C.
OECC20-GB-73	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.3567 mm
OECC20-GB-74	 NMFS CMECS (modified): Sandy Mud	 NMFS Complex Habitat: No	 d85 = 0.2441 mm

Station	A.	B.	C.
OECC20-GB-75	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.2853 mm
OECC20-GB-76	 NMFS CMECS (modified): Fine/Very Fine Sand	 NMFS Complex Habitat: No	 d50 = 0.2276 mm

Station	A.	B.	C.
OECC20-GB-77	 NMFS CMECS (modified): Medium Sand	 NMFS Complex Habitat: No	 d50 = 0.2534 mm
OECC20-GB-78	 NMFS CMECS (modified): Fine/Very Fine Sand	 NMFS Complex Habitat: No	 d50 = 0.2015 mm

Station	A.	B.	C.
OECC20-GB-79	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.1842 mm
OECC20-GB-80	 NMFS CMECS (modified): Muddy Sand	 NMFS Complex Habitat: No	 d50 = 0.0941 mm

APPENDIX D: CMECS CLASSIFICATION MAPS FOR GRABS AND VIDEO TRANSECTS

Please see accompanying PDF file.

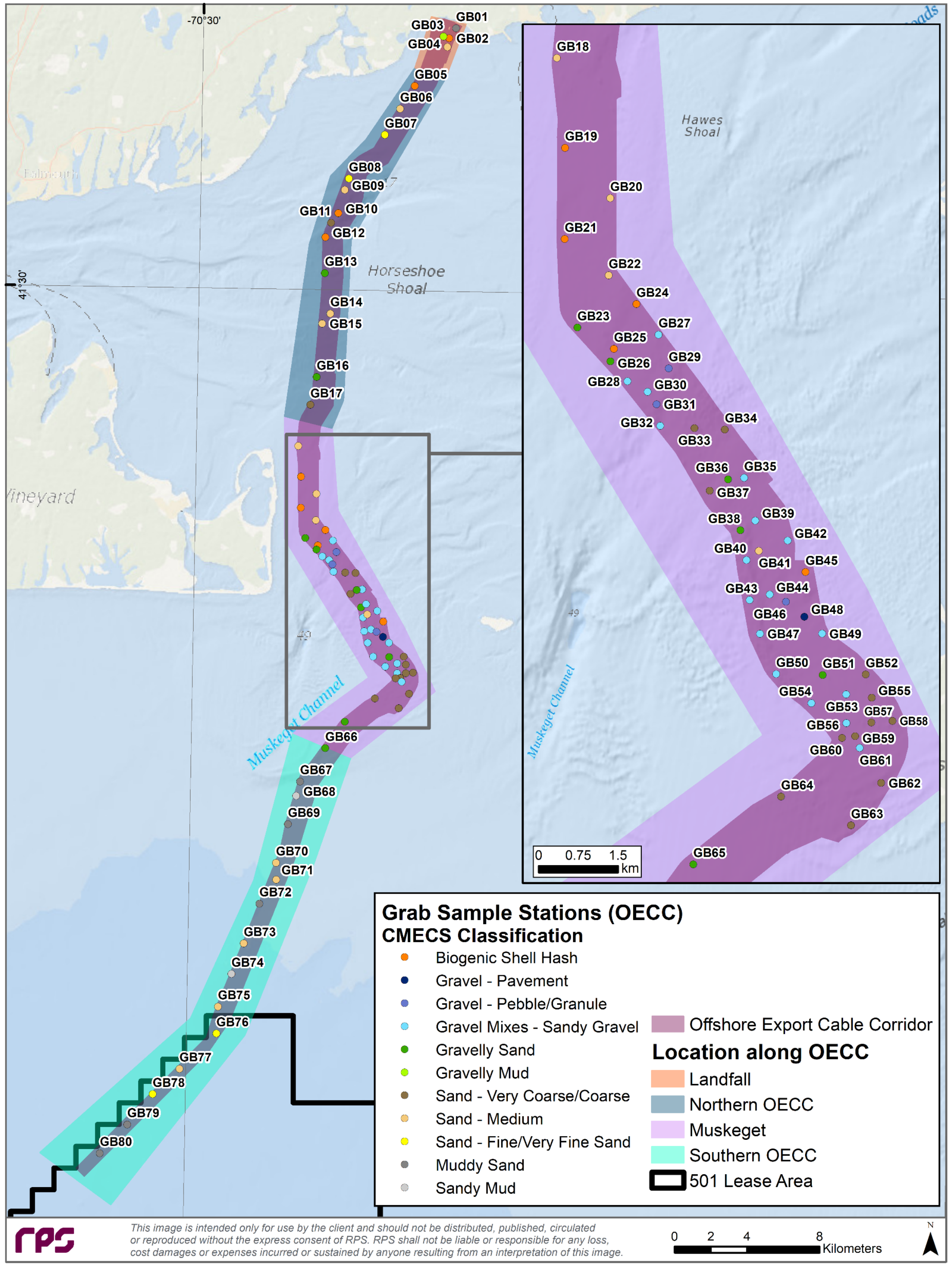
CMECS Classifications for Grab Samples and Still Images Derived from Video Analysis

RPS, Delivered 06/07/2021

Slides 2 – 3 = CMECS classifications at grab sample stations within OECC and SWDA
Slide 4 = Overview map with all video transect locations
Slides 5 – 19 = CMECS classifications along video transects within OECC – Northern region
Slides 20 – 54 = CMECS classifications along video transects within OECC – Muskeget Channel region
Slides 55 – 67 = CMECS classifications along video transects within OECC – Southern region
Slides 66 – 79 = CMECS classifications along video transects within SWDA

Legend abbreviations: B = boulder, C = cobble, PG = pebble/granule, and SM = sand/mud

MAKING COMPLEX EASY



-70°30'
41°30'
GB01
GB02
GB03
GB04
GB05
GB06
GB07
GB08
GB09
GB10
GB11
GB12
GB13
GB14
GB15
GB16
GB17
Horseshoe Shoal
Vineyard
Muskeget Channel
GB66
GB67
GB68
GB69
GB70
GB71
GB72
GB73
GB74
GB75
GB76
GB77
GB78
GB79
GB80
GB18
GB19
Hawes Shoal
GB20
GB21
GB22
GB23
GB24
GB25
GB26
GB27
GB28
GB29
GB30
GB31
GB32
GB33
GB34
GB35
GB36
GB37
GB38
GB39
GB40
GB41
GB42
GB43
GB44
GB45
GB46
GB47
GB48
GB49
GB50
GB51
GB52
GB53
GB54
GB55
GB56
GB57
GB58
GB59
GB60
GB61
GB62
GB63
GB64
GB65
0 0.75 1.5 km
Grab Sample Stations (OECC)
CMECS Classification
Biogenic Shell Hash
Gravel - Pavement
Gravel - Pebble/Granule
Gravel Mixes - Sandy Gravel
Gravelly Sand
Gravelly Mud
Sand - Very Coarse/Coarse
Sand - Medium
Sand - Fine/Very Fine Sand
Muddy Sand
Sandy Mud
Offshore Export Cable Corridor
Location along OECC
Landfall
Northern OECC
Muskeget
Southern OECC
501 Lease Area
rps
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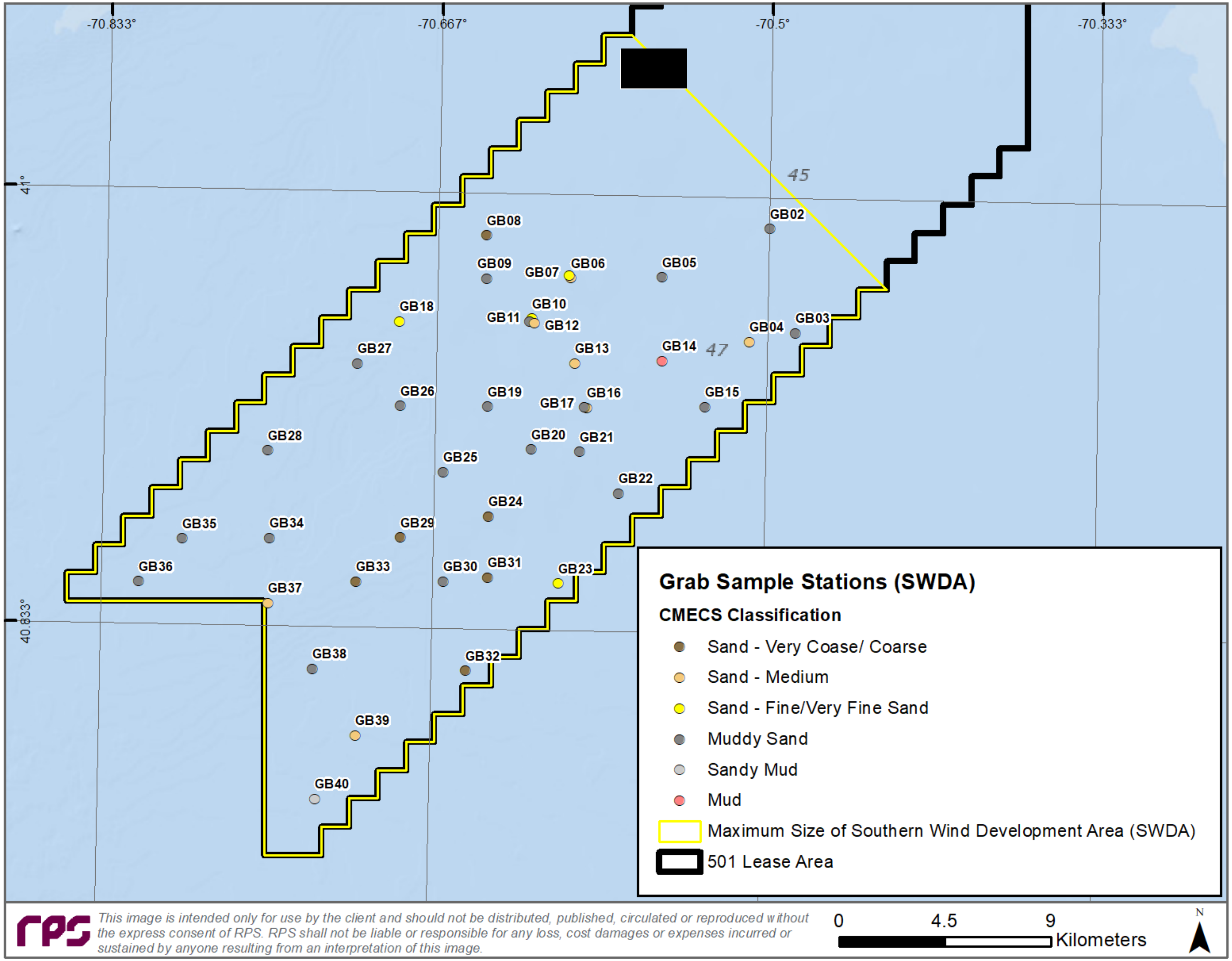
0 2 4 8 Kilometers
N


-70.833°
-70.667°
-70.5°
-70.333°
41°
40.833°
[redacted]
45
47
GB02
GB03
GB04
GB05
GB06
GB07
GB08
GB09
GB10
GB11
GB12
GB13
GB14
GB15
GB16
GB17
GB18
GB19
GB20
GB21
GB22
GB23
GB24
GB25
GB26
GB27
GB28
GB29
GB30
GB31
GB32
GB33
GB34
GB35
GB36
GB37
GB38
GB39
GB40
Grab Sample Stations (SWDA)
CMECS Classification
Sand - Very Coase/ Coarse
Sand - Medium
Sand - Fine/Very Fine Sand
Muddy Sand
Sandy Mud
Mud
Maximum Size of Southern Wind Development Area (SWDA)
501 Lease Area
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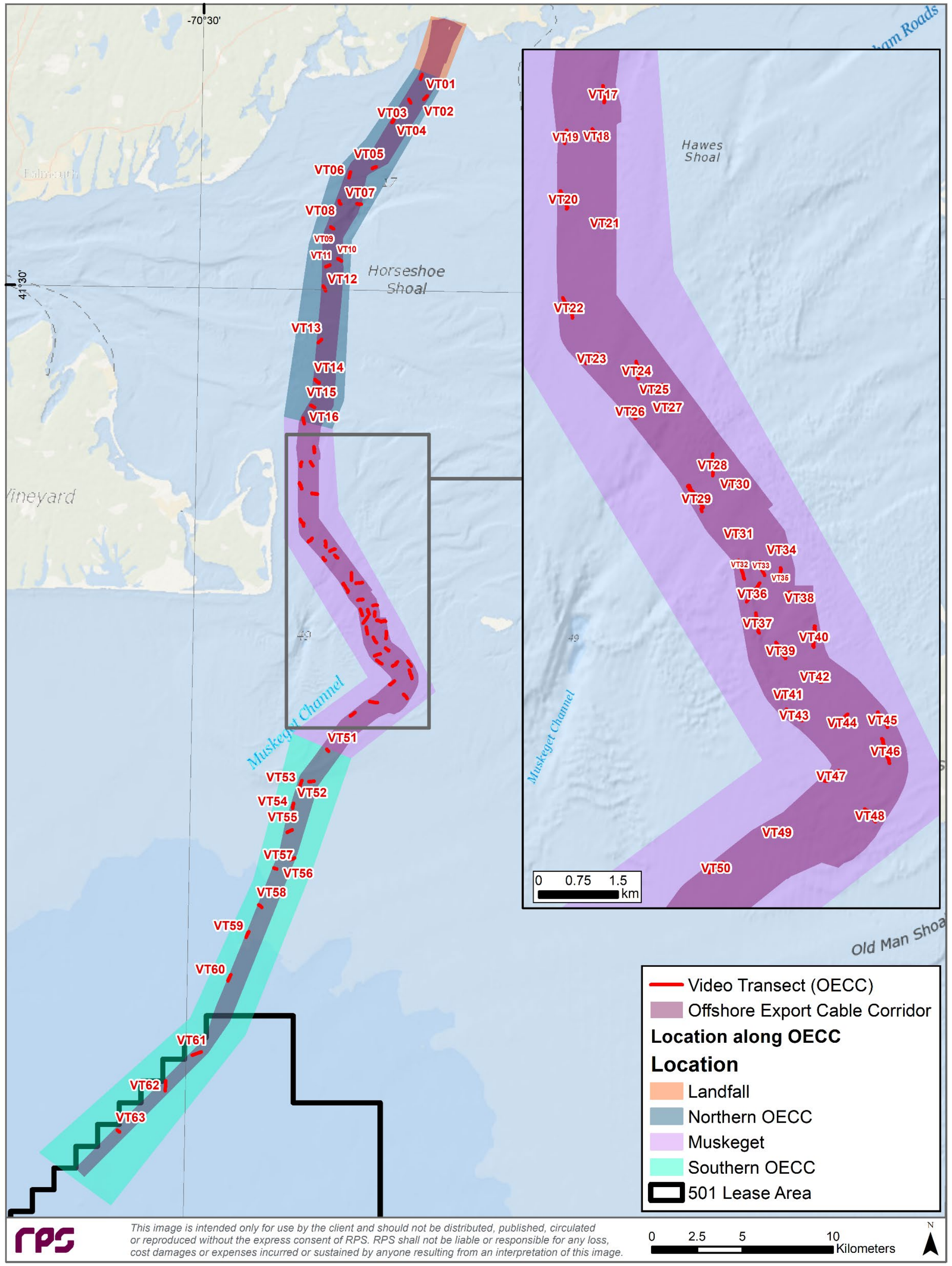
0
4.5
9
Kilometers
N



-70°30'
41°30'
Horseshoe Shoal
Hawes Shoal
Muskeget Channel
Old Man Shoal
Vineyard
VT01
VT02
VT03
VT04
VT05
VT06
VT07
VT08
VT09
VT10
VT11
VT12
VT13
VT14
VT15
VT16
VT17
VT18
VT19
VT20
VT21
VT22
VT23
VT24
VT25
VT26
VT27
VT28
VT29
VT30
VT31
VT32
VT33
VT34
VT35
VT36
VT37
VT38
VT39
VT40
VT41
VT42
VT43
VT44
VT45
VT46
VT47
VT48
VT49
VT50
VT51
VT52
VT53
VT54
VT55
VT56
VT57
VT58
VT59
VT60
VT61
VT62
VT63
0 0.75 1.5 km
Video Transect (OECC)
Offshore Export Cable Corridor
Location along OECC
Location
Landfall
Northern OECC
Muskeget
Southern OECC
501 Lease Area
rps
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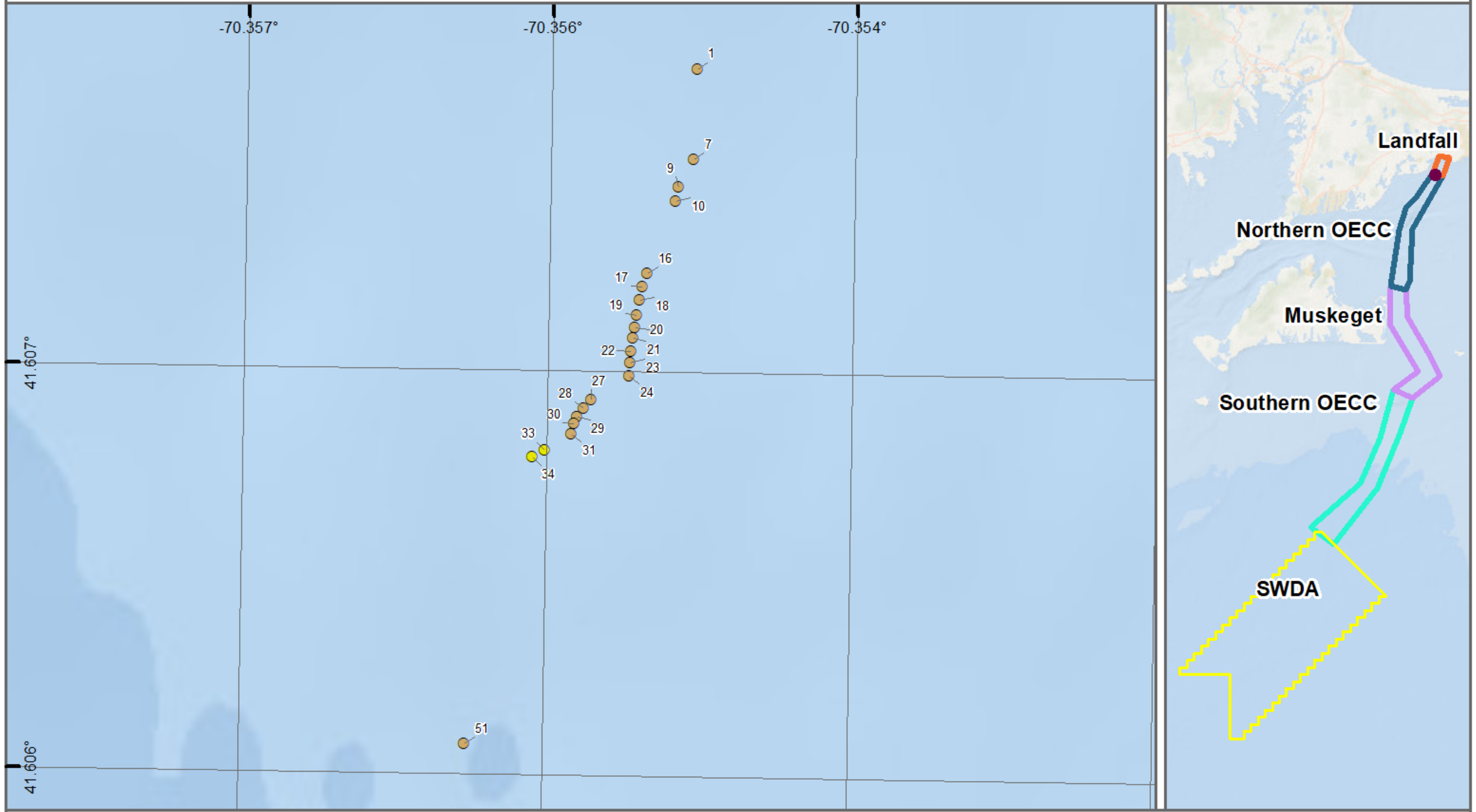
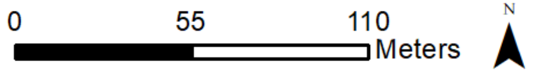
0 2.5 5 10 Kilometers
N

OECC Zone: Northern OECC Transect: OECC20-VT-01



CMECS Classification

- Gravelly Sand/Mud with P/G
- Sand/Mud



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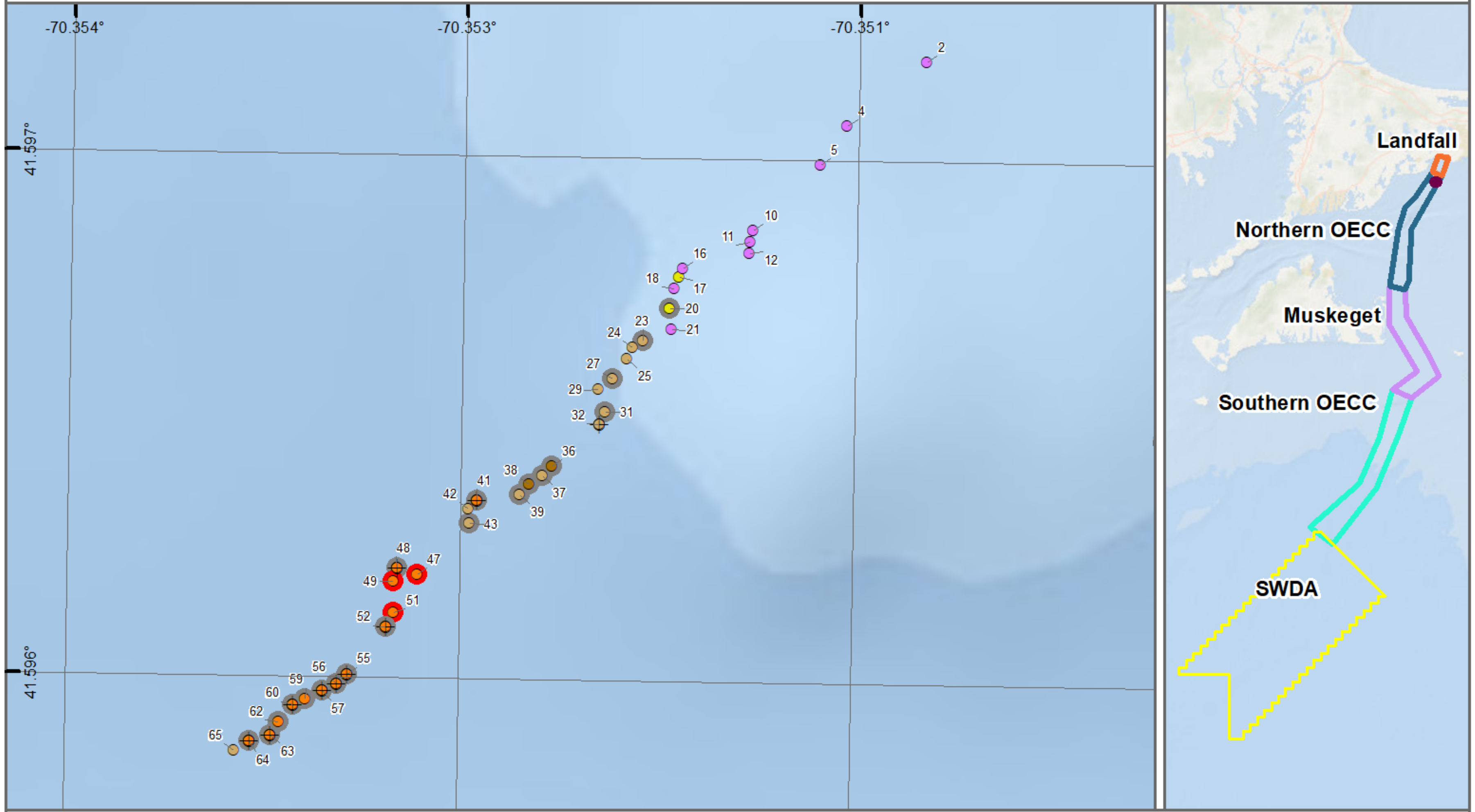
OECC Zone: Northern OECC Transect: OECC20-VT-02



CMECS Classification

- Biogenic Shell Hash
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud/Shell Mix
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Dense or complete
- Moderate

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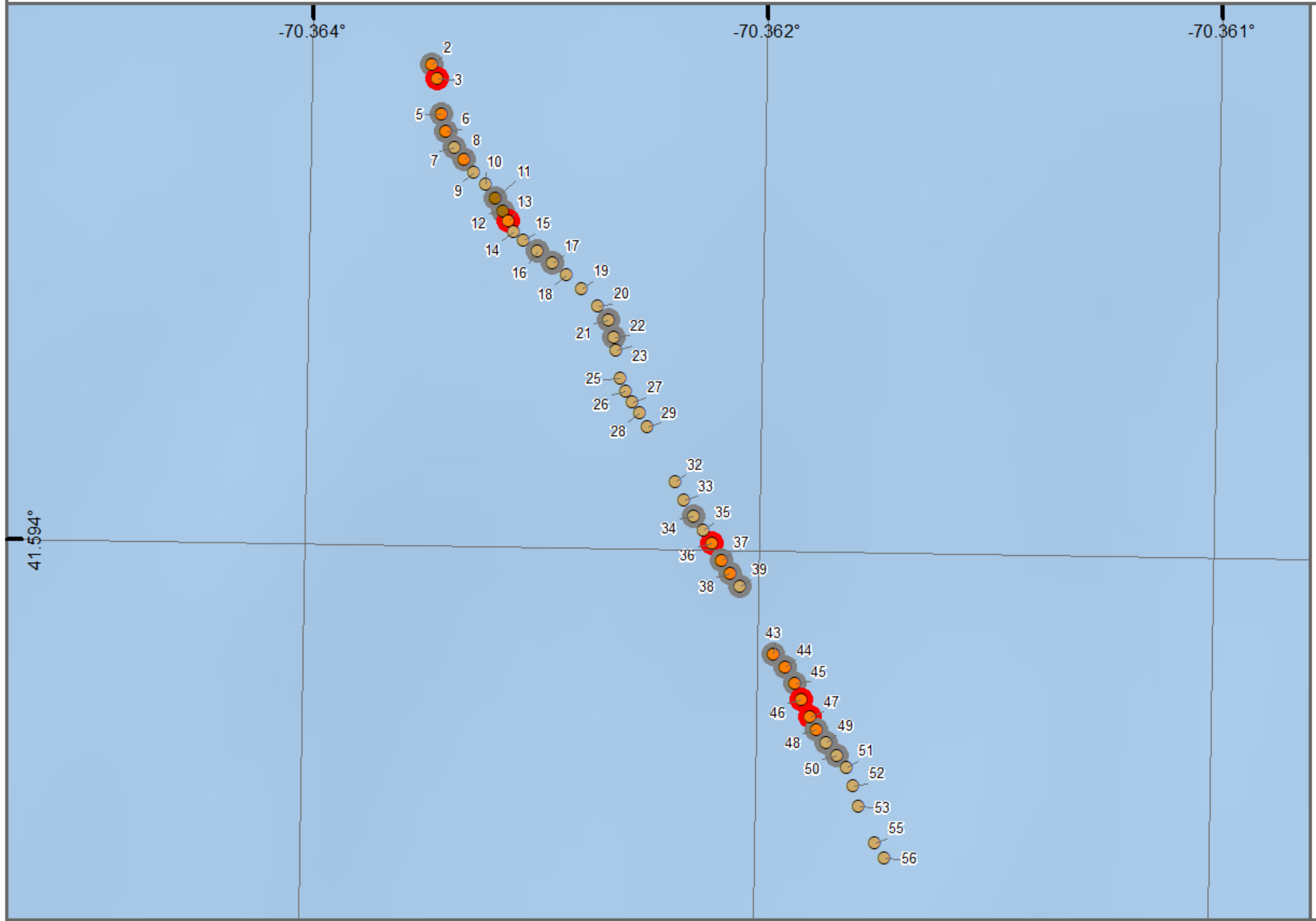
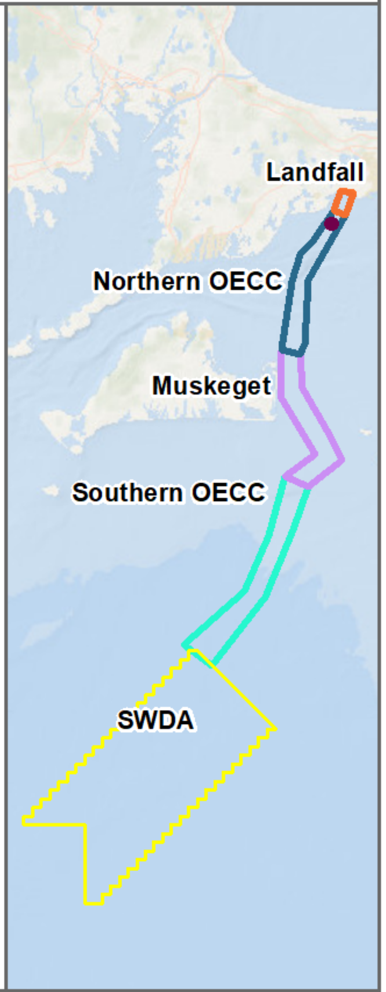
0 40 80 Meters

N

OECC Zone: Northern OECC   Transect: OECC20-VT-03





CMECS Classification

- Biogenic Shell Hash
- Sand/Mud/Shell Mix
- Sand/Mud

Shell Cover

- Dense or complete
- Moderate

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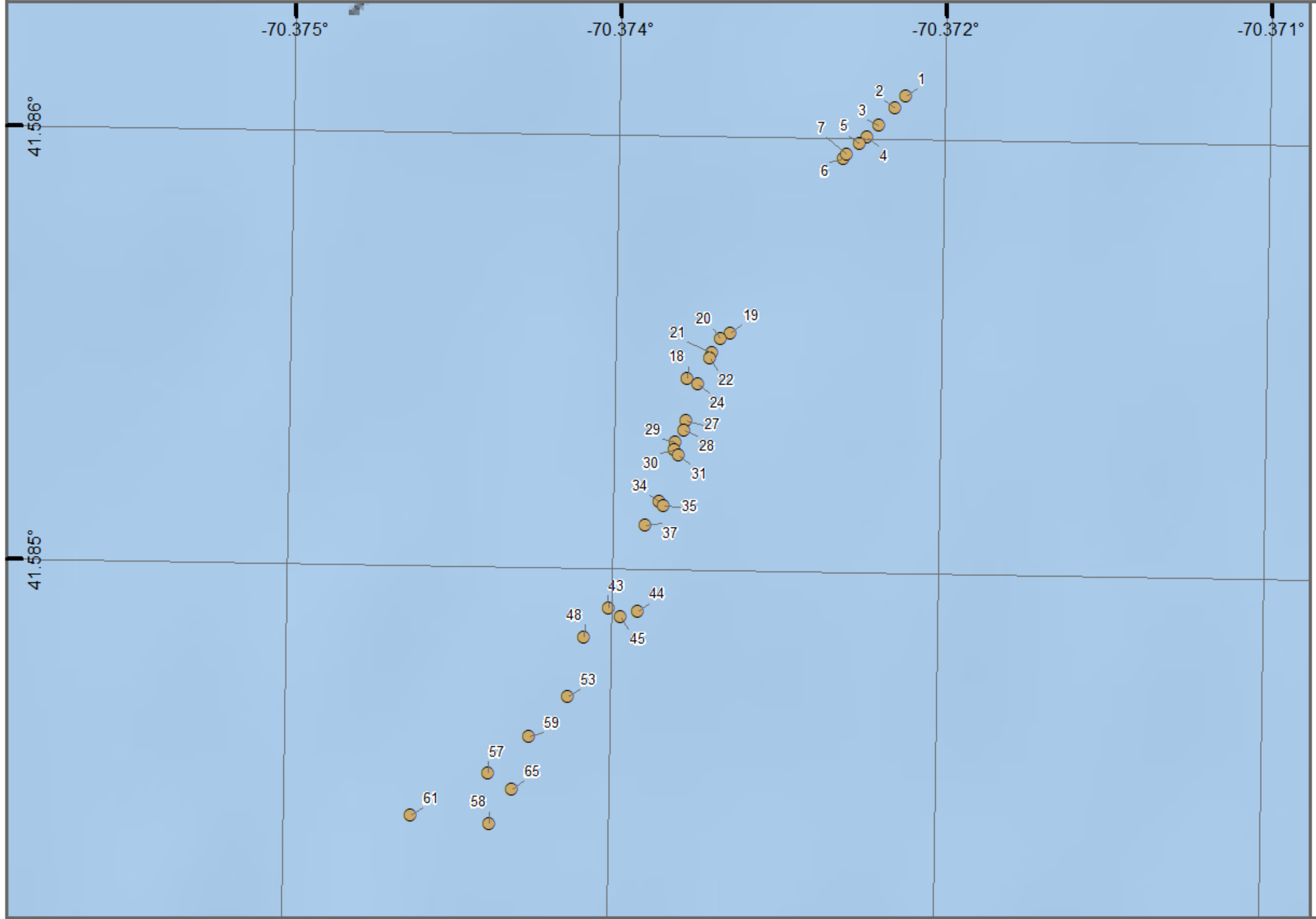
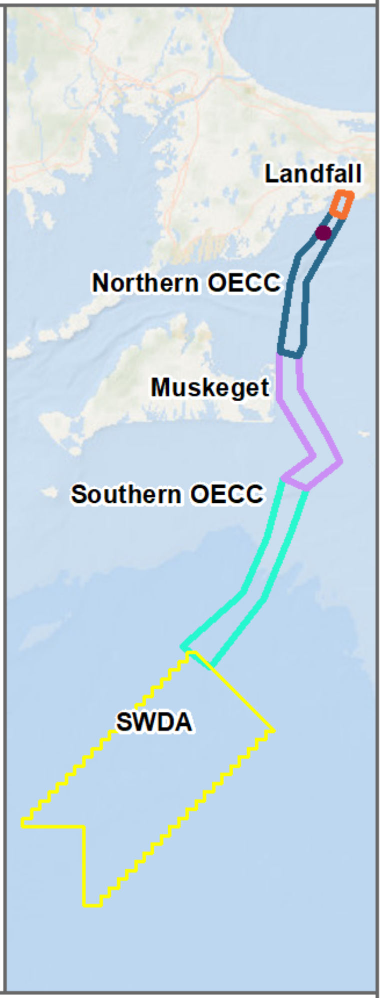
0 40 80 Meters

N

OECC Zone: Northern OECC Transect: OECC20-VT-04





CMECS Classification

Sand/Mud

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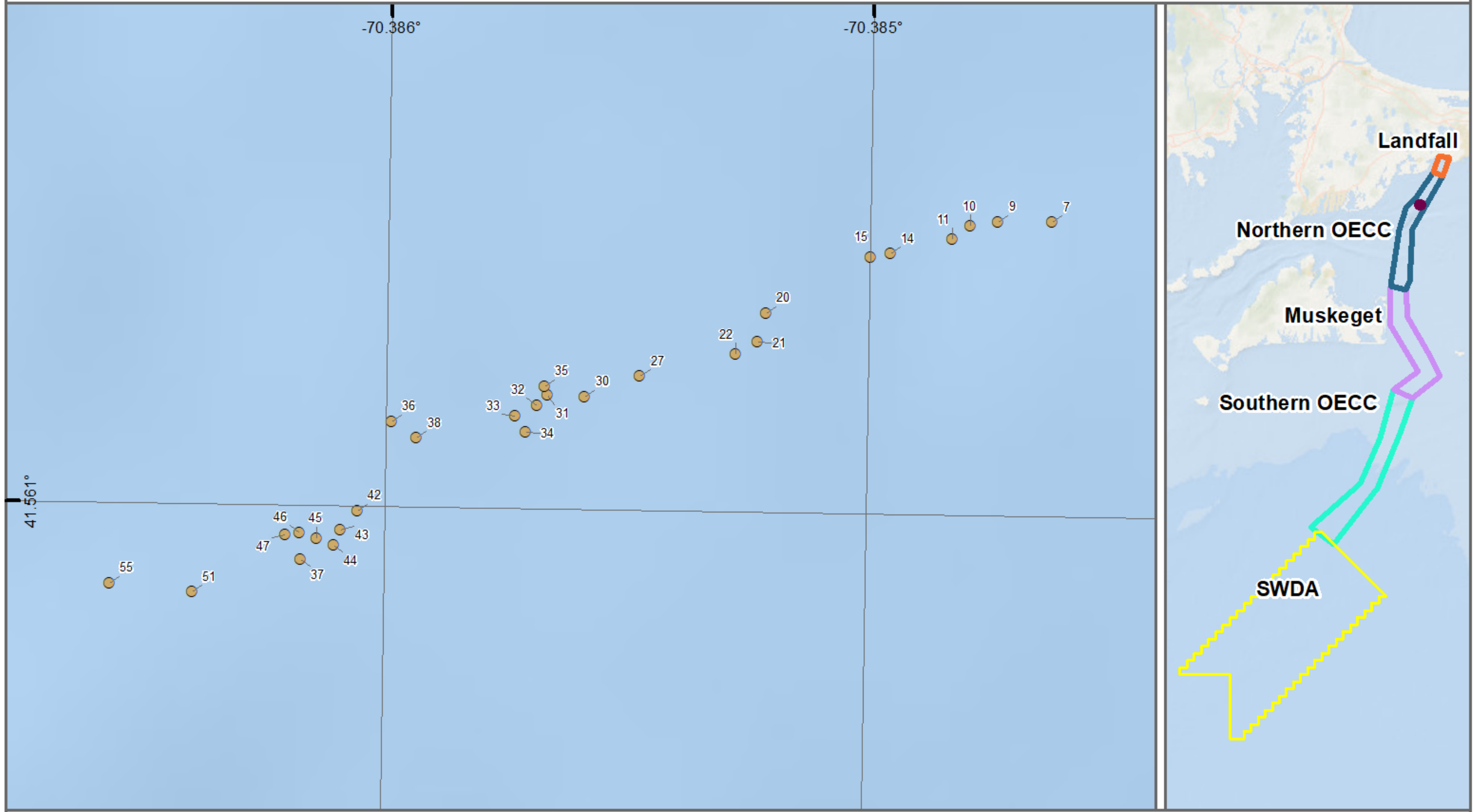
0 60 120 Meters

N

OECC Zone: Northern OECC Transect: OECC20-VT-05



CMECS Classification

Sand/Mud

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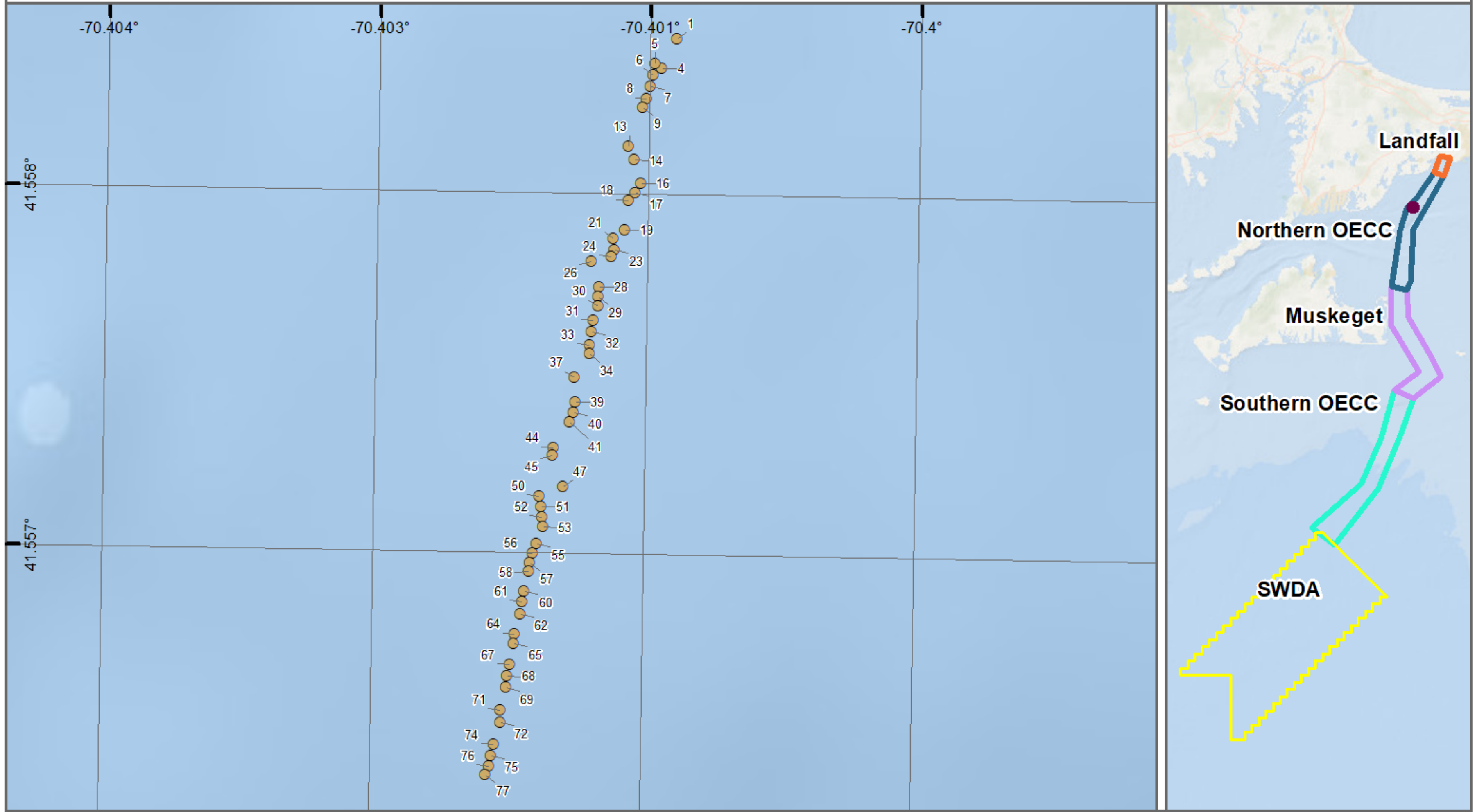
0 35 70 Meters

N

OECC Zone: Northern OECC Transect: OECC20-VT-06



CMECS Classification

Sand/Mud

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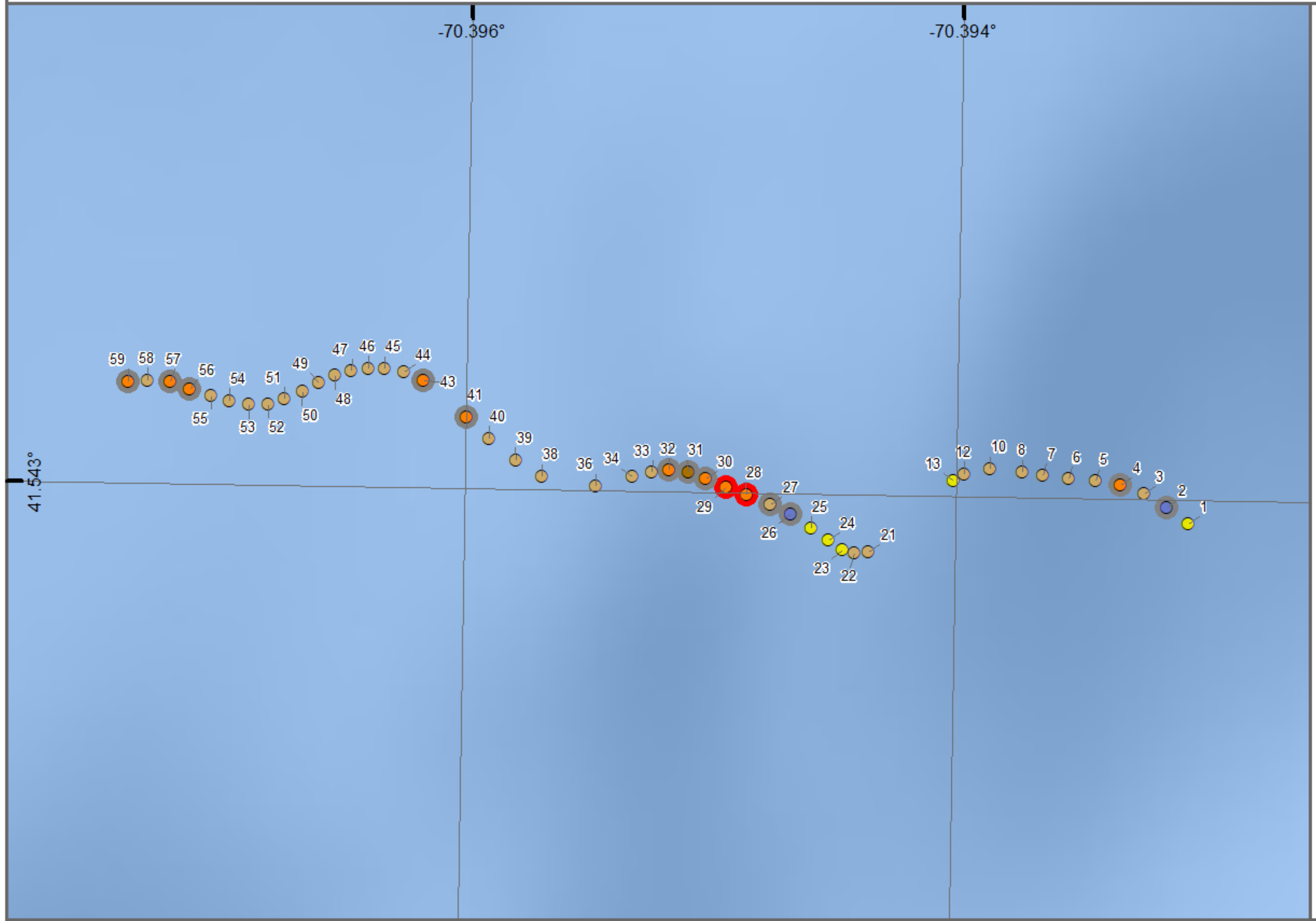
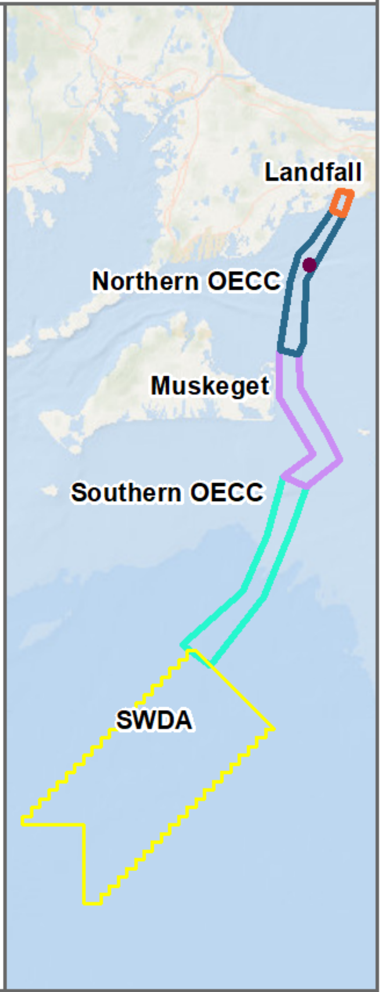
0 62.5 125 Meters

