Conservation Plan

for the

Southern Watershed Area

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CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

Conservation Plan

for the

Southern Watershed Area

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For:

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EXECUTIVE SUMMARY

The Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR), at the request of the Hampton Roads Planning District Commission, has prepared a Conservation Plan to serve as one component of the Southern Watershed Area Management Program (SWAMP). SWAMP is a collaborative management effort seeking to protect and enhance the natural resources, sensitive lands, and water supplies of the Southern Watersheds Area (SWA) of Chesapeake and Virginia Beach while maintaining a balance with economic development opportunities. This Conservation Plan is intended to provide a science-based foundation for conserving the area's biological resources and integrates with three other SWAMP components: an Agriculture Plan, a Multiple Benefits Conservation Plan, and a Rural Area Preservation Plan. The sections of the plan are briefly summarized below.

Planning for Conservation. The Plan discusses the growing body of knowledge that now clearly demonstrates the social and economic benefits of retaining intact natural ecosystems and open-space as integrated components of human communities. The benefits or *ecosystem services* that such non-developed areas provide are real, substantial, and increasingly measurable. However, since these benefits are not well-recognized through traditional economic valuation, they are often not weighed against the more tangible values of economic development (money and jobs). Thus, they are frequently overlooked, undervalued, or ignored.

Scattered, unconnected natural areas representing remnants of once-continuous natural habitats have limited potential to provide diverse ecosystem services. One alternative that allows growing human communities and natural systems to coexist is to provide connections between remnant patches of habitat by means of a system of linear open spaces called *conservation corridors*. Corridors and greenways restore some of the previous landscape connectivity, providing habitat connections for wide-ranging animals as well as the gene flow necessary to maintain healthy, viable populations of plants and animals. In addition to providing wildlife habitat connections and protecting ecosystems, conservation corridors have been used to promote and enhance local parks, recreational, and educational interests

Ecosystem Description and **Natural Resources.** The Conservation Plan identifies the most significant biological resources that remain in the SWA and describes adjacent land and water, as well as natural processes that support them. The three watersheds of the SWA – Northwest River, North Landing River, and Back Bay – represent the northern extent of the Albemarle–Pamlico Estuary. This area is uniquely located both at the northern range limit for many southern species and at the southern range limit for many northern species. Because of this merging of southern and northern affinities, biodiversity of the SWA is remarkable. Extensive wetlands of the SWA have helped to protect the region's natural resources from rapid development patterns so evident just northward. As a result, the SWA supports 19 rare natural communities plus 67 plant and 22 animal species rare to Virginia.

DCR identifies *conservation sites,* defined as areas of land that support occurrences of rare plants and animals plus exemplary natural communities. These rare species and their habitats are in turn defined as *natural heritage resources*. Conservation sites contain both natural heritage resources and the lands and waters necessary to maintain natural processes critical to these resources. Conservation site boundaries are drawn primarily to reflect habitat requirements and ecological, not political or property boundaries. Because these boundaries are based primarily on ecosystem-level processes, conservation sites are optimal units upon which to base conservation and resource management plans. Sites are also specifically designed to protect natural heritage resources, which are often highly sensitive to disturbance caused by human land use and development. Thus, conservation sites are

often effective indicators of relatively intact and functional natural ecosystems, incorporating an array of natural resources and physical features – common as well as rare. Conservation sites therefore represent a rough minimum area necessary to protect existing natural biodiversity. Detailed descriptions of conservation sites that form the core of the SWA's priority conservation lands are appended to this Summary; the sites are depicted in Figure 3.

Development of Conservation Corridors. Conservation corridors provide connectivity for wildlife (and people) between primary natural habitats that otherwise become isolated by unplanned land use development patterns. Designating conservation corridors in advance of a fast-developing urban landscape is a proactive approach for retaining natural landscape connectivity, natural resources, and other open-space benefits. Corridors situated in already developed areas have great potential for restoring open-space and landscape level ecosystem functions. A system of conservation corridors will sustain natural communities and populations of native plants and animals while also providing a multitude of values to Chesapeake and Virginia Beach, including:

- protection of riparian systems;
- improved surface and ground water quality;
- reduced air and noise pollution
- recreational opportunities such as wildlife-watching, canoeing, kayaking, hunting and fishing where appropriate, walking, hiking, and bicycling;
- natural history, natural resource conservation, and biological educational opportunities;
- enhanced property values;
- improved quality of life.

This Plan presents a set of options for landscape level conservation corridor placement suggesting increasing levels of natural resource conservation. Options are based on various combinations of (1) currently protected lands, (2) known conservation sites, and (3) additional conservation corridor lands. Five options are presented in a series of maps (*Figures 6 - 12*) that display proposed landscape visions varying considerably in extent, ranging from the status quo up to a high level of open-space protection.

The *Low Corridor Density Option* represents the status quo and is comprised of the current acreage of public and private protected lands in the SWA (38,523 acres; 15.8% of the total SWA). The *Moderate-Low Corridor Density Option* includes both currently protected lands plus those linear areas that connect them – up to a width of one-half mile (50,249 acres; 20.7%). The *Medium Corridor Density Option* augments the simple corridor system defined in the previous option with additional currently unprotected conservation sites from the SWA (94,853 acres; 39.0%). The *Moderate-High Corridor Density Option* includes all existing but currently unprotected conservation sites on both public and private lands, plus half-mile wide corridors forming a network of connected conservation lands (98,480 acres; 40.5%). Finally, the *High Corridor Density Option* includes all currently protected conservation lands, all conservation sites, corridor lands connecting these areas, and additional conservation corridors that increase landscape connectivity and allow large-scale ecosystem processes to remain functional (108,909 acres; 44.8%). Much of the land area in the three higher corridor density options includes currently developed land uses. These areas could be designated as potential conservation lands and restored to open-space such as ball fields, managed forests, and agricultural lands as opportunities arise over a long time span (decades).

Much of this land area would be designated as future open-space and include currently developed land uses that would be restored over time. Figure 11 depicts this conservation corridor density with selected land uses in the SWA. Private property rights considerations should be paramount in any implementation strategies, since most lands designated within corridors are privately owned. Fee

simple purchase, conservation easements, purchase of development rights, or agricultural reserve programs are effective methods by which fair compensation can be made. Extensive areas are already in some state of development, while others are undergoing land-use alterations. Many (if not most) areas within corridors would require hydrologic and vegetative restoration representing many opportunities for mitigation.

Within conservation corridors a variety of land uses, in addition to protection of ecosystem services, are possible. These include both private and public uses, such as:

- Public recreation – hunting, fishing, hiking, biking, canoeing, wildlife viewing
- Agriculture
- Forestry
- Low intensity, low impact residential, commercial, or industrial development
- Natural history education

Stewardship of Corridor Habitats. Conservation planners recognize that appropriate land management practices are necessary to protect, support, or restore ecological processes that sustain the biodiversity of natural areas and provide optimum natural resource benefits to people. Corridor areas will present heightened stewardship challenges because they are so closely integrated into the context of human development, and because restoration of altered habitats is much more difficult than maintenance of existing natural habitat.

The Conservation Plan discusses key stewardship issues relating to the development and maintenance of conservation corridors. These include:

- water quality monitoring
- public use
- prescribed fire
- hydrologic restoration
- invasive species control
- restoring natural vegetation/communities
- habitat creation
- forest management
- habitat restoration
- mitigation banks
- wildlife management

Protection Methods. The Plan outlines a variety of land protection tools and approaches that are available to facilitate the protection of natural areas and open-space for areas not already in some class of protected status. Methods can be tailored to different conservation needs and specific landowner situations and include voluntary protection and management agreements, purchase of development rights, open space and conservation easements, and fee simple acquisition. A wide variety of funding sources and programs, including grants and financial incentive programs, exist which could potentially fund efforts towards conservation, protection, restoration, habitat enhancement, and other initiatives.

Protection Priorities. In 1989, DCR and The Nature Conservancy began protection efforts that to date, have resulted in the acquisition of 20 tracts on the North Landing River and six on the Northwest River. Additional tracts owned by the U.S. Army Corps of Engineers, the City of Chesapeake, the City of Virginia Beach, Virginia Department of Game and Inland Fisheries, and the U.S. Fish and Wildlife Service add to the lands along these rivers and Back Bay receiving at least some level of environmental protection. Protection of individual tracts containing significant

elements of biodiversity is a good first step toward conservation of critical habitats in the region; however, ecosystem-level conservation requires an approach that emphasizes linkage of natural areas and the viability of conservation sites within a larger landscape context. This plan prioritizes conservation sites and adjacent lands to facilitate immediate (near-term) protection, restoration, mitigation, and conservation efforts (Figure 13). Identification of these lands does not imply that other sites or lands are unimportant, but rather that these areas are critically important to meeting goals of the SWAMP. Prioritization of sites was based upon assessment of: site location, size, contribution to SWAMP goals, management needs, vulnerability to immediate or long-term threats, and ecological significance.

Summary and Recommendations. Communities across the country are grappling with growth and lessons of unplanned urban expansion are evident around us. The Cities of Chesapeake and Virginia Beach are fortunate to have such a remarkable assemblage of relatively-intact biological and natural resources, and are wise to work proactively to retain and enhance their open space, water quality, wildlife habitat, and biological diversity. The use of conservation corridors represents only part of an integrated ecosystem and natural resource protection strategy that will require the concerted effort of a variety of local, state, and federal agencies, both public and private. But the foundation of an effective conservation program should be a vision for a future landscape that successfully expresses the views and wishes of local residents, businesses, and government entities. Successfully managing growth means empowering citizens and leaders to make informed decisions about whether or not it is important and desirable to conserve open space and natural resources.

This Conservation Plan is one part of a multi-faceted planning effort being undertaken through the SWAMP program. Its intended role is to serve as underpinning on which to base conservation choices and as a fabric into which other planning components can be integrated. Protecting and managing conservation corridors will yield natural resource benefits to the community, and should also serve the long-term economic and quality-of-life needs of the citizens of Chesapeake and Virginia Beach.

INTRODUCTION

The cities of Chesapeake and Virginia Beach in conjunction with the Virginia Coastal Program and the Hampton Roads Planning District Commission (HRPDC) are collaborating on the Southern Watershed Area Management Program (SWAMP). The mission of SWAMP is to protect and enhance natural resources, sensitive lands, and water supplies by developing a cooperative planning and management effort for the Southern Watershed Area (SWA). The SWA encompasses portions of the Northwest River, North Landing River, and Back Bay watersheds and covers approximately 325 square miles (Figure 1).

The goals of SWAMP are to:

1) protect and enhance water quality;
2) preserve open lands;
3) ensure the compatibility of recreational activities and commerce with natural resource protection;
4) preserve the rural character of the southern watersheds while providing for residential development;
5) sustain and encourage agricultural and forestal activities in the SWA.

In early 2000, the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH) began work on this Conservation Plan which is intended to integrate with three other concurrently-developed SWAMP plans: Strategic Plan for Agriculture, Multiple Benefits Conservation Plan, and Rural Area Preservation Plan. The Conservation Plan identifies key lands that support the natural resource base and focuses on the remaining key habitats for rare species of plants and animals plus outstanding examples of native forest and marsh communities. The Plan provides a rationale and suggests options for linking these lands using the concept of *conservation corridors*, and outlines strategies to protect and sustain natural resources and processes that are integral to long-term ecosystem health. If such strategies are carried out, quality of life for the future citizens of Chesapeake and Virginia Beach will be enhanced by the planned retention of values that arise from functioning open-space, healthy forests, wetlands, and natural areas.

Values and benefits provided by open or “green” space are too often missing in localities that have allowed unchecked sprawl to design the landscape. Identification of long-term conservation goals and implementation of an effective conservation strategy to retain an adequate and desirable natural resource base is a critical goal of this plan and SWAMP as a whole.

PLANNING FOR CONSERVATION: A LITERATURE REVIEW

Planning for conservation, addressing conservation issues, and protecting land for open space help to assure the economic future of a community and increases the quality of life for its citizens (Brabec 1992; Daily *et al*. 2000; Lindsey and Knaap 1999; Scott *et al*. 1998). In the SWA of southeastern Virginia, remaining forested wetlands and agricultural lands are rapidly being replaced with residential housing, commercial and industrial development, roads, and other developed land uses – a pattern typical of areas with rapid population growth rates. From 1970 to 1990, the human population of the SWA increased 280% (HRPDC 2001). During the 1990’s, the population of Chesapeake and Virginia Beach increased by 29.6% and 7.1%, respectively (Weldon Cooper Center 2000). The necessity for economic development in urban areas is not at question – expanding population centers require vibrant business growth and suitable infrastructure. However, elimination of forests, wetlands, and open spaces bordering neighborhoods and within communities results in tremendous loss of values and benefits to people and represents a terrible sacrifice and diminished quality of life.

The value of open space has in the past been taken for granted by society and its loss considered a requisite trade-off for "progress" and economic development. However, there is current evidence that citizens of rapidly growing communities have become more aware of the positive aspects of retaining open space and containing sprawl (City of Raleigh 2000; Richmond Times-Dispatch 2000). Such changing societal views make it possible for local governments to design mechanisms to plan and manage urban expansion in order to retain natural landscape features.

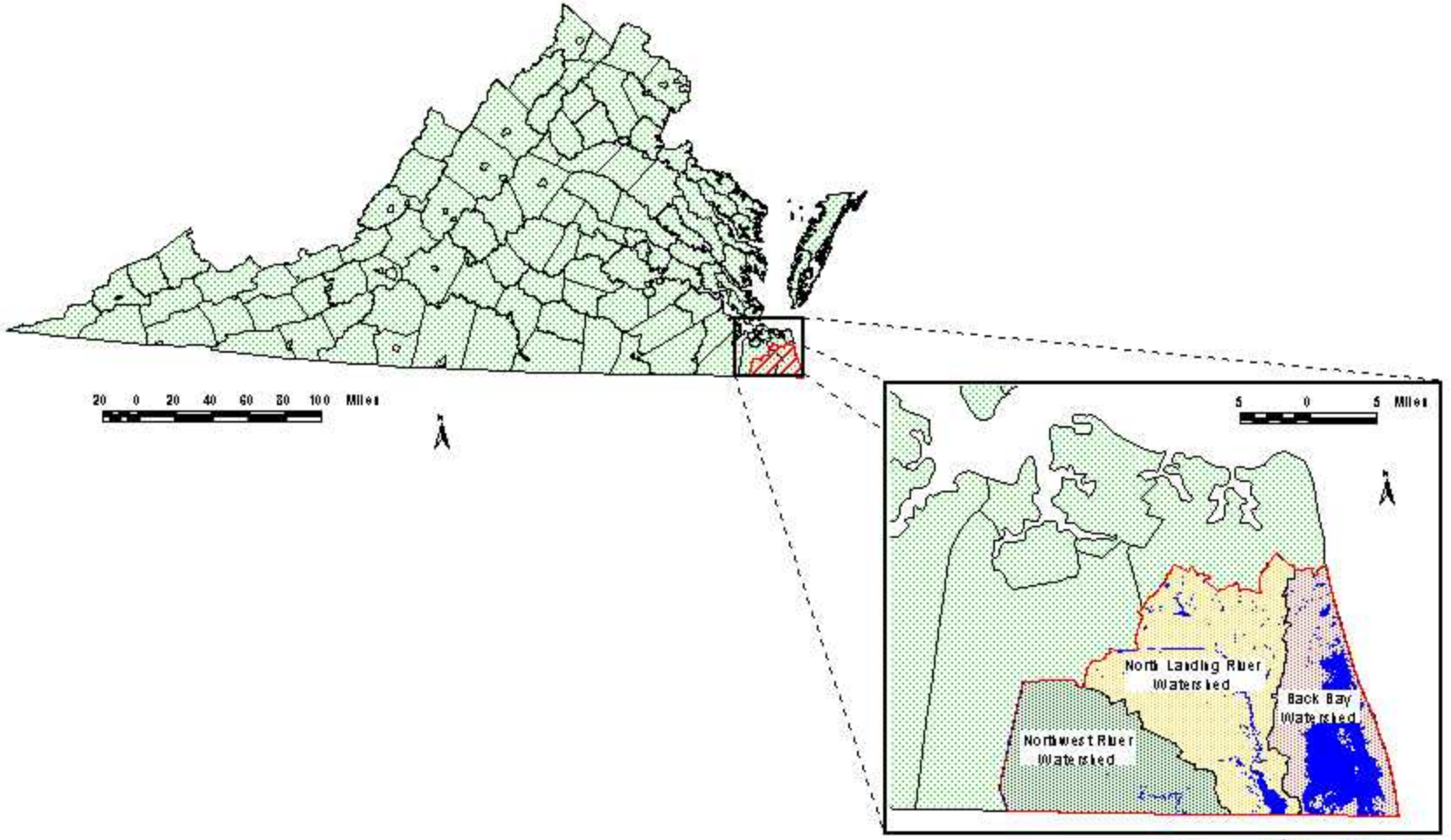
Natural ecosystems provide functions that support life - not just plants and animals of forests and marshes, but also human life. These functions have been called *ecosystem services* (Daily *et al*. 2000; Dixon and Sherman 1990; Holden and Ehrlich 1974; Kirby 1993). Examples of *ecosystem services* provided by natural habitats and open space follow:

- purification of air and water;
- mitigation of droughts and floods;
- genesis, preservation, and renewal of soils;
- detoxification and decomposition of wastes;
- pollination of crops and natural vegetation;
- dispersal of seeds;
- cycling and movement of nutrients;
- control of the vast majority of potential agricultural pests;
- maintenance of biodiversity by providing habitat for native species of plants and animals;
- protection of coastal shorelines from wave erosion;
- protection to humans from sun's ultraviolet rays;
- recreational opportunities;
- natural history education / outdoor classrooms;
- biological research opportunities;
- moderation of weather extremes and their impacts;
- provision of aesthetic beauty and intellectual stimulation that lifts the human spirit.

Benefits derived from these *services* provided by natural ecosystems have been undervalued by society. They are not traded in formal markets and so do not send price signals that warn of changes in supply or condition. Relatively few people are even conscious of the role natural *services* play in generating those ecosystem goods that *are* traded in the marketplace, such as agricultural and forest products. Placing a value on natural ecosystems, like valuing human life, is fraught with difficulties (Daily *et al*. 2000; Fausold and Lilieholm 1999; Scott *et al*. 1998). However, in order to avoid permanent loss of benefits and values, it is wise to establish fundamental ecosystem safeguards even when uncertainty over economic value remains. Numerous human-caused threats to natural ecosystems exist, including exotic species introductions, extinction of species, ground and surface water flow alterations, and habitat loss through infrastructure development (roads, buildings, rights-of-way, etc.). These changes are difficult or expensive to reverse on time scales relevant to people. With 3 million acres of open space disappearing in the United States each year (Biondo 2000), and with most remaining natural systems damaged and fragmented, it is critical that efforts be made *now* to protect and conserve open space, natural habitats, and functioning ecosystems.

The difficulty of expressing ecosystem values in traditional terms has given rise to several new ways of analyzing value and evaluating less tangible concepts. One of the new sciences devoted to this process is *contingent valuation methodology* (CVM). CVM applies benefit transfer principles, functions and services of the ecosystem, *travel cost methodology*, and *hedonic damage pricing* and arrives at an economic 'value,' or estimation of the value of ecosystem services and other public goods (Kirby 1993; Lindsey and Knaap 1999; Scott *et al*. 1998). This value is then used by planners,

Figure 1. Location and physiographic context of the Southern Watershed Area



researchers, and economists for planning and budgetary purposes. Another method used by researchers attempting to quantify the 'value of ecosystem services' is to measure *willingness to pay* (WTP) by local residents. To establish this, researchers interview and poll communities regarding a variety of topics ranging from such broad concepts as "nature conservation," to more specific issues such as wetlands preservation, salmon re-stocking, and mosquito control (Lindsey and Knaap 1999; Pate and Loomis 1997; White and Lovett 1999). Researchers have discovered that WTP is directly linked to geographic distance, and to a small degree, to the specific program or service (Fausold and Lilieholm 1999; Gresswell and Liss 1995; Lindsey and Knaap 1999; Pate and Loomis 1997; White and Lovett 1999). Lindsey and Knaap (1999) found that "…there are indeed public benefits to private landscapes, but that in any particular place, their value depends on salience and proximity to individuals, as well as other site-specific characteristics…" WTP can be used as a tangible measure of how important or valuable these things are to people.

Some economic values of open space and ecotourism are easily quantified. Proximity to open spaces (greenways, wildland corridors, and natural areas) is often touted in real estate advertisements as factors that increase the worth of property. These values have been called "enhancement value" and "livability" of an area (Fausold and Lilieholm 1999). A large body of information documents the success and enhanced value of residential development located near open spaces (Adams and Mundy 1991; Brabec 1992; Fausold and Lilieholm 1999; Vicary 1994). This enhancement value is explicitly recognized by federal income tax law - U.S. Treasury regulation Section 14(h)(3)(1). For example, Section 14(h)(4) cites an example of a landowner with ten one-acre plots who donates a conservation easement on eight of these lots: "By perpetually restricting development on this portion of the land, [the landowner] has ensured that the two remaining acres will always be bordered by parkland, thus increasing their fair market value," (Small 1990). In short, numerous studies suggest that pa rks and open sp ace have positive impacts on neighboring property values (Brabec 1992; Lindsey and Knaap 1999; Weicher and Zeibst 1973).

Recreational fishing and hunting generate approximately $70 billion dollars a year in the United States (USDI 1996). In the SWA, these activities are extremely popular attracting hunters and fishermen from around the state as well as the surrounding region. Certainly, healthy natural ecosystems are important for maintaining wildlife-dependent activities and the various service and retail industries they support.

Ecotourism and birdwatching are two of the fastest growing recreational pursuits in the U.S. and both depend on healthy ecosystems supported by intact natural processes and open space. The rise in popularity of these pastimes has recently supported increased associated business activity contributing millions of dollars to many local economies (Lindberg 1996; Kerlinger 1993; Wiedner and Kerlinger 1990). Nationwide, birders annually contributed between $20 and $30 billion to the economy during the 1990's (Kerlinger 1993). In Virginia's SWA, ecotourism and birdwatching have likewise increased dramatically during the last decade. Numbers of birders are increasing in part because people are living longer and retiring with sufficient resources to travel extensively. A growing popular interest in observing and studying other wildlife such as reptiles, amphibians, butterflies, as well as plants helps support economic endeavors such as canoe liveries and "bed and breakfasts." Healthy natural ecosystems offer substantial promise for expanded businesses, *e.g*. whale-watching trips, sea kayaking, and other forms of nature-based tourism (Bergstrom *et al.* 1990; Kirby 1993).

Maintaining and improving water quality for public water supplies and recreational use is an ecosystem-level management issue of great importance in the SWA. Intact natural systems are key to protecting water quality. Many of the Best Management Practices (BMPs) currently promoted to protect water quality are actually strategies for protecting or restoring the natural filtering processes of natural systems. Recent research has helped to establish standards for riparian buffer width needed

to protect surface water from sources of point and non-point pollution (Lowrance *et al*. 1997). New studies are being conducted, and others are needed to determine protection needs for groundwater recharge areas and techniques to address nutrient loading and run-off, soil requirements for septic systems, and appropriate stormwater collection, detention, and treatment (Leger 1990; Rideout and Adams 1990).

Contemporary efforts to identify and maintain the natural biodiversity of the SWA through surveys, protection actions, management planning, and stewardship have helped to retain rare species and natural communities (Belden 1996; Clampitt *et al*. 1993; Clark 1997; Clark and Potter 1995; Erdle *et al*. 1994; Fleming *et al*. 1998; Fleming and Moorhead 1998; Heffernan 2000; Rawinski and Fleming 1993; Rose *et al.* 1988; Wieboldt *et al*. 1998). Most protected natural areas exist as fragmented pockets in a developed landscape and connectivity declines still more with further human alterations (Godron and Forman 1983). Scattered, unconnected natural areas representing remnants of once-continuous natural habitats have limited potential to provide diverse ecosystem services. One alternative that allows growing human communities and natural systems to coexist is to provide connections between remnant patches of habitat by means of a system of linear open spaces called *conservation corridors*.

Research and development of conservation corridors to retain natural resources and conserve biodiversity is still in its infancy. Nevertheless, a rapidly growing body of literature suggests that corridors, green space, and open land are essential in our fragmented landscape (Burbrink *et al.* 1998; Lindenmayer and Nix 1992; Machtans *et al*. 1996; Noss 1987; Schaefer and Brown 1992). Highly functional presettlement landscapes are known to have been interconnected mosaics of varied habitats, with high connectivity of similar habitats (Noss 1987). Creation and retention of corridors and greenways is an attempt to restore some of the previous landscape connectivity, providing routes for the movement of individuals as well as the gene flow necessary to maintain healthy, viable populations of plants and animals (Yahner and Mahan 1996). Conservation corridors are an important landscape-level approach for restoring and protecting intact ecosystems and providing habitat connections for wide-ranging animals. Appropriately located corridors can be important complements to the strategy of large and multiple reserves (Downes *et al*. 1997; Noss 1987).

In addition to providing wildlife habitat connections and protecting ecosystems, conservation corridors have been used to promote and enhance local parks and recreational interests (City of Raleigh 2000; City of New York 2000; Indy Greenways Plan 1999; Peiser and Schwann 1993; Rails to Trails 2000; Weicher and Zeibst 1973). In Raleigh, North Carolina the Neuse River Corridor Master Plan (2000) offers a working example of greenway corridor design, strategies for establishing buffers, strategies for zoning changes to protect the 100-year flood plain, greenway trail system, and a description of the plan history and implementation. This project uses the Neuse River Corridor to connect a region of parks, nature trails, scenic drives, and educational sites. In New York City, the Department of Parks and Recreation has established a system of greenbelts and formed a non-profit corporation to protect, preserve and manage the Greenbelt Park. The corporation educates the general public and manages an endowment to benefit the greenbelt (New York City 2000).

Protection of water quality, open space preservation, natural resource base retention, and conservation of biodiversity are critical for quality of life and, in the long term, for sustaining the local economies of Chesapeake and Virginia Beach. In working towards these goals, community leaders should consider McAfee (1999) who stated in her paper on "Green Developmentalism" that "…the conservation and sustainable use of biological diversity requires not only global plans and scientific priorities, but also a multiplicity of site-specific, information-intensive technologies relying heavily on inputs of local intelligence and planning to meet local and national needs." Attainment of these goals means working with natural landscapes and processes that, from the human perspective, are

large-scale and long-term. Retaining these values will require a visionary level of planning and implementation.

BACKGROUND INFORMATION

Ecological Significance of the Southern Watershed Area

Occupying the mid-Atlantic seaboard, Virginia is uniquely located both at the northern range limit for many southern species and at the southern range limit for many northern species. The same is true for many naturally occurring community types. Because of this merging of southern and northern affinities, biodiversity of the SWA is remarkable. In addition to hundreds of common plant and animal species, the area supports 19 rare communities as well as 67 plants and 22 animal species that are rare to the state. The SWA is clearly a special area, supported by complex ecological processes. Conservation of these processes, physical landscape components, and the ecosystems they support is critical to the long-term maintenance of the SWA's high level of inherent biodiversity.

Chesapeake and Virginia Beach

The Cities of Chesapeake and Virginia Beach are situated in the southeast corner of Virginia (Figure 1). From a physiographic perspective, they lie on the lower terraces of the Atlantic Coastal Plain Province near the northern end of the Mid-Atlantic Embayed Region stretching from Back Bay in Virginia to the Neuse River embayment in North Carolina (Ward *et al*. 1991). The topography of this area is a nearly level, slightly undulating plain characterized by low elevations, low relief, and abundant wetlands. The land surface consists primarily of near-shore and lagoonal marine deposits punctuated by the Pungo Ridge, the Hickory Scarp and the Land of Promise Ridge. These are linear, north-south trending scarps representing two of several successive Pleistocene shorelines (Oaks and Coch 1973; Oaks and Whitehead 1979). Elevations above mean sea level range from less than 1.5 m (5 ft) in floodplains to 7.6 m (25 ft) on the Hickory Scarp. To the east and southeast is Back Bay, an embayed coastal shoreline containing a complex of barrier islands, bays, and sounds which are part of the Albemarle-Pamlico Estuary – one of the largest estuarine systems in the United States (Copeland *et al*. 1983; Dardeau *et al*. 1992).

The northernmost portion of the City of Chesapeake is densely populated urban and suburban land. Central and southern portions of the city are essentially rural and agricultural in character, although residential development has increased significantly in recent years. Extensive, undeveloped areas are still found on the extreme western side of Chesapeake within the Great Dismal Swamp National Wildlife Refuge and in the bottomlands of the Northwest River. The Northwest River is the primary public water supply source for Chesapeake.

The northern and northwestern portions of the City of Virginia Beach are very densely populated urban and suburban lands. The southern portion of the city is agricultural and rural in character. As is the case in many areas of southeast Virginia, residential and industrial development pressures continue to increase. Extensive undeveloped portions of Virginia Beach are found only as protected lands within and adjacent to Back Bay and the North Landing River. Some lands nearby and adjacent to these protected areas are currently undeveloped but are likely to be fragmented and altered in the near future.

Physical and Abiotic Features

Climate. Weather data recorded at Norfolk, Virginia (just north of the Cities of Chesapeake and Virginia Beach) indicate that this region has a climate with hot, humid summers and mild winters. The average annual temperature is 15.3°C (59.5°F), with an average winter temperature of 5.6°C (42°F) and an average summer temperature of 25°C (77°F). The climate is classified as humid-subtropical (Neilson 1976), with a mean annual precipitation of about 45 inches. Heavy rainfall and strong winds associated with tropical storms and hurricanes can occur in summer and fall months. Northeasters, which typically occur during fall and winter, can also generate strong winds and associated heavy precipitation, frequently causing high water levels and local flooding (Bales and Skrobialowski 1994).

Geology and Soils. Portions of Chesapeake and Virginia Beach are underlain by the Poquoson, Lynnhaven, and Sedgefield members of the Tabb Formation (Rader and Evans 1993; Mixon *et al*. 1989). These units are composed of upper Pleistocene sands, silts, clays, and peats deposited on coast-parallel plains east of the Suffolk Scarp. These sediments overlie older Pliocene deposits of the Yorktown Formation (Oaks and Whitehead 1979). Floodplains of the Northwest and North Landing Rivers are mapped as Holocene marsh and intertidal mud deposits (Rader and Evans, 1993). Soils of the City of Chesapeake have been mapped by Henry *et al.* (1959), and soils of the City of Virginia Beach have been mapped by Hatch *et al*. (1985). Soils range from fibric and sapric peat to sandy, silty, and loamy mineral soils with varying degrees of drainage. Somewhat poorly drained to very poorly drained soils dominate the flat, low-lying landscape of this region.

Hydrology. The hydrologic conditions in Chesapeake and Virginia Beach are controlled by varying interactions of groundwater, palustrine-riverine flows, and estuarine processes. Wetland habitats include extensive, saturated or winter-flooded non-riverine flats, a full range of riparian swamps, and upper estuarine marshes and swamps. Even on uplands, the water table is near the surface for much of the year, and elevation differences of only a few centimeters can greatly influence vegetation and drainage. Hydrology of these flat, expansive interfluves has been altered by extensive ditching, which has improved drainage for agriculture and development in many places.

Northwest and North Landing Rivers

The Northwest and North Landing Rivers have similar hydrology. Both rivers emerge from groundwater on somewhat amorphous, peat-mantled landscapes similar to that of the Great Dismal Swamp. In their upper to middle sections, they are each characterized by sluggish, swamp-lined channels and extensive backswamps. In their lower sections, both rivers widen abruptly and become bordered by marshes, reflecting the increasing influence of estuarine processes. South of the Virginia-North Carolina line, each river empties into Currituck Sound, a laterally embayed arm of Albemarle Sound.

The lower Northwest and North Landing Rivers in Virginia represent upstream limits of an estuarine system formed in river valleys drowned by Holocene sea level rise (Copeland *et al.* 1983). While portions of the Albemarle-Pamlico estuary in North Carolina are influenced by diurnal tides, at present the closest open connection to the ocean is approximately 100 km south of the State Line at Oregon Inlet, North Carolina. Consequently, the effect of lunar tides on the Northwest and North Landing Rivers is negligible. However, because the river channels are now oversized for the volume of water they carry, low flow velocities allow irregular wind-driven currents (wind tides) to predominate over riverine flows on a short-term basis (Stanley 1992). Strong winds from the southeast move water northward from Currituck Sound and up the two rivers, flooding fringing marshes and swamps. Conversely, strong north to west winds result in lower water levels. Because wind speeds, direction, and duration are irregular, the frequency and duration of wind tides are highly

variable. Extreme amplitudes of wind tides on the Northwest and North Landing Rivers are not precisely known, but similar wind tides have been estimated to cause as much as 1.2 m (4 ft) of variation in the water surface of the Chowan River in North Carolina, and up to 1.0 m (3.28 ft) of variation in Back Bay, Virginia (Daniel 1977; Norman 1990). Field observations indicate that powerful southerly wind-tidal events during periods of high riverine flow can drive water levels up significantly nearly to the headwaters of these systems and their tributaries.

Salinity

The Northwest and North Landing Rivers also differ from classic tidal estuaries in their salinity regimes. Extensive refractometer measurements made by Fleming and Moorhead (1998) over a two-year period indicate that a freshwater regime (< 0.5 parts per thousand salinity) prevails in these drainages for extended periods, varying into the oligohaline range (0.5 - 5.0 ppt) under certain conditions. The highest salinities (4.0 ppt on the Northwest River and 5.0 ppt on the North Landing River) were measured during a period of very low riverine flow and following a strong southerly wind tide. Such conditions favor the movement of brackish water from Currituck Sound northward into these rivers.

