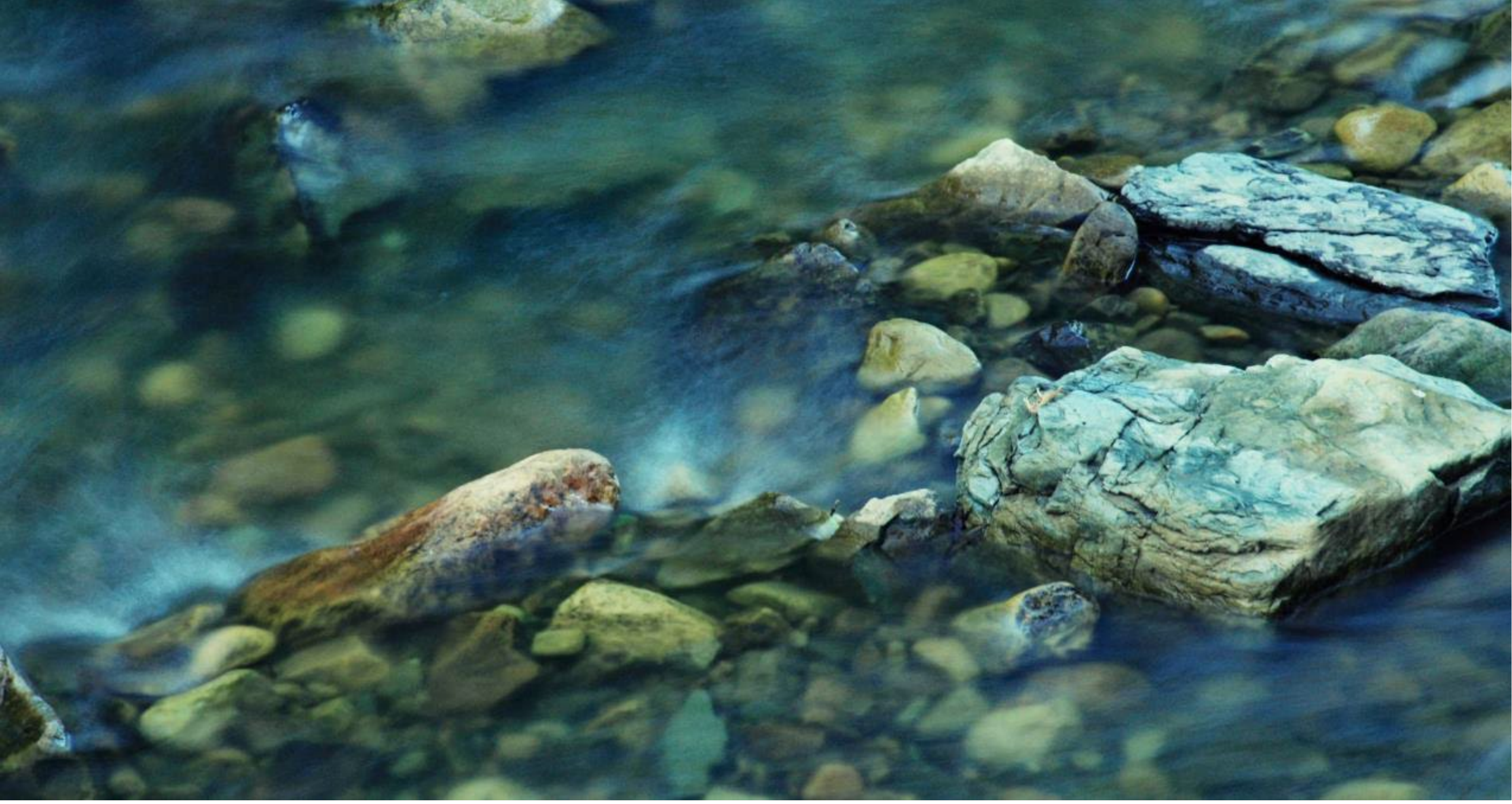
MID-CHESAPEAKE BAY ISLANDS ECOSYSTEM RESTORATION PROJECT: BARREN ISLAND BORROW AREA

APPENDIX A: SURVEY REPORTS AND DATA

APPENDIX A1: Benthic Community Sampling and Analysis Report



March 2023
Mid-Chesapeake Bay Island Ecosystem Restoration Project Environmental Surveys

Sand Borrow Area Benthic Community Sampling and Analysis Report

Prepared for Maryland Environmental Service

In coordination with Maryland Department of Transportation, Maryland Port Administration

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ABBREVIATIONS

B-IBI	benthic index of biotic integrity
COC	chain-of-custody
DGPS	differential global positioning system
m^2	square meter
mg/kg	milligram per kilogram
mg/L	milligram per liter
NAD83	North American Datum of 1983
NTU	nephelometric turbidity unit
ppt	part per thousand
Project	Mid-Chesapeake Bay Island Ecosystem Restoration Project
RGI	restoration goal index
TOC	total organic carbon

1 Introduction

In 2009, the U.S Army Corps of Engineers Baltimore District prepared an integrated feasibility study and environmental impact statement for the Mid-Chesapeake Bay Island Ecosystem Restoration Project (Project), which focuses on restoring and expanding island habitat to provide hundreds of acres of wetland and terrestrial habitat for fish, shellfish, reptiles, amphibians, birds, and mammals through the beneficial use of dredged material (USACE 2009). The feasibility study and environmental impact statement identified James Island and Barren Island, located in western Dorchester County, Maryland, as the recommended plan for island restoration (Figure 1).

Barren Island is an uninhabited island located in the Chesapeake Bay in Dorchester County, Maryland, near the Honga River and immediately west of Hoopers Island. Barren Island has experienced substantial erosion; 2020 surveys indicate that 138 acres remain. Barren Island experiences a long-term erosion rate of 14 feet per year (3 to 4 feet per year in recent years) or approximately 4.1 acres per year. At this rate, Barren Island could be completely lost by the early 2050s (2050 to 2055) without ongoing and future protection measures. The Barren Island component of the Project will restore a minimum of 72 acres of wetland habitat at Barren Island, while also protecting approximately 1,325 acres of potential submerged aquatic vegetation habitat adjacent to the island.

Currently, the National Environmental Policy Act documentation for the Project is being updated through the development of a supplemental environmental assessment for Barren Island. The purpose of this Sampling and Analysis Report is to document existing site conditions of the benthic community in the potential sand borrow areas in the vicinity of Barren Island in support of the supplemental environmental assessment for Barren Island. Design for the island restoration is ongoing, and the conditions documented in this Sampling and Analysis Report will serve as the baseline environmental conditions prior to the initiation of restoration activities.

To support the construction of the Barren Island restoration project, sand will be required. Because of the remote location of the project, sand borrow from areas in the vicinity of the project, if available, is preferred. Two areas (a northern borrow area and a southern borrow area) were identified for focused study to assess the quantity and quality of sand resources, the feasibility of sand recovery, and the potential for impacts to natural resources. The proposed northern sand borrow area is located adjacent to the Honga River, and the proposed southern sand borrow area is located southwest of the proposed project footprint (Figure 1).

Benthic community sampling in both the northern and southern borrow areas was conducted to determine the composition of the existing benthic community as part of the overall feasibility assessment and potential of the areas as sand borrow locations.

LEGEND:

- Proposed Sample Location
- Barren Island Remnants
- Proposed Barren Island Protection
- Potential Sand Borrow Area
- Focused Sand Borrow Study Area
- Shallow Draft Navigation Channels

0 1,000
Meters

ANCHOR QEA

Figure 1
Sampling Locations in the Proposed Barren Island Sand Borrow Areas
Mid-Chesapeake Bay Island Environmental Surveys

2 Field Investigation and Data Analysis

Sample collection for the Mid-Bay sand borrow benthic community study was completed from August 15 to 18, 2022. The day-to-day sequence of sampling was determined at the discretion of the Field Coordinator. Upon completion of daily field activities, samples were submitted to their respective laboratories for analysis.

The methods and procedures for the collection of field samples, sampling schedule, rationale for the sampling design, and design assumptions for locating and selecting environmental samples were carried out in accordance with the *Mid Chesapeake Bay Island Environmental Surveys Sampling and Analysis Plan and Quality Assurance Project Plan* (Anchor QEA 2021).

A total of 16 locations were sampled (i.e., 6 locations in the proposed northern borrow area and 10 locations in the proposed southern borrow area). Sampling locations were determined in the field using a Trimble ProXRS differential global positioning system (DGPS) with an accuracy of 1 to 3 meters. Northing and easting coordinates for target sampling locations are provided in Table 1.

Table 1
Sampling Coordinates for Proposed Northern and Southern Borrow Areas

Area	Location	Northing	Easting
		Maryland State Plane, NAD83, U.S. Survey feet	
Proposed northern borrow area	NSB-01	249394.40	1523957.46
	NSB-02	250104.84	1524148.65
	NSB-03	249249.92	1525176.18
	NSB-04	249977.67	1525451.32
	NSB-05	249127.46	1525980.51
	NSB-06	249889.00	1526304.74
Proposed southern borrow area	SSB-01	242174.26	1517210.06
	SSB-02	241977.96	1518248.32
	SSB-03	241223.32	1518705.74
	SSB-04	241467.28	1517746.69
	SSB-05	240464.45	1519736.00
	SSB-06	240673.81	1518614.11
	SSB-07	239571.39	1519495.42
	SSB-08	238522.38	1520190.16
	SSB-09	238163.37	1519195.53
	SSB-10	237476.81	1520321.88

2.1.1 Sample Collection

Sediment samples were collected using a stainless-steel sediment Ponar grab sampler to collect large-volume, undisturbed surficial sediment samples representative of the top 0 to 6 inches of the sediment. Sediment was collected at each location prior to the benthic community sample collection and submitted to an analytical laboratory for grain size and total organic carbon analysis. At each location, the water depth and in situ water quality parameters (including salinity, temperature, dissolved oxygen, pH, and turbidity) were measured and recorded (Table 2).

Table 2
Water Quality Parameters for Proposed Borrow Area Samples

Area	Location	Water Depth (feet)	Salinity (ppt)	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	NTU
Proposed northern borrow area	NSB-01	7.8	14.7	27.4	7.5	8.1	5.0
	NSB-02	7.0	14.7	26.2	7.4	8.1	5.3
	NSB-03	6.9	14.7	26.5	7.8	8.2	5.4
	NSB-04	6.8	14.9	25.2	7.4	8.1	2.9
	NSB-05	5.9	14.9	25.5	7.9	8.2	2.8
	NSB-06	5.9	14.9	25.1	7.4	8.2	3.0
Proposed southern borrow area	SSB-01	16.1	15.3	27.0	6.5	8.1	1.1
	SSB-02	16.6	15.2	27.0	7.1	8.1	1.2
	SSB-03	17.0	15.9	26.4	6.5	7.5	1.6
	SSB-04	18.7	15.4	26.4	6.7	7.5	1.2
	SSB-05	13.8	15.3	26.6	7.4	8.2	2.0
	SSB-06	20.4	15.3	26.6	7.2	8.1	1.5
	SSB-07	12.7	15.3	26.7	7.5	8.1	1.3
	SSB-08	12.7	15.4	26.2	7.3	8.0	1.5
	SSB-09	15.9	15.4	26.3	7.2	8.1	0.9
	SSB-10	11.7	15.9	26.5	7.5	8.1	1.1

The Ponar grab sampler uses a hinged-jaw assembly for sample collection. Upon contact with the sediment, the Ponar's jaws are drawn shut to collect the sample. Sediment samples were collected at each location using the following procedures:

- Maneuver the vessel to the monitoring station using a DGPS to within 1 meter of the target sampling location.
- Open the decontaminated grab sampler jaws to the deployment position.
- Draw the winch cable taut and vertical to the grab sampler, then slowly lower the sampler through the water column to the bottom.

- Close the jaws of the sampler when the sampler reaches the bottom and record the time and DGPS coordinates.
- Retrieve the sampler, slowly raising it back to the sampling vessel.
- Evaluate the retrieved sediment sample aboard the vessel against the following acceptability criteria:
  - The grab sampler is not overfilled (i.e., the sediment surface is not against the top of the sampler).
  - The sediment surface is relatively flat, indicating minimal disturbance or winnowing.
  - Overlying water is present, indicating minimal leakage.
  - Overlying water has low turbidity, indicating minimal sample disturbance.
  - Desired penetration depth is achieved.
- Siphon off overlying water and use a decontaminated stainless-steel spoon to collect sediment from inside the sampler, taking care not to collect sediment in contact with the sides of the sampler.
- Place the collected sediment in a decontaminated stainless-steel mixing bowl and homogenize the sediment using a decontaminated stainless-steel spoon.

After homogenization, the sediment samples were immediately placed into appropriate prelabeled sample containers, placed on ice, and maintained at 4°C until the samples were delivered to the laboratory. All jars were firmly sealed with Teflon-lined lids. Sediment samples designated for grain size and total organic carbon were collected in an 8-ounce glass jar. Because the sediment samples were collected using a grab sampler, the holding time was initiated at the time of sample collection. Samples were shipped to the analytical laboratory (Eurofins in Pittsburgh, Pennsylvania) directly from the field via overnight delivery.

After collection of the sediment samples, triplicate grab samples were collected at each location to determine the benthic community composition. The top 0 to 6 inches of the sediment was collected and sieved in the field through a 500-micron screen to remove fine sediment particles. Individual replicates were transferred to sample containers and preserved in the field using buffered 10% formalin and rose-bengal solution. Each sample container was individually labeled with an indelible ink pen with the project name, sample identification, and date and time of collection.

In the laboratory, each sample was washed with tap water through a 500-micron sieve to remove the preservation in preparation for laboratory processing. All organisms were removed from the sample material. Representative organisms of each species from each location were collected and identified to the lowest practical taxonomic level. Because Barren Island is the mesohaline portion of the Chesapeake Bay, determination of species biomass was required (Versar 2002).

2.1.2 Field Documentation

The field log book provides a description of all sampling and sample processing activities, sampling personnel, daily weather conditions, and field observations, as well as a record of all modifications to the procedures and plans identified in the *Mid Chesapeake Bay Island Environmental Surveys Sampling and Analysis Plan and Quality Assurance Project Plan* (Anchor QEA 2021). The field log book provides data and observations to enable readers to reconstruct events that occurred during the sampling period. Sampling activities were recorded in a permanently bound log book, and each page of the log book was numbered and dated by the personnel entering information. A copy of the project log book is provided in Appendix A.

2.1.3 Sample Documentation

Samples collected from each sampling location were assigned unique alphanumeric identifiers that were generally consistent with previous environmental baseline sampling events for Barren Island, using the following format:

- The first characters identify the location BI for Barren Island
- The second characters identify which borrow area the samples are from, with NSB for the northern sand borrow area and SSB for the southern sand borrow area
- Numeric characters identify the sampling location (e.g., 01 or 04).

The chain-of-custody (COC) forms are the documents used to detail the possession and transfer of samples. All COC procedures were followed for each sample throughout the collection, handling, and analysis process. Sediment samples collected in the field were documented on a COC form that was prepared by sample processing personnel and accompanied each cooler of samples submitted for analysis. Each person who had custody of the samples signed the COC form and ensured that the samples were not left unattended unless properly secured.

The benthic community samples were delivered to Cove Corporation in properly preserved conditions and according to the requirements of the COC protocols for sorting and identification. Cove Corporation conducted benthic sorting and taxonomic identification of organisms to the lowest practicable taxon for each of the samples.

2.1.4 Sample Handling Procedures

Sample containers were kept in packaging as received from the analytical laboratory until used. A sample container was withdrawn only when a sample was collected, and once filled, the sample was returned to a cooler containing the collected samples. Waterproof sample labels were filled out with an indelible ink pen and affixed to sample containers provided by the laboratory. Each label contained the project name, sample identification, preservation technique, requested analyses, date and time of collection, and initials of the person preparing the sample.

Benthic community samples were immediately preserved in the field in a buffered 10% formaldehyde solution and stored in appropriate containers out of direct sunlight on the work boat. After completion of benthic sampling, the samples were transported to Cove Corporation, in Lusby, Maryland, where samples were stored until laboratory processing.

Sediment samples for grain size and total organic carbon analyses were securely packed inside a cooler with crushed ice onboard the work vessel to maintain the samples at 4°C until delivery to the analytical laboratories.

2.1.5 Field Decontamination Procedures

Sample containers, instruments, working surfaces, and other items that may encounter sediment must meet high standards of cleanliness. All processing equipment and instruments used that are in direct contact with the sediment or surface water collected for analysis were made of glass, stainless steel, or high-density polyethylene.

All working surfaces and instruments were thoroughly cleaned and field decontaminated to minimize outside contamination between sampling events. All sampling equipment exposed to collected sediment was decontaminated between sampling locations using the following procedures:

- Rinse with site water and wash with scrub brush until free of sediment.
- Wash with a natural cleaner and a phosphate-free biodegradable soap solution.
- Rinse with distilled water.
- Air dry (in an area not adjacent to the decontamination area).

Acid or solvent washes were not used in the field because of safety considerations and problems associated with rinsate disposal and sample integrity.

2.2 Data Analysis

2.2.1 Sediment Grain Size

The sampling locations at Barren Island were predominantly sand, with samples in the proposed northern borrow area ranging from 68.7% to 92.7% sand and samples in the proposed southern borrow area ranging from 93.2% to 98.4% sand (Table 3).

Table 3
Grain Size Results

Area	Location	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Total Organic Carbon (mg/kg)
	NSB-01	4.3	75.1	15.5	5.1	4,500
	NSB-02	0	91.5	5.5	3	3,100

Area	Location	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Total Organic Carbon (mg/kg)
Proposed northern borrow area	NSB-03	0	89.2	6	4.8	2,900
	NSB-04	0	76.5	19	4.5	2,500
	NSB-05	0	78.4	16.6	5.0	2,700
	NSB-06	0	68.7	24	7.3	2,600
Proposed southern borrow area	SSB-01	0	95.4	2.5	2.1	1,300
	SSB-02	0	94.1	3.9	2	1,300
	SSB-03	0	97	0.8	2.2	1,800
	SSB-04	0	93.2	3.6	3.2	2,200
	SSB-05	0	97.4	0.3	2.3	1,400
	SSB-06	0	98.4	0.2	1.5	1,400
	SSB-07	0	96.3	0.9	2.9	1,500
	SSB-08	0	96	1	3	1,700
	SSB-09	0	96.3	0.5	3.2	1,800
	SSB-10	0	97.1	0.5	2.5	1,800

2.2.2 Benthic Community Metrics

The following metrics were used to characterize the benthic community for sampling and reference locations at Barren Island sand borrow areas:

- **Total number of taxa**: This is the total number of distinct taxa. This metric reflects the health of the community through a measurement of the variety of taxa present.
- **Shannon-Wiener species diversity index (H')**: This index is one of the most widely used indices in the ecology community. The Shannon-Wiener species diversity index is calculated as shown in Equation 1.

Equation 1

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

where:

H = Shannon-Wiener species diversity index

S = number of species per sample

p_i = proportion of total individuals in the *i*th species

- **Simpson's dominance index (c):** This varies from 0 to 1 and gives the probability that two individuals drawn at random from a population belong to the same species (Ludwig and Reynolds 1988). Simpson's dominance index incorporates species richness and evenness into a single value. The Simpson's dominance index is calculated as shown in Equation 2.

Equation 2

$$c = \sum \left(\frac{n_i}{N}\right)^2$$

where:

c	=	Simpson's dominance index
n_i	=	number of individuals in species i
N	=	total number of individuals

- **Species richness (d)**: This is the number of species in the community and is dependent on the sample size (Ludwig and Reynolds 1988). This index expresses the variety of one component of species diversity. Species richness at each location is the ratio between the total number of species and the total number of individuals. It removes abundance variability among locations so that comparisons between locations are possible. This index expresses variety independent of an evenness index, which is incorporated in general indices of diversity. Species richness is calculated as shown in Equation 3.

Equation 3

$$d = \frac{\mathrm{S}\ - 1}{\log N}$$

where:

d	=	species richness
S	=	number of species
N	=	number of individuals

- **Evenness (e)**: This is how the species abundances (e.g., the number of individuals or biomass) are distributed among the species (Ludwig and Reynolds 1988). Evenness is a measurement of the similarity of the abundances of different species. When all species are equally abundant, then evenness is 1, but when the abundances are very dissimilar (some rare and some common species), the value increases. Evenness is calculated as shown in Equation 4.

Equation 4

$$e = \frac{\bar{H}}{\log S}$$

where:

e	=	evenness
$\bar{H}$	=	Shannon-Wiener species diversity index value
S	=	number of species

2.2.3 Chesapeake Bay Benthic Index of Biotic Integrity

Benthic invertebrates are used extensively as indicators of estuarine environmental status and trends because numerous studies have demonstrated that benthos respond predictably to many kinds of natural and anthropogenic stresses (Weisberg et al. 1997). The Chesapeake Bay benthic index of biotic integrity (B-IBI) was developed by Weisberg et al. (1997) to assess benthic community health and environmental quality in the Chesapeake Bay. The Chesapeake Bay B-IBI evaluates the ecological condition of a sample by comparing values of key benthic community attributes, or metrics, to reference values expected under nondegraded conditions in similar habitat types (Versar 2002).

Because the major factors that control the structure of benthic communities in the Chesapeake Bay are salinity and sediment type (Versar 2002), results of the grain size analysis and bottom salinity data were used to classify habitats for sampling locations in the proposed Barren Island sand borrow areas. These habitat classifications were used to determine the metrics used to calculate the B-IBI for each location. Before Chesapeake Bay B-IBI metrics were calculated, samples were assigned to one of the following five salinity classes (Weisberg et al. 1997):

- Tidal freshwater (0 to 0.5 parts per thousand [ppt])
- Oligohaline (≥0.5 to 5 ppt)
- Low mesohaline (≥5 to 12 ppt)
- High mesohaline (≥12 to 18 ppt)
- Polyhaline (≥18 ppt)

The salinity for each of the Barren Island proposed sand borrow locations ranged from 14.7 to 15.9 ppt (Table 4); therefore, each of the Barren Island proposed sand borrow locations were classified as high mesohaline.

The sampling locations at Barren Island were predominantly sand, with samples in the proposed northern borrow area ranging from 68.7% to 92.7% sand and samples in the proposed southern borrow area ranging from 93.2% to 98.3% sand (Table 3).

Table 4
Habitat Classification for Benthic Index of Biotic Integrity Calculation

Area	Location	Salinity (ppt)	Silt + Clay (%)	Habitat Classification
Proposed northern borrow area	NSB-01	14.7	20.6	High mesohaline sand
	NSB-02	14.7	8.5	High mesohaline sand
	NSB-03	14.7	10.8	High mesohaline sand
	NSB-04	14.9	23.5	High mesohaline sand
	NSB-05	14.9	7.3	High mesohaline sand
	NSB-06	14.9	31.3	High mesohaline sand
Proposed southern borrow area	SSB-01	15.3	4.6	High mesohaline sand
	SSB-02	15.2	5.9	High mesohaline sand
	SSB-03	15.9	3	High mesohaline sand
	SSB-04	15.4	6.8	High mesohaline sand
	SSB-05	15.3	2.6	High mesohaline sand
	SSB-06	15.3	1.7	High mesohaline sand
	SSB-07	15.3	3.8	High mesohaline sand
	SSB-08	15.4	4	High mesohaline sand
	SSB-09	15.4	3.7	High mesohaline sand
	SSB-10	15.9	3	High mesohaline sand

Notes:
Salinity between 12 and 18 ppt = high mesohaline
Silt + clay: <40% = sand; >40% = mud

The following are metrics used in the B-IBI calculations for mesohaline habitats:

1. **Shannon-Wiener species diversity index (*H'*):** This index is one of the most widely used indices in ecology community. The Shannon-Wiener species diversity index is calculated using Equation 1.
2. **Total species abundance:** Total number of organisms present in a sample after dropping the epifauna and incidental species excluded from the B-IBI calculation (Versar 2002). The total species abundance will be normalized to the number of organisms per unit area. The conversion factor for the Ponar grab is 1 count equals 20.4 individuals per square meter (m^2).
3. **Total species biomass:** The total biomass (measured as ash free dry weight) of organisms present in a sample after dropping the epifauna and incidental species excluded from the B-IBI calculation (Versar 2002). The total biomass is normalized to the biomass of organisms per unit area.
4. **Percent abundance of carnivores and omnivores:** Percent abundance contribution of taxa classified as carnivores or omnivores to the total abundance of organisms in a sample. The list of taxa that are defined as carnivores or omnivores is provided in Versar (2002).
5. **Percent abundance of stress-indicative taxa:** This metric will be calculated as the percentage of total abundance represented by stress-indicative taxa. This metric is included only in the high

mesohaline sand classification for the B-IBI. This metric is not appropriate for use in areas of high mesohaline mud because the metric may not be sensitive (or indicative) in all benthic habitats. Benthic communities differ significantly according to habitat type, and the metrics appropriate to each type were chosen based upon their sensitivity within various benthic habitats. The list of taxa that are defined as pollution-indicative for the Chesapeake Bay is provided in Versar (2002).

6. **Percent abundance of stress-sensitive taxa:** This metric will be calculated as the percentage of total abundance represented by stress-sensitive taxa. This metric is included only in the high mesohaline sand classification for the B-IBI. The list of taxa that are defined as pollution-indicative for the Chesapeake Bay is provided in Versar (2002).

Based on the habitat type, the results from the appropriate metrics specific to the habitat type were used to calculate the B-IBI for each benthic community sampling location. The metrics and resulting scores for high mesohaline sand habitats used to calculate the Chesapeake Bay B-IBI are presented in Table 5.

The Chesapeake Bay B-IBI approach involves scoring each metric as 5, 3, or 1, depending on whether its value at a location approximates (5), deviates slightly (3), or deviates greatly (1) from conditions at reference sites (Weisberg et al. 1997). The final Chesapeake Bay B-IBI score is derived by summing individual scores for each metric and calculating an average score.

Table 5
Scoring Criteria for Benthic Index of Biotic Integrity Calculations

Metric	Scoring Criteria for High Mesohaline Sand Habitat		
	5	3	1
Shannon-Wiener species diversity index	≥3.2	2.5 to 3.2	<2.5
Abundance (organisms/m^2)	≥1,500 to 3,000	1,000 to 1,500 or ≥3,000 to 5,000	<1,000 or ≥5,000
Biomass (g/m^2)	≥3 to 15	1 to 3 or ≥15 to 50	<1 or ≥50
Abundance stress-indicative taxa (%)	≤10	10 to 25	>25
Abundance stress-sensitive taxa (%)	≥40	10 to 40	<10
Abundance of carnivores and omnivores (%)	≥35	20 to 35	<20

The B-IBI is used to establish benthic restoration goals for the Chesapeake Bay (Weisberg et al. 1997). A Chesapeake Bay restoration goal index (RGI) value of 3.0 represents the minimum restoration goal, and Chesapeake Bay RGI values of less than 3.0 are indicative of a stressed community. Values of 3.0 or greater indicate habitats that meet or exceed the restoration goals (Ranasinghe et al. 1994).

Based on the Chesapeake Bay RGI, the Chesapeake Bay Benthic Monitoring Program classifies the benthic community in four levels (Versar 2002):

- Meets restoration goals (Chesapeake Bay B-IBI that is ≥3.0)
- Marginal (Chesapeake Bay B-IBI of 2.7 to 2.9)
- Degraded (Chesapeake Bay B-IBI of 2.1 to 2.6)
- Severely degraded (Chesapeake Bay B-IBI that is ≤2.0)

A Chesapeake Bay B-IBI value of 3.0 is the threshold value between degraded and nondegraded conditions at a location.

3 Results and Discussion

Results of the benthic community analysis from the Barren Island sand borrow areas were compared to regional Chesapeake Bay B-IBI values and to the Chesapeake Bay RGI.

3.1 Benthic Community Metrics

A total of 54 unique benthic taxa were collected in the proposed northern sand borrow area, and 44 unique taxa were collected in the proposed southern sand borrow area (Tables 7 and 8). A taxonomic list and abundance (number per m^2) of the benthic fauna collected at the Barren Island proposed northern and southern borrow areas is provided in Tables 7 and 8, respectively. A list of the benthic fauna collected in the individual replicates at each location is provided in Appendix B.

For the proposed northern borrow area, bivalves and polychaetes were the dominant taxa (Table 7, Appendix B). At locations NSB-01 and NSB-05, pile worms (*Mediomastus ambiseta*) represented 41% and 39% of the total count of benthic invertebrates, respectively. The dominant taxon in the remaining sampling locations was the bivalve Mitchell macoma (*Ameritella mitchelli*), representing 29% (NSB-02), 36% (NSB-03), 47% (NSB-04), and 34% (NSB-06) of the total count of benthic invertebrates (Table 7).

For the proposed southern borrow area, bivalves and polychaetes were also the dominant taxa (Table 8, Appendix B). At locations SSB-01, SSB-05, and SSB-06, pile worms (*Mediomastus ambiseta*) or segmented worms (*Glycinde multidens*) represented 22%, 27%, and 24% of the total count of benthic invertebrates, respectively. The dominant taxon in the remaining sampling locations was the bivalve Mitchell macoma (*Ameritella mitchelli*), representing between 21% and 39% of the total count of benthic invertebrates (Table 8).

The following six metrics were used to describe the overall characteristics of the benthic community at Barren Island (i.e., total abundance, unique taxa collected, species richness, evenness, Simpson's dominance index, and the Shannon-Wiener species diversity index; Table 6).

1. Abundance ranged from 15,939 to 49,885 organisms per m^2 in the proposed northern borrow area and from 4,631 to 10,333 organisms per m^2 in the proposed southern borrow area.
2. The number of unique taxa at each benthic sample locations ranged from 18 to 32 taxa in the proposed northern borrow area and from 17 to 23 taxa in the proposed southern borrow area.
3. Species richness is a comparison of how many taxa are in a sample compared to how many individuals (Equation 3). Lower values indicate that the total benthic abundance at a location is dominated by a few taxa and does not represent a diverse benthic community. Species richness values ranged from 2.9 to 3.7 in the proposed northern borrow area and from 2.9 to 4.4 in the proposed southern borrow area.

4. Evenness is a measure of how evenly the individuals collected at a location are distributed among the taxa collected at that location (Equation 4). Evenness values ranged from 0.7 to 0.9 in the proposed northern borrow area and from 0.9 to 1.1 in the proposed southern borrow area.
5. The Shannon-Wiener species diversity index considers species richness and species evenness (Equation 1), with greater values indicating a more diverse benthic community. Shannon-Wiener species diversity indices ranged from 2.3 to 3.0 in the proposed northern borrow area and from 3.0 to 3.6 in the proposed southern borrow area.
6. Simpson's dominance index measures the diversity of a sample, with a lower value indicating a more diverse community (Equation 2). Simpson's dominance indices ranged from 0.21 to 0.27 in the proposed northern borrow area and from 0.12 to 0.21 in the proposed southern borrow area.

Results for all benthic community metrics measured at the Barren Island benthic community sampling locations were within the range of metrics measured at the Barren Island reference site for all sampling events. Additionally, the high evenness and Shannon-Wiener species diversity indices and low Simpson's dominance indices indicate that the benthic community surrounding Barren Island is a diverse community.

Table 6
Benthic Community Metrics

Area	Location	Total Abundance (m^2)	Unique Infaunal Taxa	Species Richness	Evenness	Shannon-Wiener	Simpson's Dominance
Proposed northern borrow area	NSB-01	30,100	29	3.4	0.8	2.7	0.24
	NSB-02	16,877	32	3.7	0.9	3.0	0.21
	NSB-03	21,431	18	3.0	0.8	2.6	0.23
	NSB-04	15,939	20	3.3	0.8	2.5	0.28
	NSB-05	49,885	25	3.1	0.7	2.3	0.27
	NSB-06	26,904	20	2.9	0.8	2.5	0.23
Proposed southern borrow area	SSB-01	6,889	21	4.4	1.1	3.6	0.12
	SSB-02	4,631	17	3.3	1.1	3.1	0.16
	SSB-03	5,492	17	3.0	1.1	3.2	0.13
	SSB-04	8,056	23	4.0	1.1	3.5	0.13
	SSB-05	9,950	20	2.9	1.0	3.1	0.16
	SSB-06	6,066	18	3.3	1.1	3.2	0.15
	SSB-07	10,333	22	3.8	1.1	3.6	0.12
	SSB-08	9,912	19	3.2	1.0	3.0	0.21
	SSB-09	7,520	18	3.5	1.1	3.3	0.14
	SSB-10	7,616	19	3.2	1.1	3.4	0.12

Table 7
Benthic Community Data: Proposed Northern Sand Borrow Area

Species Collected		Number					
Scientific Name	**Common Name**	**NSB-01**	**NSB-02**	**NSB-03**	**NSB-04**	**NSB-05**	**NSB-06**
Diadumene leucolena	White anemone	0	10	0	0	0	0
Edwardsia elegans	Burrowing anemone	2	0	1	1	1	0
Carinoma tremaphoros	Round worm	3	1	1	5	5	1
Stylochus ellipticus	Flatworm	0	0	1	0	0	0
Podarkeopsis levifuscina	Segmented worm	0	0	0	0	0	1
Amphiporus bioculatus	Round worm	3	1	1	1	1	0
Hypereteone foliosa	Paddleworm	1	1	0	0	0	0
Hermundura americana	Segmented worm	11	7	5	6	10	15
Alitta succinea	Pile worm	17	26	1	1	3	0
Glycinde multidens	Segmented worm	94	77	101	72	157	157
Leitoscoloplos robustus	Segmented worm	1	0	0	0	0	0
Leitoscoloplos sp. indeterminate	Segmented worm	0	2	0	0	1	0
Polydora cornuta	Whip mudworm	6	26	0	0	1	0
Polydora websteri	Mud blister worm	10	306	0	0	0	0
Marenzelleria viridis	Segmented worm	10	2	1	5	6	8
Paraprionospio treadwelli	Segmented worm	3	1	3	3	2	2
Streblospio benedicti	Ram's horn worm	4	3	3	0	46	16
Heteromastus filiformis	Bristle worm	9	16	1	3	1	0
Mediomastus ambiseta	Segmented worm	**660**	66	161	45	**1,036**	372
Pectinaria gouldii	Trumpet worm	0	0	1	1	1	0
Loimia medusa	Spaghetti worm	0	0	0	0	0	1
Gyroscala rupicola	Brown-band wentletrap	0	0	0	1	0	1
Tubificoides spp.	Segmented worms	12	0	1	0	0	3

Species Collected		Number					
Scientific Name	**Common Name**	**NSB-01**	**NSB-02**	**NSB-03**	**NSB-04**	**NSB-05**	**NSB-06**
Eulimastoma engonium	Needle odostome	16	6	3	2	3	12
Japonactaeon punctostriatus	Pitted baby-bubble	156	121	295	167	625	241
Acteocina canaliculata	Gastropod	41	49	51	34	33	23
Haminella solitaria	Gastropod	0	8	10	6	11	9
Cratena pilata	Gastropod	0	0	0	0	1	0
Arcuatula papyria	Atlantic paper mussel	2	1	1	0	0	0
Geukensia demissa	Ribbed mussel	1	12	0	0	0	0
Crassostrea virginica	Eastern oyster	0	2	0	0	0	0
Mulinia lateralis	Dwarf surf clam	43	50	42	50	45	43
Ameritella mitchelli	Mitchell macoma	303	**358**	**404**	**393**	588	**486**
Macoma petalum	Atlantic macoma	0	0	0	1	3	0
Tagelus plebeius	Stout razor clam	15	5	21	10	15	9
Gemma gemma	Amethyst gem clam	170	46	12	22	12	14
Cyrtopleura costata	Angel wing clam	0	1	1		2	0
Teredinidae sp.	Shipworm	0	2	0	0	0	0
Petricolaria pholadiformis	False angel wing	1		0	0	0	0
Amphibalanus improvisus	Bay barnacle	1	7	0	0	0	0
Americamysis almyra	Mysid shrimp	7	9	7	2	5	9
Cyclaspis varians	Copepod	0	0	0	1	0	0
Cyathura polita	Isopod	1	0	0	2	3	1
Edotia triloba	Isopod	13	7	2	4	7	3
Leptocheirus plumulosus	Amphipod	1	0	0	0	0	0
Cymadusa compta	Amphipod	0	0	0	0	0	1
Grandidierella japonica	Amphipod	5	0	0	2	0	1
Ameroculodes spp. complex	Amphipod	0	0	0	2	1	0
Apocorophium acutum	Amphipod	0	2	0	0	0	0

Species Collected		Number					
Scientific Name	**Common Name**	**NSB-01**	**NSB-02**	**NSB-03**	**NSB-04**	**NSB-05**	**NSB-06**
Melita nitida	Amphipod	0	1	0	0	0	0
Eurypanopeus depressus	Flatback mud crab	0	2	0	0	0	0
Ogyrides alphaerostris	Estuarine longeye shrimp	0	0	0	0	1	0
Diptera larva	Insects	0	0	0	0	0	1
Chironomidae larva	Midge	0	2	0	0	0	1

Note:
Bold values represent the dominant species at each location.

Table 8
Benthic Community Data: Proposed Southern Sand Borrow Area

Species Collected		Abundance (Organisms/m^2)									
Scientific Name	**Common Name**	**SSB-01**	**SSB-02**	**SSB-03**	**SSB-04**	**SSB-05**	**SSB-06**	**SSB-07**	**SSB-08**	**SSB-09**	**SSB-10**
Edwardsia elegans	Burrowing anemone	1	1	0	0	0	0	1	0	3	0
Carinoma tremaphoros	Round worm	4	2	1	5	0	1	1	5	1	0
Stylochus ellipticus	Flatworm	1	0	0	0	0	1	1	1	1	1
Fragilonemertes rosea	Ribbon worm	17	14	6	17	3	14	13	10	10	11
Podarkeopsis levifuscina	Segmented worm	0	0	0	0	0	0	0	0	0	1
Amphiporus bioculatus	Round worm	1	0	0	2	0	0	0	0	0	0
Hypereteone foliosa	Paddleworm	2	1	1	1	0	0	1	1	2	0
Hermundura americana	Segmented worm	0	0	0	0	0	0	2	1	0	0
Alitta succinea	Pile worm	5	3	10	12	44	7	45	39	15	27
Glycinde multidens	Segmented worm	**81**	60	53	73	72	**79**	99	58	81	69
Leitoscoloplos robustus	Segmented worm	0	0	0	0	0	1	0	0	0	0
Leitoscoloplos sp. indeterminate	Segmented worm	0	0	0	0	0	1	1	0	1	0
Polydora cornuta	Whip mudworm	0	0	0	0	1	0	0	0	0	0
Paraonis fulgens	Segmented worm	11	0	1	2	0	1	24	3	1	11
Marenzelleria viridis	Segmented worm	2	1	3	2	3	5	17	7	0	2
Spiophanes bombyx complex	Bristle worm	0	0	0	1	0	0	0	0	0	0
Paraprionospio treadwelli	Segmented worm	10	10	6	13	1	6	2	7	9	1
Streblospio benedicti	Ram's horn worm	1	0	1	2	21	3	11	8	1	4
Spiochaetopterus oculatus	Segmented worm	0	0	1	1	0	0	0	0	2	0
Heteromastus filiformis	Bristle worm	23	4	17	33	29	7	39	66	21	43
Mediomastus ambiseta	Segmented worm	14	19	36	39	**147**	48	30	35	72	7
Pectinaria gouldii	Trumpet worm	2	0	4	3	1	3	0	0	2	0

Species Collected		Abundance (Organisms/m²)									
Scientific Name	Common Name	SSB-01	SSB-02	SSB-03	SSB-04	SSB-05	SSB-06	SSB-07	SSB-08	SSB-09	SSB-10
Loimia medusa	Spaghetti worm	0	1	0	0	0	0	0	0	0	0
Gyroscala rupicola	Brown-band wentletrap	2	0	0	1	0	0	0	0	0	0
Tubificoides spp.	Segmented worms	0	0	0	0	7		9	0	0	0
Eulimastoma engonium	Needle odostome	1	2	1	2	3	3	2	0	1	1
Pyramidellidae sp.	Pitted baby-bubble	0	0	1	0	0	0	0	0	0	0
Japonactaeon punctostriatus	Gastropod	16	9	13	21	8	9	1	2	15	3
Acteocina canaliculata	Gastropod	53	32	47	44	42	48	21	24	22	10
Haminella solitaria	Gastropod	20	6	19	13	3	13	22	23	37	52
Arcuatula papyria	Atlantic paper mussel	1	0	1	0	2	1	1	0	1	1
Parvilucina crenella	Many lined lucine	0	1	0	3	0	0	0	0	0	0
Mulinia lateralis	Dwarf surf clam	5	13	5	11	11	6	5	2	5	14
Ameritella mitchelli	Mitchell macoma	67	**62**	**63**	**107**	112	63	**125**	**208**	**84**	**86**
Macoma petalum	Atlantic macoma	0	0	0	0	2	0	0	0	0	1
Tagelus plebeius	Stout razor clam	0	1	0	0	3	0	7	2	0	1
Gemma	Amethyst gem clam	2	0	0	4	11	1	52	19	3	45
Neomysis americana	Opossum shrimp	0	0	0	0	1	0	0	0	0	0
Lyonsia hyalina	Bivalve mollusks	1	0	0	0	0	0	0	0	0	0
Americamysis almyra	Mysid shrimp	1	3	0	6	5	0	7	3	2	6
Edotia triloba	Isopod	0	0	0	1	2	1	0	0	0	0
Crangon septemspinosa	Sand shrimp	0	0	0	0	0	1	0	0	0	0
Ameroculodes spp. complex	Amphipod	4	0	0	5	1	0	4	1	0	5
Phoronis psammophila	Horseshoe worm	11	2	0	6	0	0	7	0	5	0

Note:
Bold values represent the dominant species at each location.

3.2 Chesapeake Bay Benthic Index of Biotic Integrity

The total B-IBI score for each location is derived by averaging individual scores for each metric. A summary of the benthic community metrics and scores used to calculate the Chesapeake Bay B-IBI is presented in Table 5. Only species that met the Chesapeake Bay B-IBI macrofaunal criteria (Versar 2002) were included in the calculation.

Based on the salinities at the time of sampling, the proposed Barren Island sand borrow locations were classified as high mesohaline sand habitats. Six benthic community metrics (i.e., total abundance, Shannon Wiener species diversity index, biomass, percent abundance of stress-indicative taxa, percent abundance of stress-sensitive taxa, and percent abundance of carnivores and omnivores; Table 5) were used to calculate the B-IBI.

3.2.1 Proposed Northern Sand Borrow Area

For the six locations in the proposed northern sand borrow area (Table 9), scoring was calculated as follows:

- For total abundance, each of the locations received a score of 1.
- For the Shannon-Wiener species diversity index, one location (NSB-05) received a score of 5, four locations (NSB-02, NSB-03, NSB-04, and NSB-06) received a score of 3, and one location received a score of 1 (NSB-01).
- For biomass, five locations (NSB-01, NSB-03, NSB-04, NSB-05, and NSB-06) received a score of 3, and one location received a score of 5 (NSB-02).
- For percent abundance of stress-indicative taxa, each of the locations received a score of 5.
- For percent abundance of stress-sensitive taxa, five locations (NSB-01, NSB-02, NSB-03, NSB-04, and NSB-06) received a score of 3, and one location received a score of 1 (NSB-05).
- For percent abundance of carnivores and omnivores, each location received a score of 1.

The scores for each of the metrics at each location in the proposed northern sand borrow area were averaged to determine the total Chesapeake Bay B-IBI for each location. Scores of 3 or greater met the Chesapeake Bay RGI.

Five of the six locations in the proposed northern borrow area were classified as degraded, with B-IBIs that ranged from 2.3 to 2.67 (Table 9). Location NSB-02 was the only location that met the Chesapeake Bay RGI, with a B-IBI of 3.

3.2.2 Proposed Southern Sand Borrow Area

For the 10 locations in the proposed southern sand borrow area (Table 10), scoring was calculated as follows:

- For total abundance, one location (SSB-02) received a score of 3, and nine of the locations (SSB-01, SSB-03, SSB-04, SSB-05, SSB-06, SSB-7, SSB-8, SSB-09, and SSB-10) received a score of 1.
- For the Shannon-Wiener species diversity index, four of the locations (SSB-02, SSB-05, SSB-06, and SSB-8) received a score of 3, and six of the locations (SSB-01, SSB-03, SSB-04, SSB-7, SSB-09, and SSB-10) received a score of 1.
- For biomass, three of the locations (SSB-04, SSB-07, and SSB-8) received a score of 5, and seven of the locations (SSB-01, SSB-02, SSB-03, SSB-05, SSB-06, SSB-09, and SSB-10) received a score of 3.
- For percent abundance of stress-indicative taxa, each of the locations received a score of 5.
- For percent abundance of stress-sensitive taxa, one location (SSB-10) received a score of 5, and nine of the locations (SSB-01, SSB-02, SSB-03, SSB-04, SSB-05, SSB-06, SSB-07, SSB-08, and SSB-09) received a score of 3.
- For percent abundance of carnivores and omnivores, four of the locations (SSB-01, SSB-02, SSB-03, and SSB-06) received a score of 5, and six of the locations (SSB-04, SSB-05, SSB-07, SSB-08, SSB-09, and SSB-10) received a score of 3.

The scores for each of the metrics at each location for the proposed southern sand borrow area were averaged to determine the total Chesapeake Bay B-IBI for each location. Scores of 3 or greater met the Chesapeake Bay RGI.

Nine of the 10 locations in the proposed southern borrow area (SSB-01, SSB-02, SSB-03, SSB-04, SSB-05, SSB-06, SSB-07, SSB-08, and SSB-10), met the Chesapeake Bay RGI, with B-IBIs ranging from 3 to 3.67 (Table 10). One location (SSB-09) was classified as degraded, with a B-IBI of 2.67.

3.2.3 Chesapeake Bay Long-Term Benthic Monitoring Locations

Long-term benthic monitoring has also been part of Maryland's Water Quality Monitoring Program for the Chesapeake Bay since 1984. Currently, 48 sites within Chesapeake Bay are monitored annually by the Chesapeake Bay Benthic Monitoring Program to assess whether the benthic community condition is changing (Versar 2023).

Data for 2015 through 2021 were downloaded from the Chesapeake Bay Benthic Monitoring Program website (Versar 2023) for comparison to the Barren Island benthic community B-IBI calculations. Three high mesohaline sand locations in the mainstem portion of the Chesapeake Bay (locations 001, 006, and 015) are included in the annual Chesapeake Bay Benthic Monitoring

Program, and data from these locations were selected as most representative of the conditions at the proposed Barren Island sand borrow area. B-IBI calculations for these long-term monitoring locations from 2015 through 2019 are presented in Table 11.

The 7-year averages for the B-IBI for the high mesohaline sand monitoring locations were 2.9 (location 001), 2.8 (location 006), and 2.2 (location 015), with B-IBI scores of marginal (locations 001 and 006) and degraded (location 015). In general, the B-IBI scores from the proposed northern borrow area were similar to other mainstem Chesapeake Bay high mesohaline sand habitats, and the B-IBI scores from the proposed southern borrow area were slightly higher. It is important to note that benthic habitat can be highly variable from year to year, depending on Bay-wide and local conditions, as evidenced by the annual changes in the B-IBI scores for the mainstem Chesapeake Bay locations.

Table 9
Chesapeake Bay Benthic Index of Biotic Integrity Scoring for Barren Island Proposed Northern Sand Borrow Sites

Metric	NSB-01		NSB-02		NSB-03		NSB-04		NSB-05		NSB-06	
	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score
Salinity regime	High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand	
Shannon-Weiner species diversity index	2.7	1	3.0	3	2.6	3	2.5	3	2.3	5	2.5	3
Total abundance/m²	30,100	1	16,877	1	21,431	1	15,939	1	49,885	1	26,904	1
Biomass/m²	1.2	3	3.4	5	1.7	3	1.6	3	2.2	3	1.8	3
Percent abundance stress-indicative species	3.0	5	6.0	5	4.2	5	6.0	5	3.5	5	4.2	5
Percent abundance stress-sensitive species	46.2	3	14.0	3	21.0	3	11.5	3	42.0	1	29.5	3
Percent abundance carnivores and omnivores	10.5	1	18.6	1	14.1	1	13.8	1	7.94	1	14.1	1
B-IBI	2.3		3		2.67		2.67		2.67		2.67	
Restoration goal	Degraded		Meets restoration goal		Degraded		Degraded		Degraded		Degraded	

Note:
B-IBI scores: ≥3.0 = meets restoration goals; 2.7–2.9 = marginal; 2.1–2.6 = degraded; ≤2.0 = severely degraded

Table 10
Chesapeake Bay Benthic Index of Biotic Integrity Scoring for Barren Island Proposed Southern Sand Borrow Sites

Metric	SSB-01		SSB-02		SSB-03		SSB-04		SSB-05		SSB-06		SSB-07		SSB-08		SSB-09		SSB-10	
	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score
Salinity regime	High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand		High mesohaline sand	
Shannon-Weiner species diversity index	3.6	1	3.1	3	3.2	1	3.5	1	3.1	3	3.2	3	3.6	1	3.0	3	3.3	1	3.4	1
Total abundance/m²	6,889	1	4,631	3	5,492	1	8,056	1	9,950	1	6,066	1	10,333	1	9,912	1	7,520	1	7,616	1
Biomass/m²	1.1	3	2.1	3	1.8	3	3.3	5	2.5	3	2.2	3	3.3	5	3.3	5	2.5	3	2.8	3
Percent abundance stress-indicative species	1.7	5	5.4	5	2.1	5	3.1	5	6.2	5	3.2	5	3.0	5	1.9	5	1.5	5	4.5	5
Percent abundance stress-sensitive species	22.2	3	23.1	3	30.0	3	21.9	3	37.5	3	31.9	3	15.2	3	13.1	3	25.2	3	5.0	5
Percent abundance carnivores and omnivores	39.4	5	39.7	5	38.7	5	30.9	3	30.4	3	42.3	5	31.1	3	23.8	3	30.5	3	26.9	3
B-IBI	3		3.67		3		3		3		3.33		3		3.33		2.67		3	
Restoration goal	Meets restoration goals		Meets restoration goals		Meets restoration goals		Meets restoration goals		Meets restoration goals		Meets restoration goals		Meets restoration goals		Meets restoration goals		Degraded		Meets restoration goals	

Note:
B-IBI Scores: ≥3.0 = meets restoration goals; 2.7–2.9 = marginal; 2.1–2.6 = degraded; ≤2.0 = severely degraded

Table 11
Chesapeake Bay Benthic Index of Biotic Integrity Scores for the Chesapeake Bay High Mesohaline Sand Long-Term Benthic Monitoring Locations

Year	High Mesohaline Sand Monitoring Locations		
	Mid-Bay (Mainstem—001)	Mid-Bay (Mainstem—006)	Mid-Bay (Mainstem—015)
2015	3.7 (Meets restoration goals)	3.6 (Meets restoration goals)	2.7 (Marginal)
2016	3.0 (Meets restoration goals)	3.4 (Meets restoration goals)	1.8 (Severely Degraded)
2017	3.3 (Meets restoration goals)	3.0 (Meets restoration goals)	2.48 (Degraded)
2018	3.0 (Meets restoration goals)	3.0 (Meets restoration goals)	2.7 (Marginal)
2019	2.1 (Degraded)	2.4 (Degraded)	2.7 (Marginal)
2020	1.9 (Severely degraded)	1.9 (Severely degraded)	1.4 (Severely degraded)
2021	3.1 (Meets restoration goals)	2 (Severely degraded)	1.7 (Severely degraded)
Average B-IBI for 2015 to 2021	2.9 (Marginal)	2.8 (Marginal)	2.2 (Degraded)

Note:
Chesapeake Bay Benthic Monitoring Program (Versar 2023)

4 References

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Appendix B
Benthic Community Samples—Replicate Results

Table B-1
Barren Island Sand Borrow Areas—Northern Borrow Area
Benthic Community Counts and Biomass—NSB-01

Species List	Class	NSB-01 Abundance			NSB-01 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	--	2	--	--	0.0004	--
Carinoma tremaphoros	Palaeonemertea	--	--	3	--	--	0.0008
Amphiporus bioculatus	Hoplonemertea	--	3	--	--	0.0007	--
Hypereteone foliosa	Polychaeta	1	--	--	0.0001	--	--
Hermundura americana	Polychaeta	3	3	5	0.0067	0.0002	0.0003
Alitta succinea	Polychaeta	9	4	4	0.0138	0.0036	0.0074
Glycinde multidens	Polychaeta	25	31	38	0.0037	0.0036	0.0036
Leitoscoloplos robustus	Polychaeta	1	--	fragment	0.0086	--	0.0024
Polydora cornuta	Polychaeta	5	1		0.00005[a]	0.00005[a]	--
Polydora websteri	Polychaeta	10	--	--	0.0004	--	--
Marenzelleria viridis	Polychaeta	5	3	2	0.0053	0.0032	0.0025
Paraprionospio treadwelli	Polychaeta	1	1	1	0.00005[a]	0.0005	0.0005
Streblospio benedicti	Polychaeta	1	3	--	0.00005[a]	0.00005[a]	--
Heteromastus filiformis	Polychaeta	4	1	4	0.0018	0.0005	0.0009
Mediomastus ambiseta	Polychaeta	246	184	230	0.0063	0.0035	0.0057
Tubificoides spp.	Clitellata	2	8	2	0.0002	0.0002	0.00005[a]
Eulimastoma engonium	Gastropoda	10	1	5	0.0006	0.0002	0.0001
Japonactaeon punctostriatus	Gastropoda	65	50	41	0.0012	0.0008	0.0005
Acteocina canaliculata	Gastropoda	18	10	13	0.0011	0.001	0.0007
Arcuatula papyria	Bivalvia	2	--	--	0.0002	--	--
Geukensia demissa	Bivalvia	1	--	--	0.00005[a]	--	--
Mulinia lateralis	Bivalvia	9	15	19	0.0075	0.0095	0.03
Ameritella mitchelli	Bivalvia	114	100	89	0.0045	0.0054	0.007
Tagelus plebeius	Bivalvia	7	4	4	0.0003	0.0001	0.00005[a]
Gemma gemma	Bivalvia	55	59	56	0.0048	0.0054	0.0046
Petricolaria pholadiformis	Bivalvia	1	--	--	0.00005[a]	--	--
Amphibalanus improvisus	Hexanauplia	1	--	--	0.0084	--	--
Americamysis almyra	Malacostraca	2	4	1	0.0001	0.0006	0.0002
Cyathura polita	Malacostraca	1	--	--	0.0009	--	--
Edotia triloba	Malacostraca	5	4	4	0.0003	0.0002	0.0003
Leptocheirus plumulosus	Malacostraca	1	--	--	0.00005[a]	--	--
Grandidierella japonica	Malacostraca	3	1	1	0.0004	0.0002	0.0001

Total Number of Individuals	--	**608**	**492**	**522**
Total number of taxa (excludes fragments of a taxon)	--	**29**	**22**	**19**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-2

Barren Island Sand Borrow Areas—Northern Borrow Area

Benthic Community Counts and Biomass—NSB-02

Species List	Class	NSB-02 Abundance			NSB-02 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Diadumene leucolena	Anthozoa	10	--	--	0.0456	--	--
Carinoma tremaphoros	Palaeonemertea	--	1	--	--	0.0001	--
Amphiporus bioculatus	Hoplonemertea	1	--	--	0.0004	--	--
Hypereteone foliosa	Polychaeta	--	1	--	--	0.0044	--
Nereiphylla castanea	Polychaeta	2	--	--	REF[b]	--	--
Hermundura americana	Polychaeta	3	3	1	0.0003	0.0005	0.0004
Alitta succinea	Polychaeta	25	1		0.0263	0.0019	
Glycinde multidens	Polychaeta	28	28	21	0.0039	0.0041	0.0029
Leitoscoloplos sp. indeterminate	Polychaeta	2	--	--	0.0002	--	--
Polydora cornuta	Polychaeta	26	--	--	0.0009	--	--
Polydora websteri	Polychaeta	306	--	--	0.0125	--	--
Marenzelleria viridis	Polychaeta	1	--	1	0.0007	--	0.0008
Paraprionospio treadwelli	Polychaeta	1	--	--	0.0003	--	--
Streblospio benedicti	Polychaeta	2	--	1	0.00005[a]	--	0.0001
Heteromastus filiformis	Polychaeta	5	4	7	0.0016	0.0011	0.0019
Mediomastus ambiseta	Polychaeta	29	15	22	0.0005	0.0005	0.0006
Eulimastoma engonium	Gastropoda	4	2	--	0.0003	0.0001	--
Japonactaeon punctostriatus	Gastropoda	66	26	29	0.001	0.0004	0.0005
Acteocina canaliculata	Gastropoda	17	18	14	0.0012	0.002	0.0012
Haminella solitaria	Gastropoda	4	3	1	0.00005[a]	0.0001	0.0001
Arcuatula papyria	Bivalvia	--	--	1	--	--	0.00005[a]
Geukensia demissa	Bivalvia	12	--	--	0.0012	--	--
Crassostrea virginica	Bivalvia	2	--	--	0.3823	--	--
Mulinia lateralis	Bivalvia	32	9	9	0.0078	0.0007	0.008
Ameritella mitchelli	Bivalvia	194	83	81	0.0135	0.0142	0.0041
Tagelus plebeius	Bivalvia	4	1		0.0003	0.0002	--
Gemma gemma	Bivalvia	26	11	9	0.005	0.0003	0.0017
Cyrtopleura costata	Bivalvia	--	1	--	--	0.0001	--
Teredinidae sp.	Bivalvia	2	--	--	REF[b]	--	--
Amphibalanus improvisus	Hexanauplia	4		3	0.1555	--	0.0034
Americamysis almyra	Malacostraca	7	2		0.0004	0.0002	--
Edotia triloba	Malacostraca	5		2	0.0002		0.0002
Apocorophium acutum	Malacostraca	2	--	--	0.00005[a]	--	--
Melita nitida	Malacostraca	1	--	--	0.0002	--	--
Eurypanopeus depressus	Malacostraca	2	--	--	0.0081	--	--
Chironomidae larva	Insecta	2	--	--	0.0003	--	--

Total Number of Individuals	--	**827**	**209**	**202**
Total number of taxa (excludes fragments of a taxon)	--	**32**	**17**	**15**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

b) Samples were vouchered by Cove Corp. No samples were provided for biomass analysis

-- : no data

AFDW: ash free dry weight

g: gram

Table B-3
Barren Island Sand Borrow Areas—Northern Borrow Area
Benthic Community Counts and Biomass—NSB-03

Species List	Class	NSB-03 Abundance			NSB-03 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	--	1	--	--	0.0001	--
Stylochus ellipticus	Rhabditophora	--	--	1	--	--	0.0004
Carinoma tremaphoros	Palaeonemertea	--	--	1	--	--	0.00005[a]
Amphiporus bioculatus	Hoplonemertea	--	--	1	--	--	0.0001
Hermundura americana	Polychaeta	1	1	3	0.0005	0.0003	0.0005
Alitta succinea	Polychaeta	1	--	--	0.00005[a]	--	--
Glycinde multidens	Polychaeta	33	32	36	0.0067	0.0077	0.0069
Marenzelleria viridis	Polychaeta	1	--	--	0.0013	--	--
Paraprionospio treadwelli	Polychaeta	1	1	1	0.00005[a]	0.0002	0.0004
Streblospio benedicti	Polychaeta	2	--	3	0.0001	--	0.0002
Heteromastus filiformis	Polychaeta	--	1	--	--	0.0004	
Mediomastus ambiseta	Polychaeta	74	30	57	0.0011	0.0005	0.0012
Pectinaria gouldii	Polychaeta	1	--	--	0.00005[a]	--	--
Tubificoides spp.	Clitellata	1	--	--	0.00005[a]	--	--
Eulimastoma engonium	Gastropoda	1	--	2	0.00005[a]	--	0.0004
Japonactaeon punctostriatus	Gastropoda	128	78	89	0.002	0.0013	0.0019
Acteocina canaliculata	Gastropoda	25	12	14	0.0028	0.0005	0.0014
Haminella solitaria	Gastropoda	2	3	5	0.0001	0.00005[a]	0.0003
Arcuatula papyria	Bivalvia	--	1	--	--	0.0001	--
Mulinia lateralis	Bivalvia	18	8	16	0.0082	0.0058	0.0039
Ameritella mitchelli	Bivalvia	144	137	123	0.0087	0.0107	0.0083
Tagelus plebeius	Bivalvia	5	8	8	0.00005[a]	0.0002	0.0002
Gemma gemma	Bivalvia	6	2	4	0.0004	0.0001	0.0012
Cyrtopleura costata	Bivalvia	--	--	1	--	--	REF[b]
Americamysis almyra	Malacostraca	4	1	2	0.0004	0.0003	0.0008
Edotia triloba	Malacostraca	--	2	--	--	0.0001	--

Total Number of Individuals	--	**448**	**318**	**367**
Total number of taxa (excludes fragments of a taxon)	--	**18**	**16**	**18**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

b) Samples were vouchered by Cove Corp. No samples were provided for biomass analysis

-- : no data

AFDW: ash free dry weight

g: gram

Table B-4
Barren Island Sand Borrow Areas—Northern Borrow Area
Benthic Community Counts and Biomass—NSB-04

Species List	Class	NSB-04 Abundance			NSB-04 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	1	--	--	0.00005[a]	--	--
Carinoma tremaphoros	Palaeonemertea	2	2	1	0.0004	0.0004	0.0003
Amphiporus bioculatus	Hoplonemertea	--	--	1	--	--	0.00005[a]
Hermundura americana	Polychaeta	2	3	1	0.0004	0.0004	0.0002
Alitta succinea	Polychaeta	1	--	--	0.0064	--	--
Glycinde multidens	Polychaeta	31	14	27	0.0031	0.0025	0.0028
Marenzelleria viridis	Polychaeta		1	4		0.0009	0.0026
Paraprionospio treadwelli	Polychaeta	3	--	--	0.0012	--	--
Heteromastus filiformis	Polychaeta	--	--	3	--	--	0.0002
Mediomastus ambiseta	Polychaeta	10	24	11	0.0002	0.0006	0.0002
Pectinaria gouldii	Polychaeta	--	--	1	--	--	0.00005[a]
Gyroscala rupicola	Gastropoda	--	1	--	--	0.0002	--
Eulimastoma engonium	Gastropoda	1	--	1	0.0001	--	0.00005[a]
Japonactaeon punctostriatus	Gastropoda	85	29	53	0.0012	0.0007	0.0008
Acteocina canaliculata	Gastropoda	17	7	10	0.0015	0.0007	0.0007
Haminella solitaria	Gastropoda	3	2	1	0.0001	0.0001	0.00005[a]
Mulinia lateralis	Bivalvia	21	20	9	0.0172	0.0082	0.0065
Ameritella mitchelli	Bivalvia	151	107	135	0.0044	0.007	0.0042
Macoma petalum	Bivalvia	1	--	--	0.0012	--	--
Tagelus plebeius	Bivalvia	4	1	5	0.0002	0.0001	0.00005[a]
Gemma gemma	Bivalvia	7	8	7	0.0007	0.0008	0.0008
Americamysis almyra	Malacostraca	--	2	--	--	0.0001	--
Cyclaspis varians	Malacostraca	--	--	1	--	--	0.0001
Cyathura polita	Malacostraca	--	--	2	--	--	0.0006
Edotia triloba	Malacostraca	3	1		0.0002	0.0001	--
Grandidierella japonica	Malacostraca	1	--	1	0.0002	--	0.00005[a]
Ameroculodes spp. complex	Malacostraca	1	--	1	0.0003	--	0.00005[a]

Total Number of Individuals	--	**345**	**222**	**275**
Total number of taxa (excludes fragments of a taxon)	--	**19**	**15**	**20**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-5
Barren Island Sand Borrow Areas—Northern Borrow Area
Benthic Community Counts and Biomass—NSB-05

Species List	Class	NSB-05 Abundance			NSB-05 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	1	--	--	0.0001	--	--
Carinoma tremaphoros	Palaeonemertea	3	1	1	0.0016	0.0004	0.00005[a]
Amphiporus bioculatus	Hoplonemertea	--	--	1	--	--	0.00005[a]
Hermundura americana	Polychaeta	2	5	3	0.0003	0.0003	0.0001
Alitta succinea	Polychaeta	2	--	1	0.0003	--	0.0002
Glycinde multidens	Polychaeta	48	53	56	0.0114	0.0089	0.0055
Leitoscoloplos sp. indeterminate	Polychaeta	--	1	--	--	0.0001	--
Polydora cornuta	Polychaeta	--	1	--	--	0.00005[a]	--
Marenzelleria viridis	Polychaeta	1	1	4	0.0005	0.0006	0.002
Paraprionospio treadwelli	Polychaeta	1	--	1	0.0017		0.00005[a]
Streblospio benedicti	Polychaeta	8	28	10	0.00005[a]	0.0003	0.0001
Heteromastus filiformis	Polychaeta	--	--	1	--	--	0.00005[a]
Mediomastus ambiseta	Polychaeta	187	528	321	0.0024	0.0057	0.0044
Pectinaria gouldii	Polychaeta	--	1	--	--	0.0002	--
Eulimastoma engonium	Gastropoda	1	1	1	0.0002	0.00005	0.0001
Japonactaeon punctostriatus	Gastropoda	239	192	194	0.0049	0.0037	0.0031
Acteocina canaliculata	Gastropoda	9	10	14	0.0009	0.0008	0.0012
Haminella solitaria	Gastropoda	--	3	8	--	0.0002	0.001
Cratena pilata	Gastropoda	--	--	1	--	--	0.0003
Mulinia lateralis	Bivalvia	18	14	13	0.0089	0.005	0.0049
Ameritella mitchelli	Bivalvia	191	219	178	0.0068	0.0093	0.0046
Macoma petalum	Bivalvia		1	2		0.0008	0.0027
Tagelus plebeius	Bivalvia	11	2	2	0.0005	0.0003	0.00005[a]
Gemma gemma	Bivalvia	5	3	4	0.0007	0.0002	0.0003
Cyrtopleura costata	Bivalvia	--	--	2	--	--	0.0001
Americamysis almyra	Malacostraca	--	1	4	--	0.0006	0.0003
Cyathura polita	Malacostraca	1	1	1	0.0008	0.0007	0.0003
Edotia triloba	Malacostraca	2	--	5	0.0003		0.0003
Ameroculodes spp. complex	Malacostraca	--	--	1	--	--	0.0002
Ogyrides alphaerostris	Malacostraca	--	1	--	--	0.0003	--

Total Number of Individuals	--	**730**	**1,067**	**829**
Total number of taxa (excludes fragments of a taxon)	--	**181**	**21**	**25**

Notes:

a) AFDW biomass value was less than 0.0001 g(detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-6
Barren Island Sand Borrow Areas—Northern Borrow Area
Benthic Community Counts and Biomass—NSB-06

Species List	Class	NSB-06 Abundance			NSB-06 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	Palaeonemertea	1	--	--	0.0007	--	--
Podarkeopsis levifuscina	Polychaeta	1	--	--	0.00005	--	--
Hermundura americana	Polychaeta	2	12	1	0.0001	0.0007	0.0004
Glycinde multidens	Polychaeta	45	60	52	0.0109	0.0134	0.0093
Marenzelleria viridis	Polychaeta	2	2	4	0.0012	0.0006	0.0012
Paraprionospio treadwelli	Polychaeta	1	1	--	0.0006	0.0009	--
Streblospio benedicti	Polychaeta	4	12	--	0.0001	0.0001	--
Mediomastus ambiseta	Polychaeta	61	222	89	0.0019	0.0028	0.0011
Loimia medusa	Polychaeta	1	--	--	0.0002	--	--
Tubificoides spp.	Clitellata	--	3	--	--	0.00005[a]	--
Gyroscala rupicola	Gastropoda	1	--	--	0.0002	--	--
Eulimastoma engonium	Gastropoda	4	6	2	0.0004	0.0005	0.0002
Japonactaeon punctostriatus	Gastropoda	82	108	51	0.0015	0.0019	0.0007
Acteocina canaliculata	Gastropoda	10	5	8	0.0008	0.0003	0.0006
Haminella solitaria	Gastropoda	2	4	3	0.00005[a]	0.0001	0.00005[a]
Mulinia lateralis	Bivalvia	15	18	10	0.0065	0.0071	0.0033
Ameritella mitchelli	Bivalvia	158	181	147	0.0085	0.0068	0.0051
Tagelus plebeius	Bivalvia	1	6	2	0.00005[a]	0.0002	0.0001
Gemma gemma	Bivalvia	8	2	4	0.0009	0.00005[a]	0.0003
Americamysis almyra	Malacostraca	5	2	2	0.0011	0.00005[a]	0.0003
Cyathura polita	Malacostraca	1	--	--	0.00005[a]	--	--
Edotia triloba	Malacostraca	--	3	--	--	0.0001	--
Cymadusa compta	Malacostraca	--	--	1	--	--	0.0003
Grandidierella japonica	Malacostraca	--	1	--	--	0.00005[a]	--
Diptera larva	Insecta	--	--	1	--	--	0.0002
Chironomidae larva	Insecta	--	--	1	--	--	0.0001
Total Number of Individuals	--	**405**	**648**	**378**			
Total number of taxa (excludes fragments of a taxon)	--	**20**	**18**	**16**			

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-7
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-01

Species List	Class	SSB-01 Abundance			SSB-01 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	--	1	--	--	0.0002	--
Stylochus ellipticus	Rhabditophora	1	--	--	0.0003	--	--
Carinoma tremaphoros	Palaeonemertea	--	2	2	--	0.0009	0.0001
Fragilonemertes rosea	Pilidiophora	7	5	5	0.0047	0.0303	0.0059
Amphiporus bioculatus	Hoplonemertea	--	--	1	--	--	0.0001
Hypereteone foliosa	Polychaeta	2	--	--	0.0019	--	--
Alitta succinea	Polychaeta	3	1	1	0.0015	0.0003	0.0004
Glycera dibranchiata	Polychaeta	--	--	1	--	--	0.0039
Glycinde multidens	Polychaeta	36	25	20	0.0034	0.0017	0.0021
Paraonis fulgens	Polychaeta	4	4	3	0.00005[a]	0.0002	0.00005[a]
Marenzelleria viridis	Polychaeta	--	2	--	--	0.0017	--
Paraprionospio treadwelli	Polychaeta	4	2	4	0.0006	0.0009	0.001
Streblospio benedicti	Polychaeta	1	--	--	0.00005[a]	--	--
Spiochaetopterus oculatus	Polychaeta	2	1	--	0.0004	0.0002	--
Heteromastus filiformis	Polychaeta	8	8	7	0.0022	0.0015	0.0019
Mediomastus ambiseta	Polychaeta	8	6	--	0.0001	0.0002	--
Pectinaria gouldii	Polychaeta	1	1	--	0.0001	0.00005[a]	--
Gyroscala rupicola	Gastropoda	--	1	1	--	0.0003	0.00005[a]
Eulimastoma engonium	Gastropoda	1	--	--	0.0001	--	--
Japonactaeon punctostriatus	Gastropoda	5	4	7	0.0002	0.00005[a]	0.0003
Acteocina canaliculata	Gastropoda	15	19	19	0.0024	0.0031	0.0037
Haminella solitaria	Gastropoda	12	2	6	0.0038	0.0003	0.0016
Arcuatula papyria	Bivalvia	--	--	1	--	--	0.00005[a]
Mulinia lateralis	Bivalvia	2	2	1	0.0042	0.0048	0.0152
Ameritella mitchelli	Bivalvia	33	22	12	0.0027	0.0085	0.0013
Gemma gemma	Bivalvia	2	--	--	0.0015	--	--
Lyonsia hyalina	Bivalvia	--	--	1	--	--	0.00005[a]
Americamysis almyra	Malacostraca	--	1	--	--	0.0003	--
Ameroculodes spp. complex	Malacostraca	2	2	--	0.0003	0.0002	--
Phoronis psammophila	Unassigned	4	4	3	0.0006	0.0005	0.0009

Total Number of Individuals	--	**153**	**115**	**95**
Total number of taxa (excludes fragments of a taxon)	--	**21**	**21**	**18**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-8
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-02

Species List	Class	SSB-02 Abundance			SSB-02 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	--	1	--	--	0.0005	--
Carinoma tremaphoros	Palaeonemertea	--	1	1	--	0.0001	0.0001
Fragilonemertes rosea	Pilidiophora	9	1	4	0.0275	0.0015	0.0053
Hypereteone foliosa	Polychaeta	1	--	--	0.0007	--	--
Alitta succinea	Polychaeta	2	1	--	0.0005	0.0006	--
Glycinde multidens	Polychaeta	19	24	17	0.0013	0.0022	0.0013
Marenzelleria viridis	Polychaeta	--	1	--	--	0.0001	--
Paraprionospio treadwelli	Polychaeta	5	2	3	0.0017	0.0002	0.001
Heteromastus filiformis	Polychaeta	2	1	1	0.0003	0.0001	0.0005
Mediomastus ambiseta	Polychaeta	9	4	6	0.0002	0.0001	0.0001
Loimia medusa	Polychaeta	--	--	1	--	--	0.0001
Eulimastoma engonium	Gastropoda	1	1	--	0.00005[a]	0.00005[a]	--
Japonactaeon punctostriatus	Gastropoda	3	5	1	0.0001	0.0001	0.00005[a]
Acteocina canaliculata	Gastropoda	11	12	9	0.0011	0.0008	0.0004
Haminella solitaria	Gastropoda	3	2	1	0.0012	0.0009	0.0002
Parvilucina crenella	Bivalvia	--	--	1	--	--	0.0003
Mulinia lateralis	Bivalvia	9	3	1	0.026	0.0097	0.0083
Ameritella mitchelli	Bivalvia	20	31	11	0.0101	0.0023	0.0022
Tagelus plebeius	Bivalvia	1	--	--	0.00005[a]	--	--
Americamysis almyra	Malacostraca	--	1	2	--	0.0004	0.0005
Phoronis psammophila	Unassigned	--	2	--	--	0.00005[a]	--