N

OECC Zone: Northern OECC Transect: OECC20-VT-07





CMECS Classification

- Biogenic Shell Hash
- Gravel - Pebble/Granule
- Gravelly Sand/Mud with P/G
- Sand/Mud/Shell Mix
- Sand/Mud

Shell Cover

- Dense or complete
- Moderate

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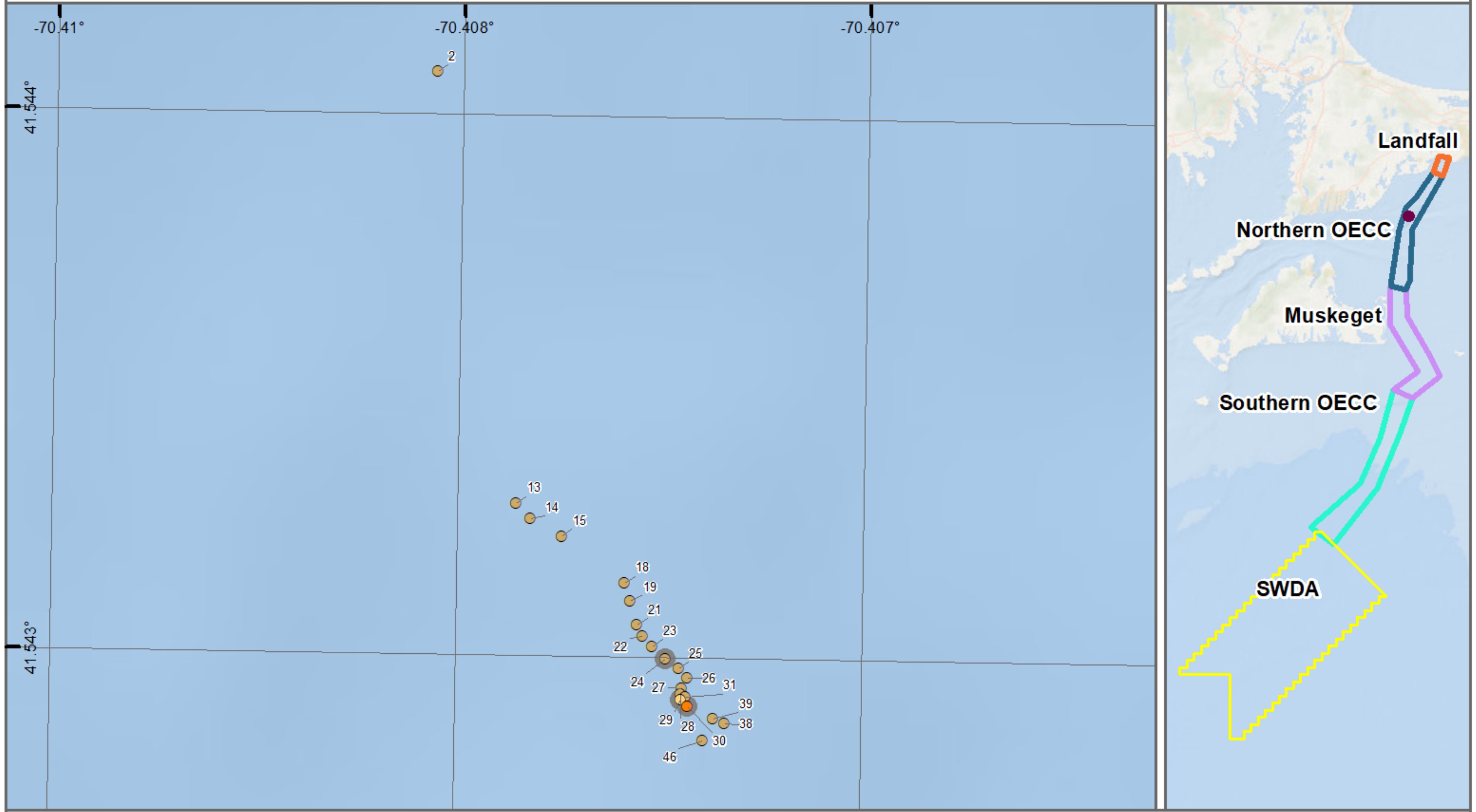
0 37.5 75 Meters

N

OECC Zone: Northern OECC   Transect: OECC20-VT-08



CMECS Classification

- Biogenic Shell Hash
- Biogenic Shell Rubble
- Sand/Mud

Shell Cover

- Moderate

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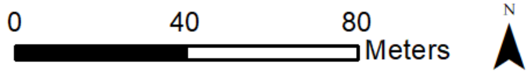
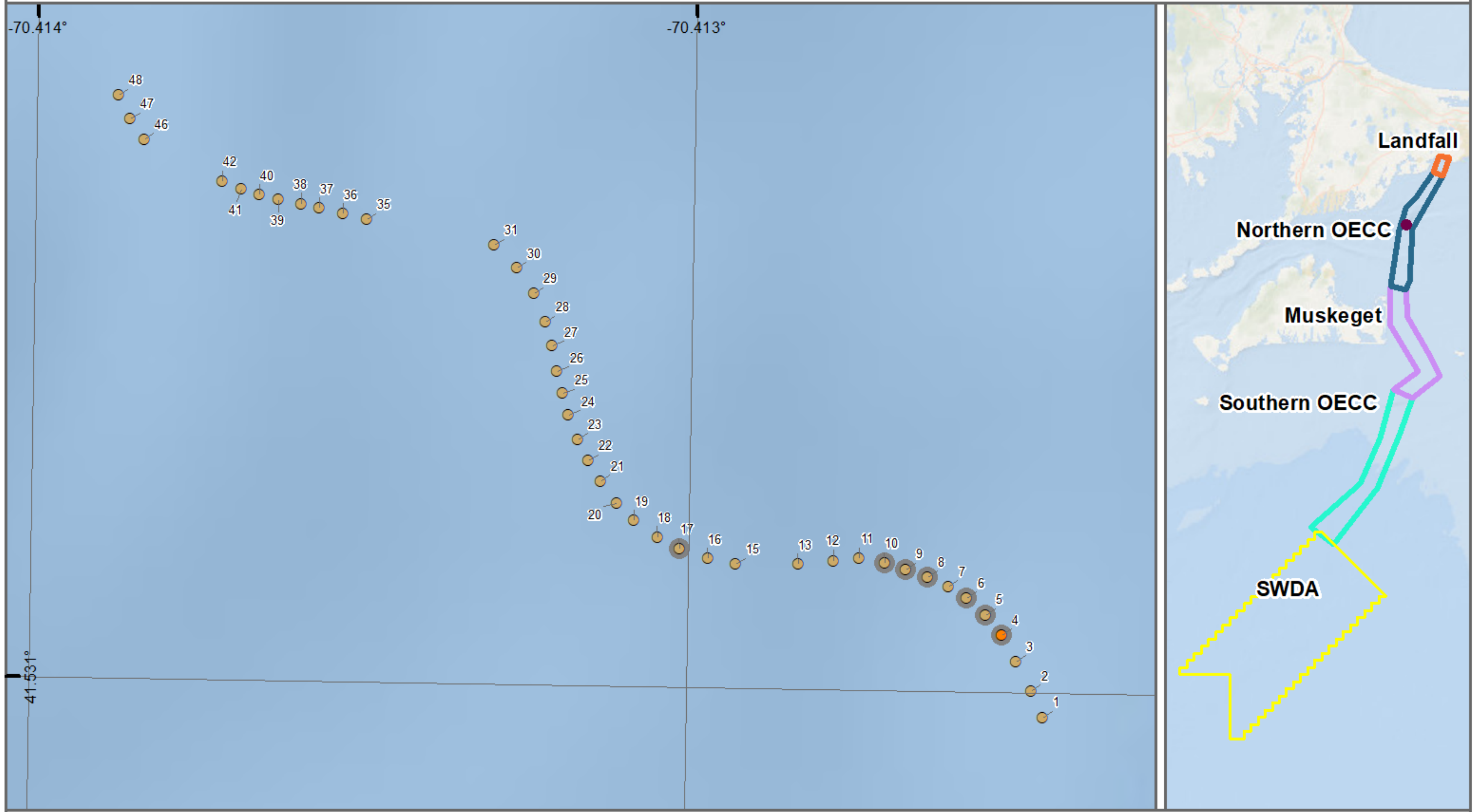


OECC Zone: Northern OECC Transect: OECC20-VT-09



CMECS Classification

- Biogenic Shell Hash
- Sand/Mud

Shell Cover

- Moderate

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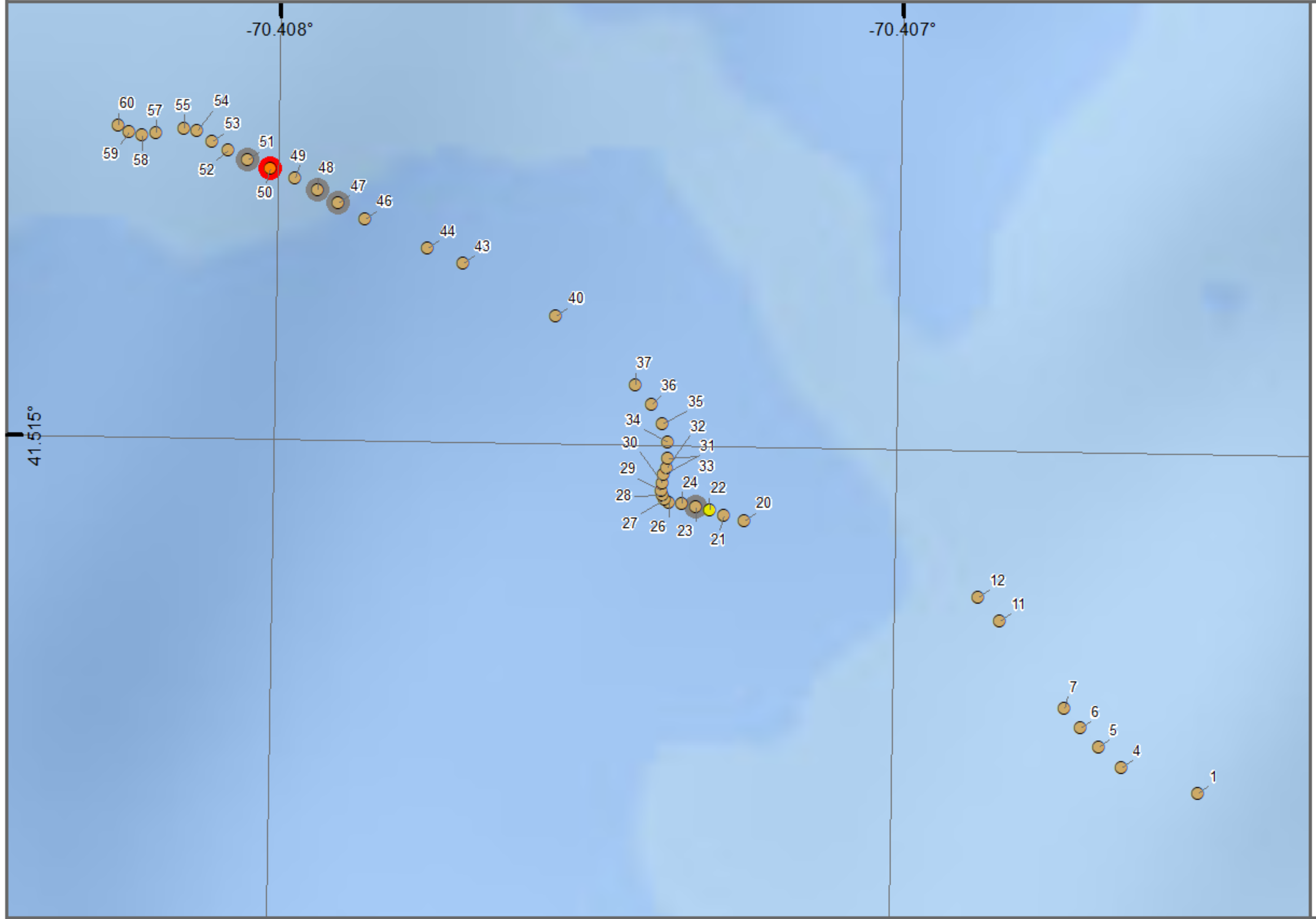
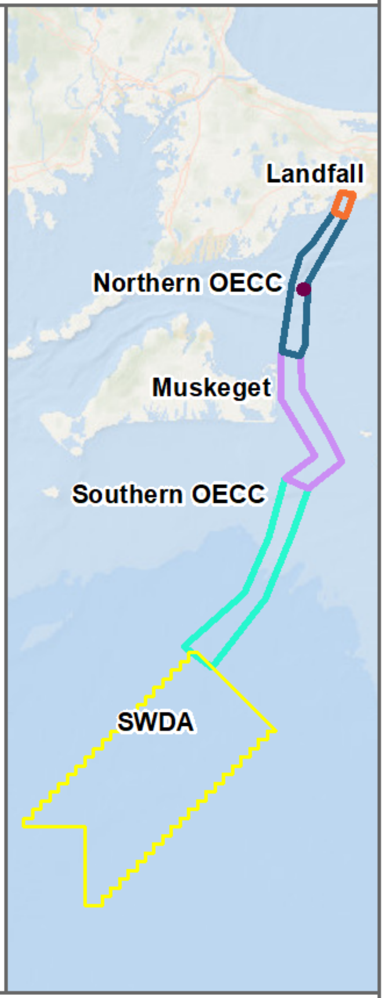
0 25 50 Meters

N

OECC Zone: Northern OECC Transect: OECC20-VT-10





CMECS Classification

- Biogenic Shell Hash
- Gravelly Sand/Mud with P/G
- Sand/Mud

Shell Cover

- Dense or complete
- Moderate

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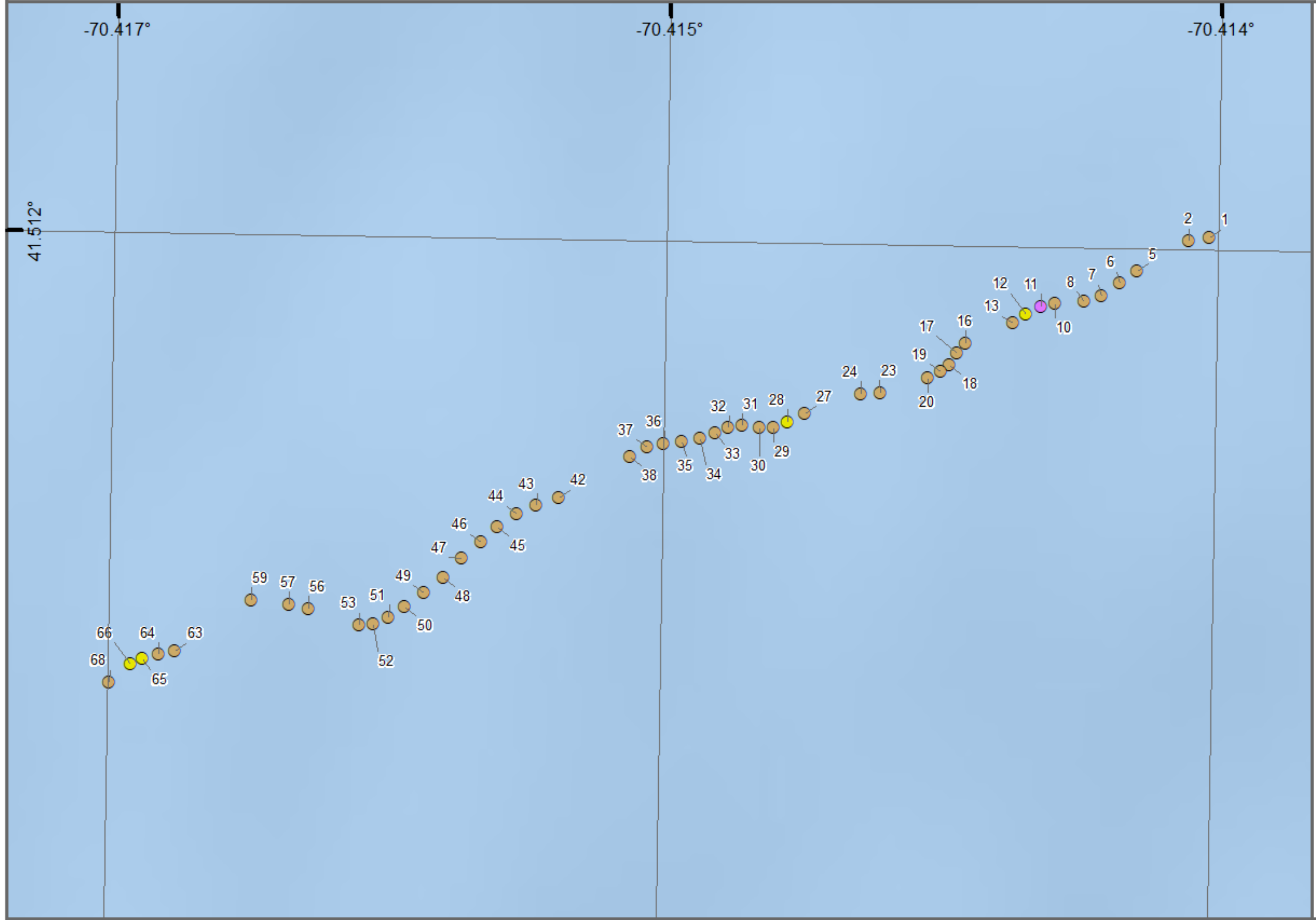
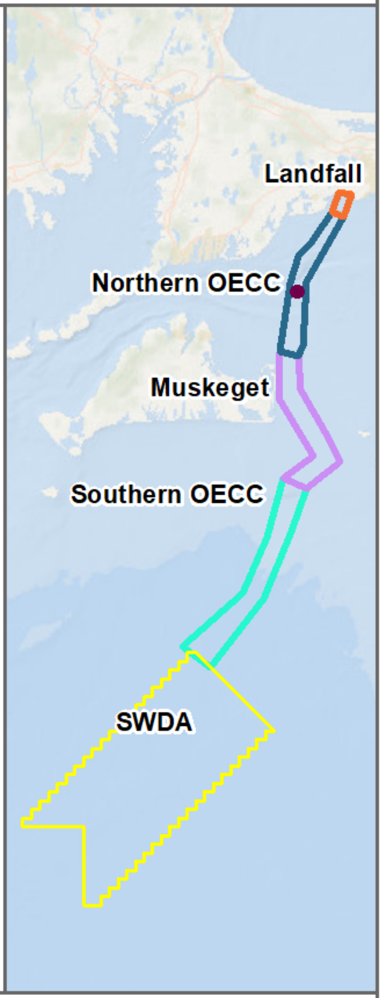
0 30 60 Meters N

OECC Zone: Northern OECC Transect: OECC20-VT-11





CMECS Classification

- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

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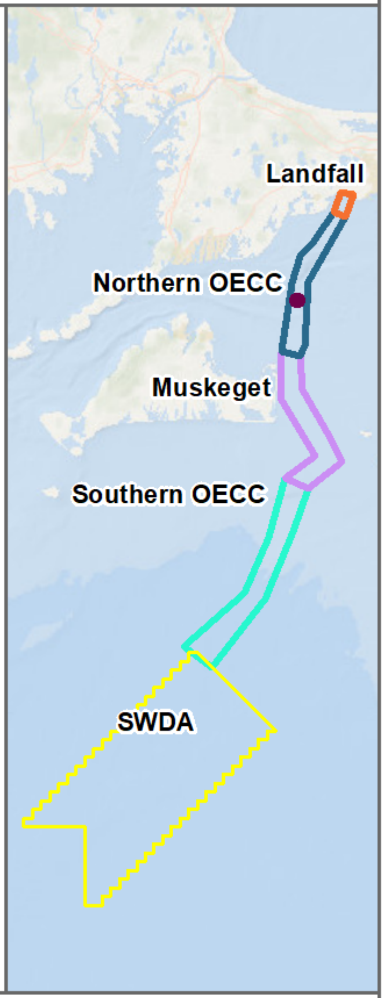
0 35 70 Meters

N

OECC Zone: Northern OECC   Transect: OECC20-VT-12



CMECS Classification

Sand/Mud

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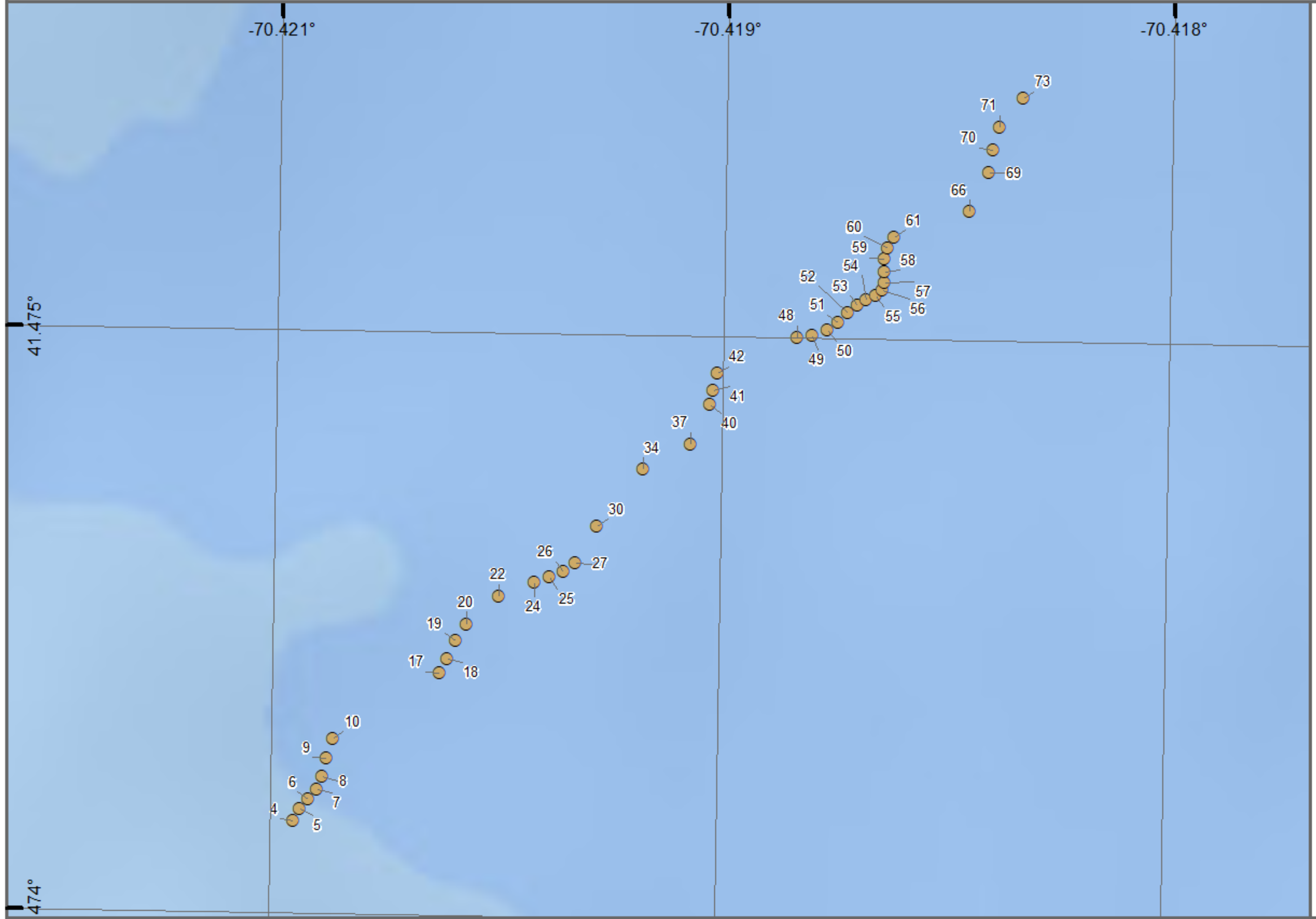
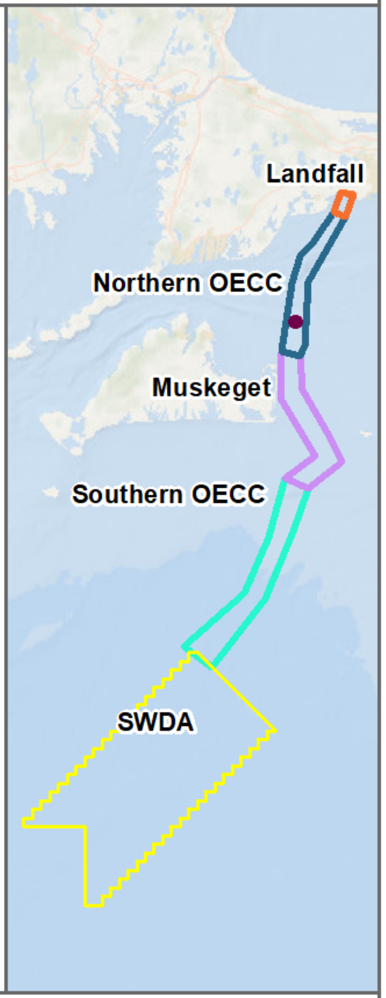
0 60 120 Meters

OECC Zone: Northern OECC Transect: OECC20-VT-13





CMECS Classification

Sand/Mud

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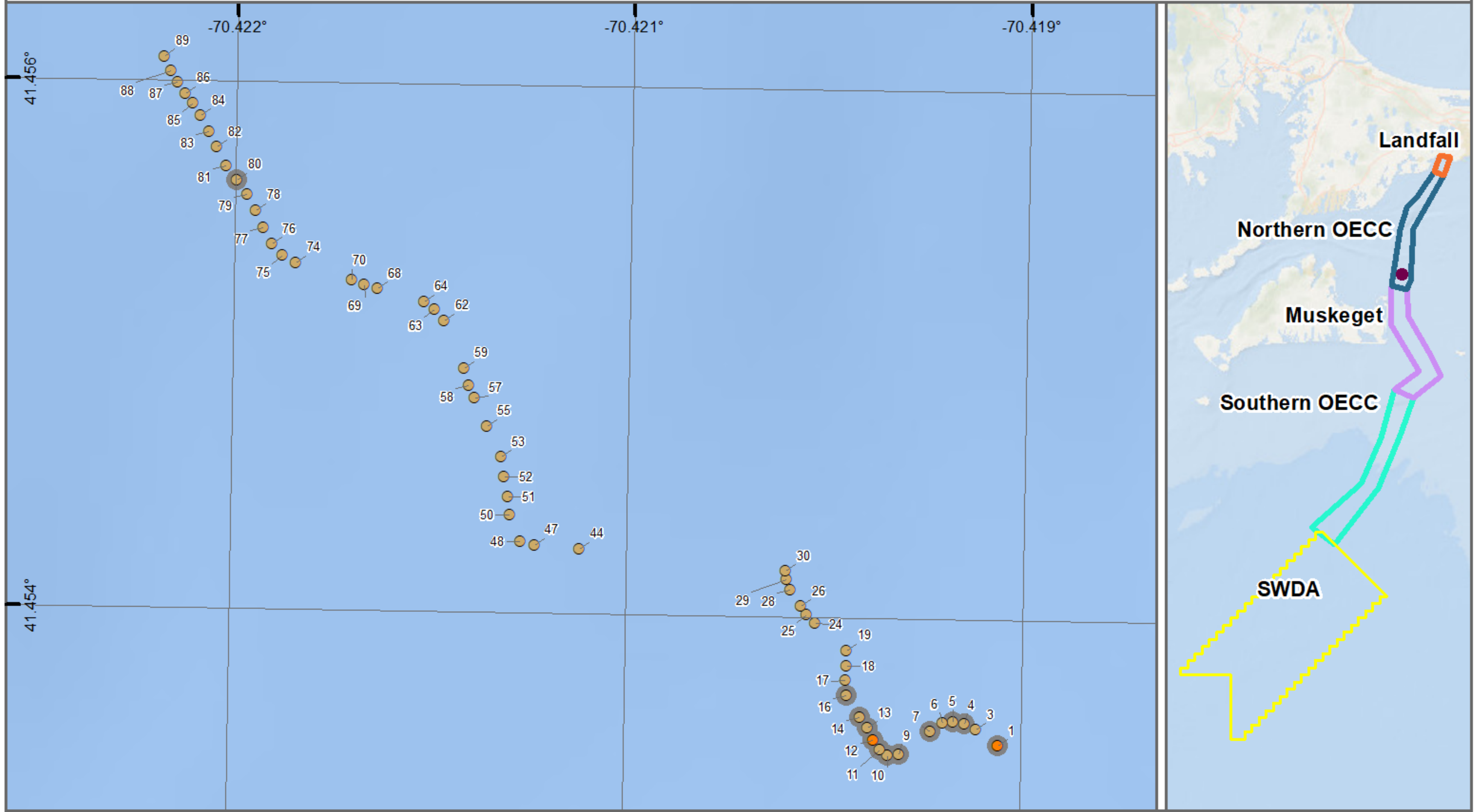
0 40 80 Meters

N

OECC Zone: Northern OECC Transect: OECC20-VT-14



CMECS Classification

- Biogenic Shell Hash
- Sand/Mud

Shell Cover

- Moderate

0 40 80 Meters

N

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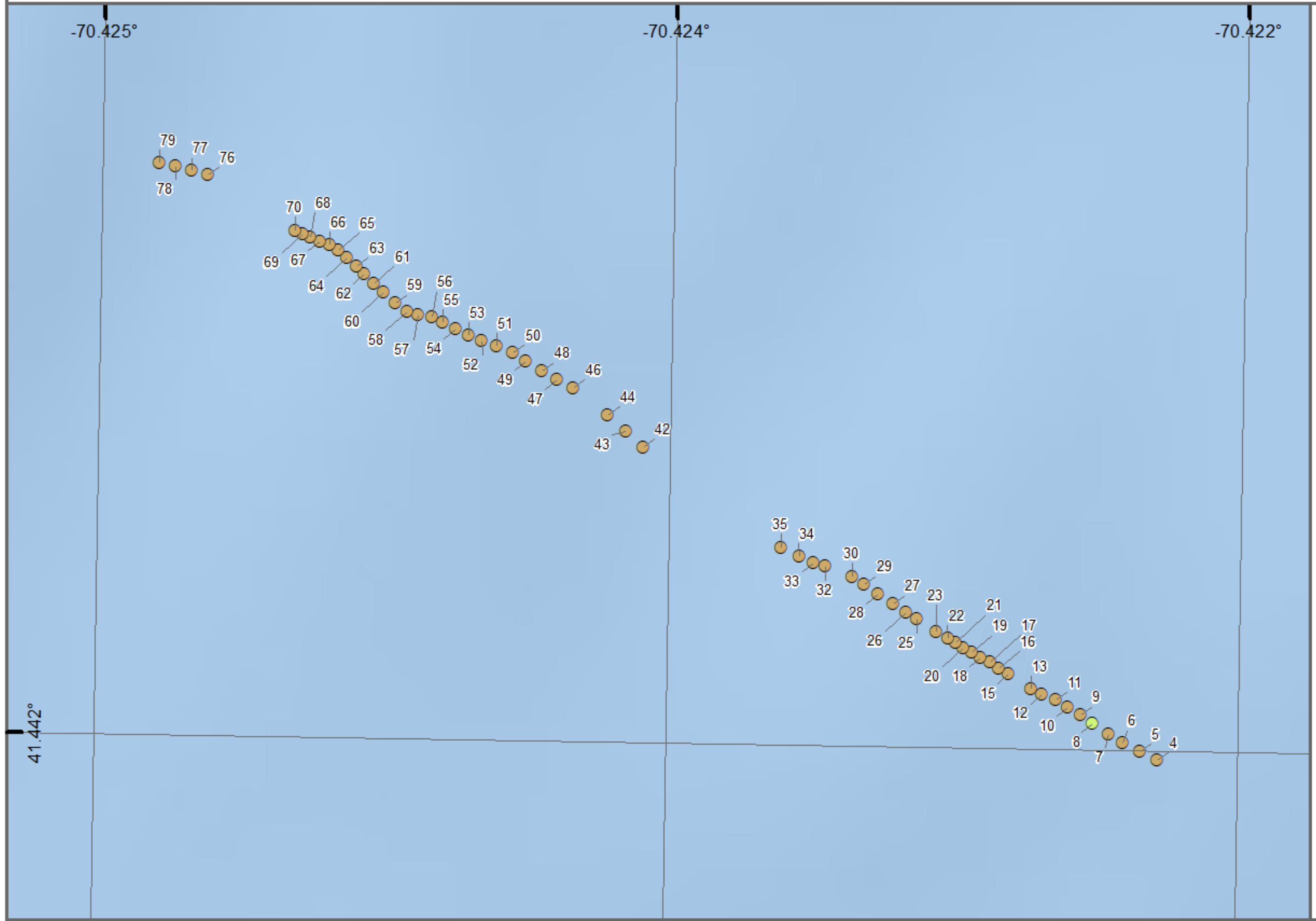
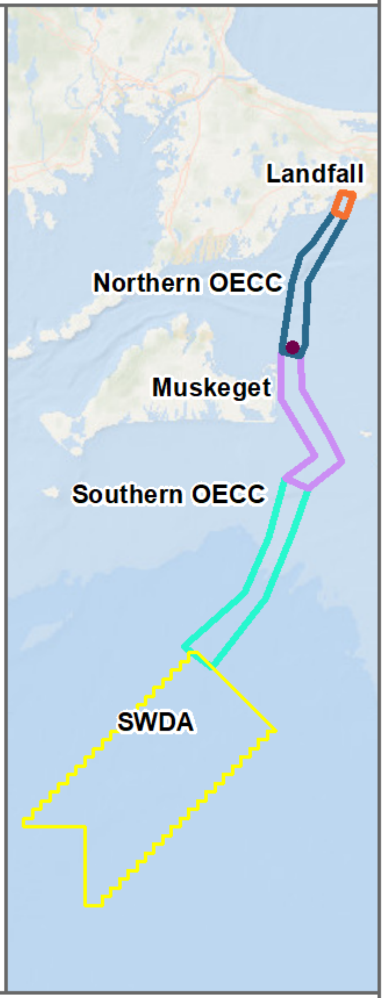
OECC Zone: Northern OECC Transect: OECC20-VT-15





CMECS Classification

- Gravelly Sand/Mud with C/P/G
- Sand/Mud

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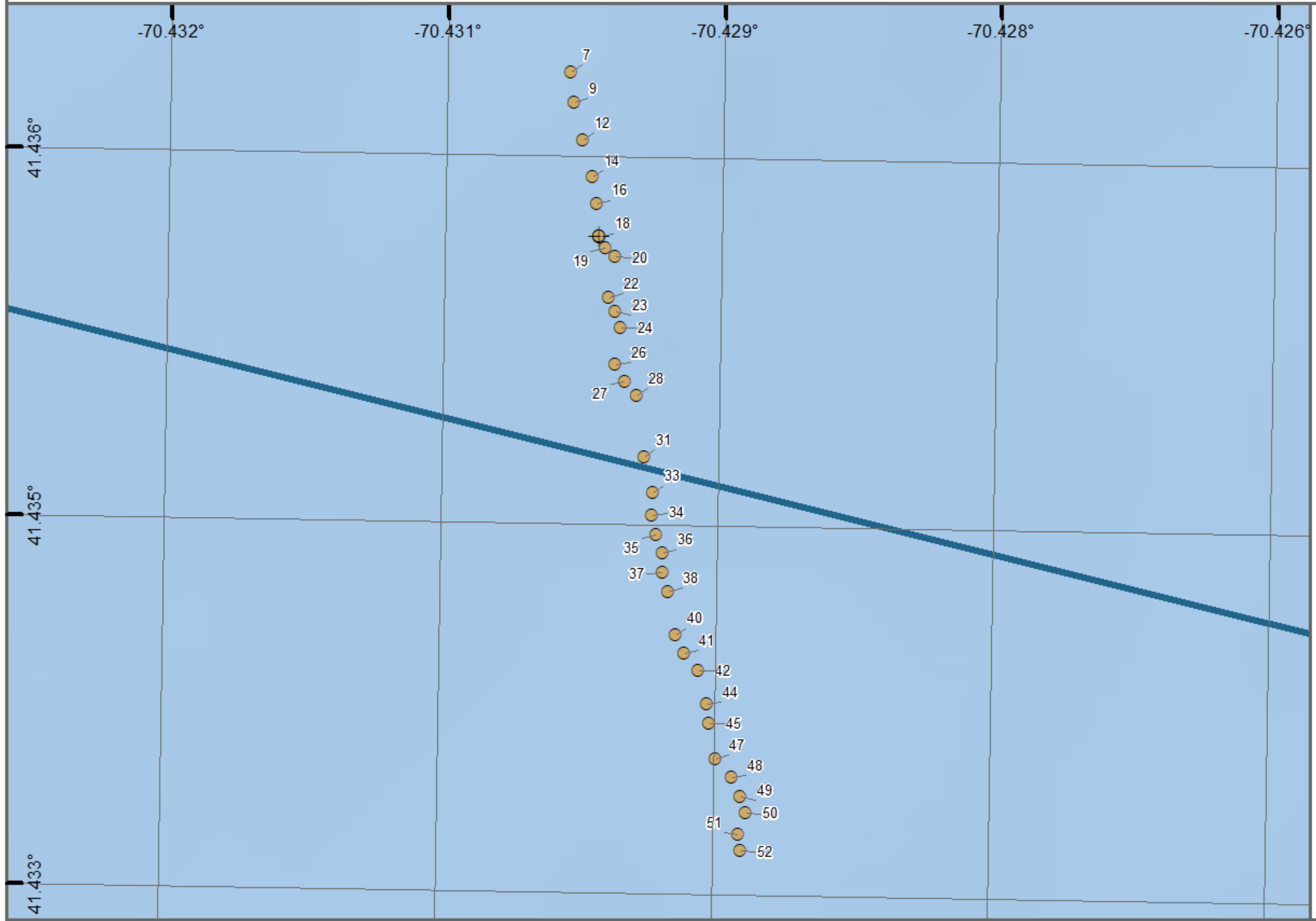
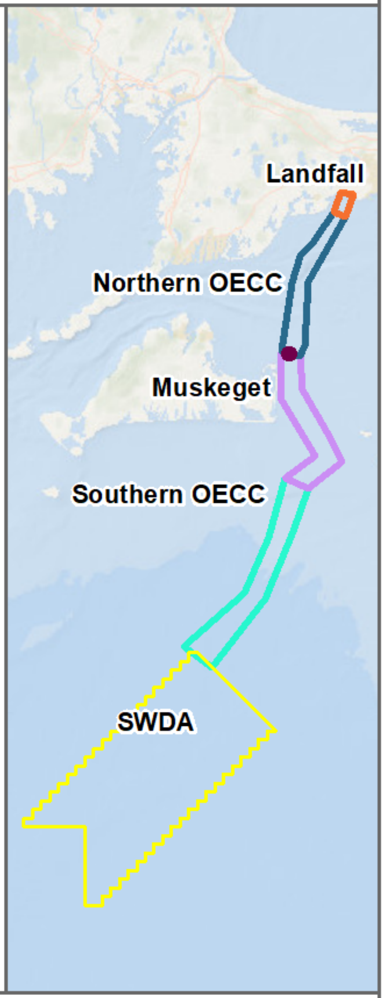
0 30 60 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-16





CMECS Classification

Sand/Mud

Flora/Fauna Cover

≥ Moderate

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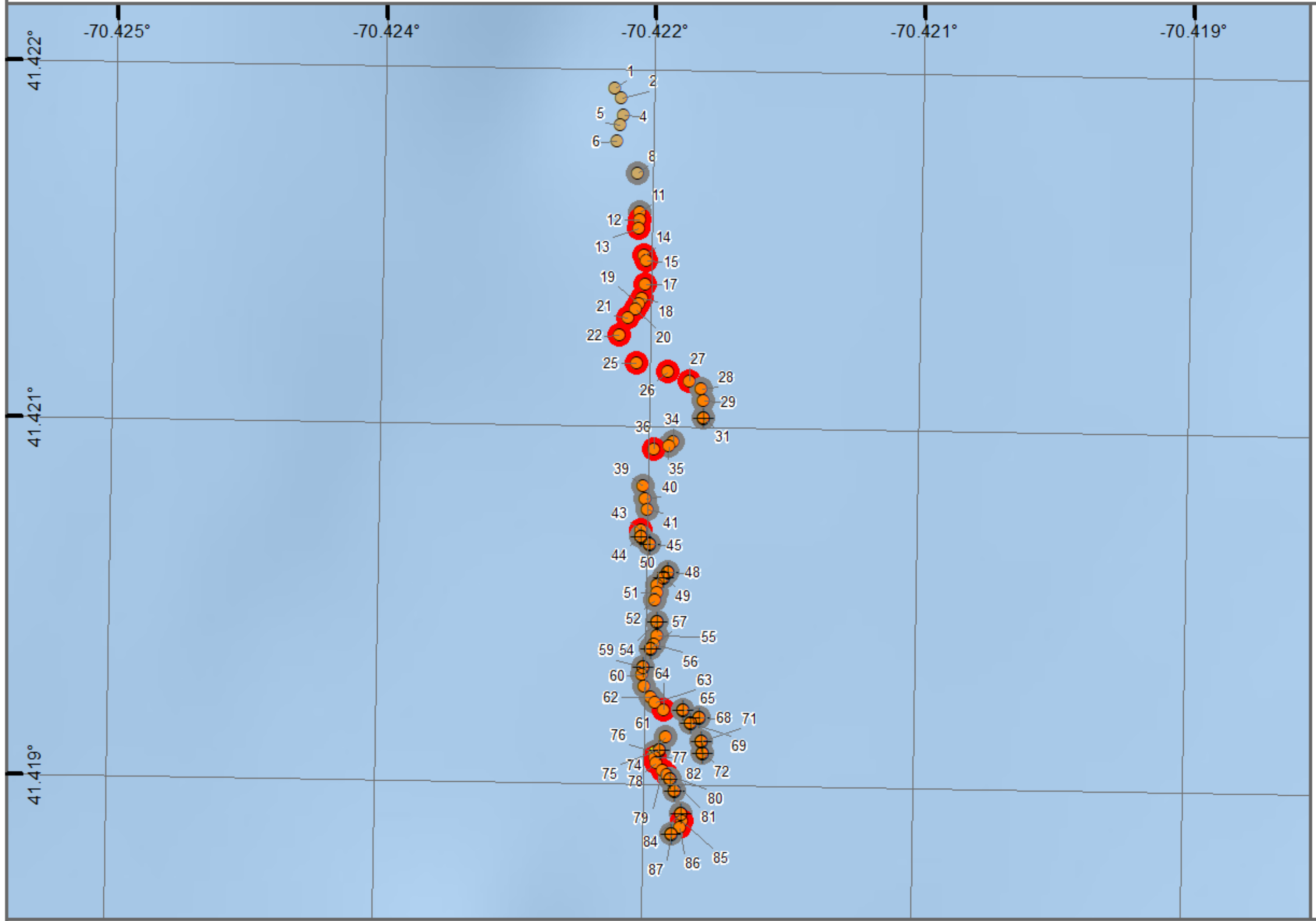
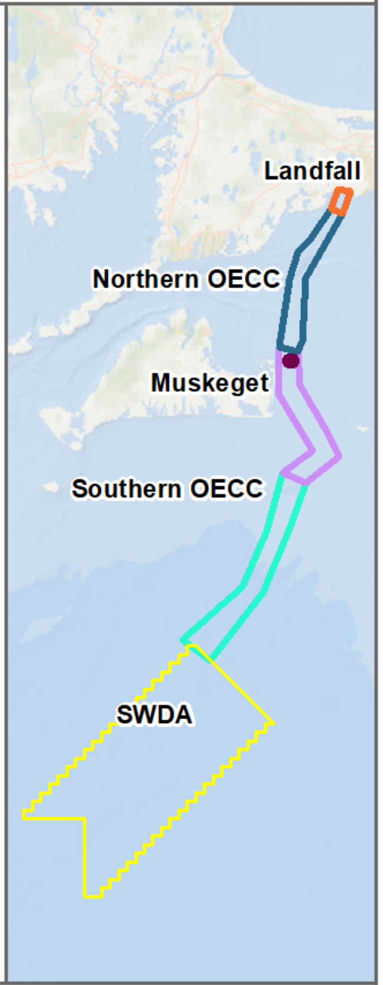
0 70 140 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-17





