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DRAFT
BARREN ISLAND HABITAT RESTORATION
EXISTING ENVIRONMENTAL CONDITIONS:



**Fall 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**

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EXECUTIVE SUMMARY

37
38
39 Barren Island and the surrounding waters were investigated over the Fall season in November
40 and December 2002. The purpose of the sampling efforts was to document the existing
41 terrestrial and aquatic resources present in and around the Barren Island remnants during the Fall
42 2002 season. This report presents results from the second season of sampling for the feasibility
43 evaluations of Barren Island. This investigation includes both terrestrial and aquatic
44 components, specifically water quality and nutrient investigations, benthic invertebrate studies,
45 fisheries sampling, vegetation identification and mapping, avian and other wildlife utilization
46 surveys, and historic and cultural resources observations.

47
48 These data will support feasibility studies of Barren Island as a potential habitat restoration
49 project that would utilize dredged material beneficially to stabilize and restore wetland and
50 upland areas of Barren Island. This study was conducted under contract to Maryland
51 Environmental Service (MES) for the Maryland Port Administration (MPA).

52
53 Barren Island is located in Dorchester County, Maryland and currently consists of three eroding
54 islands, the northern remnant, the northeastern remnant, and the southern remnant. The island
55 remnants of Barren Island are occupied by habitats that include high and low marsh areas, upland
56 forested areas, open water habitats and channels, Submerged Aquatic Vegetation (SAV) in the
57 warmer months, and sandy beaches (including saltpans and sand spits). Small areas of high and
58 low marshes can be found on all three remnants. All of the remnants are eroding, particularly
59 along the northern and western shorelines, which is resulting in bare ground, fallen trees, and
60 compromised marshes and upland areas. The northern and southern remnants are joined by low
61 marshes that terminate into a fragmented, upland forested area. Mixed stands of forest
62 dominated by loblolly pines comprise the interior of the northern and southern remnants. There
63 was evidence of a fairly recent fire that has killed some loblolly pines in the central portion of the
64 northern remnant. The northern and western shorelines of each remnant show the heaviest
65 erosion and there are many submerged snags in the adjacent water in these areas. Observations
66 from the second season of sampling in Fall 2002 showed that erosion is still occurring and
67 diminishing the shorelines of the islands.

68
69 The U.S. Army Corps of Engineers (USACE) constructed geotextile tubes in 1994 to stabilize
70 the western shoreline of Barren Island and then placed dredged material between the tube and the
71 eroding shoreline to recover the lost acreage of salt marsh (USACE 2002). The dredged material
72 was then planted with salt marsh grass species. Current inspection of the created marsh site
73 indicates a highly successful planting and a favorable rate of survival for the planted grasses.

74
75 Depths in the areas sampled ranged from 1.5 to 14 feet. *In situ* water quality was within the
76 range expected at the temperature, depth, and salinity recorded. In addition, an analysis of
77 nutrients in the water was conducted at the ten benthic stations. The Chesapeake Bay Index of
78 Biotic Integrity (B-IBI) was not calculated for the Fall 2002 benthic collection, since this
79 analysis is applicable only for warm weather benthic assessments and would typically be skewed
80 if used for assessments conducted in the fall. As a result, several general community metrics
81 were analyzed. For the Fall 2002 benthic survey, abundance (total number of organisms per
82 square meter) was low at Barren Island. The abundance of pollution-sensitive taxa was high at

83 most stations and the abundance of pollution-indicative taxa was low for most stations. In
84 general, mean metric values calculated for the benthic community were similar between seasons
85 (Summer 2002 and Fall 2002) at Barren Island. The slight variations between seasons did not
86 represent a substantive change in the benthic community profile.

87
88 The Fall 2002 fisheries investigations of the shorelines indicated that the remnants support a
89 fairly diverse fish community, including the young of commercially important species, such as
90 Atlantic menhaden, alewife, striped bass, white perch, and blue crab. All fish species were
91 typical of the region. Overall, fish collection efforts using all gear types, yielded low abundances
92 and diversity of fish and crabs. This is expected for shallow water collections during the late
93 fall, particularly when surface water temperatures decrease quickly, as occurred in November
94 and December 2002 when the fisheries studies were conducted. Migratory fish species would
95 have already left the Barren Island vicinity by late fall for over-wintering areas (down-Bay or
96 offshore areas), and many resident fish species would most likely seek warmer, deeper areas of
97 the Bay. Beach seine efforts yielded the highest abundance of fish and crabs and collections
98 were comprised mostly of forage fish. No Rare, Threatened, or Endangered (RTE) fish species
99 were collected during the Fall 2002 field effort. One of the nine species (red drum) that are
100 managed under the Magnuson-Stevens Fisheries Conservation Act [species for which the
101 Chesapeake Bay provides Essential Fish Habitat (EFH)] was collected in the vicinity of Barren
102 Island. Because SAV occurs adjacent to many of the remnants in the warmer, summer months
103 (EA 2003), Barren Island may also be providing Habitat of Particular Concern (HAPC) for red
104 drum.

105
106 Avian utilization of the island was typical for this area of the Bay. A total of 41 species of birds
107 were identified during the Barren Island Fall 2002 survey, which indicates that the area provides
108 a diversity of food and nesting opportunities for avian species. However, avian utilization of the
109 open water areas of the proposed alignments was insignificant compared to that of the wetland
110 and forested areas of the remnants. Brown pelicans were numerous during the survey and a peak
111 count of 270 individuals was observed on the small, unnamed island just south of the southern
112 remnant. A heron rookery of approximately 50 nests was located on the southern remnant in the
113 loblolly pine forest, and a bald eagle nest that was observed during the survey in September 2002
114 was still intact and in good condition. Bald eagles were actively using the remnants of Barren
115 Island and adjacent open waters; at least three individual bald eagles were noted during the
116 survey. Several other avian species identified at Barren Island during the Fall 2002 surveys have
117 conservation status determinations associated with their breeding status. The created marsh
118 offered habitat for a hunting Northern harrier and an American bittern was flushed from cattails
119 at the boundary of the created marsh. There was also evidence that diamond-backed terrapin,
120 turtles, northern water snake, white-tailed deer and raccoons are also utilizing the island
121 remnants.

122
123 During the Fall 2002 site investigations, the remnants showed no additional historical or
124 archeological resources were found on any of the island remnants (relative to other surveys).
125 Man-made open water channels, raised berms, and a tidal gut persist on both the southern and
126 northern remnants. In addition, discarded household items such as water heaters, drums, and
127 machinery were observed on both the northern and southern remnants. Bits of pottery and shards

128 of glass were observed washed up on the oyster shell beach in the southeast portion of the
129 southern remnant.

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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 second of four seasons of sampling. This report summarizes the results of the Fall sampling efforts. 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 sampling, vegetation identification and mapping, avian and other wildlife utilization surveys, and historical and cultural 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

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

225
226 In 1994, the USACE began the construction of geotextile tubes, approximately 1.5 miles in
227 length, to stabilize the western shoreline of Barren Island. The geotextile tubing was made from
228 double-lined woven fabric that was then filled with dredged material and placed a short way off-
229 shore of the island (USACE 2002). Dredged material was then placed between the tube and the
230 eroding shoreline to recover the lost acreage of salt marsh. Since June of 2001, a number of
231 groups have worked with the USACE and the USFWS to plant the 11-acre tidal salt marsh on
232 Barren Island that was created from dredged material (FOB 2002). In June 2001, during the first
233 phase, 100,000 plugs of saltmarsh cordgrass (*Spartina alterniflora*) were planted, resulting in 87
234 percent area coverage on the restoration site. In May 2002, during the second phase, 40,000
235 additional plugs of saltmarsh cordgrass plus 10,000 plugs of saltmeadow cordgrass (*Spartina*
236 *patens*) were planted (FOB 2002). Current inspection of the created marsh site indicates a 90
237 percent plus retention rate of grasses planted in the second phase and a high rate of survival in
238 the first phase (FOB 2002).

239
240 Barren Island is currently being considered for an island restoration project to be restored with a
241 50 percent upland to 50 percent wetland ratio dike alignment using suitable dredged material.

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

248
 249 Table 1-1. Design Areas and Affected Acreages of the Barren Island Proposed Alignments
 250

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

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

253
 254 The Fall 2002 seasonal sampling was conducted within and adjacent to the footprints of the
 255 proposed project and on and around the three island remnants. Details of sampling and
 256 observation areas are included with the methods for each discipline (Section 2).

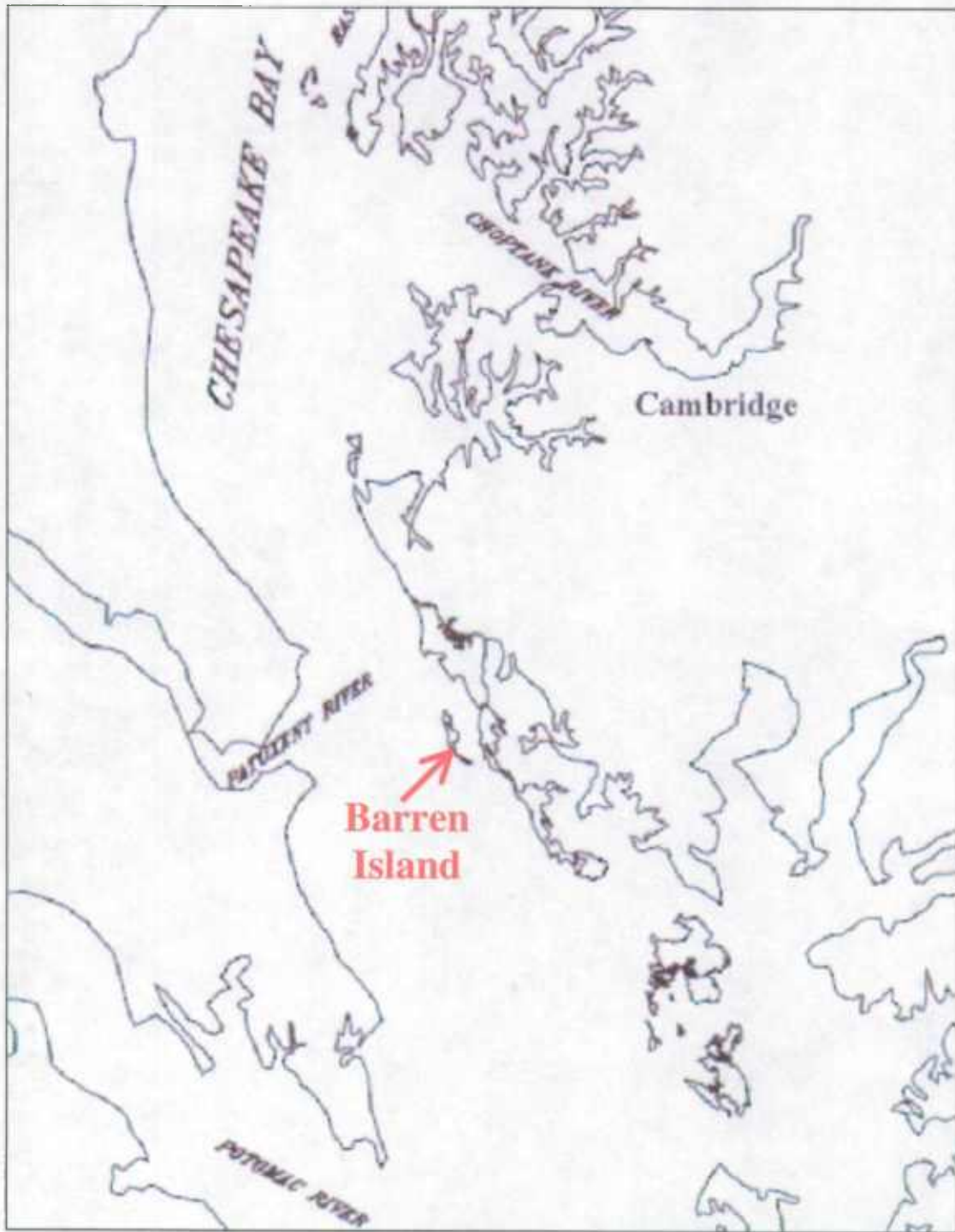
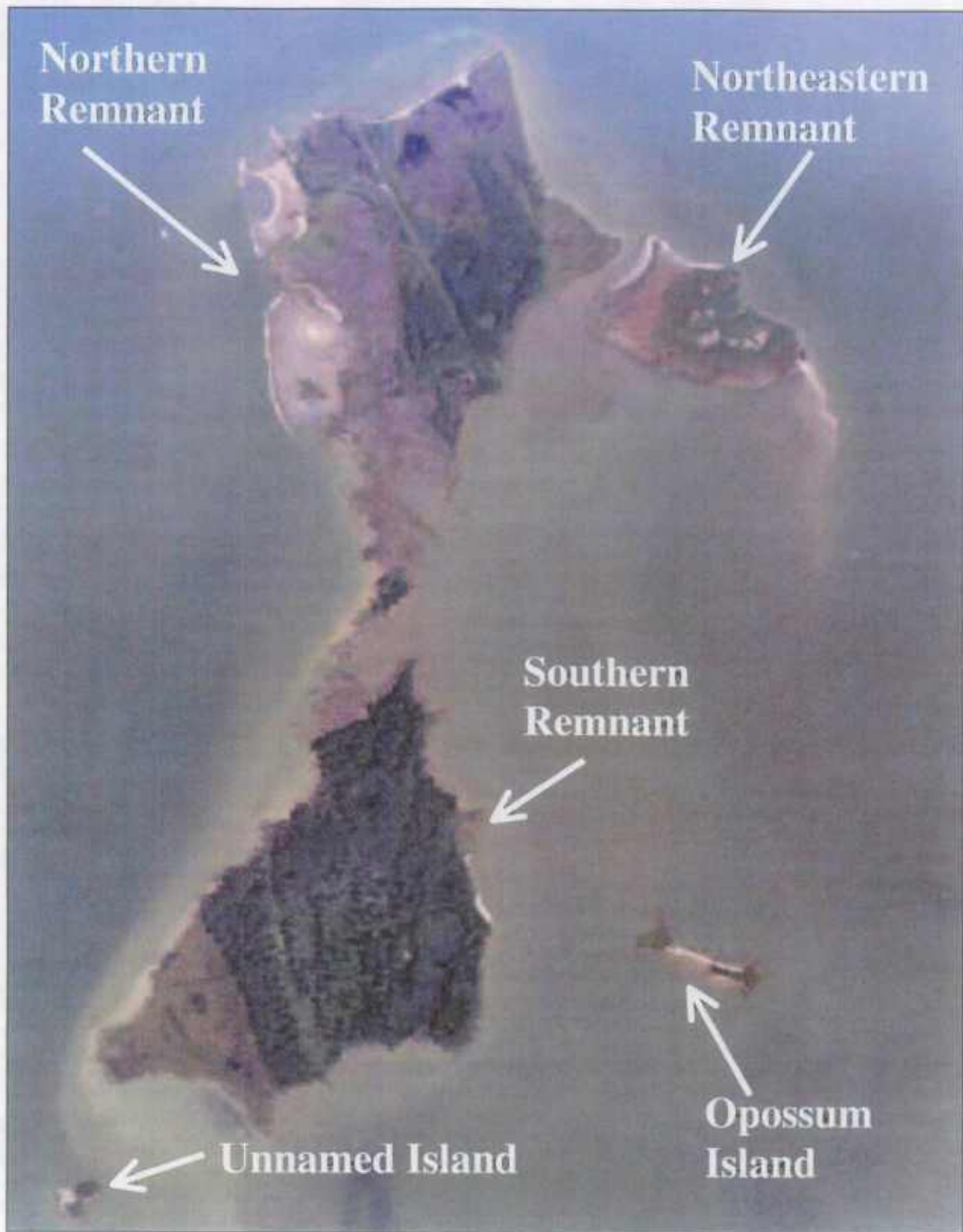
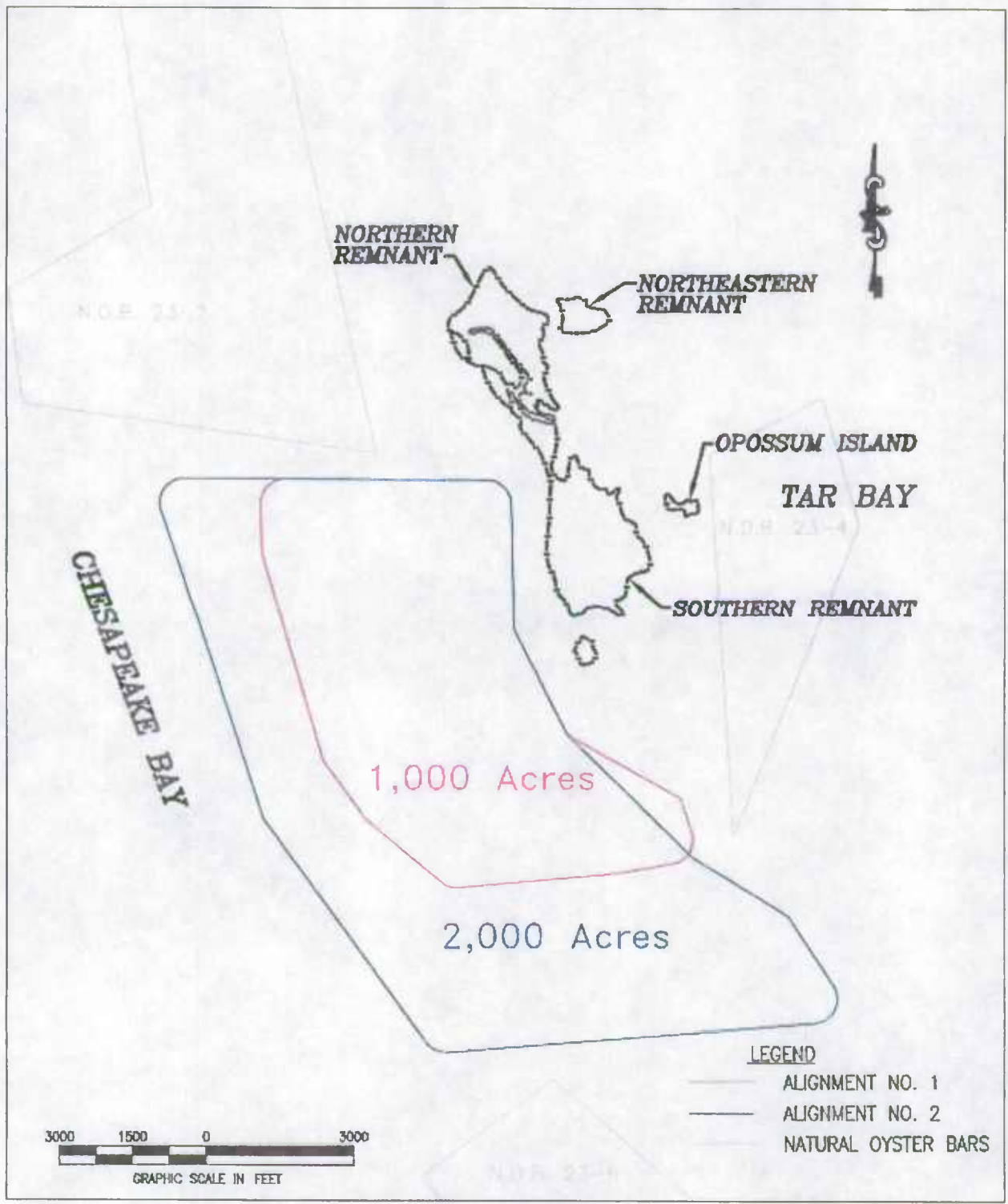


