DRAFT FINAL
BARREN ISLAND HABITAT RESTORATION
EXISTING ENVIRONMENTAL CONDITIONS:

Summer 2002 Survey

Prepared for

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, MD 21401

Prepared by

EA Engineering, Science & Technology, Inc.
15 Loveton Circle
Sparks, MD 21152

MES Contract # 03-07-11
MPA Contract # 500912
MPA Pin # 600105-P

February 2003

EXECUTIVE SUMMARY

Barren Island and the surrounding waters were investigated over the Summer season in September 2002. The purpose of the sampling efforts was to document the existing terrestrial and aquatic resources present in and around the Barren Island remnants. This report presents results from the first season of sampling for the feasibility evaluations of Barren Island in Summer 2002. This investigation includes both terrestrial and aquatic components, specifically water quality and nutrient investigations, benthic invertebrate studies, fisheries and plankton sampling, vegetation identification and mapping, avian and other wildlife utilization surveys, other resources observations, and submerged aquatic vegetation (SAV) mapping by observation.

These data will support feasibility studies of Barren Island as a potential habitat restoration project that would utilize dredged material beneficially to stabilize and restore wetland and upland areas of Barren Island. This study was conducted under contract to Maryland Environmental Service (MES) for the Maryland Port Administration (MPA).

Barren Island is located in Dorchester County, Maryland and currently consists of three eroding island remnants, the northern remnant, the northeastern remnant, and the southern remnant. The northern, northeastern, and southern remnants of Barren Island were occupied by habitats that include high and low marsh areas, upland forested areas, open water habitats and channels, sandy beaches (including saltpans and sand spits), and pockets of SAV. All of the remnants are eroding, particularly along the northern and western shorelines, which is resulting in bare ground, fallen trees, and compromised marshes and upland areas. The northern and southern remnants are joined by low marshes that terminate into a small, upland forested area. Mixed stands of forest dominated by loblolly pines comprise the interior of the northern and southern remnants. Small areas of high and low marshes can be found on all three remnants. The northern and western shorelines of each remnant show the heaviest erosion and there are many submerged snags in the adjacent water in these areas.

The U.S. Army Corps of Engineers (USACE) constructed geotextile tubes in 1994 to stabilize the western shoreline of Barren Island and then placed dredged material between the tube and the eroding shoreline to recover the lost acreage of salt marsh. The dredged material was then planted with salt marsh grass species. Current inspection of the created marsh site indicates a highly successful planting and a favorable rate of survival for the planted grasses.

Results of the physical analyses of sediments indicated that the substrates surrounding Barren Island were predominately composed of sand at all locations except two stations, BAR-1 and BAR-9, which were defined as mud. Depths in the areas sampled ranged from 2 to 12 feet. *In situ* water quality was within the range expected at the temperature, depth, and salinity recorded. In addition, an analysis of nutrients in the water was conducted at the ten benthic stations.

The Chesapeake Bay Benthic Index of Biotic Integrity (B-IBI) total scores were high (3 to 5) for all stations sampled at Barren Island both within and outside of the proposed alignments. All stations met the Chesapeake Bay Restoration Goal of a score of 3 or greater and one station (BAR-1) had a perfect score of 5. High numbers of pollution-sensitive taxa were recovered at

Barren Island and all stations received scores of 3 or 5. Low numbers of pollution-indicative taxa were collected at Barren Island and all but two stations received scores of 5.

Fisheries investigations of the shorelines indicated that the remnants support a fairly diverse fish community, including the young of commercially important species. The fisheries sampling study indicated that the fish and crabs collected around Barren Island during the field effort were typical of species that occur in the mesohaline reaches of the Chesapeake Bay. Beach seine efforts yielded the highest abundance and diversity of fish and crabs and were predominately juvenile species. Bottom trawl efforts recovered less total fish and a lower diversity of fish and crabs than beach seining. This is likely due to a lack of habitat features outside of the shore-zone of the island and most fish utilizing the area trawled are probably transients to the study area. Gillnetting efforts yielded similar species to those collected during bottom trawl efforts, although most collected during gillnetting were larger adults or subadults. The only seahorses collected during the fisheries investigations occurred at bottom trawl station BAR-004 and gillnet station BAR-G4, both located within the proposed Alignment 2. There was little difference in the number of species among stations sampled by the same gear in September 2002. No rare, threatened, or endangered (RTE) fish species were collected during the September 2002 field effort. Three of the nine species that are managed under the Magnuson-Stevens Fisheries Conservation Act (species for which the Chesapeake Bay provides Essential Fish Habitat [EFH]) were collected in the vicinity of Barren Island. Fisheries collections yielded many species of obligate bottom-feeders which is attributed to the healthy, diverse benthic community observed around the island remnants.

The larvae of six fish species were found in the ichthyoplankton collections and the blenny numerically dominated the densities at most stations. Fish eggs were not found in the plankton samples, which is typical for late summer (September) since most fish species begin spawning in the early spring. Northern pipefish larvae were found at all sampling stations and occurred intermittently in both the bottom and surface trawls. The goby was found only in the bottom trawl and the Atlantic silverside was collected only in surface trawls.

Macrozooplankton results indicated that overall higher densities were collected in bottom trawl efforts compared to plankton sampling. Crab larvae numerically dominated collections at four stations occurring in comparatively high abundance for both surface and bottom trawls. Shrimp larvae, mysid shrimp, and copepods also were collected in relatively high abundance at all stations. Although many of these organisms are considered benthic species rather than plankton species, they represent, in combination with zooplankton, important food sources for fish populations utilizing the habitat around Barren Island.

The island remnants currently support SAV growth along some of their eastern shorelines and in the quiescent waters east of the islands. Monotypic beds of widgeon grass *(Ruppia maritima)* were the only SAV observed in September 2002.

Avian utilization of the island was typical for this area of the Bay, including the federal and Maryland state-listed threatened species, the bald eagle. Bald eagles (both adults and immature birds) were observed utilizing the area in and around Barren Island and one bald eagle nest was observed on the western side of the southern remnant. Several other avian species identified at

Barren Island during the Summer 2002 surveys have conservation status determinations associated with their breeding status. Avian species were observed in the upland areas, salt marshes, shoreline areas, and the open waters adjacent to the Barren Island remnants. The island appears to provide adequate nesting habitat and food sources for a variety of songbirds and raptors. A large heron rookery was observed on the southern remnant in a loblolly pine forest. A total of 61 species of birds were identified during the avian observations on Barren Island in September 2002. However, avian utilization of the open water areas of the proposed alignments was minor compared to that of the wetland and forested areas of the remnants. In addition to avian species, there was also evidence that common wildlife species such as sika deer, raccoons, diamondback terrapins, and several snake species also utilize the island remnants.

During the site investigations, the remnants showed no historical or archeological resources apart from the past use of the island as a hunting lodge. Man-made open water channels and a tidal gut persist on both the southern and northern remnants. In addition, discarded household items such as water heaters, drums, and machinery were observed on both the northern and southern remnants. However, bits of pottery, shards of glass and a broken flint arrowhead were observed washed up on the oyster shell beach in the southeast portion of the southern remnant.

TABLE OF CONTENTS

List of Figures

List of Tables

Appendices

1.0 INTRODUCTION

1.1 PURPOSE OF STUDY

The purpose of the Barren Island environmental sampling effort is to document the existing terrestrial and aquatic resources present in and around the Barren Island remnants in the first of four seasons of sampling. These data will support feasibility studies of Barren as a potential habitat restoration project, which would utilize dredged material beneficially to stabilize and restore wetland and upland areas of Barren Island. This investigation includes both terrestrial and aquatic components, specifically water quality and nutrient investigations, benthic invertebrate studies, fisheries and plankton sampling, SAV mapping by observation, vegetation identification and mapping, avian and other wildlife utilization surveys, and other resources observations.

This study was conducted by EA Engineering, Science, and Technology, Inc. (EA) under contract to MES for the MPA.

1.2 STUDY AREA DESCRIPTION

Barren Island is located in the Chesapeake Bay near the Honga River in Dorchester County, Maryland (Figure 1-1). Barren Island is currently federally owned and managed by the U.S. Fish and Wildlife Service (USFWS) as a satellite refuge area to Blackwater National Wildlife Refuge. Barren Island is located immediately west of Hoopers Island across from the mouth of the Patuxent River in the Chesapeake Bay; Tar Bay separates Barren and Hooper islands. The western side of the island faces the Chesapeake Bay and the eastern side faces the Eastern Shore of Maryland. Two islands are located in the vicinity of Barren Island; a small island named Opossum Island is located directly east of the island and a small, unnamed island is located due south of the island. Historic and current mapping of Barren Island indicates that the island has lost approximately 78% of its acreage since 1848. Currently, Barren Island consists of three remnants that total approximately 180 acres (Figure 1-2).

In 1994, the USACE began the construction of geotextile tubes, approximately 1.5 miles in length, to stabilize the western shoreline of Barren Island. The geotextile tubing was made from double-lined woven fabric that was then filled with dredged material and placed a short way off-shore of the island (USACE 2002). Dredged material was then placed between the tube and the eroding shoreline to recover the lost acreage of salt marsh. Since June of 2001, a number of groups have worked with the USACE and the USFWS to plant the 11-acre tidal salt marsh on Barren Island that was created from dredged material (FOB 2002). In June 2001, during the first phase, 100,000 plugs of saltmarsh cordgrass (*Spartina alterniflora)* were planted, resulting in 87 percent area coverage on the restoration site. In May 2002, during the second phase, 40,000 additional plugs of saltmarsh cordgrass plus 10,000 plugs of saltmeadow cordgrass (*Spartina patens*) were planted (FOB 2002). Current inspection of the created marsh site indicates a 90 percent plus retention rate of grasses planted in the second phase and a high rate of survival in the first phase (FOB 2002).

Barren Island is currently being considered for an island restoration project to be restored with a 50 percent upland to 50 percent wetland ratio dike alignment using suitable dredged material.

Two potential dike alignments (footprints) are being considered at this phase of study (Figure 1-3). Each alignment includes a 10-ft and 20-ft upland dike height. The total baseline area of the alignments range in size from 1,000 to 2,000 acres and lie west-southwest of the Barren Island remnants. The total affected area from the footprint of the alignments range in size from 1,051 to 2,072 acres. The proposed design (baseline) area and the resulted total affected (footprint) areas are summarized below in Table 1-1 (GBA 2002).

Table 1-1. Design Areas and Affected Acreages of the Barren Island Proposed Alignments

Site Characteristics*	Alignment Number	
	1	2
Total Baseline Area (Acres)	1,000	2,000
Total Baseline Perimeter (LF)	28,655	41,854
Upland Baseline Area (Acres)	500	1,000
Upland Baseline Perimeter (LF)	22,847	34,383
Wetland Baseline Area (Acres)	500	1000
Wetland Baseline Perimeter (LF)	23,796	34,462
Total Volume for 10-ft Dike (MCY)	16.94	37.11
Total Volume for 20-ft Dike (MCY)	25.01	53.24
Total Site Capacity for 10-ft Dike (MCY)	24.16	52.62
Total Site Capacity for 20-ft Dike (MCY)	36.58	77.44
Total Affected (Footprint) Area (Acres)	**1,051**	**2,074**

*LF=linear feet, MCY=million cubic yards
Source: GBA 2002

The Summer 2002 seasonal sampling was conducted within and adjacent to the footprints of the proposed project and on and around the three island remnants. Details of sampling and observation areas are included with the methods for each discipline (Section 2).

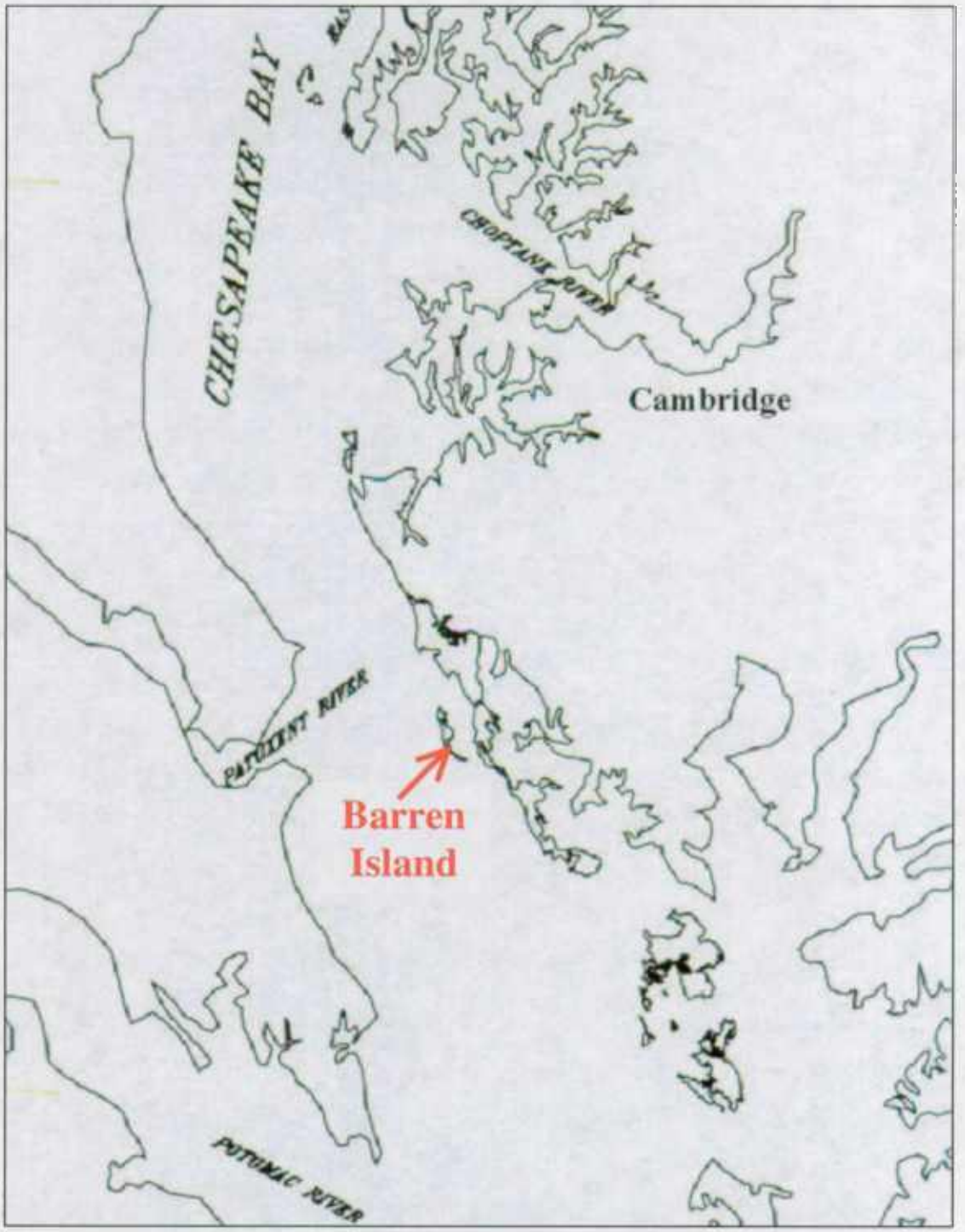


Figure 1-1. Location of Barren Island, Dorchester County, MD

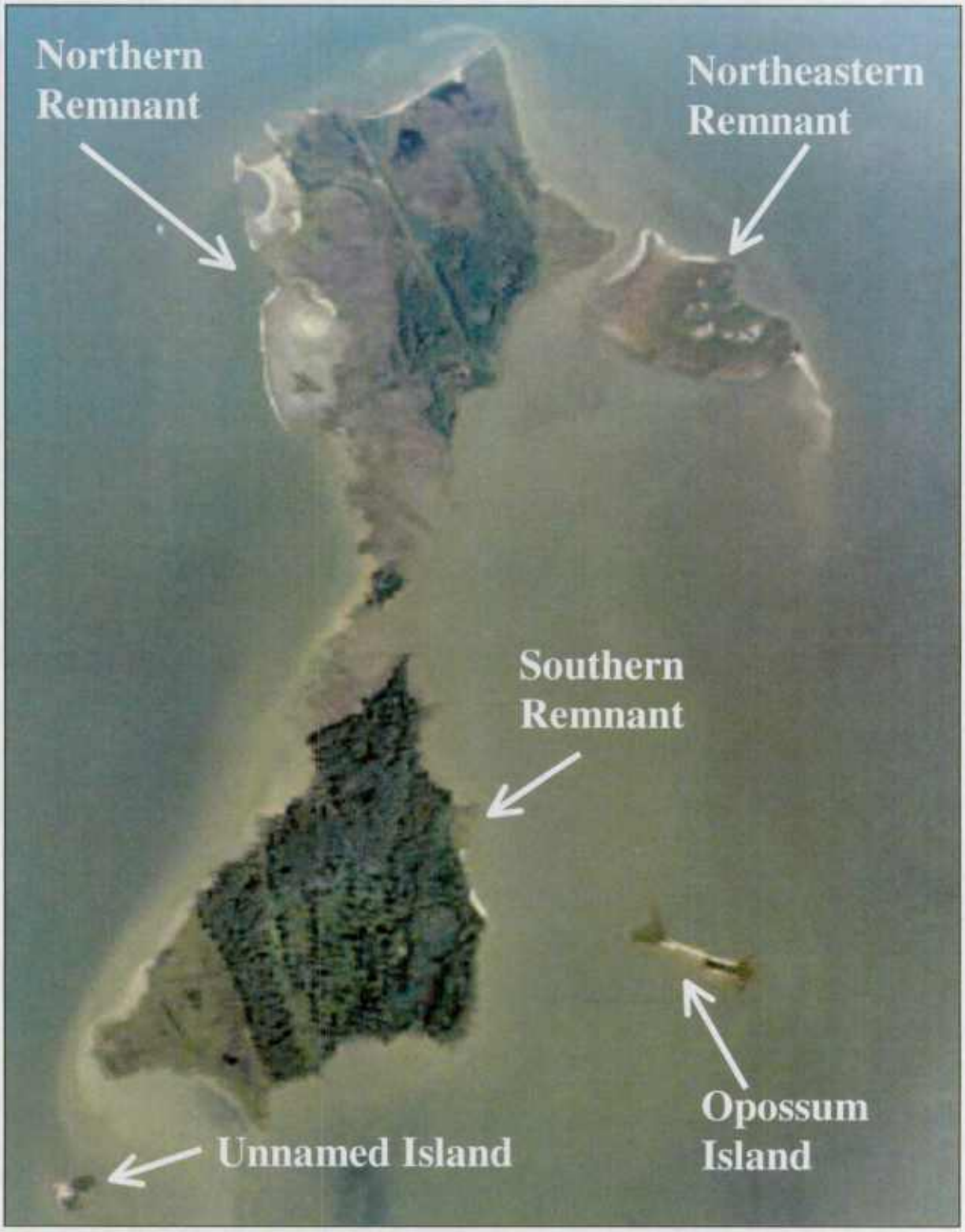


Figure 1-2. Current Barren Island Remnant Locations

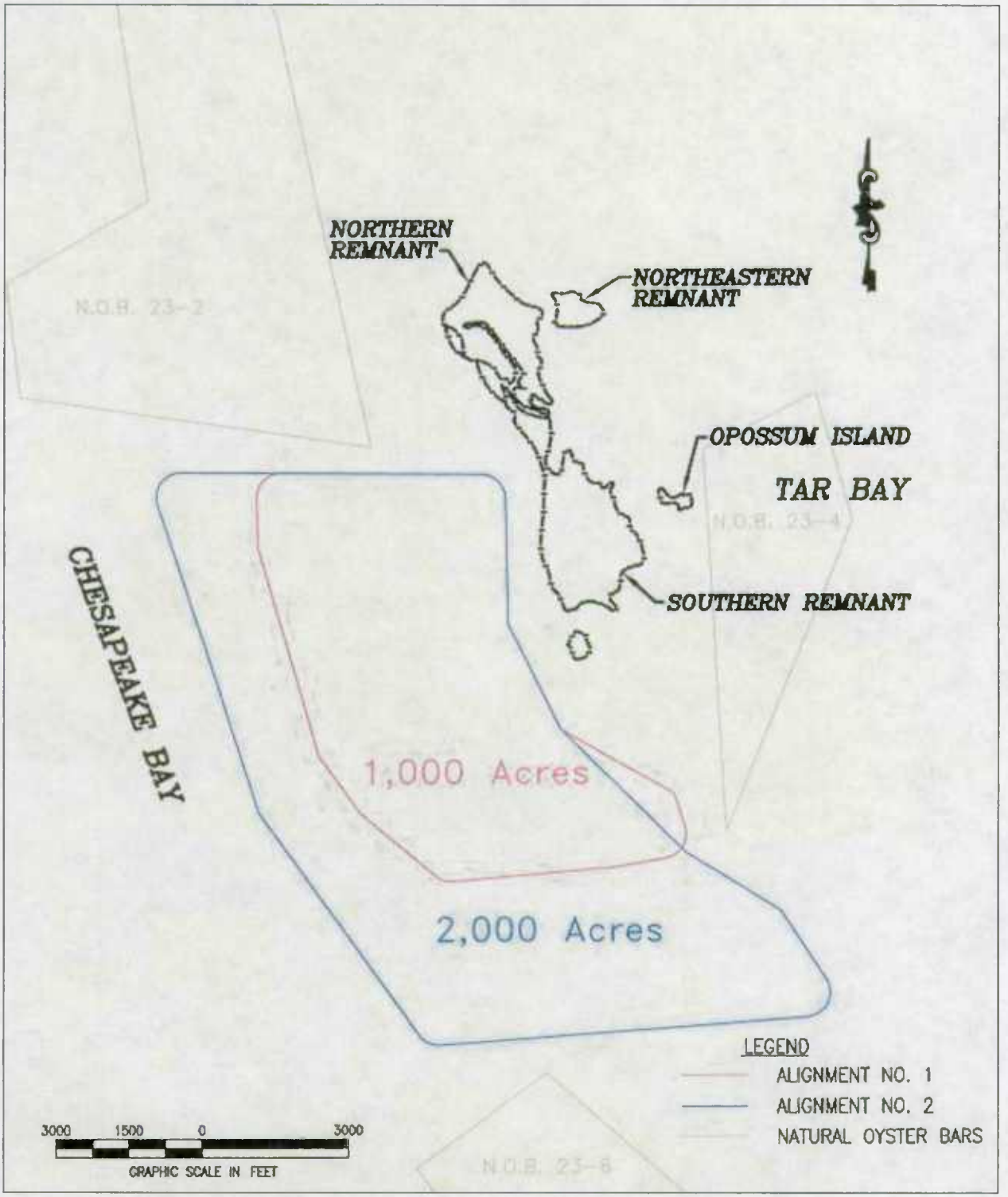


Figure 1-3. Proposed Placement Areas at Barren Island

2.0 METHODS

2.1 AQUATIC SURVEYS

2.1.1 Water Quality

At each benthic, plankton trawl, fish trawl, beach seine, and gillnet sampling station, *in-situ* water quality measurements were recorded using YSI-8300 instrumentation. Depth, water temperature, salinity, pH, and dissolved oxygen were recorded at the mid-depth of each station. Water quality information was recorded on field data sheets