CMECS Classification

- Biogenic Shell Hash
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Dense or complete
- Moderate

0 70 140 Meters

N

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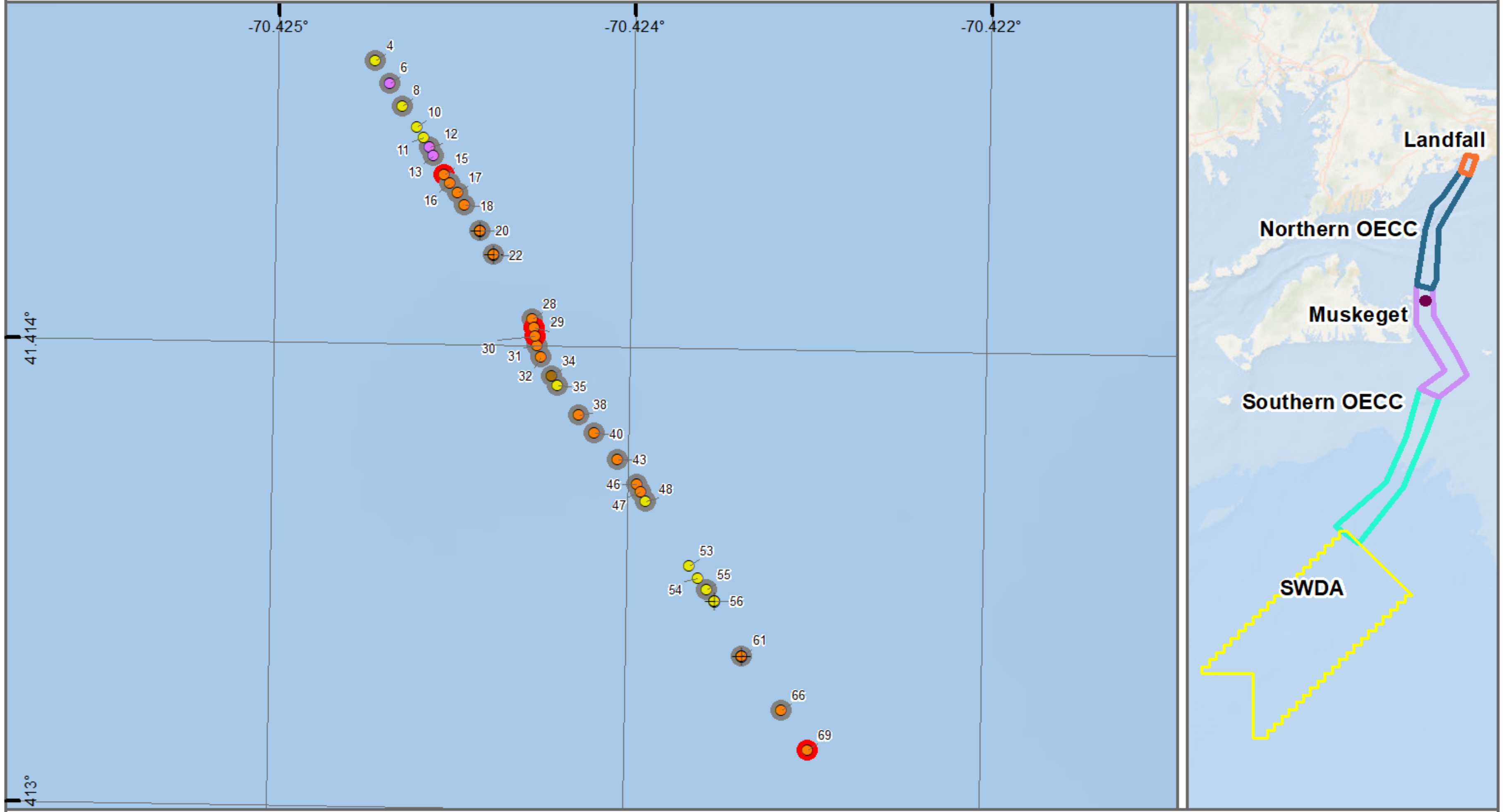
OECC Zone: Muskeget   Transect: OECC20-VT-18



CMECS Classification

- Biogenic Shell Hash
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud/Shell Mix

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Dense or complete
- Moderate

0 50 100 Meters

N

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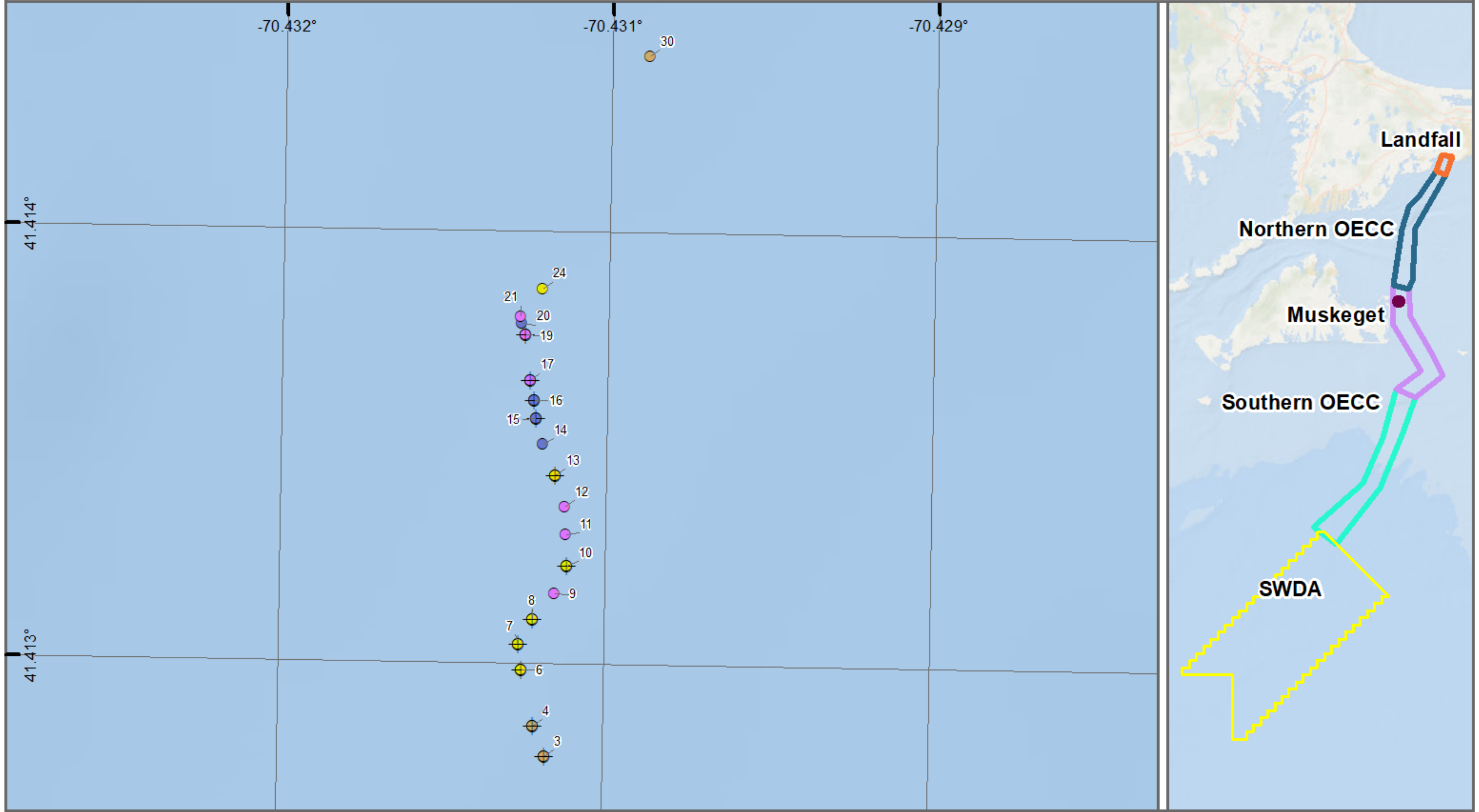
OECC Zone: Muskeget Transect: OECC20-VT-19



CMECS Classification

- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

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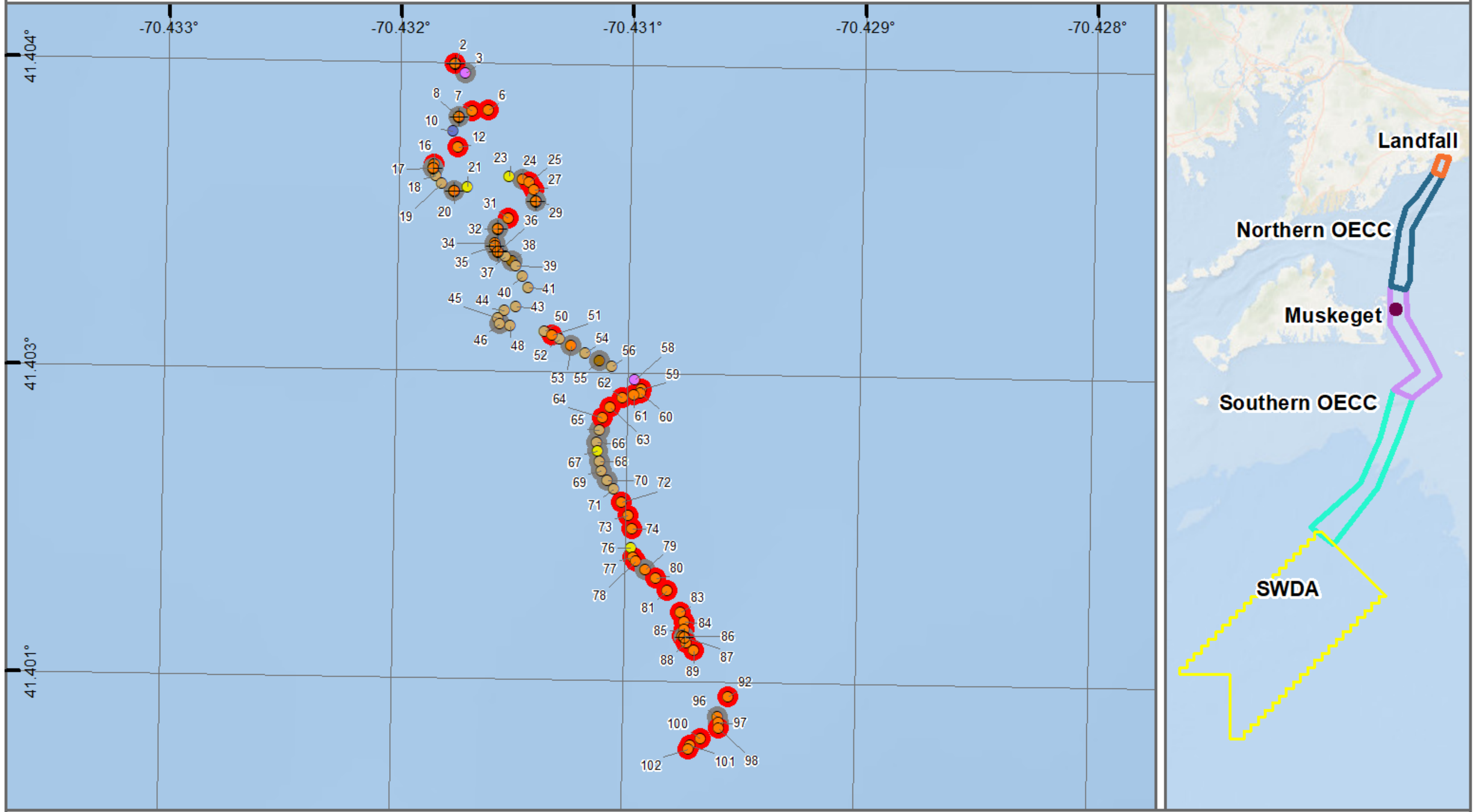
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-20



CMECS Classification

- Biogenic Shell Hash
- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud/Shell Mix
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Dense or complete
- Moderate

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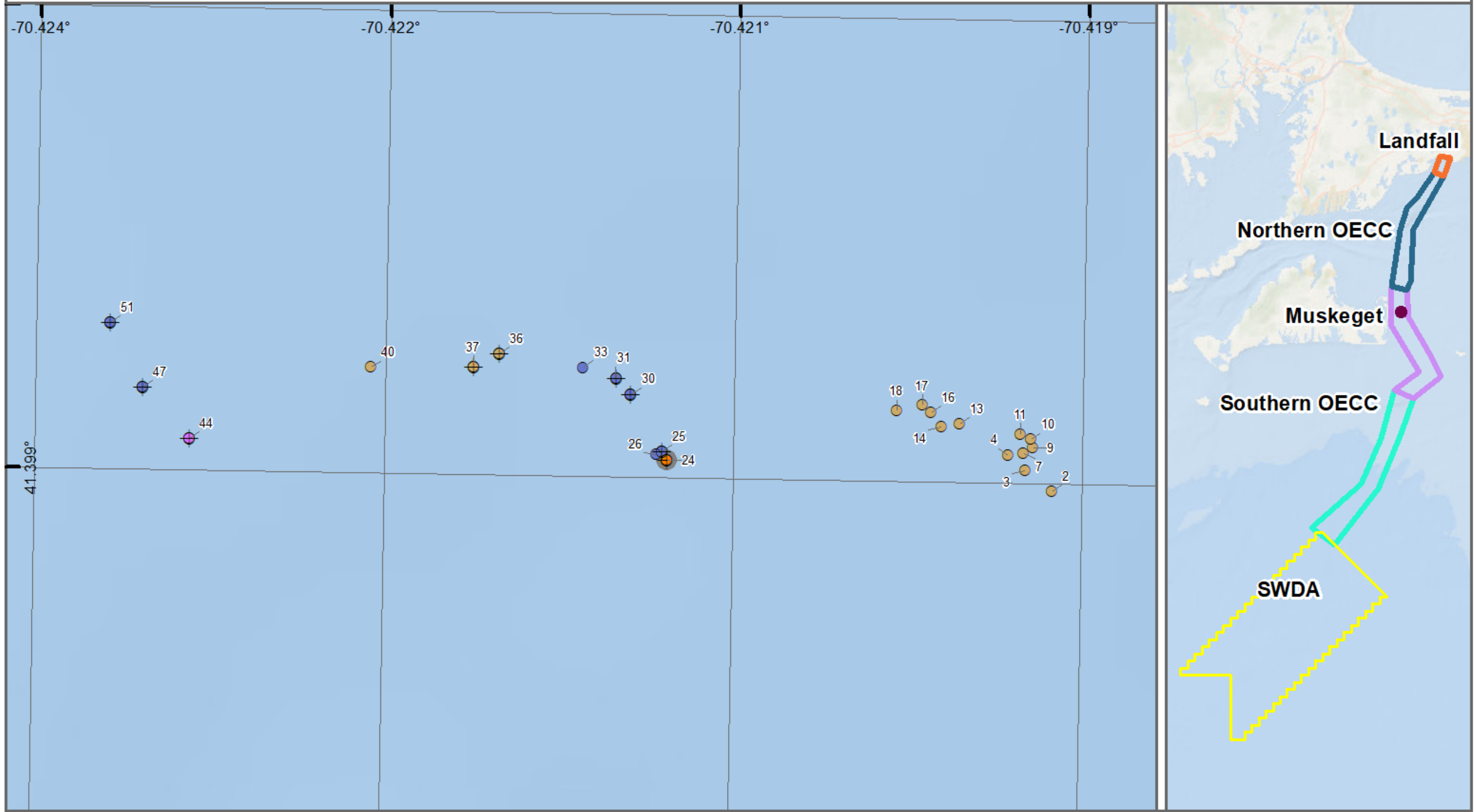
0 75 150 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-21



CMECS Classification

- Biogenic Shell Hash
- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Moderate

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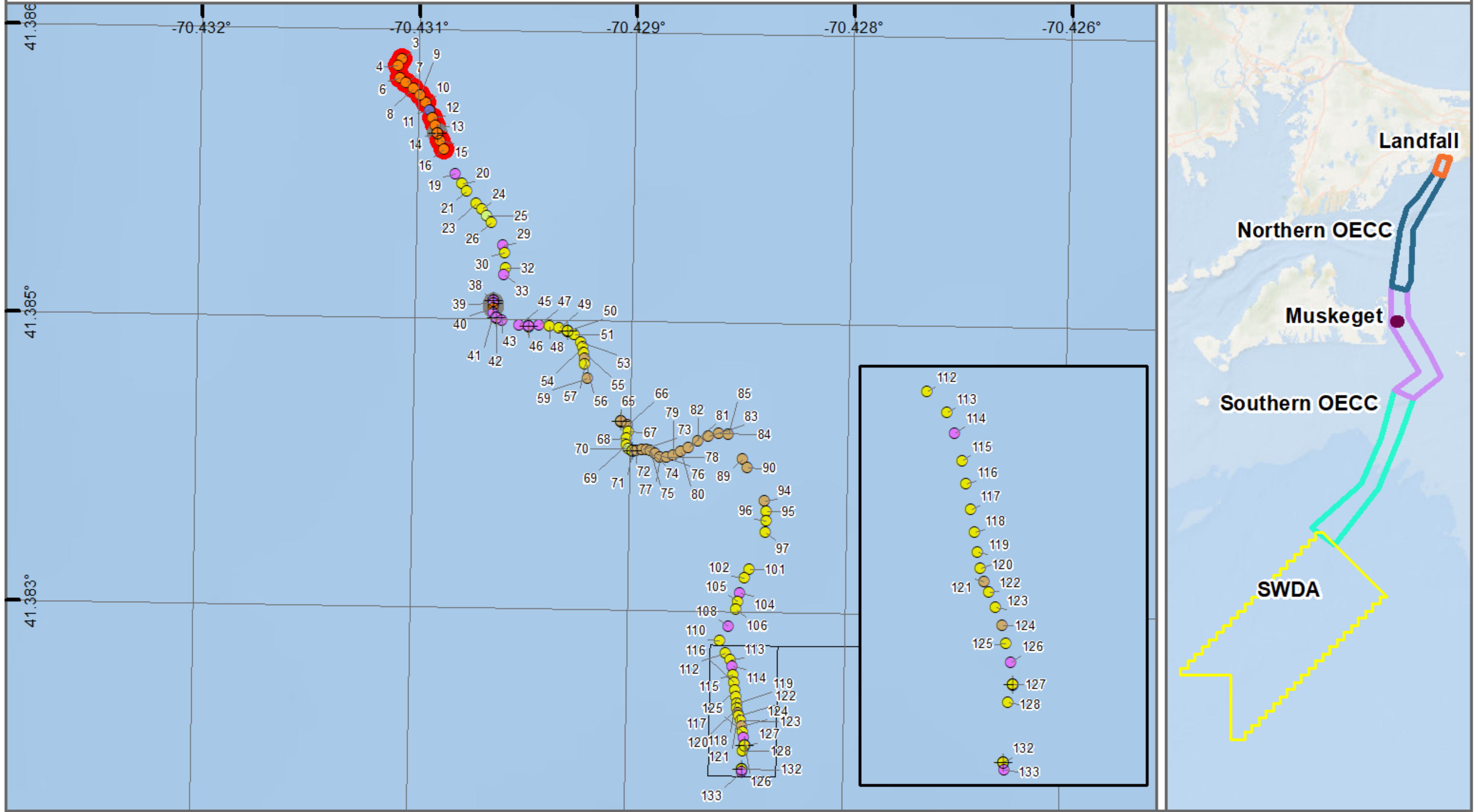
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-22



CMECS Classification

- Biogenic Shell Hash
- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with C/P/G
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Dense or complete
- Moderate

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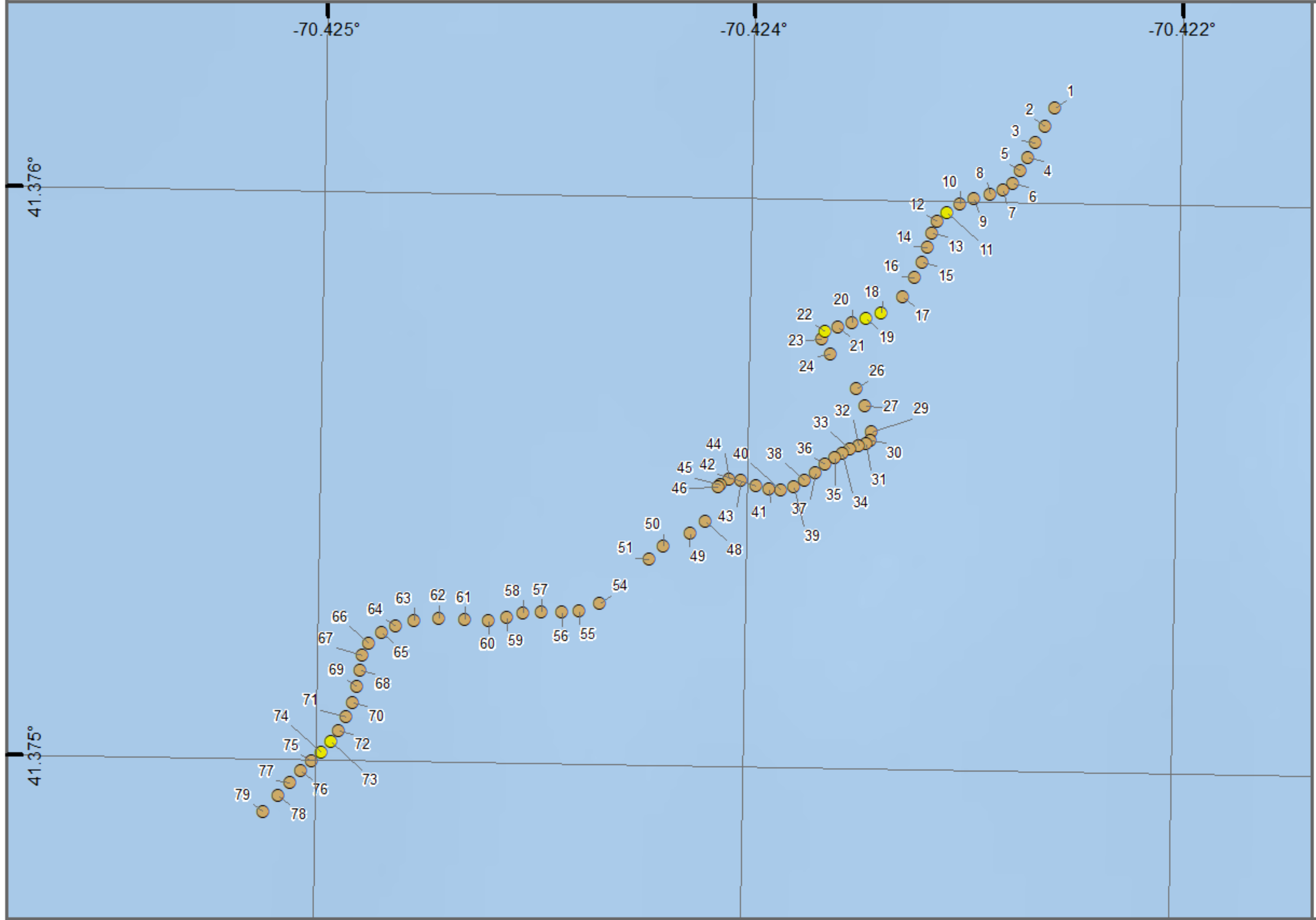
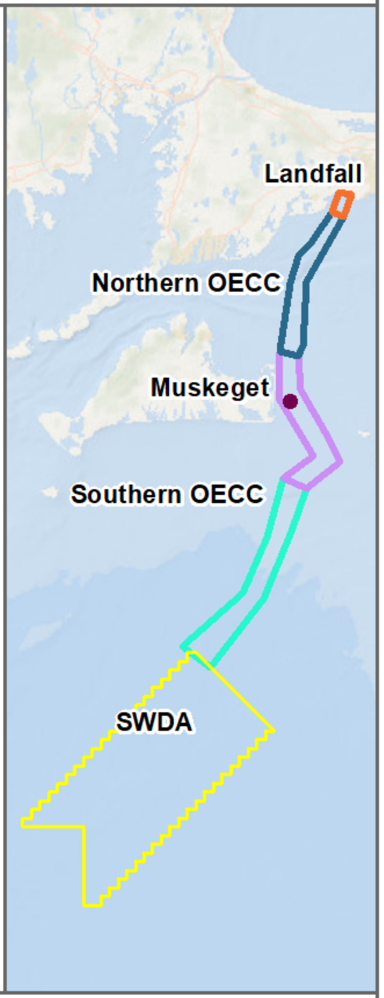
0 80 160 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-23





CMECS Classification

- Gravelly Sand/Mud with P/G
- Sand/Mud

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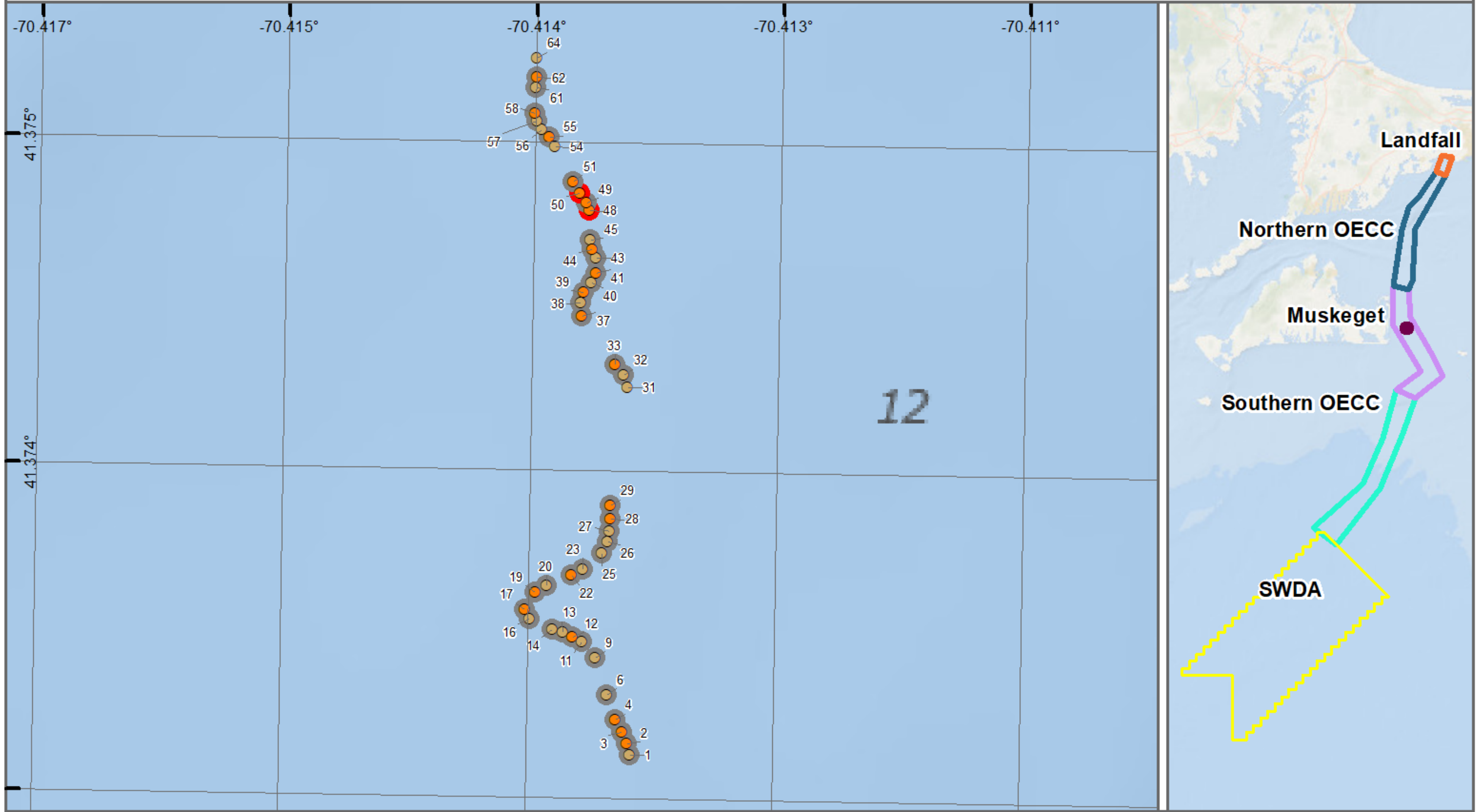
0 45 90 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-24



CMECS Classification

- Biogenic Shell Hash
- Sand/Mud

Shell Cover

- Dense or complete
- Moderate

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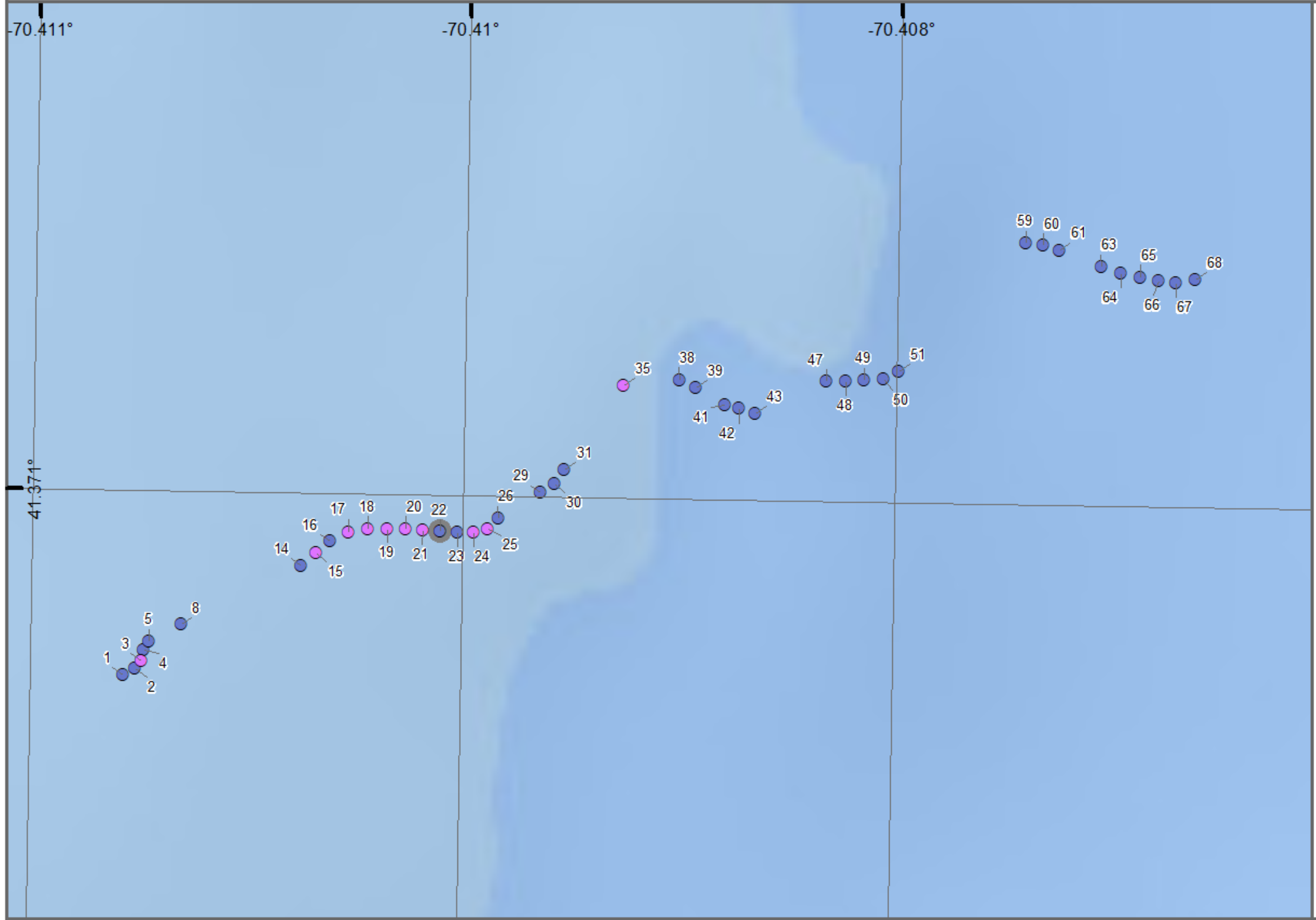
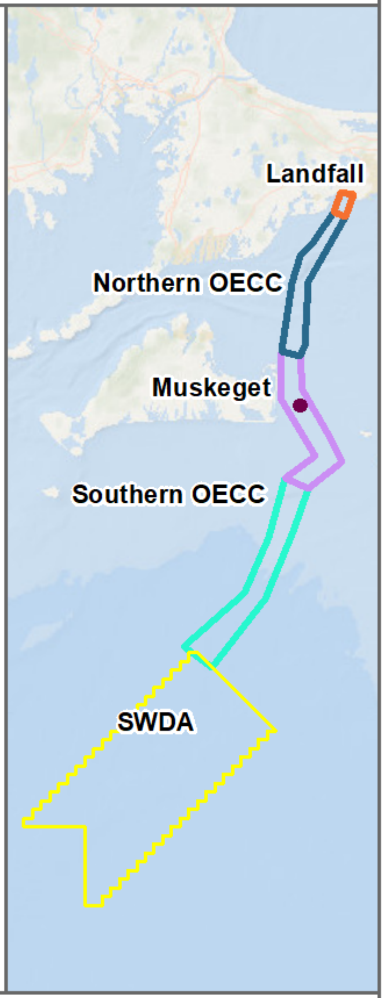
0 70 140 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-25





CMECS Classification

- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M

Shell Cover

- Moderate

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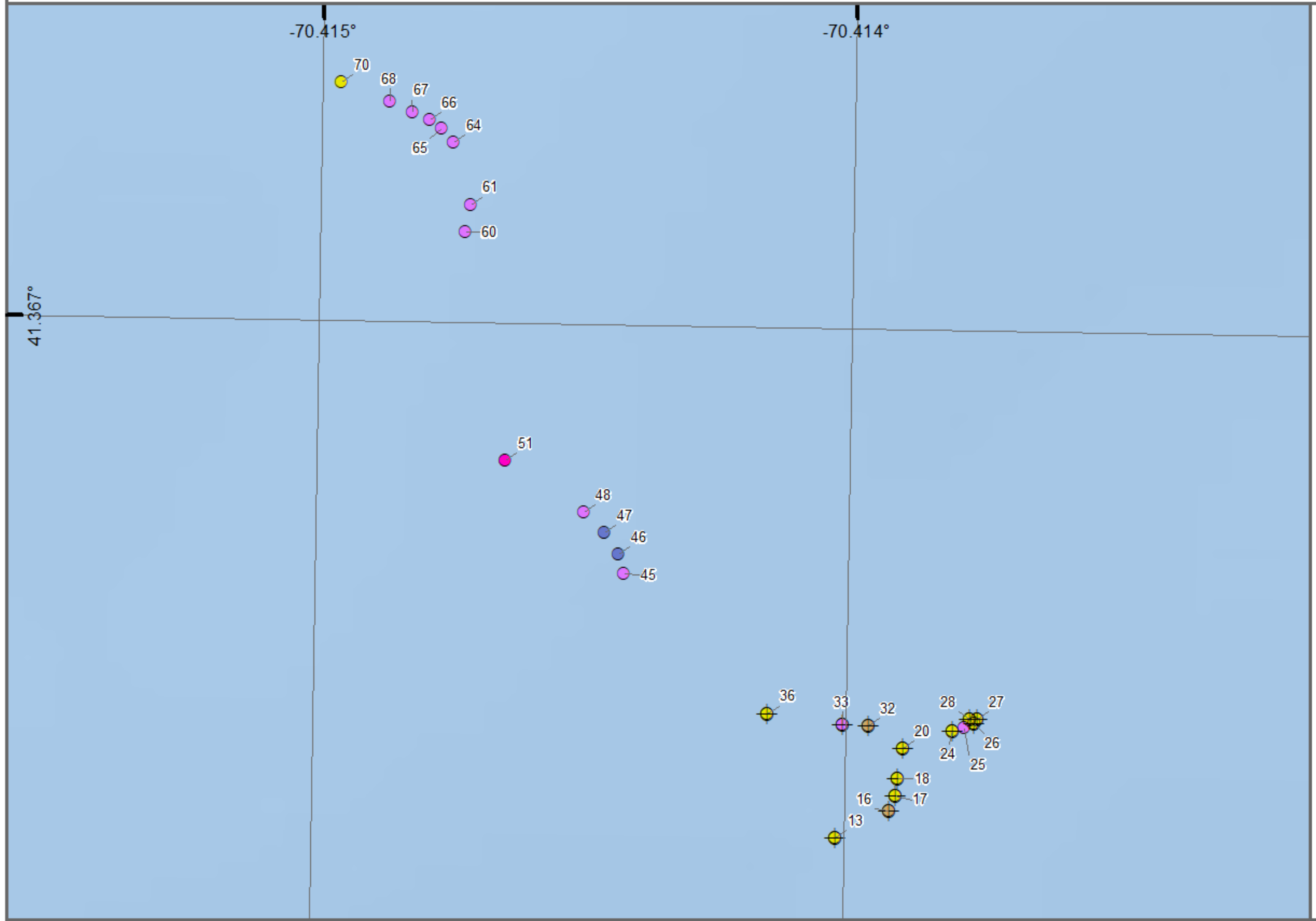
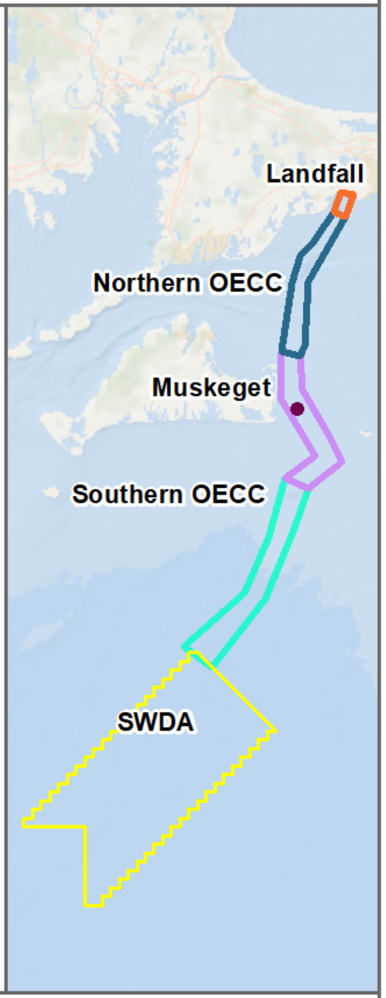
0 45 90 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-26





CMECS Classification

- Gravel - Pebble/Granule
- Gravel Mixes - Cobble/Pebble/Granule with S/M
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

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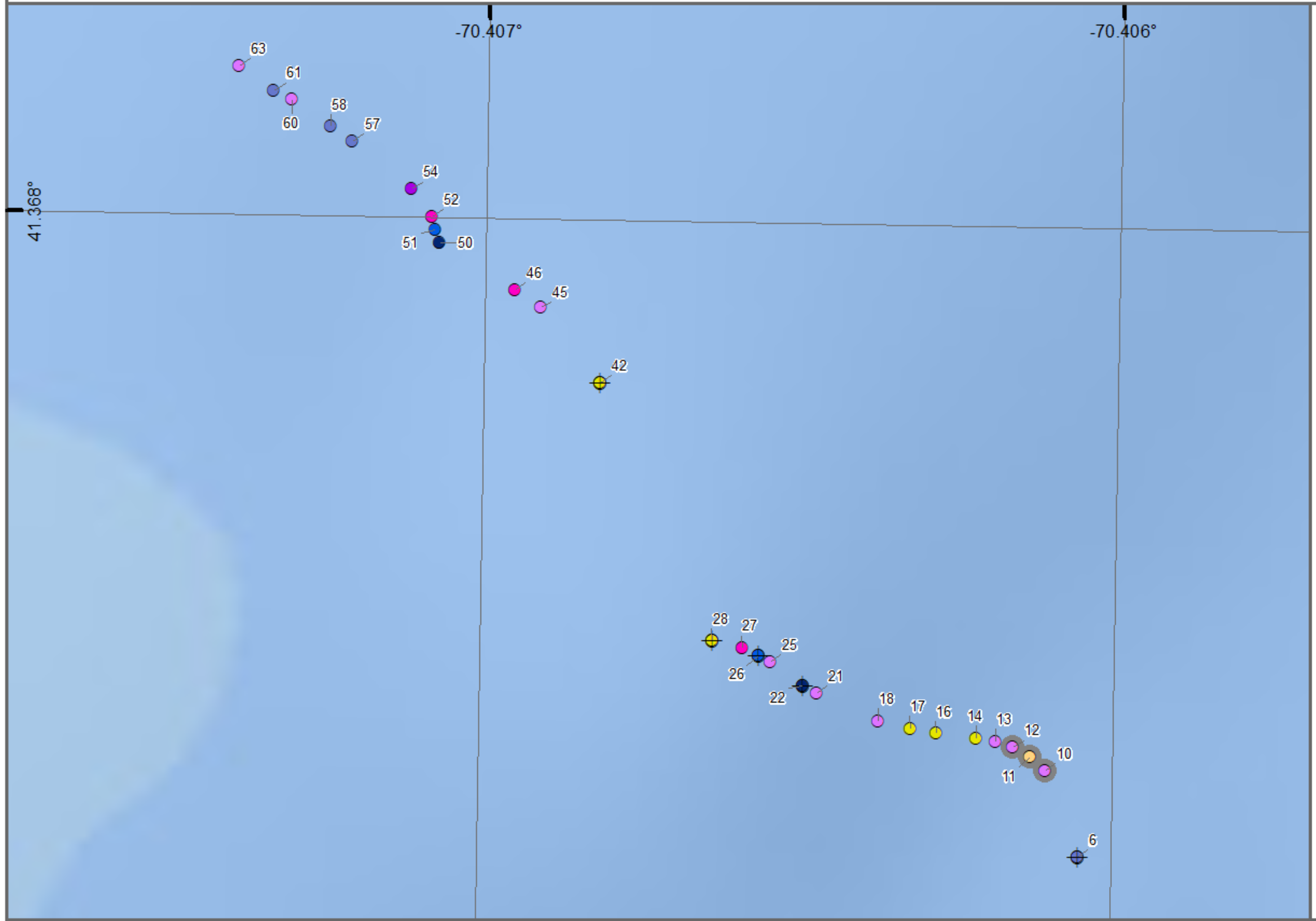
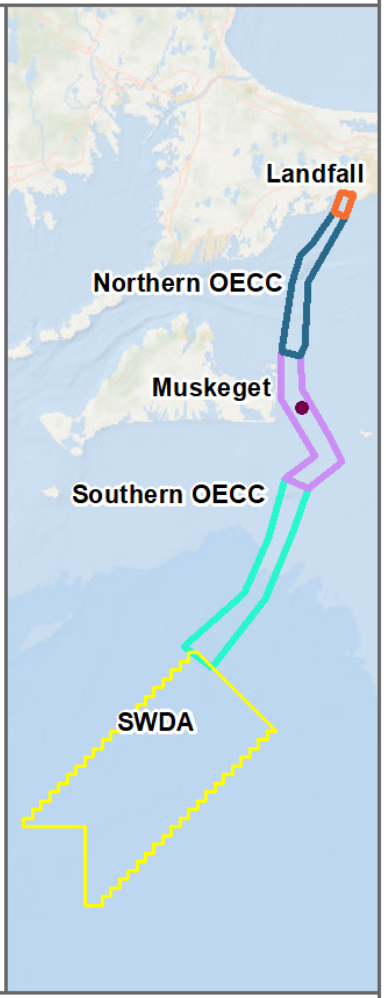
0 35 70 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-27





CMECS Classification

- Biogenic Shell Rubble
- Gravel - Cobble
- Gravel - Gravel Pavement
- Gravel - Pebble/Granule
- Gravel Mixes - Cobble with S/M
- Gravel Mixes - Cobble/Pebble/Granule with S/M
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Moderate