Figure 1-1. Location of Barren Island, Dorchester County, MD



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Figure 1-2. Current Barren Island Remnant Locations



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Figure 1-3. Proposed Placement Areas at Barren Island

2.0 METHODS

2.1 AQUATIC SURVEYS

2.1.1 Water Quality

At each benthic, 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

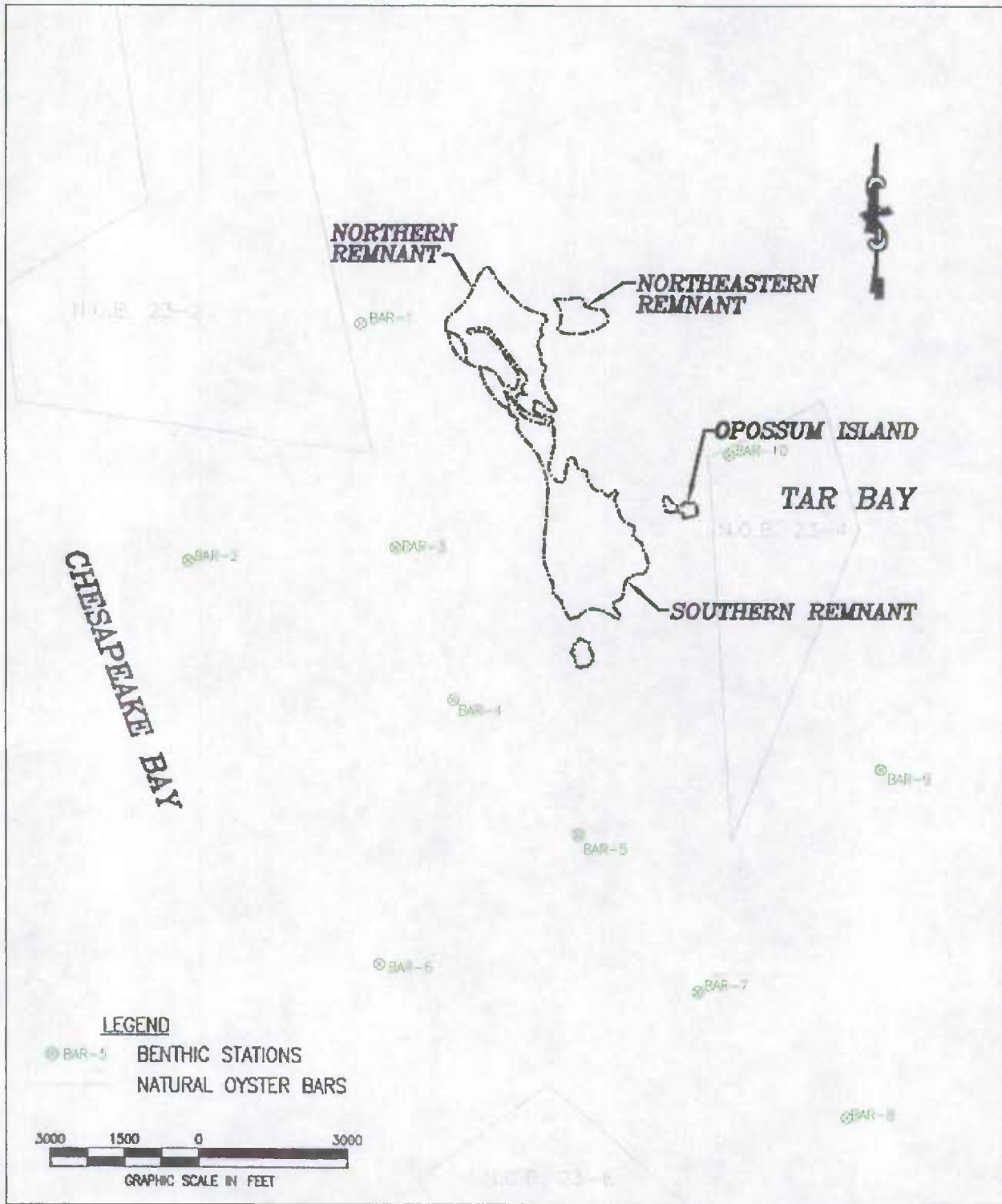
Field Methods

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) identified during the Summer 2002 survey. The Differential Global Positioning System (DGPS) was used to navigate to the previous benthic stations established during the Summer 2002 survey. The benthic stations did not differ between the Summer 2002 and Fall 2002 surveys with the exception of Station BAR-10, which was moved slightly south of the Summer 2002 station due shoaling (blow-out tidal conditions made it impossible for boats to access the station). 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. 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. 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)



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Figure 2-1. Nutrient and Benthic Sampling Stations in the Vicinity of Barren Island, Fall 2002

- 321 • Particulate Carbon
- 322 • Dissolved Organic Carbon
- 323 • Total N and Total P
- 324 • Chlorophyll-*a* and Phaeophytin
- 325 • Total Suspended Solids

326

327 **2.1.2 Benthic Community**

328

329 *Sampling Methods*

330

331 Triplicate grab samples were collected at 10 locations around Barren Island (BAR-1 through
332 BAR-10) using a standard 9-in × 9-in Ponar grab sampler (Figure 2-1). The benthic station
333 locations did not differ between the Summer 2002 and Fall 2002 surveys with the exception of
334 Station BAR-10, which was moved slightly south of the Summer 2002 station due to
335 inaccessibility during the Fall 2002 survey. Each replicate benthic sample was sieved in the field
336 through a 500-micron screen to remove fine sediment particles. Individual replicates were
337 transferred to labeled bottles and preserved in the field using buffered 10 percent formaldehyde
338 solution stained with rose bengal.

339

340 *Sample Storage and Transport*

341

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

348

349 *Laboratory Processing*

350

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

357

358 *Data Analysis*

359

360 Benthic invertebrates are used extensively as indicators of estuarine environmental status and
361 trends because numerous studies have demonstrated that benthos respond predictably to many
362 kinds of natural and anthropogenic stress (Weisberg et al. 1997). Normally, to evaluate the
363 benthic community, the metrics used to calculate The Chesapeake Bay Benthic Index of Biotic
364 Integrity (B-IBI) developed by Weisberg et al. (1997) are selected. These metrics were designed
365 to characterize the response of the benthic community to stresses. However, the B-IBI was not
366 calculated on the Fall Barren Island benthic data since this index was designed as a summertime

367 analysis. To describe the benthic community for the Fall 2002 survey and to provide an
368 assessment of benthic community condition, the following metrics were calculated.

370

- 372 • **Shannon-Weiner Diversity Index** – This \bar{H} index has probably been the most widely used
373 index in community ecology. It is based on information theory and is a measure of the
374 average degree of “uncertainty” in predicting the species of an individual chosen at random
375 from a collection of S species and N individuals (Weisberg et al. 1997). This metric is
376 influenced by species richness and the distribution of individuals among the species (Weber
377 1973). The Shannon-Weiner Diversity Index is calculated using the following equation:
378

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

379

380 where,

380

381

ni = importance^(a) value for each species

382

N = Total of importance values

383

384

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

385

386

- **Abundance** – Total abundance was calculated as total number of organisms per square
387 meter.

388

389

- **Stress-Indicative Taxa Abundance** – Calculated as the percentage of total abundance
390 represented by stress-indicative taxa.

391

392

- **Stress-Sensitive Taxa Abundance** – Calculated as the percentage of total abundance
393 represented by stress-sensitive taxa.

394

395

- **Carnivore/Omnivore Abundance** – Calculated as the percentage of total abundance
396 represented by carnivore/omnivore taxa.

397

398

Feeding guilds and life histories of the benthic fauna were assigned to each species. Feeding
399 guilds were derived from the Interstate Commission on the Potomac River Basin (ICPRB 1999)
400 and life histories were derived from Weisberg et al. (1997). A summary of the feeding guilds
401 and life histories of the benthic fauna collected at Barren Island is presented in Table 2-1.

402

403

Other Benthic Community Metrics

404

405

Four additional metrics were also selected to further characterize the benthic community and
406 include:

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408

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

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TABLE 2-1. FEEDING GUILD AND LIFE HISTORY INFORMATION FOR BENTHIC MACROINVERTEBRATES COLLECTED FROM BARREN ISLAND, FALL 2002

Taxa	Feeding Guild ^(a)	Life History ^(b)
CNIDARIA (sea anemones)		
<i>Edwardsia elegans</i> (burrowing anemone)	carnivore/omnivore	--
PLATYHELMINTHES (flatworms)		
<i>Stylochus ellipticus</i> (oyster flatworm)	--	--
NEMERTINEA (unsegmented worms)		
<i>Micrura leidyi</i> (red ribbon worm)	carnivore/omnivore	--
<i>Amphiporus bioculatus</i>	not assigned	--
ANNELIDA (segmented worms)		
POLYCHAETA (bristle worms)		
<i>Eteone heteropoda</i> (freckled paddle worm)	carnivore/omnivore	--
<i>Eteone foliosa</i>	carnivore/omnivore	--
<i>Podarkeopsis levifuscina</i>	carnivore/omnivore	--
<i>Neanthes succinea</i>	carnivore/omnivore	--
<i>Glycera dibranchiata</i>	carnivore/omnivore	--
<i>Glycinde solitaria</i> (chevron worm)	carnivore/omnivore	pollution sensitive
<i>Leitoscoloplos robustus</i>	deep deposit	--
<i>Paraonis fulgens</i>	interface	--
<i>Polydora cornuta</i>	interface	--
<i>Marenzelleria viridis</i>	interface	pollution sensitive
<i>Spiophanes bombyx</i>	interface	pollution sensitive
<i>Paraprionospio pinnata</i> (fringe-gilled mud worm)	interface	pollution indicative
<i>Streblospio benedicti</i> (barred-gilled mud worm)	interface	pollution indicative
<i>Scolelepis (P.) texana</i>	interface	--
<i>Spiochaetopterus costarum</i>	interface	pollution sensitive
<i>Heteromastus filiformis</i> (capitellid thread worm)	deep deposit	--
<i>Mediomastus ambiseta</i>	deep deposit	pollution sensitive
Maldanidae	deep deposit	--
<i>Pectinaria gouldii</i> (trumpet worm)	deep deposit	--
<i>Loimia medusa</i> (red-spotted worm)	interface	pollution sensitive
OLIGOCHAETA (aquatic worms)		
<i>Tubificoides spp.</i>	deep deposit	--
Naididae	deep deposit	--
GASTROPODA (snails)		
<i>Rictaxis punctostriatus</i>	carnivore/omnivore	--
<i>Acteocina canaliculata</i> (barrel bubble snail)	carnivore/omnivore	--
<i>Haminoea solitaria</i> (solitary bubble snail)	carnivore/omnivore	--
BIVALVIA (clams and mussels)		
Bivalvia	deep deposit	--
<i>Parvilucina multilineata</i>	suspension	--

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(a) Feeding guilds taken from Ranasinghe et al. (1993) and the ICPRB.
(b) Life histories taken from Weisberg et al. (1997).

TABLE 2-1. (CONTINUED)

Taxa	Feeding Guild ^(a)	Life History ^(b)
BIVALVIA (clams and mussels) (CONTINUED)		
Bivalvia	deep deposit	--
<i>Mulinia lateralis</i> (coot clam)	suspension	pollution indicative
<i>Macoma mitchelli</i>	interface	--
<i>Tagelus plebeius</i> (stout razor clam)	suspension	pollution sensitive
<i>Gemma gemma</i> (gem clam)	suspension	--
<i>Lyonsia hyalina</i>	interface	--
CRUSTACEA		
BRANCHIURAN (barnacles)		
<i>Balanus improvisus</i> (bay barnacle)	not assigned	--
MYSIDACEA (mysid shrimp)		
<i>Neomysis americana</i> (opossum shrimp)	--	--
<i>Americamysis almyra</i>	--	--
CUMACEA (cumacean shrimp)		
<i>Oxyurostylis smithi</i>	interface	--
ISOPODA (isopods)		
<i>Ptilanthura tenuis</i>	carnivore/omnivore	--
<i>Paracereis caudata</i> (eelgrass pill bug)	--	--
<i>Erichsonella attenuata</i> (elongated eelgrass isopod)	carnivore/omnivore	--
<i>Edotea triloba</i> (mounded-back isopod)	--	--
AMPHIPODA (beach fleas; scuds)		
<i>Ampelisca abdita</i> (four-eyed amphipod)	suspension	--
<i>Apocorophium lacustre</i>	--	--
<i>Listriella barnardi</i>	interface	--
<i>Ameroculodes spp. complex</i>	--	--
BRACHYURA (true crabs)		
<i>Callinectes sapidus</i> (blue crab)	carnivore/omnivore	--
PHORONIDA (horseshoe worms)		
<i>Phoronis sp.</i> (phoronid worm)	suspension	--
OPHIUROIDEA		
<i>Ophiuroidea</i>	deep deposit	--
ECHINODERMATA		
<i>Leptosynapta tenuis</i> (white synapta)	deep deposit	--
HEMICHORDATA		
<i>Saccoglossus kowalevskii</i> (acorn worm)	deep deposit	--
<i>Saccoglossus bromophenolosus</i>	deep deposit	--
UROCHORDATA (tunicates)		
<i>Molgula manhattensis</i> (sea grapes)	not assigned	--
CEPHALOCHORDATA		
<i>Branchiostoma caribaeum</i>	--	--

418

^(a)Feeding guilds taken from Ranasinghe et al. (1993) and the ICPRB.