Field Methods

In addition to *in situ* water quality, water quality samples for the analysis of nutrients were collected at each of the ten benthic sampling stations (BAR-1 through BAR-10). See Figure 2-1 for station locations. Water sampling was conducted exclusively for the analysis of nutrients and followed the standard methods used by the Chesapeake Bay Program and Maryland Department of the Environment (MDE). Water was pumped from a point at approximately mid-depth within the water column using a peristaltic pump and Tygon tubing. At each station two 1-L (whole water) samples and two 125-ml filtered water samples were collected. Filtered water samples were filtered in the field using a gravity filtration system and micro-pore filters. The whole water and filtered water samples were labeled with the sample location plus the date and time of sampling, then immediately stored on ice. Differential Global Positioning System (DGPS) coordinates and *in situ* water quality measurements were also recorded at each site. All nutrient sampling was conducted on the same day and iced samples were taken to Chesapeake Biological Laboratory (CBL) that afternoon/evening. Samples were recorded on standard electronic chain-of-custody forms, which were signed and delivered with the samples.

Laboratory Methods

Once at CBL, the water samples were analyzed using methods that have been standardized for the Chesapeake Bay so the results would be comparable to other Bay sampling programs. The following list of analyses were conducted on each set of samples:

- Total Dissolved Nitrogen
- Particulate Nitrogen
- Nitrite
- Nitrate + Nitrite
- Ammonium
- Organic Nitrogen
- Total Dissolved Phosphorus
- Orthophosphate (SRP)
- Particulate Carbon
- Dissolved Organic Carbon
- Total N and Total P
- Chlorophyll-*a* and Phaeophytin
- Total Suspended Solids

Figure 2-1. Benthic Stations in the Vicinity of Barren Island, September 2002

2.1.2 Benthic Community

Sampling Methods

Triplicate grab samples were collected at 10 locations around Barren Island (BAR-1 through BAR-10) using a standard 9-in × 9-in Ponar grab sampler (See Figure 2-1). One additional grab was collected at five locations for analysis of grain size. Each replicate benthic sample was sieved in the field through a 500-micron screen to remove fine sediment particles. Individual replicates were transferred to labeled bottles and preserved in the field using buffered 10 percent formaldehyde solution stained with rose bengal.

Sample Storage and Transport

Benthic samples collected during each workday were preserved in a buffered 10 percent formaldehyde solution in the field and were stored in appropriate containers out of direct sunlight on the workboat. After completion of benthic sampling, the samples were transported to EA in Sparks, Maryland, where they were logged in and stored until laboratory processing. Samples were sorted and sub-sampled in EA's Biology Laboratory, then sent to Cove Corporation (Cove) for taxonomic identification to the lowest practical taxonomic level.

Laboratory Processing

In the laboratory, each benthic infaunal sample was washed with tap water through a 0.5-mm sieve to remove the preservative in preparation for lab processing. Due to the large number of organisms in the samples, the samples were sub-sampled. The sub-samples were placed in a shallow white pan and the organisms were separated from other sample material and placed in vials. The samples were sorted by major taxonomic groups and were submitted to Cove for identification to the lowest practical taxonomic level.

2.1.2.1 Sediment Quality

One additional grab was collected at all benthic stations for analysis of grain size and physical attributes. Samples were obtained using a standard 9-in. × 9-in. Ponar grab sampler. The sediment samples were stored in certified clean containers and refrigerated at 4°C during storage. E2CR, Inc. of Baltimore, MD performed the physical analyses (grain-size, Atterberg limits, percent fines, and specific gravity). All analyses were conducted according to American Society for Testing and Materials (ASTM) standard methods. In addition, the substrate was characterized visually and recorded at each sampling station.

2.1.2.2 Chesapeake Bay 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 stress (Weisberg et al. 1997). The Chesapeake Bay Benthic Index of Biotic Integrity (B-IBI) developed by Weisberg et al. (1997) was used to evaluate the benthic community. The metrics were designed to characterize the response of the benthic community to stresses. The B-IBI combines individual metrics and assigns a score to each of the metrics to describe the benthic community and to provide an assessment of benthic community

condition. Methodology followed guidance provided in both Weisberg et al. 1997 and Interstate Commission on the Potomac River Basin (ICPRB) 1999.

In order to calculate the B-IBI, each station was classified by salinity and substrate type. Salinity at the Barren Island benthic stations in September 2002 ranged from 10.7 to 18.1 parts per thousand (ppt), classifying the stations as high mesohaline (Weisberg et al. 1997). According to the ICPRB (1999), a substrate habitat is defined as sand if the average silt/clay value is between 0 and 40 percent and as mud if the average silt/clay value is greater than 40 percent. All benthic stations (except for stations BAR-1 and BAR-9) had a silt/clay content of less than 40 percent and were classified as a sand habitat. Station BAR-1 had a silt/clay content of 41.7 percent and station BAR-9 had a silt/clay content of 86.3 percent, which would classify both stations as mud. Therefore, all of the benthic infaunal stations were classified as high mesohaline sand, except for BAR-1 and BAR-9, which were classified as high mesohaline mud.

The metrics included in the B-IBI for the high mesohaline sand and high mesohaline mud classification are as follows:

- Shannon-Weiner Diversity Index – This $\overline{H}$ index has probably been the most widely used index in community ecology. It is based on information theory and is a measure of the average degree of "uncertainty" in predicting the species of an individual chosen at random from a collection of S species and N individuals (Weisberg et al. 1997). This metric is influenced by species richness and the distribution of individuals among the species (Weber 1973). This metric is included in both the high mesohaline sand and high mesohaline mud classification for the B-IBI.

  The Shannon-Weiner Diversity Index is calculated using the following equation:

$$\overline{H} = -\sum \left(\frac{ni}{N}\right) \log_e \left(\frac{ni}{N}\right)$$

  where,

  ni = importance[(a)] value for each species
  N = Total of importance values

  (a) Importance = number of individuals of a given species

- Abundance – Total abundance was calculated as total number of organisms per square meter. This metric is included in both the high mesohaline sand and high mesohaline mud classification for the B-IBI.

- Stress-Indicative Taxa Abundance – This metric was calculated as the percentage of total abundance represented by stress-indicative taxa. This metric is appropriate for use in areas of high mesohaline sand but not 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 (ICPRB 1999).

- Stress-Sensitive Taxa Abundance – This metric was 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.

- Carnivore/Omnivore Abundance – This metric was calculated as the percentage of total abundance represented by carnivore/omnivore taxa. This metric is included in both the high mesohaline sand and high mesohaline mud classification for the B-IBI.

Table 2-1 presents the thresholds used to score each metric of the B-IBI. The IBI approach involves scoring each metric as 5, 3, or 1, depending on whether its value at a site approximates, deviates slightly, or deviates greatly from conditions at reference sites (Weisberg et al. 1997). The final B-IBI score is derived by summing individual scores for each metric and calculating an average score (IBI value). The B-IBI is an extension of an effort to establish benthic restoration goals for the Chesapeake Bay (Weisberg et al. 1997). The Chesapeake Bay Restoration Goal Index (Ranasinghe et al. 1994) was patterned after the same approach used to develop the Index of Biotic Integrity (IBI) for freshwater systems (Karr et al. 1986). A Chesapeake Bay Restoration Goal value of 3 represents the minimum restoration goal. The Restoration Goal values of less than 3 are indicative of a stressed community. Values of three or more indicate habitats that meet or exceed the restoration goals (Ranasinghe et al. 1994).

In order to calculate the B-IBI, feeding guilds and life histories of the benthic fauna were assigned to each species. Feeding guilds were derived from ICPRB (1999) and life histories were derived from Weisberg et al. (1997). A summary of the feeding guilds and life histories of the benthic fauna collected at Barren Island is presented in Table 2-2.

TABLE 2-1. THRESHOLD VALUES FOR METRICS USED TO SCORE THE CHESAPEAKE BAY BENTHIC INDEX OF BIOTIC INTEGRITY FOR HIGH MESOHALINE SAND AND MUD AT BARREN ISLAND

Metric	Scoring Criteria		
	5	3	1
High Mesohaline Sand			
Shannon-Weiner Diversity[(a)]	≥2.2	1.7-2.2	<1.7
Abundance (#/m^2)	≥1500-3000	1000-1500 or ≥3000-5000	<1000 or ≥5000
Stress-Indicative Taxa Abundance (%)	≤10	10-25	>25
Stress-Sensitive Taxa Abundance (%)	≥40	10-40	<10
Carnivore/Omnivore Abundance (%)	≥35	20-35	<20
High Mesohaline Mud			
Shannon-Weiner Diversity[(a)]	≥2.1	1.4-2.1	<1.4
Abundance (#/m^2)	≥1500-2500	1000-1500 or ≥2500-5000	<1000 or ≥5000
Carnivore/Omnivore Abundance (%)	≥25	10-25	<10

[(a)] Converted to log base e
Source: Weisberg et al. 1997 and ICPRB 1999

TABLE 2-2 FEEDING GUILD AND LIFE HISTORY INFORMATION FOR BENTHIC MACROINVERTEBRATES COLLECTED FROM BARREN ISLAND, SEPTEMBER 2002

TAXA	FEEDING GUILD[a]	LIFE HISTORY[b]
CNIDARIA (sea anemones)		
Edwardsia elegans (burrowing anemone)	carnivore/omnivore	--
PLATYHELMINTHES (flatworms)		
Stylochus ellipticus[c] (oyster flatworm)	--	--
Turbellaria sp.E[c]	--	--
NEMERTINEA (unsegmented worms)		
Amphiporus bioculatus	not assigned	--
Micrura leidyi (red ribbon worm)	carnivore/omnivore	--
GASTROPODA (snails)		
Acteocina canaliculata (barrel bubble snail)	carnivore/omnivore	--
Doridella obscura[c]	--	--
Haminoea solitaria(solitary bubble snail)	carnivore/omnivore	--
Odostomia engonia[c]	--	--
Rictaxis punctostriatus	carnivore/omnivore	--
BIVALVIA (clams and mussels)		
Gemma gemma (gem clam)	suspension	--
Geukensia demissa[c] (Atlantic ribbed mussel)	--	--
Macoma balthica (baltic clam)	interface	pollution-sensitive
Macoma mitchelli	interface	--
Mulinia lateralis (coot clam)	suspension	pollution-indicative
Parvilucina multilineata	suspension	--
Petricola pholadiformis (false angel wing)	suspension	--
ANNELIDA (segmented worms)		
OLIGOCHAETA (aquatic worms)		
Tubificoides spp.	deep deposit	pollution-indicative
POLYCHAETA (bristle worms)		
Etone foliosa	carnivore/omnivore	--
Etone herteropoda (freckled paddle worm)	carnivore/omnivore	--
Glycinde solitaria (chevron worm)	carnivore/omnivore	pollution-sensitive
Heteromastus filiformis (capitellid thread worm)	deep deposit	--
Leitoscoloplos robustus	deep deposit	--
Loimia medusa (red-spotted worm)	interface	pollution-sensitive
Mediomastus ambiseta	deep deposit	pollution-sensitive
Neanthes succinea	carnivore/omnivore	--
Paraonis fulgens	interface	--
Paraprionospio pinnata (fringe-grilled mud worm)	interface	pollution-indicative
Pectinaria gouldii (trumpet worm)	deep deposit	--
Podarkeopsis levifuscina	carnivore/omnivore	--
Polydura cornuta	interface	--
Scolelepis (P.) texana	interface	--
Spiochaetopterus costarum	interface	pollution-sensitive

478 **TABLE 2-2. (CONTINUED)**

479

TAXA	FEEDING GUILD[a]	LIFE HISTORY[b]
POLYCHAETA (bristle worms) - Continued		
Spiophanes bombyx	interface	pollution-sensitive
Streblospio benedicti (barred-gilled mud worm)	interface interface	pollution-sensitive pollution-indicative
CRUSTACEA		
AMPHIPODA (beach fleas; scuds)		
Ameroculodes spp. complex	--	--
Ampelisca abdita (small four-eyed amphipod)	suspension	--
Cymadusa compta[c] (wave-diver tube-builder amphipod)	-- --	-- --
Microprotopus raneyi[c]	--	--
Mucrogammarus mucronatus		
DECAPODA		
Ogyrides alphaerostris	carnivore/omnivore	--
ISOPODA (isopods)		
Edotea triloba[c] (mounded-back isopod)	--	--
Erichsonella spp.	carnivore/omnivore	--
Paracereis caudata[c] (eelgrass pill bug)	--	--
Ptilanthura tenuis	carnivore/omnivore	--
CUMACEA (cumacean shrimp)		
Leucon americanus	interface	--
Oxyurostylis smithi	interface	--
MYSIDACEA (mysid shrimp)		
Ameriocamysis almyra[c]	--	--
Cyclaspis varians	interface	--
Neomysis americana[c] (mysid/bay opossum shrimp)	--	--
PHORONIDA (horseshoe worms)		
Phoronis sp.	suspension	--
HEMICHORDATA (acorn worms)		
Saccoglosus kowalevskii	deep deposit	--
ENCHINODERMATA (spiny-skinned animals)		
Leptosynapta tennuis (white synapta)	deep deposit	--
CEPHALOCHORDATA		
Branchiostoma caribaeum	--	--
DIPTERA (insects)		
Chronomidae larve (midges)	carnivore/omnivore	--

480 [a] Feeding guides taken from Ranasinghe et al. (1994) and the ICPRB (1999).
481 [b] Life histories taken from Weisberg et al. (1997).
482 [c] Feeding guild for *Monoculodes* sp. was used; same family, Oedicerotidae.
483 [d] Species not meeting B-IBI macrofaunal criteria (ICPRB 1999 and Ranasinghe et al. 1994).

Data Analysis for Other Benthic Community Metrics

Four additional metrics were selected to further characterize the benthic community and include the following

- **Total Number of Taxa** is the total number of distinct taxa. This metric reflects the health of the community through a measurement of the variety of taxa present.

- **Evenness (e)** is how the species abundances (e.g., the number of individuals, biomass, etc.) are distributed among the species (Ludwig and Reynolds 1988). Evenness is a measure of how similar the abundances of different species are. When there are similar proportions of all species, then evenness is one, but when the abundances are very dissimilar (some rare and some common species), the value increases (Geneseo 1996). The equation for Evenness is:

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

where:

$\overline{H}$ = Shannon-Weiner Index value
S = number of species

- **Species richness (d)** is the number of species in the community dependent on the sample size (Ludwig and Reynolds 1988). The equation for Species Richness Index is:

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

where:

S = number of species
N = number of individuals

This index expresses the variety of component of species diversity at each station as a ratio between the total number of species (taxa) and the total number of individuals. Basically, it removes the abundance variability among stations so that comparisons between stations are possible. This index expresses variety independent of an evenness index, which is incorporated in general indices of diversity. Diversity indices incorporate both species richness and evenness into a single value.

- **Simpson's Dominance Index (c)**, which varies from 0 to 1, gives the probability that two individuals drawn at random from a population belong to the same species (Ludwig and Reynolds 1988). The equation for Simpson's Dominance Index is:

$$c = \sum (ni/N)^2$$

where,

ni = importance value for each species
N = total of importance values

2.1.3 Fisheries Studies

Three sampling techniques, bottom trawl, beach seining, and gillnetting, were employed to collect adult and juvenile fish species around Barren Island in September 2002. Fish and blue crabs were collected at fifteen locations (five beach seine locations, six bottom trawl, and four gillnet) within and adjacent to the proposed dike alignments.

Bottom Trawl

Six bottom trawl locations (BAR-001 through BAR-006) were identified in the field that reflected the range of bottom conditions within or adjacent to the proposed alignments (Figure 2-2). Two consecutive, parallel otter trawl tows were conducted at each station, spaced several hundred feet apart. Trawling was conducted from three hours before until three hours after high tide. The gear employed was a 16-foot semi-balloon otter trawl with a ¾" liner. When the net was deployed, DGPS coordinates were recorded at the beginning and end of each tow. Two separate five-minute tows were conducted at each of the six locations at a constant boat speed of 1,300 revolutions per minute (rpm). Longer tows were not conducted due to obstructions such as crab pots and downed trees. The two tows at each location were conducted parallel to the prevailing currents, tidal flow or wind, which ever is greater. A 7:1 warp-to-tow ratio was used at all times to ensure that the net was fishing on the bottom. Upon completion of each five-minute tow, the trawl was emptied into a container and processed before conducting the second tow.

Trawl samples were processed onboard and organisms were identified, enumerated, and returned to the water. A representative subsample of fifty individuals per species from each tow were to be measured to the nearest millimeter, however, no species collected numbered enough to warrant subsampling at any of the six locations. Measurements included total lengths of finfish and carapace widths of blue crabs. Data were recorded on standard fisheries datasheets. Organisms having external parasites, disease, or morphological abnormalities were noted on the datasheet. Organisms collected during the two tows at a single location were numerically combined to represent ten-minutes of total effort for summarization purposes. *In situ* water quality parameters were recorded at each of the six locations.

Beach Seine

Five beach seine locations (BAR-S1 through BAR-S5) were identified in the field, and were chosen to reflect a range of shoreline conditions within and adjacent to the proposed alignments. Because of the many snags and variable bottom conditions around much of the island remnants, the locations chosen were the areas that could be sampled effectively by seining; the beach seine locations are presented in Figure 2-3. Locations were chosen to represent as many types of shore-zone habitat as possible and to distribute the seine sites between the western and eastern sides of the island. BAR-S1 was located on the northern end of the northern remnant. BAR-S2 was located on the western shoreline of the northern remnant. BAR-S3 was located on the southwestern shoreline of the southern remnant. BAR-S4 was located on the sandspit of the northeastern remnant and BAR-S5 was located on the oyster shell beach on the eastern side of the southern remnant.