Total Number of Individuals	--	**95**	**93**	**59**
Total number of taxa (excludes fragments of a taxon)	--	**14**	**17**	**14**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-9
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-03

Species List	Class	SSB-03 Abundance			SSB-03 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	Palaeonemertea	--	1	--	--	0.00005[a]	--
Fragilonemertes rosea	Pilidiophora	1	frag.	5	0.0011	0.0005	0.0169
Hypereteone foliosa	Polychaeta	--	--	1	--	--	0.0001
Alitta succinea	Polychaeta	3	1	6	0.00005[a]	0.0004	0.0031
Glycinde multidens	Polychaeta	24	10	19	0.0018	0.0007	0.0033
Paraonis fulgens	Polychaeta	--	--	1	--	--	0.00005[a]
Marenzelleria viridis	Polychaeta	1	--	2	0.00005[a]	--	0.0019
Paraprionospio treadwelli	Polychaeta	3	3	--	0.0006	0.0012	--
Streblospio benedicti	Polychaeta	1	--	--	0.0001	--	--
Spiochaetopterus oculatus	Polychaeta	1	--	--	0.00005[a]	--	--
Heteromastus filiformis	Polychaeta	7	6	4	0.0022	0.0025	0.0015
Mediomastus ambiseta	Polychaeta	8	2	26	0.0001	0.00005[a]	0.0004
Pectinaria gouldii	Polychaeta	2	1	1	0.0002	0.00005[a]	0.0001
Eulimastoma engonium	Gastropoda	--	1	--	--	0.00005[a]	--
Pyramidellidae sp.	Gastropoda	1	--	--	--	--	--
Japonactaeon punctostriatus	Gastropoda	3	3	7	0.00005[a]	0.0001	0.0003
Acteocina canaliculata	Gastropoda	19	12	16	0.0028	0.0023	0.0026
Haminella solitaria	Gastropoda	5	4	10	0.002	0.0014	0.0026
Arcuatula papyria	Bivalvia	1	--	--	0.00005[a]	--	--
Mulinia lateralis	Bivalvia	1	2	2	0.0021	0.0146	0.0129
Ameritella mitchelli	Bivalvia	19	12	32	0.0101	0.0023	0.0008

Total Number of Individuals	--	**100**	**58**	**132**
Total number of taxa (excludes fragments of a taxon)	--	**17**	**13**	**14**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-10
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-04

Species List	Class	SSB-04 Abundance			SSB-04 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	Palaeonemertea	2	2	1	0.0006	0.0003	0.0001
Fragilonemertes rosea	Pilidiophora	5	4	8	0.0099	0.0126	0.0097
Amphiporus bioculatus	Hoplonemertea	1	--	1	0.00005	--	0.0001
Hypereteone foliosa	Polychaeta	--	1	--	--	0.0018	--
Alitta succinea	Polychaeta	3	3	6	0.0007	0.001	0.0022
Glycinde multidens	Polychaeta	20	24	29	0.0022	0.0033	0.0037
Paraonis fulgens	Polychaeta	--	2	--	--	0.0002	--
Marenzelleria viridis	Polychaeta	--	1	1	--	0.0034	0.0016
Spiophanes bombyx complex	Polychaeta	--	--	1	--	--	0.0009
Paraprionospio treadwelli	Polychaeta	4	4	5	0.0012	0.0016	0.0021
Streblospio benedicti	Polychaeta	--	1	1	--	0.0001	0.00005[a]
Spiochaetopterus oculatus	Polychaeta	1	--	--	0.0001	--	--
Heteromastus filiformis	Polychaeta	11	9	13	0.0021	0.0029	0.0037
Mediomastus ambiseta	Polychaeta	4	18	17	0.00005[a]	0.0002	0.0002
Pectinaria gouldii	Polychaeta	1	--	2	0.00005[a]	--	0.00005[a]
Gyroscala rupicola	Gastropoda	1	--	--	0.00005[a]	--	--
Eulimastoma engonium	Gastropoda	1	--	1	0.00005[a]	--	0.00005[a]
Japonactaeon punctostriatus	Gastropoda	13	2	6	0.0002	0.00005[a]	0.0003
Acteocina canaliculata	Gastropoda	22	8	14	0.003	0.0012	0.0014
Haminella solitaria	Gastropoda	5	1	7	0.001	0.0002	0.0017
Parvilucina crenella	Bivalvia	1	1	1	0.0019	0.0018	0.0004
Mulinia lateralis	Bivalvia	2	6	3	0.0114	0.0398	0.0033
Ameritella mitchelli	Bivalvia	40	22	45	0.0264	0.0005	0.0016
Gemma gemma	Bivalvia	1	2	1	0.0014	0.001	0.0001
Americamysis almyra	Malacostraca	3	2	1	0.0007	0.0005	0.0002
Edotia triloba	Malacostraca	--	1	--	--	0.00005[a]	--
Ameroculodes spp. complex	Malacostraca	2	2	1	0.0002	0.0001	0.0002
Phoronis psammophila	Unassigned	1	3	2	0.0003	0.0005	0.0001

Total Number of Individuals	--	**144**	**119**	**167**
Total number of taxa (excludes fragments of a taxon)	--	**22**	**22**	**23**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-11
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-05

Species List	Class	SSB-05 Abundance			SSB-05 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea	Pilidiophora	1	1	1	0.0029	0.0025	0.0003
Alitta succinea	Polychaeta	13	17	14	0.0069	0.0065	0.0043
Glycinde multidens	Polychaeta	20	32	20	0.0008	0.0036	0.0018
Polydora cornuta	Polychaeta	--	1	--	--	0.00005[a]	--
Marenzelleria viridis	Polychaeta	--	--	3	--	--	0.0028
Paraprionospio treadwelli	Polychaeta	1	frag.	--	0.00005[a]	0.0007	--
Streblospio benedicti	Polychaeta	11	6	4	0.0005	0.0002	0.0006
Heteromastus filiformis	Polychaeta	8	13	8	0.0026	0.0065	0.0037
Mediomastus ambiseta	Polychaeta	62	55	30	0.0013	0.0012	0.0006
Pectinaria gouldii	Polychaeta	--	1	--	--	0.0001	--
Tubificoides spp.	Clitellata	2	1	4	0.00005[a]	0.00005[a]	0.00005[a]
Eulimastoma engonium	Gastropoda		1	2	--	0.0001	0.0001
Japonactaeon punctostriatus	Gastropoda	2	--	6	0.0001	--	0.0001
Acteocina canaliculata	Gastropoda	9	23	10	0.0007	0.0048	0.0012
Haminella solitaria	Gastropoda	--	1	2	--	0.00005[a]	0.00005[a]
Arcuatula papyria	Bivalvia	--	--	2	--	--	0.0001
Mulinia lateralis	Bivalvia	4	5	2	0.2442	0.033	0.0017
Ameritella mitchelli	Bivalvia	25	48	39	0.0013	0.0012	0.001
Macoma petalum	Bivalvia	2	--	--	0.0091	--	--
Tagelus plebeius	Bivalvia	1	2	--	0.0001	0.0004	--
Gemma gemma	Bivalvia	2	2	7	0.0018	0.0004	0.0017
Neomysis americana	Malacostraca	--	1	--	--	0.0002	--
Americamysis almyra	Malacostraca	2	1	2	0.0005	0.0001	0.0003
Edotia triloba	Malacostraca	1	1		0.00005[a]	0.00005[a]	--
Ameroculodes spp. complex	Malacostraca	--	--	1	--	--	0.0002

Total Number of Individuals	--	**166**	**212**	**157**
Total number of taxa (excludes fragments of a taxon)	--	**17**	**19**	**18**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-12

Barren Island Sand Borrow Areas—Southern Borrow Area

Benthic Community Counts and Biomass—SSB-06

Species List	Class	SSB-06 Abundance			SSB-06 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus	Rhabditophora	--	--	1	--	--	0.0001
Carinoma tremaphoros	Palaeonemertea	1	--	--	0.0007	--	--
Fragilonemertes rosea	Pilidiophora	4	8	2	0.0179	0.0092	0.0168
Alitta succinea	Polychaeta	1	3	3	0.0003	0.002	0.0009
Glycinde multidens	Polychaeta	27	33	19	0.0024	0.0031	0.0017
Leitoscoloplos fragilis	Polychaeta	1	--	--	0.0018	--	--
Leitoscoloplos sp. indeterminate	Polychaeta	--	1	--	--	0.00005[a]	--
Paraonis fulgens	Polychaeta	--	1	--	--	0.00005[a]	--
Marenzelleria viridis	Polychaeta	2	Fragment	3	0.0012	0.0013	0.0017
Paraprionospio treadwelli	Polychaeta	1	1	4	0.00005[a]	0.0004	0.0024
Streblospio benedicti	Polychaeta		2	1	--	0.00005[a]	0.00005[a]
Heteromastus filiformis	Polychaeta	1	6	--	0.0006	0.0017	--
Mediomastus ambiseta	Polychaeta	7	21	20	0.0001	0.001	0.0003
Pectinaria gouldii	Polychaeta	2	1	--	0.0002	0.00005[a]	--
Eulimastoma engonium	Gastropoda	2		1	0.0001	--	0.00005[a]
Japonactaeon punctostriatus	Gastropoda	2	2	5	0.00005[a]	0.00005[a]	0.00005[a]
Acteocina canaliculata	Gastropoda	20	17	11	0.0026	0.0028	0.001
Haminella solitaria	Gastropoda	2	4	7	0.0008	0.0013	0.0008
Arcuatula papyria	Bivalvia	--	--	1	--	--	0.00005[a]
Mulinia lateralis	Bivalvia	2	2	2	0.0094	0.0002	0.01
Ameritella mitchelli	Bivalvia	14	30	19	0.0013	0.0108	0.0003
Gemma gemma	Bivalvia	--	1	--	--	0.00005[a]	--
Edotia triloba	Malacostraca	1	--	--	0.00005[a]	--	--
Crangon septemspinosa	Malacostraca	1	--	--	0.0052	--	--

Total Number of Individuals	--	**91**	**133**	**99**
Total number of taxa (excludes fragments of a taxon)	--	**18**	**16**	**15**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-13

Barren Island Sand Borrow Areas—Southern Borrow Area

Benthic Community Counts and Biomass—SSB-07

		SSB-07 Abundance			SSB-07 Biomass (g; AFDW)		
Species List	**Class**	**Replicate A**	**Replicate B**	**Replicate C**	**Replicate A**	**Replicate B**	**Replicate C**
Edwardsia elegans	Anthozoa	--	--	1	--	--	0.00005
Stylochus ellipticus	Rhabditophora	1	--	--	0.0003	--	--
Carinoma tremaphoros	Palaeonemertea	--	--	1	--	--	0.0001
Fragilonemertes rosea	Pilidiophora	5	5	3	0.0126	0.0067	0.003
Hypereteone foliosa	Polychaeta	1	--	--	0.0036	--	--
Hermundura americana	Polychaeta	1	1	--	0.0003	0.0002	--
Alitta succinea	Polychaeta	19	16	10	0.0067	0.0058	0.0093
Glycinde multidens	Polychaeta	35	40	24	0.0022	0.0036	0.0019
Leitoscoloplos sp. indeterminate	Polychaeta	1	--	--	0.0003	--	--
Paraonis fulgens	Polychaeta	24	--	--	0.0002	--	--
Marenzelleria viridis	Polychaeta	6	4	7	0.0068	0.0039	0.0093
Paraprionospio treadwelli	Polychaeta	--	1	1	--	0.0007	0.0008
Streblospio benedicti	Polychaeta	6	5	--	0.0003	0.0001	--
Heteromastus filiformis	Polychaeta	7	18	14	0.0058	0.0039	0.0033
Mediomastus ambiseta	Polychaeta	9	19	2	0.00005[a]	0.0002	0.00005[a]
Tubificoides spp.	Clitellata	4	--	5	0.00005[a]	--	0.00005[a]
Eulimastoma engonium	Gastropoda	--	2	--	--	0.0003	--
Japonactaeon punctostriatus	Gastropoda	--	--	1	--	--	0.00005[a]
Acteocina canaliculata	Gastropoda	7	9	5	0.0009	0.0008	0.0006
Haminella solitaria	Gastropoda	12	2	8	0.0033	0.0009	0.0024
Arcuatula papyria	Bivalvia	1	--	--	0.0002	--	--
Mulinia lateralis	Bivalvia	2	2	1	0.0131	0.01	0.0028
Ameritella mitchelli	Bivalvia	52	48	25	0.0087	0.0181	0.0004
Tagelus plebeius	Bivalvia	3	2	2	0.0001	0.00005[a]	0.00005[a]
Gemma gemma	Bivalvia	21	14	17	0.0028	0.0048	0.004
Americamysis almyra	Malacostraca	1	6	--	0.0003	0.0012	--
Ameroculodes spp. complex	Malacostraca	4	--	--	0.0007	--	--
Phoronis psammophila	Unassigned	--	--	7	--	--	0.0015

Total Number of Individuals	--	**222**	**194**	**134**
Total number of taxa (excludes fragments of a taxon)	--	**22**	**17**	**18**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-14
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-08

Species List	Class	SSB-08 Abundance			SSB-08 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus	Rhabditophora	--	--	1	--	--	0.00005[a]
Carinoma tremaphoros	Palaeonemertea	3	1	1	0.0005	0.0003	0.0003
Fragilonemertes rosea	Pilidiophora	4	4	2	0.0323	0.0045	0.0061
Hypereteone foliosa	Polychaeta	--	--	1	--	--	0.0021
Hermundura americana	Polychaeta	--	--	1	--	--	0.0002
Alitta succinea	Polychaeta	7	13	19	0.0032	0.0114	0.0082
Glycinde multidens	Polychaeta	17	21	20	0.0014	0.0021	0.0029
Paraonis fulgens	Polychaeta	3	--	--	0.00005[a]	--	--
Marenzelleria viridis	Polychaeta	--	4	3	--	0.0027	0.0036
Paraprionospio treadwelli	Polychaeta	--	1	2	--	0.00005[a]	0.0018
Streblospio benedicti	Polychaeta	3	2	3	0.00005[a]	0.00005[a]	0.0001
Heteromastus filiformis	Polychaeta	11	31	24	0.0044	0.014	0.0081
Mediomastus ambiseta	Polychaeta	12	18	5	0.0002	0.0001	0.0004
Japonactaeon punctostriatus	Gastropoda	1	1		0.00005[a]	0.00005[a]	--
Acteocina canaliculata	Gastropoda	8	11	5	0.0019	0.0022	0.0006
Haminella solitaria	Gastropoda	6	8	9	0.0016	0.0013	0.0033
Mulinia lateralis	Bivalvia	--	1	1	--	0.011	0.0018
Ameritella mitchelli	Bivalvia	62	95	51	0.0032	0.017	0.0076
Tagelus plebeius	Bivalvia	--	1	1	--	0.0002	0.00005[a]
Gemma gemma	Bivalvia	6	6	7	0.0044	0.0042	0.0011
Americamysis almyra	Malacostraca	--	1	2	--	0.0001	0.0001
Ameroculodes spp. complex	Malacostraca	--	1	--	--	0.0002	--

Total Number of Individuals	--	**149**	**220**	**158**
Total number of taxa (excludes fragments of a taxon)	--	**13**	**18**	**19**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-15
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-09

Species List	Class	SSB-09 Abundance			SSB-09 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	Anthozoa	--	1	2	--	0.0001	0.0002
Stylochus ellipticus	Rhabditophora	--	--	1	--	--	0.00005[a]
Carinoma tremaphoros	Palaeonemertea	1	--	--	0.0002	--	--
Fragilonemertes rosea	Pilidiophora	7	3	Fragment	0.0124	0.01	0.0007
Hypereteone foliosa	Polychaeta	--	1	1	--	0.0013	0.0018
Alitta succinea	Polychaeta	3	7	5	0.0011	0.0031	0.0015
Glycinde multidens	Polychaeta	29	20	32	0.0034	0.0018	0.0024
Leitoscoloplos sp. indeterminate	Polychaeta	--	--	1	--	--	0.0006
Paraonis fulgens	Polychaeta	1	--	--	0.00005[a]	--	--
Paraprionospio treadwelli	Polychaeta	3	1	5	0.0022	0.0005	0.0021
Streblospio benedicti	Polychaeta	1	--	--	0.0001	--	--
Spiochaetopterus oculatus	Polychaeta		1	1	--	0.0001	0.00005[a]
Heteromastus filiformis	Polychaeta	4	8	9	0.0016	0.0028	0.0036
Mediomastus ambiseta	Polychaeta	36	10	26	0.0007	0.0003	0.0005
Pectinaria gouldii	Polychaeta		2	--	--	0.0002	--
Eulimastoma engonium	Gastropoda	--	--	1	--	--	0.00005[a]
Japonactaeon punctostriatus	Gastropoda	4	5	6	0.00005[a]	0.00005[a]	0.00005[a]
Acteocina canaliculata	Gastropoda	7	7	8	0.0012	0.0004	0.0019
Haminella solitaria	Gastropoda	13	5	19	0.0043	0.0029	0.0036
Arcuatula papyria	Bivalvia	--	1	--	--	0.00005[a]	--
Mulinia lateralis	Bivalvia	1	4	--	0.0073	0.0317	--
Ameritella mitchelli	Bivalvia	30	23	31	0.0107	0.0007	0.0072
Gemma gemma	Bivalvia	1	2	--	0.0013	0.0005	--
Americamysis almyra	Malacostraca	--	--	2	--	--	0.0002
Phoronis psammophila	Unassigned	3	1	1	0.0001	0.00005[a]	0.00005[a]

Total Number of Individuals	--	**144**	**102**	**151**
Total number of taxa (excludes fragments of a taxon)	--	**16**	**18**	**17**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

-- : no data

AFDW: ash free dry weight

g: gram

Table B-16
Barren Island Sand Borrow Areas—Southern Borrow Area
Benthic Community Counts and Biomass—SSB-10

Species List	Class	SSB-10 Abundance			SSB-10 Biomass (g; AFDW)		
		Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus	Rhabditophora	1	--	--	0.0008	--	--
Fragilonemertes rosea	Pilidiophora	4	3	4	0.0059	0.0044	0.0049
Podarkeopsis levifuscina	Polychaeta	--	1	--	--	0.00005[a]	--
Alitta succinea	Polychaeta	11	8	8	0.0045	0.0053	0.0006
Glycinde multidens	Polychaeta	31	17	21	0.0022	0.0007	0.0013
Paraonis fulgens	Polychaeta	1	7	3	0.00005[a]	0.0002	0.0001
Marenzelleria viridis	Polychaeta	--	1	1	--	0.0018	0.0007
Paraprionospio treadwelli	Polychaeta	1	--	--	0.0005	--	--
Streblospio benedicti	Polychaeta	--	3	1	--	0.00005[a]	0.00005[a]
Heteromastus filiformis	Polychaeta	18	18	7	0.0042	0.0075	0.0046
Mediomastus ambiseta	Polychaeta	1	3	3	0.00005[a]	0.00005[a]	0.00005[a]
Tubificoides spp.	Clitellata	--	4	1	--	0.0001	0.00005[a]
Eulimastoma engonium	Gastropoda	1	--	--	**	--	--
Japonactaeon punctostriatus	Gastropoda	1	1	1	0.00005[a]	0.00005[a]	0.0001
Acteocina canaliculata	Gastropoda	3	3	4	0.0002	0.0007	0.0002
Haminella solitaria	Gastropoda	21	12	19	0.0066	0.0052	0.0057
Arcuatula papyria	Bivalvia	--	1	--	--	0.0001	--
Mulinia lateralis	Bivalvia	5	5	4	0.0224	0.0139	0.0142
Ameritella mitchelli	Bivalvia	37	23	26	0.0012	0.0011	0.001
Macoma petalum	Bivalvia	1	--	--	0.0013	--	--
Tagelus plebeius	Bivalvia	--	--	1	--	--	0.00005[a]
Gemma gemma	Bivalvia	16	7	22	0.0089	0.0033	0.0076
Americamysis almyra	Malacostraca	4	1	1	0.0007	0.0003	0.00005[a]
Ameroculodes spp. complex	Malacostraca	2	2	1	0.0006	0.0002	0.0002

Total Number of Individuals	--	**159**	**120**	**128**
Total number of taxa (excludes fragments of a taxon)	--	**18**	**19**	**18**

Notes:

a) AFDW biomass value was less than 0.0001 g (detectable limit) and was assigned a value of 0.00005 g.

** : species lost by laboratory before biomass was completed

-- : no data

AFDW: ash free dry weight

g: gram

Appendix C
Analytical Data

APPENDIX A2: Barren Island Borrow Area Geotechnical Investigation Report - March 2022

Mid-Chesapeake Bay Island – Barren Island

Borrow Area Investigation

March 2022

Background

The first phase of the Barren Island restoration consists of modification and creation of several thousand feet of stone structures. Future phases of the Barren Island restoration will include foundation removal and replacement in areas of poor foundation and the creation of bird islands adjacent to the proposed breakwater. A source of sand borrow is necessary for both features. Previous subsurface exploration identified a large source of sand between Barren Island and the pilot area indicated on NOAA Chart 12264. At a public meeting at the Church Creek Fire Hall in June 2021, USACE resolved to investigate sources of sand within the Honga River Channel and vicinity. The watermen identified potential sources of sand on the nautical chart.

Under contract with USACE Baltimore District (CENAB), the Robert Balter Company collected twenty-eight (28) grab samples. Sampling locations were chosen by CENAB within the Honga River Channel and immediately to the north of the channel in an area referred to as the Northern Borrow Area. The attached sample location plan shows the sample locations superimposed on the NOAA chart. Former spoil areas were avoided due to low probability of finding suitable borrow material. The samples were taken to the USACE soils laboratory at Ft. McHenry for processing. Sieve analysis was performed for each sample and Atterberg limit testing was performed to classify the fine-grained samples. This memorandum documents the results and analysis of the laboratory testing and provides recommendations for future subsurface exploration.

Sample Locations

Thirteen (13) samples were collected within the Honga River Channel. Samples within the channel were collected at a spacing of approximately 2000 feet. Fifteen (15) samples were collected in the Northern Borrow Area at a spacing between 1000 feet and 1500 feet. One quart of material was collected at each location. Sample coordinates are listed below:

Honga River		
Sample	Easting (ft)	Northing (ft)
H-1	1541778	245852
H-2	1540253	247146
H-3	1538727	248439
H-4	1537201	249732
H-5	1535471	250090
H-6	1533544	249554
H-7	1531962	248369
H-8	1530496	247355
H-9	1528668	248101
H-10	1526700	248459
H-11	1524733	248816
H-12	1522765	249174
H-13	1521289	249442

Northern Borrow Area		
Sample	Easting (ft)	Northing (ft)
NB-1	1521988	250768
NB-2	1523095	250567
NB-3	1524202	250366
NB-4	1525186	250187
NB-5	1526293	249986
NB-6	1527399	249785
NB-7	1521809	249785
NB-8	1522916	249583
NB-9	1524023	249382
NB-10	1525007	249204
NB-11	1526114	249002
NB-12	1527221	248801
NB-13	1527984	249148
NB-14	1529309	248447
NB-15	1530635	247745

Note: All coordinates are in NAD83 MD State Plane feet.

Laboratory Testing

Sieve analysis was performed on all samples according to ASTM D422. Atterberg limit testing was performed according to ASTM D4318 on all sample with fines contents greater than 50% by weight. Unified Soil Classification System (USCS) classifications were determined according to ASTM D2487. The classifications and fines contents are shown below:

Honga River		
Sample	USCS Classification	Fines Content (%)
H-1	SM	15
H-2	SP-SM	5
H-3	ML	90
H-4	ML	70
H-5	ML	66
H-6	ML	66
H-7	ML	59
H-8	ML	61
H-9	SM	19
H-10	ML	67
H-11	SM	11
H-12	SM	10
H-13	SM	10

Northern Borrow Area		
Sample	USCS Classification	Fines Content (%)
NB-1	SM	15
NB-2	CL	51
NB-3	SM	17
NB-4	SM	14
NB-5	SM	28
NB-6	SM	33
NB-7	SC	45
NB-8	SC	37
NB-9	ML	69
NB-10	SP-SM	8
NB-11	SC	27
NB-12	SM	32
NB-13	ML	58
NB-14	ML	57
NB-15	ML	51

SM : silty sand

SP-SM : poorly graded sand with silt

ML : silt

CL : lean clay

SC : clayey sand

Fines Content : Percentage of material by weight with particle size finer than 0.075 millimeter (#200 sieve).

Basis of Analysis

Results of the laboratory analysis were evaluated on the basis of two criteria to determine the suitability of borrow materials for use at Barren Island:

1. Fines Content – The ideal borrow material for use as backfill for foundation removal and replacement would be sand with less than approximately 20% fines. Material with less than 20% fines can be easily placed with mechanical or hydraulic placement. The low fines content allows for rapid decanting of water during placement and for achieving an adequate relative density with minimal to no compactive effort. A low fines content is especially important in underwater placement or hydraulic placement where compaction is not possible. Material with greater than 20% fines is more difficult to place in the proposed application, resulting in insufficient relative densities and strengths.
2. Homogeneity – The ideal borrow site would consist of a large homogeneous area of sand, free of lenses of silts and clays. With any sampling program, there is always a risk that the grab samples obtained will not truly represent the material within the borrow area. The total material sampled is several quarts while the borrow site could contain hundreds of thousands of cubic yards. It is important to find a homogeneous area to allow the designer to assign engineering properties to the borrow material with some degree of confidence. Variability in material properties among grab samples is a strong indication that borrow source material is also variable. Grab samples do not give an indication of material composition below the surface, but a large homogeneous area of suitable material at the surface will warrant further geotechnical investigation at depth.

Analysis and Recommendations

Material within the Honga River Channel is highly variable and consists mostly of silts and silty sands. There are limited stretches of the channel containing silty sands with less than 20% fines, but these stretches are adjacent to stretches of channel containing silts. The Northern Borrow Area is also highly variable, containing both silty sands, silts, lean clays, and clayey sands. Results of the grab sampling suggest that finding a large area of sand containing less than 20% fines is unlikely. Because of the variability of the material, the material is not suitable for use as backfill for foundation removal and replacement. For the foundation removal and replacement, use of an alternative borrow area or use of quarried material is recommended.

Bird island construction does not necessitate the same density and strength requirements as foundation removal and replacement, and a limited extent of the sampled area, primarily within the Northern Borrow Area, could potentially be used for bird island construction. The attached sample location plan identifies an approximately 120-acre area which could potentially be used for bird island construction. Samples within the area are NB-3, NB-4, NB-5, NB-10, NB-11, and H11, with fines contents of 17%, 14%, 28%, 11%, 27%, and 11% respectively. Samples NB-5 and NB-11 contain fines contents greater than 20%, but a blend of material taken over the borrow area might be suitable. Additional exploration is recommended within the potential borrow area. The recommended exploration consists of continuous sampling of material to a depth of 10 feet on a 500-foot grid spacing. Additional exploration will reveal material composition at depth and provide the necessary information to definitively recommend or reject this borrow area as a source for bird island construction.

Attachments

Sample Location Plan

Laboratory Gradation Curves

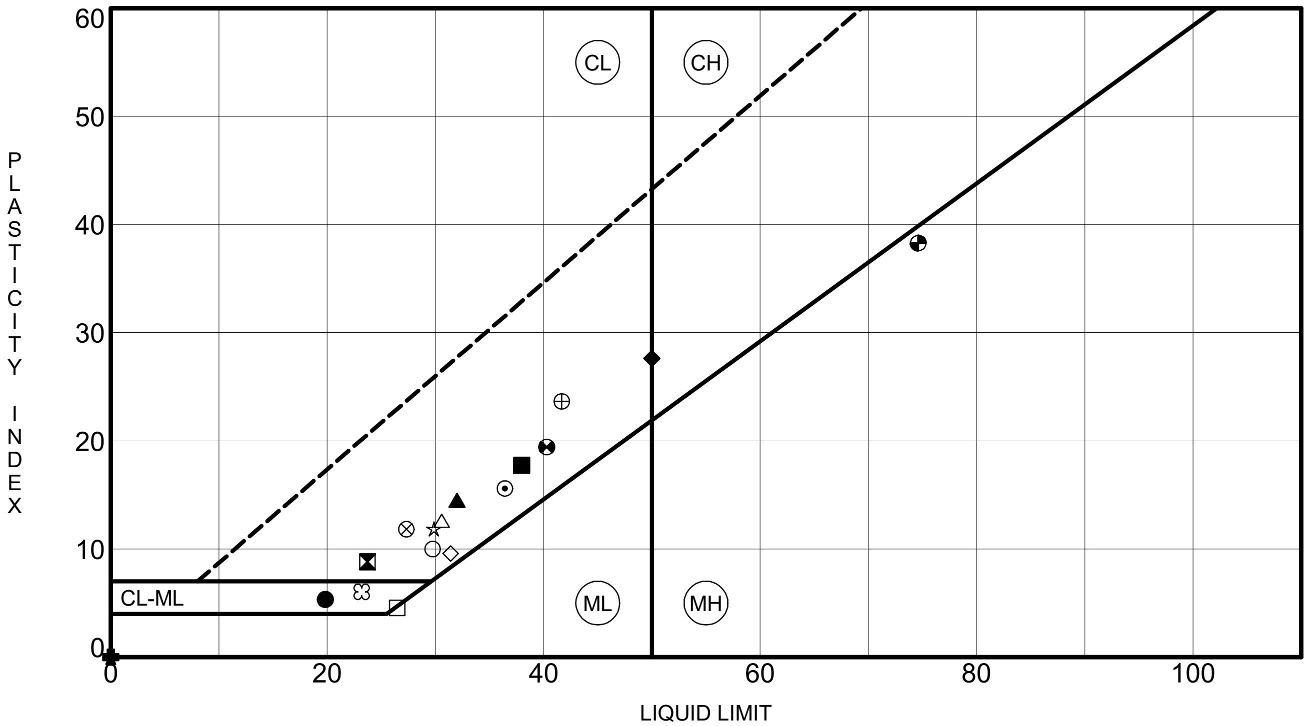
Boring	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% < #4 Sieve	% < #200 Sieve	Classification	Water Content (%)
N-01	5.0 - 7.0	20	14	6	100	66	CL-ML	
N-01	14.75 - 15.0				100	47		
N-02	10.0 - 11.5				100	48		
N-03	9.7 - 10.0	24	15	9	100	73	CL	
N-03	10.0 - 15.0	32	18	14	100	94	CL	
N-04	5.0 - 8.4				100	7		
N-04	10.0 - 15.0				100	4	SP	
N-05	8.5 - 10.0	NP	NP	NP	100	23	SM	
N-05	10.0 - 13.9				100	3	SP	
N-06	5.0 - 10.0	36	21	15	100	95	CL	
N-07	10.0 - 15.0	NP	NP	NP	100	13	SM	
N-08	9.2 - 10.0	30	20	10	100	98	CL	
N-09	8.25 - 10.0	31	18	13	100	94	CL	
N-09	12.1 - 15.0				100	39		
N-10A	7.9 - 10.0				100	93		
N-10A	10.0 - 12.5	27	15	12	100	86	CL	
N-11	5.0 - 8.6				100	84		
N-11	10.0 - 13.3	42	18	24	100	86	CL	
N-12	5.0 - 7.7	26	22	4	100	72	ML	
N-12	7.6 - 9.4				100	21		
N-13	5.0 - 9.0	40	21	19	100	94	CL	
N-14	10.0 - 13.2	75	36	39	100	90	MH	
N-15	0.0 - 4.2	30	18	12	100	90	CL	
N-15A	5.0 - 7.9				100	87		
N-16	4.0 - 5.0				100	89		
N-16	8.25 - 10.0	23	17	6	100	70	CL-ML	
N-17	6.0 - 11.0				100	30		

Summary of Laboratory Results
Barren Island Borrow Area Investigation

Dorchester County, Maryland

Project Number: 19-0050.04

Boring	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% < #4 Sieve	% < #200 Sieve	Classification	Water Content (%)
N-18	4.2 - 5.0				100	93		
N-18	5.0 - 9.2	38	20	18	100	94	CL	
N-19	5.0 - 10.0	50	22	28	100	99	CH	
N-20	0.0 - 5.0	31	22	9	100	93	CL	
N-20	9.1 - 10.0				100	41		
N-21	5.0 - 8.2	27	21	6	100	94	CL-ML	
N-21	10.0 - 15.0				100	28		
N-22	2.0 - 4.0	26	21	5	100	76	CL-ML	
N-23	6.0 - 7.0	28	21	7	100	80	CL-ML	
N-23	10.5 - 12				100	27		
N-24	2.0 - 4.0	NP	NP	NP	100	61	ML	
N-24	12.4 - 14.0				100	75		
N-25	6.0 - 8.0	NP	NP	NP	100	42	SM	
N-26	10.0 - 13.1	25	15	10	100	87	CL	
N-27	6.0 - 8.0	NP	NP	NP	100	24	SM	
N-27	12.0 - 14.0				100	9		
N-28	5.0 - 8.0				100	94		
N-28	12.25 - 13.25	33	19	14	100	96	CL	
N-29	0.0 - 2.0	37	25	12	100	91	ML	
N-30	2.0 - 4.0				100	52		
N-30	10.0 - 12.0	27	17	10	100	95	CL	
N-31	4.0 - 6.0	25	20	5	100	81	CL-ML	



	Boring	Depth	LL	PL	PI	Fines	Classification
●	N-01	5.0 - 7.0	20	14	6	66	SANDY SILTY CLAY(CL-ML)
⧗	N-03	9.7 - 10.0	24	15	9	73	LEAN CLAY with SAND(CL)
▲	N-03	10.0 - 15.0	32	18	14	94	LEAN CLAY(CL)
★	N-05	8.5 - 10.0	NP	NP	NP	23	SILTY SAND(SM)
⊙	N-06	5.0 - 10.0	36	21	15	95	LEAN CLAY(CL)
✿	N-07	10.0 - 15.0	NP	NP	NP	13	SILTY SAND(SM)
○	N-08	9.2 - 10.0	30	20	10	98	LEAN CLAY(CL)
△	N-09	8.25 - 10.0	31	18	13	94	LEAN CLAY(CL)
⊗	N-10A	10.0 - 12.5	27	15	12	86	LEAN CLAY(CL)
⊕	N-11	10.0 - 13.3	42	18	24	86	LEAN CLAY(CL)
□	N-12	5.0 - 7.7	26	22	4	72	SILT with SAND(ML)
⊗	N-13	5.0 - 9.0	40	21	19	94	LEAN CLAY(CL)
◕	N-14	10.0 - 13.2	75	36	39	90	ELASTIC SILT(MH)
☆	N-15	0.0 - 4.2	30	18	12	90	LEAN CLAY(CL)
✿	N-16	8.25 - 10.0	23	17	6	70	SILTY CLAY with SAND(CL-ML)
■	N-18	5.0 - 9.2	38	20	18	94	LEAN CLAY(CL)
◆	N-19	5.0 - 10.0	50	22	28	99	FAT CLAY(CH)
◇	N-20	0.0 - 5.0	31	22	9	93	LEAN CLAY(CL)

Test Method: ASTM D4318

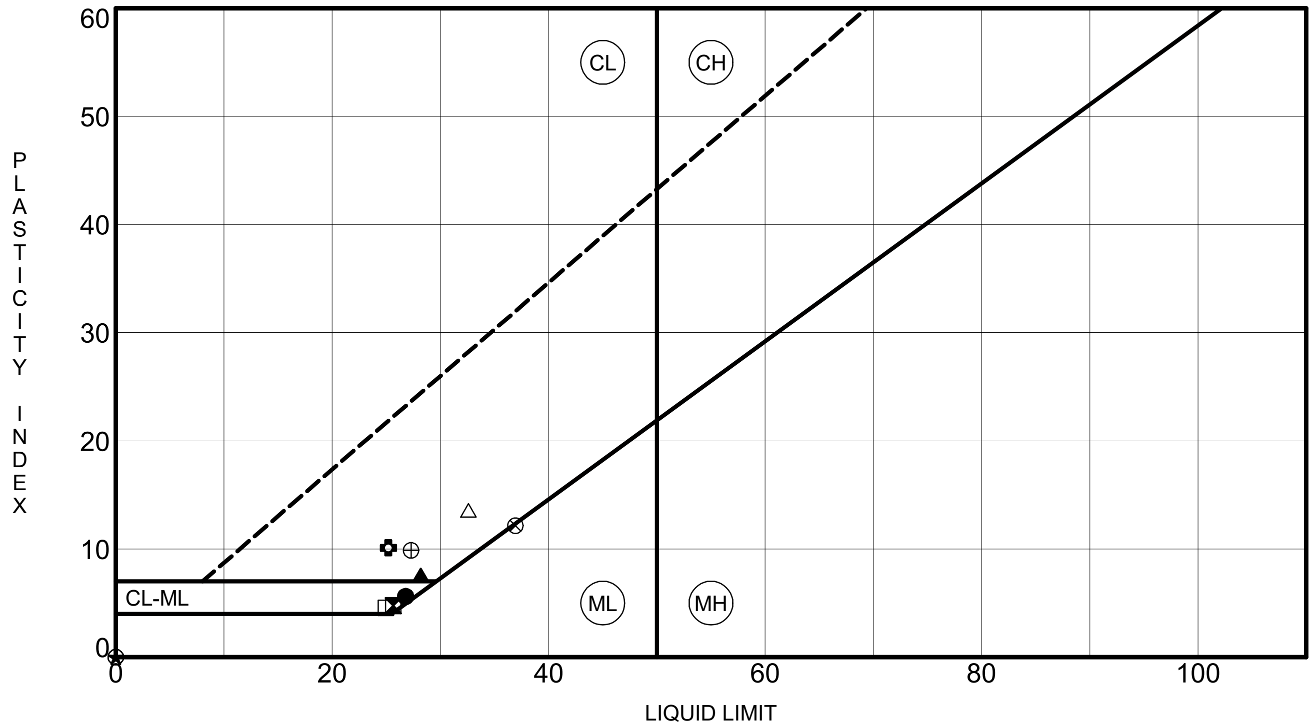
Tested By: JW, SM   Date: 9/29/2022

ATTERBERG LIMITS' RESULTS

Project: Barren Island Borrow Area Investigation

Location: Dorchester County, Maryland

Project Number: 19-0050.04



	Boring	Depth	LL	PL	PI	Fines	Classification
●	N-21	5.0 - 8.2	27	21	6	94	SILTY CLAY(CL-ML)
⧗	N-22	2.0 - 4.0	26	21	5	76	SILTY CLAY with SAND(CL-ML)
▲	N-23	6.0 - 7.0	28	21	7	80	SILTY CLAY with SAND(CL-ML)
★	N-24	2.0 - 4.0	NP	NP	NP	61	SANDY SILT(ML)
⊙	N-25	6.0 - 8.0	NP	NP	NP	42	SILTY SAND(SM)
✿	N-26	10.0 - 13.1	25	15	10	87	LEAN CLAY(CL)
○	N-27	6.0 - 8.0	NP	NP	NP	24	SILTY SAND(SM)
△	N-28	12.25 - 13.25	33	19	14	96	LEAN CLAY(CL)
⊗	N-29	0.0 - 2.0	37	25	12	91	SILT(ML)
⊕	N-30	10.0 - 12.0	27	17	10	95	LEAN CLAY(CL)
□	N-31	4.0 - 6.0	25	20	5	81	SILTY CLAY with SAND(CL-ML)

Test Method: ASTM D4318

Tested By: JW, SM Date: 10/3/2022

ATTERBERG LIMITS' RESULTS

Project: Barren Island Borrow Area Investigation

Location: Dorchester County, Maryland

Project Number: 19-0050.04

APPENDIX A3: Northern Borrow Area Geotechnical Investigation Report - November 2022

Barren Island

Northern Borrow Area Assessment

November 2022

Background

The second phase of the Barren Island restoration will require a source of sand borrow for (1) foundation replacement, (2) dredged material containment, and (3) bird island fill. A previous memorandum dated March 2022 documented the results of a grab sampling exploration program in the Honga River Channel and the Northern Borrow Area, an area immediately north of the Honga River Channel. The memorandum concluded that the material from both sites is highly variable and unsuitable for use as backfill for foundation removal and replacement but that the Northern Borrow Area might contain material suitable for bird island construction, pending further investigation. At the time of the memorandum, the plan for dredged material containment had not been developed and was not addressed in the evaluation. A geotechnical exploration program was conducted by Soil and Land Use Technology Inc. (SaLUT) in August and September 2022. The exploration program consisted of thirty-one borings in the Northern Borrow Area and twenty-six borings in the Southern Borrow Area, located approximately 1.5 miles west of Barren Island. Laboratory testing was performed to verify field classifications and determine the gradations and plasticity limits of selected samples. This memorandum documents the results of the 2022 geotechnical exploration in the Northern Borrow Area and provides the assessment of the suitability of the material for the three required purposes. The analysis of the Southern Borrow Area is not part of this memorandum.

Sample Locations

Thirty-one borings were collected within the Northern Borrow Area (Figure 1). Borings were spaced on a grid between approximately 450 ft and 550 ft apart. Each boring was conducted to a depth of approximately fifteen feet. Continuous samples were collected with either direct push sampling or split spoon sampling. In some cases, offset borings were drilled to collect samples where there was either poor or no recovery in the original boring. Sample recovery in the upper five feet of material proved to be difficult, but most borings had sufficient recovery to classify the materials. All samples were preserved in glass jars and brought to SaLUT’s laboratory for soil testing.

Laboratory Testing and Boring Logs

Laboratory testing consisted of gradation and classification according to ASTM D422 and determination of plasticity limits according to ASTM D4318. A total of forty-nine gradation tests and twenty-nine plasticity limit tests were performed on samples within the Northern Borrow Area. Results of the tests are attached to this memorandum. Boring logs were prepared by SaLUT and are also attached.

Analysis and Recommendations

The March 2022 memorandum discussed that the ideal borrow area to source material for backfill for foundation removal and replacement is a large homogenous area of sand with less than 20% fines. Boring logs within the Northern Borrow Area reveal that the material in the area is highly variable. It contains silty sand, clay, and silt. The depth of surficial sand varies throughout the borrow area between no sand (at many boreholes) and 15 ft of sand (at N-7). Table 1 presents a summary of the surficial sand depths. Fine grained materials were encountered in all but two borings and classified primarily as either ML, CL, or CL-ML according to the USCS classification system. Layers of fine-grained materials were found at the surface and between layers of sand. Geologic profiles were prepared at two transects within the borrow area and are included in Figure 2. The borings show large differences in material between adjacent borings. A sub-area within the Northern Borrow Area containing a sizeable volume of sand could not be identified.

The March 2022 memorandum concluded that the Northern Borrow Area is unsuitable for foundation replacement material but could potentially be used for bird island construction. Whereas the ideal foundation replacement material is less than 20% fines, a fines content up to 30% could be used for bird island construction. At 30% fines, the material can still decant fairly easily, but could potentially settle over time and exhibit a lower relative density and strength. Neither of these issues are critical for bird island construction because the material will be contained by stone structures and the material does not need to support any loads. A borrow area with less than 30% fines could be (1) a silty or clayey sand with less than 30% fines or (2) an area of sand with small lenses of fine-grained material that when blended contains less than 30% fines. The Northern Borrow Area does not contain large areas of sand. Layers of fine-grained material within the Northern Borrow Area are more extensive than the layers of sand. The Northern Borrow Area does not contain any areas which could be blended to produce a suitable sand.

At the time of the March 2022 memorandum, the plan for dredged material containment had not been developed. The proposed plan is to use geotextile tubes for containment. The geotextile tubes will be approximately forty feet in diameter and fifty feet in length. Sand will be pumped from the dredge to several fill ports along the length of each tube. The geotextile tubes will be pumped to a maximum height of approximately 8 feet. To prevent excessive settlement of the material within the geotextile tubes, the material used to fill the tubes should have the least amount of fines as possible. It is possible to fill tubes with fine-grained material, but the tubes will take months if not years to dewater. As the tubes dewater, they will get shorter and not provide the desired containment height. At Barren Island, the approximate eight-foot height requirement is at the practical limit of maximum height for a geotextile tube. The tubes will need to remain in-place for several years. The Northern Borrow Area is not recommended for the geotextile tubes because of the high likelihood that the material within the tubes could settle causing an unacceptable reduction of height.

Because the highly variable nature of the Northern Borrow Area material cannot provide the required engineering properties, its use is not recommended for any of the three stated needs for sand borrow in Phase 2.

Attachments

Barren Island Northern Borrow Area Logs

Barren Island Northern Borrow Area Lab Test Results

Table 1: Summary of Surficial Sand Depths

Boring	Surficial Sand Depth (ft)
N-1	4.7
N-2	-
N-3	9.7
N-4	8.4
N-5	14.3*
N-6	0
N-7	15*
N-8	9.2*
N-9	8.3
N-10	0
N-11	0
N-12	0*
N-13	0
N-14	0
N-15	0
N-16	4.0
N-17	0*
N-18	4.2
N-19	2.2
N-20	0
N-21	0
N-22	2
N-23	0*
N-24	2
N-25	10.8
N-26	10
N-27	0*
N-28	5
N-29	0
N-30	0*
N-31	2

* sand depth is presumed (due to poor recovery in top sample)

\- designates insufficient recovery to determine

Figure 1: Northern Borrow Area Boring Plan

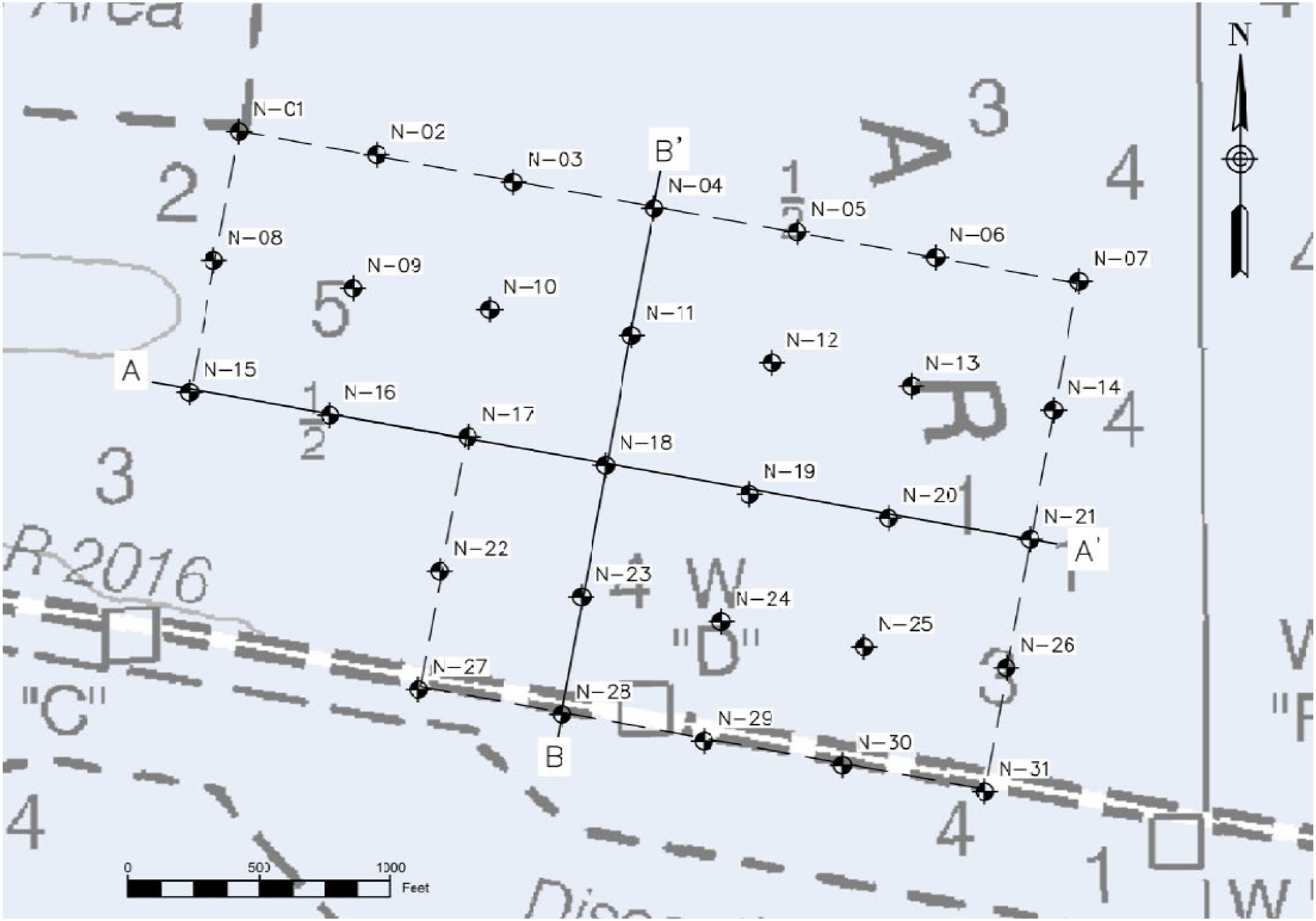
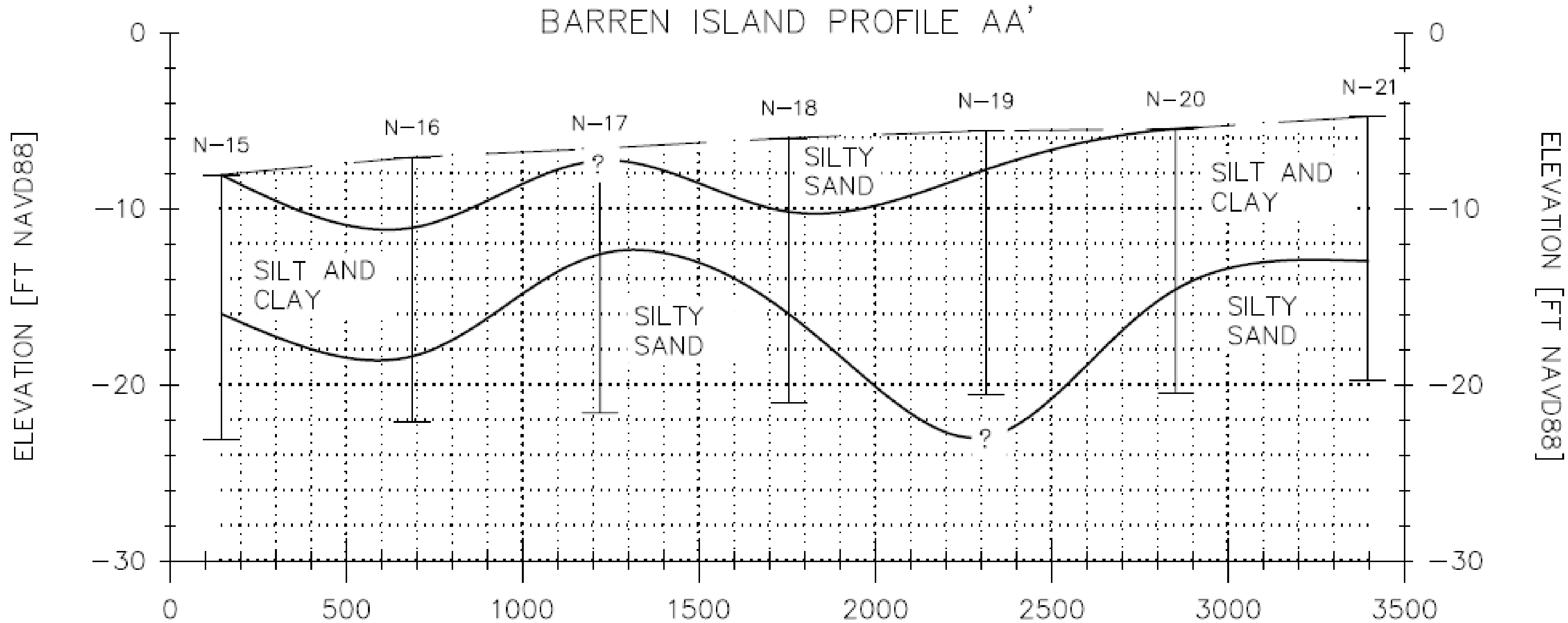
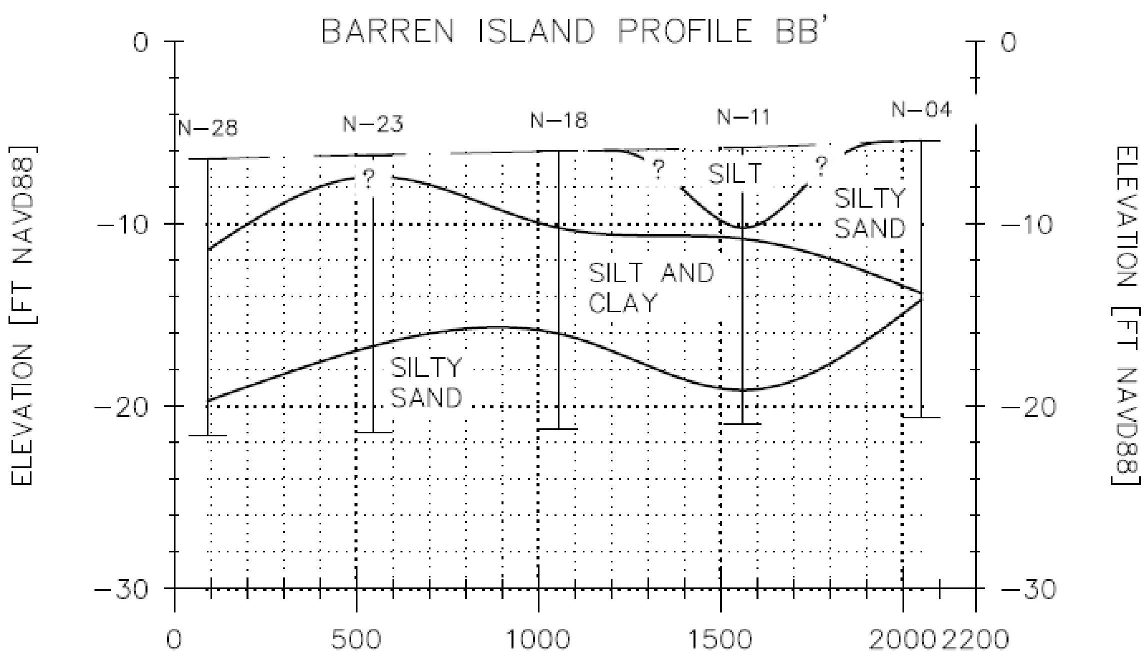


Figure 2: Northern Borrow Area Profiles





Boring	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% < #4 Sieve	% < #200 Sieve	Classification	Water Content (%)
N-01	5.0 - 7.0	20	14	6	100	66	CL-ML	
N-01	14.75 - 15.0				100	47		
N-02	10.0 - 11.5				100	48		
N-03	9.7 - 10.0	24	15	9	100	73	CL	
N-03	10.0 - 15.0	32	18	14	100	94	CL	
N-04	5.0 - 8.4				100	7		
N-04	10.0 - 15.0				100	4	SP	
N-05	8.5 - 10.0	NP	NP	NP	100	23	SM	
N-05	10.0 - 13.9				100	3	SP	
N-06	5.0 - 10.0	36	21	15	100	95	CL	
N-07	10.0 - 15.0	NP	NP	NP	100	13	SM	
N-08	9.2 - 10.0	30	20	10	100	98	CL	
N-09	8.25 - 10.0	31	18	13	100	94	CL	
N-09	12.1 - 15.0				100	39		
N-10A	7.9 - 10.0				100	93		
N-10A	10.0 - 12.5	27	15	12	100	86	CL	
N-11	5.0 - 8.6				100	84		
N-11	10.0 - 13.3	42	18	24	100	86	CL	
N-12	5.0 - 7.7	26	22	4	100	72	ML	
N-12	7.6 - 9.4				100	21		
N-13	5.0 - 9.0	40	21	19	100	94	CL	
N-14	10.0 - 13.2	75	36	39	100	90	MH	
N-15	0.0 - 4.2	30	18	12	100	90	CL	
N-15A	5.0 - 7.9				100	87		
N-16	4.0 - 5.0				100	89		
N-16	8.25 - 10.0	23	17	6	100	70	CL-ML	
N-17	6.0 - 11.0				100	30		

Summary of Laboratory Results

Barren Island Borrow Area Investigation

Dorchester County, Maryland

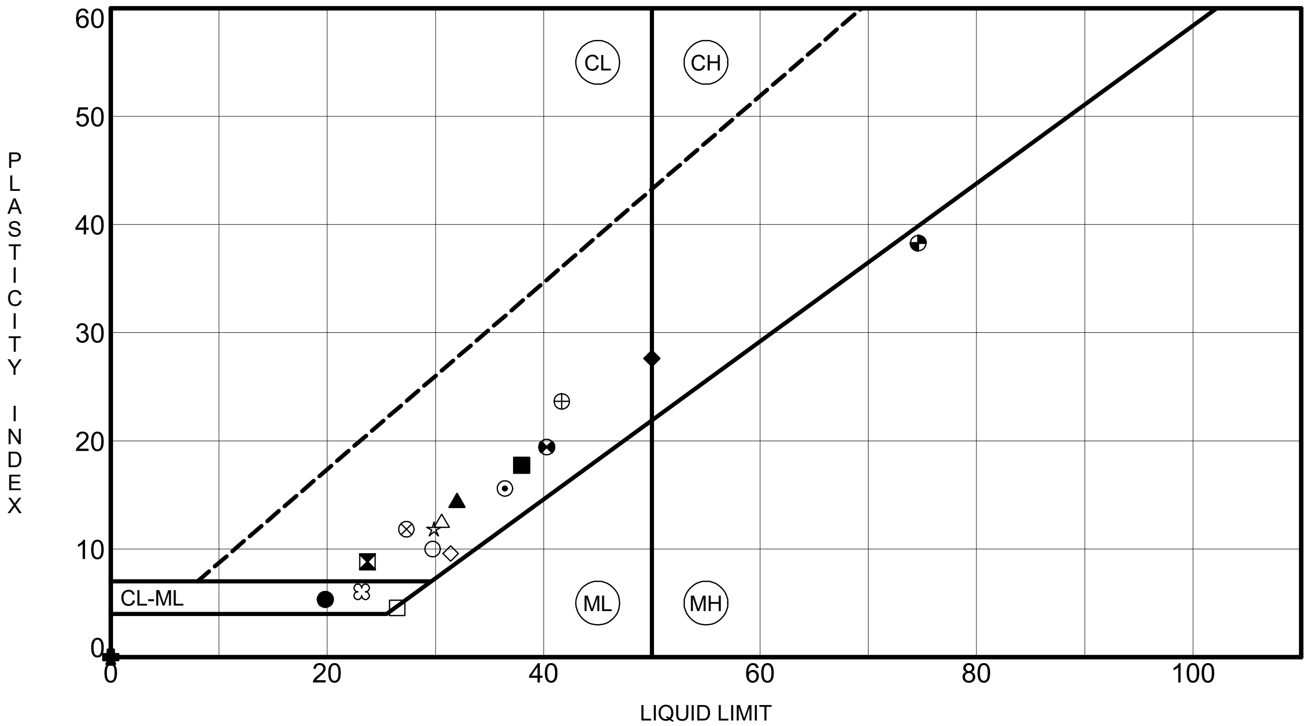
Project Number: 19-0050.04

Boring	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% < #4 Sieve	% < #200 Sieve	Classification	Water Content (%)
N-18	4.2 - 5.0				100	93		
N-18	5.0 - 9.2	38	20	18	100	94	CL	
N-19	5.0 - 10.0	50	22	28	100	99	CH	
N-20	0.0 - 5.0	31	22	9	100	93	CL	
N-20	9.1 - 10.0				100	41		
N-21	5.0 - 8.2	27	21	6	100	94	CL-ML	
N-21	10.0 - 15.0				100	28		
N-22	2.0 - 4.0	26	21	5	100	76	CL-ML	
N-23	6.0 - 7.0	28	21	7	100	80	CL-ML	
N-23	10.5 - 12				100	27		
N-24	2.0 - 4.0	NP	NP	NP	100	61	ML	
N-24	12.4 - 14.0				100	75		
N-25	6.0 - 8.0	NP	NP	NP	100	42	SM	
N-26	10.0 - 13.1	25	15	10	100	87	CL	
N-27	6.0 - 8.0	NP	NP	NP	100	24	SM	
N-27	12.0 - 14.0				100	9		
N-28	5.0 - 8.0				100	94		
N-28	12.25 - 13.25	33	19	14	100	96	CL	
N-29	0.0 - 2.0	37	25	12	100	91	ML	
N-30	2.0 - 4.0				100	52		
N-30	10.0 - 12.0	27	17	10	100	95	CL	
N-31	4.0 - 6.0	25	20	5	100	81	CL-ML	

Summary of Laboratory Results
Barren Island Borrow Area Investigation

Dorchester County, Maryland

Project Number: 19-0050.04



	Boring	Depth	LL	PL	PI	Fines	Classification
●	N-01	5.0 - 7.0	20	14	6	66	SANDY SILTY CLAY(CL-ML)
⧗	N-03	9.7 - 10.0	24	15	9	73	LEAN CLAY with SAND(CL)
▲	N-03	10.0 - 15.0	32	18	14	94	LEAN CLAY(CL)
★	N-05	8.5 - 10.0	NP	NP	NP	23	SILTY SAND(SM)
⊙	N-06	5.0 - 10.0	36	21	15	95	LEAN CLAY(CL)
✿	N-07	10.0 - 15.0	NP	NP	NP	13	SILTY SAND(SM)
○	N-08	9.2 - 10.0	30	20	10	98	LEAN CLAY(CL)
△	N-09	8.25 - 10.0	31	18	13	94	LEAN CLAY(CL)
⊗	N-10A	10.0 - 12.5	27	15	12	86	LEAN CLAY(CL)
⊕	N-11	10.0 - 13.3	42	18	24	86	LEAN CLAY(CL)
□	N-12	5.0 - 7.7	26	22	4	72	SILT with SAND(ML)
⊗	N-13	5.0 - 9.0	40	21	19	94	LEAN CLAY(CL)
◕	N-14	10.0 - 13.2	75	36	39	90	ELASTIC SILT(MH)
☆	N-15	0.0 - 4.2	30	18	12	90	LEAN CLAY(CL)
✿	N-16	8.25 - 10.0	23	17	6	70	SILTY CLAY with SAND(CL-ML)
■	N-18	5.0 - 9.2	38	20	18	94	LEAN CLAY(CL)
◆	N-19	5.0 - 10.0	50	22	28	99	FAT CLAY(CH)
◇	N-20	0.0 - 5.0	31	22	9	93	LEAN CLAY(CL)

Test Method: ASTM D4318

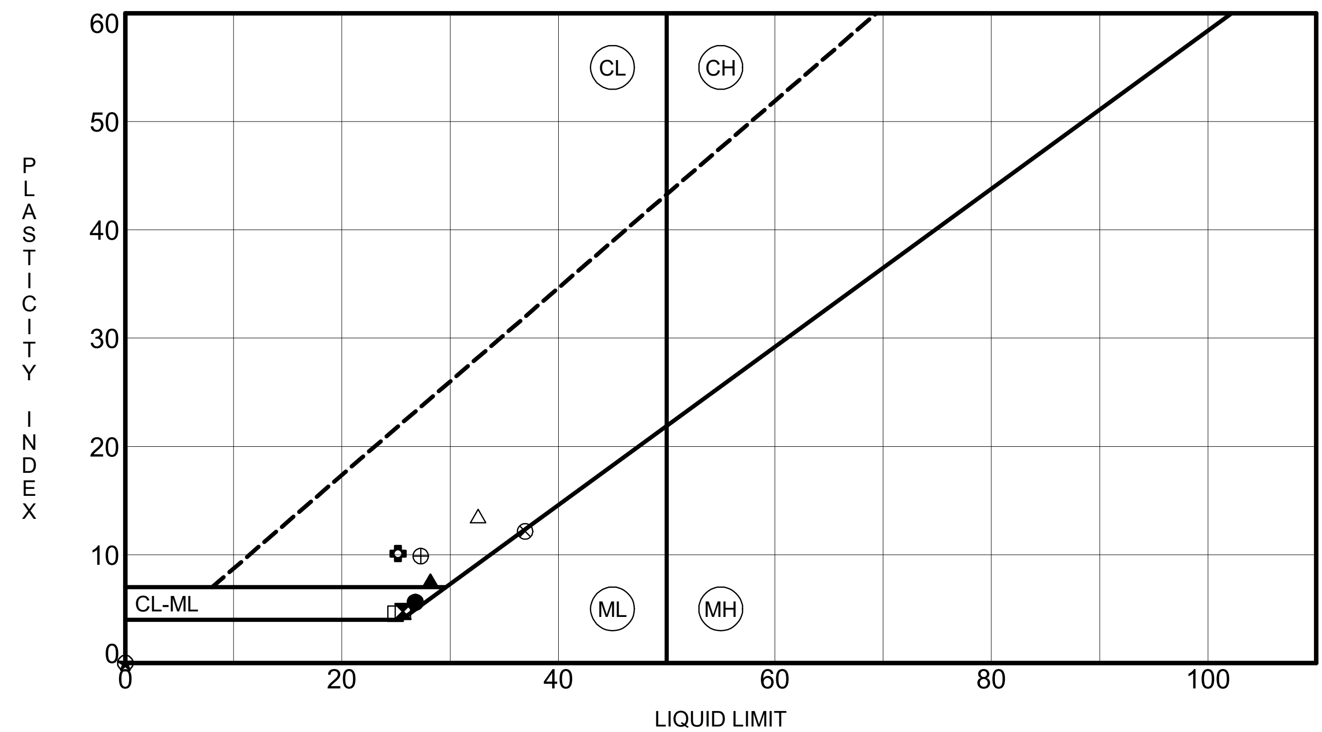
Tested By: JW, SM   Date: 9/29/2022

ATTERBERG LIMITS' RESULTS

Project: Barren Island Borrow Area Investigation

Location: Dorchester County, Maryland

Project Number: 19-0050.04



	Boring	Depth	LL	PL	PI	Fines	Classification
●	N-21	5.0 - 8.2	27	21	6	94	SILTY CLAY(CL-ML)
⧗	N-22	2.0 - 4.0	26	21	5	76	SILTY CLAY with SAND(CL-ML)
▲	N-23	6.0 - 7.0	28	21	7	80	SILTY CLAY with SAND(CL-ML)
★	N-24	2.0 - 4.0	NP	NP	NP	61	SANDY SILT(ML)
⊙	N-25	6.0 - 8.0	NP	NP	NP	42	SILTY SAND(SM)
✿	N-26	10.0 - 13.1	25	15	10	87	LEAN CLAY(CL)
○	N-27	6.0 - 8.0	NP	NP	NP	24	SILTY SAND(SM)
△	N-28	12.25 - 13.25	33	19	14	96	LEAN CLAY(CL)
⊗	N-29	0.0 - 2.0	37	25	12	91	SILT(ML)
⊕	N-30	10.0 - 12.0	27	17	10	95	LEAN CLAY(CL)
□	N-31	4.0 - 6.0	25	20	5	81	SILTY CLAY with SAND(CL-ML)

Test Method: ASTM D4318

Tested By: JW, SM Date: 10/3/2022

ATTERBERG LIMITS' RESULTS

Project: Barren Island Borrow Area Investigation

Location: Dorchester County, Maryland

Project Number: 19-0050.04

APPENDIX A4: Geotechnical Design Appendix with Attachment O - Southern Borrow Area Data Sheets - November 2022

Barren Island

Geotechnical Design Appendix

1 Introduction

This report documents the geotechnical design aspects of the Barren Island project. As the design progresses, this report will be updated to include documentation for the geotechnical design. This report includes information on the subsurface exploration program, foundation conditions, and the design cross sections. Items highlighted in yellow indicate portions of the report which will be updated at further stages of deign.

2 Subsurface Explorations

Five separate subsurface investigations have been performed for the project. The first was performed in 2001 as part of a reconnaissance study, investigating the possibility of constructing a 1000 - 2000 acre island for dredged material disposal and beneficial use. The second investigation was performed in 2004 as part of a similar beneficial use of dredged material study that was finalized in 2008. The third round of exploration was performed in 2020 as part of the present study to determine the engineering properties of the foundation for the stone structures. The fourth exploration was performed in 2022 to investigate the material composition of the Honga River channel and potential sources of sand borrow adjacent to the channel. The fifth and final investigation was also performed in 2022 to investigate an additional sand borrow area.

2.1 Previous Subsurface Explorations

2.1.1 2001 Investigation (for 2002 Reconnaissance Study)

The Maryland Port Administration (MPA) commissioned a preliminary geotechnical reconnaissance study for a beneficial use of dredged material project at the west side of Barren Island in 2001. The study had three primary goals (E2CR, 2002, p. 3):

- i) "Evaluate the geotechnical conditions at the site, especially along the proposed dike alignments;"
- ii) "Design a stable dike section for the site in order to establish a preliminary cost estimate for construction;"
- iii) "Evaluate the availability of suitable borrow material (sand) at the site, for the construction of the dike."

A total of 18 soil borings were collected for the study. All of the borings were located west of the existing Barren Island. Depths for the borings ranged from 35 to 70 feet. Laboratory testing on the samples included consolidated undrained testing, unconfined compression testing, consolidation testing, and grain size analysis including Atterberg limits. The study concluded that the site contained a sufficient quantity of suitable borrow material. The study also concluded that the majority of the site had suitable foundation conditions for the proposed dike construction, but portions of the site would require foundation removal and replacement.

2.1.2 2004 Investigation (for 2008 Feasibility Study)

In 2004, twenty-seven (27) borings were completed offshore of Barren Island to investigate the subsurface conditions for a proposed island similar to the proposed island in the 2002 study. The borings collected in 2004 were intended to supplement the borings collected as part of the 2002 study. Testing consisted of grain size analysis, Atterberg limits, and water contents. By 2008, the U.S. Army Corps of Engineers (USACE), along with the MPA, completed the feasibility study*, Mid-Chesapeake Bay Island Ecosystem Restoration Integrated Feasibility Report and Environmental Impact Statement* (USACE, 2008). The plan formulation changed. In the 2008 study, a site adjacent to James Island was selected for large ecosystem restoration (2072 acres) and a much smaller ecosystem restoration (72 acres) at Barren Island was formulated. The proposed plan at Barren Island consisted primarily of shoreline protection with stone sills, the creation of wetlands behind the stone sills, and a breakwater. Additional borings to support the design of the proposed features were not collected.

2.2 RECENT INVESTIGATIONS

2.2.1 2020 Subsurface Exploration

A combined geotechnical investigation for James and Barren Island commenced in April 2020 and was completed in January 2021. The geotechnical investigation was developed to determine the engineering properties of the foundation materials along the alignment proposed in the 2008 Feasibility Report. In-situ testing included standard penetration testing, dilatometer testing, cone penetration testing, vane shear testing, and collection of 5-inch diameter undisturbed tube samples. Samples collected during standard penetration testing were sent to the USACE soils laboratory at Ft. McHenry, Maryland. Shelby tubes were sent to the USACE soils laboratory at Savannah, Georgia.

The testing plan included collection of cone penetration tests at 500 ft increments along the Barren Island shoreline, 1000 ft increments along the proposed breakwater south of Barren Island, and some west of the proposed breakwater. All other tests were performed at the same location as one of the cone penetration tests. Clusters of tests at the same location allow direction correlation of results from one type of test to another. Upon completion of the majority of the investigation, the alignment for the proposed breakwater was changed. Because the drill crew was still working at James Island, additional standard penetration borings and vane shear tests were added to the investigation to collect data along the updated alignment. The entire geotechnical investigation for Barren Island included:

1. 45 Cone Penetration (CPT)
2. 12 Dilatometer (DMT)
3. 17 Standard Penetration Borings (SPT)
4. 4 Shelby Tube Samples at 3 separate locations
5. 17 Vane Shear at 11 separate locations (FVS)

A boring location plan as well as logs for all of the tests are included in the attached appendices.

2.2.2 2022 Honga River and Sand Borrow Investigation

A small grab-sampling investigation was performed in early 2022 to determine the engineering properties of surficial sediments within both the Honga River Channel and a potential borrow area immediately north of the channel (Northern Borrow Area). A sample location plan and laboratory testing results are included in Attachment P. The investigation consisted of collection of thirteen (13) samples within the Honga River Channel at an approximate spacing of 1500 feet along the channel centerline and collection of fifteen (15) samples within the potential borrow area. Samples were sent to the USACE soils laboratory at Ft. McHenry, MD and tested for grain size analysis and plasticity limits (for all samples classifying as fine-grained).

2.2.3 2022 Borrow Area Investigation

Two borrow areas were investigated in late 2022 – the Northern Borrow Area and Southern Borrow Area. The Southern Borrow Area was identified as an alternative to the Northern Borrow Area. Grab sampling results within the Northern Borrow Area were not promising. The investigation within the Northern Borrow Area consisted of collection of thirty-one (31) borings. The investigation within the Southern Borrow Area consisted of collection of twenty-five (25) borings. All borings were collected to an approximate depth of fifteen feet. Continuous samples were taken. Blow counts were not collected. Samples were taken to the Soil and Land Use Technology Inc.'s (SaLUT) soil laboratory for testing. Select samples were tested for grain size analysis and plasticity limits.

3 FOUNDATION CONDITIONS

Foundation conditions were determined using the results of the extensive field exploration and laboratory testing program. Geologic strata, strength, and compressibility characteristics of the foundation material were determined using multiple methods.