419

^(b)Life histories taken from Weisberg et al. (1997).

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- **Evenness (e)** – Evenness 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:

427

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

429

431 where: \bar{H} = Shannon-Weiner Index value
432 S = number of species
433

434
435
436

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

437

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

438

439 where: S = number of species
440 N = number of individuals
441

442
443
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447

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 interstation comparisons 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.

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452

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

453

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

454

455 where: ni = importance value for each species
456 N = total of importance values
457

458
459

2.1.3 Fisheries Studies

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Three sampling techniques that include bottom trawl, beach seining, and gillnetting, were employed to collect adult and juvenile fish species around Barren Island in Fall 2002. Fish and blue crabs were collected at a total of fifteen locations (five beach seine locations, six bottom trawl, and four gillnet stations) within and adjacent to the proposed dike alignments. However, only three of the five seine stations established during the Summer 2002 survey were accessible

465 during the Fall 2002 survey due to seasonally low tides. Seine stations BAR-S4 and BAR-S5
466 were completely exposed and inaccessible during the Fall 2002 survey. For all other stations, the
467 same bottom trawl, beach seine, and gillnet stations that were sampled in the Summer 2002 were
468 also sampled in the Fall 2002, due to accessibility to all stations.

469

470 ***Bottom Trawl***

471

472 Six bottom trawl locations (BAR-001 through BAR-006) were identified in the field during the
473 Summer 2002 sampling that reflected the range of bottom conditions within or adjacent to the
474 proposed alignments (Figure 2-2). Two consecutive, parallel otter trawl tows were conducted at
475 each station, spaced several hundred feet apart. Trawling was conducted from three hours before
476 until three hours after high tide. The gear employed was a 16-foot semi-balloon otter trawl with
477 a ¾" liner. When the net was deployed, DGPS coordinates were recorded at the beginning and
478 end of each tow. Two separate five-minute tows were conducted at each of the six locations at a
479 constant boat speed of 1,300 revolutions per minute (rpm). Longer tows were not conducted due
480 to obstructions such as crab pots and downed trees. The two tows at each location were
481 conducted parallel to the prevailing currents, tidal flow or wind, whichever is greater. A 7:1
482 warp-to-tow ratio was used at all times to ensure that the net was fishing on the bottom. Upon
483 completion of each five-minute tow, the trawl was emptied into a container and processed before
484 conducting the second tow.

485

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

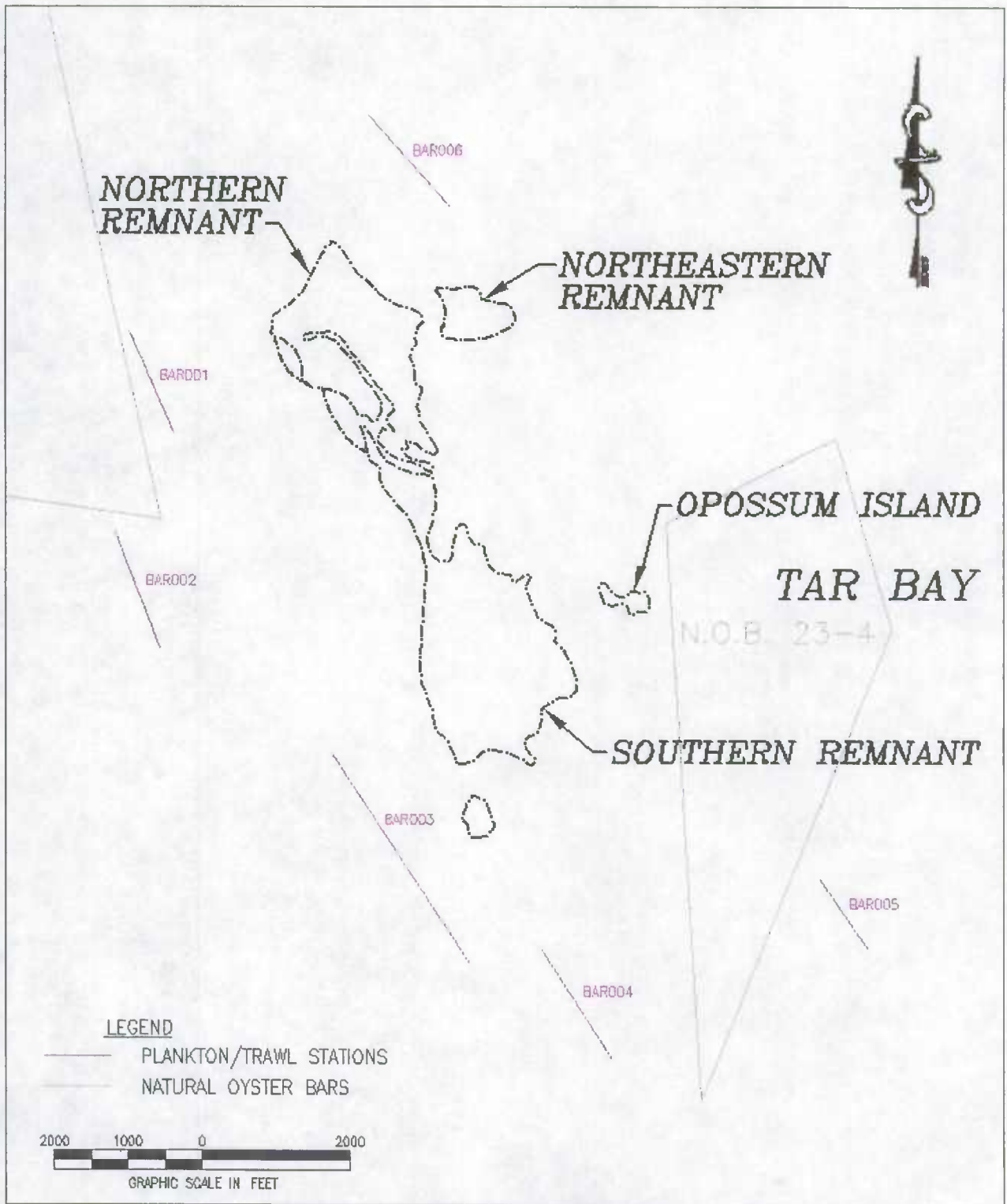
495

496 ***Beach Seine***

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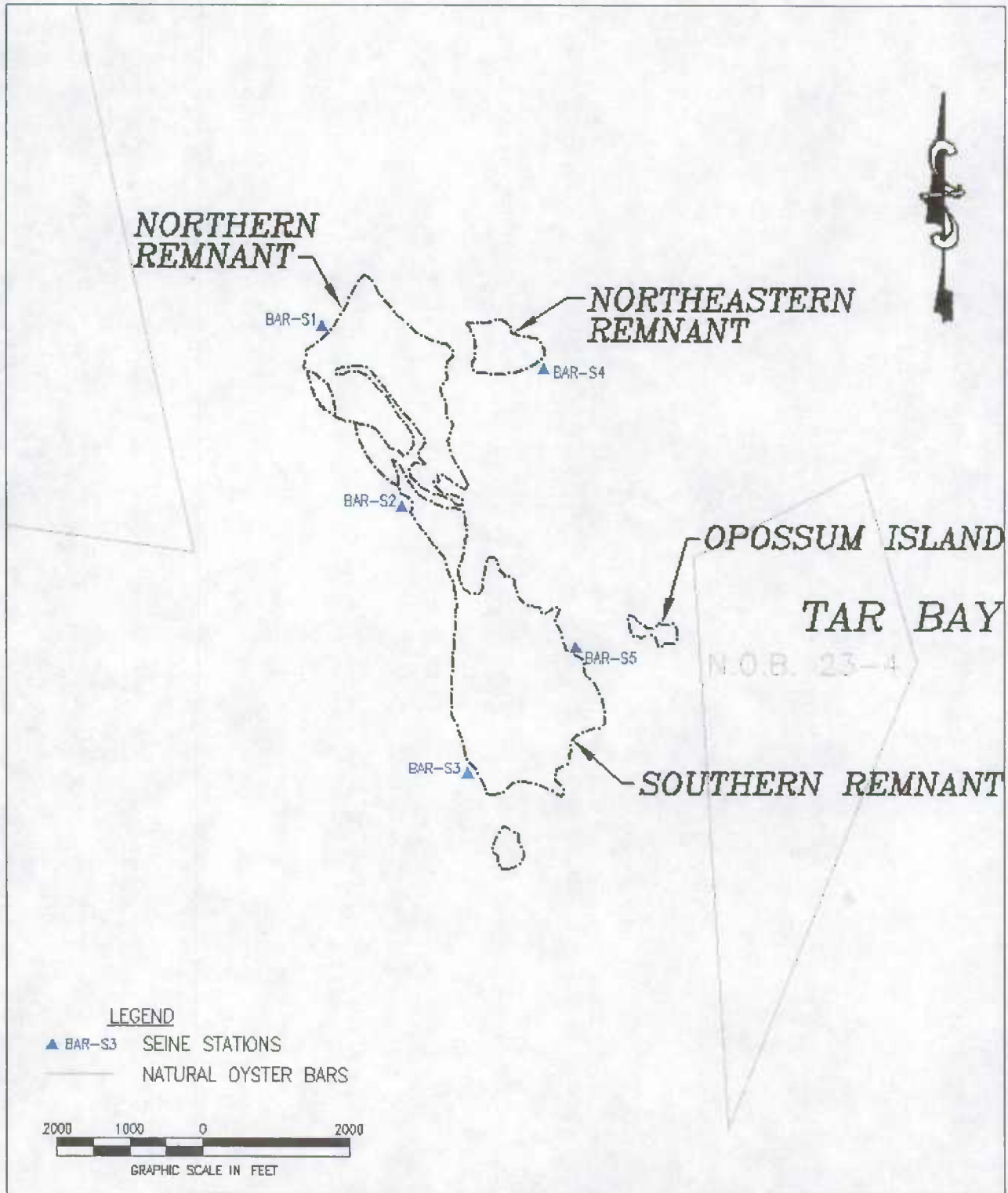
498 Five beach seine locations (BAR-S1 through BAR-S5) were identified in the field during the
499 Summer 2002 sampling, and were chosen to reflect a range of shoreline conditions within and
500 adjacent to the proposed alignments. Because of the many snags and variable bottom conditions
501 around much of the island remnants, the locations chosen were the areas that could be sampled
502 effectively by seining; the beach seine locations are presented in Figure 2-3. Locations were
503 chosen to represent as many types of shore-zone habitat as possible and to distribute the seine
504 sites between the western and eastern sides of the island. BAR-S1 was located on the northern
505 end of the northern remnant. BAR-S2 was located on the western shoreline of the northern
506 remnant. BAR-S3 was located on the southwestern shoreline of the southern remnant. BAR-S4
507 was located on the sandspit of the northeastern remnant and BAR-S5 was located on the oyster
508 shell beach on the eastern side of the southern remnant; both stations were completely exposed
509 and inaccessible during the Fall 2002 survey.

510



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Figure 2-2. Fish Trawl Stations in the Vicinity of Barren Island, Fall 2002



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

518 A 100-foot by 4-foot seine net with ¼ inch mesh was used to sample these locations. The net was
519 deployed in an arc, perpendicular to the shoreline to sample approximately 30 meters of
520 shoreline. Two consecutive and adjacent hauls were conducted at each of the five sites for a
521 combined shoreline distance of approximately 60 meters. All finfish and blue crabs were emptied
522 into a container and processed before conducting the second haul.

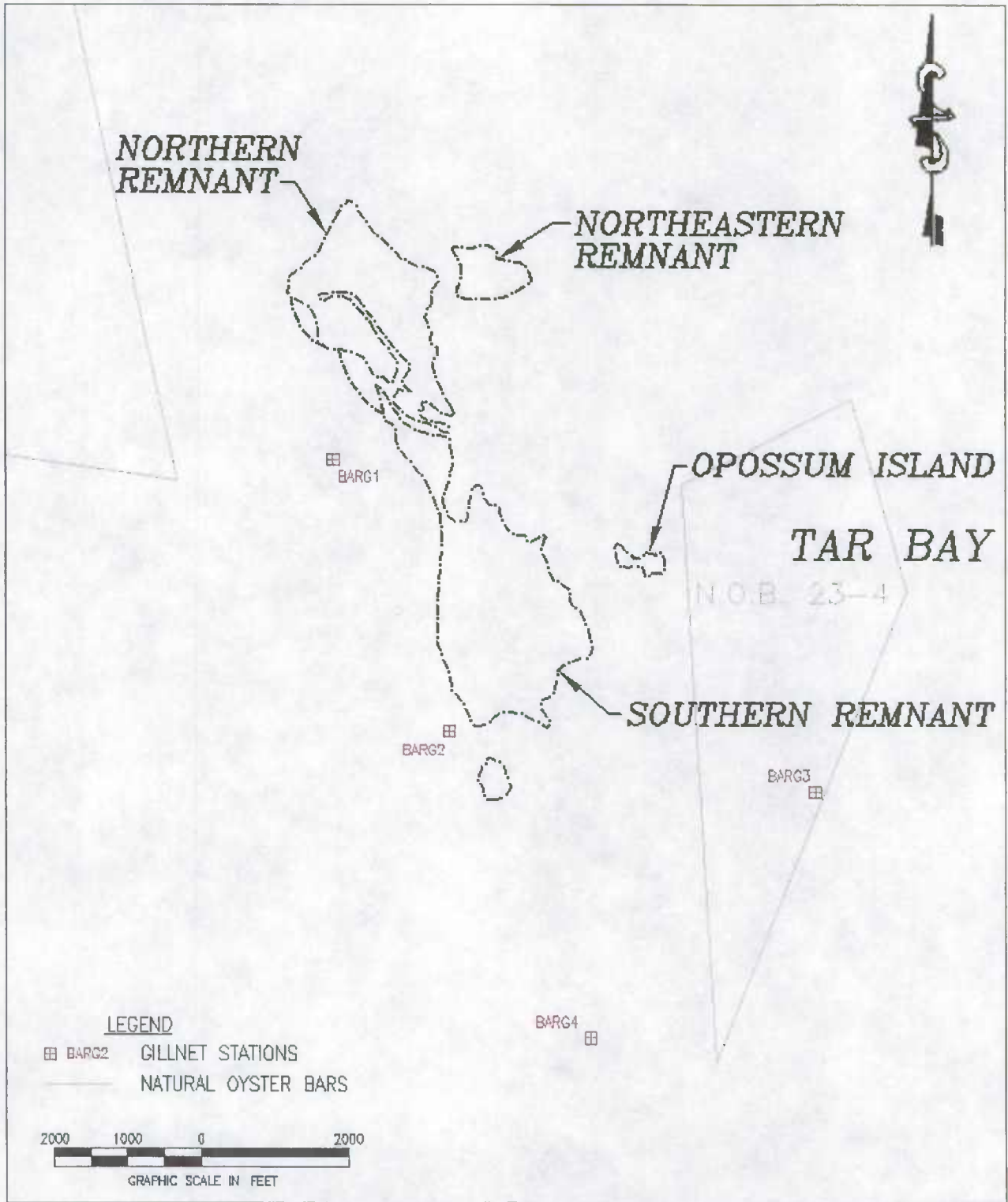
523
524 Seine samples were processed onshore, and organisms were identified, enumerated and returned
525 to the water. A representative subsample of fifty individuals per species from each haul was
526 measured to the nearest millimeter. Measurements included total lengths of finfish and carapace
527 widths of blue crabs. Data were recorded on standard fisheries datasheets. Organisms having
528 external parasites, disease, or morphological abnormalities were noted on the datasheet.
529 Organisms collected during the two hauls at a single location were numerically combined for
530 summarization purposes. *In situ* water quality parameters were recorded at each of the five
531 locations.