It is likely that both hydrologic conditions and wetland vegetation of the North Landing and Northwest Rivers have been subject to frequent large-scale changes during the Holocene due to rising sea level, peat and sediment accumulation, and instability of the barrier island and Back Bay estuarine landscape. Within the past 350 years, large inlets on the Outer Banks near Back Bay and northern Currituck Sound have opened and closed, for a time allowing brackish/saline water and lunar tides to more directly influence these rivers (Doumlele 1976, Goldsmith 1977, Priest and Dewing 1991). A noteworthy aspect of the present-day river marshes is the prevalence of characteristic brackish marsh plants such as black needle rush (*Juncus roemerianus*) and big cordgrass (*Spartina cynosuroides*), as well as isolated colonies of true halophytes such as salt marsh cordgrass (*Spartina alterniflora*), in an essentially freshwater system. These plants are probably relicts of earlier, more brackish or saline conditions. Moore (1992) has noted that riverine estuaries are frequently characterized by a lack of long-term stability, by transitory biota, and by community composition that fluctuates with controlling environmental factors. Such instability is maintained here by continuing sea level rise, large-scale storm events, and land subsidence in the mid-Atlantic tidewater region.

Human Disturbance History

Although the two rivers are similar in many ways, the North Landing River is a larger system and has a history of major hydrologic disturbances. The Chesapeake and Albemarle (C&A) Canal was constructed in the 1850's to connect the upper part of the North Landing River to the Elizabeth River. The same project involved dredging to straighten, widen, and deepen portions of the river channel from the C&A Canal to Currituck Sound. Several short canals were also dug, cutting off oxbows and creating marsh islands (Clark and Potter 1995). The C&A Canal and North Landing River, along with the Dismal Swamp Canal along US Route 17, are now major components of the Intracoastal Waterway and carry heavy boat and barge traffic. Locks to prevent saline water of the Elizabeth River from reaching the North Landing River were installed on the C&A Canal, but were left open from 1918 to 1932 (Priest and Dewing 1991). In addition, in 1989, a bypass canal was constructed around an older canal which connects West Neck Creek, a major tributary of the North Landing River, to a tributary of the Lynnhaven River, allowing water with salinity up to 24.5 ppt into the North Landing drainage (Bales and Skrobialowski 1993). A recent report on water quality indicates that all 124 river km (77 river mi) of the North Landing River and five of its tributaries fully meet water quality standards for aquatic life support and fish consumption. (VDEQ 2000). DCR's Division of Soil and Water Conservation has given the North Landing River watershed an overall water quality rating of "high" based on nonpoint source contributions from agriculture, urban, and forestry activities (VDEQ 2000).

The Northwest River has not been subject to large-scale disturbances, although a channel was dredged through the headwaters section in the distant past. A number of other minor ditches and canals also drain into upper stretches of the river, but appear to have little hydrologic impact. Much of the lower, estuarine section of the Northwest River is located in North Carolina. A recent report on water quality indicates that all 54 river km (33 river mi) of this stream and two of its tributaries fully meet water quality standards for aquatic life support and fish consumption. DCR's Division of Soil and Water Conservation has given this watershed an overall water quality rating of "high" based on nonpoint source contributions from agriculture, urban, and forestry activities (VDEQ 2000).

Great Dismal Swamp

The Great Dismal Swamp is a vast, forested wetland that lies between the James River (and its tributaries) in southeastern Virginia and the Albemarle Sound (and its tributaries) in northeastern North Carolina. The western boundary of the Swamp is marked by the Suffolk Scarp, a linear, east-facing ridge which represents one of several Pleistocene shorelines in the region. In all other directions, the Dismal Swamp's boundaries are irregular and enclose non-riverine, largely peat-mantled flats not clearly associated with streams or flowing water. The original (pre-settlement) extent of the Swamp cannot now be determined because of a long history of human alterations to the landscape, but was undoubtedly much larger than the current area. Construction of the Dismal Swamp Canal (Intracoastal Waterway) in the early 1800's, altered the hydrology of lands lying to the east of present-day US Route 17 and permitted large areas of swamp to be "improved" (Oaks and Whitehead 1979).

Environmental development of the Great Dismal Swamp began about 12,000 years B.P. (before present) in a cold, late-glacial landscape. Developing wetlands consisted of open freshwater marshes with deep-water aquatic plants, and were confined to the vicinity of stream channels in the eastern part of the area. From about 10,600 to 8,200 years B.P., the climate moderated and marshes and peat deposits expanded to the west and onto the interfluves. From 8,200 to 3,500 years B.P., wetland vegetation shifted from a dominance of grasses and deep-water aquatics to a dominance of emergents and species characteristic of boggy habitats. Westward and lateral expansions of the peat deposits continued. The present-day swamp forest vegetation became established only about 3,500 years B.P. (Whitehead and Oaks 1979).

Early explorers and settlers found the Swamp a dark and forbidding place, but began exploiting its timber resources early in the post-settlement period (Simpson 1990). During the 19th and early 20th centuries, an extensive network of drainage ditches was constructed and the entire area was repeatedly logged and burned. In some cases, historical fires in the Dismal Swamp burned across thousands of acres, destroyed large areas of peat, and burned the roots of countless living trees (Dean 1969; Simpson 1990). As a result of these impacts, original vegetation was destroyed and replaced by secondary forest types that often reflect drier habitat conditions than before.

Despite past disturbances, the Great Dismal Swamp remains one of the largest areas of continuous forest on the Atlantic Coastal Plain and contains an exceptional number of rare communities, plants, and animals. More than 100,000 acres have been acquired by the U.S. Fish and Wildlife Service and are now managed as a National Wildlife Refuge. Several significant outlying areas of swamp habitat, some of them privately owned, also remain.

ECOSYSTEM DESCRIPTIONS

Northwest River

The Northwest River riparian corridor comprises the largest (~15,000 acres) and most important natural area lying entirely within the City of Chesapeake (Figure 1). Headwaters of the Northwest River originate from groundwater, ditches, and drainage on peat-mantled flats just east of U.S. Route 17 and the Great Dismal Swamp. The river flows about 23 river miles to the state line, then for another 10 river miles through North Carolina before emptying into Tull Bay, an embayed arm of Currituck Sound. Major tributaries of the Northwest River in Virginia are Shell Landing Creek, Indian Creek, and Smith Creek. Throughout its short course through Virginia, the Northwest River undergoes a remarkable ecological and hydrological transition. Beginning as a non-riverine, groundwater-controlled wetland, it becomes a sluggish, small coastal plain river winding through expansive swamp forests, then widening into a broad estuarine waterway with wind-tidal fluctuations and marsh-lined channels.

These diverse environmental conditions foster a correspondingly rich assemblage of natural communities, plants, and animals adapted to varied wetland habitats. Adding to this diversity are mesic, forested uplands bordering the swamps and locally occurring as islands within them. Moreover, a significant number of the Northwest River's communities and biotic elements are rare, both in Virginia and globally. Within an immediate area of approximately 12,000 acres, DCR-DNH biologists have identified 17 significant community occurrences, 22 rare plant species, and 12 rare animal species to date (Figure 2). Many of the community types, particularly those associated with non-riverine flats or wind-tidal, oligohaline estuarine environments, are considered globally rare endemics or near-endemics to the mid-Atlantic coastal plain embayed region of southeastern Virginia and eastern North Carolina (Fleming and Moorhead 1998). Among the plant and animal rarities, the rare Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) occurs throughout the Northwest River drainage, and the area also encompasses one of the last remaining strongholds of the state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*). Three plants considered globally rare occur here, cypress-knee sedge (*Carex decomposita*), winged seedbox (*Ludwigia alata*), and awned mountain-mint (*Pycnanthemum setosum*).

The City of Chesapeake has supported surveys and conservation work along the Northwest River. Figure 3 shows locations of conservation sites identified to date by DCR-DNH. Available conservation site plans and information on Northwest River sites are found in Appendices B and C, respectively.

Conservation site boundaries mapped in Figure 3 are boundaries which contain all known element occurrences and land determined to be important for long-term maintenance of the elements, or for water quality preservation or enhancement. The Nature Conservancy further describes site conservation boundaries as: "Collectively, the boundaries of the conservation targets and sustaining processes (i.e. ecological boundaries) delineate the functional conservation site – the area necessary to maintain the viability of the conservation targets over time, including the natural patterns and processes that sustain the targets" (The Nature Conservancy 2000a).

The Northwest River riparian corridor provides a relatively large area of connected natural wetland habitats in an otherwise agricultural and residential landscape. Neighboring state-owned and private lands in North Carolina complete an intact and functional wildlife – natural area corridor connecting the Great Dismal Swamp, Northwest River, and North Landing River watersheds (Erdle *et al*. 1994). While the Northwest River is a major recreational resource used for fishing, hunting, and boating it is less impacted by development and receives less recreational use than the nearby North Landing River. This lends a special quality of wildness to the experience of the river and its natural areas.

Approximately 2,250 acres of the middle and lower Northwest River wetlands are owned and managed by DCR as a state natural area preserve. The 763-acre Northwest River Park owned by the City of Chesapeake contains extensive natural habitats. Additional natural areas owned by The Nature Conservancy are also situated along the river east of Route 168 (Battlefield Blvd.), and east of Route 17, north of the river. However, thousands of wetland acres and adjacent forested uplands remain in private ownership. There are many actual and potential threats to this ecosystem, including increased water withdrawal for municipal water supplies, depletion of associated groundwater aquifers, agricultural and urban non-point pollution, fragmentation of large forest blocks, conversion of forest land to non-forest uses, poor forest harvesting practices, and suppression of natural fire regimes in fire-dependent community types (Erdle *et al*. 1994; Fleming *et al*. 1998; Siudyla *et al*. 1981).

North Landing River

The North Landing River watershed covers much of the western and southwestern portions of the City of Virginia Beach and eastern portions of the City of Chesapeake, comprising a total area of approximately 105,600 acres. The North Landing River is ecologically similar to the Northwest River but is a larger stream, with most of its total length in Virginia. It rises from groundwater and drainage in west-central portion of the City of Virginia Beach and flows southward, rapidly widening in its lower reaches before emptying into Currituck Sound just south of the Virginia-North Carolina state line (Figure 1). Like the Northwest River, the North Landing River changes in a remarkably short distance from a groundwater controlled wetland to a sluggish, medium-sized coastal plain river and finally to a broad estuarine waterway with wind-tidal fluctuations and extensive bordering marshes.

The North Landing River and its tributaries support a large concentration of rare species and a diverse array of globally rare and other significant community occurrences, making this an extremely important area for biodiversity conservation in the mid-Atlantic region (Erdle *et al*. 1994). Included are large and outstanding examples of non-riverine swamp forest, pond pine woodland and its high pocosin subtype, peatland Atlantic white cedar forest, and several globally rare types of oligohaline marshes (Fleming and Moorhead 1998). Some noteworthy rare plants and animals in the watershed are the rare Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*), the state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*), the federally listed Bald Eagle (*Haliaeetus leucocephalus*), and the globally rare plants, Virginia least trillium (*Trillium pusillum* var *virginianum*), cypress-knee sedge (*Carex decomposita*), winged seedbox (*Ludwigia alata*), and Carolina lilaeopsis (*Lilaeopsis carolinensis*)(Figure 2).

The City of Virginia Beach has supported surveys and considerable conservation work along the North Landing River. Locations of conservation sites identified to date by DCR-DNH are shown in Figure 3. Available conservation site plans and information on sites on the North Landing River are found in Appendices B and D, respectively.

Despite its proximity to a major urban area, a history of disturbances, and continued use as part of the Intracoastal Waterway, the North Landing River provides a large, continuous corridor of natural wetland habitats through a landscape otherwise largely agricultural and residential in character. State-owned and private lands in North Carolina partially complete an excellent wildlife/natural area corridor that connects this river with the Northwest River and ultimately the Great Dismal Swamp (Erdle *et al*. 1994; Frost *et al.* 1990). The North Landing River is a major recreational resource used extensively for boating, hunting, and fishing. In 1988, this river and its tributaries were designated a state and local scenic resource according to the Virginia Scenic Rivers Act (Code of Virginia '10.1-

Figure 2. Locations of natural heritage element occurrences in the Southern Watershed Area

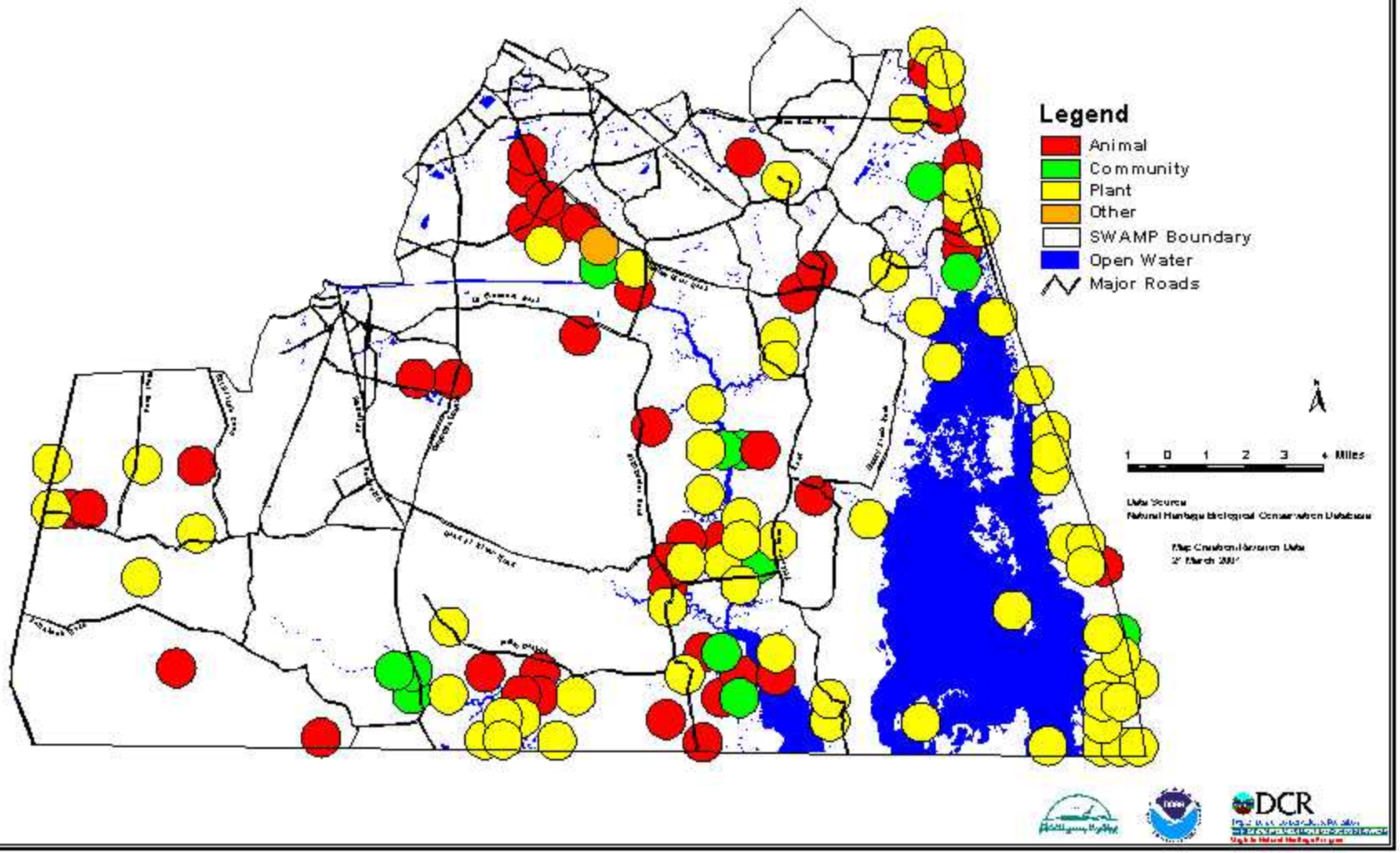
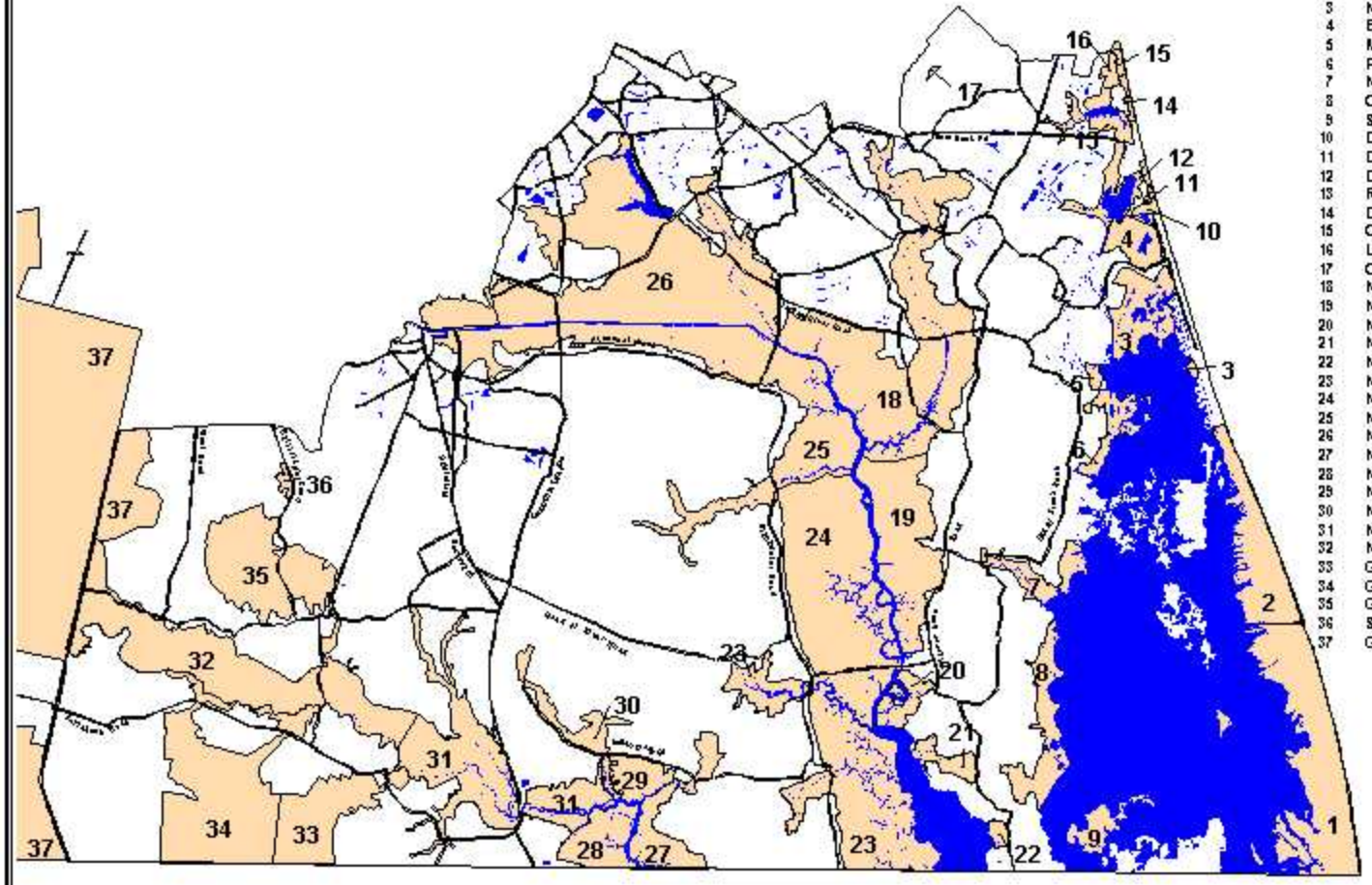


Figure 3. Conservation sites in the Southern Watershed Area



Number	Conservation Site Name
1	False Cape
2	Main Flats
3	North Bay Marshes
4	Black Gut
5	Muddy Creek
6	Porpoise Point
7	Nawney Creek
8	Campbell Landing
9	Sedge Island
10	Dam Neck Interdunal Swale
11	Dam Neck Helicopter Pad Wetlands
12	Dam Neck Middle Beach Dunes
13	Redwing Lake
14	Dam Neck Northern Dune and Swale
15	Camp Pendleton Dune and Swale
16	Lovetts Marsh
17	Old Woods
18	North Landing River: West Neck Creek
19	North Landing River: Eastern Marshes
20	North Landing River: Piney Grove Church
21	North Landing River: Oakum Creek
22	North Landing River: Morse Point
23	North Landing River: Southern Marshes
24	North Landing River: Pocaline
25	North Landing River: Pocaty River
26	North Landing River: Gum Swamp
27	Northwest River: Smith Creek
28	Northwest River: Southwestern Marshes
29	Northwest River: Northwest River Park
30	Northwest River: Indian Creek
31	Northwest River: Middle Section
32	Northwest River: Headwaters
33	Great Dismal Swamp: NSGA Northwest
34	Great Dismal Swamp: Smith Ridge
35	Green Sea
36	Shillelagh Road Flatwoods
37	Great Dismal Swamp

Data Source:
VA Natural Heritage

Map Created/Revised Date:
2nd March 2007

400 - 418), an act which provides formal recognition but does not establish scenic buffers or restrictions on visual intrusion.

Wetlands along the river have been a major focus of biodiversity protection efforts since 1989. To date, approximately 11,000 acres of wetlands have been acquired by DCR and the Virginia Chapter of The Nature Conservancy and are jointly managed as a natural area preserve (Clark and Potter 1995). Additional public lands are owned by the City of Virginia Beach and the U.S. Army Corps of Engineers. However, most land within the watershed is privately owned. There are many actual and potential threats to this ecosystem, including loss of a natural fire regime, habitat loss and fragmentation, altered surface water quality from agricultural and urban non-point source pollution, groundwater depletion, exotic and invasive species, and recreational over-use (Clark and Potter 1995; Erdle *et al*. 1994; Siudyla *et al*. 1981; Stevens and Patterson 1998).

Back Bay

The Back Bay watershed is nestled in the southeastern most corner of the state and comprises approximately 66,750 acres, including 25,100 acres of open water. Back Bay, the northern portion of the Currituck Sound embayment, is a large body of brackish water lined by marshes, shrubby wetlands, and swamps. The entire embayed area is separated from the Atlantic Ocean by a relatively narrow sand spit, which has historically been breached and broken repeatedly, creating temporary inlets. Since the closing of Currituck Inlet during a storm in 1830, Back Bay has changed from a tidally influenced saltwater estuary to a wind tide dominated fresh/brackish estuary.

Included in the Back Bay watershed are several smaller waterbodies such as Redwing Lake, Brinson's Inlet Lake (Lake Tecumseh), and Black Gut, as well as extensive agricultural areas on uplands. Major tributaries to Back Bay include Muddy Creek, Beggar's Bridge Creek, Nawney Creek, Devil Creek, Black Gut, Ashville Creek, Hell Point Creek, Scopus Marsh, and Lake Tecumseh (Figure 1). Some marshes are dominated by common reed (*Phragmites australis*), an invasive grass that grows to 10-ft and taller and can rapidly colonize and completely occupy adjoining areas. Other marshes are in their natural state and support a more diverse mosaic of vegetation types. Prevalent species in these natural marshes include big cordgrass (*Spartina cynosuroides*), narrow-leaved cattail (*Typha angustifolia*), Olney's bulrush (*Scirpus olneyi*), and black needle rush (*Juncus roemerianus*).

Back Bay, the adjacent uplands, and tributaries support a large concentration of rare species and a diverse array of globally rare and other significant community occurrences, making this an extremely important area for biodiversity conservation in the mid-Atlantic region (Clampitt *et al*. 1993). Eight rare ecological communities have been documented from the Back Bay watershed. Included are a significant barrier beach system, maritime dune grasslands, maritime shrub swamps, and one of the region's finest maritime evergreen forests, as well as several globally rare types of oligohaline marshes (Clampitt *et al*. 1993; Fleming and Moorhead 1998). Among the 40 rare plant occurrences are fibrous bladderwort (*Utricularia striata*), sticky ground-cherry (*Physalis walteri*), bay-gail holly (*Ilex coriacea*), cottony golden-aster (*Chrysopsis gossypina*), and pale grass–pink (*Calopogon pallidus*). The Back Bay watershed supports 10 rare animals, including the federally listed Bald Eagle (*Haliaeetus leucocephalus*), state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*), Least Bittern (*Ixobrychus exilis*), loggerhead turtle (*Caretta caretta*), stripe-winged baskettail (*Epitheca costalis*), and eastern glass lizard (*Ophisaurus ventralis*)(Figure 2).

Wetlands and uplands of Back Bay have been the focus of conservation and resource management activities by both the state and federal government. Within this watershed are two National Wildlife Refuges (NWR), Back Bay NWR and Mackay Island NWR, False Cape State Park, False Cape Natural Area Preserve, and two state Wildlife Management Areas (WMA), Trojan WMA and

Princess Anne WMA. Back Bay is an important wintering ground for a number of game waterfowl, and consequently the watershed has also been designated as the Back Bay Focal Area, a component of the North American Waterfowl Management Plan. Large, unfragmented forests in the Back Bay watershed also serve as critical stopovers for neotropical migratory songbirds and migrating shorebirds. In addition to fishing and hunting, other recreational activities in Back Bay watershed include canoeing, water skiing, boating, biking and camping (Erdle *et al*. 1994; Mabey *et al.* 1993).

The City of Virginia Beach and several federal agencies have supported extensive surveys and conservation work in the Back Bay watershed (see Figure 3 for locations of conservation sites identified by DCR-DNH). Available conservation site descriptions and site information for sites in the Back Bay watershed are found in Appendix E.

Long-term health of Back Bay and its associated waterways is threatened by non-point source water pollution, further fragmentation of existing forested lands, groundwater pollution, invasive species, and recreational over-use. In recent years, there has been a precipitous decline in the amount and health of submerged aquatic vegetation (SAV) in Back Bay, a likely result of decreased water quality / increased turbidity (Morton and Kane 1994; Siudyla *et al*. 1981).

NATURAL RESOURCES

The SWA supports a multitude of natural resources, including extensive wetlands, productive forest and agricultural lands, mineral resources, extensive waterways for boating and fishing, hunting for a variety of game species, recreational beaches, and numerous other water-related recreational opportunities. Along with its well-known tourist beaches, the area features a coastal state park, national wildlife refuges, and other public and private protected lands that represent critically important habitats for migratory birds, including both waterfowl and land-bird species. These in turn support outdoor recreation activity that includes bird- and wildlife-watching, plus a long tradition of waterfowl hunting in and around Back Bay and its extensive marshlands.

In addition to the many natural resources with which most residents, visitors, and tourists are familiar, the SWA also supports a remarkable array of *natural heritage resources*. These are the habitats of rare, threatened or endangered plant and animal species, rare or state significant communities, and other natural features. DCR-DNH has documented the presence of 19 rare natural communities, 67 rare plants, and 22 rare animals within the SWA (see Figure 2 for general locations of these natural heritage resource occurrences).

Natural Communities

The SWA lies near the northern terminus of the Southeastern Evergreen Forest Region, which stretches from southeastern Virginia to eastern Texas on the Atlantic and Gulf Coastal Plains (Braun 1950). This region is characterized by a prevalence of pine and pine-hardwood communities along with large areas of swamp forest and bottomland hardwoods along rivers and drainageways, plus local areas of mesic hardwood forest on uplands. A more recent classification (Keys *et al*. 1995) includes the SWA within the Outer Coastal Plain Mixed Forest Province, Atlantic Coastal Flatwoods Section, Tidal Area Subsection. Potential natural vegetation of the Tidal Area Subsection is characterized by pond pine – Atlantic white cedar – red maple forest, loblolly bay – pond pine forest, and black needlerush marsh communities. Scientific names for natural communities used in this plan are based on the classification work of Fleming and Moorhead (1998). While community names follow a standard list maintained by DCR-DNH (Fleming *et al*. 2001), many are adapted from Schafale and Weakley (1990).

There are many reasons to protect and conserve natural communities of plants and animals, both terrestrial and aquatic. In particular, rare communities – those with few remaining examples or occurrences – are especially in need of protection. Communities represent functioning units of the landscape that:

- support myriad life forms—many too cryptic or poorly known to be catalogued and prioritized individually;
- provide required habitat and symbiotic relationships for both rare and common species;
- comprise the living component of local ecosystems;
- possess unique scientific, educational, and aesthetic values.

Community Types

Upland forests. This type includes both infertile, dry oak-hickory forests of xeric sandy uplands and somewhat infertile to moderately fertile mesic mixed hardwood forests of well-drained uplands and slightly elevated "islands" within swamps. Dry oak-hickory forests are locally common in the Virginia coastal plain but rare in the generally flat, poorly drained landscape of the City of Chesapeake. Characteristic trees include white oak (*Quercus alba*), southern red oak (*Quercus falcata*), post oak (*Quercus stellata*), water oak (*Quercus nigra*), mockernut hickory (*Carya alba*), sand hickory (*Carya pallida*), and loblolly pine (*Pinus taeda*). Understory and shrub species include flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), horse-sugar (*Symplocos tinctoria*), and ericaceous (heath-family) shrubs such as lowbush blueberry (*Vaccinium pallidum*), black huckleberry (*Gaylussacia baccata*), and mountain-laurel (*Kalmia latifolia*l). Mesic mixed hardwood forests are widely distributed in fragmented patches in the southeastern corner of the Virginia and southward on the outer coastal plain. They have been much reduced by agricultural conversion, logging, and development. Significant occurrences represent the most mature and floristically distinctive stands. Characteristic species include American beech (*Fagus grandifolia*), white oak, tuliptree (*Liriodendron tulipifera*), hickories (*Carya* spp.), American holly (*Ilex opaca*), eastern hophornbeam (*Ostrya virginiana*), silky camellia (*Stewartia malacodendron*), and Christmas fern (*Polystichum acrostichoides*). Upland forests are important habitats for migratory songbirds, many common mammals, and the state endangered canebrake rattlesnake (*Crotalus horridus atricaudatus*).

Peatland Evergreen Forests. This class includes Atlantic white cedar forests and pond pine woodlands, both characterized by coniferous canopy trees and broad-leaved evergreen shrub layers. Characteristic trees of this class include Atlantic white cedar (*Chamaecyparis thyoides*) and pond pine (*Pinus serotina*), as well as broad-leaved evergreen bay species such as sweetbay (*Magnolia virginiana*) and red bay (*Persea palustris*). Typical shrubs include shining fetterbush (*Lyonia lucida*), inkberry (*Ilex glabra*), laurel-leaf greenbrier (*Smilax laurifolia*), and highbush blueberry (*Vaccinium corymbosum*). Sparsely canopied, densely shrubby stands of pond pine woodland are commonly known as high pocosins (Fleming and Moorhead 1998). Confined to saturated peat substrates and fire-influenced habitats, community types of this group are rare and declining in Virginia, due to widespread fire reduction, logging, and habitat destruction. Occurrences in the SWA tend to be small and confined to peat flats along the Northwest and North Landing Rivers (with additional limited occurrences in the Great Dismal Swamp).

Flooded Swamp Forests. This class encompasses swamp forests of coastal plain floodplains and poorly drained interstream flats subject to seasonal or semi-permanent inundation. Characteristic plants of the class include baldcypress (*Taxodium distichum*), swamp tupelo (*Nyssa biflora*), water tupelo (*Nyssa aquatica*), red maple (*Acer rubrum*), ashes (*Fraxinus* spp.), Virginia willow (*Itea virginica*), and lizard's tail (*Saururus cernuus*). Community types include seasonally to

semipermanently flooded tupelo-baldcypress swamps of eutrophic river basin flats; sloughs and backswamps; seasonally flooded coastal plain bottomland hardwoods of mineral soil swamps along smaller tributary streams; estuarine fringe swamp forests of wind tidally flooded peatlands bordering the North Landing and Northwest Rivers; and seasonally flooded non-riverine swamp forests of interfluve peat or clay flats. Evidently confined to the mid-Atlantic coastal embayed region, the last two types are globally rare, although locally common in this region (Fleming and Moorhead 1998). In the City of Chesapeake, flooded swamps provide large expanses of unbroken natural habitat in a landscape otherwise dominated by agricultural and residential uses. Consequently, they are very important to a large array of nesting birds, mammals, amphibians, reptiles, and invertebrates.

Non-Riverine Saturated Forests. This class includes forests of saturated interstream flats with perched water tables and mineral soils, or thin organic soils. Most common is non-riverine pine-hardwood forest, a successional unit dominated by loblolly pine, red maple, sweetgum (*Liquidambar styraciflua*), often with a dense giant cane (*Arundinaria gigantea* ssp. *tecta*) understory. Non-riverine wet hardwood forest, characterized by hydrophytic oaks such as swamp chestnut oak (*Quercus michauxii*) and laurel oak (*Q. laurifolia*) is evidently confined to the embayed region of the mid-Atlantic coastal plain. This community type is highly threatened by drainage, logging, and outright destruction by development, and is now generally limited to small patches.

Oligohaline Tidal Marshes and Woody Ecotones. Marshes and related shrubland and woodland communities occupying low-salinity estuarine environments comprise this class. These communities occur in patch mosaics along the lower Northwest River and along the most downstream portions of the North Landing River located in the City of Chesapeake. Woody vegetation includes tidal baldcypress woodland/savanna and tidal shrub swamp. Marsh vegetation is typically mixed and includes community types characterized by big cordgrass (*Spartina cynosuroides*), black needlerush (*Juncus roemerianus*), and spikerushes (*Eleocharis* spp.). Although both big cordgrass and black needle rush communities are typical of brackish marshes, those of the nearly fresh, wind tidal marshes of the Albemarle-Pamlico estuary are considered to be somewhat unique in their floristic composition and preponderance of freshwater associates. Virtually all community types in this class are considered more or less globally rare due to their geographic restrictions and narrow habitat requirements (Fleming and Moorhead 1998). The marshes provide important habitats for aquatic mammals, breeding waterfowl, and amphibians.

