EXHIBIT A

Report of John B. Gallegos ("Gallegos Report")

Report Regarding the Significant Adverse Impacts of the Proposed Nimmo Parkway Phase VII-B on the Natural Resources and Wildlife of the Back Bay National Wildlife Refuge

REPORT OF JOHN B. GALLEGOS REGARDING THE SIGNIFICANT ADVERSE IMPACTS OF THE PROPOSED NIMMO PARKWAY PHASE VII-B ON THE NATURAL RESOURCES AND WILDLIFE OF THE BACK BAY NATIONAL WILDLIFE REFUGE

I. Introduction and Overview

My name is John B. Gallegos, currently of Belmont, North Carolina. I am a retired professional wildlife biologist with 40 years of experience working with the U.S. Fish & Wildlife Service's (USFWS) Division of National Wildlife Refuges (NWRs). During those 40 years, I served as a wildlife biologist in New York (2 yrs.), New Jersey (7 yrs.), Vermont (7 yrs.), and in Virginia at the Back Bay NWR (the "Refuge") for 24 years (1991-2014) until my retirement. During my years of service at the Refuge, I was the Senior/Supervisory Wildlife Biologist. My areas of expertise include managing wetland habitats to benefit migratory waterbirds and other priority migratory birds, monitoring waterbird (waterfowl, wading bird, marshbird and shorebird) populations, monitoring habitats and priority landbird species, monitoring and controlling invasive species, and assisting in habitat restoration projects.

To carry out my responsibilities at the Refuge, I studied and came to understand how the Back Bay watershed and Back Bay function, along with the Refuge's complex array of unique wetland habitats. Prior to my retirement at the end of 2014, I actively participated in the drafting, preparation, and production of the 2010 Back Bay NWR Comprehensive Conservation Plan ("2010 Refuge Comprehensive Plan" or "2010 Refuge CCP"), and I was the principal author of the Refuge Marsh & Water Management Plan, the 2014 Refuge Habitat Management Plan ("2014 Refuge HMP"),[1] the Refuge Fire Management Plan, and the Refuge Inventory Plan. Data and information set forth in both the 2010 Refuge Comprehensive Plan and the 2014 Refuge HMP are referred to extensively herein.

I am aware that the City of Virginia Beach (the "City") is proposing to construct the so-called "Nimmo Parkway Phase VII-B ("Proposed Parkway") along a City-owned strip of land that cuts through one of the most sensitive areas of the Refuge. The City land, which has served as a utility right-of-way ("ROW") for several decades, traverses the western part of the Black Gut Natural Area ("BGNA").[2] The BGNA encompasses extensive, valuable wetlands, including

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[1] The 2010 Refuge CCP is available at https://www.fws.gov/sites/default/files/documents/BACKBAYNWRFinalCCP9_2010.pdf. The 2014 Refuge HMP is available at https://ecos.fws.gov/ServCat/DownloadFile/163820.

[2] The Natural Resources Technical Report to the Draft Environmental Assessment for the Nimmo Parkway Phase VII-B refers to the "Black Gut Conservation Site." *See* Report at 22 & Figure 5-2. Refuge documents, however, including the 2010 Refuge CCP and the 2014 Refuge HMP refer to this area as the Black Gut Natural Area, and this terminology is used throughout this report.

sensitive bald cypress and fresh-marsh habitats to the west, and the open waters of Black Gut to the east.

This report is based on my professional expertise as a wildlife biologist and my longstanding familiarity with the Refuge. In addition, I reviewed satellite imagery of the Refuge in September 2021, and visited the Refuge in December 2021 to ascertain current conditions within Refuge habitats adjacent to the City ROW. Based on the updated imagery and site visit, the natural conditions within that part of the Refuge surrounding the ROW remain in the same relatively undisturbed state that existed prior to my retirement at the end of 2014.

In my professional opinion, construction of the Proposed Parkway would have serious direct, secondary, and cumulative adverse impacts on Refuge resources, including the BGNA and Black Gut. These impacts, discussed in Section III below, include, among others, loss and degradation of habitat; fragmentation of contiguous, intact woodland/forest habitat; loss of important wildlife corridors; disruption and alteration of the area's hydrology—with significant implications for the long-term health of the wetlands in the Refuge and the species that depend upon them; decreases in biodiversity; and negative impacts to State and federally threatened and endangered bat species likely present in the Refuge.

I have reviewed the Draft Environmental Assessment for the Nimmo Parkway Phase VII-B ("Draft EA"), the Natural Resources Technical Report to the Draft EA, and the Indirect and Cumulative Effects Technical Report to the Draft EA. In my professional opinion, the discussion of the potential impacts on the Refuge in these documents is wholly inadequate. Because the impacts on the Refuge from the Proposed Parkway would be significant, an Environmental Impact Statement must be prepared that would thoroughly examine the direct, indirect, and cumulative effects on the Refuge and that would consider a range of reasonable alternatives. These adverse impacts from the Proposed Parkway would also result in the substantial impairment of Refuge resources and undermine the USFWS conservation mission and the purposes for which the Back Bay NWR was established—as a refuge, breeding ground, and sanctuary for migratory birds and other wildlife. Before turning to a discussion of the impacts on the Refuge from the Proposed Parkway (Section III), Section II below describes the unique ecosystem of the Refuge and the Back Bay watershed.

II. The Diversity of Wildlife and Habitats Within the Refuge That Would Be Impacted by the Proposed Parkway Are Exceptionally Valuable.

A. The Refuge's Unique Habitats and Exceptional Biodiversity

The Refuge consists of a diverse array of high-quality habitats that support a large concentration of rare species (2010 Refuge CCP at 3-26), making it "an extremely important area for biodiversity conservation in the mid-Atlantic region." (Erdle et al., 2001, app. D). As set forth in the 2014 Refuge HMP, the "Refuge's unique location mid-way along the Atlantic Coast provides for a high diversity of plant and animal species; since southeastern Virginia and northeastern North Carolina sustain both northern and southern species at their geographic range limits." (2014 Refuge HMP §1.1 at 2). "The oligohaline nature of the Back Bay Ecosystem has resulted in the unique establishment of freshwater, wetland communities," (2010 Refuge CCP at

3-26) which, because of their proximity to the Atlantic Ocean, would normally consist of brackish to saltwater systems. In addition, because biodiversity levels typically are higher in freshwater systems than brackish or saltwater ones, Back Bay's biodiversity levels are unusually high for a coastal system.

The 2014 Refuge HMP identifies several "priority habitats" in the Refuge (See 2014 Refuge HMP, Table 3-3 2014, part of which is reproduced in Appendix II, Table III *infra*). Of these habitat types, the following would likely be adversely impacted by the Proposed Parkway: Deciduous Wooded Wetland, Upland Mixed Woodland, and Maritime Upland Woodland. In brief, these habitats have the characteristics set forth below. (For fuller descriptions, see *infra* Appendix I, Map #1 and Appendix II, Table I, excerpted from Figure 5-2 and Table 2-6 respectively of the 2014 Refuge HMP). Priority shrub and tree species within these habitats include those providing mast/food and cover/nesting areas that benefit resident and migrating wildlife. Notably, the 2014 Refuge HMP indicates that the Proposed Nimmo Parkway (formerly referred to as "Ferrell Parkway") poses a direct threat to three of these habitat types, namely: Deciduous Wooded Wetland, Maritime Upland Woodland, and Upland Mixed Woodland because the Proposed Parkway would bisect, fragment and degrade portions of each.

> Deciduous Wooded Wetland: This habitat type consists of an estuarine fringe swamp forest with saturated soils along a riverine corridor (Ashville Bridge Creek). Priority tree and shrub species include: bald cypress (*Taxodium distichum*), water/swamp tupelo (*Nyssa aquatica*), sweetbay (*Magnolia virginiana*) and redbay (*Persea borbonia*). The unique ecotone blend of edge habitats where the two habitats overlap provides high biodiversity levels.
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> Upland Mixed Woodland: This habitat includes a combination of well-drained pine-hardwood and wet, hardwood forests with high water tables and depressions that hold water intermittently. Priority tree and shrub species include: pond pine, sweetbay, black tupelo/gum, red bay, six oak species (*Quercus* spp.), and American hornbeam (*Carpinus caroliniana*). As the ground elevation rises, the species compositions also change, creating unique ecotones.
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> Maritime Upland Woodland: This habitat type consists of drier, well-drained forests with sparse ground cover. Live oak (*Quercus virginiana*), laurel oak (*Quercus laurifolia*), and devilwood (*Osmanthus americanus*) are priority species. Live oak is a high priority for preservation because the Refuge represents the northern limit of its geographic range.

The close juxtaposition and overlap of habitat types create unique "edge microhabitats," which account for the greater complexity and diversity of plant and wildlife species. One important example is the juxtaposition of bald cypress-black gum/tupelo-oak wetlands (collectively, "bald cypress swamp") and freshwater marshes, because of the rareness of such habitat and of the plant and wildlife species. As discussed more fully below in Section II. B, the eastern shoreline of Ashville Bridge Creek within the Refuge supports a significant stand of bald cypress wetlands—with associated standing water and freshwater marshes. Eastward from the Creek, the bald cypress wetlands extend for approximately 600 feet and into the adjacent City-

owned ROW. Tables 3-1, at 51-52, and Table 3-2, at 53-57 of the 2014 Refuge HMP, identify the specific high priority bird and plant species and the habitats they occupy within the Refuge and adjacent City-owned ROW.[3]

B. The Black Gut Natural Area and Black Gut

The BGNA consists of approximately 660 acres that encompass the open waters of Black Gut and its associated wetlands, as well as extensive wetlands further west and north of Sandbridge Road. As depicted in the attached topographic map (*see infra* App. I, Map #2), the BGNA is situated north of Sandbridge Road and extends to just south of Lake Tecumseh and the Dam Neck Naval Base. From east to west, the BGNA extends from Ashville Bridge Creek to the east before ending near the northern part of the community of Sandbridge, Virginia.

1. Ecological Significance of Black Gut and BGNA Documented by Virginia Department of Conservation and Recreation

The Virginia Department of Conservation and Recreation ("VADCR"), Natural Heritage Division, has long recognized the ecological significance of Black Gut and the BGNA. In the early 1990s, VADCR, at the request of the City of Virginia Beach, conducted a natural resources inventory of parts of the Refuge and designated certain areas of the Refuge, including Black Gut, as "Natural Areas," based on their intact and unique natural environment. (2014 Refuge HMP at 30 (citing Clampitt, et al., 1993)).[4] (As noted above, VADCR now refers to the area as the Black Gut Conservation Site, as does the Draft EA.[5]) The VADCR inventory of the BGNA noted the presence of rare wetland habitats,[6] as well as state-listed rare plants, rare insect species, and rare

[3] Appendix II of this report, Tables I and II, include excerpts from Table 3-1("Priority Resources of Concern by Habitat for Back Bay NWR") of the 2014 Refuge HMP at 51-52, and Table 3-2 ("Refuge Habitat Types and Habitat Structure for Species Considered During the Process of Identifying Priority Resources of Concern") of the 2014 Refuge HMP at 53-57. Appendix II to this report also includes excerpts from Table 2-6 of the 2014 Refuge HMP ("Back Bay NWR Habitat Types & Communities . . .with Acreage and Percent Cover Estimates"). *See* 2014 Refuge HMP at 23-24. For purposes of this Report, the high priority habitat types and communities from Table 2-6 of the 2014 Refuge HMP, and the information from Table 3-2 of the HMP on the high priority bird species and the habitats they occupy included in Appendix II of this report, are highlighted in green.

[4] I am aware that the Virginia Natural Area Preserves Act defines "Natural Area." in part as "any area of land, water, or both land and water, whether publicly or privately owned, that retains . . . its natural character . . . or which is important in preserving rare or vanishing flora, fauna, native ecological systems, geological, natural historical, scenic or similar features of scientific or educational value benefiting the citizens of the Commonwealth." Va. Code § 10.1-209.

[5] The attached topographical map of the Black Gut Conservation Planning Area (see Appendix I, Map #3) reflects the same boundaries as the topographic map labeled the Black Gut Natural Area (see Appendix I, Map #2).

[6] VADCR identified two rare wetland habitat types: 1) Cattail - Spikerush Tall Freshwater, Semi-Permanently Flooded Marsh; and 2) Spikerush Short Freshwater Semi-Permanently Flooded Marsh. (Clampitt et al., 1993).

bird species.[7] (Clampitt, et al., 1993). The USFWS acquired the BGNA as an addition to the Refuge during the late 1980s because of the area's ecological significance.

More recently, in 2017, VADCR's Natural Heritage Program prepared a report known as the "Virginia Natural Landscape Assessment" (the "Assessment") that assessed and identified large areas of natural lands across the Commonwealth having at least 100 acres of interior cover. VADCR referred to these lands as "Ecological Cores" and evaluated these areas on the basis of numerous ecological attributes. VADCR then ranked the areas according to five categories of "ecological integrity," C1 through C5, with C1 ("Outstanding") and C2 ("Very High") being the two highest categories. VADCR ranked the ecological integrity of the BGNA (i.e., Black Gut Conservation Site) as C2 – Very High, illustrating the importance of the BGNA to Virginia's overall natural landscape. (VADCR's color-coded map of the ecological core rankings across Virginia is included in Appendix II *infra*, Map #4).[8]

Indeed, the Natural Resources Technical Report to the Draft EA also notes that the "Black Gut Conservation Site has a biodiversity significance ranking of B2 on a scale of B1-B5, with B1 being the most significant." Natural Resources Tech. Report at 22, Draft EA, app. C at 122 of pdf)). Further, the Report also notes that "DCR Conservation Sites" represent areas worthy of protection because of the natural heritage resources and habitat they support. Natural Resources Tech. Report at 21 (Draft EA, app. C at 121 of pdf). BGNA's unique natural habitats, rare species, and outstanding diversity are vital to the overall ecological integrity of the Back Bay NWR. The integrity and value of these resources, however, are significantly at risk from the Proposed Parkway, as discussed below in Section III.

2. Rare Species and Habitats of BGNA

As stated previously, the BGNA contains rare habitats, including bald cypress swamps mixed with freshwater marshes. In particular, the eastern side of Ashville Bridge Creek supports a rare stand of bald cypress-black gum-oak wetlands, as well as small ponds where amphibians, reptiles, baitfish and submerged aquatic vegetation can be found during the warmer seasons.[9]

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[7] The plant species identified consisted of the Carolina fimbristylis (*Fimbristylis caroliniana*), Long beach Seedbox (*Ludwigia brevipes*), and Viviparous spikerush (*Eleocharis vivipara*); the insect species identified were the narrow-winged damselfly (Enallagma durum), Saffron skipper (Poanes Aaroni Aaroni), and Stripe-winged baskettail (Epitheca costalis); and the rare bird species consisted of the king rail (*Rallus elegans*) and least bittern (*Ixobrychus exilis*) (Clampitt et al., 1993). In 2000, VADCR's Natural Heritage Division returned to the BGNA to document the presence (or absence) of rare plant and animal species, among other natural resources. The resulting report detailed then-current and historic sightings of rare species, including those noted previously (Walton, et al., 2001).

[8] The VADCR map is available at https://www.dcr.virginia.gov/natural-heritage/image/vanla-2017-thmb.jpg. For a fuller description of VADCR's method and process for rankings, see https://www.dcr.virginia.gov/natural-heritage/vaconvisvnla.

[9] During my December 2021 visit to the Refuge, I noted that approximately 115 feet of the City ROW along the eastern side of Ashville Bridge Creek remain forested, with an estimated 37,500 square feet consisting of bald cypress swamp.

Such habitats—and the associated plant and wildlife species—are quite rare, primarily because of the unique combination of bald cypress swamps and adjacent habitat ecotones.

a. Neotropical Bird Species

Bald cypress swamps, in particular, support the highest number of neotropical bird species of all forested habitat types in the eastern United States (DeGraaf & Rappole, 1995, Table 5 at 535-39). Many of these bird species are experiencing consistent population declines (Rosenberg, et al., 2019). Furthermore, scientists estimate that, since the 1970s, population losses of birds in North America have totaled about 2.9 billion (*id*.), underscoring the importance of protecting and maintaining this habitat type intact.

Several neotropical passerine species that are experiencing declines (*see* USFWS, 2021), both nationally and state-wide, have been recorded in the Refuge. During the spring and summer seasons of 1994-1997, an expert from the Cape Henry Audubon Society conducted point-count surveys in the Refuge, including parts of the BGNA. These surveys consistently showed several declining neotropical passerines present in the Black Gut and City-owned ROW vicinities, including the prothonotary warbler (spring & summer), prairie warbler (spring), common yellowthroat (spring & summer), white-eyed vireo (summer), wood thrush (spring & summer), yellow-billed cuckoo (summer), and indigo bunting (summer) (Gallegos 1997).[10]

b. Threatened and Endangered Bat Species

Several federally and/or state threatened and endangered bat species may be present near or within the Refuge, as indicated in the 2021 offshore wind applications submitted by Dominion Energy ("Dominion") for its project—known as the Coastal Virginia Offshore Wind Commercial Project ("CVOW")—and by Kitty Hawk Wind, LLC (Avangrid) for its Kitty Hawk project, to the Bureau of Ocean Energy Management ("BOEM"). In particular, two of the bat species are both federally and state listed: the northern long-eared bat (*Myotis septentrionalis*), currently listed as threatened, and the Indiana bat (*Myotis sodalis*), listed as endangered. Notably, the USFWS has proposed reclassifying the northern long-eared bat as endangered.[11] The remaining three bat species that may be present in or near the Refuge are listed as Virginia state endangered: the little brown bat (*Myotis lucifugus*), the Rafinesque's big-eared bat (*Corynorhinus rafinesauii*), and the tricolored bat (*Perimyotis subflavus*). [12]

[10] Spring birds can be assumed to be mostly migrants, with a few early nesters, while summer surveys reflect nesting species.

[11] *See* 87 Fed. Reg. 16442 (23 Mar. 2022).

[12] Moreover, the USFWS has included the tricolored bat in its most recent list of species under review for possible listing under the federal Endangered Species Act. USFWS's National Domestic Listing Workplan for Fiscal Years 2022-2027, published on 4 March 2022, is available at https://www.fws.gov/project/national-listing-workplan. The tricolored bat is included in the list of species to be considered in the workplan for fiscal year 2022. *See* https://www.fws.gov/sites/default/files/documents/national-domestic-listing-workplan_0.pdf.

Dominion notes in its documentation to BOEM for its offshore wind project that there are several known maternity roosts of the northern long-eared bat within twomiles of the "Onshore Project Area,"[13] and that there "are records of maternity colonies" of this species "occurring at Naval Auxiliary Landing Field Fentress" adjacent to Dominion's proposed onshore interconnection cable routes.[14] Dominion also states that recent studies (2017, 2018, 2020) have documented the presence of Indiana bats in the coastal plain of Virginia.[15] With respect to the state listed species, Dominion indicates that recent studies "have suggested the presence of coastal populations" in Virginia of the little brown bat,[16], and that both the tricolored bat and the Rafinesque's big-eared bat have been observed within two miles of the Project Area.[17]

Kitty Hawk Wind, LLC proposes Sandbridge, Virginia, as the onshore landing site for its offshore wind project and, significantly, the same City-owned ROW for the onshore cable transmission route. The documentation for the Kitty Hawk project notes the likely presence of the northern long-eared bat and Indiana bat in or near the proposed onshore project area, stating that "the northern long-eared bat and Indiana bat are the two federally protected bat species likely to occur in or near the review area. Use of the area has been reported at different seasonal peaks."[18] In addition, Kitty Hawk notes states that "Indiana bats" "were noted to use the area as a migratory/winter refugium while northern long-eared bats tended to use the area during the maternity season, and recently during the winter but likely present year-round."[19]

III. The Proposed Parkway Would Have Significant, Long-Term Impacts on Refuge Resources

The Proposed Parkway would have significant negative impacts on the Refuge, particularly on Black Gut and the bald cypress–fresh marsh habitats that comprise much of the 660-acre BGNA. The primary impacts include loss of unique and sensitive habitats such as the bald cypress wetlands; forest fragmentation; disruption or alteration of the area's hydrology; loss or decrease in diversity of wildlife species, including neotropical migratory bird species; loss of

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[13] Dominion defines the "Onshore Project Area" to include the onshore landing location in Virginia Beach, onshore export cables to Harpers Road in Virginia Beach, a switching station either south of Harpers Road or north of Princess Anne Road, and interconnection cables along one of several proposed routes from the switching station to Dominion's existing Fentress Substation located in Chesapeake, Virginia. *See* Dominion Construction and Operations Plan ("COP") at § 2.1.2, at 2-9-10, available at https://www.boem.gov/renewable-energy/state-activities/cvow-construction-and-operations-plan.

[14] Dominion COP § 4.2.3.1 at 4-168; Table 4.2-10 at 4-167.

[15] Dominion COP, Table 4.2-10 at 4-167, 4-168.-4-4-168/

[16] Dominion COP, Table 4.2-10 at 4-167.

[17] Dominion COP, Table 4.2-10 at 4-167.

[18] Kitty Hawk Construction and Operations Plan, ch. 5, § 5.3.1.1 at 36, available at https://www.boem.gov/renewable-energy/state-activities/kitty-hawk-wind-construction-and-operation-plan-commercial-lease.

[19] Kitty Hawk Wind also notes that "[r]esearch suggests woody wetlands along the coastal plain are important habitat for both species." Kitty Hawk COP, ch. 5, § 5.3.1.1 at 36. Certainly, the BGNA includes this type of habitat.

existing wildlife corridors; and the spread of invasive species.[20] To the extent that the Draft EA and technical reports address such impacts, the documents are lacking in analysis and inadequate.[21] An Environmental Impact Statement ("EIS") must be prepared to fully address these and other impacts from the Proposed Parkway.

A. Loss and Degradation of Habitat

The Draft EA notes that "[l]oss of wildlife habitat types" within the Refuge "may include," among others, "forested uplands" and "forested wetlands," and that "[l]oss of high value habitats such as the bald cypress swamp east of Ashville Bridge Creek would be minimized to the maximum extent practicable." Draft EA at 71. Further, as discussed more fully *infra*, the Draft EA also acknowledges that some wildlife may be displaced and lose habitat. *Id*. However, the Draft EA dismisses these concerns regarding loss of habitat and impacts to wildlife based on the unsupported grounds of the "widespread availability of such habitats in the project vicinity." (Draft EA at 71). The Draft EA goes on to claim that "[t]here is currently approximately 1,200 acres of contiguous undeveloped land north of the City of Virginia Beach right-of-way comprised of BBNWR, Naval Air Station Oceana Dam Neck, Hampton Roads Sanitation District property and private holdings, and approximately 1,700 acres of BBNWR habitat south of the City of Virginia beach right-[of]-way and east of Sandbridge Road, consisting of wooded, marsh, and open water habitats." (Draft EA at 71-72). The Draft EA concludes that the "acreage of potential loss of habitat as a result of the [Proposed Parkway] represents approximately 1 percent of the contiguous habitat surrounding the project." (Draft EA at 72.

Such rationalization, repeated at various places in the Draft EA and the Natural Resources Technical Report, is fundamentally unsound. First, as explained more fully below, the assumption that other nearby habitat is "widely available" to displaced individuals indicates a lack of understanding of wildlife population dynamics and habitat carrying capacity. Second, the Draft EA in effect presumes that habitat is fungible; that is, that habitat in one location is the same as habitat in another location. That is clearly not the case, and the Draft EA makes no

[20] In a review of the scientific literature of the effects of roads on habitat, one researcher noted that "evidence is accumulating that road construction may result in significant loss of biological diversity at both local and regional scales due to 1) restricted movement of species between local populations; 2) increased mortality; 3) habitat fragmentation and edge effects; 4) invasion by exotic species; and 5) increased human access to wildlife habitats, all of which are expected to increase local extinction rates or decrease local recolonization rates." (Watson, 2005 at 9 (citing Findlay & Bourdages, 2000)).

[21] The Draft EA states that "[n]o direct impacts would occur to [the Refuge] since all work is to be completed within existing right-of-way." (Draft EA at 71). However, the Natural Resources Technical Report notes that the "Black Gut Conservation Site . . . is crossed by the project in two locations: immediately east of Ashville Bridge Creek (approximately 800' crossing) and at the eastern terminus of the project corridor (approximately 950' crossing)." (Draft Natural Resources Technical Report at 22). This statement would appear to contradict the statement in the Draft EA that there would be no direct impacts to the Refuge.

attempt to evaluate or assess the characteristics, and functions and values of the habitat that the Draft EA asserts is widely available—other than to note that the habitat south of the City ROW and east of Sandbridge Road contains "wooded, marsh, and open water habitats," Draft EA at 72. Nor does the Draft EA consider the attributes of the habitat that would be impacted, including the bald cypress swamp, other than in a general way, or the impacts of such loss or degradation of such habitat on biodiversity. As VADCR notes in describing the purpose of its 2017 Virginia Natural Landscape Assessments, "[h]abitat loss is the greatest threat to biodiversity."[22]

With respect to the bald cypress swamp east of Ashville Bridge Creek in the Refuge, the Draft EA simply indicates, as noted above, that impacts to the swamp "would be minimized to the maximum extent practicable." Draft EA at 71. While the Natural Resources Technical Report indicates that "[t]he length of the bridge [over Ashville Bridge Creek] was determined to minimize impacts to the . . . swamp" and that "the bridge would span the bald cypress swamp," (Natural Resources Technical Report at 3 (Draft EA, app. C at 103 of pdf), there is no discussion or evaluation of how, or the extent to which, the bridge length would minimize impacts. Further, there is not any pertinent discussion of how the bridge would be constructed or any clear indication of the height of the bridge. The Draft EA also fails to discuss the number of bald cypress trees that would be removed in constructing the bridge and the impacts on bald cypress trees left standing, including whether such trees would be "topped" in future or the impacts on remaining trees from shading as a result of the bridge. Bald cypress trees do not tolerate shade well, and yet the Draft EA merely notes in passing that impacts to waters and wetlands "would likely include . . . shading impacts for the Ashville Bridge Creek crossing," Draft EA at 43, without any analysis of the significance of such impacts.

B. Forest Fragmentation

Construction of a new highway through forested habitat results in forest fragmentation (Atkinson & Cairns, Jr., 1992; Forman & Alexander, 1998), adversely affecting avian and other species that depend on large, contiguous wooded habitats. (Robinson et al., 1995; Kupfer & Franklin, 2009). The Refuge lands surrounding the City-owned ROW comprise the largest contiguous forested area in the Back Bay watershed. Most are included in the 660-acre BGNA. The Proposed Parkway would break up or fragment this intact, contiguous forested habitat.

In fact, the negative impacts on the Refuge from forest fragmentation caused by the construction of Sandbridge Road are a harbinger of the significant adverse impacts that the Proposed Parkway would have on the Refuge, particularly in the BGNA. The USFWS, recognizing the importance of preserving large areas of contiguous forested habitat, acquired forested and marsh habitats to the north and south of Sandbridge Road during the late 1980s and early 1990s to alleviate the negative impacts of forest fragmentation caused by the construction of Sandbridge Road. Forest habitat management strategies for the Refuge likewise have included restoration of large, unfragmented core areas to increase contiguous forested habitat

[22] Virginia Natural Landscape Assessment at Introduction, https://www.dcr.virginia.gov/natural-heritage/vaconvisvnla.

acreage.[23] Construction of the Proposed Parkway, however, would undo these efforts and amplify the adverse impacts of Sandbridge Road.

The importance of unfragmented habitat in the Refuge cannot be overstated. The large, unfragmented forest and marshes of the BGNA serve as "critical stopover locations for neotropical migratory songbirds and migrating shorebirds." (Erdle et al., app. E, 2001). Table III in Appendix II of this report provides further details on those habitat types and wildlife species that use such habitat. Most existing wetland areas of the BGNA currently are excellent landbird and waterfowl nesting and/or brood-rearing habitats. Forest fragmentation has been identified as a major cause of population decline for forest nesting birds that prefer large tracts. Fragmentation of wetlands habitat in the Refuge from construction of the Proposed Parkway would negatively impact existing wetland-dependent landbird, waterfowl, wading bird, shorebird, and marsh bird populations. Such impacts would particularly be felt by those species that breed in or use BGNA's wooded and wetland habitats during their migrations (*e.g.*, warbler, thrush, wood duck, black duck, teal, and mallard populations). Fragmentation also increases "edge areas" that are preferred by parasitic or problem/invasive bird species (*e.g.*, cowbird, house sparrow, starling). (Findlay & Bourdages, 2000; Trombulak & Frissell, 2000). Fragmentation reduces the reproductive success of native species, since nest predation and parasitism increase with forest fragmentation. (Robinson, et al., 1995). In sum, the patchwork of smaller areas created because of fragmentation provides habitat only for edge species and cannot support forest interior species. (Atkinson & Cairns, Jr., 1992). The Proposed Parkway would fragment and degrade not only valuable habitat in the Refuge for avian species but also habitat for species, such as the bobcat, that prefer large, contiguous wooded and emergent marsh habitats of the type found in the Refuge.

VADCR discussed some of the consequences of fragmentation in its 2017 Virginia Natural Landscape Assessment:

> Fragmentation of the landscape also takes an immeasurable toll on Virginia's biodiversity; roads and other development have reduced the number of large patches of natural vegetation in Virginia. Such large patches have greater benefits than the same total area of natural vegetation when distributed among smaller patches. One of these fundamental benefits pertains to the species-area relationship in which the richness of species increases progressively with habitat size. In general, biodiversity approximately doubles with every tenfold increase in habitat area. Large patches tend to have greater variety of habitats and more protection from disturbance from adjacent areas.[24]

The Draft EA acknowledges that the Proposed Parkway "would act as a barrier furthering fragmentation of the habitats north and south of the corridor." (Draft EA at 72). The Draft EA

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[23] During the mid-2000's, Refuge personnel reforested 117 acres of Refuge lands south of Sandbridge Road that were former agricultural fields to "close up the canopy" and increase contiguous forested habitat acreage to benefit migratory bird species and increase the wooded buffer needed to protect the water quality of the Back Bay watershed. *See*, *e.g.*, Table 3-3, 2014 Refuge HMP, reproduced *infra* Appendix II, Table III.