532
533 ***Gillnets***

534
535 Gillnetting was conducted at four locations within and adjacent to the proposed alignments. The
536 gillnet locations are shown on Figure 2-4 and were selected based upon bathymetry and the areas
537 that are most likely utilized by pelagic and very mobile fish species. Two hundred foot
538 experimental gillnets with five panels of different mesh size were utilized. The mesh varies from
539 ¼ inch to 2.5 inch (square mesh) and targets a wide variety of species and lifestages that would
540 typically utilize the shallows around Barren Island. One net per station was deployed as fixed
541 gear, overnight, for at least twelve hours. Nets were set perpendicular to the prevailing tidal
542 current with the smallest mesh in the shallower (near shore) waters. DGPS coordinates were
543 recorded at the centerpoint of each net.

544
545 All organisms captured in the nets were processed onboard the work boat, and organisms were
546 identified, enumerated, and returned to the water. A representative subsample of fifty
547 individuals per species at each station were measured to the nearest millimeter; including total
548 lengths of finfish and carapace widths of blue crabs. Data were recorded on standard fisheries
549 datasheets. Organisms having external parasites, disease, or morphological abnormalities were
550 noted on the datasheet. *In situ* water quality parameters were recorded at each of the four
551 locations.

552



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

557 **2.2 TERRESTRIAL SURVEYS**

558

559 **2.2.1 Vegetation Surveys**

560

561 Vegetative communities and habitat types observed at Barren Island in the first season of
562 sampling in September 2002 were categorized by field reconnaissance activities and the
563 documentation of data during field activities to the three island remnants. Additionally, aerial
564 photographs, maps, and field notes from previous investigations of James Island were also used
565 to determine the community types present at James Island. For the Fall 2002 survey, vegetative
566 communities and habitat-type observations were made on all of the Barren Island remnants and any
567 differences from previous surveys were noted. Two EA scientists walked the remnant islands and
568 noted any seasonal differences from previous efforts. The Fall 2002 observations are intended to
569 build upon the previous efforts undertaken in September 2002. All plant species were noted on
570 standardized data sheets.

571

572 The intent of the vegetation characterization component of this investigation was to identify the
573 distribution and composition of plant communities present such as low marsh, high marsh, upland,
574 and open water habitats. The plant species compositions of these areas were determined in terms of
575 dominant and sub-dominant plants (by visual dominance estimation) and determined to the genus and
576 species level, when possible. Dominant plant species and vegetative communities encountered
577 during the vegetation survey were documented on data sheets and observations were recorded
578 with a digital camera in the field and downloaded in the office as a photographic record
579 (Appendix A). Observed plant species were identified in the field and characterized by natural
580 resource type and qualitative data was recorded concerning the distribution and extent of plant
581 communities. Details of the botanical species observed within each habitat type or natural
582 resource were recorded on the data sheets. Other general observations including wildlife species
583 and topography characteristics were also noted.

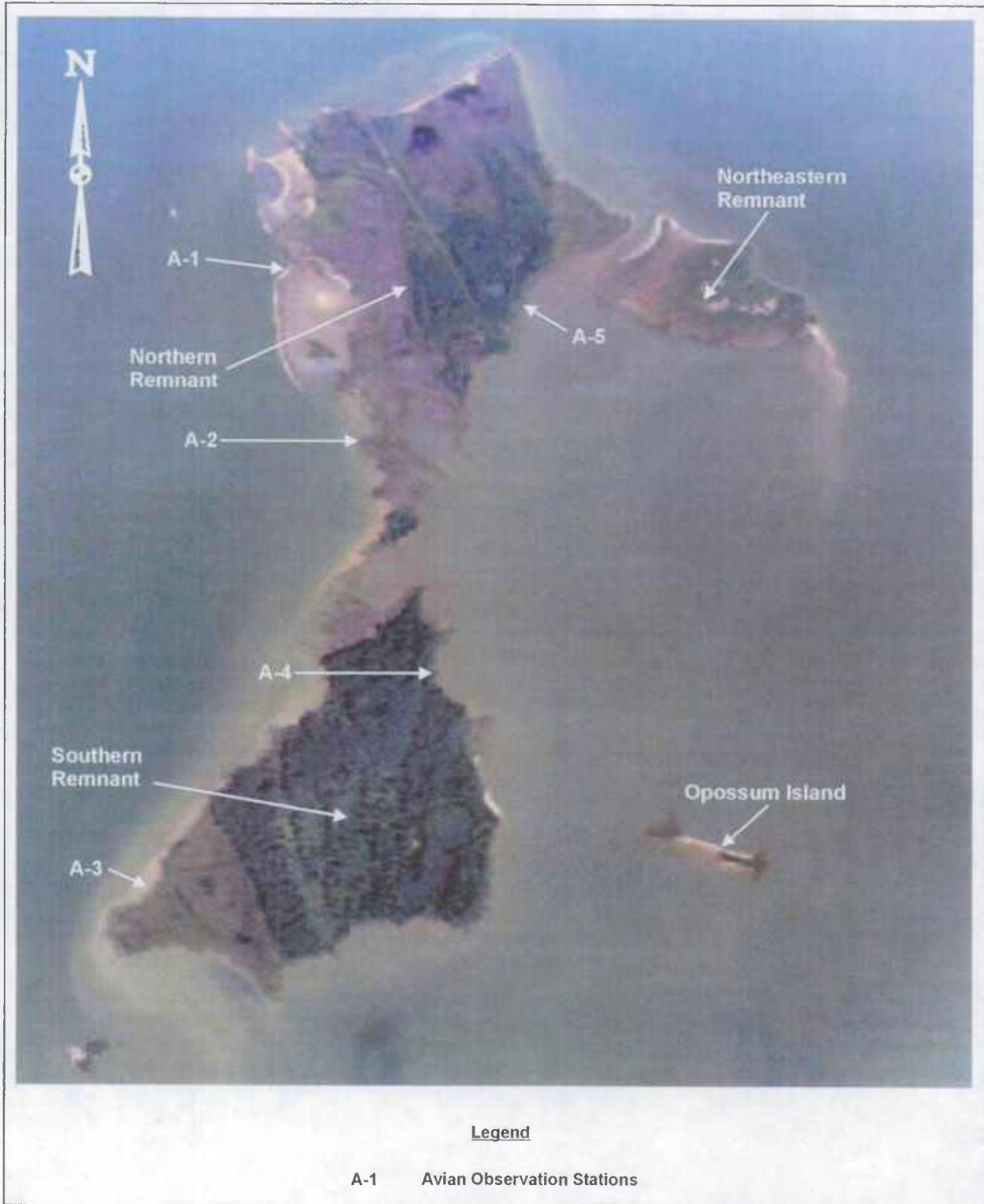
584

585 **2.2.2 Avian and Wildlife Observations**

586

587 Bird survey observations were made at five stations around the perimeter of the Barren Island
588 remnants (Figure 2-5). To be consistent, the same timed observation stations surveyed in the
589 Summer 2002 sampling were the stations surveyed during the Fall 2002 sampling. The five
590 avian stations around the perimeter of the three remnants of Barren Island (Stations A-1 to A-5)
591 were established in order to observe the range of habitat types available around the island (i.e.,
592 including forests, wetlands, open water, and beach). At each station a timed bird survey was
593 conducted covering a 180-degree observation area. Each survey was 15 minutes in length. All
594 species heard and/or observed with binoculars during the 15-minute period were recorded on
595 data sheets. The data sheet consisted of four sections that included sample information (i.e.,
596 date, time, location, and weather conditions), habitat checklist, a bird species checklist and an
597 area for notations. The checklist portion of the field data sheet had been developed for use as a
598 generic field data sheet.

599



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Figure 2-5. Avian Observations Stations at Barren Island, Fall 2002

604 Bird species considered relatively common over a wide diversity of habitat types and seasons
605 were listed in the checklist. Bird species were listed in taxonomic order and broken into
606 categories as follows:
607

- 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

608
609 The purpose for surveying birds associated with the three remnant portions of Barren Island was
610 to make observations at a portion of the remnant and the adjacent, open water. The survey
611 methods were utilized to achieve the desired results of documenting avian utilization of the
612 project area, particularly the tidal marsh, upland habitat, and adjacent tidal waters.

613
614 During the 15-minute observation period, all avian species seen and/or heard were noted along
615 with the method of observation. Individuals were enumerated when discernible. Evidence of
616 former nesting on the Barren Island remnants was also noted when observed.

617
618 In addition to the timed avian observations, incidental bird species observed were noted during
619 the Barren Island habitat characterization surveys in Fall 2002. The avian field data form
620 described above was utilized and the recorded observations followed the same methodology.
621 During the vegetation and habitat characterization surveys on each island remnant, wildlife
622 species and signs (e.g., tracks, scat, bones, etc.) observed were recorded. When possible, the
623 total number of individual wildlife species was also noted. The notation box portion of the data
624 sheet was used to record any observations of other wildlife species.

625 626 **2.2.3 Historical and Cultural Resources**

627
628 During the EA Fall 2002 surveys, observations of historical, archeological, and other resources
629 were completed in conjunction with the vegetation, avian, and wildlife observations. The intent
630 of this investigation was to identify the distribution and occurrence of possible historic and
631 archeological resources that were identified by the Maryland Historic Trust (MHT) relative to

632 the area proposed for construction. Approximately 75 percent of the northern, northeastern, and
633 southern remnants of Barren Island were traversed by EA scientists and general historic and
634 archeological observations were recorded, when applicable.
635

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. The aquatic surveys were conducted on 25 to 26 November, 2 to 4 December, and 19 to 21 December. This section details the results of the aquatic 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 seine stations) ranged from 1.5 to 14 feet. Water temperatures recorded from all stations ranged from 1.7 to 10.9°C. Salinity ranged from 15.6 to 18.7 ppt at sampling stations. Measurements of pH ranged from 8.1 to 8.4 which is typical of waters of this salinity regime. Dissolved oxygen ranged from 10.9 to 15.2 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 0.0453 to 0.1540 mg N/L, concentrations of nitrite ranged from 0.0051 to 0.0092 mg N/L, and concentrations of phosphate ranged from 0.0019 to 0.0033 mg P/L. Concentrations of ammonium ranged from 0.007 to 0.010 mg N/L.

Dissolved Organic Nutrients

Concentrations of total dissolved organic carbon (DOC) ranged from 4.09 to 5.19 mg C/L, concentrations of total dissolved nitrogen (TDN) ranged from 0.36 to 0.56 mg N/L, and concentrations of total dissolved phosphorous (TDP) ranged from 0.0089 to 0.0112 mg P/L.

679 ***Particulate Nutrients***

680

681 Particulate carbon (PC) concentrations ranged from 1.59 to 2.67 mg C/L, particulate nitrogen
682 (PN) concentrations ranged from 0.227 to 0.291 mg N/L, and particulate phosphorous (PP)
683 concentrations ranged from 0.0136 to 0.0187 mg P/L.

684

685 ***Chlorophyll a and Phaeophytin***

686

687 Chlorophyll *a* concentrations ranged from 13.27 to 21.71 µg/L, and phaeophytin concentrations
688 ranged from 6.04 to 9.57 µg/L.

689

690 ***Total Suspended Solids***

691

692 The total suspended solids (TSS) concentration in water samples from Barren Island ranged from
693 12.0 to 37.0 mg/L. Turbidity was somewhat elevated around the island at various times during
694 the Fall 2002 surveys due to wind driven waves suspending bottom sediments and eroding the
695 exposed sediments of the island. The higher TSS values at BAR-9 and BAR-10, compared to the
696 other stations, were likely due to the very shallow depths at the stations (3 ft at BAR-9 and 1.5 ft
697 at BAR-10), which facilitated sediment suspension due to wave action and propeller wash.

698

699 **3.1.2 Benthic Community**

700

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

705

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

711

712 A total of 56 separate benthic taxa were collected in November 2002 at Barren Island (Table B-
713 2). The annelids comprised the most taxa (22); followed by crustaceans (13); bivalves (7); and
714 gastropods (3). The remaining groups contained two or less taxa each: cnidaria, platyhelminthes,
715 nemertinea, ophiuroidea, hemichordata, enchinodermata, cephalochordata, and urochordata.

716

717 ***Benthic Community Metrics***

718

719 A summary of the benthic community metrics for the Fall 2002 collection at Barren Island is
720 presented in Table 3-3. The Shannon-Weiner Diversity values varied, ranging from 1.67 at
721 BAR-9 to 2.57 at BAR-2. The abundance of pollution-sensitive taxa was high at most stations
722 ranging from 9.5 percent at BAR-8 to 45.8 percent at BAR-1. The abundance of pollution-
723 indicative taxa was low for most stations ranging from 0 percent at BAR-4 and BAR-7 to 27.9

724

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TABLE 3-1. *IN SITU* WATER QUALITY MEASUREMENTS TAKEN IN ASSOCIATION WITH BIOLOGICAL COLLECTIONS, FALL 2002

Station Number	Depth (ft)	Temperature (°C)	pH	DO (mg/L)	Salinity (ppt)
Benthic Sampling					
BAR-1	7.0	8.9	7.9	10.9	17.8
BAR-2	12.0	9.7	8.1	11.9	17.6
BAR-3	7.0	9.4	7.9	11.5	18.0
BAR-4	7.0	10.2	8.1	12.0	18.1
BAR-5	5.0	9.8	8.1	12.0	18.2
BAR-6	10.0	10.8	8.2	12.5	17.6
BAR-7	5.0	10.9	8.1	12.4	18.7
BAR-8	3.0	9.5	7.9	11.1	17.8
BAR-9	3.0	8.8	7.8	11.2	16.9
BAR-10	1.5	10.3	7.9	11.6	17.8
Nutrient Sampling					
BAR-1	10.0	4.6	8.1	14.6	16.7
BAR-2	14.0	4.9	8.2	13.6	15.6
BAR-3	10.0	4.7	8.2	14.1	16.6
BAR-4	9.0	4.4	8.2	14.6	16.7
BAR-5	7.0	4.3	8.2	14.0	16.6
BAR-6	11.0	5.1	8.1	13.6	16.8
BAR-7	7.0	4.5	8.2	14.4	16.7
BAR-8	6.0	3.9	8.1	14.6	16.9
BAR-9	6.0	3.9	8.3	15.2	16.4
BAR-10	2.0	4.0	8.2	14.9	16.5
Fish Trawl Sampling					
BAR-001	9.0	6.1	8.0	12.4	17.5
BAR-002	10.0	6.5	7.9	12.6	17.9
BAR-003	7.0	5.6	8.0	13.1	18.1
BAR-004	5.0	5.3	7.9	13.4	18.1
BAR-005	3.0	5.1	8.0	13.1	17.7
BAR-006	4.0	3.3	8.0	13.7	16.9
Beach Seine Sampling					
BAR-S1	1.0	2.2	7.8	14.4	17.0
BAR-S2	1.0	1.7	7.8	14.1	16.9
BAR-S3	1.0	9.5	7.6	11.8	17.9
Gillnet Sampling					
BAR-G1	6.0	8.6	8.0	11.3	17.9
BAR-G2	8.0	5.8	8.3	13.2	16.7
BAR-G3	4.0	1.7	7.9	13.5	17.2
BAR-G4	7.0	5.8	8.2	13.3	16.5

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**TABLE 3-2. NUTRIENT CONCENTRATIONS IN WATER SAMPLES COLLECTED FROM
BARREN ISLAND, FALL 2002**