Oligohaline Floating / Aquatic Vegetation. A single community type in this class, best developed in shallow, protected guts and pools in the wind tidally flooded marshes of the Northwest River, is recognized in the SWA. Characteristic species are common hornwort (*Ceratophyllum demersum*), greater bladderwort (*Utricularia macrorhiza*), American water-lily (*Nymphaea odorata*), and other floating or submergent macrophytes. These aquatic habitats are important breeding and foraging sites for damselflies and dragonflies, specialized insects, crustaceans, amphibians, reptiles, and some fish.

Brackish and Saline Tidal Marshes. Lunar tidal brackish and salt marshes occur in the northern portion of the City of Chesapeake along branches of the Elizabeth River. Marshes characterized by saltmarsh cordgrass (*Spartina alterniflora*), saltmeadow cordgrass (*Spartina patens*), saltgrass (*Distichlis spicata*), and black needlerush (*Juncus roemerianus*) were observed in a number of localities. These marshes are extremely important as habitats for breeding and migratory waterfowl.

Rare Communities. A total of 19 rare community types, classified as significant by DCR-DNH, have been documented from the SWA (Figure 2). Table 1 lists these communities and their global and state status ranks. Comprehensive descriptions of the wetland community types are found in Fleming and Moorhead (1998) and Fleming *et al*., 2001. Descriptions of significant occurrences are provided in the appended conservation site reports. Some community types are yet to be officially

ranked while ongoing efforts by Natural Heritage programs continue that will determine global community ranges and number of occurrences.

Table 1. Rare Natural Communities of the Southern Watershed Area

Common Name	Global and State Rarity Ranks
bald cypress-tupelo swamp	G5?* S4
coastal plain bottomland hardwood forest	G3G4 S2?
estuarine fringe swamp forest	G2? S1S2
high pocosin	G2? S1S2
maritime evergreen forest	G2? S1
maritime scrub	G? S2
maritime shrub swamp	G? S2
maritime wet grassland	G? S2
mesic mixed hardwood forest	G? S3?
non-riverine swamp forest	G2G3 S1S2
non-riverine wet hardwood forest	G2 S2
pond pine forest / woodland	G2? S1S2
peatland Atlantic white cedar forest	G2 S1
tidal bald cypress woodland / savanna	G1Q S1
tidal oligohaline marsh – big cordgrass type	G2G3 S2S3
tidal oligohaline marsh – black needlerush type	G2G3 S2S3
tidal oligohaline marsh - spikerush type	G1G2 S1
tidal pool gut	G3? S1
tidal shrub swamp	G2G3 S2

*Community ranks with a question mark are awaiting official ranking.

Plants and Animals

Rare species are defined in terms of the number of known occurrences range-wide (global or G-rank) and also relative to the number of occurrences within the Commonwealth (state or S-rank). They include species with global ranks of G1, G2, G3 and G4, and state ranks of S1, S2, S3, SH, SX, and SU. Data on species with state ranks of S1, S2, SH, and SX (see Appendix A for symbol explanation) are summarized on periodically-updated master lists of Virginia's rare plants (Belden 1999) and rare animals (Roble 1999). Species with state ranks of S3 and SU are maintained on a separate "watch list." Only general information about watch list species is recorded in the field and maintained in DCR-DNH manual information files.

Plants. The SWA supports hundreds of plant species, both common and rare. Some of the species are well known, and have long documented and anecdotal histories such as giant cane (*Arundinaria gigantea* ssp. *tecta*). While native vegetation is a critical natural resource, attention is focused here on the uncommon or rare plant species. A listing of the rare plants of the SWA is provided in Table 2.

Table 2. Rare Plants of the Southern Watershed Area

Scientific Name	Common Name	Global and State Rarity Ranks
Aster puniceus var *elliottii*	Elliott's aster	G5T3T4 S1

Calephelis virginiensis	little metalmark	G4 S2
Calopogon pallidus	pale grass-pink	G4G5 SH
Carex decomposita	epiphytic sedge	G3 S2
Carex lupuliformis	false hop sedge	G3? S1
Carex reniformis	reniform sedge	G4? SH
Chamaesyce bombensis	southern beach grass	G4G5 S2
Chrysopsis gossypina	cottony golden-aster	G5 S1
Cladium jamaicense	sawgrass	G4 S1
Cleistes divaricata	spreading pogonia	G4 S1
Coreopsis falcata	pool coreopsis	G4G5 S1
Crataegus aestivalis	may hawthorn	G5 S1
Cuscuta cephalanthi	button-bush dodder	G5 S1?
Cuscuta indecora	pretty dodder	G5 S2?
Cuscuta polygonorum	smartweed dodder	G5 S2?
Dichanthelium consanguineum	blood witchgrass	G5 S1?
Eleocharis halophila	salt-marsh spikerush	G4 S1
Eleocharis radicans	rooted spikerush	G5 SH
Eleocharis vivipara	viviparous spikerush	G5 S1
Enallagma pallidum	pale bluet	G4 S1
Erigeron vernus	white-top fleabane	G5 S2
Eriocaulon decangulare	ten-angle pipewort	G5 S2
Heliotropium curassavicum	seaside heliotrope	G5 S1
Hottonia inflata	featherfoil	G4 S2S3
Hydrocotyle bonariensis	coastal-plain penny-wort	G5 S1?
Ilex coriacea	bay-gail holly	G5 S2
Iva imbricata	sea-coast marsh-elder	G5? S1S2
Juncus elliottii	bog rush	G4G5 S1S2
Juncus megacephalus	big-head rush	G4G5 S2
Kalmia carolina	Carolina sheep-laurel	G4 S2
Lilaeopsis carolinensis	Carolina lilaeopsis	G3? S1
Lipocarpha maculata	a lipocarpha	G5 S1
Lobelia elongata	elongated lobelia	G4G5 S1
Ludwigia alata	winged seedbox	G4 S1
Ludwigia brevipes	long beach seedbox	G4G5 S2
Ludwigia ravenii	raven's seedbox	G2? S1
Ludwigia repens	creeping seedbox	G5 S1
Ophioglossum petiolatum	longstem adder's-tongue	G5 SH
Panicum hemitomon	maidencane	G5? S2
Paspalum dissectum	water paspalum	G4? S2
Paspalum distichum	joint paspalum	G5 S1
Phlox pilosa ssp pilosa	downy phlox	G5T5 S2
Phyla nodiflora	common frog-fruit	G5 S1
Physalis walteri	sticky ground-cherry	G4 S2
Physostegia leptophylla	slender-leaved dragon-head	G4? S2S3
Pycnanthemum setosum	awned mountain-mint	G3? S1
Quercus hemisphaerica	Darlington's oak	G5 S1
Quercus incana	blue jack oak	G5 S2
Ranunculus hederaceus	long-stalked crowfoot	G5 SH
Rhynchospora cephalanatha var.	many-headed beakrush	G5T? S2

pleiocephala		
Rhynchospora colorata	white-topped sedge	G5 S1
Rhynchospora debilis	savannah beakrush	G4? S1
Rhynchospora fascicularis var *fascicularis*	fasciculate beakrush	G5T? S1?
Rhynchospora macrostachya var. *macrostachya*	tall horned beakrush	G4T? S2
Solidago latissimifolia	Elliott goldenrod	G5 S2
Solidago tortifolia	a goldenrod	G4G5 S1
Sphagnum macrophyllum var macrophyllum	large-leaf peatmoss	G3T3 S2
Sphagnum trinitense	Trinidad peatmoss	G4 S2S3
Stachys aspera	rough hedge-nettle	G4? S2
Tillandsia usneoides	spanish moss	G5 S2
Trillium pusillum var virginianum	Virginia least trillium	G3T2 S2
Utricularia purpurea	purple bladderwort	G5 S2
Utricularia striata	fibrous bladderwort	G4G5 S1
Vaccinium macrocarpon	large cranberry	G4 S2
Verbena scabra	sandpaper vervain	G5 S2
Xyris fimbriata	fringed yellow-eyed-grass	G5 S1
Xyris iridifolia	irisleaf yellow-eyed grass	G4G5T4T5 S1

*Rare plant ranks with a question mark are awaiting official ranking.

Animals. The SWA supports hundreds of animal species, both common and rare. Some of the species are well known, and have long documented, as well as anecdotal histories such as the black bear (*Ursus americanus*), the white-tailed deer (*Odocoileus virginianus*), and the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*). While all native animals are critical natural resources, attention here is focused on the uncommon or rare animal species. A listing of the rare animals of the SWA is provided in Table 3.

Table 3. Rare Animals of the Southern Watershed Area

Scientific Name	Common Name	Global and State Rarity Ranks
Siren lacertina	greater siren	G5 S2
Crotalus horridus atricaudatus	canebrake rattlesnake	G4TUQ S1
Ophisaurus ventralis	Eastern glass lizard	G5 S1
Ardea alba	Great Egret	G5 S2BS4
Haliaeetus leucocephalus	Bald Eagle	G4 S2
Ixobrychus exilis	Least Bittern	G5 S2
Limnothlypis swainsonii	Swainson's Warbler	G4 S2
Rallus elegans	King Rail	G4G5 S2
Rallus limicola	Virginia Rail	G5 S2
Corynorhinus rafinesquii	eastern big-eared bat	G3G4 S1
Myotis austroriparius	southeastern myotis	G3 S1
Sorex longirostris fisheri	Dismal Swamp southeastern shrew	G5T2T3 S2
Utterbackia imbecillis	paper pondshell	G5 S2S3
Pseudopolydesmus paludicolous	a millipede	G1 S1
Altides halesus	great purple hairstreak	G5 S2S3
Epitheca costalis	stripe-winged baskettail	G4 S2

Euphyes dukesi	scarce swamp skipper	G3 S2
Euphyes pilatka	saw-grass skipper	G3G4 SH
Chlorachroa dismalia	Dismal Swamp green stinkbug	G2 S1
Ploiaria hirticornis	an assassin bug	G3? S1
Cicindela trifasciata	a tiger beetle	G5 S1

*Rare animal ranks with a question mark are awaiting official ranking.

DEVELOPMENT OF CONSERVATION CORRIDORS

Conservation corridors are linear green-belts or open-space that ideally connect larger, undeveloped areas of natural vegetation. Designating conservation corridors in advance of a fast-developing urban landscape is a proactive approach for retaining natural landscape connectivity, natural resources, and other open-space benefits. Corridors situated in already developed areas have great potential for restoring open-space and landscape level ecosystem functions in localities that have undergone rapid urban growth. Connecting remnant patches (fragments) of natural habitat optimizes the use of land as open-space and increases the functions of natural areas that remain within an overall landscape context of intensive human use. A system of conservation corridors will sustain natural communities and populations of native plants and animals while also providing a multitude of values to society, including:

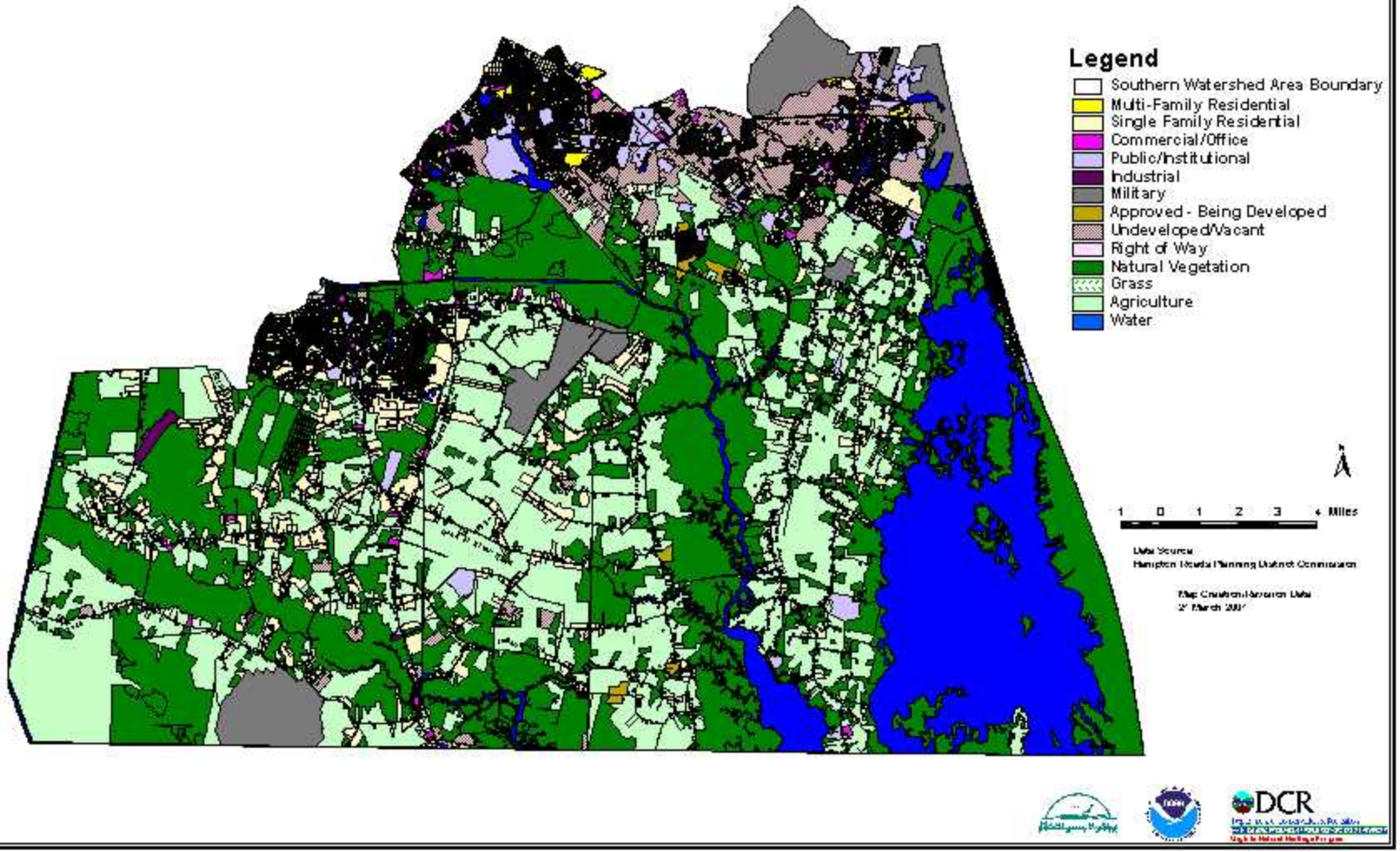
- protection of riparian systems;
- improved surface and ground water quality;
- reduced air and noise pollution
- recreational opportunities such as wildlife-watching, canoeing, kayaking, hunting and fishing where appropriate, walking, hiking, and bicycling;
- natural history, natural resource conservation, and biological educational opportunities;
- enhanced property values;
- improved quality of life.

Need for a New Conservation Strategy

Many localities have seen the need to plan patterns of urban development in ways that retain open space and have developed programs that designate green belts, greenways, and conservation corridors (City of Raleigh, NC 2000; City of New York 2000; Indy Greenways Plan 1999; Roanoke Valley Greenways 2000). While requiring dedication of substantial land area for their creation, corridors have immeasurable tangible and intangible value. Retained green space enhances real estate values of neighboring and nearby property (Adams and Mundy 1991; Fausold and Lilieholm 1999; Vicary 1994) and riparian corridors protect drinking water supplies. Along with improved water quality and reduction of air and noise pollution, benefits to the community from retained open space in conservation corridors include enhanced recreational opportunities such as fishing, hunting, canoeing, boating, walking, running, bicycling, and wildlife-watching. Opportunities for outdoor education, natural history interpretation, and nature-based tourism businesses are improved as well.

The northern portions of Virginia Beach and Chesapeake have been intensively developed and urban sprawl is now rapidly advancing southward. As of January 2001, the middle and southern portions of the SWA remain somewhat rural with a landscape comprised of agricultural and forest lands (Figure 4). However, residential and commercial land uses are increasing rapidly. Development of the SWA during the 1990's has heightened concerns for preserving water quality, retaining land uses associated with farm and forest land, and maintaining rural character of the area. To address these concerns, a

Figure 4. Land use in the Southern Watershed Area



new way of thinking about conservation is required that will allow continued acceptable development while retaining some undeveloped lands that provide the values and benefits of open space.

The North Landing River, Northwest River, and Back Bay watersheds are bordered by relatively intact riparian corridors consisting of more or less continuous linear areas of mostly wetland forest vegetation. These corridors persist in part because hydric soils have prohibited conversion to other land uses, but also because of conservation actions by public and private organizations to acquire and protect these areas. Figure 5 maps the public lands and private protected lands in and adjacent to the SWA. Through the efforts of local, state, and federal agencies as well as private organizations, the SWA still supports examples of functioning ecosystems which provide relatively clean water and a multitude of other benefits. However, as the area becomes more urban, water quality is threatened by increased nutrient, sediment, and chemical inputs from commercial and residential developed areas. Habitat for a high diversity of wildlife species, outdoor recreational opportunities, and scenic values of rural landscapes will decline and finally be eliminated unless additional measures to retain open space are taken.

Additional corridor lands could include restored areas of both currently developed areas plus marginal crop lands. Increasing buffer zone width would offer greater protection to tributary creeks, marshes, and primary water courses and ensure a high quality supply of municipal water in the SWA. Effects of habitat fragmentation on wildlife movements would also be reduced by connections provided by large unbroken linear forest. Public demands for recreational uses such as walking, running, hiking, and interpretive nature trails and water trails for canoes and kayaks could be met while still providing sufficiently large patches of habitat for natural areas and sustainable stewardship forests.

A successful conservation strategy for the SWA must determine how to maintain water quality, functioning ecosystems, and rural land uses. Future work should build on accomplishments to date, and lead to protection of attributes and qualities important to the health of both humans and other native life forms of the area. The challenge is to accomplish this goal in a rapidly developing, human-dominated landscape setting.

Conservation Corridor Options

When designing conservation corridors, it is essential to consider: 1) original goals for the corridor initiative; 2) larger natural areas to be connected by the corridors and resources that they support; 3) various uses that take place in the corridors presently and potentially; 4) wildlife species that use or may use the corridors in the future, plus their ecology, habitat requirements, and movement abilities; 5) human/wildlife interactions; and 6) future considerations such as development pressure, economic change, local long-term planning, and for coastal areas - sea-level rise (Pugh 1994).

To adequately address wildlife habitat requirements, a conservation corridor system should encompass: 1) multiple pathways linking retained habitat; 2) reservation of larger areas of suitable habitat at periodic intervals along corridors; 3) linked corridors representing a sample of existing topographic and habitat types; 4) a hierarchy of corridors comprised of broad regional corridors established to restore links between isolated forests, major wildlife corridors within production forests to link important reserved areas and a network of smaller wildlife corridors forming common linkages in the system of retained habitat (Miller *et al*. 1998; Pugh 1994;).

Five conservation corridor options are presented below. These options are named using the term *density* (commonly used to describe numbers of items within a unit of area). In this context, *density* refers to the amount of conservation corridor area within the SWA. Options are presented in order of

increasing *density*, from lowest to highest. Also included are descriptions, possibilities, and general conservation and protection considerations.

Low corridor density. This lowest level conservation option is comprised of the current acreage (30,307.2 acres, Appendix F) of public and private protected lands in the SWA (Figure 6). Many of these areas are located within the riparian zones of the Northwest River, North Landing River, or Back Bay. Following riparian borders, these lands are mostly linear in arrangement. However, they do not currently form a cohesive, contiguous, and connected system of protected lands. Large areas between parcels are not presently protected from development or land-use alterations. As present patterns of urban growth continue, habitat fragmentation will further alter the landscape, eventually eliminating corridors for wildlife movement and genetic exchange, and decreasing open space recreational opportunities. Rural land uses on low uplands and drained agricultural fields between protected wetlands will be replaced by developments. As this pattern continues and culminates, current levels of water quality are unlikely to be maintained. While some further acquisition of land for natural areas may occur in the SWA, it is presently improbable that a cohesive corridor development effort will occur.

Moderate-low corridor density. Figure 7 displays a second level of conservation corridor density. This option includes both currently-protected lands plus those linear areas (within watersheds) that connect them – up to a width of one-half mile (50248.7 acres, Appendix F). This corridor plan would require establishing minimal connections through various land protection tools such as conservation easements and purchases from willing sellers. Habitat restoration and mitigation lands would be appropriate and recommended for land areas acquired within the connecting corridor zones. Adoption of this moderately low conservation corridor density would provide somewhat increased potential for long-term water quality protection and riparian habitat protection. It would also link currently-protected public and private conservation lands, and provide a permanent habitat connection between the Great Dismal Swamp and Currituck Sound ecosystems via the Northwest River. The resulting minimal, although improved, corridor system would provide some increased benefits. However, considerable habitat fragmentation and loss would continue to occur as large areas of rural land are eliminated. Overall, only small additional resources would be protected from land-use alterations with this density of conservation corridors.

Medium corridor density. Under a third scenario that would result in a medium level of corridor density, the simple corridor system defined in the previous example is augmented by additional unprotected Natural Heritage Conservation Sites from the SWA (total of 94,853.4 acres, Appendix F). These Conservation Sites consist of those areas identified to date by DCR-DNH scientists (see Appendices C, D, and E) that support occurrences of Natural Heritage Resources. While some are disjunct fragments, most sites form distinct and continuous corridors in the Northwest River, North Landing River, and Back Bay watersheds (Figure 8). Some Natural Heritage Conservation Sites are publicly owned; however, most are in private ownership with many in agricultural use. Such areas, once acquired from willing sellers or included under purchased easements, would be promising locations for mitigation banks and habitat restoration projects. Appropriate, sustainable silvicultural land uses could be compatible with other resource protection and habitat management objectives. Attaining this level of conservation corridor density in the SWA would greatly facilitate water quality enhancement objectives, wildlife migrations, plant dispersal, and recreational opportunities. Along with a successfully adopted Agricultural Conservation Plan, preservation of a rural landscape might be attainable with this option.

Moderate-high corridor density. A fourth level of resource conservation proposed for the SWA would involve moderately-high corridor density and include (1) existing public and private conservation lands, (2) known Natural Heritage Conservation Sites, and (3) half-mile wide corridors,

Figure 5. Public lands and private protected lands in and adjacent to the Southern Watershed Area

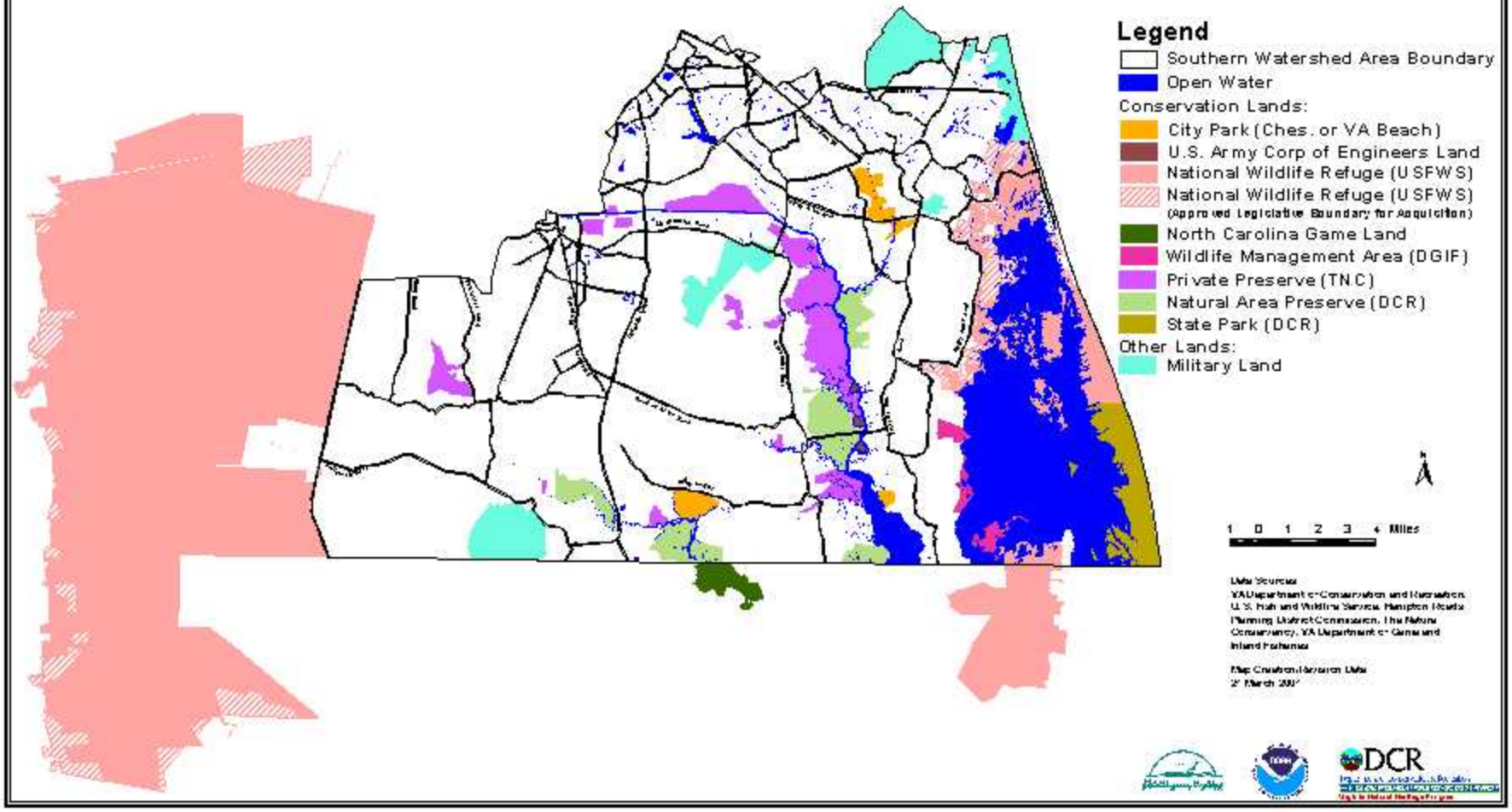


Figure 6. Low conservation corridor density

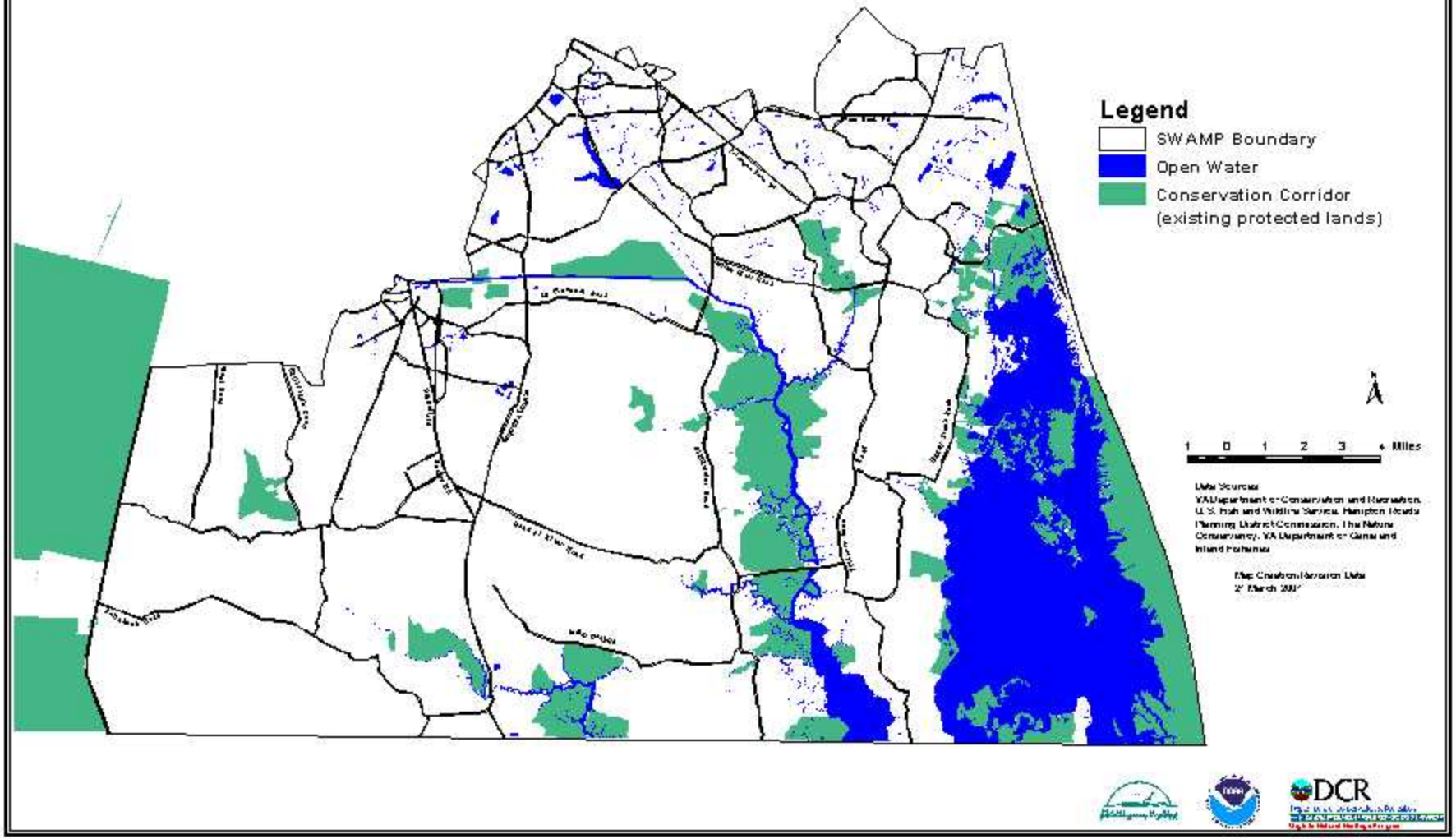


Figure 7. Moderate-low conservation corridor density

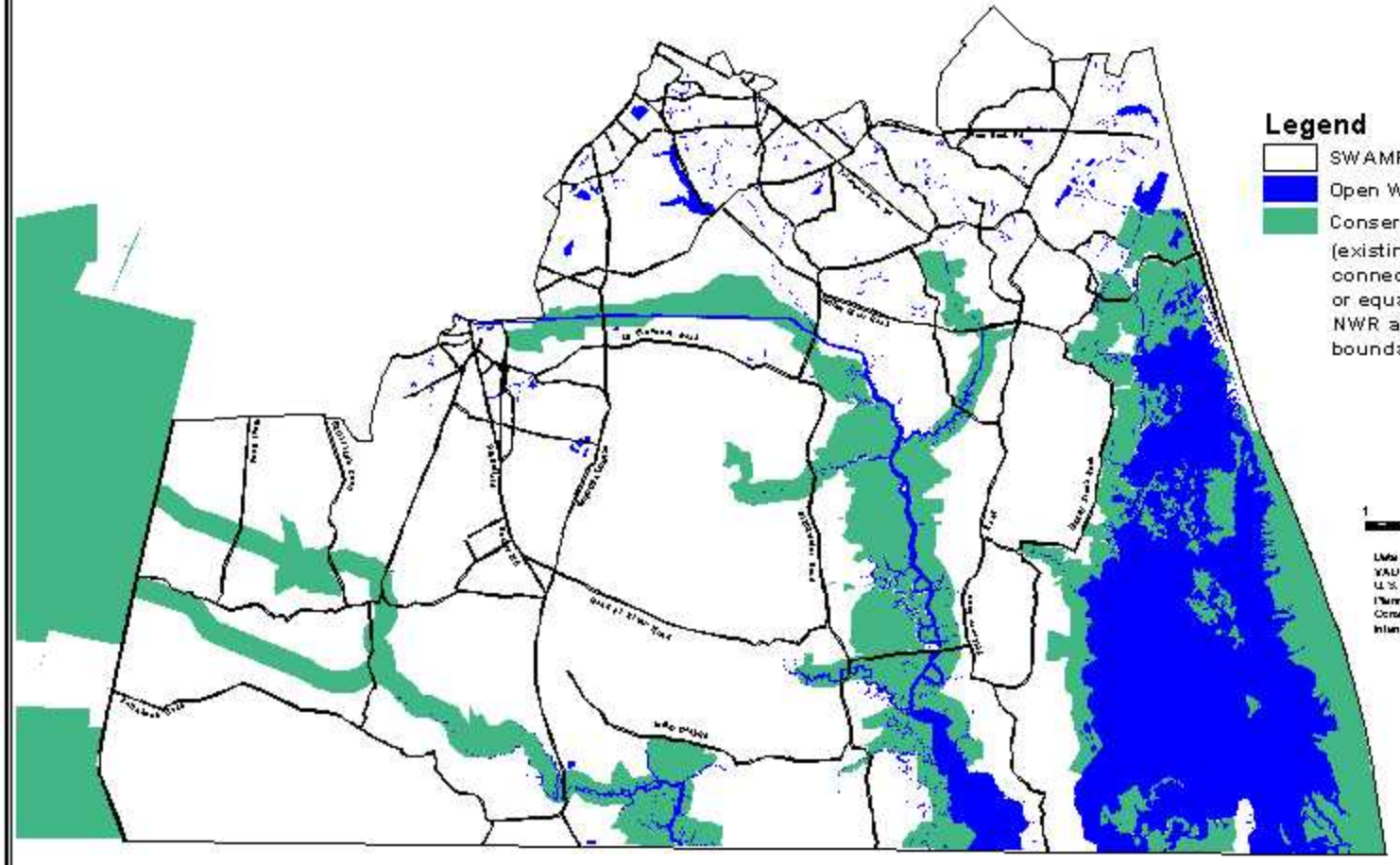
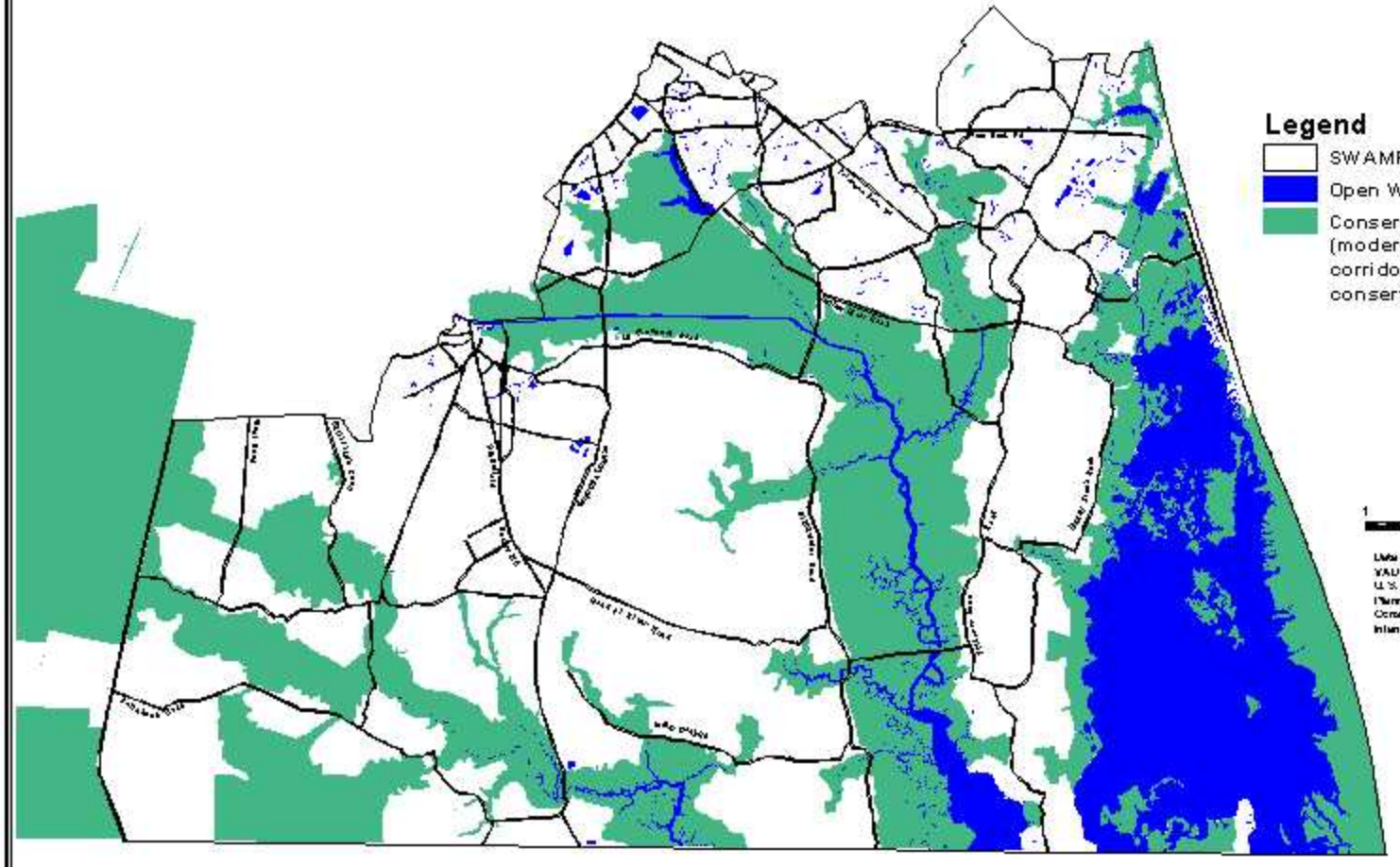


Figure 8. Medium conservation corridor density



* moderate-low conservation corridor density = existing protected lands plus connecting corridors less than or equal to 0.5 miles wide and NWR approved legislative boundaries for acquisition)

that establish connections between the three watersheds, forming a network of connected conservation lands (Figure 9) (99,339.2 acres, Appendix F). Adding connecting corridors that link protected lands with sites that still support rare species and communities will effectively achieve multiple conservation goals. Such connections enable wildlife movements and provide functional, manageable habitats; create diverse and abundant recreational activities; represent additional protections to groundwater resources and surface water quality. Designating this level of open-space protection will assist retention of the rural character of the SWA. Lands included within defined corridors would be primary considerations for mitigation banks, restoration, and mitigation efforts. Over a long time period – perhaps 50 years or more –land uses within designated corridors would be shifted to less intensive uses such as forest and wildlife management, recreation, and where appropriate, natural areas management. Habitat restoration projects would be needed to convert hardened surfaces and remove infrastructure. As a large proportion of lands delineated in this option are in private ownership, clear messages will have to be sent about the means by which lands or property rights might be acquired. Any resource protection measures should involve willing sellers and fair market compensation for property or ownership rights in order to move forward with this or other initiatives.