[24] Virginia Natural Landscape Assessment at Introduction, https://www.dcr.virginia.gov/natural-heritage/vaconvisvnla.

also notes that habitat fragmentation "can have wide-ranging indirect effects to sensitive wildlife including changes in species, lower diversity, separation of populations, disruption to wildlife movements and reduced biological diversity," (Draft EA at 78), and that "[f]ragmentation could affect nesting songbirds who require large tracts of land and could affect movement of reptiles, amphibians, and small and large mammals by both creating a barrier and through roadway avoidance," Draft EA at 72. Despite these and other similar acknowledgements,[25] the Draft EA fails adequately to address these impacts and instead simply points to "[p]ossible mitigation measures" that were developed to minimize impacts to wildlife" as a result of the Proposed Parkway, such as "landscape maintenance measures" and "adaptive lighting," Draft EA at 73, and to the purported "widespread availability of habitats in the project vicinity" such that loss of existing habitats "would not result in substantial population level impacts to wildlife," Draft EA at 71. As noted earlier, and discussed more fully below, the Draft EA provides no support whatsoever for the latter point, and such assertion is contrary to established principles of wildlife population dynamics and habitat carrying capacities.

Further, the "minimization" measures identified—such as "landscape maintenance measures," "adaptive lighting,"—and the possible "installation of wildlife crossings using small diameter concrete pipe . . . to accommodate movement of small mammals and amphibians," (Draft EA at 47), are not at all adequate to address impacts to wildlife from the construction of the Proposed Parkway. With respect to the possible "wildlife crossings" that the City is "considering," clearly, as the Draft EA implicitly acknowledges, such small culverts would be of no use to larger mammals such as bobcats and deer. Nor is there any discussion of how and whether the "small mammals and amphibians" would even find these crossings or the effectiveness of such possible culverts. Rather, the Draft EA simply asserts, without analysis, that the "crossings would minimize the impact of fragmentation and limit roadway mortality." (Draft EA at 47). The Draft EA also notes that "[t]hese types of dry culverts have been reported as effective, primarily for small mammals, in states utilizing these structures (NCHRP 2002)." (Draft EA at 47).26 But the NCHRP document that the Draft EA cites for the latter assertion is simply a desk reference offering general guidance and a framework for identifying indirect effects, assessing the consequences of such impacts, and for identifying and developing potential mitigation strategies. It does not provide support for the notion that the potential use of culverts that the City is considering here would be effective to limit mortality of amphibians and small mammals.

In sum, in my professional opinion, the Draft EA and accompanying Natural Resources Technical report fail to adequately assess the impacts of fragmentation from the Proposed Parkway on wildlife and habitat. Further, in my professional opinion, the permanent fragmentation that would result from the construction of the Proposed Parkway would degrade the value and wildlife use of habitats in this biologically valuable and sensitive area of the Refuge. These include habitats for bird species that the Refuge was initially established to

[25] In addition, the Draft EA indicates that the creation of a "new east-west barrier, inhibiting movement north-south, and could impact wildlife through mortality (e.g. wildlife-vehicle collisions), or behavior modification (e.g. roosting, breeding and feeding) from roadway avoidance." (Draft EA at 71).

[26] *See also* Natural Resources Technical Report at 27 (Draft EA at 127 of pdf).

protect. Moreover, as stated above, many neotropical bird species are experiencing consistent population declines (Rosenberg, et al., 2019), including those that frequent the Refuge, such as the Louisiana waterthrush (*Seiurus motacilla*), prothonotary warbler (*Protonotaria citrea*), prairie warbler (*Dendroica discolor*), brown-headed nuthatch (*Sitta pusilla*), black-throated green warbler (*Dendroica virens*), and brown creeper (*Certhia americana*) (USFWS, 2021).

C. Altered Hydrology

Construction of the Proposed Parkway along the existing ROW would also create a barrier to normal seasonal water fluctuations. The Draft EA and technical reports ignore or fail to address the complex hydrology of the Back Bay watershed that is influenced by wind-driven tides (rather than lunar tides). Depending upon wind direction and the corresponding wind tide, damming or ponding of water either north or south of the Proposed Parkway—with drying of areas on the leeward side—would occur, and thereby alter surface water hydrological dynamics. In other words, the Proposed Parkway will act as a dam or dike that will block the natural flow of water in the Refuge. As an example, during high-water events, surface water sheet flow from waterways that feed wetlands in the Refuge (*e.g.*, Scopus Creek, Ashville Bridge Creek, Lake Tecumseh) would be interrupted, and conversely, the drawdown of water from wetlands that would otherwise occur during low-water events would be impeded. The statement in the Draft EA that "Ashville Bridge Creek is not affected by wave velocity coming from North Bay," (Draft EA at 45), ignores the fact that, during southerly wind tidal events, there is a rapid increase of water levels from North Bay that "backflows" into the entire Back Bay watershed, that includes the Ashville Bridge Creek sub-watershed.

The damming effect created by the Proposed Parkway will change the way in which water moves across the Refuge wetlands, meaning that the surface water and/or groundwater flow patterns in the BGNA, in particular, and connected wetlands, would be significantly altered or disrupted. Changes in the hydrological system in turn would adversely impact important wetland floral and faunal communities in the Refuge; drying of areas "blocked" by the Proposed Parkway would lead to the stagnation of affected wetlands (*see* Mitsch & Gosselink, 1986), with corresponding habitat degradation and loss of species and biodiversity. The Indirect and Cumulative Effects Technical Report to the Draft EA refers to potential changes in wetland vegetation composition and hydrology, (Report at 32, 34-35, Draft EA, app. C at 916, 919-20 of pdf), but it does so only in the context of stormwater runoff from the Proposed Project. The conclusion in this Report that "indirect impacts to wetlands are anticipated to be minor," (Report at 35, Draft EA, app. C at 919 of pdf) is thus incorrect, as it ignores the larger overall impacts on wetlands hydrology as a result of the barrier that would be created by the Proposed Parkway. Instead, the fundamental changes to the hydrological system as a result of the Proposed Parkway are significant and warrant preparation of an Environmental Impact Statement that will fully assess these and other impacts discussed in this report.

D. Bisecting/Severing Existing Important Wildlife Corridor

Wildlife species currently cross the City-owned ROW to travel between northern and southern habitats in the Refuge, and as discussed above, the Draft EA acknowledges that the Proposed Parkway "could affect existing wildlife movement patterns as a result of a new east-

west barrier, inhibiting movement north-south." (Draft EA at 71). But rather than evaluate these impacts, the Draft EA simply points to possible minimization measures, which as indicated previously, are insufficient to address these concerns.

Sandbridge Road illustrates some of the impacts on wildlife and habitat that would occur from construction of the Proposed Parkway. Sandbridge Road has severed Refuge habitats to the north and south of the road, creating a physical barrier to wildlife and reducing the quality of wildlife habitats adjacent to it. As a result of this barrier, the area of the Refuge adjacent to Sandbridge Road is considerably less biologically diverse than the Refuge areas surrounding the City-owned ROW.

Construction of the Proposed Parkway would limit the ability of terrestrial species to travel to and from feeding, watering, sleeping/resting, and breeding areas north and south of the City-owned ROW, since many individuals would be unable to successfully cross the Proposed Parkway, and others would avoid it as much as possible due to the level of traffic noises and disturbances that accompany a busy road. As a consequence, the severing of existing wildlife corridors by the proposed Parkway would reduce or eliminate wildlife movements and genetic exchanges between terrestrial wildlife in areas north of the ROW and wildlife in more southern areas of the Refuge, and some terrestrial wildlife populations would likely become isolated. Of special concern is the local bobcat population.

Increased isolation of populations or species severely limits their natural dispersal processes (Atkinson and Cairns, Jr., 1992), leading to the loss of healthy, genetic diversity of affected wildlife populations (Watson, 2005). This in turn often results in the increased potential for extirpation of localized populations or the extinction of narrowly distributed species from catastrophic events (hurricanes, wildfires, or disease outbreaks (Watson, 2005, at.3)). Decreases in the reproductive pool and inbreeding lead to unhealthy, weak wildlife populations and loss of genetic diversity. In contrast, healthy wildlife populations have a variety of mechanisms that effectively limit inbreeding, but those mechanisms fail when population sizes reach critically low levels (Ralls et al., 1986).

The bisecting of Refuge habitats, particularly in the BGNA, resulting from the Proposed Parkway would likely lead to overcrowding of wildlife populations into remnant habitats, resulting in the eventual degradation of those Refuge habitats as they are stripped of available foods, vegetation, and nesting cover by overcrowded wildlife.[27] In addition, breeding landbird use and reproduction would correspondingly decrease with habitat degradation and loss of plant cover. The unsupported assumption in the Draft EA that other habitats north and south of the ROW are widely available to wildlife that may be displaced by the Proposed Parkway ignores these basic principles of wildlife population dynamics and habitat carrying capacities.

[27] In such a scenario some wildlife—particularly larger mammal populations—would ultimately starve until the carrying capacity of those habitats is balanced by the number of survivors living there. (Maier, 2021).

In addition to the impacts described above, the Proposed Parkway will inevitably result in wildlife mortality from vehicle collisions.[28] (Atkinson & Cairns, Jr. 1992; Rolley 1992). While the Draft EA acknowledges that the Proposed Parkway "could impact wildlife through mortality (e.g. wildlife-vehicle collisions)," Draft EA at 71, the document does not address the longer-term or potential magnitude of such impacts on wildlife—or the impacts on particular species of concern such as the bobcat. Refuge habitats to the north and south of Sandbridge Road support the only known population of bobcats in the larger area. The City-owned ROW runs through the heart of the bobcats' territories. I am concerned that construction of the Proposed Parkway would magnify the risk to the bobcat population and could lead to the extirpation of this unique species. The Proposed Parkway's traffic would also take a toll on deer, hawk, owl, reptile, amphibian, and small mammal populations that frequent the City-owned ROW and the Refuge surrounding the ROW.

In summary, in my professional opinion, construction of the Proposed Parkway would permanently sever or disrupt the network of north-south wildlife corridors and trails of many resident wildlife species within the BGNA, and thus potentially alter these species' home ranges and territories. This in turn would place those wildlife populations under serious duress, leading to interspecies-intraspecies conflicts. Ultimately the normal biological functions of resident wildlife populations could be seriously impaired. Placement of a few "wildlife passage culverts" for small mammals and amphibians along the Proposed Parkway is seriously inadequate to address these major threats to existing wildlife populations.

E. Potential Presence of Threatened and Endangered Species

As stated above, the documentation submitted by Dominion and Kitty Hawk Wind, LLC, to BOEM in support of their applications for their proposed offshore wind projects indicate the likely presence near the Refuge of the northern long-eared bat ("NLEB") and Indiana bat.[29] The Indiana bat is a federally listed endangered species. The NLEB is currently listed under the federal Endangered Species Act as a threatened species; however, the USFWS has proposed reclassifying the bat as an endangered species.[30] Kitty Hawk Wind, which proposes the City-owned ROW for its onshore cable transmission for the project states in its document that "the northern long-eared bat and Indiana bat are the two federally protected bat species likely to occur in or near the review area. Use of the area has been reported at different seasonal peaks."[31] In addition, Kitty Hawk states that Indiana bats "were noted to use the area as a migratory/winter refugium while northern long-eared bats tended to use the area during the maternity season, and recently during the winter but likely present year-round."[32]

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[28] Public health and safety are also a concern. The wildlife-vehicle collisions that would occur along the Proposed Parkway would also increase the risk of human fatalities and injuries.
[29] *See* Dominion Construction and Operations Plan ("COP") § 2.1.2 at 1-3, § 4.2.3.1 at 4-168, Table 4.2-10 at 4-167–4-168; Kitty Hawk COP, ch. 5, § 5.3.1.1 at 36.
[30] *See* 87 Fed. Reg. 16442 (23 Mar. 2022).
[31] Kitty Hawk COP, ch. 5, § 5.3.1.1 at 36.
[32] Kitty Hawk Wind also notes that "[r]esearch suggests woody wetlands along the coastal plain are important habitat for both species." Kitty Hawk COP, ch. 5, § 5.3.1.1 at 36. Certainly, the BGNA includes this type of habitat.

The Draft EA also notes that the "USFWS IPaC database, which identifies federally threatened and endangered species within, or affected by, the subject site" indicates the "potential for the federally threatened northern long-eared bat," (Draft EA at 49), but the Indirect and Cumulative Effects Technical Report to the Draft EA states that "there are no confirmed observations of the NLEB" within the study area," (Technical Report at 27, Draft EA, app. C at 27 of pdf). However, the report further indicates the possibility that "summer populations of the NLEB could be supported in forested habitats within and surrounding" the study area. Indirect and Cumulative Effects Technical Report at 27. In addition, the Draft EA notes that "habitat loss could indirectly impact the NLEB . . . through the fragmentation of suitable forage and summer roost habitat should [this]species be present." (Draft EA at 78). Given the possible presence and status of both the NLEB and the Indiana bat, at a minimum, surveys should be conducted to ascertain the likely presence of these bat species.

F. Invasive Species

Construction of the Proposed Parkway would likely lead to the spread of invasive species into the Refuge, including Phragmites reed (*Phragmites australis*) ("Phragmites"). Highways act as corridors for the dispersal of many, non-native invasive plant species, including Phragmites. Phragmites is a highly invasive plant species; new Phragmites invasions often parallel highways and roads and become established in adjacent drainage ditches and marshes (Jodoin et al., 2008). Seeds or plant parts are carried into previously unaffected areas, and ground disturbance from "roads and . . . road-related activities provides additional opportunities for establishment of invasive non-native plant species." (Watson, 2005 (citing Parendes & Jones, 2000)).

This has certainly been the case with areas of the Refuge adjacent to Sandbridge Road. Phragmites, as well as the invasive narrow-leaved cattail (*Typha angustifolia*), dominate wetlands along both sides of Sandbridge Road and have steadily expanded to the north and south of this road. Refuge personnel have undertaken extensive control efforts annually to try to reduce the spread and presence of Phragmites in Refuge wetlands.

Phragmites establishes easily in disturbed wetland areas, spreading rapidly into adjacent, undisturbed wetlands. It creates a monoculture that eliminates the healthy biodiversity of most wetlands by depriving native plants of sunlight and other conditions needed for survival. Phragmites also eliminates small intertidal channels and obliterates pool habitats that offer natural refuge and feeding grounds for invertebrates, fish, amphibians, and waterbirds. (USFWS, 2007, at 2). In addition, it often creates a dense jungle that native marsh birds, furbearing mammals, and even deer avoid. Decomposing stems and leaves of Phragmites also raise the marsh surface elevation more rapidly than slower-growing native marsh plants. A higher and drier marsh in turn leads to less vigorous growth of native marsh vegetation, allowing Phragmites to gain a stronger foothold and continue its spread over the marsh (USFWS, 2007, at 2). [33]

[33] In addition, the Proposed Parkway likely would serve as a vector for introducing pest insect species into the BGNA. (Atkinson & Cairns, Jr., 1992).

My December 2021 visit to the Refuge and the City-owned ROW bears this out. The small Phragmites stand, which I last observed in the ROW prior to my 2014 retirement, has expanded into several small ponds in the ROW's western end and into the Refuge's bald cypress swamps to the north and south of the ROW. The expansion of Phragmites is filling those small ponds and likely reducing their use by waterfowl, wading birds, and other waterbirds.

Notably, the Draft EA refers in a few places to Phragmites "dominant emergent wetlands" (*see* Draft EA at 47, 71), in discussing the potential loss of habitat along Ashville Bridge Creek; yet the Draft EA does not address the likely proliferation of Phragmites into the Refuge or the impacts on Refuge Resources as a result of construction of the Proposed Parkway. Rather, the technical report simply indicates that "the potential for the establishment of . . . terrestrial invasive species during construction of the project would be minimized by following provisions in the VDOT's Road and Bridge Specifications." (Indirect and Cumulative Effects Technical Report at 37_. In my professional opinion, the Proposed Parkway would likely result in furthering the spread of the existing Phragmites stands in the City ROW into Refuge wetlands adjacent to the Proposed Parkway, including the BGNA. From there this invasive species would spread further north and south into other sensitive, valuable Refuge habitats.

G. Water Quality Impacts from Increased Pollution into the Refuge

Construction of the Proposed Parkway, and thus the creation of new impermeable surfaces, would result in pollutants from the new road surface (*e.g.*, oil, diesel, gasoline, etc.) being carried with stormwater runoff into Ashville Bridge Creek and adjacent wetlands, degrading the water quality of the BGNA and Black Gut. (Pye et al., 1983). In addition, sediment exposed during construction would also likely drain into adjacent Refuge wetlands and waters. As indicated in the scientific literature: "Roads have long been recognized as the primary, human-caused source of soil and water disturbances in forested environments." (Watson, 2005, app. 1 at 8). Other pollutants associated with runoff from highway construction sites, such as phosphorous, would also likely lower dissolved oxygen levels, potentially leading to eutrophication of the receiving wetland. (Atkinson & Cairns, Jr., 1992).

The technical reports to the Draft EA acknowledge that construction of the Proposed Parkway "would introduce impervious surface to an otherwise undeveloped area,"[34] and could "increase the total volume and duration of runoff discharged to streams located in and downstream of the direct impact areas,"[35] and thus indirectly impact water quality as well as wildlife uses. The documents conclude, however, that because stormwater management measures "would be implemented to minimize water quality impacts," indirect impacts to wetlands "are anticipated to be minor." [36] The Technical Reports and the Draft EA, however, fail to analyze the impacts from pollutant loadings specifically into the BGNA and Black Gut, and thus the conclusion that impacts would be "minor" is unsupported. In addition, the lack of analysis is especially concerning in light of statements acknowledging that "proposed runoff from the [Proposed Parkway] would sheet flow through conserved open space in the right-of-

[34] Natural Resources Technical Report at 28.
[35] Indirect and Cumulative Effects Technical Report at 34.
[36] Indirect and Cumulative Effects Technical Report at 36.

way *and into the surrounding wetlands*, where applicable." (Indirect and Cumulative Effects Technical Report at 34 (emphasis added)).

H. Cumulative Impacts

The cumulative adverse impacts from the construction of the Proposed Parkway on the habitats, wildlife, and ecological processes of the Refuge, especially with respect to Black Gut and the BGNA, would be massive, posing serious long-term threats to these resources. Cumulative effects from the piecemeal losses of wetlands ultimately affect the functioning of the system as a whole (Weller, et al., 1988). Indeed, cumulative impacts are a major source of wetland loss and functional degradation. (*See* Gosselink, et al., 1990; Gosselink & Lee, 1989).

In addition, I understand that construction of the so-called "Nimmo Parkway Phase VII-A" is scheduled to begin possibly in the summer 2022. The Proposed Parkway Phase VII-B would connect to Phase VII-A at the eastern end of Phase VII-A. Taken together, these two projects would constitute a roughly 2.5-mile corridor through the middle of an ecologically significant area, thereby magnifying the adverse impacts on the Refuge. However, the Draft EA fails to consider the combined impacts of the two projects. In addition, as stated above, Kitty Hawk Wind, LLC is proposing to use the City-owned ROW as the onshore transmission corridor for its offshore wind project. The installation and maintenance of above ground transmission lines and towers in this corridor would also likely have serious adverse impacts—including those impacts discussed above (Section III. Parts A-G)—on Refuge resources. Therefore, the combined impacts of all three of these projects should be thoroughly examined and evaluated in an Environmental Impact Statement.

IV. Consideration of Alternatives to the Proposed Parkway

Finally, I note that the Draft EA rejects consideration of a "Build Alternative along the existing Sandbridge Road," in lieu of construction of the Proposed Parkway, in part on the basis that modifying Sandbridge Road would require right-of-way from the Refuge and that, "[t]herefore," though "feasible," such an alternative "would not avoid direct impacts" to the Refuge. (Draft EA at 72). However, as indicated earlier in this report, construction of Sandbridge Road itself has adversely affected Refuge resources adjacent to this road. As a result, this area of the Refuge is significantly less biologically diverse than the Refuge areas surrounding the City-owned ROW. As indicated throughout this report, the Proposed Parkway would have serious and irreparable impacts on the unique and sensitive habitats in the Refuge. Thus, I urge decisionmakers to objectively consider a "build alternative along the existing Sandbridge Road" instead of the Proposed Parkway.

Conclusion

As set forth in this Report, construction of the Proposed Parkway on the City-owned ROW would have serious, long-term, negative impacts on the unique habitats and critical wildlife resources of the Back Bay National Wildlife Refuge, and thus undermine the purposes for which the Refuge was established. Under NEPA, an Environmental Impact Statement thus should be prepared that will thoroughly analyze such impacts and objectively consider a full

range of alternatives. I urge City officials and state and federal decisionmakers to reject the Proposed Parkway project and instead look to realistic alternatives that would avoid impacts to the biologically rich and rare habitats and wildlife populations that the Proposed Parkway would destroy or irreparably damage.

John B. Gallegos

Dated 23 June 20222

LITERATURE CITED

Atkinson, Robert B. & Cairns, John, Jr. (1992). *Ecological Risks of Highways*. University Center for Environmental and Hazardous Materials Studies, Virginia Polytechnic Institute and State University, Blacksburg, VA (and references therein)), *reprinted from* Cairns, J., Jr., Neiderlehner, B.R. & Orvos, D.R. (Eds.), *Predicting Ecosystem Risk*. Princeton Scientific Publishing Co., Inc.

Clampitt, C.A., Ludwig, J.C., Rawinski, T.J. & Pague, C.A. (1993). A Natural Areas Inventory of the City of Virginia Beach, Virginia. Natural Heritage Technical Report #93-14. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Richmond, VA, https://repository.library.noaa.gov/view/noaa/2231.

DeGraaf, Richard M. & Rappole, John H. (1995). *Neotropical Migratory Birds - Natural History, Distribution and Population Change* Comstock Publishing Associates, Cornell University Press.

Dominion Energy. (2021). Construction and Operations Plan for Coastal Virginia Offshore Wind Commercial Project, https://www.boem.gov/renewable-energy/state-activities/cvow-construction-and-operations-plan.

Erdle, S. Y., Weber, J. T., Myers, R. K. & Carter-Lovejoy, S. H. (2001). Conservation Plan for the Southern Watershed Area. Natural Heritage Technical Report #00-12. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Richmond, VA, https://www.vbgov.com/government/departments/planning/areaplans/Documents/Pungo-Blackwater-RuralArea/consplanrpt.pdf.

Findlay, C.S. & Bourdages, J. (2000). Response time of wetland biodiversity to road construction on adjacent lands. *Conservation Biology*, 14:86-94, https://www.researchgate.net/publication/229896281_Response_Time_of_Wetland_Biodiversity_to_Road_Construction_on_Adjacent_Lands (abstract only).

Forman, R.T.T. & Alexander, L.E. (1998). Roads and their major ecological effects, *in Annual Review of Ecology and Systematics*, 29:207-231, https://www.edc.uri.edu/nrs/classes/nrs534/NRS_534_readings/FormanRoads.pdf

Gallegos, John B. (1997). Neotropical Passerine Point Counts at Back Bay N.W.R. 1994-1997 (Trails #9 & #10) (unpublished document on file with the Back Bay National Wildlife Refuge).

Gosselink, J.G., Lee, L.C. & Muir, T.A. (1990). *Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems*. Lewis Publishers, Inc.

Gosselink, J.G. & Lee, L.C. (1989). Cumulative Impact Assessment in Bottomland Hardwood Forests. *Wetlands* 9: Special Issue, https://www.researchgate.net/publication/341350865_Cumulative_Impacts_of_Bottomland_Har

dwood_Forest_Conversion_on_Hydrology_Water_Quality_and_Terrestrial_Wildlife (abstract only).

Jodoin, Yvon, Lavoie, C., Villaneuve, P., Theriault, M., Beaulieu, J. & Belzile, F. (2008). Highways as Corridors and Habitats for the Invasive Common Reed *Phragmites australis* in Quebec, Canada. *J. of Applied Ecology*, 45, 459-466, https://www.phragmites.crad.ulaval.ca/wp-content/uploads/2021/01/Jodoin_etal_JApplEcol.pdf.

Kitty Hawk Wind, LLC. (2021). Construction and Operations Plan, https://www.boem.gov/renewable-energy/state-activities/cvow-construction-and-operation-plan-commercial-lease.

Kupfer, John A. & Franklin, S.B. (2009). Linking Spatial Pattern and Ecological Responses in Human-Modified Landscapes: The Effects of Deforestation and Forest Fragmentation on Biodiversity, *in Geography Compass*, *3*(4): 1331-1355, https://www.researchgate.net/publication/229927325_Linking_Spatial_Pattern_and_Ecological_Responses_in_Human-Modified_Landscapes_The_Effects_of_Deforestation_and_Forest_Fragmentation_on_Biodiversity#:~:text=Moreover%2C%20linking%20LCC%20with%20landscape%20pattern%20changes%20is,land%20use%20expansion%20at%20spatial%20and%20temporal%20scales (abstract only).

Maier, Casandra (2021). The Effects of Animal Overpopulation. *Sciencing.com.,* https://sciencing.com/effects-animal-overpopulation-8249633.html.

Mitsch, W.J. & Gosselink, J.G. (1986). *Wetlands*. Van Nostrand Reinhold, NY.

Parendes, L.A. & Jones, J.A. (2000). Role of Light Availability and Dispersal in Exotic Plant Invasion Along Roads and Streams in the H.J. Andrews Experimental Forest, Oregon. *Conservation Biology*, 14:64-75, https://andrewsforest.oregonstate.edu/sites/default/files/lter/pubs/pdf/pub2522.pdf.

Pye, V.I., Patrick, R. & Quarles, J. (1983). *Groundwater Contamination in the United States*. University of Pennsylvania Press, Philadelphia, PA.

Ralls, K., Harvey, P.H. & Lyles, A.M. (1986). Inbreeding in Natural Populations of Birds and Mammals *in Conservation Biology* 35-36. M.E. Soule (Ed.) Sinauer Associates.

Robinson, Scott K., Thompson, Frank R., III, Donovan, Therese M., Whitehead, Donald R. & Faaborg, John. (1995). Regional Forest Fragmentation and the Nesting Success of Migratory Birds. *Science*, 267, 1987-1990, https://www.science.org/doi/10.1126/science.267.5206.1987#:~:text=Forest%20fragmentation%2C%20the%20disruption%20in%20the%20continuity%20of,forest%20birds%20because%20fragmentation%20reduces%20nesting%20%28reproductive%29%20success (abstract only).

Rolley, R.E. & Lehman, L.E. (1992). Relationship Among Raccoon Road-Kill Surveys, Harvests, and Traffic. *Wildlife Society Bulletin*, 20(3), 313-318,

https://www.jstor.org/stable/3783037 (abstract only).

Rosenberg, Kenneth V., Dokter, A.M., Blancher, P.J., Sauer, J.R., Smith, A.C., Smith, P.A., Stanton, J.A. Panjabi, A., Helft, Parr, L.M. & Marra, P.P. (2019). Decline of North American Avifauna. *Science*, 366, 120-124, https://www.researchgate.net/publication/335939269_Decline_of_the_North_American_avifauna/link/605014aa299bf17367465171/download.

Trombulak, S. C. & Frissell, C. (2000). Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology*, 14(1):18-30, https://conbio.onlinelibrary.wiley.com/doi/epdf/10.1046/j.1523-1739.2000.99084.x.

U.S. Fish and Wildlife Service. (2021). Birds of Conservation Concern 2021, https://www.fws.gov/sites/default/files/documents/birds-of-conservation-concern-2021.pdf.

U.S. Fish and Wildlife Service. (2010). Back Bay National Wildlife Refuge Comprehensive Conservation Plan, https://www.fws.gov/sites/default/files/documents/BACKBAYNWRFinalCCP9_2010.pdf.

U.S. Fish and Wildlife Service. (2014). Back Bay National Wildlife Refuge Habitat Management Plan, , https://ecos.fws.gov/ServCat/DownloadFile/163820.

U.S. Fish and Wildlife Service, Region 5, Gulf of Maine Program. (2007). Phragmites: Questions and Answers, https://www.scarboroughmarsh.org/uploads/2/6/4/9/26497083/phragmites_q_a_fact_sheet.pdf.

Walton, D. P., Van Alstine, N. E. & Chazal, A. C. (2001). A Natural Heritage Inventory of the Back Bay National Wildlife Refuge. Natural Heritage Technical Report 01-8. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Richmond, VA. (Excerpt attached)

Watson, Mark L. (2005). Habitat Fragmentation and the Effects of Roads on Wildlife and Habitats, http://safepassagecoalition.org/resources/Habitat%20Fragmentation.pdf.