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	0.0088	0.0092	0.0083	0.0078	0.0077	0.0076	0.0076	0.0051	0.0090	0.0075
Nitrate	MG N/L	0.1050	0.1540	0.1190	0.0812	0.0788	0.1110	0.0869	0.0453	0.0783	0.0635
Ammonium	MG N/L	0.010	0.010	0.007	0.007	0.008	0.010	0.007	0.008	0.009	0.008
Orthophosphate	MG P/L	0.0025	0.0033	0.0025	0.0019	0.0024	0.0032	0.0020	0.0019	0.0020	0.0019
Carbon, Dissolved Organic	MG C/L	4.72	5.08	4.69	4.09	5.19	4.68	4.41	4.09	4.74	4.33
Nitrogen, Dissolved	MG N/L	0.40	0.49	0.43	0.39	0.42	0.53	0.40	0.40	0.36	0.38
Phosphorus, Dissolved	MG P/L	0.0099	0.0112	0.0104	0.0091	0.0097	0.0100	0.0095	0.0102	0.0102	0.0089
Carbon, Particulate	MG C/L	2.13	1.59	2.14	2.57	2.66	1.70	2.63	2.31	2.65	2.67
Nitrogen, Particulate	MG N/L	0.2910	0.2360	0.2680	0.2810	0.2890	0.2340	0.2730	0.2270	0.2630	0.2690
Phosphorus, Particulate	MG P/L	0.0170	0.0167	0.0173	0.0180	0.0166	0.0156	0.0164	0.0136	0.0187	0.0161
Chlorophyll- <i>a</i> , Active	UG/L	20.11	19.52	20.31	20.48	21.39	21.71	20.9	13.27	18.98	18.09
Phaeophytin	UG/L	7.39	6.04	7.58	8.48	8.26	6.91	9.57	6.56	7.69	9.09
Total Suspended Solids	MG/L	13.8	12.0	13.8	17.7	15.8	12.5	15.8	15.8	37.0	28.5

732

TABLE 3-3. SUMMARY OF BENTHIC COMMUNITY METRICS AT BARREN ISLAND, FALL 2002

Metric	Benthic Station										Summer Mean	Fall Mean
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10		
Abundance (#/M ²)	1,483.08	652.8	2,692.8	938.4	1,468.8	1,128.12	1,699.32	2,931.48	1,611.6	2,074.68	2,785	1,668.11
Shannon-Weiner Diversity	2.006	2.57	2.069	2.223	2.441	2.476	2.264	2.23	1.674	1.906	2.15	2.19
Pollution -Sensitive Taxa Abundance (%)	45.8	36.56	25.53	44.78	18.89	32.37	18.37	9.53	13.92	19.67	35.9	26.54
Pollution-Indicative Taxa Abundance (%)	27.92	11.56	12.35	0	2.36	8.32	0	0.7	8.86	16.03	6.9	8.81
Carnivore/Omnivore Abundance (%)	35.76	25	27.05	38.91	7.78	17.36	16.81	24.29	27.22	28.22	30.8	24.84
Total # of Taxa	18	20	20	23	24	21	21	20	19	17	24.4	20.30
Simpson's Dominance Index	0.192	0.097	0.193	0.178	0.12	0.114	0.153	0.146	0.309	0.225	0.22	0.17
Species Richness	3.16	4.16	3.18	4.46	4.28	3.91	3.62	3.13	3.29	2.8	4.6	3.60
Evenness	0.69	0.86	0.69	0.71	0.77	0.81	0.74	0.74	0.57	0.67	0.65	0.73

735 percent at BAR-1. The abundance of carnivore/omnivore taxa varied at Barren Island ranging
736 from 7.8 percent at BAR-5 to 35.8 percent at BAR-1. The total number of taxa was similar at the
737 stations sampled at Barren Island, ranging from 17 taxa at BAR-10 to 24 taxa at BAR-5 (Table
738 3-3). Simpson's Dominance Index values varied ranging from 0.097 at BAR-2 to 0.309 at BAR-
739 9. Species Richness was similar at all stations ranging from 2.8 at BAR-10 to 4.5 at BAR-4.
740 Evenness was also similar at all stations ranging from 0.57 at BAR-9 to 0.86 at BAR-2.

741 **Abundance Trends**

742 **Abundance** (total number of organisms per square meter) was low at Barren Island ranging from
743 653/m² at BAR2 to 2,931/m² at BAR8 (Table 3-3).

744 Annelids were the most dominant group found at the benthic stations. Annelids dominated (49.2
745 to 94.1 percent) at all stations except BAR-9 where crustaceans dominated at 55.1 percent. The
746 dominant crustacean at BAR-9 was the amphipod *Ampelisca abdita* (51.5 percent). The
747 dominant annelids were the polychaetes *Paraprionospio pinnata*, *Glycinde solitaria*, *Paraonis*
748 *fulgens*, *Leitoscoloplos robustus*, and *Heteromastus filiformis*.

749 Overall, based on the metrics, BAR-4 exhibited the best benthic community found in the Fall
750 2002 survey. BAR-4 had a high percentage of pollution-sensitive taxa, no pollution-indicative
751 taxa, highest percentage of carnivore/omnivores, highest number of taxa, and highest species
752 richness.

753 **Summer and Fall Mean Values**

754 In general, mean metric values calculated for the benthic community were similar between
755 seasons (summer and fall) at Barren Island (Table 3-3). Most of the metric values decreased
756 slightly from summer to fall including abundance (2,785/m² to 1,668/m²), pollution sensitive taxa
757 abundance (35.9 to 26.5 percent), carnivore/omnivore abundance (30.8 to 24.8 percent), total
758 number of taxa (24.4 to 20.3), and species richness (4.6 to 3.6). Two metrics increased from
759 summer to fall, pollution-indicative taxa (6.9 to 8.8 percent) and evenness (0.69 to 0.72). The
760 mean Shannon-Weiner diversity index and mean Simpson's Dominance index were essentially
761 the same for both seasons, 2.15 (summer) and 2.18 (fall) and 0.22 (summer) and 0.17 (fall),
762 respectively. These slight variations between seasons did not represent a substantive change in
763 the benthic community profile.

764 **3.1.3 Fisheries Studies**

765 The fisheries results are summarized in the following sections, with more detailed summaries
766 and data measurements included in Appendix B. A total of 14 species, representing ten families
767 were collected during the sampling effort conducted in Fall 2002. The scientific and common
768 names of all species collected are presented in Table B-3 and detailed tables of the mean length
769 and range of measurements for all species collected by gear types are listed in Tables B-4, B-5,
770 and B-6 (Appendix B). Summaries of catches by gear type are presented in Table 3-4. *In-situ*
771 water quality measurements collected during the field effort for the fisheries studies were
772 previously discussed in Section 3.1.1 and are included in Table 3-1.

TABLE 3-4. SUMMARY OF FISH COLLECTIONS AT BARREN ISLAND, FALL 2002

Common Name	Scientific Name	Otter Trawl Stations						Seine Stations			Gillnet Stations			
		BAR-001	BAR-002	BAR-003	BAR-004	BAR-005	BAR-006	BAR-S1	BAR-S2	BAR-S3	BAR-G1	BAR-G2	BAR-G3	BAR-G4
Atlantic Menhaden	<i>Brevoortia tyrannus</i>										3			
Alewife	<i>Alosa pseudoharengus</i>				1									
Bay Anchovy	<i>Anchoa mitchilli</i>		1											
Skilletfish	<i>Gobiesox strumosus</i>						1			2				
Mummichog	<i>Fundulus heteroclitus</i>									6				
Striped Killifish	<i>Fundulus majalis</i>							1		2				
Atlantic Silverside	<i>Menidia menidia</i>						13	19	1	25				
Striped Bass	<i>Morone saxatilis</i>			1						1	3	1		
White Perch	<i>Morone americana</i>										6		1	
Red Drum	<i>Sciaenops ocellatus</i>									55				
Striped Mullet	<i>Mugil cephalus</i>							3						
Green Goby	<i>Microgobius thalassinus</i>		1			2	5							
Blue Crab	<i>Callinectes sapidus</i>										2	2		
TOTALS		0	2	1	1	2	19	23	1	91	14	3	1	0

785 **Bottom Trawl**

786

787 A total of six species representing six families were collected during bottom trawl efforts.
788 Overall, collections yielded low abundances of fish ranging from 1 to 19 individuals over all
789 stations. The highest total abundance of individuals was collected at station BAR-006, which
790 yielded one skillettfish (*Gobiesox strumosus*), thirteen Atlantic silverside (*Menidia menidia*), and
791 five green goby (*Microgobius thalassinus*). Fish species of commercial importance collected
792 during bottom trawl efforts included alewife (*Alosa pseudoharengus*) and striped bass (*Morone*
793 *saxatilis*). No fish were collected during the two consecutive tows at sampling station BAR-
794 001.

795

796 **Beach Seine**

797

798 Beach seine efforts yielded seven species representing six families. Only three of the five beach
799 seine stations were accessible during the Fall 2002 survey because of seasonally low tides.
800 Station BAR-S4 was located on the sandspit of the northeastern remnant and BAR-S5 was
801 located on the oyster shell beach on the eastern side of the southern remnant; both stations were
802 completely exposed and inaccessible during the Fall 2002 survey. Atlantic silverside (*Menidia*
803 *menidia*) was the only species collected at all sampling stations. Station BAR-S3 yielded the
804 overall highest abundance of fish collected (91 individuals), mostly due to abundant yields of red
805 drum (*Sciaenops ocellatus*) and Atlantic silverside (*Menidia menidia*). Station BAR-S2 yielded
806 the lowest overall abundance of fish collected (one individual). Fish of recreational and
807 commercial importance collected during beach seine efforts included striped bass (*Morone*
808 *saxatilis*) and red drum (*Sciaenops ocellatus*).

809

810 **Gillnet**

811

812 Gillnetting efforts yielded four species representing three families. Station BAR-G1 yielded the
813 overall highest abundance of fish collected (14 individuals). No fish or crabs were collected
814 from station BAR-G4. Commercially important species collected in gillnetting efforts included
815 white perch (*Morone americana*), striped bass (*Morone saxatilis*), Atlantic menhaden
816 (*Brevoortia tyrannus*), and blue crab (*Callinectes sapidus*). A majority of the fish and crabs
817 collected during gillnetting efforts represented larger, adult and subadult specimens.

818

819 **Fisheries Study Conclusions**

820

821 The Barren Island fisheries study for Fall 2002 indicated that the fish collected were typical
822 species that occur in mesohaline reaches of the Chesapeake Bay. Overall, fish collection efforts
823 using all gear types, yielded low abundances and diversity of fish and crabs. This is expected for
824 shallow water collections during the late fall, particularly when surface water temperatures
825 decrease quickly, as occurred in November and December 2002 when the fisheries studies were
826 conducted (See water temperatures in Table 3-1). Migratory fish species would have already left
827 the Barren Island vicinity by late fall for over-wintering areas (down-Bay or offshore areas), and
828 many resident fish species would most likely seek warmer, deeper areas of the Bay. Beach seine
829 efforts yielded the highest abundance of fish and crabs and collections were comprised mostly of
830 forage fish. Commercially important fish and crab species that were throughout the sampling
831 effort included Atlantic menhaden, alewife, striped bass, white perch, and blue crab.

832

833 Barren Island is located in an area that may provide EFH to nine species that are managed under
834 the Magnuson Stevens Fisheries Conservation Act: summer flounder (*Paralichthys dentatus*),
835 windowpane flounder (*Scophthalmus aquosus*), bluefish (*Pomatomus saltatrix*), cobia
836 (*Rachycentron canadum*), red drum (*Sciaenops ocellatus*), king mackerel (*Scomberomorus*
837 *cavalla*), Spanish mackerel (*Scomberomorus maculatus*), Atlantic butterfish (*Perprilus*
838 *triacanthus*), and black sea bass (*Centropristus striata*). Consultations with the National Marine
839 Fisheries Service (NMFS) have indicated that bluefish, summer flounder, and red drum would be
840 the species of particular concern at Barren Island (Nichols 2002). During the Fall 2002 fisheries
841 and aquatic sampling, one of the potential fish species (red drum) was collected. The waters
842 around the island remnants are supporting a variety of forage species that are known to be
843 important food sources for the species of concern. Because SAV occurs adjacent to many of the
844 remnants in the warmer, summer months (EA 2003), Barren Island may also be providing HAPC
845 for red drum. Consultations with NMFS concerning this issue are ongoing.

846

847 3.2 TERRESTRIAL SURVEYS

848

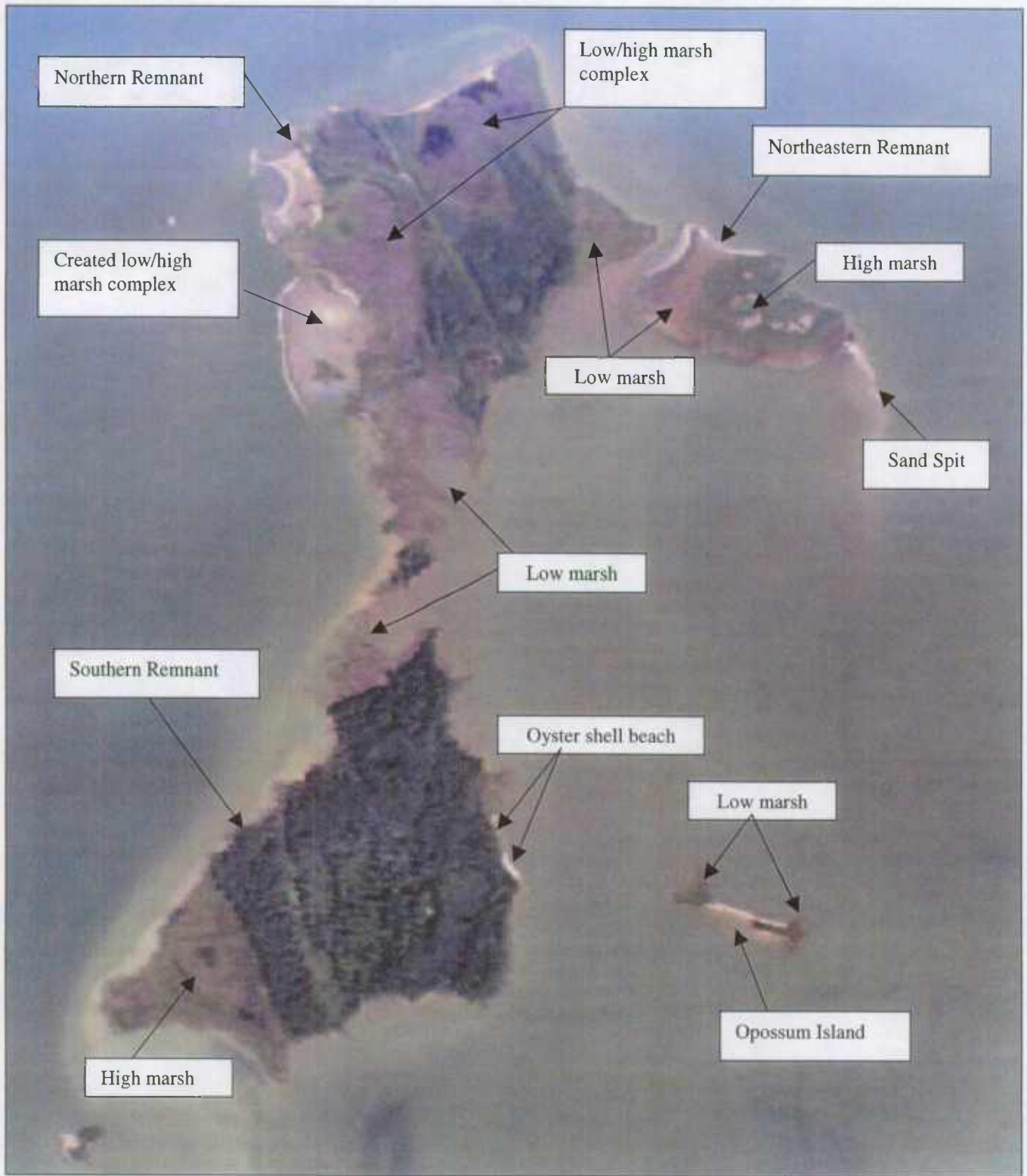
849 Terrestrial surveys, including vegetation identification and mapping and avian observations were
850 conducted during 19 to 20 November 2002.