High corridor density. This option proposes a maximal corridor density for the SWA and would yield by far the highest returns (113,581.1 acres, Appendix F) in resource protection and open-space benefits and values (Figure 10). It would also cost the most and be the most difficult proposal to implement of all those suggested. High conservation corridor density would link the Great Dismal Swamp with the North Landing River, Northwest River, and Back Bay ecosystems and represent an exceptional commitment to retaining the natural resource base of the SWA. This level includes public and private conservation lands, Natural Heritage Conservation Sites, lands connecting them, plus additional corridors to further restore landscape connectivity in order to achieve a variety of purposes. Much of this land area would be designated as future open-space and include currently developed land uses that would be restored over time. The result would be outstanding opportunities for outdoor recreation, protection of the rural landscape, ensured water quality, extensive lands continuously available for forestry and some agricultural uses. Figure 11 maps this conservation corridor density with selected land uses in the SWA. As stated above, private property rights considerations should be paramount in any discussions and implementation strategies, since most lands designated within corridors are privately owned. Fee simple purchase, conservation easements, purchase of development rights, or agricultural reserve programs are known methods by which fair compensation can be made. Extensive areas are already in some state of development, while others are undergoing land-use alterations. Many (if not most) areas within corridors would require hydrologic and vegetative restoration representing many opportunities for mitigation.

The high levels of conservation corridor density proposed here are perhaps best described as planning tools and could not be implemented over short time periods – and quite possibly, not at all. It is hoped that proposing these various levels of conservation corridor will be viewed not as ludicrous but, rather, as visionary. Figure 12 maps a comparison of the five levels of conservation corridor densities presented here, and Appendix F summarizes this information in tabular form. Localities that choose to consider such means for conserving open-space and retaining the quality of life that hinges on retaining natural resources will be lauded as forward thinking. Those that implement such programs will undoubtedly be recognized as progressive, in a new sense. This, of course, is ironic since the term “progress” once inferred unrestrained development.

STEWARDSHIP OF CORRIDOR HABITATS

Public Use

One of the strongest justifications for retaining open space in rapidly expanding population centers is to maintain places for the residents of a community to recreate and maintain connections with the natural world. Greenways, blueways, and urban trails have become part of major corridor planning efforts and catalysts for far-reaching programs of open space preservation. Competition becomes high for public use of open space as available undeveloped land becomes scarce and as real estate values soar. Thus, demand will be high for public use of land within retained conservation corridor lands. Compatible use determinations will be required to ensure that the values provide by "urban wildlands" are not compromised by public users who, sometimes simply by their presence, can "love a place to death." Appropriate uses for core natural areas might be limited to passive recreation such as wildlife watching, photography, hiking, canoeing, and natural history education. Connecting corridor lands however, might easily sustain more active recreational use, as well as forest management, agriculture, and low density and low impact development. High water quality that results from strong conservation measures will result in increased recreational fishing opportunities. In some areas, hunting may be both compatible with the conservation mission of these lands and also necessary to control expanding populations of whitetail deer.

Hydrologic Restoration

Following designation and protection actions, areas of former agricultural lands within conservation corridors may be desirable for hydrological restoration to reinstate former wetland processes. Restored hydrology will be a cornerstone upon which a return to natural community types, including forested wetland habitats, will be based. Methods to restore former soil moisture regimes may include: 1) blocking existing drainage ditches and canals; 2) removing existing field tile systems; and 3) construction of water control structures.

It should be noted that both Chesapeake and Virginia Beach have stated policies of maintaining Agriculture as a viable industry. Prior converted croplands often work well from an ecological standpoint as sites to compensate for wetlands impacts. However, if not carefully selected, these sites could have the unintended effect of taking valuable cropland out of production and lessening the viability of agriculture in the Southern Watershed.

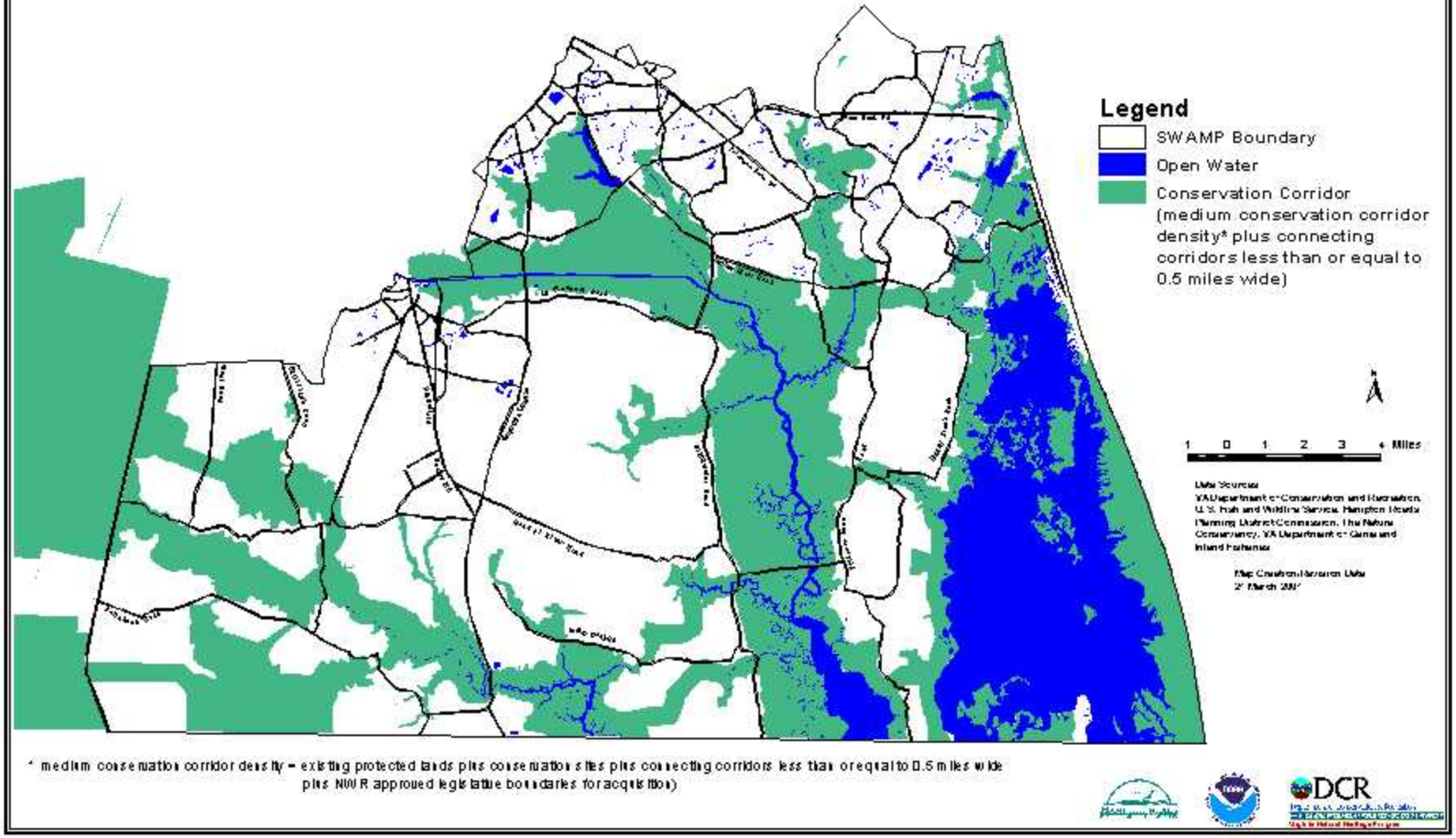
Water Quality Monitoring

For many reasons, the issue of water quality is of special concern and is a great priority in the SWA. Thus, it is imperative to closely monitor the status and condition of water supplies either under scenarios of unplanned sprawl, or during implementation of new conservation initiatives. If conservation corridors are protected, then riparian buffer areas will expand, distances between developed and paved areas will increase, and the positive impacts on water quality should be demonstrable. An intensive program to measure and report increases in SWA surface and ground water quality may give the most objective and quantifiable expression of success of landscape-level conservation actions.

Prescribed Fire

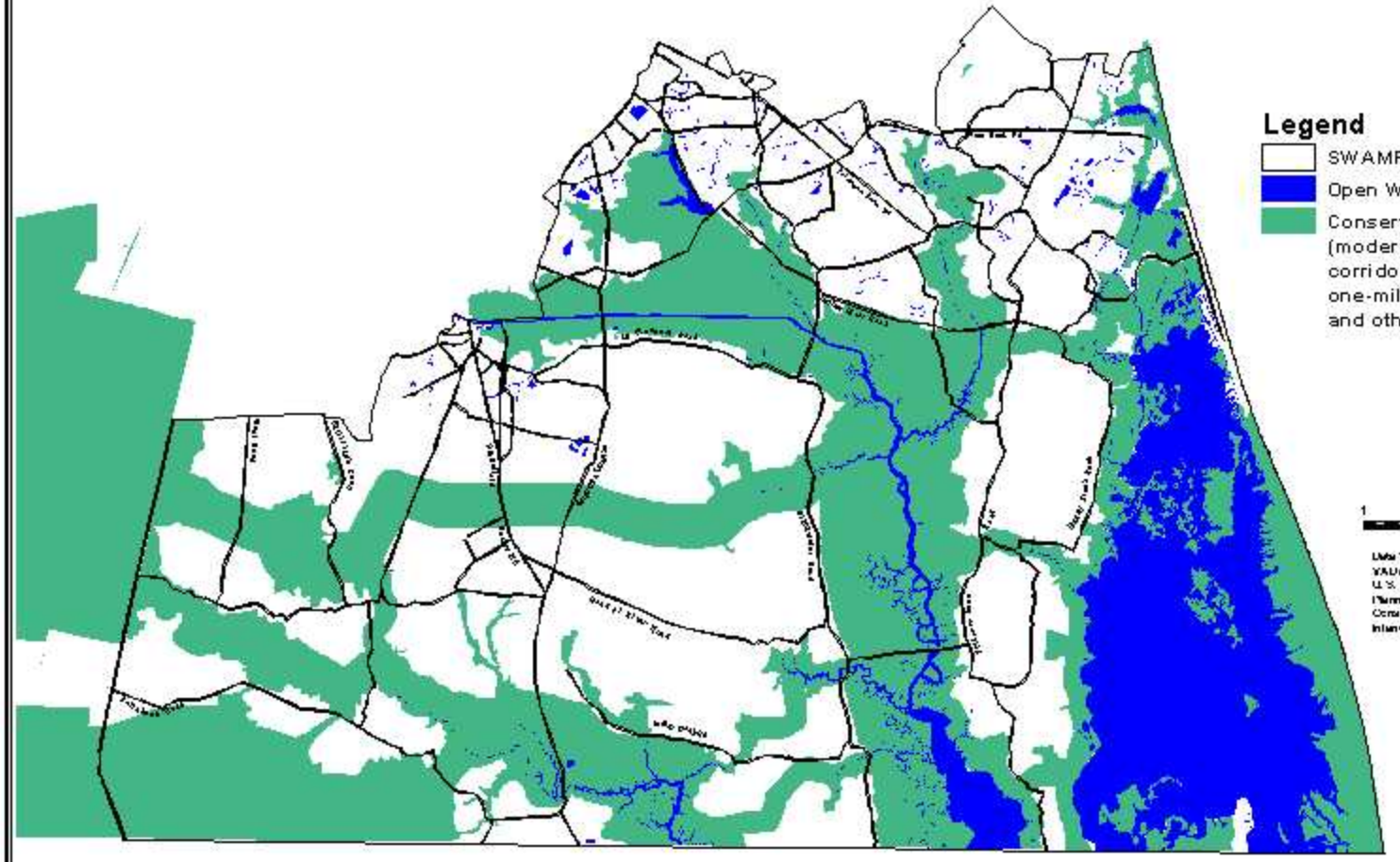
To prevent unnatural accumulations of forest fuels and to maintain fire-dependant natural communities, land managers responsible for the maintenance of community structure and composition in natural areas within conservation corridors are likely to require the use of prescribed burning. Fire, with all of its well-known negative and harmful connotations, is also a beneficial tool that can yield many positive effects when used in appropriate ways and under the right circumstances. For example, marsh communities along riparian zones of SWA rivers require periodic burning to retard invasion by trees and shrubs. Evergreen shrub bogs (pocosins) are a rare natural community

Figure 9. Moderate-high conservation corridor density



* medium conservation corridor density = existing protected lands plus conservation sites plus connecting corridors less than or equal to 0.5 miles wide plus NWR approved legislative boundaries for acquisition)

Figure 10. High conservation corridor density



* moderate-high conservation corridor density = existing protected lands plus conservation sites plus connecting corridors less than or equal to 0.5 miles wide plus NWR approved legislative boundaries for acquisition)

DCR

Figure 11. High conservation corridor density and selected land uses in the Southern Watershed Area

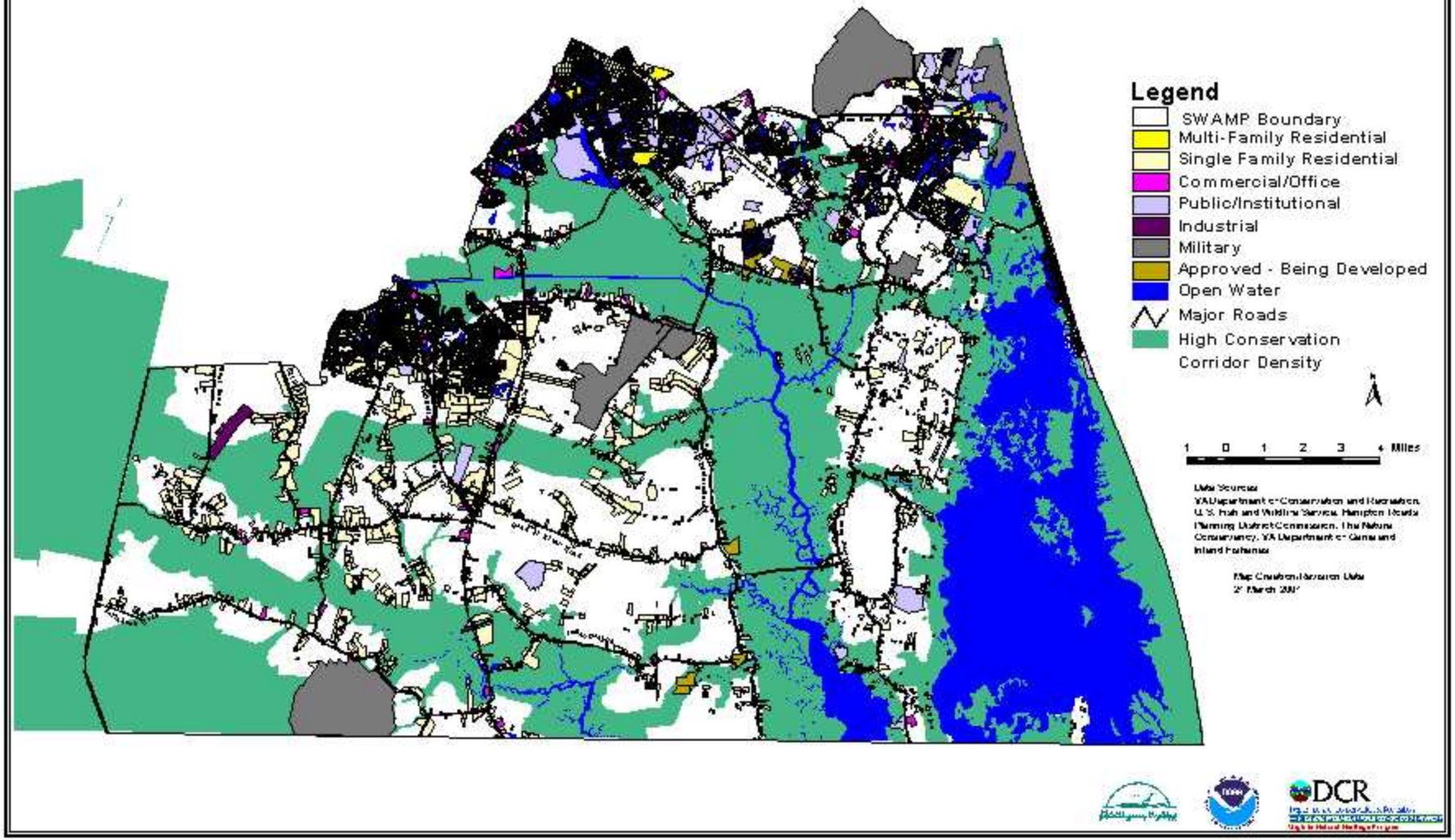
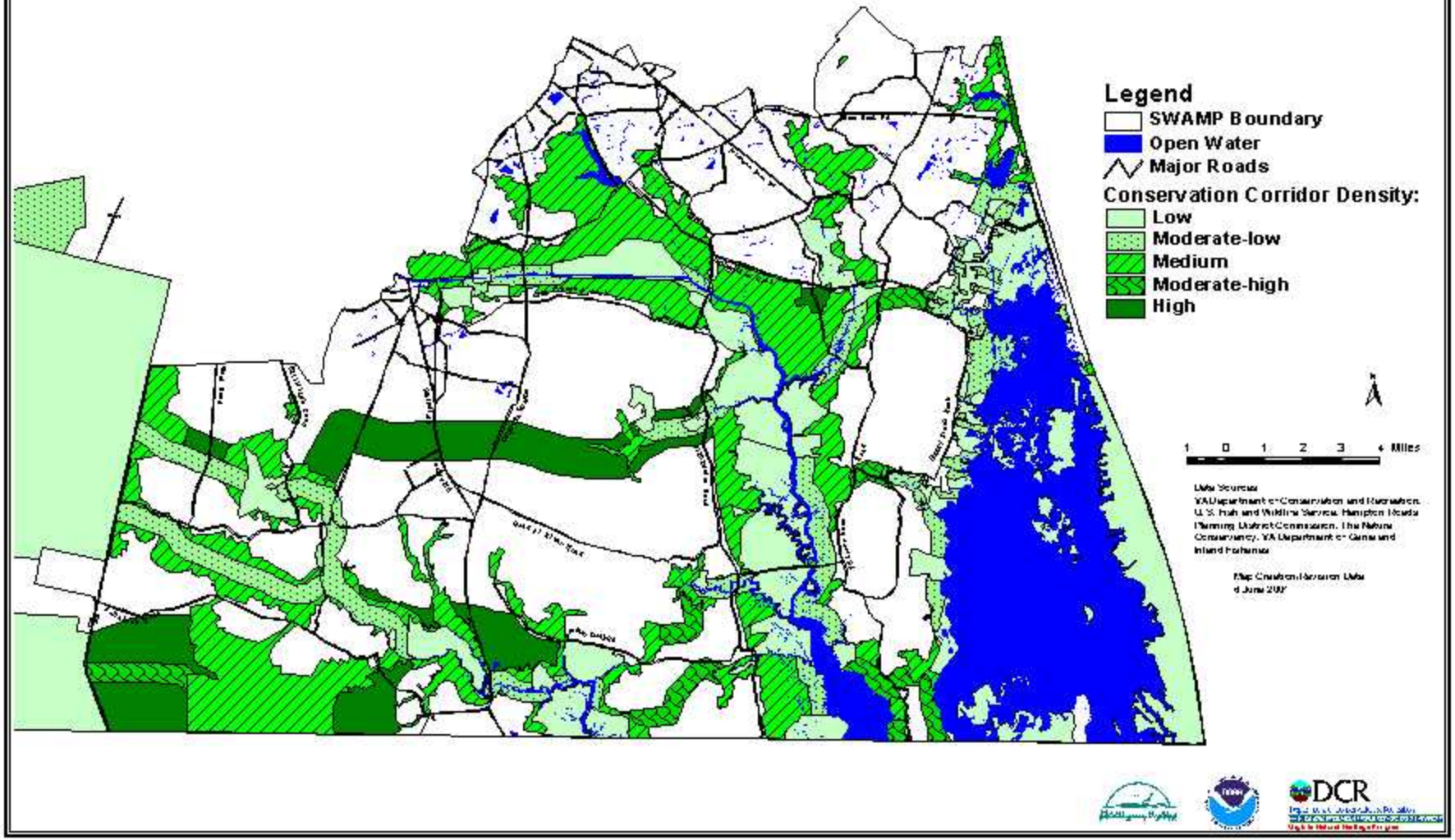


Figure 12. Comparison of the five levels of conservation corridor densities for the Southern Watershed Area



type along the North Landing River that are only maintained and prevented from succeeding to wetland pine-hardwood forest by periodic fire. Wildlife habitat required by animals that prefer early successional stages (fields, meadows, low-shrubs) is often best maintained by prescribed burning.

Invasive Species Control

An increasing number of exotic or otherwise alien species of plants and animals are invading and taking over native habitats, both terrestrial and aquatic. Some invasions are more manageable than others. Invasive plants are often a manageable pest for resource managers, especially in urban or populated regions where soil disturbance is or has been frequent. Efforts to return former agricultural fields and prior developed lands will very likely involve a broad set of invasive species management problems. However, much technology adapted from weed science and a broad assortment of approved techniques including judicious herbicide applications is available to assist such efforts.

In some cases, management or control of invasive animals may be necessary. In these cases, appropriate resources such as the Virginia Department of Game and Inland Fisheries, the U.S. Fish and Wildlife Service, the Virginia Department of Agriculture and Consumer Services, and the Virginia Department of Conservation and Recreation should be consulted.

Re-vegetation

Methods for reestablishing natural vegetation in hydrologically restored portions of conservation corridors are relatively well-known. Foresters, wildlife managers, natural area managers, and soil conservationists have developed reliable techniques for establishing trees, shrubs, native warm season grasses, and wetlands vegetation. Availability of local seed sources remains a challenge, although plant material and seed for a wide assortment of native species is generally available. It should be noted that in some cases, appropriate native seed sources may still be available within viable soil seedbanks. This document is a plan for the future, and the role of time and natural succession cannot be disregarded. Indeed, the natural succession of vegetation, ecological communities, and land use must be considered. For additional information, see the multiple benefit conservation strategy – southern watershed management plan (LandMark Design Group 2000).

Habitat Creation

Habitat can be created as a mitigation requirement. Although this type of mitigation is less preferable than habitat preservation or habitat restoration, it may have beneficial results as long as several conditions are met. One such condition is that the created habitat be located directly adjacent to an existing, functioning ecosystem, rather than disjunct. The probability for a successful creation is much higher when the created habitat can recruit species through dispersal and emigration from functioning, established habitat. Another preferred condition of habitat creation is to use soil previously removed from nearby areas. These soils would have an existing seedbank of local indigenous species, enhancing chances for success. Restoration of hydrology, and the assimilation of that restored hydrology into the adjacent functioning natural area is another condition that would augment possibilities for successful habitat creation.

Habitat Restoration

Habitat restoration as a mitigation technique will produce the most successful results when restored areas are located adjacent to functioning, established habitat, and when the restored areas are sufficiently large. Restoration techniques include, but are not limited to, restoration of hydrology by removing, or blocking ditches, or re-directing water, and planting of native vegetation. For additional

information, see the Multiple Benefit Conservation Strategy – Southern Watershed Management Plan (LandMark Design Group 2000).

Mitigation Banks

If managed appropriately, mitigation banks can be highly effective tools of conservation. Mitigation banks are sometimes portions of a natural, functioning ecosystem, and are sometimes lands in the process of being restored, or a mix of the two. These endeavors often have very successful results, especially when the bank is located within, or adjacent to an existing natural, functioning ecosystem.

Wildlife Management

While much remains to be discovered about wildlife management in conservation corridors, one expected challenge will be to develop workable techniques for controlling populations of species such as whitetail deer and nutria. Lessons from many urban interface areas of the U.S. demonstrate that whitetail deer populations, in the absence of large predators and without consistent pressure from sport hunting, will expand at undesirable rates and reach unmanageable densities. Automobile collisions involving deer plus other unwanted deer-human interactions in suburban settings will occur. Thus, it will be necessary and prudent to learn from the experience of other localities and develop strategies in advance for dealing with this potential problem.

In addition to whitetail deer, there are many other wildlife species in the SWA that will benefit from conservation corridors including migratory songbirds, wading birds, American black bear, red and gray fox, raccoon, bobcat, small rodents and insectivores, amphibians, reptiles, butterflies, dragonflies, and damselflies (American Wildlands 2000; Burbrink *et al*. 1998; Schaefer and Brown 1992; Walker and Craighead 1997).

The American black bear (*Ursus americanus*) is the largest terrestrial mammal in Virginia, and is found in relatively high numbers in the SWA. While black bear movement studies have not been completed in the SWA, bear movements in Florida and Louisiana have been well documented with studies indicating that bear do utilize corridors. However, bears are adaptable and use various types of habitat. Bear movements were documented through heavily vegetated ditches, early successional fields, and woodlots. In the absence of humans, bears were also documented moving fairly long distances through open agricultural (soybean) fields (Pelton, pers. comm.). Corridor width has been shown to be less important than other parameters such as type and density of vegetation, human presence, length of corridor, and natural areas connected by the corridors (Lindenmayer 1992; Pelton, pers. comm.; Vaughan, pers. comm.). Corridors that are large enough to be effective for supporting movements of black bears are also likely to be effective for many other species.

Presently, a black bear movement study is underway in the SWA and the Great Dismal Swamp (Vaughan, pers. comm.) to determine which areas local bears choose to move through, how often they move, and which animals are moving. Results of this study will assist in refining wildlife management considerations for future protected corridor lands, in siting actual corridor placements, and in determining alternative uses. The Virginia Department of Game and Inland Fisheries is presently finalizing a Comprehensive Management Plan for Black Bears in Virginia (Pelton, pers. comm.), to be completed in early 2001. Bear and other corridor lands wildlife habitat management considerations should be coordinated with this agency.

Forest Management

Many silvicultural activities are compatible with management objectives for conservation corridors in the SWA. Reforestation of former agricultural fields using both artificial (planting) and natural techniques will be needed to establish desired vegetative conditions on conservation lands within designated corridors. Site preparation and soil conditioning may also be required, especially on lands that have been heavily trafficked, that were in prior non-forest uses, or both. Economic returns from sound harvesting practices of forest products will be an essential incentive promoting continued forest cover, land stewardship, and reinvestment in forest management in portions of the proposed conservation corridor lands. A number of harvesting and stand establishment methods are compatible with the habitat requirements of many wildlife and plant species, and with the need to protect water quality. Combining forest and wildlife management techniques (for example, thinning followed by burning) is one effective approach for providing multiple benefits and increasing habitat diversity of the SWA while still focusing on commodity production. Use of Best Management Practices, managing for mixed-species stands, and promoting the forest stewardship ethic are among the many approaches available that will enhance values provided by managed forest lands within conservation corridors.

Considerations for the Future

Long-term planning scenarios in coastal regions involve a variety of important considerations. Coastal landscapes are dynamic and constantly influenced by sometimes harsh physical forces. They also have many amenities and so attract large numbers of people. Thus, developing coastal communities are subject to vexing management issues. Hurricanes and other severe coastal storms, land subsidence associated with groundwater withdrawals, and sea-level rise are all processes which are difficult to predict, improbable to deter, and result in profound consequences for coastal populations.

Ocean inlet formation. The closest link of Back Bay to the Atlantic Ocean is currently Oregon Inlet in North Carolina, lying 60 miles south of the state line. Historically, several inlets have opened and closed along the barrier spit that separates Back Bay from the Atlantic (Priest and Dewing 1991.) The inlet closest to Back Bay was Old Currituck Inlet, located at the present-day state line. This inlet opened in 1650 and closed in 1729. Just to the south, the New Currituck Inlet opened in 1713 and closed in 1828. Still farther south, Caffey's Inlet opened in 1798 and closed in 1812. Throughout this time there were a number of overwashes. Since the 1930's, overwashes have been infrequent with the last one occurring in 1962 during the Ash Wednesday storm (Priest and Dewing 1991).

The opening and closing of inlets to Back Bay, Currituck Sound, and the Albemarle/Pamlico Sound is a dynamic process. Shoreline stabilization and construction activities by humans may have altered the natural regime of inlet formation, but the probability of such occurrences *sometime* in the future remains 100 percent. The SWA's location in the mid-Atlantic stretch of the East Coast makes it an eventual target for a direct hurricane hit. Certain physiographic characteristics (low elevation, narrow sand ridges, etc.) make a future breach more likely at some locations than at others. Inlet formation would result in the "re-salination" of Back Bay, perhaps including the lower portions of the North Landing and Northwest Rivers. Accompanying inlet-opening could be effects such as loss of land area due to tidal flooding of lowlands and increased erosion from tidal currents. While such observations may seem speculative, it is prudent to note that the SWA lies in a "hurricane-vulnerable" area. Wise long-term land use planning must take this simple fact into account.