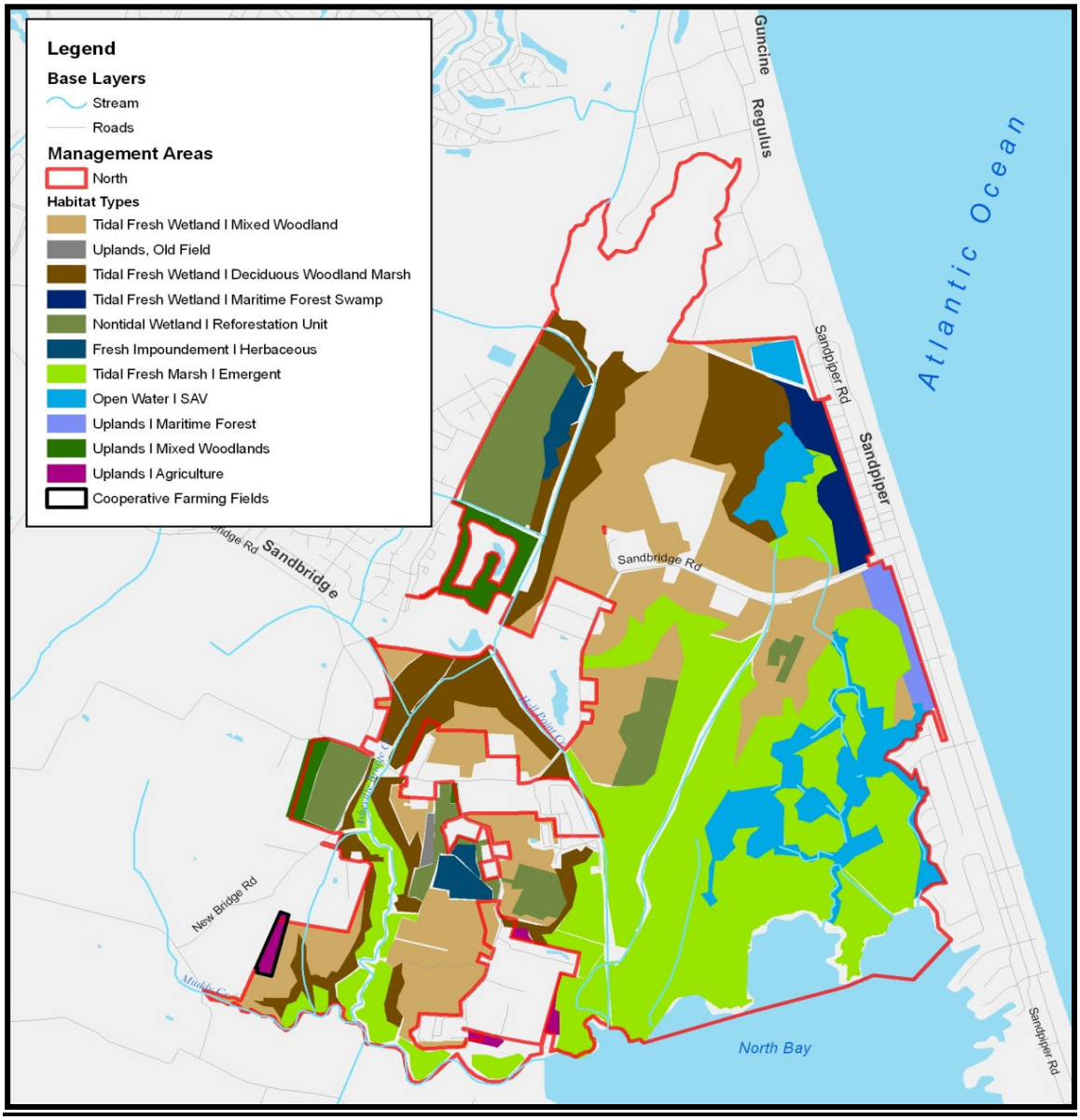
Weller, M.W., Zedler, J.B. & Sather, J.H. (1988). Research Needs for Better Mitigation: Future Directions, *in Proceedings of the National Wetlands Symposium: Mitigation of Impacts and Losses*, 428-430. Kusler, J.A., Quammen, M.L. & Brooks, G. (Eds.).

APPENDIX I - MAPS

MAP #1

Figure 5.2: North Management Area - Habitat Management Units (Habitat Types)

(from USFWS 2014 Back Bay NWR Habitat Management Plan at p.85)



MAP #2

Topographic Map of Black Gut Within the Black Gut Natural Area

(Sandbridge Road runs along the southern end of the map.)

Map *available at* https://www.topoquest.com/place-detail.php?id=1478222

Map #3

(from VADCR, Natural Heritage Inventory of the Back Bay NWR)

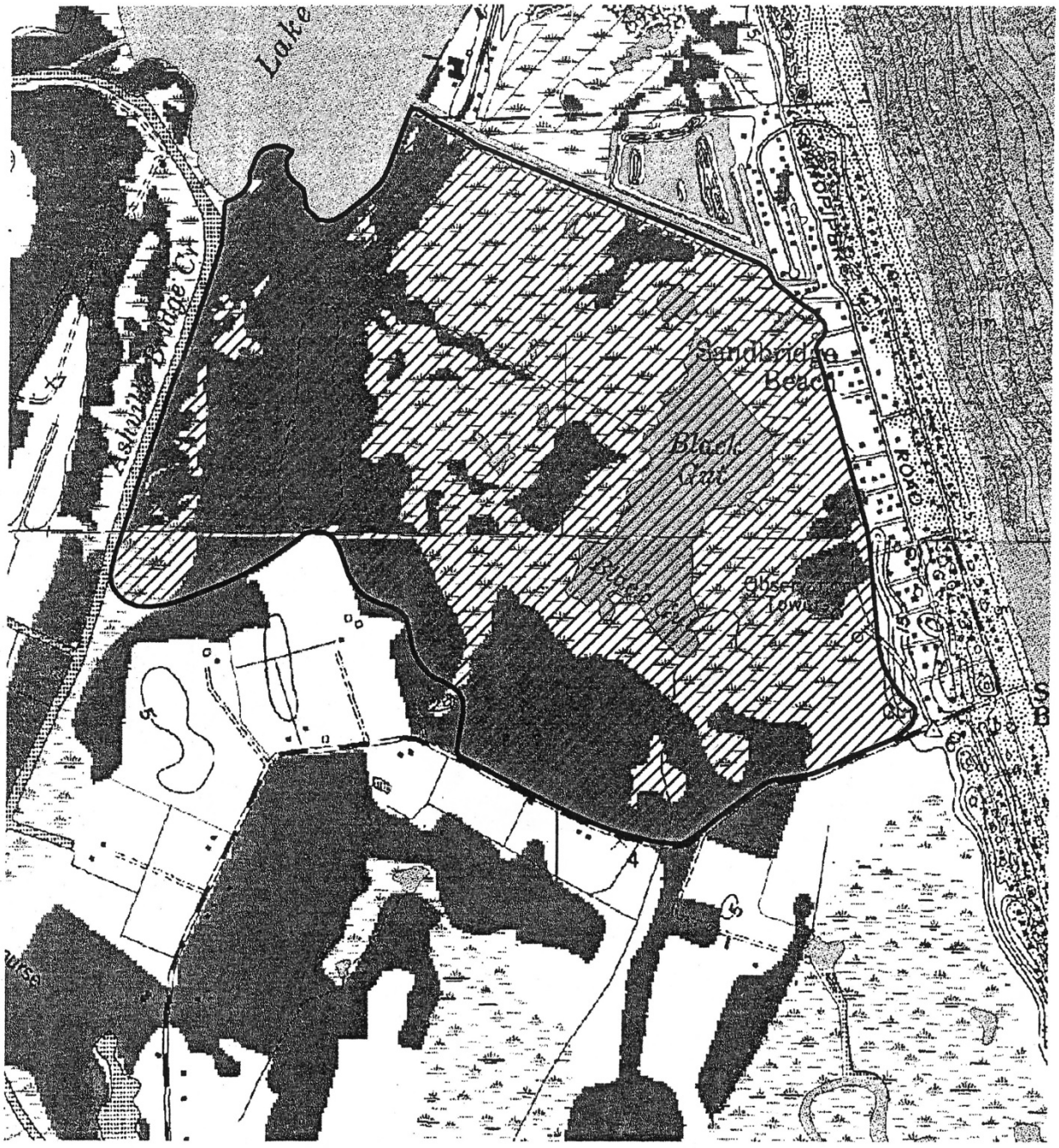
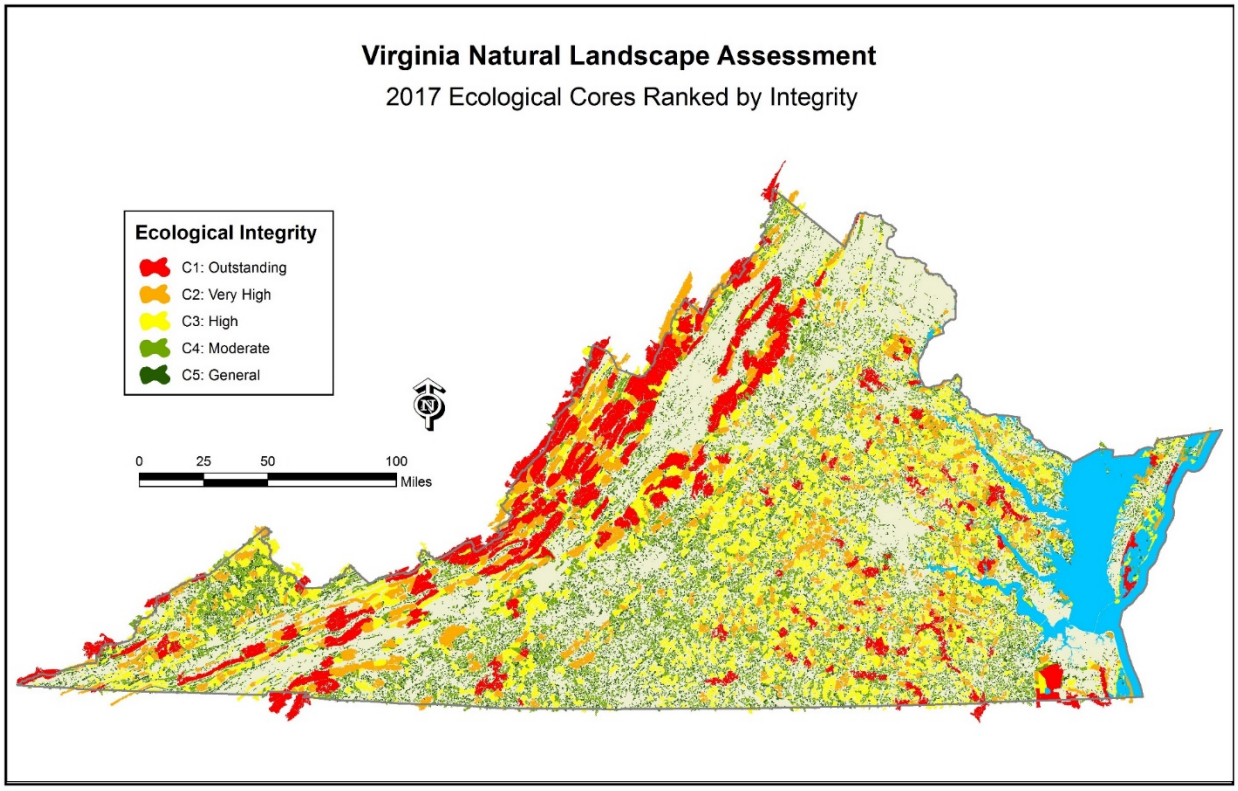


Figure 10. Black Gut Conservation Planning Boundary, Back Bay National Wildlife Refuge.

MAP #4

Virginia Natural Landscape Assessment



Map *available at* https://www.dcr.virginia.gov/natural-heritage/image/vanla-2017-thmb.jpg

APPENDIX II – TABLES

TABLE I

Back Bay NWR Habitat Types & Communities with Acreage and Percent Cover Estimates

(Selected Habitat Types from Table 2.6,* (USFWS 2014 HMP, p.23-24))

General Habitat	Vegetation Community(ies)	Dominant Species	Comments	Acres	% Cover
Mixed Wooded Wetland	Non-Riverine Wet Hardwood Forest	loblolly pine, pond pine, tupelo spp., inkberry, so. waxmyrtle & 2-3 ferns.	Saturated soils. Giant cane & Greenbriers are often present.	1,352.35	12
Deciduous Wooded Wetland (Mixed w/Marsh)	Estuarine Fringe Swamp Forest	bald cypress, swamp tupelo, loblolly pine, sweetbay, redbay, so. waxmyrtle, royal fern.	Subject to irregular wind-tidal flooding.	1,003.95	9
Maritime Wooded Swamp	Maritime Swamp Forest	red maple, sweetgum, black gum/tupelo, black willow, sweetbay, blueberry, so. waxmyrtle, redbay, VA. chain fern.	Seasonally flooded and/or saturated soils, with hummock & hollow microtopography.	132.32	1
Maritime Upland Woodland	1) Maritime Loblolly Pine Forest 2) Maritime Evergreen Forest	1) loblolly pine, red maple, black cherry, so. waxmyrtle, blueberry. 2) live oak, loblolly pine, laurel oak, black cherry, Am. holly, devilwood, blueberry, false jessamine.	Ground/herbaceous cover sparse.	244.99	2
Upland Mixed Woodland	1) Non-Riverine Pine-Hardwood Forest 2) Non-Riverine Wet Hardwood Forest	1) loblolly pine, red maple, sweetgum, pond pine, sweetbay, black tupelo, red bay, dog-hobble, cane. 2) 6 oak species, hornbeam, holly, blueberry, dog-hobble, cane, chain-fern, sedges.	Flat seasonally perched water tables, with shallow depressions that hold water intermittently.	236.46	2

Green highlighting identifies higher priority species.

*Note: The Table of Contents of the 2014 Refuge Habitat Management Plan identifies this table as Table 2-6; however, the body of the document refers to it as Table 1-6. This report refers to "Table 2-6."

TABLE II

Refuge Habitat Types and Habitat Structure for Species Considered During Process of Identifying Priority Resources of Concern on Back Bay NWR

(Selected Excerpts from Table 3-2 (USFWS HMP 2014, pp. 53-57))

Focal Species	Habitat Type	Habitat Structure	Other Benefiting Species
migrating & breeding landbirds	Maritime Upland Woodland & Upland Mixed Woodlands, Old Field, Agriculture	Prefer vegetated habitat including woodland openings and edges. Nest in trees and shrubs with numerous branches, twigs, and leaves in closed canopy palustrine forests. Some species (field sparrow) nest within a short distance of shrubs or saplings, rarely >40 m from woody vegetation, occasionally on the ground.	great horned and screech owls; broad-winged, red-shouldered and Cooper's hawks; common yellowthroat, wood thrush, eastern wood pewee, field sparrow, brown creeper, bobcat, eastern spadefoot & oak toads, live oak.
brown-headed nuthatch		Coniferous SGCN [Species in Greatest Need of Conservation] in the Coastal Plain. Favors well-decayed snags (21.8-30.5 cm dbh) with cavity heights ranging from 1.2-2.7 m for nesting. Special Habitat Need: savannah, southeastern pine forests, forages on live pines within a few hundred meters of nest	
bald eagle		Forest and wetland generalist SGCN. Special Habitat Need: Large, mature trees for nesting or roosting near large rivers, lakes, freshwater marshes, or shorelines (Andrew and Mosher 1982, Green 1985, Campbell et al. 1990).	
live oak		Northern limt of its geographic range. Important component in southeastern maritime forests. Acorn crop is Important winter food for birds and mammals on barrier islands.	
migrating & breeding landbirds	Shrub-scrub Wetland, Deciduous Wooded Wetland & Marsh	Often inhabit riparian forests and swamps. Although found in a variety of forest habitats, they favor closed-canopy forests with an abundance of large dead or dying trees for nesting, and large live trees for foraging. Nest in large, typically dead or dying trees or in upper tree branches. Prefers dense tree stands. Diet consists of a wide variety of insects and larvae, spiders and their eggs, and a small amount of seeds and other vegetable matter (during winter mostly).	glossy ibis, peregrine falcon, broad-winged hawk, red-shouldered hawk, American kestrel, purple martin, blue grosbeak, eastern towhee, yellow-breasted chat, northern harrier, marsh rabbit, spectral tiger beetle.
brown-headed nuthatch		[*See* above for "*Life History/Habitat Description*."]	
prairie warbler		Occupies various shrubby habitats, including regenerating forests, open fields, and Christmas-tree farms. Food is insects, spiders, and other small invertebrates. Gleans from leaves and branches. Sometimes hawks insects in the air. Open cup of long plant fibers and other material, lined with fine grasses, mosses, and feathers, placed in trees or shrubs, usually less than 3 m (10 ft) from ground.	
wintering & migrating dabbling ducks	Maritime Wooded Swamp; Mixed Wooded Wetland and Reforestation Unit	*Life History/Habitat Description located in* Open water-SAV. [Excerpt: Found primarily in lacustrine and palustrine aquatic bed and nonpersistent emergent habitats with abundant leafy aquatic vegetation. Coastal fresh and brackish marshes.]	great egret, sora rail, Virginia rail, upland sandpiper, Wilson's snipe, greater yellowlegs; blue-winged & green-winged teal, wood duck, mallard; screech owl, broad-winged,
American black duck		*Life History/Habitat Description located in* Freshwater Impoundment. [Open water, deciduous forest, wetland generalist SGCN in the Coastal Plain. Nest sites are diverse, but favors wooded swamps and marshes. Special Habitat Needs: open water primarily in winter, near emergent or wooded wetlands, any wetland.]	

Focal Species	Habitat Type	Habitat Structure	Other Benefiting Species
king rail		*Life History/Habitat Description located in* Freshwater Impoundment. [Wetland generalist (e.g., tidal freshwater and brackish marshes, nontidal freshwater marshes) SGCN in the Coastal Plain. Nests in an elevated platform in a clump(s) of grass or a sedge tussock in shallow water. *Special Habitat Need*: brackish or freshwater.]	red-shouldered & Cooper's hawks, American kestrel; blue grosbeak, wood thrush, eastern towhee, eastern wood pewee, northern waterthrush, wood & hermit thrushes, yellow-breasted chat, sedge & marsh wrens, black-throated green warbler, brown creeper; bobcat; oak toad; redbud, Carolina lilaeopsis, viviparous spikerush, so.magnolia.
least bittern		*Life History/Habitat Description located in* Freshwater Impoundment. [Emergent (freshwater to brackish) wetland SGCN. Nests built among dense, tall stands of emergent or woody vegetation (> 5-10 ha), usually 15-76 cm above water 8-96 cm in depth, and > 10 m from open water, channels, or openings made by muskrat. Diet consists of fish, tadpoles, and aquatic insects. *Special Habitat Needs*: dense emergent vegetation (such as cattail/bulrush).	
bald eagle		[*See* above.]	
brown-headed nuthatch		[*See* above.]	
migrating & breeding landbirds		Often inhabit tupelo and other hardwood riparian forests and swamps. They favor closed-canopy forests with an abundance of large dead or dying trees for nesting, and large live trees for foraging. Some species prefer slow-moving headwaters of blackwater creeks, and bordering swamps that feed these rivers and their tributaries. Nest in large, typically dead or dying trees or in upper tree branches. Prefers dense tree stands. Diet consists of a wide variety of insects and larvae, spiders and their eggs, and a small amount of seeds and other vegetable matter (during winter mostly). Wrens typically prefer dense cattail, Phragmites and/or black needlerush stands.	
Louisiana waterthrush		Breeds along gravel-bottomed streams & flowages in hilly, deciduous forest. Nest placed in small hollow or cavity on stream bank, under fallen log, or within roots of an upturned tree. Migrants forage in similar habitat. Diet includes insects, other arthropods, earthworms, and occasionally small frogs and fish.	
prothonotary warbler		Deciduous SGCN in the Coastal Plain. Nests in cavity trees (e.g., bald cypress & red maple) 15-20 cm dbh over or within 5 m of standing water or in low-lying, easily flooded areas with canopy cover between 50-75%. Special Habitat Need: wet bottomland hardwood with sphagnum moss for lining nest.	
wintering sparrows (LeConte's, sharp-tailed & seaside.)		*Life History/Habitat Description located in* Freshwater Impoundment [Emergent wetland SGCN in the Coastal Plain. Nests in drier sections of salt marsh, all nests are elevated. Special Habitat Need: large tidal marshes with tall emergent vegetation, openings in vegetation (e.g., pools and creek edges) where birds can forage on open mud and at base of plants.	

From (USFWS HMP 2014, pps.55-56.) Note: Green highlighting identifies priority landbirds/passerines and species of special concern (*i.e.*, bobcat).

TABLE III

Priority Habitats and Their Potential Limiting Factors on Back Bay NWR

(Excerpts From Table 3-3 (USFWS 2014 HMP, at pp. 58-59, *available at* https://ecos.fws.gov/ServCat/DownloadFile/163820))

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
Priority I Habitats:		
Fresh-water Impoundment	Important migrating and wintering waterfowl and shorebird use areas. State rare plant species.	Ocean overwash. Pump station breakdown. Invasive species (e.g., phragmites reed, feral pigs and horses, and resident Canada geese). Nutria eatouts destabilize wetlands. Sea-level rise.
Emergent Marsh	Important migrating and wintering waterfowl and shorebird use areas. Important for fish spawning and rearing. Community type is endemic to the coastal plain and is considered globally rare. Supports a substantial number of state rare plants and animals.	Erosion related to Submerged Aquatic Vegetation (SAV) loss and/or boat wakes. Invasive species (i.e. phragmites). Nutria eatouts destabilize wetlands. Sea-level rise.
Dune Grassland & Beach Overwash Flats	Sea turtle nesting. Important shorebird and raptor migration areas. Potential piping plover nesting habitat.	Storm erosion. Invasive species (i.e. beach vitex). Sea-level rise.
Deciduous Wooded Wetlands	Important for a diversity of migratory birds, other animal species, and plants. Important for fish spawning and rearing. Bald cypress swamp community type is a globally rare endemic of the Embayed Region of Southeastern Virginia (Clampitt et al. 1993).	Ferrell/Nimmo Parkway* development. Wind-tidal flooding during spring and summer. Invasive species (i.e. japanese stiltgrass). Sea-level rise.
Maritime Wooded Swamp	Important migratory waterfowl and landbird use area. Important vegetated watershed buffer. State rare plant species (i.e. southern magnolia). Important bobcat habitat. Community type is uncommon to rare in Virginia.	Wind-tidal flooding during spring and summer. Agricultural pollutants. Eastern areas prone to salt spray, storm surges, and shifting dunes. Sea-level rise. Predominance of loblolly pine and red maple. Invasive species (i.e. japanese stiltgrass).
Reforestation Units	Forest fragmentation reduction (i.e. canopy closure). Increase migratory landbird use as trees mature and mid-canopy develops. Community type is considered globally uncommon to rare.	Competition from loblolly pine and waxmyrtle. Agricultural pollutants. Invasive species (i.e. japanese stiltgrass).

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
Priority II Habitats:		
Open Water - SAV	Feeding and resting areas for migrating and wintering waterfowl. Important for fish spawning and rearing, and invertebrate species use. Limited management capability - reliant on natural processes.	SAV loss and/or damage related to boat propellers. Shoreline erosion from boat wakes and SAV absence. Public use conflicts (i.e., net fishing). Development of surrounding landscape without adequate vegetative watershed buffer. Nutria eatouts destabilize shorelines. Turbidity, sedimentation, nutrient loading/agricultural runoff, pH change. Sea-level rise.
Upland Mixed Woodland:	Vegetated watershed buffer. Breeding and migrating landbird use. Important bobcat habitat.	Ferrell Parkway* development. Predominance of loblolly pine and red maple. Invasive species (i.e. japanese stiltgrass).
Maritime Upland Woodland	Vegetated watershed buffer. Breeding and migrating landbird use. Important bobcat habitat. Community type is considered globally rare because of restricted ranges, narrow habitat requirements, and threats from coastal development.	Ferrell Parkway* development. Predominance of loblolly pine and red maple. Invasive species (i.e. japanese stiltgrass).
Back Dune Grassland	Federal and state rare plant and animal species (i.e. northeastern beach tiger beetle) use. Critical landbird migration route. Shrubs prevent dune erosion.	Dune erosion from human trespass. Dune movement that cover shrubs. Invasive species (i.e. beach vitex). Sea-level rise.
Dune Swale Wetland	Unique habitat type. State rare plant species. Community types are uncommon to rare, small-patch communities existing in fragile settings. Limited management capability - reliant on natural processes.	Invasive species (e.g., beach vitex). Erosion from storm events. Dune erosion from human trespass. Sea-level rise.
Shrub-scrub Wetlands	Federal and state rare plant and animal species (i.e. northeastern beach tiger beetle). Protects dune swale habitat and freshwater impoundments. Limited management capability - reliant on natural processes.	Dune erosion from human trespass. Storm overwash and/or dune loss. Invasive species (i.e. beach vitex). Sea-level rise.

Note: Green highlighting is not part of the original Back Bay NWR Habitat Management Plan. The highlighting indicates high priority uses and threats relating to the issues discussed in this report. Asterisks are also not part of the original "Back Bay NWR Habitat Management Plan."

*The City of Virginia Beach renamed the former "Ferrell Parkway" to Nimmo Parkway.

ATTACHMENT

Excerpt from Virginia Department of Conservation and Recreation,
A Natural Heritage Inventory of the Back Bay National Wildlife Refuge

COMMONWEALTH of VIRGINIA

A Natural Heritage Inventory of the Back Bay National Wildlife Refuge

Virginia Department of Conservation and Recreation
Division of Natural Heritage
Natural Heritage Technical Report 01-08
February 2001

Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

A NATURAL HERITAGE INVENTORY OF THE BACK BAY NATIONAL WILDLIFE REFUGE

Natural Heritage Technical Report 01-8
February 2001

by

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United States Fish and Wildlife Service
Back Bay National Wildlife Refuge
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Virginia Beach, Virginia 23456

Challenge Cost-Share Agreement
DCN#: 50181-9-J061

This report should be cited as follows:

Walton, D.P. , N.E. Van Alstine, and A.C. Chazal. 2001.
A natural heritage Inventory of the Back Bay National Wildlife Refuge. Natural Heritage Technical Report 01-8. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 101 pp. plus appendices.

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ACKNOWLEDGMENTS

This project was funded by the United States Fish and Wildlife Service under Challenge Cost-Share Agreement DCN: 50181-9-J061.

We are grateful for the logistical assistance of several members of the Back Bay National Wildlife Refuge (NWR) staff. John Stasko Refuge Manager, provided the authors with site maps, access to a boat, and access to many of the areas within the refuge. John Gallegos and Lamar Gore greatly assisted the project by shuttling the inventory staff by boat to isolated areas of the refuge and providing an excellent orientation on the property boundaries of newly acquired refuge land. Finally, John Gallegos, Lamar Gore, Eric S. Durran and M. Christine Farrel all assisted with inventory and data collection.

Stephen P. Hall of the North Carolina Natural Heritage Program and J. Bolling Sullivan are noted here for their effort and expertise in the identification of many moth species collected during the project.

The authors also wish to thank many members of the Virginia Natural Heritage Staff who provided administrative and logistical support with this project including Patricia A. Jarrell, Faye B. Mckinney and the chief biologist, J. Christopher Ludwig. Many members of the inventory and data management sections are also recognized for their support and technical expertise, including the ecology staff (Gary Fleming, Phil Coulling, Kathleen McCoy, and Shelly Parrish), the botany staff (Allen Belden and John Townsend), the zoology staff (Steve Roble, Chris Hobson, Kathy Derge, and Sherri White), the data management staff (Cathy L. Milholen, Rhonda S. Houser, Terri Killeffer, and Holly Sepety) and finally Sandra Erdle of the Stewardship staff.

INTRODUCTION

OBJECTIVES

The objectives of this study were:

To provide an introduction to natural heritage inventory methodology.

To describe the setting of the natural heritage resources within the Back Bay NWR.

To identify and locate natural heritage resources, including state and globally rare plant and animal species.

To identify natural community types of the Back Bay NWR area, to place sample vegetation plots within these communities, to record plant compositional data from these plots and to collect environmental data that may influence these communities.

And finally, to provide Natural Heritage resource protection information including conservation site boundaries and identification of natural heritage resources within these boundaries, and to provide recommendations/strategies for the conservation of these resources.

INVENTORY INTRODUCTION

The Virginia Department of Conservation and Recreation Division of Natural Heritage (DCR-DNH) is the state agency responsible by statutory authority under the Virginia Natural Area Preserves Act for inventory, database maintenance, protection, and management of Virginia's natural heritage resources. Natural heritage resources are defined as "the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest" (Virginia Natural Area Preserves Act, Section 10.1-209 through 217, *Code of Virginia*). The Division provides the only comprehensive effort to identify the Commonwealth's most significant natural areas through ongoing scientific biological survey. Data gathered during this State-wide survey are assembled and managed through a sophisticated Biological and Conservation Data System (BCD) in which information on ecosystems and species, their biology, habitats, locations, conservation status, and management needs is continually updated and refined. The Division is part of an international network of natural heritage programs that utilize standardized inventory methodologies and BCD technology.

The intent of the inventory is to document the presence (or absence), distribution, and population status of specific elements of biological diversity. These include federally listed threatened or endangered species, proposed or candidate species for federal listing, other rare plant and animal species monitored by DCR-DNH, and communities considered to be rare or significant by DCR-DNH. The practical goal of the inventory is to assist the Back Bay NWR in determining the location of natural heritage resources so that these critical areas can be targeted for protection.

EXPLANATION OF THE NATURAL HERITAGE RANKING SYSTEM

Each of the significant natural features (species, community type, etc.) monitored by DCR-DNH is considered an element of natural diversity, or simply an **element**. Each element is assigned a rank that indicates its relative rarity on a five-point scale (1 = extremely rare; 5 = abundant; Table 1). The primary criterion for ranking elements is the number of occurrences, i.e. the number of known distinct localities or populations. Also of great importance is the number of individuals at each locality or, for highly mobile organisms, the total number of individuals. Other considerations include the condition of the occurrences, the number of protected occurrences, and threats. However, the emphasis remains on the number of occurrences, so that ranks essentially are an index of known biological rarity. These ranks are assigned both in terms of the element's rarity within Virginia (its state or S-rank) and the element's rarity over its entire range (its global or G-rank). Subspecies and varieties are assigned a taxonomic (T-) rank in addition to their G-rank. Taken together, these ranks give an instant picture of an element's rarity. For example, a designated rank of G5S1 indicates an element which is abundant and secure range-wide, but extremely rare in Virginia. Ranks for community types are provisional, or in many cases lacking, due to ongoing efforts by the natural heritage network to classify community taxa. Rarity ranks used by DCR-DNH are not legal designations, and they are continuously updated to reflect new information.