3.1 REGIONAL GEOLOGY

The regional geology near Barren Island and surrounding Dorchester County, MD consists mostly of Holocene and Pleistocene deposits, as indicated on the surficial geology map published by the Maryland Geological Survey (Owens & Denny, 1986). The map identifies three geological formations in the vicinity of Barren Island: Kent Island Formation, tidal marsh deposits, and the Chesapeake Group. The surficial geology of Barren Island is comprised of the Kent Island Formation and tidal marsh deposits. Underlying both deposits is the Chesapeake Group. A review of historic maps dating as far back as 1898 from the U.S. Geological Survey indicate the Barren Island has experienced significant erosion over the past century. Borings were drilled both outside and within the historic footprint of the island. For context, Attachment F includes the boring location plan superimposed on a historic map of the island.

3.1.1 Kent Island Formation

The Kent Island Formation consists of interbedded silt, clay, and sand, with abundant organic matter in places (Owens & Denny, 1986). The formation ranges in thickness from about 10 – 40 feet. In southwest Dorchester County, the formation underlies long, narrow areas separated by tidal marsh. The formation dates to the Pleistocene epoch.

3.1.2 Tidal Marsh Deposits

Tidal marsh deposits consist of silt or clay, locally mixed with thin beds of sand (Owens & Denny, 1986). The sediment is dark gray to gray-brown due to decayed organic matter and is unconsolidated. Tidal marsh deposits date to the Holocene epoch.

3.1.3 Chesapeake Group

The Chesapeake underlies both the Kent Island Formation and tidal marsh deposits (Owens & Denny, 1986). The Chesapeake Group consists of interbedded loose micaceous sand, dark silt, and clay. There are limited outcrops of the formation in Dorchester County.

3.2 IN-SITU TESTING

Index property testing of the samples obtained from the SPT testing verified the material properties from the CPT and DMT tests. All logs were used to develop geologic profiles along the proposed alignment. In-situ testing for the strength of the foundation materials consisted of SPT, CPT, DMT, and FVS tests. Where tests were clustered together, correlations for all tests were plotted on top of each other and collectively used to determine the strength of the foundation materials.

3.3 STRATA AND GEOLOGIC PROFILES

CPT testing provided the most comprehensive data on the subsurface stratigraphy. To verify the soil behavior types determined from the CPT testing, a total of 10 borings, each to a depth of approximately 60 ft, were collected at the same location as 10 of the CPT tests. Two commonly computed CPT soil behavior types were determined. The first relates the soil behavior type to the friction ratio and cone resistance (f_s/q_c and q_c) and the second relates the soil behavior type to the corrected cone resistance and the pore pressure ratio (q_t and $\Delta u/(q_t - u_0)$) (FHWA, 1988, p. II: 63). The soil behavior type classifies the soil into 12 distinct zones, each with a description of how the soil behaves (FHWA, 1988, p. p. II:63). For example, the description of a soil with a classification of 3 is clay and the description of a soil with a classification of 7 is silty sand to sandy silt. After reviewing the USCS classifications from the gradation logs and comparing them to the soil behavior types of the corresponding CPT tests, it was clear that soil behavior types based on the pore pressure ratio more closely matched the USCS classifications. By comparing the laboratory testing results to the CPT soil behavior types, the following correlation between soil behavior type and gradation was developed:

CPT Soil Behavior Type Classification (Pore Pressure Parameter)	Corresponding USCS Classification
2, 3, 4	CL, CH, ML, SC
5, 6, 7, 8	SM
9	SM, SP-SM

Table 1: CPT Soil Behavior Types

3.3.1 Stratum 1: Lean Clay, Clayey Sand, and Sandy Clay

This stratum is encountered primarily at the existing mudline and can also be found underlying Stratum 2: Silty Sand and Clayey Sand. Average layer thickness for surficial layers is approximately 10 ft. Interbedded layers are as thin as one (1) ft and as thick as approximately 20 ft. This stratum consists primarily of lean clay, clayey sand, sandy clay, and limited non-plastic silts. The soil behavior type (SBT) is generally between 2 and 4, indicating the silts behave in an undrained manner, as evidenced by the generation of excess pore water pressure during CPT testing. Shear strengths outside of the footprint of the historic island are generally quite low, in the range of approximately 50 psf to 200 psf. Blow counts range from weight of hammer (WOH) to four (4). Shear strengths within the historic footprint of the island are higher (300 psf and higher).

3.3.2 Stratum 2: Silty Sand and Clayey Sand

This stratum is the primary stratum that underlies the entire site. This stratum consists of silty sands and clayey sands, with varying fines contents. Fines contents ranged from as low as six (6) to as high as forty-nine (49), with an average fines content of twenty-four (24). Almost no clean sands were encountered. The SBT is generally between 5 and 9. Increasing SBT indicates decreasing fines content. This stratum has a wide range of thicknesses and can be found interspersed with Stratum 1: Silt. Blow counts range from WOH to thirty-nine (39). Correlated friction angles vary from as low as thirty (30) degrees to as high as fifty (50) degrees, but these values were not directly used in the analyses. Refer to Section 3.4 for more details. This stratum is underlain by Stratum 3: Clay.

3.3.3 Stratum 3: Clay

The stratum is found in almost every log. It consists of lean clay and fat clay, with an average plasticity index of approximately 25. This stratum is usually encountered at depths around 30 ft, but can be found in depths as shallow as 22 ft. Pockets of silty sand were encountered in a few boreholes. The strength of this stratum varies, but all of it is overconsolidated to varying degrees. The material was determined to be overconsolidated by examining the ratio of undrained shear strength to the in-situ effective stress. In a normally consolidated material, one would expect this ratio to be between 0.2 and 0.3 (Kulhhawy., 1990, pp. 4-28). Plots of this ratio can be found in Attachment H. The ratio almost always exceeds 0.5 and in many cases, exceeds 1.0. Blow counts range from WOH to seventy-one (71). Shear strengths in this layer are generally over 1000 psf and increase with depth, up to approximately 10,000 psf for the depths measured.

3.4 UNDRAINED SHEAR STRENGTH DETERMINATIONS

Undrained shear strengths were determined using all of the available data (CPT, DMT, and FVS) except SPT data. Data from CPT tests was calibrated with the FVS data to determine correlation coefficients for undrained shear strength. Shear strengths derived from the dilatometer data and blow counts were plotted on top of the CPT data. At every CPT location, plots were created showing the shear strengths calculated from each method. Blow counts were ultimately not correlated to undrained shear strengths because of the wide range of shear strengths one blow count represents.

3.4.1 Field Vane Shear

Field vane shear was the basis against which undrained shear strengths from all other in-situ testing were calibrated and compared. Fifteen (15) vane shear tests were performed at eleven (11) separate locations. All of these locations coincided with SPT testing. Six of the locations coincided with CPT testing and four of these locations coincided with DMT testing. FVS was primarily collected in depths of less than 20 ft to verify the strengths in the shallow layers most important to the slope stability analysis, but a few tests were performed to verify strengths in the foundation clays.

Gradation analysis and Atterberg limit testing were performed for the samples collected during the associated SPT testing. With the exception of samples taken at B-246, all tested samples in depths less than 20 ft had a plasticity index less than 16. All samples tested at depths greater than 20 ft had a plasticity index between 20 and 25. Undrained shear strengths were corrected using the Bjerrum correction (Duncan, 2014, p. 67) factor. Because none of the materials were highly plastic, the corrected shear strengths are very close to the uncorrected shear strengths.

Samples collected in Stratum 1 were either nonplastic or had a low plasticity index (PI <= 10). Care must be taken interpreting results of in-situ testing of low-plasticity silts because it is difficult to assess whether the tests are determining drained behavior, undrained behavior, or something in-between (Duncan, 2014, p. 52). CPT soil behavior types indicate the soil was behaving in an undrained manner. Strength used for slope stability analysis were determined by taking into consideration the results of all in-situ testing, and are discussed in Section 4.6.4.

Boring	Associated DMT/CPT	Depth [ft]	Elevation [ft, NAVD88]	USCS, Plasticity Index	Uncorrected Shear Strength (psf)	Bjerrum Correction Factor	Corrected Shear Strength (psf)
B-201	None	7	-9.7	CL, *	40	1.0	40
		8	-10.7	CL, *	20	1.0	20
		41	-43.7	CL, 25	2320	0.9	2090
B-224	CP-224, DMT-206	35	-41.6	CL, 24	4220	0.9	3800
B-227	CP-227	6	-15.5	CL, *	200	1	200
		30	-39.5	CL, 21	5200	0.9	4680
B-230	CP-230	4	-10.4	CL, *	40	1.0	40
		14	-20.4	SC, 3	40	1.0	40
B-232	CP-232, DMT-205	13	-20.1	SC, 16	340	1.0	340
B-244	CP-244, DMT-201	7	-12.1	ML, 10	100	1.0	100
B-246	CP-246, DMT-212	7	-12.1	CH, 31	100	0.9	90
B-302	None	6	-14.8	SM, 3	1000	1.0	1000
B-303	None	6	-14.7	CL, 25	1180	0.9	1060
B-304	None	4	-11.9	CL, 19	1230	1.0	1230
B-305	None	10	-17.5	SC, 10	940	1.0	940

*Not enough sample to run PI.

Table 2 : FVS Summary

3.4.2 CPT

Two different methods were used to calculate the undrained shear strength for soil having a SBT below 4. The first method is the Nkt method in which shear strength is determined according to the following equation:

$$S_u = \frac{q_t - \sigma_{vo}}{N_{kt}}$$

$S_u = undrained\ shear\ strength$

$q_t = corrected\ cone\ tip\ resistance$

$\sigma_{vo} = total\ vertical\ stress$

$N_{kt} = correlation\ coefficient$

The second method correlates the excess pore pressure to the undrained shear strength according to the following equation:

$$S_u = \frac{\Delta u}{N_{\Delta u}}$$

$\Delta u = excess\ pore\ pressure$

$N_{\Delta u} = pore\ pressure\ parameter$

The first method requires an estimate of the total vertical stress. Soil unit weights were estimated using the correlation from T. Lunne, as presented in the CPeT-IT user's manual (GeoLogismiki, 2014, p. 88). Unit weights are assumed constant for each soil behavior type index. Consideration was given to the unit weight estimation method by Mayne, which is a function of sleeve friction and effective vertical stress (Mayne, 2010, p. 4). However, the Mayne method produced unrealistically low unit weights in materials with low sleeve friction.

Values of both correlation coefficients were varied until the shear strengths computed from the CPT data most closely matched the shear strengths computed from the vane shear data. For the Nkt method, two values provided best fit. Best fit in Stratum 1 was found using Nkt = 20. Best fit in Stratum 3 was found using Nkt = 11. Best fit using the pore pressure method of computing strengths was found using $N_{\Delta u}$ = 8 and did not require different parameters in the two different strata. Attachment G includes the plots used to calibrate the CPT data against the FVS data. The CPT logs provided in Attachment C include the measured CPT data and basic index parameters. Attachment H includes plots of the correlated shear strengths.

3.4.3 DMT

Undrained shear strengths were computed from the DMT results using the WinDMT program. Shear strengths were determined for all testing intervals with an I_D (material index) less than 0.6. The program uses the following equation:

$$S_U = 0.22\sigma'_v(0.5k_D)^{1.25}$$

$S_u = undrained\ shear\ strength$

$\sigma'_v = effective\ vertical\ stress$

$k_D = horizontal\ stress\ index$

The program computes unit weights for materials using Marchetti's relationship between I_D and the dilatometer modulus (E_D) (FHWA, 1988, p. III: 4.19). DMT logs are provided in Attachment D and include measured DMT data, calculated intermediate parameters, and computed shear strengths. Shears strengths derived from the DMT are also plotted against shear strengths derived from the CPT data in Attachment H.

3.4.4 SPT

A single blow count from an SPT test covers a wide range of shear strength values. A blow count of less than N=1 (WOH or WOR) covers strengths between approximately 0 psf and 800 psf. In every case, a blow count greater than or equal to 1 will provide an adequate factor of safety against slope failure. Unfortunately, many of the blow counts were less than 1. Enough FVS and CPT data was collected so that shear strengths did not have to be determined with blow counts.

3.5 Drained Shear Strength Determinations

Drained shear strengths in cohesionless materials were determined primarily from CPT and DMT testing, but strengths were also correlated with SPT blow counts. For the few SPT borings where a CPT was not also performed at the same location, drained shear strengths were determined from blow counts. Laboratory testing was performed to determine drained shear strengths in cohesive materials, but correlations were ultimately used.

3.5.1 CPT

Two different methods were used to calculate the friction angle for soil having a SBT greater than 4. Both friction angles are effective stress friction angles for triaxial compression. The Kulhawy and Mayne (Kulhhawy., 1990, p. 4.15) approximation was computed according to the follow equation:

$$\emptyset_{TC} = \tan^{-1}[0.1 + 0.38 * \log\left(\frac{q_c}{\sigma'_{vo}}\right)]$$

$\emptyset_{TC} = Friction\ angle\ (triax.\ compression)$

$q_c = tip\ resistance$

$\sigma'_{vo} = effective\ vertical\ stress$

The Robertson and Campanella correlation, as reported by Duncan (2014, p. 48) was computed according to the follow equation:

$$\emptyset_{TC} = \tan^{-1}[\frac{1}{2.68}[\log(\frac{q_C}{\sigma'_{vo}})] + 0.29]$$

$All\ variables\ same\ as\ above.$

While the use of the triaxial compression friction angle is almost always conservative, care must be taken when using these correlations for sands with high fines contents. Both of these methods are based on laboratory testing of unaged and uncemented sands, primarily low to medium compressibility sands with little fines (Kulhhawy., 1990, p. 2.30). Because nearly all the sands at Barren Island are silty or clayey, friction angles were reduced in the slope stability analysis to account for the decrease in strength due to the presence of fines.

3.5.2 DMT

Drained shear strengths were computed from the DMT results using the WinDMT program. Friction angles were determined for all testing intervals with an I_D (material index) greater than 1.2. The program uses a complex iterative procedure which does not lend itself to hand or spreadsheet computation. The procedure is documented in (FHWA, 1988, p. 4.28). The program reports the plane strain friction angle, which is different than the friction angle computed with the CPT correlations. To convert the plane strain friction angle to the triaxial compression friction angle, the following equation from (FHWA, 1988, p. 5.14) was used:

$$\emptyset_{TC} = \emptyset_{ps} - (\tfrac{\emptyset_{ps}-32}{3}) \text{ for } \emptyset_{ps} > 32$$

$$\emptyset_{TC} = \emptyset_{ps}\ for\ \emptyset_{ps} \leq 32$$

$\emptyset_{TC} = triaxial\ compression\ friction\ angle$

$\emptyset_{ps} = plane\ strain\ friction\ angle$

3.5.3 SPT

Several correlations between friction angle and blow-count were reviewed. Duncan provides numerous correlations with blow count alone, but given the relatively low blow counts in Stratum 2: Silty Sand and Clayey Sand, many of these methods resulted in correlated friction angles less than 30 degrees (Duncan, 2014, p. 47). A correlation by Kulhawy was chosen because it specifically accounts for the overburden stress (Kulhhawy., 1990, pp. 4-14):

$$\emptyset_{TC} = \tan^{-1}\left[\left(\frac{N}{12.2 + 20.3 * \frac{\sigma'_{vo}}{p_a}}\right)^{0.34}\right]$$

$\emptyset_{TC} = triaxial\ compression\ friction\ angle$

$N = blow\ count\ (60\%\ efficiency)$

$\sigma'_{vo} = effective\ vertical\ stress$

$p_a = atomospheric\ pressure$

3.5.4 Laboratory Testing

Laboratory testing was used to determine the drained shear strength of cohesive materials for use in the long-term slope stability analysis. Four three-point consolidated-undrained (CU) triaxial tests with pore water pressure measurements were performed. The three points correspond to three different confining pressures, approximately equal to: the in-situ vertical effective stress, the proposed vertical effective stress, and a stress in excess of the maximum past pressure. The water pressure measurements allow computation of the effective stress at failure and thus the effective stress friction angles. Effective stress friction angles were computed by setting the cohesion to zero and drawing a best-fit tangent line to the three Mohr's circles at failure. Failure was evaluated using the maximum principal stress ratio (greatest σ_1/σ_3) and the maximum deviator stress (σ_1- σ_3).

Results are summarized in *Table 3*. Individual test results are provided in Attachment J.

Boring	Depth (ft)	USCS Classification	Effective Stress Friction Angle, ϕ (stress ratio)	Effective Stress Friction Angle, ϕ (deviator)
B-207	12 - 16	SC	40.0	39.3
B-207	35 -39	CL	35.2	36.5
B-224	30 - 34	CL	41.2	48.6
B-244	5 - 9	ML	36.9	36.1

Table 3 : CU Test Result Summary

Values for effective stress friction angles were higher than expected. Duncan reports typical friction angles for CU tests for silts between 33 and 41 degrees (Duncan, 2014, p. 58). Duncan reports typical values for clays with a plasticity index of 10 as 33 +/- 5 degrees (Duncan., 1980, p. 74). Values are thought be higher because of inaccurate pore water pressure measurements. Inaccurate water pressure measurements explain why undrained shear strengths align with field data, but drained shear strengths (determined by the same test) are not accurate. For tests where water pressure is measured, *EM 1110-2-1906: Laboratory Soils Testing* says that the time to reach maximum deviator stress should generally be at least 120 minutes and considerably longer for materials of low permeability (USACE, 1986, pp. X-36). The longer time to failure allows the water pressure within the sample to equilibrate. Samples reached maximum deviator stress between approximately 30 and 45 minutes. Because the samples were failed too fast, the reported water pressure measurements and thus the drained shear strengths are not thought to be accurate. Long-term stability of the proposed structures was not expected to control the design, so effective stress friction angles of cohesive materials were set to 30 degrees. Based on the typical reported values for low-plasticity silts and clays, this value is conservative, but still provides enough strength for an acceptable long-term factor of safety.

3.6 COMPRESSIBILITY

Soil compressibility was determined using the CPT and DMT data. The constrained modulus derived from the CPT data was calibrated against the modulus derived from the DMT data. The DMT modulus was verified using the results of the laboratory oedometer testing on undisturbed samples.

3.6.1 CPT and DMT Correlations

DMT tests provide one of the best sources of compressibility and deformation characteristics of in-situ soil. At every testing interval, the DMT provides an estimate of the in-situ elastic modulus at in-situ effective stress. Similarly, correlations can be used to determine the elastic modulus with CPT data, though DMT is generally recognized as providing better estimates of elastic modulus.

The constrained modulus was computed from the DMT data using the WinDMT program, which computes it according to the following formula:

$$M = R_M * E_D$$

$M = constrained\ elastic\ modulus$

$R_M = correlation\ coefficient$

$E_D = dilatometer\ modulus$

Equations for the correlation coefficient can be found in FHWA 1988 (III: 4.43). Using the CPT data, the constrained modulus can be correlated to the cone resistance:

$$M = \alpha * q_C$$

$\alpha = correlation\ coefficient$

For each DMT test that was performed, there was also a corresponding CPT test. The moduli computed using the CPT and DMT test were plotted against each other for each of the 12 DMT tests. Assuming that the values derived from the DMT were more accurate, values of the α coefficient were varied to provide the best agreement between the two tests. It was found that one value of α provided good agreement for drained soils, and two values of α provided good agreement for undrained soils. The two values for α corresponded to the two different strata of undrained soils: Stratum 1 and Stratum 3. This is because the DMT data does a much better job at accounting for the stress history and corresponding elastic properties. The CPT data does not directly account for variations in over-consolidation ratio and their effect on compressibility characteristics. In summary, the best-fit α values were:

$$\alpha_{drained} = 9$$

$$\alpha_{undrained,\ Stratum\ 1} = 6$$

$$\alpha_{undrained,\ Stratum\ 3} = 17$$

Values of α are independent of units used because units for the modulus and the cone resistance are the same.

3.6.2 Laboratory Oedometer Testing

Oedometer testing was performed to verify the constrained modulus determined from the DMT and CPT data. Testing was performed on four samples, but only three of the samples had corresponding DMT and CPT data. The fourth sample (B-207 at a depth of 35 – 39 ft) did not have corresponding DMT and CPT data because both tests hit early refusal before a depth of 35 ft. Laboratory data can be found in Attachment J. For each test, the constrained modulus for the load increment nearest the proposed load increment (in-situ vertical effective stress to proposed vertical effective stress) was determined:

$$M = {}^{\Delta\sigma}/_{\Delta\varepsilon}$$

$$\epsilon = \frac{\Delta e}{1 + e_o}$$

$M =$ *constrained elastic modulus*

$\Delta\sigma$ = stress increment

$\varepsilon = strain$

$e_o = initial\ void\ ratio$

Table 4 presents the comparison of the test results. All values of constrained modulus were reported with only one significant figure to reflect the amount of uncertainty in the measurement. Overall, there is excellent agreement among all tests, giving confidence that accurate estimations of settlement can be computed using the correlated moduli from the CPT and DMT data.

Boring	Sample Depth (ft)	Constrained Modulus from DMT (tsf)	Constrained Modulus from CPT (tsf)	Constrained Modulus from Oedometer (tsf)
B-207	12 - 16	30	50	50
B-224	30 – 34	200	300	300
B-244	5 – 9	10	10	10

Table 4: Oedometer Test Results and Comparisons

4 CROSS SECTION DESIGN

Cross sections were designed according to technical guidance provided in the *Shore Protection Manual*, *EM 1110-2-2904: Design of Breakwaters and Jetties,* and *CERC-93-19: Engineering Design Guidance for Detached Breakwaters as Shoreline Stabilization Structures*. The coastal engineer provided critical design parameters. Geotechnical aspects of the design included armor stone geometry, underlayer design, and foundation filter design.

4.1 DESIGN PROCEDURE

The design of the cross sections for all structures followed the guidance of the *Shore Protection Manual*, *EM 1110-2-*2903, and *CERC-93-19. EM 1110-2-2903* provides a comprehensive design procedure for the design of rubble-mound structures. *EM 1110-2-*2903 provides recommendations for rubble-mound structures subject to seaward wave exposure with zero-to-moderate overtopping and structures with wave exposure from both sides with moderate overtopping. In the long-term, the majority of structures on Barren Island will not be subject to waves from both sides, but because the construction sequencing will subject the structures to waves on both sides for many years, the cross section for wave exposure from both sides was selected as the basis for design. Figure 1 is the cross section from *EM 1110-2-2903*.

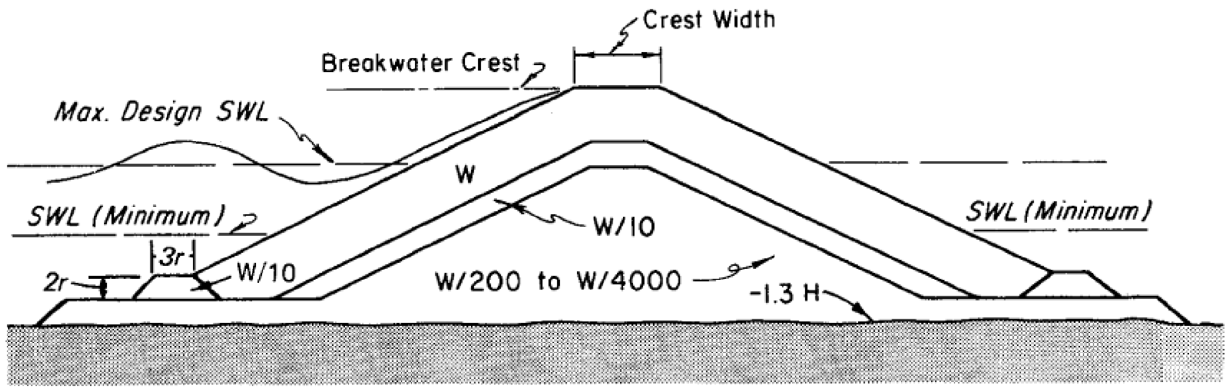


Figure 1: Rubble-Mound Section for Wave Exposure from Both Sides with Moderate Overtopping (USACE, 1986, p. 4.13)

Some modifications had to be made to the cross section for the conditions at Barren Island. *CERC-93-19* provides additional design guidance for conventional breakwaters, low-crested breakwaters, and reef breakwaters. The typical cross sections provided in *EM 1110-2-*2903 are for conventional high-crested breakwaters. In some cases, the geometry of the structure does not allow for construction of all the typical layers of a conventional breakwater (USACE, 1993, p. 95). At Barren Island, the coastal engineer recommended a shorter structure, somewhere in between a conventional breakwater and a low-crested breakwater. Given the shallow height of the structures, incorporating multiple underlayers was not practical. Recommendations from *CERC-93-19* were taken to simplify the design of the structure and make it constructable. For every section except the breakwater section, the core and bedding layer was designed so that it could also meet filter requirements for the armor stone, eliminating the need for a separate underlayer.

4.2 COASTAL CONSIDERATIONS

The coastal engineer separated the Barren Island alignment into five distinct sections based on the coastal climate and the existing structures: Northeast Sill, Existing Sill, Southwest Still, Southeast Sill, and Breakwater. For each section, the coastal engineer provided the crest elevation, crest width, armor stone size, number of armor stone layers, and armor stone slopes. Random placement was specified for all armor stone sections. The breakwater elevation was increased from the recommended El. 8.0 to the proposed elevation of El. 8.5 to account for settlement, as discussed in Section 4.7.

Reach	Crest Elevation (ft, NAVD88)	Crest Width (ft)	Armor Stone W_{50} (lbs)	Number of Armor Units	Armor Stone Slope
Northeast Sill	6.0	7.5	2600	2	1.5H:1V
Existing Sill	6.0	9.0	4300	2	1.5H:1V
Southwest Sill	6.0	9.0	4300	2	1.5H:1V
Southeast Sill	6.0	9.0	4300	2	1.5H:1V
Breakwater	8.5	9.5	5400	2	1.5H:1V

Table 5: Coastal Reaches and Parameters

4.3 Armor Stone Design

EM 1110-2-2903 and the *Shore Protection Manual* go into great detail on the engineering design of cover layers. They present several alternatives and design methods for the alternatives. Rubble mound structures are the most common. Based on previous experience with armored slopes at Poplar Island, the coastal engineer selected a rubble mound structure for the design.

The manual specifies that armor stone slopes shall be no steeper than 1.5 Horizontal : 1 Vertical (1.5:1) (USACE, 1986, p. 4.11). The existing structures at Barren Island were built with 1.5:1 slopes. Given that the structures were built between 2003 and 2009 and are still standing with little damage, it can be surmised that 1.5:1 side slopes are indeed stable. The coastal engineer selected a 1.5:1 side slopes for both sides of all structures.

Crest elevation and width of the structures were specified by the coastal engineer. Typically, at the beginning of the design, the coastal engineer selects a design wave height which will reduce the wave climate in the lee of the structure to an acceptable limit. For the current design, the coastal engineer specified the crest elevation corresponding to total water level (TWL) elevations at varying recurrence intervals. EM 1110-2-2093 specifies that the armor stone should be extended downslope to an elevation below minimum still water level (SWL) elevation of 1.5 times the design significant wave height (see *Figure 1*). Given the shallow elevation of the structures and the design wave heights, the armor stone was extended all the way down both slopes. The armor stone was also selected for the toe of the structures for the same reasons.

Armor stone gradation was based on the gradations employed at Poplar Island and the technical guidance provided in *CERC-93-19.* Armor stone gradation is a balance between stability of the proposed armor stone, cost of producing the stone, and practicality of producing the stone. An excessively narrow gradation will increase the cost of the structure, and an excessively wide gradation might impact the stability of the structure. *CERC-93-19* provides a recommended upper and lower limit to armor stone gradations based on the median armor stone weight – the Dutch Wide and Dutch Narrow gradation (USACE, 1993, p. 97). Using the equations in the text:

% Passing	Dutch Wide Gradation (W_x')	Dutch Narrow Gradation (W_x')	Average (W_x')
2	0.19	0.63	0.41
15	0.30	0.72	0.5
50	1	1	1
85	3.37	1.4	2.4
98	5.29	1.6	3.45

$$W_x' = \frac{W_x}{W_{50}}$$

$$W_x = weight\ for\ x\ \%\ passing$$

$$W_{50} = median\ armor\ stone\ weight$$

Table 6: Dutch Wide and Dutch Narrow Gradations

Taking both recommended limits into consideration, the following armor stone gradation is proposed:

% Passing	Proposed Gradation (W_x')
0 - 2	0.4
0 – 15	0.5
35 - 55	1
85 – 100	1.5
98 - 100	2

Table 7: Proposed Armor Stone Gradation

Using the proposed gradation, the following example armor stone gradation is calculated for the 5400 lb armor stone:

% Passing	Proposed Weight (lb)
0 - 2	0.4 * 5400 = **2200**
0 – 15	0.5 * 5400 = **2700**
35 - 55	1 * 5400 = **5400**
85 – 100	1.5 * 5400 = **8100**
98 - 100	2 * 5400 = **10**,**800**

Table 8: Example Armor Stone Gradation

The Poplar Island stone specification was chosen for the required physical properties of the stone. Table 9 provides a summary of the properties. Potential quarries were investigated which could provide stone meeting the specification. The quarry investigation is included in Attachment M.

Property Test	Method	Test Value
Petrography	ASTM D-4992 ASTM C-295	Fresh, interlocking crystalline, with few vugs (petrology), no planes of weakness, no clay minerals, and no soluble minerals
Specific Gravity	ASTM C-97 ASTM D-6473	2.65 minimum
Absorption	ASTM C-127 ASTM D-6473	Less than 1%
Abrasion	ASTM C-535 ASTM C-131	Less than 20% loss for 500 revolutions
Magnesium Sulfate	ASTM C-88 ASTM D-5240	Less than 5% loss soundness for 5 cycles
Freezing and Thawing	ASTM D-5312	Less than 2% loss after 30 cycles
Wetting and Drying	ASTM D-5313	Less than 2% loss after 80 cycles

Table 9: Armor Stone Physical Properties

4.4 Underlayer Design

According to EM 1110-2-2093, for conventional breakwaters, the first underlayer shall be at least two stones thick and be 1/10th the weight of the armor stone (USACE, 1986, p. 4.16). With the shallow height of the structures and relatively large thickness of armor stone, a first underlayer is impractical for every section except the breakwater. The breakwater was designed with core stone that serves as both the underlayer and the core stone. Table 9 presents the proposed core store gradation. It is similar to the armor stone gradation, but allows for a slightly wider range of weights above 50% passing.

% Passing	Proposed Weight (lb)
0 - 2	220
0 – 15	270
35 - 55	540
85 – 100	1100
98 - 100	1600

Table 10: Proposed Underlayer/Core Stone

4.5 Bedding Layer and Foundation Filter Design

The foundation along the alignment changes and is either silty sand, silt, or lean clay, as indicated on the geologic profiles provided in Attachment F. EM 1110-2-2093 recommends the use of a bedding layer and filter blanket (USACE, 1986, p. 4.16). The bedding layer and filter blanket serve many purposes including protecting the structures from excessive settlement resulting from leaching and protecting the foundation of the structures from undermining (USACE, 1986, p. 4.16). The manual recommends a protective layer of quarry run between 4 and 7 inches in diameter. *CERC-93-19* provides two filter criteria for bedding and armor stone (USACE, 1993, p. 64):

$$\frac{d_{50,armor}}{d_{50,bedding}} < 6.8$$

$$d_x = diameter\ at\ x\ \%\ passing$$

$$\frac{d_{15,armor}}{d_{85,bedding}} < 4$$

To avoid multiple types of bedding stone, one bedding stone was selected that would meet filter criteria for the largest armor stone size (W_{50} = 5400 lb). The bedding layer also doubles as the core material for existing sill, southwest sill, and southeast still. The northeast sill has no core stone. PennDOT R-4 was selected as the bedding layer for all structures. This is larger than the typical 4 – 7-inch diameter quarry run used in conventional breakwaters, but the larger size is necessary to meet filter criteria. R-4 has the following gradation (PennDOT, 2020, p. Section 850):

Rock Size, inches	R-4 (% Passing)
12	100
9	
6	15 - 50
4	
3	0 - 15
2	

Table 11: PennDOT R-4

EM 1110-2-2093 states that a plastic filter cloth (geotextile) or a crushed stone layer can be used as a filter blanket, but must meet filter criteria with the existing foundation materials. The predominant surficial foundation material is fine silty sand. Both Moffat and Nichol (1983) and FHWA (FHWA) provide guidance for determining the apparent opening size of geotextile used in dynamic flow environments. Even with the most lenient criteria in Moffat and Nichol (Moffat and Nichol, 1983, p. 294), filter criteria still can't be met with an apparent opening size equivalent to the #70 sieve. The #70 sieve is approximately the finest commercially available geotextile apparent opening size which also meets strength and survivability requirements, as discussed in the next section. Because filter criteria can't be met with a geotextile alone, a combination of geotextile and #10 stone was selected. #10 stone meets traditional filter criteria with the foundation materials and the geotextile meets filter criteria with the #10 stone. (USACE, 1986, p. 4.13). Figure 1 depicts the complete bedding layer and foundation filter system. The gradation for the #10 stone is provided in Table 11.

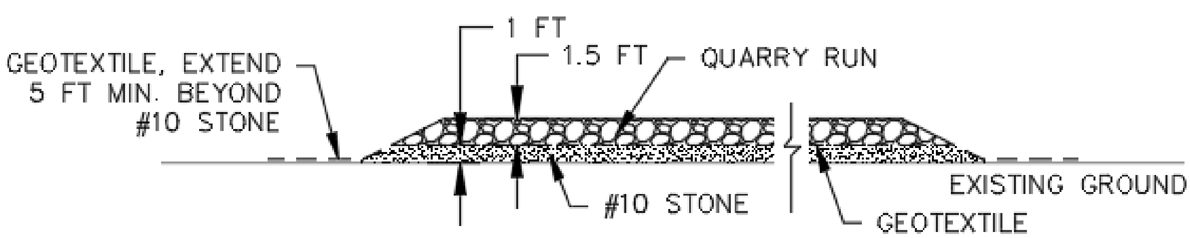


Figure 2: Proposed Bedding Layer and Foundation Filter

Sieve	AASHTO M43 Specification, % Passing	Vulcan Tested Gradation, % Passing
3/8” (9.5 mm)	100	100
#4 (4.75 mm)	85 – 100	98.8
#8 (2.36 mm)		72.6
#10 (2 mm)		66.5
#16 (1.18 mm)		48.5
#20 (0.85 mm)		41.0
#30 (0.6 mm)		34.6
#40 (0.425 mm)		29.8
#50 (0.3 mm)		26.4
#80 (0.18 mm)		23.3
#100 (0.15 mm)	10 - 30	21.0
#200 (0.075 mm)		16.84

Table 12: #10 Stone Gradation

4.5.1 Proposed Geotextile

The proposed geotextile is primarily based on experience with geotextiles used at Poplar Island. Besides design guidance given in *Geosynthetic Design and Construction Guidelines* (FHWA, 1998) and *Construction Materials for Coastal Structures* (Moffat and Nichol, 1983), there exists little recent design guidance for geotextile applications in marine environments. In this case, the best resource for design guidance is past performance history with geotextiles in similar environments. The Poplar geotextile design was first documented in the *Poplar Island Phase II DDR* (USACE, 2000) and more recently, the *Poplar Island Expansion DDR* (USACE, 2015). Slight changes were made to permittivity, puncture strength, and seam strength.

Permittivity was slightly reduced to allow for use of the Thrace-Linq GTF-500 fabric. Even though the Poplar specification calls for a permittivity of 0.15 /sec, the fabric used extensively in the lateral expansion of the island did not meet the specification. The fabric has performed well, so the proposed permittivity was reduced slightly to allow for use of GTF-500. Values of puncture strength for the Poplar Island geotextile had not been updated when ASTM D6241 was updated. The new ASTM standard uses a much larger diameter probe, so the previously specified puncture strength is no longer applicable. The proposed puncture strength was taken as the minimum of the puncture strength of the GTF-500 and 9197SPR fabrics. Seam strengths were updated. With increasing wide-width tensile strength, seam efficiencies tend to decrease. Typical seam efficiencies for fabric of this strength are usually 40-60% of the wide-width tensile strength. Lab testing submitted for the Poplar Island Lateral Expansion Contract 3 indicated a seam efficiency of 52% for the project. A 50% seam efficiency is proposed instead of specifying an exact number. If a higher strength fabric is selected, the required seam strength will also increase.

Property	Standard	Poplar Specification	Proposed Specification
Apparent Opening Size [U.S. Sieve]	ASTM D 4751	#70 - #100	#70 - #100
Permittivity [1/sec]	ASTM D 4491	0.15	0.135
CBR Puncture [lbs]	ASTM D 6241	120	1400
Grab Tensile Strength [lbs]	ASTM D 4632	300	300
Trapezoidal Tear [lbs]	ASTM D 4533	100	100
Ultraviolet Stability [% strength retained after 500 hours exposure]	ASTM D 4355	80%	80%
Wide-Width Tensile Strength [lb/in at ultimate strain]	ASTM D 4595	300	300
Factory Seam Strength [lb/in]	ASTM D 4595	180	50% of wide-width strength at ultimate strain
Field Seam Strength [lb/in]	ASTM D 4884	160	50% of wide-width strength at ultimate strain

Table 13: Poplar Island Geotextile Specification vs. Proposed Specification

4.5.2 Geotextile Availability

The proposed geotextile is atypical in its combination of high wide-width tensile strength and fine apparent opening size. There are many commercially available geotextiles which meet the majority of requirements with the exception of the apparent opening size. Most of the available geotextiles have an apparent opening size equivalent to the #40 sieve. There are geotextiles with finer apparent opening sizes, but most do not meet the strength requirements.

Representatives from several geotextile manufacturers and suppliers were contacted to discuss potential products that could be used. Manufacturers included TenCate, US Fabrics, WINFAB, and Carthage Mills. Manufacturers were provided the Poplar Island geotextile specification and asked if they had any products which meet specification. None of the manufacturers had off-the-shelf fabrics meeting specification, but representatives from WINFAB were especially helpful. WINFAB manufactures many of their geotextiles in Georgia and can produce custom geotextile to suit any need. WINFAB had previously worked on a fabric intended to meet the Poplar Island specification and provided the product sheet for the 9197SPR fabric. All reported properties are based on testing performed by their in-house laboratory.

Two known fabrics meet the proposed geotextile specification – Thrace-LINQ GTF-500 and WINFAB 919SPR. Manufacturer reported properties are included in Table 13. With the potential demand of several hundred thousand square yards, if not a million square yards, it is expected that other geotextile manufacturers could develop products which also meet the proposed specification. Barren Island will require over 100,000 square yards of geotextile and James Island will require several times more.

Property	Standard	Proposed Specification	Thrace-LINQ GTF-500	WINFAB 9197SPR
Apparent Opening Size [U.S. Sieve]	ASTM D 4751	#70 - #100	#80	#70
Permittivity [1/sec]	ASTM D 4491	0.135	0.136	0.15
CBR Puncture [lbs]	ASTM D 6241	1400	1400	1600
Grab Tensile Strength [lbs]	ASTM D 4632	300	600	300
Trapezoidal Tear [lbs]	ASTM D 4533	100	200	100
Ultraviolet Stability [% strength retained after 500 hours exposure]	ASTM D 4355	80%	80%	-
Wide-Width Tensile Strength [lb/in at ultimate strain]	ASTM D 4595	300	400	300
Factory Seam Strength [lb/in]	ASTM D 4595	50% of wide-width strength at ultimate strain	213*	150
Field Seam Strength [lb/in]	ASTM D 4884	50% of wide-width strength at ultimate strain	-	-

- Indicates not reported

* Poplar Island Contract 3 independent laboratory testing

Table 14: Available Geotextile Products

4.6 Slope Stability Analysis

Slope stability analysis was conducted with Slope/W in accordance with EM 1110-2-1902: Slope Stability (USACE, 2003). Critical cross sections for each coastal reach were identified. At each location, simplified soil profiles were generated, and the proposed structures were modeled. The analysis revealed areas of poor foundation conditions which are incapable of supporting the proposed structures. Recommendations are provided for remediating the poor foundation.

4.6.1 Design Conditions and Methods

EM 1110-2-1902 identifies four design conditions for which slope stability should be evaluated: end-of-construction, long-term, maximum surcharge pool, and rapid drawdown (USACE, 2003, p. 3.2). The manual was primarily written for stability analysis of dams and levees, but can also be applied to coastal structures. The proposed structures at Barren Island will not be subjected to pools and rapid drawdowns. Only end-of-construction and long-term conditions are applicable. Past experience with design of coastal structures at Poplar Island indicates the most critical design condition is the end-of-construction condition, but long-term stability analysis was also conducted.

The Slope/W program was selected to perform the stability analysis. Slope/W gives several options for analysis method (for example Morgenstern and Price, Spencer, Bishop, Janbu). Each of the analysis methods employ different assumptions for inter-slice forces so that the resulting system of equations can be solved. Some methods satisfy all conditions of conditions of equilibrium (sum of horizontal forces, sum of vertical forces, and sum of moments) and some methods don't. A study by Duncan and Wright concluded that all methods which satisfy all conditions of equilibrium result in a factor of safety within +/- 5% (Duncan., 1980). For this analysis, Spencer's method was selected. Spencer's method satisfies all conditions of equilibrium.

4.6.2 Identification of Critical Sections

At least one cross section for each of the reaches identified by the coastal engineer was selected for slope stability analysis. Locations were selected by inspection of the plots of strength correlations at each CPT location, as shown in Attachment H. The worst locations for foundation strength are the locations which have thick layers of low-strength cohesive materials close to the ground surface. Cohesive materials were not encountered at the surface for the entire alignment. Near the northwest end of the project, the surficial geology is composed of silty sands, as indicated on the geologic profiles in Attachment F. Such locations were expected to yield acceptable factors of safety against slope failure, but slope stability analysis for these reaches was also performed.

4.6.3 Piezometric Line

Selection of pore water pressure conditions can have a significant impact on the computed factor of safety. While pore water pressure conditions don't affect the strengths of materials assumed to behave in an undrained matter, they decrease the strengths of cohesionless materials. Water pressures acting on the face of the proposed structures can also provide stabilizing forces on the structure which change as the water level changes. It's not immediately clear which water level is most conservative.

A series of analyses was performed to examine the effect of the water level on the factor of safety. Water levels were varied between mean lower low water (MLLW) and mean higher high water (MHHW) for two different foundation conditions: one with a cohesive foundation and one with a cohesionless foundation. In both cases, the same stone structure was modeled. In both cases, the lowest factor of safety was found using the lowest water elevation. For all subsequent analyses, a water elevation corresponding to MLLW (El. -1.2 NAVD88) was selected.

4.6.4 Material Properties

Material properties for the foundation were interpreted from the DMT and CPT correlations provided in Attachment H. A simplified soil profile was created at each CPT location a stability analysis was performed. The soil profiles can be seen on the slope stability figures provided in Attachment K. The soil profile consisted of drained layers with an effective stress analysis ($c = 0$ and ϕ), and undrained layers with a total stress analysis ($\phi = 0$ and c). Unit weights were estimated from the CPT logs and the correlation from Lunne (GeoLogismiki, 2014). Unit weights were then adjusted based on the correlated strength values. Units weights were increased for higher strength materials and decreased for lower strength materials.

Undrained shear strengths were used for the undrained analysis. The undrained shear strengths on the CPT plots were calibrated against the vane shear tests and corrected according to the Bjjerum correction, so they could be directly used in analysis. Layers with different shear strengths were identified and the average strength value from available correlations was used. In most cases, this meant that the average strength value from the Nkt and NΔu correlations was used. When there was also DMT data, the shear strength from the DMT data was also considered.

Drained shear strengths were also determined from the CPT and DMT correlations. Layers were identified based on trends in the correlated friction angle, but layers were not as distinct as the undrained layers. The correlations showed that the friction angle varied over short distances. To err on the side of conservatism, peaks in the friction angle with depth were ignored and values used were the low to average values. To correct for the fact that the correlations were derived from mostly clean sand, friction angles were further reduced by 2 degrees. There is precedent to suggest that with increasing fines, the peak friction angle decreases, but 2 degrees was based on judgement after consulting Chapter 2 of (Kulhhawy., 1990). Most discussion on the topic primarily deals with the effect of soil compressibility on correlations between cone tip resistance and relative density. However, fines content correlates directly with soil compressibility and relative density correlates directly with friction angle. Friction angles for drained layers were capped at 40 degrees.

Because the proposed structures consist entirely of stone, they were all modeled as one region. Stone was assigned a unit weight of 125 pcf (pounds per cubic foot) and a friction angle of 40 degrees. Tensile strengths from any geotextiles were ignored. The geotextile is intended to provide filtration between the foundation and stone materials. While it can provide strength to the dike, potential damage during construction and degradation of the geotextile could minimize or eliminate the potential strength.

4.6.5 Slope Stability Results and Recommendations

Slope stability was calculated for each reach. Early analysis of CPT data revealed extremely poor foundation conditions for the southernmost extent of the breakwater alignment provided in the feasibility study. This extent included CP-238 through CP-244. Through coordination with the environmentalist and coastal engineer, this problematic reach was eliminated prior to the 35% design, and the results are not included in this appendix. A summary of the results is presented below. Graphics are provided in Attachment K.

Reach	**Critical Foundation Condition**	**Short Term Factor of Safety**	**Failure Type**	**Acceptable**
Northeast Sill	CP-202	0.81	deep-seated	No
Northeast Sill (with foundation remediation)	CP-202	1.63	deep-seated	Yes
Northeast Sill	CP-208	1.93	toe	Yes
Existing Sill	CP-210	1.77	toe	Yes
	CP-219	1.45	deep-seated	Yes
Southwest Sill	CP-220	1.74	toe	Yes
Southeast Sill	CP-225	1.58	deep-seated	Yes
Breakwater	CP-225	1.33	deep-seated	Yes

Table 15 : Slope Stability Summary – End-of-Construction

Reach	Critical Foundation Condition	Long Term Factor of Safety	Failure Type	Acceptable
Northeast Sill	CP-202	Not Done		
	CP-208	1.93	toe	Yes
Northeast Sill (with foundation remediation)	CP-202	1.78	Toe	Yes
Existing Sill	CP-210	1.77	toe	Yes
	CP-219	1.65	toe	Yes
Southwest Sill	CP-220	1.79	toe	Yes
Southeast Sill	CP-225	1.78	toe	Yes
Breakwater	CP-225	1.69	toe	Yes

Table 16 : Slope Stability Summary – Long Term

As expected, deep-seated failures were observed for structures founded on cohesive foundations and toe failures were observed for structures founded on cohesionless foundation materials. EM 1110-2-1902 recommends a minimum factor of safety of 1.3 for end-of-construction conditions and 1.5 for long-term conditions (USACE, 2003, p. 3.2). The analysis revealed two additional problematic areas – one along the northeast sill and one along the southeast sill. The existing sill, southwest still, and revised breakwater reaches all have an acceptable factor of safety against slope failure.

Poor foundation conditions were encountered from CP-202 through CP-205. CP-201 was never performed because the shallow depth of water did not allow access for the CPT barge. Average shear strengths for the surficial layer of silt were approximately 100 psf, far less than what is needed to support the proposed structure. Upon further examination of historic dredging documents, it is surmised that this poor foundation material is the disposal site of dredged material from the Honga River Channel in the 80s. The material was likely placed unconfined, forming what is now known as Tar Bay Wildlife Management Area. Subsequent drilling was not performed because it was assumed that the unconfined disposal of the dredged material created poor foundation conditions in the entire vicinity and the ability to relocate the proposed structure would not be possible. If the sills must be built in this area, foundation removal and replacement will be necessary. This will require removal to a depth of approximately 7 ft for a length of 2500 ft. The slope stability results presented in Table 15 and Table 16 include the factor of safety for the recommended foundation remediation, which is discussed in more detail in the next section.

Problematic foundation was also encountered along the southeast sill at CP-246. CP-246 contains a 10 ft layer of silt with a shear strength of approximately 100 psf. B-306 also shows the presence of this layer.

Historical mapping of the island from as far back as 1898 reveals that this a portion of the southeast alignment is not founded on the historic footprint of the island. Accretion of silt in this area could explain the poor foundation conditions. Fortuitously, the environmentalist wanted to change the southeast alignment so that it is much closer to the existing shoreline at Barren Island. The change was made after the demobilization of the drill crew, so additional subsurface exploration could not be performed. It is assumed that if the proposed southeast sill is located near the shore and on the historical footprint of the island, the sill can be placed without the need for foundation removal and replacement.

4.6.6 Foundation Remediation Recommendations for Northeast Sill

Several potential options exist for constructing embankments on poor foundation. Some options include pre-loading, staged construction, use of lightweight fill, use of displacement sections, and excavation. Excavation and replacement is the recommended alternative.

4.6.6.1 Pre-Loading or Staged Construction

Pre-loading or staged construction involves pre-consolidating the foundation with thin lifts of material over a period of months of years. As more lifts are added, the foundation consolidates and gains strength, allowing the placement of the next lift. Pre-loading is typically done with fill material that will not become part of the final structure, while staged construction is done with the actual structure material. This method of construction can be effective when the foundation strength is marginally less than what is required to achieve a satisfactory factor of safety. Pre-loading and staged construction were not selected because the foundation material is so weak that is incapable of supporting even small loads. The first lift of material would cause a bearing failure and the immediate displacement of the existing foundation.

4.6.6.2 Use of Lightweight Fill

Whereas the typical saturated unit weight of stone is 125 - 130 pounds per cubic foot depending on the placement density, lightweight fill can have a significantly lower unit weight – closer to that of water. The lower unit weight reduces the pressure at the foundation and can improve slope stability. Possible materials include wood debris, lightweight slag, and shell. Lightweight fill was not chosen because the reliability of the fill materials and compatibility with armor stone. Possible fill materials may break down over time and cause failure of the proposed structures. Most fill materials are also too small to achieve filtration with the armor stone.

4.6.6.3 Displacement Section

With the displacement technique, the structure is built on the soft foundation, knowing that the foundation will fail and displace the weak foundation material. Displacement sections require several volumes of displaced material to support 1 volume of structure (Fowler, 1989, p. 11). For the northeast sill, this would mean displacing the entire problematic layer with rock. The displacement method was not chosen because it would be far more expensive to displace the soft ground with stone than it is to excavate and replace the material.

4.6.6.4 Excavation and Replacement

Excavation and replacement is the simplest and most reliable means of foundation remediation. It involves removing the poor foundation material and replacing it with a fill material with better strength. A source of fill material is required. This method works best when there is a limited extent of poor foundation to remove. Depending on the length of the northeast still, the volume of excavation is approximately between 30,000 and 50,000 CY. The depth of excavation is up to approximately 8 feet.

A zone of excavation and replacement was modeled for the northeast sill section. The bottom extent of the excavation is El. -12, which is slightly below the poor foundation material that was identified on CPT logs CP-202 through CP-205. The base width of the excavation is 40 feet. The excavation daylights at 3 Horizontal : 1 Vertical side slopes. The replacement material will come from the southern borrow area, which is described later in this report in Section 5. With this proposed configuration, a satisfactory factor of safety for the northeast still for end-of-construction and long-term conditions can be achieved.

4.7 Settlement Analysis

Settlement was calculated at every CPT location using the Janbu method, as described in (FHWA, 1988, p. IV: 5.2):

$$\rho = \sum_{i=1}^{n} \left(\frac{\Delta\sigma_v'}{M}\right) h_i$$

$\rho = settlement$

$\Delta\sigma_v' = increase\ in\ effective\ stress$

$M = constrained\ modulus$

$n = number\ of\ layers$

$h = height\ of\ layer$

The Janbu method is also known as the ordinary method. As opposed the special method, the ordinary method assumes that the constrained modulus is constant and equal to the modulus at the current state of effective stress. As was discussed earlier, the moduli derived from the CPT were calibrated to the moduli derived from the DMT. The ordinary method generally provides an acceptable estimate of settlement, but can be problematic in cases where the foundation loads are high compared to the in-situ effective stress or in cases where the soil is slightly overconsolidated. For preliminary design, the Janbu method was deemed acceptable. The surficial soils appear to be either normally consolidated or overconsolidated from the former island that washed away. None of the proposed foundation loads will greatly exceed the loads from the former island. Both the DMT and CPT data indicate the clay foundation is highly overconsolidated.

The DMT provides the drained, constrained modulus, at the current state of effective stress. By using a drained constrained modulus, both the elastic (initial) and primary consolidation settlement are taken into account. Secondary compression is not. Settlement for drained and undrained layers was calculated separately. Drained settlement was defined as settlement for any soil layer with a SBT greater than four (4). Drained settlement is the elastic settlement. Undrained settlement was defined as the settlement for any soil with a SBT less than or equal to four (4). Elastic settlement was not calculated separately for the undrained layers, and settlement in the undrained layers is reported as primary consolidation settlement even though a small fraction of the settlement is elastic. It was assumed that primary consolidation settlement up to a foot could be tolerated, but at that point the slope stability may govern the design. Elastic settlement will occur during construction and not cause any issues. It was also assumed that primary consolidation settlement less than half a foot would not require any overbuild of the structures. Given no negative construction tolerances for armored slopes, the contractor will likely build the structures slightly above the construction template, making it unnecessary to overbuild if settlements are less than half a foot.

Plots of settlement are provided in Attachment I. For all structures, elastic settlement was less than approximately one inch. This will not cause any issues during construction, nor will it cause significant increases in material quantities. Except for the breakwater, primary consolidation settlement for all structures was less than approximately six inches. Table 16 provides a summary of the anticipated primary consolidation settlement for the structures by reach. Computed settlement for the breakwater exceeds 6 inches, so overbuilding the breakwater by 0.5 feet is recommended.

Reach	Anticipated Primary Consolidation Settlement (inches)	Overbuild
Northeast Sill*	1 - 5	No
Existing Sill	1 – 5	No
Southwest Sill	1 - 4	No
Southeast Sill	3 – 5	No
Breakwater	3 - 7	Yes, by 0.5 ft

*Does not include reach that will require foundation remediation

Table 17: Settlement Predictions

5 Borrow Area Analysis

A source of sand borrow is required for (1) foundation replacement, (2) dredged material containment, and (3) bird island fill. Two potential borrow sources were identified for exploration. The first source, the Northern Borrow Area (NBA), is an area immediately north of the Honga River Channel. It was identified after discussions with local watermen at a public meeting in Church Creek, MD. The second source, the Southern Borrow Area (SBA), was identified using the results of the 2001 and 2004 subsurface investigations. A comprehensive subsurface investigation was undertaken in 2022 in both areas. The SBA was ultimately selected. Two sub-areas were identified within the SBA – Area A and Area B. Both areas are shown in Attachment O.

5.1 Potential Borrow Sources

5.1.1 Northern Borrow Area

A public meeting was held at the Church Creek Fire Hall in June 2021 to discuss the use of offshore sand resources in the vicinity of Barren Island. The SBA had already been identified. At the meeting, the waterman identified an area immediately north of the Honga River Channel which they believed contained sandy material. Locals and project stakeholders preferred the NBA over the SBA. Grab samples were collected in 2022 within the borrow area and the channel to investigate the material composition. A comprehensive investigation was undertaken later in 2022.

Boring logs within the Northern Borrow Area reveal that the material in the area is highly variable. It contains silty sand, clay, and silt. The depth of surficial sand varies throughout the borrow area between no sand (at many boreholes) and 15 ft of sand (at N-7). Fine grained materials were encountered in all but two borings and classified primarily as either ML, CL, or CL-ML according to the USCS classification system. Layers of fine-grained materials were found at the surface and between layers of sand. The borings show large differences in material between adjacent borings. A sub-area within the Northern Borrow Area containing a sizeable volume of sand could not be identified. A quantitative analysis of the material properties within the NBA was not performed.

5.1.2 Southern Borrow Area

The SBA was identified after examining the results of both the 2001 and 2004 subsurface investigation. It is approximately 1.5 miles to the west of Barren Island and just east of deeper water and the deep draft navigation channel. A figure of the borrow area is included in Attachment O. The outer limit of the SBA represents the bounds of borings which show deep deposits of sandy material from previous subsurface explorations. In many cases, the borings indicate sandy material for the full boring depth.

Most borings contained silty sand to the full depth of the boring. Some borings, such as S-8 and S-13 contained limited extents of surficial sand (3.3 ft and 6 ft respectively). For this reason, the entire area is not considered acceptable for sand borrow. The SBA was further divided into two areas to avoid silts and clays – Area A and Area B. Area A is 44.4 acres. Area B is 40.2 acres. These areas were selected for a quantitative analysis.

5.2 Borrow Area Material Properties

A custom computer program was developed to compute composite gradations from the laboratory data. After selecting the boreholes for the analysis and the elevation range of interest, the program computes composite grading by taking weighted averages of all sieve data within the elevation range. Sieve data is weighted by the length of sample which the sieve data represents. The program was run in five-foot elevation increments in Area A and Area B. The average existing ground elevation is approximately El. -15, so limited samples were taken below El. -30. The results from El. -30 to El. -35 may not accurately represent the composition of the borrow area. The program outputs a composite gradation curve and the percentage of gravel, sand, and fines for the curve. The output is included in Attachment O. The results are summarized in Table 18 and Table 19.

Elevation Range (NAVD88, ft)	% Gravel	% Sand	% Fines	D_{50} (mm)
0 to -20	0	80.5	19.5	0.12
-20 to -25	0	78.1	21.9	0.12
-25 to -30	1.4	75.3	23.3	0.13
-30 to -35	4.5	73.5	22.0	0.20
0 to -35	0.9	77.5	21.7	0.13

Table 18: Southern Borrow Area, Area A Material Properties

Elevation Range (NAVD88, ft)	% Gravel	% Sand	% Fines	D_{50} (mm)
0 to -20	0	82.6	17.4	0.17
-20 to -25	0	84.9	15.1	0.19
-25 to -30	0.3	87.7	12.0	0.22
-30 to -35	1.6	92.8	5.6	0.29
0 to -35	0.1	84.7	15.2	0.20

Table 19: Southern Borrow Area, Area B Material Properties

Material within both areas is predominantly fine silty sand. Some samples at depths between 10 and 15 feet contain a small percentage of gravel. Overall, the median grain size within Area A is 0.13 mm. The median grain size within Area B is 0.20 mm.

5.3 Borrow Area Recommendations

The ideal borrow material for the three previously stated uses (foundation replacement, dredged material containment, and bird island construction) is sand with less than approximately 20% fines. Material with less than 20% fines can be easily placed with mechanical or hydraulic placement. The low fines content allows for rapid decanting of water during placement and for achieving an adequate relative density with minimal to no compactive effort. A low fines content is especially important in underwater placement or hydraulic placement where compaction is not possible. Material with greater than 20% fines is more difficult to place in the proposed application, resulting in insufficient relative densities and strengths.

The ideal borrow area is an area that contains a significant quantity of ideal borrow material with little variation over area and depth. As of the writing of this report, the quantity of material needed on the project is unknown but estimated at less than 500,000 CY. Both Area A and Area B within the SBA are suitable sources of sand borrow. If dredged to a depth of 15 feet, they can each provide approximately one million cubic yards of sand. The allowable dredging depth is primarily an environmental consideration and is not addressed in this report.

6 WETLAND DESIGN

The goal of the project is ultimately to create wetlands from dredged material. The source of the dredged material will be local shallow draft navigation channels. The Honga River Channel has already been identified. The Phase 1 construction contract is underway, but it does not include construction of any containment features for the dredged material. Containment features for the Phase 2 contract will include modifications to the stone still to incorporate a filter and geotextile tubes to contain material near the existing Barren Island shoreline.

6.1 CONTAINMENT STRUCTURES

6.1.1 Perimeter Sills and Filtration Design

The stone sills currently being construction in the Phase 1 contract are comprised only of stone. Barren Island has been the placement site for dredged material from the Honga River Channel for several of the past dredging cycles. Dredged material was placed behind stone structures and geotextile tubes (which have no longer survived). Prior to placing material behind the structures, a geotextile filter was installed on the leeside of the structures and covered with 25 lb to 150 lb stone to prevent displacement. A similar strategy is proposed for the stone structures about to be built.

A sketch of the proposed filter design is included in Attachment L. The filter consists of two layers of quarry run stone with a geotextile in between. A layer of quarry run will be placed on the leeside of the stone structures so that the geotextile is not placed directly against armor stone. The geotextile will then be placed against the quarry run and covered with an additional layer of quarry run. The proposed geotextile for the stone structure modification is the same geotextile to be used for the foundation filter of the stone structures. The specified geotextile has a high wide-width tensile and puncture strength in combination with a small apparent opening size (between #70 sieve and #100 sieve).

6.1.2 Geotextile Tubes

A geotextile tube was chosen to provide containment near the shore of Barren Island. The proposed geotextile tube will prevent overwash of the existing island during dredged material inflow and allow for freeboard. The elevation of the existing island varies, but on average, it is approximately El. +2 NAVD88.

The proposed top of geotextile tube is El. +4 NAVD88. The tubes will be placed in water no deeper than El. -3 NAVD88 so that the height of the tube is less than 8 feet. One foot was added to the tube height to account for any foundation settlement. An 8-foot-tall tube represents that maximum practical height of a single tube. Any taller, and it would be more practical to stack smaller diameter tubes.

Geotextile tubes are commonly proprietary products and designed by specialty companies. One such example is geotube®. Because they are proprietary, performance specifications are provided to the contractor and the contractor works with the specialty companies to develop the final design. For the containment, the following specifications are proposed:

Minimum tube circumference: 40 feet

Minimum height of filled tube: 8 ft

Material to fill tubes: Gradation logs will be provided for the borrow area. On average, the material is approximately 80% sand, 20% silt, 0.15 mm < d50 < 0.2 mm.

Additional requirements will be developed during the development of the project specifications.

6.1.3 Material Source for Inflow

Nearby shallow draft navigation channels are the intended source of material to create wetlands. To date, only one channel has been definitively chosen – the Honga River Channel. In 2022, thirteen grab samples were collected at an approximately spacing of 1500 ft along the channel centerline. A sample location plan, laboratory gradations, and plasticity limits are included in Attachment P. Laboratory testing results are summarized in Table 20. Of the thirteen samples, six classified as silty sand and the remainder classified as silt.

Sample	USCS Classification	Fines Content (%)
H-1	SM	15
H-2	SP-SM	5
H-3	ML	90
H-4	ML	70
H-5	ML	66
H-6	ML	66
H-7	ML	59
H-8	ML	61
H-9	SM	19
H-10	ML	67
H-11	SM	11
H-12	SM	10
H-13	SM	10

Table 20: Honga River Grab Sampling Results

6.1.4 Inflow Schedule and Sequence

This section will be updated when the inflow schedule is known.

6.1.5 Wetland Planting and Grading

This section will be updated after material inflow.

7 REFERENCES

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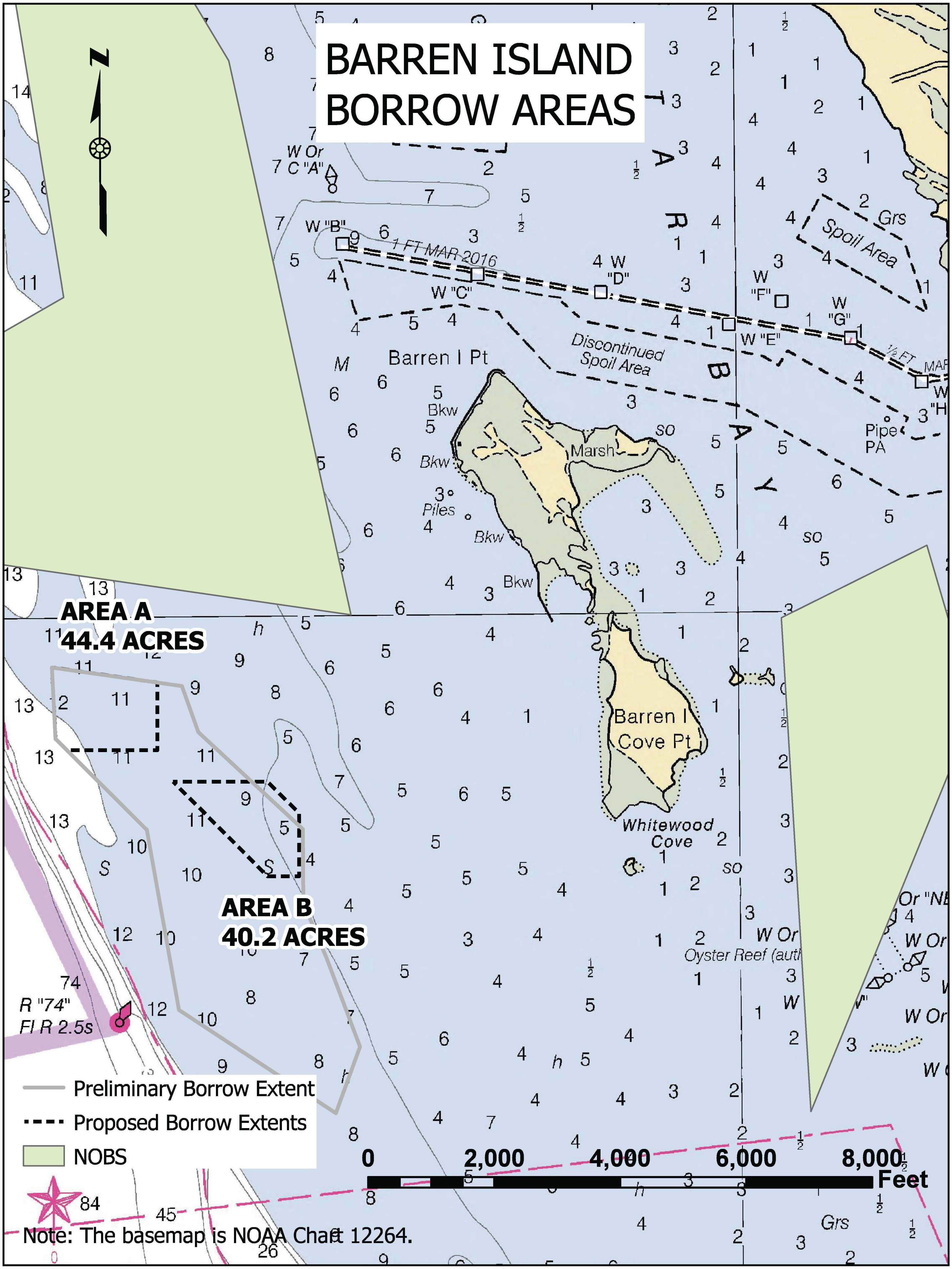
8 ATTACHMENTS

Attachment A	Boring Location Plan (2020 Exploration)
Attachment B	Boring Logs and Gradation Analyses
Attachment C	Cone Penetration Logs
Attachment D	Dilatometer Logs
Attachment E	Field Vane Shear Reports
Attachment F	Geologic Profiles
Attachment G	CPT Shear Strength Calibration
Attachment H	Strength Correlations
Attachment I	Compressibility Correlations and Settlement
Attachment J	Laboratory Triaxial and Oedometer Testing
Attachment K	Slope Stability Results
Attachment L	Proposed Cross Sections
Attachment M	Quarry Investigation
Attachment N	Borrow Area Investigation
Attachment O	Southern Borrow Area
Attachment P	Honga River Grab Sampling Results

Attachment O - Southern Borrow Area Data Sheets


BARREN ISLAND
BORROW AREAS
AREA A
44.4 ACRES
AREA B
40.2 ACRES
Barren I Pt
Barren I
Cove Pt
Whitewood
Cove
Marsh
Discontinued
Spoil Area
Spoil Area
1 FT MAR 2016
R "74"
Fl R 2.5s
Preliminary Borrow Extent
Proposed Borrow Extents
NOBS
0
2,000
4,000
6,000
8,000
Feet
Note: The basemap is NOAA Chart 12264.

APPENDIX A5: Phase I Cultural Survey Report - PLACEHOLDER

APPENDIX A6: Environmental Surveys Sampling and Analysis Report - Anchor QEA, February 2022

February 2022
Mid-Chesapeake Bay Island Ecosystem Restoration Project Environmental Surveys

Sampling and Analysis Report

Prepared for Maryland Environmental Service

In coordination with Maryland Department of Transportation, Maryland Port Administration

February 2022
Mid-Chesapeake Bay Island Ecosystem Restoration Project Environmental Surveys

Sampling and Analysis Report

Prepared for
Maryland Environmental Service
259 Najoles Road
Millersville, Maryland 21108

Prepared by
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ABBREVIATIONS

µg/L	micrograms per liter
B-IBI	Benthic Index of Biotic Integrity
CBWQM	Chesapeake Bay Water Quality Monitoring Program
COMAR	Maryland Code of Regulations
DGPS	differential global positioning system
DO	dissolved oxygen
EIS	environmental impact statement
FS	feasibility study
g	gram
m^2	square meter
MDNR	Maryland Department of Natural Resources
MDOT MPA	Maryland Department of Transportation Maryland Port Administration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeter
NTU	Nephelometric Turbidity Unit
ppt	parts per thousand
Project	Mid-Chesapeake Bay Island Ecosystem Restoration Project
RGI	Restoration Goal Index
SAR	Sampling and Analysis Report
SAV	submerged aquatic vegetation
SEA	Supplemental Environmental Assessment
SEIS	Supplemental Environmental Impact Statement
su	standard unit
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers

1 Introduction

The U.S. Army Corps of Engineers (USACE) Baltimore District and the non-federal sponsor, the Maryland Department of Transportation Maryland Port Administration (MDOT MPA), are proposing to restore 2,144 acres of remote island habitat in the Chesapeake Bay. In 2009, USACE Baltimore District prepared an integrated feasibility study (FS) and environmental impact statement (EIS) for the Mid-Chesapeake Bay Island Ecosystem Restoration Project (Project), which focuses on restoring and expanding island habitat to provide hundreds of acres of wetland and terrestrial habitat for fish, shellfish, reptiles, amphibians, birds, and mammals through the beneficial use of dredged material (USACE 2009). The FS/EIS identified James Island and Barren Island, located in western Dorchester County, Maryland, as the recommended plan for island restoration (Figure 1-1).

James Island is a privately owned, uninhabited island, situated near the mouth of the Little Choptank River, approximately 1 mile north of Taylors Island. Since 1847, the island has experienced substantial erosion, and based on surveys completed in 2020, James Island currently consists of multiple eroding island remnants totaling approximately 3 acres. The James Island component of the Project will restore 2,072 acres of remote island habitat adjacent to the remnants.

Barren Island is an uninhabited island, located in the Chesapeake Bay in Dorchester County, Maryland, near the Honga River and immediately west of Hoopers Island. Barren Island has also experienced substantial erosion; 2020 surveys that indicated that 138 acres remain. Barren Island experiences a long-term erosion rate of 14 feet per year (3 to 4 feet per year in recent years) or approximately 4.1 acres per year. At this rate, Barren Island could be completely lost by the early 2050s (2050-2055) without ongoing and future protection measures. The Barren Island component of the Project will restore a minimum of 72 acres of wetland habitat at Barren Island while also protecting approximately 1,325 acres of potential submerged aquatic vegetation (SAV) habitat adjacent to the island.

The objectives of the ecosystem restoration project at James and Barren Islands are as follows (USACE 2009):

1. Restore and protect wetland, aquatic, and terrestrial island habitat for fish, reptiles, amphibians, birds, and mammals.
2. Protect existing island ecosystems, including sheltered embayments, to prevent further loss of island and aquatic habitat.
3. Provide dredged material placement capacity based on the need identified in the Federal Dredged Material Management Plan (USACE 2017).
4. Increase wetland acreage in the Chesapeake Bay watershed to assist with meeting the Chesapeake 2000 Agreement goals.
5. Decrease local erosion and turbidity.

6. Promote conditions to establish and enhance SAV.
7. Promote conditions that support oyster colonization.

As part of the FS/EIS, a sampling program was implemented to document the existing environmental conditions on and adjacent to James Island and Barren Island (USACE 2009). Four seasonal studies were completed in 2002 and 2003 to document baseline environmental conditions. Both aquatic and terrestrial sampling were conducted, and the environmental surveys included water quality and nutrient analyses, fish and plankton sampling, benthic sampling and sediment testing, vegetation identification and mapping (both aquatic and terrestrial), SAV surveys, avian and other wildlife observations (both aquatic and terrestrial), horseshoe crab spawning surveys, diamondback terrapin nesting surveys, crab pot surveys, clam surveys, and pound net fishers phone surveys (USACE 2009).

Currently, the National Environmental Policy Act documentation for the Project is being updated through the development of a Supplemental Environmental Assessment (SEA) for Barren Island and a Supplemental Environmental Impact Statement (SEIS) for James Island. The purpose of this Sampling and Analysis Report (SAR) is to document existing site conditions in the vicinity of Barren and James islands in support of the SEA for Barren Island and the SEIS for James Island. The sampling designs for these site-specific environmental surveys were consistent with the baseline sampling program completed in 2002 and 2003, and the number of sampling locations selected for this program was similar to that used in the baseline sampling program. Design for the island restoration is ongoing, and the conditions documented in this SAR will serve as the baseline environmental conditions of the Project area prior to the initiation of restoration activities.