Subsidence. Subsidence – the gradual sinking of land – is occurring to some extent in the SWA. This process is most often caused by extraction of groundwater, oil, or natural gas as well as by the

weight of sediment loads in an historic river delta. In parts of southeast Virginia, subsidence is thought to be occurring due to the effects of a bolide (meteor) impact and crater formation approximately 35 million years ago (Poag 2000). Subsequent regional geological changes include disrupted coastal aquifers and ground instability, which are likely contributing to land subsidence and sea level rise in parts of the SWA.

Sea level rise. Sea level rise at the confluence of the lower James River and Chesapeake Bay (on the rim of the bolide impact crater) is higher than average, estimated at approximately 3.5 mm/year, while global sea level rise is estimated at approximately 1-2 mm/year (USGS 2000). While sea level rise may seem to be of little significance to much of the population in the United States, in the nation's coastal areas and especially in Virginia's SWA, it is an inevitability that must be taken into consideration with long-term planning and contingencies. Indeed, the location of the SWA with regards to hurricane vulnerability, combined with the certainty of sea-level rise and subsidence makes long-term planning for this area of great importance.

Planning initiatives. At the present time, several other planning initiatives are underway in the SWA. The Virginia Chapter of The Nature Conservancy is conducting a conservation and protection planning initiative for the Green Sea Wetlands in the City of Chesapeake. Beginning in 2001, the U.S. Fish and Wildlife Service has plans to extend Comprehensive Conservation Planning initiatives into Virginia by initiating this process on the Back Bay NWR. Comprehensive Conservation Planning (called for by the 1997 Refuge Improvement Act), will examine every aspect of the Back Bay NWR program from management activities to biological monitoring and long-term goals. Projects such as these, along with ongoing research and management plans in progress by various land managers in Chesapeake and Virginia Beach (The Nature Conservancy 2000b; VDCR 2001; VDGIF 2000) will provide useful information for long-term conservation planning in the SWA.

The Department of Conservation and Recreation's Division of Natural Heritage, with funding from the U.S. Environmental Protection Agency, completed a project entitled, *Development of a Comprehensive GIS Database for the North Landing/Northwest Rivers Wetland Ecosystem.* A major focus of the project was development and mapping of a vegetation classification scheme. The community classification is described in detail in DCR-DNH Technical Report 98-9, June 1998, *Comparative Wetlands Ecology Study of the Great Dismal Swamp, Northwest River, and North Landing River in Virginia*. Fine-scaled mapping of natural communities was originally intended for both the Northwest River and the North Landing River wetlands, but funding constraints limited detailed mapping to Northwest River communities. The map produced for this project (Appendix G) is a valuable management tool, and provides considerable opportunity for SWAMP partners to prioritize wetland types for protection and restoration. The utility of this classification would be considerably expanded by extending mapping efforts to North Landing River, Back Bay, and additional wetlands within the SWA.

PROTECTION METHODS

A variety of tools and approaches are available to facilitate the protection of natural areas and open-space. Methods can be tailored to different conservation needs and specific landowner situations and include voluntary protection and management agreements, purchase of development rights, conservation easements, and fee simple acquisition.

Protection of Private Lands

Virginia Registry of Natural Areas. Natural area registry with DCR is a protection tool which involves a voluntary commitment by the landowner to protect a site. No rights to the land are given by the owner, and permanent natural area protection does not occur. The Natural Area Registry program encourages landowners of significant natural areas throughout Virginia to voluntarily protect resources on their land to the best of their ability. Landowners who participate in the program agree to inform DCR of any potential threats to resources or other changes, such as intent to sell the property. Aside from being rewarded with the pride of owning and conserving an important piece of Virginia's natural heritage, the landowner receives a plaque recognizing the significance of their property and their effort in conserving it. Moreover, the landowner may receive management advice and assistance from professional natural area stewardship staff, if they so desire. Registry is an option available to both public and private landowners and may be used alone or in conjunction with another protection tool such as a management agreement.

Management agreements. This tool is an option for landowners who wish to manage their land to protect its biodiversity values but have no immediate desire to sell their property or encumber the land with an easement. A management agreement is a legal agreement that permits prescribed management activities by another organization or agency, but does not provide permanent protection. Under this option, the landowner and the management agency or organization will prepare a mutually acceptable agreement that clearly states management objectives, schedules, and responsibilities. These agreements fulfill specific management goals for a natural area, at least on a temporary basis, while meeting individual needs of the landowner.

Open space and conservation easements. Easements are legally enforceable agreements between a landowner and a government agency or conservation organization that place restrictions on present and future uses of land. State agencies and local governments can hold easements, or property, under the provisions of the Open Space Land Act (*Code of Virginia* 10.1-1700 *et seq*.). The Virginia Outdoors Foundation, which was created to accept and hold gifts of open space land, also accepts easements (*Code of Virginia* 10.1-1800 *et seq*.). Non-profit organizations can hold conservation easements under the provisions of the Virginia Conservation Easement Act (*Code of Virginia* 10.1-1009 *et seq*.). An easement can run for a term of years or can be perpetual, observed by present and all future owners of the land. Restrictive terms of an easement are entirely negotiable between the parties. Present and future landowners may continue to enjoy many uses of the property while conservation goals for the site are met. Landowners who sell or donate easements may also receive financial benefits such as a reduction of federal estate taxes and Virginia inheritance taxes, a reduction of real estate assessment values, and entitlement to a charitable deduction for state and federal income tax purposes.

A landowner that makes a gift of a conservation easement or gift of a fee-simple interest in land to a public conservation agency or private conservation group may be eligible for a state tax credit for that gift. The donor of the qualifying gift can use a portion of the value of that gift as a state tax credit to offset the state income taxes that the landowner might owe the Commonwealth of Virginia (*Code of Virginia,* Section 58.1-510 through 513). The tax credit can be claimed for an amount equal to 50% of the fair market value of the gift.

If a landowner sells land or sells an easement on land that will be used for open space for at least thirty years there is a new law that allows the landowner to avoid any state capital tax on the sale (*Code of Virginia*, Sections 58.1 – 322 and 58.1 – 402). Therefore, a landowner will receive a greater financial return after taxes for a sale of property, or an interest in property for conservation purposes than for development or other purposes.

Protection of Public and Private Lands

Natural area dedication. Natural area dedication provides legal protection for parcels on which the landowner restricts future uses of a property for the purpose of preserving the land in its natural state. Dedication of a property places it in the Virginia Natural Areas Preserve (NAP) system managed by DCR. This protection option is available to private landowners, state agencies, and other public bodies excepting the federal government. With natural area dedication, the landowner retains ownership rights and the right to sell or transfer the property, but relinquishes the right to use the land in ways that are inappropriate for the conservation goals set by DCR. In effect, Natural Area Dedication is a specific type of easement and the landowner may receive the same financial benefits as in the easement option. Only lands of the highest ecological significance qualify for Natural Area Dedication.

A legal deed of Dedication is prepared which states the purpose of the dedication and future permitted and/or prohibited activities allowed. A Natural Area Management Plan is prepared by DCR-DNH. Dedicated NAPs are managed following DCR's guidelines for management of NAPs.

Acquisition. Acquisition includes the outright sale of all or a portion of the rights to property from a willing buyer to a willing seller. Mitigation banks, land trusts, private organizations, state, and federal agencies all use various forms of acquisition from time to time.

Research natural areas / special management areas. Legal or administrative designations such as Research Natural Areas (RNA) or Special Management Areas (SMA) are important for protecting biologically significant areas on federally owned lands.

Inclusion as part of a mitigation strategy. If mitigation lands are located such that inclusion with an existing protected natural area is ecologically sound, and if restoration or creation management has been successful; these lands could be included in, or added onto protected lands. Subsequently, if the lands meet certain other criteria, the areas could be legally dedicated or permanently protected in some other way.

Programs and Funding Sources

A wide variety of funding sources and programs including grants and financial incentive programs exist which could potentially fund efforts towards conservation, protection, restoration, habitat enhancement, and other initiatives. Some of these programs and sources include federal grants such as the North American Wetlands Conservation grant program of the U.S. Fish and Wildlife Service, wetland grants from the North American Wetlands Conservation Council, and state grants such as the Virginia Land Conservation Foundation (VLCF), Virginia Forest Legacy Program, Virginia Beach Agricultural Reserve Program, Conservation Reserve Enhancement Program, Native Plant Conservation Initiative, Clean Water Act Nonpoint Source Grants, Partners for Fish and Wildlife Program, Wildlife Habitat Incentives Program, Corporate Wetland Restoration Partnership, Environmental Quality Incentives Program, and Pathways to Nature. Brief descriptions of two of these follow.

Virginia Land Conservation Foundation. The VLCF uses state funds appropriated biennially by the General Assembly for fee-simple acquisition or for the purchase of conservation easements in order to protect lands in four categories: open space and parks, natural areas, historic areas, and farmland and forest preservation. Individual grant applications are submitted by local governments and non-profits from throughout the state. VLCF has flexibility to provide funding for needed

projects anywhere in Virginia, meeting conservation needs in both rural and urban areas. State funding for VLCF was first committed in 1999 with $1.75 million received.

Forest legacy. The U.S. Forest Service Forest Legacy Program assists state governments in identifying and protecting important private forest tracts. The program promotes the "Working Forestlands" concept into general land conservation efforts and focuses on the ideal that diverse, well managed forests provide the most public benefits and are worthy of protection from economic pressure for development. Thus, Forest Legacy aims to protect and conserve important forests that are threatened by conversion to non-forest uses. The program, which began in Virginia in January 2001, is administered through the Virginia Department of Forestry and will provide funding primarily to purchase conservation easements to influence disposition of important forestland while continuing private ownership.

PROTECTION PRIORITIES

In 1989, The Nature Conservancy and DCR began protection efforts that, to date, have resulted in the acquisition of 20 tracts on the North Landing River and six on the Northwest River. Additional tracts owned by the U.S. Army Corps of Engineers, the City of Virginia Beach, the City of Chesapeake, Virginia Department of Game and Inland Fisheries, and the U.S. Fish and Wildlife Service add to the lands along these rivers and in Back Bay receiving at least some level of environmental protection (Figure 5). Appendix H lists pertinent federal and state natural resource laws that also afford some protection to these areas.

Protection of individual sites containing significant elements of biodiversity is a good first step toward conservation of critical habitats in the region. However, it is an inescapable fact that ecosystem-level conservation requires an approach that emphasizes linkage of natural areas and the viability of conservation sites within a larger landscape context. One of the most compelling aspects of the watersheds comprising portions of the Cities of Chesapeake and Virginia Beach, is the remaining interdigitated mosaic of large, diverse, and undisturbed wetland habitats that result from the contiguity of the three systems. Forested, non-riverine wetlands at the head of the Northwest River abut the vast wetlands of the Great Dismal Swamp National Wildlife Refuge (Figure 1). Unfortunately, a heavily traveled road, U.S. Route 17 and the Dismal Swamp Canal / Intracoastal Waterway prevent the two forested areas from merging, but their proximity still provides a linkage that is used by many mobile animals and is particularly valuable to migratory songbirds. Forested wetlands and marshes continuously line the Northwest River to its confluence with Currituck Sound at Tull Bay, then continue to the east and north to the mouth of the North Landing River. From there, large wetlands continue almost unbroken to the North Landing headwaters in the vicinity of Gum Swamp and North Landing. Conservation sites and adjacent lands identified by DCR, DNH scientists have been prioritized by watershed, to facilitate immediate (near-term) protection, restoration, mitigation, and conservation efforts (Figure 13). Identification of these lands does not imply that other sites or lands are unimportant, merely that these areas are critically important to meeting goals of the SWAMP. Prioritization of sites included an assessment of: site location, size, contribution to SWAMP goals, management needs, vulnerability and immediate or long-term threats, ecological significance, and interviews with inventory scientists or review of technical reports and field notes.

Northwest River watershed: The Northwest River basin comprises the largest and most important natural area within the City of Chesapeake. The river is a major contributor to the Currituck Sound, and ultimately the Albemarle/Pamlico estuarine system. In Virginia, it is the only corridor connecting flora and fauna of the Great Dismal Swamp to original Swamp remnants, and to other riverine

systems. Large areas here are partially to entirely unprotected and are critical to ensuring long-term conservation of lands necessary to maintain the natural corridors described above.

Priorities: Protection efforts that contribute to conservation of the following sites and adjacent lands should be considered high priority. Land within the site boundaries, as well as land adjacent to the boundaries (Figure 13) is important to protect, restore or enhance. Most of these sites contribute significantly to creation of potential corridors discussed in this conservation plan, and as such, make significant contributions to achievement of overall SWAMP goals. Specific site conservation plans for the sites listed below can be found in Appendix C.

Sites: Headwaters
Smith Ridge
NSGA Northwest
Middle Section
Smith Creek
Southwestern Marshes

North Landing River watershed: This watershed merits a very high level of protection. In addition to serving as a recreational, scenic, and educational asset for residents of the City of Virginia Beach and surrounding areas, the North Landing River watershed also facilitates flood protection for the City during storm events, it filters and stabilizes surface water for a large portion of the City, and it supports a diverse array of plants, animals, and ecological communities. The North Landing River is also a major tributary to the Currituck Sound, and ultimately, the Albemarle/Pamlico Estuarine system.

Priorities: Protection efforts that contribute to the conservation of the following sites and adjacent lands should be considered high priority. Most of these sites contribute significantly to the potential corridors discussed in this report. Specific site conservation plans for the sites listed below can be found in Appendix D.

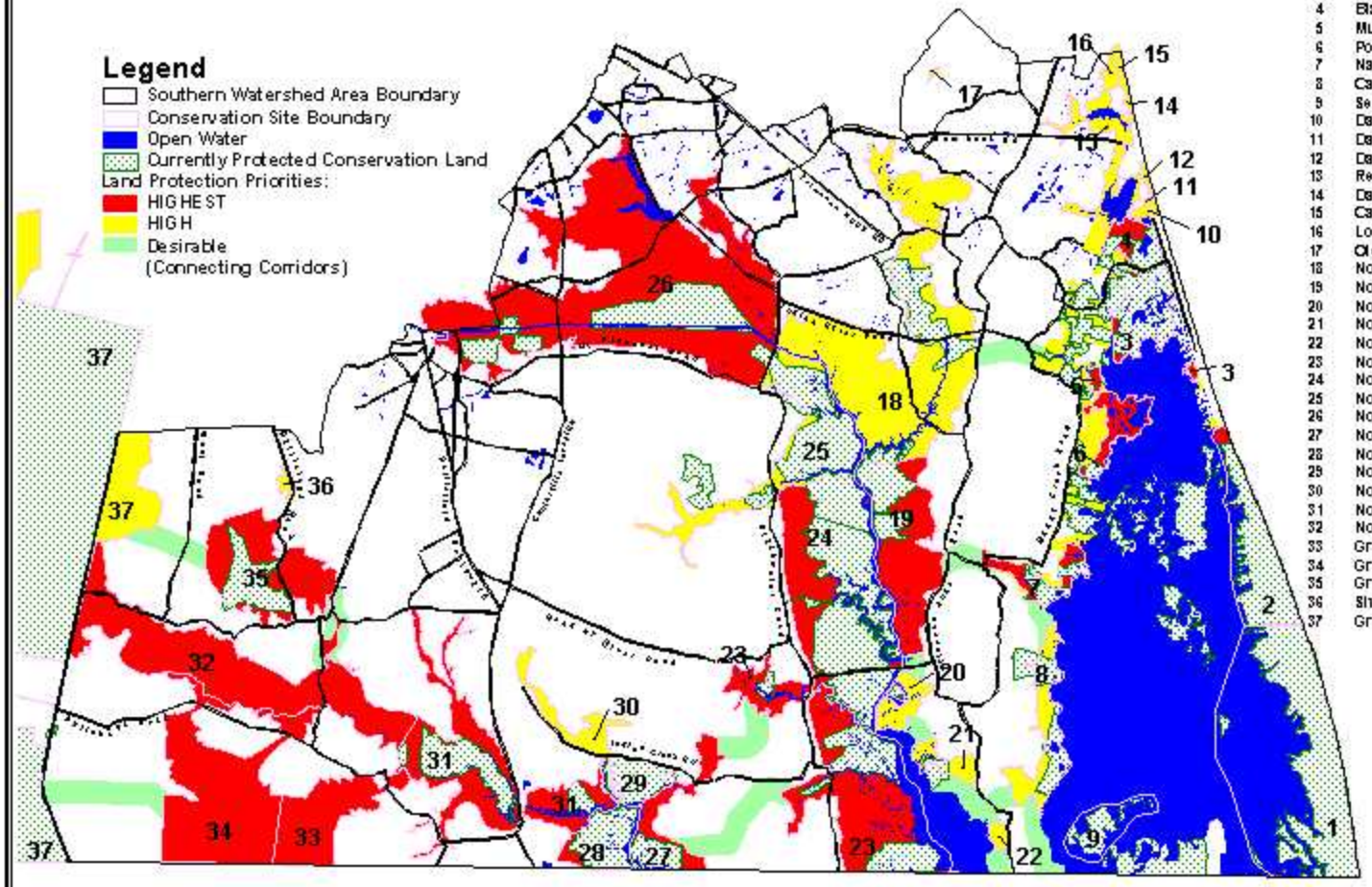
Sites: Gum Swamp
North Landing River Pocosins
Eastern Marshes
Southern Marshes

Back Bay watershed: This watershed also merits a high level of protection as it also supports a diverse array of rare plants, animals, and ecological communities. Back Bay serves as a recreational, scenic and educational asset for residents of the City of Virginia Beach, facilitates flood protection for the City during storm events and hurricane season, and is a major tributary to the Currituck Sound, and ultimately, the Albemarle/Pamlico Estuarine system.

Priorities: Protection efforts that contribute to the conservation of the following Back Bay sites and adjacent lands (Figure 13) should be considered high priority. Most of these sites contribute significantly to the potential corridors discussed in this report. Specific site conservation plans for the sites listed below can be found in Appendix E.

Sites: Black Gut
Back Bay National Wildlife Refuge
Nawney Creek
Muddy Creek
False Cape State Park

Figure 13. Lands targeted for protection in the Southern Watershed Area



Number	Conservation Site Name
1	False Cape
2	Main Flats
3	North Bay Marshes
4	Black Gut
5	Muddy Creek
6	Porpoise Point
7	Nawney Creek
8	Campbell Landing
9	Sedge Island
10	Dam Neck Interdunal Swale
11	Dam Neck Helicopter Pad Wetlands
12	Dam Neck Middle Beach Dunes
13	Redwing Lake
14	Dam Neck Northern Dune and Swale
15	Camp Pendleton Dune and Swale
16	Lovetts Marsh
17	Old Woods
18	North Landing River: West Neck Creek
19	North Landing River: Eastern Marshes
20	North Landing River: Piney Grove Church
21	North Landing River: Oakum Creek
22	North Landing River: Morse Point
23	North Landing River: Southern Marshes
24	North Landing River: Pocaline
25	North Landing River: Pocaty River
26	North Landing River: Gum Swamp
27	Northwest River: Smith Creek
28	Northwest River: Southwestern Marshes
29	Northwest River: Northwest River Park
30	Northwest River: Indian Creek
31	Northwest River: Middle Section
32	Northwest River: Headwaters
33	Great Dismal Swamp: NSGA Northwest
34	Great Dismal Swamp: Smith Ridge
35	Green Sea
36	Shillelagh Road Flatwoods
37	Great Dismal Swamp

Data Source:
VA Natural Heritage

Map Creation/Revision Date:
June 2007

DCR

SUMMARY AND RECOMMENDATIONS

Communities across the country are grappling with growth, and the lessons of unplanned urban expansion are evident around us. New efforts begun now, such as a conservation corridor initiative, could help the Cities of Chesapeake and Virginia Beach to retain desirable levels of open space and greenways, protect water quality, wildlife habitat, and rare forms of life in the process. A century ago, Theodore Roosevelt helped set this nation on the path of conservation. He reminded us that "Our responsibilities to the coming millions are like that of parents to children. In wasting our resources, we are wronging our descendants." Conservation is not a new idea; but its application in areas of rapid growth has never been more timely and needed than today.

The use of conservation corridors represents only part of an integrated ecosystem and natural resource protection strategy. Many effective resource conservation techniques are currently promoted through programs conducted by agencies such as the USDA Natural Resource Conservation Service, Virginia Tech-Cooperative Extension, DCR-Division of Soil and Water Conservation, Virginia Department of Environmental Quality, Virginia Department of Forestry, Virginia Department of Game and Inland Fisheries, and the Cities of Chesapeake and Virginia Beach.

While effective in their own right, most existing conservation programs do not address the need for conceptualizing and designing a landscape preferred by citizens and yielding optimum long-term natural resource and open-space benefits. Such an initiative can and must derive from the localities themselves, expressing the views and wishes of local residents, businesses, and government entities. Successfully managing growth means empowering citizens and leaders to make informed decisions about whether or not it is important and desirable to conserve open space and natural resources. This should be done in advance of sprawl and while there is still time to protect and retain the best of what is left. Such success will only be attained if ideas, options, and potential outcomes are presented and debated in an open public process.

Expanded conservation corridor options will be complex to implement, as they cross locality and political lines, and involve a variety of legal, regulatory, and social issues. While this plan does not provide a specific framework or blueprint for corridor implementation, some suggested land protection approaches have been put forward. Fair market compensation for property or development use rights from willing sellers is the only means by which privately owned lands should be obtained for conservation purposes. In the end, societal and political processes will largely determine whether or not such planned efforts at retention of open space and natural resources will come to fruition.

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APPENDICES

Appendix A - 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 across its entire range (its Global or G-rank). Subspecies and varieties are assigned a Taxonomic (T-) rank in addition to their G-rank. A Q indicates taxonomic uncertainty. 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 rare in Virginia. In some cases, ranks are provisional or lacking, due to ongoing efforts by the Natural Heritage network to classify community syntaxa and cryptic plants or animals. 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. GM and GW are ranks used only for communities, and refer to highly modified (GM) and ruderal (GW) vegetation respectively. 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. These ranks should not be interpreted as legal designations.

S1	Extremely rare; usually 5 or fewer occurrences in the state, or in the case of communities, covering less than 50 hectares in aggregate; or may have a few remaining individuals; often especially vulnerable to extirpation.
S2	Very rare; usually between 5 and 20 occurrences, or in the case of communities, covering less than 250 hectares in aggregate; 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.
SM	Applied to vegetation extensively modified by disturbance but considered recoverable by management, time, or restoration of ecological processes.

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.

SW Applied to vegetation dominated by ruderal or exotic species.

SX Apparently extirpated from the state.

The spot on the landscape that supports a natural heritage resource is an element occurrence. DCR-DNH has mapped over 7,500 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). 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. A rank of H (historical) is used to indicate an historical occurrence that could not be relocated by recent survey. 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 in Table 2.

Table 2. Biodiversity ranks used to indicate site significance.

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.

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 highlighted. USFWS also maintains a review listing of potential endangered

and threatened taxa known as candidate species. Table 3 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.

As of February 27, 1996, species formerly referred to as Category 2 (C2) candidates for listing as threatened or endangered are no longer considered "candidates" under the Endangered Species Act. The USFWS no longer maintains a formal, comprehensive list of such species. However, the Virginia Field Office of the USFWS intends to maintain an informal list of these and other "Species of Concern" that may warrant future consideration as candidates. These "Species of Concern" can be regarded as species for which the Service has insufficient scientific information to support a listing proposal. Former Category 1 (C1) species are now considered "candidates" (C) for listing. "Candidate" species are species for which the USFWS has enough scientific information to warrant a proposal for listing. The designation of Category 3 species (3A, 3B, 3C) has been discontinued. However, the USFWS will continue to maintain its files on these species in case new information indicates a need for reevaluation.

Table 3. 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 the listed as threatened
C	Candidate: status data supports listing of taxon as endangered or threatened
SOC	Species of Concern: no official status, evidence of vulnerability, but insufficient data exists.

In Virginia, two acts have authorized the creation of official state endangered and threatened species lists. One act (Code of Virginia ' 29.1-563 through 570), administered by the Virginia Department of Game and Inland Fisheries (DGIF), authorizes listing of fish and wildlife species, not including insects. The other act (Code of Virginia ' 3.1-1020 through 1030), 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).

(September 2000)

Appendix B – Introduction to Site Conservation Plans

Sites: Table 1 lists sites included in this report by watershed, and gives the site biodiversity rank (B-rank) for each site, as well as the source of the site information (if available) and the conservation planning boundary used in this document. For explanations of B-ranks see Appendix A. Site conservation boundaries were most often taken from the Technical Report in which the site appeared originally, and from which the boundary was digitized. In some cases, boundaries were obtained from Managed Area Files, where known boundaries of protected and/or publicly owned lands are kept, or from a recent Digitizing Project. In cases where a boundary was taken from the digitizing project, or altered slightly to reflect new information, boundaries were drawn by J. C. Ludwig, T. L. Smith, or S. Y. Erdle. Boundaries reflected in Figure 3 of the text of the Conservation Plan for the SWA should be considered to be the most current and accurate boundaries available at this time.

It is important to note that the following site conservation plans were, for the most part, taken directly from the Technical Report in which they appeared originally. For the sake of consistency and logistics, some reports have been slightly abbreviated from their original form. Completed site conservation plans are not available for all sites, as some areas were inventoried and described prior to the current methodology.

Table 1. Sites included in this report, Site Biodiversity Rank, source of site conservation planning boundary.

Site Name	Site Biodiv. (B) Rank	Source of site conservation planning boundary
Northwest River Watershed		
1. Headwaters	B3	Fleming, G.P., C.S. Hobson, and B. Carmean. 1998. Natural Heritage Inventory of the City of Chesapeake, Virginia: Conservation Priorities, Significant Natural Communities, and Rare Species. Nat. Heritage Tech. Rpt. 98-10, VA Dept. of Cons. and Recreation, Richmond, VA
2. Smith Ridge	B4	see Fleming *et al*., Tech Rpt 98-10
3. NSGA Northwest	B3	see Fleming *et al*., Tech Rpt 98-10
4. Middle Section	B2	see Fleming *et al*., Tech Rpt 98-10
5. Indian Creek	B3	Erdle, for this conservation planning document
6. Smith Creek	B2	see Fleming *et al*., Tech Rpt 98-10
7. Northwest River Park	B2	see Fleming *et al*., Tech Rpt 98-10
8. Southwestern Marshes	B2	see Fleming *et al*., Tech Rpt 98-10
9. Shillelagh Road Flatwoods	B4	see Fleming *et al*., Tech Rpt 98-10
10. Green Sea	B?	VanEerden, TNC Green Sea office, Norfolk, VA
North Landing River Watershed		
1. Upper West Neck Creek	B5	Erdle, S.Y., M.A. Donoff, L.R. Smith, C.A. Caljouw, and H.C. Bernick, III. 1994. Conservation Planning for the Management and Protection of Natural Areas in the City of Virginia Beach, VA. Nat. Heritage Tech. Rpt. 94-12. Virginia Dept. of Cons. and Recreation, Richmond, VA.
2. Old Woods	B?	GMF S.USVAHP*
3. Gum Swamp	B2	see Fleming *et al*., Tech Rpt 98-10
4. North Pocaty	B2	see Fleming *et al*., Tech Rpt 98-10
5. North Landing River Pocosins	B3	see Erdle *et al.*, Tech Rpt 94-12
6. Eastern Marshes	B3	see Erdle *et al.*, Tech Rpt 94-12

7. Piney Grove Church	B5	Clampitt, C.A., J.C. Ludwig, T.J. Rawinski, and C.A. Pague. 1993. A Natural Areas Inventory of the City of Virginia Beach, VA. Nat. Heritage Tech. Rpt. 93-14. VA Dept. of Cons. and Recreation, Richmond, VA.
8. Oakum Creek	B3	see Erdle *et al.*, Tech Rpt 94-12
9. Morse Point	B5	see Clampitt *et al.*, Tech Rpt 93-14
10. Southern Marshes	B3	see Erdle *et al.*, Tech Rpt 94-12
Back Bay Watershed		
1. Lovetts Marsh	B?	Buhlmann, K.A., J.C. Ludwig, and C.A. Pague. 1992. A Natural Heritage Resources Inventory and Biological Assessment of the Fleet Combat Training Center, Dept. of the Navy, Virginia Beach, VA. Nat. Heritage Tech. Rpt. 92-02. Dept. of Cons. and Recreation, Richmond, VA
2. Dam Neck Northern Dune and Swale	B?	see Buhlmann *et al.*, Tech Rpt 92-02
3. Upper Redwing Lake	B?	Ludwig, J.C. – Digitizing project
4. Southeast Redwing Lake	B5	see Buhlmann *et al.*, Tech Rpt 92-02
5. Dam Neck Middle Beach Dunes	B4	see Buhlmann *et al.*, Tech Rpt 92-02
6. Dam Neck Helicopter Pad Wetlands	B?	see Buhlmann *et al.*, Tech Rpt 92-02
7. Dam Neck Interdunal Swale	B?	see Buhlmann *et al.*, Tech Rpt 92-02
8. Black Gut	B4	see Erdle *et al.*, Tech Rpt 94-12
9. North Bay Marshes	B4	see Clampitt *et al.*, Tech Rpt 93-14
10. Porpoise Point	B5	see Clampitt *et al.*, Tech Rpt 93-14
11. Wash Flats	B4	GMF S.USVAHP*1746
12. Back Bay National Wildlife Refuge	B2	managed area files
13. Nawney Creek	B4	see Erdle *et al.*, Tech Rpt 94-12
14. Muddy Creek	B5	see Erdle *et al.*, Tech Rpt 94-12
15. Campbell Landing	B3	see Clampitt *et al.*, Tech Rpt 93-14
16. Sedge Island	B5	GMF S.USVAHP3*1789
17. False Cape State Park	B2	managed area files

Site Conservation Plans

To enhance protection and facilitate management of biodiversity in the southern watershed area (SWA), 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 all known element occurrences and land determined to be important for long-term maintenance of the elements, or for water quality preservation or enhancement.. The following standard reporting format is used for each site:

Site Name: Site names generally reflect a geographic locality and, in some cases, a prevalent or recognizable landscape feature.

Locality: The regional location of 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: The location of the site, using geographical landmarks and roads, is given.

Natural Heritage Resources Table: This field provides a synopsis of the natural heritage resources (rare species and significant communities). Historical occurrences are listed only if the associated data was known to have been collected within the site boundary.

Site Description: A brief narrative (if available) describing the site, significant elements, vegetation, habitat, and current land use. In keeping with standard DCR-DNH report formats, the first reference to a plant species in a narrative is by common name, followed by its scientific name in parentheses. Subsequent references to the same plants or animals are by common name only.

Site Conservation Plan Boundary and Map: For purposes of this report, all site plans reference Figure 3 in the Conservation Plan for the SWA). A "site conservation plan boundary" text section will not appear in each plan, but the associated boundary depicted in Figure 3 should suffice. Conservation planning boundaries are drawn for planning purposes **only** and are not regulatory, acquisition boundaries, or legal designations, and carry no legal or regulatory authority.

The site map (Figure 3 of the Conservation Plan for the SWA) shows the site conservation planning boundary which contains all known element occurrences and land determined to be important for long-term maintenance of the elements, or for water quality preservation or enhancement. The Nature Conservancy further describes site conservation boundaries as: "Collectively, the boundaries of the conservation targets and sustaining processes (i.e. ecological boundaries) delineate the functional conservation site – the area necessary to maintain the viability of the conservation targets over time, including the natural patterns and processes that sustain the targets" (The Nature Conservancy 2000a). The following factors are considered when drawing these boundaries:

X the extent of current and potential habitat for rare species and ecological communities;
X species movement and migration corridors;
X maintenance of surface water quality within the site and the surrounding watershed;
X maintenance of the hydrologic integrity of groundwater resources;
X land intended to mitigate off-site impacts;
X land or activities necessary to preclude or minimize exotic species; and
X land necessary for management activities (*e.g.*, prescribed burning, invasive species control).

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 brief summary of the major issues and factors that should be considered in management of the site for water quality preservation or enhancement, and for biodiversity and natural heritage resource values. As a rule, generalized recommendations are provided based on potential threats identified. Expertise of scientists familiar with each site has been used in preparing these recommendations. As pointed out, management needs of a few element occurrences are so complex or 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 rare elements) is provided.

Appendix C – Site Conservation Plans: Northwest River

Great Dismal Swamp – an overview

The Great Dismal Swamp is a vast, forested wetland, located between the James River and its tributaries in southeastern Virginia and the Albemarle Sound and its tributaries in northeastern North Carolina. The western boundary of the Swamp is marked by the Suffolk Scarp, a linear, east-facing ridge that represents one of several Pleistocene shorelines in the region. In all other directions, the Dismal Swamp boundaries are irregular and enclose non-riverine, largely peat-mantled flats not clearly associated with streams or flowing water. The original (pre-settlement) extent of the swamp cannot now be determined accurately because of a long history of human alterations to the landscape, but is estimated to have been approximately four times the current size (Oaks and Whitehead 1979). The construction of the Dismal Swamp Canal (Intracoastal Waterway) in the early 1800's, in particular altered hydrology of lands lying to the east of present-day US Route 17 and permitted large areas of swamp to be "improved" (Oaks and Whitehead 1979).

Environmental development of the Great Dismal Swamp began about 12,000 years B.P. (before present) in a cold, late-glacial landscape. Developing wetlands consisted of open freshwater marshes with deep-water aquatic plants, and were confined to the vicinity of stream channels in the eastern part of the area. From about 10,600 to 8,200 years B.P., the climate moderated and the marshes and peat deposits expanded to the west and onto the interfluves. From 8,200 to 3,500 years B.P., wetland vegetation shifted from a dominance of grasses and deep-water aquatics to a dominance of emergents and species characteristic of boggy habitats. The westward and lateral expansions of the peat deposits continued. The present-day swamp forest vegetation became established only about 3,500 years B.P. (Whitehead and Oaks 1979).