Table 1. Definition of natural heritage state rarity ranks. Global ranks are similar, but refer to a species' range-wide status. Note that GA and GN are not used and GX means extinct. Sometimes ranks are combined (e.g. S1S2) to indicate intermediate or somewhat unclear status. Elements with uncertain taxonomic validity are denoted by the letter Q, after the global rank. Ranks for most community types have not been generated due to ongoing community classification efforts. These ranks should not be interpreted as legal designations.

S1	Extremely rare; usually 5 or fewer occurrences in the state; or may have a few remaining individuals; often especially vulnerable to extirpation.
S2	Very rare; usually between 5 and 20 occurrences; or few occurrences with many individuals; often susceptible to becoming endangered.
S3	Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
S4	Common; usually more than 100 occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.
S5	Very common; demonstrably secure under present conditions.
SA	Accidental in the state
SH	Historically known from the state, but not verified for an extended period, usually more than 15 years; this rank is used primarily when inventory has been attempted recently.
SN	Regularly occurring migrants or transient species which are non-breeding, seasonal residents. (Note that congregation and staging areas are monitored separately).
SU	Status uncertain, often because of low search effort or cryptic nature of the element.
SX	Apparently extirpated from the state.
SE	Exotic; not believed to be a native component of Virginia's flora.

The spot on the landscape that supports a natural heritage resource is an **element occurrence**. DCR-DNH has mapped over 9,000 element occurrences in Virginia. Information on the location and quality of these element occurrences is computerized within the Division's BCD system, and additional information is recorded on maps and in manual files.

In addition to ranking each element's rarity, each element occurrence is ranked to differentiate large, outstanding occurrences from small, vulnerable ones. In this way, protection efforts can be aimed not only at the rarest elements, but at the best examples of each. Species occurrences are ranked in terms of quality (size, vigor, etc.) of the population; the condition (pristine to disturbed) of the habitat; the viability of the population; and the defensibility (ease or difficulty of protecting) of the occurrence. Community occurrences are ranked according to their size and overall natural condition. These **element occurrence ranks** range from A (excellent) to D (poor). Sometimes these ranks are combined to indicate intermediate or somewhat unclear status, e.g. AB or CD, etc. In a few cases, especially those involving cryptic animal elements, field data may not be sufficient to reliably rank an occurrence. In such cases a rank of E (extant) may be given. Element occurrence ranks reflect the current condition of the species' population or community. A poorly-ranked element occurrence can, with time, become highly-ranked as a result of successful management or restoration.

Element ranks and element occurrence ranks form the basis for ranking the overall significance of sites. Site **biodiversity ranks** (B-ranks) are used to prioritize protection efforts, and are defined as follows:

B1 Outstanding Significance: only site known for an element; an excellent occurrence of a G1 species; or the world's best example of a community type.

B2 Very High Significance: excellent example of a rare community type; good occurrence of a G1 species; or excellent occurrence of a G2 or G3 species.

B3 High Significance: excellent example of any community type; good occurrence of a G3 species.

B4 Moderate Significance: good example of a community type; excellent or good occurrence of state-rare species.

B5 General Biodiversity Significance: good or marginal occurrence of a community type or state-rare species.

Note: sites supporting rare subspecies or varieties are considered slightly less significant than sites supporting similarly ranked species.

EXPLANATION OF FEDERAL AND STATE STATUS CATEGORIES

The U.S. Fish and Wildlife Service (USFWS) is responsible for the listing of endangered and threatened species under the Endangered Species Act of 1973, as amended. Federally listed species (including subspecific taxa) are afforded a degree of legal protection under the Act, and, therefore, sites supporting these species need to be identified. USFWS also maintains a review listing of potential candidate endangered and threatened taxa. Table 2 illustrates the various status categories used by USFWS and followed in this report. The status category of candidate species is based largely on the Service's current knowledge about the biological vulnerability and threats to a species.

Table 2. U.S. Fish and Wildlife Service species status codes, with abbreviated definitions.

LE	Listed endangered
LT	Listed threatened
PE	Proposed to be listed as endangered
PT	Proposed to be listed as threatened
S	Synonyms
C	Candidate: status data supports listing of taxon as endangered or threatened, but listing has been delayed by pending proposals of higher priority taxa

In Virginia, two acts have authorized the creation of official state endangered and threatened species lists. One act (section 29.1-563 through 570, *Code of Virginia*), administered by the Virginia Department of Game and Inland Fisheries (DGIF), authorizes listing of fish and wildlife species, not including insects. The other act (section 3.1-1020 through 1030, *Code of Virginia*), administered by the Virginia Department of Agriculture and Consumer Services (VDACS), allows for listing of plant and insect species. In general, these acts prohibit or regulate taking, possessing, buying, selling, transporting, exporting, or shipping of any endangered or threatened species appearing on the official lists. Species protected by these acts are indicated as either listed endangered (LE) or listed threatened (LT). Species under consideration for listing are indicated as candidates (C).

DGIF has also created an informal category of Special Concern (SC) for animals that merit special attention. This is a non-regulatory category that affords no legal protection. In addition, DCR-DNH maintains lists of rare and watchlist plant and animal taxa (Killeffer 2000, Roble 1998). Plant and animal taxa designated as rare in Virginia include those having a state rank of S1, S2, S2/S3, or SH. Plant taxa placed on the watchlist include those taxa with uncommon or uncertain status including those ranked S3, SU, and SE?. Animal taxa designated as watchlist taxa include those with ranks of S3, S3S4, and SU.

STUDY AREA OVERVIEW

Location and Physiography

Back Bay NWR created in 1938, is located in the south east corner of Virginia and encompasses a barrier island and bay system from the extension of Currituck Sound of North Carolina north into Virginia. The refuge falls within the Atlantic Coastal Plain physiographic region (Figure 1) and currently lies entirely within the City of Virginia Beach. The basic perimeter can be delineated by a rectangle from 75 degrees 52-58 seconds west and 36 degrees 32-45 seconds North (Norman 1990). The property includes a mosaic of islands, independent upland and wetland units and one much larger main unit intermixed between privately and other publicly owned property within the 66,780 acre watershed. The large unit is bordered by a Virginia Beach City Park to the north, False Cape State Park to the south, the Atlantic Ocean to the east, and the Back Bay to the west.

This 6,340 acre management area contains a series of open wetlands including Redwing Lake, Black Gut, and Lake Tecumseh; a complex mixture of habitats from maritime beach, dunes, swales and oligohaline wind tidal marshes to bottomland forest; and several globally rare and state rare species. The refuge also includes agricultural and residential lands that are currently allowed to return to a natural state.

Back Bay itself is 11.7 km long, 9.6 km wide at it widest point to the south, and is 1.2 km wide at its northern end. It is divided into seven smaller bay systems: Back, Buzzard, Halfmoon, North Bay, Redhead, Sand, and Shipps. The average depth of the bay is 1.3 m, with its deepest point (3 m) occurring between Back Bay and Redhead Bay (Norman 1990). It is connected to Currituck Sound, which subsequently empties into Albemarle Sound. This much larger body of water mixes with and flows through Croatan Sound, to Pamlico Sound (Copeland *et al.* 1983). The entire system is commonly referred to as the Pamlico Estuary, or an estuarine system. This particular system is believed to be a "classical riverine estuary formed in a drowned river valley" (Hackney *et al.* 1992, Christensen 2000). By this description, the Albemarle and Pamlico sounds in North Carolina are lagoons, with lagoon being defined as a "body of water, separated in most cases from the ocean by off shore bars or islands, of marine origin and which is usually parallel to the coastline." Most lagoons have many associated back bays and tributaries, and Hackney *et al.* (1992) further defines bays as "semi-enclosed or detached estuarine areas, that are "back" from the estuary's center or connection(s) with the sea." This type of estuarine system is diverse in its geologic, hydrologic, and chemical make-up, and consequently supports a huge array of plants, animals, and vegetative communities.

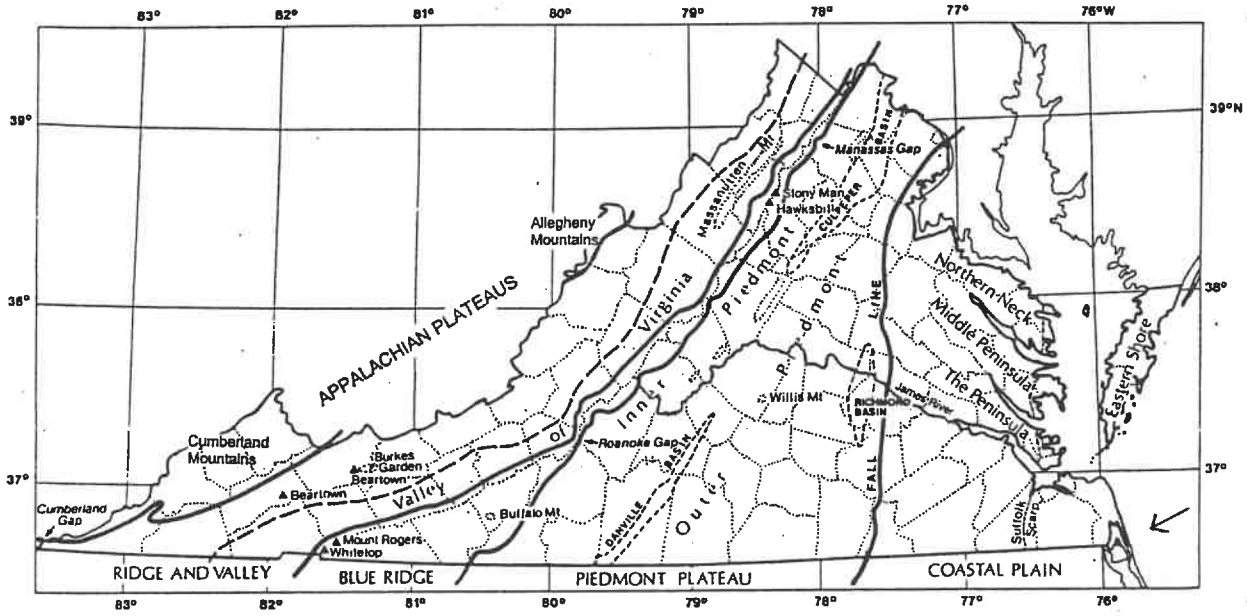


Figure 1. Location and physiographic position of the Back Bay National Wildlife Refuge. (Map from Woodward and Hoffman, 1991, with copyright permission)

Climate (Based on Norfolk data)

The climate of the Back Bay area is mild and is tempered by its proximity to the ocean and gulf current. The mean annual temperature is 15.2 degrees Celsius with a mean July temperature of 25.7 C and a mean

February temperature of 5.2 C. There is a typical frost-free period of 245 days from mid March to mid November. Rainfall is considered to be relatively even with the heaviest periods occurring in July and August. The average total rainfall for the area is 113.5 cm. Winds are predominantly from the south-southwest in the summer and from the north and west-southwest in winter (Norman 1990). This area is also influenced by hurricanes and the highest wind speeds in Virginia (134 mph one minute sustained winds with gusts to 150 mph) were recorded during Hurricane Gloria in 1944 just north of Back Bay at Cape Henry (Watson 2001a)

Topography

The relief of Back Bay is characterized by broad and generally flat areas with gentle slopes. These broad zones are interrupted by long, narrow low ridges running in a north- south direction. Steep slopes are limited to edges of bays and drainageways (Hatch *et al.* 1982). Much of the refuge is near sea level with the highest points occurring on some of the dunes 15-20 ft above sea level.

Geology

The predominant geology of the barrier island (Table 3) consists of broad sandy beaches of Holocene marine sediments subdivided into three groups.

Table 3. Geologic map units of Back Bay National Wildlife Refuge. Virginia Division of Mineral Resources Geologic Map of Virginia (1993).

Unit Symbol	Formation and Period	Description
Qm	Holocene deposits of coastal barriers, lagoons and marshes	Soft mud, medium to dark gray; and peat, grayish brown. Comprises sediments of marshes in the coastal areas of the Chesapeake Bay. 0-10 ft thick.
Qtp	Holocene Surficial deposits of riverine estuarine and coastal terraces and plains	Poquoson member, medium to coarse pebbly sand grading upward into clayey fine sand and silt, light to medium gray. Underlies ridge and swale topography from sea level to 11 ft. 0-15 ft thick.
Qs	Holocene deposits of coastal barriers, lagoons and marshes	Sand, pale gray to light yellowish, poorly sorted to well sorted shelly in part. Contains angular to rounded fragments and whole valves of mollusks. Coastal barrier island and narrow beach dune ridges bordering brackish water marshes. Up to 40 ft thick. *Only the dune system of the refuge

Soils

Soils of the coastal plain are generally Ultisols subtype Aquults U1a –Aquults with Aquents, Histosols, Quartzipsamments, and Udults; and are gently sloping (Martin and Boyce 1993).

Six soils types have been reported from this area of the refuge. They are the Back Bay Nawney very poorly drained soils; the Newhan-Duckston-Corolla excessively to poorly drained soils; the Acredale-Tomotley-Nimmo poorly drained soils with sandy substratum; the State-Tetotum-Augusta well drained,

moderately well drained, and somewhat poorly drained soils; the Dragston, Munden-Bojac somewhat poorly drained, moderately well drained, and well drained soils; and the Udorthents Urban land – well drained soils. Back Bay Also is bordered by Atlantic coast beach that is partly characterized as Corolla and Newhan soils when vegetation is present. The shrub zone adjacent to the beach and dune system is characterized by predominantly mixtures of Corolla and Duckston soils, while areas further west, away from the ocean and into forested areas are predominantly Newhan, Corolla, and Duckston soils. The wind-tidal oligohaline marshes that form the perimeter of the bay and refuge are Backbay soils. The individual series are listed and described in Table 4.

Within the Bay itself, sediments are distributed in a fairly consistent pattern with sandy sediments deposited on the eastern edge of the bay, silty sediments deposited along the north/south midline of the bay and clay sediments deposited along the western third of Back Bay (Swift *et al.* 1990).

Hydrology

The barrier island has a lens of freshwater occurring some 15 feet below the surface and is bordered by ocean water to the east and fresh-to-oligohaline water of Back Bay to the west. Currently within the refuge, freshwater is maintained in several holding ponds and the water level is manipulated for migratory waterfowl (J. Gallegos pers. com.).

Salinity

The present day salinity level of the bay is 0.5-1 ppt, but it is believed to have fluctuated several more parts-per-thousand over the last several hundred years. Much of this variation is related to opening and closing of natural inlets along the barrier island and from washovers. One inlet along the Virginia-North Carolina border was open from about 1650 to approximately 1729 (Goldsmith 1977). Currently the nearest opening to the ocean is 43 km south at Oregon inlet.

The earliest salinity records (1925) show a level of less than 2 ppt. In 1933 and 1962, after washovers, the salinity level rose dramatically to almost 12 ppt and 26 ppt, respectively. Wave heights on the ocean were as high as 25 ft during the "Ash Wednesday" Storm of 1962. Starting in 1965, ocean water was mechanically pumped into the bay. This created a more constant elevated salinity level in comparison to the pulsed increases after storm events. This pump, in operation until 1987, resulted in a salinity level of between 2 - 4 ppt with a peak of 5.4 ppt. (Norman and Southwick 1990, Southwick and Norman 1990)

Previous storm events are likely to have had similar impacts. Indeed, historical descriptions of two storms, one in 1667 and one in 1749 indicate tremendous storm surges with water levels of 12 and 15 feet above normal within the Chesapeake Bay, respectively. No storms of this magnitude have been recorded in the 19th and 20th Centuries in this area (Watson 2001a).

Tides (Bay)

The distance, size, and orientation of Oregon inlet all play a role in limiting lunar tides on the bay side of the refuge. However, wind blowing in a constant direction can create tides up to a meter above sea level lasting several days. It is unknown how the hydrostatic pressure associated with these tides affects movement of ground water and the hydration of more inland wetland systems. The mean water level in the bay is +1 ft above mean sea level (msl) and tides vary from –2 to +3 ft of msl (Priest and Dewing 1990).

Table 4. Soil Series and characteristics of Back Bay National Wildlife Refuge (Soil Survey of City of Virginia Beach, Virginia, Hatch *et al.* 1982).

Series	Characteristics
Acerdale	Deep and poorly drained soils, formed in loamy marine and fluvial sediments. On inland flats of the coastal plain 0-2% slopes.
Augusta	Deep and somewhat poorly drained, formed in loamy fluvial and marine sediments. On inland ridges of the coastal plain. 0-2% slopes.
Backbay	Deep and very poorly drained, formed from organic material and underlying loamy marine and fluvial sediments.
Bojac	Deep and well drained, formed in loamy fluvial and marine sediments. On inland ridges of the coastal plain, slopes from 0-2%.
Corolla	Deep and moderately well drained to somewhat poorly drained, formed from sandy marine sediments. On the coastal plain with slopes 0-6%.
Dragston	Deep and somewhat poorly drained, formed in loamy fluvial and marine sediments. On inland ridges of the coastal plain. 0-2% slopes
Duckston	Deep and poorly drained, formed in sand marine sediments. On the coastal plain. Slopes 0-2%.
Munden	Deep and moderately well drained, formed in loamy fluvial and marine sediments. On inland ridges of the coastal plain. 0-2% slopes
Nawney	Deep and very poorly drained, formed from fluvial sediments. Along inland drainageways and floodplains, 0-2% slopes.
Newhan	Deep and excessively drained, formed in sandy marine and eolian sediments. On coastal dunes with slopes 2-30%.
Nimmo	Deep and poorly drained, formed in fluvial and marine sediments overlying sandy sediments. On inland flats of the coastal plain. 0-2% slopes.
Psamments	Well drained and moderately drained sandy material of a disturbed nature from excavation, grading, or filling.
State	Deep and well drained, formed in loamy fluvial and marine sediments on inland upland and sideslopes of the coastal plain. 0-6% slopes.
Tetotum	Deep and moderately well drained, formed in fluvial and marine sediments. On ridges and sideslopes inland on the coastal plain. 0-2% slopes.
Tomotley	Deep and poorly drained, formed in loamy marine and fluvial sediments. On inland flats of the coastal plain. 0-2% Slopes.
Udorthents	Soils altered by excavation or covered by fill.

Historic Human Disturbance

Both the bay and the barrier island have been greatly disturbed since the time of colonization. Much of the barrier island was cleared of trees and farming was attempted in some areas. Along the beach a life-saving station built by the US Lifesaving Service, a precursor to the Coast Guard in the 1880s (Gannet *et al.* 1891). Introduced wildlife such as pigs and ponies roam over many parts of the refuge rooting in wetlands.

Fire

Fire activity is believed to have been part of the past natural disturbance regime for the barrier island vegetation and has purported to be an important variable in the successional pathways of the marshes (Frost 1995). Within the marsh system, *Typha* ssp. and *Hibiscus* appear to be a climax species after fire. Spike rushes and knotweeds are the first colonizers after a fire and are followed by common threesquare (*Schoenoplectus pungens*), Olney threesquare (*Schoenoplectus americanus*), and saltmarsh bulrush (*Scirpus robustus*). These species are then out-competed by the climax species. (Priest 1990, Frost 1995)

In contrast, areas dominated by live oaks burn very poorly (Barbour 1987) and, although young oaks are sensitive to burning, older oak are much less sensitive to the effects of fire. However, changes likely related to the dynamics of the local human population led to a dramatic increase in fires in the area from 1900 to 1940. Although the frequency of fires increased, the total area burned decreased, resulting in a net loss of burned area.

Introduced fauna

Feral ponies, hogs, and nutria were introduced into the area and are observed frequently in the refuge. In the area of the green hills, evidence of pigs digging/rooting at the bases of live oaks is apparent at most trees. Both feral hogs and nutria are considered nuisance species by the State of Virginia (DGIF 2000). Trampling and grazing by ponies can alter the structure and composition of a small wetlands overnight.

Management (restoration/alteration)

During the 1900s, disturbance has included dune restoration with stabilization by planted exotic sedges (*Carex kobomugi*) and native beach grasses (DCR-DNH 1998a). Prior to the building of a dune system along the beach edge, washovers brought salty ocean water up onto and across the barrier island. Most of this activity ceased with the creation of the dune system in the 1930s. However, two washovers are recorded in the years since. The first of these was the Ash Wednesday storm of 1962 and the last was associated with the class-5 hurricane Camille in 1969 which created what has been classified as the worst natural disaster in Virginia (Watson 2001b).

Management of the refuge itself has led to many modifications of the areas. In areas where washovers occurred in the past, a series of dikes were created to control the water level to create habitat for migratory waterfowl. Additionally, the pumping of ocean water into the bay has changed the bay's salinity, and in turn the aquatic fauna and flora.

Mean Sea Level Rise

There is a current measurable trend in the increase of the mean sea level along the Atlantic coast. In areas along the Gulf Coast the resulting rise in water level is having a profound affect on vegetation and the Virginia coastline is projected to be the most severely impacted area. In these areas, species less tolerant to the increased salinity and/or water level are dying off and are being replaced by more tolerant species. Adams reports (see IBIS p 104.) that mean sea level is the primary determiner of marsh species in mesohaline lunar tidal areas. Comparison of 1891 and current USGS maps show significant signs of

shoreline erosion along some islands, and many marshes east of Long Island no longer exist.

Vegetation and floristics

The vascular flora of the Back Bay Watershed contains 574 species of 309 genera with 50 species listed on the Virginia Natural Heritage Program's rare species or watch list (Wright 1990, Ludwig *et al.* 1990). Cyanobacteria, diatoms, and chlorophyceans of 158 species make up the phytoplankton component of the bay. These small free-floating aquatic species are primarily freshwater species (Marshall 1990). There are still as yet, an unknown number of bryophytes and fungi.

Marsh systems dominate the landscape in the refuge and 22% of the watershed is comprised of wetlands. Within these communities 109 vascular plant species have been recorded with five dominant species: cattails (*Typha* ssp.), black needle rush (*Juncus roemerianus*), giant cordgrass (*Spartina cynosuroides*), saltmeadow cordgrass (*Spartina patens*), and switch grass (*Panicum virgatum*)(Priest and Dewing 1990). The invasive species common reed (*Phragmites australis*) (DCR-DNH 1998b) has expanded quickly over the last two decades and accounts for 10% of marsh cover within the refuge. (J. Gallegos pers. com.)

METHODOLOGY

OVERVIEW OF NATURAL HERITAGE METHODOLOGY

The inventory of the Back Bay NWR was conducted through the five of the six basic stages listed below. Stage 4 was omitted under this contract because all property of interest for inventory was owned by the contracting agency.

1) Review of aerial photographs. Aerial photographs of the survey area are reviewed in detail to identify sites to be studied in the subsequent stages. To aid in their interpretation, the photographs are compared with topographic and geologic maps.

2) Gathering existing information. Museum collections are visited by DCR-DNH staff, and specimen label information is recorded for rare species. Published and unpublished information on natural areas within the inventory area is collected and assimilated in conjunction with review of aerial photographs. Maps of lands within the survey area are gathered, BCD databases are accessed, and the known distribution of natural heritage resources is examined. Local naturalists, soil conservationists, foresters, and college faculty are often consulted for additional information. During this stage, some potential natural areas are eliminated from further consideration while others are added.

3) Planning for field survey. Based on preceding efforts, field plans are developed to maximize the productivity of the limited field time. Among the factors considered are: when the survey can best be conducted; which staff scientist(s) should be involved (i.e., what is the potential for rare plants, rare animals or exemplary communities); and how much time should be budgeted for completing the survey.

4) Landowner contact. The ownership of tracts targeted for field survey is determined though county courthouse records. Contact with landowners is subsequently made in writing, by telephone, or in person. During this stage, some areas targeted for field survey are removed from further consideration where landowners cannot be reached or access permission is denied.

4) Field survey. During this stage, detailed information is collected on the rare species and exemplary natural communities present within the study area. Portions of a site not visited on foot are evaluated on the basis of aerial photographs and other information. The area of land needed to protect the special biological features is determined. Threats and past or present disturbances are also evaluated. Element occurrence data is transcribed onto DCR-DNH maps and entered into the BCD system. Throughout this stage of concentrated field inventory, continual communication between DCR-DNH project team members (botanists, zoologists, and ecologists) is emphasized to ensure that all significant natural areas are visited by appropriate specialists and that data is coordinated. In addition, some flexibility is built into the process so that priorities can be adjusted when unexpected elements are encountered.

5) Compilation of results and preparation of final report. As fieldwork is completed, DCR-DNH biologists review the information gathered and rank sites according to their ecological significance. Maps are drawn showing conservation planning boundaries, and protection and management recommendations are written. These are combined with site reports and other required information in preparing a final report.

COMMUNITY INVENTORY

The need to protect indigenous biotic communities and ecosystems has become a major focus of conservation efforts by Federal, state, and private organizations in recent years. Community classification, inventory, and protection should be regarded as an essential complement to rare species inventories. Natural communities represent functioning units of the landscape which:

1. support myriad life forms too cryptic or poorly known to be catalogued and prioritized individually;

2. provide the nurturing environment for both rare and common species;

3. contribute to the maintenance of larger ecosystems; and

4. possess unique intrinsic scientific, educational, and aesthetic values.

It is therefore important to locate, classify, and evaluate these features as part of any comprehensive inventory of natural heritage resources.

Most community types have not yet been fully defined or ranked due to ongoing classification efforts by the Federal Geographic Data Committee, The Nature Conservancy, and the network of Natural Heritage ecologists (Anderson *et al.* 1998, Grossman *et al.* 1998). In Virginia, the current definition of communities is at a broad, natural community group level (Fleming *et al.* 2001). Classification at the natural community level groups together community types with similar structural, floristic, and habitat similarities, e.g., dry oak-hickory forests. Thus, a natural community group is essentially a group of ecologically allied community types. A few community types that have been quantitatively sampled and studied intensively by DCR-DNH ecologists have been formally classified at the association level. Units at this level are defined by a high degree of compositional and environmental similarity, and are named using diagnostic species of the association, e.g., the *Acer rubrum - Nyssa sylvatica / Ilex verticillata / Osmunda cinnamomea* (Red Maple - Black Gum / Winterberry / Cinnamon Fern) Saturated Forest. The ongoing goal of Division ecologists is a comprehensive classification of Virginia's communities at the association level.

For purposes of this study, significant communities are defined to include both outstanding examples of common community types (e.g., old-growth mixed hardwood forest) and all examples of rare community types (e.g., certain seepage-influenced, fire-maintained wetlands). Community nomenclature follows the Natural Communities of Virginia by Fleming *et al.* 2001 and is modeled after the Classification of the Natural Communities of North Carolina (Schafale and Weakley 1990). As the National Vegetation Community Classification (NVCC) becomes populated with descriptions these assemblages and the individual plots will be cross-walked to the NVCC (Grossman *et al.* 1998).

Data collection began in early 2000 with a review of BCD database information and scientific literature. Staff ecologists also relied on aerial photographs, topographic maps, geologic maps, and soil surveys to identify potential new significant communities or boundary extensions of known communities. Previous fieldwork completed by DCR-DNH ecologist Chris Clampitt and information from individuals knowledgeable about the Back Bay NWR significantly contributed to the selection of sites for field work. Table 5 provides information on previously described communities for the refuge area.

Table 5. Significant natural community elements previously reported from the Back Bay

Element:	Number of Occurrences:
Oligotrophic Semi-permanently Flood herbaceous wetland*	
Cattail/Spikerush tall freshwater marsh	1
Spikerush short freshwater marsh	1

*This community group is currently labeled wind-tidal oligohaline marsh

Ecological fieldwork began in May 2000, and continued through October 2000. During this period, visits were made to targeted sections of Back Bay. Close communication was maintained between the ecologists, botanists, and zoologists working on the project, and concurrent multidisciplinary investigation of significant sites was arranged when possible. DCR-DNH field zoologist Anne Chazal and field botanist Nancy Van Alstine were responsible for the zoological and botanical work ,respectively.

Standard information was collected for each section of the refuge visited by ecologists and was coordinated with data collected by botanists and zoologists when necessary. When significant communities were located, additional data were collected on occurrence size, condition, boundaries, biotic and abiotic factors, floristics, evidence of disturbance, successional trends, and immediate or long-term threats. Community occurrences were ranked primarily by their quality and size.

Field sampling

Vegetation and environmental data were collected from sample plots that represent locally uniform habitat types in what initially appear to be rare or less common community types. Plots were sampled using the releve method (sensu Peet *et al.* 1998), with 100 m^2 plots used to document shrubland and herbaceous vegetation and 400 m^2 for forest plots. Each plot was placed in areas with relatively homogeneous and representative vegetation. Within these plots, the percent cover of each vascular plant species was estimated as a vertical projection onto the plot area and assigned to one of nine cover classes. In forms prior to 1998, the cover classes system used the traditional Braun-Blanquet methodology (Westoff and van der Maarl 1973) while forms after that year use a modified class system (Table 6).