A 100-foot by 4-foot seine net with ¼ inch mesh was used to sample these locations. The net was deployed in an arc, perpendicular to the shoreline to sample approximately 30 meters of

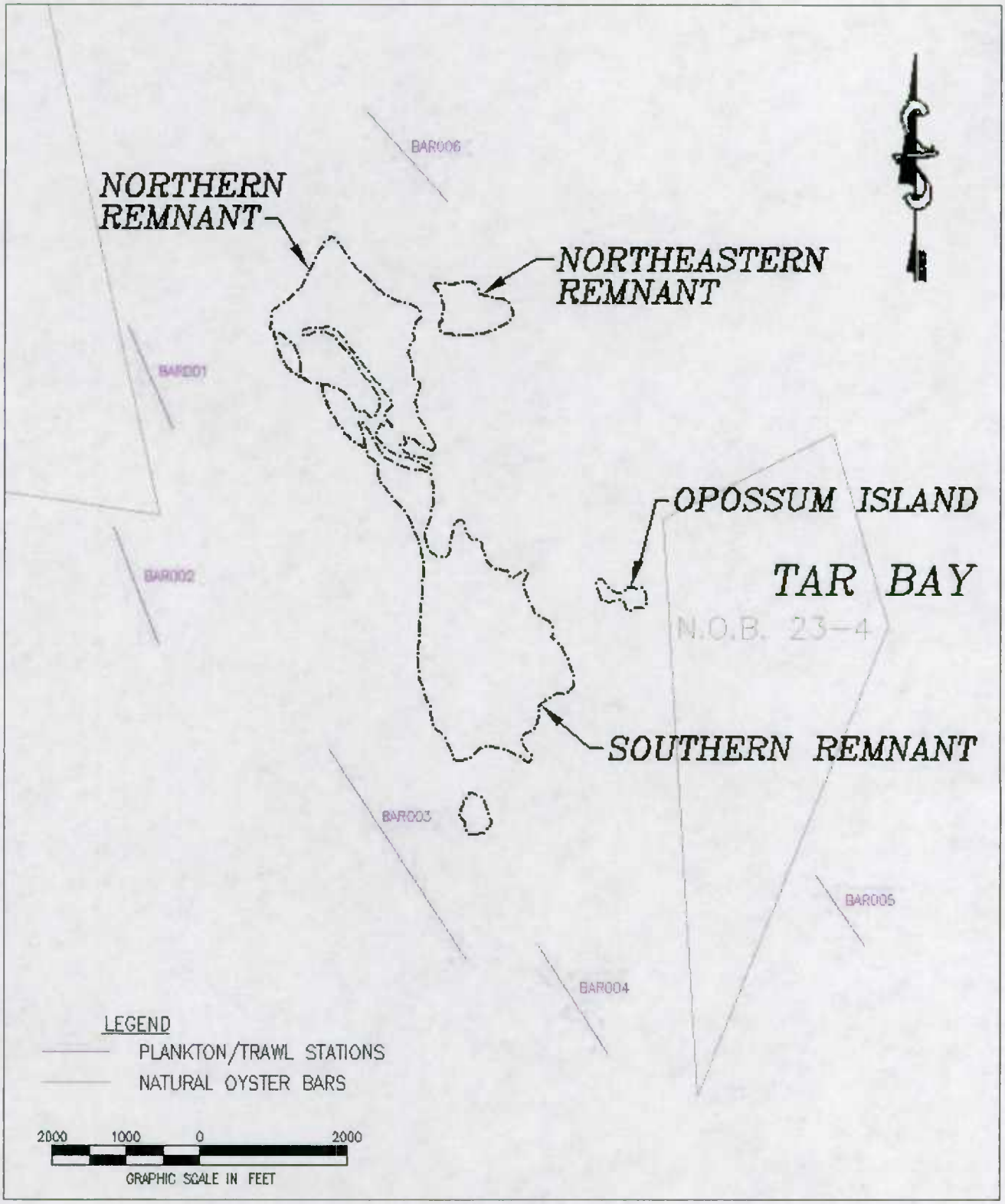


Figure 2-2. Plankton / Trawl Stations in the Vicinity of Barren Island, September 2002

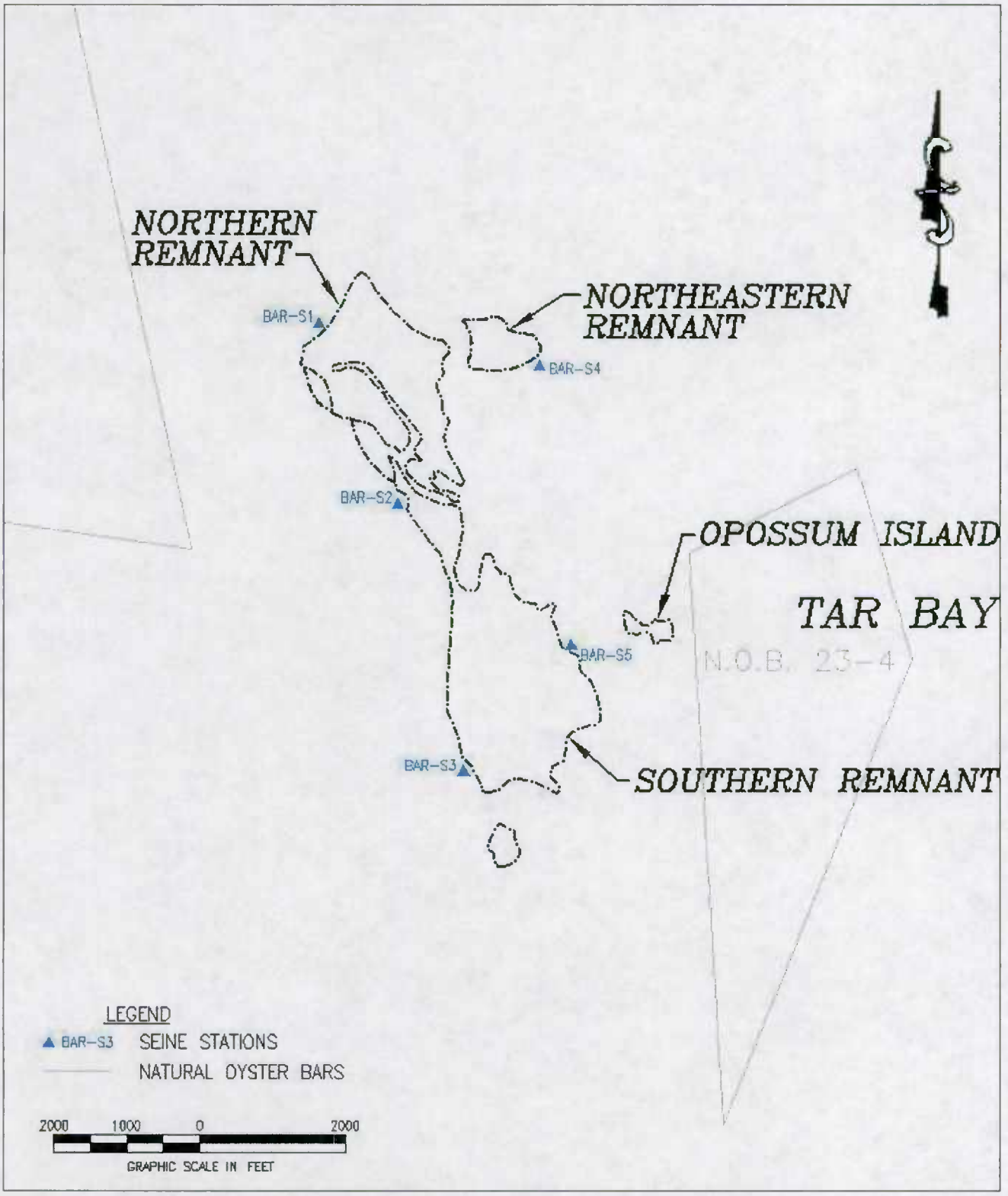


Figure 2-3. Seine Stations in the Vicinity of Barren Island, September 2002

shoreline. Two consecutive and adjacent hauls were conducted at each of the five sites for a combined shoreline distance of approximately 60 meters. All finfish and blue crabs were emptied into a container and processed before conducting the second haul.

Seine samples were processed onshore, and organisms were identified, enumerated and returned to the water. A representative subsample of fifty individuals per species from each haul was measured to the nearest millimeter. Measurements included total lengths of finfish and carapace widths of blue crabs. Data were recorded on standard fisheries datasheets. Organisms having external parasites, disease, or morphological abnormalities were noted on the datasheet. Organisms collected during the two hauls at a single location were numerically combined for summarization purposes. *In situ* water quality parameters were recorded at each of the five locations.

Gillnets

Gillnetting was conducted at four locations within and adjacent to the proposed alignments. The gillnet locations are shown on Figure 2-4 and were selected based upon bathymetry and the areas that are most likely utilized five 5 panels of different mesh size were utilized. The mesh varies from ¾ inch to 2.5 inch (square mesh) and targets a wide variety of species and lifestages that would typically utilize the shallows around Barren Island. One net per station was deployed as fixed gear, overnight, for at least twelve hours. Nets were set perpendicular to the prevailing tidal current with the smallest mesh in the shallower (near shore) waters. DGPS coordinates were recorded at the centerpoint of each net.

All organisms captured in the nets were processed onboard the work boat, and organisms were identified, enumerated, and returned to the water. A representative subsample of fifty individuals per species at each station were measured to the nearest millimeter; including total lengths of finfish and carapace widths of blue crabs. Data were recorded on standard fisheries datasheets. Organisms having external parasites, disease, or morphological abnormalities were noted on the datasheet. *In situ* water quality parameters were recorded at each of the four locations.

2.1.4 Plankton Studies

Plankton sampling was conducted at six locations, utilizing the same basic stations as the fisheries (trawl) locations (Figure 2-2). Two consecutive, but separate five-minute tows were conducted. One tow was conducted at the water surface and one tow was conducted at the bottom. For each tow, a constant boat speed of 1,100 rpm was maintained. The gear utilized were two 2.5-M long, conical plankton nets with 0.5-m mouth openings, made from 505-micron mesh. These were mounted side-by-side on a rigid metal towing frame and sled, and 1-liter plastic collection jars were screwed into the threaded codends. A General Oceanics digital flowmeter was affixed in the mouth of each net to record sample volume. A third flowmeter was attached to the sled frame outside of the nets for the purposes of monitoring net clogging. If substantially lower flowmeter readings were found in-net as compared to outside, the tow was repeated. Before deploying the plankton sled, six-digit flowmeter readings were recorded from each of the three meters and DGPS beginning positions were recorded. The standard towing

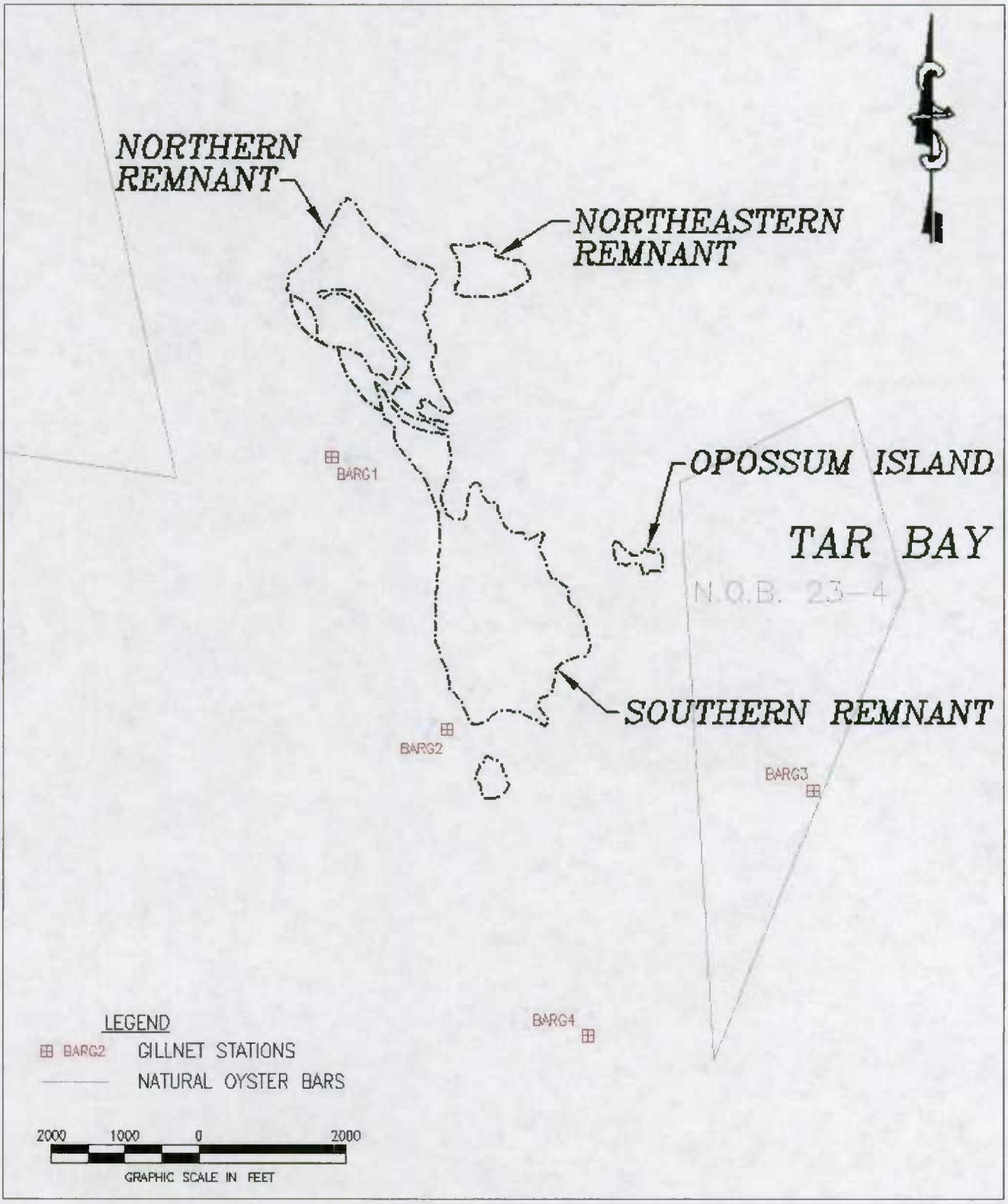


Figure 2-4. Gillnet Stations in the Vicinity of Barren Island, September 2002

period was five minutes from the time that the nets were set and the tow was parallel to the prevailing currents.

The amount of line deployed was calculated from a nomograph using the water depth and a cable angle. At the end of each tow, the final flowmeter and DGPS readings were recorded. The contents of each net were then rinsed, concentrating the catch into the codend jar. Sample jars were removed from the nets, labeled (inside and out), and preserved with 10 percent buffered formalin solution. At each station, mid-depth *in situ* water quality measurements were recorded.

In the laboratory, samples were rinsed using a 400-micron sieve to remove excess formalin. Detritus and debris were removed prior to sorting. Larger organisms were also removed and recorded. Samples were sorted completely and all fish eggs, larvae, and juveniles encountered were segregated for identification and enumeration. Ichthyoplankton were identified to the lowest practical taxon and enumerated. Macrozooplankton were also removed and enumerated by class. All observations were noted on standard laboratory sorting sheets. The remaining sample was recondensed and represerved for storage.

Plankton are reported as densities per 100 m^3. This was done by converting the net (final minus initial) flowmeter reading to a distance and volumes (based upon the net-mouth opening), then extrapolating the catches to the number of organism per 100 m^3. *In situ* water quality parameters were recorded at each of the six plankton station locations.

2.1 TERRESTRIAL SURVEYS

2.2.1 Vegetation Surveys

Vegetative communities and habitat types observed at Barren Island in September were categorized and documented by a field reconnaissance of the three island remnants. Additionally, aerial photographs, maps, and field notes from previous investigations of Barren Island were also used to determine the community types present at Barren Island. The intent of the vegetation characterization component of this investigation was to identify the distribution and composition of plant communities present such as low marsh, high marsh, upland, open water, and SAV habitats. The plant species composition of these areas was determined in terms of dominant and sub-dominant plants (by visual dominance estimation) determined to the genus and species level, where possible. In September 2001 MES conducted a site visit to Barren Island, traversed the three island remnants, made notes on general habitat types, and observed shoreline erosion by boat. In September 2002, two EA scientists traversed approximately 75 percent of the northern, northeastern, and southern remnants of Barren Island and recorded more detailed floristic and habitat observations. Dominant plant species and vegetative communities encountered during the vegetation survey were documented on data sheets and observations were recorded with a digital camera in the field. Digital images were downloaded in the office and organized as a photographic record (See Appendix A). Observed plant species were identified in the field and characterized by natural resource type. Qualitative plant distribution and community data were recorded. Details of the botanical species observed within each habitat type or natural resource were recorded on the data sheets. Other general observations including wildlife species and topography characteristics were also noted.

2.2.2 Avian and Wildlife Observations

Timed bird survey observations were made during September 2002. Five avian stations around the perimeter of the three remnants of Barren Island (Stations A-1 to A-5) were established in order to observe the range of habitat types available around the island (i.e., including forests, wetlands, open water, SAV, and beach). See Figure 2-5 for the avian station locations. At each station a timed bird survey was conducted covering a 180-degree observation area. Each survey was 15 minutes in length. All species heard and/or observed with binoculars during the 15-minute period were recorded on data sheets. The data sheet consisted of four sections: sample information (date, time, location, weather conditions), habitat checklist, a bird species checklist and an area for notations. The checklist portion of the field data sheet had been developed for use as a generic field data sheet.

Bird species considered relatively common over a wide diversity of habitat types and seasons were listed in the checklist. Bird species were listed in taxonomic order and broken into categories as follows:

- Loons-Herons
- Geese-Ducks
- Vultures-Hawks
- Game Birds
- Shorebirds
- Gulls
- Doves-Cuckoos
- Owls
- Nightjars-Swifts
- Hummingbirds
- Kingfishers
- Woodpeckers
- Flycatchers
- Shrikes
- Vireos
- Jays-Crows
- Larks
- Swallows
- Titmice-Chickadees
- Creepers-Nuthatches
- Wrens
- Kinglets-Gnatcatchers
- Thrushes
- Mimics
- Starlings-Waxwings
- Warblers
- Tanagers
- Towhees-Sparrows
- Cardinals-Grosbeaks
- Blackbirds
- Finches
- Old World Sparrows

The purpose for surveying birds associated with the three remnant portions of Barren Island was to make observations at a portion of the remnant and the adjacent, open water. The survey methods were utilized to achieve the desired results of documenting avian utilization of the project area, particularly the tidal marsh, upland habitat, and adjacent tidal waters.

During the 15-minute observation period, all avian species seen and/or heard were noted along with the method of observation. Individuals were enumerated when discernible. Evidence of former nesting on the Barren Island remnants was also noted when observed.

In addition to the timed avian observations, incidental bird species observed were noted during the Barren Island habitat characterization surveys in September 2002. The avian field data form

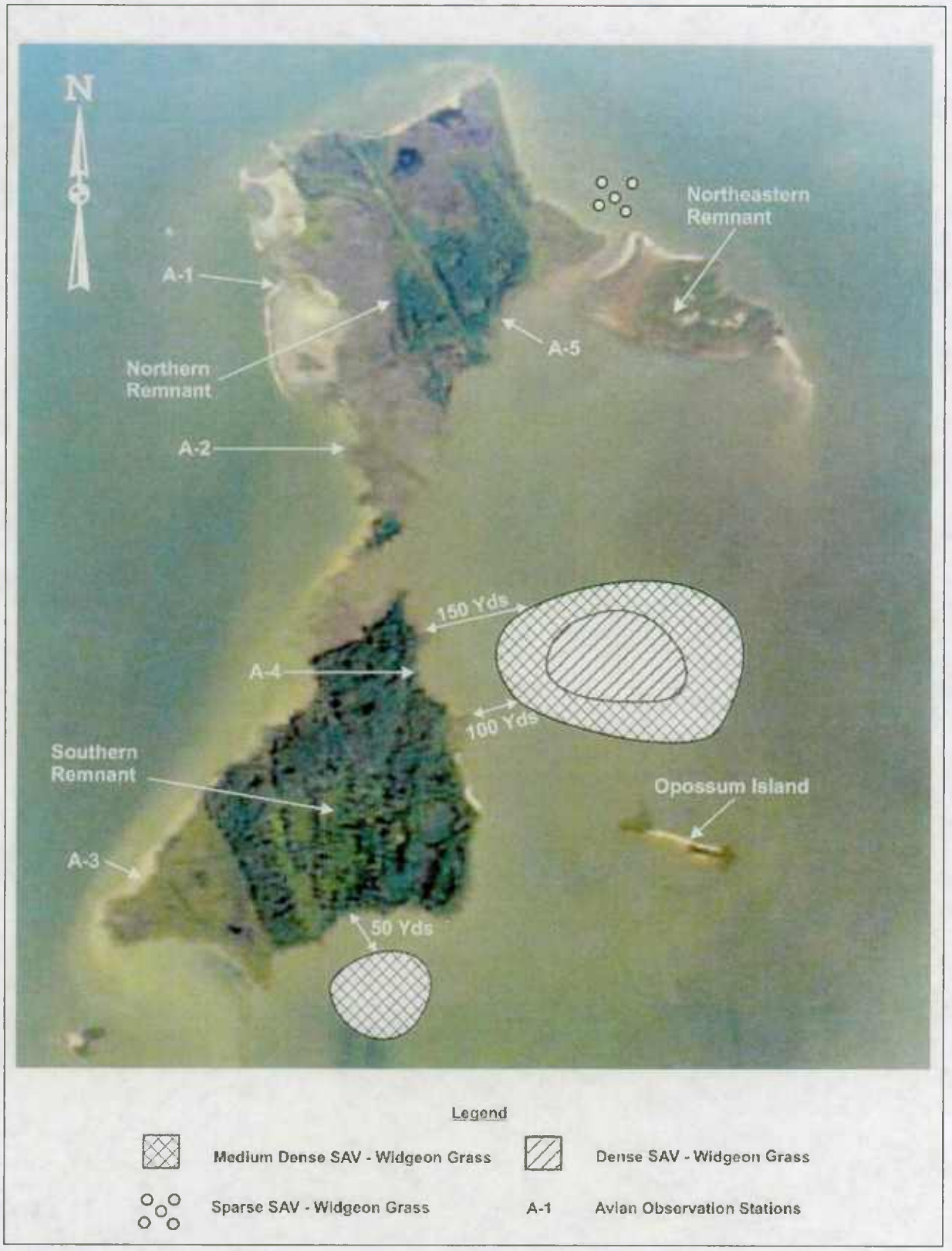


Figure 2-5. Avian Observation Stations in the Vicinity and Extent of Submerged Aquatic Vegetation on Barren Island, September 2002

described above was utilized and the recorded observations followed the same methodology. During the vegetation and habitat characterization surveys on each island remnant, wildlife species and signs (e.g., tracks, scat, bones, etc.) observed were recorded. When possible, the total number of individual wildlife species was also noted. The notation box portion of the data sheet was used to record any observations of other wildlife species.