851

852 3.2.1 Vegetation Surveys

853

854 The northern, northeastern, and southern remnants of Barren Island were occupied by high and
855 low marsh areas, upland forest areas, open water habitats and channels, and sandy beaches
856 including saltpans and sand spits (Figure 3-1). All of the remnants are eroding (particularly
857 along the northern and western shorelines) which is resulting in bare ground, fallen trees, and
858 compromised marshes. The northern remnant is connected with the southern remnant by a
859 narrow, low marsh area dominated and a small, wooded upland area. The shoreline along the
860 narrow corridor that connects the northern and southern remnants is eroded on the western side
861 with bank heights ranging from 1 to 4 ft high; the banks along the eastern shoreline are not
862 severely eroded and are approximately 1 ft high. Additional erosion was evident on all three
863 island remnants and most pronounced along the northern and western shorelines. The majority
864 of the wooded portions of the island remnants appear to be relatively mature, although young
865 seedlings were also present. There was evidence of a fairly recent fire that has killed some
866 loblolly pines in the central portion of the northern remnant. The northern and western
867 shorelines of each remnant show the heaviest erosion and there are many submerged snags in the
868 adjacent water in these areas. A prominent sand spit was observed during the low tide is located
869 at the southeastern point of the northeastern remnant. On the sand spit and in other sandy areas
870 along the shorelines, shell, driftwood, and other debris were present. An overgrown road or
871 runway strip transects the central portion of the northern remnant and a raised 3 to 4-ft berm runs
872 along both the northern and southern remnants. Other habitat features and natural resources
873 observed on Barren Island during the Fall 2002 survey were similar to the observations made
874 during the Summer 2002 survey. A cumulative list of plant species observed during the Fall
875 2002 survey is included in Table 3-5. Details concerning vegetation on the three island remnants
876 are included in the Summer 2002 survey (EA 2003) and a general description is included below.
877 Photos from the terrestrial surveys are included in Appendix A of this report.



878
879
880

Figure 3-1. Location of Marshes at Barren Island, Fall 2002

881 The low marsh areas and open water areas are dominated by saltmarsh cordgrass (both tall and
882 short form), and black needlerush; saltmarsh bulrush (*Fimbristylis castanea*) appears periodically
883 throughout the low marsh. The low marsh areas were often associated around the island
884 remnants in a fringe fashion. The high marsh areas are dominated by saltmeadow cordgrass
885 interspersed with saltgrass (*Distichlis spicata*) and the dominant shrub, marsh elder (*Iva*
886 *frutescens*). In depressions or "pannes" in the marsh floor, slender glasswort (*Salicornia*
887 *europaea*), sea lavender (*Limonium carolinianum*), and saltmarsh aster (*Aster tenuifolius*) were
888 observed. Upland forest areas were evident in the central portions of both the northern and the
889 southern island remnants and are dominated by stands of Loblolly pine (*Pinus taeda*). Pockets of
890 deciduous plant species including common persimmon (*Diospyros virginiana*), sweetgum
891 (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*) and willow oak (*Quercus phellos*)
892 also inhabit the upland areas. The canopy of loblolly pines was not dense and an open
893 understory of pine needles and interspersed American holly (*Ilex opaca*) was observed.
894 Common reed grass (*Phragmites australis*) was observed as small stands in the marsh areas, the
895 upland areas, and along the shorelines. Open water areas and wet channels are dispersed
896 throughout the upper and lower marsh areas and run intermittently across the northern and
897 southern remnants. Opossum Island, located east of the southern remnant consists of two low
898 marsh areas connected by a sandy beach. Opossum Island is dominated by saltmarsh cordgrass
899 and two small stands of common reed, with dead, standing loblolly pines located adjacent to the
900 shorelines.

901
902 Sandy, non-vegetated areas and salt pans are located on the northeastern remnant and in the
903 southwestern portion of the northern remnant, in the same vicinity as the created marsh areas. A
904 marsh habitat, created from dredged materials to replace acreage lost from erosion, is located in
905 the southwestern portion of the northern remnant. The created marsh is approximately 11 acres
906 and was planted in June 2001 with 100,000 plugs of saltmarsh cordgrass (FOB 2002). In May
907 2002, 40,000 additional plugs of saltmarsh cordgrass and 10,000 plugs of saltmeadow cordgrass
908 were planted in the marsh. Offshore geotextile tubes protect the created marsh by dissipating
909 wave energy to reduce erosion. The created marsh appears successful and the marsh grasses
910 have reseeded and expanded from the original plantings.

911
912 Significantly eroded shorelines are evident along the western shoreline of both the northern and
913 the southern remnants and clay shelves range from one to four ft in height. Dead, standing, and
914 downed loblolly pines were observed along the western shoreline. Bank erosion is also evident
915 along the northernmost shoreline of the northern remnant with bank heights approximately 4 ft in
916 height. In addition, the southwestern portion of the island that is not protected by geotubes
917 exhibited erosion along the shorelines of approximately 3 to 4 ft in height. Bank erosion on the
918 southern remnant was observed most severely along the western shoreline with bank heights
919 approximately 3 to 4 ft in height and along the southern shoreline with bank heights
920 approximately 1 to 2 ft in height. Observations from the second season of sampling in Fall 2002
921 showed that erosion is still occurring and diminishing the shorelines of the islands
922

923
924
925

**TABLE 3-5. CUMULATIVE LIST OF PLANT SPECIES OBSERVED AT
BARREN ISLAND, FALL 2002**

Plant Group	Scientific Name	Common Name
Herbaceous plants	<i>Andropogon virginicus</i>	Broomsedge
	<i>Distichlis spicata</i>	Salt Grass
	<i>Echinochloa walteri</i>	Walter's Millet
	<i>Elymus virginicus</i>	Virginia Wild Rye
	<i>Hystrix patula</i>	Bottlebrush Grass
	<i>Juncus effusus</i>	Soft Rush
	<i>Juncus roemerianus</i>	Black Needlerush
	<i>Juncus tenuis</i>	Path Rush
	<i>Panicum virgatum</i>	Switch Grass
	<i>Phragmites australis</i>	Common Reed
	<i>Phytolacca americana</i>	Pokeweed
	<i>Pluchea purpurascens</i>	Saltmarsh Fleabane
	<i>Polygonum punctatum</i>	Dotted Smartweed
	<i>Rubus allegheniensis</i>	Common Raspberry
	<i>Salicornia europaea</i>	Slender Glasswort
	<i>Salsola kali</i>	Common Saltwort
	<i>Scirpus cyperinus</i>	Woolgrass
	<i>Scirpus robustus</i>	Saltmarsh Bulrush
	<i>Setaria faberi</i>	Giant Foxtail Grass
	<i>Setaria parviflora</i>	Marsh Bristlegrass
	<i>Solidago sempervirens</i>	Seaside Goldenrod
	<i>Solidago graminifolia</i>	Flat-Top Goldenrod
<i>Spartina alterniflora</i>	Saltmarsh Cordgrass	
<i>Spartina cynosuroides</i>	Big Cordgrass	
<i>Spartina patens</i>	Saltmeadow Cordgrass	
<i>Typha latifolia</i>	Broad-Leaved Cattail	
Upland Species	<i>Acer rubrum</i>	Red Maple
	<i>Baccharis halimifolia</i>	Groundsel-Tree
	<i>Celtis occidentalis</i>	Common Hackberry
	<i>Diospyros virginiana</i>	Common Persimmon
	<i>Ilex opaca</i>	American Holly
	<i>Iva frutescens</i>	Marsh-Elder
	<i>Juniperis virginiana</i>	Eastern Red Cedar
	<i>Liquidambar styraciflua</i>	Sweet Gum
<i>Morus alba</i>	White Mulberry	

926

927
928

TABLE 3-5. (CONTINUED)

Plant Group	Scientific Name	Common Name
Upland Species (Continued)	<i>Myrica cerifera</i>	Wax Myrtle
	<i>Pinus taeda</i>	Loblolly Pine
	<i>Platanus occidentalis</i>	Sycamore
	<i>Prunus serotina</i>	Black Cherry
	<i>Quercus phellos</i>	Willow Oak
	<i>Rhus copallinum</i>	Winged Sumac
	<i>Robinia pseudoacacia</i>	Black Locust
	<i>Salix nigra</i>	Black Willow
	<i>Ulmus rubra</i>	Slippery Elm
Vines	<i>Campsis radicans</i>	Trumpet Creeper
	<i>Lonicera japonica</i>	Japanese Honeysuckle
	<i>Smilax rotundifolia</i>	Greenbriar
	<i>Toxicodendron radicans</i>	Poison Ivy

929

930 **3.2.2 Avian and Wildlife Observations**

931
932 A total of 41 species of birds were identified during a visit to the Barren Island site in November
933 2002. The species list is presented in Table 3-6 and includes species observed during the timed
934 surveys as well as the habitat characterization surveys. Types of avian species that were
935 documented utilizing the various habitats of Barren Island and the adjacent waters included
936 resident species and breeding and migrating species. Resident species reside and utilize the
937 habitat on Barren Island year-round. Breeding and migrating species reside on Barren Island for
938 a portion of the year, primarily for breeding and migrating through the area, and use the islands
939 for resting and feeding. Avian species were observed in the upland areas, saltmarsh and
940 shoreline areas, and the open waters adjacent to the island remnants.

941
942 The open waters surrounding the remnants of Barren Island were used by primarily piscivorous
943 species of birds such as brown pelican, double-crested cormorant, herring and great black-backed
944 gulls, and Forster's terns. Brown pelicans were numerous during the visit with a peak count of
945 270 observed loafing on a small, unnamed island south of the southern remnant.

946
947 Wintering red-throated and common loons as well as migrating northern gannet were seen diving
948 for fish in the open waters along the western shoreline of the north and south remnants.
949 Wintering and migrant waterfowl species were evident during the November 2002 visit including
950 several species of diving ducks. Diving ducks were noted actively feeding in the open waters
951 around the Barren Island remnants. Species observed included long-tailed duck (formerly
952 known as oldsquaw), black scoter, surf scoter, and bufflehead. Several bald eagles (adults and
953 immature birds) were observed foraging over the open water areas at various times during the
954 visit to Barren Island.

955
956 The shoreline of the northeastern remnant of Barren Island includes a sandy spit exposed at low
957 tide and under only a few inches of water at high tide. The spit was used by all of the gull and
958 tern species observed as well as Canada geese, mute swans, and tundra swans for resting and
959 loafing. Tundra swans, winter residents, were also observed in small groups and single
960 individuals in the protected area along the southern edge of northeastern remnant. Sanderlings
961 were observed foraging along the wave edges on the sand spit at all times except during the
962 highest tide; sanderling is a winter resident species in the Chesapeake Bay.

963
964 The created marsh offered habitat for a hunting Northern harrier and a great blue heron foraged
965 along the shallow waters of the northern remnant in the created marsh. An American bittern was
966 flushed from the cattails along the southeastern boundary of the created marsh on 19 November
967 2002. It is difficult to ascertain whether or not the bird was a resident, migrant or wintering
968 individual based on a single observation however, potential exists for American bittern to utilize
969 the created marsh for nesting.

970
971 No species of rails were observed in the salt marsh habitat during the site visits. However rails
972 are notoriously secretive and difficult to survey. The visit to Barren Island in November did not
973 occur at an optimum time for observing rails. It is possible that evening or early morning
974 surveys in May or June could result in the documentation of rails utilizing the salt marsh habitat
975 on the remnants of Barren Island particularly the created marsh on the western side of the
976 northern remnant.

977
978
979

TABLE 3-6. CUMULATIVE LIST OF AVIAN SPECIES OBSERVED AT BARREN ISLAND, FALL 2002

Common Name	Scientific Name	Habitat Observed ¹	Status of Bird ²	Number Observed ³
Red-throated Loon	<i>Gavia stellata</i>	O	WR;M	1
Common Loon	<i>Gavia immer</i>	O	WR;M	3
Brown Pelican	<i>Pelecanus occidentalis</i>	O	R?	250
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	O	R?	73
Northern Gannet	<i>Morus bassanus</i>	O	WR?;M?	5
American Bittern	<i>Botaurus lentiginosus</i>	M	WR;R?	1
Great Blue Heron	<i>Ardea herodias</i>	M,S	R	1
Turkey Vulture	<i>Cathartes aura</i>	FO	SR/R	36
Mute Swan	<i>Cygnus olor</i>	O	R	230
Tundra Swan	<i>Cygnus columbianus</i>	O	WR;M	24
Canada Goose	<i>Branta canadensis</i>	O	WR;R?	30
American Black Duck	<i>Anas rubripes</i>	O,M	WR;R?	4
Gadwall	<i>Anas strepera</i>	O	WR?	2
Long-tailed Duck (Oldsquaw)	<i>Clangula hyemalis</i>	O	WR;M	3
Surf Scoter	<i>Melanitta perspicillata</i>	O	WR;M	7
Black Scoter	<i>Melanitta nigra</i>	O	WR;M	10
Scoter sp.	<i>Melanitta sp.</i>	O	WR;M	150
Bufflehead	<i>Bucephala albeola</i>	O	WR;M	17
Northern Harrier	<i>Circus cyaneus</i>	M	WR;M	1
Bald Eagle	<i>Haliaeetus leucocephalus</i>	S,U;FO	R	3
Sanderling	<i>Calidris alba</i>	S	M	40
Herring Gull	<i>Larus argentatus</i>	S,O	R	16
Great Black-backed Gull	<i>Larus marinus</i>	S,O	R	100
Forster's Tern	<i>Sterna forsteri</i>	S,O	R?	8
Belted Kingfisher	<i>Ceryle alcyon</i>	M	R?;M?	1
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	U	R	1
Downy Woodpecker	<i>Picoides pubescens</i>	U	R	4
Hairy Woodpecker	<i>Picoides hirsutus</i>	U	R	1
Northern Flicker	<i>Colaptes auratus</i>	U	R/M	1
American Crow	<i>Corvus brachyrhynchos</i>	U,S	R	2
Carolina Chickadee	<i>Poecile carolinensis</i>	U	R	2
Brown-headed Nuthatch	<i>Sitta pusilla</i>	U	R	1
Carolina Wren	<i>Thryothorus ludovicianus</i>	U	R	3
Winter Wren	<i>Troglodytes troglodytes</i>	U	WR;M	2
Ruby-crowned Kinglet	<i>Regulus calendula</i>	U	WR;M	6
Golden-crowned Kinglet	<i>Regulus satrapa</i>	U	WR;M	8

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

981 ²Status: SR = Summer Resident; R = Year round Resident; M = Migrant; WR = Winter Resident

982 ³Number observed is the maximum number of individuals observed at one time during the visit(s) to Barren Island

983

TABLE 3-6. (CONTINUED)

Common Name	Scientific Name	Habitat Observed ¹	Status of Bird ²	Number Observed ³
Eastern Bluebird	<i>Sialis sialis</i>	U	R	1
Yellow-rumped (Myrtle)Warbler	<i>Dendroica coronata</i>	U	WR;M	12
Northern Cardinal	<i>Cardinalis cardinalis</i>	U	R	3
White-throated Sparrow	<i>Zonotrichia albicollis</i>	U	WR;M	4
Fox Sparrow	<i>Passerella iliaca</i>	U	WR;M	1
Song Sparrow	<i>Melospiza melodia</i>	U	R?;WR	3
Swamp Sparrow	<i>Melospiza georgianna</i>	U	WR;M	3
Dark-eyed Junco	<i>Junco hyemalis</i>	M	WR;M	2
American Goldfinch	<i>Carduelis tristis</i>	FO	WR?;M	2

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

987 ²Status: SR = Summer Resident; R = Year round Resident; M = Migrant; WR = Winter Resident

988 ³Number observed is the maximum number of individuals observed at one time during the visit(s) to Barren Island

989

990 A heron rookery located on the southern remnant was inactive in November but remnants of egg
991 shells were found on the ground under the rookery trees attesting to active nesting during the
992 breeding season 2002. Approximately 50 nests were noted throughout the loblolly pine forest. A
993 bald eagle nest observed during a visit in September was still intact and in good condition.