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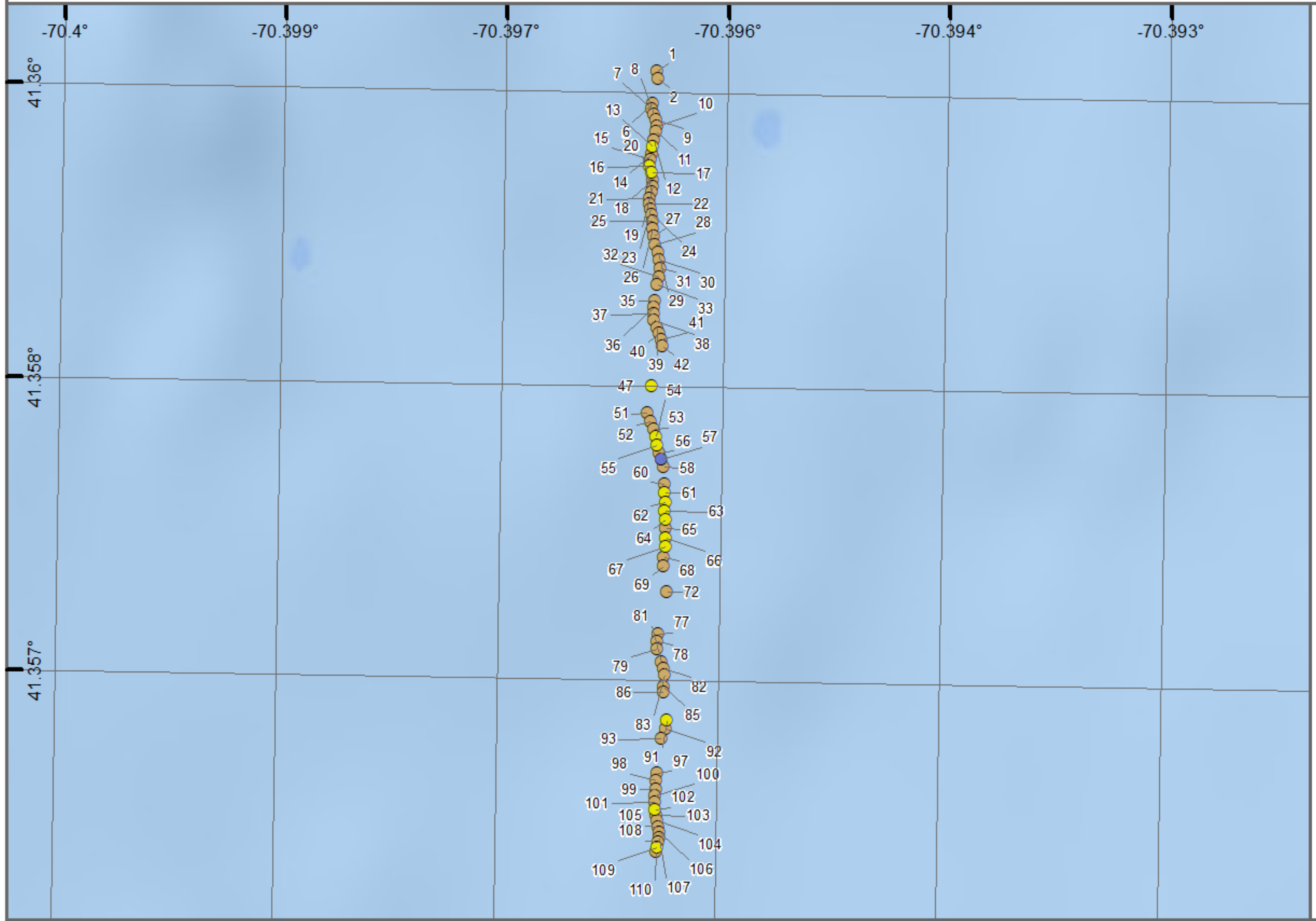
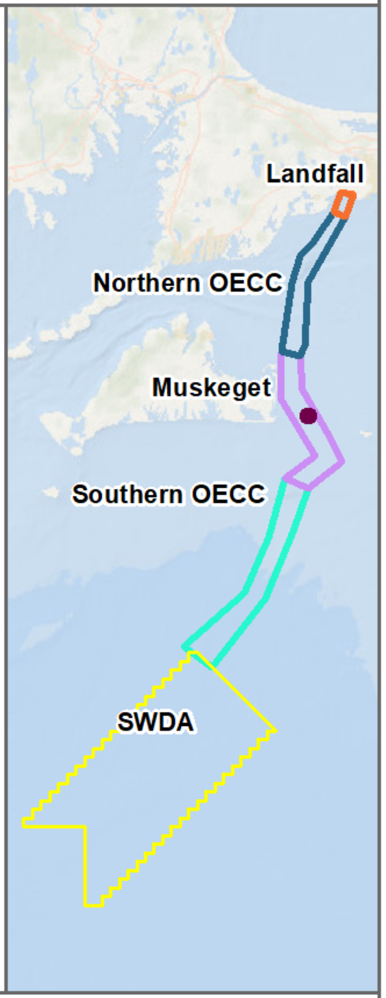
0 30 60 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-28





CMECS Classification

- Gravel - Pebble/Granule
- Gravelly Sand/Mud with P/G
- Sand/Mud

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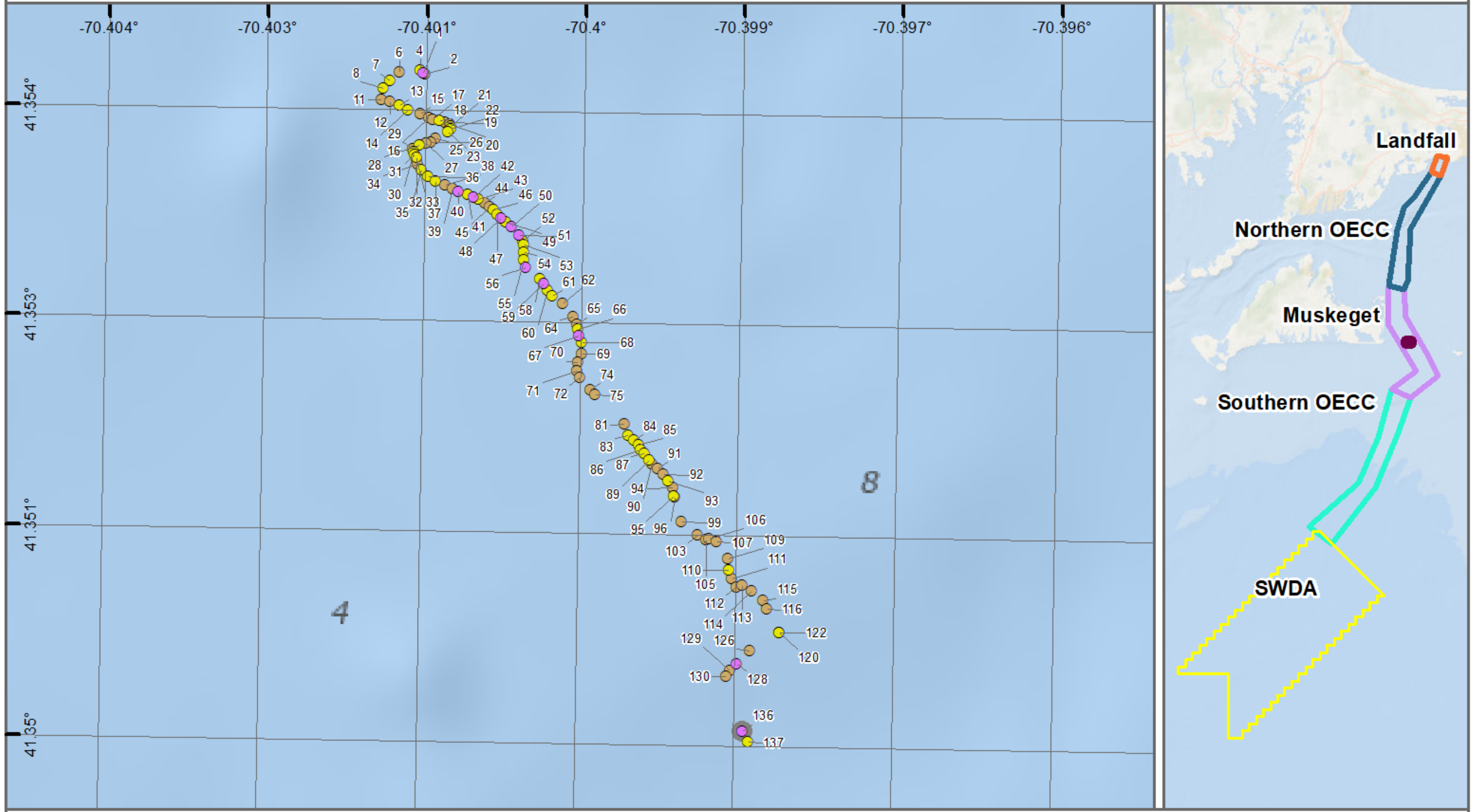
0 87.5 175 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-29



CMECS Classification

- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

Shell Cover

- Moderate

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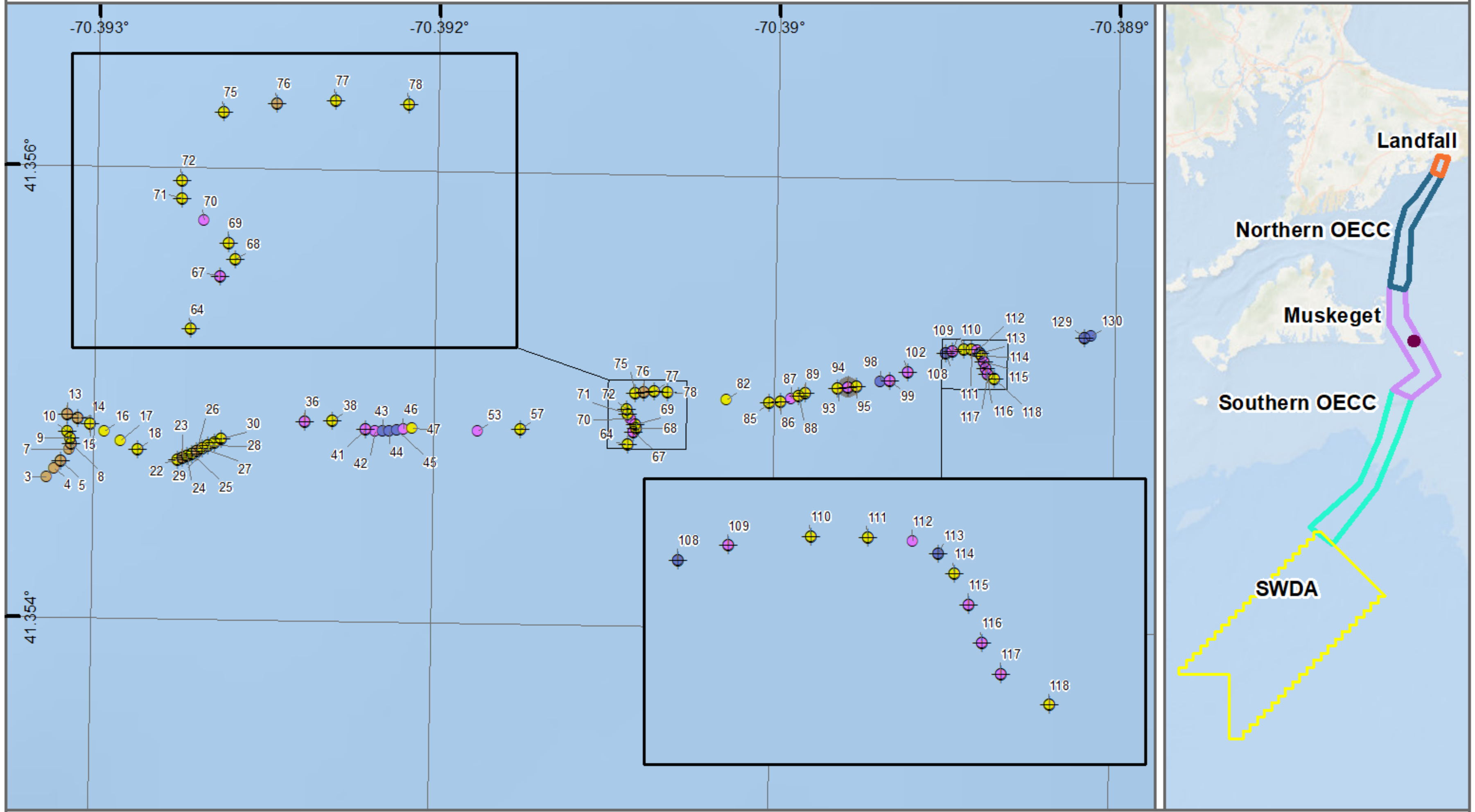
0 110 220 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-30



CMECS Classification

- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Moderate

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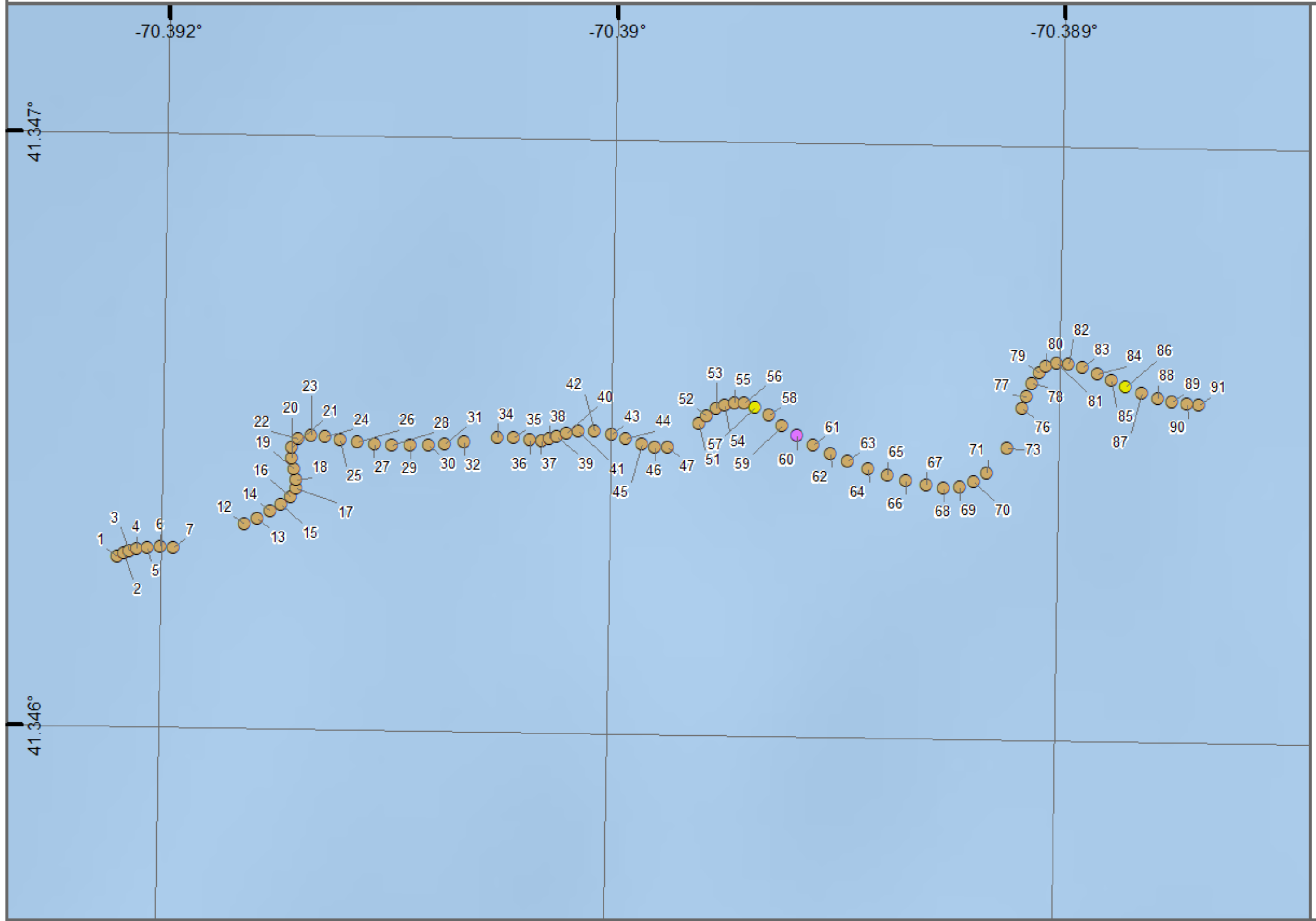
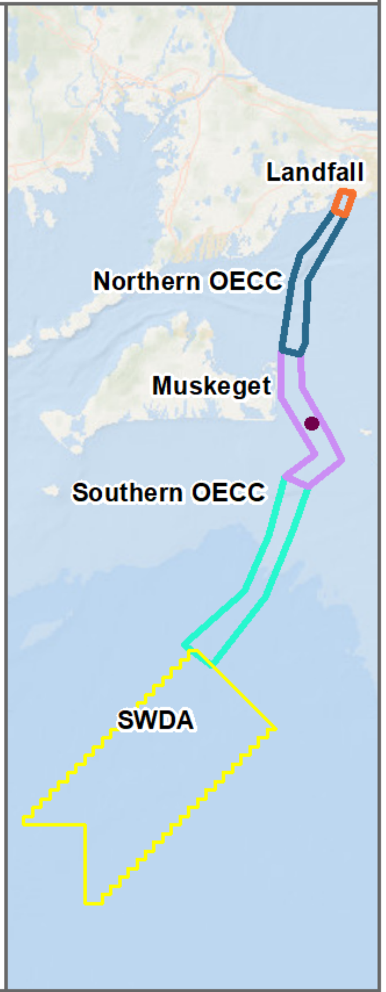
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-31





CMECS Classification

- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

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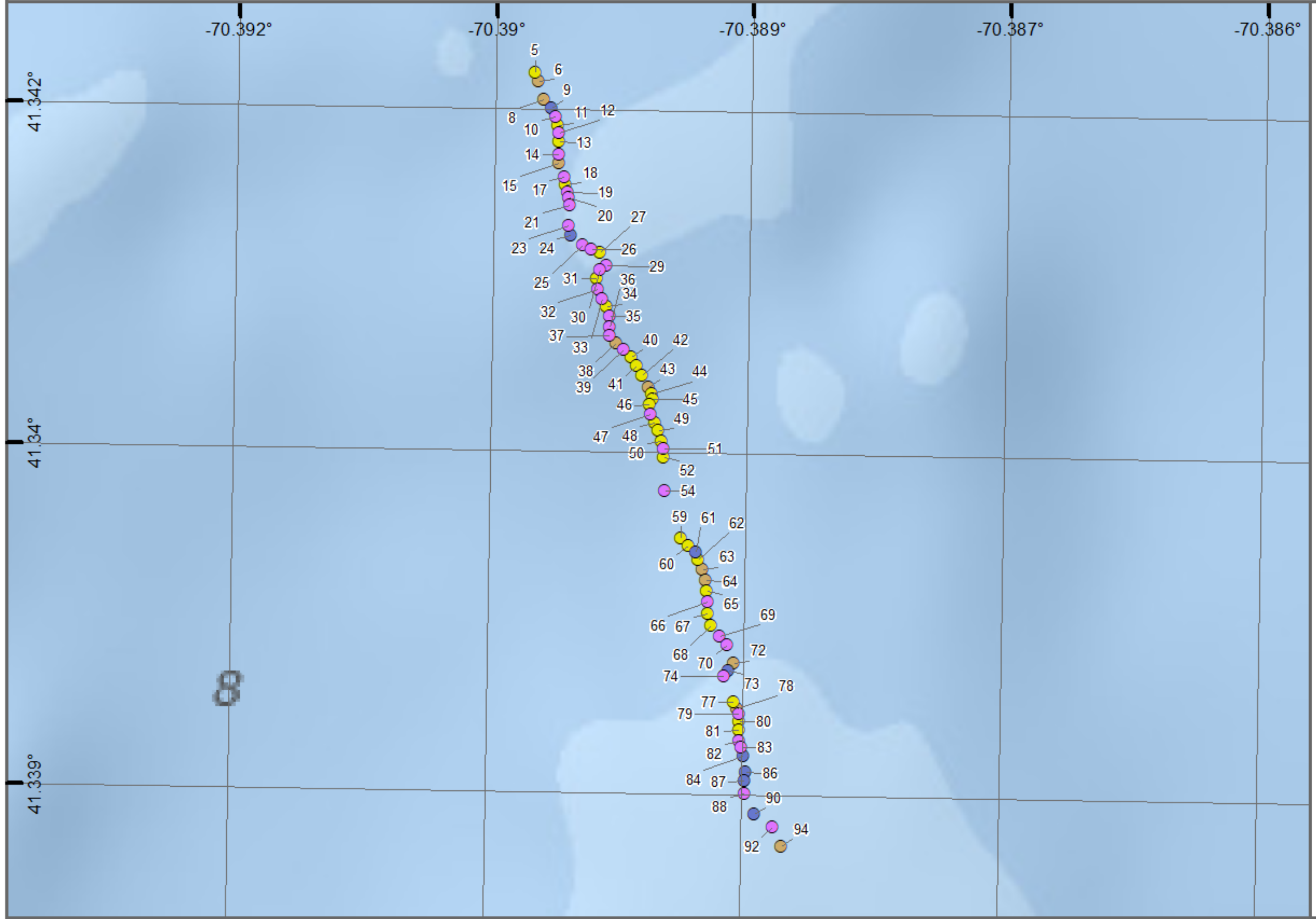
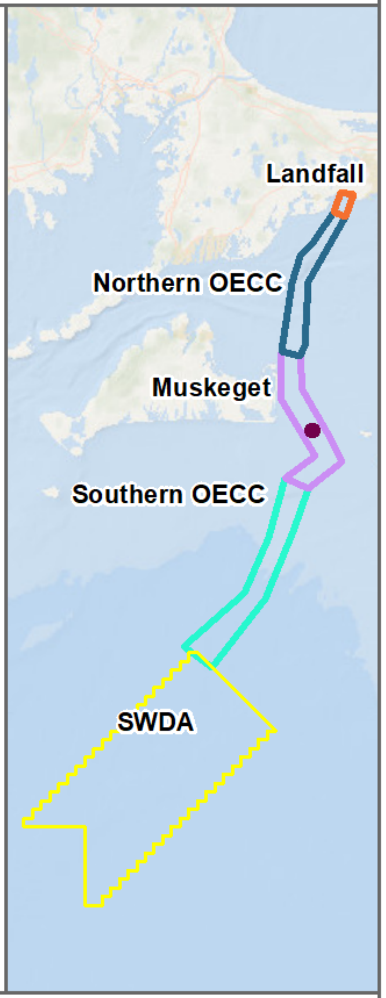
0 40 80 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-32





CMECS Classification

- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

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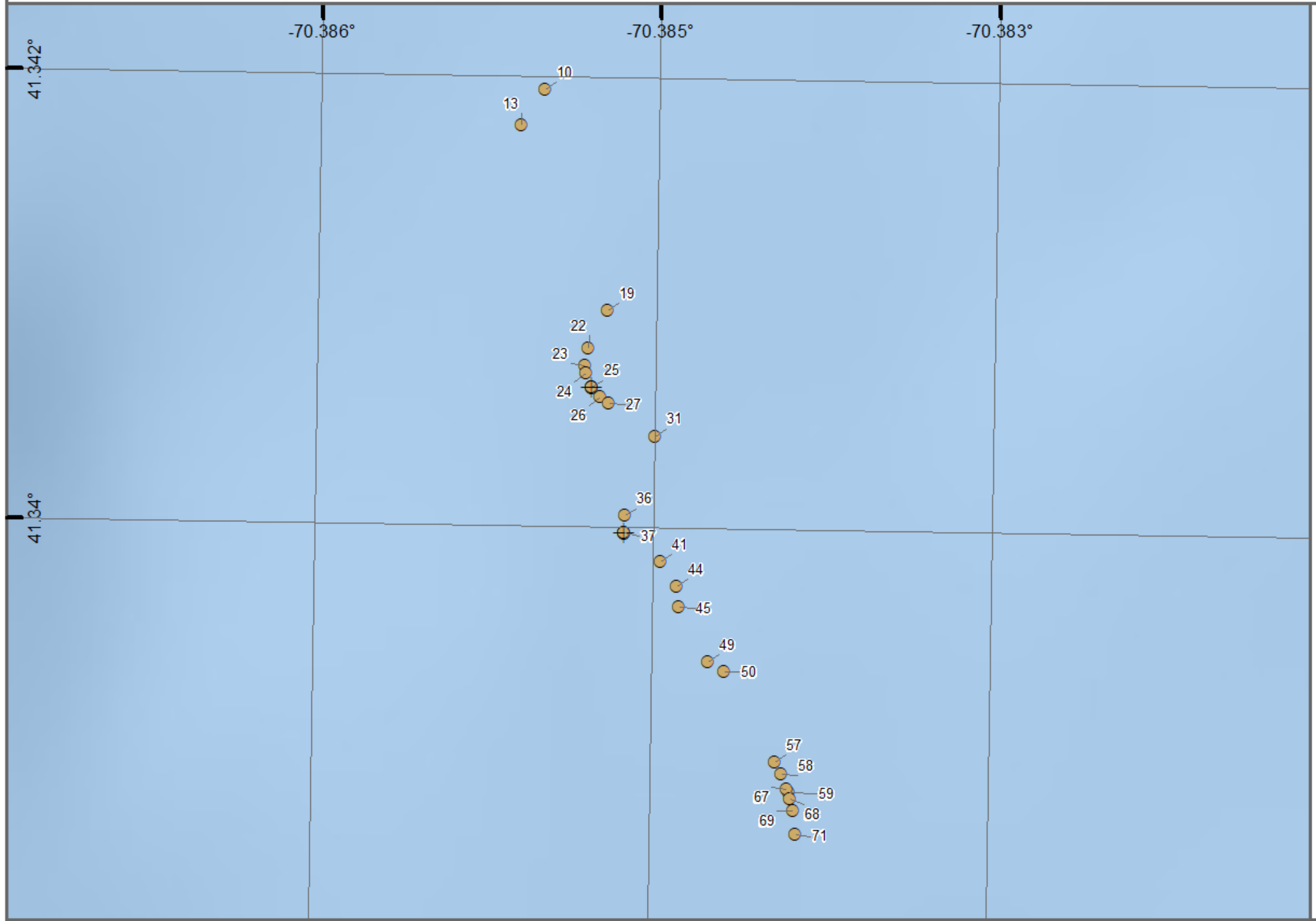
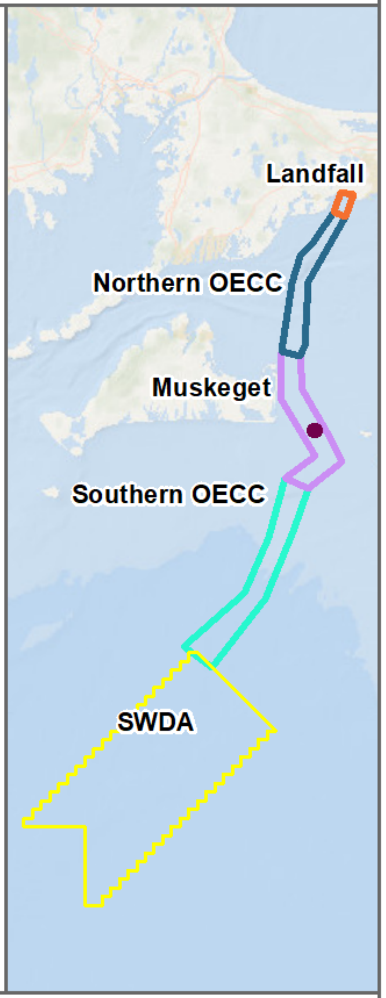
0 75 150 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-33





CMECS Classification

Sand/Mud

Flora/Fauna Cover

≥ Moderate

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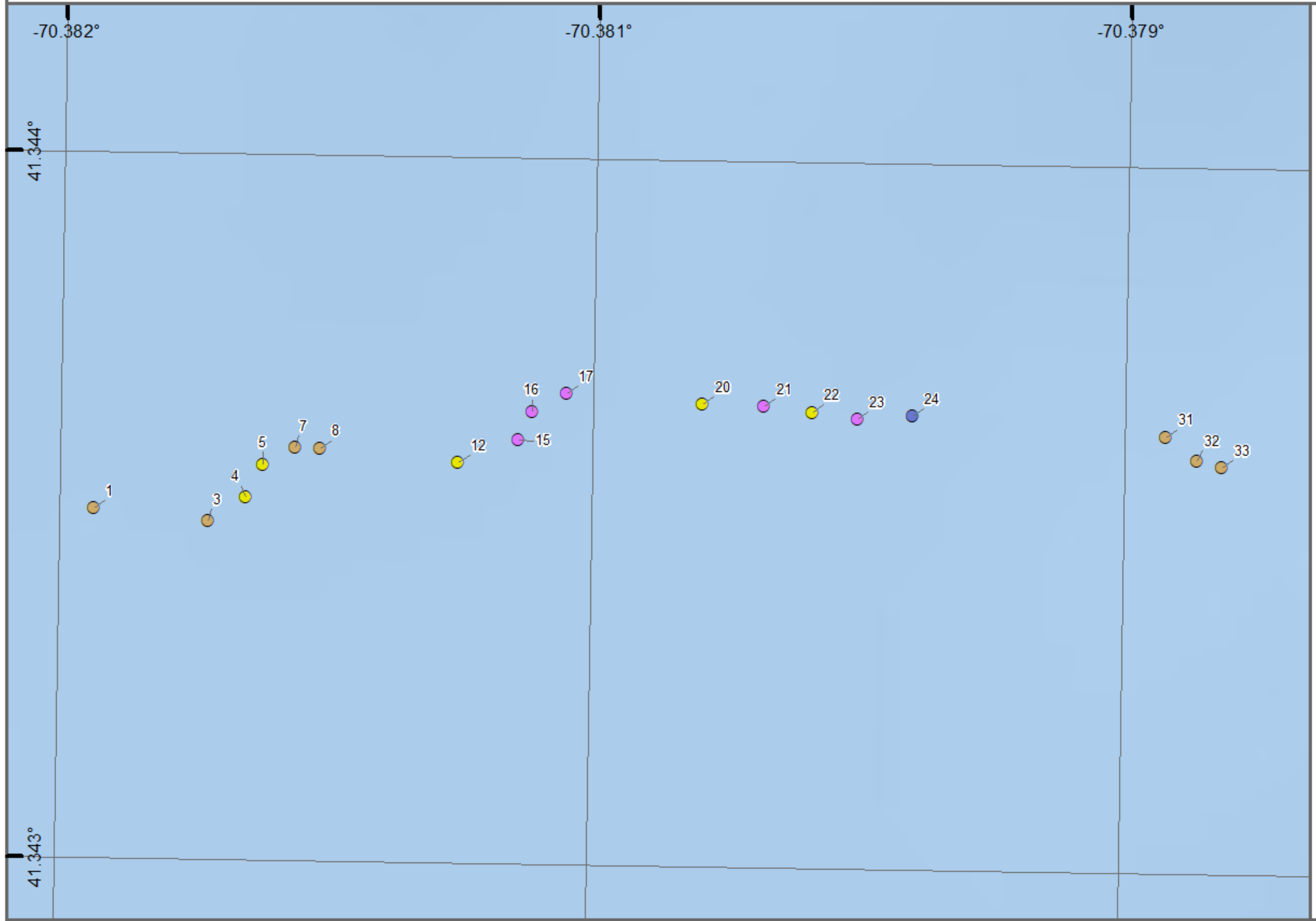
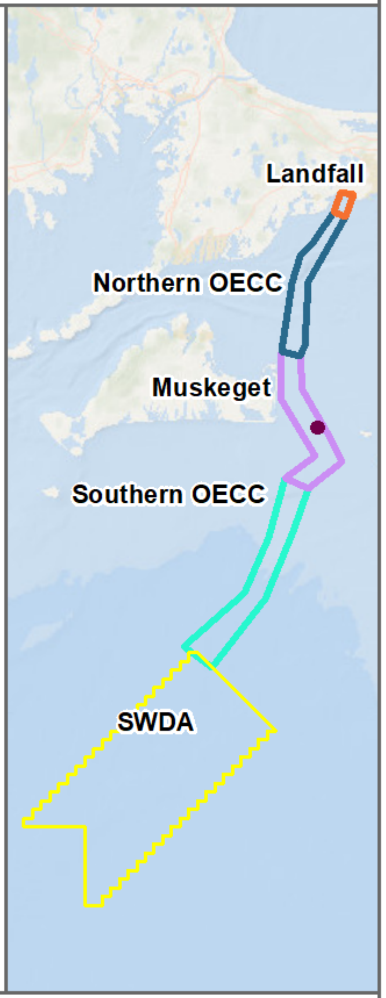
0 55 110 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-34





CMECS Classification

- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

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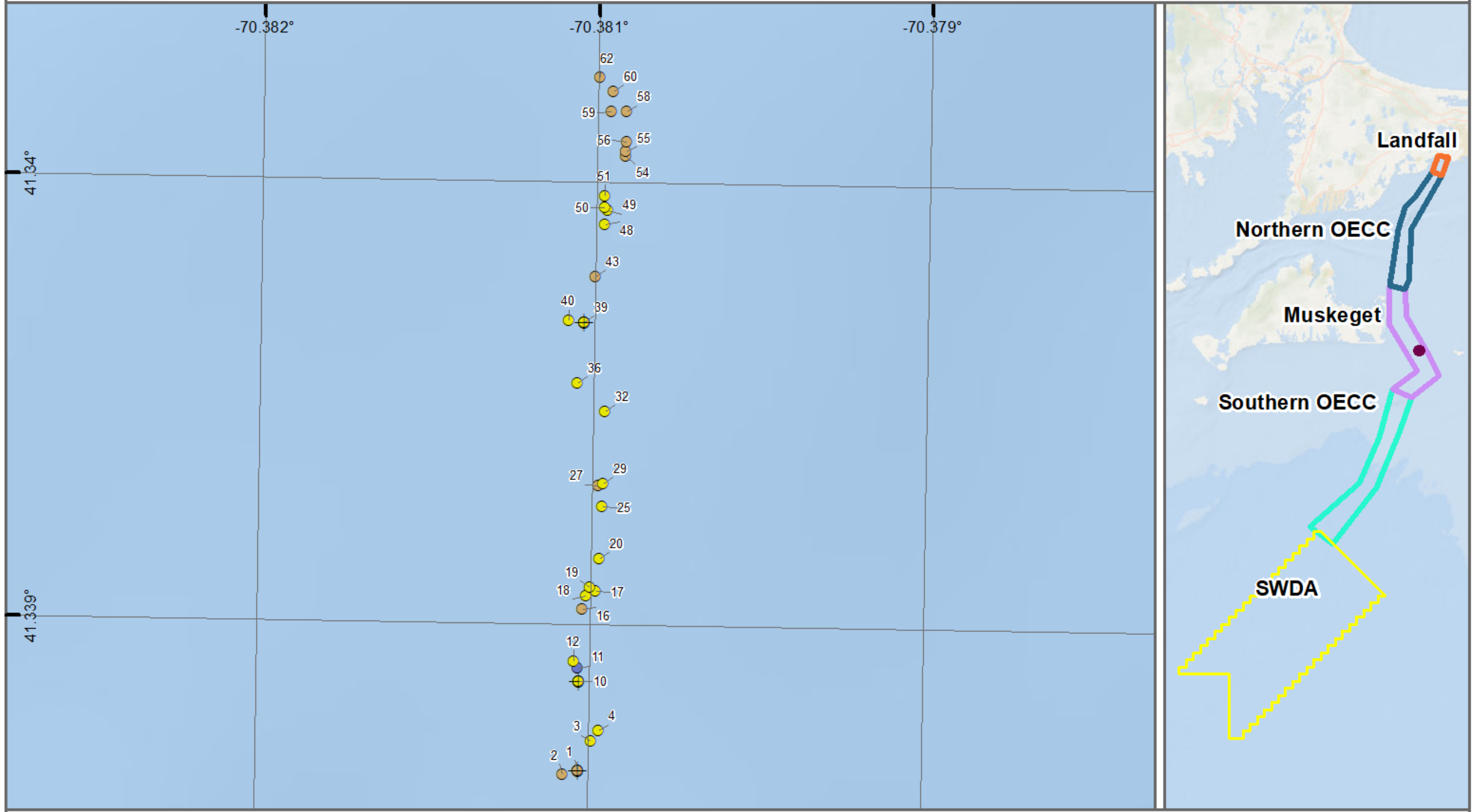
0 35 70 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-35



CMECS Classification

- Gravel - Pebble/Granule
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

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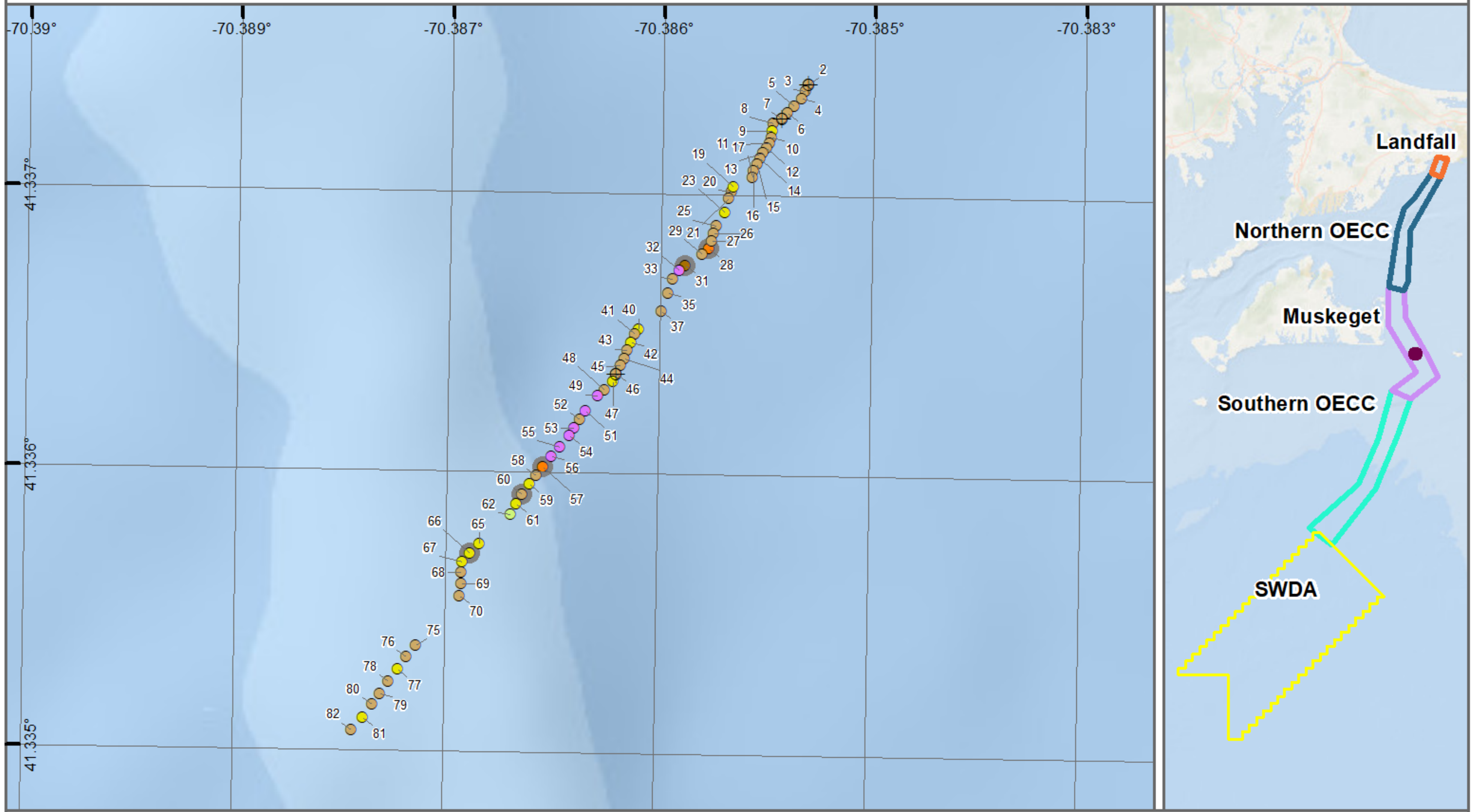
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-36



CMECS Classification

- Biogenic Shell Hash
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with C/P/G
- Gravelly Sand/Mud with P/G
- Sand/Mud/Shell Mix
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Moderate

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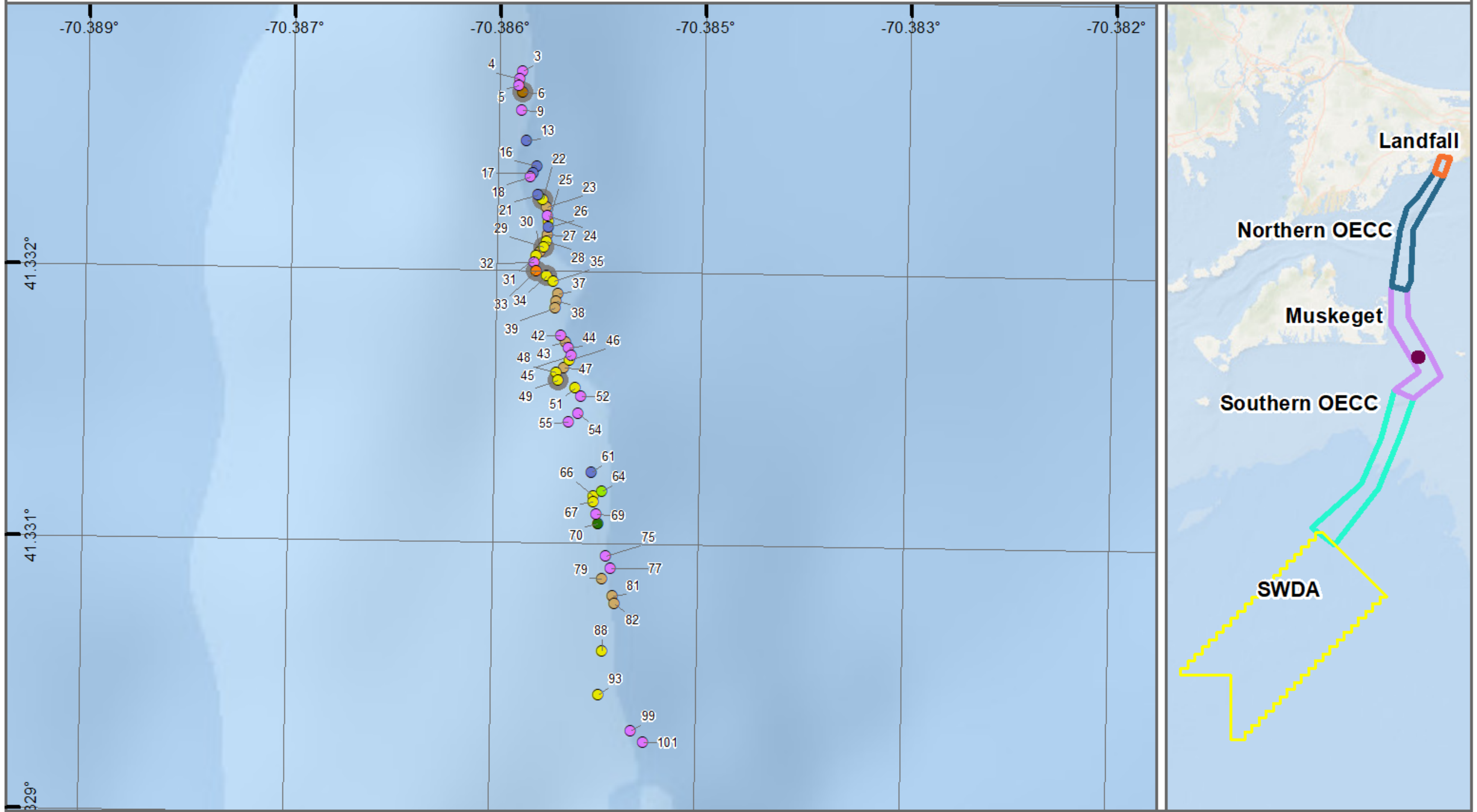
0 80 160 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-37



CMECS Classification

- Biogenic Shell Hash
- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with B
- Gravelly Sand/Mud with B/C/P/G
- Gravelly Sand/Mud with P/G
- Sand/Mud/Shell Mix
- Sand/Mud