2.2.3 Historical and Cultural Resources

During both the MES September 2001 and the EA September 2002 surveys, observations of historical, archeological, and other resources were completed in conjunction with the vegetation, avian, and wildlife observations. The intent of this investigation was to identify the distribution and occurrence of possible historic and archeological resources that were identified by the Maryland Historic Trust (MHT) relative to the area proposed for construction. Approximately 75 percent of the northern, northeastern, and southern remnants of Barren Island were traversed by EA scientists and general historic and archeological observations were recorded, when applicable.

2.3 Submerged Aquatic Vegetation (SAV) Mapping

Occurrence of SAV in the vicinity of Barren Island was mapped as part of the reconnaissance for the vegetation, avian, and seining investigations of the island (Figure 2-5). The entire island remnants were encircled by boat and all occurrences of SAV were visually identified. Species compositions of the beds and relative densities were recorded and noted on maps. When plausible, the extent of the beds from the shoreline was measured. This was accomplished by setting the boat at the edge of an area containing SAV and the width of the bed to the shoreline was measured using a lazer range finder. All observations were drawn on a map.

3.0 RESULTS AND ANALYSIS

3.1 AQUATIC SURVEYS

The field sampling program was designed to assess the existing aquatic resources within and adjacent to the proposed alignments at Barren Island as described in Section 2. This section details the results of the investigations.

3.1.1 Water Quality

In-Situ Measurements

At each benthic, fish trawl, beach seine, gillnet, and plankton trawl sampling station, *in-situ* water quality measurements were recorded using YSI-8300 instrumentation. Depth, water temperature, salinity, pH, and dissolved oxygen were recorded at the mid-depth of each station. Water quality information is summarized in Table 3-1.

Depths in the areas sampled (except beach seine stations) ranged from 2 to 12 feet. Water temperatures recorded from all stations ranged from 22 to 25.8°C. Salinity ranged from 10.7 to 18.1 ppt at sampling stations. This is typical (although 10.7 ppt is somewhat low) for this reach of the Chesapeake Bay. Turbidity was recorded at seven of the ten benthic stations and ranged from 2.0 to 6.4 ntu, which is expected for the area. Measurements of pH ranged from 8.1 to 8.4, which is typical of waters of this salinity regime. Dissolved oxygen ranged from 6.9 to 8.5 mg/L and is within the range expected at these temperatures, depths, and salinities.

Nutrient Analyses

Water samples collected from each sampling station were analyzed for dissolved inorganic nutrients, dissolved organic nutrients, particulate nutrients, chlorophyll-*a*, phaeophytin, and total suspended solids. Results of the nutrient analyses are presented in Table 3-2 and summarized in the following subsections.

Dissolved Inorganic Nutrients

Concentrations of nitrate ranged from 0.0028 to 0.0129 mg N/L, concentrations of nitrite ranged from 0.0011 to 0.0029 mg N/L, and concentrations of phosphate ranged from 0.0027 to 0.0054 mg P/L. Concentrations of ammonium ranged from 0.006 to 0.02 mg N/L.

Dissolved Organic Nutrients

Concentrations of total dissolved organic carbon (DOC) ranged from 4.29 to 5.55 mg C/L, concentrations of total dissolved nitrogen (TDN) ranged from 0.29 to 0.39 mg N/L, and concentrations of total dissolved phosphorous (TDP) ranged from 0.013 to 0.017 mg P/L.

Particulate Nutrients

Particulate carbon (PC) concentrations ranged from 0.775 to 1.9 mg C/L, particulate nitrogen (PN) concentrations ranged from 0.153 to 0.329 mg N/L, and particulate phosphorous (PP) concentrations ranged from 0.0167 to 0.0314 mg P/L.

779 **TABLE 3-1. *IN SITU* WATER QUALITY MEASUREMENTS TAKEN IN**
780 **ASSOCIATION WITH BIOLOGICAL COLLECTIONS, SEPTEMBER 2002***
781

Station Number	Depth (ft)	Temperature (C)	pH	DO (mg/L)	Salinity (ppt)	Turbidity (ntu)
Benthic Sampling						
BAR-1	8.0	24.6	8.2	8.2	14.4	---
BAR-2	12.0	24.6	8.2	8.5	14.5	---
BAR-3	9.0	24.7	8.2	8.5	14.3	5.6
BAR-4	4.0	24.7	8.2	8.0	14.3	6.4
BAR-5	6.0	25.5	8.2	7.5	17.0	2.1
BAR-6	9.0	25.8	8.3	7.6	17.5	2.0
BAR-7	5.0	24.3	8.3	7.5	16.1	6.9
BAR-8	4.0	24.2	8.2	7.3	17.0	5.5
BAR-9	5.0	24.2	8.2	7.3	17.3	5.5
BAR-10	2.0	25.5	8.3	8.0	16.1	---
Plankton Trawl Sampling						
BAR-001	9.0	25.4	8.3	7.3	18.1	---
BAR-002	9.0	25.2	8.3	7.0	18.1	---
BAR-003	9.0	25.3	8.3	7.0	17.9	---
BAR-004	6.0	25.4	8.2	7.0	17.5	---
BAR-005	5.0	24.4	8.2	6.9	17.8	---
BAR-006	5.0	25.5	8.4	7.5	17.9	---
Fish Trawl Sampling						
BAR-001	3.0	24.9	8.2	---	10.7	---
BAR-002	8.0	23.8	8.2	---	12.8	---
BAR-003	8.0	---	---	---	---	---
BAR-004	5.0	24.6	8.3	---	13.2	---
BAR-005	4.0	24.6	8.2	---	13.5	---
BAR-006	5.0	25.5	8.2	7.7	16.7	---
Beach Seine Sampling						
BAR-S1	1.0	25.7	8.4	8.1	18.1	---
BAR-S2	---	---	---	---	---	---
BAR-S3	---	24.7	8.1	6.9	17.3	---
BAR-S4	1.0	---	---	---	---	---
BAR-S5	---	---	---	---	---	---
Gillnet Sampling						
BAR-G1	---	---	---	---	---	---
BAR-G2	7.0	23.0	8.2	---	15.0	---
BAR-G3	---	22.0	8.3	7.4	15.4	---
BAR-G4	---	---	---	---	---	---

782 *---Reflects no reading recorded

783 **TABLE 3-2. NUTRIENT CONCENTRATIONS IN WATER SAMPLES COLLECTED FROM BARREN ISLAND,**
784 **SEPTEMBER 2002**
785

Analyte	Units	Station Number									
		BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
Nitrite	MG N/L	0.0014	0.0029	0.0011	0.0015	0.0011	0.0012	0.0013	0.0012	0.0013	0.0015
Nitrate	MG N/L	0.0129	0.0080	0.0033	0.0048	0.0060	0.0034	0.0028	0.0028	0.0028	0.0028
Ammonium	MG N/L	0.02	0.009	0.010	0.010	0.008	0.008	0.008	0.007	0.006	0.009
Orthophosphate	MG P/L	0.0042	0.0054	0.0028	0.0035	0.0030	0.0029	0.0027	0.0031	0.0028	0.0032
Carbon, Dissolved Organic	MG C/L	5.54	4.50	4.90	4.42	4.47	4.40	4.29	4.92	5.55	4.81
Nitrogen, Dissolved	MG N/L	0.39	0.29	0.29	0.30	0.31	0.30	0.29	0.30	0.32	0.33
Phosphorus, Dissolved	MG P/L	0.0168	0.013	0.0146	0.017	0.0147	0.0132	0.014	0.0137	0.0146	0.0136
Carbon, Particulate	MG C/L	0.858	0.775	0.92	0.92	1.03	0.895	1.12	0.833	1.2	1.9
Nitrogen, Particulate	MG N/L	0.167	0.153	0.17	0.174	0.197	0.171	0.231	0.161	0.22	0.329
Phosphorus, Particulate	MG P/L	0.018	0.0172	0.0184	0.0192	0.0192	0.0179	0.018	0.0167	0.0205	0.0314
Chlorophyll-*a*, Active	UG/L	4.99	5.93	5.45	4.81	5.31	7.94	4.23	5.0	5.95	8.76
Phaeophytin	UG/L	1.77	2.33	2.01	1.65	1.59	2.81	1.34	1.57	1.57	2.71
Total Suspended Solids	MG/L	16.0	13.5	16.6	23.5	17.6	14.0	13.4	13.7	15.7	67.7

786

Chlorophyll-a and Phaeophytin

Chlorophyll-*a* concentrations ranged from 4.81 to 8.76 ug/L, and phaeophytin concentrations ranged from 1.34 to 2.81 ug/L.

Total Suspended Solids

The total suspended solids (TSS) concentration in water samples from Barren Island ranged from 13.4 to 67.7 mg/L. Turbidity was somewhat elevated around the island at various times during the Summer 2002 surveys due to wind driven waves suspending bottom sediments and eroding the exposed sediments of the island. The higher TSS values at BAR-10 were likely due to the very shallow depths at the station (2 feet) which facilitated sediment suspension due to wave action and propeller wash.

3.1.2 Benthic Community

Results of the benthic community evaluations are included in the following sections and detailed in Appendix B. Ten benthic stations were sampled in September 2002 (BAR-1 to BAR-10). Six of the ten benthic stations were located within the proposed alignments at Barren Island and include stations BAR-2, BAR-3, BAR-4, BAR-5, BAR-6, and BAR-7.

A taxonomic list of the benthic macroinvertebrates collected from Barren Island in September 2002 is presented in Table B-1 (Appendix B). Mean densities for each benthic macro-invertebrate collected at each station are presented in Table B-2 (Appendix B). *In-situ* water quality measurements collected during the field effort for the benthic studies were previously discussed in Section 3.1.1 and are included in Table 3-1.

3.1.2.1 Sediment Quality

Grain-size test results are presented in Figure 3-1 and Table 3-3. The results indicate that the sediment around Barren Island is predominately comprised of sand (57.6 to 98.0 percent) at eight locations except for BARSED-9, which was predominately comprised of silt-clay (86.3 percent) and BARSED-1, which was over 40 percent silt-clay (41.7 percent). Both BARSED-9 and BARSED-1 were characterized as mud. Of the ten Barren Island sediment samples, location BARSED-2 had the highest proportion of sand (98.0 percent).

3.1.2.2 Chesapeake Bay Benthic Index of Biotic Integrity (B-IBI)

A summary of the benthic community metrics and scores used to calculate the B-IBI for the September 2002 collection at Barren Island is presented in Table 3-4. Abundance (total number of organisms per square meter) varied at Barren Island ranging from 687/m^2 at BAR-10 to 7,583/m^2 at BAR-6, which resulted in B-IBI scores ranging from 1 to 5. The Shannon-Weiner Diversity values also varied, ranging from 1.492 at BAR-6 to 2.532 at BAR-7, which resulted in B-IBI scores ranging from 1 to 5. The abundance of pollution-sensitive taxa was high at most stations ranging from 10.5 percent at BAR-8 to 60.3 percent at BAR-3, resulting in B-IBI scores of either 3 or 5 at all the stations. The abundance of pollution-indicative taxa was low for most stations ranging from 1.2 percent at BAR-7 to 21.7 percent at BAR-10, resulting in B-IBI scores of either 3 or 5 at all the stations. Pollution-sensitive and pollution-indicative taxa were not

FIGURE 3-1. GRAIN SIZE DISTRIBUTION FOR BULK SEDIMENTS FROM BARREN ISLAND, SEPTEMBER 2002

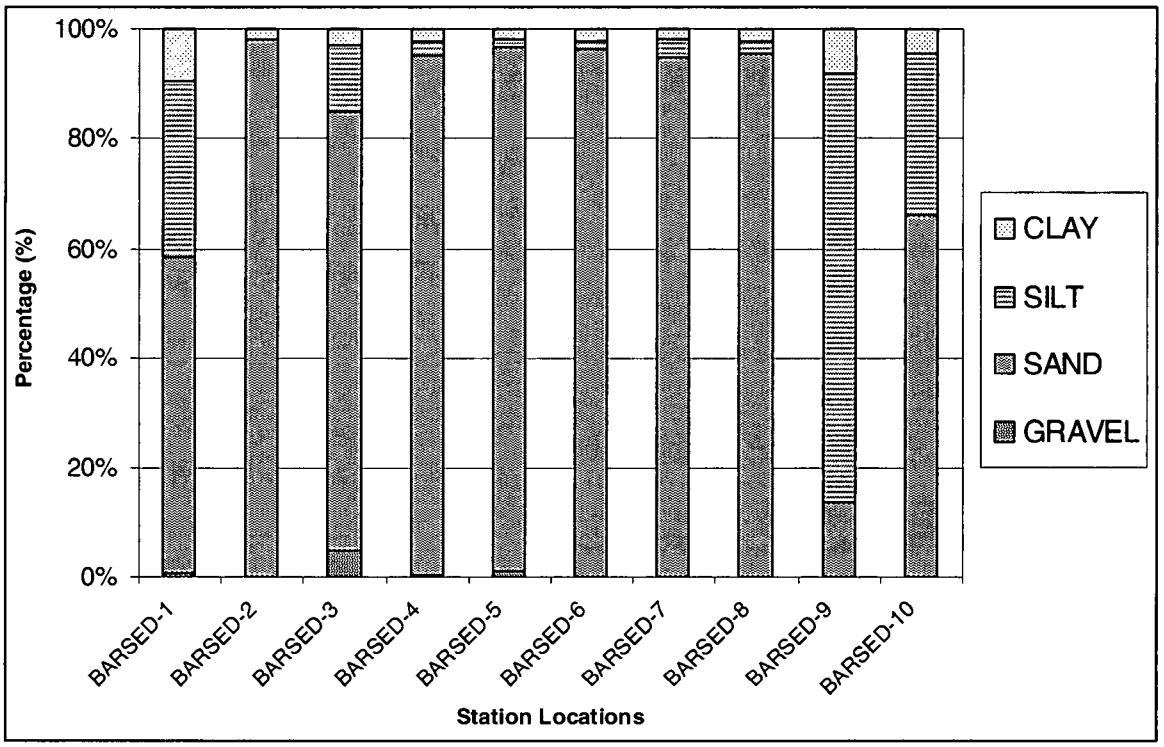


TABLE 3-3. PHYSICAL CHARACTERISTICS OF SEDIMENTS FROM BENTHIC STATIONS AT BARREN ISLAND, SEPTEMBER 2002

Analyte	Units	Station Location									
		BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
Cobbles	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gravel	%	0.7	0.0	4.6	0.2	1.1	0.0	0.1	0.0	0.0	0.0
Sand	%	57.6	98.0	80.5	94.9	95.6	96.2	94.9	95.5	13.7	66.3
Silt	%	32.1	0.0	11.8	2.8	1.3	1.6	3.0	2.3	78.2	29.2
Clay	%	9.6	2.0	3.1	2.1	2.0	2.2	2.0	2.2	8.1	4.5
Silt + Clay	%	41.7	2.0	14.9	4.9	3.3	3.8	5.0	4.5	86.3	33.7
Moisture	%	58.4	34.1	29.5	31.7	27.4	40.3	34.8	39.1	50.3	45.8
Specific Gravity	G/ML	2.67	2.69	2.65	2.70	2.63	2.69	2.72	2.66	2.66	2.69

calculated at the high mesohaline mud stations BAR-1 or BAR-9. Station BAR-1 was classified as mud, but the substrate was very similar to sand since the silt/clay content was 41.7 percent, a value barely qualifying above 40 percent. The abundance of carnivore/omnivore taxa varied at Barren Island, ranging from 14 percent at BAR-5 and BAR-9 to 79.9 percent at BAR-6, resulting in scores of 1 to 5 at all stations. The scores for each of the metrics at each station were averaged to determine the total B-IBI for each station. Scores of 3.0 or greater are considered as meeting the Chesapeake Bay Restoration Goal. Total B-IBI scores were high (3.0 – 5.0) for all stations sampled at Barren Island in September 2002. All stations met the Chesapeake Bay Restoration Goal, and station BAR-1 had a perfect score of 5.0.

Other Benthic Community Metrics

Four additional metrics were calculated to further characterize the benthic community and included the total number of taxa collected at each station, the Simpson's Dominance Index, Species Richness, and Evenness (Table 3-5).

A total of 45 separate benthic taxa (only species meeting B-IBI macrofaunal criteria were included) were collected in September 2002 at Barren Island (Table B-1 in Appendix B). The annelids comprised the most taxa (18); crustaceans (10); bivalves (6); gastropods (3); and nemerineans (2). One taxa each was found for cnidaria, phoronida, hemichordata, enchinodermata, cephalochordata, and diptera. The total number of taxa varied at Barren Island, ranging from 16 taxa at BAR-10 to 30 taxa at BAR-5 and BAR-6.

Simpson's Dominance Index values varied at Barren Island in September 2002 ranging from 0.114 at BAR-7 to 0.359 at BAR-9 (Table 3-5). Species Richness was similar at all stations ranging from 3.68 at BAR-10 to 5.53 at BAR-5. Evenness was also similar at all stations ranging from 0.42 at BAR-6 to 0.79 at BAR-10.

Station BAR-6 had one of the lowest B-IBI scores (3.0) due to high overall abundance but low numbers of pollution-sensitive taxa. BAR-9 also scored a 3.0 due to low numbers of carnivore/omnivore taxa. Even though these stations had the lowest B-IBI scores at Barren Island, they still met the Chesapeake Bay Restoration Goal. The highest B-IBI score was a perfect 5.0 at station BAR-1. The second highest B-IBI scores (4.6) were found at BAR-4 and BAR-8. All three stations had low abundance and high numbers of carnivore/omnivore taxa. BAR-1 and BAR-8 also had high scores for the Shannon-Weiner diversity index and BAR-4 had high numbers of pollution-sensitive taxa. Additionally, BAR-8 had low numbers of pollution-indicative taxa.