Early explorers and settlers found the Swamp a dark and forbidding place, but began exploiting its timber resources early in the post-settlement period (Simpson 1990). During the 19th and early 20th centuries, an extensive network of drainage ditches was constructed and the entire area was repeatedly logged and burned. In some cases, historical fires in the Dismal Swamp raged over thousands of hectares, destroyed large areas of peat, and burned the roots of countless living trees, causing total devastation (Dean 1969; Simpson 1990). As a result of these impacts, the original vegetation was destroyed and replaced by secondary forests that in many areas reflect drier habitat conditions than before.

Despite past disturbances, the Great Dismal Swamp remains one of the largest areas of continuous forest on the Atlantic Coastal Plain and contains an exceptional number of rare communities, plants, and animals. More than 100,000 acres have been acquired by the U.S. Fish and Wildlife Service and are now managed as a National Wildlife Refuge. Several significant outlying tracts, some of them privately owned, also remain. Several sites included in this report are contiguous with the Great Dismal Swamp, and remain very similar to the Swamp in vegetation and character. For this reason an overview of the Great Dismal Swamp is included. Although the Swamp and the Northwest River are separate system, they are similar in many ways, and to a small degree, headwaters of the Northwest River draw from the Great Dismal Swamp, as well as from lands immediately east.

Northwest River – an overview

The Northwest River basin comprises the largest and most important natural area lying entirely within the City of Chesapeake. The headwaters of this stream originate from groundwater, ditches, and drainage on peat-mantled flats just east of U.S. Route 17 and the Great Dismal Swamp. The River flows for a relatively short distance (about 23 river miles) to the state line, then flows for another 10 river miles through North Carolina before emptying into Tull Bay, an embayed arm of Currituck Sound. Eventually Currituck Sound flows south into the Albemarle Sound and subsequently, to the Pamlico Sound, and is a major tributary to the Albemarle / Pamlico Sound estuarine system. Major tributaries of the Northwest River in Virginia are Shell Landing Creek, Indian Creek, and Smith Creek. Throughout its short course

through Virginia, the Northwest River undergoes a remarkable ecological and hydrological transition. Beginning as a non-riverine, groundwater-controlled wetland, it becomes a typical sluggish, small coastal plain river snaking through expansive swamp forests, then widens into a broad estuarine waterway with wind-tidal fluctuations and marsh-lined channels.

These diverse environmental conditions foster a correspondingly rich assemblage of natural communities, plants, and animals adapted to varied wetland habitats. Adding to this diversity are mesic, forested uplands bordering the swamps and locally occurring as islands within them. Moreover, a significant number of the Northwest River's communities and biotic elements are rare, both in Virginia and globally. Within a macrosite of approximately 12,000 acres, DCR-DNH biologists have identified 17 significant community occurrences, 22 rare plant populations, and 12 rare animal populations to date. Many of the community types, particularly those associated with non-riverine flats or wind-tidal, oligohaline estuarine environments, are considered globally rare endemics or near-endemics of the mid-Atlantic coastal plain embayed region of southeastern Virginia and eastern North Carolina (Fleming and Moorhead, 1998). Among the plant and animal rarities, the state rare Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) occurs throughout the Northwest River drainage, and the area also encompasses one of the last remaining strongholds of the state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*). Three plants considered globally rare occur here as well: cypress-knee sedge (*Carex decomposita*), winged seedbox (*Ludwigia alata*), and awned mountain-mint (*Pycnanthemum setosum*).

The Northwest River bottomland in Virginia provides a relatively large, continuous area of natural wetland habitats in a landscape otherwise largely agricultural and residential in character. Neighboring state-owned and private lands in North Carolina complete an excellent wildlife/natural area corridor that connects the Great Dismal Swamp, Northwest River, and North Landing River watersheds (Erdle *et al*. 1994). The Northwest River itself is a major recreational resource used for fishing, hunting, and boating. However, it is relatively untouched by modern development and is much less used than its neighbor, the North Landing River. This lends a special quality of wildness and remoteness to the experience of the river and its natural areas.

Approximately 2,250 acres of the middle and lower Northwest River wetlands are owned and managed by DCR as a state natural area preserve. A 763-acre City-owned park with extensive natural areas and a smaller preserve owned by The Nature Conservancy, are also situated along the river east of Rt. 168 (Battlefield Boulevard). Thousands of wetland acres and adjacent forested uplands remain in private ownership. In this conservation planning document, 9 sites along the Northwest River (refer to Figure 3 in the body of the document) are described and mapped. Currently, threats to ecosystem integrity appear to be minimal. Potential threats include increased water withdrawal for municipal water supplies, depletion of associated groundwater aquifers, agricultural and urban non-point pollution, fragmentation of large forest blocks, intensive timber management, and suppression of a natural fire regime in certain fire-dependent community types. DCR's Division of Soil and Water Conservation has given the Northwest River an overall rating of "high" based upon the nonpoint source contributions from agriculture, urban, and forestry activities (DEQ 2000).

HEADWATERS

Locality: City of Chesapeake, Virginia

Quadrangle: Lake Drummond SE - 3607653; Moyock - 3607652

Location: This site includes the Northwest River bottomland and a few immediately adjacent forested slopes from U.S. Route 17 on the west to about 2 miles SE of Bunch Walnuts Road.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
***Nyssa biflora - Taxodium distichum - Acer rubrum* / *Clethra alnifolia* / *Woodwardia areolata* Seasonally Flooded Forest**	Non-Riverine Swamp Forest
***Nyssa aquatica - Taxodium distichum* / *Fraxinus caroliniana* / *Triadenum walteri* Semipermanently Flooded Forest**	Water Tupelo - Baldcypress swamp
Plants:	
Panicum hemitomon	maidencane
Wisteria frutescens	American wisteria
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: This section of the Northwest River corridor is heavily forested (refer to Figures 3 and 4) and features a gradual transition from non-riverine flats that are seasonally flooded by groundwater to a blackwater stream with typical floodplain and backswamp development. It is difficult to determine the extent of presettlement stream channels in this section since the existing channels were all historically created or enlarged by dredging and augmented by several major ditches and canals draining from adjacent interfluves and through the headwaters wetlands. Some of these artificial waterways were dug as early as 1820, and were apparently used to move lumber from the Dismal Swamp to navigable parts of the river downstream and on to Currituck Sound. From the vicinity of Bunch Walnuts Road eastward, the Northwest River appears to flow in its natural channel, bordered by a wide floodplain with extensive backswamps, especially on the north side. This site covers a very large area, only portions of which were examined during the project.

In the western portion of the site, between U.S. Route 17 and Lake Drummond Causeway, topography, peat substrates, and vegetation resemble those of the Great Dismal Swamp. Wet habitats here are shallowly flooded during the winter and spring months but usually draw down by early summer; other habitats near the western edge are merely saturated. Young non-riverine swamp forest covers most of this area, with some non-riverine pine-hardwood forest in the saturated habitats. A relatively wet, mixed and mature stand of non-riverine swamp forest occurs just west of the Lake Drummond Causeway Bridge. The stand contains baldcypress (*Taxodium distichum*), red maple (*Acer rubrum*), swamp tupelo (*Nyssa biflora*), water tupelo (*Nyssa aquatica*), and laurel oak (*Quercus laurifolia*) up to 90 cm dbh, with an understory of sweet pepperbush (*Clethra alnifolia*) and common greenbrier (*Smilax rotundifolia*). This community type is endemic to the mid-Atlantic coastal embayed region and high quality examples are now rare because of extensive logging and destructive peat fires (Fleming and Moorhead 1998).

Between Lake Drummond Causeway and Bunch o'Walnuts Road, the general composition of the swamp forest changes to that of a typical riverine water tupelo-baldcypress swamp. Behind a low riverside levee, flats and backswamps are seasonally to semipermanently flooded. The forest vegetation is generally characterized by second-growth stands of water tupelo and/or baldcypress, with well-developed understory layers of Carolina ash (*Fraxinus caroliniana*). Stands consisting mostly of large water tupelo up to 1.0 m dbh also occur in several places. Several species not found elsewhere on the Northwest River, including overcup oak (*Quercus lyrata*), Louisiana sedge (*Carex louisianica*), and pale manna-grass (*Torreyochloa pallida*) occur in these stands. A few small islands and bordering uplands supporting non-riverine wet hardwood forest and mesic mixed hardwood forest are found in this area.

Extensive and remote wetlands of this site provide viable habitat conditions for populations of both state listed animals, the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*), and the canebrake rattlesnake (*Crotalus horridus atricaudatus*) (Erdle and Pagels 1995, Mitchell and Schwab 1991). The

state-rare grass maidencane (*Panicum hemitomon*) occurs abundantly in powerlines and roadside ditches throughout the headwaters area from Lake Drummond Causeway to U.S. Route 17. Elsewhere in its range, this species occurs in natural depression pond habitats; whether such a habitat exists or once existed at this site is not known.

Threats: Threats to this site and its element occurrences include habitat conversion, increased drainage, fragmentation of the continuous forest corridor, intensive clearcutting and forest management, agricultural non-point pollution, and indiscriminate killing of canebrake rattlesnakes.

Management Recommendations: Maintenance of existing forested wetlands and supporting hydrology is critical to the integrity of this site and its relationship to adjacent natural areas. Land use conversions, clearcutting, and other activities that could alter hydrology, water quality, and habitat quality should be discouraged.

Protection Recommendations: Most of the land comprising this site is privately owned. Portions of the site though, are in conservation ownership, and are held by the Commonwealth of Virginia, Department of Conservation and Recreation, and by The Nature Conservancy. Another portion of this site is an existing, privately owned wetland mitigation bank. The mitigation bank is contiguous with property held by The Nature Conservancy. The site is part of an integrated Northwest River ecosystem, and is a particularly critical link in a continuous natural area corridor that includes the Great Dismal Swamp, the Northwest River, and the North Landing River (Erdle *et al*. 1994). Protection efforts here have a direct impact on water quality of the Northwest River, and contribute significantly to protection of the watershed. It's recommended that protection and conservation efforts within, and adjacent to this site be vigorously pursued using a full range of land protection tools.

It is particularly important that land within, and adjacent to this site is protected. This can be accomplished through many means (see conservation plan text), including (but not limited to) acquisition, Natural Area Registry or Dedication, Open Space Easements, or as mitigation lands. The Northwest River Headwaters site is a critical link in a corridor linking the Great Dismal Swamp and the Northwest River headwaters with other areas within the SWA.

SMITH RIDGE

Locality: City of Chesapeake, Virginia

Quadrangle: Lake Drummond SE - 3607653

Location: The site is located just north of North Carolina and approximately 2.5 miles east of U.S. Route 17. It is bounded on the north by upland vegetation, to the west by a large ditch and farm road, on the south by another ditch and the state line, and on the east by a tract owned by the City of Chesapeake.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
***Chamaecyparis thyoides* / *Lyonia lucida* - *Ilex coriacea* /*Osmunda cinnamomea* Saturated Forest**	Peatland Atlantic White-cedar Forest
***Nyssa biflora* - *Taxodium distichum* - *Acer rubrum* / *Clethra alnifolia* / *Woodwardia areolata* Seasonally Flooded Forest**	Non-Riverine Swamp Forest
Plants:	
Ilex coriacea	sweet gallberry
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake

Sorex longirostris fisheri Dismal Swamp southeastern shrew

Site Description: Smith Ridge is one of the most important privately owned natural areas in the City of Chesapeake. The site is an eastern extension of the Great Dismal Swamp and encompasses a large, forested, non-riverine wetland that is partitioned by a network of ditches and dirt roads (refer to Figures 3 and 4). Soils within the conservation planning boundary are predominately shallow mucky peats, with a large area of Portsmouth mucky loam in the western portion, south of Smith Ridge proper (Henry *et al*. 1959). The natural area is used for timber management and hunting. This site has not been surveyed by DCR-DNH biologists, but information has been assembled from aerial photographs, historical sources, and cooperators who have studied the area.

A detailed description of the early post-settlement vegetation at this site is provided by William Byrd's surveying party as it traversed the state line in 1728 (Simpson 1990, Frost 1989). Upon reaching the eastern edge of the Dismal Swamp, Byrd's men reported travelling through enormous canebrakes of nearly pure giant cane (*Arundinaria gigantea* ssp. *tecta*) about three meters tall, then entering an extensive and dense white-cedar forest. Disturbed remnants of these community types exist today, despite intensive past logging, ditching, and fire suppression. Much of the virgin Atlantic white-cedar (*Chamaecyparis thyoides*) was removed around 1900, and additional logging occurred in the 1930's (Frost 1989). Current vegetation consists of a mosaic of second-growth non-riverine swamp forest and poor quality Atlantic white-cedar forest with much loblolly pine (*Pinus taeda*) on the deeper peats, and dense thickets of giant cane under sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), or loblolly pine on the shallower peats and mineral soil. Some of the latter communities have only scattered, open-grown trees and appear almost savanna-like.

The existing occurrence of peatland Atlantic white-cedar forest covers perhaps 50 acres in Virginia and is marginal in quality. Atlantic white-cedar regenerated poorly following logging, allowing loblolly pine to become established and dominate the stand. A few pond pine (*Pinus serotina*) also occur here, and typical peatland shrubs such as red bay (*Persea palustris*), shining fetterbush (*Lyonia lucida*), and the state-rare sweet gallberry (*Ilex coriacea*), persist in the understory.

Non-riverine swamp forest covers extensive acreage with variable, usually mixed dominance by red maple, swamp tupelo (*Nyssa biflora*), sweetgum, baldcypress (*Taxodium distichum*), and tuliptree (*Liriodendron tulipifera*). One of the most unusual vegetational features of the site is found on relatively well-drained, low peaty ridges located south of Smith Ridge. Woody understory species of exceptional size abound here, with large American holly (*Ilex opaca*) 29 - 48 cm (11 - 19") dbh dominating some portions of the area. Several state and national champion tree specimens have also been recorded (VFA 1991):

X co-national champion and state champion horse-sugar (*Symplocos tinctoria*), 21 m (70 ft) tall and 28 cm (11") dbh, and 16 m (54 ft) tall and 44 cm (17") dbh;

X state champion sweetbay (*Magnolia virginiana*), 25 m (82 ft) tall and 61 cm (24") dbh; and

X state champion paw-paw (*Asimina triloba*), 19 m (63 ft) tall and 21 cm (8").

In addition to significant communities and rare plants, the site supports the state listed Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) and canebrake rattlesnake (*Crotalus horridus atricaudatus*). These populations are relatively contiguous with populations existing in the Great Dismal Swamp National Wildlife Refuge.

Threats: A large tract on the western border of the site was converted to farmland during the 1980's. The same farm has been proposed for both a landfill site and a wetlands mitigation site. Intensive timber management and increased ditching and drainage threaten existing forest communities and rare animal populations. Peatland Atlantic white-cedar forest is dependent upon periodic fire for stand renewal, so

fire suppression must also be considered a threat. Other potential threats include pollution or eutrophication of wetlands from agricultural run-off and expansion of an existing sand mining operation into significant forested habitats. The canebrake rattlesnake continues to be threatened by senseless, deliberate killing (Mitchell and Schwab 1991).

Management Recommendations: Maintenance or restoration of a natural hydrologic regime, reintroduction of fire, and less intensive timber management are essential to maintaining or enhancing the existing element occurrences. Landowners are encouraged to adhere to agricultural and silvicultural best management practices designed to minimize sedimentation and run-off. According to Frost (1989), this site has exceptionally good potential for restoration of the now-extirpated canebrake community type.

Protection Recommendations: This site is privately owned and continues to be threatened by potential land use changes and intensive commercial timber management. Because of its biodiversity importance, we recommend that a full array of protection tools be applied to ensure long-term protection of at least portions of this area.

It is particularly important that land within and adjacent to this site is protected. This can be accomplished through many means, including but not limited to, acquisition, Natural Area Registry or Dedication, Open Space Easements, or as mitigation lands. The Northwest River Smith Ridge site is a critical link in a corridor linking the Great Dismal Swamp with swamp 'fingers' or extensions in North Carolina. Corridors linking these areas contribute to overall health of the estuarine ecosystem.

NSGA NORTHWEST

Locality: City of Chesapeake, Virginia

Quadrangle: Lake Drummond SE - 3607653

Location: This site is located in the southwestern portion of the NSGA Northwest Naval Reservation, encompassing a forested tract lying west of the ROTHR radio antenna and north of the Virginia – North Carolina state line. Its westernmost portion includes a wedge of land donated to the City of Chesapeake Department of Parks and Recreation in the 1970's.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Nyssa biflora – Taxodium distichum – Acer rubrum / Clethra alnifolia / Woodwardia areolata **Seasonally Flooded Forest**	Non-riverine Swamp Forest
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: This site encompasses one of the easternmost extensions of the Great Dismal Swamp in Virginia (see Figure 3). Except for a small but impressive stand of old non-riverine wet hardwood forest and scattered patches of non-riverine pine-hardwood forest, the area is forested with second-growth non-riverine swamp forest similar to that occurring in the Great Dismal Swamp National Wildlife Refuge. Soils are predominantly well-decomposed peat, with a band of poorly drained mineral soils on the eastern edge of the site. A network of natural, microtopographic swales or depressions laces the area and is readily visible on infrared aerial photographs. The site is also dissected by numerous drainage ditches and hunting roads. Extensive logging and a severe fire which may have burned out underlying

peat in places occurred in the 1940's (Belden 1993). The area is currently used for hunting and passive recreation.

Two significant community occurrences were documented here. The old stand of non-riverine wet hardwood forest occurs on the eastern edge of the site and is dominated by large swamp chestnut oak (*Quercus michauxii*), water oak (*Quercus nigra*), and laurel oak (*Quercus laurifolia*) ranging up to 104 cm dbh. Occasional large American beech (*Fagus grandifolia*) is also associated with this stand. American hornbeam (*Carpinus caroliniana*) is the dominant small tree and large shrub, while coastal dog-hobble (*Leucothoe axillaris*) is the dominant small shrub. Scarcely ten acres in size, this occurrence is exceptionally mature and of very high quality. This is a globally rare community type endemic to the mid-Atlantic coastal embayed region and highly threatened by a variety of potential disturbances throughout its range (Fleming and Moorhead 1998).

The non-riverine swamp forest covering most of the site has been much disturbed by cutting but is less altered than many other stands of the type in this region. Canopy composition is more or less mixed and includes red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), swamp tupelo (*Nyssa biflora*), baldcypress (*Taxodium distichum*), and laurel oak. Prominent understory and herbaceous species include red bay (*Persea palustris*), sweet pepperbush (*Clethra alnifolia*), American holly (*Ilex opaca*), netted chain fern (*Woodwardia areolata*), and Virginia chain fern (*Woodwardia virginica*). Given time and proper management, this stand can become an outstanding representative of the type, which is also considered globally rare (Fleming and Moorhead 1998). The site provides a relatively large area of viable habitat for the state rare Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) and the canebrake rattlesnake (*Crotalus horridus atricaudatus*) (Erdle *et al*. 1994; Rose *et al*. 1988).

Threats: The most important potential threats to Natural Heritage resources here are wetland drainage and intensive timber management. An additional threat to the integrity of natural communities comes from the invasive exotic vine Japanese honeysuckle (*Lonicera japonica*), which has become rampant in disturbed clearings and along edges of the site. The canebrake rattlesnake continues to be threatened by senseless, deliberate killing (Mitchell and Schwab 1991).

Management Recommendations: Current recreational uses of the site are compatible with maintaining viable habitat conditions for Natural Heritage resources. Some timber harvests, expansion of developed facilities, and other activities that could disturb the forest environment and hydrology of the site should be avoided. To the extent possible, the natural hydrology of the area should be restored. It is strongly recommended that DCR-DNH be consulted during future development or refinement of management plans for this site.

Protection Recommendations: The site is on lands owned by the federal government and the City of Chesapeake and used primarily for recreation. Natural resource conservation should be given strong consideration in any land use planning for the site.

It is particularly important that land within and adjacent to this site is protected. This can be accomplished through many means (see conservation plan text), including but not limited to, acquisition, Natural Area Registry or Dedication, Open Space Easements, or as mitigation lands. The Northwest River NSGA site is a critical link in a corridor linking the Great Dismal Swamp with swamp 'fingers' or extensions in North Carolina. Corridors linking these areas contribute to overall health of the estuarine ecosystem.

MIDDLE SECTION

Locality: City of Chesapeake, Virginia

Quadrangle: Moyock - 3607652

Location: This site includes the Northwest River and adjacent wetlands from ca. 3.25 mi. NW of the Rt. 168 (Battlefield Boulevard) bridge to ca. 2.0 mi. east of the bridge.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
***Eleocharis fallax - Eleocharis rostellata – Scirpus americanus - Sagittaria lancifolia* Tidally Flooded Herbaceous Vegetation**	Spikerush - Olney Three-square Marsh
***Fagus grandifolia - Quercus alba* / *Stewartia malacodendron* Forest [provisional]**	Mesic Mixed Hardwood Forest
***Fagus grandifolia - Quercus alba* / *Stewartia malacodendron* Forest [provisional]**	Mesic Mixed Hardwood Forest
***Myrica cerifera - Salix caroliniana* / *Thelypteris palustris pubescens* Tidally Flooded Shrubland**	Tidal Shrub Swamp (Southern Bayberry -Carolina Willow type)
***Pinus serotina* / *Smilax laurifolia - Ilex glabra* / *Woodwardia virginica* Saturated Woodland**	Pond Pine Woodland
***Taxodium distichum - Nyssa biflora - Pinus taeda* / *Myrica cerifera* / *Osmunda regalis* var. *spectabilis* Tidally Flooded Forest**	Estuarine Fringe Swamp Forest
Plants:	
Carex decomposita	cypress-knee sedge
Erigeron vernus	white-top fleabane
Eriocaulon decangulare	ten-angle pipewort
Lobelia elongata	elongated lobelia
Tillandsia usneoides	Spanish-moss
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: This site is bisected and somewhat fragmented by Rt. 168 (Battlefield Boulevard), but wetlands on either side have a very similar ecological character (see Figure 3). Here, the Northwest River is flanked by expansive swamp forests dominated primarily by tupelos (*Nyssa* spp.) and baldcypress (*Taxodium distichum*). Some backswamps in this section are very wide and contain isolated, mesic upland islands up to 10 acres in size. West of the Rt. 168 bridge, between the river and its major unnamed northern branch, is an interior swamp area of coarse peat that apparently has remained isolated from fluvial processes for some time. Along the northern branch just west of Rt. 168 are several small, narrow marshes representing the upstream limits of herbaceous estuarine vegetation in the watershed. Most of this site is remote and serene. There are, however, a few residences and boat houses near the river on both sides of Rt. 168, and the City of Chesapeake municipal water withdrawal plant is located just east of the bridge.

Heading downstream in this stretch, areas close to the river channel are progressively subject to frequent water level fluctuations induced by wind tides and have relatively coarse, somewhat poorly decomposed peat substrates. The forest community that occupies these areas, commonly called estuarine fringe swamp forest, has a canopy composed primarily of swamp tupelo (*Nyssa biflora*), baldcypress, loblolly

pine (*Pinus taeda*), and water tupelo (*Nyssa aquatica*), with southern bayberry (*Myrica cerifera*) and royal fern (*Osmunda regalis* var. *spectabilis*) characteristic of the shrub and herb layers, respectively. This community type, a mid-Atlantic embayed region endemic, becomes more widespread downstream along the marsh-lined, more estuarine section of the river. In the muckier, stagnant backswamps, which are rarely or never influenced by wind-tidal flooding, a more typical tupelo-baldcypress swamp community prevails. Dominant trees include the two tupelos and baldcypress, but loblolly pine and southern bayberry are absent and the shrub and herbaceous flora is more diverse. Most of the swamp forests were cut around the turn of the century or more recently. Large areas of the site's interior swamps remain unexplored due to basic inaccessibility and the difficulty of traversing these very wet, dense habitats on foot.

Swamp islands support significant stands of mesic mixed hardwoods, some of them quite mature. Characteristic species here include American beech (*Fagus grandifolia*), several oaks (*Quercus* spp.), mockernut hickory (*Carya alba*), flowering dogwood (*Cornus florida*), eastern hophornbeam (*Ostrya virginiana*), silky camellia (*Stewartia malacodendron*), and big-leaf snowbell (*Styrax grandifolius*). The isolated peatland supports a globally rare pond pine woodland that has recently lost most of its pond pine (*Pinus serotina*) canopy as the result of a southern pine beetle (*Dendroctonus frontalis*) infestation.

Small marshes west of Rt. 168 are representative of a very rare type of low to mid-height herbaceous vegetation developed only in nearly fresh, oligohaline estuaries or on groundwater-influenced margins of brackish tidal estuaries (Fleming and Moorhead 1998). Characteristic species here include creeping spikerush (*Eleocharis fallax*), beaked spikerush (*Eleocharis rostellata*), twigrush (*Cladium mariscoides*), Olney three-square (*Scirpus americanus*), halberd-leaved tearthumb (*Polygonum arifolium*), arrow arum (*Peltandra virginica*), tickseed sunflower (*Bidens coronata*), aster boltonia (*Boltonia asteroides*), bristly sedge (*Carex comosa*), and many others. Shrubs and tree saplings appear to be increasing in these marshes, and aerial photographs taken in the 1940's (Henry *et al*. 1959) show more extensive marsh areas that are now completely overgrown. This trend may reflect a natural successional process occurring at the edge of estuarine influences, or a recent lack of fire in these marshes, or both. According to Frost (1995), wildfires are an important ecological factor in regulating succession in fresh to oligohaline marshes of the mid-Atlantic embayed region, and a recent reduction or suppression of fires has led to a region-wide reduction in marsh diversity, as well as increased invasion by woody species.

The combination of remote upland islands and extensive swamps provides ideal habitat for viable populations of the state listed Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*), and the canebrake rattlesnake (*Crotalus horridus atricaudatus*) (Erdle and Pagels 1995, Mitchell and Schwab 1991). Two rare plants are presently recorded at this site, and three others are known from historical records.

Threats: Potential hydrological threats include increased water withdrawal, agricultural and urban non-point source pollution, toxic or hazardous materials spills on Rt. 168, and shoreline damage from excessive boat traffic and wakes. Threats to ecosystem integrity include clearcutting, fragmentation of forest and wetland corridors, reduction or lack of a natural fire regime in fire-dependent marshes and peatland pond pine woodlands, and degradation of marshes by shrubs and invasive species. Outbreaks of southern pine beetle are cyclic disturbances that cause temporary damage but are not critical threats to the Pond Pine Woodland; lack of fire is a much more serious threat to the viability of these communities. Common reed (*Phragmites australis*), a large grass that tends to aggressively displace other vegetation in wetlands where soils or hydrology have been disturbed, is present and increasing in the site's marshes. Senseless, deliberate killing of canebrake rattlesnakes continues to be a problem throughout this reptile's range.

Management Recommendations: Maintenance of existing forested wetlands and supporting hydrology is critical to the integrity of this site and its relationship to adjacent natural areas. Land use conversions, clearcutting, and other activities that could alter hydrology and habitat quality should be discouraged.

Water quality in this section should be closely monitored. Prescribed burning to simulate or approximate natural fire regimes in the site's marshes and Pond Pine Woodland is strongly recommended. Frequent burning may provide some control of common reed in the marshes, but additional control measures may also be warranted (Clark 1997).

Protection Recommendations: A tract of 926 acres, located just west of the Rt. 168 bridge, has been acquired by DCR and is managed as part of a state natural area preserve (Heffernan, 2000). A smaller preserve owned and managed by The Nature Conservancy is located east of the bridge on the north side of the river, west of Indian Creek. The remainder is privately owned. The site is part of an integrated Northwest River ecosystem, and is a critical link in a continuous natural area corridor that includes the Great Dismal Swamp, the Northwest River, and the North Landing River (Erdle *et al*. 1994), and contributes to long-term health and function of the Currituck Sound estuarine system. Additional protection efforts here will contribute to protection of larger, more significant landscape units and should be vigorously pursued using a full range of land protection tools.

INDIAN CREEK

Locality: City of Chesapeake, Virginia

Quadrangle: Moyock - 3607652

Location: The site is located north of the Northwest River, south of Indian Creek Road, and immediately adjacent to the western border of Northwest River Park.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Tillandsia usneoides	Spanish-moss
Animals:	
Enallagma pallidum	pale bluet
Crotalus horridus atricaudatus	canebrake rattlesnake
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: Indian Creek (refer to Figure 3) is a small, slow flowing blackwater creek. It is part of a fairly broad floodplain swamp comprised primarily of baldcypress (*Taxodium distichum*), swamp tupelo (*Nyssa biflora*) and sweetgum (*Liquidambar styraciflua*). Mid and understory vegetation in the forested habitats bordering the creek is fairly dense, with pockets of emergent and overhanging shoreline vegetation. One small clump of Spanish moss (*Tillandsia usneoides*) was found at this site. The shoreline of Indian Creek is sunlit only during portions of the day.

Three rare animals occur at Indian Creek, the state listed canebrake rattlesnake (*Crotalus horridus atricaudatus*) and Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*), as well as the pale bluet (*Enallagma pallidum*). The pale bluet is rare in Virginia and is declining globally, yet the population of this rare damselfly at Indian Creek is large and thriving. This rare damselfly is known from only two locations in Virginia, the other site is along the shore of Lake Drummond in the Great Dismal Swamp. These animals are dependent upon quiet, slow-moving, dark-stained waters with much shoreline vegetation to provide cover. Since the pale bluet lays it's eggs on the sides of sticks, cypress knees or stumps (often just below the water's surface), water quality is very important to long-term health of the population.

Threats: Common reed (*Phragmites australis*), a large grass that tends to aggressively displace other vegetation in wetlands where soils or hydrology have been disturbed, forms dense clones in parts of the marshes. Clearcutting, forest fragmentation, and large-scale land use changes are potential threats in

privately owned swamps and uplands buffering the western edge of the site. Activities which degrade water quality in Indian Creek, or in the Northwest River could pose significant threats to the pale bluet.

Management Recommendations: Maintenance of existing hydrology, forested wetlands, shoreline vegetation, and marshes are critical to the integrity of this site, its relationship to adjacent natural areas, and long-term viability of the rare damselfly population. Land use conversions, clearcutting, and other activities that alter hydrology and habitat quality should be discouraged.

Protection Recommendations: The site is part of an integrated Northwest River ecosystem, and is a critical link in a continuous natural area corridor that includes the Great Dismal Swamp, the Northwest River, and the North Landing River (Erdle *et al*. 1994). Additional protection efforts here especially along the western edge of this site are needed to help ensure long-term viability of the rare natural resources at Indian Creek. Protection efforts on the western side of the site can be accomplished through many means (see conservation plan text), including, but not limited to, acquisition, Natural Area Registry or Dedication, Open Space Easements, or as mitigation lands.

NORTHWEST RIVER PARK

Locality: City of Chesapeake, Virginia

Quadrangle: Moyock - 3607652

Location: The site is located approximately 2.5 miles NE of the community of Northwest. It is bounded on the north by Indian Creek Road, on the west by Indian Creek, on the south by the Northwest River, and on the east by Smith Creek and a small upland tract.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Eleocharis fallax - Eleocharis rostellata - Scirpus americanus - Sagittaria lancifolia **Tidally Flooded Herbaceous Vegetation**	Spikerush - Olney Three-square Marsh
Myrica cerifera - Salix caroliniana / Thelypteris palustris **var.** ***pubescens*** **Tidally Flooded Shrubland**	Tidal Shrub Swamp (Southern Bayberry Carolina Willow type)
Quercus michauxii - Quercus laurifolia / Carpinus caroliniana / Carex debilis **Saturated Forest**	Non-Riverine Wet Hardwood Forest
Taxodium distichum - Nyssa biflora - Pinus taeda / Myrica cerifera / Osmunda regalis **var.** ***spectabilis*** **Tidally Flooded Forest**	Estuarine Fringe Swamp Forest
Plants:	
Carex decomposita	cypress-knee sedge
Eriocaulon decangulare	ten-angle pipewort
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Physostegia leptophylla	slender-leaved dragon-head
Stachys aspera	rough hedgenettle
Tillandsia usneoides	Spanish-moss
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake

Enallagma pallidum pale bluet
Sorex longirostris fisheri Dismal Swamp southeastern shrew

Site Description: Northwest River Park (refer to Figures 3, 4, and 5) is a City of Chesapeake facility devoted to low-intensity, mostly nature-oriented recreational activities. A 29-acre lake winds through the center of the area, which features a campground, hiking trails, picnic areas, and opportunities for fishing and canoeing. The Park also offers a variety of programs designed to enhance knowledge and appreciation of nature and cultivate proper use of the natural environment.

The vast majority of the Park's acreage is maintained in its natural condition and consists of extensive secondary upland forests and forested swamps along the river and its two major tributaries. Water levels in the river and its bordering wetlands are influenced by frequent wind-tidal fluctuations. Many of the swamps belong to the estuarine fringe swamp forest community type, which is a globally rare endemic of the mid-Atlantic coastal embayed region. Small stands of oligohaline tidal shrub swamp and low to mid-height, oligohaline spikerush-Olney three-square marsh, also globally rare community types, occur in a small embayment near the confluence of the river and Indian Creek. The rare plants cypress-knee sedge (*Carex decomposita*) and Spanish moss (*Tillandsia usneoides*) are associated with swamp forests at this site, while the rare plants ten-angle pipewort (*Eriocaulon decangulare*), elongated lobelia (*Lobelia elongata*), winged seedbox (*Ludwigia alata*), slender-leaved dragon-head (*Physostegia virginiana*), and rough hedgenettle (*Stachys aspera*) are found in the marsh and adjacent tidal shrublands.