Shell Cover

- Moderate

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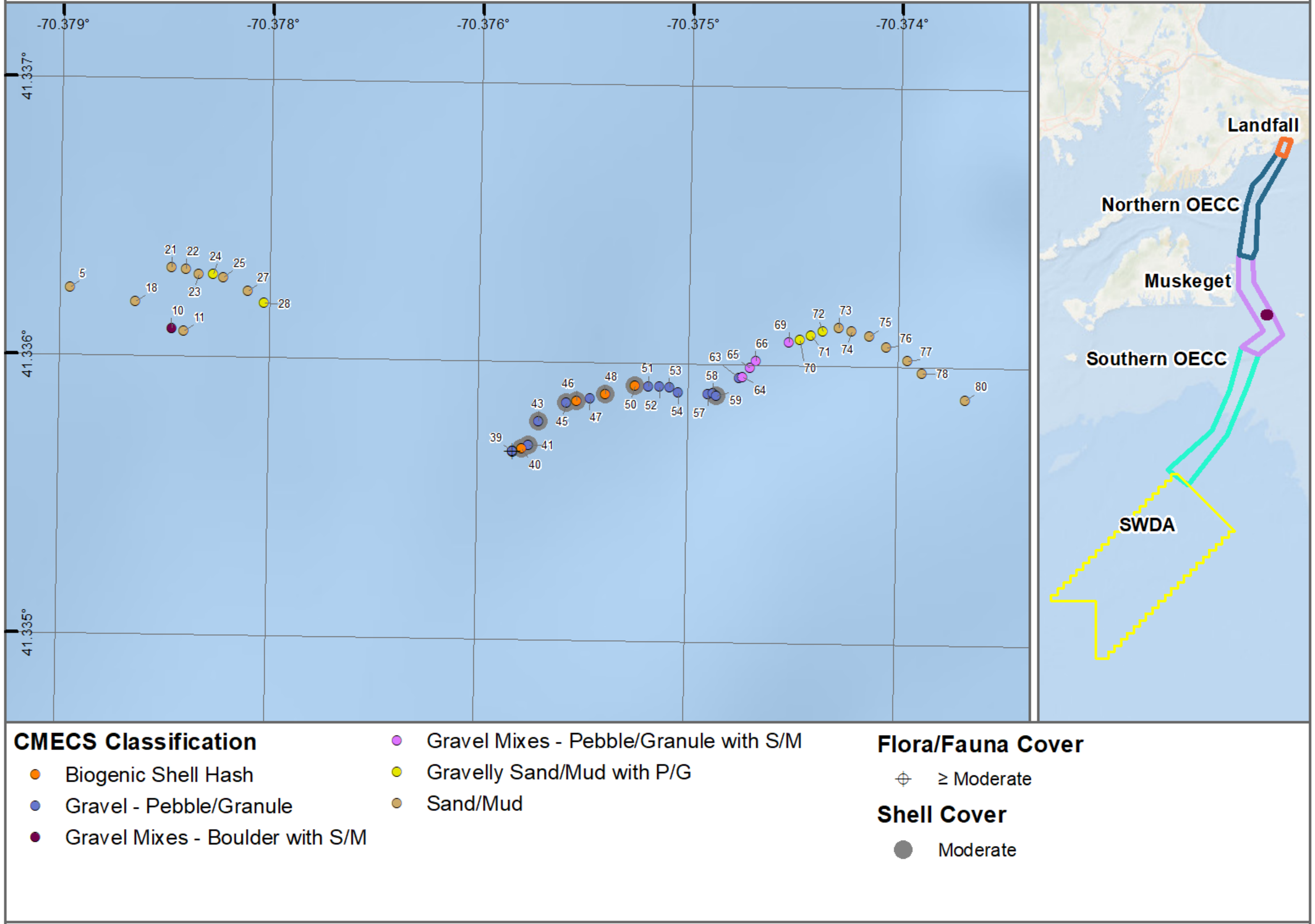
0 85 170 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-38



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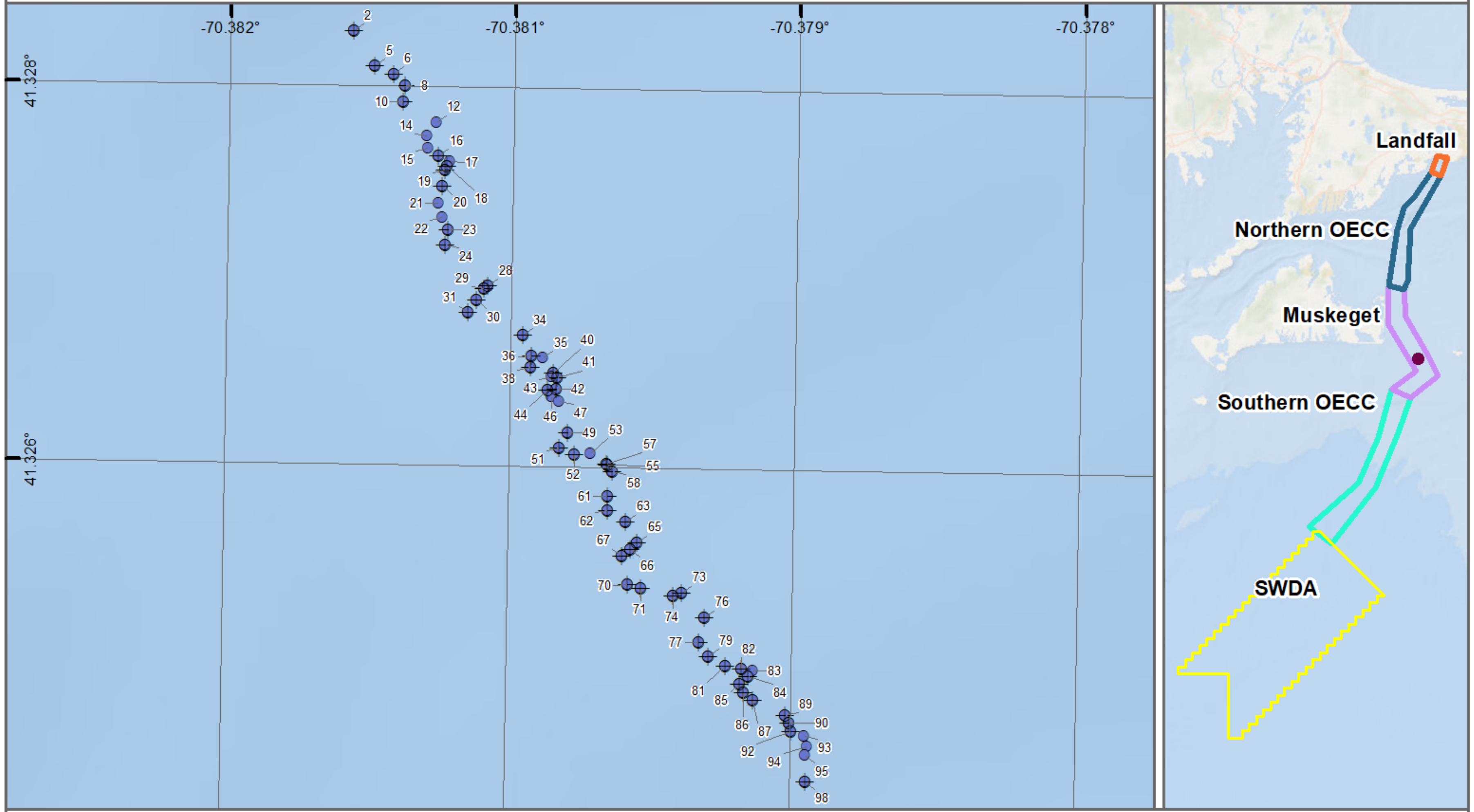
OECC Zone: Muskeget Transect: OECC20-VT-39



CMECS Classification

Gravel - Pebble/Granule

Flora/Fauna Cover

≥ Moderate

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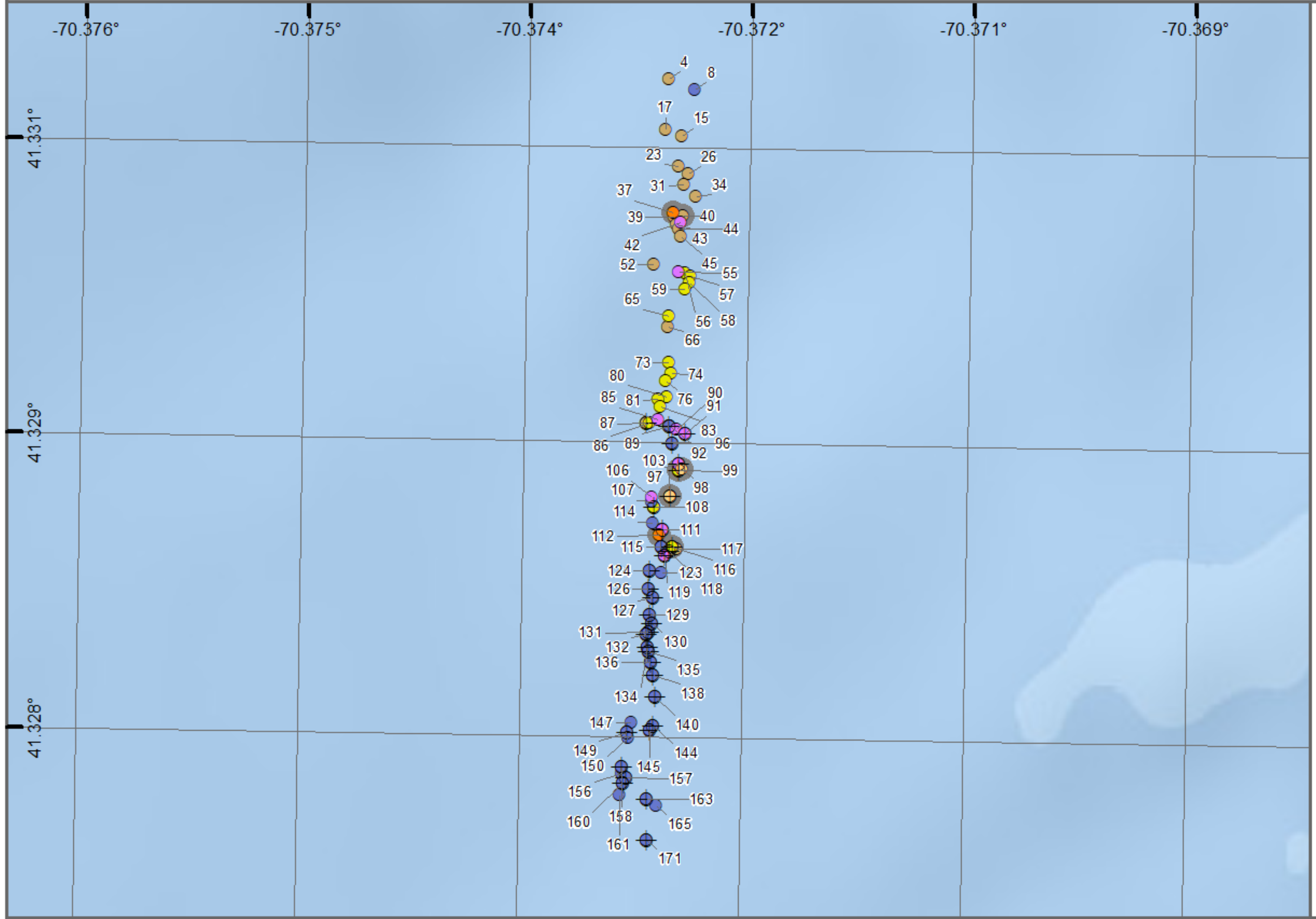
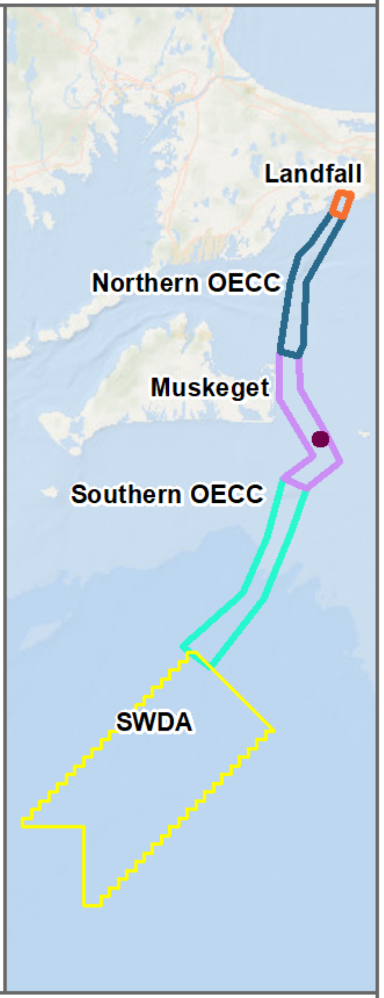
0 60 120 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-40





CMECS Classification

- Biogenic Shell Hash
- Biogenic Shell Rubble
- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Moderate

0 87.5 175 Meters

N

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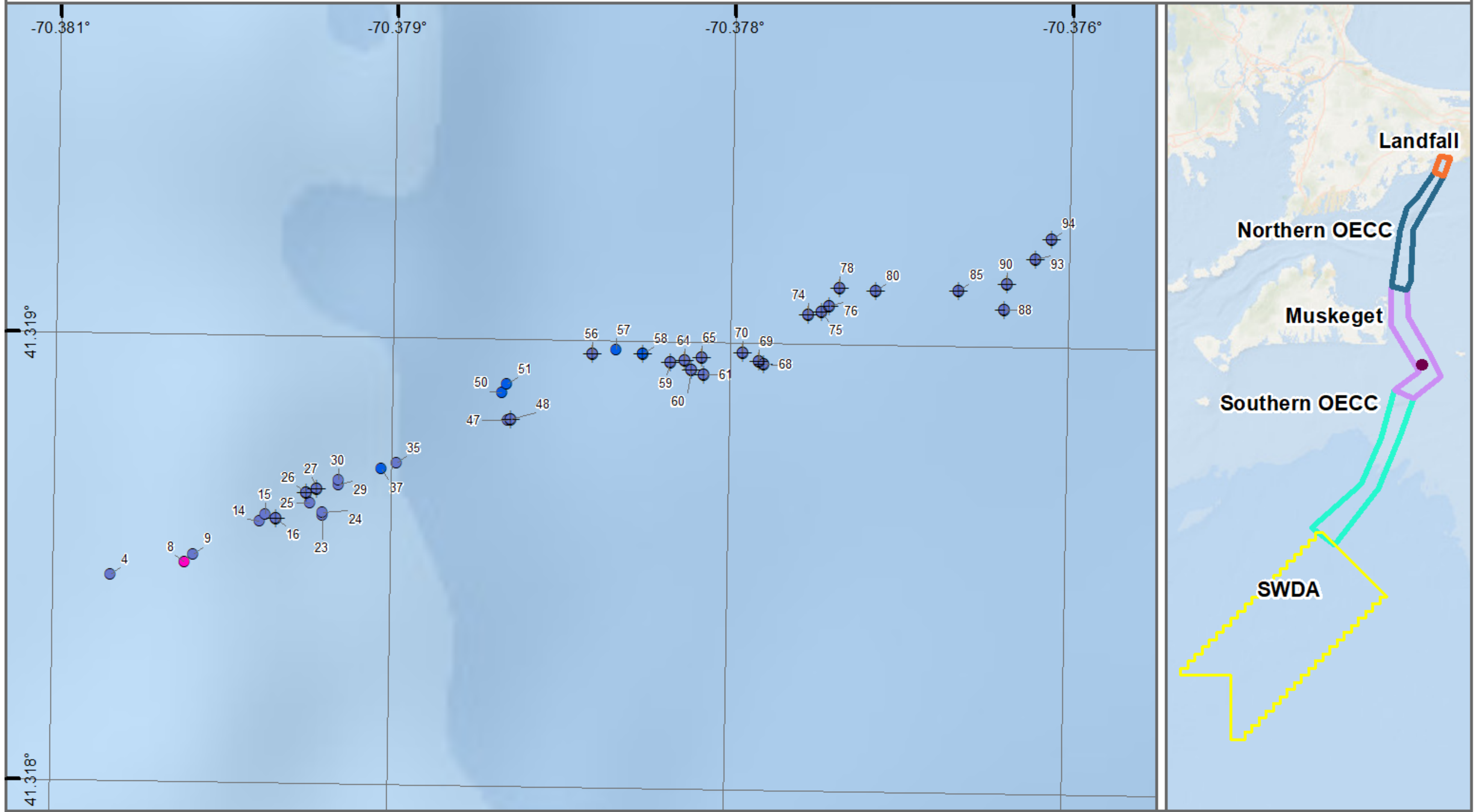
OECC Zone: Muskeget Transect: OECC20-VT-41



CMECS Classification

- Gravel - Gravel Pavement
- Gravel - Pebble/Granule
- Gravel Mixes - Cobble/Pebble/Granule with S/M

Flora/Fauna Cover

- ≥ Moderate

0 50 100 Meters

N

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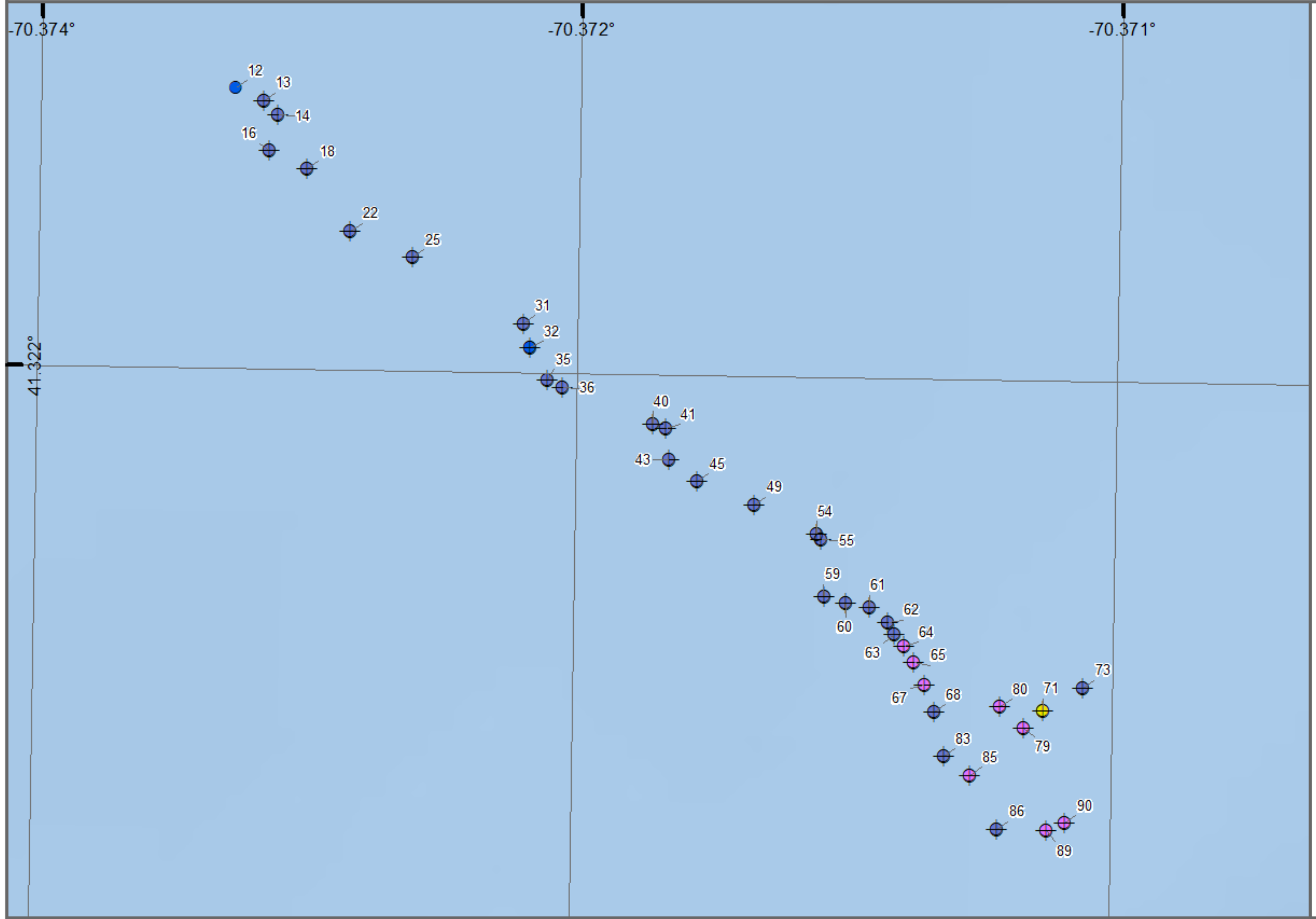
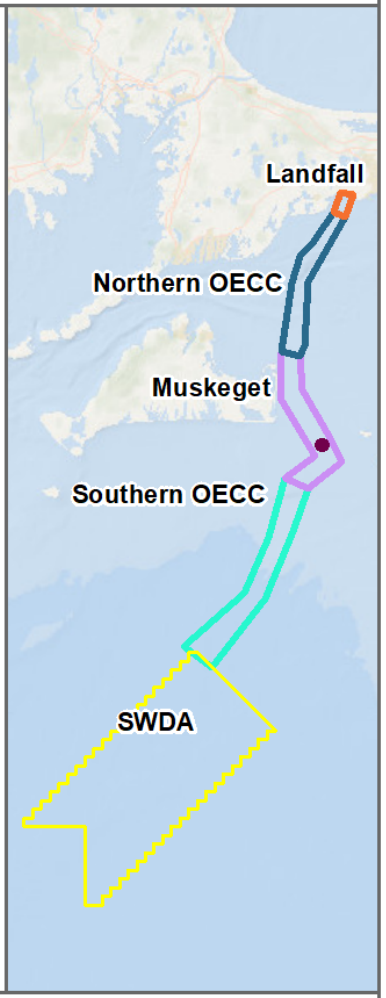
OECC Zone: Muskeget Transect: OECC20-VT-42





CMECS Classification

- Gravel - Gravel Pavement
- Gravel - Pebble/Granule
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G

Flora/Fauna Cover

- ≥ Moderate

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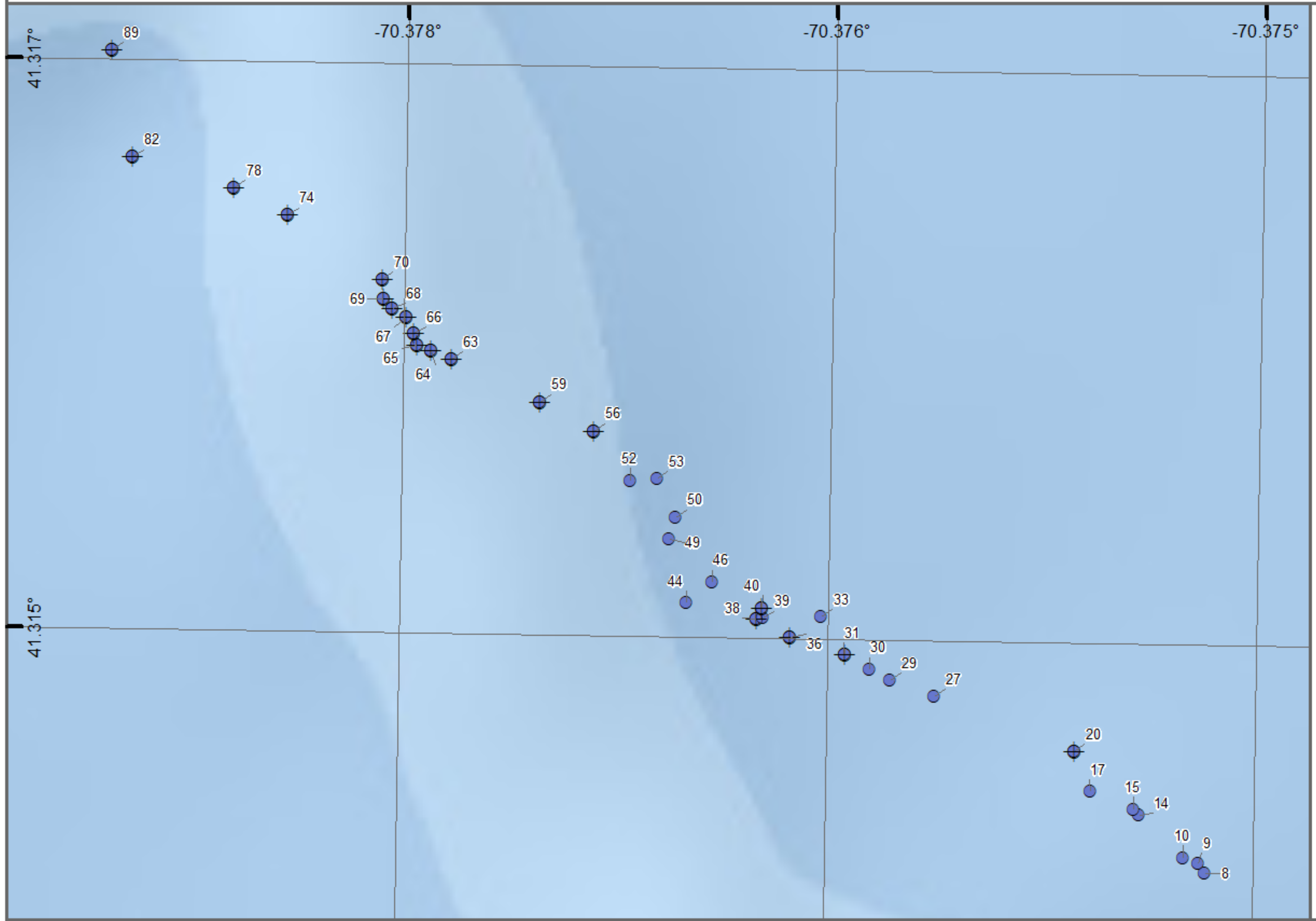
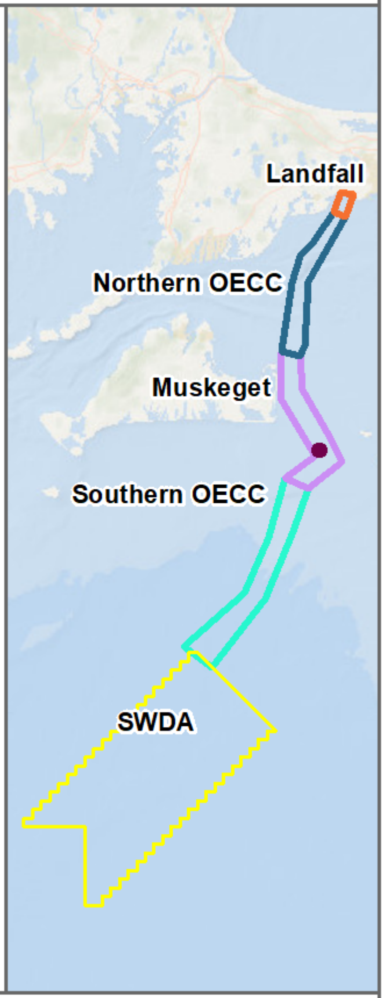
0 35 70 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-43





CMECS Classification

Gravel - Pebble/Granule

Flora/Fauna Cover

≥ Moderate

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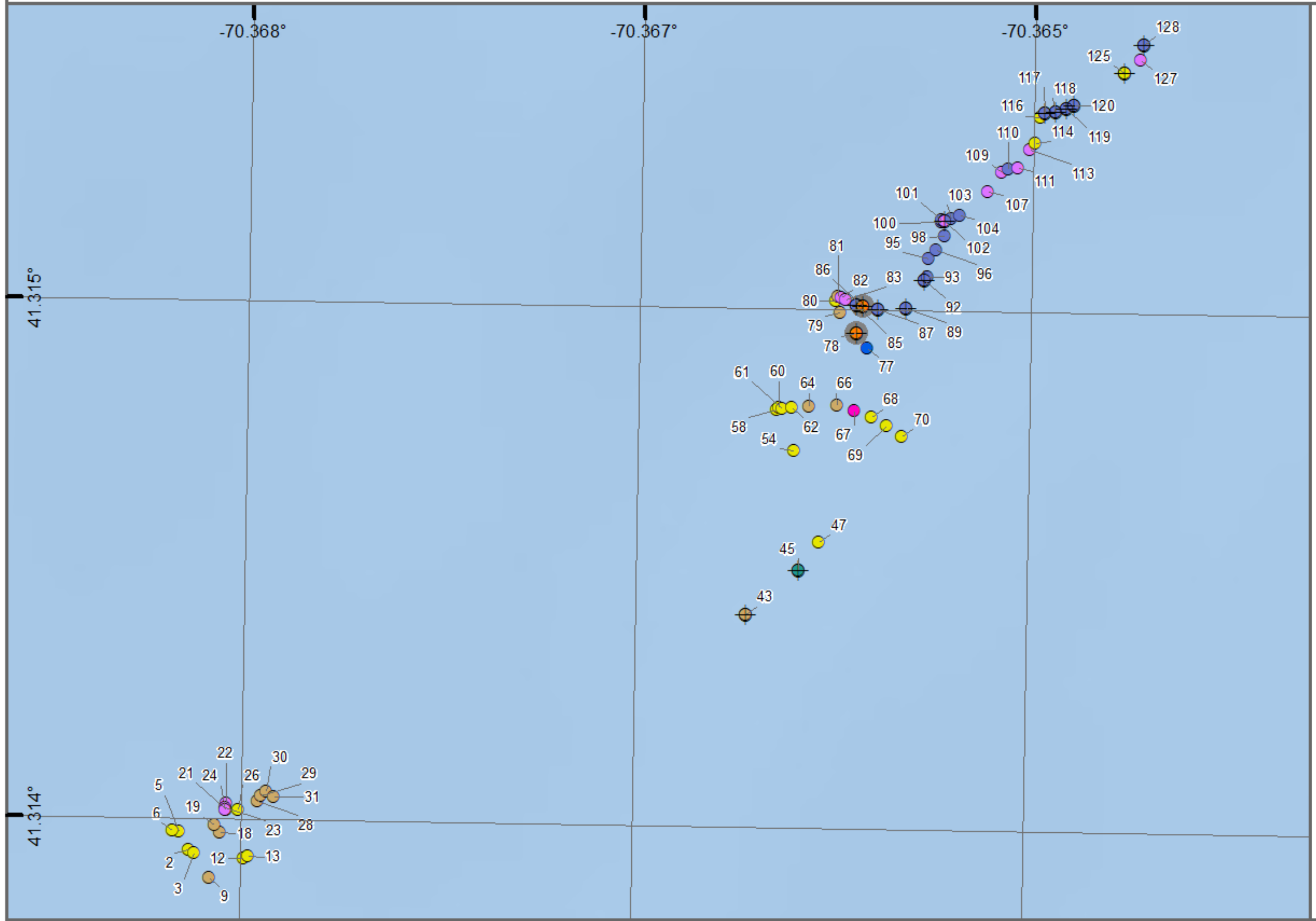
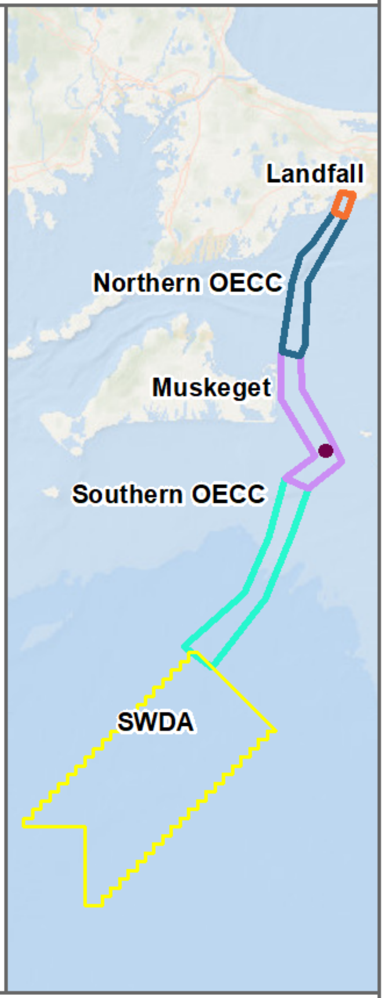
0 45 90 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-44





CMECS Classification

- Biogenic Shell Hash
- Gravel - Gravel Pavement
- Gravel - Pebble/Granule
- Gravel Mixes - Cobble/Pebble/Granule with S/M
- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with B/P/G
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

Shell Cover

- Moderate

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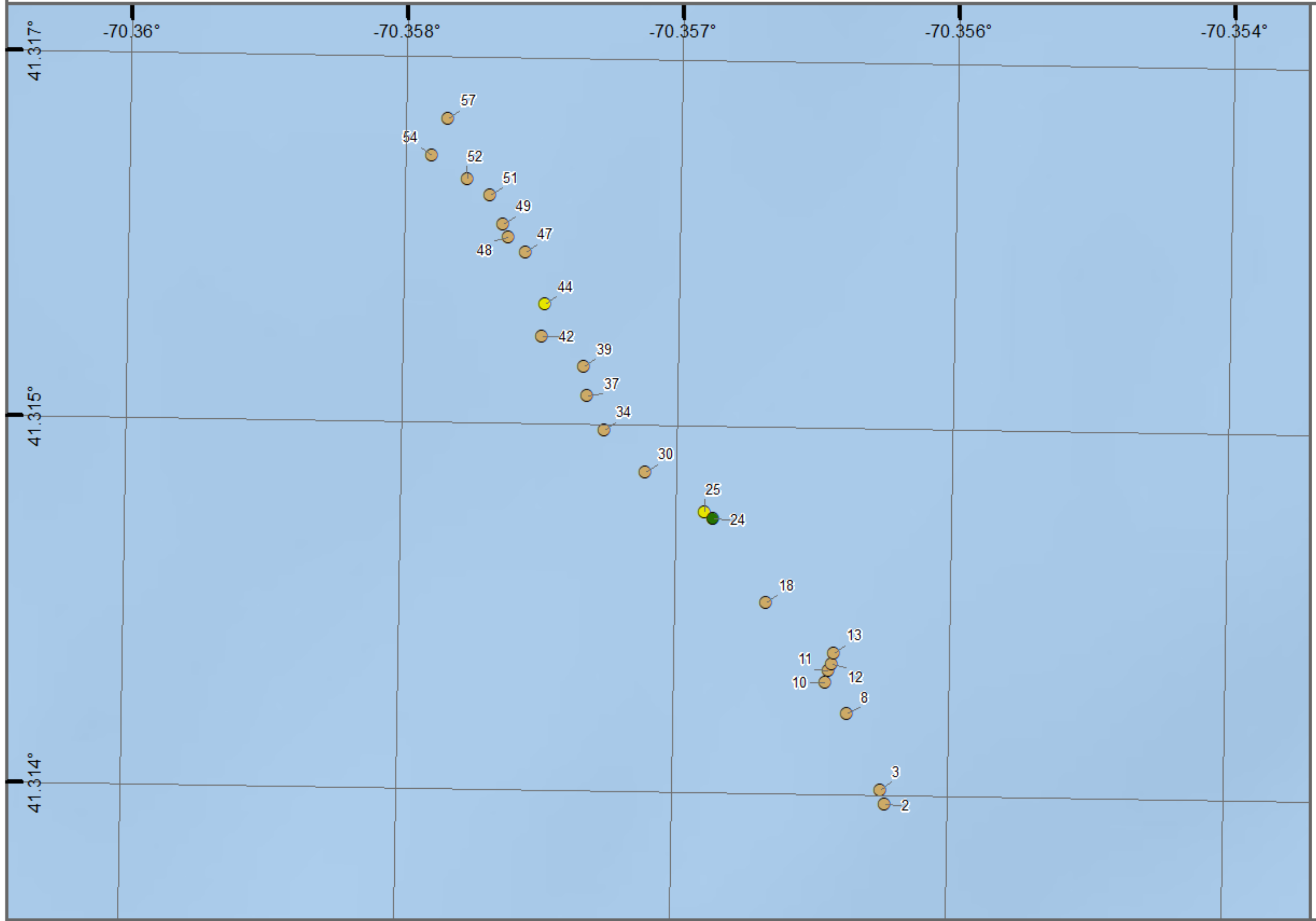
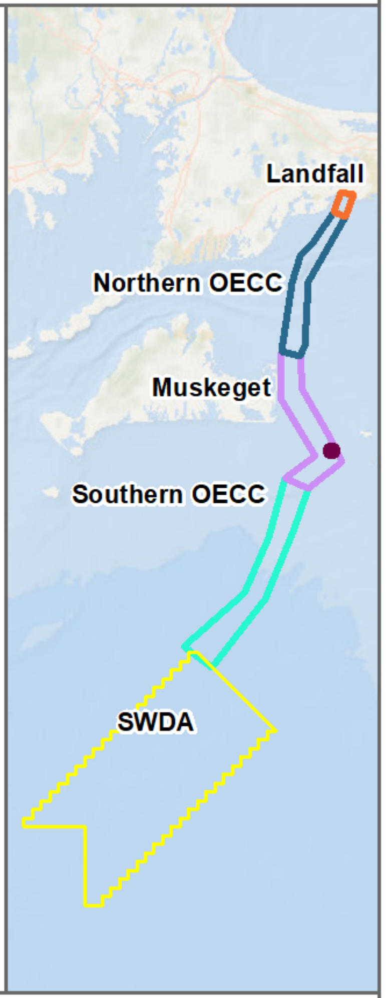
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-45





CMECS Classification

- Gravelly Sand/Mud with B
- Gravelly Sand/Mud with P/G
- Sand/Mud

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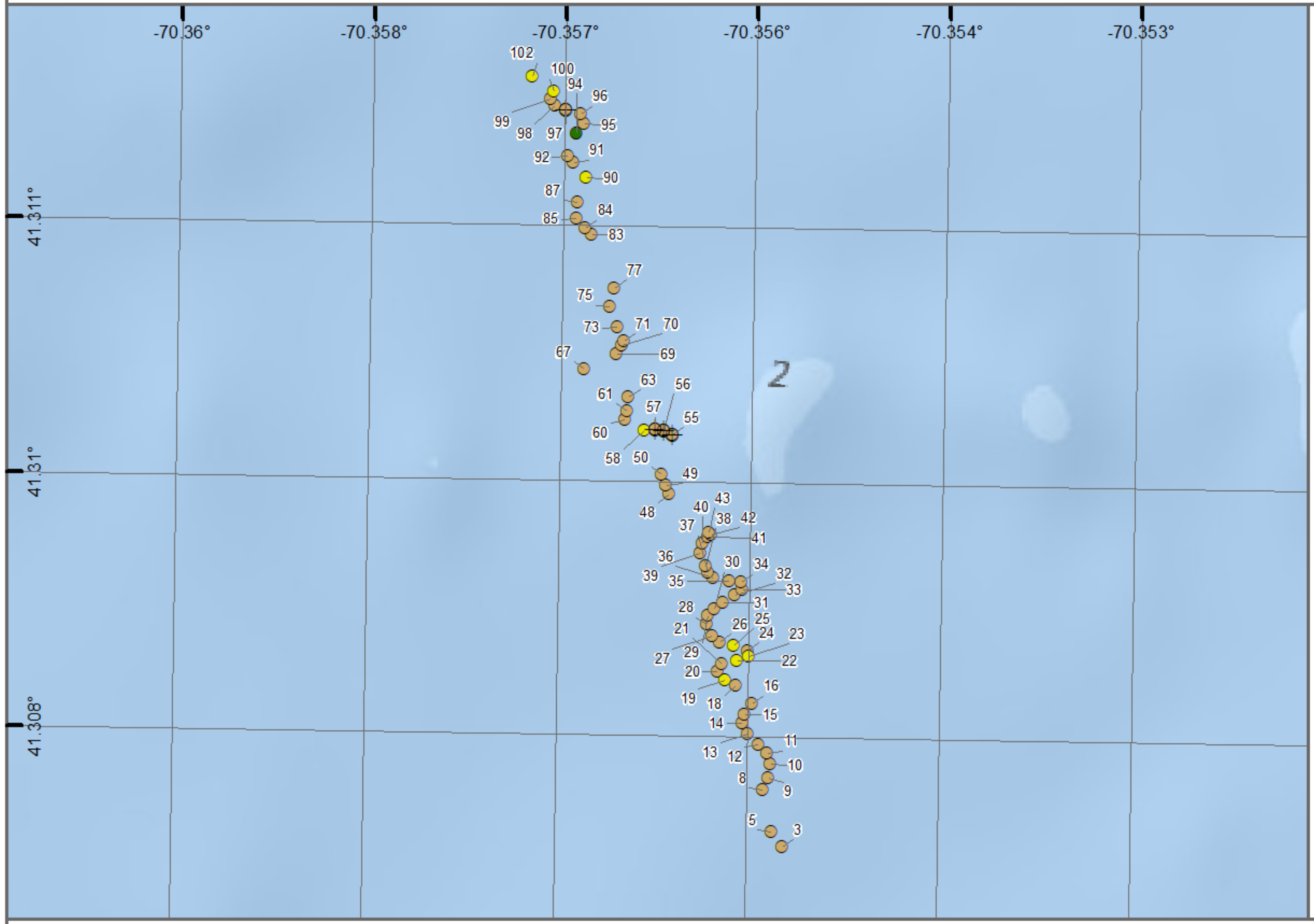
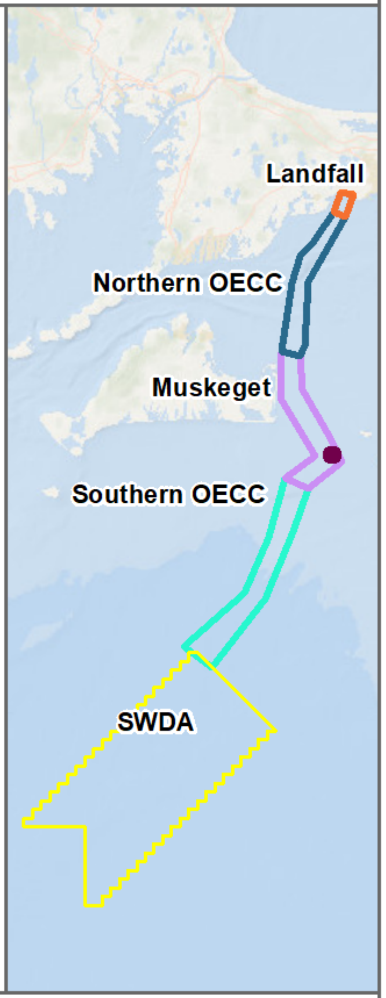
0 70 140 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-46





CMECS Classification

- Gravelly Sand/Mud with B
- Gravelly Sand/Mud with P/G
- Sand/Mud

Flora/Fauna Cover

- ≥ Moderate

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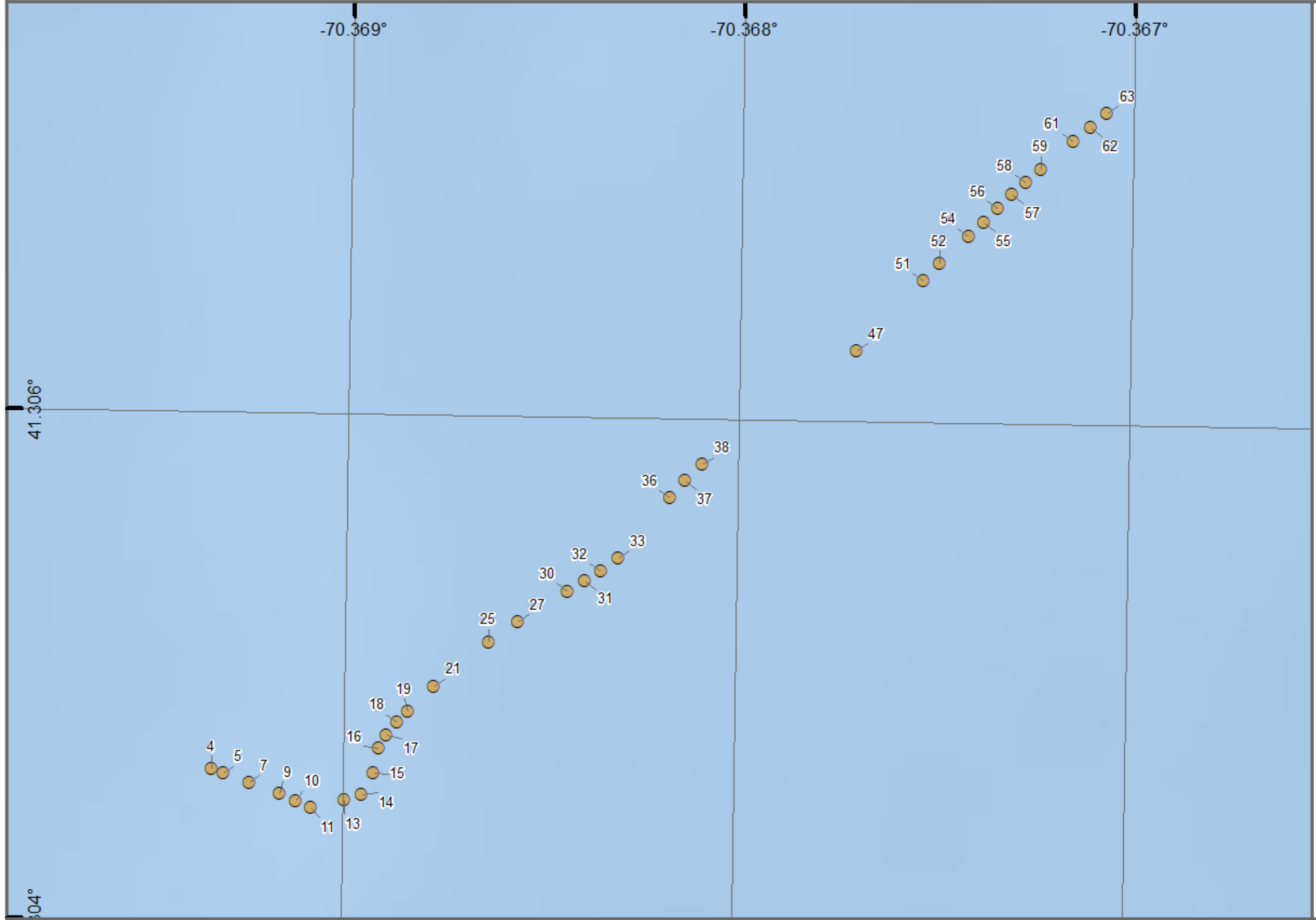
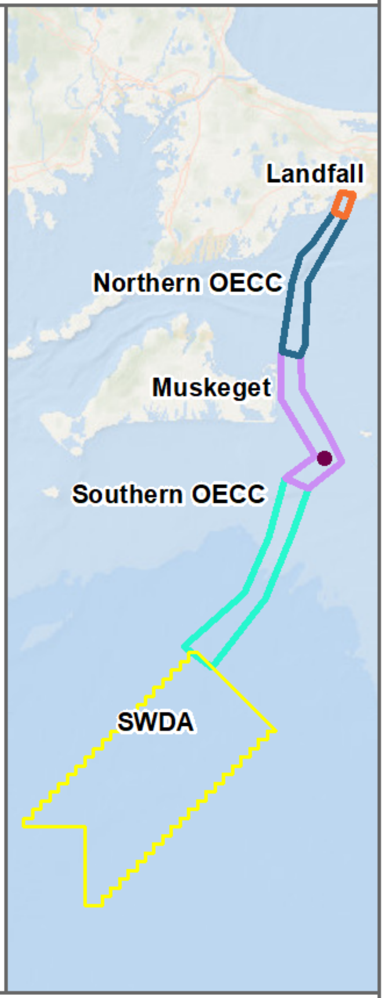
0 100 200 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-47