The cover of each plant taxon in all strata (herb, shrub, and tree layers) combined was estimated as a single total cover value (tc). The overall cover of mosses, lichens, and liverworts was estimated as a single value. Woody lianas and herbaceous vines were considered as any other growth form and assigned to the stratum of their occurrence. Any vascular plant present in similar habitat outside the plot boundaries was recorded parenthetically, and its cover assigned a value of one. The total vegetative cover in each stratum was also estimated by assignment to one of six broad classes: dense (80-100%), somewhat open (60-80%), open (40-60%), very open (25-40%), sparse (5-25%), and very sparse (0-5%). When woody vegetation was present, the diameters of all woody stems were counted and sorted into 10 classes based on breast height measurements with trees greater than 40 cm dbh, measured to the nearest 1cm.

Table 6. Cover class scores used in field sampling and data analysis.

ESTIMATED COVER:	TRADITIONAL BRAUN-BLANQUET COVER CLASS:	EQUIVALENT NUMERICAL COVER CLASS:
present outside plot	p	1
trace	r	1
a few, < 1%	+	2
1 - 2%	1-	3
2 - 5%	1+	4
5 - 10%	2-	5
10 – 25%	2+	6
25 – 50%	3	7
50 – 75%	4	8
75 – 100%	5	9

During plot sampling, voucher specimens were routinely collected to verify field identifications and/or to document new county distribution records in Harvill *et al.* (1992).

A standard set of environmental data was measured or estimated at each plot. Slope inclination and aspect were measured to the nearest degree. In plots with variable microtopography, slope was measured at several points and averaged. Elevation was determined to the nearest 10 ft (ca. 3 m) using topographic maps. The percent cover of different surface substrates was estimated visually, with precision varying such that values summed to 100%. Topographic position, slope shape (both horizontally and vertically), soil drainage class, soil moisture regime, and inundation were assessed using scalar values. Soil parent material was determined to the greatest precision possible using existing geological maps.

Soil samples were collected from the top 10 cm of mineral or organic soil (below the surficial litter or humus). Samples were dried in a laboratory oven, sieved, and will be analyzed for pH, phosphorus (P), soluble sulfur, exchangeable cations (calcium [Ca], magnesium [Mg], potassium [K], and sodium [Na], in ppm), extractable micronutrients (boron [B], iron [Fe], manganese [Mn], copper [Cu], zinc [Zn], and aluminum [Al], in ppm), total exchange capacity, and percent organic matter (Brookside Laboratories, using Mehlich III extraction procedures). General soil color and texture were evaluated in the field and recorded on plot forms. Evidence of any past or ongoing disturbance was also recorded at each site.

Standard metadata, or information regarding the implementation of the sampling protocol, were recorded at each plot. These included plot numbers, date(s) of sampling, participants, geopolitical locality (county / city), watershed, site name, USGS quadrangle map, latitude and longitude, plot size and configuration, and a written description of the plot location. Plots were assigned unique, permanent, alphanumeric codes. Opposite corners of plot locations were recorded with a Trimble GeoExplorer II GPS. unit. All plot locations were mapped as precisely as possible on USGS 7.5 quadrangle maps and in a geographical information system (GIS) using ArcView software (ESRI 1996). UTM (Universal Trans Mercator) coordinates of plot locations were derived from the GPS files using Pathfinder Office software (Trimble 1997). Finally, plot data will be added to a larger dataset of maritime communities for analysis by DCR-DNH ecologists using PC-Ord cluster analysis software (McCune and Medford 1999).

The vegetation of the Back Bay watershed was initially evaluated by visual inspection of aerial photography. Sites of interest, determined from either historical information or from photographic interpretation were plotted on maps and a trip was conducted to determine the best plot locations.

Table 7. Topographic / hydrologic environmental indices recorded at each plot sampling site.

Topographic position:

A - plain/level
B - toe
C - lower slope
D - middle slope
E - upper slope
F - escarpment/face
G - ledge/terrace
H - crest
I - basin/depression
J - flood plain
K - stream bottom

Surface Substrate: % cover:

decaying wood
bedrock
boulders (> 24" diam.)
stones (> 10" round or > 15" flattened)
cobbles (3-10" rounded)
gravel (incl. channery)
sand
mineral soil
organic matter
water
other

Measured Slope (degrees):

Slope shape:

Vertical
C - concave
X - convex
S - straight
Horizontal
C - concave
X - convex
S - straight
H - hummock and hollow microtopography

Measured Aspect:

_____ degrees
F (flat)
V (variable)

Soil Drainage Class:

A - very poorly drained
B - poorly drained
C - somewhat poorly drained
D - moderately well-drained
E - well-drained
F - rapidly drained

Inundation:

A - never
B - infrequently
C - regularly, for < 6 mos.
D - regularly, for > 6 mos.
E - always submerged by shallow water (< 30 cm)
F - always submerged by deep water (> 30 cm)

Soil Moisture Regime:

A - very xeric (moist for negligible time after precipitation)
B - xeric (moist for brief time)
C - somewhat xeric (moist for short time)
D - submesic (moist for moderately short time)
E - mesic (moist for significant time)
F - subhygric (wet for significant part of growing season; mottles < 20 cm)
G - hygric (wet for most of growing season; permanent seepage/mottling)
H - subhydric (water table at or near surface for most of the year)
I - hydric (water table at or above surface year round)
_ - ephemeral seepage/subsurface water present locally in plot

Hydrologic Regime:

Tidal
A - Irregularly exposed
B - Regularly flooded
C - Irregularly flooded
D - Wind tidally influenced
Non-Tidal
A - Permanently flooded
B - Semipermanently flooded
C - Seasonally flooded
D - Seasonally flooded/saturated
E - Intermittently/temporarily flooded
F - Saturated
Salinity/Halinity
A - Saltwater
B - Brackish
C - Oligohaline
D – Freshwater

BOTANICAL INVENTORY

For purposes of this study, rare plants are defined as the rarest known species in Virginia as designated by DCR-DNH. In Virginia, rare plants include species with global ranks of G1, G2, and G3, and state ranks of S1, S2, SH, and SX. Data on species with state ranks of S1, S2 (or S2S3), SH, and SX are maintained in the BCD system and summarized annually on a master list of Virginia's rare plants (Killeffer 2000). Species with state ranks of S3 and SU are not tracked using BCD, but maintained on a separate "watchlist." Only general information about watchlist species is recorded in the field and maintained in manual information files.

To initiate the inventory of rare plants at Back Bay NWR, existing data on element occurrences within and near the study site were obtained from DCR-DNH's BCD database and manual files. Data in BCD were partly based on information gathered from past rare plant surveys at Back Bay conducted in 1988 (DCR-DNH database) and 1992 (Clampitt *et al.* 1993), botanical literature, and from examination of collections at the following institutions: College of William and Mary, George Mason University, Longwood College, Lynchburg College, National Arboretum, Old Dominion University, University of Richmond, U.S. National Herbarium (Smithsonian Institution), University of North Carolina, Virginia Commonwealth University, and Virginia Polytechnic Institute and State University.

Over the years, 28 occurrences of 18 rare plant taxa have been observed on Back Bay NWR, both on the barrier island portion, on the islands, and the more recent acquisitions around the shores or in the drainage of Back Bay. Table 8 shows the rare plants that have been reported for Back Bay NWR, the dates they were last seen, the preferred survey time, and the habitat, both specific for a particular occurrence and more general for that species. Twenty-seven other taxa, that have been found in the Back Bay area, and could potentially occur at Back Bay NWR are shown in Appendix A.

Given the large land area of Back Bay NWR and the funding level for the botanical portion of this inventory, advice was sought from Back Bay NWR personnel as to their priorities for areas to be surveyed and the relative importance of finding new occurrences vs. updating and more accurately plotting rare plant occurrence seen previously. Back Bay NWR staff determined that surveys for new occurrences on the recently acquired lands on the north, northwest, and western shores of Back Bay and documenting the locations of the known rare plant occurrences on these more recent acquisitions by means of a Global Positioning System (GPS) unit was the highest priority, followed by surveys on the islands. Surveys on the barrier island portion of the National Wildlife Refuge would be done if time allowed.

All rare plant surveys conducted at Back Bay NWR by the DCR-DNH Field Botanist occurred between August 15 and September 27, 2000. Additional rare plant discoveries were made by the Field Ecologist Dean P. Walton on the barrier island portion of the Refuge between May 16 and October 24, as he conducted the vegetation community survey; rarities found by the Ecologist were not documented by GPS, but approximate location information and population data was recorded. Surveys by boat were conducted in mid-August to late September along the western shoreline of Back Bay, in the North Bay marshes, Black Gut, Muddy Creek, and along Long Island. During these boat surveys, searches by foot were conducted in areas of previously known rare plant occurrences or when habitat appeared appropriate for target species. Back Bay NWR staff John Gallegos and Lamar Gore operated the boats and assisted with foot surveys. A portion of the Garcia Tract southwest of Lake Tecumseh was investigated with John Gallegos. Although time did not allow for any significant survey work by the Field Botanist on the barrier island portion of Back Bay NWR, one site at the south end of the Wash

Flats site was investigated by the Field Botanist due to findings by the Field Ecologist, and the rare plants there were documented.

During botanical inventory, field data were recorded during each site survey. These data included the site location, directions, and a site description, as well as comments on land use, potential hazards, exotic flora and fauna, and off-site considerations. When a rare plant occurrence was located, additional data were recorded, including the date(s) when the species was found, population boundaries and concentrations within those boundaries, approximate number of individuals, reproductive and phenological status, and species viability. Habitat factors such as moisture, light, and associated species, as well as any apparent immediate or long-term threats to the rare species population were also noted. When a plant rarity was found, most locations were documented using a Global Positioning System (GPS) unit. The exception to this is the Carolina lilaeopsis (*Lilaeopsis carolinensis*), common along the shoreline of Back Bay, including Long Island. Rare species occurrences were ranked on the basis of all available data and, if available, Element Global Rank Specifications developed by The Nature Conservancy and Natural Heritage Programs. Data on plant rarities found in this survey have been entered into DCR-DNH's BCD database.

Table 8 Rare plants reported for Back Bay NWR prior to the 2000 inventory.

QUAD	CONSERVATION SITE	TAXON (Element Occurrence #)	GLOBAL/ STATE RANK	LAST SEEN	SURVEY TIME	HABITAT -specific to EO (general habitat)
North Bay	Black Gut	*Eleocharis vivipara* (001)	G5/S1	1973	August-November	Low wet sandy opening (Swamps on Coastal Plain)
		Ludwigia brevipes (010) - extends onto Virginia Beach quad to north	G4G5/S2	1991	June-September	Open-partly shaded exposed mud of pools and marshes (Pondshores, low wet places, interdune swales, gravel pits, ditches)
	Long Island	*Crataegus aestivalis* (001) ID not confirmed.	G5/S1	1939	March-April; June-July	Low woods along bay. (Swamp forests)
		Juncus elliottii (003)	G4G5/S1S2	1939	May-September	Inner border of brackish-fresh marsh (Margins of ponds and lakes, depressions in savannas and flatwoods, wet disturbed clearings, roadside ditches)
		Juncus megacephalus (002)	G4G5/S2	1939	June-August	Inner border of brackish-fresh marsh (Brackish and freshwater marshes, bogs, ditches, wet open places)
		Lilaeopsis carolinensis (001)	G3/S1	1939	May-June	Shallow pool in brackish to fresh marsh (freshwater marshes and pondshores, ditches, interdune ponds, shores of estuarine sounds and rivers)
		Rhynchospora colorata (001)	G5/S1	1939	May-September	- (Wet savannas, ditches, in acid soils)
		Verbena scabra (003)	G5/S1	1939	March-December	Inner border of brackish to fresh marsh. (Moist habitats)
	Muddy Creek	*Lilaeopsis carolinensis* (007)	G3/S1	1992	May-June	On sand at very edge of bay, within 20 cm of waterline. (Freshwater marshes and pond shores, ditches, interdune ponds, shores of estuarine sounds and rivers)

QUAD	CONSERVATION SITE	TAXON (Element Occurrence #)	GLOBAL/ STATE RANK	LAST SEEN	SURVEY TIME	HABITAT -specific to EO (general habitat)
North Bay (cont'd)	Nawney Creek	*Lilaeopsis carolinensis* (008) -continues onto quad below (Knotts Island), but that portion not on NWR	G3/S1	1992	May-June	Sandy, wave-washed shore (Freshwater marshes and pond shores, ditches, interdune ponds, shores of estuarine sounds and rivers)
	North Bay Marshes	*Ludwigia alata* (006) –this occurrence spans two Conservation Sites, North Bay Marshes and Porpoise Point (not on Back Bay NWR)	G3G4/S1	1991	June-September	Mid-height to tall palustrine-estuarine wetland. (Interdune ponds, freshwater-slightly brackish marshes)
	Wash Flats	*Erigeron vernus* (004)	G5/S2	1988	late March-June	Damp sandy depression. (Savannas, seepages, interdune swales)
		Iva imbricata (003)	G5?/S1S2	1939	late August- November	Sand dunes (Dunes, upper beach, island end-flats)
		Juncus elliottii (001)	G4G5/S1S2	1947	May-September	Wet soil. Marsh. (Margins of ponds and lakes, depressions in savannas and flatwoods, wet disturbed clearings, roadside ditches.)
		Juncus megacephalus (006)	G4G5/S2	1988	June-August	Dry soil. On damp, sandy soil, marsh. (Brackish and freshwater marshes, bogs ditches, wet open places)
		Lilaeopsis carolinensis(003)	G3?/S1	1988	May-June	Marsh. (freshwater marshes and pond shores, ditches, interdune ponds, shores of estuarine sounds and rivers)
		Ludwigia brevipes (009)	G4G5/S2	1990	June-September	Rush-sedge impoundment (Pondshores, low wet places, interdune swales, gravel pits, ditches)
		Ludwigia brevipes (007)	G4G5/S2	1988	June-September	(Pondshores, low wet places, interdune swales, gravel pits, ditches)
		Ludwigia repens (002)	G5/S1	1988	June-September	(Ditches, pools streams)
		Phyla nodiflora (002)	G5/S1	1947	May-November	Damp soil. Dry soil. (Sandy soils of roadsides, lawns, ditches, disturbed areas)

QUAD	CONSERVATION SITE	TAXON (Element Occurrence #)	GLOBAL/ STATE RANK	LAST SEEN	SURVEY TIME	HABITAT -specific to EO (general habitat)
North Bay (cont'd)	Wash Flats (cont'd)	*Phyla nodiflora* (003)	G5/S1	1988	May-November	1961: Sandy peat of broad marsh (Sandy soils of roadsides, lawns, ditches, disturbed areas)
		Rhynchospora colorata (002)	G5/S1	1965	May-September	Sandy soil. (Wet savannas, ditches, in acid soils)
		Rhynchospora colorata (005)	G5/S1	1988	May-September	Impoundment proper. (Wet savannas, ditches, in acid soils)
		Rhynchospora debilis (001)	G4?/S1	1952	July-September	On maritime sands and in marshes. (Savannas, sandhill seeps)
		Rhynchospora fascicularis var. fascicularis (006)	G5T?/S1?	1988	June-September	- (Savannas, limesink ponds)
		Vaccinium macrocarpon (012)	G4/S2	1988	May-July; August-November	Damp sandy depression along side of road (On coast -interdune swales)
		Verbena scabra (001)	G5/S1	1947	March-December	Frequent in dry soil. (Moist habitats)
Virginia Beach	Black Gut	*Ludwigia brevipes* (010)- extends onto North Bay quad to the south	G4G5/S2	1991	June-September	Open-partly shaded exposed mud of pools and marshes (Pondshores, low wet places, interdune swales, Gravel pits, ditches)
Knotts Island	No known EO's on Back Bay NWR					

ZOOLOGICAL INVENTORY

For purposes of this study, rare animals are defined as the rarest known species in the Virginia. They include species with global ranks of G1, G2, and G3, and state ranks of S1, S2, S3, SH, SX, and SU. Data on species with state ranks of S1, S2 (or S2S3), SH, and SX are maintained in the BCD system and summarized annually on a master list of Virginia's rare animals (Roble 1996). Species with state ranks of S3 and SU are not tracked using BCD, but are maintained on a separate "watchlist." Only general information about watchlist species is recorded in the field and maintained in manual information files.

To initiate inventory of rare animals at Back Bay NWR, existing data on element occurrences within and near the park were obtained from the BCD database and reviewed. Additional information was gathered from zoological literature and from examination of selected collections at the following institutions: National Museum of Natural History, the Carnegie Museum, Lord Fairfax Community College, Eastern Mennonite College, Old Dominion University, Virginia Polytechnic Institute and State University, Virginia Commonwealth University, and the Virginia Museum of Natural History.

After an orientation meeting, fieldwork was initiated in March 2000. Surveys took place between March and September 2000. Inventory for targeted species required repeated visits to many sites and potential habitats at different seasons.

A full complement of inventory and sampling methods was employed, including:

Sweep nets - Lepidopterans, odonates, tiger beetles, and other flying invertebrates were sampled in terrestrial and aquatic habitats using sweep nets.

UV-light traps - Nocturnal lepidopterans and other invertebrates were captured using standard bucket traps equipped with a blacklight (= ultraviolet) powered by a 12-volt gel-cell battery. Ethyl acetate was used as a killing agent. Traps were run overnight in a variety of habitats. Often a UV-light was used with a white sheet and the moths were taken in a kill-jar and non-lepidopterans were taken in alcohol. Localities are illustrated in Figures 12, 17, and 28.

Sugaring - Some nocturnal insects that are not attracted to UV-light come to bait. The bait is a mixture of fermented beer, fruit, and sugar, which is applied to tree trunks and other structures. The moths were collected with a kill-jar and non-lepidopterans were taken in alcohol.

Cover boards – Eight cover boards (approximately 2'x4') made of pressboard, were scattered through a section of dune-swale habitat (near the A/B dike drift fence) to survey for reptiles and amphibians. Localities are illustrated on Figure 28.

Pitfall traps – Unbaited pitfall traps in association with aluminum drift fences were used to survey terrestrial invertebrates (van den Berghe 1992). A wire mesh was placed over pitfalls to discourage vertebrates from being caught. Information about the drift fences is summarized in Table 9. Localities are illustrated in Figures 12 and 28.

Mist nets – Two mist net arrays were set during one trapping session to survey for bats. One net measured 18'x18' and was stretched across a roadway with a closed tree canopy which created a 'tunnel' effect. The second 6'x18' array stretched across shallow standing water. Both were located in maritime forest habitat. Localities are illustrated in Figure 28.

All specimens collected during the study were preserved using standard methods (Martin 1977; McDiarmid 1994). Most of the specimens have been or will be deposited in the Virginia Museum of Natural History; some specimens may be deposited in the National Museum of Natural History and the reference collection (primarily Lepidoptera and Odonata) of the DCR-DNH.

Table 9. 2000 Back Bay National Wildlife Refuge drift fence locations and information.

Site Name (Habitat)	Location	Length	Number of Pitfall Traps	Date Installed (2000)	Date Closed (2000)	Number of Sampling Periods
S Black Gut (pine/ hardwood)	ca. 1 km W Sandbridge Beach (Figure 12)	3 m	6	31 May	27 Sept	8
E A/B Dike (dune-swale)	ca. 0.25 km ESE jct. A/B dike rd and E Refuge Rd. (Figure 28)	4 m	4	31 May	26 Sept	8

RESULTS

DESCRIPTION OF NATURAL COMMUNITY CLASSES AND COMMUNITY TYPES

Thirty-six plots were sampled covering nineteen natural community types in the Back Bay Refuge. Within a hierarchial system the communities can be broken down into four major systems: terrestrial, palustrine, estuarine, and marine. The majority of communities sampled were in the palustrine system with 16 plots. The terrestrial system was the next heaviest system sampled with 11 plots followed by the estuarine system with eight plots and the marine system with one. The general placement of these plots with regard to the refuge as a whole is shown in Figure 2. The one plot on Long Island is shown in Figure 3. Plots in the northern section of Back Bay NWR including Black Gut and the North Bay Marshes are indicated in Figure 4. The great majority of the plots were placed within the Sand Ridge barrier island and are indicated in Figure 5, the central section of Sandridge and Figure 6, the southern end of Back Bay NWR adjoining False Cape State Park, and including the Green Hills area of the refuge. Two plots were sampled on the mainland on the western edge of the refuge (Figure 7).

The final two plots (Figure 8), covering wind tidal assemblages, were located just outside the refuge and were sample to represent communities within the refuge. The shift between low and high tides in a wind tidal system is not related to a lunar cycle but is more random and changes with prevailing winds. Tides may be elevated for days and then recede. These plots were sampled at a time and location when the prevailing weather conditions were favorable for sampling. Plot data were collected within the proclamation boundary in prior years and their locations and plot codes are shown in Figure 9.

Each of the year 2000 plots was reviewed and each was attributed to a natural community type. The descriptions of these plant assemblages is reported below along the associated plot (s). Individual plot forms are supplied in Appendix E (including the plots from prior years). The communities cover four systems (Terrestrial, Palustrine, Estuarine, and Marine) and four subcategories. The descriptions of these natural communities are as follows:

TERRESTRIAL SYSTEM

MARITIME ZONE COMMUNITIES

Maritime Dune Grasslands

Coastal graminoid communities of ocean- and bay-fronting dunes that are greatly influenced by storm surge activity. Communities of this group are characterized by a few well-adapted herbaceous species and exhibit zonation that is likely related to gradients of salt spray and soil moisture. The dominant plants are meadow cordgrass (*Spartina patens*), American beachgrass (*Ammophila breviligulata*), sea oats (*Uniola paniculata),* bitter seabeach grass (*Panicum amarum*), beach panic grass (*Panicum amarulum*), and seaside little bluestem (*Schizachyrium scoparium* ssp. *littorale*). On steep dune slopes facing the ocean, American beachgrass forms narrow, almost monotypic stands. However, the crest of primary dunes and more gentle back slopes and terraces are dominated by sea oats and/or bitter seabeach grass, with a slightly more diverse assemblage of low-cover species such as seaside goldenrod (*Solidago sempervirens* var. *sempervirens*), sea-beach evening-primrose (*Oenothera humifusa*), seaside spurge (*Chamaesyce polygonifolia*), purple lovegrass (*Eragrostis spectabilis*), purple sandgrass (*Triplasis purpurea*), and dune sandbur (*Cenchrus tribuloides*). Away from the primary dune and salt spray, a series of smaller secondary dunes spread inward. These dunes are characteristically colonized by beach

panic grass or seaside little bluestem. Sea oats and American beachgrass are present but their cover drops significantly away from primary dune. This zone contains the same sparse assemblage of species as the previous zone with the addition of meadow cordgrass, which forms dense patches along terraces of the smaller dunes. Development and coastal erosion are the major threats to this community. Additionally, walking on these dunes reduces their stability and increases the chance of breaching during storm events. The exotic Japanese sedge (*Carex kobomugi*), initially planted to stabilize dune systems, has become an invasive pest on the southeastern Virginia coast (DCR-DNH 1998a). Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR17, BBNR19.**

Maritime Scrub

Shrublands of somewhat protected maritime back dunes and leeward dune slopes. Communities in this group generally occupy inland edges of maritime dune systems in a zone sheltered from constant ocean salt spray. The vegetation is characterized by several tree, shrub and dwarf shrub species. Dominant scrubby species include northern bayberry (*Myrica pensylvanica*), live oak (*Quercus virginiana*, southeastern Virginia only), persimmon (*Diospyros virginiana*), and black cherry (*Prunus serotina* var. *serotina*). In the northern coastal plain of Virginia, high-tide bush (*Baccharis halimifolia*) is also characteristic. Many woody species are significantly stunted in this habitat and, like the live oak, are often much broader than they are tall. Few herbaceous or graminoid species are present under the shrub canopy but frequent canopy gaps support most of the species found in the dune grasslands. In some remnant dunes and areas of dune blowouts, the dwarf shrub sand-heather (*Hudsonia tomentosa*) forms an assemblage with beach goldenrod (*Solidago sempervirens*), bitter beach grass (*Panicum amarum*), Gray's flatsedge (*Cyperus grayi*), and beach pinweed (*Lechea maritima*). This community type, present on Assateague Island and the southeastern Virginia coast, often occurs in a mosaic with maritime dune woodlands. Maritime shrublands are threatened by coastal development and by natural and anthropogenic disturbances that destroy the protective primary dune system. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR3, BBNR6, BBNR32, BBNR34.**

Maritime Dune Woodlands

Deciduous and evergreen broadleaf woodlands of unstable protected back dunes or secondary dunes subject to more regular salt spray. Distribution in Virginia is more localized and restricted to ocean-facing dune systems than that of maritime pine forests. Habitats are commonly on convex, rapidly drained dunes and less frequently on xeric sand flats. Floristic composition of communities in this group varies considerably with geography. Along the southeastern Virginia coast (City of Virginia Beach), live oak (*Quercus virginiana*), bluejack oak (*Quercus incana*), and sassafras (*Sassafras albidum*) dominate stands, with loblolly pine (*Pinus taeda*) and black cherry (*Prunus serotina* var. *serotina*) as less abundant associates. On the Eastern Shore (Accomack and Northampton Counties), a community type of widely spaced loblolly pine with scattered, scrubby oaks (*Q. nigra* and *Q. falcata*), dwarf-shrub patches of sand-heather (*Hudsonia tomentosa*), and large areas of exposed sand occurs on the highest back-dune systems. Another xeric back-dune community dominated by black cherry, prickly-pear (*Opuntia humifusa*), and seaside little bluestem (*Schizachyrium scoparium* ssp. *littorale*) has been documented in two Eastern Shore locations. Scattered herbaceous plants that occur in these woodlands include seabeach needlegrass (*Aristida tuberculosa*), oval-leaved panic grass (*Dichanthelium ovale* var. *ovale*), Canada frostweed (*Helianthemum canadense*), woolly ragwort (*Senecio tomentosa*), and narrow-leaf silk-grass (*Pityopsis graminifolia* var. *latifolia*). All communities in this group are considered globally and state rare. This community, noted in First Landing State Park was not observed in Back Bay NWR but may be present.