Because of their global rarity, cypress-knee sedge and winged seedbox are particularly noteworthy plants of the Northwest River ecosystem. The historical range of cypress-knee sedge encompassed the Atlantic coast and midwestern U.S., but the species has disappeared from a large number of its historical locations (Ostlie 1990). Also called epiphytic sedge, this species typically grows in undisturbed, organic-rich backswamps and riverside swamp edges, usually occurring on floating or partially submerged logs, stumps, or baldcypress knees. Seed dispersal is believed to be facilitated by waterfowl that inadvertently carry the ripe perigynia on their feet and deposit them onto appropriate microhabitats when they land (Ostlie 1990). The species is known from only two other Virginia watersheds, one of them the North Landing River.

Winged seedbox, which occurs in the low, spikerush (*Eleocharis*) dominated marshes, is uncommon to rare throughout its range on the southeastern Atlantic and Gulf Coastal Plains (Godfrey and Wooten 1981). The Northwest River population, occurring at the species' northern range limit, is large and viable. Winged seedbox is also known in Virginia from the similarly fresh to oligohaline marshes of the North Landing River and Back Bay, but is most abundant and characteristic on the Northwest River.

One of the most significant community occurrences is a 50-acre stand of non-riverine wet hardwood forest on poorly drained flats with perched water tables in the central part of the Park. Dominant overstory species here include swamp chestnut oak (*Quercus michauxii*), laurel oak (*Quercus laurifolia*), sweetgum (*Liquidambar styraciflua*), and loblolly pine (*Pinus taeda*), with an understory of American hornbeam (*Carpinus caroliniana*) and giant cane (*Arundinaria gigantea* ssp. *tecta*). This is a fair quality occurrence, recovering from past logging, but with proper management can become a good example of this globally rare and highly threatened community type (Fleming and Moorhead 1998).

Three rare animals occur at Northwest River Park, including populations of the state listed canebrake rattlesnake (*Crotalus horridus atricaudatus*) and the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*). DCR-DNH zoologists also documented a large population of the state-rare pale bluet (*Enallagma pallidum*) from the swamp forest edges along Indian Creek. This damselfly is known from only one other locality in Virginia, along the shore of Lake Drummond in the Great Dismal Swamp.

Threats: As long as the Park maintains current levels of development and recreational use, threats to the site and its element occurrences are minimal. Shrub invasion and lack of a natural fire regime appear to be long-term threats to the small marsh community in the Park. Off-site threats of potential impact include non-point source pollution, increased water withdrawals from the river, and shoreline damage from increased boat traffic, wakes and potential spills.

Management Recommendations: Current land use should be maintained. Prescribed burning to simulate or approximate natural fire regimes in the site's marshes is recommended.

Protection Recommendations: Land protection for this site is essentially complete. However, significant habitats and rare species information should be incorporated into formal management plans for the Park, and some formal designation such as Natural Area Registry should be considered for particularly important areas. Additional protection efforts for lands adjacent to the park, especially on the western side of Indian Creek, may help buffer and further protect rare natural resources at the Northwest River Park.

SMITH CREEK

Locality: City of Chesapeake, Virginia

Quadrangle: Moyock - 3607652

Location: The site is located approximately 3 miles east of the community of Northwest. It encompasses the wetlands and adjoining forested uplands along Smith Creek and the Northwest River from Indian Creek Road west and south to the North Carolina line.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Eleocharis fallax - Eleocharis rostellata – Scirpus americanus – Sagittaria lancifolia **Tidally Flooded Herbaceous Vegetation**	Spikerush - Olney Three-square marsh
Fraxinus pennsylvanica **/** ***Cornus foemina*** **/** ***Carex bromoides*** **Seasonally Flooded Forest**	Coastal Plain Bottomland Hardwoods (Green Ash type)
Juncus roemerianus - Pontederia cordata **Tidally Flooded Herbaceous Vegetation**	Black Needle Rush Marsh (oligohaline type)
Myrica cerifera - Salix caroliniana **/** ***Thelypteris palustris*** **var.** ***pubescens*** **Tidally Flooded Shrubland**	Tidal Shrub Swamp (Southern Bayberry-Carolina Willow type)
Pinus serotina **/** ***Smilax laurifolia - Ilex glabra*** **/** ***Woodwardia virginica*** **Saturated Woodland**	Pond Pine Woodland
Spartina cynosuroides - Panicum virgatum – Phyla lanceolata **Tidally Flooded Herbaceous Vegetation**	Big Cordgrass Marsh (oligohaline type)
Taxodium distichum - Nyssa biflora - Pinus taeda **/** ***Myrica cerifera*** **/** ***Osmunda regalis*** **var.** ***spectabilis***	Estuarine Fringe Swamp

Tidally Flooded Forest

Plants:	
Carex decomposita	cypress-knee sedge
Cladium jamaicense	sawgrass
Cuscuta indecora	pretty dodder
Eriocaulon decangulare	ten-angle pipewort
Physostegia leptophylla	slender-leaved dragon-head
Pycnanthemum setosum	awned mountain-mint
Stachys aspera	rough hedgenettle
Utricularia purpurea	purple bladderwort
Xyris iridifolia	iris-leaf yellow-eyed-grass
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: Situated on the east side of the Northwest River between Northwest River Park and the state line (see Figures 3 and 4), this site contains a mosaic of upland forests, swamp forests, pond pine woodlands, and oligohaline marshes and shrub swamps. The Northwest River attains its greatest estuarine character here and in the Southwestern Marshes on the opposite side of the river channel. Except in small tributary wetlands and a few interior swamp islands, wind-tidal water fluctuations are frequent and relatively large marshes border the channels. Nine rare plants and two rare animals have been documented at this site.

Marshes of this site consist of patch-mosaics of several globally rare community types endemic or nearly endemic to oligohaline estuaries of the mid-Atlantic coastal embayed region. The rarest type is a short-statured community that tends to develop in the interior marsh zones away from channels. Characteristic species here are creeping spikerush (*Eleocharis fallax*), beaked spikerush (*Eleocharis rostellata*), Olney three-square (*Scirpus americanus*), bull-tongue arrowhead (*Sagittaria lancifolia*), and the rare plants winged seedbox (*Ludwigia alata*), ten-angle pipewort (*Eriocaulon decangulare*), elongated lobelia (*Lobelia elongata*), and iris-leaf yellow-eyed grass (*Xyris iridifolia*). Along channel edges, where tidal flushing and nutrient inputs are enhanced, marshes of tall, coarse graminoids such as big cordgrass (*Spartina cynosuroides*) and cattails (*Typha* spp.) predominate. Other marsh stands are composed of nearly monospecific black needle rush (*Juncus roemerianus*). Tidal shrublands dominated by southern bayberry (*Myrica cerifera*), Carolina willow (*Salix caroliniana*), and tree saplings often form an ecotonal zone between the marshes and adjacent swamp forests.

The flora of these oligohaline marshes and related shrublands contains a mixture of freshwater species and species more typical of brackish marshes such as saltmeadow cordgrass (*Spartina patens*), big cordgrass, and especially black needle rush. In the Northwest and North Landing River drainages, populations of black needle rush, cordgrass and other more or less halophytic species may be relicts of earlier, more saline, lunar tidal environments which prevailed prior to the closing of two large inlets on the Outer Banks. Although both big cordgrass and black needle rush communities are typical of brackish marshes, those of the nearly fresh Albemarle-Pamlico estuarine system are considered unique in their floristic composition and prevalence of freshwater associates (Fleming and Moorhead 1998).

Two stands of globally rare pond pine woodland occur on saturated, interior swamp peatlands which lie beyond the range of wind-tidal flooding. Perhaps in part because they are surrounded by wet swamps, these communities are somewhat fire suppressed and have nearly closed canopies of pond pine (*Pinus serotina*) and red maple (*Acer rubrum*). Typical evergreen peatland species such as inkberry (*Ilex glabra*), red bay (*Persea palustris*), laurel-leaf greenbrier (*Smilax laurifolia*), and sweetbay (*Magnolia virginiana*) predominate in the shrub layer.

Threats: Lack of a natural fire regime is a threat to the continued viability of the site's marsh communities and Pond Pine Woodland. Frost (1995) has demonstrated the importance of fire in regulating succession in oligohaline, embayed region marshes and peatland communities. Common reed (*Phragmites australis*), a large grass that tends to aggressively displace other vegetation in wetlands where soils or hydrology have been disturbed, forms dense clones in parts of the marshes. Clearcutting and forest fragmentation is a potential threat in some of the privately owned swamps and uplands buffering the site's wetlands. Potential hydrological threats include agricultural and urban non-point source pollution and shoreline damage from excessive boat traffic and wakes.

Management Recommendations: Maintenance of existing hydrology, forested wetlands, and marshes is critical to the integrity of this site and its relationship to adjacent natural areas. Land use conversions, clearcutting, and other activities that could alter hydrology and habitat quality should be discouraged. Prescribed burning to simulate or approximate natural fire regimes in the site's marshes and pond pine woodlands is strongly recommended. Frequent burning may provide some control of common reed in the marshes, but additional control measures also appear to be warranted (Clark 1997).

Protection Recommendations: A tract of 415 acres, located at the southern end of the site and containing many of the marshes in this section, has been acquired by DCR and is managed as part of a state natural area preserve (Heffernan 2000). The remainder of the site is privately owned. The site is part of an integrated Northwest River ecosystem, and is a critical link in a continuous natural area corridor that includes the Great Dismal Swamp, the Northwest River, and the North Landing River (Erdle *et al*. 1994). Additional protection efforts aimed at lands within or adjacent to this site will further protect this primary tributary to the Northwest River, and ultimately the estuarine system. Some parts of this site are connected through a potential corridor to other forested wetlands near the North Landing River. Maintenance and enhancement of this "pathway" will help ensure a movement corridor between the Northwest River and North Landing River watersheds north of the State line.

SOUTHWESTERN MARSHES

Locality: City of Chesapeake, Virginia

Quadrangle: Moyock - 3607652

Location: The site encompasses wetlands and adjoining uplands along the Northwest River and an unnamed southern tributary, from the end of Neck Road on the west, to the North Carolina line on the south.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
***Ceratophyllum demersum - Utricularia macrorhiza - Nymphaea odorata* Tidally Flooded Hydromorphic Vegetation**	Tidal Pool/Gut
***Eleocharis fallax - Eleocharis rostellata - Scirpus Sagittaria lancifolia americanus* - Tidally Flooded Herbaceous Vegetation**	Spikerush - Olney Three-square marsh
***Fagus grandifolia - Quercus alba / Stewartia malacodendron* Forest [provisional]**	Mesic Mixed Hardwood Forest
***Juncus roemerianus - Pontederia cordata* Tidally Flooded Flooded Herbaceous Vegetation**	Black Needle Rush Marsh (oligohaline type)

***Myrica cerifera - Salix caroliniana* / *Thelypteris* var. *palustris pubescens* Tidally Flooded Shrubland**	Tidal Shrub Swamp (Southern Bayberry-Carolina Willow type)
***Nyssa aquatica - Taxodium distichum* / *Fraxinus caroliniana* / *Triadenum walteri* Semipermanently Flooded Forest**	Water Tupelo – Baldcypress swamp
***Pinus serotina* / *Smilax laurifolia - Ilex glabra* / *Woodwardia virginica* Saturated Woodland**	Pond Pine Woodland
***Spartina cynosuroides - Panicum virgatum - Phyla lanceolata* Tidally Flooded Herbaceous Vegetation**	Big Cordgrass Marsh (oligohaline type)
***Taxodium distichum - Nyssa biflora - Pinus taeda* / *Myrica cerifera*/*Osmunda regalis* var. *spectabilis* Tidally Flooded Forest**	Estuarine Fringe Swamp Forest
***Taxodium distichum* / *Zizania aquatica - Carex canescens* ssp. *disjuncta* Tidally Flooded Woodland [provisional]**	Tidal Baldcypress Woodland/ Savannah

Plants:	
Carex decomposita	cypress-knee sedge
Cladium jamaicense	sawgrass
Coreopsis falcata	pool coreopsis
Dichanthelium consanguineum	blood panic grass
Eriocaulon decangulare	ten-angle pipewort
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Physostegia leptophylla	slender-leaved dragon-head
Pycnanthemum setosum	awned mountain-mint
Stachys aspera	rough hedgenettle
Utricularia purpurea	purple bladderwort
Xyris iridifolia	iris-leaf yellow-eyed-grass
Animals:	
Atlides halesus	great purple hairstreak
Crotalus horridus atricaudatus	canebrake rattlesnake
Euphyes dukesii	scarce swamp skipper
Ixobrychus exilis	Least Bittern
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: With ten significant communities, 13 rare plants, and 5 rare animals, this site contains the greatest biotic diversity of any area along the Northwest River. The river attains its greatest estuarine character here, just above the North Carolina line (refer to Figures 3 and 4), and is subject to regular wind-tidal water fluctuations. The wetlands contain a variety of swamp forests, pond pine woodlands, and oligohaline marshes and shrub swamps. In addition, a fine mesic mixed hardwood forest grows on a forested upland in the southern part of the site.

The marshes are quite extensive in this unit and consist of patch-mosaics of several globally rare community types endemic or nearly endemic to oligohaline estuaries of the mid-Atlantic coastal embayed region. The rarest type is a short-statured community that tends to develop in the interior marsh zones away from channels. Characteristic species here are creeping spikerush (*Eleocharis fallax*), beaked spikerush (*Eleocharis rostellata*), Olney three-square (*Scirpus americanus*), bull-tongue arrowhead (*Sagittaria lancifolia*), and the rare plants winged seedbox (*Ludwigia alata*), ten-angle

pipewort (*Eriocaulon decangulare*), elongated lobelia (*Lobelia elongata*), and iris-leaf yellow-eyed-grass (*Xyris iridifolia*). Along channel edges, where tidal flushing and nutrient inputs are enhanced, marshes of tall, coarse graminoids such as big cordgrass (*Spartina cynosuroides*) and cat-tails (*Typha* spp.) predominate. Other marsh stands are composed of nearly monospecific black needle rush (*Juncus roemerianus*). Tidal shrublands dominated by southern bayberry (*Myrica cerifera*), Carolina willow (*Salix caroliniana*), and tree saplings often form an ecotonal zone between the marshes and adjacent swamp forests.

The flora of these oligohaline marshes and related communities contains a mixture of freshwater species and species more typical of brackish marshes such as saltmeadow cordgrass (*Spartina patens*), big cordgrass, and especially black needle rush. In the Northwest and North Landing River drainages, populations of black needle rush, cordgrass, and other more or less halophytic species may be relicts of earlier, more saline, lunar tidal environments which prevailed prior to the closing of two large inlets on the Outer Banks. Although both big cordgrass and black needle rush communities are typical of brackish marshes, those of the nearly fresh Albemarle-Pamlico estuarine system are considered unique in their floristic composition and prevalence of freshwater associates (Fleming and Moorhead 1998).

An unusual and perhaps unique baldcypress (*Taxodium distichum*) savanna with stunted trees forming an open canopy, occurs on very poorly decomposed, somewhat quaking peat at the edge of a marsh. This community is located at the foot of an upland slope, a very unusual situation in the study area marshes, and may be influenced by groundwater inputs. Wild rice (*Zizania aquatica*) and silvery sedge (*Carex canescens* var. *disjuncta*), two uncommon species in the Northwest River wetlands, dominate the herbaceous layer. Also present, but not recorded elsewhere in the watershed, are rose pogonia (*Pogonia ophioglossoides*) and Virginia's only known population of pool coreopsis (*Coreopsis falcata*) (Wieboldt *et al*. 1998).

An aquatic community dominated by various combinations of floating and submersed species such as common hornwort (*Ceratophyllum demersum*), greater bladderwort (*Utricularia macrorhiza*), American water-lily (*Nymphaea odorata*), common water-flaxseed (*Spirodela polyrhiza*), and sword bogmat (*Wolffiella gladiata*), is prevalent in shallow guts and large pools in the marshes.

Stands of globally rare pond pine woodland occur on saturated, interior swamp peatlands which lie beyond the range of wind-tidal flooding. Fine examples of both estuarine fringe swamp forest and typical water tupelo-baldcypress swamp also occur here. On the upland at the south end of the site, a fine mesic mixed hardwood forest contains American beech (*Fagus grandifolia*), several oak species (*Quercus* spp.), several hickories (*Carya* spp.), tuliptree (*Liriodendron tulipifera*), flowering dogwood (*Cornus florida*), eastern hophornbeam (*Ostrya virginiana*), silky camellia (*Stewartia malacodendron*), bigleaf snowbell (*Styrax grandifolius*), paw-paw (*Asimina triloba*), American hornbeam (*Carpinus caroliniana*), and a diverse assemblage of herbaceous species. Some portions of this occurrence, especially those bordering the swamps, are quite mature.

A breeding population of the state-rare bird Least Bittern (*Ixobrychus exilis*) was found in the tall graminoid marshes of this site. Two state-rare odonates, including the globally uncommon to rare scarce swamp skipper (*Euphyes dukesii*), were also documented from the wetlands. A viable population of the state listed canebrake rattlesnake (*Crotalus horridus atricaudatus*) still inhabits the mesic forests bordering interior swamps of the site. Although not documented from this site to date, due to the mobile nature of this animal, and the proximity to documented locations, it is highly likely that the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) is also found here.

Two additional rare plants of note are the globally rare awned mountain-mint (*Pycnanthemum setosum*), which grows along the borders of upland flatwoods (Wieboldt et al. 1998), and the familiar saw-grass (*Cladium jamaicense*) of the Everglades and other southern wetlands, which approaches its northern range limits here.

Threats: Lack of a natural fire regime is a threat to the continued viability of the site's marsh communities and pond pine woodlands. Frost (1995) has demonstrated the importance of fire in regulating succession in oligohaline, embayed region marshes and peatland communities. Common reed (*Phragmites australis*), a large grass that tends to aggressively displace other vegetation in wetlands where soils or hydrology have been disturbed, forms dense clones in parts of the marshes. In addition, monospecific stands of cat-tails appear to be invading and replacing some stands of the globally rare spikerush-Olney three-square marsh at this site (Fleming and Moorhead 1998). Potential hydrological threats include agricultural and urban non-point source pollution, groundwater pumping at an adjacent sand mining facility, and shoreline damage from excessive boat traffic and wakes.

Management Recommendations: Maintenance of existing hydrology, forested wetlands, and marshes is critical to the integrity of this site and its relationship to adjacent natural areas. The relationship between groundwater and water levels in adjacent swamps needs to be studied and monitored. Prescribed burning to simulate or approximate natural fire regimes in the site's marshes and pond pine woodlands is strongly recommended. Frequent burning may provide some control of common reed in the marshes, but additional control measures also appear to be warranted (Clark 1997). Research should be implemented to elucidate the ecological dynamics of invasive cat-tail populations and determine effective control methods.

Protection Recommendations: A tract of 917 acres, comprising all the critical portions of this site, has been acquired by DCR and is managed as part of a state natural area preserve (Heffernan, 2000). The remaining lands are privately owned. The site is part of an integrated Northwest River ecosystem, and its protection contributes significantly to maintenance of a continuous natural area corridor that includes the Great Dismal Swamp, the Northwest River, the North Landing River (Erdle *et al*. 1994), and ultimately the Albemarle / Pamlico Sound estuarine system. Protection of lands adjacent to this Natural Area Preserve will serve to further buffer resources against natural and anthropogenic threats.

SHILLELAGH ROAD FLATWOODS

Locality: City of Chesapeake, Virginia

Quadrangle: Deep Creek - 3607663

Location: The site is located on the west side of Shillelagh Road, approximately 3 miles north of its junction with Benefit Road and east of the Chesapeake Airport.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Ilex coriacea	sweet gallberry
Trillium pusillum* var. *virginianum	Virginia least trillium

Site Description: One of only two known extant populations of the rare plant Virginia least trillium (*Trillium pusillum* var. *virginianum*) within the City of Chesapeake occurs at this site. This taxon is globally rare, with a restricted range in the coastal plain from southern Maryland to northeastern North Carolina. Several disjunct populations have also been discovered in the Virginia mountains (Cabe 1984, Roe 1978, Meanley 1969).

A large portion of the site is situated in Shillelagh Farms (see Figures 3 and 4), a residential development with relatively large lots that partially retain the wooded character of the surrounding landscape. Hundreds of Virginia least trillium occur in saturated pine and pine-hardwood forests on both developed and undeveloped lots. Because of difficulties in obtaining access to private property, only a small

portion of this area was surveyed, but habitat similar to that supporting known Virginia least trillium colonies covers at least 100 acres on the west side of Shillelagh Road. The communities with which the least trillium is associated are characterized by canopies of loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*) in variable proportions. Common understory and shrub species include giant cane (*Arundinaria gigantea* ssp. *tecta*), hairy highbush blueberry (*Vaccinium fuscatum*), coastal dog-hobble (*Leucothoe axillaris*), Virginia willow (*Itea virginica*), evergreen bayberry (*Myrica heterophylla*), and muscadine grape (*Vitis rotundifolia*). The uncommon orchid southern twayblade (*Listera australis*) is also frequent in the area. This type of non-riverine pine-hardwood forest is common in the greater Chesapeake region but only rarely supports Virginia least trillium.

In addition to the Virginia least trillium, three seedlings of the rare holly, sweet gallberry (*Ilex coriacea*), were documented and it seems probable that a larger population exists in the area. Moreover, the site is located well within the general Virginia ranges of both state listed animals, the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) and the canebrake rattlesnake (*Crotalus horridus atricaudatus*), and there appears to be viable habitat present for these animals.

Threats: Some of the Virginia least trillium colonies are threatened with incidental destruction as residential lots in the Shillelagh Farms subdivision are cleared and developed. Although considerable forested acreage is still present within the site boundary, it is not known whether future development will eliminate all substantial blocks of undeveloped forest in this area.

Management Recommendations: Additional inventory and research is needed to determine the full extent of the rare plant populations and the status of lands containing potential habitat for documented and potential rare species. In general, minimizing the destruction of forested areas in the planning, design, and construction of residences may allow rare plant populations to persist in developed areas. Property owners should be informed of the significance of these species and encouraged to voluntarily protect the plants on their land.

Protection Recommendations: Unless additional populations of Virginia least trillium can be located on land not slated for development, this area is not a viable natural area conservation site in the traditional sense. However, because the least trillium is globally rare and frequently subject to local extirpation, there is strong justification for encouraging careful land use planning and voluntary protection by landowners, including the potential use of Natural Area Registries or Open Space or Conservation Easements. At least one property owner here is enthusiastically protecting colonies of Virginia least trillium on the wooded portion of a developed lot.

GREEN SEA

Locality: City of Chesapeake, Virginia

Quadrangle: Deep Creek - 3607663

Location: The site is located northeast of the community of Cornland. It is roughly bounded to the east by Shillelagh Road, to the south by Benefits Road, to the west by 12-foot ditch, and to the north by Shillelagh Farms subdivision.

Site Description: The Green Sea site supports extensive areas of non-riverine wet pine-hardwood forest, with understory vegetation dominated by cane (*Arundinaria gigantea* ssp. *Tecta*). Historically, under more frequent fire and logging, this area likely supported sizeable canebrake communities, now virtually eliminated from southeastern VA. The tract is the largest contiguous and most hydrologically intact property in the area formerly kinown as the Green Sea. It is also an integral parcel in a forested wetland corridor connecting the Northwest River to Dismal Swamp.

Conservation Plan for the SWA: 2001

The property was purchased in 1998 by TNC with funds from the VA Wetland Restoration Trust Fund, a program jointly administered by TNC and the US Army Corps of Engineers. Drainage ditches impacting over 12 acres of land were plugged in 2000, beginning restoration of the site's hydrologic regime. Much of the property was selectively logged in the mid-1990's, with larger pines and hardwoods removed at that time. Average age of canopy trees is < 50 yrs. old. Larger and older stems of swamp chestnut oak, white oak, cherrybark oak, loblolly pine, pond pine, and tulip poplar are scattered.

Two minor drainages dissect the property; both flow into 12-foot ditch, a channelized and highly altered tributary to NW River. Swamp forest vegetation including cypress, gum, sweet gum and red maple dominate the bottoms.

The site is considered a stronghold for canebrake rattlesnakes (A. Savitsky, pers. comm.). Extensive habitat exists for the Dismal Swamp Shrew as well as for Swainson's warbler. Black bear are seen occasionally and numerous migratory songbirds utilize the property spring through fall. Several occurrences of Virginia least-trillium have been identified. Seasonally wet depressions scattered across the property may yield other rare plant species.

Land use history on the property is poorly known. Some farming occurred in the past as old ridge and furrow marks have been found. The bulk of the property was likely too wet, however, to support agricultural crops. Scattered stumps with charred bases indicate presence of fire in the past 20-50 years. It is unclear when the last fire occurred. TNC plans to burn a majority of the site to thin midstory hardwood densities and to rejuvenate cane stands and other understory species.

The property is adjacent to two other tracts owned by TNC. Restoration activities on these properties will restore forested wetlands to 45 + acres of prior-converted cropland on these tracts. Restoration of these areas will also improve hydrologic connectivity to this site.

Conservation targets:
Non-riverine wet pine hardwood forest (forested canebrake)
Trillium pusillum var. *virginianum*
Crotalus horridus atricaudatus

A site conservation plan has not been completed for this site.

Appendix D – Site Conservation Plans: North Landing River

North Landing River Watershed – an overview

The North Landing River watershed covers much of the western and southwestern portions of the City of Virginia Beach and portions of the City of Chesapeake, comprising a total area of approximately 105,600 acres. The North Landing River is ecologically similar to the Northwest River but is a larger river, with most of its total length in Virginia. It rises from groundwater and drainage in west-central Virginia Beach City and flows southward, rapidly widening in its lower reaches before emptying into Currituck Sound just south of the Virginia-North Carolina state line (refer to Figure 1 in the body of the document). Like the Northwest River, the North Landing River changes in a remarkably short distance from a groundwater controlled wetland to a sluggish, medium-sized coastal plain river and finally to a broad estuarine waterway with wind-tidal fluctuations and extensive bordering marshes.

The North Landing River and its tributaries support a large concentration of rare species and a diverse array of globally rare and other significant community occurrences, making this an extremely important area for biodiversity conservation in the mid-Atlantic region (Erdle *et al.* 1994a). Included are large and outstanding examples of non-riverine swamp forest, pond pine woodland, and its high pocosin subtype, peatland Atlantic white-cedar forest, and several globally rare types of oligohaline marshes (Fleming and Moorhead, 1998). Among the rare plants and animals in the watershed are the federally listed Bald Eagle (*Haliaeetus leucocephalus*), scarce swamp skipper (*Euphyes dukesi*), and globally rare plants, Virginia least trillium (*Trillium pusillum* var. *virginianum*), cypress-knee sedge, or epiphytic sedge (*Carex decomposita*), winged seedbox (*Ludwigia alata*), and Carolina lilaeopsis (*Lilaeopsis carolinensis*).

Despite its proximity to a major urban area, a history of disturbances, and continued use as part of the Intracoastal Waterway, the North Landing River provides a large, continuous corridor of natural wetland habitats through a landscape otherwise largely agricultural and residential in character. State-owned game lands in North Carolina partially complete an excellent wildlife/natural area corridor that connects this river with the Northwest River and ultimately the Great Dismal Swamp (Erdle *et al.* 1994; Frost, LeGrand, and Schneider 1990). The North Landing River is a major recreational resource used extensively for boating, hunting, and fishing. The Virginia Scenic Rivers Program began in 1970 with approval by the General Assembly of the Virginia Scenic Rivers Act, and in 1988, this river and its tributaries were designated a state and local scenic resource according to this Act (Code of Virginia, Chapter 4, Section 10.1-413.2). While this designation recognizes aesthetic as well as functional values of this remarkably beautiful river, it does not carry provisions that establish scenic buffers or restrictions on visual intrusion.

Wetlands along the river have been a major focus of biodiversity protection efforts since 1989. To date, approximately 11,000 acres of wetlands have been acquired by DCR and the Virginia Chapter of The Nature Conservancy. Some public lands are owned by the City of Virginia Beach and the U.S. Army Corps of Engineers, however, most land within the watershed is privately owned. Ten conservation sites along the North Landing River (refer to Figure 3 in the body of the document) are discussed in this document. There are many actual and potential threats to this ecosystem, including loss of a natural fire regime, habitat loss and fragmentation, altered surface water quality from agricultural and urban non-point source pollution, groundwater pollution and depletion, exotic and invasive species, and recreational over-use (Clark and Potter, 1995).

DCR's Division of Soil and Water Conservation has assigned this Waterbody an overall rating of "high" based upon the nonpoint source contributions from agriculture, urban, and forestry activities (DEQ 2000). Land bordering the North Landing River, and especially the northern portion of the river, is subject to intense development pressures. A public education program for current residents, developers, builders, and river users might enhance public awareness about this riverine system, the tremendous biodiversity it supports, and its contribution to the larger estuarine system. The City of Virginia Beach is

encouraged to promote and facilitate the designation of greenways, corridors, open space, and development of interpretive facilities in areas appropriate for public access. Establishment of programs to encourage environmentally sensitive planning and construction practices will help protect sensitive natural heritage resources.

UPPER WEST NECK CREEK

Locality: City of Virginia Beach

Quadrangle: Pleasant Ridge - 3607661; Creeds - 3607651

Location: The site includes the wetland and adjacent forested upland on the east side of the North Landing River and both sides of West Neck Creek, north of Indian River Road and just south, southwest of NAS Oceana.

Natural Heritage Resources

Element (scientific) name	Common name
Animals:	
Sorex longirostris fisheri	Dismal Swamp southeastern shrew
Crotalus horridus atricaudatus	canebrake rattlesnake

Site Description: The floodplain of West Neck Creek is a mix of young to maturing forests dominated by red maple (*Acer rubra*), sweetgum (*Liquidambar styraciflua*), black gum, and loblolly pine (*Pinus taeda*). West Neck creek has been channelized and the berm is overgrown in grasses, greenbriars (*Smilax* spp.), and shrubs. Several powerline and pipeline right-of-ways cross the site and support similar vegetation. The uplands are being developed, especially along London Bridge Road (refer to Figures 3 and 4 in the body of the document).

This site supports the state rare Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*). Although not documented from this site specifically, due to the mobile nature of this animal, the proximity to documented locations, and local hearsay, it is highly likely that the state rare canebrake rattlesnake (*Crotalus horridus atricaudatus*) is found here as well.

Threats: Common reed (*Phragmites australis*), a large grass that tends to aggressively displace other vegetation in wetlands where soils or hydrology have been disturbed, forms dense clones in parts of the marshes and along creek shores of Upper West Neck Creek. Alteration or perturbation of existing hydrology could pose a threat to the area, existing vegetation and subsequently, the Dismal Swamp southeastern shrew and the canebrake rattlesnake.

Surrounding residential and agricultural pesticide and herbicide use should adhere to BMP's designed to minimize negative effects on wetlands and wetland dependant species. Pesticides used for lawn and farm pest species could inadvertently jeopardize rare butterfly populations. Biocides should be carefully chosen and applied by skilled certified applicators.

Potential threats also include drainage and hydrological perturbations, land use conversion, and habitat loss; clearcutting and forest fragmentation; road construction, non-point source pollution, increased groundwater withdrawals and depletion, and indiscriminate killing of canebrake rattlesnakes (Mitchell and Schwab 1991).

Management Recommendations: Maintenance of existing hydrology, forested wetlands, and marshes is critical to the integrity of this site. Research should be implemented to elucidate ecological dynamics of invasive plant populations and determine effective control methods. Due to rapidly encroaching development in the immediate area, forested wetlands, open water, and shrub swamps should be buffered by natural lands as much as possible. Efforts to buffer this

area will not only help protect water quality in West Neck Creek, and ultimately the North Landing River, but it will help serve as a corridor for movement of plants and animals as well. A substantial corridor or greenway in this area will also provide natural habitat in which animals such as the canebrake rattlesnake can move and forage naturally, hopefully decreasing the number of snake/human interactions.

Monitoring of invasive species is recommended for Upper West Neck Creek. Results of monitoring should dictate the necessity for appropriate control measures. Long term monitoring of rare species is recommended to track health of populations and changes in habitat.

Protection Recommendations: The area is part of an integrated West Neck Creek/North Landing River ecosystem, and it's protection contributes significantly to water quality, flow, and a continuous natural corridor that includes existing tributaries, and rivers of the Currituck Sound/Albemarle-Pamlico Sound embayed region. Much of this area is owned by the City of Virginia Beach, and because so much of the City's open space has been developed, it is recommended that Upper West Neck Creek be protected and buffered to the greatest extent possible.

OLD WOODS

Locality: City of Virginia Beach

Quadrangle: Princess Anne - 3607671

A site conservation plan has not been completed for this site.

GUM SWAMP

Locality: Cities of Chesapeake and Virginia Beach, Virginia

Quadrangle: Pleasant Ridge - 3607661; Fentress - 3607662; Princess Anne - 3607671; Kempsville - 3607672

Location: The site covers a large area of wetlands and forested uplands, extending from Stumpy Lake on the North to the Centerville Road bridge over the Intracoastal Waterway on the southwest, to the North Landing bridge over North Landing River on the southeast.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Nyssa biflora – Taxodium distichum – Acer rubrum / Clethra alnifolia / Woodwardia areolata	Seasonally flooded forest / non-riverine swamp forest
Nyssa aquatica – *Taxodium distichum / Fraxinus caroliniana / Triadenum walteri Semipermanently flooded forest*	water tupelo – baldcypress swamp
Plants:	
Phlox pilosa	downy phlox
Tillandsia usneoides	Spanish-moss
Trillium pusillum* var. *virginianum	Virginia least trillium
Animals:	
Ardea herodias	great blue heron – nesting colony

Casmerodius albus	great egret – nesting colony
Crotalus horridus atricaudatus	canebrake rattlesnake
Haliaeetus leucocephalus	Bald Eagle
Pseudopolydesmus paludicolis	a millipede
Sorex longirostris fisheri	Dismal Swamp southeastern shrew
Utterbackia imbecillis	paper pondshell

Site Description: This site contains the western headwaters region of the North Landing River and is mostly characterized by flooded swamp forests. Stumpy Lake, a large artificial impoundment, and a sizeable area of saturated non-riverine forest both north and south of Elbow Road, are also included within the boundary (see Figures 3 and 4). Stumpy Lake and surrounding forested and scrub wetlands are owned by the City of Norfolk and used as a municipal water reservoir. Below the dam at Elbow Road, Gum Swamp flows through a mucky, mostly semipermanently flooded bottomland to its confluence with the North Landing River near North Landing. The southern boundary of the site is the Intracoastal Waterway (Chesapeake and Albemarle Canal), constructed in the 1850's to connect the upper part of the North Landing River to the Elizabeth River. In the area lying north of the Intracoastal Waterway, west of Gum Swamp, and south of Elbow Road is an expansive, densely forested non-riverine wetland underlain by mucky peat and seasonally flooded by perched groundwater.