CMECS Classification

Sand/Mud

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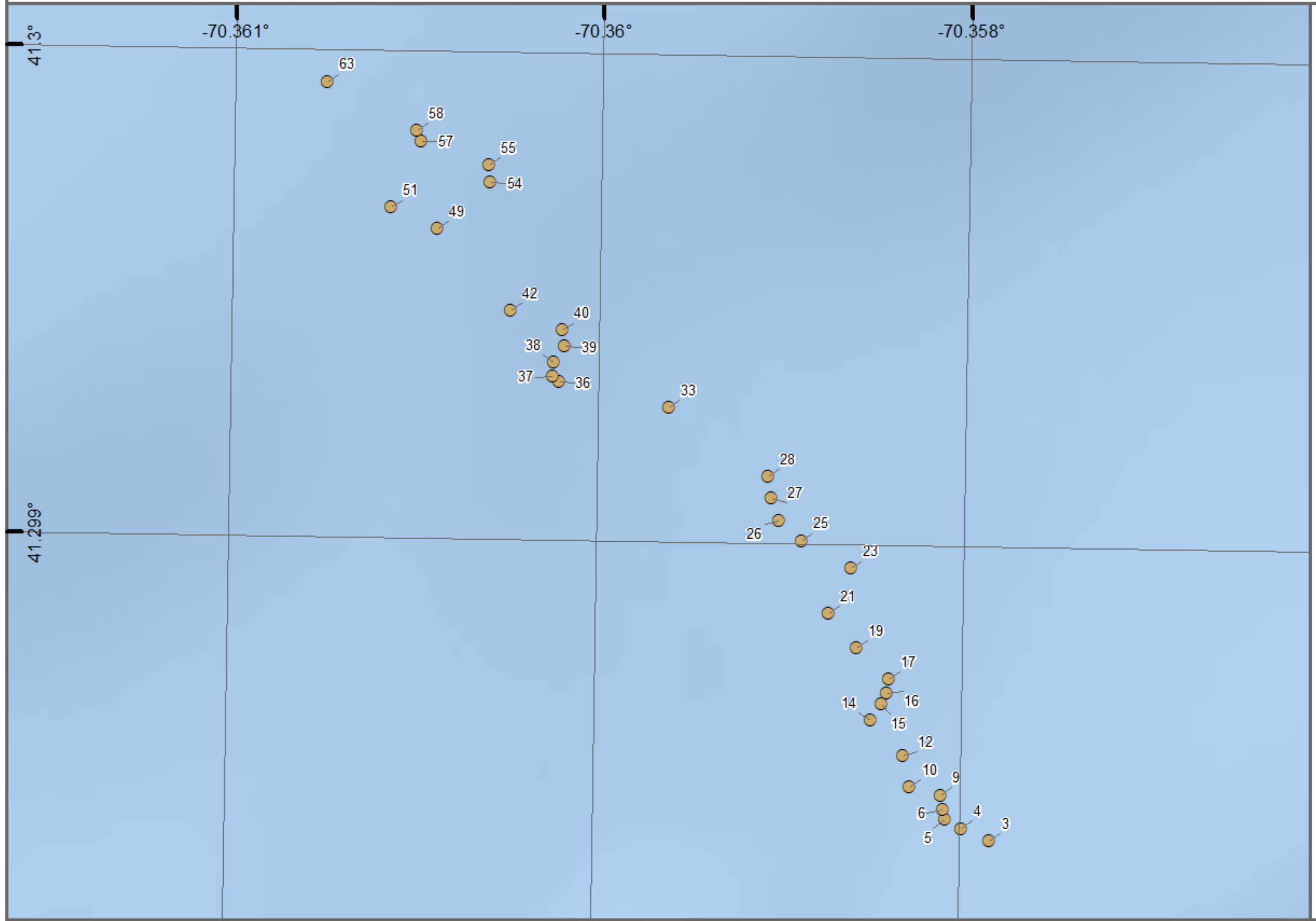
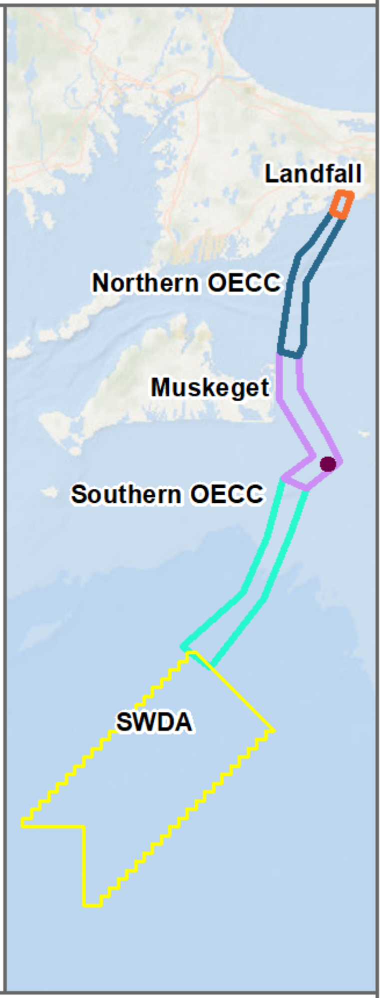
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-48





CMECS Classification

Sand/Mud

rps

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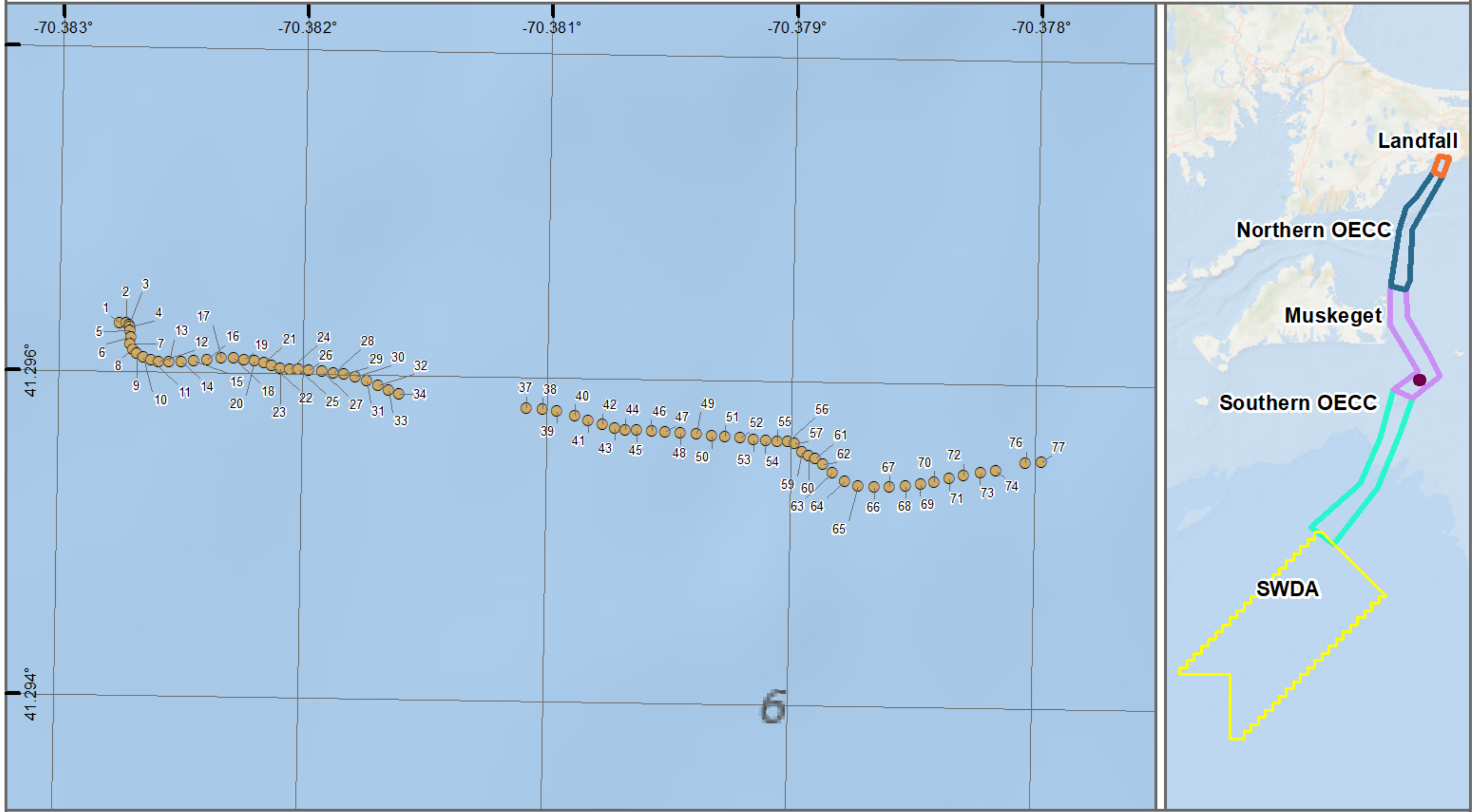
0 50 100 Meters

N

OECC Zone: Muskeget Transect: OECC20-VT-49



CMECS Classification

Sand/Mud

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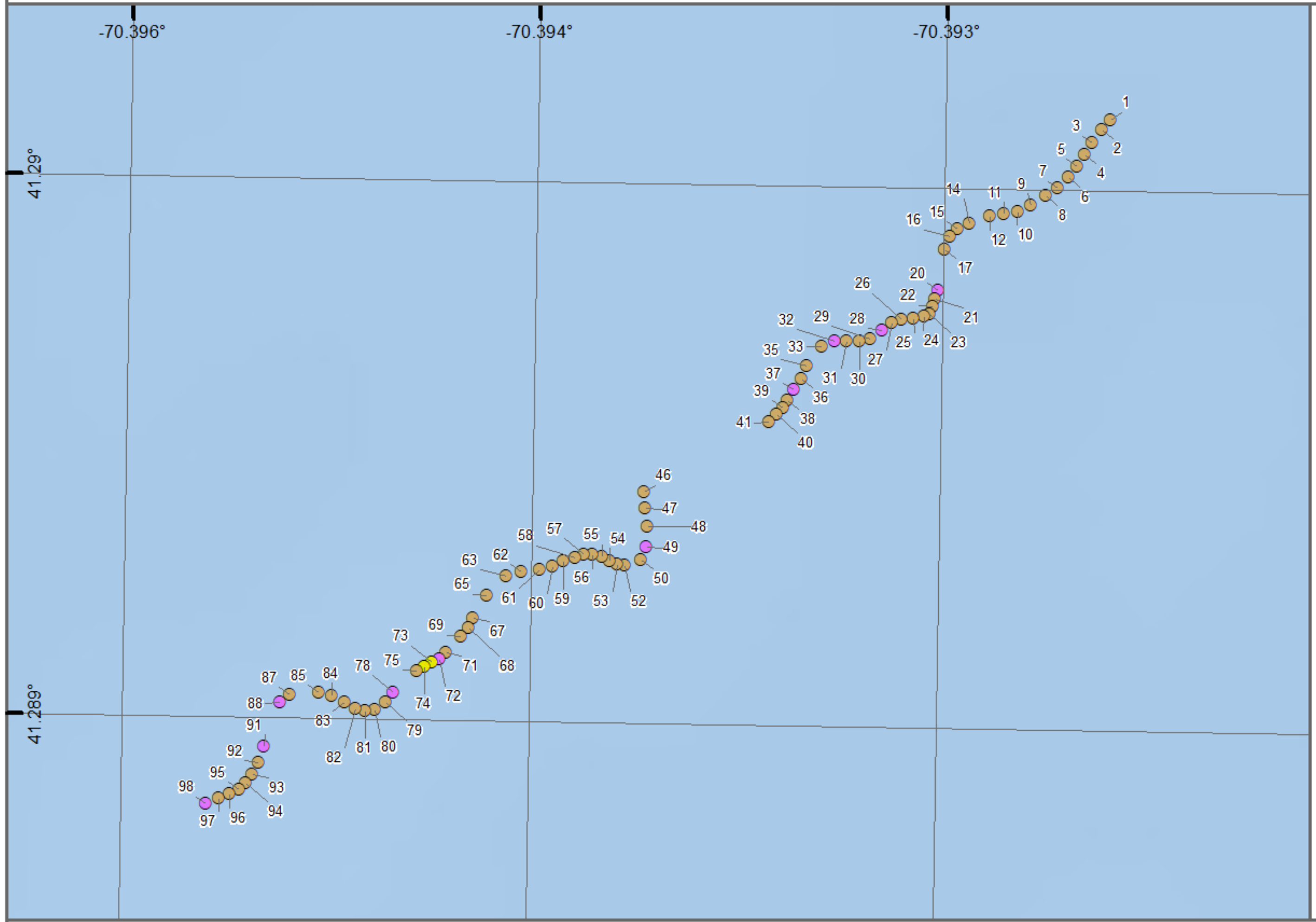
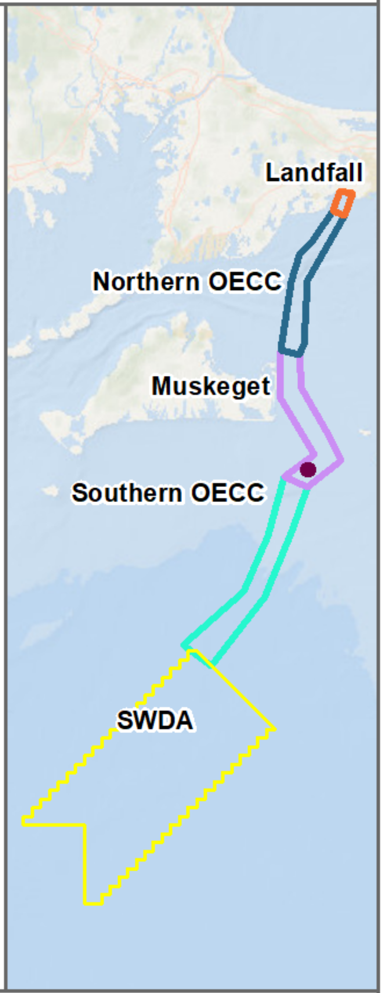
0 70 140 Meters

OECC Zone: Muskeget Transect: OECC20-VT-50





CMECS Classification

- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

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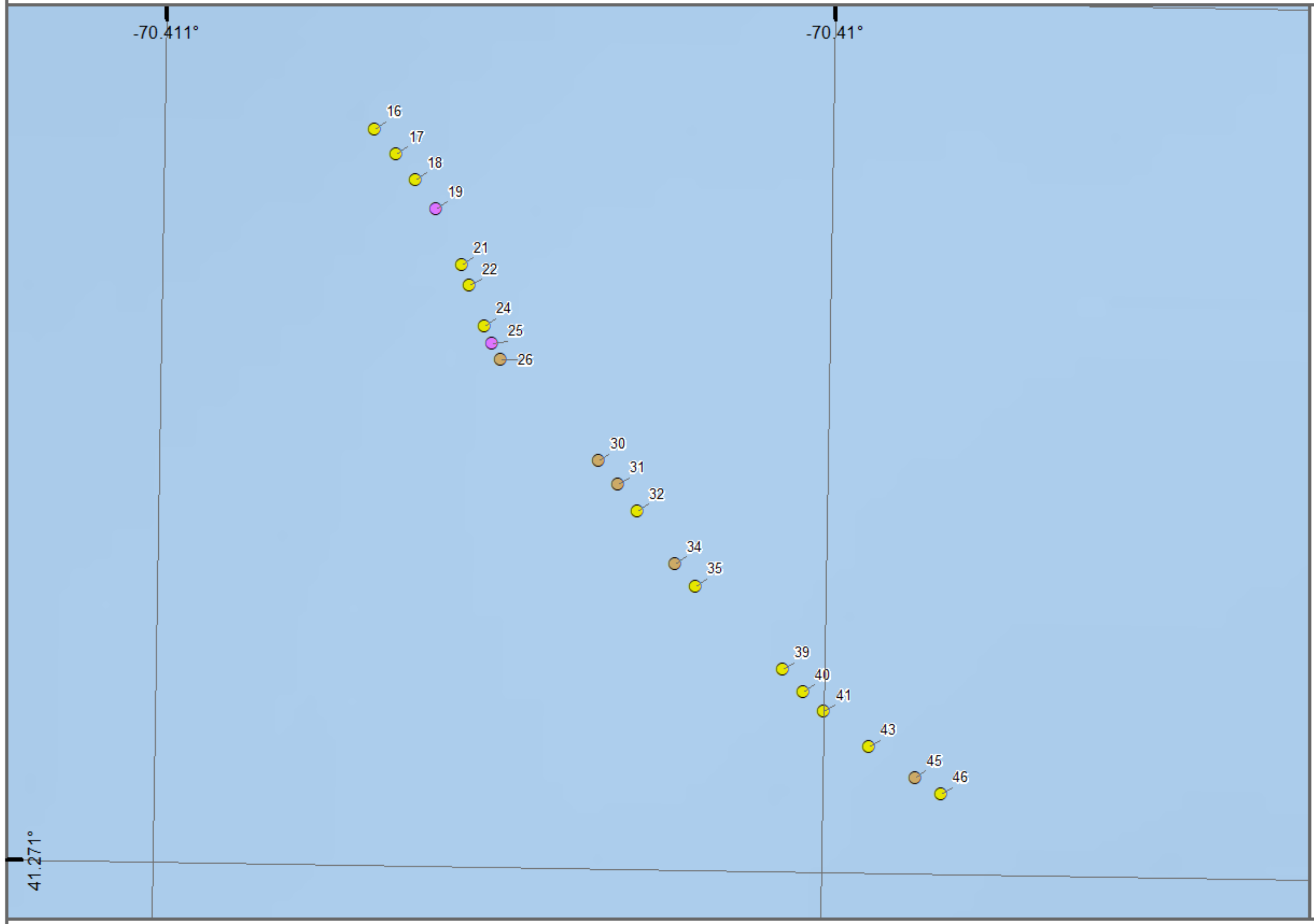
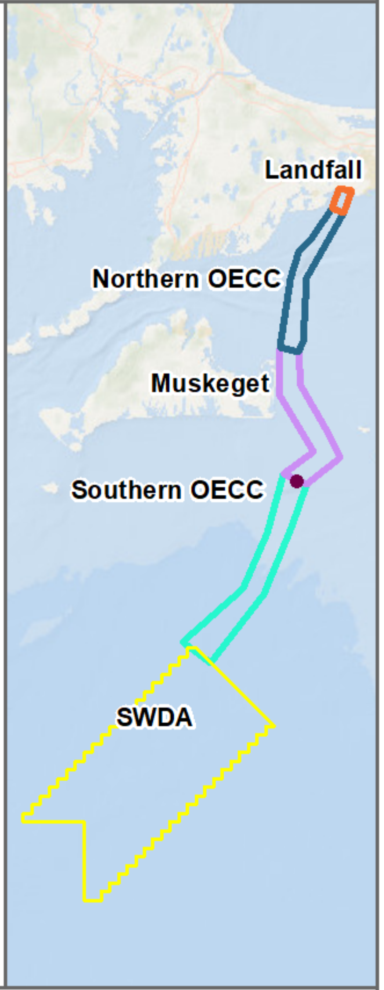
0 45 90 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-51





CMECS Classification

- Gravel Mixes - Pebble/Granule with S/M
- Gravelly Sand/Mud with P/G
- Sand/Mud

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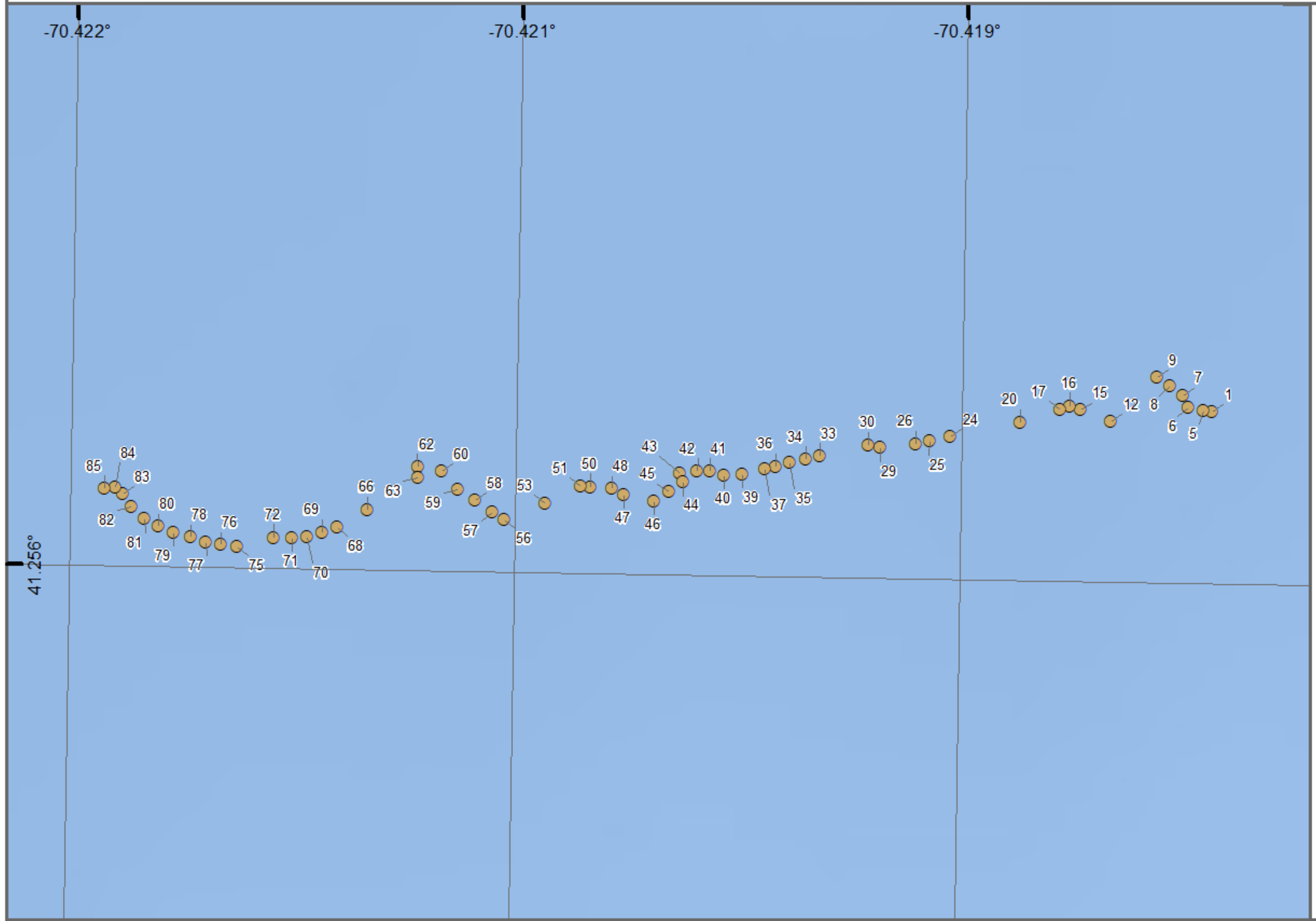
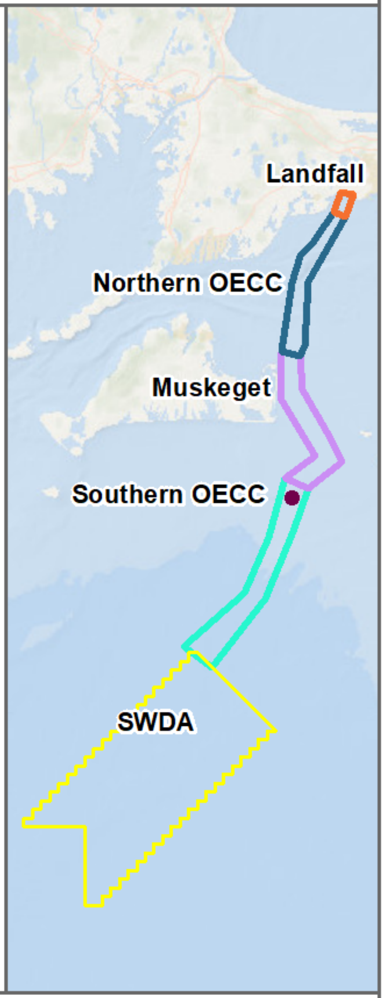
0 25 50 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-52





CMECS Classification

Sand/Mud

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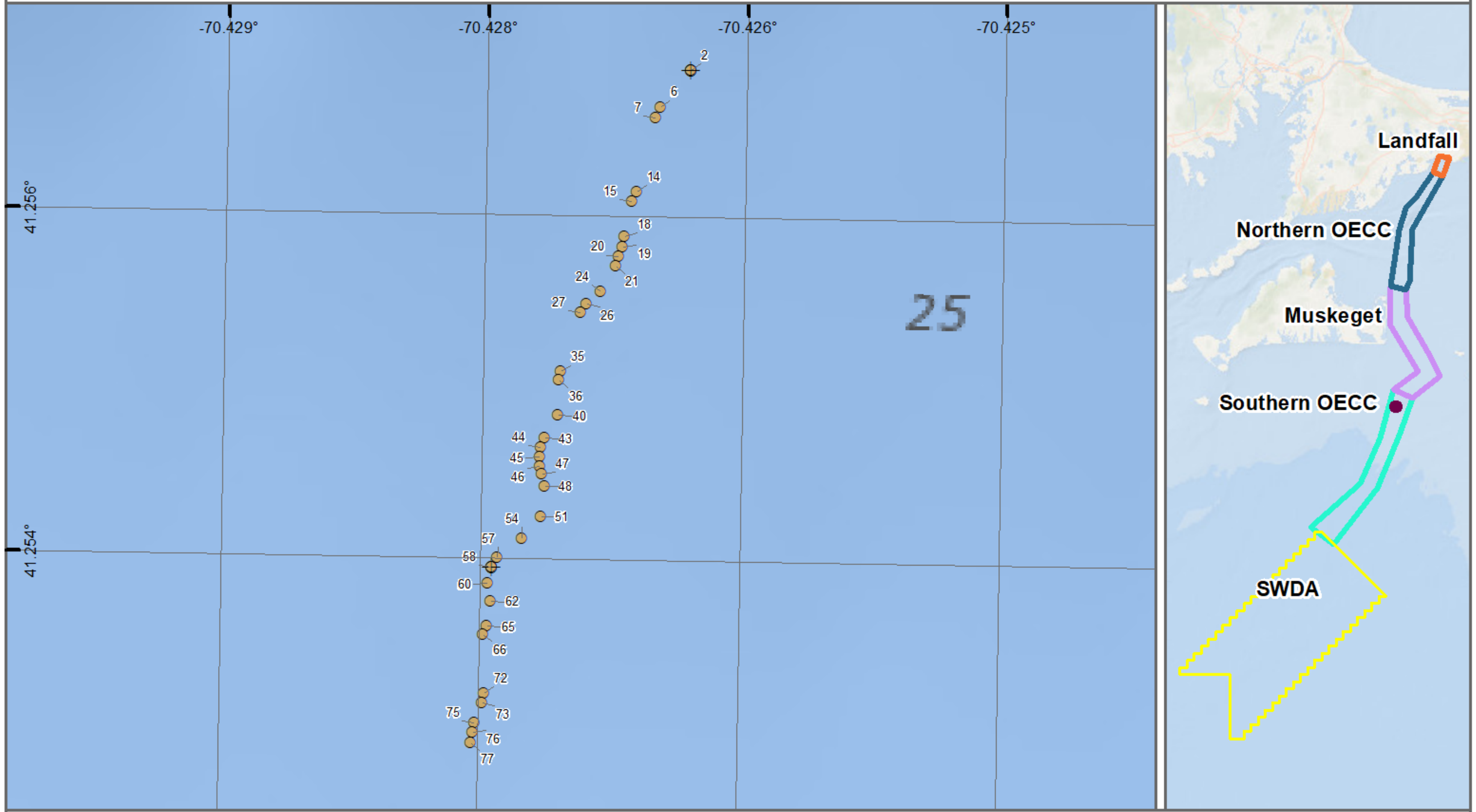
0 40 80 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-53



CMECS Classification

Sand/Mud

Flora/Fauna Cover

≥ Moderate

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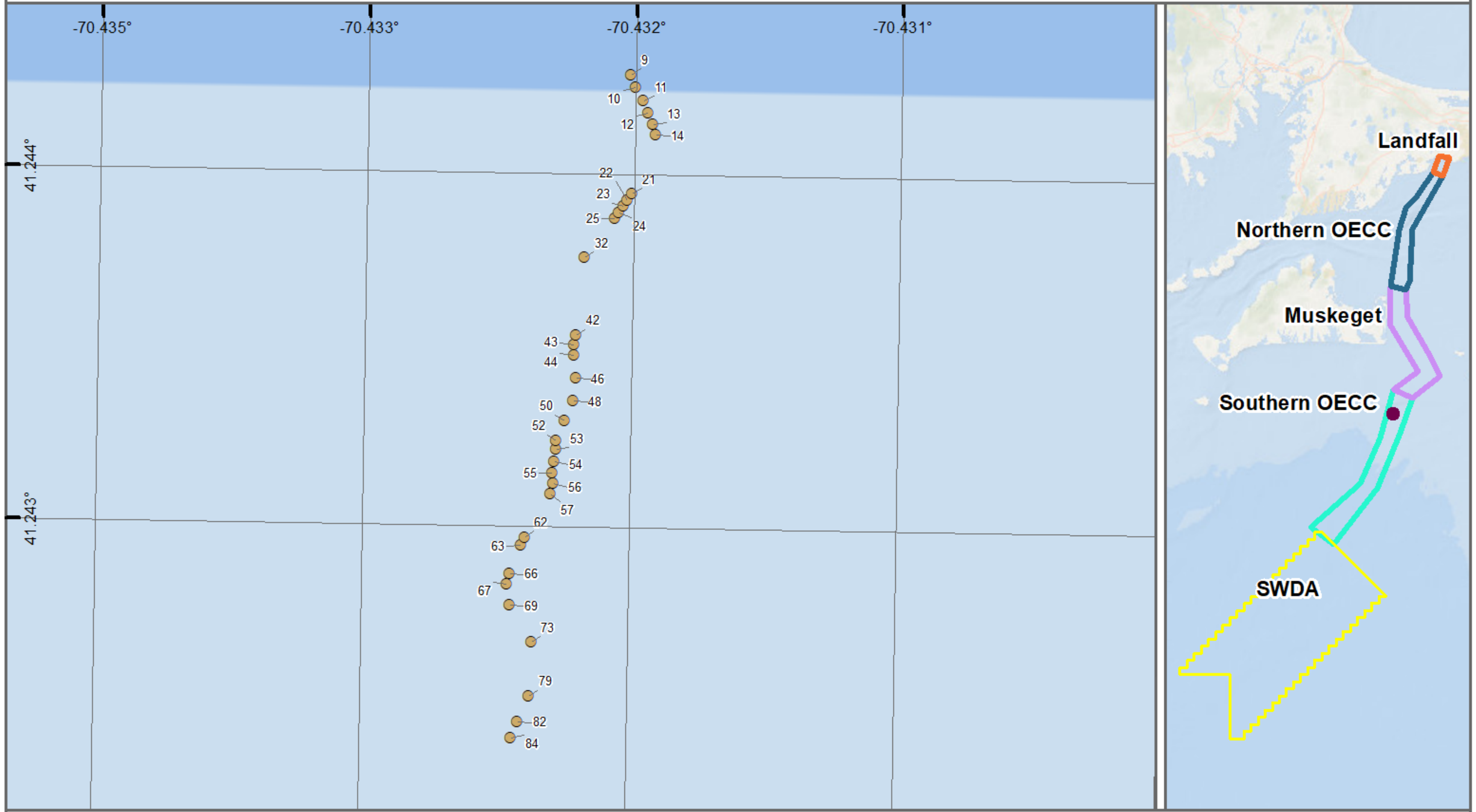
0 65 130 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-54



CMECS Classification

Sand/Mud

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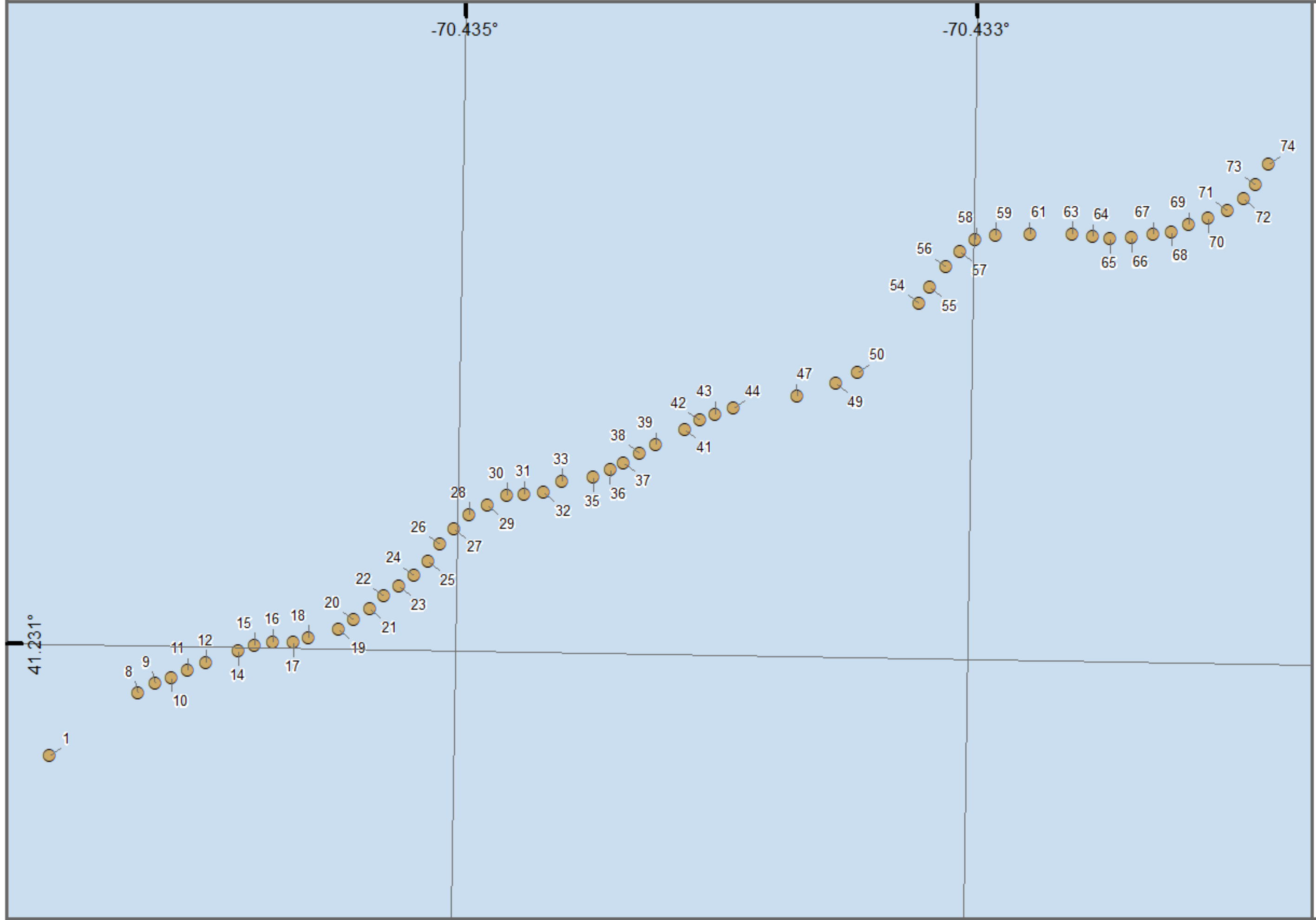
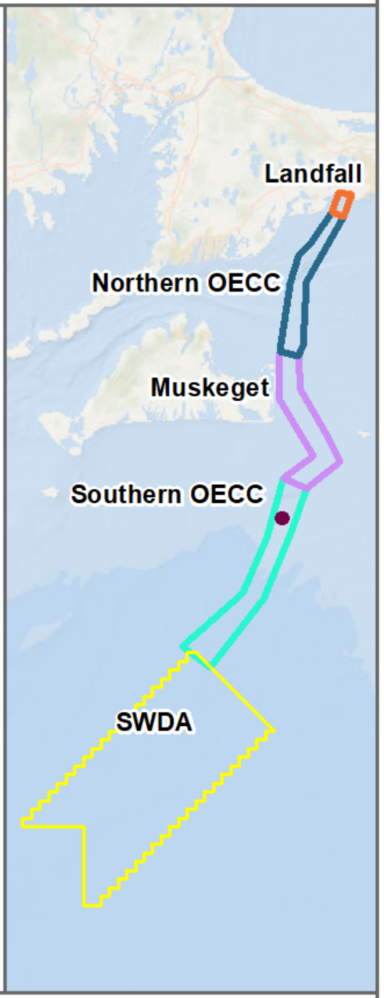
0 65 130 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-55





CMECS Classification

Sand/Mud

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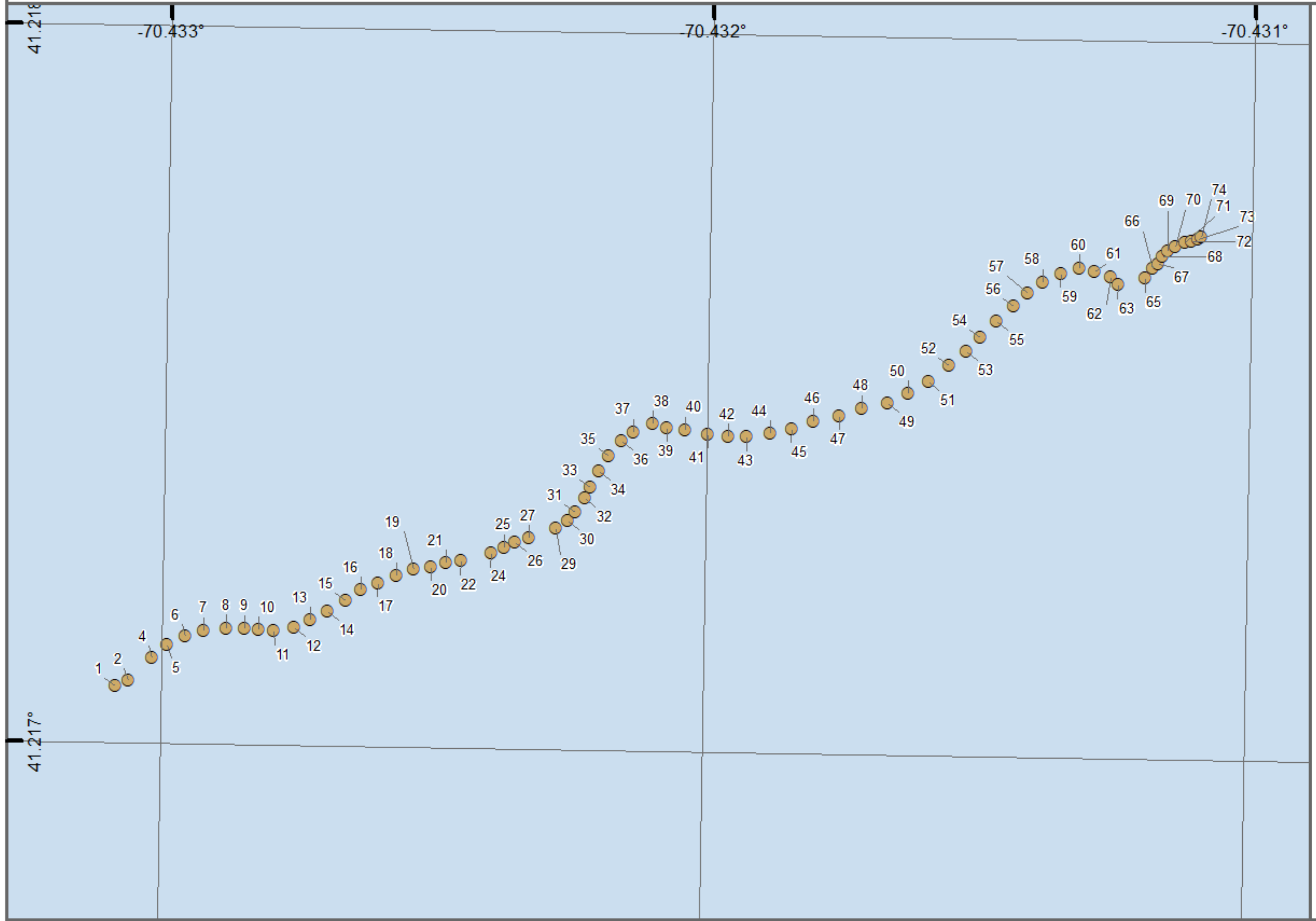
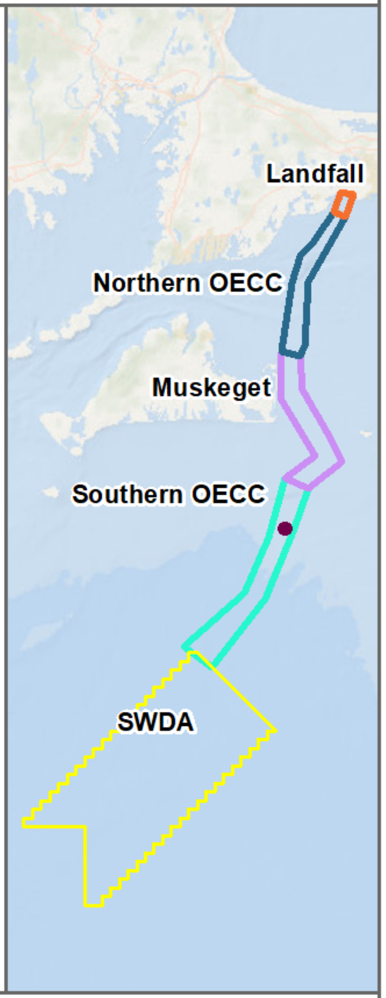
0 37.5 75 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-56