Abundance Trends

Annelids were the most dominant group found at the benthic stations. Annelids dominated (55 to 87 percent) at all stations except BAR-6 where gastropods dominated at 76.8 percent. The dominant annelid was the polychaete *Mediomastus ambiseta* and the dominant gastropod at BAR-6 was *Acteocina canaliculata.* Gastropods and crustaceans were the second most dominant groups found at the benthic stations. The dominant gastropod was *Acteocina canaliculata* and the dominant crustacean was the cumacean shrimp *Oxyurostylis smithi.*

TABLE 3-4. SUMMARY OF BENTHIC COMMUNITY METRICS AND SCORES USED TO CALCULATE THE B-IBI, SEPTEMBER 2002, BARREN ISLAND

Metric	Metric Values by Station									
	BAR-1[c]	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9[c]	BAR-10
Abundance (#/m^2)[a]	2,217.48	1,617.72	3,182.40	2,727.48	3,196.68	7,582.68	1,564.68	1,938.00	3,135.48	687.48
Shannon-Weiner Diversity[a][b]	2.181	2.174	2.149	2.178	2.523	1.492	2.532	2.291	1.733	2.284
Stress-Sensitive Taxa Abundance (%)	--	59.27	60.26	47.12	34.08	11.89	25.68	10.53	--	26.71
Stress –Indicative Taxa Abundance (%)	--	3.78	6.15	2.99	3.64	2.31	1.17	3.89	--	21.66
Carnivore/Omnivore Abundance (%)	33.67	17.91	26.47	36.05	13.98	79.90	22.16	35.05	13.99	28.49

Metric	B-IBI Scores by Station									
	BAR-1[c]	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
Abundance (#/m^2)[a]	5	5	3	5	3	1	5	5	3	1
Shannon-Weiner Diversity[a][b]	5	3	3	3	5	1	5	5	3	5
Stress-Sensitive Taxa Abundance (%)	--	5	5	5	3	3	3	3	--	3
Stress –Indicative Taxa Abundance (%)	--	5	5	5	5	5	5	5	--	3
Carnivore/Omnivore Abundance (%)	5	1	3	5	1	5	3	5	3	3
TOTAL B-IBI Score[d]	**5.0**	**3.8**	**3.8**	**4.6**	**3.4**	**3.0**	**4.2**	**4.6**	**3.0**	**3.0**

(a) Includes all species collected.
(b) Log used was log base e
(c) BAR-1and BAR-9 are high mesohaline mud; B-IBI calculations are not necessary for stress-sensitive taxa abundance and stress-indicative taxa abundance.
(d) Mean of the metric scores; scores of 3.0 or greater are considered as meeting the Chesapeake Bay Restoration Goal.

TABLE 3-5. SUMMARY OF ADDITIONAL BENTHIC COMMUNITY METRICS[a] AT BARREN ISLAND, SEPTEMBER 2002

Metric	Additional Metrics by Station									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
Total # of Taxa[b]	22	25	27	27	30	30	24	19	24	16
Simpson's Dominance Index	0.190	0.244	0.247	0.206	0.145	0.415	0.114	0.145	0.359	0.146
Species Richness	4.49	4.93	5.20	5.17	5.53	4.70	4.78	3.72	4.24	3.68
Evenness	0.66	0.65	0.61	0.63	0.71	0.42	0.77	0.74	0.53	0.79

(a) Includes all species collected.
(b) Excludes species not meeting B-IBI macrofaunal criteria

Precipitation Data

Based upon preliminary national precipitation data during the months preceding the September 2002 sampling at Barren Island, August 2002 was near average, ranking as one of the 46 driest such periods on record. August 2002 marks the second consecutive August that has been near average, nationally. Based upon preliminary national precipitation data, during the actual sampling at Barren Island, September 2002 was slightly wetter than average, ranking as one of the 74 driest such periods and one of the 35 wettest such periods on record. There has been no significant trend in mean national September precipitation over the last century, though September is one of only three months in 2002 which has averaged slightly more precipitation than the mean. Short-term conditions in Maryland improved during September, but long-term dryness over the last 12 months has resulted in the third driest hydrologic year (October-September) in the 108-year record (NOAA 2002).

Summary of Summer 2002 Benthic Findings

Abundance varied at Barren Island ranging from 687/m^2 at BAR-10 to 7,583/m^2 at BAR-6. The Shannon-Weiner Diversity values also varied, ranging from 1.492 at BAR-6 to 2.532 at BAR-7. The abundance of pollution-sensitive taxa was high at most stations ranging from 10.5 percent at BAR-8 to 60.3 percent at BAR-3. The abundance of pollution-indicative taxa was low for most stations ranging from 1.2 percent at BAR-7 to 21.7 percent at BAR-10. The abundance of carnivore/omnivore taxa varied at Barren Island ranging from 14 percent at BAR-5 and BAR-9 to 79.9 percent at BAR6.

B-IBI scores for abundance at Barren Island ranged from 1 at BAR-6 and BAR-10 to 5 at BAR-1, -2, -4, -7, and -8. The Shannon-Weiner Diversity scores ranged from 1 at BAR-6 to 5 at BAR-1, -5, -7, -8, and -10. Due to high numbers of pollution-sensitive taxa at Barren Island all stations received scores of 3 or 5. Due to low numbers of pollution-indicative taxa at Barren Island all stations received scores of 5, except for BAR-10, which received a score of 3. The scores for abundance of carnivore/omnivore taxa ranged from 1 at BAR-2 and BAR-5 to 5 at BAR-1, -4, -6, and -8.

The scores for each of the metrics at each station were averaged to determine the total B-IBI for each station. Scores of 3.0 or greater are considered as meeting the Chesapeake Bay Restoration Goal. Total B-IBI scores were high (3.0 – 5.0) for all stations sampled at Barren Island both within and outside of the proposed alignments in September 2002. All stations met the Chesapeake Bay Restoration Goal and one station, BAR-1, located to the west of the northern remnant and north of the proposed alignments, scored a perfect 5.0.

3.1.3 Fisheries Studies

The fisheries results are summarized in the following sections, with more detailed summaries of the data in Appendix B. A total of 32 species, representing 19 families were collected during the fall sampling effort conducted in September 2002. The scientific and common names of all species collected are presented in Table B-3 and detailed tables of the mean length and range of measurements for all species collected by gear types are listed in Tables B-4, B-5, and B-6 (Appendix B). Summaries of catches by gear type are presented in Table 3-6. *In-situ* water

quality measurements collected during the field effort for the fisheries studies were previously discussed in Section 3.1.1 and are included in Table 3-1.

Bottom Trawl

A total of six bottom trawl stations were sampled in September 2002. The trawl stations that were located within the proposed alignments included stations BAR-002, BAR-003, and BAR-004. Bottom trawl efforts yielded a total of ten species representing eight families and a total of over 6,400 individuals. The most abundant species collected at all stations (except BAR-002) was bay anchovy (*Anchoa mitchilli*), with the highest abundance (84 percent of all bottom trawl collected individuals) recovered at station BAR-005. Bay anchovy made up 97 and 99 percent of all collected species at stations BAR-001 and BAR-003, respectively. In contrast, striped anchovy (*Anchoa hepsetus*) was collected in low abundances at all six sampling stations. The lowest total abundance of fish was collected at station BAR-002, which yielded only 10 total individuals and included one blue crab (*Callinectes sapidus*), three Atlantic spadefish (*Chaetodipterus faber*), four striped anchovy (*Anchoa hepsetus*), one summer flounder (*Paralichthys dentatus*), and one weakfish *(Cynoscion regalis*). Station BAR-004 had a similar low total abundance of fish (eleven individuals), however it was the only station where a lined seahorse (*Hippocampus erectus*) was collected. Station BAR-006 yielded the least number of species, but the highest number of blue crabs (five individuals) of any sampling station.

Based on DGPS estimates of position, each five minute trawling tow covered approximately 15 seconds of latitude, or 300 meters yielding a total of 600 meters of bottom area sampled for both tows at each location. Station depths and thus depth of sampling varied from 3 to 8 ft and are as follows: BAR-001 was 3 ft, BAR-005 was 4 ft, BAR-004 and BAR-006 were 5 ft, and BAR-002 and BAR-003 were 8 ft.

Beach Seine

A total of five beach seine stations were sampled in September 2002. Seine stations BAR-S2 and BAR-S3 were located immediately east of the proposed alignments, along the western shoreline of the remnants. Seining yielded more fish at each station than trawling. Twenty-six species representing 16 families were taken in seine collections Bay anchovy (*Anchoa mitchilli*) numerically dominated the collections at BAR-S1, BAR-S2, and BAR-S3 with abundances ranging from 1,131 to 1,709 individuals. Station BAR-S4 yielded the highest abundance of Atlantic silversides (*Menidia menidia*). Seine station BAR-S5 yielded the lowest overall fish abundance (104 individuals) although diversity was comparable to other seine stations.

Gillnet

A total of four gillnet stations were sampled in September 2002. Gillnet stations BAR-G2 and BAR-G4 were located within the proposed alignments. Gillnetting efforts yielded similar total abundance of fish at four sample stations ranging from 77 to 123 individuals per station. Overall, a total of fourteen species representing eight families were taken in gillnet collections. Stations BAR-G1 and BAR-G3 yielded the highest abundance of Atlantic menhaden (*Brevoortia tyrannus*). At station BAR-G2, collections yielded a high abundance of weakfish (*Cynoscion regalis*), and at station BAR-G4 the most abundant species collected was spot (*Leiostomus xanthurus*). Low abundances of commercially and recreationally important species were also collected during gillnet efforts including bluefish (*Pomatomus saltatrix*), alewife (*Alosa*

pseudoharengus), Atlantic croaker (*Micropogonias undulatus*), red drum *(Sciaenops ocellatus*), summer flounder (*Paralichthys dentatus*), and blue crab (*Callinectes sapidus*).

Fisheries Study Conclusions

The fisheries sampling study indicated that the fish and crabs collected around Barren Island during the September 2002 field effort were typical of species that occur in the mesohaline reaches of the Chesapeake Bay. Beach seine efforts, which targeted species that utilize the shorezone, yielded the highest abundance and diversity of fish and crabs. Fish collected in beach seine efforts were predominately juvenile species. Bottom trawl efforts recovered less total fish and a lower diversity of fish and crabs then beach seining. However, the majority of the trawl collected individuals were species associated with bottom and nearshore habitats. Gillnetting efforts yielded similar species to those collected during bottom trawl efforts, although most collected during gillnetting were larger adults or subadults. The only seahorses collected during the fisheries investigations occurred at bottom trawl station BAR-004 and gillnet station BAR-G4, both located within the proposed Alignment 2 which may indicate that slightly different habitat exists in this area (relative to the other stations). Otherwise, very few differences were noted among stations (sampled by the same gear). No RTE fish species were collected during the September 2002 field effort.

Three of the nine species that are managed under the Magnuson-Stevens Fisheries Conservation Act (species for which the Chesapeake Bay provides Essential Fish Habitat [EFH]) were collected in the vicinity of Barren Island. These include bluefish, summer flounder, and red drum, which were all collected as juveniles, although adult bluefish were also collected in gillnet surveys. Nearly all of the drum species that are known to inhabit the Bay were collected in the vicinity of Barren. Red drum are obligate bottom feeders and their presence and abundance in this area is consistent with the diverse benthic community noted as part of the aquatic investigations. Fisheries collections also include several other species that are obligate bottom feeders including (e.g. spadefish, flounders) which also reinforce this observation.

3.1.4 Plankton Studies

Results of the plankton sampling effort are summarized as larval fish densities in Table 3-7. Plankton sampling was conducted at the same stations as the bottom trawl locations for the fisheries study. Larvae of six fish species were found in the plankton collections and include bay anchovy, blenny, Atlantic silverside, northern pipefish, lined seahorse, and goby. Fish eggs were not found in the plankton samples, which is typical for late summer (September) since most fish species begin spawning in early spring. The blenny numerically dominated the plankton densities at most stations, with the highest density (20.51 individuals/100m^3) occurred at station BAR-005. Blennies have a protracted annual spawning period and would be expected to be abundant in late summer in this area. Northern pipefish larvae were found at all sampling stations and occurred intermittently in both the bottom and surface trawls. The goby was found only in the bottom trawl collections at four stations (BAR-001, BAR-002, BAR-003, and BAR-004) and Atlantic silversides were collected only in surface trawls at three stations (BAR-001, BAR-005, and BAR-006). Station BAR-005 yielded the highest overall larval fish densities mostly due to the high density of blennies collected during bottom trawl efforts.

1039
1040

TABLE 3-6. SUMMARY OF FISH COLLECTIONS AT BARREN ISLAND, SEPTEMBER 2002

Common Name	Scientific Name	Bottom Trawl Collection						Seine Collection					Gillnet Collection			
		BAR-001	BAR-002	BAR-003	BAR-004	BAR-005	BAR-006	BAR-S1	BAR-S2	BAR-S3	BAR-S4	BAR-S5	BAR-G1	BAR-G2	BAR-G3	BAR-G4
Alewife	*Alosa pseudoharengus*												1			
Atlantic Croaker	*Micropogonias undulatus*												12	7	5	9
American Eel	*Anguilla rostrata*								1							
Atlantic Menhaden	*Brevoortia tyrannus*									1	1		52	5	58	2
Atlantic Silverside	*Menidia menidia*							68	30	10	1,349	2				
Atlantic Spadefish	*Chaetodipterus faber*		3								2					
Bay Anchovy	*Anchoa mitchilli*	460		504	6	5,397	33	1,131	1,250	1,709						
Black Drum	*Pogonias cromis*								2	1		1				
Blackcheek Tonguefish	*Symphurus plagiusa*								1		3	5	1			
Blue Crab	*Callinectes sapidus*		1	3	2	1	5	10	24	4	12	58	5	5	1	4
Bluefish	*Pomatomus saltatrix*	1											4	15	14	10
Feathered Blenny	*Hypsoblennius hentz*			1												
Green Goby	*Microgobius thalassinus*										1	3				
Hogchoker	*Trinectes maculatus*								1		5	13	4	1		
Inshore Lizardfish	*Synodus foetens*												2	5	2	5
Lined Seahorse	*Hippocampus erectus*				1						1					
Mummichog	*Fundulus heteroclitus*											1				
Naked Goby	*Gobiosoma bosci*										13	3				
Red Drum	*Sciaenops ocellatus*								7	1	125	4		3		
Silver Perch	*Bairdiella chrysoura*							60	18	1		2	3	7	12	5
Skilletfish	*Gobiesox strumosus*								2							
Southern Kingfish	*Menticirrhus americanus*							102	59	5			2	1		7
Spot	*Leiostomus xanthurus*										2	2	17	24	26	32
Spotted Seatrout	*Cynoscion nebulosus*										3					
Striped Anchovy	*Anchoa hepsetus*	13	4	2	1	2	6	6	8	2						
Striped Bass	*Morone saxatilus*										1					
Striped Blenny	*Chasmodes bosquianus*			1							1	1				
Striped Killifish	*Fundulus majalis*							4		1	20	4				
Summer Flounder	*Paralichthys dentatus*	1	1						1	1					1	
Weakfish	*Cynoscion regalis*	1	1		1	2		97	33	33			11	36	4	3
White Perch	*Morone americana*											5				
TOTALS		**476**	**10**	**511**	**11**	**5,402**	**44**	**1,478**	**1,437**	**1,769**	**1,539**	**104**	**114**	**109**	**123**	**77**

1041

TABLE 3-7. SUMMARY OF LARVAL FISH DENSITIES (#/100m^3) IN THE VICINITY OF BARREN ISLAND, SEPTEMBER 2002

Species Collected	BAR-001				BAR-002				BAR-003			
	Surface		Bottom		Surface		Bottom		Surface		Bottom	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Blenny	0.00	0.00	9.50	6.96	1.14	0.00	7.86	4.04	4.60	1.14	3.60	1.10
Bay Anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic Silverside	3.45	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipefish	0.00	0.00	0.00	1.16	0.00	0.00	0.00	3.03	0.00	0.00	1.20	0.00
Lined Seahorse	0.00	0.00	1.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby	0.00	0.00	2.38	1.16	0.00	0.00	4.49	1.01	0.00	0.00	7.19	11.01

Species Collected	BAR-004				BAR-005				BAR-006			
	Surface		Bottom		Surface		Bottom		Surface		Bottom	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Blenny	2.16	6.45	8.87	11.84	0.00	1.13	16.18	20.51	0.00	0.00	3.22	4.18
Bay Anchovy	0.00	0.00	0.00	0.00	0.00	2.25	0.00	3.42	1.20	0.00	1.07	0.00
Atlantic Silverside	0.00	0.00	0.00	0.00	2.42	0.00	0.00	0.00	1.20	0.00	0.00	0.00
Pipefish	0.00	3.23	2.22	1.48	0.00	0.00	4.62	2.28	0.00	2.36	1.07	0.00
Lined Seahorse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	1.04
Goby	0.00	0.00	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Macrozooplankton results are presented in Table 3-8 and indicated overall higher densities were collected in bottom collections compared to surface tows, which is typical of daytime plankton distributions in the Bay. Station BAR-003 yielded the highest density of zooplankton. Crab larvae numerically dominated collections at four stations (BAR-001, BAR-004, BAR-005, and BAR-006), occurring in comparatively high abundance for both surface and bottom trawls. Shrimp larvae, mysid shrimp, and copepods also were collected in relatively high abundance at all stations. Other macroinvertebrates collected in the plankton trawls from the Barren Island study area included amphipods, isopods, cnidarians, polychaetes, nudibranchs, pelecyopods, cumaceans, and tubellarians. Although many of these organisms are considered benthic species rather than plankton species, they represent, in combination with zooplankton, important food sources for fish populations frequenting areas around Barren Island.

3.2 TERRESTRIAL SURVEYS

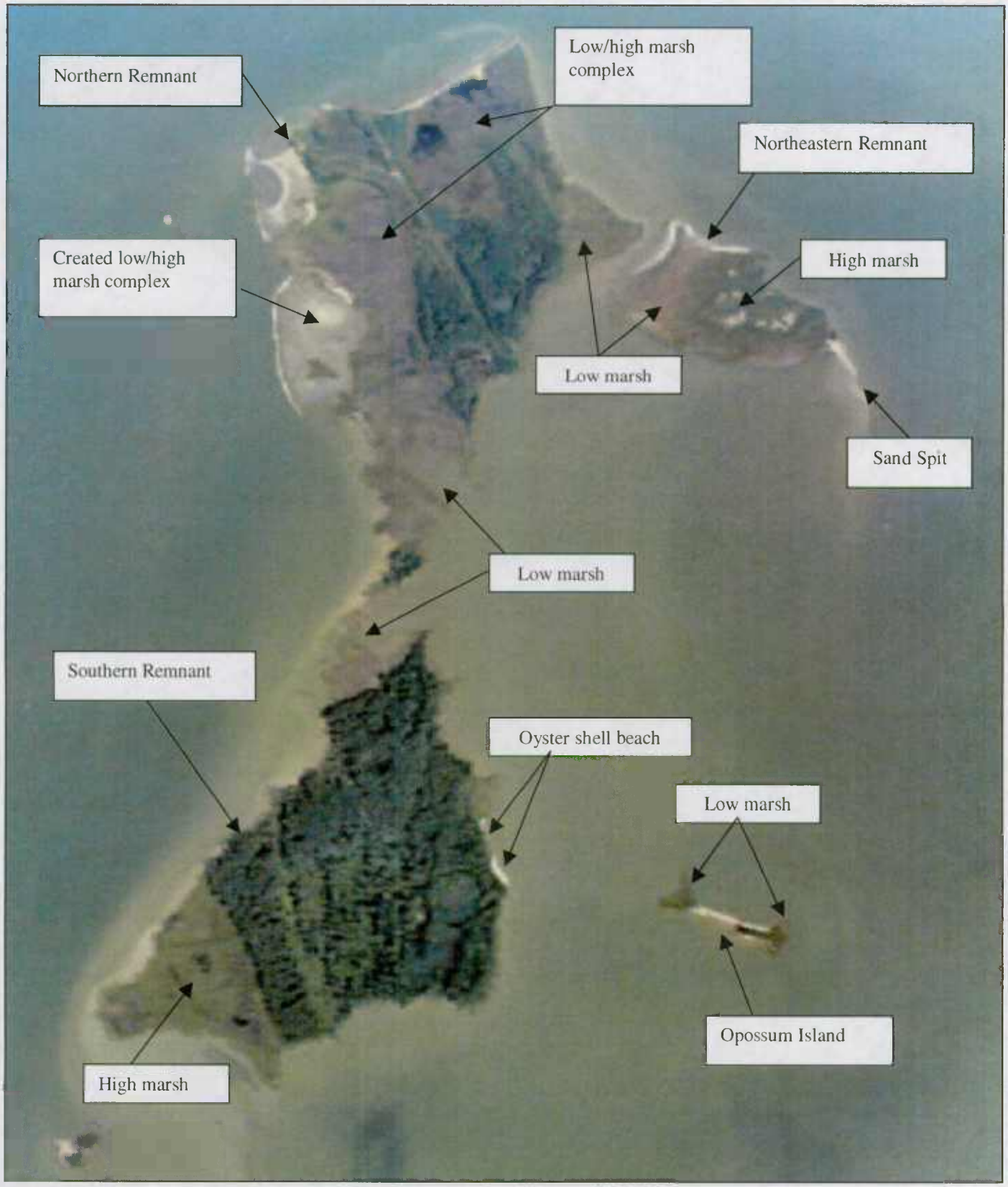
Terrestrial surveys, including vegetation identification and mapping and avian observations were conducted on 16-19 September 2002.