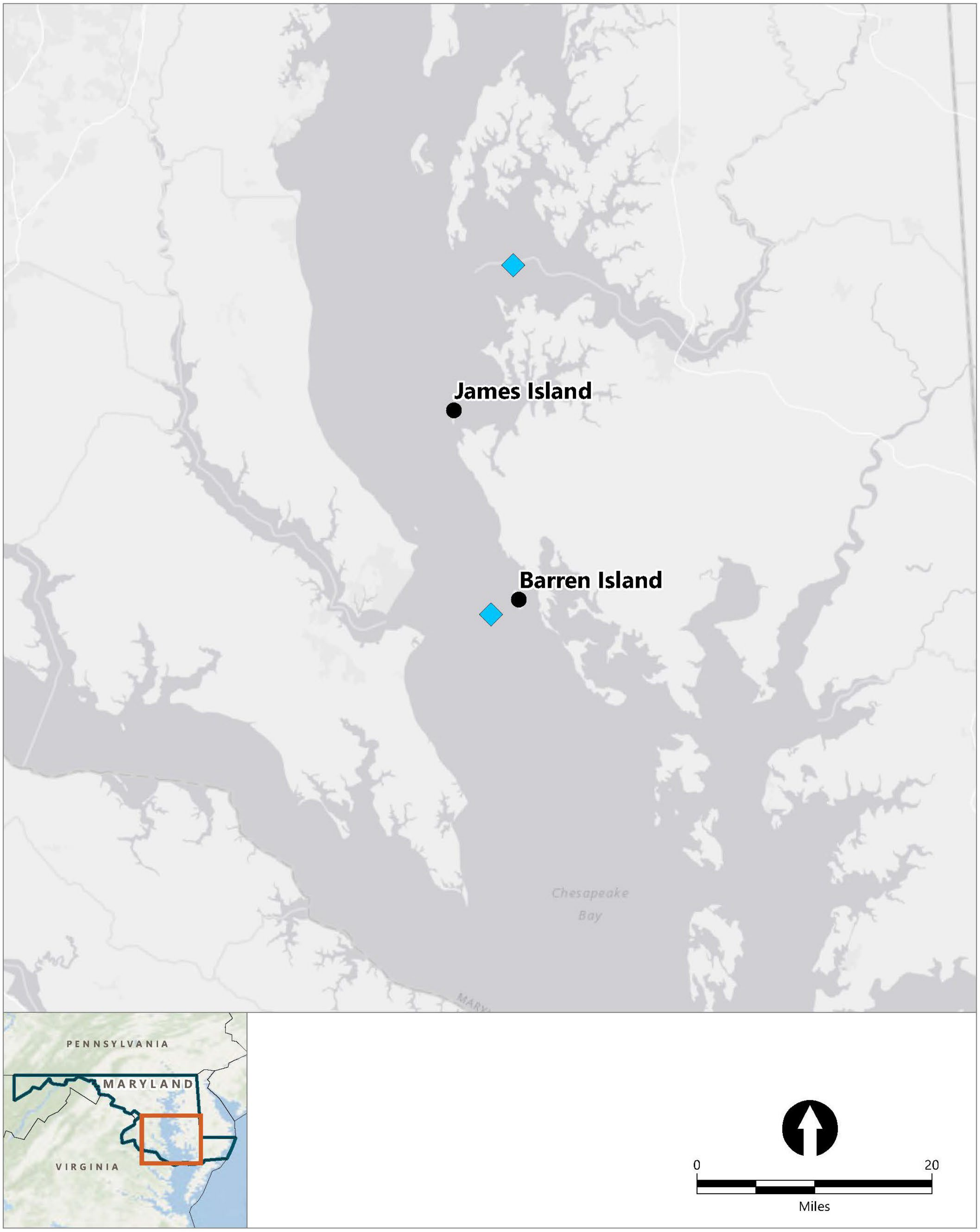
The purpose of this sampling effort is to sample benthic communities, fish assemblages, avian communities, and clam populations to provide the data necessary to document the existing environmental conditions in the Project area during each of the four seasons.

The specific objectives of the Mid-Chesapeake Bay Island Environmental Surveys sampling program are as follows:

- In the spring, summer, and fall seasons, collect benthic community samples to document baseline (pre-construction) seasonal benthic communities in the vicinity of James Island and Barren Island.
- In each season (spring, summer, fall, and winter), collect surface water samples to measure baseline (pre-construction) seasonal water quality conditions in the vicinity of James Island and Barren Island.
- In each season (spring, summer, fall, and winter), conduct fisheries surveys using a variety of sampling gear (including beach seines, trawls, gillnets, and pop nets [spring and summer only]) to document baseline (pre-construction) seasonal fish and crab communities in the vicinity of James Island and Barren Island.

- In the fall, conduct soft-shell and razor clam surveys to document baseline (pre-construction) clam populations in the vicinity of James Island and Barren Island.
- Conduct monthly crab pot surveys during the months of May, June, July, August, and September in the proposed restoration footprint (plus an additional 0.25-mile perimeter) to document crab fishing in the vicinity of James Island and Barren Island.
- In the spring and summer, conduct avian surveys to document baseline (pre-construction) bird populations and behaviors in the vicinity of James Island and Barren Island.

Figure 1-1
Mid-Chesapeake Bay Island Ecosystem Restoration Project Area



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1.1 Project Overview

The environmental sampling framework for the Project includes water quality, benthic community sampling, fish and crab assemblage documentation, bivalve population study, and avian surveys. These pre-construction environmental sampling studies will determine the baseline environmental conditions for the Project. The results of this investigation will be compared to results of post-construction environmental monitoring conducted after island restoration is completed and to document environmental conditions or changes, if any, in the Project area.

Surface water sampling documents water quality in the vicinity of James Island and Barren Island each season, measures nutrient concentrations, and supports the interpretation of biological (benthic, fish, and clam) data. Water quality samples were tested for the same parameters tested in the Chesapeake Bay Program (Chesapeake Bay Program 2017).

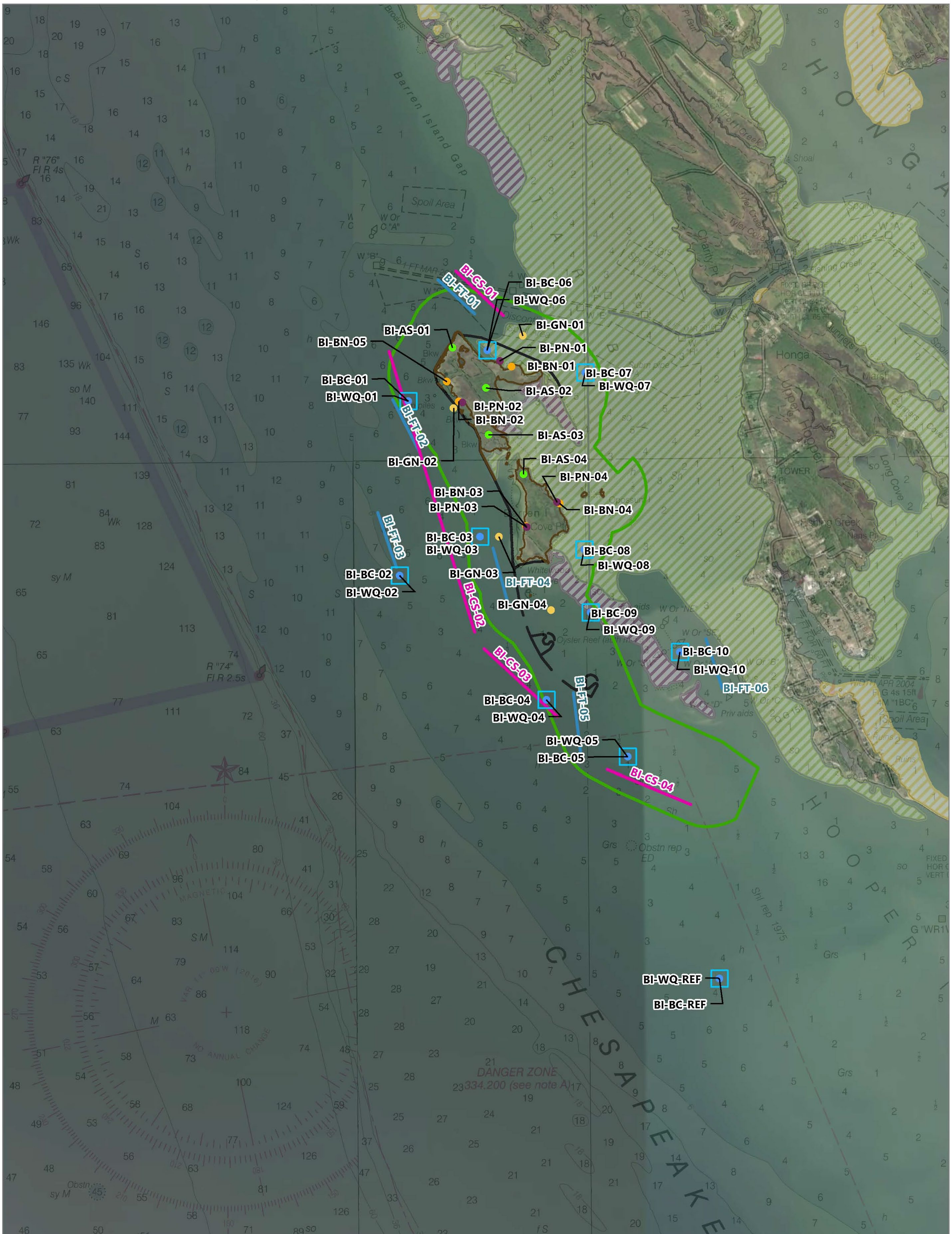
Benthic community sampling characterizes the benthic community in the Project area at James Island and Barren Island. Community composition, abundance, and diversity are documented in each sample. During the summer seasonal sampling event, additional sediment from each benthic community sampling location was collected and analyzed for grain size and total organic carbon.

Fisheries surveys document the use of proximal waters in the Project area by measuring fish and crab populations and densities in a variety of habitats. The waters in the vicinity of James Island and Barren Island were sampled using beach seines, trawls, gillnets, and pop nets.

Avian surveys document species and numbers of birds nesting on or using James Island and Barren Island. These baseline avian surveys will be used to evaluate if there is an increase in number and diversity of waterfowl in the vicinity of James Island and Barren Island area after island restoration is completed.

The data collected through the fisheries, bivalve, and avian surveys will be used in conjunction with the results of previous seasonal fisheries surveys (USACE 2009) to establish baseline information on the fish and crab communities in the area of the Chesapeake Bay surrounding Barren Island and James Island. All components of the environmental sampling framework and sampling locations are shown in Figures 1-2 and 1-3 for Barren Island and James Island, respectively.

Figure 1-2
Barren Island Environmental Survey Components



LEGEND:

- Avian Survey
- Beach Seine
- Benthic Community
- Gill Net
- Pop Net
- Water Quality
- Fisheries Trawl
- Soft-Shell and Razor Clam Trawl
- Soft-Shell and Razor Clam Survey
- Fisheries Trawls
- Crabpot Survey
- Barren Island Remnants
- Proposed Barren Island Protection

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

0 2,000
Meters

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and Barren Island remnants.
3. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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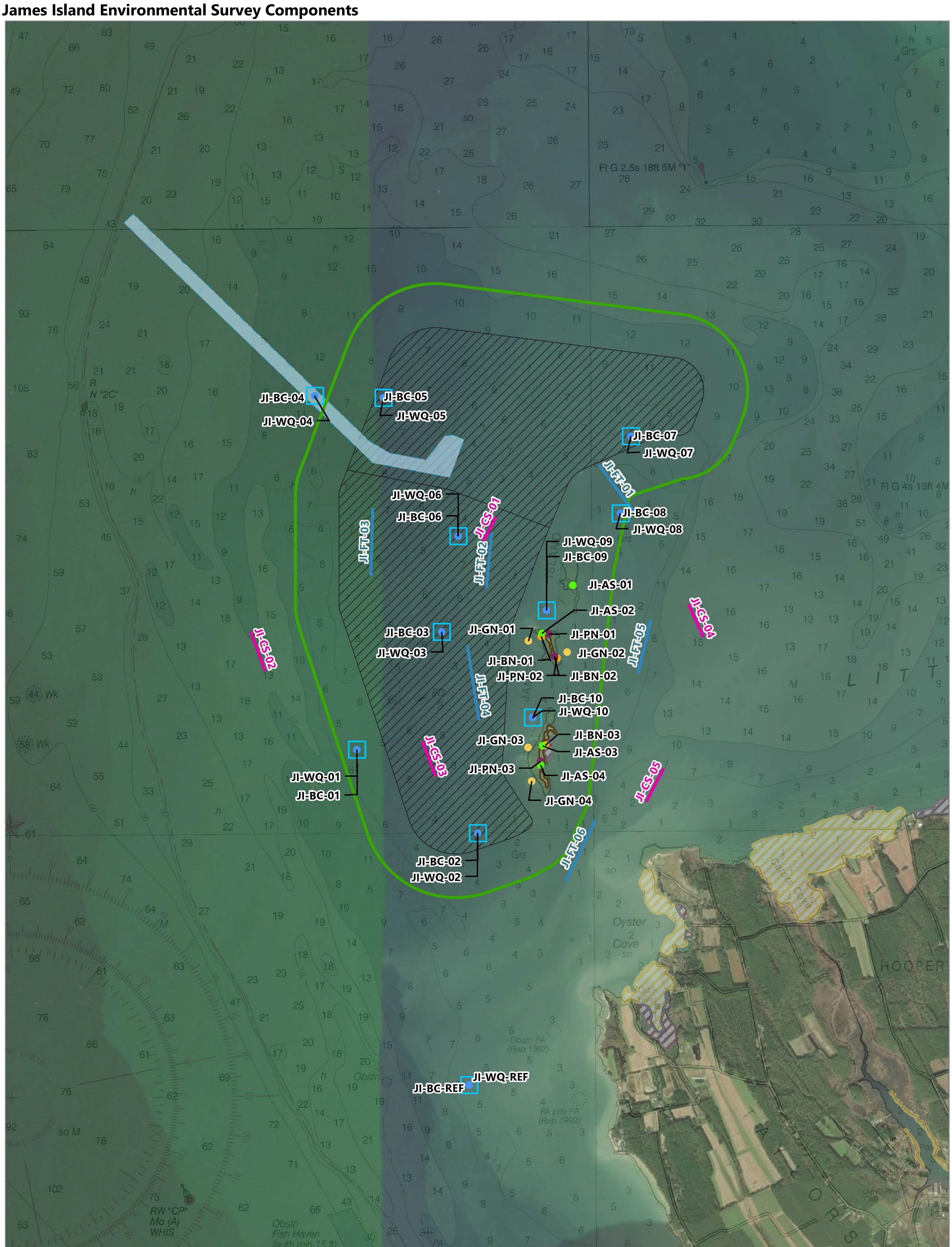
Figure 1-3
James Island Environmental Survey Components



LEGEND:

- Avian Survey
- Beach Seine
- Benthic Community
- Gill Net
- Pop Net
- Water Quality
- Fisheries Trawl
- Soft-Shell and Razor Clam Trawl
- Soft-Shell and Razor Clam Survey
- Fisheries Trawls
- Crabpot Survey
- James Island Remnants
- Proposed James Island Access Channel
- Proposed James Island Alignment

Existing SAV Bed

- Moderate 40-70% cover
- Sparse 10-20% cover
- Very Sparse 0-10% cover

0 2,000
Meters

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and James Island remnants.
3. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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1.2 Project Schedule

Sampling to evaluate existing conditions is conducted seasonally, consistent with the timing of the sampling completed in 2002 and 2003 as part of the FS/EIS (USACE 2009). The sampling conducted to complete the environmental surveys occurs during the following seasons:

- Summer 2020: June, July, and August
- Fall 2020: September, October, and November
- Winter 2021: December, January, and February
- Spring 2021: March, April, and May

A summary and schedule of the completed Project components completed is provided in Table 1-1.

Table 1-1
Mid-Chesapeake Bay Island Ecosystem Restoration Project Sampling Schedule

Season	Task	Dates Completed
Summer (June, July, and August)	Water quality sampling	August 31, 2020, to September 1, 2020
	Benthic community sampling (including grain size and total organic carbon analyses)	August 24 to 28, 2020
	Fisheries surveys	August 25, 2020, to September 4, 2020
	Beach seining	
	Bottom trawling	
	Gillnetting	
	Pop netting	
	Crab pot survey	June 23, 2021
		July 23, 2021
		August 30, 2020
	Avian surveys	September 2 to 3, 2020
Fall (September, October, and November)	Water quality sampling	October 21, to 22, 2020
	Benthic community sampling	October 19 to 23, 2020
	Fisheries surveys	November 4 to 9, 2020
	Beach seining	
	Bottom trawling	
	Gillnetting	
	Crab pot survey	September 29, 2020
	Bivalve surveys	December 14 and 19, 2020

Season	Task	Dates Completed
Winter (December, January, and February)	Water quality sampling	March 9 to 10, 2021
	Fisheries surveys	February 25 to 28, 2021
	Beach seining	
	Bottom trawling	
	Gillnetting	
Spring (March, April, and May)	Water quality sampling	May 24 to 25, 2021
	Benthic community sampling	May 24 to 28, 2021
	Fisheries surveys	May 4 to 10, 2021
	Beach seining	
	Bottom trawling	
	Gillnetting	
	Pop netting	
	Avian surveys	May 26 to 27, 2021
	Crab pot surveys	May 18, 2021

2 Sampling Methodology

This section provides a brief description of the methodology used for each Project component. Details regarding sampling methodology are provided in the *Sampling and Analysis Plan and Quality Assurance Project Plan* (Anchor QEA 2020).

2.1 Water Quality Sampling

Water quality issues in the Chesapeake Bay range from variation in physical properties, such as temperature, salinity, dissolved oxygen (DO), and turbidity to loadings of nutrients. Excessive nutrients, such as nitrogen and phosphorus, cause the greatest impairments of water quality in the Chesapeake Bay. Surface water samples were collected from Barren Island and James Island to measure water quality. Standard protocols provided in *Methods and Quality Assurance for Chesapeake Bay Water Quality Monitoring Programs* (Chesapeake Bay Program 2017) were followed for target analytes, detection limits, methodologies, and sample holding times for the water samples.

Surface water samples were collected at 22 locations around James Island and Barren Island during the summer, fall, winter, and spring seasonal sampling events. Eleven locations – 10 nearshore locations and one background location – were sampled from the area surrounding Barren Island (Figure 2-1) and 11 locations – 10 nearshore locations and one background location – were sampled from the area surrounding James Island (Figure 2-2) during each of the seasonal sampling events (summer, fall, winter, and spring). The background location was included in the program to allow for direct comparison during future monitoring events (if any) in the event some of the baseline locations are inaccessible as a result of project implementation. A summary of the water quality sampling program, including sample locations and analyses, is provided in Table 2-1.

Water quality was analyzed by measuring a variety of physical properties and chemical constituents that can affect the health of the ecosystem and its living resources. During in situ water quality sampling, physical properties including temperature, pH, conductivity, salinity, DO, and turbidity were recorded using a water quality instrument placed directly in the waterbody. Water quality parameters were recorded at the surface, mid-depth, and bottom (within 1 foot) of the water column at each location.

Water was collected from the mid-depth of the water column, with care not to disturb the sediment, using a peristaltic pump and Tygon tubing. After the tubing was lowered to the appropriate depth, the water sample was then pumped directly into the appropriate pre-labeled sample containers. One 2-liter bottle of whole water was collected from each location. A 250-milliliter aliquot of water was filtered in the field using a syringe filter. All samples were placed in an ice filled cooler immediately after collection to ensure samples do not exceed the 4°C holding temperature. Samples were hand-delivered to Chesapeake Biological Laboratory in Solomons, Maryland for analysis on the same day as sample collection.

Sample filtration was conducted in the laboratory for particulate nitrogen, particulate phosphorus, particulate carbon, and total suspended solids analysis requirements within 8 hours of sample collection. The water samples were analyzed for total dissolved nitrogen, particulate nitrogen, nitrite, nitrate + nitrite, ammonium, organic nitrogen, total dissolved phosphorus, orthophosphate, organic phosphorus, particulate phosphorus, particulate carbon, dissolved organic carbon, total nitrogen, total phosphorus, chlorophyll *a*, phaeophytin *a*, and total suspended solids (Table 2-1).

The Maryland Department of Natural Resources (MDNR) has a Chesapeake Bay Water Quality Monitoring Program (CBWQM) that has routinely sampled year-round in the Chesapeake Bay since 1985 and in the Coastal Bays since 1999. Five years of water quality data (2016 to 2020) from the CBWQM were summarized for the fixed monitoring stations closest to Barren Island (station CB5.1) and James Island (station EE2.2) (Figure 2-3) to provide context to the data collected during this effort.

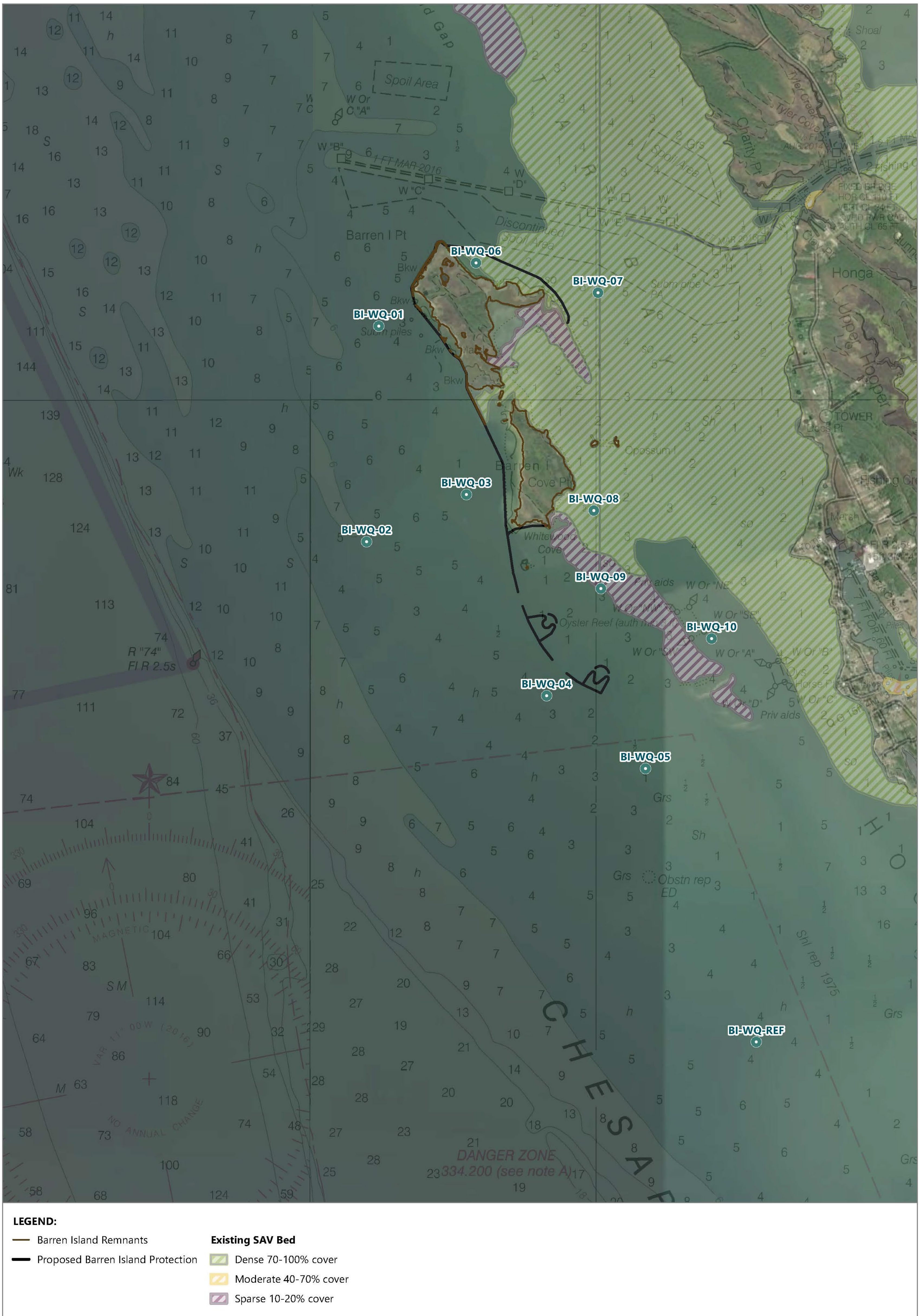
Station CB5.1 is located in the Mid-Chesapeake Bay, west of Barren Island in approximately 34.7 m (114 feet) of water. Station EE2.2 is located in approximately 12.5 m (41 feet) of water, near the mouth of the Little Choptank River approximately 1 mile northeast of James Island. The most recent 5 years of surface water quality data were used as a representative comparison to existing seasonal conditions because these samples most closely resemble the conditions during the sampling conducted for this study.

Table 2-1
Surface Water Sampling and Analysis Program

Area	Location	Coordinates		Analyses																	
		Northing	Easting	Chlorophyll, Active	Phaeophytin	Chlorophyll	Dissolved Organic Carbon	Organic nitrogen	Organic phosphorus	Ammonium	Nitrite	Nitrite + Nitrate	Particulate Carbon	Particulate Nitrogen	Orthophosphate	Particulate Phosphorus	Dissolved Nitrogen	Dissolved Phosphorus	Total Nitrogen	Total Phosphorus	TSS
Barren Island	BI-WQ-01	245397.89	1522101.17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-02	240208.01	1522056.52	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-03	241336.39	1524267.20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-04	236431.80	1526327.91	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-05	234724.12	1528713.04	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-06	247001.33	1524609.28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-07	246287.87	1527478.70	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-08	240986.37	1527469.03	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-09	239083.25	1527615.61	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-10	237930.38	1530390.49	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BI-WQ-REF	228030.52	1531651.51	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Area	Location	Coordinates		Analyses																	
		Northing	Easting	Chlorophyll, Active	Phaeophytin	Chlorophyll	Dissolved Organic Carbon	Organic nitrogen	Organic phosphorus	Ammonium	Nitrite	Nitrite + Nitrate	Particulate Carbon	Particulate Nitrogen	Orthophosphate	Particulate Phosphorus	Dissolved Nitrogen	Dissolved Phosphorus	Total Nitrogen	Total Phosphorus	TSS
James Island	JI-WQ-01	306620.99	1495951.99	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-02	304226.65	1499644.99	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-03	310221.64	1498541.50	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-04	317348.69	1494645.77	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-05	317283.65	1496764.28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-06	313107.53	1499020.16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-07	316178.11	1504175.97	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-08	313848.94	1503823.15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-09	310872.55	1501695.80	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-10	307629.99	1501284.99	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JI-WQ-REF	228030.14	1531605.27	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Figure 2-1
Barren Island Water Quality Monitoring Locations



NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

Publish Date: 2022/02/03, 12:30 PM | User: nwagner
Filepath: \\orcas\gis\Jobs\Maryland_ES_0530\MidBayBioAssessment\Maps\2021_06_SAR\AQ_MidBayIES_Figure0201_0202_WQ_Survey.mxd

Figure 2-2
James Island Water Quality Monitoring Locations

LEGEND:

- James Island Remnants
- Proposed James Island Access Channel
- Proposed James Island Alignment

Existing SAV Bed

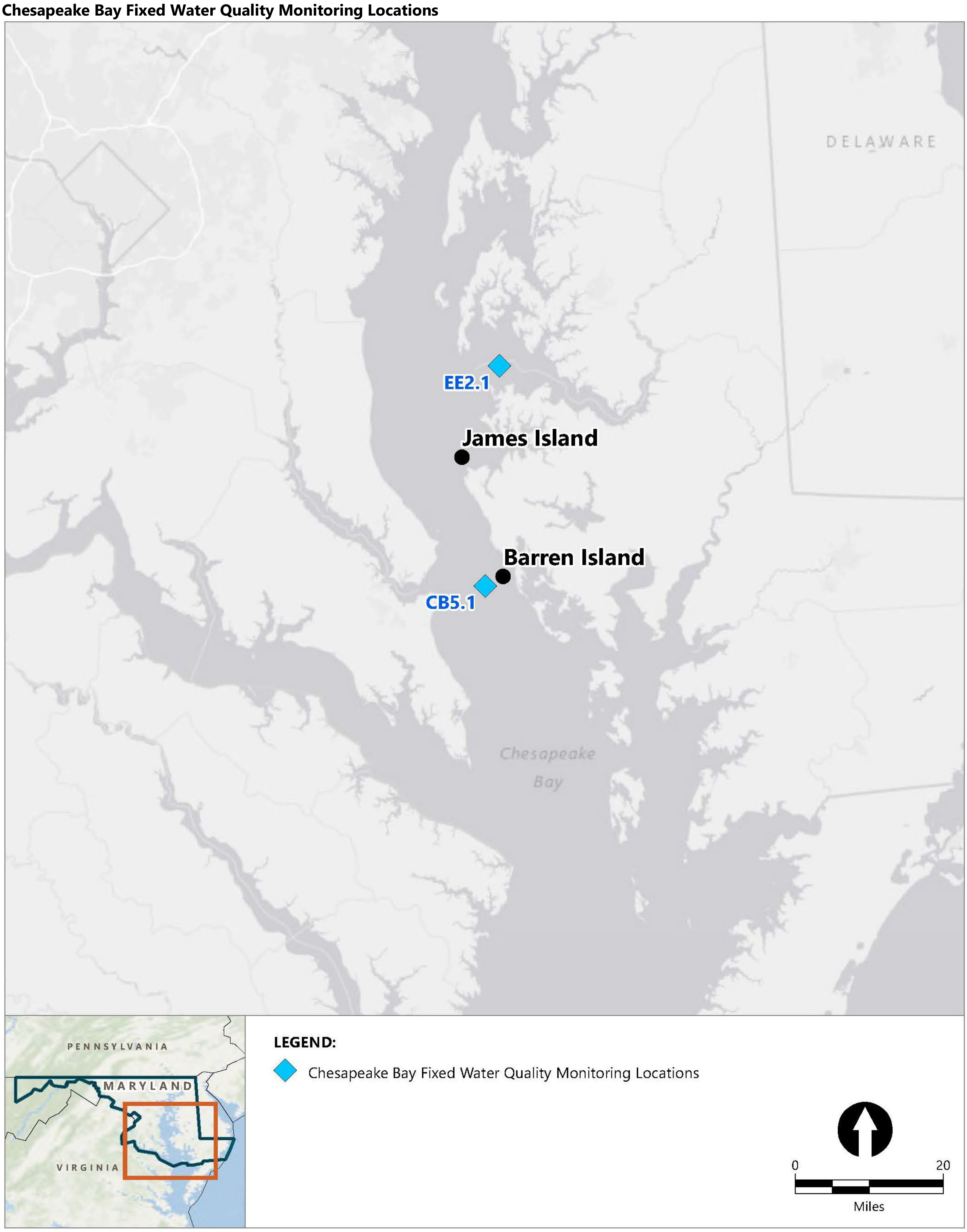
- Moderate 40-70% cover
- Sparse 10-20% cover
- Very Sparse 0-10% cover

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

0 2,000
Meters

Publish Date: 2022/02/03, 12:30 PM | User: nwagner
Filepath: \\orcas\gis\Jobs\Maryland_ES_0530\MidBayBioAssessment\Maps\2021_06_SAR\AQ_MidBayIES_Figure0201_0202_WQ_Survey.mxd

Figure 2-3
Chesapeake Bay Fixed Water Quality Monitoring Locations



Publish Date: 2022/02/02, 12:50 PM | User: jquinley
Filepath: \\orcas\GIS\Jobs\Maryland_ES_0530\MidBayBioAssessment\Maps\2021_06_SAR\AQ_MidBayIES_Figure0203_ChesapeakeBayFixedWQMonitoringLocs.mxd

2.2 Benthic Community Sampling

Benthic community sample locations were colocated with the surface water sample locations. Ten locations were sampled from the area surrounding James Island (Figure 2-4), and 10 locations were all sampled from the area surrounding Barren Island (Figure 2-5) during the summer, fall, and spring sampling events. Benthic community samples were not included in the winter sampling event because of the bottom water temperatures. Benthic community reference sites were sampled for each island to evaluate the data collected from the sampling locations. Reference sites were sampled at the same time as the sampling locations to assess benthic community conditions outside the influence of restoration activities for each of the islands. The Barren Island reference sample was located approximately 1.5 miles south of the Project site (Figure 2-4). The James Island reference sample was located approximately 2 miles south of the Project site (Figure 2-5).

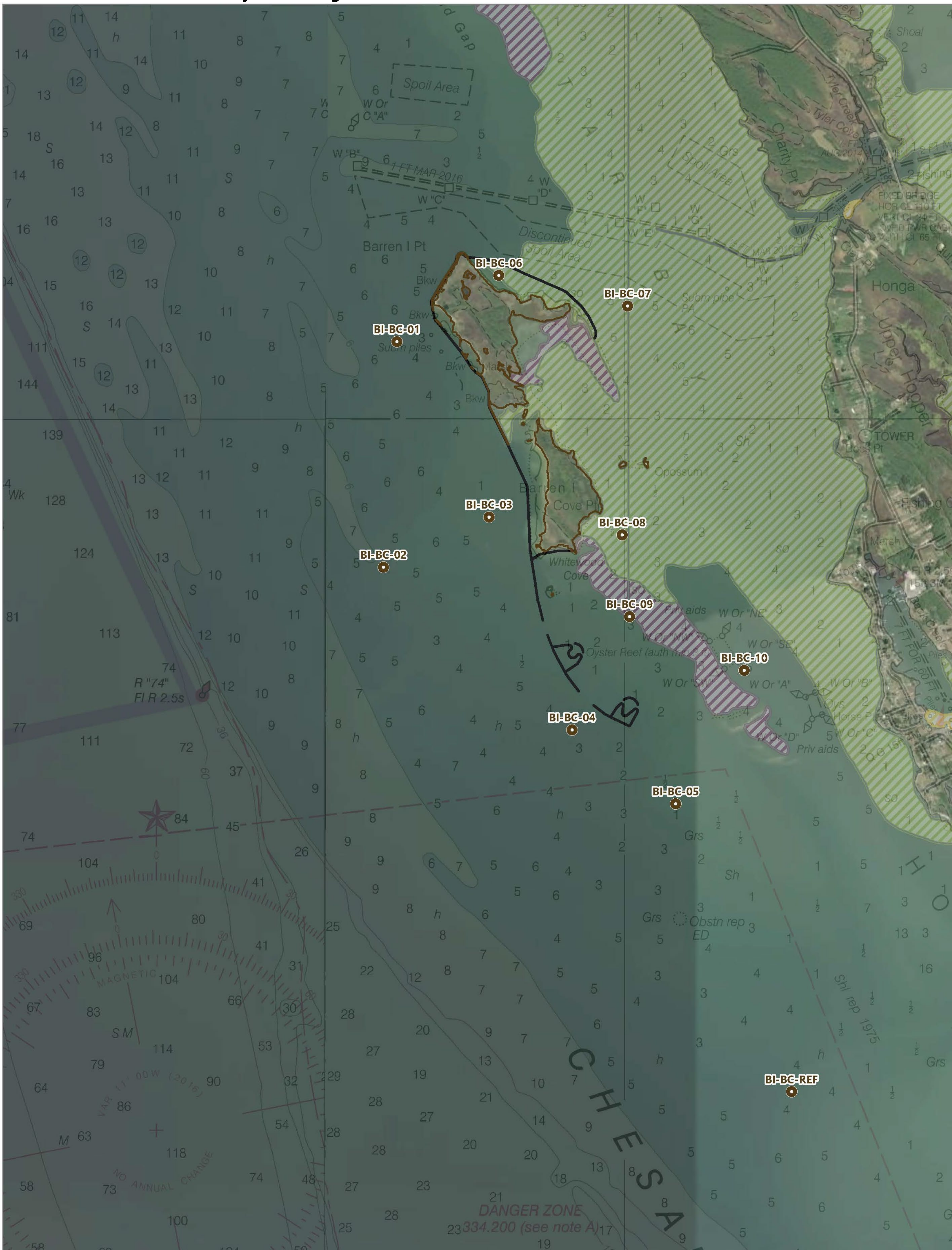
At each location, the water depth and in situ water quality parameters (including salinity, temperature, DO, and pH) were measured and recorded.

Sediment samples were collected using a stainless-steel sediment grab sampler (Ponar or equivalent), which is used to collect large-volume, undisturbed surficial sediment samples representative of the top 0 to 6 inches of the sediment. Triplicate grab samples were collected at each location to determine the benthic community composition. The top 0 to 6 inches of the sediment was collected and sieved in the field through a 500-micron screen to remove fine sediment particles. Individual replicates were transferred to sample containers and preserved in the field using buffered 10% formalin and rose-bengal solution. During the summer sampling event, sediment was collected at each location prior to the benthic community sample collection and submitted to an analytical laboratory for grain size and total organic carbon analysis.

The benthic community samples were delivered to Cove Corporation in properly preserved conditions and according to the requirements of the chain-of-custody protocols for sorting and identification. Cove Corporation conducted benthic sorting and taxonomic identification of organisms to the lowest practicable taxon for each of the samples.

In the laboratory, each sample was washed with tap water through a 500-micron sieve to remove the preservation in preparation for laboratory processing. All organisms were removed from the sample material. Representative organisms of each species from each location were collected and identified to the lowest practical taxonomic level. Because James Island and Barren Island are in the mesohaline portion of the Chesapeake Bay, determination of species biomass was required (Versar 2002).

Figure 2-4
Barren Island Benthic Community Monitoring Locations



LEGEND:

- Benthic Community Sampling Location
- Barren Island Remnants
- Proposed Barren Island Protection

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

0 — 2,000
Meters

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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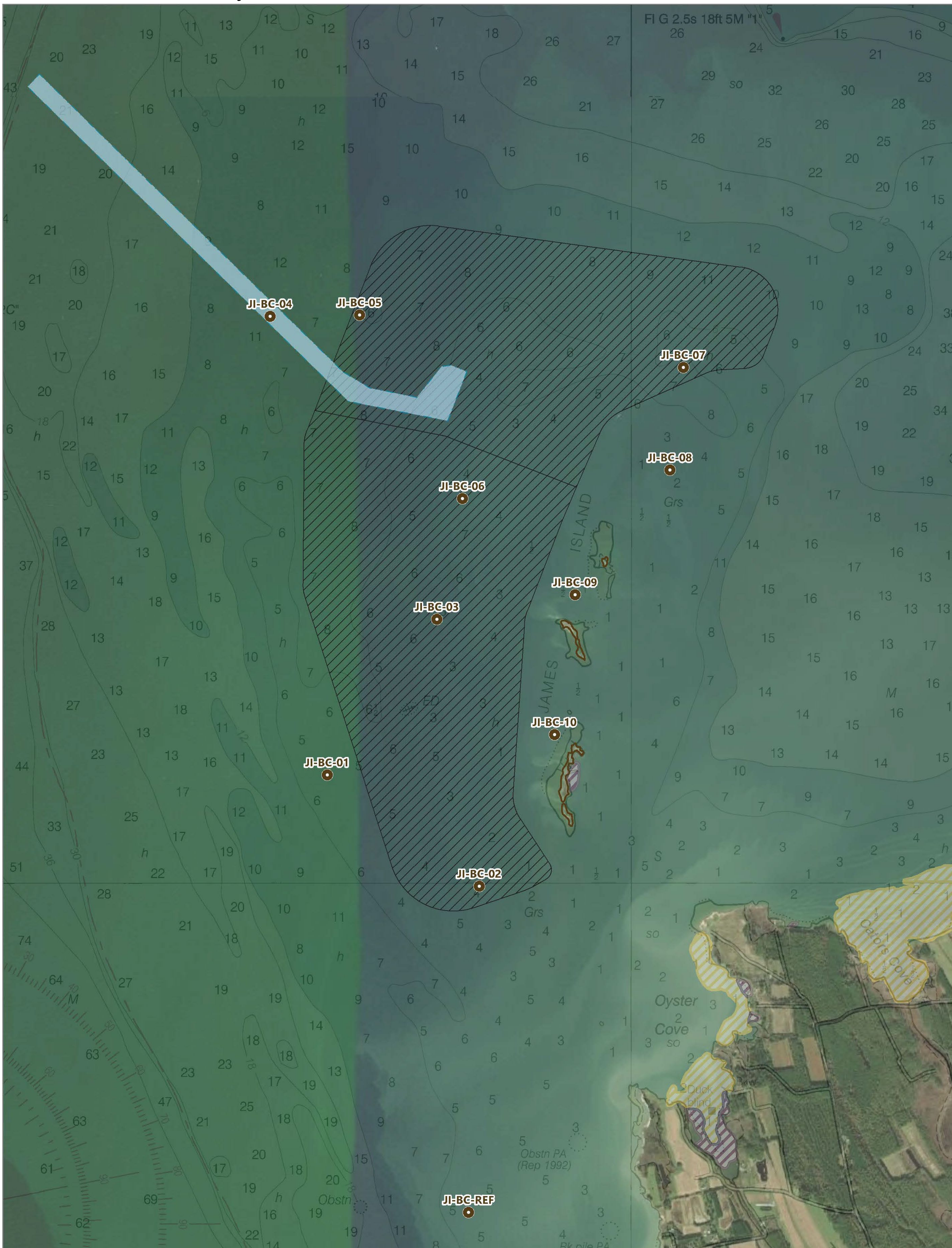
Figure 2-5
James Island Benthic Community Locations



LEGEND:

- Benthic Community Sampling Location
- James Island Remnants
- Proposed James Island Access Channel
- Proposed James Island Alignment

Existing SAV Bed

- Moderate 40-70% cover
- Sparse 10-20% cover
- Very Sparse 0-10% cover

0 2,000
Meters

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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2.2.1 Benthic Community Data Analysis

Results of the benthic community analysis from James Island and Barren Island were compared to Project-specific reference locations (JI-BC-REF and BI-BC-REF), to regional Chesapeake Bay Benthic Index of Biotic Integrity (B-IBI) values, and to the Chesapeake Bay Restoration Goal Index (RGI).

The following metrics were used to characterize the benthic community at sampling and reference locations at Barren Island and James Island:

- **Total Number of Taxa**: This is the total number of distinct taxa. This metric reflects the health of the community through a measurement of the variety of taxa present.
- **Shannon-Wiener Species Diversity Index (H')**: This index is one of the most widely used indices in the ecology community. The Shannon-Wiener Species Diversity Index is calculated as shown in Equation 2-1:

Equation 2-1

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

where:

H'	=	Shannon-Wiener Species Diversity Index
S	=	number of species per sample
p_i	=	proportion of total individuals in the ith species

- **Simpson's Dominance Index (c):** This varies from 0 to 1 and gives the probability that two individuals drawn at random from a population belong to the same species (Ludwig and Reynolds 1988). Simpson's Dominance Index incorporates species richness and evenness into a single value. The Simpson's Dominance Index is calculated as shown in Equation 2-2:

Equation 2-2

$$c = \sum \left(\frac{n_i}{N}\right)^2$$

where:

c	=	Simpson's Dominance Index
n_i	=	number of individuals in species i
N	=	total number of species

- **Species richness (d)**: This is the number of species in the community and is dependent on the sample size (Ludwig and Reynolds 1988). This index expresses the variety of one component of species diversity. Species richness at each location is the ratio between the total number of species (taxa) and the total number of individuals. It removes abundance variability among locations so that comparisons between locations are possible. This index expresses variety independent of an evenness index, which is incorporated in general indices of diversity. The Species Richness Index is calculated as shown in Equation 2-3:

Equation 2-3

$$d = \frac{S - 1}{\log N}$$

where:

d	=	species richness
S	=	number of species
N	=	number of individuals

- **Evenness (e)**: This is how the species abundances (e.g., the number of individuals, biomass) are distributed among the species (Ludwig and Reynolds 1988). Evenness is a measurement of the similarity of the abundances of different species. When all species are equally abundant, then evenness is 1, but when the abundances are very dissimilar (some rare and some common species), the value increases. Evenness is calculated as shown in Equation 2-4:

Equation 2-4

$$e = \frac{\overline{H}}{\log S}$$

where:

e	=	evenness
$\overline{H}$	=	Shannon-Wiener Species Diversity Index value
S	=	number of species

2.2.2 Chesapeake Bay Benthic Index of Biotic Integrity

Benthic invertebrates are used extensively as indicators of estuarine environmental status and trends because numerous studies have demonstrated that benthos respond predictably to many kinds of natural and anthropogenic stresses (Weisberg et al. 1997). The Chesapeake Bay B-IBI was developed by Weisberg et al. (1997) to assess benthic community health and environmental quality in the Chesapeake Bay. The Chesapeake Bay B-IBI evaluates the ecological condition of a sample by comparing values of key benthic community attributes, or metrics, to reference values expected under nondegraded conditions in similar habitat types (Versar 2002). Alden et al. (2002) conducted a series of statistical and simulation studies to evaluate and optimize the B-IBI. The results of Alden et al. (2002) indicated the Chesapeake Bay B-IBI is sensitive, stable, robust, and statistically sound.

Because the major factors that control the structure of benthic communities in the Chesapeake Bay are salinity and sediment type (Versar 2002), results of the grain size analysis and bottom salinity data were used to classify habitats for sampling locations at James Island and Barren Island. These habitat classifications were used to determine the metrics used to calculate the B-IBI for each location. Before Chesapeake Bay B-IBI metrics were calculated, samples were assigned to one of the following five salinity classes (Weisberg et al. 1997):

- Tidal freshwater (0 to 0.5 parts per thousand [ppt])
- Oligohaline (≥0.5 to 5 ppt)
- Low mesohaline (≥5 to 12 ppt)
- High mesohaline (≥12 to 18 ppt)
- Polyhaline (≥18 ppt)

The results of the salinity levels measured during the summer and fall benthic community sampling events and the grain size results from samples collected during the summer benthic community sampling event are provided in Table 2-2. All but one of the James Island sampling locations were classified high mesohaline sand (JI-BC-09 was classified as high mesohaline mud) and the Barren Island benthic community sampling locations were classified as either high mesohaline mud or high mesohaline sand.

Table 2-2
Habitat Classification for Benthic Index of Biotic Integrity (B-IBI) Calculation

Area	Location	Salinity		Silt + Clay (%)	Habitat Classification
		Summer	Fall		
James Island	JI-01	13.4	15.8	2.1	High mesohaline sand
	JI-02	13.2	15.9	5.5	High mesohaline sand
	JI-03	13.2	16.5	7.2	High mesohaline sand
	JI-04	13.6	16.7	3.8	High mesohaline sand
	JI-05	13.4	16.6	6.1	High mesohaline sand
	JI-06	13.4	14.2	3.2	High mesohaline sand
	JI-07	13.4	16.5	2.5	High mesohaline sand
	JI-08	13.2	16	3.3	High mesohaline sand
	JI-09	13.2	16.3	49	High mesohaline mud
	JI-10	13.2	15.9	2.9	High mesohaline sand
	JI-REF	13.6	16	8.6	High mesohaline sand
Barren Island	BI-01	13	16.3	15.8	High mesohaline sand
	BI-02	13.3	16.5	5.5	High mesohaline sand
	BI-03	12.8	16	3.8	High mesohaline sand
	BI-04	13	15.7	5.4	High mesohaline sand
	BI-05	13.3	15.7	8.5	High mesohaline sand
	BI-06	12.9	15.5	72.9	High mesohaline mud
	BI-07	12.8	15.5	45.5	High mesohaline mud
	BI-08	13.1	15.7	48.6	High mesohaline mud
	BI-09	13	15.9	7.2	High mesohaline sand
	BI-10	13.5	15.6	66.6	High mesohaline mud
	BI-REF	13.7	16	5.2	High mesohaline sand

Notes:
salinity between 12 and 18 ppt = high mesohaline
silt + clay: <40% = sand; >40% = mud

The following are metrics used in the B-IBI calculations for mesohaline habitats:

1. **Shannon-Wiener Species Diversity Index (*H'*):** This index is one of the most widely used indices in ecology community. The Shannon-Wiener Species Diversity Index is calculated using Equation 2-1.
2. **Total Species Abundance:** Total number of organisms present in a sample after dropping the epifauna and incidental species excluded from the B-IBI calculation (Versar 2002). The total species abundance will be normalized to the number of organisms per unit area. The conversion factor for the Ponar grab is 1 count = 20.4 individuals per square meter (m^2).

3. **Total Species Biomass:** The total biomass (measured as ash free dry weight) of organisms present in a sample after dropping the epifauna and incidental species excluded from the B-IBI calculation (Versar 2002). The total biomass is normalized to the biomass of organisms per unit area.
4. **Percent Abundance of Carnivores and Omnivores:** Percent abundance contribution of taxa classified as carnivores or omnivores to the total abundance of organisms in a sample. The list of taxa that are defined as carnivores or omnivores is provided in Versar (2002).
5. **Percent Abundance of Stress-Indicative Taxa:** This metric will be calculated as the percentage of total abundance represented by stress-indicative taxa. This metric is included only in the high mesohaline sand classification for the B-IBI. This metric is not appropriate for use in areas of high mesohaline mud because the metric may not be sensitive (or indicative) in all benthic habitats. Benthic communities differ significantly according to habitat type, and the metrics appropriate to each type were chosen based upon their sensitivity within various benthic habitats. The list of taxa that are defined as pollution-indicative for the Chesapeake Bay is provided in Versar (2002).
6. **Percent Abundance of Stress-Sensitive Taxa:** This metric will be calculated as the percentage of total abundance represented by stress-sensitive taxa. This metric is included only in the high mesohaline sand classification for the B-IBI. The list of taxa that are defined as pollution-indicative for the Chesapeake Bay is provided in Versar (2002).

Based on the habitat type, the results from the appropriate metrics specific to the habitat type were used to calculate the B-IBI for each benthic community sampling location. The metrics and resulting scores for high mesohaline sand and high mesohaline mud habitats used to calculate the Chesapeake Bay B-IBI are presented in Table 2-3.

The Chesapeake Bay B-IBI approach involves scoring each metric as 5, 3, or 1, depending on whether its value at a location approximates (5), deviates slightly (3), or deviates greatly (1) from conditions at reference sites (Weisberg et al. 1997). The final Chesapeake Bay B-IBI score is derived by summing individual scores for each metric and calculating an average score.

Table 2-3
Scoring Criteria for Biotic Integrity (B-IBI) Calculations

Metric	Scoring Criteria for Mesohaline Habitat		
	5	3	1
High Mesohaline Sand			
Shannon-Wiener Species Diversity Index	≥3.2	2.5 to 3.2	<2.5
Abundance (organisms/m^2)	≥1,500 to 3,000	1,000 to 1,500 or ≥3,000 to 5,000	<1,000 or ≥5,000

Metric	Scoring Criteria for Mesohaline Habitat		
	5	3	1
Biomass (g/m^2)	≥3 to 15	1 to 3 or ≥15 to 50	<1 or ≥50
Abundance pollution-indicative taxa (%)	≤10	10 to 25	>25
Abundance pollution-sensitive taxa (%)	≥40	10 to 40	<10
Abundance of carnivores and omnivores (%)	≥35	20 to 35	<20
High Mesohaline Mud			
Shannon-Wiener Species Diversity Index	≥3.0	2.0 to 3.0	<2.0
Abundance (organisms/m^2)	≥1,500 to 2,500	1,000 to 1,500 or ≥2,500 to 5,000	<1,000 or ≥5,000
Biomass (g/m^2)	≥2 to 10	0.5 to 2 or ≥10 to 50	<0.5 or ≥50
Abundance pollution-indicative taxa (%)	≤5	5 to 30	>30
Abundance pollution-sensitive taxa (%)	≥60	30 to 60	<30
Abundance of carnivores and omnivores (%)	≥25	10 to 25	<10
Biomass deeper than 5 centimeters (%)	≥60	10 to 60	<10

The B-IBI is used to establish benthic restoration goals for the Chesapeake Bay (Weisberg et al. 1997). The Chesapeake Bay RGI (Ranasinghe et al. 1994) was patterned after the same approach used to develop the IBI for freshwater systems (Karr et al. 1986). A Chesapeake Bay RGI value of 3.0 represents the minimum restoration goal, and Chesapeake Bay RGI values of less than 3.0 are indicative of a stressed community. Values of 3.0 or greater indicate habitats that meet or exceed the restoration goals (Ranasinghe et al. 1994).

Based on the Chesapeake Bay RGI, the Chesapeake Bay Benthic Monitoring Program classifies the benthic community in four levels (Versar 2002):

- Meets restoration goals (Chesapeake Bay B-IBI that is ≥3.0)
- Marginal (Chesapeake Bay B-IBI of 2.7 to 2.9)
- Degraded (Chesapeake Bay B-IBI of 2.1 to 2.6)
- Severely degraded (Chesapeake Bay B-IBI that is ≤2.0)

A Chesapeake Bay B-IBI value of 3.0 is the threshold value between degraded and nondegraded conditions at a location.

2.3 Fisheries Surveys

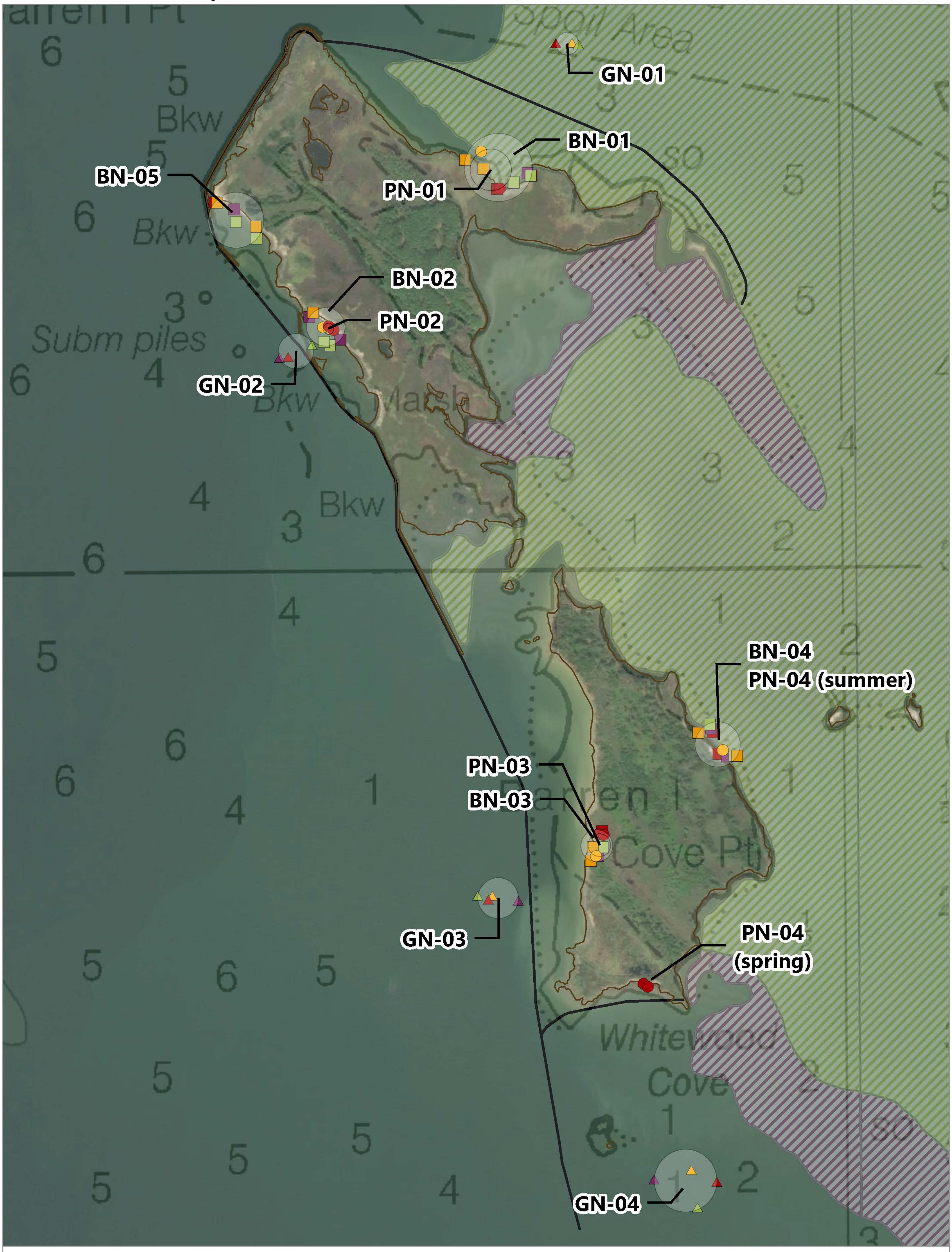
Littoral and subtidal habitats support diverse populations of numerous species of finfish and macroinvertebrates. These habitats are used as rearing areas, migration corridors, spawning areas, and places of refuge from predators. Fisheries surveys were conducted to document existing fish and blue crab (*Callinectes sapidus*) communities in the vicinity of James Island and Barren Island.

The fish community surveys were completed using multiple types of fish collection gear, depending on the habitat in which the sampling gear will be used. Sample gear will include beach seines, bottom trawls, gillnets, and pop nets. Sample locations for Barren Island and James Island fisheries surveys are provided in Figures 2-6a and b and 2-7a and b, respectively.

Beach seining, bottom trawls, and gillnets were used during all four sampling seasons (summer, fall, winter, and spring). Pop nets were used only during the summer sampling season (August 2020) and the spring sampling season (May 2021) to be consistent with the data collected during the 2002/2003 baseline surveys. All captured species were returned to the water immediately following processing.

At each location for each type of sampling, water depth, and water quality parameters (temperature, pH, DO, turbidity, and salinity) were measured from the mid-depth of the water column.

Figure 2-6a
Barren Island Fisheries Survey Locations



LEGEND:

Barren Island Remnants
Proposed Barren Island Protection

Existing SAV Bed

Dense 70-100% cover
Sparse 10-20% cover

SAMPLING EVENT:

Popnet Samples	Gillnet Samples	Beach Seine Samples
Summer	Summer	Summer
Spring	Fall	Fall
	Winter	Winter
	Spring	Spring

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. PN-04 was re-located during the spring sampling event due to changes in habitat conditions at the original sampling location.
3. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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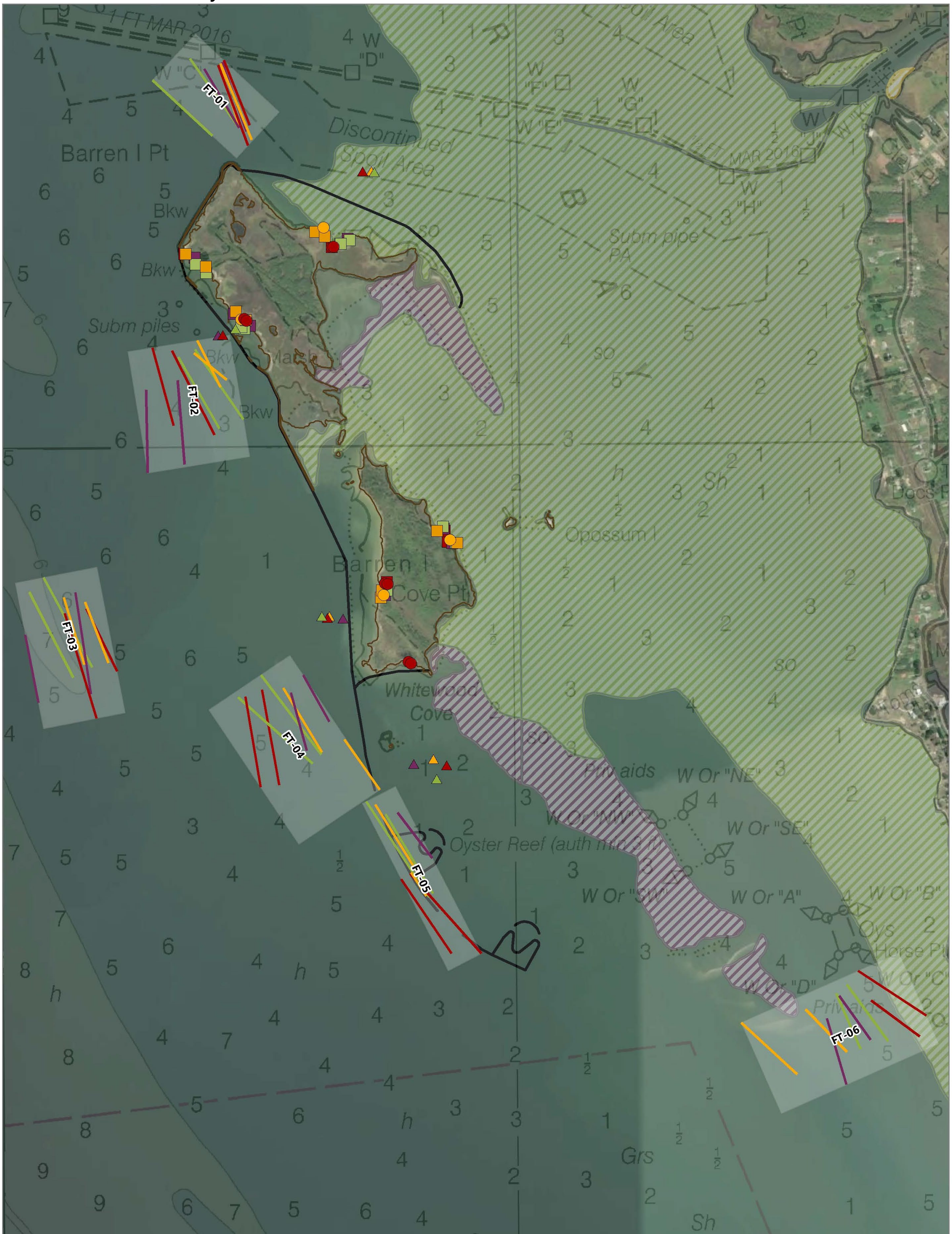
Figure 2-6b
Barren Island Fisheries Survey Locations



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

SAMPLING EVENT:

Popnet Samples	Gillnet Samples	Beach Seine Samples	Fisheries Trawl
Summer	Summer	Summer	Summer
Spring	Fall	Fall	Fall
	Winter	Winter	Winter
	Spring	Spring	Spring

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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2.3.1 Beach Seining

Beach seines were used to collect data on nearshore fish assemblages in the Project area. Locations were chosen to represent various types of offshore-zone habitat as well as the eastern and western sides of the islands. Three locations were sampled at James Island (Figure 2-7a and b), and five locations were sampled at Barren Island (Figure 2-6a and b) during all seasons. In the baseline survey, there were four beach seine locations at James Island, but as a result of the continued erosion at James Island, one of the beach seine locations no longer exists and there was no suitable habitat at an alternate location that could be substituted into the program. Therefore, only three beach locations at James Island were sampled. Coordinates for all sampling locations were documented by differential global positioning system (DGPS).

A 100-foot seine net was used to sample the seine locations. The net was deployed in an arc, perpendicular to the shoreline, to sample approximately 30 meters of shoreline. Two consecutive and adjacent hauls were made at each of the locations for a combined shoreline distance of approximately 60 meters.

All fish and crab collected in the seine net were identified to the lowest practicable taxon and counted before being returned to the water. A representative subsample of up to 50 individuals for each species for each haul were measured to the nearest millimeter. For each location, the total number of organisms collected during the two hauls were summed for a total count. During the spring sampling event only, a representative subsample of up to 50 individuals for each species for each haul was weighed to the nearest 0.1 gram (g).

2.3.2 Bottom Trawling

Bottom trawls were used to collect data on the benthic or demersal assemblages present in the vicinity of the Project. Bottom trawl surveys were conducted during all four seasons (summer, fall, winter, and spring).

Bottom trawling was conducted at 12 locations: six at Barren Island (Figure 2-6a and b) and six at James Island (Figure 2-7a and b). Locations were chosen to represent various types of offshore-zone habitat as well as the eastern and western sides of the islands. Two separate 5-minute otter trawl tows were conducted at each location. For each location, the total number of organisms collected during the two trawl tows were summed to represent 10 minutes of total effort. All fish and crab collected in the bottom trawls were identified to the lowest practicable taxon and counted before being returned to the water. A representative subsample of up to 50 individuals for each species at each location were measured to the nearest millimeter. During the spring sampling event only, a representative subsample of up to 50 individuals for each species for each haul was weighed to the nearest 0.1 g.

2.3.3 Gillnetting

Gillnetting was used to collect data on fish present throughout the water column near James Island and Barren Island. Gillnet surveys were conducted during all four seasons (summer, fall, winter, and spring).

Gillnets were set at eight locations, four at James Island (Figure 2-7a and b) and four at Barren Island (Figure 2-6a and b). Coordinates for all sampling locations were documented by DGPS. One gillnet was set per location. The gillnets were 100 feet in length with five panels of varying mesh sizes ranging from 0.75 inch to 2.5 inches to target all fish species. All organisms collected in the gillnets were identified to the lowest practicable taxon and counted before being returned to the water. A representative subsample of up to 50 individuals for each species from each location was measured to the nearest millimeter. During the spring sampling event only, a representative subsample of up to 50 individuals for each species was weighed to the nearest 0.1 g.

2.3.4 Pop Nets

Pop nets were used to collect data on nearshore fish assemblages and blue crab communities present near the Project area. Pop nets were used only during the summer sampling season (August 2020) and the spring sampling season (May 2021). Because of continued erosion at the site between the summer and spring seasons, two locations – PN-4 at Barren Island and PN-2 at James Island – were inaccessible for pop net deployment during the spring sampling event and were relocated (Figures 2-6a and 2-7a). Sites selected for the spring sampling event were in areas with similar site characteristics and water depths to the original locations to ensure that data collected would be representative of the same target fish population.

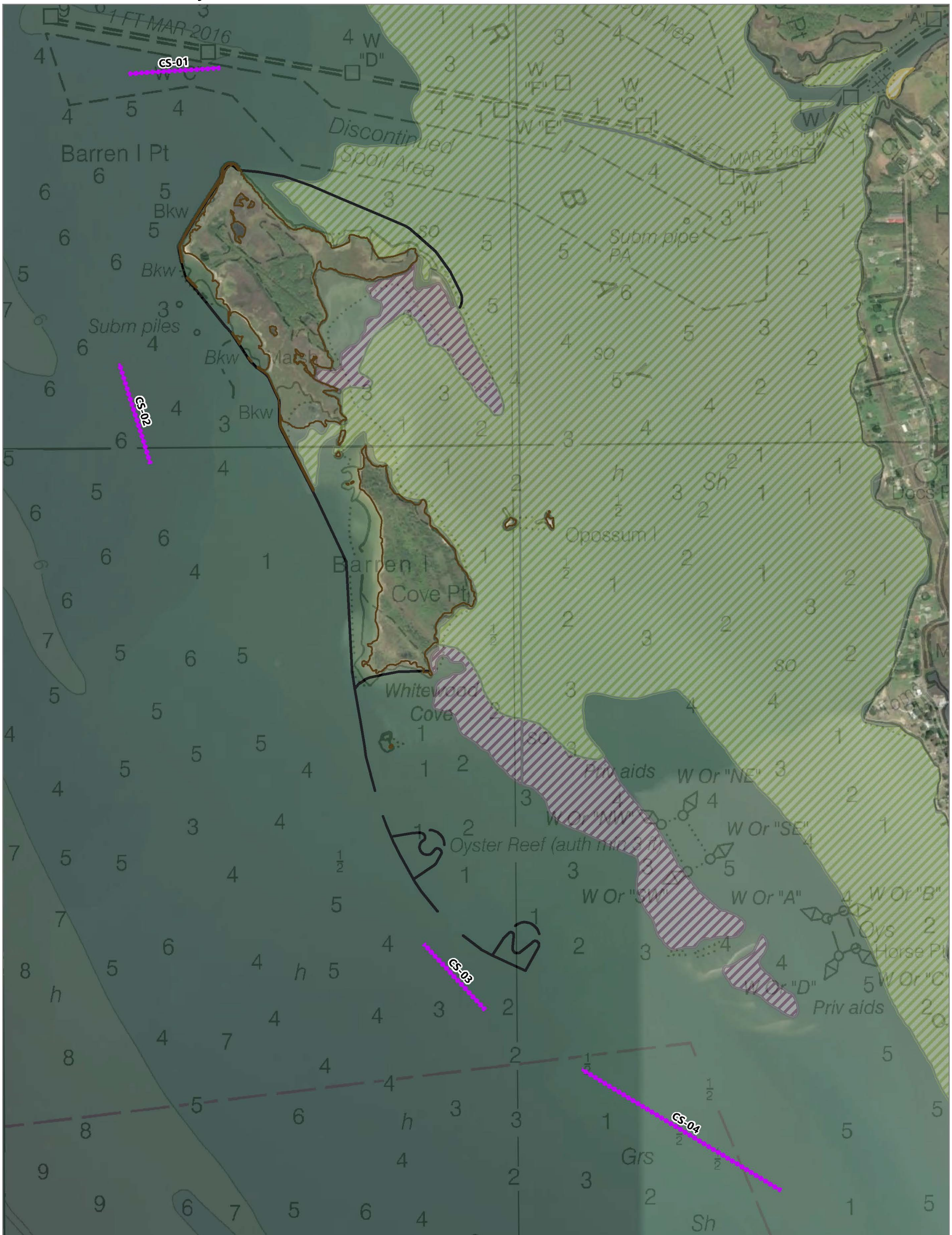
Pop nets were deployed at seven locations, three at James Island (Figure 2-7a and b) and four at Barren Island (Figure 2-6a and b). Coordinates for all sampling locations were documented by DGPS. Pop nets were set in areas as close to the beach seine locations as possible and in areas of SAV, if present. Two pop nets were set at each sampling location to collect two consecutive samples during the daytime high tide. Pop nets were set for at least one full tidal cycle to reduce interference from deploying the pop net. The pop nets were released approximately 2 hours after peak daytime high tide. All organisms collected in the pop nets were identified to the lowest practicable taxon and counted before being returned to the water. The total length of a representative subsample of up to 50 individuals for each species was measured from each pop net. During the spring sampling event, a representative subsample of up to 50 individuals for each species for each haul was weighed to the nearest 0.1 g.

2.4 Bivalve Surveys

A commercial clammer licensed to catch soft-shell clams was contracted to perform the bivalve surveys in the Project area. This survey was completed during the fall season only, consistent with the baseline surveys and the commercial clam season. Nine transects were surveyed in total: four transects at Barren Island (Figure 2-8) and five transects at James Island (Figure 2-9). The transects were approximately 100 to 200 meters in length and required approximately 15 minutes to complete. For each transect, the water depth and in situ water quality parameters were measured. The water quality parameters were measured from the mid-depth of the water column and included temperature, salinity, pH, and DO.

A hydraulic dredge was used to conduct the bivalve surveys. After each transect had been completed, the bivalves collected during the survey were processed. Soft-shell clams were sorted into two categories based on size: 1) legal harvestable size of 2 inches or greater; and 2) sublegal size less than 2 inches. The number of individuals in each size class were counted. All other bivalves were identified, counted, and measured.

Figure 2-8
Barren Island Bivalve Survey Locations



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

SAMPLING EVENT:

Clam Survey

- Fall

NOTES:

1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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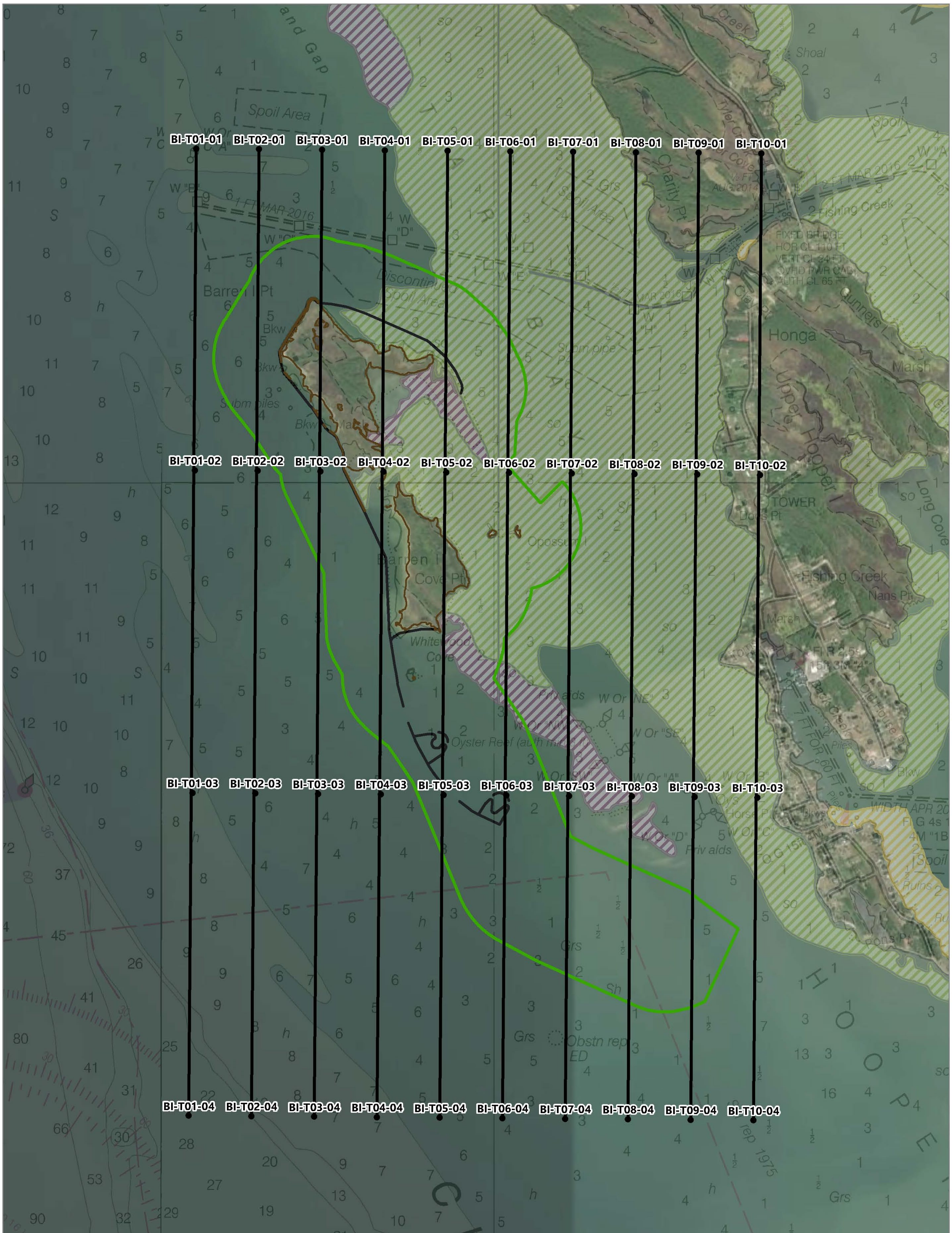
2.5 Crab Pot Surveys

Crab pot surveys were completed in August 2020, September 2020, May 2021, June 2021, and July 2021 at Barren Island and James Island. The survey area included the proposed restoration footprint plus a 0.25-mile perimeter. The crab pot survey area at Barren Island is 1,619 acres, and the survey area at James Island covers a total of 3,846 acres.