CMECS Classification

Sand/Mud

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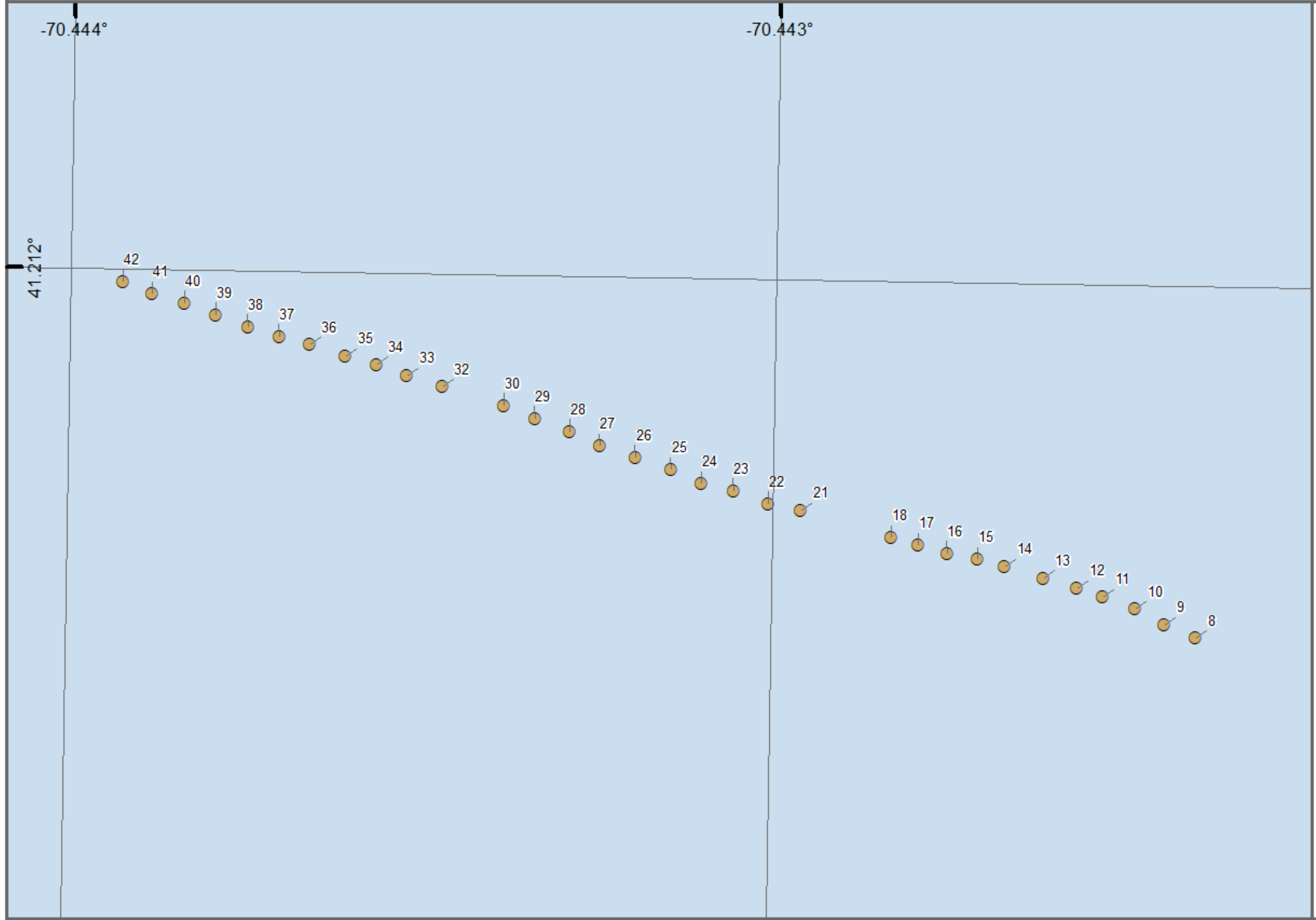
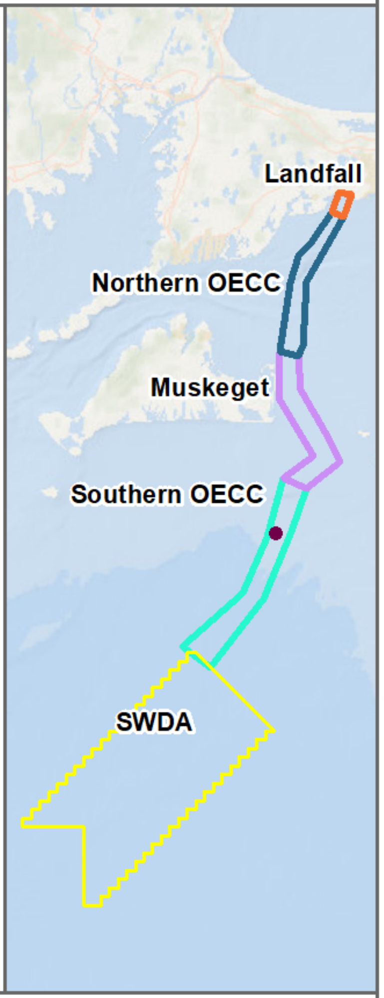
0 35 70 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-57





CMECS Classification

Sand/Mud

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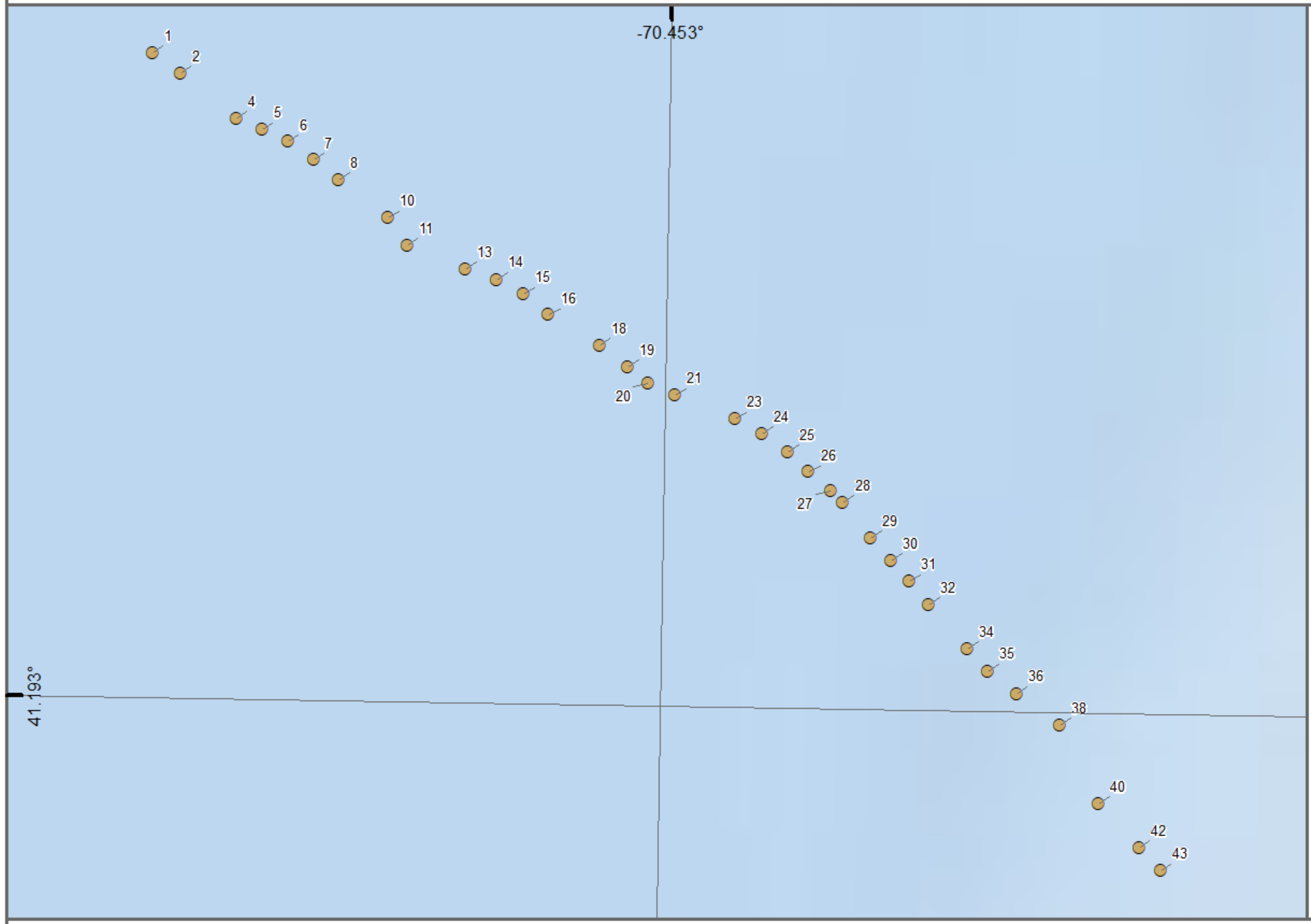
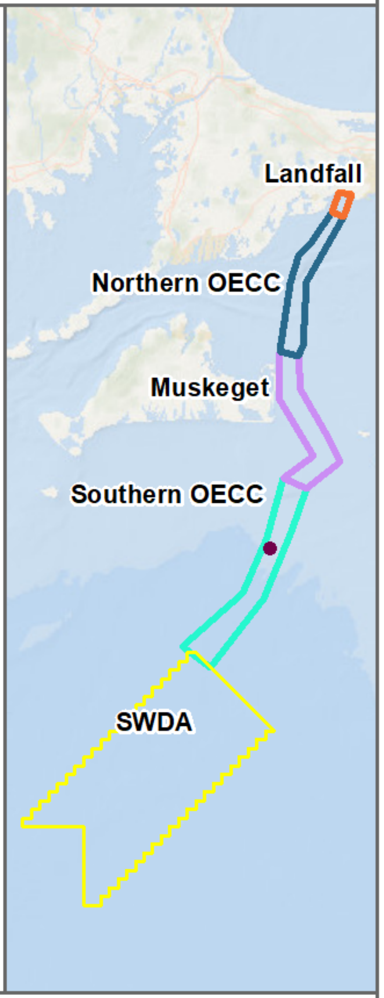
0 25 50 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-58





CMECS Classification

Sand/Mud

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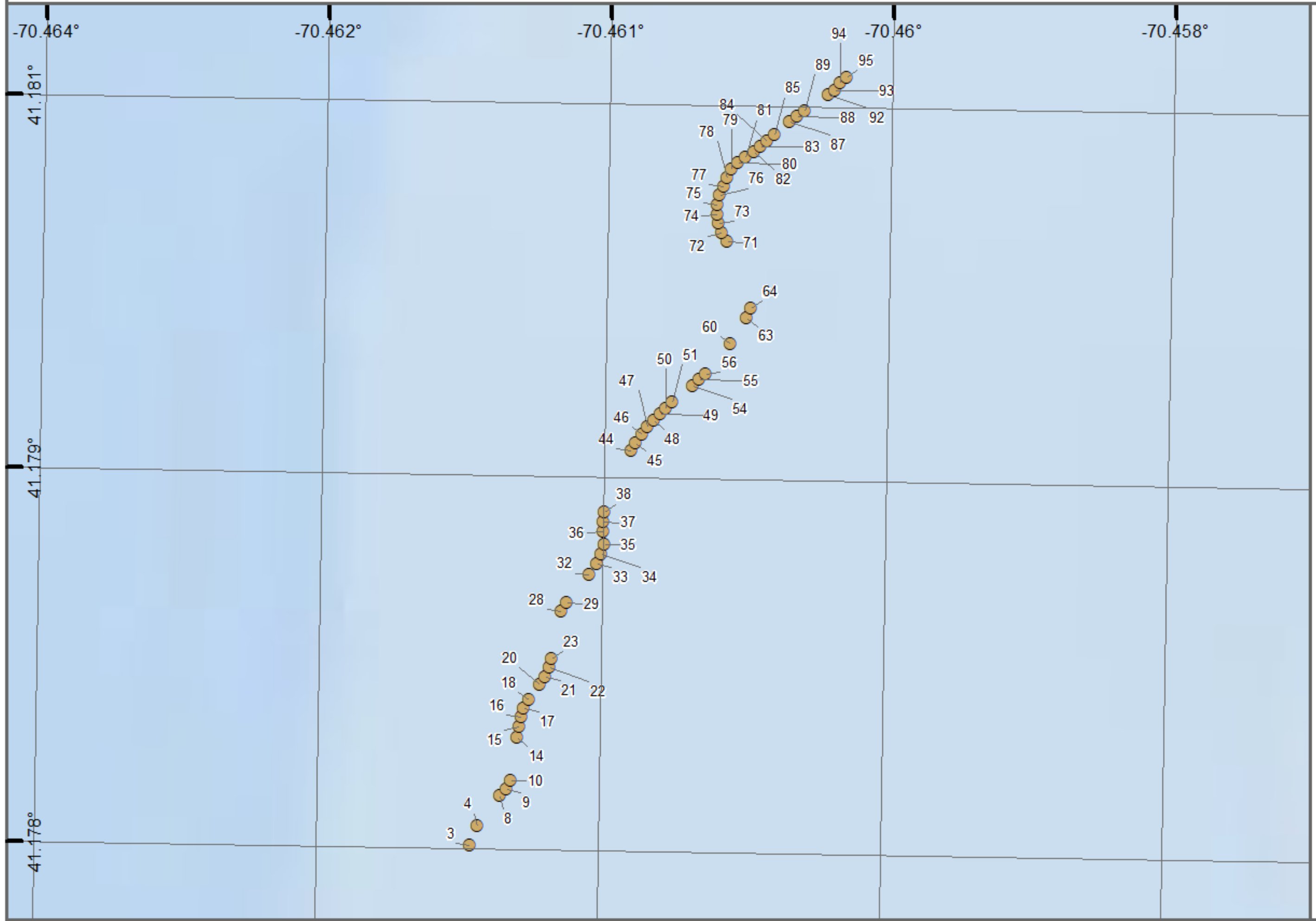
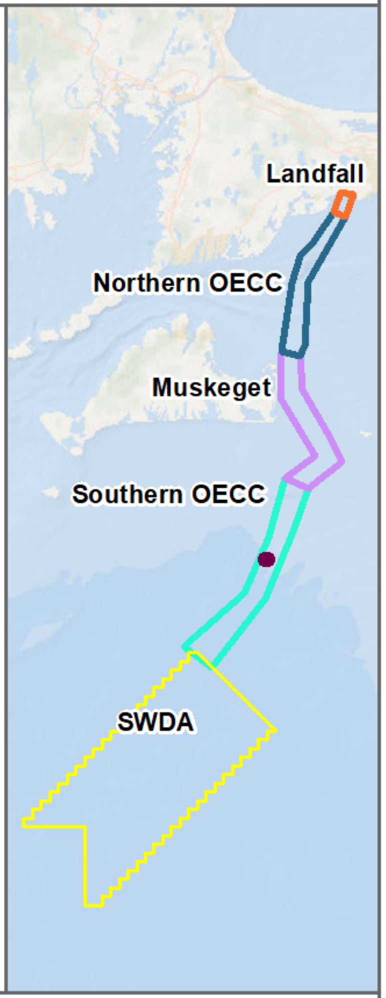
0 25 50 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-59





CMECS Classification

Sand/Mud

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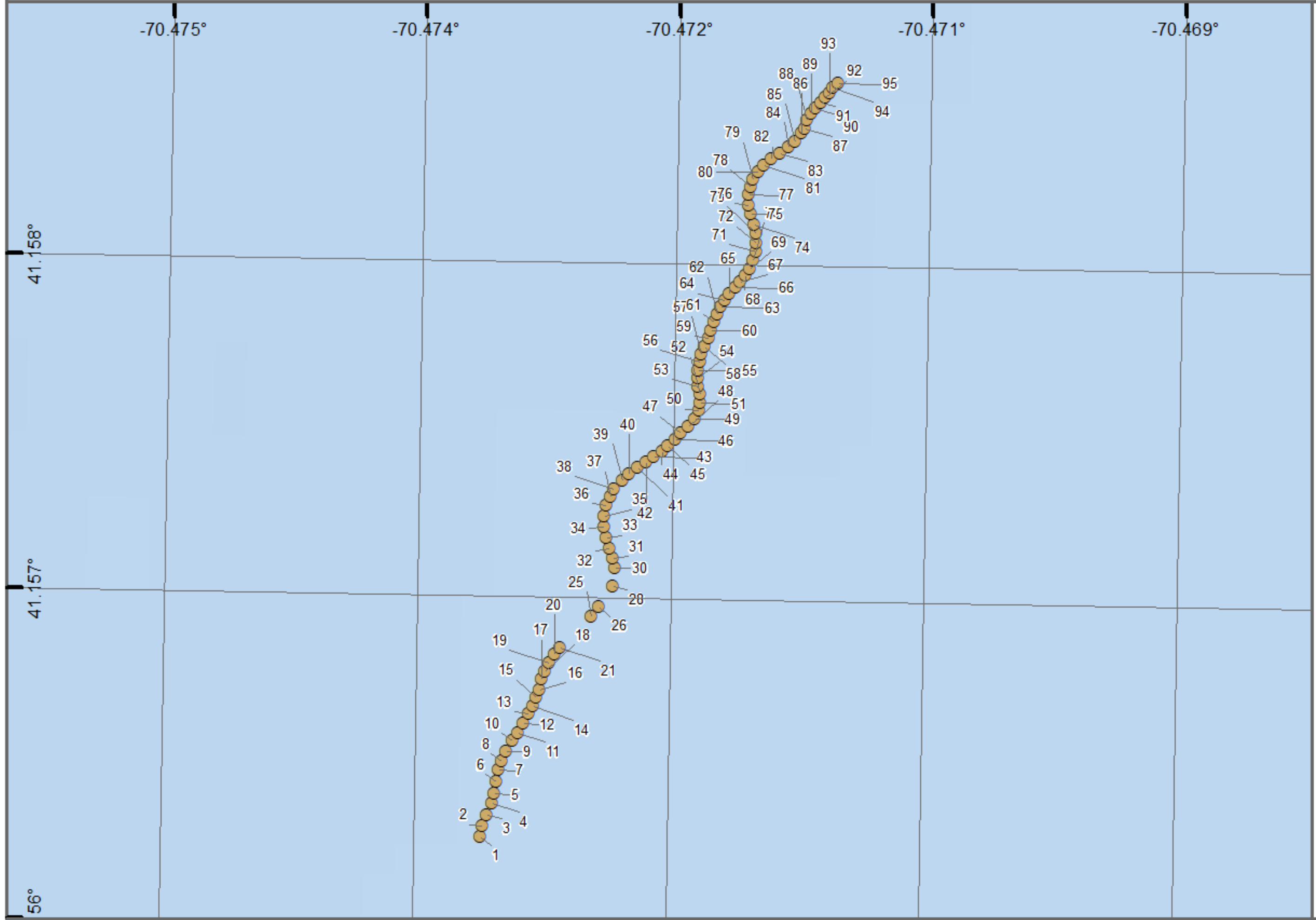
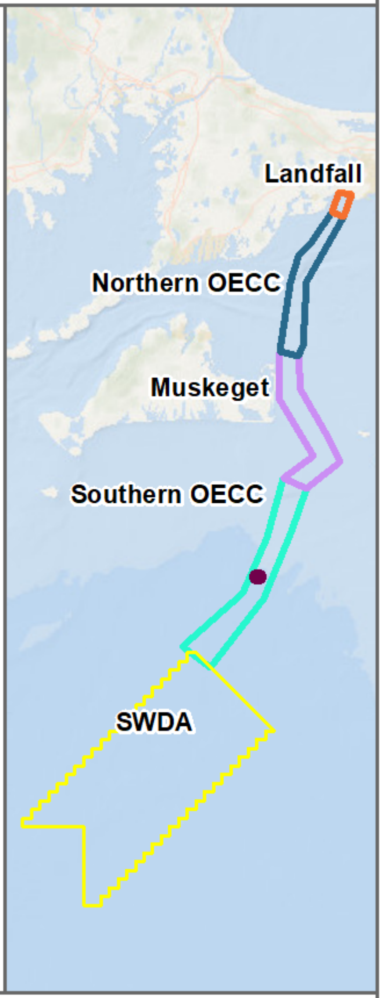
0 70 140 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-60





CMECS Classification

Sand/Mud

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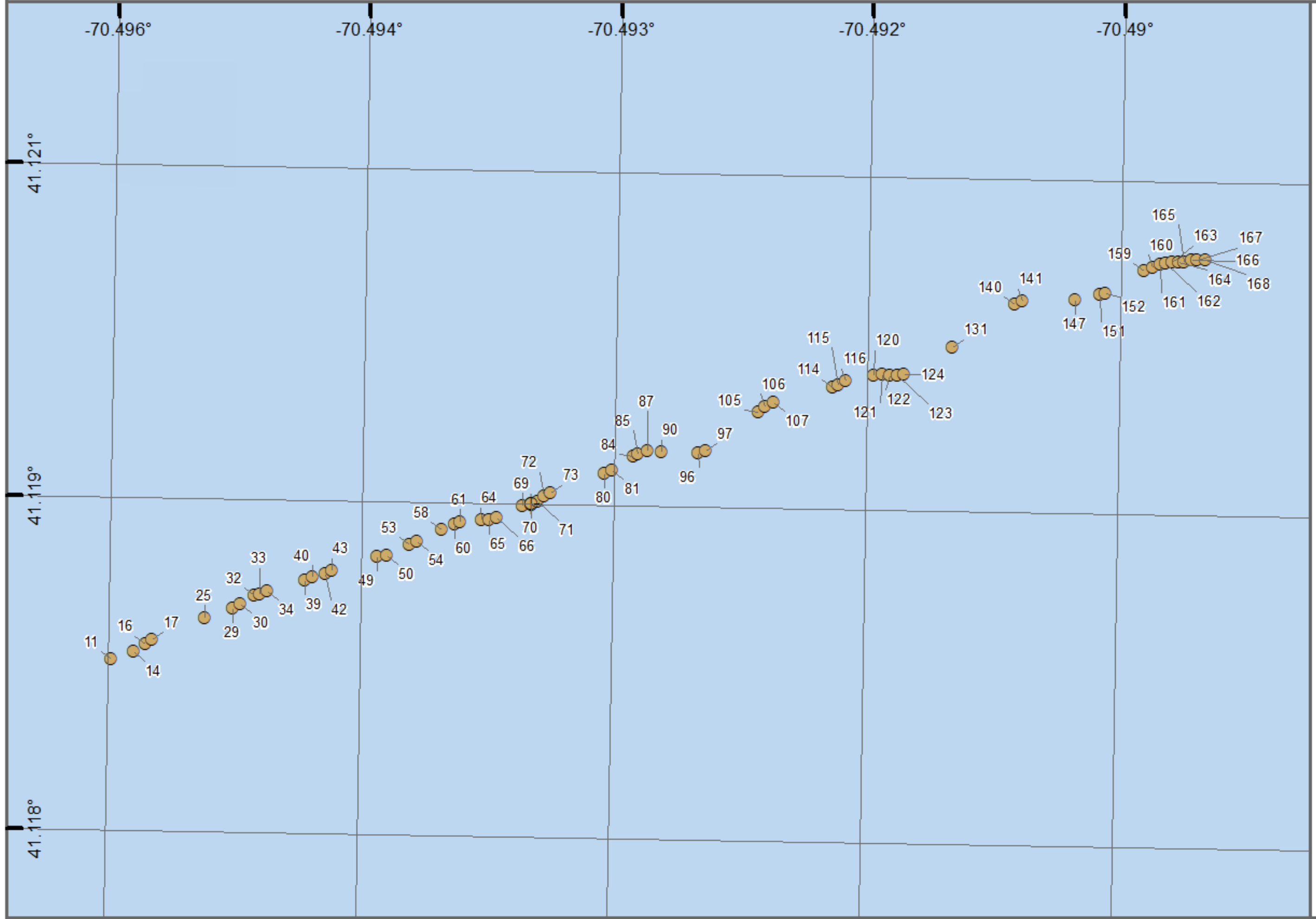
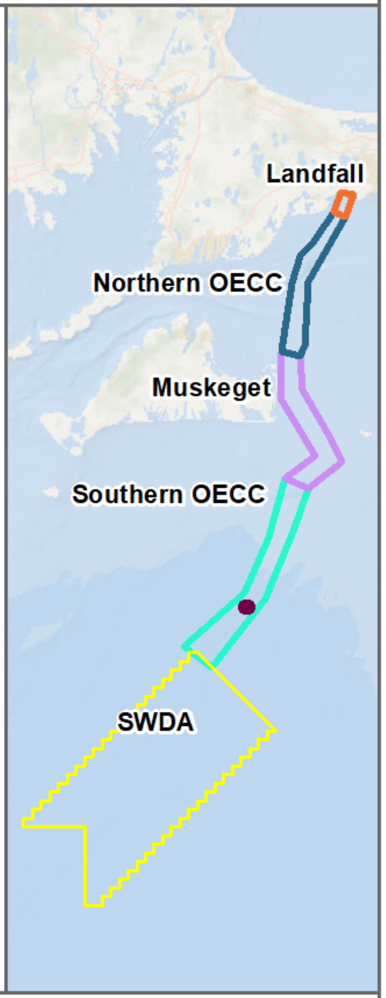
0 75 150 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-61





CMECS Classification

Sand/Mud

Flora/Fauna Cover

≥ Moderate

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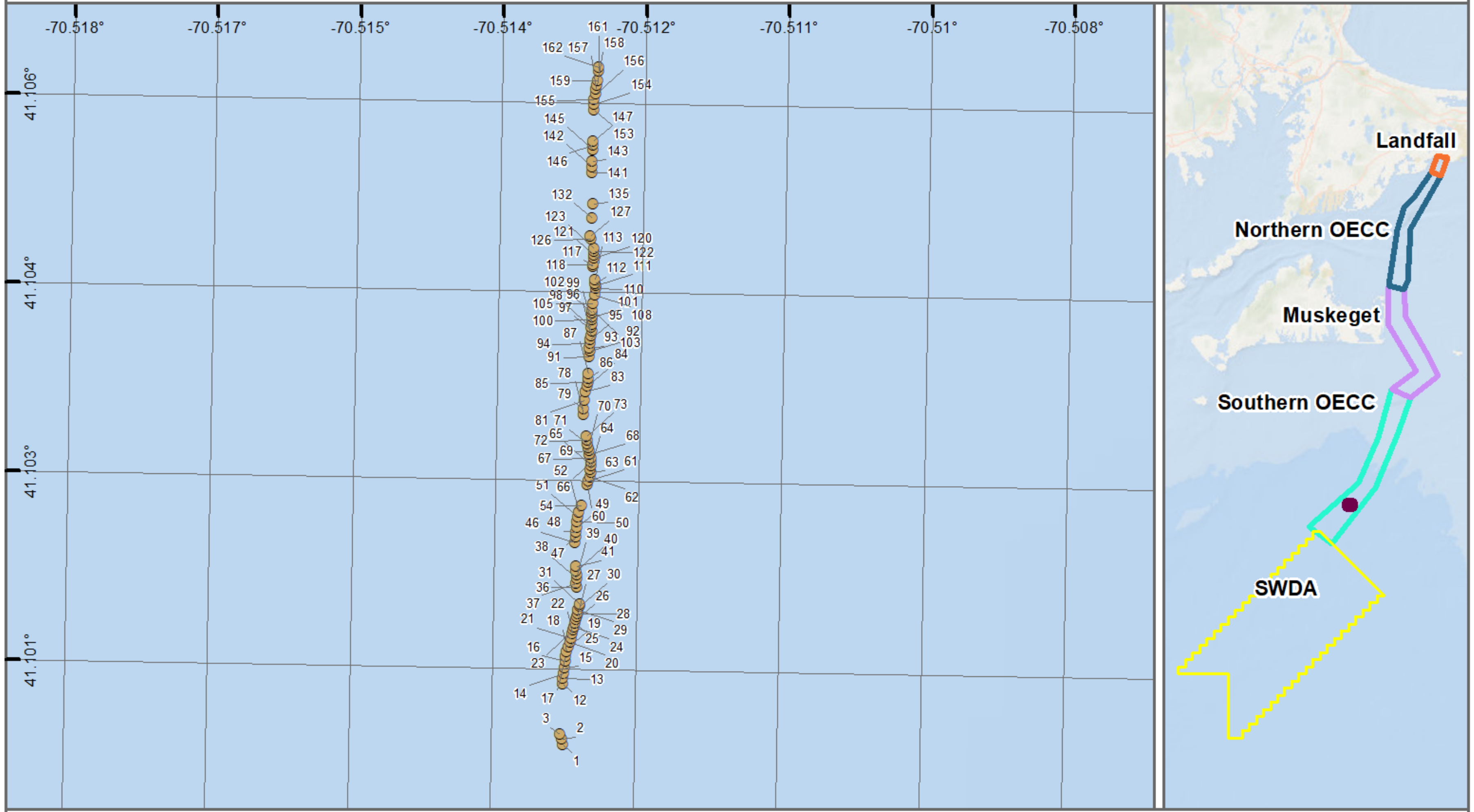
0 75 150 Meters

N

OECC Zone: Southern OECC   Transect: OECC20-VT-62



CMECS Classification

Sand/Mud

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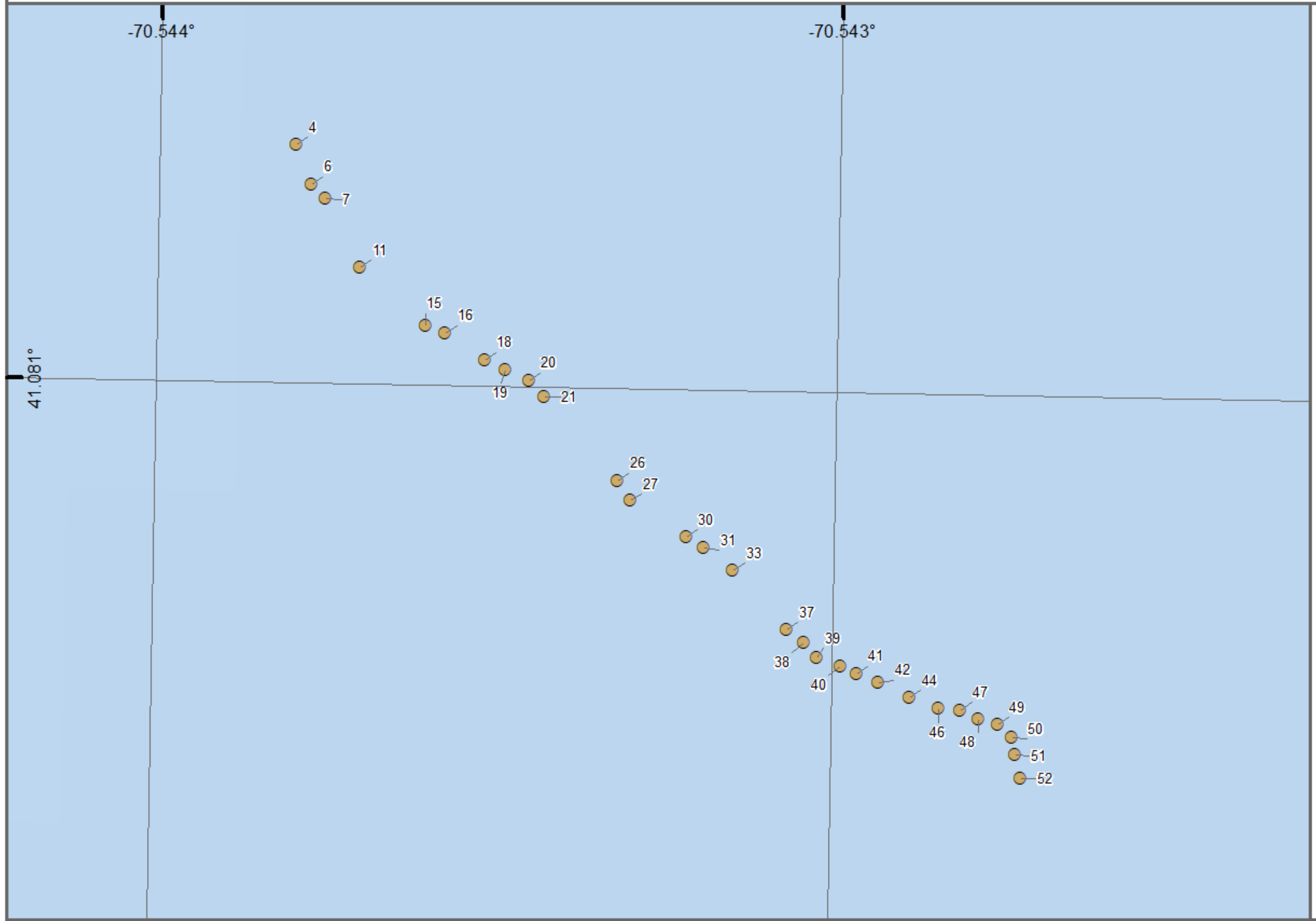
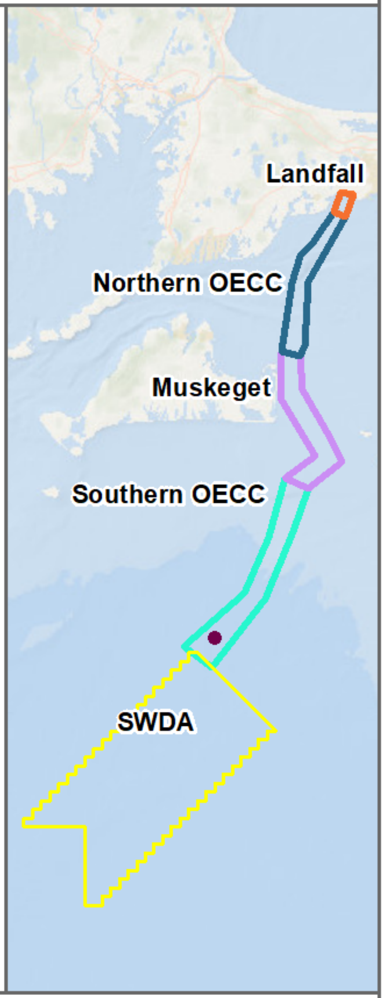
0 120 240 Meters

N

OECC Zone: Southern OECC Transect: OECC20-VT-63





CMECS Classification

Sand/Mud

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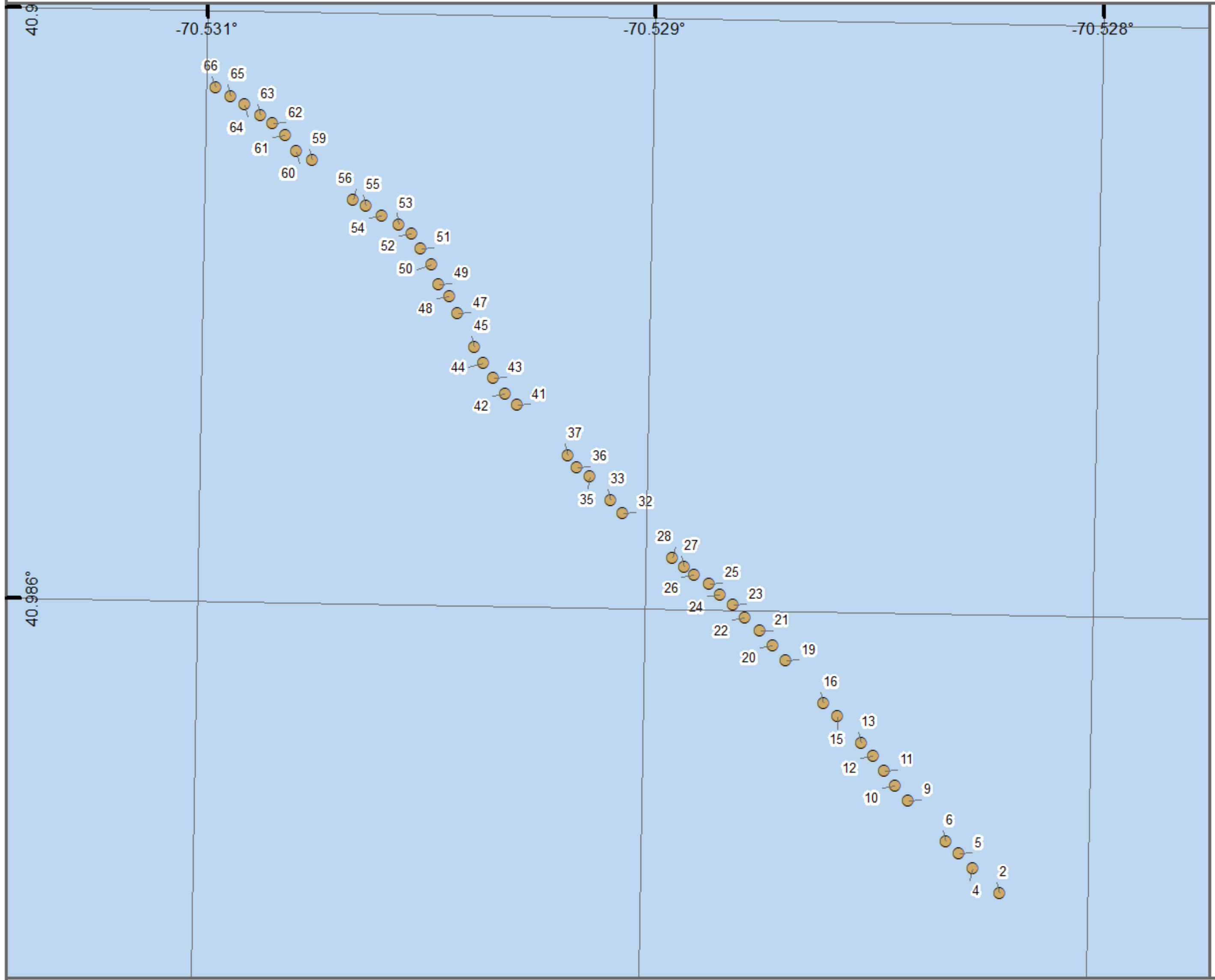
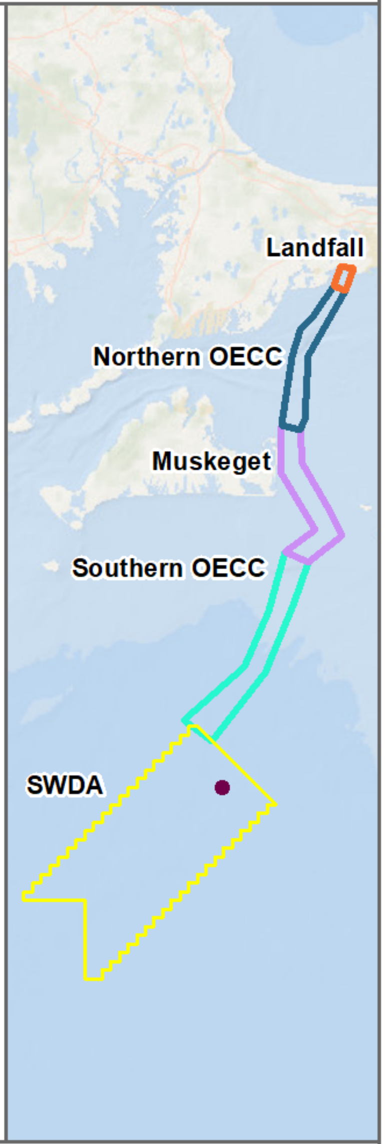
0 25 50 Meters

N

SWDA Zone

Transect: SWDA20-VT-01





CMECS Classification

Sand/Mud

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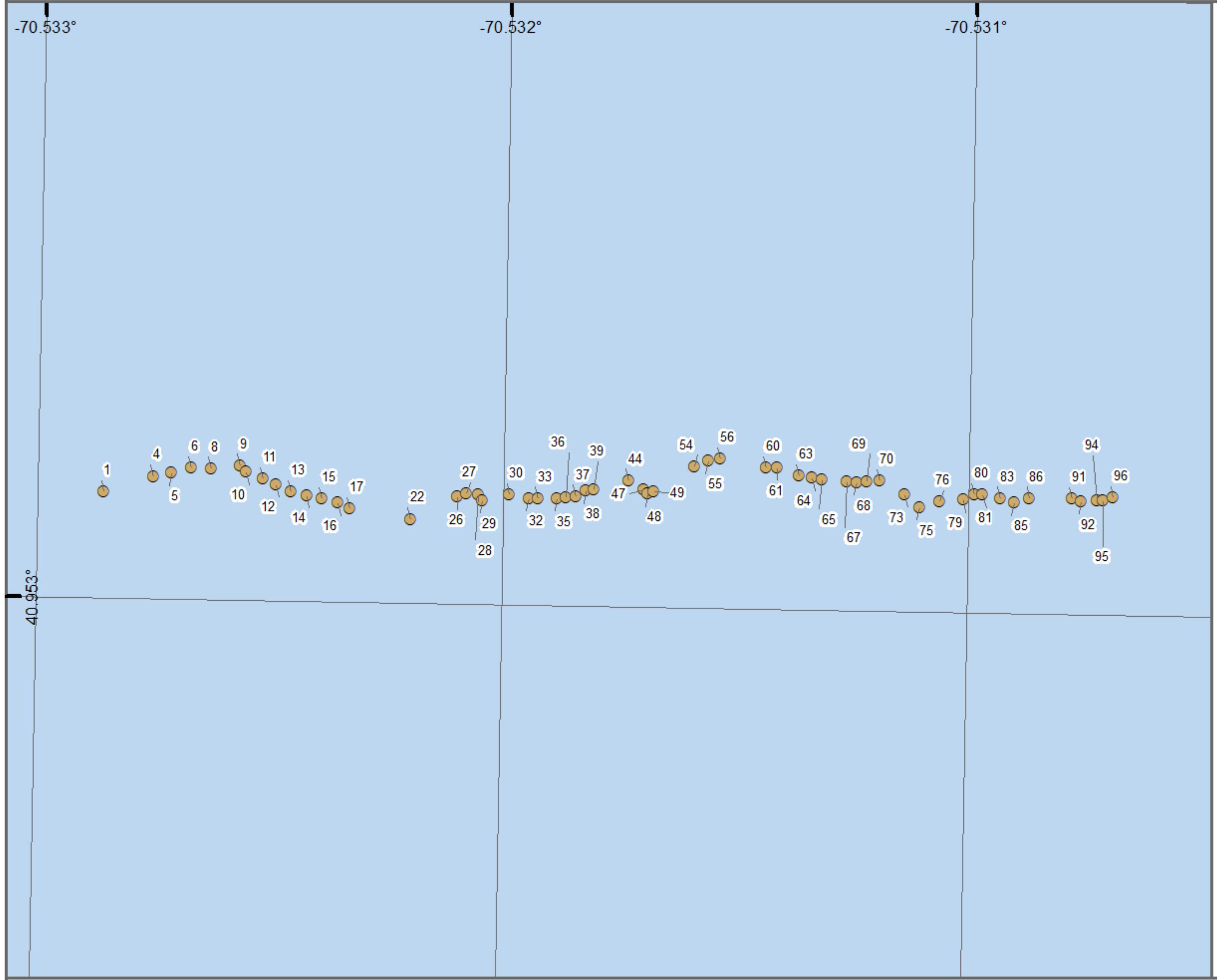
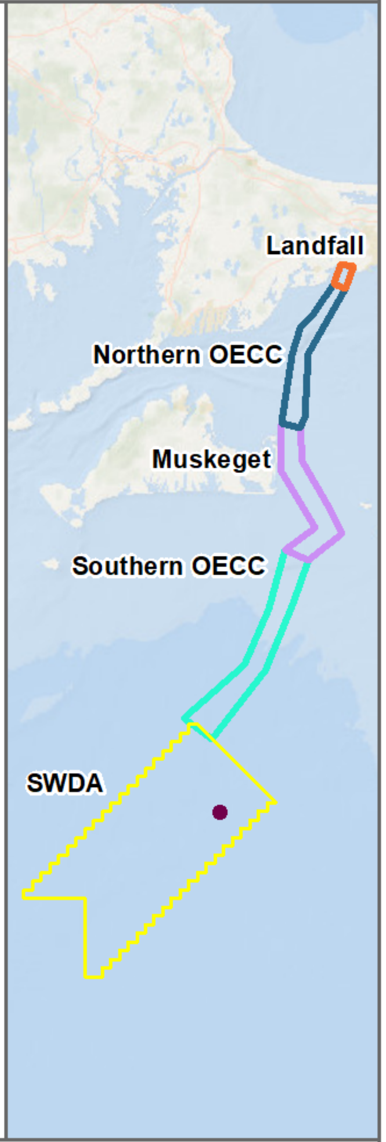
0 40 80 Meters