Maritime Evergreen Forests
Species-poor mixed coastal forests with a prominent component of broadleaf evergreen trees. This group reaches its northernmost limits along the southeastern Virginia coast, where it is confined to areas on and near False Cape and Cape Henry (City of Virginia Beach). Habitats are back dunes and the leeward sides of stabilized dunes that are protected from the ocean salt spray. Live oak (*Quercus virginiana*) is the dominant species in mixtures with (*Pinus taeda*), Darlington's oak (*Q. hemisphaerica* var. *hemisphaerica*), and black cherry (*Prunus serotina* var. *serotina*). Characteristic understory plants include poison ivy (*Toxicodendron radicans* ssp. *radicans*), common greenbrier (*Smilax rotundifolia*), southern bayberry (*Myrica cerifera*), American holly (*Ilex opaca* var. *opaca*), devilwood (*Osmanthus americanus* var. *americanus*), and highbush blueberry (*Vaccinium corymbosum*). Ground cover is sparse, consisting of a thin layer of dry leathery oak leaves and scattered forbs such as yellow jesamine (*Gelsemium sempervirens*) and narrow-leaved golden-aster (*Pityopsis graminifolia* var. *latifolia*). In Virginia, two state-rare moths, the orange panopoda (*Panopoda repanda*) and the owlet (noctuid) moth *Metria amella*, feed on live oak in these communities. Most communities in this group are considered globally rare because of restricted ranges, narrow habitat requirements, and threats from coastal development. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR2, BBNR15.**

Maritime Loblolly Pine Forests
Pine-dominated forests of sheltered, oceanside and bayside dunes and sand flats generally protected from salt spray. Communities in this group are distributed along the length of the outer Coastal Plain maritime zone and barrier islands in Virginia, including the western shore of the Chesapeake Bay. Soils in these habitats are often covered by a thick duff layer up to 15 cm (6 in) thick and this dense organic accumulation may be the result of a suppressed fire regime in some stands. The upper mineral soil horizon is dark sand or very sandy clay, and the water table may be relatively near the surface. Forest overstories are characterized by nearly pure loblolly pine (*Pinus taeda*), with sparse to dense understories of red maple (*Acer rubrum*), black cherry (*Prunus serotina* var. *serotina*), and/or sassafras (*Sassafras albidum*). Shrubs, which vary greatly in cover, include southern bayberry (*Myrica cerifera*) and highbush blueberry (*Vaccinium corymbosum*). Muscadine grape (*Vitis rotundifolia*) and greenbriers (*Smilax rotundifolia* and *S. bona-nox*) are quite common throughout. Although the canopy and shrub strata can be quite dense, the herbaceous layer is usually and characteristically sparse and of low diversity. Slender spikegrass (*Chasmanthium laxum*) is one of the few herbaceous plants that may be abundant. Because they are restricted to a narrow geographic range (Delaware to northern North Carolina) and are subject to development pressure, maritime forest communities are considered globally uncommon to rare. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR10.**

Maritime Mixed Forests
Mixed forests of sheltered back dunes along both flanks of the Eastern Shore (Accomack and Northampton Counties), as well as Cape Henry and False Cape in southeastern Virginia (City of Virginia Beach). Habitats are most frequently located on the leeward slopes of bay-side dunes or old ocean-side dunes well protected from salt spray and winds. Soils are well drained to rapidly drained, nutrient-poor sands and sandy loams. Overstories contain variable mixtures of loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), southern red oak (*Quercus falcata*), and black cherry (*Prunus serotina* var. *serotina*). American holly (*Ilex opaca* var. *opaca*) is a frequent understory tree. The shrub and herb layers are often covered with dense tangles of common greenbrier (*Smilax rotundifolia*) and muscadine grape (*Vitis*

rotundifolia). These communities are known only from the barrier beach areas of Virginia and North Carolina and are probably globally uncommon or rare. Few mature stands have been documented and the restricted habitats are subject to major development pressure. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR22.**

PALUSTRINE SYSTEM

NON-ALLUVIAL WETLANDS OF THE COASTAL PLAIN AND PIEDMONT

Non-Riverine Pine – Hardwood Forests

Saturated mixed forests of poorly drained, outer Coastal Plain terraces. In Virginia, the principal range of these communities is from Surry and Isle of Wight Counties south to the City of Suffolk on the west and the North Landing River (City of Virginia Beach on the east). Habitats are flat, with seasonally perched water tables and frequent shallow depressions which pond water intermittently. Soils are silt, sand, and clay loams, frequently with a thin (< 30 cm) organic mantle. The current vegetation of these flatwoods is dominated by mixtures of loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*), frequently with scattered pond pine (*P. serotina*). Small trees and shrubs can include sweetbay (*Magnolia virginiana*), blackgum (*Nyssa sylvatica*), red bay (*Persea palustris*), and coastal dog-hobble (*Leucothoe axillaris*). Giant cane (*Arundinaria gigantea* ssp. *tecta*) typically dominates the shrub layer in patchy to very dense colonies. Herbaceous species are sparse. For the most part, these forests appear to be successional stands that have replaced once-extensive "canebreaks" (i.e., giant cane savannas with scattered pond pine) following the virtual elimination of fire in the region. A few occurrences appear to have replaced non-riverine wet hardwood forests (see below) or Atlantic white-cedar forests following heavy cutting or catastrophic fires. Although communities in this group are not conservation priorities in their modified condition, they provide opportunities for ecological restoration of now-extirpated canebreak vegetation. In addition, several rare species, including the globally rare Virginia least trillium (*Trillium pusillum* var. *virginianum*) and large populations of the state-rare bird Swainson's warbler (*Limnothlypis swainsonii*) are associated with non-riverine pine-hardwood forests. Giant cane is believed to be the host plant for several state and globally rare insects. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR31.**

Non-Riverine Wet Hardwood Forests

Saturated to shortly seasonally flooded deciduous forests of poorly drained, Coastal Plain terraces. These include broad, outer Coastal Plain interfluves, as well as the outermost, never-flooded alluvial terraces of major rivers inland. In Virginia, these communities range locally from inland portions of the Eastern Shore south through much of southeastern Virginia. Habitats are flat, with seasonally perched water tables and frequent shallow depressions which pond water intermittently. Soils are silt, sand, and clay loams, sometimes with very thin organic horizons. Mixtures of hydrophytic oaks (*Quercus* spp.) characterize forests of this group. Dominants, varying regionally, include swamp chestnut *oak (Q. michauxii*), cherrybark oak (*Q. pagoda*), willow oak (*Q. phellos*), laurel oak (*Q. laurifolia*), water oak (*Q. nigra*), and pin oak (*Q. palustris*). Cutting and other disturbances result in higher proportions of sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and other intolerant trees. Small trees and shrubs include American hornbeam (*Carpinus caroliniana* ssp. *caroliniana*), giant cane (*Arundinaria gigantea ssp. tecta*), American holly (*Ilex opaca* var. *opaca*), coastal dog-hobble (*Leucothoe axillaris*), and highbush blueberries (*Vaccinium* spp.). The herb layer tends to be depauperate, but usually contains netted chain-fern (*Woodwardia areolata*) and a variety of sedges, e.g.,

Carex abscondita, *C. debilis* var. *debilis*, *C. intumescens*. Large, rhizomatous colonies of the sedges *Carex striata* var. *brevis*, *C. bullata*, and *C. barrattii* occasionally dominate. Communities of this group have been greatly reduced in extent or modified by extensive agricultural clearing, logging, conversion to pine silvicultures, and hydrologic alterations such as ditching and draining. Most, if not all, community types in this group are now globally uncommon to rare. Associated rare species include the globally rare Virginia least trillium (*Trillium pusillum* var. *virginianum*), the federally listed Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*), and the state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*). Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR01, BBNR36.**

NON-TIDAL MARITIME WETLANDS

Maritime Wet Grasslands

Graminoid-dominated seasonal wetlands of maritime dune systems. In Virginia, these wetlands are confined to the barrier beaches of the Eastern Shore (Accomack and Northampton Counties) and southeastern Virginia (City of Virginia Beach). Encompassing swales and low hollows between secondary dunes, habitats are characterized by perched water tables and shallow seasonal flooding. These swales are predominantly influenced by fresh water from rainstorms but some may be periodically flooded by salt water from ocean storm surges. A thin, organically enriched, surficial soil layer aids moisture retention. The hydrologic regime and distance from salt spray are the major contributors to this group's diversity of community types, all of which support a relatively dense and diverse assemblage of plant species. Typically, occurrences are dominated by one or more species of grasses, *e.g.*, saltmeadow cordgrass (*Spartina patens*); rushes (e.g., *Juncus scirpoides*, *J. dichotomus*, *J. acuminatus*, *J. megacephalus*, or *J. canadensis*); and/or sedges (*e.g.*, *Cyperus odoratus*, *Fimbristylis caroliniana*, *Fuirena pumila*, or *Schoenoplectus pungens*). Considerable compositional variation related both to regional distribution and site-specific topography needs intensive study. In smaller, temporarily flooded swales where rushes are dominant, small slender goldenrod (*Euthamia caroliniana*), long-leaved aster (*Aster novi-belgii* var. *elodes*), yellow-eyed grass (*Xyris jupicai)*, and zigzag bladderwort (*Utricularia subulata)*, may also characteristic. Swales further inland contain additional assemblages of species including dwarf umbrella-sedge (*Fuirena pumila*), ladies'-tresses (*Spiranthes* spp.), spoon-leaved sundew (*Drosera intermedia)*, southern bog clubmoss (*Lycopodiella appressa*), white-top fleabane (*Erigeron vernus*), whorled nutrush (*Scleria verticillata*), and white-topped sedge (*Rhynchospora colorata*). All types within the group are uncommon to rare small patch communities existing in fragile settings. They also support several state rare insects including a tiger beetle (*Cicindella trifasciata*) and a dragonfly (*Anax longipes*). In common with most maritime communities, threats to this group include development and sea-level rise. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR4, BBNR5, BBNR8, BBNR9, BBNR13, BBNR33.**

Maritime Shrub Swamps

Seasonally flooded shrublands of sheltered, maritime dune hollows where water is present throughout most of the year. Perched water tables and intermittent to seasonal flooding characterize the hydrology. Both groundwater and surface water is typically fresh (< 0.5 ppt), although salt water may pool in these areas after episodic storm surges during events like hurricanes. Soils are stratified, with a thin layer of muck up to 10 cm thick over wet sand. Along the coast of Virginia, species composition of these communities changes rapidly from the southeastern coast to the Eastern Shore. Southern areas characteristically contain southern bayberry (*Myrica cerifera*), along with inkberry (*Ilex glabra*), and highbush blueberry (*Vaccinium corymbosum*). However, inkberry and highbush blueberry are less

important in this group northward on the Eastern Shore. Climbing vines of poison ivy (*Toxicodendron radicans* var. *radicans*) are abundantly intertwined with the shrubs in most occurrences of these swamps. Herb layers are rich in ferns, including royal fern (*Osmunda regalis* var. *spectabilis*), marsh fern (*Thelypteris palustris* var. *pubescens*), netted chain fern (*Woodwardia areolata*) and Virginia chain fern (*Woodwardia virginica*), but also include a variety of forbs such as whorled water-pennywort (*Hydrocotyle verticillata* var. *verticillata*). The geographic distribution and conservation status of communities in this group are currently obscure and need intensive study. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR20, BBNR21.**

Maritime Swamp Forests

Seasonally flooded, or less frequently saturated, maritime wetland forests occurring in large, protected, interdune swales or along sluggish streams just inland from estuarine zones. In Virginia, occurrences are scattered along the outer Coastal Plain from The Eastern Shore (Accomack and Northampton Counties) to Cape Henry and False Cape (City of Virginia Beach). The status of these communities on the western shore of the Chesapeake Bay is less clear. Habitats are generally characterized by hummock-and-hollow microtopography, with mucky to highly mottled, sandy soils and sizeable areas of seasonally standing water. The apparent nutrient status and flooding regimes of soils in these habitats are highly variable and probably relates to the wide compositional variation in documented stands. Dominant canopy trees include red maple (*Acer rubrum*), sweetgum (Liquidambar styraciflua), blackgum (*Nyssa sylvatica*), black willow (*Salix nigra*), sweetbay (*Magnolia virginiana*) and, in the Cape Henry/False Cape area, baldcypress (*Taxodium distichum*) and Atlantic white-cedar (*Chamaecyparis thyoides*). Shrubs are diverse but usually include highbush blueberries (*Vaccinium corymbosum*, *V. fuscatum*, *V. formosum*), southern bayberry (*Myrica cerifera*), red bay (*Persea palustris*), and greenbriers (*Smilax* spp.). Herb layers range from very species-poor and dominated almost entirely by Virginia chain fern (*Woodwardia virginica*) or low shrubs, to species-rich with a diversity of marsh and swamp species. Community types in this group are uncommon to rare in Virginia and are subject to encroaching development, logging, and agricultural pollutants. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR14.**

Interdune Ponds

Seasonally to semi permanently flooded, maritime herbaceous wetlands occupying deep interdune basins and swales. In Virginia, these wetlands are distributed very locally in a zone behind barrier beaches from the Eastern Shore (Accomack and Northampton Counties) to Cape Henry and False (City of Virginia Beach). This group includes both freshwater ponds, in which rainwater and groundwater quickly dilutes infrequent salt-water inputs, and slightly brackish ponds subject to more frequent salt water inputs. The latter, which appear to have salinity regimes that vary over time from entirely fresh to slightly mesohaline, are probably best characterized as oligohaline ponds. Community composition varies with geography, topographic position, exposure to storm surges and salt spray, hydroperiod, and soil properties. Seasonally flooded, freshwater ponds usually contain large cover of bulrushes (e.g., *Scirpus cyperinus*, *Schoenoplectus pungens* var. *pungens*, *Schoenoplectus tabernaemontani*), grasses (e.g., *Panicum virgatum*, *Panicum rigidulum* var. *condensum*, *Spartina patens*), and/or squarestem spikerush (*Eleocharis quadrangulata*). Rare freshwater ponds, or their marginal zones, are dominated by nearly pure stands of twig rush (*Cladium mariscoides*). Seasonally flooded oligohaline ponds may be dominated by narrow-leaved cattail (*Typha angustifolia*), eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*), and/or saltmarsh bulrush (*Bolboschoenus robustus*). Semi permanently flooded oligohaline ponds are dominated by coastal water-hyssop (*Bacopa monnieri*), white spikerush (*Eleocharis albidum*),

and sago pondweed (*Potamogeton pectinatus*). All of the community types in this group are very locally distributed, small-patch wetlands that can be considered rare in Virginia. Clarification of their global status must await refinements in classification. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR11, BBNR12, BBNR23.**

Estuarine Fringe Pine Forests

Saturated coniferous maritime forests occurring in backdune depressions of barrier islands and on terrace flats bordering estuaries further inland. The overall range of this group is from southern New Jersey to North Carolina. In Virginia, these communities are locally scattered along both shores of the Chesapeake Bay, and around Back Bay and estuarine tributaries of Currituck Sound in the southeastern corner of the state. Occasionally, stands occupy slightly elevated "islands" within the upper portions of salt marshes. Habitats are level flats with shallow water tables and hummock-and-hollow microtopography. Areas of seasonally ponded water and organic muck are present; elsewhere, soils are heavily mottled sands. Loblolly pine (*Pinus taeda*) is the dominant canopy tree, with occasional associates. Southern bayberry (*Myrica cerifera*) and vines of common greenbrier (*Smilax rotundifolia*) and poison ivy (*Toxicodendron radicans*) are usually abundant. In southern areas, *e.g.*, on False Cape, pond pine (*Pinus serotina*) and inkberry (*Ilex glabra*) are characteristic woody associates. Wetland species such as cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis* var. *spectabilis*), switchgrass (*Panicum virgatum*), and smartweeds (*Polygonum* spp.) dominate species-poor herb layers. A distinctive variant occurring in southeastern Virginia and North Carolina has a dense understory of giant cane (*Arundinaria gigantea* ssp. *tecta*). Estuarine fringe pine forests are similar to and often intergrade with non-wetland maritime loblolly pine forests and maritime evergreen forests. Community types in this group are probably all globally uncommon to rare because of their restriction to the mid-Atlantic Coast and vulnerability to development pressure. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR16, BBNR35.**

ESTUARINE SYSTEM

TIDAL WETLANDS

Wind-Tidal Oligohaline Marshes

Herbaceous wetlands subject to irregular wind-tidal flooding along the shores of estuaries that have been cut off from oceanic influences by the closure of inlets. In Virginia, these communities are limited to the embayed region in the extreme southeastern part of the state, where they are confined to the North Landing and Northwest Rivers, tributaries of Currituck Sound, and Back Bay. Although these systems are no longer influenced by lunar tides, wind-driven currents may produce as much as 1 m variation in water levels and contribute to a salinity regime that fluctuates between completely fresh and about 5 ppt . Vegetation consists of a mixture of freshwater species and species more typical of mesohaline marshes. Patch-dominance of the tall marsh graminoids big cordgrass (*Spartina cynosuroides*), black needlerush (*Juncus roemerianus*), and cat-tails (*Typha latifolia* and *T. angustifolia*) is common, although diverse tall marshes with big cordgrass, sawgrass (*Cladium jamaicense*), switchgrass (*Panicum virgatum*), marsh horned beakrush (*Rhynchospora macrostachya* var. *colpophila*), eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*), etc., also occur. More locally distributed are patches of diverse short-statured marshes characterized by creeping spikerush (*Eleocharis fallax*), beaked spikerush (*E. rostellata*), twigrush (*Cladium mariscoides*), Olney three-square (*Schoenoplectus americanus*), bull-tongue arrowhead (*Sagittaria lancifolia* ssp. *media*), pickerelweed (*Pontederia cordata*), dotted

smartweed (*Polygonum punctatum*), Canada rush (*Juncus canadensis*), and a large number of minor associates. Shallow, muck-filled pools within the marshes are dominated by American water-lily (*Nymphaea odorata*). Community types of the mid-Atlantic wind-tide marshes have a very limited distribution, are considered globally uncommon to rare, and support a large number of state-rare plants and animals. Threats include ditching, water pollution, boat wakes, and destruction by nutria (*Myocastor coypus*), a naturalized exotic mammal. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR 7, BBNR25, BBNR26, BBNR27, BBNR28, BBNR30.**

Estuarine Fringe Swamp Forests

Mixed forests subject to irregular wind-tidal flooding along the North Landing and Northwest Rivers, estuarine tributaries of Currituck Sound. Although these systems are no longer influenced by lunar tides because of inlet closures, they are subject to wind-driven currents that produce as much as 1 m variation in water levels and contribute to a salinity regime that fluctuates between completely fresh and about 5 ppt . These forests border the wind-tidal marshes along the lower portions of the two rivers, extending well upstream of the limit of marshes in narrowing channel-side belts. They may represent a long-term seral stage in succession from marsh to swamp forest. Habitats have a strong hummock-and-hollow microtopography, with an average flooding depth 40 cm above the hollow bottoms. Soils are coarse, fibric peats that appear indistinguishable from adjacent marsh peats. Baldcypress (*Taxodium distichum*), swamp tupelo (*Nyssa biflora*), and loblolly pine (*Pinus taeda*) are the dominant canopy trees in variable combinations. Sweetbay (*Magnolia virginiana*) and redbay (*Persea palustris*) are scattered understory trees, while southern bayberry (*Myrica cerifera*) dominates the shrub layer. The herb layer is diverse, containing species characteristic of both marshes and swamps, but royal fern (*Osmunda regalis* var. *spectabilis*) often greatly dominates. As currently defined, estuarine fringe swamp forests appear to be globally rare endemics of the embayed region of southeastern Virginia and northern North Carolina. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR24.**

Tidal Mesohaline and Polyhaline Aquatic Beds

Hydromorphic herbaceous vegetation of shallow estuarine bays, tidal creeks, and salt marsh pools. Habitats have salt concentrations > 5 ppt and are permanently flooded by tidal waters or occasionally exposed at extreme low tides. Species richness is very low, with one to a few submerged vascular aquatics present. These consist primarily of beaked ditch-grass (*Ruppia maritima*), common eel-grass (*Zostera marina*), horned pondweed (*Zannichellia palustris*), and sago pondweed (*Potamogeton pectinatus*). Aquatic algae are frequent to abundant associates. Although these communities are scattered throughout the eastern Virginia maritime zone, at present there are few data on their composition, distribution, and ecological dynamics in this region. Within the greater area of the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR29.**

MARINE SYSTEM

Upper Beaches and Overwash Flats

Sparsely vegetated ocean shores and flats behind breached foredunes. These habitats are situated just above the mean high tide limit, but are flooded by high spring tides and storm surges. Constant salt spray and rainwater maintain generally moist conditions. Substrates consist of unconsolidated sand and shell sediments that are constantly shifted by winds and floods. Dynamic disturbance regimes largely

limit vegetation to pioneering, salt-tolerant, often succulent annuals. American searocket (*Cakile edentula* ssp. *edentula*) and Russian-thistle (*Salsola kali* ssp. *kali*) are usually most numerous and characteristic. Other scattered associates include sea-purslane (*Sesuvium maritimum*), sea-beach knotweed (*Polygonum glaucum*), bushy knotweed (*Polygonum ramosissimum* var. *prolificum*), sea-blites (*Suaeda linearis* and *S. maritima*), and sea-beach orach (*Atriplex pentandra*). In Virginia, these communities are distributed along the ocean side of the Eastern Shore (Accomack and Northampton Counties) and on Cape Henry and False Cape (City of Virginia Beach). Upper beach / overwash flat habitats are critical to several globally rare, federally listed species, including the northeastern beach tiger beetle (*Cicindella dorsalis dorsalis*). The threatened plant seabeach amaranth (*Amaranthus pumilus*) occurred historically on overwash flats in both Eastern Shore counties. The loggerhead sea turtle (*Caretta caretta*) and the piping plover (*Charadrius melodus melodus*) utilize beaches and overwash flats for nesting. Extensive construction of high, artificial dunes along the Atlantic coast has reduced the extent of these habitats by increasing oceanside beach erosion and eliminating the disturbance regime that creates and maintains overwash flats. Within the Back Bay Wildlife Refuge, this community group is represented by the following plots: **BBNR18.**

The natural communities in the Back Bay NWR described above follow a characteristic pattern on the landscape that repeat in many areas of the coastal plain within, and outside the state (Stalter and Odum 1993). In the Back Bay area they can be visualized along an east-west transect. As one follows the transect from the ocean west across the sand ridge barrier island into Back Bay and across the mainland the plant communities. The first vegetated zone is the long linear upper beach and overwash flats. The initial flats that may have existed on Back Bay are no longer present as result of the construction of a series of dunes. These dunes support Maritime Dune Grasslands. Inner dunes protected from constant salt spray support maritime scrub and low areas in between these support Maritime Wet Grasslands and Interdune Ponds. At the inward edge of the dune system the vegetation becomes more woody. Maritime Dune Woodlands and Maritime Mixed Forests occur on higher ground associated with the dune edge and Maritime Shrub Swamps or Wet Pine Woodlands occur in the low zones. Uplands on the middle of the barrier island support forest communities of Maritime Evergreen Forest and Maritime Loblolly Forest while lower intermixed areas support Maritime Swamp Forest. On the bay side of the barrier islands the forests form Estuarine Fringe Swamps. Open areas surrounding all edges of the bay support Wind-Tidal Oligohaline Marshes and Tidal Mesohaline Aquatic Beds. Islands in the bay support the wetter Coniferous Forests and Non-Riverine Wet Hardwood Forests as well as Wind-Tidal Oligohaline Marsh. Finally, on the west coast of the bay, Estuarine Fringe Swamp Forest and woodlands are present in addition to the marshes.

⊙ Plot locations based on GPS data of plot corner.

✱ Plot locations based on topographic map.

Figure 2. Year 2000 Plot locations based on GPS data, Back Bay National Wildlife Refuge.

⊙ Plot location based on GPS data.

Figure 3. Long Island Plot Location. Back Bay National Wildlife Refuge.

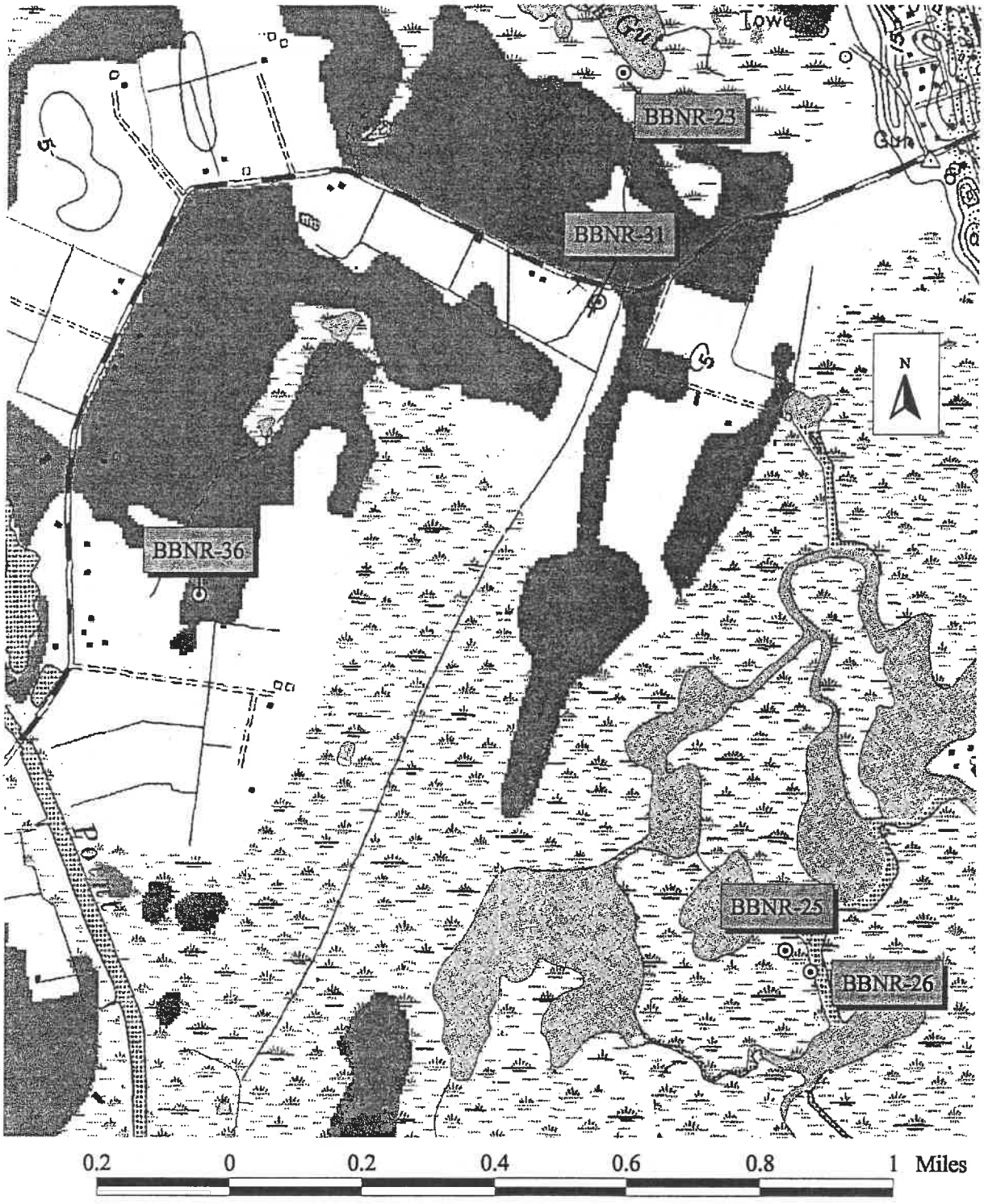
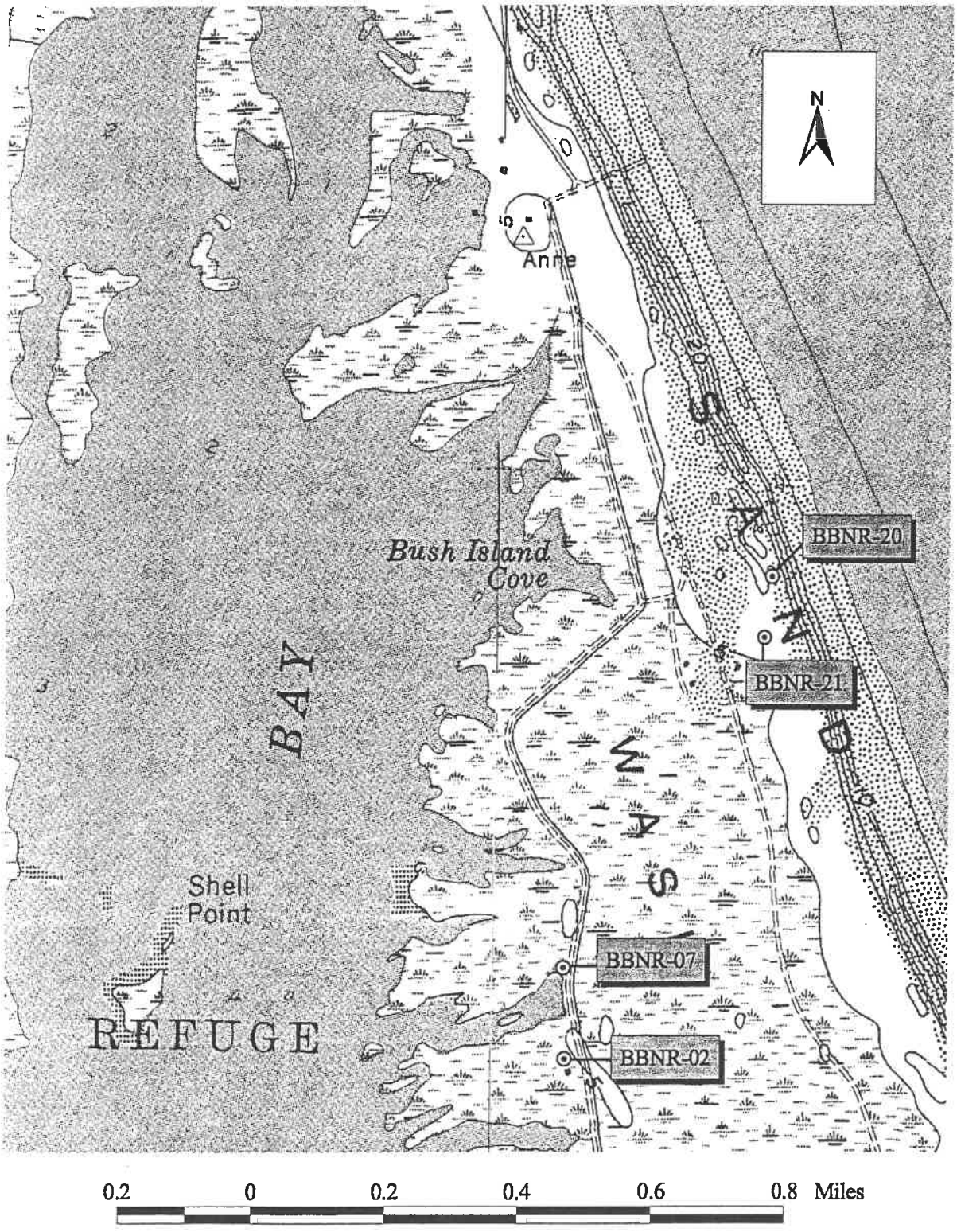
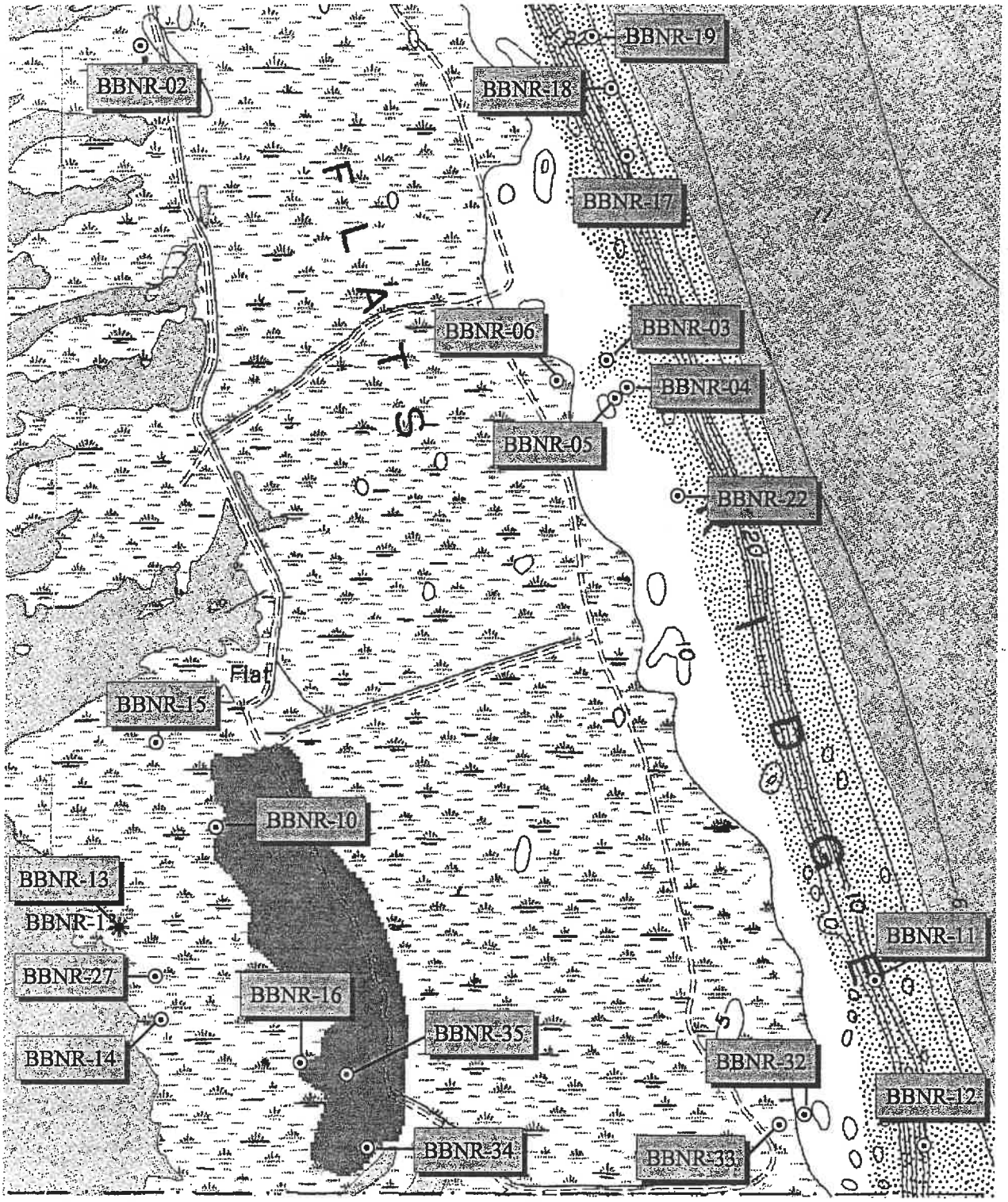


Figure 4. Plot locations - Northern Section, Back Bay National Wildlife Refuge.