Crab pots were enumerated by counting the visible buoys marking the locations of crab pots. Transects were established every 500 meters within the survey area to ensure complete coverage of the crab pot survey area. Transects were drawn from north to south over the survey area, and two mid-transect points were used to document the location and relative density of the crab pots observed between the points along each transect. Figures 2-10 and 2-11 show the survey transects and survey areas for Barren Island and James Island, respectively. Only crab pots within the survey boundary were included in the total counts for the survey.

Figure 2-10
Barren Island Crab Pot Survey Transects



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection
- Crabpot Survey Footprint
- Crabpot Survey Point
- Crabpot Survey Transect

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and remnants.
3. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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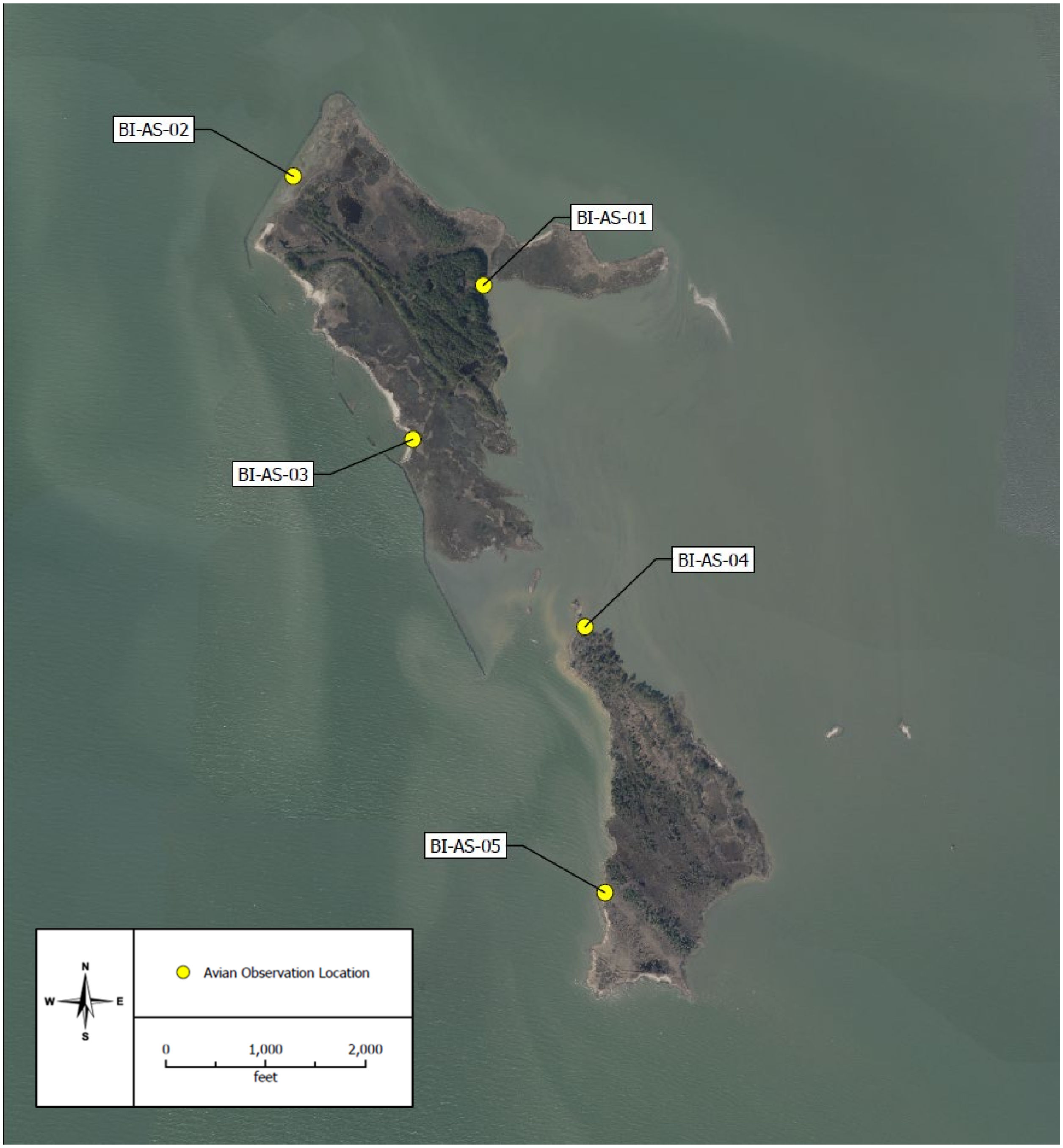
2.6 Avian Surveys

Avian surveys were conducted at nine locations in summer 2020: four at James Island and five at Barren Island. Sampling locations aimed to capture the range of habitats available (e.g., forest, scrub-shrub, salt marsh, open water, mudflat, and shoreline). Final locations were determined in the field based on site conditions, site access, and representativeness of the habitat conditions. The Barren Island avian survey locations are provided in Figure 2-12. The avian survey locations for the northern and southern remnants of James Island are provided in Figures 2-13 and 2-14, respectively.

At each sampling location, two 15-minute timed observations were conducted to provide a survey of the entire 360° viewshed. The first observation was oriented in a 180° arc along the shoreline and running out to open water. For the second observation, the observer turned 180° to observe the remaining shoreline and an arc running over the island. The pair of timed observations were conducted twice at each location during the surveys, once in the early morning and once at midday, so that surveys were conducted during both high- and low-tide conditions. At each of the sampling locations during the observation period, all birds heard or observed with binoculars or a spotting scope were identified and counted, and behavioral observations were recorded. Incidental bird observations made outside the survey periods were also noted.

Figure 2-12
Barren Island Avian Observation Locations



3 Barren Island Results

This section presents the results for all environmental surveys conducted at Barren Island during each season that sampling was conducted.

3.1 Water Quality

Quarterly water quality sampling was conducted in the vicinity of Barren Island in summer 2020, fall 2020, winter 2021, and spring 2021. A complete description of sampling locations, sample dates, and in situ water quality parameters (including temperature, DO, salinity, pH, and turbidity) are provided in Table 3-1. Water temperatures exhibited typical seasonal trends. The warmer water temperatures were generally recorded during the summer (ranging from 24.2°C to 25.3°C) and coolest water temperatures recorded during the winter (6.2°C to 8.3°C).

Overall, the DO concentrations varied seasonally. Because warm water has less ability to hold DO than cold water, DO concentrations tend to be lower in the summer compared to the winter. The lowest DO levels were measured during the summer season (ranging from 6.9 to 7.3 milligrams per liter [mg/L]) and maximum DO levels were measured in the winter (11.7 to 12.9 mg/L). During all seasons, DO values were greater than 5.0 mg/L, which is considered healthy and allows the Chesapeake Bay's aquatic system to thrive.

The highest salinities were measured during the fall (ranging from 15 to 16.3 ppt) and the lowest salinities occurred during the spring (ranging from 11.3 to 12.9 ppt), which is consistent with typical weather patterns in the area. During spring rains, salinity is usually lower compared to the drier fall months, when salinity is usually higher.

In general, the pH measurements at Barren Island were very similar to each other, both between locations and seasons. The range of pH measurements from all locations and for all seasons was from 7.8 to 8.4.

Turbidity values were recorded in Nephelometric Turbidity Units (NTU). Generally, turbidity levels were lower in the fall (ranging from 1.4 to 4.9 NTU) and winter (ranging from 2.3 to 4.8 NTU), with little variation between sample locations. Higher variability and turbidity levels were recorded during the spring (ranging from 1.5 to 11.0 NTU) and summer (ranging from 4.7 to 18.9 NTU). Secchi depth was also recorded during the spring 2021 sampling event. The maximum Secchi depth reading was 5.7 feet.

Results for the chemical constituents and nutrient parameters measured in Barren Island surface water samples are provided in Table 3-2. Orthophosphate was not detected in most surface water samples during the summer, fall, and winter sampling events. It was detected in most samples in low concentrations during the spring sampling event. Ammonium was generally detected in only the winter and spring sampling events, also at low concentrations. All remaining nutrients were generally detected in low concentrations. Generally, the highest concentrations of chlorophyll, phaeophytin, dissolved organic carbon, organic nitrogen, organic phosphorus, particulate carbon, particulate nitrogen, particulate phosphorus, total dissolved nitrogen, total dissolved phosphorus, total nitrogen, total phosphorus, and total suspended solids were measured during the summer 2020 sampling season. Highest concentrations of nitrite and nitrite + nitrate were measured during the winter 2021 season. Overall, there was little variability in nutrients between sampling location and season, with the exception of sampling location BI-WQ-06 during the spring sampling event. Concentrations of chlorophyll, phaeophytin, particulate carbon, particulate nitrogen, particulate phosphorus, total nitrogen, total phosphorus and total suspended solids were all higher in this sample but still within the range of normal variability for this region of the Chesapeake Bay.

Table 3-1
Barren Island Water Quality Sample Locations and Water Quality Parameters

Season	Sample ID	Date	Time	Northing	Easting	Water Depth (feet)	Temp (°C)	DO (mg/L)	Salinity (ppt)	pH	Turbidity (NTU)
Summer	BI-WQ-01	9/1/2020	8:05	245397.89	1522101.17	6	25.1	7	13	8.2	8.7
	BI-WQ-02	9/1/2020	8:40	240208.01	1522056.52	4.5	25.3	7	13.3	8.3	4.8
	BI-WQ-03	9/1/2020	8:22	241336.39	1524267.20	4.5	24.6	7	12.8	8.2	13.3
	BI-WQ-04	9/1/2020	9:00	236431.80	1526327.91	4	24.7	7	13	8.2	10
	BI-WQ-05	9/1/2020	9:15	234724.12	1528713.03	3.3	24.9	7.2	13.3	8.3	7.4
	BI-WQ-06	9/1/2020	7:40	247001.33	1524609.28	2	24.3	7	12.9	8.1	11.9
	BI-WQ-07	9/1/2020	7:13	246287.87	1527478.70	2.3	24.4	6.9	12.8	8	15.2
	BI-WQ-08	9/1/2020	10:30	240986.37	1527469.03	1.8	24.2	7.3	13.1	8.3	18.9
	BI-WQ-09	9/1/2020	10:53	239083.25	1527615.60	2.3	24.4	7.1	13	8.2	11.6
	BI-WQ-10	9/1/2020	10:02	237930.38	1530390.49	3	24.4	7.2	13.5	8.3	11.2
	BI-WQ-REF	9/1/2020	9:38	228030.52	1531651.51	3.5	24.9	7.3	13.7	8.3	4.7
Fall	BI-WQ-01	10/22/2020	12:05	245439.14	1522135.82	11	19.5	8.5	15.9	8.1	3.6
	BI-WQ-02	10/22/2020	11:36	240181.33	1521882.44	7.5	19.9	8.6	16.3	8.2	1.4
	BI-WQ-03	10/22/2020	11:50	241346.89	1524314.12	8.2	19.5	8.5	15.9	8.1	3.8
	BI-WQ-04	10/22/2020	10:55	236458.10	1526314.22	8.7	19.6	8.6	15.9	8.1	1.9
	BI-WQ-05	10/22/2020	10:36	234714.31	1528750.82	5.9	19.5	8.4	15.7	8.1	2.7
	BI-WQ-06	10/22/2020	12:55	246996.96	1524506.69	2.7	20.2	8	15.5	8	4.6
	BI-WQ-07	10/22/2020	12:30	246295.06	1527492.67	3.5	20.2	8.4	15	8.1	4.9
	BI-WQ-08	10/22/2020	8:51	240983.17	1527437.34	3.2	19.2	8.3	15.7	8.1	3.3
	BI-WQ-09	10/22/2020	9:25	239083.02	1527624.61	4.2	19.4	8.5	15.9	8.1	3.4
	BI-WQ-10	10/22/2020	10:10	237885.57	1530343.36	5.1	19.1	8.3	15.6	8.1	4.9
	BI-WQ-REF	10/22/2020	11:17	228063.89	1531516.24	6.5	19	8.2	15.7	8.1	3

Season	Sample ID	Date	Time	Northing	Easting	Water Depth (feet)	Temp (°C)	DO (mg/L)	Salinity (ppt)	pH	Turbidity (NTU)
Winter	BI-WQ-01	3/10/2021	10:47	245422.46	1522149.58	11.8	6.9	12.5	13.4	8.2	3.5
	BI-WQ-02	3/10/2021	10:15	240179.81	1521907.56	9.1	6.2	12.9	13.8	8.2	2.3
	BI-WQ-03	3/10/2021	10:30	241382.73	1524304.91	8.9	6.9	12.6	13.5	8.2	2.9
	BI-WQ-04	3/10/2021	8:22	236440.47	1526298.51	7.2	6.5	12.6	13.6	8.2	2.8
	BI-WQ-05	3/10/2021	8:06	234717.53	1528772.79	5.6	7.0	12.1	13.2	8.0	4.3
	BI-WQ-06	3/10/2021	11:07	246933.52	1524518.61	3.8	8.3	11.7	12.8	8.0	4.8
	BI-WQ-07	3/10/2021	11:33	246302.14	1527479.06	4.5	8.3	11.7	13.2	8.0	4.3
	BI-WQ-08	3/10/2021	9:54	240545.37	1526800.52	1.7	7.3	12.4	13.4	8.2	3.3
	BI-WQ-09	3/10/2021	9:10	239046.61	1527600.37	4.0	6.7	12.5	13.5	8.2	3.3
	BI-WQ-10	3/10/2021	8:50	237861.83	1530323.00	5.0	7.2	11.9	13.1	8.0	4.4
	BI-WQ-REF	3/10/2021	7:42	228064.59	1531503.88	5.2	6.8	12.1	13.2	8.0	3.9
Spring	BI-WQ-01	5/24/2021	9:36	245419.43	1522124.59	10.8	22.1	9.2	11.3	8.4	2.0
	BI-WQ-02	5/24/2021	10:12	240167.83	1521876.89	8.8	22.1	8.8	11.7	8.3	1.5
	BI-WQ-03	5/24/2021	9:53	241364.52	1524255.97	8.2	23.0	8.7	11.6	8.3	2.9
	BI-WQ-04	5/24/2021	10:32	236442.45	1526268.21	7.5	24.7	7.5	12.6	7.8	5.3
	BI-WQ-05	5/24/2021	10:53	234786.67	1528741.85	6.0	23.4	8.0	12.0	8.0	3.5
	BI-WQ-06	5/24/2021	8:34	246909.77	1524546.45	2.8	24.0	7.6	12.6	7.8	10.2
	BI-WQ-07	5/24/2021	9:05	246348.17	1527541.47	3.5	23.8	8.0	11.9	8.1	7.9
	BI-WQ-08	5/24/2021	11:54	240965.10	1527380.11	3.0	23.5	7.8	12.3	7.9	11.0
	BI-WQ-09	5/24/2021	11:32	239063.82	1527577.75	4.3	23.6	7.9	12.3	7.9	5.8
	BI-WQ-10	5/24/2021	11:12	237880.39	1530279.72	5.5	23.2	7.6	12.4	7.8	8.0
	BI-WQ-REF	5/24/2021	12:27	228058.82	1531491.41	7.5	21.8	8.2	12.9	7.9	3.1

Table 3-2
Barren Island Surface Water Quality Sample Results

Analyte	Units	BI-WQ-REF				BI-WQ-01				BI-WQ-02			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Chlorophyll, active	µg/L	**11.0**	**4.1**	**11.9**	**10.2**	**13.0**	**3.9**	**12.1**	**8.6**	**11.0**	**2.6**	**11.3**	**8.6**
Phaeophytin *a*	µg/L	**3.0**	**1.6**	**1.8**	**2.5**	**3.5**	**1.7**	**2.3**	**1.6**	**2.8**	**1.1**	**2.3**	**1.7**
Chlorophyll *a*	µg/L	**12.6**	**5.0**	**12.9**	**11.6**	**14.9**	**4.8**	**13.4**	**9.5**	**12.6**	**3.2**	**12.6**	**9.5**
Dissolved organic carbon	mg/L	**3.74**	**3.74**	**3.76**	**3.4**	**3.78**	**3.6**	**3.48**	**3.16**	**3.44**	**3.68**	**3.38**	**3.49**
Organic nitrogen	mg/L	**0.34**	**0.3342**	**0.306**	**0.27**	**0.43**	**0.30**	**0.27**	**0.29**	**0.35**	**0.32**	**0.28**	**0.25**
Organic phosphorus	mg/L	**0.013**	**0.013**	**0.009**	**0.012**	**0.017**	**0.012**	**0.007**	**0.011**	**0.016**	**0.013**	**0.007**	**0.009**
Ammonium	mg/L	0.009 U	0.009 U	**0.011**	**0.042**	0.009 U	0.009 U	**0.012**	0.009 U	0.009 U	0.009 U	**0.011**	0.009 U
Nitrite	mg/L	**0.002**	**0.004**	**0.005**	**0.007**	**0.002**	**0.004**	**0.004**	**0.005**	**0.002**	**0.003**	**0.005**	**0.005**
Nitrite + nitrate	mg/L	**0.007**	**0.017**	**0.113**	**0.091**	**0.008**	**0.010**	**0.134**	**0.041**	**0.007**	**0.010**	**0.142**	**0.087**
Particulate carbon	mg/L	**1.61**	**0.683**	**1.79**	**1.42**	**1.81**	**0.809**	**1.95**	**1.34**	**1.54**	**0.713**	**1.79**	**1.22**
Particulate nitrogen	mg/L	**0.27**	**0.124**	**0.235**	**0.226**	**0.34**	**0.14**	**0.25**	**0.24**	**0.29**	**0.12**	**0.22**	**0.21**
Orthophosphate	mg/L	0.0034 U	0.0034 U	**0.0038**	**0.0052**	0.0034 U	0.0034 U	0.0034 U	**0.0228**	0.0034 U	0.0034 U	0.0034 U	**0.0049**
Particulate phosphorus	mg/L	**0.026**	**0.010**	**0.020**	**0.020**	**0.033**	**0.012**	**0.018**	**0.021**	**0.027**	**0.009**	**0.015**	**0.019**
Total dissolved nitrogen	mg/L	**0.36**	**0.36**	**0.43**	**0.4**	**0.45**	**0.32**	**0.42**	**0.34**	**0.37**	**0.34**	**0.43**	**0.35**
Total dissolved phosphorus	mg/L	**0.017**	**0.016**	**0.012**	**0.017**	**0.021**	**0.015**	**0.010**	**0.033**	**0.020**	**0.016**	**0.010**	**0.014**
Total nitrogen	mg/L	**0.61**	**0.4**	**0.59**	**0.62**	**0.63**	**0.43**	**0.63**	**0.53**	**0.59**	**0.42**	**0.59**	**0.52**
Total phosphorus	mg/L	**0.044**	**0.028**	**0.022**	**0.029**	**0.048**	**0.032**	**0.023**	**0.033**	**0.045**	**0.023**	**0.022**	**0.031**

Analyte	Units	BI-WQ-REF				BI-WQ-01				BI-WQ-02			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Total suspended solids	mg/L	**19.6**	**11**	**32.3**	**32.8**	**25.6**	**13.75**	**12**	**24**	**18.8**	**7.5**	**9.3**	**24.3**

Notes:
Bold cells are detected constituents.
R: Poor replication between pads; sample rejected because the difference is greater than 50%.
U: compound not detected

Analyte	Units	BI-WQ-03				BI-WQ-04				BI-WQ-05			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Chlorophyll, active	µg/L	**16.6**	**3.9**	**13.7**	**7.7**	**14.3**	**2.6**	**11.7**	**6.5**	**13.4**	**2.5**	**13.5**	**7.3**
Phaeophytin *a*	µg/L	**3.6**	**1.7**	**2.0**	**1.5**	**3.2**	**1.2**	**1.8**	**1.3**	**3.1**	**1.2**	**2.0**	**2.3**
Chlorophyll *a*	µg/L	**18.7**	**4.8**	**14.9**	**8.6**	**16.1**	**3.2**	**12.7**	**7.3**	**15.2**	**3.2**	**14.6**	**8.6**
Dissolved organic carbon	mg/L	**4.53**	**3.57**	**4.03**	**3.38**	**4.25**	**3.68**	**3.42**	**3.52**	**3.74**	**3.58**	**3.67**	**3.63**
Organic nitrogen	mg/L	**0.47**	**0.36**	**0.35**	**0.22**	**0.38**	**0.30**	**0.26**	**0.26**	**0.36**	**0.32**	**0.27**	**0.27**
Organic phosphorus	mg/L	**0.019**	**0.018**	**0.009**	**0.010**	**0.016**	**0.011**	**0.002**	**0.014**	**0.022**	**0.011**	**0.003**	**0.010**
Ammonium	mg/L	**0.011**	0.009 U	**0.019**	0.009 U	**0.029**	0.009 U	0.009 U	**0.022**	0.009 U	0.009 U	**0.01**	**0.009**
Nitrite	mg/L	**0.002**	**0.002**	**0.004**	**0.005**	**0.002**	**0.003**	**0.005**	**0.005**	**0.002**	**0.002**	**0.005**	**0.006**
Nitrite + nitrate	mg/L	**0.012**	**0.012**	**0.136**	**0.088**	**0.059**	**0.014**	**0.136**	**0.097**	**0.019**	**0.005**	**0.128**	**0.085**
Particulate carbon	mg/L	**2.27**	**0.841**	**1.93**	**1.27**	**1.83**	**0.614**	**1.86**	**0.898**	**1.86**	**0.588**	**1.85**	**1.3**
Particulate nitrogen	mg/L	**0.42**	**0.15**	**0.25**	**0.21**	**0.34**	**0.11**	**0.24**	**0.15**	**0.34**	**0.11**	**0.24**	**0.22**
Orthophosphate	mg/L	**0.0037**	**0.0049**	0.0034 U	**0.015**	**0.0048**	0.0034 U	0.0034 U	**0.014**	0.0034 U	0.0034 U	0.0034 U	**0.008**
Particulate phosphorus	mg/L	**0.045**	**0.011**	**0.017**	**0.019**	**0.034**	**0.009**	**0.015**	**0.018**	**0.035**	**0.008**	**0.018**	**0.023**

Analyte	Units	BI-WQ-03				BI-WQ-04				BI-WQ-05			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Total dissolved nitrogen	mg/L	**0.49**	**0.38**	**0.50**	**0.32**	**0.47**	**0.32**	**0.40**	**0.38**	**0.39**	**0.33**	**0.41**	**0.36**
Total dissolved phosphorus	mg/L	**0.022**	**0.023**	**0.013**	**0.025**	**0.021**	**0.014**	**0.005**	**0.028**	**0.025**	**0.014**	**0.006**	**0.018**
Total nitrogen	mg/L	**0.75**	**0.44**	**0.59**	**0.47**	**0.65**	**0.40**	**0.56**	**0.51**	**0.60**	**0.39**	**0.62**	**0.66**
Total phosphorus	mg/L	**0.057**	**0.028**	**0.021**	**0.025**	**0.049**	**0.024**	**0.021**	**0.034**	**0.047**	**0.023**	**0.023**	**0.055**
Total suspended solids	mg/L	**39.2**	**13.75**	**11.5**	**27**	**26.8**	**8.75**	**10**	**33.8**	**30**	**8.5**	**12.2**	**146.2**

Notes:
Bold cells are detected constituents.
R: Poor replication between pads; sample rejected because the difference is greater than 50%.
U: compound not detected

Analyte	Units	BI-WQ-06				BI-WQ-07				BI-WQ-08			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Chlorophyll, active	µg/L	**14.4**	**3.3**	**10.1**	**77.1**	**14.9**	**4.7**	**11.2**	**6.3**	**13.8**	**2.8**	**12.5**	**7.1**
Phaeophytin *a*	µg/L	**3.8**	**1.3**	**1.3**	**32.2**	**4.9**	**2.0**	**1.7**	**1.7**	**3.7**	**1.2**	**1.8**	**2.0**
Chlorophyll *a*	µg/L	**16.5**	**4.0**	**10.9**	**94.9**	**17.6**	**5.8**	**12.2**	**7.2**	**15.9**	**3.5**	**13.5**	**8.1**
Dissolved organic carbon	mg/L	**4.11**	**3.57**	**3.86**	**3.93**	**4.35**	**4.09**	**3.51**	**3.27**	**3.39**	**3.7**	**3.38**	**3.34**
Organic nitrogen	mg/L	**0.39**	**0.31**	**0.30**	**0.30**	**0.43**	**0.32**	**0.28**	**0.27**	**0.37**	**0.31**	**0.29**	**0.27**
Organic phosphorus	mg/L	**0.013**	**0.009**	**0.008**	**0.019**	**0.016**	**0.013**	**0.005**	**0.013**	**0.012**	**0.010**	**0.005**	**0.012**
Ammonium	mg/L	0.009 U	0.009 U	**0.016**	**0.027**	0.009 U	**0.01**	**0.018**	**0.009**	0.009 U	0.009 U	0.009 U	**0.015**
Nitrite	mg/L	**0.002**	**0.003**	**0.004**	**0.008**	**0.002**	**0.003**	**0.005**	**0.005**	**0.002**	**0.005**	**0.005**	**0.006**
Nitrite + nitrate	mg/L	**0.008**	**0.017**	**0.102**	**0.074**	**0.007**	**0.008**	**0.123**	**0.059**	**0.008**	**0.014**	**0.142**	**0.082**
Particulate carbon	mg/L	**2.08**	**0.76**	**1.54**	**22**	**2.46**	**0.977**	**1.6**	**1.22**	**2.02**	**0.646**	**1.92**	**1.21**

Analyte	Units	BI-WQ-06				BI-WQ-07				BI-WQ-08			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Particulate nitrogen	mg/L	**0.40**	**0.13**	**0.21**	**3.20**	**0.44**	**0.15**	**0.21**	**0.21**	**0.38**	**0.12**	**0.24**	**0.20**
Orthophosphate	mg/L	0.0034 U	0.0034 U	0.0034 U	**0.0481**	0.0034 U	0.0034 U	0.0034 U	**0.0192**	0.0034 U	0.0034 U	0.0034 U	**0.0066**
Particulate phosphorus	mg/L	**0.041**	**0.011**	**0.015**	**0.240**	**0.042**	**0.012**	**0.014**	**0.022**	**0.039**	**0.009**	**0.017**	**0.025**
Total dissolved nitrogen	mg/L	**0.41**	**0.34**	**0.42**	**0.40**	**0.45**	**0.34**	**0.42**	**0.34**	**0.39**	**0.33**	**0.44**	**0.37**
Total dissolved phosphorus	mg/L	**0.016**	**0.013**	**0.012**	**0.067**	**0.019**	**0.016**	**0.008**	**0.032**	**0.016**	**0.014**	**0.008**	**0.019**
Total nitrogen	mg/L	**0.76**	**0.42**	**0.59**	**1.57**	**0.79**	**0.47**	**0.61**	**0.51**	**0.65**	**0.40**	**0.60**	**0.51**
Total phosphorus	mg/L	**0.054**	**0.032**	**0.025**	**0.146**	**0.057**	**0.026**	**0.024**	**0.032**	**0.051**	**0.023**	**0.024**	**0.033**
Total suspended solids	mg/L	**60.8**	**12.5**	**11.8**	**2,405**	**40**	**14.5**	**13**	**39**	**42.5**	**10.75**	**14.7**	**54.5**

Notes:
Bold cells are detected constituents.
R: Poor replication between pads; sample rejected because the difference is greater than 50%.
U: compound not detected

Analyte	Units	BI-WQ-09				BI-WQ-10			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Chlorophyll, active	µg/L	**18.4**	**2.9**	**13.1**	**7.5**	**15.5**	**2.9**	**11.6**	**6.5**
Phaeophytin *a*	µg/L	**4.4**	**1.3**	**1.7**	**1.7**	**3.5**	**1.2**	**1.7**	**1.8**
Chlorophyll *a*	µg/L	**20.9**	**3.6**	**14.1**	**8.5**	**17.5**	**3.5**	**12.5**	**7.5**
Dissolved organic carbon	mg/L	**4.27**	**3.63**	**3.41**	**3.47**	**3.7**	**3.75**	**3.58**	**3.42**
Organic nitrogen	mg/L	**0.41**	**0.31**	**0.28**	**0.27**	**0.39**	**0.32**	**0.29**	**0.28**
Organic phosphorus	mg/L	**0.017**	**0.010**	**0.006**	**0.013**	**0.016**	**0.009**	**0.005**	**0.011**

Analyte	Units	BI-WQ-09				BI-WQ-10			
		Summer 2020	Fall 2020	Winter 2021	Spring 2021	Summer 2020	Fall 2020	Winter 2021	Spring 2021
Ammonium	mg/L	0.009 U	0.009 U	0.009 U	**0.016**	0.009 U	0.009 U	**0.01**	**0.025**
Nitrite	mg/L	**0.003**	**0.010**	**0.005**	**0.006**	**0.002**	**0.002**	**0.005**	**0.006**
Nitrite + nitrate	mg/L	**0.016**	**0.017**	**0.131**	**0.071**	**0.006**	**0.008**	**0.111**	**0.070**
Particulate carbon	mg/L	**2.72**	**0.619**	**1.88**	**1.02**	**2.05**	**0.616**	**1.67**	**1.04**
Particulate nitrogen	mg/L	**0.56**	**0.11**	**0.24**	**0.18**	**0.38**	**0.14**	**0.22**	**0.18**
Orthophosphate	mg/L	**0.0049**	0.0034 U	0.0034 U	**0.0066**	0.0034 U	0.0034 U	0.0034 U	**0.0074**
Particulate phosphorus	mg/L	**0.070**	**0.011**	**0.019**	**0.024**	**0.038**	**0.007**	**0.014**	**0.023**
Total dissolved nitrogen	mg/L	**0.43**	**0.34**	**0.42**	**0.36**	**0.40**	**0.34**	**0.41**	**0.38**
Total dissolved phosphorus	mg/L	**0.022**	**0.013**	**0.009**	**0.019**	**0.020**	**0.013**	**0.008**	**0.019**
Total nitrogen	mg/L	**0.83**	**0.39**	**0.64**	**0.52**	**0.68**	**0.39**	**0.53**	**0.52**
Total phosphorus	mg/L	**0.070**	**0.024**	**0.027**	**0.032**	**0.053**	**0.027**	**0.023**	**0.034**
Total suspended solids	mg/L	**43**	**11.5**	--R	**42.8**	**37**	**10**	**12.2**	**40.7**

Notes:

Bold cells are detected constituents.

R: Poor replication between pads; sample rejected because the difference is greater than 50%.

U: compound not detected

MDNR has a CBWQM that has routinely sampled year-round in the Chesapeake Bay since 1985 and in the Coastal Bays since 1999. Five years of water quality data (2016 to 2020) from the CBWQM were summarized for the fixed monitoring station closest to Barren Island (Station CB5.1; MDNR 2021). Station CB5.1 is located in the Mid-Chesapeake Bay, west of Barren Island in approximately 34.7 meters (114 feet) of water. The most recent 5 years of surface (14 feet) water quality data at Station CB5.1 were chosen as a representative comparison to existing seasonal conditions because these samples most closely resemble the conditions of the sampling locations conducted at Barren Island. Means and ranges for physical water quality parameters and nutrients are presented in Tables 3-3 and 3-4, respectively, and are used for comparisons to the existing conditions.

Overall, the seasonal physical in situ water quality and nutrient parameters measured at the islands were similar to and typical of conditions in shallow, mesohaline areas of the middle portion of the Chesapeake Bay (with the exception of BI-WQ-06 during the spring season, as previously noted). Seasonal patterns of water quality and nutrient parameters measured at Barren Island were similar to seasonal distributions at CBWQM Station CB5.1. Additionally, the range in values for both the water quality parameters and nutrient concentrations were similar to the ranges measured at CBWQM Station CB5.1 from 2016 to 2020. Turbidity measurements were not collected at CB5.1 during the dates that coincide with the quarterly sampling at the islands, so comparisons to this data are not possible.

Table 3-3
Average and Range of Water Quality Variables at CBWQM Station CB5.1 (2016–2020)

		Sample Season[a]			
Analyte	**Units**	**Summer (August)**	**Fall (October)**	**Winter (March)**	**Spring (May)**
Temperature	°C	27.2 (24.8–29.1)	20.6 (19.6–21.6)	6.3 (5–8)	17.7 (14.7–20.5)
DO	mg/L	7.1 (4.2–9.3)	8.7 (6.8–10.1)	12.4 (12–12.8)	9.1 (7.5–10.1)
Salinity	ppt	12.6 (7.6–16.8)	15.0 (8.2–17.9)	12.0 (8.6–13.9)	10.4 (6.5–12.7)
pH	su	8.1 (7.7–8.4)	8.0 (7.8–8.2)	8.2 (8.0–8.4)	8.1 (7.8–8.5)
Secchi depth	feet	4.1 (2.6–5.2)	3.9 (2.6–4.9)	6.7 (5.2–7.9)	5.9 (3.3–9.2)

Note:
a. The value provided is the calculated average. The full range of results is provided in parentheses.

Table 3-4
Average and Range of Nutrient Concentrations at CBWQM Station CB5.1 (2016–2020)

Analyte	Units	Sample Season[a]			
		Summer (August)	Fall (October)	Winter (March)	Spring (May)
Phaeophytin *a*	µg/L	1.8 (0.36–3.9)	2.8 (1.5–4.2)	1.1 (0.74–1.7)	0.73 (0.67–0.77)
Chlorophyll *a*	µg/L	11 (7.1–17.5)	12.4 (8.9–15)	8.3 (6.1–9.6)	5 (3.4–7.9)
Organic nitrogen	mg/L	0.51 (0.39–0.62)	0.49 (0.46–0.56)	0.41 (0.32–0.48)	0.39 (0.34–0.43)
Organic phosphorus	mg/L	0.01 (0.006–0.02)	0.013 (0.009–0.017)	0.003 (0.0007–0.005)	0.005 (0.002–0.01)
Ammonium	mg/L	0.009 (0.002–0.016)	0.01 (0.007–0.013)	0.01 (0.006–0.013)	0.023 (0.008–0.048)
Nitrite	mg/L	0.006 (0.0003–0.05)	0.024 (0.001–0.062)	0.005 (0.005–0.006)	0.007 (0.005–0.009)
Nitrite + nitrate	mg/L	0.028 (0.001–0.11)	0.14 (0.002–0.4)	0.38 (0.26–0.66)	0.28 (0.19–0.58)
Particulate carbon	mg/L	1.4 (0.84–1.9)	1.2 (0.93–1.4)	0.89 (0.68–1.1)	0.87 (0.61–1.2)
Particulate nitrogen	mg/L	0.22 (0.17–0.29)	0.21 (0.17–0.25)	0.13 (0.11–0.16)	0.15 (0.11–0.2)
Orthophosphate	mg/L	0.005 (0.002–0.011)	0.004 (0.002–0.005)	0.003 (0.003–0.004)	0.003 (0.002–0.003)
Particulate phosphorus	mg/L	0.02 (0.014–0.025)	0.018 (0.013–0.025)	0.008 (0.007–0.009)	0.01 (0.007–0.016)
Total dissolved nitrogen	mg/L	0.33 (0.28–0.43)	0.42 (0.31–0.72)	0.64 (0.49–1)	0.54 (0.42–0.81)
Total dissolved phosphorus	mg/L	0.016 (0.009–0.031)	0.016 (0.013–0.019)	0.006 (0.005–0.006)	0.007 (0.005–0.012)
Total nitrogen	mg/L	0.55 (0.46–0.72)	0.65 (0.48–1)	0.78 (0.64–1.1)	0.7 (0.58–1)
Total phosphorus	mg/L	0.035 (0.027–0.045)	0.034 (0.026–0.041)	0.014 (0.012–0.015)	0.017 (0.013–0.027)
Total suspended solids	mg/L	5.8 (3–11.2)	7.6 (4.3–11.6)	4.9 (2.8–9.1)	3.6 (2.4–4.5)

Note:
a. The value provided is the calculated average. The full range of results is provided in parentheses.

3.2 Benthic Community

Benthic sampling was conducted in summer 2020, fall 2020, and spring 2021 at 10 locations in the vicinity of Barren Island and at one reference location (Figure 2-4). A complete description of benthic sampling locations, sample dates, and measured water quality parameters is provided in Table 3-5.

3.2.1 Habitat Classification

Sediment was also collected during the summer 2020 sampling event for grain size and total organic carbon content determination. Results of the grain size and total organic carbon analyses are provided in Table 3-6. The sampling locations at Barren Island were predominantly sand, with 8 of the 10 sampling locations composed of more than 50% sand. Sampling locations BI-BC-06 and BI-BC-10 were predominantly silts and clays, which composed 72.9% and 66.6% of the samples, respectively. The Barren Island reference location was also predominantly sand (94.9%; Table 3-6).

The bottom salinities measured at all Barren Island benthic sampling locations during the summer, fall, and spring sampling events were greater than 12 ppt (Table 3-5); therefore, each of the Barren Island benthic sampling locations were classified as high mesohaline. The only exception to this is sampling location BI-BC-10 during the spring sampling event, which had a measured bottom salinity of 11.4 ppt. Therefore, this one location was classified as low mesohaline.

Table 3-5
Barren Island Benthic Community Sample Locations and Water Quality Parameters

Season	Sample ID	Date	Time	Northing	Easting	Water Depth (feet)	Temp (°C)	DO (mg/L)	Salinity (ppt)	pH	Turbidity (NTU)
Summer	BI-BC-01	8/26/2020	1220	245305.87	1522029.64	11.2	27.4	7.1	13	8.5	16.9
	BI-BC-02	8/26/2020	1443	240155.05	1521885.92	8.0	27.7	7.3	13	8.5	6
	BI-BC-03	8/26/2020	1320	241316.71	1524298.52	7.2	27.5	7.3	13.2	8.4	17.6
	BI-BC-04	8/28/2020	837	236461.35	1526353.50	7.1	27.5	6.9	13.6	8.3	5.9
	BI-BC-05	8/27/2020	1438	234732.89	1528795.46	6.0	28.2	7.7	14.1	8.4	14.6
	BI-BC-06	8/26/2020	1038	246921.70	1524532.64	3.5	27.3	7.1	13.3	8.2	42.1
	BI-BC-07	8/28/2020	1027	246299.99	1527500.59	4.7	27.1	6.8	13.4	8.3	22.1
	BI-BC-08	8/27/2020	932	240933.53	1527477.12	4.3	27.1	7.2	13.4	8.1	22.7
	BI-BC-09	8/27/2020	1052	239083.46	1527627.80	5.4	27.5	7.4	13.4	8.2	17.2
	BI-BC-10	8/27/2020	1212	237881.93	1530355.51	5.8	27.6	7.6	13.8	8.3	9.4
	BI-BC-REF	8/27/2020	1322	228058.40	1531513.66	7.4	27.6	7.7	15	8.3	13.2
Fall	BI-BC-01	10/23/2020	1325	245439.14	1522135.82	11.0	20.1	8.5	16.3	8.2	3.5
	BI-BC-02	10/23/2020	1228	240185.34	1521865.67	8.0	20.2	9	16.5	8.2	0.9
	BI-BC-03	10/22/2020	1445	241374.89	1524324.90	8.0	19.7	8.8	16	8.2	5.7
	BI-BC-04	10/23/2020	1120	236434.94	1526303.41	7.5	20.1	8.3	15.7	8.2	1.9
	BI-BC-05	10/23/2020	936	234742.49	1528732.41	6.0	19.7	8.3	15.7	8.1	1.7
	BI-BC-06	10/22/2020	1255	246996.96	1524506.69	2.0	20.2	8	15.5	8.0	4.6
	BI-BC-07	10/21/2020	1454	246310.23	1527516.04	4.0	20.5	8.7	15.5	8.1	10.8
	BI-BC-08	10/22/2020	851	240983.17	1527437.33	2.0	19.2	8.3	15.7	8.1	3.3
	BI-BC-09	10/22/2020	925	239083.02	1527624.61	4.0	19.4	8.5	15.9	8.1	3.3
	BI-BC-10	10/23/2020	1039	237854.77	1530313.81	5.0	19.7	8.2	15.6	8.1	2.6
	BI-BC-REF	10/23/2020	845	228064.15	1531499.73	8.0	19.6	8.5	16	8.1	1.4

Season	Sample ID	Date	Time	Northing	Easting	Water Depth (feet)	Temp (°C)	DO (mg/L)	Salinity (ppt)	pH	Turbidity (NTU)
Spring	BI-BC-01	5/26/2021	740	245438.98	1522115.74	14.0	21.2	7.6	13.0	7.7	15.2
	BI-BC-02	5/26/2021	945	240216.89	1521889.57	9.5	21.5	7.8	13.0	7.7	6.7
	BI-BC-03	5/26/2021	845	241360.93	1524336.48	8.4	21.4	7.6	13.0	7.7	14.1
	BI-BC-04	5/26/2021	1055	236470.45	1526291.17	7.9	21.6	7.9	13.0	7.8	6.2
	BI-BC-05	5/26/2021	1235	234762.61	1528682.10	6.8	22.3	8.2	13.1	7.8	15.5
	BI-BC-06	5/24/2021	1545	247052.17	1524466.97	4.2	21.8	8.2	12.5	7.9	8.5
	BI-BC-07	5/24/2021	1439	246298.28	1527453.43	6.0	23.1	7.9	12.8	7.8	7.4
	BI-BC-08	5/25/2021	1315	240989.94	1527484.86	3.5	21.4	8.1	12.8	7.8	11.2
	BI-BC-09	5/25/2021	1405	239146.59	1527703.15	5.8	21.4	8.4	12.9	7.9	11.2
	BI-BC-10	5/25/2021	1540	237928.74	1530340.05	10.4	20.6	8.8	11.4	8.2	1.0
	BI-BC-REF	5/26/2021	1400	228075.85	1531519.41	8.2	21.3	9.2	12.3	8.3	3.1

Table 3-6
Barren Island Sediment Sample Results

Analyte	Units	Barren Island										
		BI-BC-REF	BI-BC-01	BI-BC-02	BI-BC-03	BI-BC-04	BI-BC-05	BI-BC-06	BI-BC-07	BI-BC-08	BI-BC-09	BI-BC-10
Gravel	%	0	0	0	0	0.3	0.9	0	0	0	0	0.4
Sand	%	94.9	84.2	94.5	96.3	94.2	90.7	27.1	54.5	51.4	92.8	33.1
Silt	%	3.3	9.8	4.1	1.7	4.1	5.9	18.5	37.3	44.6	5.1	61.3
Clay	%	1.9	6	1.4	2.1	1.3	2.6	54.4	8.2	4	2.1	5.3
Percent moisture	%	28.2	25.7	20.9	25.5	23.6	26.8	32.1	33.2	31.7	28.8	32.3
Total organic carbon	mg/kg	1,100	1,200	1,300	1,300	1,300	2,400	1,100	5,400	2,700	1,200	2,400

3.2.2 Benthic Community Metrics

A taxonomic list and abundance (number per m^2) of the benthic fauna collected at the Barren Island benthic sampling locations during the summer 2020, fall 2020, and spring 2021 sampling events are provided in Tables 3-7 through 3-9, respectively. A list of the benthic fauna collected in individual replicates collected at each location is provided in Appendix A.

A total of 33 unique benthic taxa were collected during the summer sampling event (Table 3-7), 34 unique taxa were collected during the fall sampling event (Table 3-8), and 53 unique taxa were collected during the spring sampling event (Table 3-9). Bivalves (specifically Mitchell macoma [*Ameritella mitchelli*], amethyst gem clam [*Gemma gemma*], and dwarf surf clam [*Mulinia lateralis*]) and polychaetes (specifically pile worm [*Alitta succinea*] and *Mediomastus ambiseta*) were the dominant taxa during the summer sampling event (Table 3-7). During the fall sampling event, Mitchell macoma was the dominant taxa at 9 of the 10 benthic community sampling locations and the reference location. The dominant taxon in the remaining benthic community sampling location was also a bivalve, amethyst gem clam (Table 3-8). The most dominant species identified during both the summer and fall sampling events was Mitchell macoma, representing 25% and 38% of the total count of benthic invertebrate taxa, respectively. In the spring sampling event, bivalves (specifically amethyst gem clam and dwarf surf clam) were also the dominant species at 9 of the 10 benthic community sampling locations and the reference location. The dominant taxon in the remaining benthic community sampling location was a polychaete (*Mediomastus ambiseta*; Table 3-9).

Six metrics were used to describe the overall characteristics of the benthic community at Barren Island—total abundance, unique taxa collected, species richness, evenness, Simpson's Dominance Index, and the Shannon-Wiener Diversity Index. These results are presented in Table 3-10 for all sampling events.

Abundance ranged from 1,818 to 9,517 organisms per m^2 in the summer, from 1,537 to 8,598 organisms per m^2 in the fall sampling event, and from 1,244 to 8,235 organisms per m^2 in the spring sampling event. The total abundance at the reference site was 1,920; 1,569; and 1,244 organisms per m^2 in the summer, fall, and spring sampling events, respectively (Table 3-10). The reference location consistently had the lowest or close to the lowest abundance of all locations during all sampling events.

The number of unique taxa at each benthic sample locations ranged from 9 to 15 taxa during the summer sampling event, from 8 to 18 taxa during the fall sampling event, and from 16 to 35 taxa during the spring sampling event. There was generally little change in the number of unique taxa at a location between the summer and fall events; however, higher numbers of unique taxa were documented during the spring sampling event. There were 10 unique taxa at the reference site during both the summer and fall sampling events and 16 unique taxa during the spring sampling event. The reference location consistently had the lowest numbers of unique taxa for all sampling locations during all sampling events (Table 3-10).

Species richness is a comparison of how many taxa are in a sample compared to how many individuals (Equation 2-3). Lower values indicate that the total benthic abundance at a location is dominated by a few taxa and does not represent a diverse benthic community. Species richness values ranged from 1.8 to 2.8 during the summer sampling event, from 1.7 to 2.8 during the fall sampling event, and from 2.3 to 3.7 during the spring sampling event. The species richness value at the reference site was 2.0 for summer and fall and increased to 2.4 during the spring sampling event. The reference location consistently had among the lowest species richness values of all locations during all sampling events (Table 3-10).

Evenness is a measure of how evenly the individuals collected at a location are distributed among the taxa collected at that location (Equation 2-4), with a maximum value of 1 indicating that the individuals are distributed as evenly as possible. Evenness values ranged from 0.6 to 0.8 during all sampling events. With the exception of BI-BC-09, evenness results either decreased or remained the same at all benthic community sampling locations. Evenness values at the reference site were 0.8, 0.5, and 0.8 for summer, fall, and spring, respectively. Generally, the reference site evenness values were similar to, or slightly greater than, the evenness values measured at the Barren Island locations (Table 3-10).

The Shannon-Wiener Species Diversity Index considers species richness and species evenness (Equation 2-1), with greater values indicating a more diverse benthic community. Shannon-Wiener Species Diversity Indices ranged from 1.6 to 2.0 during the summer sampling event, from 1.3 to 1.9 during the fall sampling event, and from 1.5 to 2.2 during the spring sampling event. Shannon-Wiener Species Diversity Indices at the reference site were 1.8,1.1, and 1.8 for summer, fall, and spring, respectively. The reference site Shannon-Weiner Species Diversity Indices measured at the reference site were within the range of values measured at the sampling locations (Table 3-10).

Simpson’s Dominance Index measures the diversity of a sample, with a lower value indicating a more diverse community (Equation 2-2). Simpson’s Dominance Indices ranged from 0.2 to 0.3 during the summer sampling event, from 0.2 to 0.4 during the fall sampling event, and from 0.1 to 0.4 during the spring sampling event. Simpson’s Dominance Indices at the reference site were 0.2, 0.5, and 0.2 for summer, fall, and spring, respectively (Table 3-10). All values indicate that the benthic communities present at the reference and sampling locations are diverse.

Results for all benthic community metrics measured at the Barren Island benthic community sampling locations were within the range of metrics measured at the Barren Island reference site for all sampling events. Additionally, the high evenness and Shannon-Wiener Species Diversity Indices and low Simpson's Dominance Indices indicate that the benthic community surrounding Barren Island is a diverse community.

Table 3-7
Barren Island Benthic Community Data: Summer 2020

Species Collected		Abundance (Organisms/m^2)										
Scientific Name	**Common Name**	**BI-BC-REF**	**BI-BC-01**	**BI-BC-02**	**BI-BC-03**	**BI-BC-04**	**BI-BC-05**	**BI-BC-06**	**BI-BC-07**	**BI-BC-08**	**BI-BC-09**	**BI-BC-10**
Alitta succinea	Pile worm	51	57	19	6	64	166	**568**	153	57	57	147
Americamysis almyra	Mysid shrimp	64	32	45	6	13	153	0	38	115	64	51
Ameritella mitchelli	Mitchell macoma	549	**919**	306	**989**	970	**772**	485	976	1,652	663	1926
Ameroculodes spp. Complex	Amphipod	0	0	0	0	6	0	6	0	6	0	0
Amphibalanus improvisus	Bay barnacle	0	6	0	0	0	26	0	0	6	0	0
Amphiporus bioculatus	Round worm	0	0	0	0	0	0	0	0	0	6	0
Carcinoma tremaphoros	Round worm	0	6	19	0	6	6	6	0	0	0	0
Cyathura polita	Isopod	0	13	0	0	0	6	26	96	19	6	0
Cyclaspis varians	Copepod	0	0	0	0	0	0	6	0	0	0	13
Fragilonemertes rosea	Rose worm	38	6	32	26	26	6	0	0	0	13	0
Gemma gemma	Amethyst gem clam	0	319	**772**	313	**1,059**	689	0	0	0	498	0
Glycera dibranchiata	Bloodworm	0	0	0	0	0	6	0	0	0	0	0
Glycinde multidens	Segmented worm	128	230	51	108	115	134	38	651	740	147	995
Haminella solitaria	Gastropod	0	0	0	0	6	6	0	6	13	13	6
Heteromastus filiformis	Bristle worm	83	376	57	115	249	115	0	408	262	96	166
Hypereteone heteropoda	Paddleworm	0	0	0	0	0	0	0	0	0	0	6
Japonactaeon punctostriatus	Pitted baby-bubble	64	26	13	51	159	32	0	57	51	19	440
Leitoscoloplos fragilis	Segmented worm	0	0	6	0	0	0	0	0	0	0	0
Lepidactylus dytiscus	Amphipod	0	0	0	0	0	0	0	0	0	6	0
Limecola petalum	Bivalve	0	0	0	0	0	0	0	13	6	0	0
Loimia medusa	Spaghetti worm	6	0	0	0	6	6	0	0	0	0	0
Marenzelleria viridis	Segmented worm	0	26	45	6	19	32	0	555	6	6	83
Mediomastus ambiseta	Segmented worm	32	332	6	70	128	70	32	**1,505**	338	19	**3,827**
Mulinia lateralis	Dwarf surf clam	**651**	300	364	383	236	721	134	274	**1,977**	**1,033**	1,703
Paraprionospio alata	Segmented worm	0	19	0	0	0	0	0	32	0	0	26
Parvilucina crenella	Many-lined lucine	13	0	0	0	0	0	0	0	0	0	0
Petricolaria pholadiformis	False angel wing	0	0	0	0	0	0	121	0	0	0	0
Polydora cornuta	Whip mudworm	0	0	0	0	13	0	26	0	0	0	0
Siphonenteron bicolour	Round worm	0	0	0	6	6	0	0	38	0	0	0
Streblospio benedicti	Ram's horn worm	242	70	140	51	70	108	370	134	70	26	121
Stylochus ellipticus	Flatworm	0	0	6	0	0	6	0	0	0	0	0
Tagelus plebeius	Stout razor clam	0	0	6	0	19	6	0	0	13	6	0
Tubificoides spp.	Segmented worms	0	45	0	0	13	64	0	38	32	0	6

Note:
Bold values represent the dominant species at each location.

Table 3-8
Barren Island Benthic Community Data: Fall 2020

Species Collected		Abundance (Organisms/m²)										
Scientific Name	**Common Name**	**BI-BC-REF**	**BI-BC-01**	**BI-BC-02**	**BI-BC-03**	**BI-BC-04**	**BI-BC-05**	**BI-BC-06**	**BI-BC-07**	**BI-BC-08**	**BI-BC-09**	**BI-BC-10**
Alitta succinea	Pile worm	0	64	6	6	115	281	13	45	57	32	83
Americamysis almyra	Mysid shrimp	32	6	13	0	13	6	0	6	0	6	6
Ameritella mitchelli	Mitchell macoma	**1,123**	**1,148**	**1,971**	**1,040**	2,666	**2,475**	**663**	**995**	**663**	**1,180**	**2,169**
Ameroculodes spp. Complex	Amphipod	0	0	19	0	0	0	0	0	0	0	0
Amphibalanus improvisus	Bay barnacle	0	6	0	0	0	0	0	0	0	6	0
Carinoma tremaphoros	Round worm	0	0	0	0	19	6	0	6	6	13	0
Cyathura polita	Isopod	0	6	0	0	6	19	0	26	0	6	0
Cyclaspis varians	Copepod	0	6	0	0	6	6	0	0	0	0	0
Eurypanopeus depressus	Flatback mud crab	0	0	0	0	6	0	0	0	0	0	0
Fragilonemertes rosea	Rose worm	19	0	51	38	32	6	0	0	0	0	0
Gemma gemma	Amethyst gem clam	13	1,008	1,493	727	**3,189**	2,335	147	0	6	823	6
Glycinde multidens	Segmented worm	172	427	262	472	644	281	115	300	549	96	1,116
Haminella solitaria	Gastropod	13	0	89	0	0	6	0	0	0	0	0
Hermundura americana	Segmented worm	0	0	0	6	0	0	0	6	0	0	0
Heteromastus filiformis	Bristle worm	26	179	89	57	281	115	19	38	179	108	134
Hypereteone heteropoda	Paddleworm	0	0	0	0	0	0	0	0	0	0	19
Japonactaeon punctostriatus	Pitted baby-bubble	13	51	26	45	217	45	0	0	0	0	166
Leitoscoloplos fragilis	Segmented worm	0	0	13	0	0	0	0	0	0	0	0
Leitoscoloplos robustus	Segmented worm	0	0	0	0	0	0	0	6	0	0	0
Limecola petalum	Bivalve	0	0	0	6	0	0	0	0	0	0	0
Lyonsia hyalina	Mussel	0	0	0	0	6	0	0	0	0	0	0
Marenzelleria viridis	Segmented worm	0	6	6	6	77	19	19	77	6	0	64
Mediomastus ambiseta	Segmented worm	19	364	26	491	542	185	255	108	587	45	1416
Mulinia lateralis	Dwarf surf clam	26	45	13	57	45	108	13	26	134	45	255
Mya arenaria	Soft-shell clam	0	0	0	0	51	26	0	0	0	0	0
Paraonis fulgens	Segmented worm	0	0	13	0	0	0	0	0	0	0	0
Paraprionospio alata	Segmented worm	0	6	0	6	6	6	0	0	0	0	0
Petricolaria pholadiformis	False angel wing	0	0	0	0	0	6	0	0	0	0	0
Polydora cornuta	Whip mudworm	0	0	0	0	13	6	0	0	0	0	0
Siphonenteron bicolour	Round worm	0	0	0	0	13	0	0	0	0	0	0

Note:
Bold values represent the dominant species at each location.

Species Collected		Abundance (Organisms/m²)										
Scientific Name	**Common Name**	**BI-BC-REF**	**BI-BC-01**	**BI-BC-02**	**BI-BC-03**	**BI-BC-04**	**BI-BC-05**	**BI-BC-06**	**BI-BC-07**	**BI-BC-08**	**BI-BC-09**	**BI-BC-10**
Streblospio benedicti	Ram's horn worm	51	172	0	51	172	89	51	51	281	108	338
Stylochus ellipticus	Flatworm	6	0	0	0	57	0	0	0	0	0	0
Tagelus plebeius	Stout razor clam	57	115	351	51	344	402	242	0	6	140	19
Tubificoides spp.	Segmented worms	0	26	0	0	77	57	0	0	13	0	6

Note:
Bold values represent the dominant species at each location.

Table 3-9
Barren Island Benthic Community Data: Spring 2021

Species Collected		Abundance (Organisms/m²)										
Scientific Name	**Common Name**	**BI-BC-REF**	**BI-BC-01**	**BI-BC-02**	**BI-BC-03**	**BI-BC-04**	**BI-BC-05**	**BI-BC-06**	**BI-BC-07**	**BI-BC-08**	**BI-BC-09**	**BI-BC-10**
Acteocina canaliculata	Channeled barrel-bubble	13	115	32	64	26	13	0	0	6	0	19
Alitta succinea	Pile worm	0	0	0	0	0	0	13	13	0	0	13
Americamysis almyra	Mysid shrimp	0	0	0	0	6	0	6	0	0	0	0
Ameritella mitchelli	Mitchell macoma	364	638	198	338	204	204	313	1314	957	325	842
Ameroculodes spp. complex	Amphipod	172	128	230	249	128	45	313	166	0	300	57
Amphibalanus improvisus	Bay barnacle	0	0	0	0	523	64	32	0	580	0	13
Amphiporus bioculatus	Round worm	0	0	0	0	6	0	0	0	0	0	0
Amphiporus caecus	Round worm	0	0	0	0	0	0	19	0	0	0	0
Apocorophium lacustre	Scud	0	0	0	0	102	0	1014	0	77	0	0
Ascidiacea sp.	Sessile tunicate	0	0	0	0	13	0	0	0	0	0	0
Bodotriidae	Cumacea	0	0	0	0	0	0	6	0	0	0	0
Carinoma tremaphoros	Round worm	0	0	0	0	0	6	0	0	0	0	0
Chironomidae larva	Midge	0	0	0	0	0	0	6	0	0	0	0
Cyathura polita	Isopod	0	0	0	6	0	0	6	19	83	0	38
Cyclaspis varians	Copepod	0	0	0	0	6	0	0	19	38	0	6
Edotia triloba	Isopod	6	45	19	19	0	51	204	45	364	13	140
Edwardsia elegans	Burrowing anemone	0	0	0	0	0	0	6	6	0	0	0
Eulimastoma engonium	Needle odostome	0	0	0	0	0	6	0	0	26	0	0
Fragilonemertes rosea	Rose worm	6	13	77	13	6	19	6	6		26	0
Gammarus mucronatus	Scud	0	0	6	0	19	0	51	0	121	6	0
Gemma gemma	Amethyst gem clam	0	**1990**	344	**1046**	**3661**	**1110**	89	0	26	**2315**	19
Geukensia demissa	Ribbed mussel	0	0	0	0	38	0	13	0	0	0	0
Glycinde multidens	Segmented worm	32	140	19	172	77	89	147	836	785	172	861
Grandidierella japonica	Aorid amphipod	0	0	0	0	13	0	338	108	64	0	64

Note:
Bold values represent the dominant species at each location.

Species Collected		Abundance (Organisms/m^2)										
Scientific Name	**Common Name**	**BI-BC-REF**	**BI-BC-01**	**BI-BC-02**	**BI-BC-03**	**BI-BC-04**	**BI-BC-05**	**BI-BC-06**	**BI-BC-07**	**BI-BC-08**	**BI-BC-09**	**BI-BC-10**
Heteromastus filiformis	Bristle worm	45	217	625	204	236	26	64	32	26	70	45
Hypereteone foliosa	Paddleworm	0	0	6	0	0	0	0	0	0	0	0
Hypereteone heteropoda	Paddleworm	0	45	26	19	51	6	77	13	204	0	64
Idoteidae	Isopod	0	0	0	0	26	0	0	0	0	0	0
Japonactaeon punctostriatus	Pitted baby-bubble	0	0	0	0	0	0	0	0	19	0	19
Leitoscoloplos fragilis	Segmented worm	13	0	70	6	6	0	6	0	0	13	0
Leptocheirus plumulosus	Amphipod	0	70	13	108	6	6	57	1257	89	102	293
Leucon (Leucon) americanus	Cumacea	0	6	0	0	0	0	0	0	0	0	13
Limecola petalum	Bivalve	26	26	0	13	64	102	6	128	957	64	855
Littoridinops tenuipes	Henscomb hydrobe	0	0	0	0	0	0	6	0	0	0	0
Marenzelleria viridis	Segmented worm	57	70	77	57	255	96	26	6		45	13
Mediomastus ambiseta	Segmented worm	38	268	51	83	153	210	179	**3081**	746	128	893
Mulinia lateralis	Dwarf surf clam	**364**	638	**676**	440	153	108	89	351	**989**	191	**1033**
Mya arenaria	Soft-shell clam	6	38	70	0	45	6	45	26	19	0	6
Neomysis americana	Opossum shrimp	0	6	0	13	0	0	0	0	0	0	0
Oedicerotidae	Amphipod	0	0	0	0	0	0	0	0	153	0	0
Paranthus rapiformis	Onion anemone	0	0	0	0	6	0	0	0	0	0	0
Paraonis fulgens	Segmented worm	0	0	57	6	0	0	6	0	0	6	0
Paraprionospio alata	Segmented worm	0	0	0	0	0	0	0	6	0	0	0
Petricolaria pholadiformis	False angel wing	0	0	0	0	0	0	13	0	0	0	0
Platyhelminthes sp. A	Flatworm	0	0	0	0	0	0	0	0	6	0	0
Polydora cornuta	Whip mudworm	0	6	19	0	651	51	689	0	702	0	0
Polydora websteri	Mud blister worm	0	0	0	0	26	0	0	0	6	0	0
Sayella chesapeakea	Sea snail	0	0	0	0	13	0	0	6	32	6	0
Siphonenteron bicolour	Round worm	0	6	0	0	0	0	6	0	0	0	0
Streblospio benedicti	Ram's horn worm	32	147	274	185	344	281	**1046**	759	274	64	389
Stylochus ellipticus	Flatworm	0	0	0	0	6	0	0	0	0	0	6
Tagelus plebeius	Stout razor clam	64	70	38	89	96	19	45	0	0	51	0
Tubificoides spp.	Segmented worms	6	0	32	0	89	19	6	38	26	6	13

Note:
Bold values represent the dominant species at each location.

Table 3-10
Barren Island Benthic Community Metrics

Metric	Barren Island											
	BI-BC-REF			BI-BC-01			BI-BC-02			BI-BC-03		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Total abundance/m²	1,920	1,569	1,244	2,781	3,636	4,682	1,888	4,440	2,960	2,130	3,062	3,132
Total biomass (g/m²)	0.5	0.7	3.2	1.1	0.6	4.5	0.6	0.5	0.8	1.0	0.7	3.4
Unique infaunal taxa	10	10	16	14	13	21	12	12	22	10	11	20
Species richness (Ludwig-Reynolds)	2.0	2.0	2.4	2.6	2.3	2.4	2.4	2.0	2.9	1.9	2.1	2.4
Evenness	0.8	0.5	0.8	0.8	0.7	0.7	0.7	0.6	0.8	0.7	0.7	0.8
Shannon-Wiener H' (ln)	1.8	1.1	1.8	2.0	1.9	1.8	1.7	1.4	2.2	1.6	1.7	2.0
Simpson's dominance	0.2	0.5	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.2
Shannon-Wiener H' (log base 2)	2.6	1.6	2.7	2.9	2.7	2.6	2.5	2.1	3.1	2.3	2.4	2.9
Percent abundance pollution-indicative species	46	5.1	34	12	6.1	17	27	0.7	35	20	3.0	21
Percent biomass pollution-indicative species	38	20	33	60	29	65	42	26	7.9	55	45	63
Percent abundance pollution-sensitive species	2.0	4.9	13	13	14	10	3.0	8.5	8.2	3.7	17	8.0
Percent biomass pollution-sensitive species	0.6	1.4	1.9	2.2	8.7	1.6	1.9	8.3	4.5	4.1	1.6	2.3
Percent abundance carnivores and omnivores	9.3	11	2.2	13	15	4.2	3.7	6.0	1.8	5.6	14	6.7

Metric	Barren Island											
	BI-BC-04			BI-BC-05			BI-BC-06			BI-BC-07		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Total abundance/m²	3,183	8,598	7,055	3,132	6,487	2,539	1,818	1,537	4,950	4,975	1,690	8,235
Total biomass (g/m²)	2.3	0.9	2.9	1.3	0.7	1.6	0.3	0.7	1.2	0.9	3.1	2.5
Unique infaunal taxa	14	18	33	15	15	22	9	8	35	14	9	22
Species richness (Ludwig-Reynolds)	2.6	2.8	2.9	2.8	2.4	2.8	1.9	1.7	3.7	2.4	1.8	2.3
Evenness	0.7	0.6	0.6	0.7	0.6	0.7	0.8	0.7	0.7	0.8	0.6	0.6
Shannon-Wiener H' (ln)	1.9	1.8	1.6	2.0	1.6	1.9	1.7	1.6	2.2	2.0	1.3	1.7
Simpson's dominance	0.2	0.3	0.4	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.4	0.3
Shannon-Wiener H' (log base 2)	2.7	2.6	2.3	2.9	2.3	2.7	2.4	2.3	3.2	2.9	1.9	2.4
Percent abundance pollution-indicative species	10	2.6	7.2	26	3.2	16	26	3.9	31	8	4.0	16

Metric	Barren Island											
	BI-BC-04			BI-BC-05			BI-BC-06			BI-BC-07		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Percent biomass pollution-indicative species	43	30	48	48	22	39	40	5.1	57	16	2.4	39
Percent abundance pollution-sensitive species	7.1	12	9.0	4.0	10	14	3.6	34	7.9	43	12	45
Percent biomass pollution-sensitive species	5.7	2.5	8.3	3.2	7.9	4.5	11	1.2	4.6	16	62	4.4
Percent abundance carnivores and omnivores	6.6	10	1.9	12	10	4.2	37	11	8.1	19	21	13

Metric	Barren Island								
	BI-BC-08			BI-BC-09			BI-BC-10		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Total abundance/m²	5,364	2,488	7,374	2,679	2,609	3,904	9,517	5,798	5,715
Total biomass (g/m²)	0.9	1.4	12.5	0.6	0.7	4.6	1.1	1.5	12.0
Unique infaunal taxa	14	10	27	12	10	19	12	11	24
Species richness (Ludwig-Reynolds)	2.3	1.8	2.8	2.3	1.9	2.3	1.8	1.8	2.4
Evenness	0.6	0.8	0.8	0.7	0.6	0.6	0.7	0.7	0.7
Shannon-Wiener H' (ln)	1.6	1.8	2.2	1.7	1.5	1.5	1.7	1.7	2.0
Simpson's dominance	0.3	0.2	0.1	0.2	0.3	0.4	0.2	0.2	0.2
Shannon-Wiener H' (log base 2)	2.4	2.5	3.2	2.5	2.1	2.1	2.4	2.4	2.9
Percent abundance pollution-indicative species	38	16	20	37	5.4	7.1	19	10	27
Percent biomass pollution-indicative species	37	59	73	30	24	64	34	36	78
Percent abundance pollution-sensitive species	7.3	25	14	1.9	7.0	5.9	40	26	18
Percent biomass pollution-sensitive species	12	2.0	0.3	1.3	1.1	1.0	15	17	0.4
Percent abundance carnivores and omnivores	16	25	16	8.1	5.2	4.7	13	21	19

3.2.3 *Chesapeake Bay Benthic Index of Biotic Integrity*

The total B-IBI score for each location is derived by averaging individual scores for each metric. A summary of the benthic community metrics and scores used to calculate the Chesapeake Bay B-IBI are presented in Table 3-11. Only species that met the Chesapeake Bay B-IBI macrofaunal criteria (Versar 2002) were included in the calculation. The B-IBI was derived using data for warmer months and is only indicated for the summer season. However, it was calculated for the fall and spring seasons for comparative purposes. Total scores for all but the summer season should be used with caution.

The calculated B-IBI scores were low for all Barren Island benthic locations for summer 2020 and fall 2020, and spring 2021 ranging from 1.8 to 2.9, with three exceptions. High scores occurred at Barren Island locations BI-BC-03 during fall 2020 (total B-IBI score of 3.0), BI-BC-06 during summer 2020 (total B-IBI score of 3.2), and BI-BC-07 during summer 2020 (total B-IBI score of 3.7), each of which was classified as meeting the restoration goal. Location BI-BC-01 received the classification of marginal during the fall and spring sampling events (total B-IBI scores of 2.9 and 2.7 for fall and spring, respectively). During the spring sampling event, three additional locations were classified as marginal (BI-BC-03, BI-BC-05, and BI-BC-09). All remaining samples were classified as either degraded or severely degraded. The Barren Island reference site was also classified as severely degraded during the summer sampling event (total B-IBI score of 1.9) and degraded during the fall and spring sampling events (total B-IBI score of 2.2 and 2.3 for fall and spring, respectively; Table 3-11).

These results were compared to the B-IBI scores calculated from the benthic sampling conducted in 2002 and 2003 and presented in the FS/EIS (USACE 2009). Total B-IBI scores ranged from 2.2 to 5.0 for all locations at Barren Island. The total B-IBI scores calculated for the summer 2002 samples were all greater than 3.0, resulting in the classification of meets restoration goals for all samples (USACE 2009).

Long-term benthic monitoring has also been part of Maryland's Water Quality Monitoring Program for the Chesapeake Bay since 1984. Currently, 48 sites within Chesapeake Bay are monitored annually by the Chesapeake Bay Long-Term Benthic and Assessment Monitoring Program to assess whether the benthic community condition is changing (Versar 2017). Data for 2015 through 2019 were downloaded from the Chesapeake Bay Benthic Monitoring Program website (2020 data were not yet available; Versar 2020) for comparison to the Barren Island benthic community B-IBI calculations. Three high mesohaline sand and one high mesohaline mud locations in the mainstem portion of the Chesapeake Bay are included in the annual Chesapeake Bay Long-Term Benthic and Assessment Monitoring Program. The three high mesohaline sand monitoring locations are located in the Mid-Bay Mainstem (001, 006, and 015), and the high mesohaline mud monitoring location is in the

Upper Bay Mainstem (024). B-IBI calculations for these long-term monitoring locations for 2015 through 2019 are presented in Table 3-12.

The 5-year averages for the B-IBI for the high mesohaline mud monitoring location (024) and two of the high mesohaline mud monitoring locations (001 and 006) all exceed 3.0, meaning they are classified as meets restoration goals. The 5-year average for one high mesohaline mud location (015) is 2.4, resulting in a classification of degraded. Results of the Barren Island B-IBI calculation were generally consistent with long-term monitoring location 015; however, they were less than the results of the remaining Chesapeake Bay long-term benthic monitoring locations.