3.2.1 Vegetation Surveys

The northern, northeastern, and southern remnants of Barren Island were occupied by high and low marsh areas, upland forest areas, open water habitats and channels, sandy beaches (including saltpans and sand spits), and pockets of SAV (Figure 3-2). All of the remnants are eroding (particularly along the northern and western shorelines) which is resulting in bare ground, fallen trees, and compromised marshes. The low marsh areas are dominated by saltmarsh cordgrass and the high marsh areas are dominated by saltmeadow cordgrass interspersed with saltgrass (*Distichlis spicata*) and the dominant shrub, marsh elder (*Iva frutescens*). The high marsh areas were also sub-dominated by black needlerush (*Juncus roemerianus*). The low marsh areas were often associated around the island remnants in a fringe fashion. Upland forest areas were evident in the central portions of both the northern and the southern island remnants and are dominated by stands of Loblolly pine (*Pinus taeda*). Pockets of deciduous plant species including common persimmon (*Diospyros virginiana*), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*) and willow oak (*Quercus phellos*) also inhabit the upland areas. The majority of the wooded portions of the island remnants appear to be relatively mature. In sandy areas along the shorelines, shell, driftwood, and other debris were present. Erosion was evident on all three island remnants and most pronounced along the northern and western shorelines. A cumulative list of all plant species observed on the island remnants is presented in Table 3-9.

Northern Remnant

The northern remnant of Barren Island consists of natural resources that include open water habitats, wetland habitats (both upper, lower, and created marshes), upland forest habitats, nonvegetated sandy areas, and saltpans. Both upper and lower marsh areas are located along the shorelines and in the western and southern portions of the northern remnant. Open water areas and wet channels are dispersed throughout the upper and lower marsh areas and run intermittently across the entire northern remnant. The low marsh areas and open water areas are dominated by saltmarsh cordgrass (both tall and short form), and black needlerush; saltmarsh bulrush (*Fimbristylis castanea*) appears periodically throughout the low marsh. The low marsh



1092
1093

Figure 3-2. Location of Marshes on Barren Island, September 2002

TABLE 3-8. SUMMARY OF MACROZOOPLANKTON DENSITIES (#/100/m^3) IN THE VICINITY OF BARREN ISLAND, SEPTEMBER 2002

SPECIES	BAR-001				BAR-002				BAR-003			
	Surface		Bottom		Surface		Bottom		Surface		Bottom	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
crab larvae	13.8	24.5	301.7	276.0	27.3	30.9	60.6	97.9	181.9	180.4	164.2	157.4
shrimp larvae	9.2	12.3	93.8	85.8	23.9	16.0	113.3	134.3	48.3	36.5	39.6	30.8
mysid shrimp	0.0	1.1	1.2	0.0	38.6	0.0	0.0	0.0	3.5	2.3	197.8	307.1
Amphipoda	0.0	0.0	1.2	0.0	1.1	0.0	0.0	0.0	0.0	1.1	12.0	11.0
Isopoda	1.2	2.2	3.6	0.0	0.0	1.1	16.8	12.1	1.2	0.0	10.8	6.6
Polychaeta	0.0	0.0	1.2	1.2	1.1	1.1	2.2	3.0	0.0	0.0	2.4	0.0
Cnidaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Nudibranchia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copepoda	21.9	127.2	32.1	35.9	14.8	23.5	19.1	22.2	6.9	0.0	4.8	7.7
Gastropoda	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pelecypoda	0.0	0.0	0.0	0.0	1.1	1.1	0.0	1.0	8.1	4.6	2.4	6.6
Cumacea	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	13.2	23.1
Tubellaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPECIES	BAR-004				BAR-005				BAR-006			
	Surface		Bottom		Surface		Bottom		Surface		Bottom	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
crab larvae	33.5	139.8	383.5	193.8	70.3	158.9	121.3	104.8	13.2	27.1	77.3	67.9
shrimp larvae	2.2	16.1	73.2	44.4	116.4	109.3	58.9	47.8	15.6	23.6	39.7	48.1
mysid shrimp	0.0	1.1	0.0	23.7	0.0	1.1	129.4	11.4	0.0	0.0	24.7	0.0
Amphipoda	0.0	2.2	24.4	1.5	1.2	7.9	4.6	3.4	21.6	5.9	11.8	7.3
Isopoda	0.0	0.0	6.7	3.0	1.2	1.1	11.6	19.4	0.0	1.2	2.1	1.0
Polychaeta	0.0	0.0	0.0	1.5	0.0	0.0	2.3	3.4	16.8	20.0	5.4	3.1
Cnidaria	1.1	0.0	2.2	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nudibranchia	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	14.4	2.4	19.3	0.0
Copepoda	2.3	30.1	10.7	27.8	9.1	13.9	14.6	2.0	3.5	11.4	3.6	5.5
Gastropoda	0.0	0.0	0.0	0.0	0.0	0.0	14.6	1.0	0.0	0.0	7.2	0.0
Pelecypoda	0.0	1.1	3.6	1.2	0.0	0.0	1.1	0.0	2.3	1.1	6.0	3.3
Cumacea	0.0	0.0	11.9	1.2	0.0	0.0	2.2	1.0	0.0	0.0	0.0	0.0
Tubellaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.8	3.5	1.1	0.0

TABLE 3-9. CUMULATIVE LIST OF PLANT SPECIES OBSERVED AT BARREN ISLAND, SEPTEMBER 2002

Plant Group	Scientific Name	Common Name
Submerged Aquatic Vegetation	*Ruppia maritima*	Widgeon Grass
	Ulva lactuca	Sea Lettuce
Herbaceous plants	*Andropogon virginicus*	Broomsedge
	Aster tenuifolius	Saltmarsh Aster
	Atriplex patula	Spear Saltbush
	Cenchrus tribuloides	Saltmarsh Cockspur
	Distichlis spicata	Salt Grass
	Echinochloa walteri	Walter's Millet
	Fimbristylis castanea	Saltmarsh Bulrush
	Hystrix patula	Bottlebrush Grass
	Juncus effusus	Soft Rush
	Juncus roemerianus	Black Needlerush
	Juncus tenuis	Path Rush
	Kosteletzskya virginica	Seashore Mallow
	Limonium carolinianum	Sea Lavender
	Microstegium vimineum	Japanese Stiltgrass
	Panicum virgatum	Switch Grass
	Phragmites australis	Common Reed
	Phytolacca americana	Pokeweed
	Pluchea purpurascens	Saltmarsh Fleabane
	Polygonum punctatum	Dotted Smartweed
	Rubus allegheniensis	Common Raspberry
	Rubus idaeus	Wild Red Raspberry
	Salicornia europaea	Slender Glasswort
	Salsola kali	Common Saltwort
	Scirpus robustus	Saltmarsh Bulrush
	Setaria faberi	Giant Foxtail Grass
	Setaria parviflora	Marsh Bristlegrass
	Solidago sempervirens	Seaside Goldenrod
	Spartina alterniflora	Saltmarsh Cordgrass
	Spartina cynosuroides	Big Cordgrass
	Spartina patens	Saltmeadow Cordgrass
	Typha angustifolia	Narrow-Leaved Cattail
	Typha latifolia	Broad-Leaved Cattail

TABLE 3-9 (CONTINUED)

Plant Group	Scientific Name	Common Name
Upland Species	*Acer rubrum*	Red Maple
	Baccharis halimifolia	Groundsel-Tree
	Celtis occidentalis	Common Hackberry
	Diospyros virginiana	Common Persimmon
	Ilex opaca	American Holly
	Iva frutescens	Marsh-Elder
	Juniperis virginiana	Eastern Red Cedar
	Liquidambar styraciflua	Sweet Gum
	Morus alba	White Mulberry
	Myrica cerifera	Wax Myrtle
	Nyssa sylvatica	Blackgum
	Osage orange	Maclura Pomifera
	Pinus taeda	Loblolly Pine
	Platanus occidentalis	Sycamore
	Prunus serotina	Black Cherry
	Quercus falcata	Pin Oak
	Quercus phellos	Willow Oak
	Robinia pseudoacacia	Black Locust
Vines	*Campsis radicans*	Trumpet Creeper
	Lonicera japonica	Japanese Honeysuckle
	Smilax rotundifolia	Greenbriar
	Toxicodendron radicans	Poison Ivy
	Vitis sp.	Grape Species

areas are located along the shorelines, along the eastern portion of the remnant that is contiguous with the northeastern remnant, the western portion, and the southern portion of the island that is conjoined with the southern remnant. In depressions or "pannes" in the marsh floor, slender glasswort (*Salicornia europea*), sea lavender (*Limonium carolinianum*), and saltmarsh aster (*Aster tenuifolius*) were observed. The high marsh is dominated by saltmeadow cordgrass and saltgrass and interspersed at the edge of the high marsh with the shrubs marsh-elder and groundsel-tree (*Baccharis halimifolia*). The high marsh areas are located in the northern and western areas of the island remnant and surround the low marsh areas. Sandy, non-vegetated areas and saltpans are located in the southwestern portion of the island remnant, in the same vicinity as the created marsh (detailed below). Saltpans surrounding open water areas are also located in the northern portion of the island remnant, adjacent to low marsh areas.

A marsh habitat, created from dredged materials to replace acreage lost from erosion, is located in the southwestern portion of the northern remnant. The created marsh is approximately 11 acres and was planted in June 2001 with 100,000 plugs of saltmarsh cordgrass (FOB 2002). In May 2002, 40,000 additional plugs of saltmarsh cordgrass and 10,000 plugs of saltmeadow cordgrass were planted in the marsh. Offshore geotextile tubes protect the created marsh by

dissipating wave energy to reduce erosion. The created marsh appears successful and the marsh grasses have reseeded and expanded from the original plantings.

Loblolly pine is the dominant upland species in the northern remnant and monotypic stands were observed in the eastern and southern portions of the northern remnant. Sycamore, common persimmon, black cherry (*Prunus serotina*), and willow oak were observed as sub-dominant deciduous tree species among the non-monotypic loblolly pine stands. The canopy of loblolly pines was not dense and an open understory of pine needles and interspersed American holly (*Ilex opaca*) was observed. Common reed (*Phragmites australis*) surrounds the upland area in the northeastern portion of the remnant; stands of common reed are also located in the southern portion of the remnant and the northern shoreline, adjacent to the marsh areas. An overgrown road or runway strip transects the central portion of the island and is surrounded by a raised 3 to 4-ft berm on both the eastern and western boundary of the roadway/runway. Upland plant species consisting of loblolly pine, eastern red cedar (*Juniperus virginiana*), switchgrass (*Panicum virgatum*), wax myrtle (*Myrica cerifera*), broomsedge (*Andropogon virginicus*), groundsel-tree, and marsh elder dominate the cleared roadway/runway area.

The northern remnant is connected with the southern remnant by a narrow, low marsh area dominated by saltmarsh cordgrass and a scarcely standing group of loblolly pines and persimmon trees. Pockets of high marsh dominated by saltmeadow grass and saltgrass persist along with interspersed stands of black needlerush and common reed grass. The shoreline along the narrow corridor that connects the northern and southern remnants is eroded on the western side with bank heights ranging from 1 to 4 ft high; the banks along the eastern shoreline are not severely eroded and are approximately 1 ft high. Dead, standing, and downed loblolly pines were observed along the western shoreline. Bank erosion was also observed along the northernmost shoreline of the fragment with bank heights approximately 4 ft in height. In addition, the southwestern portion of the island that is not protected by geotubes exhibited erosion along the shorelines of approximately 3 to 4 ft in height.

Northeastern Remnant

The northeastern remnant of Barren Island consists of natural resources that include wetland habitats (both upper and lower marshes), sandy saltpans, SAV, open water, and a sand spit. The northeastern remnant is discontinuous with the northern remnant by a small open water channel on the western shoreline of the northeastern remnant. This small, protected channel area between the two island fragments is inhabited sparsely by widgeon grass (*Ruppia maritima*). The central portions of the northeastern remnant are composed of patches of open sandy saltpans surrounded by common reed and marsh elder. Upper marsh areas are also located in the central portion of the northeastern remnant and are inhabited by saltmeadow cordgrass and saltgrass. Sea lavender is interspersed throughout the upper marsh areas on the southern side of the remnant. The lower marsh areas are located along the perimeter and on the northwestern side of the remnant. The low marsh areas are dominated by saltmarsh cordgrass and to a lesser extent, slender glasswort. An open water area is located within the low marsh on the northwestern area of the remnant and is surrounded by saltmarsh cordgrass. Bank erosion was observed along the northeastern shoreline of the fragment with bank heights approximately 0.5 ft in height. A sand spit that was observed during the low tide is located at the southeastern point of the remnant.

Southern Remnant

The southern remnant of Barren Island consists of natural resources that include wetland habitats (both high and lower marshes), open water and channels, forested areas, SAV, and beach areas. The high and low marsh areas are located in the southwestern portion of the remnant and along the shoreline. Low marshes dominated by saltmarsh cordgrass are located along the southern, southwestern, and eastern perimeter shorelines of the remnant. Open water areas immediately surrounded by saltmarsh cordgrass and interspersed in the high marsh are located at the southwestern tip of the remnant.

The high marsh is dominated by saltmeadow cordgrass and saltgrass and intersected by open water channels that span the length of the remnant in the south. Switchgrass, marsh elder, and dead, standing loblolly pines are subdominant in the high marsh areas. Upland, forested areas are the prevailing habitat on the southern remnant. The forested areas are dominated by loblolly pines and range from densely to sparsely vegetated. In addition to loblolly pines, upland vegetation that occurs in pockets of mixed deciduous trees on the southern remnant includes sweetgum, sycamore, common persimmon, black locust (*Robinia pseudoacacia*), wax myrtle, blackgum, willow oak, black cherry, and American holly. Open canopy areas in the forest are located in the southeastern portion of the remnant and are inhabited predominantly by grasses that include Bottlebrush grass (*Hystrix patula*), common reed, saltmarsh cockspur (*Cenchrus tribuloides*) and soft rush (*Juncus effusus*). Vines and scrubby vegetation that inhabit the open canopy areas includes poison ivy (*Toxicodendron radicans*), greenbriar (*Smilax rotundifolia*), and common raspberry (*Rubus allegheniensis*). An approximately 3-ft raised berm is located along the eastern portion of the remnant and runs north-south the entire length of the island. The raised berm is located in forested areas dominated by loblolly pine and in open areas surrounded by common reed grass and deciduous trees.

An oyster shell beach is located on the eastern shoreline in the central portion of the remnant. Red-jointed fiddler crabs and debris washed on shore were observed at the oyster shell beach areas. Common reed grass dominates the eastern shoreline and is interspersed with marsh elder. Small patches of saltmarsh cordgrass in the low marsh areas and saltmeadow cordgrass and saltgrass in the higher marsh areas were also observed along the eastern shoreline, although to a lesser extent than common reed grass. A small islet of low marsh is located southwest of the southern remnant and is vegetated with saltmarsh cordgrass and dead, standing marsh elder. The banks on this islet are approximately 1 foot. Opossum Island, located east of the southern remnant consists of two low marsh areas connected by a sandy beach. Opossum Island is dominated by saltmarsh cordgrass and two small stands of common reed. Dead, standing loblolly pines are also located adjacent to the sandy beach.

Significantly eroded shorelines are evident along the western shoreline and clay shelves range from one to four ft in height. Many downed loblolly pines were observed along the shoreline in the vicinity. Bank erosion on the southern remnant was observed most severely along the western shoreline with bank heights approximately 3 to 4 ft in height. Dead, standing loblolly pines along the shoreline and snags in the water were also observed in the same vicinity. The southern shoreline also exhibited evidence of erosion with bank heights approximately 1 to 2 ft in height. Bank erosion 2 to 3 ft in height was also observed along the southeastern and northeastern shorelines, along with snags in the surrounding waters.

3.2.2 Avian and Other Wildlife Observations

A total of 61 species of birds were identified during a visit to the Barren Island site in September 2002. The species list is presented in Table 3-10 and includes species observed during the timed surveys as well as the habitat characterization surveys. Types of avian species that were documented utilizing the various habitats of Barren Island and the adjacent waters included resident species and breeding and migrating species. Resident species reside and utilize the habitat on Barren Island year-round. Breeding and migrating species reside on Barren Island for a portion of the year, primarily for breeding and migrating through the area, and use the islands for resting and feeding. Avian species were observed in the upland areas, saltmarsh and shoreline areas, and the open waters adjacent to the island remnants.

The open waters surrounding the remnants of Barren Island were used by primarily piscivorous species of birds such as brown pelican, double-crested cormorant, laughing, herring and great black-backed gulls, and royal, caspian and Forster's terns. Mute swans were observed in the nearshore area south of the northeastern remnant where SAV beds were located. The mute swans were in this area for short periods during the day; they appeared to prefer spending most of the day along the shoreline of nearby Hooper's Island. Four bald eagles (two adults and two immature birds) were observed foraging over the open water areas at various times during the visit to Barren Island.

The shoreline of the Barren Island remnants, including the geotubes and sandy spits exposed at low tide were used by all the gull and tern species observed as well as double-crested cormorants for resting and loafing. Southbound migrant shorebirds were documented along the shorelines and geotubes foraging and resting. Species observed included black-bellied, Wilson's, and semi-palmated plovers, greater and lesser yellowlegs, sanderling, least, western and semi-palmated sandpiper. Many of these species were observed for only one day of the four-day visit; they utilize the available habitat on Barren Island for resting and feeding before moving on their journey to their wintering grounds.

No species of rails were observed in the salt marsh habitat during the site visits. However, rails are notoriously secretive and difficult to survey. The survey that was conducted did not occur at an optimum time for observing rails. It is possible that evening or early morning surveys in May or June could result in the documentation of rails utilizing the salt marsh habitat on the remnants of Barren Island, particularly the created marsh on the western side of the northern remnant.

Waders such as great blue heron, great and snowy egrets, and green heron foraged along the shallow waters of the northern remnant. Great egrets and snowy egrets used the shrubs and low trees in the created marsh on the western side of the northern remnant. A heron rookery was located on the southern remnant. Approximately 50 nests were noted in the loblolly pine forest. Since the visit occurred in September, no active nests were found, however, many empty eggshells were found on the forest floor under the nest area attesting to active nesting during the 2002 breeding season. One bald eagle nest was observed on the western side of the south remnant during the September 2002 site visit.