⊙ Plot Locations.

Figure 5. Plot locations. Central Section of the Back Bay National Wildlife Refuge.



⊙ Plot locations based on GPS data.

✱ Plot locations based on topopgraphic map.

Figure 6. Plot locations. South end of Back Bay National Wildlife Refuge.

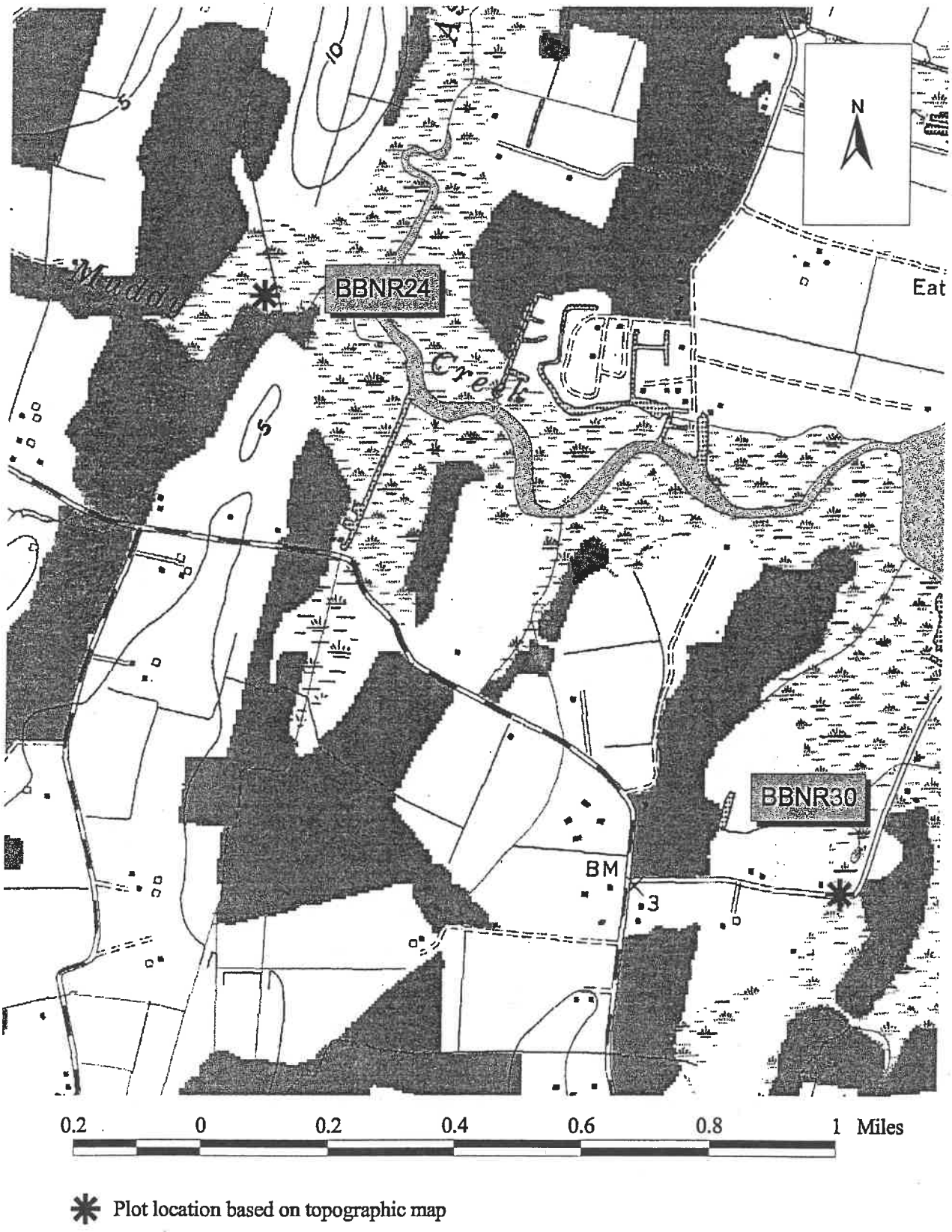
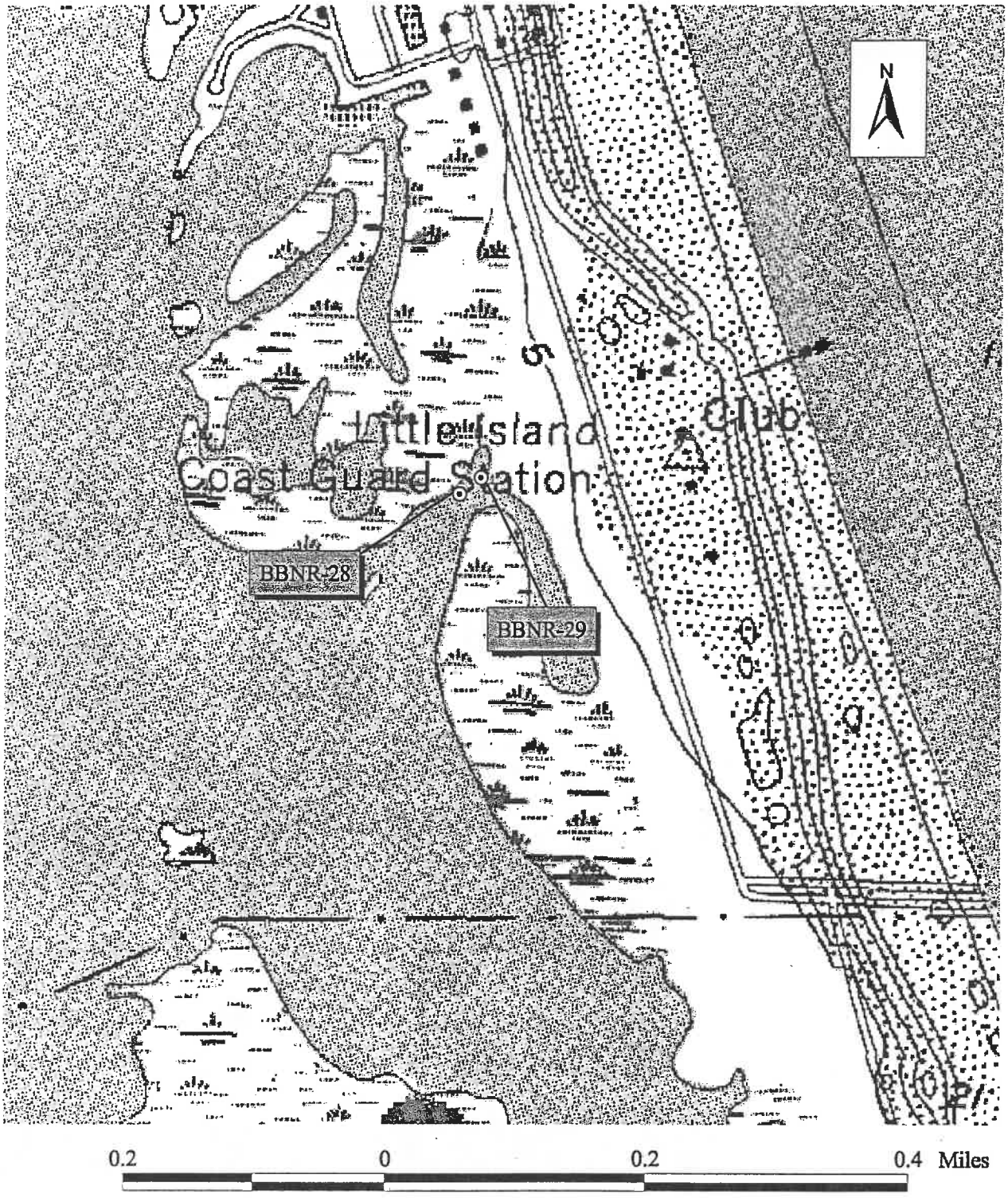


Figure 7. Plot locations in the western section of the Back Bay National Wildlife Refuge.



⊙ Plot location.

Figure 8. Plot locations just outside of Back Bay National Wildlife Refuge, but representative of communities within the refuge boundary.

⊙ Plot locations based on topographic maps.

Figure 9. Locations of vegetation plots sampled in the Back Bay National Wildlife Refuge prior to 2000.

BOTANY INVENTORY RESULTS

RARE PLANT SPECIES: Details on the rare plant species, as designated by DCR-DNH (See Melthods), that have been found on Back Bay NWR and their status in 2000 are presented below. No Federal or State listed plant species have been found on Back Bay NWR.

***Crataegus aestivalis* (May hawthorn) (G5/S1):** M.L. Fernald and B. Long collected a specimen identified as this hawthorn in 1939 in "low woods along Back Bay, Long Island" (Coll.#10671, US National Herbarium). There may be a question about the identification of this specimen. (DCR-DNH database). This tree, in the rose (Rosaceae) family, was not seen in the limited field work done on Long Island in 2000. This hawthorn is distributed in swamp forests in the southeastern US (Kartesz 1999, Weakley 2000). In Virginia, it has only been found in the City of Virginia Beach (Harvill *et al.* 1992).

***Erigeron vernus* (white-top fleabane) (G5/S2):** In 2000 a total of approximately 35 plants were noted in individual clusters of approximately five plants each within several different habitat types. White-top fleabane, a member of the aster (Astereaceae) family, was most commonly observed in interdune swales between the eastern gravel road in the Refuge and the most inland large dunes. The interdune swales in this zone tend to stay moist longer and support a more diverse assemblage of plant species including many more dicots than the interdune swales between the major dunes. Coinleaf (*Centella erecta*), royal fern (*Osmunda regalis*), poison ivy (*Toxicodendron radicans*), and saltmeadow cordgrass (*Spartina patens*) are dominants in this habitat with scattered shrubs of southern bayberry (*Myrica cerifera*), highbush blueberry (*Vaccinium corymbosum*), and inkberry (*Ilex glabra*). In the intermittently wet swales between the larger dunes rushes (*Juncus* spp.) are dominant and white-top fleabane was noted only once in this setting. Another habitat that supported white-top fleabane was a small swale-like opening in the canopy of the moist shrub zone dominated by inkberry and highbush blueberry. A population of white-top fleabane was observed in 1988 in a damp sandy depression approximately "0.3 mile south of headquarters" in the same general area as that seen in 2000. White-top fleabane is a biennial or short-lived perennial found in wet savannas, seepages and interdune swales from eastern Virginia to Florida and Louisiana (Gleason and Cronquist 1991,Weakley 2000). In Virginia this fleabane has been documented in the Cities of Virginia Beach, Hampton, and Chesapeake, and in Accomack, Suffolk and Greensville Counties (Harvill *et al.* 1992, DCR-DNH database).

***Eleocharis vivipara* (viviparous spikerush) (G5/S1):** This species was collected by C.E. Stevens in 1973 near "Sandbridge [by a] low wet sandy opening by Black Gut" (DCR-DNH database). There was insufficient time to survey the Black Gut area thoroughly enough in 2000 to determine if this species is still present and if there is more to be found within the site. Viviparous spikerush is a perennial member of the sedge (Cyperaceae) family distributed from southeast Virginia to Florida. It has been documented from the City of Virginia Beach and in Accomack, and Southampton Counties in Virginia (Harvill *et al.* 1992).

***Hydrocotyle bonariensis* (coastal water-pennywort) (G5/S1?):** This member of the carrot (Apiaceae) family was observed in two locations in the Wash Flats site in 2000, the first reporting of this species for Back Bay NWR. One occurrence consisted of plants covering an approximately 3 x 3 meter area on the north side of the base of a skeletal metal structure within the dune system of the Refuge. Vegetation was very sparse in this area of shifting sands and only a few associated species were present including beach panic grass (*Panicum amarum* var. *amarulum*) and sea-beach evening-primrose (*Oenothera humifusa*). A second occurrence was noted on the northern border of the Refuge and the Virginia Beach City park. A small 0.25 x 0.25 meter cluster of stems was visible about 3 meters off the road. These plants were

growing on a mostly bare sand pile, likely of human origin. Coastal water-pennywort is distributed widely in South and Central America and extends north into the southeastern Coastal Plain of North America as far north as Virginia (Weakley 2000). In Virginia it has been documented in the City of Virginia Beach and in Southampton County (Harvill *et al.* 1992, DCR-DNH database).

***Iva imbricata* (sea-coast marsh-elder) (G5?/S1S2):** This perennial, fleshy herb or subshrub in the aster (Asteraceae) family was collected by A.B. Massey (Coll.# 23219, VPI & SU Herbarium) "on sand dunes Back Bay," possibly within the Wash Flats site. None was observed in 2000 but time did not allow for adequate survey of the Wash Flats site. A population does occur just north of the boundary of Back Bay NWR (DCR-DNH database) and this species is likely to be found within the Refuge. Sea-coast marsh-elder is distributed from southeast Virginia to Florida and west to Louisiana, occurring on dunes, upper beach, and island-end flats (Weakley 2000). In Virginia, it has been documented in the Cities of Virginia Beach, Norfolk, Hampton, and Chesapeake (Harvill *et al.* 1992, DCR-DNH database).

***Juncus elliottii* (bog rush) (G4G5/S1S2):** Collected in 1947 by E. Chamberlain in a marsh north of Back Bay NWR headquarters (Coll. # 19209, VPI & SU Herbarium), this member of the rush (Juncaceae) family was not observed in 2000, but time did not allow for adequate survey of the Wash Flats site. Bog rush is a chiefly coastal plain species found in wet to damp sandy or peaty soils from Delaware to Florida and Texas (Gleason and Cronquist 1991). In Virginia. it has been documented from six counties in the southern Coastal Plain (Harvill *et al.* 1992).

***Juncus megacephalus* (big-headed rush) (G4G5/S2):** This member of the rush (Juncaceae) family was collected in 1939 by M.L. Fernald and B. Long at " inner border of brackish to fresh marsh, along Back Bay, at [the] eastern margin of Long Island (Coll.# 10574, National Arboretum, US National Herbarium). It was observed in 1988 near the maintenance building in the Wash Flats site (DCR-DNH database). It was not observed during the limited surveys of Long Island or during the community inventory surveys in the Wash Flats site in 2000; however a large population consisting of 7 subpopulations in False Cape State Park extends to within 25 meters of the southern boundary of Back Bay NWR, so it is likely that additional surveys for this species would result in the discovery of this species. Big-headed rush is found in brackish and freshwater marshes, bogs, ditches, and wet, open places from eastern Maryland to Florida and west to southeast Texas (Weakley 2000). In Virginia, it has been reported only in the City of Virginia Beach, and in Northampton and Accomack Counties (Harvill *et al.* 1992, DCR-DNH database).

***Lilaeopsis carolinensis* (Carolina lilaeopsis) (G3/S1):** M.L. Fernald and B. Long collected this rare member of the carrot (Apiaceae) family in 1939 in the shallow pool of a small pond back of the marsh at the eastern margin of Long Island (Coll.#8949, VPI & SU Herbarium, Fernald 1940). An extensive population of this species was documented in 1992 along the shoreline north and south of the mouth of Nawney Creek on the western shore of Back Bay. It was additionally observed near the mouth of Muddy Creek in the northwest corner of Back Bay. A patch about "25 feet long and a few feet wide" was seen in 1988 approximately "1 mile south of headquarters" within the Wash Flats site (DCR-DNH database).

In the 2000 survey, extensive mats of a *Lilaeopsis* species were seen during boat surveys within the Back Bay NWR section of the Nawney Creek site, although diminished-to-absent in sections where the invasive species common reed (*Phragmites australis*) (DCR-DNH 1998b) now forms monoclonal stands. Plants were seen on a Back Bay NWR tract south of the mouth of Muddy Creek. Plants were collected on a point within the North Bay Marshes site and on the north shoreline of Long Island. These plants along the shoreline of Back Bay or Long Island were mostly sterile and small compared to the

dimensions reported in Weakley (2000). In contrast, a colony of plants found in 2000 in a protected swale at the south end of the Wash Flats site, although with no inflorescences to confirm the identity, were robust in dimensions. John Gallegos of Back Bay NWR reported during this inventory another area of Carolina Lilaeopsis in the southeast section of Impoundment B; time did not allow for investigation of this colony.

Examinations of *Lilaeopsis* collections made in the Back Bay shoreline sites, the Wash Flats site and specimens of eastern lilaeopsis (*Lilaeopsis chinensis*), a more common species, collected in a marsh along a tributary of the James River, show the Back Bay shoreline plants to be somewhat intermediate in characters. Further examination by an expert of the *Lilaeopsis* species in the Back Bay shoreline sites will be undertaken; until then all will be considered as *L. carolinensis*. Results of the detailed examinations will be relayed to Back Bay NWR natural resource managers when available. In North America, Carolina lilaeopsis is distributed from southeast Virginia to Florida and west to Louisiana; it is also found in southern South America (Weakley 2000). In Virginia, Carolina lilaeopsis is known only from the City of Virginia Beach. (Harvill *et al.* 1992, DCR-DNH database).

***Lipocarpha maculata* (American lipocarpha) (G5/S1):** Two flowering/fruiting plants of this species were found in the south end of the Wash Flats site in 2000; this species had not been previously documented at Back Bay NWR, but has been found further south at False Cape State Park. The habitat for the Refuge site is emergent marsh within an area subject to a manipulated hydrological regime. The plants were growing in a densely vegetated zone where the water had drawn-down in late September. Associated species included dwarf umbrella sedge (*Fuirena pumila*), the watchlist species coastal water-hyssop (*Bacopa monnieri*), marsh water-pennywort (*Hydrocotyle umbellata*), common threesquare (*Schoenoplectus pungens*), and smooth bur-marigold (*Bidens laevis*). This is a sedge of damp to wet, chiefly sandy, soil in the southeastern US Coastal Plain from the eastern shore of Virginia to Florida and Texas (Gleason and Cronquist 1991). In Virginia it has been documented from eight counties in southeastern Virginia (Harvill *et al.* 1992).

***Ludwigia alata* (winged seedbox) (G3G4/S1):** In 2000 the known North Bay Marsh occurrence of this species, found in 1992 and consisting of multiple subpopulations, was documented using GPS; one new subpopulation was discovered and documented in 2000. Approximately 300 plants were observed in the North Bay Marsh site. Additional subpopulations of this occurrence were documented in 1992 in areas outside of Back Bay NWR, including the Porpoise Point area and on the east shore of Back Bay (DCR-DNH database). Details on the North Bay Marsh subpopulations seen in 2000 are included in Appendix B. A new occurrence with two small subpopulations was found on Long Island. One subpopulation consisted of two plants in a marsh on the west side of the narrowed portion of Long Island. Associated species at this location included Walter's barnyard grass (*Echinochloa walteri*), dotted smartweed (*Polygonum punctatum*), the watchlist species sheathed flatsedge (*Cyperus haspan*), gibbous panic grass (*Sacciolepis striata*), and bull-tongue arrowhead (*Sagittaria lancifolia*). Another subpopulation of five plants was found in a marsh on a cove on the east side of Long Island with narrow-leaved cattail (*Typha angustifolia*), saltmarsh cordgrass (*Spartina alterniflora*), bull-tongue arrowhead, dotted smartweed, and annual saltmarsh aster (*Aster subulatus*). It seems likely that additional surveys within Back Bay NWR, particularly in the North Bay Marshes site and on Long Island will produce more colonies of this species. Winged-seedbox is a perennial herb in the evening-primrose (Onagraceae) family that grows in interdune ponds and fresh to slightly brackish marshes from southeast Virginia to Florida and west to southeast Louisiana (Weakley 2000). In Virginia it has been documented only in the Cities of Virginia Beach and Chesapeake (Harvill *et al.* 1992, DCR-DNH database).

***Ludwigia brevipes* (long beach seedbox)(G4G5/S2):** Black Gut was searched for the species, which was seen in large numbers in 1992, but in 2000 all that was found was a small floating mat approximately 0.8 x 0.6 meter. This mat consisted of possibly ten stems of long beach seedbox, in late flower to young fruit or sterile, entangled with marsh seedbox (*Ludwigia palustris*) in a pool in the marsh on the west side of Black Gut. This pool was between a stand of narrow-leaved cattail (*Typha angustifolia*) and a muskrat mound. Associated species included dotted smartweed (*Polygonum punctatum*), creeping spikerush (*Eleocharis fallax*), and stiff marsh bedstraw (*Galium tinctorium*). It is unclear if this species has seriously declined since 1991, if high water levels in Black Gut in 2000 flooded out habitat, if the sites seen in 1991 were missed in 2000, or if the differences in the survey dates (June vs. August) would account for the difference in the population size. A previously unknown location for this species, which will be treated as a subpopulation of an occurrence in False Cape State Park that extends to near the Refuge border, was found in 2000 toward the southern end of the Wash Flats site in an emergent marsh within an area with a manipulated hydrological regime. About 50 stems, in flower, fruit, or sterile, were found in ten locations scattered along approximately 20 meters of a linear channel of shallow pooled water that is less vegetated than the surrounding marsh. Associated species included marsh water-pennywort (*Hydrocotyle umbellata*), pale spikerush (*Eleocharis flavescens*), the watchlist species coastal water-hyssop (*Bacopa monnieri*), and dotted smartweed (*Polygonum punctatum).* Two occurrences had been reported previously in the Wash Flats site including: a 1990 report by J. Wright of "several mats 2-6 ft long [that extend] back into [the] first wet meadow in the canal opposite the visitors center (DCR-DNH database) and a sighting about "1 mile south of headquarters" in 1988 (DCR-DNH database). Only a brief unsuccessful attempt was made to find the occurrence in the canal near the visitors center; the other occurrence was not targeted for a survey. This state rare species occurs in shallow water to wet shores in the Coastal Plain from New Jersey to South Carolina (Gleason and Cronquist 1991). In Virginia, this species has been documented from the Cities of Virginia Beach and Chesapeake and the counties of Isle of Wight and Southampton (Harvill *et al.* 1992).

***Ludwigia repens* (creeping seedbox) (G5/S1):** This mat-forming perennial in the evening-primrose (Onagraceae) family was reported as being seen in the Wash Flats area of Back Bay NWR in 1988 (DCR-DNH database). No specimen was collected, however. This species was not surveyed for or seen in 2000 during the community inventory work conducted in the Wash Flats site. Additional creeping seedbox surveys are needed. It can be found in ditches, pools, and streams in the southern US from the east coast, as far north as Virginia, west to California, and in Bermuda and the West Indies (Weakley 2000, Kartesz 1999). Harvill *et al.* (1992) reports this species as a species of doubtful establishment documented in Greensville and Frederick Counties in Virginia.

***Phyla nodiflora* (common frog-fruit) (G5/S1):** Common frog-fruit has been found within the Wash Flats site in damp and dry soil of the "headquarters yard" by E.B. Chamberlain Jr. in 1947 (Coll.#7-14, VPI & SU Herbarium), in "sandy peat of broad marsh, Back Bay Federal Refuge" by R. Kraal in 1961 (Coll.#14390, VPI & SU Herbarium), and approximately "1 mile south of headquarters" in 1988 (DCR-DNH database). Common frog-fruit was not surveyed for in 2000 and was not seen during community inventory work in the Wash Flats site. Additional surveys for this species are needed. Common frog-fruit, a member of the vervain (Verbenaceae) family and a weedy species of roadsides, ditches, lawns, and disturbed areas, is a pan-tropical species extending across southern North America (Weakley 2000). It has been found only in the City of Virginia Beach in Virginia (Harvill *et al.* 1992).

***Rhynchospora colorata* (white-topped sedge) (G5/S1):** Extensive subpopulations of this sedge were found during community inventory work in the Wash Flats site in 2000, and it is likely that more remain

to be found. White-topped sedge formed large clusters of from 5,000-10,000 plants in seasonally wet and semi-permanently wet marshes along both sides of the eastern gravel road within the Refuge. Co-dominants in this habitat included common threesquare (*Schoenoplectus pungens*), coinleaf (*Centella erecta*), and Walter's barnayard grass (*Echinochloa walteri*). Several occurrences were previously known from collections or survey work. E.B. Chamberlain collected a specimen in 1947 from the "marsh south of headquarters" (Coll.# 12-15, VPI & SU Herbarium). A.M. Harvill collected a specimen from "sandy soil on E border of Back Bay" (Coll.# 13490, Longwood College Herbarium). A 1988 survey found a population on a dike in an impoundment approximately "0.5 mile south of headquarters" (DCR-DNH database). A collection was made at the "inner border of brackish and fresh marsh along Back Bay, at [the] eastern margin of Long Island" by M.L. Fernald in 1939 (Coll.# 19092, VPI & SU Herbarium). Only limited survey work was conducted on Long Island in 2000 and, therefore, additional surveys for this species on the island are needed. White-topped sedge is distributed in wet savannas and ditches in the southeastern US Coastal Plain from southeastern Virginia to Florida and west to Texas, extending into Central America and northern South America (Weakley 2000). In Virginia, this sedge has been documented in the City of Virginia Beach, and the Counties of Northampton and James City (Harvill *et al.* 1992).

***Rhynchospora debilis* (savannah beakrush) (G4?/S1):** This species was collected in 1952 in the Sand Ridge area which extends into the Wash Flats Conservation Site within Back Bay NWR by J.H. Penson (US National Herbarium). It was not seen in 2000 but time did not allow for adequate surveys. Savannah beakrush is found in the southeastern US with its northernmost occurrence in Virginia (Weakley 2000). In Virginia this species has been found in nine counties in the southeast and in Accomack County on the Eastern Shore (Harvill *et al.* 1992).

***Rhynchospora fascicularis* var. *fascicularis* (fasciculate beakrush) (G5T?/S1?):** This beakrush, a member of the sedge (Cyperaceae) family, was observed in 1988 near the maintenance building at Back Bay NWR (DCR-DNH database). This occurrence was not surveyed for in 2000, but a subpopulation was found of an occurrence previously documented in False Cape State Park that extends to near the Back Bay NWR/False Cape SP boundary. This subpopulation consisted of a few small clumps growing in openings between the shrubs in the shrub/scrub wetlands just inland of the last major dunes. Associated species included inkberry (*Ilex glabra*), highbush blueberry (*Vaccinium corymbosum*), poison ivy (*Toxicodendron radicans*), and common greenbrier (*Smilax rotundifolia*). Fasciculate beakrush is a plant of wet acid soil found on the Coastal Plain from tropical America north to Texas and reaching its northernmost limits in southeast Virginia (Gleason and Cronquist 1991). Harvill *et al.* (1992) reported it from only four counties in Virginia, including the Cities of Virginia Beach and Chesapeake, and the counties of Isle of Wight and Chesterfield.

***Tillandsia usneoides* (Spanish moss)(G5/S2):** This epiphyte of the bromeliad (Bromeliaceae) family was collected by A.B. Massey on cypress trees within the Back Bay area in 1946 (Coll.# 582, VPI & SU Herbarium). It was not seen during the 2000 survey. Spanish moss is found within tropical America, north to Virginia, and historically to southern Maryland. In Virginia, this species has been documented from five southeastern counties on the Coastal Plain and Northampton County on the Eastern Shore (Harvill *et al.* 1992).

***Vaccinium macrocarpon* (large cranberry) (G4/S2):** An occurrence of this cranberry was observed in 1988 approximately "0.5 mile south of headquarters." It was not rediscovered in 2000, but time did not allow for adequate surveys for this species. Large cranberry is the cranberry of commercial cultivation and is native to northeastern North America, extending south to North Carolina in disjunct populations of

the Outer Coastal Plain and Appalachian Mountains (Weakley 2000). It has a similar distribution in the Outer Coastal Plain and mountains of Virginia, known in native populations from the Cities of Virginia Beach and Chesapeake and the counties of Giles, Grayson, and Carroll (Harvill *et al.* 1992) Surveys for this species are needed at Back Bay NWR.