Table 3-11
Chesapeake Bay B-IBI Scoring for Barren Island Benthic Locations

Metric	Barren Island											
	BI-BC-REF			BI-BC-01			BI-BC-02			BI-BC-03		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Salinity regime	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)
Shannon-Wiener H' (log base 2)	2.3	1.0	2.3	3.0	3.0	2.3	2.3	1.0	3.7	1.0	2.3	3.0
Total abundance/m²	5.0	4.3	3.0	4.3	3.7	3.0	5.0	2.3	4.3	5.0	3.7	4.3
Biomass/m²	1.0	1.0	3.7	1.0	1.7	5.0	1.0	1.0	1.0	1.7	2.3	4.3
Percent abundance pollution-indicative species	1.0	5.0	1.0	3.7	5.0	3.0	1.7	5.0	1.0	3.0	5.0	3.0
Percent biomass pollution-indicative species	--	--	--	--	--	--	--	--	--	--	--	--
Percent abundance pollution-sensitive species	1.0	1.0	3.0	2.3	3.0	1.7	1.0	1.0	1.7	1.0	3.0	1.7
Percent biomass pollution-sensitive species	--	--	--	--	--	--	--	--	--	--	--	--
Percent abundance carnivores and omnivores	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.7	1.0
B-IBI	1.9	2.2	2.3	2.6	2.9	2.7	2.0	1.9	2.1	2.1	3.0	2.9
Restoration goal	Severely degraded	Degraded	Degraded	Degraded	Marginal	Marginal	Severely degraded	Severely degraded	Degraded	Degraded	Meets restoration goals	Marginal

Notes:
B-IBI Scores: ≥ 3.0 = meets restoration goals; 2.7-2.9 = marginal; 2.1-2.6 = degraded; ≤ 2.0 = severely degraded
--: Metric was not used for this habitat classification

Metric	Barren Island											
	BI-BC-04			BI-BC-05			BI-BC-06			BI-BC-07		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Salinity regime	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (mud)	High Mesohaline (mud)	High Mesohaline (mud)	High Mesohaline (mud)	High Mesohaline (mud)	High Mesohaline (mud)
Shannon-Wiener H' (log base 2)	3.0	2.3	1.7	3.0	1.7	3.0	3.0	2.3	4.3	3.0	1.0	3.0
Total abundance/m²	3.7	1.0	1.7	3.7	1.0	5.0	3.7	2.3	3.7	1.7	4.3	1.0
Biomass/m²	1.7	3.0	3.7	1.0	1.7	2.3	3.0	1.0	3.0	5.0	3.0	4.3
Percent abundance pollution-indicative species	4.3	5.0	4.3	1.0	5.0	3.0	--	--	--	--	--	--
Percent biomass pollution-indicative species	--	--	--	--	--	--	4.3	2.3	1.0	5.0	3.7	1.7
Percent abundance pollution-sensitive species	1.7	2.3	1.7	1.0	2.3	2.3	--	--	--	--	--	--
Percent biomass pollution-sensitive species	--	--	--	--	--	--	1.0	1.0	1.0	4.3	1.0	1.0
Percent abundance carnivores and omnivores	1.0	1.0	1.0	1.0	1.0	1.0	4.3	1.7	1.7	3.0	3.7	3.0
B-IBI	2.6	2.4	2.3	1.8	2.1	2.8	3.2	1.8	2.4	3.7	2.8	2.3

Metric	Barren Island											
	BI-BC-04			BI-BC-05			BI-BC-06			BI-BC-07		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Restoration goal	Degraded	Degraded	Degraded	Severely degraded	Degraded	Marginal	Meets restoration goals	Severely degraded	Degraded	Meets restoration goals	Marginal	Degraded

Metric	Barren Island								
	BI-BC-08			BI-BC-09			BI-BC-10		
	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021	Summer 2020	Fall 2020	Spring 2021
Salinity regime	High Mesohaline (mud)	High Mesohaline (mud)	High Mesohaline (mud)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (sand)	High Mesohaline (mud)	High Mesohaline (mud)	Low Mesohaline (mud)
Shannon-Wiener H' (log base 2)	3.0	3.0	5.0	1.7	1.0	1.0	3.0	3.0	3.7
Total abundance/m^2	2.3	3.7	1.7	4.3	4.3	3.0	1.0	1.0	1.7
Biomass/m^2	3.0	2.3	3.7	1.7	1.7	5.0	3.0	3.0	3.7
Percent abundance pollution-indicative species	--	--	--	1.0	5.0	5.0	--	--	--
Percent biomass pollution-indicative species	1.0	1.7	1.0	--	--	--	1.0	2.3	1.0
Percent abundance pollution-sensitive species	--	--	--	1.0	1.0	1.0	--	--	--
Percent biomass pollution-sensitive species	1.0	1.0	1.0	--	--	--	1.0	1.0	1.0
Percent abundance carnivores and omnivores	3.0	3.7	3.0	1.0	1.0	1.0	2.3	3.0	3.0
B-IBI	2.2	2.6	2.6	1.8	2.3	2.7	1.9	2.2	2.3
Restoration goal	Degraded	Degraded	Degraded	Severely degraded	Degraded	Marginal	Severely degraded	Degraded	Degraded

Notes:
B-IBI Scores: ≥ 3.0 = meets restoration goals; 2.7-2.9 = marginal; 2.1-2.6 = degraded; ≤ 2.0 = severely degraded
--: Metric was not used for this habitat classification

Table 3-12
Chesapeake Bay B-IBI Scores for the Chesapeake Bay High Mesohaline Long-Term Benthic Monitoring Locations

Year	High Mesohaline Sand Monitoring Locations			
	Mid-Bay (Mainstem – 001)	**Mid-Bay (Mainstem – 006)**	**Mid-Bay (Mainstem – 015)**	**Upper Bay (Mainstem – 024)**
2015	3.7 (Meets restoration goals)	3.6 (Meets restoration goals)	2.7 (Marginal)	3.8 (Meets restoration goals)
2016	3.0 (Meets restoration goals)	3.4 (Meets restoration goals)	1.8 (Severely Degraded)	3.1 (Meets restoration goals)
2017	3.3 (Meets restoration goals)	3.0 (Meets restoration goals)	2.48 (Degraded)	3.7 (Meets restoration goals)
2018	3.0 (Meets restoration goals)	3.0 (Meets restoration goals)	2.7 (Marginal)	3.7 (Meets restoration goals)
2019	2.1 (Degraded)	2.4 (Degraded)	2.7 (Marginal)	3.3 (Meets restoration goals)
Average B-IBI for 2015 to 2019	3.0 (Meets restoration goals)	3.1 (Meets restoration goals)	2.4 (Degraded)	3.5 (Meets restoration goals)

Source: Chesapeake Bay Benthic Monitoring Program (Versar 2020)

3.3 Fisheries Surveys

To identify the fish species using the area around Barren Island, a four-season sampling program was implemented including surveys in summer 2020, fall 2020, winter 2021, and spring 2021. Survey sampling techniques include bottom trawling, beach seining, gillnetting, and pop netting. Bottom trawl, beach seine, and gillnet surveys were conducted during all four seasons. The bottom trawl is used to collect data on the benthic fish assemblages and the beach seine provides data on the nearshore fish assemblages and blue crab assemblages. The gillnet surveys were used to collect data on fish assemblages in the offshore water column. Pop netting, which targets fish that use the SAV beds in the vicinity of Barren Island as habitat, was conducted in summer 2020 and spring 2021.

As expected, sampling data indicated that beach seine surveys detected juvenile fish, while bottom trawl and gillnet surveys detected larger subadult to adult fish, mainly due to juveniles and smaller fish remaining closer to the shore where they are more likely to be captured in a seine net, while larger fish tend to be in deeper water where they are more likely to be captured in a trawl or gillnet. In addition, beach seine surveys generally collected more species than other sampling gear.

3.3.1 Beach Seine Survey Results

A summary of species collected, number of each species collected, and range of sizes collected in beach seines for each sampling season is provided in Table 3-13. Individual lengths for all fish and crab collected are provided in Appendix B. Overall, 22 different species of fish and one invertebrate were collected throughout all four sampling seasons. The fall survey resulted in the greatest number of fish collected, with the lowest abundance and species diversity observed during the winter survey.

At Barren Island, the summer 2020 beach seine sampling produced 14 different species of fish and one species of invertebrate, the blue crab. Bay anchovy (*Anchor mitchilli*) was the most abundant, and Atlantic menhaden (*Brevoortia tyrannus*) and Atlantic silverside (*Menidia menidia*) were also present in high abundances. Other fish collected in significant numbers include silver perch (*Bairdiella chrysoura*) and spot (*Leiostomus xanthurus*). Five or less of each of the following species were also collected during the summer 2020 event (in order of abundance): weakfish (*Cynoscion regalis*), mummichog (*Fundulus heteroclitus*), striped anchovy (*Anchoa hepsetus*), harvest fish (*Peprilus paru*), spotted seatrout (*Bairdiella chrysoura*), blackcheek tonguefish (*Symphurus plagiusa*), cownose ray (*Rhinoptera bonasus*), striped blenny (*Chasmodes bosquianus*), and striped killifish (*Fundulus majalis*).

The fall 2020 beach seine sampling produced 15 different species of fish and two species of invertebrates (blue crab and unknown crab). The Atlantic silverside was the most abundant fish (making up 92% of the total number of fish collected), and bay anchovy, mummichog, juvenile red drum (S*ciaenops ocellatus*), sheepshead minnow (*Cyprinodon variegatus*), and striped killifish were also present in high abundances. Five or less of each of the following species were also collected during the fall 2020 event (in order of abundance): Atlantic menhaden, spot, spotted seatrout, northern kingfish (*Menticirrhus saxatilis*), banded killifish (*Fundulus diaphanous*), inland silverside (*Menidia beryllina*), northern pipefish (*Syngnathus fuscus*), silver perch, and white perch (*Morone americana*).

Five different fish species were collected during the winter 2021 survey. Atlantic silverside was caught in the greatest numbers, but overall abundance was substantially lower than the fall 2020 survey (63 in the winter versus 3,376 in the fall). Five or less of each of the following species were also collected during the winter 2021 event (in order of abundance): striped killifish, bay anchovy, Atlantic menhaden, and gizzard shad (*Dorosoma cepedianum*).

The spring 2021 survey yielded nine fish species and one species of invertebrate (blue crab). Bay anchovy were caught in the greatest abundance, and Atlantic silverside, Atlantic menhaden, mummichog, striped killifish, spot, and white perch were also caught in relative high numbers. Inland silverside and northern pipefish were also caught during the survey.

Table 3-13
Barren Island Beach Seine Collection Data

Species Collected		Summer Collection				Fall Collection				Winter Collection			
Scientific Name	**Common Name**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**
Fish													
Brevoortia tyrannus	Atlantic menhaden	78	58	135	101	5	111	153	126	1	104	104	104
Menidia menidia	Atlantic silverside	58	50	92	71	3,376	49	120	88	63	85	124	104
Fundulus diaphanus	Banded killifish	--	--	--	--	1	44	44	44	--	--	--	--
Anchoa mitchilli	Bay anchovy	234	42	77	50	116	48	83	55	3	51	55	54
Symphurus plagiusa	Blackcheek tonguefish	1	135	135	135	--	--	--	--	--	--	--	--
Rhinoptera bonasus	Cownose ray	1	310	310	310	--	--	--	--	--	--	--	--
Dorosoma cepedianum	Gizzard shad	--	--	--	--	--	--	--	--	1	182	182	182
Peprilus paru	Harvest fish	2	110	120	115	--	--	--	--	--	--	--	--
Menidia beryllina	Inland silverside	--	--	--	--	1	36	36	36	--	--	--	--
Menticirrhus saxatilis	Northern kingfish	--	--	--	--	2	91	100	96	--	--	--	--
Fundulus heteroclitus	Mummichog	4	65	88	79	62	45	81	67	--	--	--	--
Syngnathus fuscus	Northern pipefish	--	--	--	--	1	84	84	84	--	--	--	--
Sciaenops ocellatus	Red drum	--	--	--	--	57	37	89	61	--	--	--	--
Cyprinodon variegatus	Sheepshead minnow	--	--	--	--	40	32	50	39	--	--	--	--
Bairdiella chrysoura	Silver perch	12	40	107	77	1	210	210	210	--	--	--	--
Leiostomus xanthurus	Spot	11	119	144	132	4	119	145	135	--	--	--	--
Cynoscion nebulosus	Spotted seatrout	2	95	100	98	3	107	116	113	--	--	--	--
Anchoa hepsetus	Striped anchovy	4	53	98	76	--	--	--	--	--	--	--	--
Chasmodes bosquianus	Striped blenny	1	50	50	50	--	--	--	--	--	--	--	--
Fundulus majalis	Striped killifish	1	95	95	95	12	45	133	86	5	42	99	62
Cynoscion regalis	Weakfish	5	30	53	45	--	--	--	--	--	--	--	--
Morone americana	White perch	--	--	--	--	1	199	199	199	--	--	--	--
Invertebrate													
Callinectes sapidus	Blue crab	59	5	155	73	11	6	82	24	--	--	--	--
--	Crab (unknown)	--	--	--	--	1	16	16	16	--	--	--	--

Species Collected		Spring Collection						
Scientific Name	**Common Name**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Minimum Weight (g)**	**Maximum Weight (g)**	**Average Weight (g)**
Fish								
Brevoortia tyrannus	Atlantic menhaden	101	5	65	42	0.1	1.1	0.5
Menidia menidia	Atlantic silverside	124	63	128	94	1.7	11.8	5.1
Fundulus diaphanus	Banded killifish	--	--	--	--	--	--	--
Anchoa mitchilli	Bay anchovy	319	38	119	57	0.3	2.3	1.0
Symphurus plagiusa	Blackcheek tonguefish	--	--	--	--	--	--	--
Rhinoptera bonasus	Cownose ray	--	--	--	--	--	--	--
Dorosoma cepedianum	Gizzard shad	--	--	--	--	--	--	--
Peprilus paru	Harvest fish	--	--	--	--	--	--	--
Menidia beryllina	Inland silverside	3	56	114	80	1.6	9.6	4.3
Menticirrhus saxatilis	Northern kingfish	--	--	--	--	--	--	--
Fundulus heteroclitus	Mummichog	75	41	106	60	0.9	17.3	3.4
Syngnathus fuscus	Northern pipefish	1	166	166	166	2.0	2.0	2.0
Sciaenops ocellatus	Red drum	--	--	--	--	--	--	--
Cyprinodon variegatus	Sheepshead minnow	--	--	--	--	--	--	--
Bairdiella chrysoura	Silver perch	--	--	--	--	--	--	--
Leiostomus xanthurus	Spot	50	27	50	36	0.1	1.3	0.5
Cynoscion nebulosus	Spotted seatrout	--	--	--	--	--	--	--
Anchoa hepsetus	Striped anchovy	--	--	--	--	--	--	--
Chasmodes bosquianus	Striped blenny	--	--	--	--	--	--	--
Fundulus majalis	Striped killifish	62	46	114	78	1.0	16.4	5.6
Cynoscion regalis	Weakfish	--	--	--	--	--	--	--
Morone americana	White perch	15	132	258	219	28.1	266.1	155.1
Invertebrates								
Callinectes sapidus	Blue crab	1	85	85	85	34.9	34.9	34.9
--	Crab (unknown)	--	--	--	--	--	--	--

3.3.2 Bottom Trawl Survey Results

A summary of species collected, number of each species collected, and range of sizes collected in bottom trawls for each sampling season is provided in Table 3-14. Individual lengths for all fish and crab collected are provided in Appendix B. Overall, seven different species of fish and one invertebrate were collected throughout all four sampling seasons. The spring survey resulted in the greatest number of fish collected. No fish were collected during the winter bottom trawl survey.

During the summer 2020 bottom trawl survey, six fish, including blackcheek tonguefish, spot, and weakfish, and three blue crabs were collected. During the fall 2020 bottom trawl survey, 15 bay anchovies, one gizzard shad, and four blue crabs were collected. The spring 2021 bottom trawl survey yielded both the highest number of species and greatest abundance collected. Seventy bay anchovy, 29 spot, one butterfish (*Peprilus triacanthus*), and one spotted hake (*Urophycis regia*) were collected.

Table 3-14
Barren Island Bottom Trawl Collection Data

Species Collected		Summer Collection				Fall Collection			
Scientific Name	**Common Name**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**
Fish									
Anchoa mitchilli	Bay anchovy	--	--	--	--	15	34	63	55
Symphurus plagiusa	Blackcheek tonguefish	3	98	133	119	--	--	--	--
Peprilus triacanthus	Butterfish	--	--	--	--	--	--	--	--
Dorosoma cepedianum	Gizzard shad	--	--	--	--	1	156	156	156
Leiostomus xanthurus	Spot	2	127	132	130	--	--	--	--
Urophycis regia	Spotted hake	--	--	--	--	--	--	--	--
Cynoscion regalis	Weakfish	1	150	150	150	--	--	--	--
Invertebrate									
Callinectes sapidus	Blue crab	3	65	130	91	4	108	130	117

Notes:
a. No fish were collected in bottom trawls during the winter collection.
--: no data

Species Collected		Spring Collection						
Scientific Name	**Common Name**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Minimum Weight (g)**	**Maximum Weight (g)**	**Average Weight (g)**
Fish								
Anchoa mitchilli	Bay anchovy	70	43	80	57	0.3	3.2	1.1
Symphurus plagiusa	Blackcheek tonguefish	--	--	--	--	--	--	--
Peprilus triacanthus	Butterfish	1	90	90	90	10.7	10.7	10.7
Dorosoma cepedianum	Gizzard shad	--	--	--	--	--	--	--

Species Collected		Spring Collection						
Scientific Name	Common Name	Total Count	Minimum Length (mm)	Maximum Length (mm)	Average Length (mm)	Minimum Weight (g)	Maximum Weight (g)	Average Weight (g)
Leiostomus xanthurus	Spot	29	38	180	147.5	0.5	83.6	42.2
Urophycis regia	Spotted hake	1	151	151	151	31.3	31.3	31.3
Cynoscion regalis	Weakfish	--	--	--	--	--	--	--
Invertebrate								
Callinectes sapidus	Blue crab	1	150	150	150	146.1	146.1	146.1

Notes:
a. No fish were collected in bottom trawls during the winter collection.
--: no data

3.3.3 Gillnet Survey Results

A summary of species collected, number of each species collected, and range of sizes collected in gillnets for each sampling season is provided in Table 3-15. Individual lengths for all fish and crab collected are provided in Appendix B. Overall, 11 different species of fish and one invertebrate were collected throughout all four sampling seasons. The summer 2020 survey resulted in the greatest number of species and greatest abundance of fish collected.

The summer 2020 gill net surveys produced nine different species of fish and one species of invertebrate, the blue crab. Spot and Atlantic menhaden were present in the greatest abundances. Gizzard shad was also collected in significant numbers. Five or less of each of the following species were also collected during the summer 2020 survey (in order of abundance): Spanish mackerel (*Scomberomorus maculatus*), bluefish (*Pomatomus saltatrix*), harvest fish, striped bass (*Morone saxatilis*), northern sand lance (*Ammodytes dubius*), and silver perch.

Only two fish species were collected during the fall 2020 gill net survey: six spot and two gizzard shad. The winter 2021 gill net survey also yielded only two fish species: four Atlantic menhaden and three alewife (*Alosa pseudoharengus*). Three species of fish were collected during the spring 2021 survey: three bluefish, two spot, and one hickory shad (*Alosa mediocris*).

Table 3-15
Barren Island Gill Net Collection Data

Species Collected		Summer Collection				Fall Collection				Winter Collection			
Scientific Name	Common Name	Total Count	Minimum Length (mm)	Maximum Length (mm)	Average Length (mm)	Total Count	Minimum Length (mm)	Maximum Length (mm)	Average Length (mm)	Total Count	Minimum Length (mm)	Maximum Length (mm)	Average Length (mm)
Fish													
Alosa pseudoharengus	Alewife	--	--	--	--	--	--	--	--	3	287	300	294
Brevoortia tyrannus	Atlantic menhaden	71	104	340	156	--	--	--	--	4	139	302	201
Pomatomus saltatrix	Bluefish	4	303	345	320	--	--	--	--	--	--	--	--
Dorosoma cepedianum	Gizzard shad	13	225	446	360	2	331	355	343	--	--	--	--
Peprilus paru	Harvest fish	2	127	213	170	--	--	--	--	--	--	--	--
Alosa mediocris	Hickory shad	--	--	--	--	--	--	--	--	--	--	--	--
Ammodytes dubius	Northern sand lance	1	805	805	805	--	--	--	--	--	--	--	--
Bairdiella chrysoura	Silver perch	1	196	196	196	--	--	--	--	--	--	--	--
Scomberomorus maculatus	Spanish mackerel	5	278	512	333	--	--	--	--	--	--	--	--
Leiostomus xanthurus	Spot	98	112	213	142	6	120	151	132	--	--	--	--
Morone saxatilis	Striped bass	2	196	390	293	--	--	--	--	--	--	--	--
Invertebrate													
Callinectes sapidus	Blue crab	17	75	150	113	--	--	--	--	--	--	--	--

Note:
--: no data

Species Collected		Spring Collection						
Scientific Name	Common Name	Total Count	Minimum Length (mm)	Maximum Length (mm)	Average Length (mm)	Minimum Weight (g)	Maximum Weight (g)	Average Weight (g)
Fish								
Alosa pseudoharengus	Alewife	--	--	--	--	--	--	--
Brevoortia tyrannus	Atlantic menhaden	3	140	153	144	25	25	25
Pomatomus saltatrix	Bluefish	--	--	--	--	--	--	--
Dorosoma cepedianum	Gizzard shad	--	--	--	--	--	--	--
Peprilus paru	Harvest fish	--	--	--	--	--	--	--
Alosa mediocris	Hickory shad	1	460	460	460	689	689	689
Ammodytes dubius	Northern sand lance	--	--	--	--	--	--	--
Bairdiella chrysoura	Silver perch	--	--	--	--	--	--	--
Scomberomorus maculatus	Spanish mackerel	--	--	--	--	--	--	--
Leiostomus xanthurus	Spot	2	160	172	166	56	75	65.5

Species Collected		Spring Collection						
Scientific Name	**Common Name**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Minimum Weight (g)**	**Maximum Weight (g)**	**Average Weight (g)**
Morone saxatilis	Striped bass	--	--	--	--	--	--	--
Invertebrate								
Callinectes sapidus	Blue Crab	--	--	--	--	--	--	--

Note:
--: no data

3.3.4 Pop Net Survey Results

A summary of species collected, number of each species collected, and range of sizes collected in pop nets for the summer 2020 and spring 2021 surveys is provided in Table 3-16. Individual lengths for all fish and crab collected are provided in Appendix B. Overall, three different species of fish and one invertebrate were collected over both sampling seasons. The summer 2020 survey resulted in the greatest number species number of species and greatest abundance of fish collected.

During the summer 2020 pop net survey, 199 bay anchovies, nine Atlantic silversides, and six blue crabs were collected. Eight spot were collected during the spring 2021 pop net survey.

Table 3-16
Barren Island Pop Net Collection Data

Species Collected		Summer Collection				Spring Collection						
Scientific Name	**Common Name**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Total Count**	**Minimum Length (mm)**	**Maximum Length (mm)**	**Average Length (mm)**	**Minimum Weight (g)**	**Maximum Weight (g)**	**Average Weight (g)**
Fish												
Menidia menidia	Atlantic silverside	9	25	79	68	--	--	--	--			
Anchoa mitchilli	Bay anchovy	199	22	59	46	--	--	--	--			
Leiostomus xanthurus	Spot	--	--	--	--	8	22	30	24.6			
Invertebrate												
Callinectes sapidus	Blue crab	6	5	62	20	--	--	--	--	--	--	--

Note:
--: no data

3.3.5 *Comparison to Previous (2002/2003) Fisheries Surveys*

The species caught in the fisheries surveys were typical of mesohaline areas of the Mid-Chesapeake Bay Region. Based on the fisheries survey results, the area around Barren Island is attracting fish in the juvenile and adult life stages. As evident from the beach seine surveys, the habitat immediately adjacent to the island is an important habitat to a variety of juvenile finfish.

Table 3-17 presents the results of the 2020 and 2021 fisheries surveys compared with the survey results conducted at Barren Island in 2002 to 2003 and presented in the FS/EIS (USACE 2009). The beach seine surveys conducted at Barren Island in 2002 to 2003 found that bay anchovy and Atlantic silverside were generally present in the greatest abundances, similar to the results from the 2020 and 2021 beach seine surveys. However, the species diversity and fish abundance were greater during the 2002 and 2003 surveys than the 2020 and 2021 surveys for the summer, winter, and spring seasons. The fall beach seine survey conducted in 2020 has both greater diversity and substantially greater abundance than the fall 2002 survey (Table 3-17).

The most common finfish species collected during the 2002 and 2003 bottom trawl surveys was the bay anchovy (USACE 2009), similar to the results of the bottom trawl surveys conducted as part of this field investigation. However, the species diversity and fish abundance were greater during the 2002 and 2003 surveys than the 2020 and 2021 surveys for the summer, fall, and spring seasons. The winter surveys yielded similar results, with only one fish collected during the 2002 survey and no fish collected during the 2020 survey (Table 3-17).

For fish collected with a gill net, Atlantic menhaden were the most abundant fish collected at Barren Island during both the 2020 and 2021 and 2002 and 2003 surveys, However, when comparing the number of species collected and fish abundance, in all seasons the number of species collected and fish abundance for the 2002 and 2003 surveys exceeds the number of species and abundance collected as part of the 2020 and 2021 gillnetting surveys (Table 3-17).

The most common finfish species collected during the 2002 and 2003 pop net surveys was the bay anchovy (USACE 2009), similar to the results of the pop net surveys conducted as part of this field investigation. However, the 2002 and 2003 pop net surveys at Barren Island found greater species diversity and fish abundance than the 2020 and 2021 surveys (Table 3-17).

Overall species diversity appears to have decreased slightly from the 2002 and 2003 fisheries surveys presented in the FS/EIS (USACE 2009). Whereas results and species present were similar to those reported in the SAR, the 2002 and 2003 fisheries surveys reported greater number of species for all sample gear types. However, bay anchovy, Atlantic menhaden, and Atlantic silverside continue to be present in the greatest numbers.

Table 3-17
Barren Island Fisheries Survey Summary

Gear	2002/2003 Surveys		2020/2021 Surveys	
	Number of Species Collected	Total Number of Fish Collected	Number of Species Collected	Total Number of Fish Collected
SUMMER				
Beach Seine	26	6,327	15	414
Bottom Trawl	10	6,454	4	6
Gill Net	14	423	10	197
Pop Net	10	1,053	3	208
FALL				
Beach Seine	7	115	17	3,682
Bottom Trawl	6	25	3	16
Gill Net	4	18	2	8
Pop Net	--	--	--	--
WINTER				
Beach Seine	5	88	5	73
Bottom Trawl	1	1	0	0
Gill Net	5	89	2	7
Pop Net	--	--	--	--
SPRING				
Beach Seine	14	1,407	10	750
Bottom Trawl	4	656	5	101
Gill Net	10	172	3	6
Pop Net	8	340	1	8

Notes:
--: No data – gear was not sampled

3.4 Bivalve Surveys

Two commercially important clams are found in the vicinity of Barren Island: soft-shell and razor clams. Soft-shell and razor clam surveys identified razor clams as more prevalent than soft-shell clams. Bivalve surveys were conducted at four locations around Barren Island on December 14, 2020. Water quality parameters, including temperature, DO, salinity, and pH, were measured at each transect and are provided in Table 3-18.

Fifteen legal harvestable soft-shell clams were collected in the Barren Island transects (11 at transect BI-CS-02 and four at transect BI-CS-04); no sublegal soft-shell clams were collected. The greatest number of bivalves collected was from transect BI-CS-04 (four soft-shell clams and 131 razor clams). The remaining three transects yielded bivalve counts ranging from 36 to 85 (Table 3-18).

In summary, Barren Island surveys identified 15 legal soft-shell clams (no soft-shell clams less than 2 inches in length were identified), 267 razor clams, and 25 oysters (Table 3-18). There were no locations in the Barren Island survey with a productive natural clam bar ranking as defined by the Maryland Code of Regulations (COMAR) 08.02.08.11 criteria (producing 500 hard-shell clams per hour, one-half bushel of soft-shell clams per hour, or one-half bushel of razor clams per hour).

Table 3-18
Barren Island Bivalve Survey Results

Sample Area	Survey Transect	Date	Time	Water Depth (feet)	Temp (°C)	DO (mg/L)	Salinity (ppt)	pH	Bivalve Counts		
									Soft-Shell Clams	Razor Clams	Oysters
Barren Island	BI-CS-01	12/14/2020	11:00	4	9.9	9.5	14.3	6.9	--	16	20
	BI-CS-02	12/14/2020	9:54	8	10.5	9.4	13.8	7	11	69	5
	BI-CS-03	12/14/2020	9:36	5.5	11.6	9.2	14.2	7	--	51	--
	BI-CS-04	12/14/2020	5:50	3	11.6	8.1	14	7.2	4	131	--

Notes:
a. Soft-shell clams greater than 2 inches only.
--: no data

3.5 Crab Pot Surveys

Crab pot surveys in the vicinity of Barren Island were conducted in August 2020, September 2020, May 2021, June 2021, and July 2021 to assess use of the area by commercial fishermen during part of the April to December crab season. The location and number of crab pots observed in the vicinity of the Barren Island footprint are provided in Figures 3-1 through 3-5 for August 2020, September 2020, May 2021, June 2021, and July 2021, respectively. Sampling points along each transect were used to identify relative crab pot density within subareas. For several of the surveys, areas where crab pots were visibly clustered were noted in the field and are represented on the applicable figures by the location of the icons with the crab pot counts. On each figure, the blue boxes represent the area in which the crab pots were observed. The numbers within the boxes are the number of crab pots counted within the area of the blue box.

The August 2020 survey was conducted on August 30, 2020. Four hundred and ninety crab pots were observed surrounding Barren Island. The majority of the crab pots were observed south of the island, with fewer crab pots observed immediately west and north. No crab pots were observed east of the island. The number of crab pots observed and the general vicinity in which the crab pots were located are provided in Figure 3-1.

During the September 2020 survey, conducted on September 29, 2020, 83 crab pots were observed. The crab pot distribution was similar to the August survey, with most crab pots located south of the southern remnant. Again, no crab pots were observed east of the island. The number of crab pots observed and the general vicinity in which the crab pots were located for the September 2020 survey are provided in Figure 3-2.

A total of 533 crab pots were counted during the May 2021 survey, conducted on May 18, 2021. One hundred and ninety-two crab pots were located on the north side of the island, and a cluster of 231 crab pots were observed due west of the southern part of the island. A dense cluster containing 110 crab pots was located southeast of the island. The number of crab pots observed and the general vicinity in which the crab pots were located for the May 2021 survey are provided in Figure 3-3.

The June 2021 survey was conducted on June 23, 2021. A total of 277 crab pots were observed during this survey. One hundred and twenty crab pots were located along the west side and immediately north of Barren Island. The remaining 157 crab pots were located south of Barren Island. A dense cluster containing 62 crab pots was located on the southeast side of the island. The number of crab pots observed and the general vicinity in which the crab pots were located for the June 2021 survey are provided in Figure 3-4.

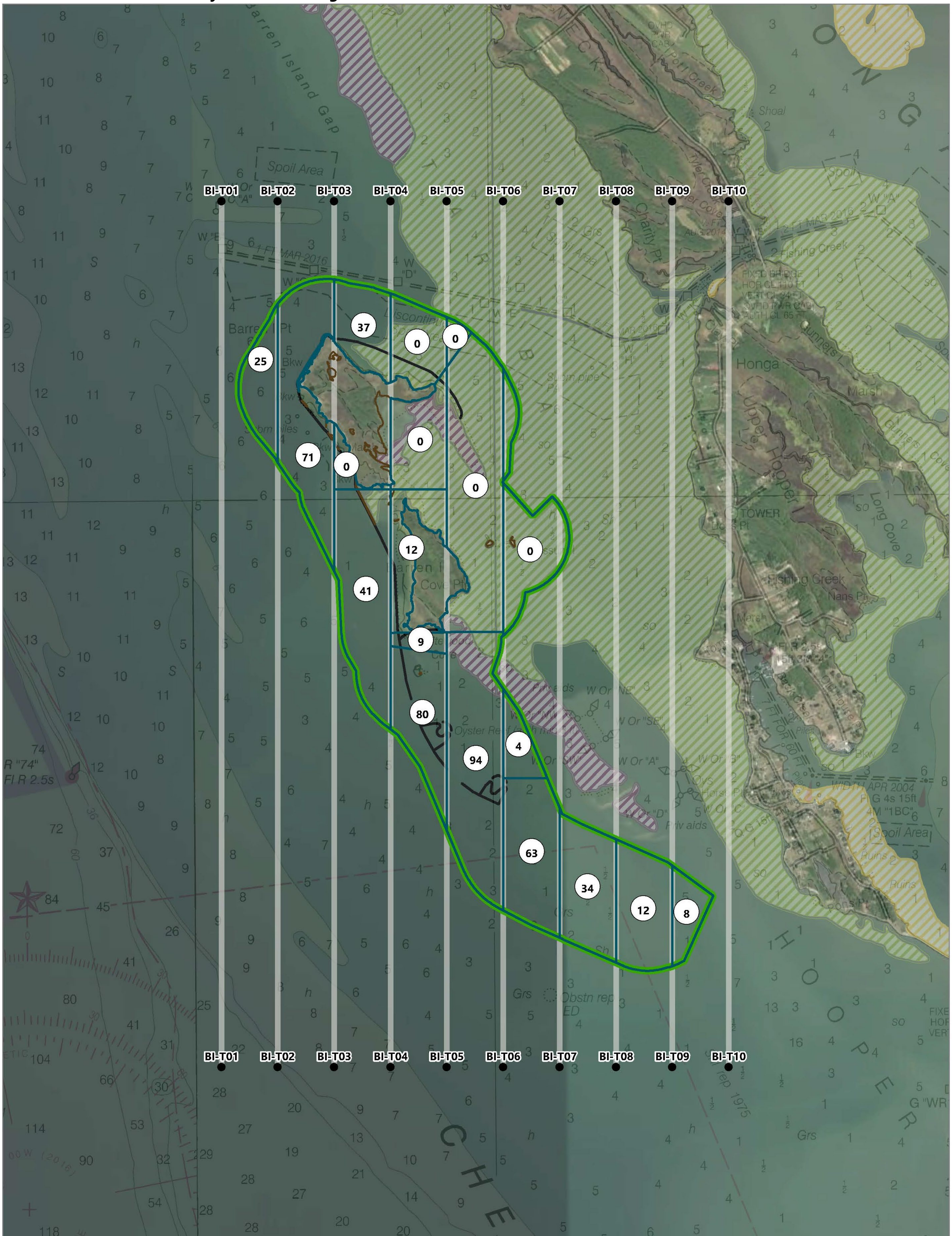
The July 2021 survey was conducted on July 23, 2021. A total of 264 crab pots were observed during this survey. One hundred and ninety-eight crab pots were located along the west side and immediately north of Barren Island. The remaining crab pots were located south of Barren Island. The number of crab pots observed and the general vicinity in which the crab pots were located for the July 2021 survey are provided in Figure 3-5.

Table 3-19 presents the relative crab pot numbers observed during each sampling event. The estimated density of crab pots (number of crab pots per acre of area surveyed) ranged from 0.1 pot to 0.4 pot per acre. The greatest crab pot density was measured during the May 2021 survey.

Table 3-19
Crab Pot Estimates Surrounding Barren Island

Survey Month	Total Number of Crab Pots Observed	Survey Area (acres)	Estimated Density (pots/acre)
August 2020	490	1,619	0.3
September 2020	83	1,619	0.1
May 2021	533	1,619	0.4
June 2021	277	1,619	0.2
July 2021	264	1,619	0.2

Figure 3-1
Barren Island Crab Pot Survey Transects – August 2020



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection
- Crab Pot Survey Footprint
- Crab Pot Survey Transect
- Crab Pot Count Area

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and Barren Island remnants.
3. The numbers provided in the figure represent the number of crab pots observed within in the crab pot survey footprint. See Section 3.5 for additional information.
4. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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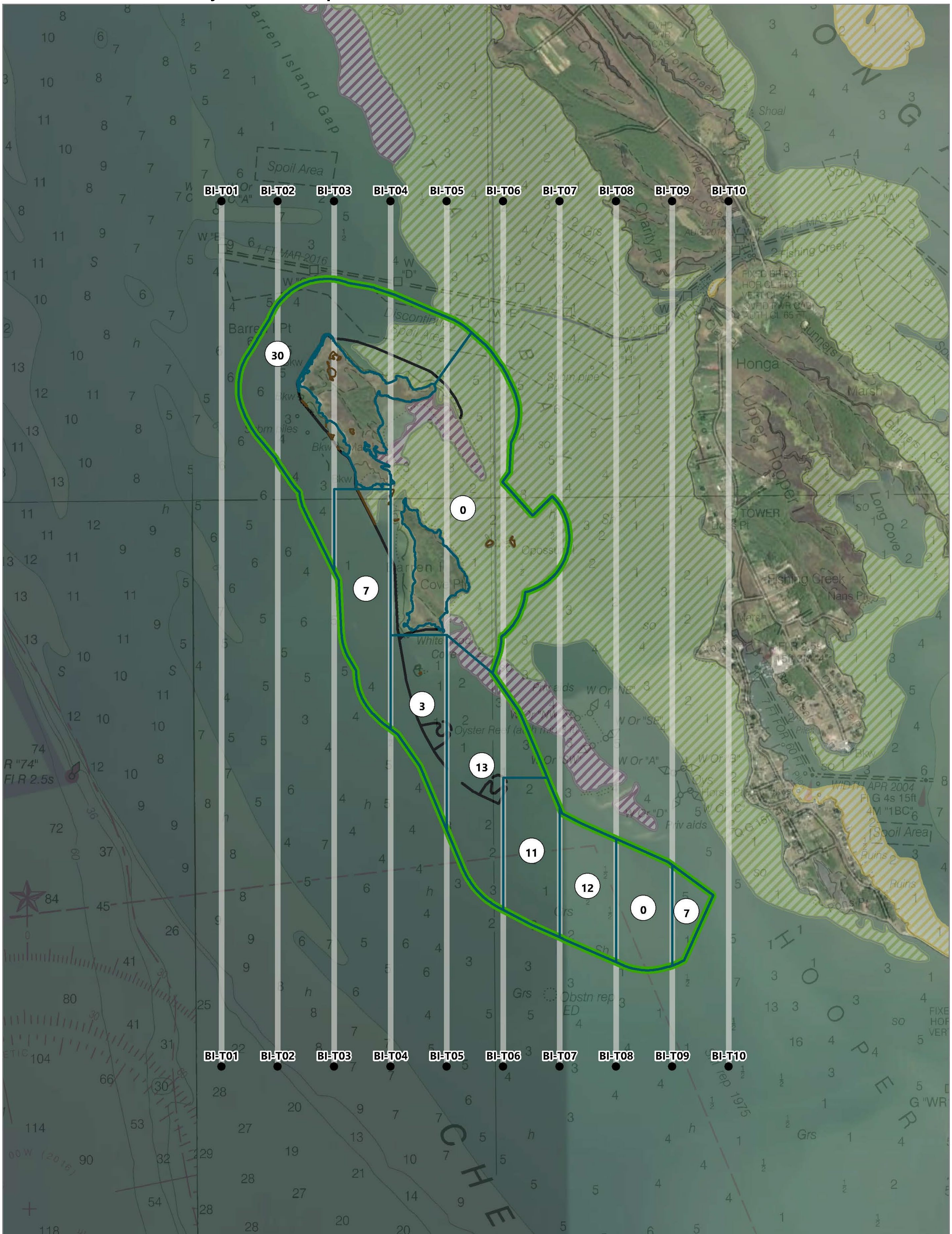
Figure 3-2
Barren Island Crab Pot Survey Transects – September 2020



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection
- Crab Pot Survey Footprint
- Crab Pot Survey Transect
- Crab Pot Count Area

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and Barren Island remnants.
3. The numbers provided in the figure represent the number of crab pots observed within in the crab pot survey footprint. See Section 3.5 for additional information.
4. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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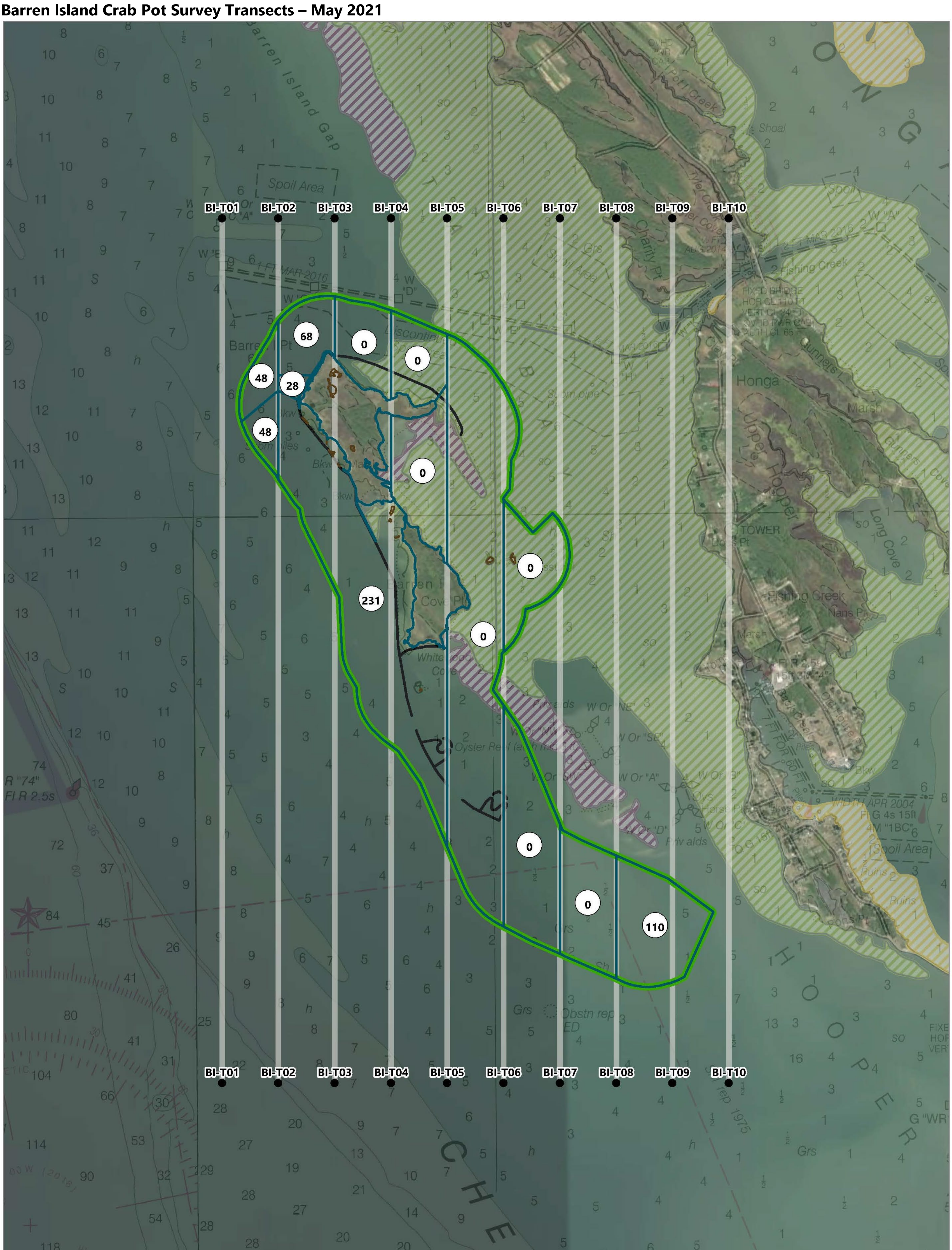
Figure 3-3
Barren Island Crab Pot Survey Transects – May 2021



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection
- Crab Pot Survey Footprint
- Crab Pot Survey Transect
- Crab Pot Count Area

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and Barren Island remnants.
3. The numbers provided in the figure represent the number of crab pots observed within in the crab pot survey footprint. See Section 3.5 for additional information.
4. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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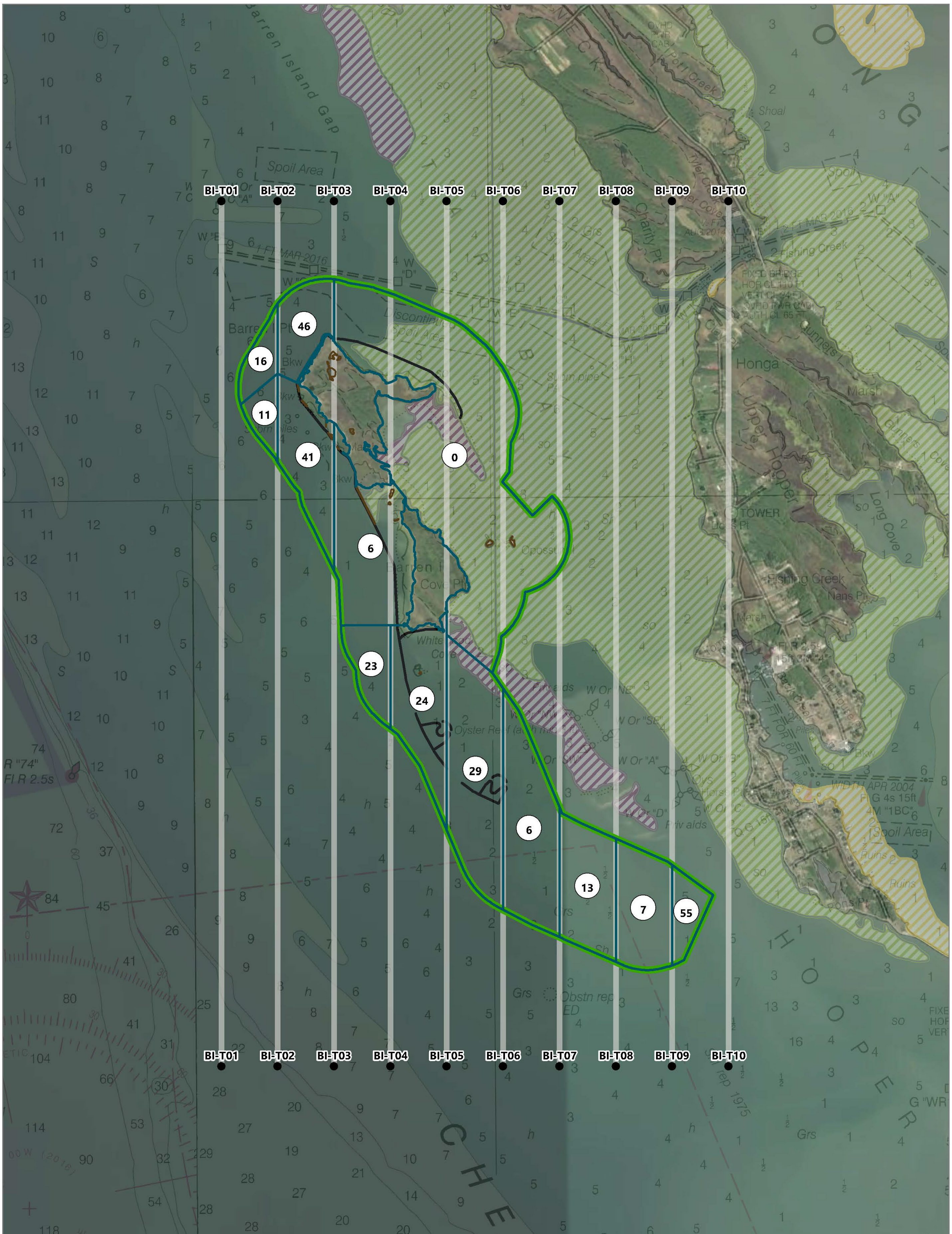
Figure 3-4
Barren Island Crab Pot Survey Transects – June 2021



LEGEND:

Barren Island Remnants
Proposed Barren Island Protection
Crab Pot Survey Footprint
Crab Pot Survey Transect
Crab Pot Count Area

Existing SAV Bed
Dense 70-100% cover
Moderate 40-70% cover
Sparse 10-20% cover

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and Barren Island remnants.
3. The numbers provided in the figure represent the number of crab pots observed within in the crab pot survey footprint. See Section 3.5 for additional information.
4. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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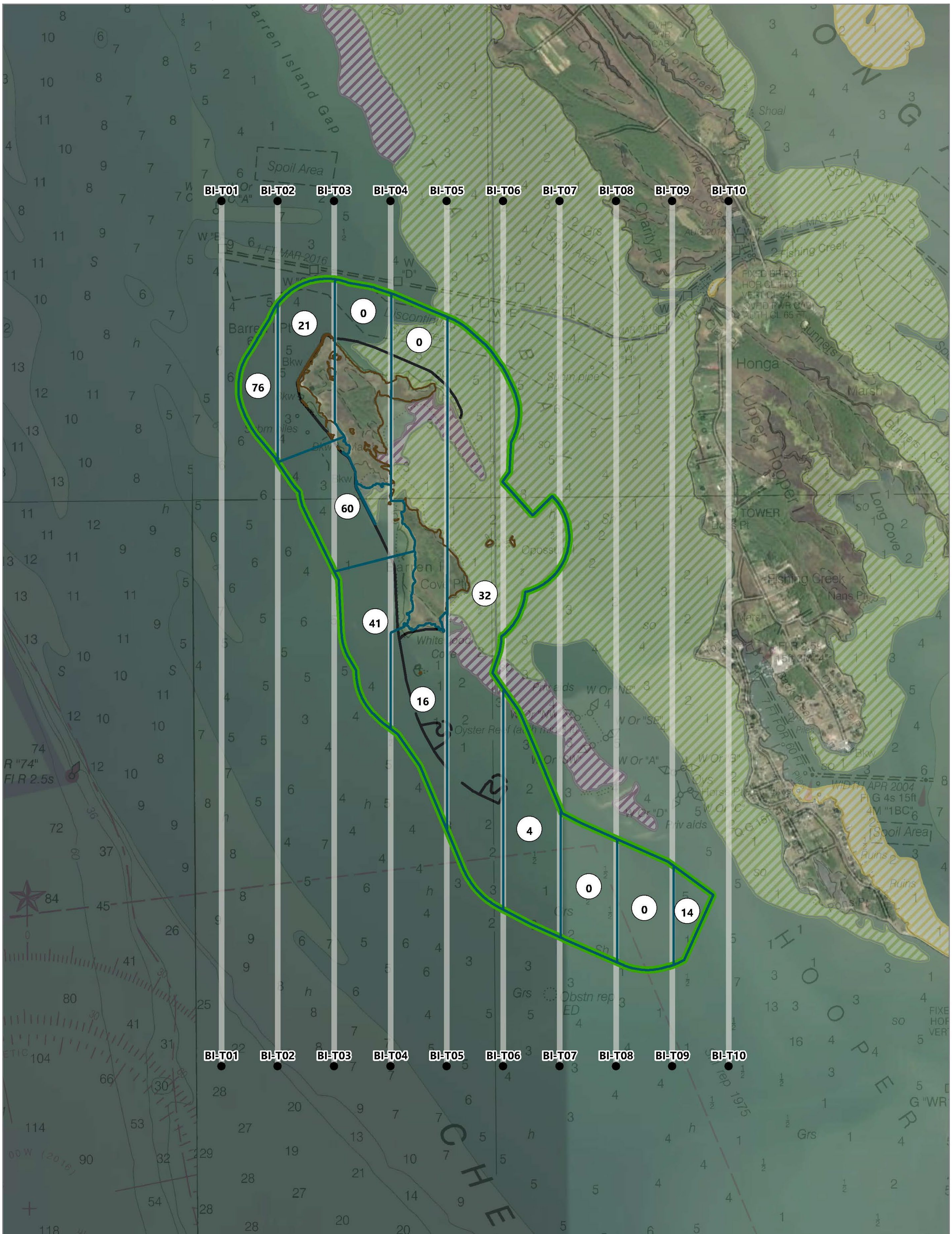
Figure 3-5
Barren Island Crab Pot Survey Transects – July 2021



LEGEND:

- Barren Island Remnants
- Proposed Barren Island Protection
- Crab Pot Survey Footprint
- Crab Pot Survey Transect
- Crab Pot Count Area

Existing SAV Bed

- Dense 70-100% cover
- Moderate 40-70% cover
- Sparse 10-20% cover

0 1,600
Meters

NOTES:
1. Basemaps obtained from Esri aerial imagery and NOAA raster nautical charts streaming services.
2. Crabpot survey boundary includes the area within 0.25 mile of the proposed restoration footprint and Barren Island remnants.
3. The numbers provided in the figure represent the number of crab pots observed within in the crab pot survey footprint. See Section 3.5 for additional information.
4. Existing SAV locations are from Virginia Institute of Marine Science 2018 interpretations of digital multispectral imagery and was downloaded from MD iMAP. Results of 2020 analysis can accessed via ArcGIS REST Services.

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3.6 Avian Surveys

Avian surveys were performed in summer 2020 and spring 2021. The surveys covered a representative range of habitats on the island, including forest, saltmarsh, open water, scrub-shrub, and shoreline.

3.6.1 Summer Survey Results

Five locations at Barren Island were included in the summer avian survey conducted on September 3, 2020. Survey locations are shown in Figure 2-12 and were chosen based on site conditions, access, and representativeness of the habitat conditions. A summary of the survey results is provided in Table 3-20.

A total of 37 species and 2,490 individuals were observed at Barren Island during the summer 2020 surveys. Brown pelican (*Pelecanus occidentalis*; 1,192 individual) and double-crested cormorant (*Phalacrocorax auritus;* 723 individuals) accounted for more than 75% of all observations made during the surveys. The majority of brown pelican and double-crested cormorants were observed resting on the riprap breakwater structures, the pound net west of Barren Island, and on the small island fragments on the southeast side of Barren Island. Other individuals were observed foraging over the open waters of the Chesapeake Bay. Great blue heron (*Ardea herodias*) and great egret (*Ardea alba*) were commonly observed foraging along the shoreline and in the salt marsh habitats.

Three migrating shorebird species, semipalmated plover (*Charadrius semipalmatus*), sanderling (*Calidris alba*), and spotted sandpiper (*Actitis macularius*) were observed foraging on the riprap breakwater structures on the western side of Barren Island. Three clapper rails (*Rallus crepitans*) were seen or heard within saltmarsh habitat on the island. This species likely breeds on the Barren Island remnants.

Most songbirds observed during the surveys were likely migrating individuals using the scrub-shrub and forest habitat on the island as a temporary stopover for resting and foraging. However, some species also likely do breed within the loblolly pine and mixed pine and deciduous forest habitat provided on the island, including eastern wood-pewee (*Contopus virens*), great crested flycatcher (*Myiarchus crinitus*), eastern kingbird (*Tyrannus tyrannus*), blue-gray gnatcatcher (*Polioptila caerulea*), and pine warbler (*Setophaga pinus*). Other species are likely year-round residents within the forest habitats, including brown-headed nuthatch (*Sitta pusilla*), Carolina wren (*Thryothorus ludovicianus*), and northern cardinal (*Cardinalis cardinalis*).

Multiple raptor nests were observed in the pines on the southern remnant, including several osprey (*Pandion haliaetus*) nests and one bald eagle (*Haliaeetus leucocephalus*) nest. Other osprey nests were observed on channel marker structures near the island. It is likely that both ospreys and bald eagles nest on this island, and adults and juveniles for both species were observed.

A wide variety of both resident and migratory bird species were observed using all habitats available at Barren Island during the September 2020 avian survey. The late summer survey period did not provide direct evidence of the breeding birds present on Barren Island because of the late date of the surveys in early September. However, the surveys did document the presence of likely resident species and species that use the islands as stopover sites for resting and foraging during migration.

Avian surveys were conducted in 2002 and 2003 as part of the FS/EIS (USACE 2009). During the summer 2002 survey, a total of 230 birds were observed at Barren Island. The number of birds observed during the summer 2020 survey is approximately an order of magnitude greater than the 2002 survey. Most of this is likely due to the high numbers of brown pelican and double-crested cormorant observed during the 2020 survey (totaling 1,915 individuals). Additionally, 37 species were observed in the 2020 survey, as compared to 16 bird species in the 2002 survey (USACE 2009).

Table 3-20
Barren Island Avian Summer Survey Results

Species Observed				Number Observed[c]	
Scientific Name	Common Name	Status[a]	Habitat[b]	Morning Survey	Afternoon Survey
Corvus brachyrhynchos	American crow	R	FO	6	0
Setophaga ruticilla	American redstart	M	S/S	0	1
Haliaeetus leucocephalus	Bald eagle	R, M	F, FO	5	6
Riparia riparia	Bank swallow	M	FO	9	0
Hirundo rustica	Barn swallow	M	FO	173	44
Mniotilta varia	Black-and-white warbler	M	F	1	1
Polioptila caerulea	Blue-gray gnatcatcher	S, M	S/S	2	0
Dolichonyx oryzivorus	Bobolink	M	FO	1	0
Pelecanus occidentalis	Brown pelican	S	O, FO, SH	554	638
Sitta pusilla	Brown-headed nuthatch	R	F	3	0
Thryothorus ludovicianus	Carolina wren	R	F, S/S	6	4
Rallus crepitans	Clapper rail	R	S	3	0

Notes:

a. Status:
- M: migrant
- R: year-round resident
- S: summer resident
- W: winter resident

b. Habitat:
- F: Forest
- FO: flyover
- MF: mudflat
- O: open water
- S: saltmarsh
- SH: shore
- S/S: scrub-shrub

c. Individual birds may have been observed during both surveys

Species Observed		Status[a]	Habitat[b]	Number Observed[c]	
Scientific Name	Common Name			Scientific Name	Common Name
Geothlypis trichas	Common yellowthroat	S, M	S/S	1	0
Phalacrocorax auratus	Double-crested cormorant	S, M	O, FO, SH	466	257
Tyrannus tyrannus	Eastern kingbird	S, M	S	0	1
Contopus virens	Eastern wood-pewee	S, M	F	1	0
Sterna forsteri	Forster's tern	S, M	O, FO	50	12
Dumetella carolinensis	Gray catbird	S, M	S/S	1	0
Larus marinus	Great black-backed gull	R, M	O, FO	1	4
Ardea herodias	Great blue heron	R	F, O, FO, SH	10	8
Myiarchus crinitus	Great crested flycatcher	S, M	F	3	0
Ardea alba	Great egret	S, M	S, FO, SH	9	6
Larus argentatus	Herring gull	R, M	O	12	5
Leucophaeus atricilla	Laughing gull	S, M	O, FO, SH	86	20
Empidonax minimus	Least flycatcher	M	S	1	0
Cardinalis	Northern cardinal	R	F, S/S	6	3
Pandion haliaetus	Osprey	S, M	F, O, FO	12	15
Setophaga pinus	Pine warbler	S, M	F	2	1
Agelaius phoeniceus	Red-winged blackbird	R	F, S/S		6
Larus delawarensis	Ring-billed gull	M, W	O, FO	1	2
Thalasseus maximus	Royal tern	S, M	O, FO	6	4
Archilochus colubris	Ruby-throated hummingbird	M	F, FO, S/S	4	0
Calidris alba	Sanderling	M	FO, SH	1	5
Charadrius semipalmatus	Semipalmated plover	M	SH	0	2
Actitis macularius	Spotted sandpiper	M	SH	0	1
Tachycineta bicolor	Tree swallow	M	FO	5	0
Cathartes aura	Turkey vulture	R, M	FO	1	2

Notes:

a. Status:
- M: migrant
- R: year-round resident
- S: summer resident
- W: winter resident

b. Habitat:
- F: Forest
- FO: flyover
- MF: mudflat
- O: open water
- S: saltmarsh
- SH: shore
- S/S: scrub-shrub

c. Individual birds may have been observed during both surveys

3.6.2 Spring Survey Results

Five locations at Barren Island were included in the summer avian survey conducted on May 26, 2021. Survey locations were consistent with the summer 2020 avian survey locations (Figure 2-12) and covered a representative range of habitats on the island, including forest, saltmarsh, open water, scrub-shrub, and shoreline. A summary of the survey results is provided in Table 3-21.

A total of 627 birds from 40 different species were observed during the spring 2021 survey. Double-crested cormorants were observed in the greatest abundance, accounting for 37% of all observations made (236 individuals). Most double-crested cormorants were observed flying over or resting on the pound nets west of Barren Island or foraging over the open waters of the Chesapeake Bay.

One summer resident shorebird species, willet (*Tringa semipalmata*), and one migratory shorebird species, semipalmated plover, were observed on the northern remnant of Barren Island during the timed surveys.

Twenty-three bald eagles and 37 ospreys were observed during the timed surveys. Additionally, multiple raptor nests were observed on Barren Island, including several osprey nests and one bald eagle nest on each island remnant. Other osprey nests were observed on channel marker structures near the island.

Great blue heron and great egret were commonly observed flying over and foraging along the shoreline and in the salt marsh habitats. A heron rookery was observed on the island during avian surveys conducted in 2003 and 2004 (BBL 2004) and nests of both species were observed during these surveys throughout the southern remnant of Barren Island, indicating that nearly the entire southern remnant serves as a rookery for these species. Great blue herons accounted for approximately 10% of the total number of birds observed during the timed surveys.

Most songbirds observed were year-round or summer residents using the scrub-shrub and forest habitat on the island. Evidence of breeding was confirmed during the timed surveys or incidentally for many of these species, including eastern kingbird, brown-headed nuthatch, Carolina wren, eastern bluebird (*Sialia sialis*), European starling (*Sturnus vulgaris*), common grackle (*Quiscalus quiscula*), boat-tailed grackle (*Quiscalus major*), red-winged blackbird (*Agelaius phoeniceus*), and northern cardinal. Downy woodpecker (*Picoides pubescens*) was the only species of woodpecker observed during the spring 2021 surveys, and breeding was confirmed in the pine forests on the northern remnant.

A wide variety of both resident and migratory bird species were observed using all habitats available at Barren Island during the spring 2021 avian survey. Additionally, direct evidence of the presence of a variety of breeding birds was recorded during the survey. Fourteen species were confirmed as breeding on the two Barren Island remnants, and several other species were observed that are likely to breed on the island.

Avian surveys were conducted in 2002 and 2003 as part of the FS/EIS (USACE 2009). During the spring 2003 survey, a total of 298 birds were observed at Barren Island. The number of birds observed during the spring 2021 survey is approximately two times greater than the 2002 survey, likely due to the high number of double-crested cormorants observed during the 2021 survey. In both surveys, double-crested cormorant, great blue heron, and great egret were present in the greatest abundances. Greater diversity was observed during the 2021 survey, with 40 species recorded during the 2021 survey and 20 bird species recorded in the 2003 survey (USACE 2009).

Table 3-21
Barren Island Avian Spring Survey Results

Species Observed				Number Observed[c]	
Scientific Name	Common Name	Status[a]	Habitat[b]	Morning Survey	Afternoon Survey
Corvus brachyrhynchos	American crow	R	F	4	1
Spinus tristis	American goldfinch	R	FO	0	1
Haliaeetus leucocephalus	Bald eagle[d]	R	F, FO	12	11
Hirundo rustica	Barn swallow	M	FO	7	0
Quiscalus major	Boat-tailed grackle[d]	R	FO, S	13	11
Pelecanus occidentalis	Brown pelican	S	O, FO	0	25
Molothrus ater	Brown-headed cowbird	R	FO	2	0
Sitta pusilla	Brown-headed nuthatch[d]	R	F	1	0
Poecile carolinensis	Carolina chickadee	R	F	2	0
Thryothorus ludovicianus	Carolina wren[d]	R	F, S/S	8	3
Rallus crepitans	Clapper rail	R	S	8	0
Quiscalus quiscula	Common grackle[d]	R	FO	4	5
Sterna sp.	Common/Forster's tern	S, M	O, FO	3	2

Notes:
--: unidentified species

a. Status:
- M: migrant
- R: year-round resident
- S: summer resident
- W: winter resident

b. Habitat:
- F: Forest
- FO: flyover
- MF: mudflat
- O: open water
- S: saltmarsh
- SH: shore
- S/S: scrub-shrub

c. Individual birds may have been observed during both surveys
d. Confirmed breeding

Species Observed		Status[a]	Habitat[b]	Number Observed[c]	
Scientific Name	Common Name			Scientific Name	Common Name
Phalacrocorax auritus	Double-crested cormorant	S, M	O, FO, SH	89	147
Picoides pubescens	Downy woodpecker[d]	R	F	1	0
Sialia sialis	Eastern bluebird[d]	R	F	1	0
Tyrannus tyrannus	Eastern kingbird[d]	S, M	S	5	5
Contopus virens	Eastern wood-pewee	S, M	F	1	0
Sturnus vulgaris	European starling[d]	R	FO	2	4
Sterna forsteri	Forster's tern	S, M	O	0	2
Plegadis falcinellus	Glossy ibis	S, M	FO	0	5
Larus marinus	Great black-backed gull	R, M	O, FO	0	2
Ardea herodias	Great blue heron[d]	R	F, O, FO, SH, S	32	31
Myiarchus crinitus	Great crested flycatcher	S, M	F	6	2
Ardea alba	Great egret[d]	S, M	FO, SH, F	21	15
Larus argentatus	Herring gull	R, M	SH, FO	2	1
Leucophaeus atricilla	Laughing gull	S, M	FO	0	1
Sternula antillarum	Least tern	S, M	FO	1	0
Cardinalis cardinalis	Northern cardinal[d]	R	S/S	3	2
Mimus polyglottos	Northern mockingbird	R	F	2	1
Icterus spurius	Orchard oriole	R, M	F	3	1
Pandion haliaetus	Osprey[d]	S, M	O, FO, SH	17	20
Setophaga pinus	Pine warbler	S, M	F	5	0
Vireo olivaceus	Red-eyed vireo	S, M	F	2	0
Agelaius phoeniceus	Red-winged blackbird[d]	R	S, S/S	21	20
Thalasseus maximus	Royal tern	S, M	SH	3	0
Charadrius semipalmatus	Semipalmated plover	M	SH	5	0
Tachycineta bicolor	Tree swallow	M	FO	1	3

Notes:
--: unidentified species

a. Status:
- M: migrant
- R: year-round resident
- S: summer resident
- W: winter resident

b. Habitat:
- F: Forest
- FO: flyover
- MF: mudflat
- O: open water
- S: saltmarsh
- SH: shore
- S/S: scrub-shrub

c. Individual birds may have been observed during both surveys
d. Confirmed breeding

Species Observed				Number Observed[c]	
Scientific Name	Common Name	Status[a]	Habitat[b]	Morning Survey	Afternoon Survey
Cathartes aura	Turkey vulture	R, M	FO	0	10
--	Unidentified gull	--	FO	0	1
Calidris sp.	Unidentified peep	M	SH, FO	6	0
--	Unidentified shorebird	--	FO	1	0
Tringa semipalmata	Willet	S, M	SH	1	0

Notes:
--: unidentified species

a. Status:
- M: migrant
- R: year-round resident
- S: summer resident
- W: winter resident

b. Habitat:
- F: Forest
- FO: flyover
- MF: mudflat
- O: open water
- S: saltmarsh
- SH: shore
- S/S: scrub-shrub

c. Individual birds may have been observed during both surveys
d. Confirmed breeding

Appendix A
Barren Island Benthic Community
Replicate Sample Results

Table A-1a
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-01

Species List	BI-BC-01 Abundance			BI-BC-01 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros			1			0.00030
Fragilonemertes rosea			1			0.00520
Alitta succinea	3	1	5	0.00110	0.00050	0.00340
Glycinde multidens	10	15	11	0.00200	0.00300	0.00170
Marenzelleria viridis		3	1		0.00450	0.00290
Paraprionospio alata	1		2	0.00060		0.00150
Streblospio benedicti	2	7	2	0.00005	0.00010	0.00005
Heteromastus filiformis	16	21	22	0.00470	0.01170	0.00500
Mediomastus ambiseta	18	26	8	0.00030	0.00090	0.00020
Tubificoides spp.	3	2	2	0.00010	0.00005	0.00010
Eulimastoma engonium	2		1	0.00005		0.00020
Japonactaeon punctostriatus	1	2	1	0.00005	0.00030	0.00020
Acteocina canaliculata	4	11	4	0.00020	0.00030	0.00010
Geukensia demissa		1			0.00005	
Mulinia lateralis	5	28	14	0.00280	0.01070	0.01480
Ameritella mitchelli	36	61	47	0.00260	0.00150	0.00180
Gemma gemma	13	24	13	0.00160	0.00230	0.00110
Amphibalanus improvisus	1			0.00020		
Americamysis almyra		3	2		0.00020	0.00010
Cyathura polita	1		1	0.00010		0.00020

Notes:
AFDW: ash free dry weight
g: gram

Table A-1b

Barren Island Summer Benthic Community Counts and Biomass – BI-BC-02

Species List	BI-BC-02 Abundance			BI-BC-02 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus			1			0.00030
Carinoma tremaphoros	1		2	0.00010		0.00270
Fragilonemertes rosea	4	1		0.02010	0.00840	
Alitta succinea		frag.	3		0.00010	0.00140
Glycinde multidens	6	1	1	0.00090	0.00020	0.00040
Leitoscoloplos fragilis			1			0.00280
Marenzelleria viridis	2	4	1	0.00180	0.00270	0.00230
Streblospio benedicti	7	11	4	0.00050	0.00040	0.00030
Heteromastus filiformis	4	1	4	0.00250	0.00300	0.00070
Mediomastus ambiseta		1			0.00010	
Eulimastoma engonium		1			0.00005	
Japonactaeon punctostriatus		1	1		0.00005	0.00005
Acteocina canaliculata		1	1		0.00020	0.00005
Mulinia lateralis	22	23	12	0.00320	0.01340	0.00200
Ameritella mitchelli	17	14	17	0.00150	0.00030	0.00620
Tagelus plebeius		1			0.00005	
Gemma gemma	41	41	39	0.00110	0.00320	0.00280
Americamysis almyra	5	1	1	0.00020	0.00030	0.00010

Notes:

AFDW: ash free dry weight

frag.: fragment

g: gram

Table A-1c
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-03

Species List	BI-BC-03 Abundance			BI-BC-03 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Siphonenteron bicolour			1			0.00080
Fragilonemertes rosea	frag.	4		0.00010	0.04150	
Alitta succinea			1			0.00010
Glycinde multidens	5	6	6	0.00060	0.00050	0.00080
Marenzelleria viridis	1			0.00100		
Streblospio benedicti	5	1	2	0.00020	0.00005	0.00010
Heteromastus filiformis	6	3	9	0.00280	0.00110	0.00370
Mediomastus ambiseta	7	2	2	0.00010	0.00010	0.00010
Japonactaeon punctostriatus	1	1	6	0.00005	0.00010	0.00040
Acteocina canaliculata	3	3	10	0.00005	0.00010	0.00030
Mulinia lateralis	22	9	29	0.01700	0.00930	0.01210
Ameritella mitchelli	50	36	69	0.00410	0.00180	0.00380
Gemma gemma	14	21	14	0.00120	0.00140	0.00030
Americamysis almyra		1			0.00020	

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-1d
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-04

Species List	BI-BC-04 Abundance			BI-BC-04 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	1			0.00010		
Siphonenteron bicolour		1			0.00030	
Fragilonemertes rosea	frag.	2	2	0.00160	0.00180	0.00310
Alitta succinea	4	3	3	0.00640	0.00390	0.00090
Glycinde multidens	6	7	5	0.00050	0.00120	0.00070
Polydora cornuta	1	1		0.00010	0.00005	
Marenzelleria viridis		1	2		0.00100	0.00070
Streblospio benedicti	7	2	2	0.00030	0.00005	0.00020
Heteromastus filiformis	16	12	11	0.00600	0.00630	0.00340
Mediomastus ambiseta	10	1	9	0.00020	0.00005	0.00030
Loimia medusa	1			0.00110		
Tubificoides spp.	1		1	0.00005		0.00005
Eulimastoma engonium	1	1		0.00010	0.00005	
Japonactaeon punctostriatus	5	15	5	0.00030	0.00030	0.00010
Acteocina canaliculata	1	2	1	0.00010	0.00005	0.00010
Haminella solitaria	1			0.00005		
Geukensia demissa	1	2	1	0.00005	0.00010	0.00005
Mulinia lateralis	12	15	10	0.00700	0.01080	0.01990
Ameritella mitchelli	52	76	24	0.01890	0.01010	0.00590
Tagelus plebeius			3			0.00005
Gemma gemma	77	72	17	0.01280	0.00830	0.00200
Americamysis almyra		2			0.00020	
Edotia triloba	1			0.00005		
Ameroculodes spp. complex			1			0.00020

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-1e

Barren Island Summer Benthic Community Counts and Biomass – BI-BC-05

Species List	BI-BC-05 Abundance			BI-BC-05 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus			1			0.00010
Carinoma tremaphoros			1			0.00020
Fragilonemertes rosea	frag.	frag.	1	0.00010	0.00010	0.00280
Alitta succinea	11	5	10	0.01070	0.00260	0.00720
Glycera dibranchiata		1			0.00730	
Glycinde multidens	8	10	3	0.00110	0.00220	0.00090
Marenzelleria viridis	3	2		0.00660	0.00180	
Streblospio benedicti	5	8	4	0.00020	0.00030	0.00020
Heteromastus filiformis	5	3	10	0.00130	0.00350	0.00470
Mediomastus ambiseta	2	6	3	0.00005	0.00010	0.00005
Loimia medusa		1			0.00040	
Tubificoides spp.		6	4		0.00010	0.00005
Japonactaeon punctostriatus	2	2	1	0.00005	0.00005	0.00005
Acteocina canaliculata			4			0.00010
Haminella solitaria		1			0.00005	
Geukensia demissa	1		1	0.00010		0.00010
Mulinia lateralis	29	38	46	0.01890	0.00330	0.00450
Ameritella mitchelli	32	37	52	0.00400	0.00100	0.00480
Tagelus plebeius			1			0.00005
Gemma gemma	32	24	52	0.00380	0.00330	0.00730
Amphibalanus improvisus	3	1		0.00060	0.00005	
Americamysis almyra	1	18	5	0.00005	0.00150	0.00120
Cyathura polita		1			0.00030	
Edotia triloba	2			0.00010		
Melita nitida	1			0.0002		

Notes:

AFDW: ash free dry weight

frag.: fragment

g: gram

Table A-1f

Barren Island Summer Benthic Community Counts and Biomass – BI-BC-06

Species List	BI-BC-06 Abundance			BI-BC-06 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros			1			0.00090
Alitta succinea	29	29	31	0.02980	0.03780	0.03080
Glycinde multidens	2	2	2	0.00020	0.00020	0.00010
Polydora cornuta	1		3	0.00005		0.00030
Streblospio benedicti	35	14	9	0.00110	0.00040	0.00020
Mediomastus ambiseta		3	2		0.00010	0.00005
Eulimastoma engonium	1	2	1	0.00010	0.00010	0.00010
Acteocina canaliculata	1			0.00010		
Geukensia demissa		1	2		0.00005	0.00010
Mulinia lateralis	12	3	6	0.00210	0.00040	0.00130
Ameritella mitchelli	42	19	15	0.00090	0.00030	0.00050
Petricolaria pholadiformis	10	7	2	0.00110	0.00090	0.00020
Cyclaspis varians			1			0.00005
Cyathura polita	2	1	1	0.00040	0.00050	0.00030
Ameroculodes spp. complex		1			0.00010	

Notes:

AFDW: ash free dry weight

g: gram

Table A-1g
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-07

Species List	BI-BC-07 Abundance			BI-BC-07 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Lineidae sp. (?*Fragilonemertes*)		frag.			0.00560	
Siphonenteron bicolour		6			0.00420	
Alitta succinea	8	8	8	0.02060	0.02400	0.02050
Glycinde multidens	36	41	25	0.01220	0.01600	0.00850
Marenzelleria viridis	23	35	29	0.07640	0.12990	0.08280
Paraprionospio alata	1	4		0.00110	0.00640	
Streblospio benedicti	6	9	6	0.00020	0.00010	0.00010
Heteromastus filiformis	26	10	28	0.00920	0.00560	0.00920
Mediomastus ambiseta	82	106	48	0.00250	0.00240	0.00180
Tubificoides spp.	1	3	2	0.00005	0.00005	0.00005
Eulimastoma engonium	1	3	1	0.00005	0.00010	0.00010
Japonactaeon punctostriatus	4	2	3	0.00010	0.00010	0.00010
Acteocina canaliculata			1			0.00020
Haminella solitaria	1			0.00005		
Mulinia lateralis	14	17	12	0.00460	0.00340	0.00270
Ameritella mitchelli	54	58	41	0.01240	0.00870	0.00130
Limecola petalum	1	1		0.00180	0.00780	
Americamysis almyra	3	1	2	0.00020	0.00020	0.00040
Cyathura polita	6	5	4	0.00270	0.00110	0.00130
Edotia triloba			1			0.00005