994

995 The loblolly pine forests, which comprised much of the upland area on the northern and southern
996 remnants of Barren Island, provided habitat for resident passerine species such as Carolina wren,
997 Carolina chickadee, brown-headed nuthatch, downy and hairy woodpeckers, and swamp
998 sparrow. Fall passerine migration had peaked in September in the Chesapeake Bay area around
999 Barren Island however late moving migrants such as, ruby and golden-crowned kinglets, brown
1000 creeper, winter wren, yellow-rumped warbler, dark-eyed juncos, fox sparrow and white-throated
1001 sparrows were observed in the upland habitat areas. It is likely that some of these species will
1002 spend the winter months on Barren Island joining the year round resident species.

1003

1004 Raptors and vultures were observed in the vicinity of Barren Island most often flying over the
1005 island, foraging along the shoreline and adjacent open water, or perched in the snags along the
1006 northwestern shoreline of the southern remnant. Turkey vultures were noted occasionally soaring
1007 over the island and are possibly residents nearby. A bald eagle nest was located in the loblolly
1008 pine plantation on the southern remnant but was not active at the time of the visit (November).
1009 Bald eagles were actively using the remnants of Barren Island and adjacent open waters. At least
1010 3 individual bald eagles were noted during the site visit; two adults and one first-year juvenile.
1011 Several osprey nests were located on Barren Island most of them on platforms constructed
1012 specifically to attract nesting osprey. Ospreys were not observed during the November visit;
1013 individuals of the species had moved to their southern wintering areas.

1014

1015 Timed bird surveys were conducted at five locations around the perimeter of Barren Island's
1016 remnants. During the 15-minute survey at each location avian species and numbers of
1017 individuals were recorded. The results of the surveys are tabulated in Table 3-7. Several species
1018 of passerines (e.g., Carolina wren, downy woodpecker) were heard during the timed surveys; the

1019
1020
1021

TABLE 3-7. AVIAN SPECIES OBSERVED AT TIMED SURVEY SITES AT BARREN ISLAND, FALL 2002

Common Name	Scientific Name	Avian Station Number				
		A-1	A-2	A-3	A-4	A-5
Red-throated Loon	<i>Gavia stellata</i>	1				
Common Loon	<i>Gavia immer</i>	3	2	1		
Brown Pelican	<i>Pelecanus occidentalis</i>	14	17	262		
Northern Gannet	<i>Morus bassanus</i>	5				
Double-crested Cormorant	<i>Phalacrocorax auritus</i>			77	2	
Great Blue Heron	<i>Ardea herodias</i>	1				1
Turkey Vulture	<i>Cathartes aura</i>				100	36
Canada Goose	<i>Branta canadensis</i>	3			11	2
Mute Swan	<i>Cygnus olor</i>					
Tundra Swan	<i>Cygnus columbianus</i>			7		5
Swan sp.	<i>Cygnus sp.</i>				270	86
Gadwall	<i>Anas strepera</i>					2
Bufflehead	<i>Bucephala albeola</i>	17	7	14	5	3
Surf Scoter	<i>Melanitta perspicillata</i>			7		
Bald Eagle	<i>Haliaeetus leucocephalus</i>		2		1	2
Herring Gull	<i>Larus argentatus</i>		8			16
Great Black-backed Gull	<i>Larus marinus</i>	2	4	9	6	93
Forster's Tern	<i>Sterna forsteri</i>			8		4
Downy Woodpecker	<i>Picoides pubescens</i>		1			
Carolina Wren	<i>Thryothorus ludovicianus</i>		1			
Winter Wren	<i>Troglodytes troglodytes</i>				1	
Golden-crowned Kinglet	<i>Regulus satrapa</i>				1	
Yellow-rumped (Myrtle) Warbler	<i>Dendroica coronata</i>				1	
American Goldfinch	<i>Carduelis tristis</i>	2				
UID ducks (diving)	N/A	20				
UID shorebirds	N/A					6
Total Individuals		68	42	385	398	256

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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 two exceptions: 1) A-3 included a view of the small remnant used by brown pelicans and double-crested cormorants for loafing and resting and 2) A-4 where a large flock of mute swans was observed.

Wildlife species including remnant (dead) horseshoe crabs (*Limulus polyphemus*) were found along the tide lines and low marsh areas of the (Table 3-8). The low marsh areas are inhabited by Atlantic ribbed mussels (*Geukensia demissa*) along the shorelines and among the saltmarsh cordgrass; marsh periwinkles (*Littorina irrorata*), red-jointed fiddler crabs (*Uca minax*) and

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**TABLE 3-8. CUMULATIVE LIST OF WILDLIFE SPECIES OBSERVED AT
BARREN ISLAND, FALL 2002**

Common Name	Scientific Name
Invertebrates	
<i>Callinectes sapidus</i>	Blue Crab
<i>Crassostrea virginica</i>	American Oyster
<i>Geukensia demissa</i>	Atlantic Ribbed Mussel
<i>Limulus polyphemus</i>	Horseshoe Crab
<i>Littorina irrorata</i>	Marsh Periwinkle
<i>Uca minax</i>	Red-Jointed Fiddler Crab
<i>Uca pugnax</i>	Marsh Fiddler Crab
Fish	
<i>Fundulus heteroclitus</i>	Striped Killifish
Reptiles	
<i>Malaclemys terrapin</i>	Diamond-Backed Terrapin (shell only)
<i>Nerodia sipedon</i>	Northern Water Snake
<i>Terrapene carolina</i>	Box Turtle
Mammals	
<i>Odocoileus virginianus</i>	White-Tailed Deer
<i>Cervus nippon</i>	Sika Deer
<i>Procyon lotor</i>	Raccoon (tracks only)

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marsh fiddler crabs (*Uca pugnax*) were also observed in the water-filled salt pans in the created marsh. 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 a dead, northern water snake. Mammals (white-tailed deer and sika deer) and their tracks were observed in the marsh and the upland areas. Raccoons were identified by their tracks as seen in the sand, mud, and clay areas. Shells of Atlantic ribbed mussel and American oyster (*Crassostrea virginica*), were found along the beach areas. Striped killifish (*Fundulus heteroclitus*) were observed in the waters surrounding Barren Island during boat transportation.

Of the avian species identified at Barren Island, several have conservation status determinations made either by the USFWS Office of Endangered Species in accordance with the Endangered Species Act, or by the Maryland Department of Natural Resources (DNR) in accordance with the Nongame and Endangered Species Conservation Act (Maryland DNR 2003). The bald eagle, a federal and state-listed threatened species is documented as a breeding species in the Chesapeake Bay region, including Dorchester County. American bittern is a Maryland State Listed Species in Need of Conservation and is also known nesting species in Dorchester County (Iloff et. al., 1996). It is unknown whether or not American bittern utilize the marsh habitat on Barren Island for nesting; surveys were not conducted during the nesting season. Several other species observed on Barren Island during the Fall 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

1058 pelican, double-crested cormorant, gadwall, northern harrier, winter wren, golden-crowned
1059 kinglet, and dark-eyed junco are all listed species, however, the Maryland list RTE species is
1060 based on the rarity of the species as breeding species (Maryland DNR 2003). Winter wren,
1061 golden-crowned kinglet, and dark-eyed junco were possibly migrants or wintering individuals
1062 utilizing other geographical areas for breeding and the habitats of Barren Island for wintering or
1063 feeding and resting during their southward movements. Brown pelican are known breeding
1064 species on a small remnant of Barren Island to the south of the southern remnant. Double-
1065 crested cormorant and gadwall are documented breeding species for Dorchester County, MD
1066 (Illif et. al., 1996).

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1068 **3.2.3 Historical and Cultural Resources**

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1070 No additional historical or cultural resources were observed on the remnants during the Fall 2002
1071 survey (relative to previous surveys). The northern remnant of Barren Island showed
1072 confirmation of the historic use of the island including evidence of an old hunting lodge.
1073 Remnants of a demolished hunting lodge are located in the water by bulkheads on the northern
1074 tip of the northern remnant and an old roadbed or runway is evident and transects the central
1075 portion of the northern island. Straight channels that appeared to be manmade with open water
1076 were observed adjacent to the runway on the northern remnant and in the southern portion of the
1077 southern remnant in the low marsh areas. A tidal gut that terminated at the eastern shoreline of
1078 the northern remnant was observed that eventually connected with the open water channel. In
1079 addition, discarded household items such as water heaters and drums are located in a deciduous
1080 area in the central portion of the island. An old, rusty crane is located in the northern section of
1081 the northern remnant and an old, rusty bulldozer is located in the central section of the southern
1082 remnant. A small, hunting cabin that has been constructed recently is located on the northeastern
1083 tip of the southern remnant. Glass shards and bits of pottery were observed on the oyster shell
1084 beach in the southeast portion of the southern remnant. No other historic or archeological
1085 resources were observed on the remnants during the site visit.

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4.0 CONCLUSIONS

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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 salt pans. There was evidence of a fairly recent fire that has killed some loblolly pines in the central portion of the northern remnant. 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.

Depths in the areas sampled ranged from 1.5 to 14 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. Abundance (total number of organisms per square meter) was low at Barren Island for the Fall 2002 survey. The abundance of pollution-sensitive taxa was high at most stations and the abundance of pollution-indicative taxa was low for most stations. In general, mean metric values calculated for the benthic community were similar between seasons (Summer 2002 and Fall 2002) at Barren Island. The slight variations between seasons did not represent a substantive change in the benthic community profile.

The Fall 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, alewife, striped bass, white perch, and blue crab. All fish species were typical of the region. Overall, fish collection efforts using all gear types, yielded low abundances and diversity of fish and crabs. This is expected for shallow water collections during the late fall, particularly when surface water temperatures decrease quickly, as occurred in November and December 2002 when the fisheries studies were conducted. Migratory fish species would have already left the Barren Island vicinity by late fall for over-wintering areas (down-Bay or offshore areas), and many resident fish species would most likely seek warmer, deeper areas of the Bay. Beach seine efforts yielded the highest abundance of fish and crabs and collections were comprised mostly of forage fish. No RTE fish species were collected during the Fall 2002 field effort. One of the nine species (red drum) that are managed under the Magnuson-Stevens Fisheries Conservation Act (species for which the Chesapeake Bay provides EFH) was collected in the vicinity of Barren Island. Because SAV occurs adjacent to many of the remnants in the warmer, summer months, Barren Island may also be providing Habitat of Particular Concern (HAPC) for red drum.

Avian utilization of the island was typical for this area of the Bay. A total of 41 species of birds were identified during the Barren Island Fall 2002 survey, which indicates that the area is

1133 providing a good diversity of food and nesting opportunities. However, avian utilization of the
1134 open water areas of the proposed alignments was insignificant compared to that of the wetland
1135 and forested areas of the remnants. Brown pelicans were numerous during the Fall 2002 survey
1136 and a peak count of 270 were observed on the small unnamed island just south of the southern
1137 remnant. A heron rookery of approximately 50 nests was located on the southern remnant in the
1138 loblolly pine forest, and a bald eagle nest observed during a visit in September was still intact
1139 and in good condition. Bald eagles were actively using the remnants of Barren Island and
1140 adjacent open waters; at least three individual bald eagles were noted during the site visit.
1141 Several other avian species identified at Barren Island during the Fall 2002 surveys have
1142 conservation status determinations associated with their breeding status. The created marsh
1143 offered habitat for a hunting Northern harrier and an American bittern was flushed from cattails
1144 at the boundary of the created marsh. There was also evidence that diamond-backed terrapin,
1145 turtles, eastern mud turtle, white-tailed deer and raccoons are also utilizing the island remnants.
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1147 During the site investigations, the remnants showed no additional historical or archeological
1148 resources on any of the island remnants (relative to previous surveys). Man-made open water
1149 channels and a tidal gut persist on both the southern and northern remnants. In addition,
1150 discarded household items such as water heaters, drums, and machinery were observed on both
1151 the northern and southern remnants. Bits of pottery and glass shards were observed washed up
1152 on the oyster shell beach in the southeast portion of the southern remnant.
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Appendix A:

Photographic Record of Fall 2002 Survey

Photographic Record

Barren Island
Chesapeake Bay, MD
November 2002



Old, cleared roadway/runway that transects the Northern Remnant



Stand of Phragmites adjacent to old, cleared roadway/runway on northern portion of Northern Remnant



Black willow in deciduous area in northern portion of Northern Remnant



Stand of Loblolly pines in eastern portion of Northern Remnant



Discarded garbage - corrugated metal, drums, hot water heater in deciduous portion of Northern Remnant



Raised berm in deciduous area (persimmons) located on southeastern portion of Northern Remnant

Photographic Record

Barren Island
Chesapeake Bay, MD
November 2002



Looking at Northeastern Remnant and two tundra swans from southeastern shoreline of Northern Remnant



Stand of Persimmons in deciduous area in eastern portion of Northern Remnant



Beach washoff on southeastern shoreline of Northern Remnant



Bird scanning at Station A-5



Looking north from southern area of Northern Remnant



Marsh succession at southeastern shoreline of Northern Remnant

Photographic Record

Barren Island
Chesapeake Bay, MD
November 2002



Open water (slightly saline) in high marsh at southern portion of Northern Remnant



Open water tidal gut in low marsh in the southern portion of the Northern Remnant



Old crane adjacent to tidal gut in Northern Remnant



Deer skull found on southwestern portion of Northern Remnant



Standing fresh water from wet fall in southern portion of Northern Remnant



Evidence of burned loblolly pines in central portion of Northern Remnant

Photographic Record

Barren Island
Chesapeake Bay, MD
November 2002



Concrete stone found in central portion of Northern Remnant



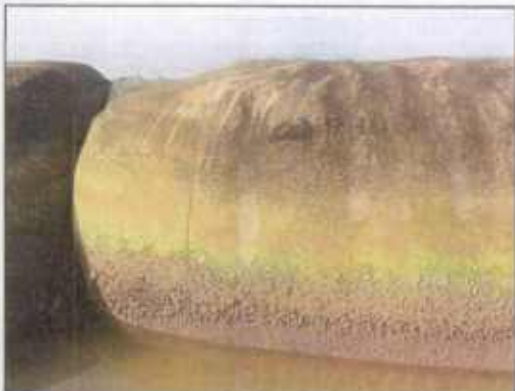
Erosion in clay bank at northern tip of Northern Remnant



Exposed pipe at low tide on northern shoreline of Northern Remnant



Low tide and exposed beach adjacent to geotube on western shoreline of Northern Remnant



Exposed geotube at low tide on western shoreline of Northern Remnant



Small pocket of upland in central area of marsh in Northern Remnant

Photographic Record

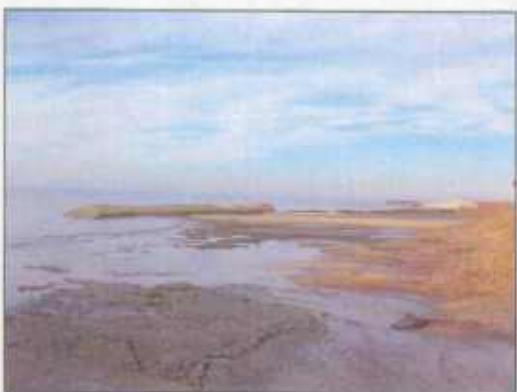
Barren Island
Chesapeake Bay, MD
November 2002



Small pocket of upland in central area of marsh in Northern Remnant



Planted *Spartina patens* in created marsh in Northern Remnant



Low tide near geotubes in Northern Remnant



Large, open water pond in southwestern portion of Northern Remnant



Tidal gut at southwestern shoreline of Northern Remnant



Ivory barnacles on driftwood

Photographic Record

Barren Island
Chesapeake Bay, MD
November 2002



Downed loblolly pines and snags on western shore of southern tip of Northern Remnant