N

SWDA Zone Transect: SWDA20-VT-02





CMECS Classification

Sand/Mud

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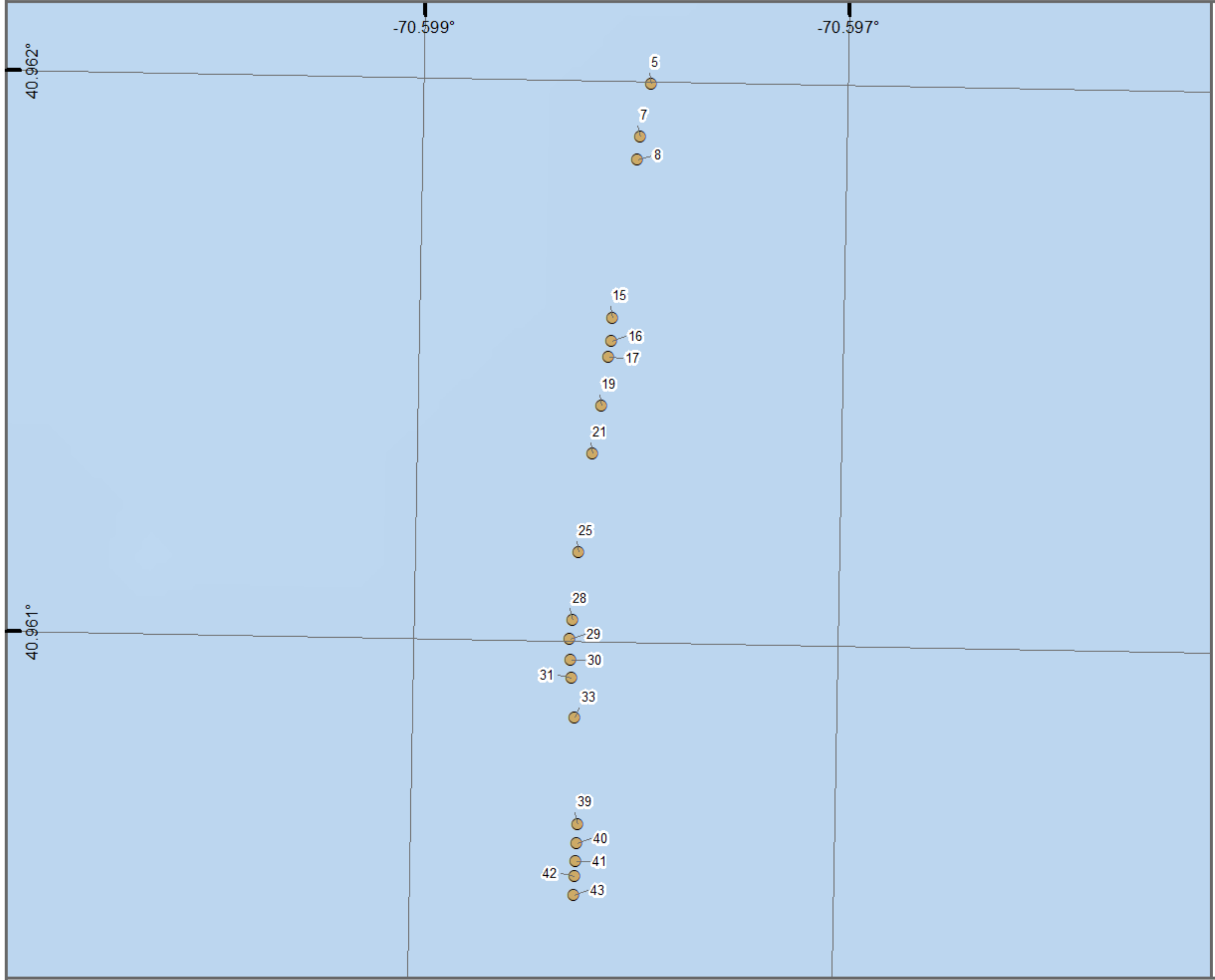
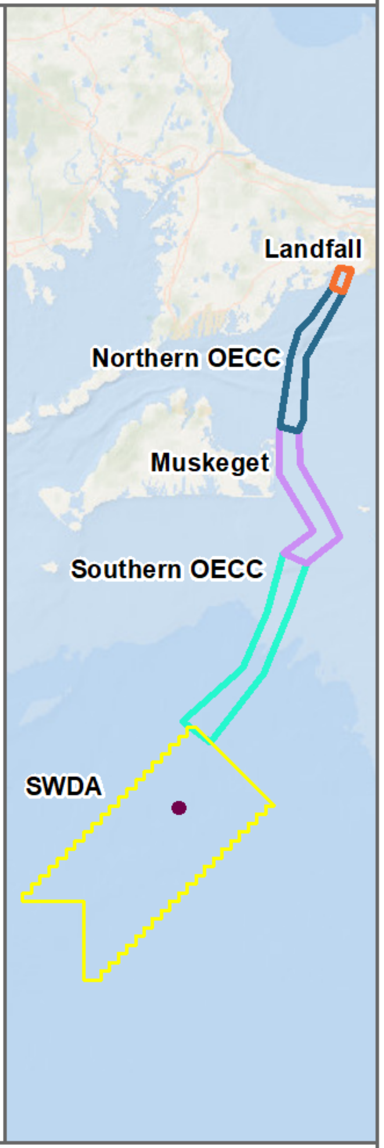
0 37.5 75 Meters

N

SWDA Zone Transect: SWDA20-VT-03





CMECS Classification

Sand/Mud

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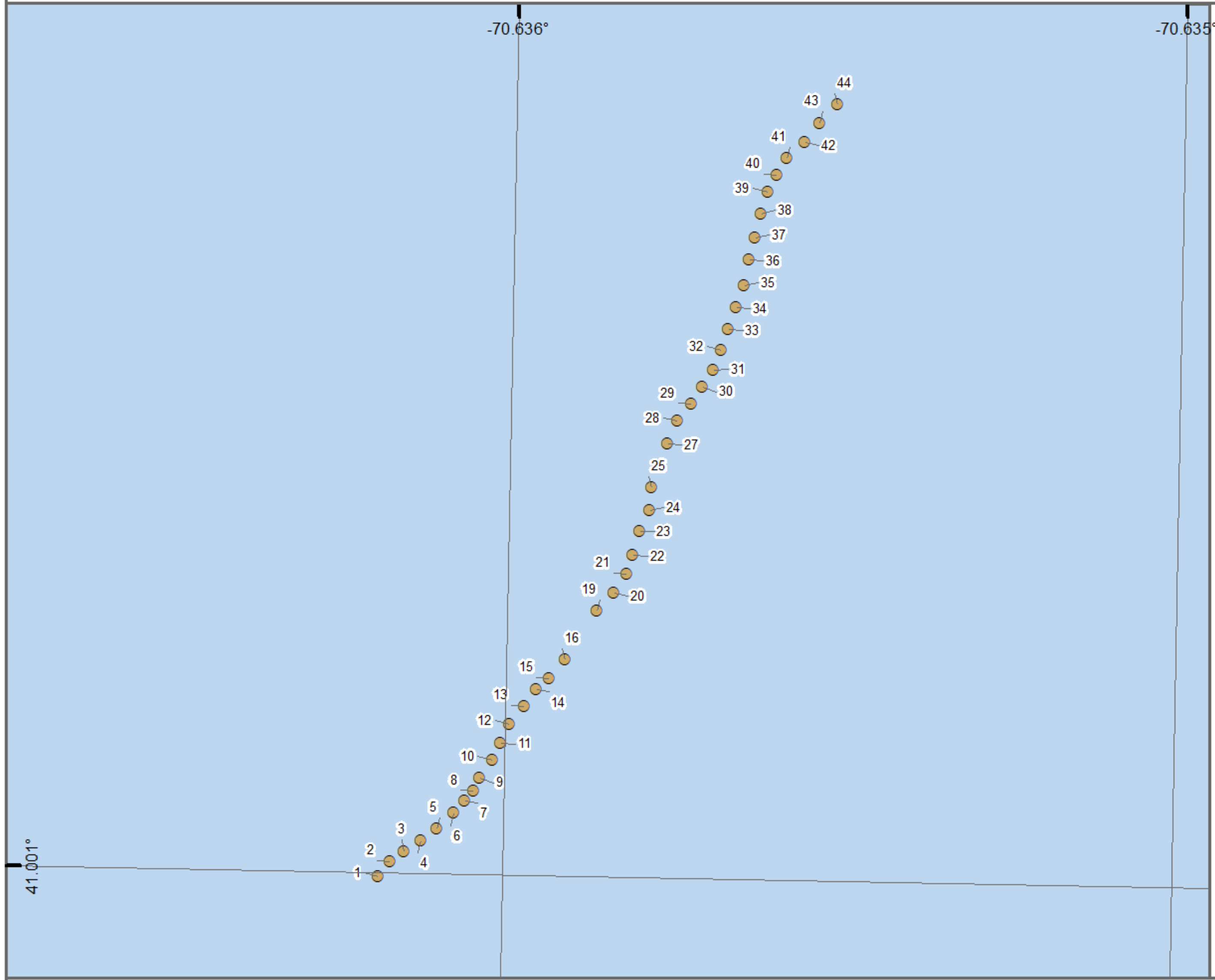
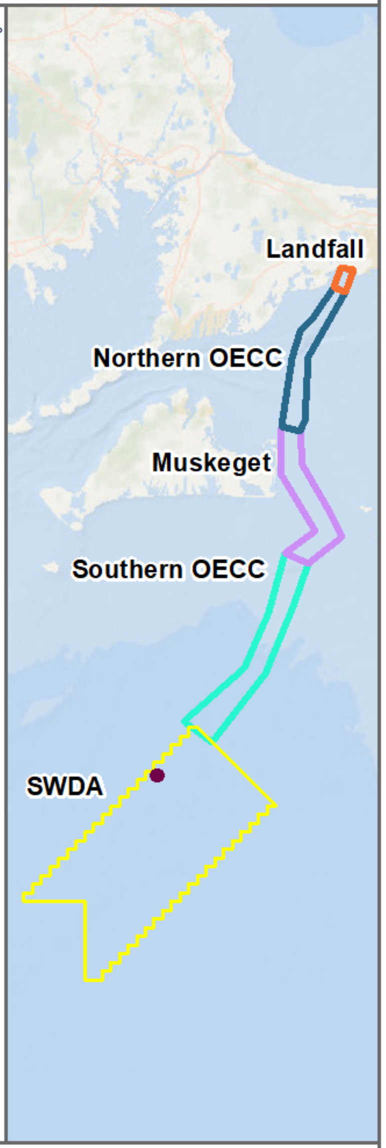
0 40 80 Meters

N

SWDA Zone Transect: SWDA20-VT-04





CMECS Classification

- Sand/Mud

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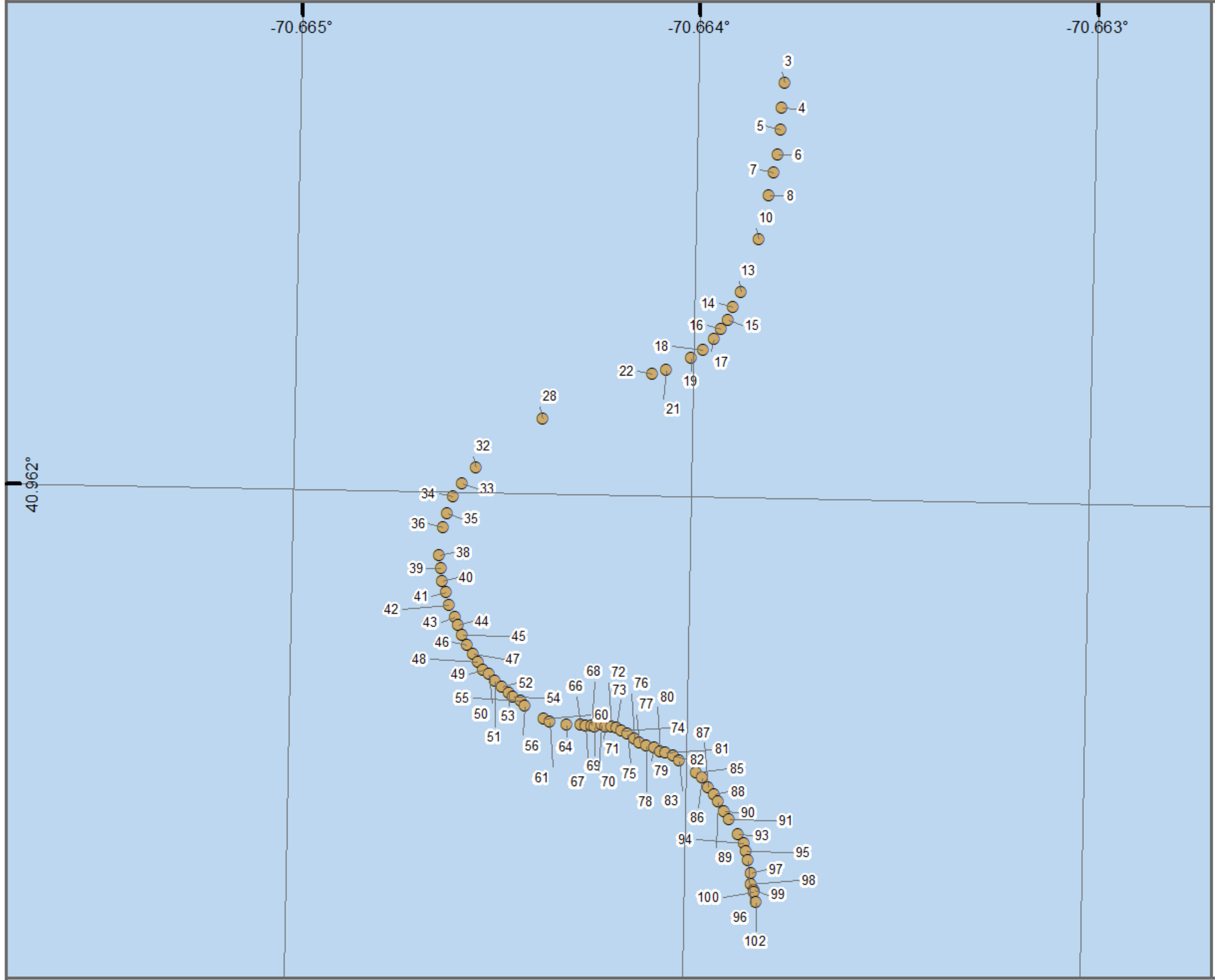
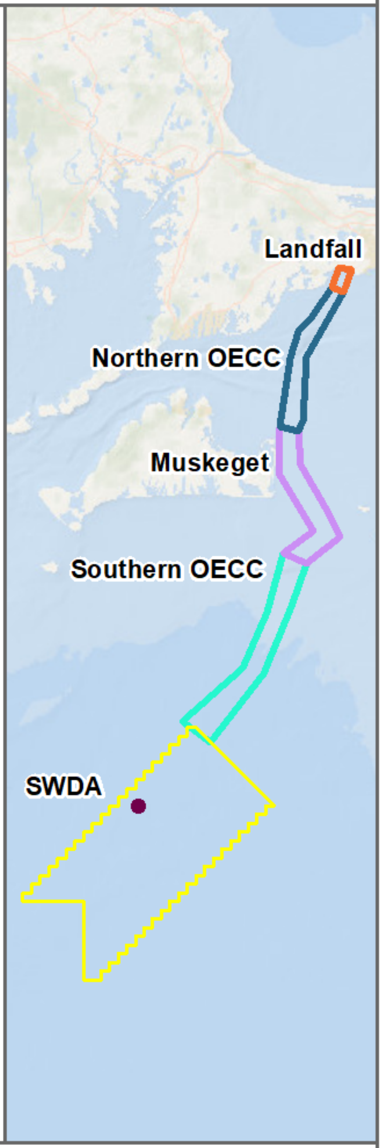
0 25 50 Meters

N

SWDA Zone Transect: SWDA20-VT-05





CMECS Classification

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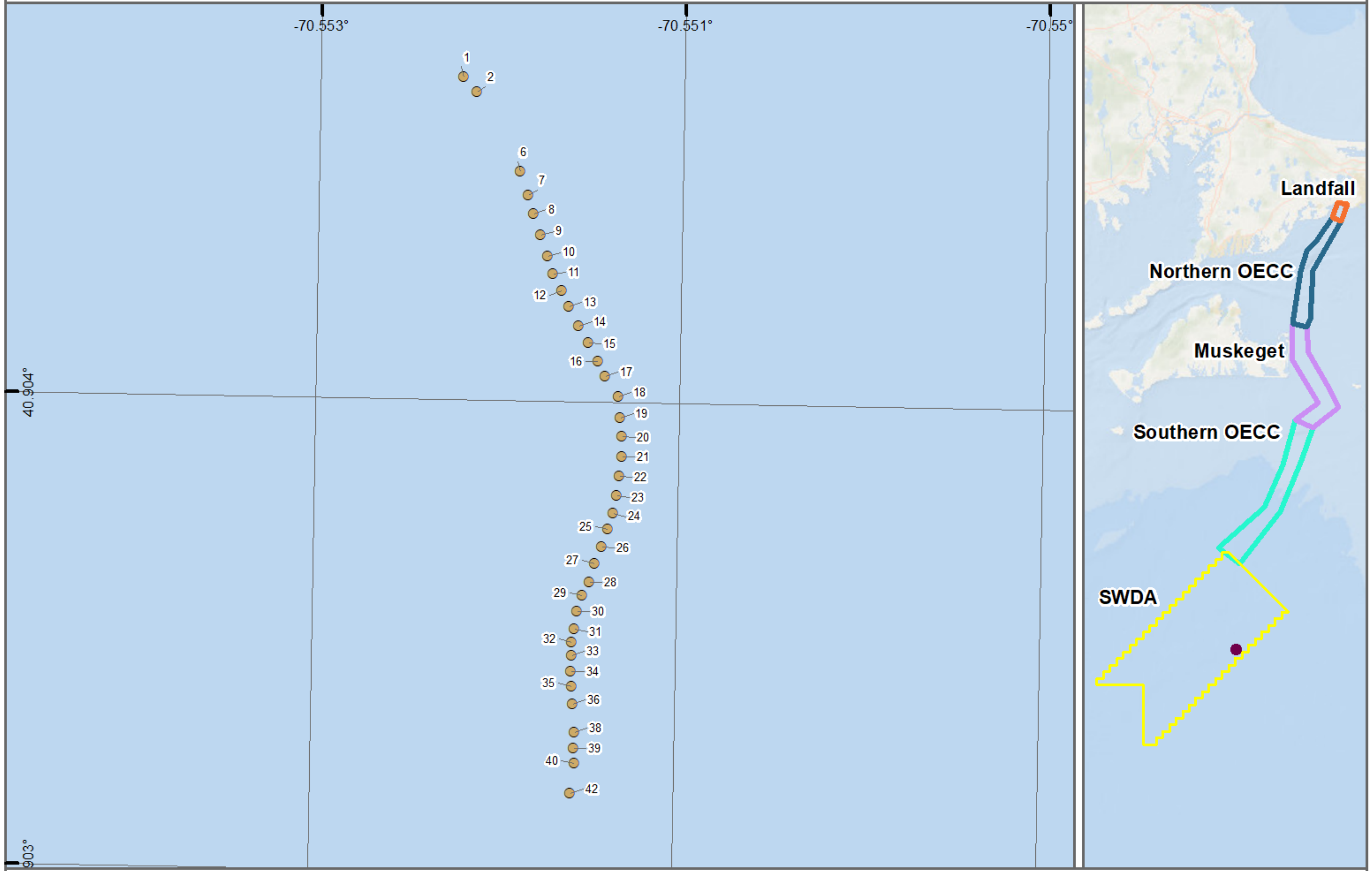
0 45 90 Meters

N

SWDA Zone Transect: SWDA20-VT-06



CMECS Classification

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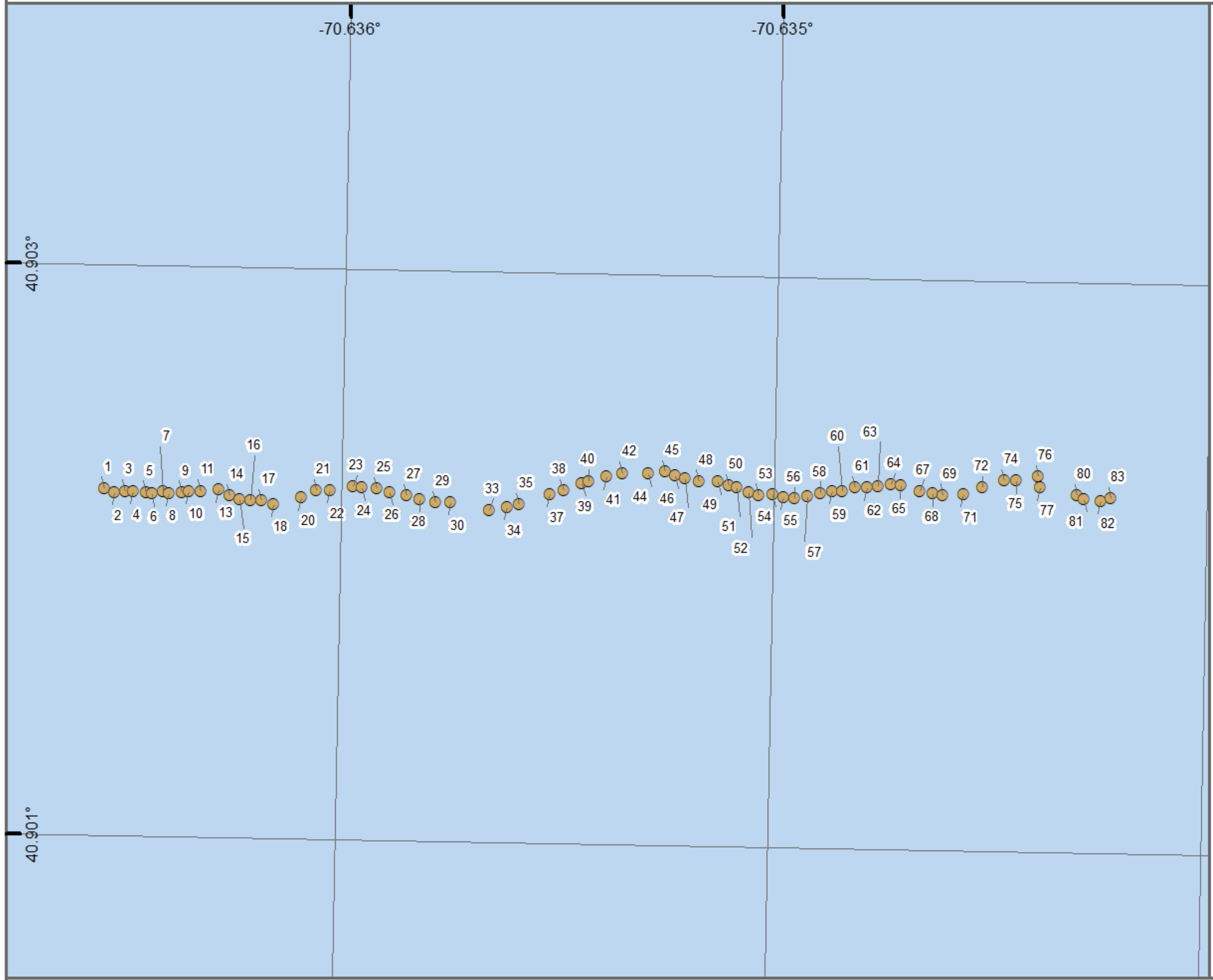
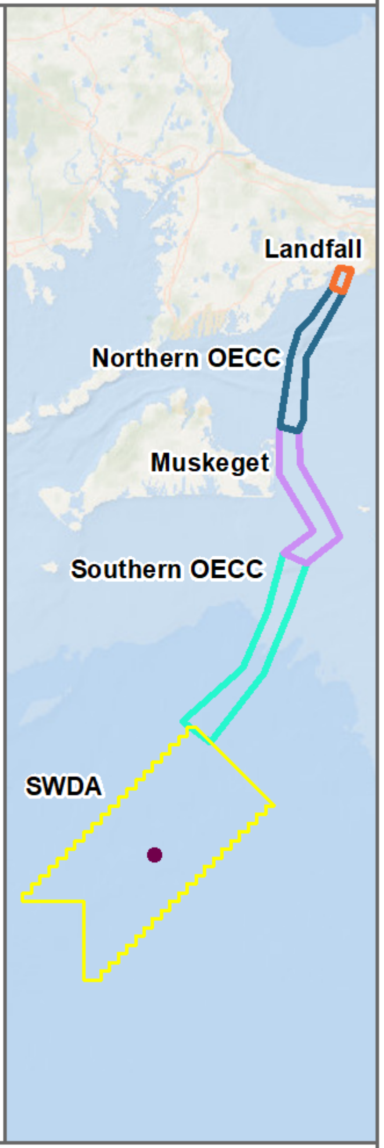
SWDA Zone

Transect: SWDA20-VT-07





CMECS Classification

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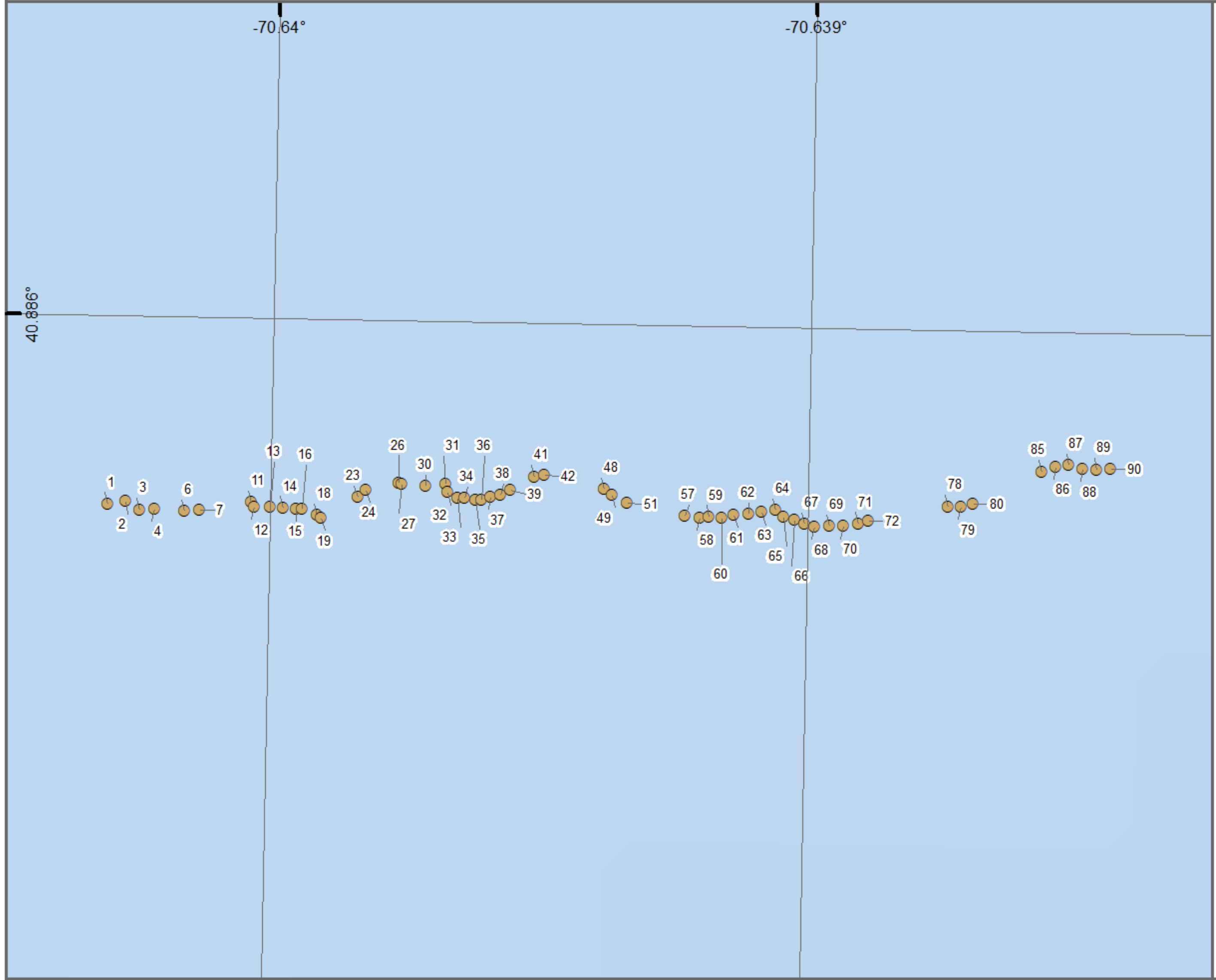
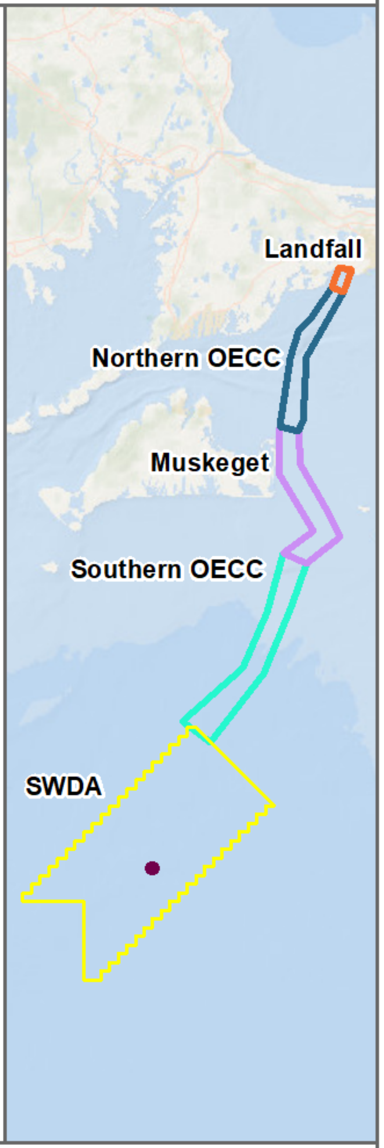
0 40 80 Meters

N

SWDA Zone

Transect: SWDA20-VT-08





CMECS Classification

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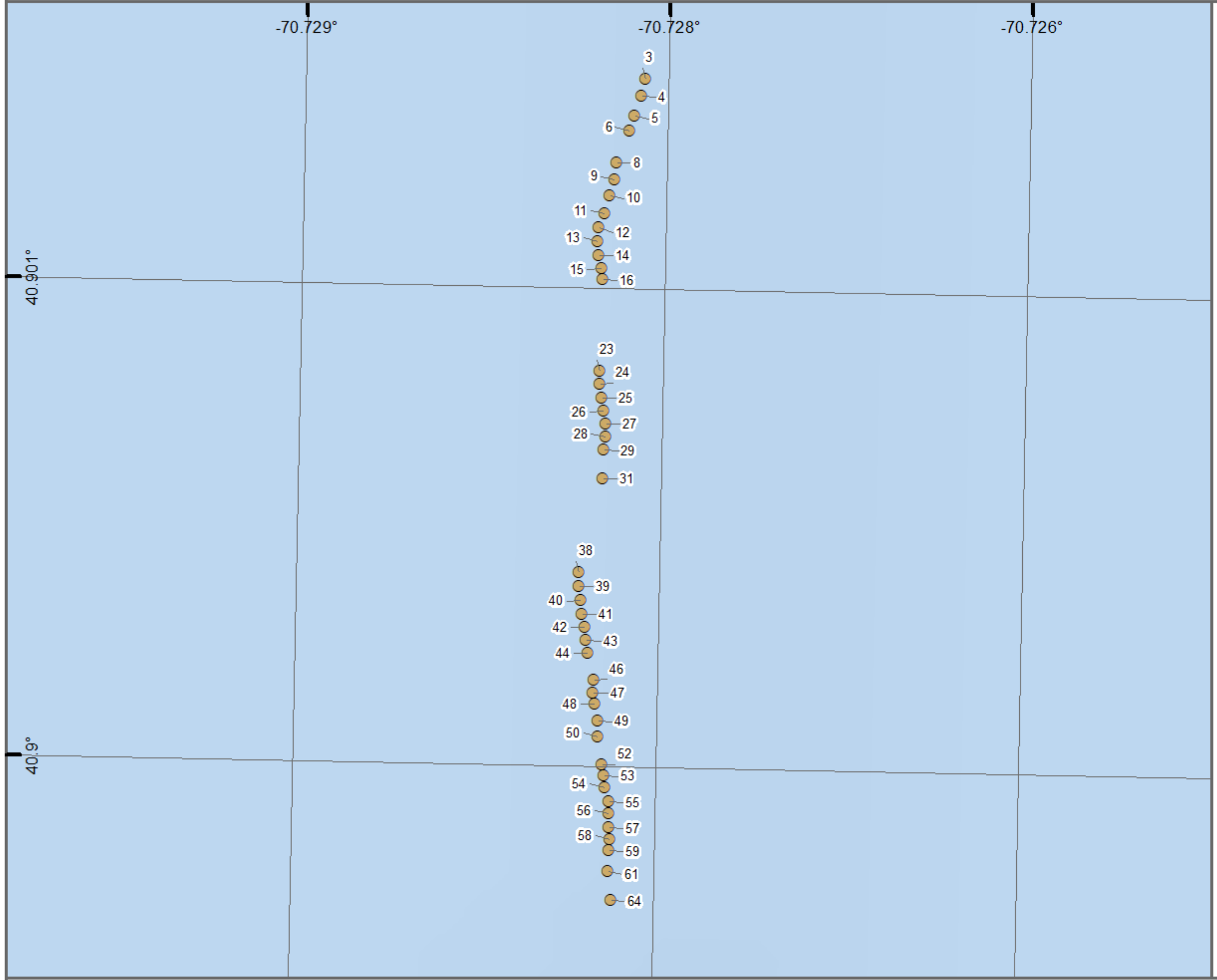
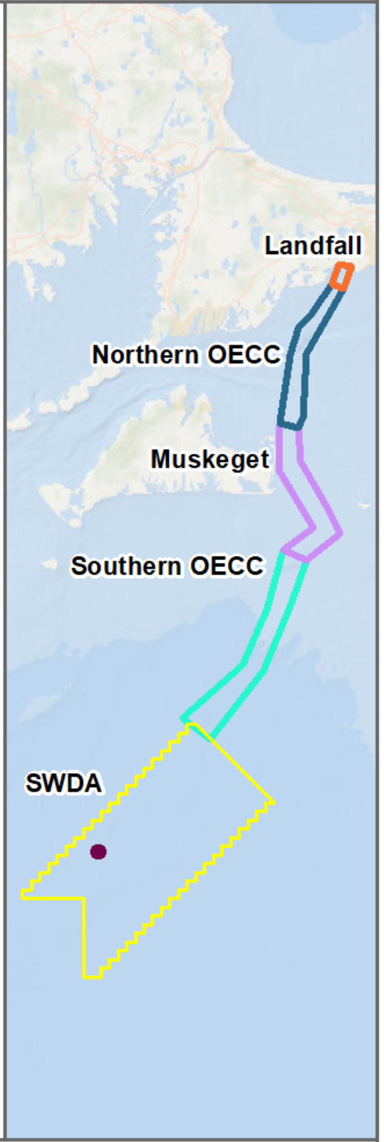
0 30 60 Meters

N

SWDA Zone

Transect: SWDA20-VT-09





CMECS Classification

Sand/Mud

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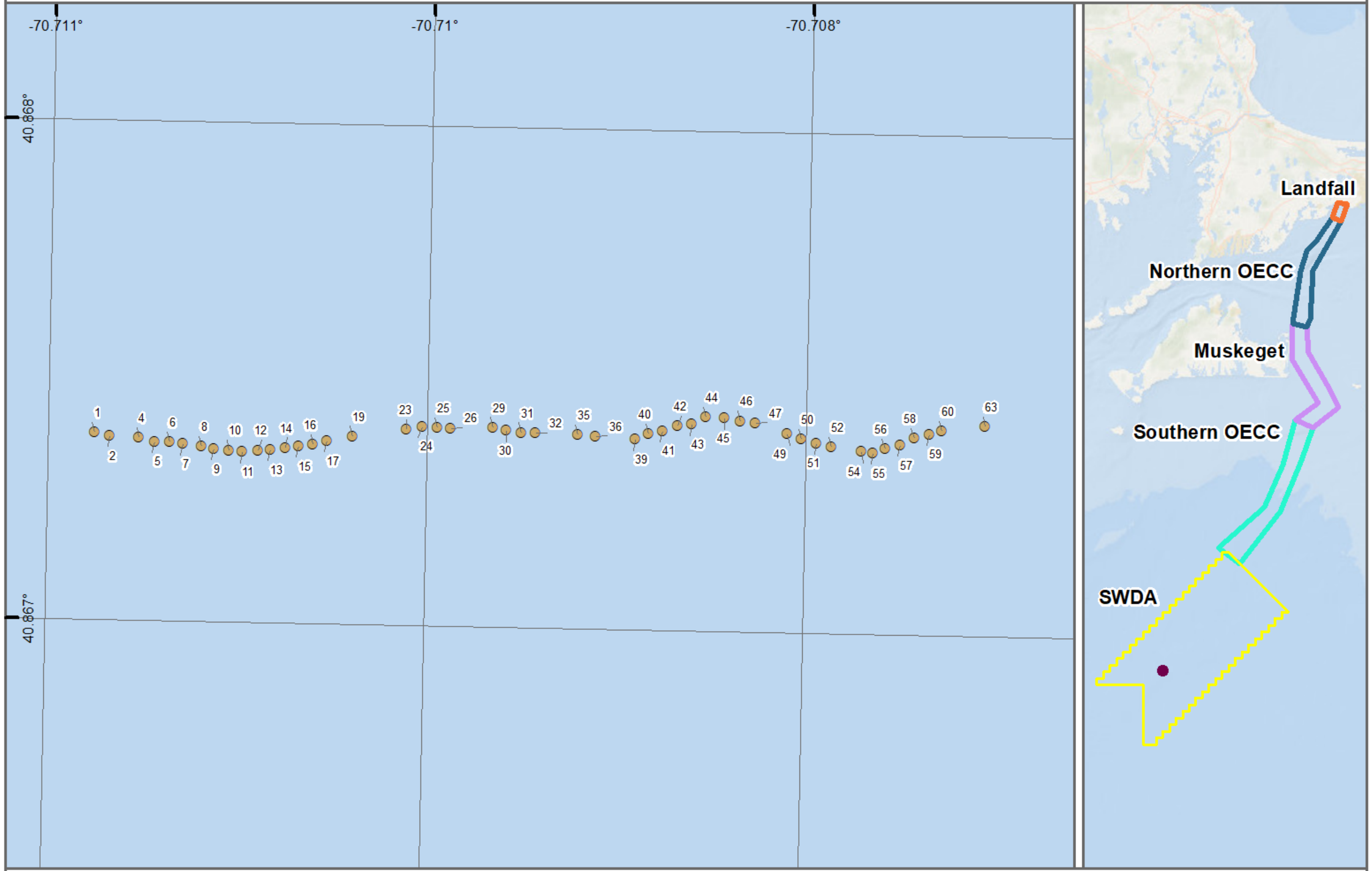
0 50 100 Meters

N

SWDA Zone Transect: SWDA20-VT-10



CMECS Classification

Sand/Mud

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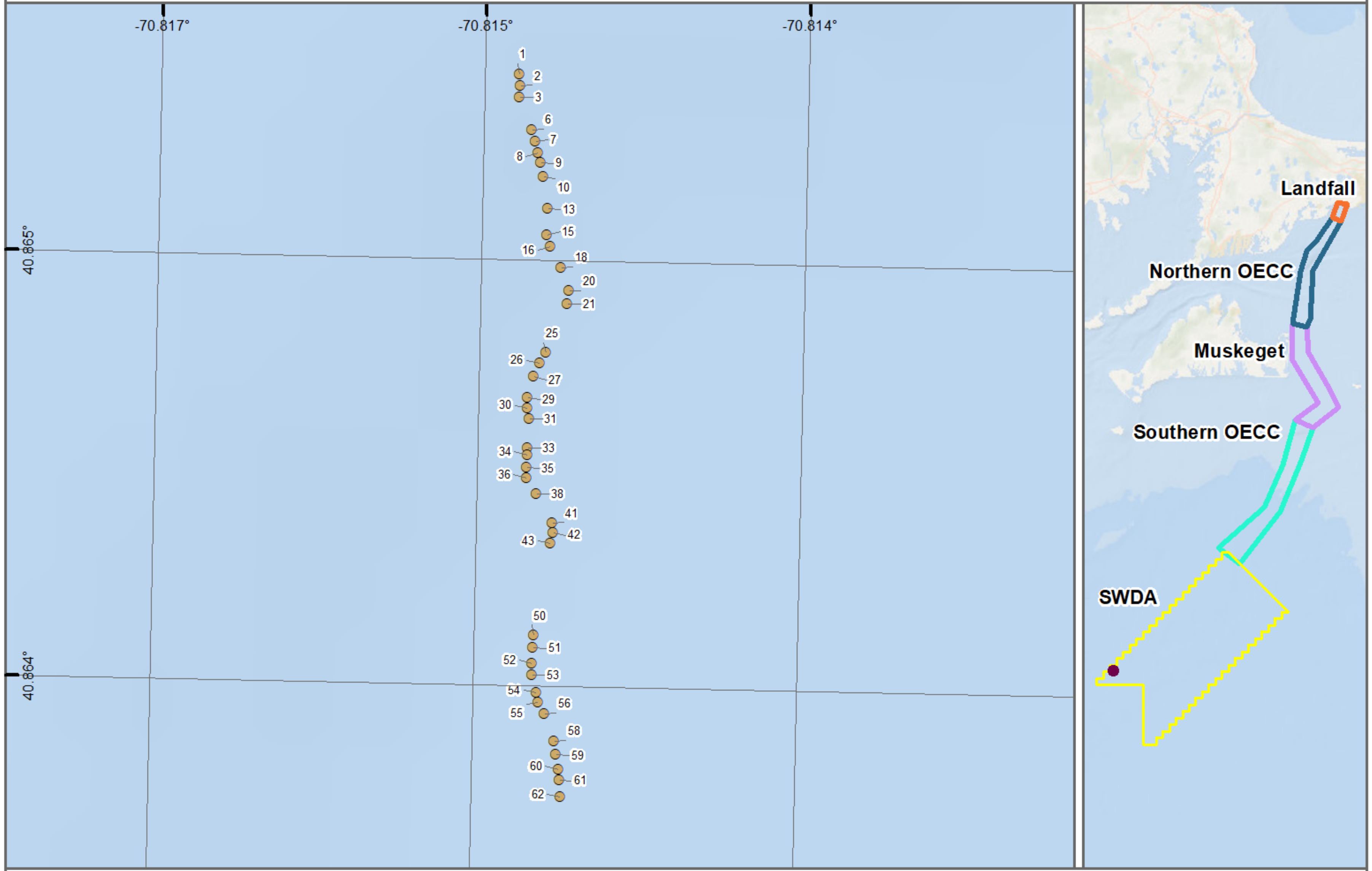
0 40 80 Meters

N

SWDA Zone   Transect: SWDA20-VT-11



CMECS Classification

- Sand/Mud

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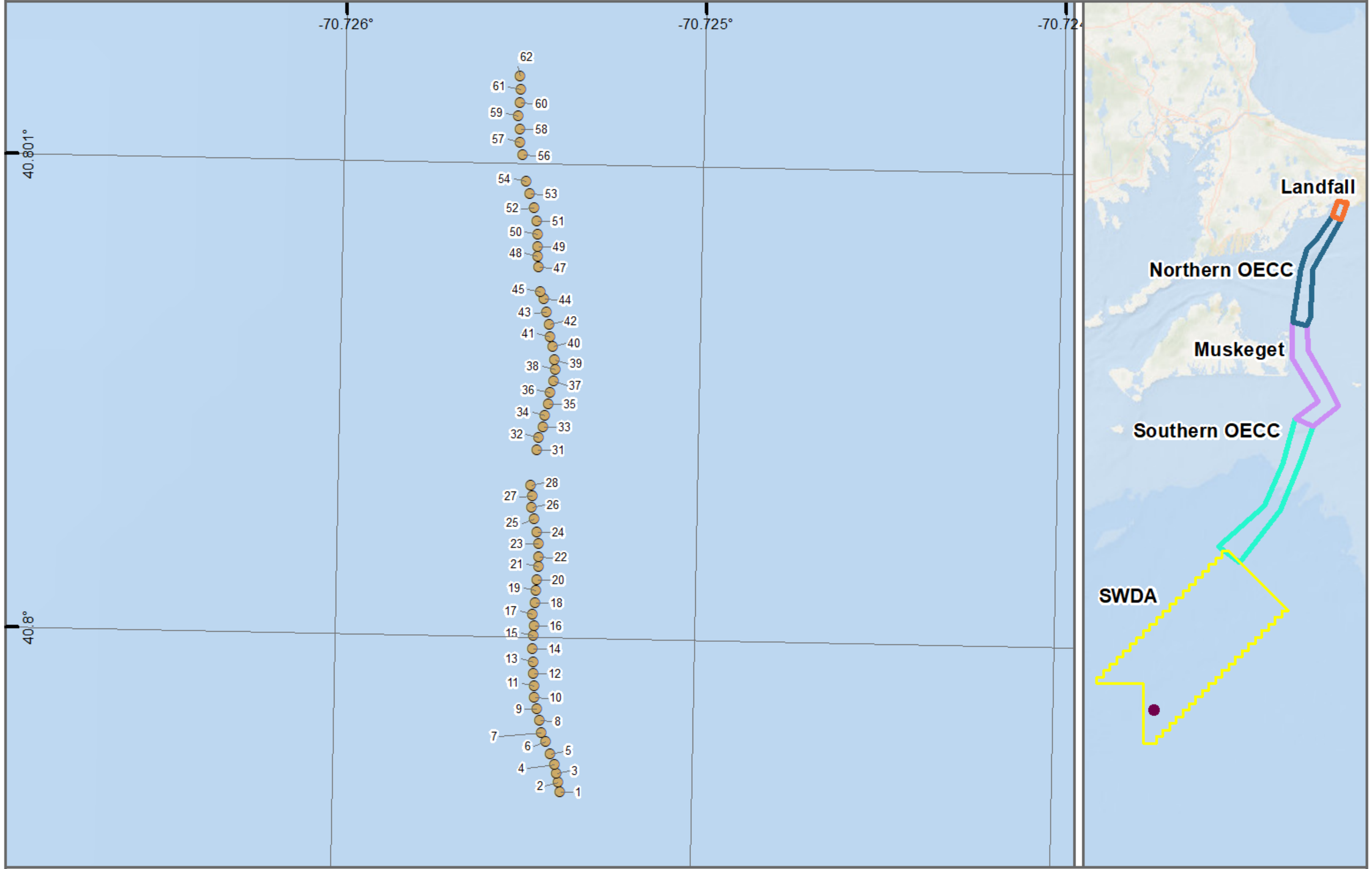
0 50 100 Meters

N

SWDA Zone Transect: SWDA20-VT-12



CMECS Classification

Sand/Mud

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0 45 90 Meters

N