1261 **TABLE 3-10. CUMULATIVE LIST OF AVIAN SPECIES OBSERVED AT BARREN**
1262 **ISLAND, SEPTEMBER 2002**
1263

Common Name	Scientific Name	Habitat Observed[1]	Status of Bird[2]	Number Observed[3]
Brown Pelican	*Pelecanus occidentalis*	O	SR/R	19
Double-crested Cormorant	*Phalacrocorax auritus*	O	SR/R	150
Great Blue Heron	*Ardea herodias*	M,S	R	1
Great Egret	*Ardea alba*	M,S	R	2
Snowy Egret	*Egretta thula*	M,S	SR/R	1
Green Heron	*Butorides virescens*	M	R	1
Turkey Vulture	*Cathartes aura*	FO	SR/R	4
Mute Swan	*Cygnus olor*	O	R	106
Osprey	*Pandion haliaetus*	O	SR/M	1
Bald Eagle	*Haliaeetus leucocephalus*	S,U;FO	R	4
Sharp-shinned Hawk	*Accipiter striatus*	U;FO	R/M	2
Peregrine Falcon	*Falco peregrinus*	S;FO	M	1
Black-bellied Plover	*Pluvialis squatarola*	S	M	3
Semi-palmated Plover	*Charadrius semmipalmatus*	S	M	1
Wilson's Plover	*Charadrius wilsonia*	S	M	1
Greater Yellowlegs	*Tringa melanoleuca*	S	M	8
Lesser Yellowlegs	*Tringa flavipes*	S	M	1
Sanderling	*Calidris alba*	S	M	5
Western Sandpiper	*Calidris mauri*	S	M	1
Semi-palmated Sandpiper	*Calidris pusilla*	S	M	1
Least Sandpiper	*Calidris minutilla*	S	M	6
Laughing Gull	*Larus atricilla*	S,O	R	22
Herring Gull	*Larus argentatus*	S,O	R	35
Great Black-backed Gull	*Larus marinus*	S,O	R	12
Caspian Tern	*Sterna caspia*	S,O	SR/M	1
Royal Tern	*Sterna maxima*	S,O	SR	9
Forster's Tern	*Sterna fosteri*	S,O	SR/R	9
Ruby-throated Hummingbird	*Archilochus colubris*	U	M	1
Downy Woodpecker	*Picoides pubescens*	U	R	1
Northern Flicker	*Colaptes auratus*	U	R/M	1
Acadian Flycatcher	*Empidonax virescens*	U	SR/M	1
Eastern Phoebe	*Sayornis phoebe*	U	SR/M	2
Red-eyed Vireo	*Vireo olivaceus*	U	SR/M	4
American Crow	*Corvus brachyrhynchos*	U,S	R	1
Barn Swallow	*Hirundo rustica*	M	SR/M	5
Carolina Chickadee	*Poecile carolinensis*	U	R	1
Brown-headed Nuthatch	*Sitta pusilla*	U	R	5
Carolina Wren	*Thryothorus ludovicianus*	U	R	3
House Wren	*Troglodytes aedon*	U	SR/M	1

1264

1265 **TABLE 3-10 (CONTINUED)**

1266

Common Name	Scientific Name	Habitat Observed[1]	Status of Bird[2]	Number Observed[3]
Blue-gray Gnatcatcher	*Polioptila caerulea*	U	SR/M	1
Veery	*Catharus fuscescens*	U	M	2
Swainson's Thrush	*Catharus ustulatus*	U	M	1
Hermit Thrush	*Catharus guttatus*	U	M	1
Wood Thrush	*Hylocichla mustelina*	U	M	1
American Robin	*Turdus migratorius*	U	R	1
Gray Catbird	*Dumetella carolinensis*	U	SR/R	5
Tennessee Warbler	*Vermivora peregrina*	U	M	1
Brewster's Warbler (hybrid)	*Vermivora chrysoptera x V. pinus*	U	M	1
Magnolia Warbler	*Dendroica magnolia*	U	M	1
Black-throated Blue Warbler	*Dendroica caerulescens*	U	M	1
Pine Warbler	*Dendroica pinus*	U	SR/R	3
Yellow Warbler	*Dendroica petechia*	M	SR/M	1
Black-and-white Warbler	*Mniotilta varia*	U	M	1
American Redstart	*Setophaga ruticilla*	U	M	1
Ovenbird	*Seiurus aurocapillus*	U	M	1
Louisiana Waterthrush	*Seiurus motacilla*	U	M	1
Common Yellowthroat	*Geothlypis trichus*	M,S	SR/R	4
Yellow-breasted Chat	*Icteria virens*	U	M	1
Northern Cardinal	*Cardinalis cardinalis*	U	R	4
Seaside Sparrow	*Ammodramus maritimus*	M	R	1
Boat-tailed Grackle	*Quiscalus major*	M	SR/R	22

1267 [1]Habitat: U = Upland; M = Marsh; S = Shoreline; O = Open Water; FO = Flying over

1268 [2]Status: SR = Summer Resident; R = Year round Resident; M = Migrant

1269 [3]Number observed is the maximum number of individuals observed at one time during the entire visit to Barren
1270 Island

1271

1272 The loblolly pine forests, which comprised much of the upland areas on the northern and
1273 southern remnants of Barren Island, provided habitat for resident passerine species such as
1274 Carolina wren, Carolina chickadee, tufted titmouse, brown-headed nuthatch, downy woodpecker
1275 and American robin. In addition the timing of the visit to Barren Island coincided with fall
1276 passerine migration and a number of neotropical migrants were observed feeding and foraging
1277 among the pines and understory during the site visit. Tennessee, magnolia, black-throated blue
1278 and black-and-white warbler, American redstart, ovenbird, Louisiana waterthrush and yellow-
1279 breasted chat were noted along with hermit, wood and Swainson's thrushes and veery. Sightings
1280 were often of small mixed feeding flocks. Of particular note was a single Brewster's warbler
1281 hybrid of the blue-winged and golden-winged warbler; the plumage was of the back cross adult
1282 as illustrated in Sibley (Sibley 2000).

1283

1284 Raptors and vultures were observed in the vicinity of Barren Island most often flying over the
1285 island, foraging along the shoreline and adjacent open water, or perched in the snags along the
1286 northwestern shoreline of the southern remnant. Turkey vultures were noted occasionally

soaring over the island. A bald eagle nest that was located in the loblolly pine plantation on the southern remnant but was not active at the time of the visit (September). Bald eagles were actively using the remnants of Barren Island and adjacent open waters. At least four individual bald eagles were noted during the site visit; two adults, one first-year juvenile and one third-year juvenile. Ospreys observed may have been summer resident birds or migrants moving south through the area. Several osprey nests were located on the island, with most of the nests observed on platforms constructed specifically to attract nesting osprey. None of the nests were active at the time of the visit. A migrant peregrine falcon was observed on 17 and 18 September perched in the snags on the northwestern side of the southern remnant. Two sharp-shinned hawks were observed over the northern remnant and could have been resident birds or migrants.

Timed bird surveys were conducted at five locations around the perimeter of Barren Island's remnants. During the 15-minute survey at each location avian species and numbers of individuals were recorded. The results of the surveys are tabulated in Table 3-11. Several species of passerines (Carolina wren, downy woodpecker) were heard during the timed surveys; the majority of species observed were species that utilized the shoreline, marsh, and/or open water adjacent to Barren Island. Avian usage of the habitats in the vicinity of the survey locations did not vary substantially from one site to another with the exception of location A-4 where a large flock of Mute Swans were observed.

Wildlife species observed during the terrestrial investigations are summarized in Table 3-12. Wildlife species including remnant (dead) horseshoe crabs (*Limulus polyphemus*) were found along the tide lines and low marsh areas of the remnants where waves had deposited them after their spring spawning. The low marsh areas are inhabited by Atlantic ribbed mussels (*Geukenisa demissa)* along the shorelines and among the saltmarsh cordgrass; marsh periwinkles, red-jointed fiddler crabs and marsh fiddler crabs were also observed in the low marsh areas. Blue crabs (*Callinectes sapidus*) were noted along the shorelines and in the open water and wet channel areas in the low marshes. Several diamond-backed terrapin shells were observed along with several live box turtles and an eastern mud turtle. Mammals (white-tailed deer and raccoons) were identified by their tracks as seen in the sand, mud, and clay areas. Shells of ribbed mussel and American oyster, were found along the beach areas. Tiger beetle species (not the RTE-listed Northeastern tiger beach beetle) were observed utilizing the sandy areas along the sand spit on the northeastern fragment along with oyster shells, debris, and SAV (washed on shore). Although the observed tiger beetles were not identified to the species level, the beetles clearly were not the RTE-listed species based upon a visual comparison. In addition, a large flock of monarch butterflies were observed feeding on groundsel-trees on the northern island fragment; other butterflies were noted and included in the table below. Striped killifish, rockfish, and the Atlantic needlefish were observed in the waters surrounding Barren Island during boat transportation and SAV mapping.

Of the avian species identified at Barren Island, several have conservation status determinations made either by the USFWS's Office of Endangered Species in accordance with the Endangered Species Act (bald eagle), or by the Maryland Department of Natural Resources (DNR) in accordance with the Non-game and Endangered Species Conservation Act (Wilson's plover, royal tern). Bald eagle are federal and state-listed threatened species that have been a documented breeding species in the Chesapeake Bay region, including Dorchester County.

Wilson's plover and royal tern are Maryland state-listed endangered species. Wilson's plover have been documented as breeding in Worcester County, MD (Iliff 1996) and could be possible nesting species in the Chesapeake Bay area in the appropriate habitat. Royal tern are a known breeding species in Dorchester County. It is unknown whether or not these species utilize habitat on Barren Island for nesting; surveys were not conducted during the nesting season of these species.

Several other species observed on Barren Island during the Summer 2002 survey are also listed on the list of RTE Animals of Maryland prepared by the Maryland Wildlife and Heritage Division of the DNR. Brown pelican, double-crested cormorant, sharp-shinned hawk, laughing gull, hermit thrush, magnolia and black-throated blue warblers are all Heritage listed species, however, the Maryland list of RTE species is based on the rarity of the species based on their breeding status (Maryland DNR 2003). Nearly all of these species were migrants utilizing other geographical areas for breeding and the habitats of Barren Island for feeding and resting during their southward movements. Sharp-shinned hawk (*Accipiter striatus*) could have been migrants or residents, perhaps nesting on the nearby mainland. Brown pelican, double-crested cormorant, and laughing gulls are all known breeding species on a small remnant of Barren Island to the south of the southern remnant (Illif 1996).

TABLE 3-11. AVIAN SPECIES OBSERVED AT TIMED SURVEY SITES AT BARREN ISLAND, SEPTEMBER 2002

Common Name	Scientific Name	Avian Observation Stations				
		A-1	A-2	A-3	A-4	A-5
Brown Pelican	*Pelecanus occidentalis*	---	---	4	---	1
Double-crested Cormorant	*Phalacrocorax auritus*	4	11	3	1	11
Great Blue Heron	*Ardea herodias*	---	---	---	---	1
Great Egret	*Ardea alba*	---	1	---	1	2
Mute Swan	*Cygnus olor*	---	---	---	106	4
Bald Eagle	*Haliaeetus leucocephalus*	1	1	2	1	---
Peregrine Falcon	*Falco peregrinus*	---	1	---	---	---
Laughing Gull	*Larus atricilla*	1	---	---	1	2
Herring Gull	*Larus argentatus*	9	11	7	9	---
Great Black-backed Gull	*Larus marinus*	---	1	1	9	---
Royal Tern	*Sterna maxima*	---	---	---	3	1
Forster's Tern	*Sterna forsteri*	1	1		2	1
Downy Woodpecker	*Picoides pubescens*	---	---	---	1	---
American Crow	*Corvus brachyrhynchos*	---	---	---	---	7
Carolina Wren	*Thryothorus ludovicianus*	---	---	---	1	---
Unidentified Ducks	N/A	---	---	---	5	---
TOTAL		**16**	**27**	**13**	**140**	**30**

TABLE 3-12. CUMULATIVE LIST OF WILDLIFE SPECIES OBSERVED AT BARREN ISLAND, SEPTEMBER 2002

Common Name	Scientific Name
Invertebrates	
Callinectes sapidus	Blue Crab
Cicindela sp. (not listed species)	Tiger Beetle Species
Geukenisa demissa	Atlantic Ribbed Mussel
Limulus polyphemus	Horseshoe Crab
Littorina irrorata	Marsh Periwinkle
Uca minax	Red-Jointed Fiddler Crab
Uca pugnax	Marsh Fiddler Crab
Butterflies	
Danaus plexippus	Monarch
Limenitis arthemis	Red Spotted Purple
Colias eurytheme	Orange Clouded Sulphur
Everes comyntas	Eastern Tailed Blue
Cercyonis pegala	Common Wood Nymph
Fish	
Fundulus heteroclitus	Striped Killifish
Morone saxitalis	Rockfish
Strongylura marina	Atlantic Needlefish
Reptiles	
Kinosternon subrubrum subrubrum	Eastern Mud Turtle
Malaclemys terrapin	Diamond-Backed Terrapin (shell only)
Terrapene carolina	Box Turtle
Mammals	
Odocoileus virginianus	White-Tailed Deer
Procyon lotor	Raccoon (tracks only)

3.2.3 Historical and Cultural Resources

The northern remnant of Barren Island showed confirmation of the historic use of the island including evidence of an old hunting lodge (See photographic record in Appendix A). Remnants of a demolished hunting lodge are located in the water by bulkheads on the northern tip of the northern remnant and an old roadbed or runway is evident and transects the central portion of the northern island. Straight channels that appeared to be manmade with open water were observed adjacent to the runway on the northern remnant and in the southern portion of the southern remnant in the low marsh areas. A tidal gut that terminated at the eastern shoreline of the northern remnant was observed that eventually connected with the open water channel. In addition, discarded household items such as water heaters and drums are located in a deciduous area in the central portion of the island. An old, rusty crane was also observed in the northern section of the northern remnant and an old, rusty bulldozer was observed in the central section of the southern remnant. A small, hunting cabin that has been constructed recently is located on the

northeastern tip of the southern remnant. Glass shards, bits of pottery, and a flint arrowhead were observed on the oyster shell beach in the southeast portion of the southern remnant. No other historic or archeological resources were observed on the remnants during the site visit.

3.3 Submerged Aquatic Vegetation (SAV) Mapping

EA scientists mapped the existing areas of SAV adjacent to Barren Island during the September 2002 field surveys and the areas are mapped in Figure 2-5. The SAV beds were predominantly located adjacent to the protected, eastern shoreline of the island remnants and at approximately 3 feet (ft) in depth. Widgeon grass (*Ruppia maritima*) was the only species identified in any of the beds, but sea lettuce (*Ulva lactuca*), a macroalgae, and eelgrass (*Zostera marina*) were observed washed up on the beach at the northern tip of the Northern Remnant and along the sand spit on the Northeastern Remnant. Because the SAV survey was conducted late in the growing season (which normally occurs from April through October) for some SAV, species like horned pondweed (*Zannichellia palustris*), which senesces early in the summer, would not have been observed during the September survey. A small bed of widgeon grass that was comprised of small (2 ft by 2 ft) patches was observed and located approximately 50 yards (yds) from the southeastern shoreline of the Southern Remnant. A very dense and large bed of widgeon grass that was comprised of large patches (10 ft by 10 ft), medium patches (3 ft by 3 ft), and small patches was observed and located 100 to 150 yards from the shoreline where the northern and southern remnants are joined. The extent of the large SAV bed is located south of the northeastern remnant and north of Opossum Island.

4.0 CONCLUSIONS

Barren Island currently consists of three eroding island remnants. Shoreline erosion is most pronounced and severe along the northern and western shorelines and ranges from 1 to 4 ft in height. Downed trees and submerged snags were observed in the shallow waters of these areas. The northern and southern remnants are connected by a narrow, high-low marsh complex and the northeastern remnant is separated from the northern remnant by a small, open water channel. Mixed forest stands dominated by loblolly pine are located at the interior of the northern and southern remnants and the northeastern remnant is dominated by high and low marshes and patches of open sandy saltpans. Small remnants of high marsh can be found on all three remnants and the southern remnant has a fairly extensive high marsh complex in the southern portion of the island. Low marshes are generally located in a fringe fashion around the perimeter of the remnants. The created marsh located behind the geotextile tubes on the northern remnant generally appears successful and the marsh grasses have reseeded and expanded from the original plantings.

Avian utilization of the island was typical for this area of the Bay. A total of 61 species of birds were identified during a four-day site visit to Barren Island in September 2002, which indicates that the area is providing a good diversity of food and nesting opportunities. A heron rookery of approximately 50 nests was located on the southern remnant in the loblolly pine forest. Since the visit occurred in September, no active nests were found, however, many empty egg shells were found on the forest floor under the nest area attesting to active nesting during the breeding season in 2002. One bald eagle nest was observed on the western side of the southern remnant during the September 2002 site visit. Several other avian species identified at Barren Island during the Summer 2002 surveys have conservation status determinations associated with their breeding status. Evidence of other raptor nests and songbird nesting was also found. There was also evidence that diamond-backed terrapin, turtles, eastern mud turtle, white-tailed deer and raccoons are also utilizing the island remnants.

The island remnants currently support SAV growth along some of their eastern shorelines and in the quiescent waters east of the islands. Monotypic beds of widgeon grass were found in September 2002. Fisheries investigations of the shorelines indicated that the remnants support a fairly diverse fish community, including the young of commercially important species, such as Atlantic menhaden, striped bass, and blue crab. All fish species were typical of the region. There was little difference in the number of species among stations sampled by the same gear in September 2002. Trawling yielded few species, which is likely attributed to a lack of habitat features outside of the shore-zone of the island. In addition, most fish utilizing the area trawled are probably transients to the study area. No RTE fish species were collected during the September 2002 field effort. Three of the nine species that are managed under the Magnuson-Stevens Fisheries Conservation Act (species for which the Chesapeake Bay provides EFH) were collected in the vicinity of Barren Island. Fisheries collections yielded many species of obligate bottom-feeders, which can be attributed to the healthy, diverse benthic community observed around the island remnants.

Ichthyoplantkton densities were relatively high and were dominated by blennies, which is expected in the late summer of this region. Zooplankton were typical of the region. In general, the benthic community is typical of this area of the Bay and yielded total B-IBI scores of 3.0 or

greater (indicating that they met the Chesapeake Bay Restoration Goal). All stations met the Chesapeake Bay Restoration Goal and one station, BAR-1, located to the west of the northern remnant and north of the proposed alignments, scored a perfect 5.0.

Grain-size test results indicate that the sediment around Barren Island is predominately comprised of sand (57.6 to 98.0 percent) at eight locations except for BARSED-9, which was predominately comprised of silt-clay (86.3 percent) and BARSED-1, which was 41.7 percent silt-clay; Both BARSED-9 and BARSED-1 were classified as mud.

During the site investigations, the remnants showed no historical or archeological resources apart from the past use of the island as a hunting lodge. Man-made open water channels and a tidal gut persist on both the southern and northern remnants. In addition, discarded household items such as water heaters, drums, and machinery were observed on both the northern and southern remnants. However, bits of pottery, glass shards and a broken flint arrowhead were observed washed up on the oyster shell beach in the southeast portion of the southern remnant.

5.0 REFERENCES

Friends of Blackwater (FOB) 2002. *Barren Island Marsh Restoration Project.* Downloaded from webpage http://www.friendsofblackwater.org

Gahagan and Bryant Associates, Inc. (GBA) 2002. *Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Barren Island.* Baltimore, MD. February.

Geneseo. 1996. Geneseo State University of New York. Ecology, Biology 203, Measuring Biodiversity. October. Accessed on 22 February 2001. http://darwin.bio.geneseo.edu/sugg/classes/ecology/lectures/lectures_22.htm.

Iliff, Marshall J., Robert F. Ringler, James L. Stasz. 1996. Field List of the Birds of Maryland, Maryland Avifauna Number 2, Maryland Ornithological Society, third edition, May 1996.

Interstate Commission on the Potomac River Basin (ICPRB). 1999. *Methodology Applied in the Calculation of Chesapeake Bay Program Benthic Index of Biotic Integrity (B-IBI) Values.* Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, Maryland. 30 December.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. *Assessing Biological Integrity in Running Waters: A Method and its Rationale.* Special Publication 5, Illinois Natural History Survey. Champaign, Illinois.

Ludwig, J.A., and J.F. Reynolds. 1998. *Statistical Ecology - A Primer on Methods and Computing.* John Wiley & Sons. 337 pp.

Maryland Department of Natural Resources (DNR) 2003. Downloaded inforamation from the Natural Heritage website http://www.dnr.state.md.us/wildlife/rtedorchesteranimals.html.

National Oceanic Atmospheric and Administration (NOAA). 2002. Climate at a Glance. Downloaded from webpage http://ncdc.noaa.gov/cgi-bin/cag3/state_map_display.pl.

Ranasinghe, J.A., S.B. Weisberg, D.M. Dauer, L.C. Schaffner, R.J. Diaz, and J.B. Frithsen. 1994. *Chesapeake Bay Benthic Community Restoration Goals.* Prepared for U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, MD and The Governor's Council on Chesapeake Bay Research Fund, Chesapeake Bay Research and Monitoring Division, Tidewater Admin., Maryland Dept. of Natural Resources, Annapolis, MD. December.

United States Army Corps of Engineers (USACE) 2002. *Shoreline Stabilization and Wetland Restoration at Barren Island and Historic Smith Island, Chesapeake Bay, Maryland: Innovative Geotextile Tube Technology.* Downloaded from webpage http://www.wes.army.mil

1507 Weber, C.I., Ed. 1973. Biological field and laboratory methods for measuring the quality of
1508 surface waters and effluents. EPA-600/73-001
1509
1510 Weisberg, S.B., D.M. Dauer, L.C. Schaffner, and J.B. Frithsen. 1997. An estuarine Benthic
1511 Index of Biotic Integrity (B-IBI) for Chesapeake Bay. *Estuaries* 20(1):149-158. March.
1512

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Weather tower at northwestern shore of Northern Remnant with *Spartina patens* and *Distichlis spicata.*

Looking east at *Spartina patens* and open water at northwestern shore of Northern Remnant.

Rubble from old hunting lodge at northwestern shore of Northern Remnant.

Looking northeast from second geotube (south) at Spartina alterniflora marsh on Northern Remnant.

Slender glasswort in low marsh area along western shore of Northern Remnant.

Looking south at open sandy area adjacent to created marsh along western shore of Northern Remnant.

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Planted marsh of *Spartina patens* along western shore of Northern Remnant.

Rows of *Spartina patens* in planted marsh along western shore of Northern Remnant.

Tall form of *Spartina alterniflora* along western shore of Northern Remnant.

Remnants of an old barge in the central area of the marsh in Northern Remnant along treeline.

Saltmarsh aster surrounded by *Distichlis spicata* in central area of Northern Remnant.

Bank erosion along the northwestern shoreline of the Northern Remnant.

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Looking north at Spartina alterniflora and Juncus roemerianus in central area of the marsh in the Northern Remnant.

Blue crab and fiddler crab in low marsh on the Northern Remnant.

Looking south at open water and high marsh at the northwestern tip of the Northern Remnant.