Dead, standing loblolly pines on northwestern tip of Southern Remnant



Atlantic ribbed mussels and sea lettuce on southwestern shoreline of Northern Remnant



Blue crab on beach



Paw prints on beach on Northern Remnant



Low marsh and open water areas at southern tip of Southern Remnant

Photographic Record

**Barren Island
Chesapeake Bay, MD
November 2002**



Open water channel that bisects low marsh area at southern portion of Southern Remnant



Dead, standing loblolly pines at southern portion of Southern Remnant



Upland and marsh transition at southwestern portion of Southern Remnant



Northern water snake at marsh edge at southwestern portion of Southern Remnant



American holly in understory in loblolly pine forest at Southern Remnant



Open, wet area overrun with greenbriar in southeastern portion of Southern Remnant

Photographic Record

Barren Island
Chesapeake Bay, MD
November 2002



Loblolly pine forest in northeastern portion of Southern Remnant



Significant bank erosion on northwestern portion of Southern Remnant



Old, rusty bulldozer on northern, central portion of Southern Remnant



Open water area running through loblolly pine forest in central portion of Southern Remnant



Pelicans occupying unnamed island of *Spartina alterniflora*, located southwest of Southern Remnant



Pelicans occupying unnamed island, southwest of Southern Remnant

Appendix B:

Benthic Macroinvertebrate and Fisheries Results

**TABLE B-1. TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES
COLLECTED WITH A PONAR FROM BARREN ISLAND, FALL 2002^(a)**

CNIDARIA (sea anemones)

Edwardsia elegans (burrowing anemone)

PLATYHELMINTHES (flatworms)

Stylochus ellipticus (oyster flatworm)

NEMERTINEA (unsegmented worms)

Micrura leidyi (red ribbon worm)

Amphiporus bioculatus

ANNELIDA (segmented worms)

POLYCHAETA (bristle worms)

Eteone heteropoda (freckled paddle worm)

Eteone foliosa

Podarkeopsis levifuscina

Neanthes succinea

Glycera dibranchiata

Glycinde solitaria (chevron worm)

Leitoscoloplos robustus

Paraonis fulgens

Polydora cornuta

Marenzelleria viridis

Spiophanes bombyx

Paraprionospio pinnata (fringe-grilled mud worm)

Streblospio benedicti (barred-gilled mud worm)

Scolecopsis (P.) texana

Spiochaetopterus costarum

Heteromastus filiformis (capitellid thread worm)

Mediomastus ambiseta

Maldanidae

Pectinaria gouldii (trumpet worm)

Loimia medusa (red-spotted worm)

OLIGOCHAETA (aquatic worms)

Tubificoides spp.

Naididae

GASTROPODA (snails)

Rictaxis punctostriatus

Acteocina canaliculata (barrel bubble snail)

Haminoea solitaria (solitary bubble snail)

^(a)Common names taken from Chesapeake Bay Program (CBP) (CBP 1992).

TABLE B-1. (CONTINUED)

BIVALVIA (clams and mussels)

Parvilucina multilineata
Mulinia lateralis (coot clam)
Macoma mitchelli
Tagelus plebeius (stout razor clam)
Gemma gemma (gem clam)
Lyonsia hyalina

CRUSTACEA

BRANCHIURAN (barnacles)

Balanus improvisus (bay barnacle)

MYSIDACEA (mysid shrimp)

Neomysis americana (opossum shrimp)
Americamysis almyra

CUMACEA (cumacean shrimp)

Oxyurostylis smithi

ISOPODA (isopods)

Ptilanthura tenuis
Paracereis caudata (eelgrass pill bug)
Erichsonella attenuata (elongated eelgrass isopod)
Edotea triloba (mounded-back isopod)

AMPHIPODA (beach fleas; scuds)

Ampelisca abdita (four-eyed amphipod)
Apocorophium lacustre
Listriella barnardi
Ameroculodes spp. complex

BRACHYURA (true crabs)

Callinectes sapidus (blue crab)

PHORONIDA (horseshoe worms)

Phoronis sp. (phoronid worm).

OPHIUROIDEA

Ophiuroidea

ECHINODERMATA

Leptosynapta tenuis (white synapta)

HEMICHORDATA

Saccoglossus kowalevskii (acorn worm)
Saccoglossus bromophenolosus

^(a)Common names taken from Chesapeake Bay Program (CBP) (CBP 1992).

TABLE B-1. (CONTINUED)

UROCHORDATA (tunicates)

Molgula manhattensis (sea grapes)

CEPHALOCHORDATA

Branchiostoma caribaeum

^(a)Common names taken from Chesapeake Bay Program (CBP) (CBP 1992).

TABLE B-2. MEAN DENSITIES (#/M³) OF BENTHIC MACROINVERTEBRATES COLLECTED WITH A PONAR AT BARREN ISLAND, FALL 2002

Taxon	Benthic Station									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
CNIDARIA (sea anemones)										
<i>Edwardsia elegans</i> (burrowing anemone)	0	0	0	0	0	0	0	0	6.8	0
PLATYHELMINTHES (flatworms)										
<i>Stylochus ellipticus</i> (oyster flatworm)	0	0	0	0	6.8	0	0	0	0	0
NEMERTINEA (unsegmented worms)										
<i>Micrura leidyi</i> (red ribbon worm)	13.6	0	0	34	6.8	20.4	13.6	6.8	6.8	0
<i>Amphiporus bioculatus</i>	6.8	13.6	13.6	20.4	13.6	27.2	20.4	0	27.2	0
ANNELIDA (segmented worms)										
POLYCHAETA (bristle worms)										
<i>Eteone heteropoda</i> (freckled paddle worm)	6.8	0	20.4	0	6.8	0	0	0	0	13.6
<i>Eteone foliosa</i>	0	13.6	0	0	13.6	0	6.8	6.8	0	13.6
<i>Podarkeopsis levifuscina</i>	0	0	6.8	0	0	0	0	0	0	0
<i>Neanthes succinea</i>	95.2	13.6	217.6	6.8	0	20.4	0	6.8	204	251.6
<i>Glycera dibranchiata</i>	0	6.8	0	0	0	0	0	0	0	0
<i>Glycinde solitaria</i> (chevron worm)	394.4	115.6	448.8	312.8	47.6	122.4	54.4	115.6	210.8	299.2
<i>Leitoscoloplos robustus</i>	0	40.8	0	27.2	217.6	217.6	170	734.4	6.8	54.4
<i>Paraonis fulgens</i>	0	0	0	13.6	292.4	0	523.6	652.8	0	0
<i>Polydora cornuta</i>	0	0	0	0	6.8	0	0	0	0	13.6
<i>Marenzellaria viridis</i>	0	0	0	6.8	0	0	0	0	0	0
<i>Spiophanes bombyx</i>	0	54.4	0	6.8	0	47.6	0	0	0	0
<i>Paraprionospio pinnata</i> (fringe-gilled mud worm)	408	74.8	326.4	0	0	88.4	0	0	129.2	81.6
<i>Streblospio benedicti</i> (barred-gilled mud worm)	0	0	0	0	34	6.8	0	0	13.6	251.6
<i>Scoelelepis (P.) texana</i>	0	27.2	0	20.4	156.4	27.2	108.8	136	0	0
<i>Spiochaetopterus costarum</i>	0	6.8	0	0	0	0	0	0	0	0
<i>Heteromastus filiformis</i> (capitellid thread worm)	0	6.8	40.8	6.8	0	0	6.8	6.8	6.8	850
<i>Mediomastus ambiseta</i>	285.6	61.2	238	95.2	231.2	190.4	251.6	156.4	13.6	108.8

TABLE B-2. (CONTINUED)

Taxon	Benthic Station									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
POLYCHAETA (bristle worms) CONTINUED										
Maldanidae	0	0	0	6.8	0	0	0	0	0	0
<i>Pectinaria gouldii</i> (trumpet worm)	40.8	88.4	27.2	13.6	13.6	54.4	13.6	0	0	0
<i>Loimia medusa</i> (red-spotted worm)	0	0	0	0	0	6.8	0	0	0	0
OLIGOCHAETA (aquatic worms)										
<i>Tubificoides spp.</i>	20.4	0	0	0	0	0	0	0	0	6.8
Naididae	0	0	0	0	0	0	0	0	0	6.8
GASTROPODA (snails)										
<i>Rictaxis punctostriatus</i>	0	0	0	0	0	0	40.8	0	0	0
<i>Acteocina canaliculata</i> (barrel bubble snail)	0	6.8	61.2	6.8	13.6	0	163.2	312.8	0	0
<i>Haminoea solitaria</i> (solitary bubble snail)	0	0	0	0	0	20.4	6.8	258.4	0	0
BIVALVIA (clams and mussels)										
<i>Bivalvia</i>	0	0	0	0	6.8	0	0	0	0	0
<i>Parvilucina multilineata</i>	0	6.8	0	0	0	0	0	0	0	0
<i>Mulinia lateralis</i> (coot clam)	6.8	0	6.8	0	0	0	0	20.4	0	0
<i>Macoma mitchelli</i>	0	0	20.4	6.8	6.8	6.8	0	0	0	13.6
<i>Tagelus plebeius</i> (stout razor clam)	0	0	0	0	0	0	6.8	6.8	0	0
<i>Gemma gemma</i> (gem clam)	0	0	0	6.8	0	0	0	13.6	0	0
<i>Lyonsia hyalina</i>	0	0	0	0	0	0	6.8	0	0	0
CRUSTACEA										
BRANCHIURAN (barnacles)										
<i>Balanus improvisus</i> (bay barnacle)	0	0	0	0	47.6	0	0	0	0	0
MYSIDACEA (mysid shrimp)										
<i>Neomysis americana</i> (opossum shrimp)	0	0	0	0	0	0	0	6.8	0	0
<i>Americamysis almyra</i>	6.8	0	0	0	0	0	0	0	6.8	0
CUMACEA (cumacean shrimp)										
<i>Oxyurostylis smithi</i>	40.8	27.2	122.4	61.2	40.8	34	54.4	47.6	6.8	6.8

TABLE B-2. (CONTINUED)

Taxon	Benthic Station									
	BAR-1	BAR-2	BAR-3	BAR-4	BAR-5	BAR-6	BAR-7	BAR-8	BAR-9	BAR-10
ISOPODA (isopods)										
<i>Ptilanthura tenuis</i>	20.4	0	20.4	6.8	20.4	6.8	0	6.8	6.8	0
<i>Paracereis caudata</i> (eelgrass pill bug)	0	0	0	0	27.2	0	0	0	0	0
<i>Erichsonella attenuata</i> (elongated eelgrass isopod)	0	0	0	0	0	0	0	0	6.8	0
<i>Edotea triloba</i> (mounded-back isopod)	0	6.8	0	0	6.8	6.8	0	0	0	6.8
AMPHIPODA (beach fleas; scuds)										
<i>Ampelisca abdita</i> (four-eyed amphipod)	20.4	0	979.2	6.8	0	0	0	0	829.6	74.8
<i>Apocorophium lacustre</i>	0	0	0	0	0	0	0	0	6.8	0
<i>Listriella barnardi</i>	0	6.8	0	0	0	0	6.8	0	6.8	0
<i>Ameroculodes spp. complex</i>	13.6	0	40.8	61.2	183.6	27.2	61.2	115.6	20.4	20.4
BRACHYURA (true crabs)										
<i>Callinectes sapidus</i> (blue crab)	0	0	13.6	0	0	0	0	0	0	0
PHORONIDA (horseshoe worms)										
<i>Phoronis sp.</i> (phoronid worm)	6.8	0	0	0	0	0	6.8	0	0	0
OPHIUROIDEA										
<i>Ophiuroidea</i>	0	0	13.6	0	0	0	0	0	0	0
ECHINODERMATA										
<i>Leptosynapta tenuis</i> (white synapta)	47.6	61.2	6.8	197.2	61.2	170	156.4	142.8	0	0
HEMICHORDATA										
<i>Saccoglossus kowalevskii</i> (acorn worm)	47.6	0	68	6.8	6.8	13.6	20.4	0	95.2	0
<i>Saccoglossus bromophenolosus</i>	0	0	0	0	0	0	0	176.8	0	0
UROCHORDATA (tunicates)										
<i>Molgula manhattensis</i> (sea grapes)	0	0	0	6.8	0	0	0	0	0	0
CEPHALOCHORDATA										
<i>Branchiostoma caribaеum</i>	0	13.6	0	0	0	13.6	0	0	0	0
Total Mean Density	1482.4	652.8	2692.8	938.4	1468.8	1128.8	1700	2930.8	1611.6	2074

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

Common Name		Scientific Name	
Family	Species	Family	Species
Herrings	Atlantic menhaden	Clupeidae	<i>Brevoortia tyrannus</i>
	alewife		<i>Alosa pseudoharengus</i>
Anchovies	bay anchovy	Engraulidae	<i>Anchoa mitchilli</i>
	striped anchovy		<i>Anchoa hepsetus</i>
Clingfishes	skilletfish	Gobiesocidae	<i>Gobiesox strumosus</i>
Killifish	mummichog	Cyprinodontidae	<i>Fundulus heteroclitus</i>
	striped killifish		<i>Fundulus majalis</i>
Silversides	Atlantic silverside	Atherinidae	<i>Menidia menidia</i>
Temperate basses	striped bass	Moronidae	<i>Morone saxatilis</i>
	white perch		<i>Morone americana</i>
Drums	red drum	Sciaenidae	<i>Sciaenops ocellatus</i>
Mullets	striped mullet	Mugilidae	<i>Mugil cephalus</i>
Gobies	green goby	Gobiidae	<i>Microgobius thalassinus</i>
Swimming crabs	blue crab	Portunidae	<i>Callinectes sapidus</i>

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

Common Name	Mean Length (mm) and Range (mm) for Otter Trawl Stations					
	BAR-001	BAR-002	BAR-003	BAR-004	BAR-005	BAR-006
Atlantic Menhaden	---	---	---	---	---	---
Alewife	---	---	---	144	---	---
Bay Anchovy	---	45	---	---	---	---
Skilletfish	---	---	---	---	---	43
Mummichog	---	---	---	---	---	---
Striped Killifish	---	---	---	---	---	---
Atlantic Silverside	---	---	---	---	---	81 (66-104)
Striped Bass	---	---	477	---	---	---
White Perch	---	---	---	---	---	---
Red Drum	---	---	---	---	---	---
Striped Mullet	---	---	---	---	---	---
Green Goby	---	49	---	---	45 (44-46)	43 (39-46)
Blue Crab	---	---	---	---	---	---

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

Common Name	Mean Length (mm) and Range (mm) for Beach Seine Stations		
	BAR-S1	BAR-S2	BAR-S3
Atlantic Menhaden	---	---	---
Alewife	---	---	---
Bay Anchovy	---	---	---
Skilletfish	---	---	47.5 (47-48)
Mummichog	---	---	46 (31-83)
Striped Killifish	56	---	43.5 (42-45)
Atlantic Silverside	67 (46-89)	54	79 (61-97)
Striped Bass	---	---	337
White Perch	---	---	---
Red Drum	---	---	69 (45-89)
Striped Mullet	223 (210-235)	---	---
Green Goby	---	---	---
Blue Crab	---	---	---

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

Common Name	Mean Length (mm) and Range (mm) for Gillnet Stations			
	BAR-G1	BAR-G2	BAR-G3	BAR-G4
Atlantic Menhaden	157 (134-192)	---	---	---
Alewife	---	---	---	---
Bay Anchovy	---	---	---	---
Skilletfish	---	---	---	---
Mummichog	---	---	---	---
Striped Killifish	---	---	---	---
Atlantic Silverside	---	---	---	---
Striped Bass	189 (169-203)	235	---	---
White Perch	197 (163-246)	---	177	---
Red Drum	---	---	---	---
Striped Mullet	---	---	---	---
Green Goby	---	---	---	---
Blue Crab	106.5 (86-127)	113.5 (90-135)	---	---