***Verbena scabra* (sandpaper vervain) (G5/S2):** This species was documented in the "inner border of brackish to fresh marsh along Back Bay at [the] eastern margin of Long Island" with a collection by M.L. Fernald and B. Long in 1939 (Coll.# 10799, US National Herbarium). A 1947 collection (Coll.# 17-20, VPI & SU Herbarium) was made by E.B. Chamberlain Jr. in the "headquarters yard, Back Bay NWR" in the Wash Flats site in 1947. Sandpaper vervain was not seen in 2000 during brief visits to Long Island nor during community work in the Wash Flats site, but time did not allow for adequate surveys. Sandpaper vervain is distributed in the southern US from the east to west coasts (Kartesz 1999). In Virginia, it is documented in scattered locations in the Coastal Plain, Piedmont, and Ridge and Valley physiographic provinces (Harvill *et al.* 1992, DCR-DNH database).

Two other plant rarities were reported to DCR-DNH during this inventory by John Gallegos of Back Bay NWR; time did not allow for visits to these sites by DCR-DNH staff to confirm or assess the population numbers.

***Cladium jamaicense* (sawgrass) (G5/S2):** This state rare plant, the sedge that dominates sections of the Everglades in Florida, was reported to be present in a 30 x 30 foot area toward the southern end of Pool G, east of the eastern gravel road that runs north-south through the Refuge. Sawgrass is distributed from southeast Virginia to Florida and west to Texas, and in the West Indies (Weakley 2000). In Virginia it has been documented in the Cities of Virginia Beach and Chesapeake and in Accomack County (Harvill *et al.* 1992).

***Paspalum distichum* (joint paspalum) (G5/S1):** A *Paspalum* sp. that may be the state rare grass *P. distichum* was reported to be in two vegetation plots in Pool B in the Wash Flats site. It has been found on the edge of an impoundment also in False Cape State Park to the south. Joint paspalum is found in brackish or freshwater marshes, swamps, wet ground, and waste places in subtropical to warm temperate regions throughout the world (Gleason and Cronquist 1991, Weakley 2000). In North America it is found in the southern US ranging as far north as Pennsylvania in the east and to Washington state in the west (Kartesz 1999). It has been documented in Virginia in four counties in southeastern Virginia and in Accomack County on the Eastern Shore (Harvill *et al.* 1992, DCR-DNH database).

ZOOLOGICAL INVENTORY RESULTS

Prior to the study, certain animals were 'targeted' as rarities that either had been known from Back Bay NWR or that had a probability of being on the refuge. Table 10 shows the species found or most likely to be found at Back Bay NWR, methods employed to find each, and the results of our inventory. To date, most of the Odonata and Lepidoptera, and groups of Coleoptera of interest (e.g. tiger beetles) have been identified with three rarities found (Table 10). Some identifications are still pending confirmation from experts. Surveys for vertebrate groups found no element occurrences. Appendix C includes an expanded list of all target species, even those with only a remote potential of occurring at Back Bay NWR but they were included because they have been documented in the Virginia Beach area. Appendix D includes some species lists created from observations and collections made at Back Bay NWR by DCR-DNH in 2000.

Some rare animals occurring on Back Bay NWR were not extensively surveyed for by DCR-DNH because other contractors and/or Back Bay NWR personnel were either already involved with surveys (e.g. marsh birds) or aware of the species presence. For example, a bald eagle pair was nesting on the property west of Sandbridge Beach. In addition, Back Bay NWR staff monitored the nest from one loggerhead sea turtle, (*Caretta caretta*). Apparently, there were some successful hatchlings from this egg clutch. Both of these sites are approximated on the maps; however, data associated with them are not presented here.

Table 10. Rare Species found or most likely to be found at Back Bay National Wildlife Refuge, 2000.

Species	G Rank/ S Rank	Previously known from Back Bay NWR?	Methods used	Results and Comments (rarities found are in italics)
Anax longipes	G5/S2	No	Visual surveys for adults	None were found; there is suitable habitat throughout Back Bay NWR
Cicindela lepida	G4/S1	No	Visual transects, pitfall traps with drift fence, UV traps	None were found; in Virginia, the only records are from Assateague Island
Cicindela trifasciata	G5/S1	No	Visual transects, pitfall traps with drift fence	One site located E of B/C dike road
Heterocampa astarte	G?/S1S2	No	UV trap/sugaring	Two sites located, W B/C dike and off West Dike road
Ixobrychus exilis	G5/S2	Yes	Visual/aural surveys	None were found
Metria amella	G?/S1S2	No	UV trap/sugaring	One site located off West Dike road
Ophisaurus ventralis	G5/S1	No	Cover boards, visual surveys	None were found
Rallus elegans	G4G5/S2	Yes	Visual/aural surveys	One calling bird was heard near Black Gut, outside of the breeding season
Various insects	Various ranks	No	Pitfall traps with drift fence, cover board, sweepnet, Dipnet, UV-light trap	Specimens have been sent to the VA Museum of Natural History and identifications are pending

One site was located for the state rare tiger beetle, *Cicindela trifasciata* (G5S1)(Figure 28). Three individuals were seen on 26 July 2000 east of the B/C dike road. All were seen in proximity to ephemeral ponds in the dunes along the damp soil where the ponds had recently drawn down. It is likely that this species is more extensive throughout the sand dunes of Back Bay NWR given the amount of quality habitat available. Further surveys could document the size of the population and its range. Management needs for this species entail maintaining the natural dynamics of the dune system as much as possible. Altered hydrology of ephemeral pools, erosion of the dunes, and excessive trampling to the habitat could all be detrimental to this tiger beetle.

Two rare moths, both associated with live oak, were found on Back Bay NWR (Figure 28). *Heterocampa astarte* was captured at two locations on different dates. The first collection (n=1) was from a UV trap set just off West Dike road in the maritime forest on 30 May 2000. The second collection (n = 2) came from two UV traps set on 25 July 2000 west of B/C dike road in the live oak/pine woods. The second moth, *Metria amella*, was also taken just off West Dike Rd in the maritime forest. This collection was made while surveyors tended a sheet illuminated by a UV light in conjunction with several sugaring points along the road. This procedure was conducted from 2000h – 2315h on 25 July 2000. Further surveys would be beneficial for increasing our knowledge of the ranges of both these moths and each population's viability. Appropriate management for these moths includes maintaining the habitat (live oak forests), and avoiding uses of general pesticides in the area. It should also be noted that a third live oak-associated moth, *Panopoda repanda* S1S3, was not found at Back Bay NWR but has been recorded at False Cape State Park, just to the south (DCR-DNH collection). Further surveys in Back Bay NWR could potentially capture this species as well.

One calling King Rail (*Rallus elegans*)(G4G5S2) was heard on 15 March 2000 during a visit to the southeast side of Black Gut. King Rails have been documented in this area during breeding season (late May – mid August) previously; however, because the call was heard so early in the year, breeding activity was not reconfirmed for this site by this observation. A different contractor for Back Bay NWR was able to confirm King Rails breeding on the refuge in 2000 (J. Gallegos, pers. comm.). The extensive marsh habitat likely has other rails utilizing it for a breeding area. More surveys implementing a variety of techniques would be useful in determining which species are on Back Bay NWR and at what densities they occur.

Because of the time constraints of the contract, complete inventory of all Back Bay NWR properties for all targeted species was not possible. Further survey work is needed to determine the presence or absence of certain species and to enhance the known faunal list for the area managed by Back Bay NWR.

SITE REPORTS

INTRODUCTION TO THE SITE REPORTS

To enhance protection and facilitate management of biodiversity at Back Bay NWR, boundaries have been provided for landscape units which merit practical and justifiable recommendation as conservation sites. A Conservation Site is a natural area that includes one or more element occurrences and has been assigned a biodiversity rank of at least B5. Reports follow for the Conservation Sites identified during the Natural Heritage Inventory of this area. The following standard reporting format is used for each Conservation Site:

SITE NAME: Site names generally reflect a geographic locality and, in some cases, a prevalent landscape feature.

SIZE: The approximate acreage within the conservation-planning boundary, as determined by planimeter or grid, is given.

BIODIVERSITY RANK: The overall significance of the natural area, in terms of the rarity of natural heritage resources and the quality of their occurrences, is indicated. As described in the Methodology section, these ranks range from B1 (very high significance) to B5 (general biodiversity significance).

LOCALITY: The county (or counties) containing the site is listed.

QUADRANGLE: The name of the USGS 7.5' quadrangle(s) that includes the site is listed.

QUADRANGLE CODE: The code used by DCR-DNH for the quadrangle is listed. The first five digits of the code represent latitude and longitude (in degrees) of the quadrangle.

LOCATION: Location of the site within Back Bay NWR, using geographical landmarks, is given.

NATURAL HERITAGE RESOURCE SUMMARY TABLE: This field provides a synopsis of the natural heritage resources (rare species and significant communities), together with their status ranks (global, state, USFWS, Virginia legal) and element occurrence ranks. Detailed occurrence data for the rare species and significant communities can be found following each site report.

SITE DESCRIPTION: A brief narrative describing the site, its significant elements, vegetation, habitat, and current land use is presented. The first reference to a species in a narrative is by common name, followed by its scientific name in parentheses. Subsequent references to the same species are by common name only.

BOUNDARY JUSTIFICATION: The preliminary conservation planning boundary delineated in this report contains all known occurrences of natural heritage resources and adjacent buffer lands required for their immediate protection. The information field explains the basis for the specific site boundaries.

THREATS: Threats to the site and its natural heritage resources are described. These may include both real, imminent threats and potential threats posed by types of land use activities or other factors that currently are not impacting the site.

MANAGEMENT RECOMMENDATIONS: This field is a summary of the major issues and factors that should be considered in management of the site for its biodiversity and natural heritage resource values. As a rule, generalized recommendations are provided based on potential threats identified during the survey work. The expertise of inventory biologists familiar with each site, as well as input from DCR-DNH natural areas program biologists, has been utilized in preparing these recommendations. However, within the context of a short-term (1 year) inventory effort it may be difficult to identify highly specific management strategies. In addition, the management needs of a few element occurrences are so obscure that additional study by experts may be needed. In many cases, monitoring of element occurrences or site factors is recommended to determine the best long-term management practices. In all cases, if land use changes or specific high-impact actions are proposed within a site's boundary, consultation with DCR-DNH staff is recommended to assess impacts on the natural heritage resources.

PROTECTION RECOMMENDATIONS: A summary of the actions and priority needed to ensure long-term protection of the site and its elements is provided.

REFERENCES: Pertinent literature is listed.

SITE MAPS: The site map, drawn on copies of the USGS 7.5' quad(s), shows the preliminary Conservation Planning Boundary. This boundary includes additional land determined to be important for long-term maintenance of the elements and considers the following factors when drawing these boundaries.

- the extent of current and potential habitat for rare species and exemplary natural communities;
- species movement and migration corridors;
- maintenance of surface water quality within the site and the surrounding watershed;
- maintenance of the hydrologic integrity of groundwater resources;
- land intended to mitigate a wide variety of off-site impacts;
- land or activities necessary to preclude or minimize exotic species; and
- land necessary for management activities, e.g., prescribed burning.

The boundaries are intended for conservation planning purposes and, at the very least, should prevent inadvertent damage to the natural areas.

ELEMENT LOCATION MAPS: Maps showing the exact location of each element occurrence within a site are included following the site map. In the case of animal elements, which are often highly mobile organisms, the maps indicate where actual collections were made and/or specimens were observed. These location maps are intended to provide Back Bay NWR natural resource managers with requisite site-specific information. However, since rare species are often sensitive to disturbance or may be sought out by collectors, we strongly recommend that this information not be shared with the public or with persons not directly involved in the stewardship of these sites.

BLACK GUT

Size: ca. 640 acres **Biodiversity Rank:** B4

Locality: City of Virginia Beach, VA

Quadrangle: North Bay; Virginia Beach **Quadrangle Code:** 3607568; 3607578

Location: This unit is bordered by Sandbridge Road to the south, the community of Sandbridge Beach along Sandpiper Road to the east, Lake Tecumseh to the north and Atwoodtown Road to the west.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
COMMUNITIES:					
Wind-tidal oligohaline marsh					B
Wind-tidal oligohaline marsh					B
Maritime Scrub					C
Maritime Loblolly Pine Forests					B
Maritime Shrub Swamps					C
Maritime Swamp Forests					C
Interdune Ponds					C
Estuarine Fringe Pine Forests					C
Estuarine Fringe Swamp Forests					C
PLANTS: Found in 2000					
Ludwigia brevipes Long beach seedbox	G4G5	S2			AB*
Not seen in 2000:					
Eleocharis vivipara Viviparous spikerush	G5	S1			
ANIMALS: Not seen in 2000					
Ixobrychus exilis Least bittern	G5	S2			E
Rallus elegans King Rail	G4G5	S2			B
Epitheca costalis Striped-winged baskettail	G4	S2			C

*Rank based on previous observation. Only a small patch was observed on this survey well past peak flowering time.

Site Description: Black Gut, initially named Rainey Pond on an 1891 USGS topographical map of the area, is an open water system consisting of one primary open water area and several much smaller open pools surrounded by marshland. It is connected to North Bay via a dredged channel and to Lake Tecumseh by contiguous marsh and a second dredged channel. The large open pool contains Eelgrass (*Vallisneria americana*) and water lilies (*Nymphaea odorata)* and American lotus (*Nelumbo lutea*) along

the marsh edge. It is within the low marsh area that the rare viviparous spikerush (*Eleocharis vivipara*) has historically been found. Farther away from the open water, past the low marsh, the vegetation fluctuates somewhat between mid-height and low marshes, and gradually grades into tall herbaceous palustrine wetland. The tall herbaceous wetland can be further described as a cattail spikerush tall freshwater marsh association. This community is dominated primarily by spikerush (*Juncus roemerianus*), narrow-leaved cattail (*Typha angustifolia*) and rose mallow (*Hibiscus moscheutos*). It is within this mid-height and tall herbaceous wetland that the rare plant long beach seedbox (*Ludwigia brevipes*) can be found. During a year 2000 survey, only a small population of long beach seedbox was noted. However, the population observed was well beyond peak survey time for this species. The wetland is bordered in parts by common reed (*Phragmites australis*). Forested areas included Pond pine forest and Loblolly-red maple forest. Rare plant elements are shown in Figure 11.

Rare animals know from the Black Gut site include king rail (*Rallus elegans*), least bittern (*Ixobrychus exilis*), and the stripe-winged baskettail (*Epitheca costalis*). Two watch listed species, big bluet (*Enallagma durum*) and saffron skipper (*Poanes aaroni aaroni*) are also documented from the area. Occurrences of these species are found scattered throughout the marshes and surrounding wetlands. These animals are of course, mobile and may use a variety of habitats for resting, foraging, and reproduction.

Boundary Justification: The boundary for this site includes all the animal, plant, and significant natural community element occurrences. Small buffer zones of natural habitat along the conservation site border were added when possible. Conservation site boundaries adjacent to open water were not buffered as the water forms a natural boundary. Boundary lines adjacent to developed areas were not buffered as there is no longer any buffer. The boundary at this site incorporated the predominant natural vegetation in the immediate area and was limited by development on all sides.

Threats: The primary threats to this area are associated with the pressure of commercial and residential development, increased competition by common reed (*Phragmites australis*) (DCR-DNH 1998b) and the non-native plant, alligatorweed (*Alternanthera philoxeroides*) (DCR-DNH 1998c), increased competition of nutria (*Myocastor coypus*) on muskrat populations and the long-term threat of sea level rise. Sea level rise resulting in higher water levels and in a breach of the barrier islands could have a dramatic effect on these community types.

Conversion of rural open space to residential and tract housing developments, or other intensive land uses such as golf courses can have significant secondary impacts on sensitive natural areas. Threats associated with development include loss of buffer zone surrounding sensitive areas, hydrologic changes such as decreased water table levels, increased toxic run-off, increased sedimentation, and habitat destruction. Poorly planned farming activities and pesticide use could also impact water quality in Black Gut, and ultimately the Back Bay estuarine system.

Management Recommendations: Development of support from local residents and designation/recognition of specific areas with noted rare species or habitat is a major key in good management of sensitive lands (See Erdle *et al.* 1994).

Invasive species such as common reed and nutria are problem species throughout the watershed, requiring biological monitoring and specialized control programs(DCR-DNH 1998b, DGIF 2000). Common reed is an aggressive grass that has spread rapidly in the watershed. It quickly invades disturbed areas and is extremely tolerant of increased salinities, nutrients and sediments. Once

established, it easily forms dense clones and replaces native vegetation, including many rare plants. When native plants are displaced, food and shelter for waterfowl and wildlife are eliminated. Common reed should be photo-monitored by aerial photography/gps/ground truthing such that rates of expansion can be accurately assessed and implementation of control methods correctly applied. Alligatorweed in Virginia is at the apparent northern extent of its range (DCR-DNH 1998c). Management personnel should familiarize themselves with this species and note new occurrences to see if this species is expanding in the area.

Nutria are large rodents introduced from South America in 1899 into southern U.S. marshes to bolster the fur trade and as an additional food source. The State of Virginia considers this species a nuisance species (DGIF 2000) and in the Back Bay watershed, this species has increased and is out competing native muskrats for marsh habitat and food. Studies are needed to determine the status of nutria in the Back Bay area, and the most effective means of control.

Long-term monitoring is recommended for rare natural communities, rare plants and animals. Species like the long beach seedbox, the king rail, and the invertebrate species should be monitored to ensure continued health and productivity of the existing populations.

Protection Recommendations: Protection measures should include the implementation of management recommendations and consultation with DCR-DNH when changes in land use or management practices are contemplated. The Conservation Planning Boundary should be formally incorporated into the planning and management documents for Back Bay NWR.

Developing partnerships and management strategies with landowners is essential in protecting critical buffers and carrying out management programs. Impacts from surrounding land-uses should be mitigated by encouraging sound soil and water conservation practices and maintaining vegetated buffers to wetlands.

It is recommended that the City of Virginia Beach, U.S. Fish and Wildlife Service, Department of Defense, Department of Conservation and Recreation and local landowners develop cooperative management and protection plans for Black Gut and any associated land buffering of the natural heritage resources.

The Black Gut site falls within the city designated planning area known as "Courthouse/ Sandbridge". Planners and officials of the City of Virginia Beach are aware of the environmental significance of Back Bay, and this area has been designated as an "environmentally sensitive area" (City of Virginia Beach, 1991). The distinction of being an environmentally sensitive area however, does not afford the bay or the immediate surrounding lands any additional protection from development or land use alteration.

However, there is a "Southern Watersheds Management Ordinance" cited in the Comprehensive Plan for the City in the "Environmental Policies and Objectives" section, page II-D-6 (City of Virginia Beach, 1991). This management ordinance sets "standards that include, but are not limited to the provision of reserve sewage disposal drainfield sites, minimal disturbance of land, the controls for all land disturbing activities over 2,500 square feet of development within fifty feet of any shoreline or wetland, and the use of best management practice facilities for controlling stormwater runoff."

Farming practices are generally considered compatible with natural area preservation. Nearby agricultural landowners should adhere to Best Management Practices designed to minimize

sedimentation and agricultural runoff in this watershed.

Current logging practices do not appear to threaten natural heritage resources at this site, largely because of the marginal condition of the wetland timber resource and the minimal amount of timber harvest in the immediate area. Logging is not recommended in wetland areas and logging practices on uplands should follow strict BMP's designed to maintain hydrologic flow, reduce erosion, and control sedimentation. Large tract clear-cutting or other large-scale land altering activities could influence hydrology and water quality in the area. These activities should be monitored closely to ensure that proper buffers are established to protect sensitive resources and water quality, as well as to provide corridors for wildlife movement.

Pesticide use in the area should be carefully planned to minimize negative impacts on sensitive wetlands. Pesticides used for lawns, gardens, agriculture or forests could inadvertently jeopardize rare invertebrates. Buffers to wetlands should be maintained and biocides must be carefully chosen and applied by skilled certified applicators. An effort should be extended to Non-resident visitors and renters in the nearby beach development to provide information on the appropriate use and care of these wetlands.

Issues regarding sea-level rise can only be managed on a national and international level.

References

Clampitt, C.A., J.C. Ludwig, T.J. Rawinski, and C.A. Pague. 1993. A natural areas inventory of the City of Virginia Beach, Virginia. Natural Heritage Technical Report 93-14. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 35 pp. plus appendices.

DCR-DNH. 1998b. Invasive alien plant species of Virginia: Common Reed (*Phragmites australis*). Factsheet. Virginia Dept. of Conservation and Recreation, Div. of Natural Heritage. Richmond, VA.

DCR-DNH. 1998c. Invasive alien plant species of Virginia: Alligatorweed (*Alternanthera philoxeroides*). Factsheet. Virginia Dept. of Conservation and Recreation, Div. of Natural Heritage. Richmond, VA.

DGIF. 2000. Department of Game and Inland Fisheries regulation 4 VAC 15-20-160.

Erdle, S.Y., M.A. Donoff, L.R. Smith, C.A. Caljouw, and H.C. Bernick, III. 1994. Conservation and Planning for the Management and Protection on Natural Areas in the City of Virginia Beach, Virginia. Natural Heritage Technical Report # 94-12. Virginia Department of Conservation and Recreation, Division of Natural Heritage.

Fleming, G.P., P.P. Coulling, D.P. Walton, K.M. McCoy, and M.R. Parrish. 2001. The natural communities of Virginia: classification of ecological community groups. First approximation. Natural Heritage Technical Report 01-1. Virginia Department of

Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report. January 2001. 76 pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. 2nd ed. The New York Botanical Garden, Bronx, USA.

Godfrey, R.K. and J.W. Wooten. 1981. Aquatic and Wetland Plants of Southeastern United States: Dicotyledons. The University of Georgia Press. Athens GA. 933 pp.

Harvill, A.M., T.R. Bradley, C.E. Stevens, T.F. Wieboldt, D.M.E. Ware, D.W. Ogle, G.W. Ramsey, and G.P. Fleming. 1992. Atlas of the Virginia flora III. Virginia Botanical Associates, Burkeville, VA. 144 pp.

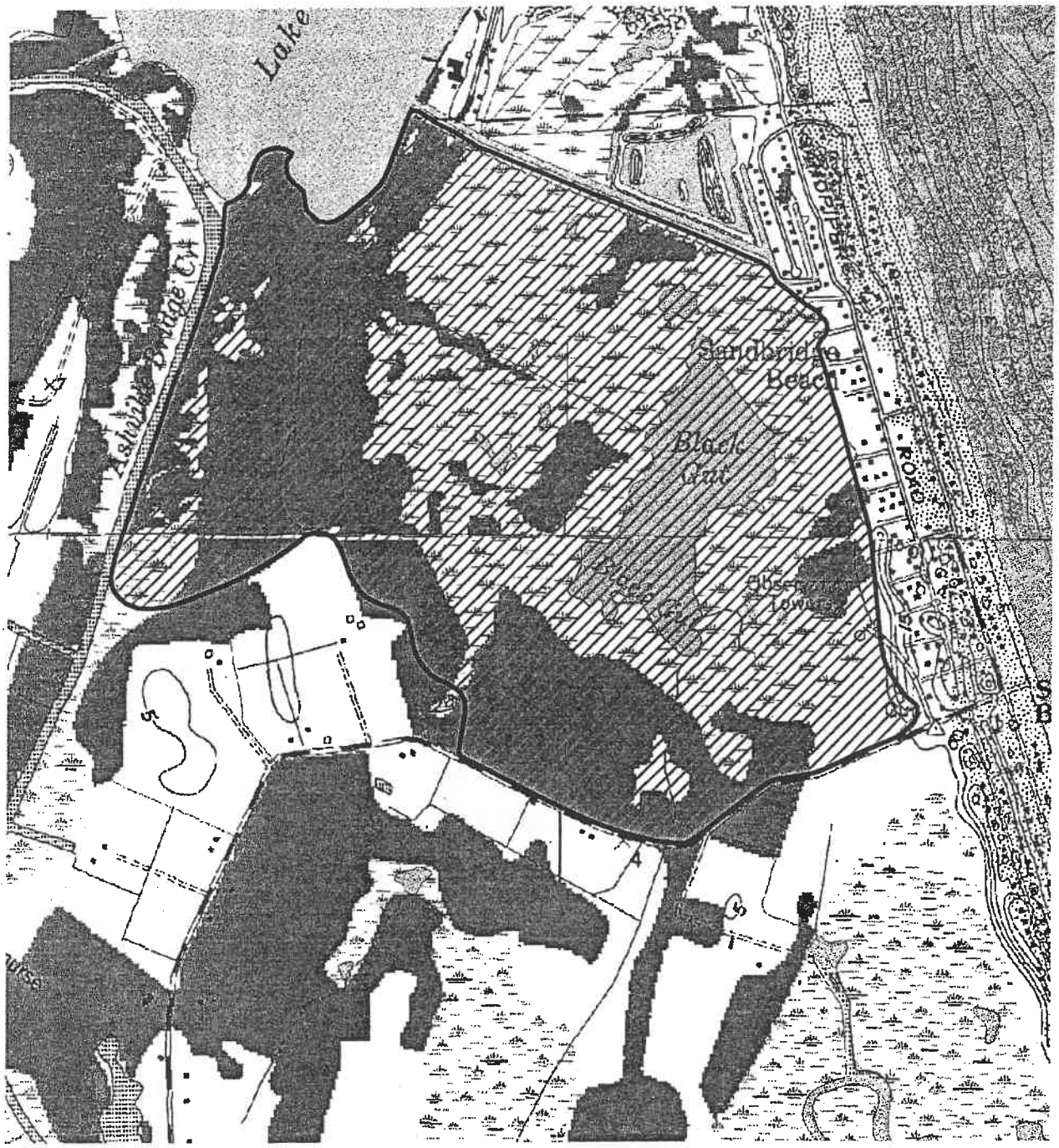


Figure 10. Black Gut Conservation Planning Boundary, Back Bay National Wildlife Refuge.

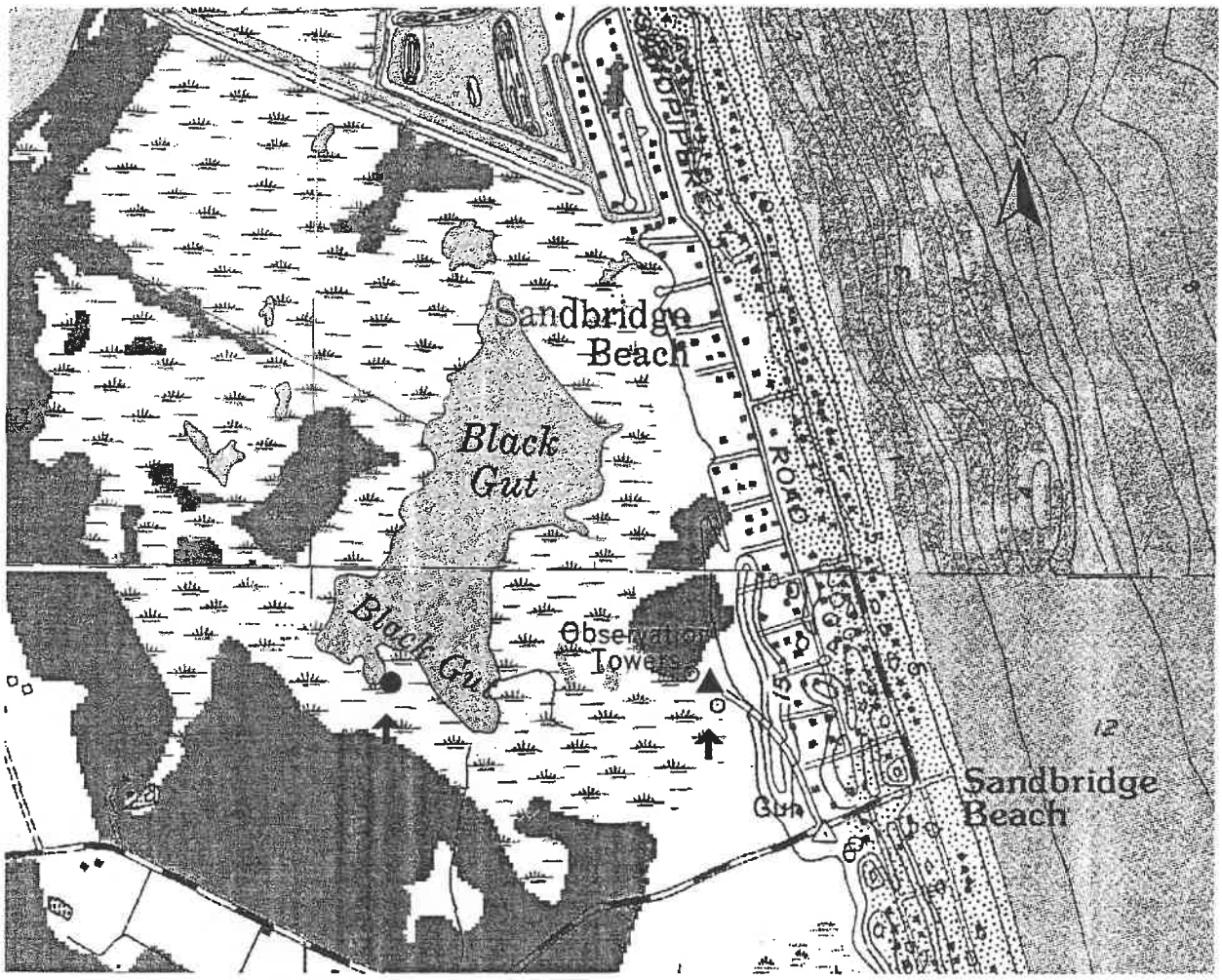


Figure 11. Locations of rare plants observed within the Black Gut Conservation Site. The locations of *Ludwigia brevipes* seen around Black Gut in 1991 were not mapped at the time of that survey. Back Bay National Wildlife Refuge. Virginia Beach and North Bay USGS 7.5' quadrangles.

Figure 12 - Trap and element occurrence locations in the Black Gut and Atwoodtown Road areas of Back Bay National Wildlife Refuge.