High marsh of Spartina patens and Distichlis spicata at the northern tip of the Northern Remnant.

Looking northeast at the sandy beach along the northwestern tip of the Northern Remnant.

Bank erosion along the northern coast of the Northern Remnant.

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Osprey nest and bird scanning at Station A-3 along the southwestern tip of the Southern Remnant.

Bank erosion along the southwestern shoreline of the Southern Remnant.

Open water and Distichlis spicata in high marsh at southwestern area of the Southern Remnant.

Heron rookery along forest edge at southwestern area of Southern Remnant.

Open area in forest at southern area of Southern Remnant.

Heron egg found below the heron rookery in the southwestern area of Southern Remnant.

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Eroding Loblolly pines along the northwestern shoreline of the Southern Remnant and bird scanning station A-2 and bald eagle siting in background.

Eastern mud turtle along the northwestern shoreline of the Southern Remnant.

Forest stand and bank erosion at the upland area connecting the Northern and Southern Remnants.

Northeastern shoreline of Northeastern Remnant with *Phragmites australis*, *Distichlis spicata*, and *Spartina patens*.

Unvegetated sandy, salty area in central portion of Northeastern Remnant.

Sea lavender and *Distichlis spicata* in high marsh area of Northeastern Remnant.

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Beach along northern shoreline of Northeastern Remnant.

Looking southeast at sand spit along eastern shoreline of Northeastern Remnant.

Open water pond with remnant piers at northwestern shoreline of Northern Remnant.

Looking south at old runway/canal of northwestern area of Northern Remnant.

Looking south at bird scanning Station A5 with osprey nest in background at Northern Remnant.

Forested area (Persimmon trees) along eastern shoreline of Northern Remnant.

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

Loblolly pine stand and deer carcass along eastern area of Northern Remnant

Looking at Southern Remnant from east with Opossum Island in the foreground.

Forested area along the northwestern areas of the Southern Remnant.

Hunting cabin located along the northeastern shoreline of the Southern Remnant.

Box turtle along northeastern shoreline of Southern Remnant.

Looking north at erosion along northeastern shoreline of Southern Remnant

Photographic Record

Barren Island
Chesapeake Bay, MD
September 2002

U-shaped berm in forested area at northern portion of Southern Remnant.

Oyster shell beach at eastern shoreline of Southern Remnant.

Old tractor in deciduous forest in central-eastern portion of Southern Remnant.

Widgeon grass washed up on beach at northwestern shoreline of Northern Remnant.

Monarch butterflies on groundsel tree in forested area in northwestern portion of Northern Remnant.

Looking south at beach on western shore of Northern Remnant.

Photographic Record

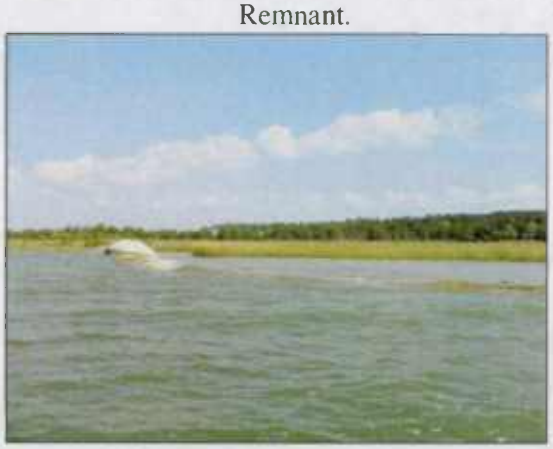
Barren Island
Chesapeake Bay, MD
September 2002

Shallow water habitat along western shore of Northern Remnant.

Spartina alterniflora and Atlantic ribbed mussels along western shoreline of Northern Remnant.

Downed Loblolly pines in forested areas of the northwestern portion of the Northern Remnant.

Salt pan in the northeastern area of the Northern Remnant.



Looking northeast at geotubes adjacent to created wetland.

Glass, pottery, and flint pieces found along the oyster shell beach on the Southern Remnant.

TABLE B-1. TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES COLLECTED WITH A PONAR FROM BARREN ISLAND, SEPTEMBER 2002

CNIDARIA (sea anemones)
- *Edwardsia elegans* (burrowing anemone)

PLATYHELMINTHES (flatworms)
- *Stylochus ellipticus*[(b)] (oyster flatworm)
- *Turbellaria sp. E*[(b)]

NEMERTINEA (unsegmented worms)
- *Amphiporus bioculatus*
- *Micrura leidyi* (red ribbon worm)

GASTROPDA (snails)
- *Acteocina canaliculata* (barrel bubble snail)
- *Doridella obscura*[(b)]
- *Haminoea solitaria* (solitary bubble snail)
- *Odostomia engonia* [(b)]
- *Rictaxis punctostriatus*

BIVALVIA (clams and mussels)
- *Gemma gemma* (gem clam)
- *Geukensia demissa*[(b)] (atlantic ribbed mussel)
- *Macoma balthica* (baltic clam)
- *Macoma mitchelli*
- *Mulinia lateralis* (coot clam)
- *Parvilucina multilineata*
- *Petricola pholadiformis* (false angel wing)

ANNELIDA (segmented worms)

OLIGOCHAETA (aquatic worms)
- *Tubificoides spp.*

POLYCHAETA (bristle worms)
- *Etone foliosa*
- *Etone herteropoda* (freckled paddle worm)
- *Glycinde solitaria* (chevron worm)
- *Heteromastus filiformis* (capitellid thread worm)
- *Leitoscoloplos robustus*
- *Loimia medusa* (red-spotted worm)
- *Mediomastus ambiseta*
- *Neanthes succinea*
- *Paraonis fulgens*
- *Paraprionospio pinnata* (fring-grilled mud worm)
- *Pectinaria gouldii* (trumpet worm)
- *Podarkeopsis levifuscina*
- *Polydora cornuta*
- *Scolelepis (Parascolelepis) texana*

Spiochaetopterus costarum
Spiophanes bombyx
Streblospio benedicti (barred-gilled mud worm)

CRUSTACEA
AMPHIPODA (beach fleas; scuds)
Ameroculodes spp. complex
Ampelisca abdita (small four-eyed amphipod)
Cymadusa compta (wave-diver tube-builder amphipod)
Microprotopus raneyi[(b)]
Mucrogammarus mucronatus

DECAPODA
Ogyrides alphaerostris

ISOPODA (isopods)
Edotea triloba [(b)] (mounded-back isopod)
Erichsonella spp.
Paracereis caudata[(b)] (eelgrass pill bug)
Ptilanthura tenuis

CUMACEA (cumacean shrimp)
Leucon americanus
Oxyurostylis smithi

MYSIDACEA (mysid shrimp)
Ameriocamysis almyra[(b)]
Cyclaspis varians
Neomysis americana[(b)] (mysid/bay opposum shrimp)

PHORONIDA (horseshoe worms)
Phoronis sp.

HEMICHORDATA
Saccoglosus kowalevskii

ENCHINODERMATA (spiny-skinned animals)
Leptosynapta tennuis (white synapta)

CEPHALOCHORDATA
Branchiostoma caribaeum

DIPTERA (insects)
Chronomidae larve (midges)

[(a)]Common names taken from Chesapeake Bay Program (CBP) (CBP 1992).
[(b)] Species not meeting B-IBI macrofaunal criteria (ICPRB 1999 and Ranasinghe et al. 1994).

TABLE B-2. MEAN DENSITIES (#/M^3) OF BENTHIC MACROINVERTEBRATES COLLECTED WITH A PONAR AT BARREN ISLAND, SEPTEMBER 2002

TAXON	STATION									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
CNIDARIA (sea anemones)										
Edwardsia elegans (burrowing anemone)		6.12		6.12						
PLATYHELMINTHES (flatworms)										
Stylochus ellipticus[(a)] (oyster flatworm)	20.4	6.12	20.4	6.12		6.12	6.12	14.28	14.28	
Turbellaria sp. E[(a)]					122.4					
NEMERTINEA (unsegmented worms)										
Amphiporus biocalatus	14.28	20.4	6.12	14.28	20.4	14.28	14.28			
Micrura leidyi (red ribbon worm)	6.12				6.12	14.28		6.12	6.12	
Nemertinea[(a)]					26.52					
GASTROPODA (snails)										
Acteocina canaliculata (barrel bubble snail)	250.92	128.52	250.92	618.12	148.92	4692	75.48	204	6.12	
Doridella obscura[(a)]			6.12							
Gastropoda[(a)]			6.12							
Haminoea solitaria (solitary bubble snail)	6.12	40.8	14.28	40.8	20.4	1122	6.12	259.08	26.52	
Odostomia engonia[(a)]	6.12			6.12		6.12				
Rictaxis punctostriatus					14.28	6.12				
BIVALVIA (clams and mussels)										
Bivalvia[(a)]			6.12		40.8					
Gemma gemma (gem clam)	6.12		20.4	6.12	136.68					
Geukensia demissa[(a)] (atlantic ribbed mussel)	14.28		6.12		6.12					
Macoma balthica (baltic clam)			20.4			6.12				
Macoma mitchelli			14.28	61.2	6.12	61.2	14.28	6.12	34.68	14.28
Mulinia lateralis (coot clam)	55.08		40.8	40.8	14.28	87.72	6.12	61.2	61.2	6.12
Parvilucina multilineata		26.52								
Petricola pholadiformis (false angel wing)	14.28						6.12			

TABLE B-2. (CONTINUED)

TAXON	STATION									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
ANNELIDA (segmented worms)										
OLIGOCHAETA (aquatic worms)										
Oligochaeta[(a)]										14.28
Tubificoides spp.			61.2	14.28	67.32		6.12		34.68	46.92
POLYCHAETA (bristle worms)										
Eteone foliosa					6.12		6.12			
Etone heteropoda (freckled paddle worm)	26.52	6.12	34.68	6.12	14.28	14.28		6.12		26.52
Glycinde solitaria (chevron worm)	197.88	81.6	387.6	265.2	197.88	169.32	224.4	148.92	299.88	136.68
Heteromastus filiformis (capitellid thread worm)	34.68		218.28	20.4	20.4	14.28	26.52	6.12	87.72	183.6
Leitoscoloplos robustus	6.12	61.2		26.52	157.08	136.68	163.2	346.8		
Loimia medusa (red-spotted worm)		14.28				6.12			6.12	6.12
Mediomastus ambiseta	822.12	760.92	1483.08	1013.88	891.48	693.6	177.48	55.08	1821.72	40.8
Neanthes succinea	204	20.4	87.72	6.12	6.12	14.28	20.4		81.6	26.52
Paraonis fulgens				116.28	728.28	20.4	352.92	524.28	6.12	
Paraprionospio pinnata (fringe-grilled mud worm)	312.12	61.2	87.72	20.4		87.72			46.92	
Pectinaria gouldii (trumpet worm)	6.12	34.68	26.52			6.12	6.12			
Podarkeopsis levifuscina		6.12							6.12	
Polydora cornuta			20.4		6.12	6.12				20.4
Scolelepis (Parascolelepis) texana		6.12			81.6	34.68	40.8	14.28		
Spiochaetopterus costarum	26.52	95.88	26.52	6.12		26.52			6.12	
Spiophanes bombyx		6.12								
Streblospio benedicti (barred-gilled mud worm)	6.12		6.12	6.12	34.68		6.12	14.28	34.68	95.88

TABLE B-2. (CONTINUED)

TAXON	STATION									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
CRUSTACEA										
AMPHIPODA (beach fleas; scuds)										
Ameroculodes spp. complex	6.12	14.28	6.12	20.4	95.88	26.52	40.8	34.68		
Ampelisca abdita (small four-eyed amphipod)	40.8	102	55.08	6.12		81.6			238.68	
Cymadusa compta (wave-diver tube-builder amphipod)										34.68
Microprotopus raneyi [(a)]				20.4				6.12		
Mucrogammarus mucronatus										6.12
DECAPODA										
Ogyrides alphaerostris									6.12	
ISOPODA (isopods)										
Edotea triloba[(a)] (mounded-back isopod)	6.12	6.12	20.4	1.428	14.28	6.12	6.12		6.12	
Erichsonella spp.										6.12
Paracereis caudata [(a)] (eelgrass pill bug)					26.52					
Ptilanthura tenuis	40.8		67.32	40.8	6.12	26.52	14.28	55.08	6.12	
CUMACEA (cumacean shrimp)										
Leucon americanus		6.12		6.12					34.68	6.12
Oxyurostylis smithi		55.08	75.48	142.8	102	26.52	108.12	40.8		
MYSIDACEA (mysid shrimp)										
Americamysis almyra[(a)]		20.4	14.28	75.48	26.52	14.28	55.08	26.52	20.4	6.12
Cyclaspis varians			6.12	26.52	40.8		20.4	6.12		6.12
Neomysis americana [(a)] (mysid/bay opposum shrimp)	6.12	6.12	20.4	26.52	20.4	67.32	14.28	20.4	6.12	
PHORONIDA										
Phoronis sp.		6.12	6.12	26.52	26.52	26.52			26.52	
HEMICHORDATA										
Saccoglosus kowalevskii (acorn worm)	6.12		55.08	14.28		20.4			189.72	

TABLE B-2. (CONTINUED)

TAXON	STATION									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
ENCHINODERMATA										
Leptosynapta tennuis (white synapta)		6.12			55.08	14.28	136.68	81.6	14.28	
CEPHALOCHORDATA										
Branchiostoma caribaeum		6.12			6.12	20.4	6.12			
DIPTERA (insects)										
Chronomidae larve (midges)	14.28									

(a) Species not meeting B-IBI macrofaunal criteria (ICPRB 1999; Ranasinghe et al. 1993).

TABLE B-3. FISHES AND CRABS COLLECTED DURING FISHERIES STUDIES AT BARREN ISLAND, SEPTEMBER 2002

Common Name		Scientific Name	
Family	**Species**	**Family**	**Species**
Freshwater eels	American Eel	Anguillidae	*Anguilla rostrata*
Herrings	Atlantic Menhaden	Clupeidae	*Brevoortia tyrannus*
	Alewife		*Alosa pseudoharengus*
Anchovies	Bay Anchovy	Engraulidae	*Anchoa mitchilli*
	Striped Anchovy		*Anchoa hepsetus*
Lizardfishes	Inshore Lizardfish	Synodontidae	*Synodus foetens*
Clingfishes	Skilletfish	Gobiesocidae	*Gobiesox strumosus*
Killifish	Mummichog	Cyprinodontidae	*Fundulus heteroclitus*
	Striped Killifish		*Fundulus majalis*
Silversides	Atlantic Silverside	Atherinidae	*Menidia menidia*
Pipefishes	Lined Seahorse	Syngnathidae	*Hippocampus erectus*
Temperate basses	Striped Bass	Moronidae	*Morone saxatilus*
	White Perch		*Morone americana*
Bluefishes	Bluefish	Pomatomidae	*Pomatomus saltatrix*
Drums	Silver Perch	Sciaenidae	*Bairdiella chrysoura*
	Spotted Seatrout		*Cynoscion nebulosus*
	Weakfish		*Cynoscion regalis*
	Spot		*Leiostomus xanthurus*
	Southern Kingfish		*Menticirrhus americanus*
	Atlantic Croaker		*Micropogonias undulatus*
	Red Drum		*Sciaenops ocellatus*
	Black Drum		*Pogonias cromis*
Spadefishes	Atlantic Spadefish	Ephippidae	*Chaetodipterus faber*
Mullets	Striped Mullet	Mugilidae	*Mugil cephalus*
Blennies	Feathered Blenny	Blenniidae	*Hypsoblennius hentz*
	Striped Blenny		*Chasmodes bosquianus*
Gobies	Naked Goby	Gobiidae	*Gobiosoma bosci*
	Green Goby		*Microgobius thalassinus*
Lefteye flounders	Summer Flounder	Bothidae	*Paralichthys dentatus*
Soles	Hogchoker	Soleidae	*Trinectes maculatus*
Tonguefishes	Blackcheek Tonguefish	Cynoglossidae	*Symphurus plagiusa*
Swimming crabs	Blue Crab	Portunidae	*Callinectes sapidus*

TABLE B-4. SUMMARY OF MEAN LENGTH (mm) AND RANGE OF MEASUREMENTS (mm) FOR BARREN ISLAND OTTER TRAWL FISH COLLECTIONS, SEPTEMBER 2002.

Species	Mean Length (mm) and Range (mm) for Otter Trawl Stations					
	BAR-001	**BAR-002**	**BAR-003**	**BAR-004**	**BAR-005**	**BAR-006**
Atlantic Spadefish	---	70 (65-75)	---	---	---	---
Bay Anchovy	58 (48-66)	---	60 (50-162)	59 (54-66)	56 (42-68)	56 (46-62)
Blue Crab	---	148	140 (115-176)	83 (75-91)	61	75 (56-95)
Bluefish	265	---	---	---	---	---
Feathered Blenny	---	---	33	---	---	---
Lined Seahorse	---	---	---	51	---	---
Striped Anchovy	81 (55-96)	91 (75-96)	94 (91-96)	79	104	100 (92-116)
Summer Flounder	239	241	---	---	---	
Weakfish	76	61	---	26	54 (55-52)	---

TABLE B-5 SUMMARY OF MEAN LENGTH (mm) AND RANGE OF MEASUREMENTS (mm) FOR BARREN ISLAND SEINE FISH COLLECTIONS, SEPTEMBER 2002.

Species	Mean Length (mm) and Range (mm) for Seine Stations				
	BAR-S1	**BAR-S2**	**BAR-S3**	**BAR-S4**	**BAR-S5**
Atlantic Spadefish	---	---	---	34 (30-38)	---
Southern Kingfish	113 (56-151)	112 (71-154)	73 (35-105)	---	---
American Eel	---	690	---	---	---
Atlantic Menhaden	---	---	132	125	---
Atlantic Silverside	57 (47-71)	72 (55-89)	74 (52-89)	60 (45-96)	69 (61-76)
Bay Anchovy	54 (42-72)	54 (26-74)	60 (42-90)	---	---
Black Drum	---	236 (231-241)	231	---	227
Blackcheek Tonguefish	---	126	---	59 (30-91)	50 (41-59)
Blue Crab	83 (30-136)	73 (12-123)	90 (68-125)	44 (12-91)	49 (12-145)
Green Goby	---	---	---	36	32 (25-41)
Hogchoker	---	116	---	33 (22-42)	93 (20-132)
Lined Seahorse	---	---	---	44	---
Mummichog	---	---	---	---	62
Naked Goby	---	---	---	44 (31-98)	37 (30-41)
Red Drum	---	45 (36-55)	325	40 (22-86)	27 (17-32)
Silver Perch	113 (85-156)	120 (76-153)	130	---	112 (102-121)
Skilletfish	---	32 (30-34)	---	---	---
Spot	---	---	---	156 (147-165)	169 (162-176)
Spotted Seatrout	---	---	---	70 (56-82)	---
Striped Anchovy	88 (80-95)	90 (75-102)	91 (89-92)	---	---
Striped Bass	---	---	---	135	---
Striped Blenny	---	---	---	62	31
Striped Killifish	50 (45-60)		119	76 (48-107)	64 (36-99)
Summer Flounder	---	284	440	---	---
Weakfish	68 (32-150)	82 (43-195)	74 (55-102)	---	---
White Perch	---	---	---	---	262 (225-295)

TABLE B-6 SUMMARY OF MEAN LENGTH (mm) AND RANGE OF MEASUREMENTS (mm) FOR BARREN ISLAND GILLNET FISH COLLECTIONS, SEPTEMBER 2002.

Species	Mean Length (mm) and Range (mm) for Gillnet Stations			
	BAR-G1	**BAR-G2**	**BAR-G3**	**BAR-G4**
Alewife	256	---	---	---
Atlantic Croaker	195 (181-206)	203 (191-215)	197 (185-204)	195 (190-208)
Atlantic Menhaden	297 (130-402)	240 (132-403)	145 (115-396)	360 (352-368)
Blackcheek Tonguefish	139	---	---	---
Blue Crab	116 (85-132)	125 (98-139)	162	113 (86-131)
Bluefish	316 (274-391)	303 (255-425)	318 (220-428)	264 (218-296)
Hogchoker	117 (85-150)	121	---	---
Inshore Lizardfish	208 (125-291)	196 (115-319)	267 (255-278)	307 (255-394)
Red Drum	---	400 (395-409)	---	---
Silver Perch	130 (125-139)	159 (140-197)	157 (126-211)	163 (130-203)
Southern Kingfish	178 (175-180)	142	---	159 (135-136)
Spot	171 (153-199)	180 (155-230)	170 (64-199)	169 (150-211)
Summer Flounder	---	---	233	---
Weakfish	324 (261-491)	250 (142-345)	280 (196-323)	372 (285-435)