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-1h
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-08

Species List	BI-BC-08 Abundance			BI-BC-08 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea		frag.			0.00010	
Alitta succinea	4	1	4	0.00240	0.00050	0.00720
Glycinde multidens	54	35	27	0.01470	0.01080	0.01120
Marenzelleria viridis		1	frag.		0.00100	0.00030
Streblospio benedicti	5	4	2	0.00010	0.00005	0.00010
Heteromastus filiformis	11	10	20	0.00120	0.00100	0.00250
Mediomastus ambiseta	13	11	29	0.00020	0.00030	0.00090
Tubificoides spp.	2	1	2	0.00005	0.00005	0.00005
Eulimastoma engonium	4	6	3	0.00020	0.00010	0.00005
Japonactaeon punctostriatus	5	2	1	0.00020	0.00005	0.00030
Acteocina canaliculata		1			0.00005	
Haminella solitaria	1	1		0.00005	0.00005	
Mulinia lateralis	140	78	92	0.06300	0.03230	0.03390
Ameritella mitchelli	131	62	66	0.01290	0.00450	0.00460
Limecola petalum		1			0.00590	
Tagelus plebeius	2			0.00100		
Amphibalanus improvisus		1			0.00020	
Americamysis almyra	2	4	12	0.00005	0.00050	0.00080
Cyathura polita	2		1	0.00040		0.00005
Edotia triloba	2	1	4	0.00030	0.00005	0.00030
Ameroculodes spp. complex		1			0.00005	

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-1i

Barren Island Summer Benthic Community Counts and Biomass – BI-BC-09

Species List	BI-BC-09 Abundance			BI-BC-09 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea	1		1	0.00980		0.03870
Amphiporus bioculatus		1			0.00020	
Alitta succinea	2	6	1	0.00130	0.00790	0.00040
Glycinde multidens	6	10	7	0.00120	0.00140	0.00030
Marenzelleria viridis		1			0.00020	
Streblospio benedicti	1	1	2	0.00010	0.00005	0.00020
Heteromastus filiformis	5	6	4	0.00140	0.00240	0.00050
Mediomastus ambiseta	3			0.00010		
Japonactaeon punctostriatus	1	1	1	0.00005	0.00005	0.00020
Acteocina canaliculata		1	1		0.00010	0.00005
Haminella solitaria	1	1		0.00005	0.00010	
Geukensia demissa		1			0.00010	
Mulinia lateralis	22	79	61	0.00350	0.01250	0.01040
Ameritella mitchelli	23	37	44	0.00180	0.00300	0.00290
Tagelus plebeius			1			0.00005
Gemma gemma	21	33	24	0.00250	0.00500	0.00360
Americamysis almyra	3	3	4	0.00080	0.00040	0.00060
Cyathura polita	1			0.00050		
Edotia triloba	1		1	0.00020		0.00005
Melita nitida	1			0.00010		
Lepidactylus dytiscus		1			0.00010	

Notes:

AFDW: ash free dry weight

g: gram

Table A-1j
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-10

Species List	BI-BC-10 Abundance			BI-BC-10 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Hypereteone heteropoda	1			0.00020		
Alitta succinea	5	11	7	0.00250	0.01180	0.00940
Glycinde multidens	58	52	46	0.02070	0.01560	0.01680
Marenzelleria viridis	3	7	3	0.01050	0.00910	0.00390
Paraprionospio alata	1	1	2	0.00110	0.00170	0.00150
Streblospio benedicti	8	3	8	0.00030	0.00010	0.00020
Heteromastus filiformis	6	8	12	0.00130	0.00190	0.00120
Mediomastus ambiseta	206	125	269	0.00440	0.00400	0.00730
Tubificoides spp.			1			0.00010
Eulimastoma engonium			1			0.00005
Sayella chesapeakea	1			0.00010		
Japonactaeon punctostriatus	29	12	28	0.00130	0.00040	0.00110
Acteocina canaliculata	1	2	11	0.00010	0.00020	0.00020
Haminella solitaria		1			0.00005	
Geukensia demissa	1			0.00010		
Mulinia lateralis	101	74	92	0.02600	0.02250	0.03800
Ameritella mitchelli	118	68	116	0.00770	0.00460	0.00790
Americamysis almyra	5		3	0.00070		0.00060
Cyclaspis varians			2			0.00010
Edotia triloba		4	4		0.00030	0.00010

Notes:
AFDW: ash free dry weight
g: gram

Table A-1k
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-REF

Species List	BI-BC-REF Abundance			BI-BC-REF Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea		3	3		0.02560	0.01800
Alitta succinea	3	4	1	0.00050	0.00270	0.00010
Glycinde multidens	7	6	7	0.00080	0.00070	0.00150
Streblospio benedicti	7	9	22	0.00050	0.00060	0.00130
Heteromastus filiformis	4	7	2	0.00390	0.00950	0.00190
Mediomastus ambiseta	frag.	3	2	0.00005	0.00005	0.00010
Loimia medusa	1			0.00060		
Japonactaeon punctostriatus	4	3	3	0.00010	0.00005	0.00010
Acteocina canaliculata		1			0.00005	
Parvilucina crenella		2			0.00030	
Mulinia lateralis	36	31	35	0.00180	0.00560	0.01070
Ameritella mitchelli	37	25	24	0.00820	0.00460	0.00170
Americamysis almyra	3	3	4	0.00030	0.00020	0.00050

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-2a
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-01

Species List	BI-BC-01 Abundance			BI-BC-01 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Alitta succinea	1	4	5	0.00020	0.00350	0.00430
Glycinde multidens	15	30	22	0.00100	0.00230	0.00200
Marenzelleria viridis			1			0.00110
Paraprionospio alata			1			0.00005
Streblospio benedicti	6	11	10	0.00050	0.00040	0.00060
Heteromastus filiformis	11	13	4	0.00570	0.00280	0.00160
Mediomastus ambiseta	14	23	20	0.00050	0.00050	0.00080
Tubificoides spp.	2	1	1	0.00010	0.00010	0.00010
Eulimastoma engonium	1	3		0.00005	0.00010	
Japonactaeon punctostriatus	1	5	2	0.00005	0.00040	0.00010
Acteocina canaliculata		7	5		0.00170	0.00070
Mulinia lateralis	1	4	2	0.02140	0.06470	0.02530
Ameritella mitchelli	44	98	38	0.00930	0.00350	0.00860
Tagelus plebeius	3	9	6	0.00005	0.00020	0.00010
Gemma gemma	41	77	40	0.00070	0.00130	0.00130
Amphibalanus improvisus	1			0.01090		
Americamysis almyra			1			0.00005
Cyclaspis varians		1			0.00005	
Cyathura polita		1			0.00030	
Apocorophium lacustre	1			0.00005		

Notes:
AFDW: ash free dry weight
g: gram

Table A-2b
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-02

Species List	BI-BC-02 Abundance			BI-BC-02 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea	1	1	6	0.00410	0.00110	0.01490
Alitta succinea			1			0.00005
Glycinde multidens	13	12	16	0.00090	0.00070	0.00100
Leitoscoloplos fragilis		2			0.00220	
Paraonis fulgens		2			0.00010	
Marenzelleria viridis		1			0.00030	
Heteromastus filiformis	6	4	4	0.00120	0.00090	0.00130
Mediomastus ambiseta	2		2	0.00010		0.00010
Eulimastoma engonium		3			0.00030	
Japonactaeon punctostriatus	1		3	0.00005		0.00020
Acteocina canaliculata	4			0.00030		
Haminella solitaria	7	4	3	0.00180	0.00170	0.00160
Mulinia lateralis	1	1		0.01490	0.02130	
Ameritella mitchelli	99	80	130	0.00330	0.00160	0.00420
Tagelus plebeius	19	12	24	0.00030	0.00020	0.00060
Gemma gemma	72	74	88	0.00090	0.00190	0.00300
Americamysis almyra	1		1	0.00005		0.00005
Edotia triloba			1			0.00005
Ameroculodes spp. complex	1	1	1	0.00020	0.00030	0.00005

Notes:
AFDW: ash free dry weight
g: gram

Table A-2c
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-03

Species List	BI-BC-03 Abundance			BI-BC-03 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea	2	2	2	0.00790	0.00800	0.00140
Hermundura americana		1			0.00040	
Alitta succinea		1			0.00180	
Glycinde multidens	15	50	9	0.00100	0.00380	0.00050
Marenzelleria viridis	1		frag.	0.00080		0.00130
Paraprionospio alata		1			0.00120	
Streblospio benedicti	2	6		0.00005	0.00030	
Heteromastus filiformis	2	5	2	0.00070	0.00280	0.00040
Mediomastus ambiseta	24	41	12	0.00070	0.00190	0.00050
Japonactaeon punctostriatus	5	1	1	0.00010	0.00010	0.00005
Acteocina canaliculata	4	3	9	0.00060	0.00080	0.00140
Geukensia demissa	1	1		0.00010	0.00010	
Mulinia lateralis	3	5	1	0.02570	0.03920	0.01880
Ameritella mitchelli	56	69	38	0.01200	0.00440	0.00340
Limecola petalum		1			0.00520	
Tagelus plebeius	7		1	0.00020		0.00005
Gemma gemma	40	40	34	0.00680	0.00710	0.00140

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-2d

Barren Island Fall Benthic Community Counts and Biomass – BI-BC-04

Species List	BI-BC-04 Abundance			BI-BC-04 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus	4	4	1	0.00090	0.00100	0.00020
Carinoma tremaphoros		3			0.00380	
Siphonenteron bicolour	1		1	0.00020		0.00250
Fragilonemertes rosea	1	1	3	0.00050	0.00240	0.01030
Alitta succinea	7	5	6	0.00480	0.00400	0.00740
Glycinde multidens	40	28	33	0.00290	0.00160	0.00200
Polydora cornuta			2			0.00010
Polydora websteri	1		5	0.00010		0.00030
Marenzelleria viridis	6	2	4	0.00580	0.00250	0.00640
Paraprionospio alata	1			0.00060		
Streblospio benedicti	12	6	9	0.00070	0.00040	0.00070
Heteromastus filiformis	13	20	11	0.01090	0.00580	0.00460
Mediomastus ambiseta	35	18	32	0.00100	0.00040	0.00100
Tubificoides spp.	2	5	5	0.00005	0.00010	0.00010
Eulimastoma engonium	5	6	6	0.00010	0.00030	0.00030
Sayella chesapeakea	2	1		0.00020	0.00010	
Japonactaeon punctostriatus	18	6	10	0.00040	0.00010	0.00030
Acteocina canaliculata	6	3	2	0.00290	0.00050	0.00030
Geukensia demissa	6	13	14	0.00030	0.00020	0.00050
Mulinia lateralis	4		3	0.08920		0.10810
Ameritella mitchelli	92	193	133	0.00350	0.00180	0.00630
Tagelus plebeius	22	18	14	0.00050	0.00030	0.00030
Gemma gemma	169	187	144	0.01540	0.02520	0.01450
Mya arenaria	4	2	2	0.00020	0.00005	0.00010
Lyonsia hyalina			1			0.00020
Americamysis almyra	1	1		0.00005	0.00005	
Cyclaspis varians			1			0.00005
Cyathura polita	1			0.00070		
Edotia triloba	1	1	1	0.00030	0.00010	0.00005
Apocorophium lacustre			10			0.00060
Melita nitida			2			0.00010
Eurypanopeus depressus			1			0.00630

Notes:

AFDW: ash free dry weight

g: gram

Table A-2e
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-05

Species List	BI-BC-05 Abundance			BI-BC-05 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros			1			0.00030
Fragilonemertes rosea	frag.	1	frag.	0.00190	0.00530	0.00040
Alitta succinea	11	31	2	0.00950	0.01780	0.00260
Glycinde multidens	17	17	10	0.00110	0.00110	0.00080
Polydora cornuta		1			0.00020	
Polydora websteri		2			0.00005	
Marenzelleria viridis		2	1		0.00360	0.00100
Paraprionospio alata	1			0.00040		
Streblospio benedicti	5	3	6	0.00030	0.00020	0.00030
Heteromastus filiformis	6	8	4	0.00330	0.00360	0.00320
Mediomastus ambiseta	5	19	5	0.00005	0.00070	0.00010
Tubificoides spp.		9			0.00040	
Eulimastoma engonium	2	3	1	0.00005	0.00020	0.00010
Japonactaeon punctostriatus		5	2		0.00020	0.00010
Acteocina canaliculata	4	2	4	0.00050	0.00040	0.00070
Haminella solitaria	1			0.00010		
Geukensia demissa	1	1	2	0.00005	0.00010	0.00040
Mulinia lateralis	1	9	7	0.01220	0.07620	0.02450
Ameritella mitchelli	131	107	150	0.00440	0.00460	0.00520
Tagelus plebeius	18	23	22	0.00030	0.00030	0.00020
Gemma gemma	183	114	69	0.00760	0.00280	0.01220
Petricolaria pholadiformis		1			0.00010	
Mya arenaria	3		1	0.00020		0.00005
Americamysis almyra			1			0.00005
Cyclaspis varians			1			0.00005
Cyathura polita	3			0.00070		
Edotia triloba	1	1		0.00005	0.00010	
Apocorophium lacustre	1			0.00020		

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-2f
Barren Island Summer Benthic Community Counts and Biomass – BI-BC-06

Species List	BI-BC-06 Abundance			BI-BC-06 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Alitta succinea		1	1		0.00110	0.00080
Glycinde multidens	6	5	7	0.00090	0.00100	0.00040
Marenzelleria viridis	2		1	0.00200		0.00040
Streblospio benedicti		6	2		0.00030	0.00005
Heteromastus filiformis	1		2	0.00040		0.00130
Mediomastus ambiseta	1	29	10	0.00005	0.00070	0.00010
Acteocina canaliculata	1	1		0.00010	0.00040	
Mulinia lateralis	1	1		0.01680	0.00540	
Ameritella mitchelli	40	54	10	0.00200	0.00340	0.00110
Tagelus plebeius	9	21	8	0.00020	0.00050	0.00010
Gemma gemma	7	15	1	0.00010	0.00020	0.00010

Notes:
AFDW: ash free dry weight
g: gram

Table A-2g
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-07

Species List	BI-BC-07 Abundance			BI-BC-07 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	frag.		1	0.00360		0.00540
Hermundura americana	1			0.00020		
Alitta succinea	3	2	2	0.00590	0.01050	0.00490
Glycinde multidens	25	16	6	0.00570	0.00350	0.00170
Leitoscoloplos robustus			1			0.00700
Marenzelleria viridis	3	7	2	0.00580	0.00900	0.00300
Streblospio benedicti	8			0.00020		
Heteromastus filiformis		6			0.00200	
Mediomastus ambiseta	13	2	2	0.00030	0.00005	0.00005
Acteocina canaliculata	2	1	2	0.00010	0.00020	0.00010
Mulinia lateralis		3	1		0.03450	0.00005
Ameritella mitchelli	62	57	37	0.00450	0.01340	0.01100
Americamysis almyra		1			0.00040	
Cyathura polita	1	2	1	0.00005	0.00200	0.00060
Edotia triloba	1	1		0.00010	0.00010	

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-2h

Barren Island Fall Benthic Community Counts and Biomass – BI-BC-08

Species List	BI-BC-08 Abundance			BI-BC-08 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	1			0.00020		
Alitta succinea	4	3	2	0.01070	0.00580	0.00160
Glycinde multidens	39	13	34	0.00360	0.00190	0.00590
Marenzelleria viridis	frag.	1	frag.	0.00240	0.00270	0.00510
Streblospio benedicti	19	7	18	0.00080	0.00030	0.00080
Heteromastus filiformis	12	5	11	0.00440	0.00110	0.00390
Mediomastus ambiseta	27	23	42	0.00130	0.00110	0.00270
Tubificoides spp.		1	1		0.00005	0.00005
Eulimastoma engonium		1	2		0.00020	0.00010
Acteocina canaliculata			1			0.00005
Mulinia lateralis	7	2	12	0.03280	0.00870	0.00830
Ameritella mitchelli	30	25	49	0.00250	0.00420	0.02050
Tagelus plebeius	1			0.00005		
Gemma gemma		1			0.00005	
Edotia triloba			2			0.00020

Notes:

AFDW: ash free dry weight

frag.: fragment

g: gram

Table A-2i
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-09

Species List	BI-BC-09 Abundance			BI-BC-09 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Carinoma tremaphoros	1	1		0.00060	0.00005	
Alitta succinea	1	4		0.00005	0.00270	
Glycinde multidens	7	3	5	0.00100	0.00030	0.00030
Streblospio benedicti	3	11	3	0.00010	0.00070	0.00030
Heteromastus filiformis	3	12	2	0.00210	0.00990	0.00160
Mediomastus ambiseta	3	3	1	0.00010	0.00010	0.00005
Acteocina canaliculata	1			0.00030		
Mulinia lateralis	2	4	1	0.00290	0.04330	0.00005
Ameritella mitchelli	52	83	50	0.00350	0.00380	0.00080
Tagelus plebeius	3	13	6	0.00010	0.00020	0.00010
Gemma gemma	47	38	44	0.00330	0.00160	0.00370
Amphibalanus improvisus	1			0.00790		
Americamysis almyra	1			0.00010		
Cyathura polita		1			0.00020	

Notes:
AFDW: ash free dry weight
g: gram

Table A-2j
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-10

Species List	BI-BC-10 Abundance			BI-BC-10 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Hypereteone heteropoda	2		1	0.00010		0.00010
Alitta succinea	7	4	2	0.00730	0.00390	0.00490
Glycinde multidens	56	49	70	0.00870	0.00760	0.00870
Marenzelleria viridis	3	5	2	0.00390	0.00490	0.00390
Streblospio benedicti	14	21	18	0.00070	0.00110	0.00070
Heteromastus filiformis	7	9	5	0.00210	0.00430	0.00180
Mediomastus ambiseta	74	70	78	0.00290	0.00240	0.00270
Tubificoides spp.			1			0.00005
Eulimastoma engonium	2	3	4	0.00005	0.00010	0.00030
Japonactaeon punctostriatus	9	12	5	0.00040	0.00070	0.00020
Acteocina canaliculata	2	2	5	0.00030	0.00040	0.00060
Mulinia lateralis	15	9	16	0.04980	0.00050	0.01860
Ameritella mitchelli	108	114	118	0.00870	0.00720	0.00870
Tagelus plebeius	2	1		0.00005	0.00005	
Gemma gemma		1			0.00005	
Americamysis almyra		1			0.00005	
Edotia triloba	1	1	2	0.00005	0.00010	0.00010
Apocorophium lacustre	1			0.00010		

Notes:
AFDW: ash free dry weight
g: gram

Table A-2k
Barren Island Fall Benthic Community Counts and Biomass – BI-BC-REF

Species List	BI-BC-REF Abundance			BI-BC-REF Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus		1			0.00020	
Fragilonemertes rosea	1	2	frag.	0.00220	0.00470	0.00270
Glycinde multidens	8	12	7	0.00040	0.00090	0.00060
Streblospio benedicti	3	3	2	0.00030	0.00010	0.00010
Heteromastus filiformis	2	2		0.00100	0.00090	
Mediomastus ambiseta	1		2	0.00010		0.00010
Japonactaeon punctostriatus		1	1		0.00005	0.00005
Acteocina canaliculata	4		2	0.00070		0.00005
Haminella solitaria	1	1		0.00005	0.00005	
Mulinia lateralis	1		3	0.00820		0.03150
Ameritella mitchelli	68	63	45	0.01100	0.00190	0.00550
Tagelus plebeius	6	1	2	0.00010	0.00005	0.00005
Gemma gemma			2			0.00050
Americamysis almyra	1	1	3	0.00050	0.00040	0.00010

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-3a
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-01

Species List	BI-BC-01 Abundance			BI-BC-01 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Siphonenteron bicolour		1			0.00010	
Fragilonemertes rosea	1	1		0.00160	0.00240	
Hypereteone heteropoda	2	1	4	0.00010	0.00010	0.00030
Glycinde multidens	8	8	6	0.00300	0.00350	0.00220
Polydora cornuta			1			0.00005
Marenzelleria viridis	5	5	1	0.00260	0.00150	0.00050
Streblospio benedicti	9	6	8	0.00040	0.00005	0.00010
Heteromastus filiformis	9	14	11	0.00160	0.00430	0.00310
Mediomastus ambiseta	30	4	8	0.00150	0.00005	0.00020
Acteocina canaliculata	1	8	9	0.00080	0.00550	0.00490
Mulinia lateralis	22	51	27	0.08850	0.23620	0.15420
Ameritella mitchelli	32	35	33	0.06760	0.05590	0.04380
Limecola petalum	2	2		0.00180	0.00140	
Tagelus plebeius	3	8		0.00080	0.00390	
Gemma gemma	94	96	122	0.00450	0.01270	0.00800
Mya arenaria	1	1	4	0.00010	0.00005	0.00005
Neomysis americana		1			0.00150	
Leucon (Leucon) americanus			1			0.00005
Edotia triloba	2	2	3	0.00005	0.00020	0.00020
Leptocheirus plumulosus	5	5	1	0.00120	0.00140	0.00020
Ameroculodes spp. complex	6	11	3	0.00040	0.00140	0.00020

Notes:
AFDW: ash free dry weight
g: gram

Table A-3b
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-02

Species List	BI-BC-02 Abundance			BI-BC-02 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea	3	6	3	0.00700	0.01750	0.00580
Hypereteone heteropoda	3		1	0.00010		0.00030
Hypereteone foliosa	1			0.00050		
Glycinde multidens	2	1		0.00070	0.00020	
Leitoscoloplos fragilis	2	4	5	0.00020	0.00010	0.00710
Paraonis fulgens	4	2	3	0.00020	0.00030	0.00030
Polydora cornuta	2	1		0.00020	0.00005	
Marenzelleria viridis		6	6		0.00150	0.00140
Streblospio benedicti	10	24	9	0.00030	0.00050	0.00050
Heteromastus filiformis	38	24	36	0.00650	0.00500	0.00720
Mediomastus ambiseta	3	5		0.00005	0.00020	
Tubificoides spp.	2	3		0.00010	0.00005	
Acteocina canaliculata		2	3		0.00080	0.00290
Mulinia lateralis	42	37	27	0.00050	0.00030	0.00030
Ameritella mitchelli	15	10	6	0.02950	0.01110	0.01370
Tagelus plebeius	2	1	3	0.00090	0.00020	0.00130
Gemma gemma	11	36	7	0.00120	0.00510	0.00080
Mya arenaria	3	4	4	0.00005	0.00010	0.00010
Edotia triloba	1	2		0.00005	0.00020	
Leptocheirus plumulosus			2			0.00020
Gammarus mucronatus		1			0.00020	
Ameroculodes spp. complex	5	11	20	0.00020	0.00200	0.00160

Notes:
AFDW: ash free dry weight
g: gram

Table A-3c
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-03

Species List	BI-BC-03 Abundance			BI-BC-03 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea		1	1		0.01060	0.00430
Hypereteone heteropoda	2	1		0.00010	0.00010	
Glycinde multidens	8	10	9	0.00360	0.00370	0.00370
Leitoscoloplos fragilis	1			0.00020		
Paraonis fulgens	1			0.00020		
Marenzelleria viridis	2	3	4	0.00070	0.00060	0.00090
Streblospio benedicti	14	7	8	0.00030	0.00005	0.00030
Heteromastus filiformis	8	11	13	0.00180	0.00100	0.00260
Mediomastus ambiseta	10		3	0.00005		0.00020
Acteocina canaliculata	5	2	3	0.00340	0.00100	0.00170
Mulinia lateralis	18	19	32	0.11600	0.10940	0.10280
Ameritella mitchelli	16	14	23	0.05190	0.01900	0.06110
Limecola petalum	1	1		0.00150	0.00050	
Tagelus plebeius	6	4	4	0.00310	0.00200	0.00220
Gemma gemma	50	60	54	0.00870	0.00380	0.00540
Neomysis americana			2			0.00170
Cyathura polita			1			0.00280
Edotia triloba	1	1	1	0.00010	0.00010	0.00020
Leptocheirus plumulosus	8	5	4	0.00140	0.00100	0.00130
Ameroculodes spp. complex	13	18	8	0.00150	0.00210	0.00110

Notes:
AFDW: ash free dry weight
g: gram

Table A-3d
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-03

Species List	BI-BC-04 Abundance			BI-BC-04 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Paranthus rapiformis	1			0.00470		
Stylochus ellipticus			1			0.00005
Fragilonemertes rosea	frag.			0.00240		
Amphiporus bioculatus		1			0.00150	
Hypereteone heteropoda	4	2	2	0.00020	0.00005	0.00005
Glycinde multidens	6	5	1	0.00490	0.00290	0.00010
Leitoscoloplos fragilis	1			0.00060		
Polydora cornuta		98	4		0.00160	0.00010
Polydora websteri		4			0.00030	
Marenzelleria viridis	19	8	13	0.00570	0.00440	0.00660
Streblospio benedicti	13	32	9	0.00040	0.00090	0.00020
Heteromastus filiformis	21	7	9	0.00490	0.00120	0.00380
Mediomastus ambiseta	8	7	9	0.00020	0.00010	0.00040
Tubificoides spp.	3	8	3	0.00010	0.00010	0.00010
Sayella chesapeakea	1		1	0.00020		0.00020
Acteocina canaliculata	3	1		0.00260	0.00130	
Geukensia demissa	1	2	3	0.00005	0.00050	0.00020
Mulinia lateralis	8	12	4	0.02820	0.15010	0.03990
Ameritella mitchelli	19	9	4	0.00970	0.00270	0.00150
Limecola petalum	8	2		0.03920	0.00290	
Tagelus plebeius	5	6	4	0.00340	0.00490	0.00180
Gemma gemma	304	129	141	0.02480	0.01290	0.00760
Mya arenaria	4		3	0.00030		0.00005
Amphibalanus improvisus	1	75	6	0.00010	0.07370	0.00140
Americamysis almyra		1			0.00070	
Cyclaspis varians		1			0.00030	
Idoteidae	2	1	1	0.00020	0.00005	0.00010
Leptocheirus plumulosus	1			0.00010		
Apocorophium lacustre		14	2		0.00060	0.00010
Grandidierella japonica		2			0.00060	
Gammarus mucronatus	1	1	1	0.00010	0.00040	0.00005
Ameroculodes spp. complex	7	11	2	0.00030	0.00040	0.00030
Ascidiacea sp.		2			0.0004	

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-3e

Barren Island Spring Benthic Community Counts and Biomass – BI-BC-05

Species List	BI-BC-05 Abundance			BI-BC-05 Biomass (g; AFDW)		
	Replicate A	**Replicate B**	**Replicate C**	**Replicate A**	**Replicate B**	**Replicate C**
Carinoma tremaphoros			1			0.00020
Fragilonemertes rosea	2		frag.	0.01170		0.00140
Hypereteone heteropoda			1			0.00020
Glycinde multidens	6	5	3	0.00400	0.00310	0.00160
Polydora cornuta	1	5	2	0.00005	0.00030	0.00010
Marenzelleria viridis	3	6	6	0.00070	0.00270	0.00520
Streblospio benedicti	7	8	29	0.00010	0.00020	0.00050
Heteromastus filiformis	1	2	frag.	0.00020	0.00040	0.00010
Mediomastus ambiseta	5	5	23	0.00020	0.00020	0.00070
Tubificoides spp.	1		2	0.00005		0.00005
Eulimastoma engonium		1			0.00005	
Acteocina canaliculata	2			0.00070		
Mulinia lateralis	8	6	3	0.01310	0.08970	0.01120
Ameritella mitchelli	8	9	15	0.00480	0.01440	0.01980
Limecola petalum	2	5	9	0.00160	0.00910	0.02950
Tagelus plebeius	2	1		0.00050	0.00040	
Gemma gemma	98	26	50	0.00710	0.00630	0.00540
Mya arenaria		1			0.00010	
Amphibalanus improvisus	2	8		0.00005	0.00010	
Edotia triloba	7		1	0.00070		0.00005
Leptocheirus plumulosus		1			0.00030	
Ameroculodes spp. complex	3		4	0.00040		0.00060

Notes:

AFDW: ash free dry weight

frag.: fragment

g: gram

Table A-3f
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-06

Species List	BI-BC-06 Abundance			BI-BC-06 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	1			0.00010		
Siphonenteron bicolour		1			0.00070	
Fragilonemertes rosea			1			0.00430
Amphiporus caecus	2	1		0.00020	0.00020	
Hypereteone heteropoda	6	1	5	0.00050	0.00020	0.00040
Alitta succinea	1		1	0.00340		0.01050
Glycinde multidens	11	6	6	0.00360	0.00290	0.00230
Leitoscoloplos fragilis		1			0.00120	
Paraonis fulgens		1			0.00005	
Polydora cornuta	48	46	14	0.00180	0.00160	0.00060
Marenzelleria viridis	1	2	1	0.00005	0.00140	0.00005
Streblospio benedicti	36	100	28	0.00110	0.00200	0.00080
Heteromastus filiformis	2	7	frag.	0.00050	0.00510	0.00080
Mediomastus ambiseta	12	15	1	0.00020	0.00030	0.00005
Tubificoides spp.		1			0.00005	
Littoridinops tenuipes			1			0.00010
Geukensia demissa	1	1		0.00005	0.00005	
Mulinia lateralis	6	4	4	0.03830	0.03020	0.03630
Ameritella mitchelli	19	19	11	0.00950	0.00600	0.01010
Limecola petalum			1			0.00100
Tagelus plebeius	3	1	3	0.00120	0.00040	0.00150
Gemma gemma	6	2	6	0.00070	0.00030	0.00060
Petricolaria pholadiformis	1		1	0.00120		0.00090
Mya arenaria	4	3		0.00190	0.00010	
Amphibalanus improvisus	3	1	1	0.00005	0.00005	0.00010
Americamysis almyra		1			0.00005	
Bodotriidae	1			0.00005		
Cyathura polita			1			0.00190
Edotia triloba	15	13	4	0.00200	0.00100	0.00060
Leptocheirus plumulosus	3	4	2	0.00020	0.00080	0.00005
Apocorophium lacustre	58	68	33	0.00440	0.00670	0.00380
Grandidierella japonica	18	17	18	0.00000	0.00000	0.00000
Gammarus mucronatus	5	3		0.00030	0.00020	
Ameroculodes spp. complex	23	19	7	0.00260	0.00140	0.00080
Chironomidae larva		1			0.00040	

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-3g
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-07

Species List	BI-BC-07 Abundance			BI-BC-07 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Edwardsia elegans	1			0.00070		
Fragilonemertes rosea	1			0.00010		
Hypereteone heteropoda		2			0.00010	
Alitta succinea	1		frag.	0.00400		0.00060
Glycinde multidens	46	48	37	0.01800	0.01870	0.01410
Marenzelleria viridis	1			0.00030		
Paraprionospio alata		1			0.00180	
Streblospio benedicti	21	64	34	0.00040	0.00090	0.00070
Heteromastus filiformis	1	1	3	0.00080	0.00080	0.00640
Mediomastus ambiseta	133	169	181	0.00320	0.00360	0.00780
Tubificoides spp.	1	3	2	0.00005	0.00005	0.00005
Sayella chesapeakea	1			0.00010		
Mulinia lateralis	21	22	12	0.07080	0.06550	0.02200
Ameritella mitchelli	78	86	42	0.03070	0.05520	0.02100
Limecola petalum	7	6	7	0.01300	0.00740	0.02250
Mya arenaria	2	1	1	0.00010	0.00010	0.00005
Cyclaspis varians	1		2	0.00005		0.00005
Cyathura polita	3			0.00020		
Edotia triloba	4	1	2	0.00020	0.00005	0.00030
Leptocheirus plumulosus	40	69	88	0.00640	0.01350	0.02270
Grandidierella japonica	6	3	8	0.00100	0.00005	0.00000
Ameroculodes spp. complex	7	5	14	0.00050	0.00030	0.00070

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-3h
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-08

Species List	BI-BC-08 Abundance			BI-BC-08 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Platyhelminthes sp. A			1			0.00040
Hypereteone heteropoda	15	5	12	0.00190	0.00060	0.00160
Glycinde multidens	51	23	49	0.03690	0.01460	0.03860
Polydora cornuta	8	4	98	0.00010	0.00010	0.00090
Polydora websteri			1			0.00080
Streblospio benedicti	13	7	23	0.00020	0.00005	0.00030
Heteromastus filiformis	2	frag.	1	0.00040	0.00030	0.00020
Mediomastus ambiseta	48	33	36	0.00230	0.00190	0.00100
Tubificoides spp.	1	2	1	0.00005	0.00005	0.00005
Eulimastoma engonium	2	2		0.00050	0.00030	
Sayella chesapeakea	3	1	1	0.00040	0.00020	0.00005
Japonactaeon punctostriatus	2		1	0.00060		0.00030
Acteocina canaliculata	1			0.00050		
Mulinia lateralis	78	31	46	0.81070	0.24220	0.39890
Ameritella mitchelli	57	37	56	0.03110	0.01490	0.03180
Limecola petalum	71	34	45	0.16820	0.05760	0.06310
Gemma gemma	1	1	2	0.00005	0.00080	0.00010
Mya arenaria	1		2	0.00005		0.00020
Amphibalanus improvisus	12	11	68	0.00580	0.00250	0.01880
Cyclaspis varians		1	5		0.00005	0.00040
Cyathura polita	1	5	7	0.00005	0.00005	0.00005
Edotia triloba	8	6	43	0.00100	0.00090	0.00340
Leptocheirus plumulosus	9	2	3	0.00100	0.02770	0.00005
Apocorophium lacustre	10		2	0.00080		0.00005
Grandidierella japonica		2	8		0.00010	0.00070
Gammarus mucronatus	2	2	15	0.00005	0.00005	0.00070
Oedicerotidae	4	2	18	0.00090	0.00010	0.00180

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-3i
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-09

Species List	BI-BC-09 Abundance			BI-BC-09 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea	frag.	3		0.00120	0.03440	
Glycinde multidens	8	12	7	0.00300	0.00540	0.00330
Leitoscoloplos fragilis	1	frag.		0.00005	0.00070	
Paraonis fulgens		1			0.00010	
Marenzelleria viridis	2	3	2	0.00140	0.00190	0.00020
Streblospio benedicti	2	4	4	0.00005	0.00020	0.00030
Heteromastus filiformis	4	5	2	0.00190	0.00400	0.00060
Mediomastus ambiseta	11	5	4	0.00040	0.00020	0.00020
Tubificoides spp.			1			0.00005
Sayella chesapeakea			1			0.00020
Mulinia lateralis	10	10	10	0.10550	0.10240	0.28640
Ameritella mitchelli	18	17	16	0.04620	0.02730	0.02150
Limecola petalum	3	5	2	0.00330	0.01460	0.00240
Tagelus plebeius	2	4	2	0.00040	0.00120	0.00050
Gemma gemma	150	108	105	0.02570	0.01070	0.01180
Edotia triloba	1		1	0.00020		0.00010
Leptocheirus plumulosus	5	4	7	0.00040	0.00020	0.00030
Gammarus mucronatus			1			0.00020
Ameroculodes spp. complex	20	9	18	0.00240	0.00060	0.00280

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Table A-3j
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-10

Species List	BI-BC-10 Abundance			BI-BC-10 Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Stylochus ellipticus	1			0.00340		
Hypereteone heteropoda	3	3	4	0.00070	0.00100	0.00090
Alitta succinea	2			0.01900		
Glycinde multidens	55	44	36	0.02760	0.02140	0.01640
Marenzelleria viridis		2			0.00160	
Streblospio benedicti	15	35	11	0.00010	0.00070	0.00030
Heteromastus filiformis	1	3	3	0.00040	0.00040	0.00130
Mediomastus ambiseta	56	44	40	0.00220	0.00180	0.00190
Tubificoides spp.		2			0.00005	
Japonactaeon punctostriatus	2		1	0.00060		0.00010
Acteocina canaliculata	1	1	1	0.00030	0.00110	0.00050
Mulinia lateralis	44	73	45	0.48890	0.56090	0.40680
Ameritella mitchelli	37	56	39	0.00880	0.01650	0.00870
Limecola petalum	48	46	40	0.11890	0.08470	0.07830
Gemma gemma		3			0.00005	
Mya arenaria	1			0.00030		
Amphibalanus improvisus	1	1		0.00010	0.00005	
Leucon (*Leucon*) *americanus*	1		1	0.00005		0.00005
Cyclaspis varians			1			0.00020
Cyathura polita	1	4	1	0.00005	0.00060	0.00005
Edotia triloba	9	9	4	0.00070	0.00080	0.00090
Leptocheirus plumulosus	8	20	18	0.00120	0.00490	0.00400
Grandidierella japonica	3	5	2	0.00000	0.00000	0.00010
Ameroculodes spp. complex	2	5	2	0.00020	0.00040	0.00005

Notes:
AFDW: ash free dry weight
g: gram

Table A-3k
Barren Island Spring Benthic Community Counts and Biomass – BI-BC-REF

Species List	BI-BC-REF Abundance			BI-BC-REF Biomass (g; AFDW)		
	Replicate A	Replicate B	Replicate C	Replicate A	Replicate B	Replicate C
Fragilonemertes rosea		1			0.00040	
Glycinde multidens	frag.	2	2	0.00005	0.00170	0.00080
Leitoscoloplos fragilis	1	1		0.00005	0.00020	
Marenzelleria viridis	5	1	3	0.00130	0.00040	0.00210
Streblospio benedicti		1	4		0.00010	0.00010
Heteromastus filiformis	2	2	3	0.00080	0.00020	0.00260
Mediomastus ambiseta	2	1	3	0.00005	0.00005	0.00005
Tubificoides spp.			1			0.00005
Acteocina canaliculata		1	1		0.00090	0.00060
Mulinia lateralis	24	17	16	0.13420	0.00150	0.04830
Ameritella mitchelli	22	15	20	0.06390	0.13680	0.07490
Limecola petalum	1		3	0.00640		0.01480
Tagelus plebeius	4	3	3	0.00090	0.00120	0.00290
Mya arenaria		1			0.00010	
Edotia triloba			1			0.00005
Ameroculodes spp. complex	8	10	9	0.00120	0.00100	0.00070

Notes:
AFDW: ash free dry weight
frag.: fragment
g: gram

Appendix B
Barren Island Fish Collection Data

Table B-1a
Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	55	
BI-BN-01a	Bay anchovy	47	
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	51	
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	52	
BI-BN-01a	Bay anchovy	48	
BI-BN-01a	Bay anchovy	55	
BI-BN-01a	Bay anchovy	46	
BI-BN-01a	Bay anchovy	52	
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	51	
BI-BN-01a	Bay anchovy	48	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	43	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	42	
BI-BN-01a	Bay anchovy	48	
BI-BN-01a	Bay anchovy	52	
BI-BN-01a	Bay anchovy	45	
BI-BN-01a	Bay anchovy	52	
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	53	
BI-BN-01a	Bay anchovy	54	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	48	
BI-BN-01a	Bay anchovy	53	
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	44	
BI-BN-01a	Bay anchovy	48	
BI-BN-01a	Bay anchovy	45	
BI-BN-01a	Bay anchovy	45	
BI-BN-01a	Bay anchovy	53	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	55	
BI-BN-01a	Bay anchovy	51	
BI-BN-01a	Bay anchovy	51	
BI-BN-01a	Bay anchovy	49	

Table B-1a
Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	45	
BI-BN-01a	Bay anchovy	49	
BI-BN-01a	Bay anchovy	50	
BI-BN-01a	Bay anchovy	48	
BI-BN-01a	Bay anchovy	47	
BI-BN-01a	Atlantic menhaden	105	
BI-BN-01a	Atlantic menhaden	95	
BI-BN-01a	Atlantic menhaden	98	
BI-BN-01a	Atlantic menhaden	93	
BI-BN-01a	Atlantic menhaden	100	
BI-BN-01a	Atlantic menhaden	99	
BI-BN-01a	Atlantic menhaden	97	
BI-BN-01a	Atlantic menhaden	93	
BI-BN-01a	Atlantic menhaden	110	
BI-BN-01a	Atlantic menhaden	106	
BI-BN-01a	Atlantic menhaden	118	
BI-BN-01a	Atlantic menhaden	108	
BI-BN-01a	Atlantic menhaden	103	
BI-BN-01a	Atlantic menhaden	104	
BI-BN-01a	Atlantic menhaden	128	
BI-BN-01a	Atlantic menhaden	106	
BI-BN-01a	Atlantic menhaden	135	
BI-BN-01a	Atlantic menhaden	104	
BI-BN-01a	Atlantic menhaden	105	
BI-BN-01a	Atlantic menhaden	101	
BI-BN-01a	Atlantic menhaden	90	
BI-BN-01a	Atlantic menhaden	102	
BI-BN-01a	Atlantic menhaden	113	
BI-BN-01a	Atlantic menhaden	105	
BI-BN-01a	Atlantic menhaden	104	
BI-BN-01a	Atlantic menhaden	107	
BI-BN-01a	Atlantic menhaden	101	
BI-BN-01a	Atlantic menhaden	90	
BI-BN-01a	Atlantic menhaden	100	
BI-BN-01a	Atlantic menhaden	109	
BI-BN-01a	Atlantic menhaden	100	
BI-BN-01a	Atlantic menhaden	99	
BI-BN-01a	Atlantic menhaden	94	
BI-BN-01a	Atlantic menhaden	108	
BI-BN-01a	Atlantic menhaden	97	
BI-BN-01a	Atlantic menhaden	115	
BI-BN-01a	Atlantic menhaden	103	
BI-BN-01a	Atlantic menhaden	94	

Table B-1a

Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-01a	Atlantic menhaden	89	
BI-BN-01a	Atlantic menhaden	87	
BI-BN-01a	Atlantic menhaden	105	
BI-BN-01a	Atlantic menhaden	102	
BI-BN-01a	Atlantic menhaden	126	
BI-BN-01a	Atlantic menhaden	97	
BI-BN-01a	Atlantic menhaden	105	
BI-BN-01a	Atlantic menhaden	105	
BI-BN-01a	Atlantic menhaden	96	
BI-BN-01a	Atlantic menhaden	100	
BI-BN-01a	Atlantic menhaden	119	
BI-BN-01a	Atlantic menhaden	99	
BI-BN-01a	Cownose ray	310	
BI-BN-01a	Spot	140	
BI-BN-01a	Harvest fish	110	
BI-BN-01a	Harvest fish	120	
BI-BN-01a	Blue crab	95	
BI-BN-01a	Silver perch	75	
BI-BN-01a	Blue crab	52	
BI-BN-01a	Blue crab	68	
BI-BN-01a	Atlantic silverside	69	
BI-BN-01a	Atlantic silverside	57	
BI-BN-01b	Atlantic menhaden	92	
BI-BN-01b	Atlantic menhaden	96	
BI-BN-01b	Atlantic menhaden	111	
BI-BN-01b	Atlantic menhaden	86	
BI-BN-01b	Atlantic menhaden	86	
BI-BN-01b	Atlantic menhaden	90	
BI-BN-01b	Atlantic menhaden	92	
BI-BN-01b	Atlantic menhaden	89	
BI-BN-01b	Atlantic menhaden	80	
BI-BN-01b	Atlantic menhaden	107	
BI-BN-01b	Atlantic menhaden	88	
BI-BN-01b	Atlantic menhaden	120	
BI-BN-01b	Atlantic menhaden	58	
BI-BN-01b	Atlantic menhaden	93	
BI-BN-01b	Atlantic menhaden	85	
BI-BN-01b	Bay anchovy	50	
BI-BN-01b	Bay anchovy	52	
BI-BN-01b	Bay anchovy	47	
BI-BN-01b	Bay anchovy	52	
BI-BN-01b	Bay anchovy	55	
BI-BN-01b	Bay anchovy	77	
BI-BN-01b	Bay anchovy	48	

Table B-1a

Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-01b	Bay anchovy	48	
BI-BN-01b	Blue crab	90	
BI-BN-01b	Blue crab	28	
BI-BN-01b	Silver perch	107	
BI-BN-01b	Blue crab	155	
BI-BN-01b	Blue crab	110	
BI-BN-01b	Blue crab	68	
BI-BN-01b	Blue crab	43	
BI-BN-01b	Spot	135	
BI-BN-01b	Silver perch	80	
BI-BN-01b	Blue crab	20	
BI-BN-01b	Blue crab	42	
BI-BN-01b	Blue crab	88	
BI-BN-01b	Blue crab	5	
BI-BN-01b	Blue crab	110	
BI-BN-01b	Blue crab	98	
BI-BN-01b	Blackcheek tonguefish	135	
BI-BN-01b	Blue crab	115	
BI-BN-01b	Silver perch	75	
BI-BN-01b	Blue crab	70	
BI-BN-01b	Atlantic silverside	50	
BI-BN-02a	Bay anchovy	50	
BI-BN-02a	Blue crab	102	
BI-BN-02a	Atlantic silverside	85	
BI-BN-02a	Spot	131	
BI-BN-02a	Atlantic silverside	80	
BI-BN-02a	Atlantic silverside	86	
BI-BN-02a	Atlantic silverside	84	
BI-BN-02a	Atlantic silverside	86	
BI-BN-02a	Atlantic silverside	91	
BI-BN-02a	Blue crab	73	
BI-BN-02a	Blue crab	65	
BI-BN-02a	Blue crab	68	
BI-BN-02a	Atlantic silverside	86	
BI-BN-02a	Atlantic silverside	77	
BI-BN-02a	Atlantic silverside	80	
BI-BN-02a	Spot	136	
BI-BN-02a	Spot	144	
BI-BN-02a	Spot	134	
BI-BN-02a	Blue crab	65	
BI-BN-02a	Blue crab	55	
BI-BN-02a	Blue crab	70	
BI-BN-02a	Atlantic silverside	87	

Table B-1a

Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-02a	Blue crab	50	
BI-BN-02a	Blue crab	50	
BI-BN-02a	Blue crab	65	
BI-BN-02a	Blue crab	57	
BI-BN-02a	Atlantic silverside	65	
BI-BN-02a	Striped killifish	95	
BI-BN-02a	Blue crab	99	
BI-BN-02a	Atlantic silverside	92	
BI-BN-02a	Atlantic silverside	83	
BI-BN-02a	Atlantic silverside	82	
BI-BN-02a	Atlantic silverside	83	
BI-BN-02a	Atlantic silverside	69	
BI-BN-02a	Blue crab	75	
BI-BN-02a	Blue crab	62	
BI-BN-02a	Blue crab	66	
BI-BN-02a	Blue crab	103	
BI-BN-02a	Blue crab	67	
BI-BN-02a	Atlantic silverside	82	
BI-BN-03a	Bay anchovy	51	
BI-BN-03a	Atlantic silverside	54	
BI-BN-03a	Atlantic silverside	67	
BI-BN-03a	Bay anchovy	62	
BI-BN-03a	Spot	126	
BI-BN-03a	Silver perch	94	
BI-BN-03a	Spot	130	
BI-BN-03a	Bay anchovy	64	
BI-BN-03a	Bay anchovy	55	
BI-BN-03a	Spot	127	
BI-BN-03a	Bay anchovy	51	
BI-BN-03a	Blue crab	65	
BI-BN-03a	Atlantic silverside	54	
BI-BN-04a	Bay anchovy	49	
BI-BN-04a	Bay anchovy	50	
BI-BN-04a	Atlantic silverside	63	
BI-BN-04a	Atlantic silverside	74	
BI-BN-04a	Bay anchovy	50	
BI-BN-04a	Atlantic silverside	60	
BI-BN-04a	Bay anchovy	49	
BI-BN-04a	Atlantic silverside	60	
BI-BN-04a	Atlantic silverside	62	
BI-BN-04a	Atlantic silverside	71	
BI-BN-04a	Bay anchovy	47	
BI-BN-04a	Atlantic silverside	79	
BI-BN-04a	Spot	119	

Table B-1a

Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-04a	Bay anchovy	50	
BI-BN-04a	Blue crab	60	
BI-BN-04a	Atlantic silverside	56	
BI-BN-04a	Blue crab	13	
BI-BN-04a	Bay anchovy	50	
BI-BN-04a	Atlantic silverside	60	
BI-BN-04a	Bay anchovy	51	
BI-BN-04a	Bay anchovy	48	
BI-BN-04a	Bay anchovy	47	
BI-BN-04a	Atlantic silverside	50	
BI-BN-04a	Atlantic silverside	60	
BI-BN-04b	Blue crab	63	
BI-BN-04b	Blue crab	50	
BI-BN-04b	Blue crab	143	
BI-BN-04b	Blue crab	88	
BI-BN-04b	Blue crab	113	
BI-BN-04b	Bay anchovy	55	
BI-BN-04b	Blue crab	62	
BI-BN-04b	Blue crab	152	
BI-BN-04b	Blue crab	84	
BI-BN-04b	Bay anchovy	50	
BI-BN-04b	Bay anchovy	47	
BI-BN-04b	Bay anchovy	46	
BI-BN-04b	Blue crab	135	
BI-BN-04b	Bay anchovy	47	
BI-BN-04b	Atlantic silverside	55	
BI-BN-04b	Bay anchovy	49	
BI-BN-04b	Bay anchovy	55	
BI-BN-04b	Silver perch	100	
BI-BN-04b	Bay anchovy	50	
BI-BN-04b	Mummichog	78	
BI-BN-04b	Blue crab	52	
BI-BN-04b	Mummichog	65	
BI-BN-04b	Atlantic silverside	65	
BI-BN-04b	Weakfish	53	
BI-BN-04b	Mummichog	84	
BI-BN-04b	Atlantic silverside	53	
BI-BN-04b	Atlantic silverside	70	
BI-BN-04b	Atlantic silverside	57	
BI-BN-04b	Atlantic silverside	70	
BI-BN-04b	Atlantic silverside	75	
BI-BN-04b	Atlantic silverside	68	
BI-BN-04b	Blue crab	96	
BI-BN-04b	Atlantic silverside	77	

Table B-1a
Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-04b	Spotted seatrout	95	
BI-BN-04b	Blue crab	42	
BI-BN-04b	Mummichog	88	
BI-BN-04b	Blue crab	76	
BI-BN-04b	Atlantic silverside	62	
BI-BN-04b	Blue crab	32	
BI-BN-04b	Atlantic silverside	86	
BI-BN-04b	Blue crab	48	
BI-BN-04b	Atlantic silverside	64	
BI-BN-04b	Atlantic silverside	66	
BI-BN-04b	Striped blenny	50	
BI-BN-04b	Atlantic silverside	83	
BI-BN-04b	Blue crab	43	
BI-BN-04b	Blue crab	53	
BI-BN-04b	Blue crab	60	
BI-BN-05a	Atlantic silverside	63	
BI-BN-05a	Bay anchovy	50	
BI-BN-05a	Atlantic silverside	66	
BI-BN-05a	Bay anchovy	48	
BI-BN-05a	Atlantic silverside	62	
BI-BN-05a	Blue crab	55	
BI-BN-05a	Silver perch	40	
BI-BN-05a	Atlantic silverside	81	
BI-BN-05a	Atlantic silverside	62	
BI-BN-05a	Blue crab	73	
BI-BN-05a	Silver perch	82	Parasite on gills
BI-BN-05a	Spotted seatrout	100	
BI-BN-05a	Blue crab	105	
BI-BN-05a	Weakfish	48	
BI-BN-05a	Weakfish	30	
BI-BN-05a	Weakfish	42	
BI-BN-05a	Weakfish	50	
BI-BN-05b	Bay anchovy	55	
BI-BN-05b	Striped Anchovy	98	
BI-BN-05b	Atlantic silverside	65	
BI-BN-05b	Bay anchovy	49	
BI-BN-05b	Bay anchovy	49	
BI-BN-05b	Bay anchovy	54	
BI-BN-05b	Atlantic menhaden	100	
BI-BN-05b	Striped Anchovy	76	
BI-BN-05b	Atlantic silverside	84	
BI-BN-05b	Striped Anchovy	53	
BI-BN-05b	Atlantic silverside	82	
BI-BN-05b	Blue crab	76	

Table B-1a

Barren Island Seine Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-BN-05b	Bay anchovy	47	
BI-BN-05b	Atlantic silverside	85	
BI-BN-05b	Bay anchovy	50	
BI-BN-05b	Bay anchovy	59	
BI-BN-05b	Bay anchovy	53	
BI-BN-05b	Silver perch	88	
BI-BN-05b	Bay anchovy	48	
BI-BN-05b	Atlantic silverside	72	
BI-BN-05b	Silver perch	88	
BI-BN-05b	Silver perch	48	
BI-BN-05b	Spot	127	
BI-BN-05b	Silver perch	51	

Note:

mm: millimeter

Table B-1b

Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-01a	Red drum	54	
BI-BN-01a	Bay anchovy	57	
BI-BN-01b	Sheepshead minnow	49	
BI-BN-01b	Sheepshead minnow	40	
BI-BN-01b	Sheepshead minnow	45	
BI-BN-01b	Sheepshead minnow	40	
BI-BN-01b	Sheepshead minnow	50	
BI-BN-01b	Sheepshead minnow	36	
BI-BN-01b	Sheepshead minnow	46	
BI-BN-01b	Sheepshead minnow	39	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	43	
BI-BN-01b	Sheepshead minnow	34	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	44	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	36	
BI-BN-01b	Sheepshead minnow	36	
BI-BN-01b	Sheepshead minnow	35	
BI-BN-01b	Sheepshead minnow	43	
BI-BN-01b	Sheepshead minnow	39	
BI-BN-01b	Sheepshead minnow	40	
BI-BN-01b	Sheepshead minnow	40	
BI-BN-01b	Sheepshead minnow	41	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	40	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	43	
BI-BN-01b	Sheepshead minnow	38	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	37	
BI-BN-01b	Sheepshead minnow	32	
BI-BN-01b	Atlantic silverside	79	
BI-BN-01b	Northern pipefish	84	
BI-BN-01b	Sheepshead minnow	50	
BI-BN-01b	Sheepshead minnow	35	
BI-BN-01b	Sheepshead minnow	35	
BI-BN-01b	Red drum	55	
BI-BN-01b	Sheepshead minnow	36	
BI-BN-01b	Sheepshead minnow	32	
BI-BN-01b	Sheepshead minnow	35	
BI-BN-01b	Sheepshead minnow	42	
BI-BN-02a	Atlantic silverside	79	
BI-BN-02a	Atlantic silverside	116	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-02a	Atlantic silverside	72	
BI-BN-02a	Atlantic silverside	87	
BI-BN-02a	Atlantic silverside	86	
BI-BN-02a	Atlantic silverside	81	
BI-BN-02a	Atlantic silverside	109	
BI-BN-02a	Red drum	69	
BI-BN-02a	Atlantic silverside	114	
BI-BN-02a	Atlantic silverside	79	
BI-BN-02a	Atlantic silverside	95	
BI-BN-02a	Atlantic silverside	111	
BI-BN-02a	Atlantic silverside	86	
BI-BN-02a	Atlantic silverside	90	
BI-BN-02a	Atlantic silverside	76	
BI-BN-02a	Atlantic silverside	94	
BI-BN-02a	Atlantic silverside	79	
BI-BN-02a	Atlantic silverside	91	
BI-BN-02a	Striped killifish	133	
BI-BN-02a	Atlantic silverside	78	
BI-BN-02a	Atlantic silverside	71	
BI-BN-02a	Atlantic silverside	91	
BI-BN-02a	Atlantic silverside	87	
BI-BN-02a	Atlantic silverside	95	
BI-BN-02a	Atlantic silverside	76	
BI-BN-02a	Atlantic silverside	105	
BI-BN-02a	Atlantic silverside	104	
BI-BN-02a	Spot	145	
BI-BN-02a	Atlantic silverside	107	
BI-BN-02a	Atlantic silverside	91	
BI-BN-02a	Atlantic silverside	97	
BI-BN-02a	Atlantic silverside	79	
BI-BN-02a	White Perch	199	
BI-BN-02a	Atlantic silverside	89	
BI-BN-02a	Red drum	61	
BI-BN-02a	Red drum	61	
BI-BN-02a	Red drum	49	
BI-BN-02a	Atlantic silverside	92	
BI-BN-02a	Atlantic silverside	94	
BI-BN-02a	Atlantic silverside	92	
BI-BN-02a	Atlantic silverside	79	
BI-BN-02a	Atlantic silverside	78	
BI-BN-02a	Atlantic silverside	96	
BI-BN-02a	Atlantic silverside	101	
BI-BN-02a	Atlantic silverside	111	
BI-BN-02a	Atlantic silverside	101	

Table B-1b

Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-02a	Atlantic silverside	86	
BI-BN-02a	Atlantic silverside	81	
BI-BN-02a	Atlantic silverside	81	
BI-BN-02a	Atlantic silverside	118	
BI-BN-02a	Atlantic silverside	101	
BI-BN-02a	Crab (unknown)	16	
BI-BN-02a	Blue crab	10	
BI-BN-02a	Blue crab	6	
BI-BN-02a	Blue crab	62	
BI-BN-02a	Spotted seatrout	116	
BI-BN-02a	Atlantic silverside	80	
BI-BN-02a	Atlantic silverside	76	
BI-BN-02a	Red drum	48	
BI-BN-02a	Atlantic silverside	119	
BI-BN-02a	Red drum	70	
BI-BN-02a	Atlantic silverside	89	
BI-BN-02a	Bay anchovy	59	
BI-BN-02a	Bay anchovy	58	
BI-BN-02a	Bay anchovy	66	
BI-BN-02a	Bay anchovy	55	
BI-BN-02a	Bay anchovy	53	
BI-BN-02a	Bay anchovy	55	
BI-BN-02a	Bay anchovy	61	
BI-BN-02a	Bay anchovy	60	
BI-BN-02a	Atlantic silverside	91	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	53	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Bay anchovy	56	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	53	
BI-BN-02a	Bay anchovy	51	
BI-BN-02a	Bay anchovy	55	
BI-BN-02a	Bay anchovy	56	
BI-BN-02a	Bay anchovy	59	
BI-BN-02a	Bay anchovy	50	
BI-BN-02a	Atlantic silverside	113	
BI-BN-02a	Atlantic silverside	84	
BI-BN-02a	Spot	131	
BI-BN-02a	Spot	144	
BI-BN-02a	Bay anchovy	60	
BI-BN-02a	Bay anchovy	56	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-02a	Bay anchovy	58	
BI-BN-02a	Bay anchovy	56	
BI-BN-02a	Bay anchovy	60	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Bay anchovy	55	
BI-BN-02a	Bay anchovy	53	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Bay anchovy	57	
BI-BN-02a	Bay anchovy	57	
BI-BN-02a	Bay anchovy	59	
BI-BN-02a	Bay anchovy	54	
BI-BN-02a	Bay anchovy	60	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Spot	119	
BI-BN-02a	Bay anchovy	53	
BI-BN-02a	Bay anchovy	55	
BI-BN-02a	Bay anchovy	64	
BI-BN-02a	Bay anchovy	52	
BI-BN-02a	Bay anchovy	50	
BI-BN-02a	Bay anchovy	50	
BI-BN-02a	Bay anchovy	58	
BI-BN-02a	Bay anchovy	51	
BI-BN-02b	Bay anchovy	54	
BI-BN-02b	Bay anchovy	53	
BI-BN-02b	Atlantic silverside	94	
BI-BN-02b	Bay anchovy	55	
BI-BN-02b	Bay anchovy	54	
BI-BN-02b	Bay anchovy	60	
BI-BN-02b	Bay anchovy	52	
BI-BN-02b	Bay anchovy	54	
BI-BN-02b	Bay anchovy	53	
BI-BN-02b	Red drum	53	
BI-BN-02b	Bay anchovy	55	
BI-BN-02b	Bay anchovy	51	
BI-BN-02b	Bay anchovy	55	
BI-BN-02b	Bay anchovy	57	
BI-BN-02b	Bay anchovy	58	
BI-BN-02b	Kingfish	91	
BI-BN-02b	Blue crab	82	
BI-BN-02b	Red drum	74	

Table B-1b

Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-02b	Atlantic silverside	82	
BI-BN-02b	Atlantic silverside	86	
BI-BN-02b	Atlantic silverside	49	
BI-BN-02b	Atlantic silverside	111	
BI-BN-02b	Atlantic silverside	92	
BI-BN-02b	Atlantic silverside	115	
BI-BN-02b	Atlantic silverside	81	
BI-BN-02b	Atlantic silverside	80	
BI-BN-02b	Atlantic silverside	84	
BI-BN-02b	Atlantic silverside	85	
BI-BN-02b	Atlantic silverside	66	
BI-BN-02b	Atlantic silverside	76	
BI-BN-02b	Atlantic silverside	70	
BI-BN-02b	Atlantic silverside	52	
BI-BN-02b	Atlantic silverside	79	
BI-BN-02b	Atlantic silverside	78	
BI-BN-02b	Atlantic silverside	86	
BI-BN-02b	Atlantic silverside	65	
BI-BN-02b	Atlantic silverside	79	
BI-BN-02b	Atlantic silverside	74	
BI-BN-02b	Atlantic silverside	81	
BI-BN-02b	Atlantic silverside	68	
BI-BN-02b	Atlantic silverside	72	
BI-BN-02b	Atlantic silverside	114	
BI-BN-02b	Atlantic silverside	94	
BI-BN-02b	Atlantic silverside	98	
BI-BN-02b	Atlantic silverside	74	
BI-BN-02b	Atlantic silverside	79	
BI-BN-02b	Atlantic silverside	93	
BI-BN-02b	Atlantic silverside	76	
BI-BN-02b	Atlantic silverside	87	
BI-BN-02b	Atlantic silverside	73	
BI-BN-02b	Atlantic silverside	76	
BI-BN-02b	Atlantic silverside	74	
BI-BN-02b	Atlantic silverside	115	
BI-BN-02b	Atlantic silverside	95	
BI-BN-02b	Atlantic silverside	76	
BI-BN-02b	Atlantic silverside	113	
BI-BN-02b	Atlantic silverside	86	
BI-BN-02b	Atlantic silverside	63	
BI-BN-02b	Atlantic silverside	71	
BI-BN-02b	Atlantic silverside	72	
BI-BN-02b	Atlantic silverside	82	
BI-BN-02b	Atlantic silverside	71	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-02b	Blue crab	17	
BI-BN-03a	Silver perch	210	
BI-BN-03a	Atlantic menhaden	153	
BI-BN-03a	Atlantic silverside	93	
BI-BN-03a	Spotted seatrout	107	
BI-BN-03a	Spotted seatrout	115	
BI-BN-03a	Kingfish	100	
BI-BN-03a	Red drum	49	
BI-BN-03b	Bay anchovy	69	
BI-BN-03b	Bay anchovy	83	
BI-BN-03b	Bay anchovy	71	
BI-BN-03b	Bay anchovy	52	
BI-BN-03b	Red drum	39	
BI-BN-03b	Sheepshead minnow	39	
BI-BN-03b	Red drum	44	
BI-BN-03b	Sheepshead minnow	44	
BI-BN-03b	Sheepshead minnow	34	
BI-BN-03b	Red drum	44	
BI-BN-03b	Striped killifish	45	
BI-BN-04a	Atlantic silverside	97	
BI-BN-04a	Atlantic silverside	78	
BI-BN-04a	Atlantic silverside	95	
BI-BN-04a	Atlantic silverside	104	
BI-BN-04a	Atlantic silverside	77	
BI-BN-04a	Atlantic silverside	78	
BI-BN-04a	Atlantic silverside	90	
BI-BN-04a	Atlantic silverside	98	
BI-BN-04a	Atlantic silverside	85	
BI-BN-04a	Atlantic silverside	105	
BI-BN-04a	Atlantic silverside	97	
BI-BN-04a	Atlantic silverside	108	
BI-BN-04a	Atlantic silverside	86	
BI-BN-04a	Atlantic silverside	89	
BI-BN-04a	Atlantic silverside	96	
BI-BN-04a	Atlantic silverside	75	
BI-BN-04a	Atlantic silverside	114	
BI-BN-04a	Atlantic silverside	85	
BI-BN-04a	Atlantic silverside	76	
BI-BN-04a	Atlantic silverside	111	
BI-BN-04a	Atlantic silverside	75	
BI-BN-04a	Atlantic silverside	73	
BI-BN-04a	Atlantic silverside	83	
BI-BN-04a	Atlantic silverside	80	
BI-BN-04a	Atlantic silverside	68	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-04a	Atlantic silverside	79	
BI-BN-04a	Atlantic silverside	88	
BI-BN-04a	Atlantic silverside	81	
BI-BN-04a	Atlantic silverside	95	
BI-BN-04a	Atlantic silverside	98	
BI-BN-04a	Red drum	59	
BI-BN-04a	Striped killifish	85	
BI-BN-04a	Red drum	89	
BI-BN-04a	Atlantic silverside	77	
BI-BN-04a	Atlantic silverside	84	
BI-BN-04a	Atlantic silverside	95	
BI-BN-04a	Atlantic silverside	91	
BI-BN-04a	Atlantic silverside	78	
BI-BN-04a	Atlantic silverside	84	
BI-BN-04a	Atlantic silverside	91	
BI-BN-04a	Atlantic silverside	79	
BI-BN-04a	Atlantic silverside	84	
BI-BN-04a	Atlantic silverside	84	
BI-BN-04a	Atlantic silverside	95	
BI-BN-04a	Atlantic silverside	82	
BI-BN-04a	Atlantic silverside	88	
BI-BN-04a	Atlantic silverside	84	
BI-BN-04a	Atlantic silverside	95	
BI-BN-04a	Atlantic silverside	86	
BI-BN-04a	Atlantic silverside	81	
BI-BN-04a	Atlantic silverside	91	
BI-BN-04a	Atlantic silverside	81	
BI-BN-04a	Atlantic silverside	74	
BI-BN-04a	Red drum	66	
BI-BN-04a	Mummichog	66	
BI-BN-04a	Red drum	44	
BI-BN-04a	Striped killifish	107	
BI-BN-04a	Mummichog	62	
BI-BN-04a	Mummichog	66	
BI-BN-04a	Mummichog	67	
BI-BN-04a	Striped killifish	77	
BI-BN-04a	Mummichog	72	
BI-BN-04a	Mummichog	72	
BI-BN-04a	Mummichog	70	
BI-BN-04a	Mummichog	62	
BI-BN-04a	Striped killifish	101	
BI-BN-04a	Mummichog	61	
BI-BN-04a	Blue crab	16	
BI-BN-04a	Mummichog	65	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-04a	Striped killifish	95	
BI-BN-04a	Mummichog	81	
BI-BN-04a	Mummichog	47	
BI-BN-04a	Mummichog	66	
BI-BN-04a	Mummichog	75	
BI-BN-04a	Mummichog	57	
BI-BN-04a	Mummichog	80	
BI-BN-04a	Striped killifish	77	
BI-BN-04a	Mummichog	61	
BI-BN-04a	Red drum	37	
BI-BN-04a	Striped killifish	71	
BI-BN-04a	Mummichog	45	
BI-BN-04a	Mummichog	62	
BI-BN-04a	Mummichog	72	
BI-BN-04a	Red drum	48	
BI-BN-04a	Mummichog	70	
BI-BN-04a	Mummichog	63	
BI-BN-04a	Mummichog	72	
BI-BN-04a	Mummichog	71	
BI-BN-04a	Mummichog	58	
BI-BN-04a	Mummichog	71	
BI-BN-04a	Mummichog	68	
BI-BN-04a	Mummichog	69	
BI-BN-04a	Mummichog	66	
BI-BN-04a	Striped killifish	72	
BI-BN-04a	Mummichog	70	
BI-BN-04a	Mummichog	74	
BI-BN-04a	Red drum	52	
BI-BN-04a	Mummichog	80	
BI-BN-04a	Mummichog	66	
BI-BN-04a	Mummichog	69	
BI-BN-04a	Mummichog	78	
BI-BN-04a	Mummichog	78	
BI-BN-04a	Mummichog	68	
BI-BN-04a	Mummichog	64	
BI-BN-04a	Mummichog	64	
BI-BN-04a	Mummichog	70	
BI-BN-04a	Mummichog	78	
BI-BN-04a	Mummichog	58	
BI-BN-04a	Mummichog	81	
BI-BN-04a	Mummichog	72	
BI-BN-04a	Mummichog	74	
BI-BN-04a	Mummichog	60	
BI-BN-04a	Mummichog	66	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-04a	Mummichog	56	
BI-BN-04a	Mummichog	62	
BI-BN-04a	Mummichog	68	
BI-BN-04a	Blue crab	16	
BI-BN-04a	Inland silverside	36	
BI-BN-04b	Red drum	49	
BI-BN-04b	Red drum	66	
BI-BN-04b	Red drum	79	
BI-BN-04b	Red drum	61	
BI-BN-04b	Red drum	66	
BI-BN-04b	Red drum	68	
BI-BN-04b	Red drum	72	
BI-BN-04b	Red drum	80	
BI-BN-04b	Atlantic silverside	82	
BI-BN-04b	Atlantic silverside	76	
BI-BN-04b	Atlantic silverside	108	
BI-BN-04b	Atlantic silverside	101	
BI-BN-04b	Atlantic silverside	76	
BI-BN-04b	Atlantic silverside	82	
BI-BN-04b	Atlantic silverside	99	
BI-BN-04b	Atlantic silverside	104	
BI-BN-04b	Atlantic silverside	115	
BI-BN-04b	Atlantic silverside	114	
BI-BN-04b	Atlantic silverside	91	
BI-BN-04b	Atlantic silverside	79	
BI-BN-04b	Atlantic silverside	76	
BI-BN-04b	Atlantic silverside	80	
BI-BN-04b	Atlantic silverside	92	
BI-BN-04b	Atlantic silverside	87	
BI-BN-04b	Atlantic silverside	110	
BI-BN-04b	Atlantic silverside	108	
BI-BN-04b	Atlantic silverside	72	
BI-BN-04b	Atlantic silverside	106	
BI-BN-04b	Red drum	63	
BI-BN-04b	Red drum	50	
BI-BN-04b	Atlantic silverside	95	
BI-BN-04b	Atlantic silverside	81	
BI-BN-04b	Atlantic silverside	79	
BI-BN-04b	Atlantic silverside	115	
BI-BN-04b	Atlantic silverside	100	
BI-BN-04b	Atlantic silverside	93	
BI-BN-04b	Atlantic silverside	83	
BI-BN-04b	Atlantic silverside	89	
BI-BN-04b	Atlantic silverside	94	

Table B-1b

Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-04b	Atlantic silverside	80	
BI-BN-04b	Atlantic silverside	96	
BI-BN-04b	Atlantic silverside	103	
BI-BN-04b	Atlantic silverside	104	
BI-BN-04b	Atlantic silverside	79	
BI-BN-04b	Atlantic silverside	86	
BI-BN-04b	Atlantic silverside	86	
BI-BN-04b	Atlantic silverside	111	
BI-BN-04b	Atlantic silverside	108	
BI-BN-04b	Atlantic silverside	110	
BI-BN-04b	Atlantic silverside	98	
BI-BN-04b	Atlantic silverside	87	
BI-BN-04b	Atlantic silverside	84	
BI-BN-04b	Atlantic silverside	102	
BI-BN-04b	Atlantic silverside	111	
BI-BN-04b	Atlantic silverside	84	
BI-BN-04b	Atlantic silverside	71	
BI-BN-04b	Atlantic silverside	90	
BI-BN-04b	Atlantic silverside	76	
BI-BN-04b	Atlantic silverside	86	
BI-BN-04b	Atlantic silverside	83	
BI-BN-04b	Red drum	80	
BI-BN-04b	Red drum	66	
BI-BN-04b	Red drum	62	
BI-BN-04b	Red drum	50	
BI-BN-04b	Red drum	46	
BI-BN-04b	Striped killifish	113	
BI-BN-04b	Blue crab	12	
BI-BN-04b	Red drum	66	
BI-BN-04b	Red drum	66	
BI-BN-04b	Red drum	73	
BI-BN-04b	Red drum	64	
BI-BN-04b	Red drum	73	
BI-BN-04b	Red drum	57	
BI-BN-04b	Red drum	65	
BI-BN-04b	Red drum	69	
BI-BN-04b	Red drum	77	
BI-BN-04b	Red drum	59	
BI-BN-04b	Red drum	85	
BI-BN-04b	Red drum	66	
BI-BN-04b	Red drum	74	
BI-BN-04b	Red drum	70	
BI-BN-04b	Red drum	71	
BI-BN-04b	Red drum	65	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-04b	Red drum	44	
BI-BN-04b	Red drum	61	
BI-BN-04b	Red drum	60	
BI-BN-04b	Red drum	56	
BI-BN-04b	Red drum	45	
BI-BN-04b	Blue crab	15	
BI-BN-04b	Blue crab	16	
BI-BN-04b	Blue crab	17	
BI-BN-05a	Atlantic silverside	73	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	76	
BI-BN-05a	Atlantic silverside	73	
BI-BN-05a	Atlantic silverside	76	
BI-BN-05a	Atlantic silverside	72	
BI-BN-05a	Atlantic silverside	116	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	49	
BI-BN-05a	Atlantic silverside	80	
BI-BN-05a	Atlantic silverside	99	
BI-BN-05a	Atlantic silverside	114	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	53	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	50	
BI-BN-05a	Bay anchovy	56	
BI-BN-05a	Bay anchovy	53	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	55	
BI-BN-05a	Bay anchovy	55	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	51	
BI-BN-05a	Bay anchovy	57	
BI-BN-05a	Bay anchovy	52	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	52	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	50	
BI-BN-05a	Bay anchovy	52	
BI-BN-05a	Bay anchovy	60	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	56	
BI-BN-05a	Bay anchovy	57	
BI-BN-05a	Bay anchovy	60	
BI-BN-05a	Bay anchovy	51	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-05a	Bay anchovy	53	
BI-BN-05a	Bay anchovy	55	
BI-BN-05a	Bay anchovy	57	
BI-BN-05a	Bay anchovy	60	
BI-BN-05a	Bay anchovy	53	
BI-BN-05a	Bay anchovy	58	
BI-BN-05a	Bay anchovy	52	
BI-BN-05a	Bay anchovy	55	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	53	
BI-BN-05a	Bay anchovy	56	
BI-BN-05a	Bay anchovy	48	
BI-BN-05a	Bay anchovy	49	
BI-BN-05a	Bay anchovy	59	
BI-BN-05a	Bay anchovy	50	
BI-BN-05a	Bay anchovy	55	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	52	
BI-BN-05a	Bay anchovy	50	
BI-BN-05a	Bay anchovy	54	
BI-BN-05a	Bay anchovy	52	
BI-BN-05a	Bay anchovy	56	
BI-BN-05a	Bay anchovy	57	
BI-BN-05a	Atlantic silverside	83	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	89	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	91	
BI-BN-05a	Atlantic silverside	95	
BI-BN-05a	Atlantic silverside	108	
BI-BN-05a	Atlantic silverside	115	
BI-BN-05a	Atlantic silverside	110	
BI-BN-05a	Atlantic silverside	112	
BI-BN-05a	Atlantic silverside	72	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	101	
BI-BN-05a	Atlantic silverside	97	
BI-BN-05a	Atlantic silverside	92	
BI-BN-05a	Atlantic silverside	81	
BI-BN-05a	Atlantic silverside	78	
BI-BN-05a	Atlantic silverside	74	
BI-BN-05b	Atlantic menhaden	112	
BI-BN-05b	Atlantic silverside	94	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-05b	Atlantic silverside	73	
BI-BN-05b	Atlantic silverside	82	
BI-BN-05b	Atlantic silverside	72	
BI-BN-05b	Atlantic silverside	99	
BI-BN-05b	Atlantic silverside	71	
BI-BN-05b	Atlantic silverside	71	
BI-BN-05b	Atlantic silverside	62	
BI-BN-05b	Atlantic menhaden	120	
BI-BN-05b	Atlantic silverside	120	
BI-BN-05b	Atlantic silverside	84	
BI-BN-05b	Atlantic silverside	91	
BI-BN-05b	Atlantic silverside	76	
BI-BN-05b	Atlantic silverside	77	
BI-BN-05b	Atlantic silverside	87	
BI-BN-05b	Atlantic silverside	91	
BI-BN-05b	Atlantic silverside	84	
BI-BN-05b	Atlantic silverside	86	
BI-BN-05b	Atlantic silverside	87	
BI-BN-05b	Atlantic silverside	71	
BI-BN-05b	Atlantic silverside	115	
BI-BN-05b	Atlantic silverside	67	
BI-BN-05b	Atlantic silverside	92	
BI-BN-05b	Atlantic silverside	87	
BI-BN-05b	Atlantic silverside	81	
BI-BN-05b	Atlantic silverside	84	
BI-BN-05b	Atlantic silverside	77	
BI-BN-05b	Atlantic silverside	83	
BI-BN-05b	Atlantic silverside	115	
BI-BN-05b	Bay anchovy	55	
BI-BN-05b	Bay anchovy	52	
BI-BN-05b	Bay anchovy	60	
BI-BN-05b	Banded Killifish	44	
BI-BN-05b	Striped killifish	50	
BI-BN-05b	Atlantic menhaden	133	
BI-BN-05b	Atlantic menhaden	111	
BI-BN-05b	Atlantic silverside	108	
BI-BN-05b	Atlantic silverside	99	
BI-BN-05b	Atlantic silverside	81	
BI-BN-05b	Atlantic silverside	78	
BI-BN-05b	Atlantic silverside	66	
BI-BN-05b	Atlantic silverside	85	
BI-BN-05b	Atlantic silverside	90	
BI-BN-05b	Atlantic silverside	109	
BI-BN-05b	Atlantic silverside	102	

Table B-1b
Barren Island Seine Net Collection Results – Fall

Sample ID	Species	Length (mm)	Notes
BI-BN-05b	Atlantic silverside	105	
BI-BN-05b	Atlantic silverside	82	
BI-BN-05b	Atlantic silverside	79	
BI-BN-05b	Atlantic silverside	83	
BI-BN-05b	Atlantic silverside	86	
BI-BN-05b	Atlantic silverside	91	
BI-BN-05b	Atlantic silverside	98	
BI-BN-05b	Atlantic silverside	68	
BI-BN-05b	Atlantic silverside	70	
BI-BN-05b	Atlantic silverside	71	
BI-BN-05b	Atlantic silverside	95	
BI-BN-05b	Atlantic silverside	96	
BI-BN-05b	Atlantic silverside	80	

Note:
mm: millimeter

Table B-1c
Barren Island Seine Net Collection Results – Winter

Sample ID	Species	Length (mm)	Notes
BI-BN-01b	Bay anchovy	55	
BI-BN-02a	Atlantic menhaden	104	
BI-BN-02a	Striped killifish	63	
BI-BN-02a	Bay anchovy	55	
BI-BN-02a	Bay anchovy	51	
BI-BN-02b	Striped killifish	42	
BI-BN-03a	Gizzard shad	182	
BI-BN-03a	Atlantic silverside	101	
BI-BN-03a	Atlantic silverside	124	
BI-BN-03a	Atlantic silverside	103	
BI-BN-03a	Atlantic silverside	102	
BI-BN-03a	Atlantic silverside	99	
BI-BN-03b	Atlantic silverside	101	
BI-BN-03b	Atlantic silverside	122	
BI-BN-03b	Atlantic silverside	104	
BI-BN-03b	Atlantic silverside	111	
BI-BN-03b	Atlantic silverside	106	
BI-BN-03b	Atlantic silverside	94	
BI-BN-03b	Atlantic silverside	123	
BI-BN-03b	Atlantic silverside	90	
BI-BN-04a	Atlantic silverside	111	
BI-BN-04b	Striped killifish	46	
BI-BN-05a	Atlantic silverside	110	
BI-BN-05a	Atlantic silverside	95	
BI-BN-05a	Atlantic silverside	119	
BI-BN-05a	Atlantic silverside	108	
BI-BN-05a	Atlantic silverside	104	
BI-BN-05a	Atlantic silverside	109	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	115	
BI-BN-05a	Atlantic silverside	87	
BI-BN-05a	Atlantic silverside	119	
BI-BN-05a	Atlantic silverside	104	
BI-BN-05a	Atlantic silverside	118	
BI-BN-05a	Atlantic silverside	92	
BI-BN-05a	Atlantic silverside	96	
BI-BN-05a	Atlantic silverside	103	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	115	
BI-BN-05a	Atlantic silverside	116	
BI-BN-05a	Atlantic silverside	103	
BI-BN-05a	Atlantic silverside	110	
BI-BN-05a	Atlantic silverside	124	
BI-BN-05a	Atlantic silverside	94	

Table B-1c
Barren Island Seine Net Collection Results – Winter

Sample ID	Species	Length (mm)	Notes
BI-BN-05a	Atlantic silverside	101	
BI-BN-05a	Atlantic silverside	104	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	103	
BI-BN-05a	Atlantic silverside	114	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	106	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	85	
BI-BN-05a	Atlantic silverside	105	
BI-BN-05a	Atlantic silverside	104	
BI-BN-05a	Atlantic silverside	103	
BI-BN-05a	Atlantic silverside	98	
BI-BN-05a	Atlantic silverside	95	
BI-BN-05a	Atlantic silverside	94	
BI-BN-05a	Atlantic silverside	93	
BI-BN-05a	Atlantic silverside	95	
BI-BN-05a	Atlantic silverside	117	
BI-BN-05a	Atlantic silverside	116	
BI-BN-05a	Atlantic silverside	97	
BI-BN-05a	Atlantic silverside	100	
BI-BN-05a	Atlantic silverside	98	
BI-BN-05a	Atlantic silverside	101	
BI-BN-05a	Atlantic silverside	95	
BI-BN-05a	Atlantic silverside	112	
BI-BN-05a	Atlantic silverside	114	
BI-BN-05a	Striped killifish	60	
BI-BN-05b	Striped killifish	99	

Note:
mm: millimeter

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-01a	White perch	250	175.8
BI-BN-01a	White perch	233	176
BI-BN-01a	White perch	233	185.9
BI-BN-01a	White perch	207	126.9
BI-BN-01a	White perch	257	252.8
BI-BN-01a	White perch	236	181.2
BI-BN-01a	White perch	235	161.5
BI-BN-01a	White perch	207	121.2
BI-BN-01a	White perch	258	266.1
BI-BN-01a	White perch	215	136.2
BI-BN-01a	White perch	224	178.8
BI-BN-01a	White perch	175	80.1
BI-BN-01a	White perch	132	28.1
BI-BN-01a	Bay anchovy	63	1.5
BI-BN-01a	Bay anchovy	52	0.6
BI-BN-01a	Bay anchovy	59	0.6
BI-BN-01a	Bay anchovy	57	1.2
BI-BN-01a	Bay anchovy	68	1.9
BI-BN-01a	Bay anchovy	60	1.2
BI-BN-01a	Bay anchovy	65	1.7
BI-BN-01a	Bay anchovy	55	1
BI-BN-01a	Bay anchovy	58	1.1
BI-BN-01a	Bay anchovy	57	1
BI-BN-01a	Bay anchovy	55	0.7
BI-BN-01a	Bay anchovy	56	0.9
BI-BN-01a	Bay anchovy	60	1.5
BI-BN-01a	Bay anchovy	55	1.1
BI-BN-01a	Bay anchovy	57	0.8
BI-BN-01a	Bay anchovy	59	1.1
BI-BN-01a	Bay anchovy	50	0.6
BI-BN-01a	Bay anchovy	62	1.4
BI-BN-01a	Atlantic menhaden	46	0.5
BI-BN-01a	Atlantic menhaden	48	0.6
BI-BN-01a	Atlantic menhaden	44	0.1
BI-BN-01a	Atlantic menhaden	45	0.2
BI-BN-01a	Atlantic menhaden	40	0.5
BI-BN-01a	Atlantic menhaden	42	0.5
BI-BN-01a	Atlantic menhaden	42	0.3
BI-BN-01a	Atlantic menhaden	44	0.7
BI-BN-01a	Atlantic menhaden	42	0.2
BI-BN-01a	Atlantic menhaden	43	0.3
BI-BN-01a	Atlantic menhaden	41	0.3
BI-BN-01a	Atlantic menhaden	65	1
BI-BN-01a	Atlantic menhaden	44	0.6

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-01a	Atlantic menhaden	51	0.8
BI-BN-01a	Atlantic menhaden	44	0.4
BI-BN-01a	Atlantic menhaden	42	0.4
BI-BN-01a	Atlantic menhaden	47	0.6
BI-BN-01a	Atlantic silverside	101	6.1
BI-BN-01a	Atlantic silverside	89	4.1
BI-BN-01a	Atlantic silverside	90	4.1
BI-BN-01a	Atlantic silverside	95	5.2
BI-BN-01a	Atlantic silverside	92	4.6
BI-BN-01a	Atlantic silverside	109	8.1
BI-BN-01a	Bay anchovy	54	0.8
BI-BN-01a	Bay anchovy	55	0.9
BI-BN-01a	Bay anchovy	60	1.6
BI-BN-01a	Atlantic menhaden	47	0.4
BI-BN-01a	Atlantic menhaden	44	0.6
BI-BN-01a	Atlantic menhaden	42	0.5
BI-BN-01a	Atlantic menhaden	5.2	1
BI-BN-01a	Atlantic menhaden	40	0.3
BI-BN-01a	Atlantic menhaden	37	0.3
BI-BN-01a	Atlantic menhaden	40	0.3
BI-BN-01a	Atlantic menhaden	40	0.4
BI-BN-01a	Bay anchovy	56	1.1
BI-BN-01a	Bay anchovy	55	0.9
BI-BN-01a	Bay anchovy	55	0.9
BI-BN-01a	Bay anchovy	59	1.3
BI-BN-01a	Bay anchovy	55	0.7
BI-BN-01a	Bay anchovy	62	1.2
BI-BN-01a	Bay anchovy	62	1.4
BI-BN-01a	Bay anchovy	55	0.8
BI-BN-01a	Bay anchovy	57	1
BI-BN-01a	Bay anchovy	60	1.3
BI-BN-01a	Bay anchovy	54	1
BI-BN-01a	Bay anchovy	50	0.7
BI-BN-01a	Bay anchovy	53	0.9
BI-BN-01a	Bay anchovy	50	0.9
BI-BN-01a	Bay anchovy	48	0.6
BI-BN-01a	Bay anchovy	47	0.6
BI-BN-01a	Bay anchovy	50	0.6
BI-BN-01a	Bay anchovy	60	1.4
BI-BN-01a	Bay anchovy	64	1.6
BI-BN-01a	Bay anchovy	60	1.1
BI-BN-01a	Bay anchovy	53	0.9
BI-BN-01a	Bay anchovy	52	1.3
BI-BN-01a	Bay anchovy	56	1.3

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-01a	Bay anchovy	52	1
BI-BN-01a	Bay anchovy	55	1.1
BI-BN-01a	Bay anchovy	54	1
BI-BN-01a	Bay anchovy	54	0.9
BI-BN-01a	Bay anchovy	55	0.9
BI-BN-01a	Inland silverside	70	1.8
BI-BN-01a	Atlantic menhaden	39	0.2
BI-BN-01a	Atlantic menhaden	44	0.6
BI-BN-01a	Atlantic menhaden	38	0.4
BI-BN-01a	Atlantic menhaden	45	0.5
BI-BN-01a	Atlantic menhaden	44	0.3
BI-BN-01a	Atlantic menhaden	44	0.6
BI-BN-01a	Atlantic menhaden	40	0.3
BI-BN-01a	Atlantic menhaden	45	0.7
BI-BN-01a	Atlantic menhaden	44	0.3
BI-BN-01a	Atlantic menhaden	40	0.2
BI-BN-01a	Atlantic menhaden	40	0.4
BI-BN-01a	Atlantic menhaden	41	0.6
BI-BN-01a	Atlantic menhaden	40	0.5
BI-BN-01a	Atlantic menhaden	38	0.3
BI-BN-01a	Atlantic menhaden	40	0.2
BI-BN-01a	Atlantic menhaden	40	0.5
BI-BN-01a	Atlantic menhaden	31	0.3
BI-BN-01a	Atlantic menhaden	44	0.6
BI-BN-01a	Atlantic silverside	95	5
BI-BN-01a	Atlantic silverside	90	4.5
BI-BN-01a	Atlantic silverside	95	5
BI-BN-01a	Atlantic silverside	128	11.8
BI-BN-01a	Atlantic silverside	95	4.5
BI-BN-01a	Atlantic silverside	101	6.9
BI-BN-01a	Atlantic silverside	94	4.6
BI-BN-01a	Atlantic silverside	85	3.6
BI-BN-01a	Bay anchovy	55	0.6
BI-BN-01a	Bay anchovy	49	0.4
BI-BN-01a	Atlantic menhaden	42	0.7
BI-BN-01a	Atlantic menhaden	42	0.4
BI-BN-01a	Atlantic menhaden	45	0.7
BI-BN-01a	Atlantic menhaden	46	0.6
BI-BN-01a	Atlantic menhaden	47	0.6
BI-BN-01a	Atlantic menhaden	46	0.6
BI-BN-01a	Atlantic menhaden	45	0.3
BI-BN-01b	Atlantic silverside	84	3.4
BI-BN-01b	Atlantic silverside	105	6.5
BI-BN-01b	Atlantic silverside	90	4.3

Table B-1d

Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-01b	Atlantic silverside	96	5
BI-BN-01b	Atlantic silverside	93	4.2
BI-BN-01b	Atlantic silverside	109	5.5
BI-BN-01b	Atlantic silverside	103	5.9
BI-BN-01b	Atlantic silverside	115	9.4
BI-BN-01b	Atlantic silverside	82	3
BI-BN-01b	Atlantic silverside	97	5.3
BI-BN-01b	Atlantic silverside	101	7.2
BI-BN-01b	Bay anchovy	73	2.1
BI-BN-01b	Bay anchovy	63	1.7
BI-BN-01b	Bay anchovy	57	1
BI-BN-01b	Bay anchovy	55	1
BI-BN-01b	Bay anchovy	58	1.3
BI-BN-01b	Bay anchovy	57	0.9
BI-BN-01b	Bay anchovy	65	2.3
BI-BN-01b	Bay anchovy	70	2.3
BI-BN-01b	Blue crab	85	34.9
BI-BN-01b	Inland silverside	114	9.6
BI-BN-01b	Spot	50	1.1
BI-BN-01b	Atlantic menhaden	41	0.5
BI-BN-01b	Atlantic menhaden	40	0.3
BI-BN-01b	Atlantic menhaden	41	0.5
BI-BN-01b	Atlantic menhaden	45	0.6
BI-BN-01b	Atlantic menhaden	47	0.5
BI-BN-01b	Atlantic menhaden	42	0.4
BI-BN-01b	Atlantic silverside	102	6.4
BI-BN-01b	Atlantic silverside	103	6.6
BI-BN-01b	Atlantic silverside	97	5.6
BI-BN-01b	Atlantic silverside	107	6.1
BI-BN-01b	Atlantic silverside	99	5.6
BI-BN-01b	Atlantic silverside	93	4.4
BI-BN-01b	Atlantic silverside	90	4.6
BI-BN-01b	Atlantic silverside	78	2.8
BI-BN-01b	Atlantic silverside	92	4.4
BI-BN-01b	Atlantic silverside	97	6
BI-BN-01b	Atlantic silverside	94	5
BI-BN-01b	Atlantic silverside	122	11
BI-BN-01b	Atlantic silverside	92	4.5
BI-BN-01b	Atlantic silverside	96	5.9
BI-BN-01b	Atlantic silverside	100	6.3
BI-BN-01b	Atlantic silverside	108	8.5
BI-BN-01b	Atlantic silverside	107	7.6
BI-BN-01b	Atlantic silverside	96	5.7
BI-BN-01b	Atlantic silverside	97	5.3

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-01b	Atlantic silverside	98	5.2
BI-BN-01b	Atlantic silverside	100	6.2
BI-BN-01b	Atlantic silverside	95	5
BI-BN-02a	Atlantic silverside	86	3.6
BI-BN-02a	Atlantic silverside	91	4.5
BI-BN-02a	Atlantic silverside	95	5.6
BI-BN-02a	Atlantic silverside	105	7.6
BI-BN-02a	Atlantic silverside	105	7.3
BI-BN-02a	Atlantic silverside	104	6.5
BI-BN-02a	Atlantic silverside	95	6.7
BI-BN-02a	Atlantic silverside	86	3.8
BI-BN-02a	Atlantic silverside	103	5
BI-BN-02a	Atlantic silverside	95	5.1
BI-BN-02a	Atlantic silverside	101	5.8
BI-BN-02a	Atlantic silverside	88	3.8
BI-BN-02a	Atlantic silverside	92	4.4
BI-BN-02a	Atlantic silverside	91	4.4
BI-BN-02a	Atlantic silverside	96	4.8
BI-BN-02a	Atlantic silverside	79	2.6
BI-BN-02a	Atlantic silverside	99	5.6
BI-BN-02a	Atlantic silverside	92	5.3
BI-BN-02a	Atlantic silverside	88	3.8
BI-BN-02a	Atlantic silverside	89	4.4
BI-BN-02a	Atlantic silverside	93	4.6
BI-BN-02a	Atlantic silverside	92	3.4
BI-BN-02a	Atlantic silverside	82	3
BI-BN-02a	Atlantic silverside	93	4.8
BI-BN-02a	Atlantic silverside	86	4.1
BI-BN-02a	Atlantic silverside	93	4.2
BI-BN-02a	Atlantic silverside	89	3.9
BI-BN-02a	Atlantic silverside	85	3.6
BI-BN-02a	Atlantic silverside	104	6.7
BI-BN-02a	Atlantic silverside	100	5.6
BI-BN-02a	Atlantic silverside	88	3.8
BI-BN-02a	Atlantic silverside	91	4.5
BI-BN-02a	Atlantic silverside	95	5.1
BI-BN-02a	Atlantic silverside	85	7.8
BI-BN-02a	Atlantic silverside	82	3
BI-BN-02a	Atlantic silverside	94	4.6
BI-BN-02a	Atlantic silverside	79	3.4
BI-BN-02a	Atlantic silverside	82	3.3
BI-BN-02a	Atlantic silverside	93	4.7
BI-BN-02a	Atlantic silverside	98	5.2
BI-BN-02a	Atlantic silverside	92	4.2

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-02a	Spot	34	0.4
BI-BN-02a	Spot	31	0.2
BI-BN-02a	Spot	33	0.3
BI-BN-02a	Bay anchovy	63	1.5
BI-BN-02a	Bay anchovy	56	0.9
BI-BN-02a	Bay anchovy	54	0.9
BI-BN-02a	Bay anchovy	69	1.2
BI-BN-02a	Bay anchovy	62	1.3
BI-BN-02a	Bay anchovy	59	0.8
BI-BN-02a	Bay anchovy	52	0.4
BI-BN-02a	Bay anchovy	60	1.1
BI-BN-02a	Bay anchovy	54	0.7
BI-BN-02a	Bay anchovy	58	0.9
BI-BN-02a	Bay anchovy	60	1.2
BI-BN-02a	Bay anchovy	60	1.2
BI-BN-02a	Bay anchovy	58	0.8
BI-BN-02a	Bay anchovy	59	1
BI-BN-02a	Bay anchovy	56	0.7
BI-BN-02a	Bay anchovy	61	1.1
BI-BN-02a	Bay anchovy	59	1
BI-BN-02a	Bay anchovy	54	0.7
BI-BN-02a	Bay anchovy	56	0.7
BI-BN-02a	Bay anchovy	55	0.8
BI-BN-02a	Bay anchovy	59	1
BI-BN-02a	Bay anchovy	54	0.7
BI-BN-02a	Bay anchovy	59	1.1
BI-BN-02a	Spot	28	0.1
BI-BN-02a	Spot	32	0.4
BI-BN-02a	Spot	32	0.3
BI-BN-02a	Spot	36	0.4
BI-BN-02a	Spot	32	0.3
BI-BN-02a	Spot	36	0.4
BI-BN-02a	Spot	34	0.4
BI-BN-02a	Spot	40	0.5
BI-BN-02a	Spot	35	0.5
BI-BN-02a	Spot	27	0.5
BI-BN-02a	Spot	39	0.6
BI-BN-02a	Spot	34	0.4
BI-BN-02a	Spot	41	0.7
BI-BN-02a	Spot	40	0.7
BI-BN-02a	Spot	33	0.4
BI-BN-02a	Spot	34	0.4
BI-BN-02a	Atlantic menhaden	47	0.2
BI-BN-02a	Pipefish	166	2

Table B-1d

Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-02a	Spot	42	0.8
BI-BN-02a	Spot	36	0.6
BI-BN-02a	Spot	42	0.7
BI-BN-02a	Spot	41	0.7
BI-BN-02a	Spot	36	0.5
BI-BN-02a	Spot	36	0.5
BI-BN-02a	Spot	38	0.5
BI-BN-02a	Spot	46	0.8
BI-BN-02a	Spot	31	0.4
BI-BN-02a	Spot	36	0.5
BI-BN-02a	Spot	31	0.4
BI-BN-02a	Spot	36	0.4
BI-BN-02a	Spot	37	0.3
BI-BN-02a	Spot	36	0.5
BI-BN-02a	Spot	36	0.3
BI-BN-02a	Spot	39	0.4
BI-BN-02a	Spot	37	0.3
BI-BN-02a	Spot	34	0.3
BI-BN-02a	Spot	32	0.2
BI-BN-02a	Spot	31	0.2
BI-BN-02a	Spot	30	0.2
BI-BN-02a	Spot	33	0.2
BI-BN-02a	Spot	31	0.2
BI-BN-02a	Spot	33	0.2
BI-BN-02a	Spot	34	0.2
BI-BN-02b	Atlantic silverside	96	5.4
BI-BN-02b	Atlantic silverside	91	4.5
BI-BN-02b	Atlantic silverside	91	4.2
BI-BN-02b	Atlantic silverside	91	4.3
BI-BN-02b	Atlantic silverside	92	4
BI-BN-02b	Atlantic silverside	89	4
BI-BN-02b	Atlantic silverside	90	4.1
BI-BN-02b	Atlantic silverside	89	4.2
BI-BN-02b	Atlantic silverside	84	3.3
BI-BN-02b	Atlantic silverside	93	4.8
BI-BN-02b	Atlantic silverside	96	4.8
BI-BN-02b	Atlantic silverside	106	7.3
BI-BN-02b	Atlantic silverside	85	3.4
BI-BN-02b	Atlantic silverside	102	5.8
BI-BN-02b	Atlantic silverside	84	3.5
BI-BN-02b	Atlantic silverside	83	3.3
BI-BN-02b	Atlantic silverside	90	4.2
BI-BN-02b	Atlantic silverside	114	8.7
BI-BN-02b	Mummichog	53	3.1

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-02b	Bay anchovy	54	0.8
BI-BN-02b	Bay anchovy	52	0.5
BI-BN-02b	Bay anchovy	50	0.5
BI-BN-02b	Bay anchovy	62	1.1
BI-BN-02b	Bay anchovy	60	1.2
BI-BN-02b	Bay anchovy	60	1.3
BI-BN-02b	Bay anchovy	57	0.9
BI-BN-02b	Bay anchovy	65	0.9
BI-BN-02b	Bay anchovy	57	0.8
BI-BN-02b	Bay anchovy	63	1.4
BI-BN-02b	Bay anchovy	56	0.9
BI-BN-02b	Bay anchovy	54	0.7
BI-BN-02b	Bay anchovy	61	1.2
BI-BN-02b	Bay anchovy	56	0.8
BI-BN-02b	Bay anchovy	58	1.6
BI-BN-02b	Bay anchovy	53	0.5
BI-BN-02b	Bay anchovy	51	0.6
BI-BN-02b	Bay anchovy	57	0.8
BI-BN-02b	Bay anchovy	56	1
BI-BN-02b	Bay anchovy	58	0.9
BI-BN-02b	Bay anchovy	55	0.8
BI-BN-02b	Bay anchovy	51	0.7
BI-BN-02b	Bay anchovy	54	0.7
BI-BN-02b	Bay anchovy	58	0.9
BI-BN-02b	Bay anchovy	54	0.7
BI-BN-02b	Bay anchovy	61	1.1
BI-BN-02b	Bay anchovy	66	1.2
BI-BN-02b	Bay anchovy	58	1.1
BI-BN-02b	Bay anchovy	54	0.8
BI-BN-02b	Bay anchovy	52	0.7
BI-BN-02b	Bay anchovy	56	0.9
BI-BN-02b	Bay anchovy	49	0.5
BI-BN-02b	Bay anchovy	54	0.8
BI-BN-02b	Bay anchovy	56	0.9
BI-BN-03a	White perch	219	135.6
BI-BN-03a	White perch	206	119.9
BI-BN-03a	Atlantic silverside	90	5.2
BI-BN-03a	Atlantic silverside	93	3.8
BI-BN-03a	Atlantic silverside	95	4.9
BI-BN-03a	Atlantic menhaden	42	0.5
BI-BN-03a	Atlantic menhaden	42	0.5
BI-BN-03a	Atlantic menhaden	40	0.4
BI-BN-03a	Atlantic menhaden	41	0.5
BI-BN-03a	Bay anchovy	67	1.5

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-03a	Bay anchovy	55	0.8
BI-BN-03a	Bay anchovy	55	0.8
BI-BN-03a	Bay anchovy	59	1
BI-BN-03a	Bay anchovy	60	1.4
BI-BN-03a	Bay anchovy	61	1
BI-BN-03a	Bay anchovy	58	1.1
BI-BN-03a	Bay anchovy	67	1.3
BI-BN-03a	Bay anchovy	69	1.5
BI-BN-03a	Bay anchovy	64	1.3
BI-BN-03a	Bay anchovy	59	1.2
BI-BN-03a	Bay anchovy	61	1.2
BI-BN-03a	Bay anchovy	55	0.8
BI-BN-03a	Bay anchovy	60	1.2
BI-BN-03a	Bay anchovy	55	0.8
BI-BN-03a	Bay anchovy	60	1.2
BI-BN-03a	Bay anchovy	61	1.2
BI-BN-03a	Bay anchovy	57	1
BI-BN-03a	Bay anchovy	68	1.5
BI-BN-03a	Bay anchovy	53	0.8
BI-BN-03a	Bay anchovy	61	1.2
BI-BN-03a	Bay anchovy	56	0.8
BI-BN-03a	Bay anchovy	55	1
BI-BN-03a	Bay anchovy	56	0.6
BI-BN-03a	Bay anchovy	51	0.6
BI-BN-03a	Bay anchovy	57	1.2
BI-BN-03a	Bay anchovy	55	1.1
BI-BN-03a	Bay anchovy	57	1.3
BI-BN-03a	Bay anchovy	61	1.2
BI-BN-03a	Bay anchovy	70	2
BI-BN-03a	Bay anchovy	61	1.4
BI-BN-03a	Bay anchovy	56	2
BI-BN-03a	Bay anchovy	55	1
BI-BN-03a	Bay anchovy	60	1.1
BI-BN-03a	Bay anchovy	52	0.8
BI-BN-03a	Bay anchovy	58	0.8
BI-BN-03a	Bay anchovy	56	1
BI-BN-03a	Bay anchovy	60	1
BI-BN-03a	Bay anchovy	60	1.2
BI-BN-03a	Bay anchovy	119	0.7
BI-BN-03a	Bay anchovy	57	0.9
BI-BN-03a	Bay anchovy	55	0.7
BI-BN-03a	Bay anchovy	59	1
BI-BN-03a	Bay anchovy	49	0.6
BI-BN-03a	Bay anchovy	55	0.7

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-03a	Bay anchovy	60	1.1
BI-BN-03a	Bay anchovy	60	1.2
BI-BN-03a	Bay anchovy	60	1.4
BI-BN-03a	Bay anchovy	67	1.8
BI-BN-03a	Bay anchovy	60	1.2
BI-BN-03a	Bay anchovy	56	0.8
BI-BN-03a	Bay anchovy	57	1
BI-BN-03b	Bay anchovy	45	0.4
BI-BN-03b	Bay anchovy	54	0.7
BI-BN-03b	Bay anchovy	55	0.9
BI-BN-03b	Bay anchovy	48	0.6
BI-BN-03b	Bay anchovy	55	1.1
BI-BN-03b	Bay anchovy	58	1
BI-BN-03b	Bay anchovy	56	1
BI-BN-03b	Bay anchovy	65	1.8
BI-BN-03b	Bay anchovy	62	1.2
BI-BN-03b	Bay anchovy	50	0.6
BI-BN-03b	Bay anchovy	58	1
BI-BN-03b	Bay anchovy	53	0.7
BI-BN-03b	Bay anchovy	50	0.7
BI-BN-03b	Bay anchovy	60	1.1
BI-BN-03b	Bay anchovy	49	0.5
BI-BN-03b	Bay anchovy	59	1.2
BI-BN-03b	Bay anchovy	60	1.3
BI-BN-03b	Bay anchovy	55	0.9
BI-BN-03b	Bay anchovy	55	0.8
BI-BN-03b	Bay anchovy	52	0.7
BI-BN-03b	Bay anchovy	55	0.7
BI-BN-03b	Bay anchovy	50	0.6
BI-BN-03b	Bay anchovy	58	1.1
BI-BN-03b	Bay anchovy	61	1.4
BI-BN-03b	Bay anchovy	62	1.3
BI-BN-03b	Bay anchovy	51	0.6
BI-BN-03b	Bay anchovy	53	0.7
BI-BN-03b	Bay anchovy	57	1
BI-BN-03b	Bay anchovy	51	0.7
BI-BN-03b	Bay anchovy	58	1.1
BI-BN-03b	Bay anchovy	59	1.1
BI-BN-03b	Bay anchovy	55	0.9
BI-BN-03b	Bay anchovy	62	1.1
BI-BN-03b	Bay anchovy	59	1
BI-BN-03b	Bay anchovy	57	0.9
BI-BN-03b	Bay anchovy	52	0.6
BI-BN-03b	Bay anchovy	55	0.9

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-03b	Bay anchovy	58	1
BI-BN-03b	Bay anchovy	57	1
BI-BN-03b	Bay anchovy	49	0.5
BI-BN-03b	Bay anchovy	55	0.9
BI-BN-03b	Bay anchovy	50	0.6
BI-BN-03b	Bay anchovy	66	1.5
BI-BN-03b	Bay anchovy	55	0.8
BI-BN-03b	Bay anchovy	57	1
BI-BN-03b	Bay anchovy	58	1
BI-BN-03b	Bay anchovy	52	0.8
BI-BN-03b	Bay anchovy	51	0.7
BI-BN-03b	Bay anchovy	56	0.9
BI-BN-03b	Bay anchovy	60	1.1
BI-BN-03b	Atlantic menhaden	43	0.2
BI-BN-03b	Atlantic menhaden	41	0.4
BI-BN-03b	Atlantic menhaden	42	0.5
BI-BN-03b	Atlantic silverside	105	6.9
BI-BN-03b	Atlantic silverside	78	3
BI-BN-03b	Atlantic silverside	93	4.8
BI-BN-03b	Atlantic silverside	94	5.4
BI-BN-03b	Atlantic silverside	96	5.5
BI-BN-03b	Atlantic menhaden	39	0.3
BI-BN-03b	Atlantic menhaden	40	0.3
BI-BN-03b	Atlantic menhaden	42	0.3
BI-BN-03b	Atlantic menhaden	40	0.3
BI-BN-03b	Atlantic silverside	95	4.8
BI-BN-04a	Striped killifish	72	3.7
BI-BN-04a	Striped killifish	82	6.4
BI-BN-04a	Striped killifish	82	6.4
BI-BN-04a	Striped killifish	100	10.1
BI-BN-04a	Striped killifish	74	4.2
BI-BN-04a	Striped killifish	82	5.6
BI-BN-04a	Striped killifish	55	2.7
BI-BN-04a	Striped killifish	83	5.9
BI-BN-04a	Striped killifish	70	3.3
BI-BN-04a	Striped killifish	70	3.6
BI-BN-04a	Striped killifish	83	6.9
BI-BN-04a	Striped killifish	58	1.9
BI-BN-04a	Striped killifish	72	4
BI-BN-04a	Striped killifish	90	7.3
BI-BN-04a	Striped killifish	98	11.4
BI-BN-04a	Striped killifish	106	12.4
BI-BN-04a	Striped killifish	71	4
BI-BN-04a	Striped killifish	85	6.1

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-04a	Striped killifish	114	16.4
BI-BN-04a	Striped killifish	82	5
BI-BN-04a	Striped killifish	94	8.4
BI-BN-04a	Striped killifish	101	11
BI-BN-04a	Striped killifish	105	12.4
BI-BN-04a	Striped killifish	76	4.3
BI-BN-04a	Striped killifish	75	4.4
BI-BN-04a	Striped killifish	66	3.1
BI-BN-04a	Striped killifish	73	4
BI-BN-04a	Striped killifish	80	5.3
BI-BN-04a	Striped killifish	86	6.5
BI-BN-04a	Striped killifish	76	4.7
BI-BN-04a	Atlantic silverside	115	8.9
BI-BN-04a	Atlantic silverside	90	4.3
BI-BN-04a	Atlantic silverside	63	1.7
BI-BN-04a	Spot	46	1.1
BI-BN-04a	Striped killifish	64	2.4
BI-BN-04a	Mummichog	84	8.7
BI-BN-04a	Mummichog	63	3.5
BI-BN-04a	Mummichog	60	3
BI-BN-04a	Mummichog	106	14.9
BI-BN-04a	Mummichog	106	17.3
BI-BN-04a	Mummichog	57	2.5
BI-BN-04a	Mummichog	69	11.5
BI-BN-04a	Striped killifish	63	2.5
BI-BN-04a	Striped killifish	75	4.2
BI-BN-04a	Striped killifish	75	4.5
BI-BN-04a	Striped killifish	92	8.5
BI-BN-04a	Striped killifish	69	2.1
BI-BN-04a	Striped killifish	86	6.5
BI-BN-04a	Striped killifish	71	4.5
BI-BN-04a	Striped killifish	73	4.1
BI-BN-04a	Striped killifish	95	8.4
BI-BN-04a	Striped killifish	85	6.5
BI-BN-04a	Striped killifish	106	12.9
BI-BN-04a	Striped killifish	74	3.9
BI-BN-04a	Striped killifish	95	9.1
BI-BN-04a	Striped killifish	68	3.1
BI-BN-04a	Striped killifish	83	6.3
BI-BN-04a	Striped killifish	72	3.7
BI-BN-04b	Bay anchovy	54	0.9
BI-BN-04b	Bay anchovy	60	1.2
BI-BN-04b	Bay anchovy	60	1.1
BI-BN-04b	Bay anchovy	56	0.9

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-04b	Bay anchovy	59	1.2
BI-BN-04b	Bay anchovy	59	1.2
BI-BN-04b	Bay anchovy	55	0.7
BI-BN-04b	Bay anchovy	55	1
BI-BN-04b	Bay anchovy	61	1.2
BI-BN-04b	Bay anchovy	55	0.9
BI-BN-04b	Mummichog	51	1.7
BI-BN-04b	Mummichog	73	5.6
BI-BN-04b	Mummichog	55	2
BI-BN-04b	Mummichog	73	6.2
BI-BN-04b	Mummichog	61	3.5
BI-BN-04b	Mummichog	55	1.8
BI-BN-04b	Mummichog	58	2.6
BI-BN-04b	Mummichog	81	7
BI-BN-04b	Mummichog	65	4.5
BI-BN-04b	Mummichog	79	7
BI-BN-04b	Mummichog	79	7
BI-BN-04b	Mummichog	61	3
BI-BN-04b	Mummichog	41	0.9
BI-BN-04b	Mummichog	58	2.4
BI-BN-04b	Mummichog	63	3.6
BI-BN-04b	Mummichog	61	3.3
BI-BN-04b	Mummichog	70	6
BI-BN-04b	Mummichog	50	1
BI-BN-04b	Atlantic menhaden	44	1.1
BI-BN-04b	Atlantic menhaden	55	0.5
BI-BN-04b	Mummichog	78	7.5
BI-BN-04b	Mummichog	82	6.3
BI-BN-04b	Mummichog	51	2.4
BI-BN-04b	Mummichog	45	1.2
BI-BN-04b	Mummichog	56	2.1
BI-BN-04b	Striped killifish	52	1.9
BI-BN-04b	Striped killifish	74	4.1
BI-BN-04b	Striped killifish	110	15.5
BI-BN-04b	Striped killifish	74	4.3
BI-BN-04b	Striped killifish	75	5.3
BI-BN-04b	Striped killifish	79	5.5
BI-BN-04b	Mummichog	56	2.2
BI-BN-04b	Mummichog	65	2.3
BI-BN-04b	Mummichog	54	1.8
BI-BN-04b	Mummichog	57	2.2
BI-BN-04b	Mummichog	65	4.3
BI-BN-04b	Mummichog	65	3.7
BI-BN-04b	Mummichog	86	10.7

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-04b	Mummichog	55	2.5
BI-BN-04b	Mummichog	48	1.2
BI-BN-04b	Bay anchovy	56	1.6
BI-BN-04b	Bay anchovy	50	0.6
BI-BN-04b	Bay anchovy	58	1.1
BI-BN-04b	Bay anchovy	61	1.3
BI-BN-04b	Striped killifish	59	3.6
BI-BN-04b	Striped killifish	63	2.7
BI-BN-04b	Mummichog	55	2.3
BI-BN-04b	Mummichog	55	2.1
BI-BN-04b	Mummichog	54	3.4
BI-BN-04b	Mummichog	52	1.9
BI-BN-04b	Mummichog	59	2.6
BI-BN-04b	Mummichog	44	1.1
BI-BN-04b	Mummichog	67	4.4
BI-BN-04b	Mummichog	45	1
BI-BN-04b	Mummichog	50	1.6
BI-BN-04b	Mummichog	58	2.3
BI-BN-04b	Mummichog	50	1.7
BI-BN-04b	Mummichog	55	2
BI-BN-04b	Mummichog	58	2
BI-BN-04b	Mummichog	69	4
BI-BN-04b	Mummichog	59	2.6
BI-BN-04b	Mummichog	70	5.2
BI-BN-04b	Mummichog	49	1.3
BI-BN-04b	Mummichog	43	1
BI-BN-04b	Striped killifish	70	2.6
BI-BN-04b	Striped killifish	49	1.6
BI-BN-04b	Striped killifish	69	3.3
BI-BN-04b	Striped killifish	46	1
BI-BN-04b	Spot	50	0.5
BI-BN-04b	Spot	49	1.3
BI-BN-05a	Bay anchovy	54	0.7
BI-BN-05a	Bay anchovy	52	0.6
BI-BN-05a	Bay anchovy	52	0.7
BI-BN-05a	Bay anchovy	56	0.9
BI-BN-05a	Bay anchovy	57	1.1
BI-BN-05a	Bay anchovy	67	1.2
BI-BN-05a	Bay anchovy	57	0.9
BI-BN-05a	Bay anchovy	59	0.8
BI-BN-05a	Bay anchovy	57	0.8
BI-BN-05a	Bay anchovy	59	0.9
BI-BN-05a	Bay anchovy	38	0.3
BI-BN-05a	Bay anchovy	58	0.7

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-05a	Bay anchovy	60	1.2
BI-BN-05a	Bay anchovy	57	0.7
BI-BN-05a	Bay anchovy	52	0.8
BI-BN-05a	Bay anchovy	54	0.6
BI-BN-05a	Bay anchovy	55	0.9
BI-BN-05a	Bay anchovy	57	0.8
BI-BN-05a	Bay anchovy	57	0.9
BI-BN-05a	Bay anchovy	51	0.7
BI-BN-05a	Bay anchovy	60	1.2
BI-BN-05a	Bay anchovy	50	0.7
BI-BN-05a	Bay anchovy	57	1
BI-BN-05a	Bay anchovy	55	0.9
BI-BN-05a	Bay anchovy	53	0.6
BI-BN-05a	Bay anchovy	55	0.7
BI-BN-05a	Bay anchovy	54	0.7
BI-BN-05a	Bay anchovy	60	1.1
BI-BN-05a	Bay anchovy	55	0.8
BI-BN-05a	Bay anchovy	54	0.8
BI-BN-05a	Bay anchovy	55	0.8
BI-BN-05a	Bay anchovy	54	0.6
BI-BN-05a	Bay anchovy	53	0.8
BI-BN-05a	Bay anchovy	54	0.8
BI-BN-05a	Bay anchovy	54	1
BI-BN-05a	Bay anchovy	56	1.1
BI-BN-05a	Bay anchovy	56	0.9
BI-BN-05a	Atlantic menhaden	37	0.3
BI-BN-05a	Atlantic menhaden	44	0.6
BI-BN-05a	Atlantic menhaden	40	0.4
BI-BN-05a	Atlantic menhaden	41	0.4
BI-BN-05a	Atlantic menhaden	41	0.5
BI-BN-05a	Atlantic menhaden	39	0.4
BI-BN-05a	Atlantic menhaden	40	0.4
BI-BN-05a	Atlantic menhaden	47	0.7
BI-BN-05a	Atlantic menhaden	48	0.7
BI-BN-05a	Atlantic menhaden	38	0.3
BI-BN-05a	Atlantic menhaden	40	0.4
BI-BN-05a	Atlantic menhaden	40	0.5
BI-BN-05a	Atlantic menhaden	43	0.5
BI-BN-05a	Atlantic menhaden	40	0.4
BI-BN-05a	Atlantic menhaden	41	0.5
BI-BN-05a	Atlantic menhaden	41	0.5
BI-BN-05a	Atlantic menhaden	38	0.3
BI-BN-05a	Atlantic menhaden	39	0.3
BI-BN-05a	Atlantic menhaden	46	0.6

Table B-1d

Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-05a	Atlantic menhaden	38	0.3
BI-BN-05a	Atlantic menhaden	42	0.5
BI-BN-05a	Atlantic menhaden	39	0.3
BI-BN-05a	Atlantic menhaden	43	0.3
BI-BN-05b	Bay anchovy	55	1
BI-BN-05b	Bay anchovy	50	1.5
BI-BN-05b	Bay anchovy	61	1.3
BI-BN-05b	Bay anchovy	54	0.9
BI-BN-05b	Bay anchovy	53	0.8
BI-BN-05b	Bay anchovy	59	1.1
BI-BN-05b	Bay anchovy	60	1.2
BI-BN-05b	Bay anchovy	55	0.9
BI-BN-05b	Bay anchovy	55	0.8
BI-BN-05b	Bay anchovy	55	0.9
BI-BN-05b	Bay anchovy	59	1.1
BI-BN-05b	Bay anchovy	58	0.9
BI-BN-05b	Bay anchovy	55	1
BI-BN-05b	Bay anchovy	55	0.8
BI-BN-05b	Bay anchovy	60	1.2
BI-BN-05b	Bay anchovy	56	1
BI-BN-05b	Bay anchovy	59	1
BI-BN-05b	Bay anchovy	57	1.1
BI-BN-05b	Bay anchovy	60	1.2
BI-BN-05b	Bay anchovy	55	1.1
BI-BN-05b	Bay anchovy	59	1
BI-BN-05b	Bay anchovy	59	1
BI-BN-05b	Bay anchovy	57	1
BI-BN-05b	Bay anchovy	60	1.3
BI-BN-05b	Bay anchovy	67	2.3
BI-BN-05b	Bay anchovy	62	1.4
BI-BN-05b	Bay anchovy	51	0.7
BI-BN-05b	Bay anchovy	57	1
BI-BN-05b	Bay anchovy	57	0.9
BI-BN-05b	Bay anchovy	55	1
BI-BN-05b	Bay anchovy	55	0.8
BI-BN-05b	Bay anchovy	57	1
BI-BN-05b	Bay anchovy	58	1
BI-BN-05b	Bay anchovy	61	1.4
BI-BN-05b	Bay anchovy	54	1
BI-BN-05b	Bay anchovy	55	0.8
BI-BN-05b	Bay anchovy	58	1
BI-BN-05b	Bay anchovy	47	0.5
BI-BN-05b	Bay anchovy	60	1.5
BI-BN-05b	Bay anchovy	57	1.1

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-05b	Bay anchovy	55	0.9
BI-BN-05b	Bay anchovy	66	1.9
BI-BN-05b	Bay anchovy	56	0.6
BI-BN-05b	Bay anchovy	57	1
BI-BN-05b	Bay anchovy	66	1
BI-BN-05b	Bay anchovy	61	1.2
BI-BN-05b	Bay anchovy	56	0.8
BI-BN-05b	Bay anchovy	55	0.8
BI-BN-05b	Bay anchovy	55	0.9
BI-BN-05b	Bay anchovy	56	1
BI-BN-05b	Atlantic silverside	87	4
BI-BN-05b	Atlantic silverside	86	4
BI-BN-05b	Atlantic silverside	95	5.1
BI-BN-05b	Atlantic silverside	84	3.6
BI-BN-05b	Atlantic silverside	102	7.5
BI-BN-05b	Atlantic silverside	87	4.6
BI-BN-05b	Mummichog	52	1
BI-BN-05b	Mummichog	55	2
BI-BN-05b	Mummichog	45	1.5
BI-BN-05b	Mummichog	48	1.4
BI-BN-05b	Mummichog	46	1.5
BI-BN-05b	Mummichog	45	1.1
BI-BN-05b	Mummichog	54	2.1
BI-BN-05b	Mummichog	54	2.1
BI-BN-05b	Mummichog	50	1.4
BI-BN-05b	Mummichog	52	1.6
BI-BN-05b	Mummichog	54	1.8
BI-BN-05b	Mummichog	45	1.1
BI-BN-05b	Mummichog	58	2.5
BI-BN-05b	Mummichog	49	1.6
BI-BN-05b	Mummichog	59	2.6
BI-BN-05b	Mummichog	54	1.8
BI-BN-05b	Mummichog	57	2.4
BI-BN-05b	Striped killifish	65	2.8
BI-BN-05b	Striped killifish	57	2.2
BI-BN-05b	Striped killifish	72	4.3
BI-BN-05b	Atlantic menhaden	48	0.6
BI-BN-05b	Atlantic menhaden	41	0.4
BI-BN-05b	Atlantic menhaden	45	0.5
BI-BN-05b	Atlantic menhaden	46	0.5
BI-BN-05b	Atlantic menhaden	45	0.5
BI-BN-05b	Atlantic menhaden	46	0.6
BI-BN-05b	Atlantic menhaden	40	0.4
BI-BN-05b	Atlantic menhaden	40	0.3

Table B-1d
Barren Island Seine Net Collection Results – Spring

Sample ID	Species	Length (mm)	Weight (g)
BI-BN-05b	Spot	35	0.5
BI-BN-05b	Spot	45	0.9
BI-BN-05b	Inland silverside	56	1.6

Notes:
g: gram
mm: millimeter

Table B-2a

Barren Island Gill Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-GN-01	Atlantic menhaden	127	
BI-GN-01	Atlantic menhaden	123	
BI-GN-01	Atlantic menhaden	126	
BI-GN-01	Atlantic menhaden	126	
BI-GN-01	Atlantic menhaden	124	
BI-GN-01	Atlantic menhaden	127	
BI-GN-01	Gizzard shad	361	
BI-GN-01	Gizzard shad	363	
BI-GN-01	Gizzard shad	317	
BI-GN-01	Gizzard shad	334	
BI-GN-01	Gizzard shad	389	
BI-GN-01	Gizzard shad	394	
BI-GN-01	Bluefish	313	
BI-GN-01	Bluefish	345	
BI-GN-01	Bluefish	303	
BI-GN-01	Gizzard shad	326	
BI-GN-01	Atlantic menhaden	135	
BI-GN-01	Atlantic menhaden	121	
BI-GN-01	Atlantic menhaden	122	
BI-GN-01	Atlantic menhaden	110	
BI-GN-01	Spot	116	
BI-GN-01	Atlantic menhaden	136	
BI-GN-01	Atlantic menhaden	130	
BI-GN-01	Spot	114	
BI-GN-01	Spot	129	
BI-GN-01	Striped bass	196	
BI-GN-01	Spot	127	
BI-GN-01	Atlantic menhaden	127	
BI-GN-01	Atlantic menhaden	134	
BI-GN-01	Spot	143	
BI-GN-01	Atlantic menhaden	133	
BI-GN-01	Spot	150	
BI-GN-01	Spot	132	
BI-GN-01	Spot	119	
BI-GN-01	Spot	117	
BI-GN-01	Atlantic menhaden	139	
BI-GN-01	Atlantic menhaden	122	
BI-GN-01	Spot	185	
BI-GN-01	Spot	159	
BI-GN-01	Spot	128	
BI-GN-01	Spot	124	
BI-GN-01	Spot	151	
BI-GN-01	Spot	147	
BI-GN-01	Atlantic menhaden	137	

Table B-2a

Barren Island Gill Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-GN-01	Atlantic menhaden	125	
BI-GN-01	Atlantic menhaden	128	
BI-GN-01	Atlantic menhaden	119	
BI-GN-01	Atlantic menhaden	128	
BI-GN-01	Spot	151	
BI-GN-01	Spot	123	
BI-GN-01	Spot	122	
BI-GN-01	Spot	122	
BI-GN-01	Spot	125	
BI-GN-01	Spot	135	
BI-GN-01	Spot	129	
BI-GN-01	Spot	117	
BI-GN-01	Spot	134	
BI-GN-01	Spot	151	
BI-GN-01	Spot	123	
BI-GN-01	Spot	160	
BI-GN-01	Spot	179	
BI-GN-01	Atlantic menhaden	129	
BI-GN-01	Spot	131	
BI-GN-01	Spot	123	
BI-GN-01	spot	129	
BI-GN-01	Gizzard shad	225	
BI-GN-01	Spot	127	
BI-GN-01	Spot	169	
BI-GN-01	Spot	119	
BI-GN-01	Spot	147	
BI-GN-01	Spot	120	
BI-GN-01	Atlantic menhaden	126	
BI-GN-01	Spot	157	
BI-GN-01	Atlantic menhaden	144	
BI-GN-01	Spot	154	
BI-GN-01	Spot	154	
BI-GN-01	Spot	139	
BI-GN-01	Spot	161	
BI-GN-01	Spot	179	
BI-GN-01	Atlantic menhaden	136	
BI-GN-01	Spot	141	
BI-GN-01	Spot	147	
BI-GN-01	Spot	160	
BI-GN-01	Gizzard shad	338	
BI-GN-01	Spot	130	
BI-GN-01	Atlantic menhaden	133	
BI-GN-01	Atlantic menhaden	126	
BI-GN-01	Spot	133	

Table B-2a

Barren Island Gill Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-GN-01	Spot	128	
BI-GN-01	Spot	135	
BI-GN-01	Atlantic menhaden	128	
BI-GN-01	Atlantic menhaden	131	
BI-GN-01	Spot	131	
BI-GN-01	Atlantic menhaden	122	
BI-GN-01	Atlantic menhaden	124	
BI-GN-01	Atlantic menhaden	115	
BI-GN-01	Atlantic menhaden	135	
BI-GN-01	Atlantic menhaden	137	
BI-GN-01	Harvest fish	127	
BI-GN-01	Atlantic menhaden	129	
BI-GN-01	Blue crab	150	
BI-GN-01	Blue crab	135	
BI-GN-01	Blue crab	81	
BI-GN-01	Blue crab	102	
BI-GN-01	Blue crab	142	
BI-GN-01	Blue crab	109	
BI-GN-01	Blue crab	95	
BI-GN-01	Blue crab	117	
BI-GN-01	Atlantic menhaden	121	
BI-GN-01	Atlantic menhaden	137	
BI-GN-01	Atlantic menhaden	136	
BI-GN-01	Spot	120	
BI-GN-01	Spot	114	
BI-GN-01	Spot	124	
BI-GN-01	Atlantic menhaden	128	
BI-GN-01	Atlantic menhaden	139	
BI-GN-01	Atlantic menhaden	121	
BI-GN-01	Spot	126	
BI-GN-01	Spot	176	
BI-GN-01	Spot	118	
BI-GN-01	Atlantic menhaden	121	
BI-GN-01	Atlantic menhaden	119	
BI-GN-01	Atlantic menhaden	104	
BI-GN-02	Spot	145	
BI-GN-02	Blue crab	120	
BI-GN-02	Spot	183	
BI-GN-02	Spot	163	
BI-GN-02	Spot	157	
BI-GN-02	Spot	170	
BI-GN-02	Spot	207	
BI-GN-02	Atlantic menhaden	125	
BI-GN-02	Atlantic menhaden	128	

Table B-2a
Barren Island Gill Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-GN-02	Spot	152	
BI-GN-03	Blue crab	140	
BI-GN-03	Blue crab	125	
BI-GN-03	Gizzard shad	369	
BI-GN-03	Atlantic menhaden	290	
BI-GN-03	Atlantic menhaden	322	
BI-GN-03	Atlantic menhaden	334	
BI-GN-03	Atlantic menhaden	340	
BI-GN-03	Atlantic menhaden	338	
BI-GN-03	Spanish mackerel	512	
BI-GN-03	Atlantic menhaden	215	
BI-GN-03	Atlantic menhaden	320	
BI-GN-03	Atlantic menhaden	140	
BI-GN-03	Atlantic menhaden	250	
BI-GN-03	Atlantic menhaden	143	
BI-GN-03	Atlantic menhaden	217	
BI-GN-03	Silver perch	196	
BI-GN-03	Spanish mackerel	278	
BI-GN-03	Atlantic menhaden	225	
BI-GN-03	Harvest fish	213	
BI-GN-03	Northern sand lance	805	
BI-GN-03	Atlantic menhaden	135	
BI-GN-03	Spanish mackerel	290	
BI-GN-03	Atlantic menhaden	150	
BI-GN-03	Atlantic menhaden	292	
BI-GN-03	Spanish mackerel	296	
BI-GN-03	Blue crab	75	
BI-GN-03	Spanish mackerel	287	
BI-GN-04	Blue crab	93	
BI-GN-04	Striped bass	390	
BI-GN-04	Blue crab	110	
BI-GN-04	Gizzard shad	413	
BI-GN-04	Gizzard shad	409	
BI-GN-04	Spot	128	
BI-GN-04	Spot	163	
BI-GN-04	Spot	168	
BI-GN-04	Gizzard shad	446	
BI-GN-04	Spot	151	
BI-GN-04	Spot	149	
BI-GN-04	Spot	213	
BI-GN-04	Blue crab	100	
BI-GN-04	Spot	124	
BI-GN-04	Spot	155	
BI-GN-04	Spot	150	

Table B-2a
Barren Island Gill Net Collection Results – Summer

Sample ID	Species	Length (mm)	Notes
BI-GN-04	Spot	118	
BI-GN-04	Spot	155	
BI-GN-04	Spot	159	
BI-GN-04	Atlantic menhaden	120	
BI-GN-04	Spot	125	
BI-GN-04	Spot	158	
BI-GN-04	Spot	147	
BI-GN-04	Blue crab	95	
BI-GN-04	Atlantic menhaden	136	
BI-GN-04	Spot	112	
BI-GN-04	Spot	126	
BI-GN-04	Blue crab	132	

Note:
mm: millimeter

Table B-2b
Barren Island Gill Net Collection Results – Fall, Summer, and Spring

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Fall	BI-GN-01	Spot	122	
	BI-GN-01	Spot	151	
	BI-GN-01	Spot	140	
	BI-GN-02	Gizzard shad	355	
	BI-GN-02	Gizzard shad	331	
	BI-GN-02	Spot	135	
	BI-GN-02	Spot	120	
	BI-GN-02	Spot	125	
Winter	BI-GN-01	Alewife	296	
	BI-GN-02	Atlantic menhaden	302	
	BI-GN-03	Atlantic menhaden	139	
	BI-GN-04	Alewife	287	
	BI-GN-05	Alewife	300	
	BI-GN-03	Atlantic menhaden	192	
	BI-GN-04	Atlantic menhaden	169	
Spring	BI-GN-03	Hickory Shad	460	689
	BI-GN-04	Atlantic menhaden	153	25
	BI-GN-05	Spot	172	75
	BI-GN-06	Spot	160	56
	BI-GN-07	Atlantic menhaden	140	25
	BI-GN-08	Atlantic menhaden	140	25

Notes:

a. Weight was measured during the spring sampling event only.

g: gram

mm: millimeter

Table B-3
Barren Island Bottom Trawl Collection Results – All Seasons

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Summer	BI-FT-01	Weakfish	150	
	BI-FT-02	Blue crab	65	
	BI-FT-04	Blue crab	77	
	BI-FT-04	Blackcheek tonguefish	98	
	BI-FT-04	Blackcheek tonguefish	133	
	BI-FT-05	Blue crab	130	
	BI-FT-05	Blackcheek tonguefish	127	
	BI-FT-06	Spot	127	
	BI-FT-06	Spot	132	
Fall	BI-FT-01	Gizzard shad	156	
	BI-FT-01	Bay anchovy	61	
	BI-FT-02	Blue crab	119	
	BI-FT-02	Blue crab	130	
	BI-FT-02	Blue crab	108	
	BI-FT-03	Bay anchovy	40	
	BI-FT-03	Bay anchovy	34	
	BI-FT-05	Bay anchovy	63	
	BI-FT-05	Bay anchovy	57	
	BI-FT-05	Bay anchovy	60	
	BI-FT-05	Bay anchovy	55	
	BI-FT-05	Bay anchovy	55	
	BI-FT-05	Bay anchovy	57	
	BI-FT-05	Bay anchovy	54	
	BI-FT-05	Bay anchovy	58	
	BI-FT-05	Bay anchovy	58	
	BI-FT-05	Bay anchovy	54	
	BI-FT-05	Bay anchovy	59	
	BI-FT-05	Bay anchovy	56	
	BI-FT-06	Blue crab	109	
Spring	BI-FT-02b	Bay anchovy	64	1.5
	BI-FT-04a	Bay anchovy	59	0.9
	BI-FT-04a	Bay anchovy	43	0.5
	BI-FT-04b	Bay anchovy	59	1.1
	BI-FT-04b	Bay anchovy	53	0.9
	BI-FT-04b	Bay anchovy	61	1.5
	BI-FT-04b	Bay anchovy	58	1.1
	BI-FT-04b	Bay anchovy	80	3.2
	BI-FT-04b	Bay anchovy	56	1.1
	BI-FT-04b	Bay anchovy	62	1.2
	BI-FT-04b	Bay anchovy	60	1.1
	BI-FT-04b	Bay anchovy	65	1.5
	BI-FT-04b	Bay anchovy	64	2
	BI-FT-04b	Bay anchovy	55	1
	BI-FT-04b	Bay anchovy	60	1

Table B-3

Barren Island Bottom Trawl Collection Results – All Seasons

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Spring (continued)	BI-FT-04b	Bay anchovy	58	1
	BI-FT-04b	Bay anchovy	65	1.6
	BI-FT-04b	Bay anchovy	62	1.3
	BI-FT-04b	Bay anchovy	50	0.5
	BI-FT-04b	Bay anchovy	54	0.8
	BI-FT-04b	Bay anchovy	56	1
	BI-FT-04b	Bay anchovy	52	0.9
	BI-FT-04b	Bay anchovy	52	0.7
	BI-FT-04b	Bay anchovy	55	1
	BI-FT-04b	Bay anchovy	58	1
	BI-FT-04b	Bay anchovy	55	1
	BI-FT-04b	Bay anchovy	66	1.9
	BI-FT-04b	Bay anchovy	61	1.4
	BI-FT-04b	Bay anchovy	65	1.6
	BI-FT-04b	Bay anchovy	58	0.9
	BI-FT-04b	Bay anchovy	54	0.8
	BI-FT-04b	Bay anchovy	50	0.6
	BI-FT-04b	Bay anchovy	55	0.9
	BI-FT-04b	Bay anchovy	55	0.8
	BI-FT-04b	Bay anchovy	60	1.3
	BI-FT-05a	Bay anchovy	65	0.5
	BI-FT-05a	Bay anchovy	44	0.3
	BI-FT-05a	Bay anchovy	52	0.9
	BI-FT-05a	Bay anchovy	52	0.8
	BI-FT-05a	Bay anchovy	55	1
	BI-FT-05a	Bay anchovy	54	0.8
	BI-FT-05a	Bay anchovy	68	1.8
	BI-FT-05a	Bay anchovy	57	0.9
	BI-FT-05a	Bay anchovy	58	1
	BI-FT-05a	Bay anchovy	63	1.6
	BI-FT-05a	Bay anchovy	54	0.8
	BI-FT-05a	Bay anchovy	50	0.4
	BI-FT-05a	Bay anchovy	56	1
	BI-FT-05a	Bay anchovy	51	0.6
	BI-FT-05a	Bay anchovy	56	1
	BI-FT-05a	Bay anchovy	60	1.2
	BI-FT-05a	Bay anchovy	45	0.5
	BI-FT-05a	Bay anchovy	51	0.7
	BI-FT-05a	Bay anchovy	60	1
	BI-FT-05a	Bay anchovy	63	1.4
	BI-FT-05a	Bay anchovy	57	0.9
	BI-FT-05a	Bay anchovy	44	0.4
	BI-FT-06a	Spotted hake	151	31.3
	BI-FT-06a	Spot	152	39.4

Table B-3
Barren Island Bottom Trawl Collection Results – All Seasons

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Spring (continued)	BI-FT-06a	Spot	164	56.4
	BI-FT-06a	Spot	147	38.2
	BI-FT-06a	Spot	153	37.8
	BI-FT-06a	Spot	155	43.6
	BI-FT-06a	Spot	149	37.3
	BI-FT-06a	Spot	152	65
	BI-FT-06a	Spot	165	57.5
	BI-FT-06a	Spot	144	39
	BI-FT-06a	Spot	155	48.8
	BI-FT-06a	Spot	158	46.9
	BI-FT-06a	Spot	159	46
	BI-FT-06a	Spot	140	32.8
	BI-FT-06a	Spot	149	39.5
	BI-FT-06a	Spot	134	26.1
	BI-FT-06a	Spot	153	45.2
	BI-FT-06a	Spot	140	32.9
	BI-FT-06a	Spot	145	36.8
	BI-FT-06a	Spot	155	42.4
	BI-FT-06a	Spot	144	36.2
	BI-FT-06a	Spot	128	25
	BI-FT-06a	Spot	151	42.4
	BI-FT-06a	Spot	150	42.1
	BI-FT-06a	Butterfish	90	10.7
	BI-FT-06a	Bay anchovy	64	1.7
	BI-FT-06a	Bay anchovy	56	0.9
	BI-FT-06a	Bay anchovy	63	1.6
	BI-FT-06a	Bay anchovy	58	1.3
	BI-FT-06a	Bay anchovy	54	0.8
	BI-FT-06a	Bay anchovy	52	0.9
	BI-FT-06a	Blue crab	150	146.1
	BI-FT-06b	Spot	147	38.9
	BI-FT-06b	Spot	167	57
	BI-FT-06b	Spot	180	83.6
	BI-FT-06b	Spot	142	34.2
	BI-FT-06b	Spot	161	51.8
	BI-FT-06b	Spot	38	0.5
	BI-FT-06b	Bay anchovy	65	1.9
	BI-FT-06b	Bay anchovy	70	2

Table B-3
Barren Island Bottom Trawl Collection Results – All Seasons

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Spring (continued)	BI-FT-06b	Bay anchovy	50	0.5
	BI-FT-06b	Bay anchovy	62	1.3
	BI-FT-06b	Bay anchovy	56	0.8
	BI-FT-06b	Bay anchovy	62	0.7
	BI-FT-06b	Bay anchovy	48	0.6

Notes:

a. Weight was measured during the spring sampling event only.

g: gram

mm: millimeter

Table B-4

Barren Island Pop Net Collection Results – Summer and Spring

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Summer	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	53	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	52	
	BI-PN-01a	Bay anchovy	51	
	BI-PN-01a	Bay anchovy	56	
	BI-PN-01a	Bay anchovy	45	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	53	
	BI-PN-01a	Bay anchovy	52	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	45	
	BI-PN-01a	Bay anchovy	42	
	BI-PN-01a	Bay anchovy	49	
	BI-PN-01a	Bay anchovy	47	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	47	
	BI-PN-01a	Bay anchovy	46	
	BI-PN-01a	Bay anchovy	34	
	BI-PN-01a	Bay anchovy	42	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	43	
	BI-PN-01a	Bay anchovy	44	
	BI-PN-01a	Bay anchovy	49	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	44	
	BI-PN-01a	Bay anchovy	51	
	BI-PN-01a	Bay anchovy	45	
	BI-PN-01a	Bay anchovy	45	
	BI-PN-01a	Bay anchovy	47	
	BI-PN-01a	Bay anchovy	52	
	BI-PN-01a	Bay anchovy	49	
	BI-PN-01a	Bay anchovy	42	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	47	
	BI-PN-01a	Bay anchovy	52	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	50	
	BI-PN-01a	Bay anchovy	53	
	BI-PN-01a	Bay anchovy	46	

Table B-4
Barren Island Pop Net Collection Results – Summer and Spring

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Summer (continued)	BI-PN-01a	Bay anchovy	52	
	BI-PN-01a	Bay anchovy	51	
	BI-PN-01a	Bay anchovy	48	
	BI-PN-01a	Bay anchovy	49	
	BI-PN-01a	Bay anchovy	47	
	BI-PN-01a	Bay anchovy	55	
	BI-PN-01b	Bay anchovy	54	
	BI-PN-01b	Bay anchovy	52	
	BI-PN-01b	Bay anchovy	35	
	BI-PN-01b	Bay anchovy	55	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	46	
	BI-PN-01b	Bay anchovy	55	
	BI-PN-01b	Bay anchovy	57	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	55	
	BI-PN-01b	Bay anchovy	47	
	BI-PN-01b	Bay anchovy	57	
	BI-PN-01b	Bay anchovy	53	
	BI-PN-01b	Bay anchovy	53	
	BI-PN-01b	Bay anchovy	51	
	BI-PN-01b	Bay anchovy	52	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	50	
	BI-PN-01b	Bay anchovy	55	
	BI-PN-01b	Bay anchovy	54	
	BI-PN-01b	Bay anchovy	42	
	BI-PN-01b	Bay anchovy	49	
	BI-PN-01b	Bay anchovy	45	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	47	
	BI-PN-01b	Bay anchovy	50	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	43	
	BI-PN-01b	Bay anchovy	42	
	BI-PN-01b	Bay anchovy	52	
	BI-PN-01b	Bay anchovy	46	
	BI-PN-01b	Bay anchovy	45	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	45	
	BI-PN-01b	Bay anchovy	52	
	BI-PN-01b	Bay anchovy	49	
	BI-PN-01b	Bay anchovy	47	
	BI-PN-01b	Bay anchovy	40	

Table B-4
Barren Island Pop Net Collection Results – Summer and Spring

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Summer (continued)	BI-PN-01b	Bay anchovy	42	
	BI-PN-01b	Bay anchovy	50	
	BI-PN-01b	Bay anchovy	48	
	BI-PN-01b	Bay anchovy	45	
	BI-PN-01b	Bay anchovy	49	
	BI-PN-01b	Bay anchovy	49	
	BI-PN-01b	Bay anchovy	44	
	BI-PN-01b	Bay anchovy	43	
	BI-PN-01b	Bay anchovy	50	
	BI-PN-01b	Bay anchovy	50	
	BI-PN-01b	Bay anchovy	47	
	BI-PN-01b	Blue crab	62	
	BI-PN-02a	Bay anchovy	29	
	BI-PN-02a	Bay anchovy	30	
	BI-PN-02b	Bay anchovy	40	
	BI-PN-02b	Bay anchovy	25	
	BI-PN-02b	Bay anchovy	27	
	BI-PN-02b	Atlantic silverside	25	
	BI-PN-02b	Bay anchovy	28	
	BI-PN-02b	Bay anchovy	22	
	BI-PN-02b	Bay anchovy	27	
	BI-PN-03a	Bay anchovy	50	
	BI-PN-03a	Bay anchovy	47	
	BI-PN-03a	Bay anchovy	44	
	BI-PN-03a	Bay anchovy	31	
	BI-PN-03a	Bay anchovy	30	
	BI-PN-03a	Bay anchovy	35	
	BI-PN-03a	Bay anchovy	35	
	BI-PN-03a	Bay anchovy	42	
	BI-PN-03b	Bay anchovy	43	
	BI-PN-03b	Bay anchovy	30	
	BI-PN-03b	Bay anchovy	39	
	BI-PN-03b	Bay anchovy	46	
	BI-PN-03b	Bay anchovy	42	
	BI-PN-03b	Atlantic silverside	66	
	BI-PN-03b	Bay anchovy	40	
	BI-PN-03b	Bay anchovy	36	
	BI-PN-03b	Bay anchovy	22	
	BI-PN-03b	Bay anchovy	37	
	BI-PN-03b	Bay anchovy	40	
	BI-PN-03b	Blue crab	22	
	BI-PN-04a	Bay anchovy	47	
	BI-PN-04a	Blue crab	10	
	BI-PN-04a	Bay anchovy	48	

Table B-4
Barren Island Pop Net Collection Results – Summer and Spring

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Summer (continued)	BI-PN-04a	Bay anchovy	52	
	BI-PN-04a	Blue crab	8	
	BI-PN-04a	Bay anchovy	52	
	BI-PN-04b	Bay anchovy	50	
	BI-PN-04b	Atlantic silverside	75	
	BI-PN-04b	Bay anchovy	57	
	BI-PN-04b	Bay anchovy	57	
	BI-PN-04b	Bay anchovy	55	
	BI-PN-04b	Atlantic silverside	66	
	BI-PN-04b	Bay anchovy	52	
	BI-PN-04b	Bay anchovy	49	
	BI-PN-04b	Bay anchovy	48	
	BI-PN-04b	Bay anchovy	45	
	BI-PN-04b	Bay anchovy	48	
	BI-PN-04b	Bay anchovy	46	
	BI-PN-04b	Bay anchovy	42	
	BI-PN-04b	Bay anchovy	59	
	BI-PN-04b	Bay anchovy	50	
	BI-PN-04b	Bay anchovy	51	
	BI-PN-04b	Bay anchovy	56	
	BI-PN-04b	Bay anchovy	46	
	BI-PN-04b	Bay anchovy	49	
	BI-PN-04b	Bay anchovy	50	
	BI-PN-04b	Bay anchovy	53	
	BI-PN-04b	Atlantic silverside	78	
	BI-PN-04b	Bay anchovy	45	
	BI-PN-04b	Bay anchovy	40	
	BI-PN-04b	Bay anchovy	55	
	BI-PN-04b	Atlantic silverside	67	
	BI-PN-04b	Bay anchovy	30	
	BI-PN-04b	Bay anchovy	47	
	BI-PN-04b	Atlantic silverside	79	
	BI-PN-04b	Atlantic silverside	75	
	BI-PN-04b	Bay anchovy	50	
	BI-PN-04b	Atlantic silverside	78	
	BI-PN-04b	Bay anchovy	53	
	BI-PN-04b	Blue crab	15	
	BI-PN-04b	Blue crab	5	
	BI-PN-04b	Bay anchovy	40	

Table B-4
Barren Island Pop Net Collection Results – Summer and Spring

Season	Sample ID	Species	Length (mm)	Weight[a] (g)
Spring	BI-PN-01a	Spot	23	0.2
	BI-PN-01a	Spot	27	0.2
	BI-PN-01a	Spot	22	0.1
	BI-PN-01a	Spot	22	0.1
	BI-PN-01a	Spot	23	0.1
	BI-PN-01a	Spot	25	0.2
	BI-PN-01a	Spot	25	0.2
	BI-PN-01a	Spot	30	0.3

Notes:

a. Weight was measured during the spring sampling event only.

g: gram

mm: millimeter