Lined by baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*), Stumpy Lake is much used by waterfowl. The Virginia Department of Game and Inland Fisheries recently documented a nesting pair of Bald Eagles (*Haliaeetus leucocephalus*) on the western side of the lake. It is not known whether this nest fledged young, but the site appears to be suitably located, and to contain viable nesting, roosting, and foraging habitats for the Eagle. A globally rare millipede (*Pseudopolydesmus paludicolis*) was collected from a slough on the west side of the lake in the 1950's but the population could not be relocated during limited 1995 surveys.

Saturated flats on the west side of the lake are mostly forested in secondary non-riverine pine-hardwood communities containing dense stands of giant cane (*Arundinaria gigantea* ssp. *tecta*) under loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), and red maple (*Acer rubrum*). A few small, poor quality stands of non-riverine wet hardwood forest dominated by swamp chestnut oak (*Quercus michauxii*), sweetgum and laurel oak (*Quercus laurifolia*), and American hornbeam (*Carpinus caroliniana*), are located at the western edge of the site. Canebrake rattlesnake (*Crotalus horridus atricaudatus*), protected as an endangered species under state law, has been reported on numerous occasions from woodlands around Stumpy Lake. A similar area of non-riverine flats located south of Elbow Road, where DCR-DNH biologists documented the globally rare plant Virginia least trillium (*Trillium pusillum* var. *virginianum*), was recently clear-cut. Although this area is now devastated, it is included in the boundary because of the potential for rare species such as canebrake rattlesnake and the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) to recolonize the area as it regenerates. It is believed that some of the Virginia least trillium colonies are located in areas that were not logged, but additional fieldwork is required to determine current status of the population.

Gum Swamp contains a fine occurrence of relatively mature water tupelo-baldcypress swamp dominated by water tupelo, baldcypress, and Carolina ash (*Fraxinus caroliniana*). Sporadic colonies of Spanish moss (*Tillandsia usneoides*), which approaches its northern limits in southeastern Virginia, drape the shrubs and trees here. Large nesting colonies of Great Blue Heron (*Ardea herodia*) and Great Egret (*Casmerodius albus*) are also situated in the interior portion of this swamp.

The non-riverine peatland west of Gum Swamp supports one of Virginia's best examples of non-riverine swamp forest, the predominant community type in the Great Dismal Swamp region to the west (Fleming and Moorhead 1998). This occurrence is an impressive old forest, slightly modified by selective cutting long ago but containing many massive trees over hundreds of acres. Dominants include swamp tupelo and baldcypress ranging up to 175 cm dbh, with large (80+ cm dbh) red maple scattered throughout.

Sweet pepperbush (*Clethra alnifolia*), vine tangles, and netted chain-fern (*Woodwardia areolata*) dominate the lower layers, and the community is compositionally and environmentally similar to many swamp forests in the Great Dismal Swamp National Wildlife Refuge. Adjacent to the Intracoastal Waterway and the old growth forest is a more recently timbered secondary stand of the same vegetation, providing a fine opportunity to observe and study successional patterns.

Threats: Potential threats include drainage and hydrological perturbations, land use conversion, and habitat loss; clearcutting and forest fragmentation; road construction, non-point source pollution, increased groundwater withdrawals and depletion, and indiscriminate killing of canebrake rattlesnakes (Mitchell and Schwab 1991).

Recreational activities in the watershed include boating and shore fishing, hunting, canoeing, wildlife observation, water skiing, and power boating. The river also plays a role in interstate commerce and transportation. The waterway is still used for commercial shipping, although its primary use is for recreational boating. Toxic spills related to commercial activities are a threat to natural heritage resources. Several agencies and organizations are working to develop comprehensive strategies for the containment and clean up of spills and the protection of sensitive natural resources on the river. The Gum Swamp site is also subject to a moderate to high amount of motorized boat traffic, along the Albemarle and Chesapeake Canal. Impacts from this activity are unknown for this watershed. See North Landing River Summary Management Recommendations for additional information on possible threats posed by motorized boat traffic, and information needs.

Management Recommendations: The significant wetland forests should be protected from cutting and other forests should be allowed to remain in their natural state or regenerate. A planned highway route should be carefully considered to avoid impacts on the significant communities. Additional inventory, as well as baseline information on several rare species, is needed at this site.

Little hydrologic information exists for this northern portion of the North Landing River watershed. Hydrologic studies are recommended to determine groundwater and surface water interactions and influences on the wetlands. A better understanding of the hydrology of this area is needed to adequately protect critical upland buffers and guide future site management.

Ecotones between swamp forest and uplands are called canebrakes. Extensive areas of canebrake were once visible from Elbow Road. This vegetation type is now greatly reduced from its original size. As the name implies, canebrakes are composed primarily of cane (*Arundinaria gigantia* var *tecta*), although they also support scattered low trees and shrubs such as waxmyrtle (*Myrica cerifera*), red bay (*Persea palustris*), and sweet bay magnolia (*Magnolia virginiana*). Canebrakes provide critical habitat for such species as the Dismal Swamp southeastern shrew and the canebrake rattlesnake. A conservation planning effort for the Green Sea Wetlands is currently underway by The Virginia Chapter of The Nature Conservancy (Southern Rivers Office)(Crichton, pers. comm.). It is hoped that this effort can restore canebrake areas in the southern watershed area.

Protection Recommendations: A 1,152 acre tract which includes a sizeable part of the significant non-riverine swamp forest and some of the water tupelo-baldcypress swamp is owned and protected by The Nature Conservancy. The City of Norfolk currently owns Stumpy Lake and adjoining wetlands. The remainder of the site is privately owned and requires some form of protection to ensure the long-term viability of the entire site. Along with other sites bordering the North Landing River, this site is integral to the protection of the entire wetland ecosystem.

NORTH POCATY

Locality: City of Chesapeake, Virginia

Quadrangle: Pleasant Ridge - 3607661

Location: The site encompasses a large wetland area situated west of the North Landing River and north of the Pocaty River. The western boundary coincides with the wetland bordering Route 165 and extends southward along the edge of the upland vegetation.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
***Myrica cerifera - Salix caroliniana* / *Thelypteris palustris* var. *pubescens* Tidally Flooded Shrubland**	Tidal Shrub Swamp (Southern Bayberry-Carolina Willow type)
***Pinus serotina* / *Smilax laurifolia - Ilex glabra* / *Woodwardia virginica* Saturated Woodland**	Pond Pine Woodland
***Spartina cynosuroides - Panicum virgatum – Phyla lanceolata* Tidally Flooded Herbaceous Vegetation**	Big Cordgrass Marsh (oligohaline type)
Plants:	
Carex decomposita	cypress-knee sedge
Lobelia elongata	elongated lobelia
Animals:	
Crotalus horridus atricaudatus	canebrake rattlesnake
Euphyes dukesii	scarce swamp skipper

Site Description: This site consists almost entirely of forested wetlands. Two areas of small fringing marshes and shrublands occur along the North Landing River and a short tributary gut (see Figures 3 and 4 in the body of the document), while a narrow artificial levee occupied by upland mixed forest occurs on the south side of the river east of the North Landing bridge. Much of this site is very dense, seasonally or semipermanently flooded, and difficult to access and traverse on foot. Consequently, the thickly vegetated interior remains largely unexplored. The general character of the North Landing River here is that of a sluggish, swamp-lined coastal river beginning to show some slight evidence of embayment. However, wind-tidal flooding is confined to the channel edges in this section, which represent upstream limits of estuarine influences on the river. A wooden observation tower, constructed by The Nature Conservancy and accessible only by boat, is located at the confluence of the North Landing and Pocaty Rivers.

Extensive backswamps characterize the areas of this site away from river channels. Much of the forest is immature and consists of water tupelo (*Nyssa aquatica*) and baldcypress (*Taxodium distichum*) stands in the southern part of the site and mixed hardwoods dominated by swamp tupelo (*Nyssa biflora*), sweetgum (*Liquidambar styraciflua*), and red maple (*Acer rubrum*) in the northern portion. An overgrown woodland in the southeastern part of the site is dominated by pond pine (*Pinus serotina*) and red maple, and occupies an interior, saturated peatland which is isolated from flooding.

Fringe marshes here are dominated by tall, coarse graminoids, particularly big cordgrass (*Spartina cynosuroides*) and cattails (*Typha* spp.) but have a mixed composition with a preponderance of freshwater associates. This type of oligohaline marsh is considered globally rare and distinct from brackish tidal marshes dominated by big cordgrass (Fleming and Moorhead 1998). A globally rare type of oligohaline shrubland dominated by southern bayberry (*Myrica cerifera*), swamp rose (*Rosa palustris*), and tree saplings commonly forms an ecotone between the marshes and swamp forests, and appears to be invading the herbaceous marsh communities in many locations. This trend may reflect a

natural successional process occurring at the edge of estuarine influences, or a recent lack of fire in these marshes, or both. According to Frost (1995), wildfires are an important ecological factor in regulating succession in fresh to oligohaline marshes of the mid-Atlantic embayed region, and a recent reduction or suppression of fires has led to a region-wide reduction in marsh diversity, as well as increased invasion by woody species.

Two rare plants are documented from this site. Elongated lobelia (*Lobelia elongata*) was found in the northernmost marsh, while the globally rare cypress-knee sedge (*Carex decomposita*) is scattered through the water tupelo - baldcypress swamps along and near the Pocaty River. The historical range of the cypress-knee sedge encompassed the Atlantic coast and midwestern U.S., but the species has disappeared from a large number of its historical locations (Ostlie 1990). Also called epiphytic sedge, this species typically grows in undisturbed, organic-rich backswamps and riverside swamp edges, usually occurring on floating or partially submerged logs, stumps, or baldcypress knees. Seed dispersal is thought to be facilitated by waterfowl that inadvertently carry the ripe perigynia on their feet and deposit them onto appropriate microhabitats when they land (Ostlie 1990). The species is known from only two other Virginia watersheds, one of them the Northwest River.

The globally rare butterfly scarce swamp skipper (*Euphyes dukesii*) was documented near the North Landing Bridge; its larvae feed on shoreline sedge (*Carex hyalinolepis*), a sedge found frequently along swamp borders in this watershed. The state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*) has been reported from the southern end of the site, near Pocaty River. Although not yet documented, the state rare Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) is likely to occur here as well.

Threats: Potential hydrological threats include agricultural and urban non-point source pollution, toxic or hazardous materials spills on the Intracoastal Waterway, and shoreline damage from excessive boat traffic and wakes. Other threats include reduction or lack of a natural fire regime in fire-maintained marshes and peatland pond pine woodlands, and displacement of native marsh species by invasive clones of common reed (*Phragmites australis*). There appear to be few threats to the swamp forests over the majority of the site.

Management Recommendations: Water quality and boat traffic impacts on this section of the North Landing River should be closely monitored. Prescribed burning to simulate or approximate natural fire regimes in the site's marshes and Pond Pine Woodland is strongly recommended.

Protection Recommendations: More than 2,000 acres of this site, including all of the important wetland habitats and element occurrences, are owned by The Nature Conservancy and managed as part of the North Landing River Natural Area Preserve (Clark and Potter 1995). The U.S. Navy (Fentress Facility) and the U.S. Army Corps of Engineers own additional areas within the boundary. The remainder, including the entire upland buffer, is privately owned. Along with other sites bordering the North Landing River, this site is integral to the protection of the entire wetland ecosystem and its protection is now largely complete.

NORTH LANDING RIVER POCOSINS

Locality: City of Virginia Beach

Quadrangle: Pleasant Ridge – 3607661; Creeds - 3607651

Location: The site embraces a large wetland situated west of the North Landing River, south of the Pocaty River and includes the North Landing River Natural Area Preserve (NAP), which is bisected by Pungo Ferry Road. The western boundary more or less follows the edge of upland vegetation. The southern border is Blackwater Creek, and the eastern border is the North Landing River.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Fetter –bush, sheep-laurel low pocosin / oligotrophic saturated scrub	
pond pine/fetter-bush tall pocosin / oligotrophic saturated woodland	
three-square, bulrush, cattail oligohaline marsh / estuarine herbaceous vegetation	
big cordgrass oligohaline marsh / estuarine herbaceous vegetation	
Mid-height herbaceous palustrine wetland	
Oligotrophic saturated palustrine woodland	
Plants:	
Aster elliottii	Elliott's aster
Carex striata	a sedge
Carex walteriana	a sedge
Chamaecyparis thyoides	Atlantic white cedar
Cladium jamaciensis	sawgrass
Cleistes divaricata	spreading pogonia
Juncus megacephalus	big-headed rush
Kalmia angustifolia	sheep-laurel
Lilaeopsis attenuata	Carolina lilaeopsis
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Physostegia leptophylla	slender-leaved dragon-head
Spiranthes odorata	sweetscent ladies'-tresses
Vaccinium macrocarpon	large cranberry
Animals:	
Atlides helesus	great purple hairstreak
Crotalus horridus atricaudatus	canebrake rattlesnake
Euphyes dukesi	scarce swamp skipper
Ixobrychus exilis	Least Bittern
Poanes aaroni aaroni	saffron skipper
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: This site is noteworthy for its low and high pocosins, peatland communities locally referred to as "juniper bogs." These communities are extremely rare in Virginia. They are characterized by rare orchids and sedges, knee-high heaths, and young Atlantic white-cedar (*Chamaecyparis thyoides*) trees. Surrounding the low and high pocosins are extensive areas of forested pocosin dominated by pond pine (*Pinus serotina*), high-bush blueberry (*Vaccinium corymbosum)*, laurel-leaf greenbrier (*Smilax laurifolia*), and Virginia chain-fern (*Anchistea virginica*). Along the North Landing River, they are situated between the oligohaline marshes and deepwater swamp forests (see Figures 3 and 4). A high water table, abundance of sphagnum moss, and slow decay of organic material contribute to deep peat and acidic soils. These conditions, along with nutrient poor soils and frequent fires, are common features of pocosin communities. Plant associations grade from shrubby, low pocosins dominated by a dense layer of low heaths with occasional open herbaceous areas to tall shrub pocosins with sparse to dense small trees and shrubs. Red maple (*Acer rubrum*), Atlantic white-cedar and pond pine are dominant trees in these wetlands. A dense understory of fetterbush (*Lyonia lucida*) and sheep

laurel, inkberry (*Ilex glabra*), sweet bay (*Magnolia virginiana*) and red bay (*Persea palustris*) grow beneath the tree canopy.

Pocosins are found throughout the Atlantic coastal plain from southeastern Virginia to northern Florida, and west to Mississippi. In Virginia, peat-based pocosins have never been common, but have historically been found in the Great Dismal Swamp and along the lower Blackwater, North Landing, Northwest, and Nottoway Rivers. Currently in Virginia they are limited to remnant communities in the Great Dismal Swamp and along the North Landing River. Peat-based pocosins are considered state and globally endangered. Hydrologic alterations, fire suppression, and peat mining are the greatest threats to these wetlands. The best remaining pocosins in Virginia occur within this site along the North Landing River.

The North Landing River Pocosins site also supports robust emergent marshes, shrub swamps, and deciduous swamp forests. The marshes are fairly extensive and are considered exemplary occurrences in Virginia. Marshes along the North Landing River, sometimes referred to as back bay, or lagoon marshes, are influenced by slightly brackish to fresh water. Irregular water level fluctuations are caused by wind tides. In addition to being rare community types, these marshes support several rare species of plants and animals. Prevailing winds from the south and east push seawater through Currituck Inlet and farther north, providing a corridor for many southern plant species to reach their northern range limits. These marshes are species rich, and are considered unique to the mid-Atlantic region of Virginia and North Carolina. They are found primarily along the North Landing River, Northwest River, and the Back Bay watersheds (Caljouw and Hobbs, 1991; Clampitt 1993). Such rare plants as Elliott's aster, sawgrass, spreading pogonia, slender-leaved dragon-head and sweetscent ladies'-tresses can be found here, along with the state rare Dismal Swamp southeastern shrew, canebrake rattlesnake, Least Bittern, and several rare lepidopteran species.

Forested swamps generally occur between the uplands and pocosin wetlands. These swamps are characterized by bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), red maple, and black willow (*Salix nigra*). Sedges and grasses such as swamp sedge (*Carex hyalinolepsis*) and giant cane (*Arundinaria gigantea*) are often the only herbs in these shaded wetland communities. Openings in these forested swamps often have heavy concentrations of cane and are referred to as canebrakes.

Marshes, swamps, forests and pocosins at the North Landing River Pocosins site form a mosaic with meandering creeks and open water, closed canopy forests, and a variety of habitat types in-between. They serve a variety of ecological needs and benefits. These areas are essential in maintaining the health of the North Landing River and associated wetlands. The marshes, in addition to supporting many rare species of plants and animals, contain flood waters and mitigate against damage from storms. They provide a buffer against shoreline erosion, produce and recycle nutrients and energy, and provide a buffer between developed, agricultural and silvicultural lands which traps sediments, excess nutrients, and toxic chemical before they reach the open water of the river.

Threats: Lack of fire is the primary threat to long-term viability of the rare pocosin vegetation. Hydrologic alterations such as ditching and draining, large-scale land use changes, and peat mining also present threats to these rare wetlands. Exotic and/or invasive species such as common reed (*Phragmites australis*), and nutria (*Myocastor nutria*) have a negative impact on native flora and fauna of the marshes and could prove to be tremendous threats in the future.

Management Recommendations: A Resource Management Plan (RMP) has been developed for the North Landing River Natural Area Preserve (Clark and Potter, 1995). The RMP calls for the reintroduction of fire into fire-maintained habitats within the preserve, and a comprehensive site fire management plan is being developed. Fire plays a significant role in the development

and maintenance of pocosins and estuarine marsh communities. These wetland communities depend on fire to set back plant succession, eliminate competing vegetation, and release nutrients back into the soil. Rare plant species such as spreading pogonia, bog cranberry, sawgrass, and Atlantic white-cedar depend upon fire to maintain open habitats and proper conditions for seed germination.

Pocosin vegetation is highly flammable and fires naturally occur in these communities every two or three decades. Uncontrolled wildfires in these high intensity fuels pose a threat to human life and property. The last wildfire in this area occurred 15 – 20 years ago and burned over 2000 acres. Carefully planned and controlled burns will reduce the threat of potential wildfires causing personal injury, property loss, or ecosystem damage. Prescribed planning involves an assessment of fuel types and the development of appropriate prescriptions for burning, and the maintenance of construction of firebreaks. Planning also reduces the cost associated with wildfire control. A well thought out wildfire contingency plan will stratify types of response by area, season, and fire behavior. The plan will identify appropriate suppression methods given fuel types, existing natural and artificial firebreaks, access routes, and available fire-fighting equipment and personnel.

Monitoring is recommended for rare and threatened species at the site, as well as for species considered to be biological indicators. Monitoring will be conducted to track species vigor and population health and numbers over time, and may help detect future change and impacts. Plant community monitoring should also be conducted to correlate changes with species fluctuations and to ensure the effectiveness of management practices.

Most adjacent and surrounding land use in this area is primarily agricultural. Soybeans, wheat, tomatoes, and field corn are the principle crops grown in the area. These farming practices are generally considered compatible land uses with natural area preservation. Unfortunately, many farms are being abandoned due to hard economic times and more and more rural open lands are being replaced by residential and tract housing developments or other intensive land uses. These changes in land use may have significant secondary impacts on sensitive wetland natural areas. Surrounding agricultural landowners should adhere to best management practices designed to minimize sedimentation and agricultural runoff in this watershed. Poorly planned farming activities could impact water quality in tributary creeks and the main stem of the North Landing River.

Surrounding residential and agricultural pesticide and herbicide use should adhere to BMPs designed to minimize negative effects on wetlands and wetland dependant species. Pesticides used for lawn and farm pest species could inadvertently jeopardize rare butterflies, damselflies, or dragonflies in the area. Biocides should be carefully chosen and applied.

Current logging practices do not appear to threaten natural heritage resources. Logging is not recommended in pocosins or forested swamps of this natural area. Logging practices on uplands should follow strict BMPs designed to maintain hydrologic flow, reduce erosion, and reduce or minimize sedimentation. Large tract, clear-cutting or other large-scale land altering activities have the potential to negatively influence hydrology and water quality within the area and eliminate wildlife corridors. These activities should be carefully planned and monitored to ensure they provide the proper corridors for wildlife movement and buffers to protect sensitive resources and water quality.

Recreational activities in the watershed include boat and shore fishing, hunting, canoeing, wildlife observation, environmental interpretation, water skiing, and power boating. The river also plays a role in interstate commerce and transportation. Although the Intracoastal Waterway is still used for some commercial shipping today, its primary use is recreational boating. Toxic

spills related to commercial activities are a threat to sensitive wetland resources. Several agencies and organizations are working to develop comprehensive strategies for the containment and clean-up of spills and protection of sensitive resources.

Protection Recommendations: Portions of this site are privately owned, and portions are owned by the Commonwealth of Virginia, Department of Conservation and Recreation. Land owned and managed by the Virginia Department of Conservation and Recreation is managed as a Natural Area Preserve. The Preserve is a Dedicated Natural Area, which provides the strongest possible level of protection to natural heritage resources through formal recognition and stringent legal safeguards against conversion to inappropriate uses. Protection of adjacent lands would contribute significantly to forming a larger, more viable and defensible, natural area preserve along the North Landing River.

EASTERN WETLANDS

Locality: City of Virginia Beach

Quadrangle: Pleasant Ridge - 3607661; Creeds - 3607651

Location: The North Landing River Eastern Wetlands is located on the east side of the river. The site includes the lower portion of West Neck Creek and the wetlands on the east side of the river extending south to the Pungo Ferry Road bridge.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Oligotrophic saturated forest	Atlantic white cedar swamp
Estuarine herbaceous vegetation	big cordgrass oligohaline marsh
Oligotrophic saturated scrub	sweetbay-red bay shrub swamp
Estuarine herbaceous vegetation	three-square bulrush-cattail oligohaline marsh
Plants:	
Carex decomposita	epiphytic sedge
Cladium jamaciensis	sawgrass
Chamaecyparis thyoides	Atlantic white cedar
Lilaeopsis attenuata	Carolina lilaeopsis
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Paspalum distichum	joint paspalum
Physostegia leptophylla	slender-leaved dragon-head
Spiranthes odorata	sweetscent lady's tresses
Stewartia malachodendron	silky camellia
Animals:	
Euphyes dukesi	scarce swamp skipper
Enallagma durum	a damselfly
Altides halesus	great purple hairstreak
Ixobrychus exilis	Least Bittern
Crotalus horridus atricaudatus	canebrake rattlesnake
Sorex longirostris fisheri	Dismal Swamp southeastern shrew

Site Description: This site encompasses extensive forested swamps, estuarine marshes, bay swamps, and low forested uplands. The site is most noted for its exemplary Atlantic white-cedar swamps, the

estuarine marshes along West Neck Creek, and shrub bay swamps (Figure 3). As many as nine rare plants, seven rare animals, and four rare natural communities have been documented from this site.

Extensive swamp forests occur along the river corridor between the marsh and uplands. These swamps are characterized by baldcypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*). The forested wetlands here include two relatively large stands of Atlantic white-cedar. Atlantic white-cedar swamps are rare in Virginia, known from only six locations statewide. The largest and most exemplary stands remaining are found in the Great Dismal Swamp and along the North Landing River. Atlantic white-cedar has declined over much of its range. Geographically, it is restricted to freshwater wetlands within a narrow band of the eastern coastal United States. Although cedar swamps and bogs were never widely distributed, they are being increasingly encroached upon by mining, draining for alternate land uses, and ill-planned forestry practices (Laderman, 1987). The stands along the North Landing River are high quality examples of this rare swamp community.

Within the swamp forest are slightly raised sandy islands dominated by American beech (*Fagus grandifolia*), sweetgum, loblolly pine (*Pinus taeda*), white oak (*Quercus alba*), and red maple. These islands provide habitat for rarities such as the silky camellia (*Stewartia malachodendron*), the canebrake rattlesnake (*Crotalus horridus atricaudatus*), and the Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*).

The best marsh occurrences at this site are found along West Neck Creek, near the confluence with the North Landing River. Marshes also form a narrow fringe along the eastern border of the river. These marshes, like others along the North Landing River, are influenced by slightly brackish to fresh water and the irregular water level fluctuations caused by wind tides. Health marshes provide a variety of ecological benefits and are imperative in maintaining the health of the North Landing River ecosystem. Marshes enhance water quality, help contain flood waters, mitigate against damage from storms, buffer against shoreline erosion, and produce large amounts of nutrients and energy.

Threats: Surrounding land use in this area is primarily agricultural, and farming practices are generally considered compatible with natural area preservation. Unfortunately, many farms are being abandoned due to hard economic times and more and more rural open space is being replaced by residential and tract housing developments, or other intensive land uses. These types of land use changes may have significant impacts on sensitive natural areas.

Best Management Practices designed to minimize sedimentation, agricultural runoff, and drift should be adhered to in this watershed. Agriculture, silviculture, and urban development all influence water quality. Pesticide and herbicide use within the area should be carefully planned to minimize negative impacts on sensitive wetlands. Pesticides used for lawn, garden, or forests could inadvertently jeopardize rare invertebrates by destroying them directly, or by killing or damaging wetland food sources. Buffers to wetlands should be maintained and observed when applying chemicals.

Current logging practices do not appear to threaten natural heritage resources, largely because of the marginal condition of the wetland timber resources. Logging is not recommended in wetland areas and logging practices on uplands should follow strict BMPs 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, water quality, and to provide corridors for wildlife movement.

Management Recommendations: Fire has played an important role in creating and maintaining the natural communities at this site. Atlantic white-cedar swamps depend on fire to open habitat and

establish conditions suitable for seed germination. Regular prescribed burning of the marshes and cedar swaps will be necessary to ensure the continued health and viability of this ecosystem.

Common reed (*Phragmites australis*) occurs in many of the riverine marshes on the North Landing River. Although it has not been identified as a serious problem at this particular site, it should be monitored closely, and control actions should be taken if necessary.

The Eastern Wetlands site is subject to a moderate to high amount of motorized boat traffic, along the North Landing River. Impacts from this activity are unknown for this watershed. See North Landing River Summary Management Recommendations for additional information on possible threats posed by motorized boat traffic, and information needs.

Long-term monitoring is recommended for rare ecological communities such as the Atlantic white-cedar swamps and estuarine marshes. Additionally, rare plant and animal species should be monitored to track health and vigor of populations, and as indicators of ecosystem health.

Protection Recommendations: While a portion of this site is owned and managed by DCR-DNH, much of it remains in private ownership. Developing partnerships and management strategies with adjacent landowners is essential in protecting critical buffers and carrying out management plans for the preserve system.

PINEY GROVE CHURCH

Locality: City of Virginia Beach

Quadrangle: Creeds - 3607651

Location: The site includes marshes and some associated uplands on the east side of the North Landing River, south of Pungo Ferry Road bridge, and just west, southwest of the Piney Grove Church on Princess Anne Road.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Estuarine herbaceous vegetation	big cordgrass oligohaline marsh
Estuarine herbaceous vegetation	Three-square bulrush-cattail oligohaline marsh
Plants:	
Physostegia leptophylla	slender-leaved dragon-head

Site Description: The water level in the marshes at this site is relatively high, and coastal arrowhead is a common subordinant under the big cordgrass (*Spartina cynosuroides*) and cattails (*Typha* spp.). Marshes here support a fine population of the rare slender-leaved dragon-head (*Physostegia leptophylla*), along with many of the more common marsh species.

Threats: In the northern section and along the western edge of the island (refer to Figure 3), common reed (*Phragmites australis*) is abundant, dominating hundreds of square yards of marsh. Recreational activities in this part of the watershed include fishing, hunting, canoeing, water skiing, and power boating. The river also plays a role in interstate commerce and transportation. Although the Intracoastal Waterway is still used for some commercial shipping today, its primary use is recreational boating. Toxic spills related to commercial or recreational activities are a threat to sensitive wetland resources. Several agencies and organizations are working to develop comprehensive strategies for the containment and clean-up of spills which could threaten water quality in the North Landing River system.

Surrounding land use in this area is primarily agricultural, and farming practices are generally considered compatible with natural area preservation. Unfortunately, many farms are being abandoned due to hard economic times and more and more rural open space is being replaced by residential and tract housing developments, or other intensive land uses. These types of land use changes may have significant impacts on sensitive natural areas.

Management Recommendations: Best Management Practices designed to minimize sedimentation, agricultural runoff, and drift should be adhered to in this area. Agriculture, silviculture, and urban development all influence water quality. Pesticide and herbicide use within the area should be carefully planned to minimize negative impacts on sensitive wetlands. Pesticides used for lawn, garden, or forests could inadvertently jeopardize rare invertebrates by destroying them directly, or by killing or damaging wetland food sources. Buffers to wetlands should be maintained and observed when applying chemicals.

Current logging practices do not appear to threaten natural heritage resources, largely because of the marginal condition of the wetland timber resources. Logging is not recommended in wetland areas and logging practices on uplands should follow strict BMPs 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, water quality, and to provide corridors for wildlife movement.

Fire has played an important role in creating and maintaining the natural communities at this site. Atlantic white-cedar swamps depend on fire to open habitat and establish conditions suitable for seed germination. Regular prescribed burning of the marshes and cedar swaps will be necessary to ensure the continued health and viability of this ecosystem.

This site is subject to a moderate to high amount of motorized boat traffic, along the North Landing River. Impacts from this activity are unknown for this watershed. See North Landing River Summary Management Recommendations for additional information on possible threats posed by motorized boat traffic, and information needs.

Long-term monitoring is recommended for ecological communities. Additionally, rare plant and animal species should be monitored to track health and vigor of populations, and as indicators of ecosystem health.

Protection Recommendations: This land is in private ownership. Landowners are encouraged to adopt voluntary conservation measures, or to use any of the variety of protection options available.

OAKUM CREEK

Locality: City of Virginia Beach

Quadrangle: Creeds - 3607651

Location: The site includes marshes and some associated uplands on the east side of the North Landing River, south of Pungo Ferry Road bridge, and east, northeast of Munden Point Park.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Lilaeopsis attenuata	Carolina lilaeopsis
Lobelia elongata	elongated lobelia
Cladium jamaicense	sawgrass

Site Description: Oakum Creek is a small, slow-moving, tightly-meandering tributary to the North Landing River (see Figure 3). Several small ponds have been dredged within the marshes that border the creek. Over most of its length, the creek flows through nutrient-rich marshes, but a baldcypress (*Taxodium distichum*) swamp has formed near its mouth. The marshes are dominated by cattails (*Typha* spp.), and big cordgrass (*Spartina cynosuroides*), with common reed (*Phragmites australis*) near dredged areas. The rare plants are found near the mouth of the creek, especially where sheltered from storm waves and boat wakes by baldcypress knees. The uplands north and east of Munden Point Park (not yet surveyed) support a surprisingly species-rich forest, which may provide habitat for rare plants or butterflies.

Threats: Wakes from large or fast-moving boats may be degrading the shoreline habitat for rare plants at this site. Further encroachment from aggressive or invasive plants such as common reed threatens rare plants at Oakum Creek. Maintenance of water quality in the North Landing River is necessary to rare plants near its confluence with Oakum Creek. Further degradation of water quality and nutrient loading of Oakum Creek could jeopardize rare and native plants in the marshes.

Management Recommendations: Monitoring of rare plant populations is recommended to track health and long-term viability. Monitoring and control of invasive species if monitoring results indicate a need. Additional surveys for rare plants and animals are needed in the area, especially in the species-rich forest north east of Munden Point Park. As the population in southeast Virginia increases, the North Landing River will likely support more recreational and commercial use. Effects of boat wakes and recreational use should be monitored to determine direct or indirect impacts on shorelines, marshes, flora and fauna of the North Landing River.

Protection Recommendations: Expansion of Munden Point Park could help protect rare species at the confluence of Oakum Creek and the North Landing River. Park personnel at Munden Point Park should be informed of rare species proximity, and compatible and incompatible activities.

MORSE POINT

Locality: City of Virginia Beach

Quadrangle: Creeds - 3607651

Location: The site includes marshes and some associated uplands on the east side of the North Landing River, south of Munden Point Park and Walke Point, but north of the State Line.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Lilaeopsis attenuata	Carolina lilaeopsis
Lobelia elongata	elongated lobelia
Cladium jamaicense	sawgrass

Site Description: Morse Point is a small marsh along the east side of the widest portion of the North Landing River (see Figures 1 and 3). It is dominated by black needlerush (*Juncus roemerianus*), with forested wetlands on the landward ecotone. Scattered baldcypress (*Taxodium distichum*) and wax myrtle (*Myrica cerifera*) line the river. The marsh has been reduced in size and degraded by dredging and filling to create a campground and boat ramp.

Threats: Continued dredging could eliminate rare plants from this already small marsh. Wakes caused by large or fast-moving boats may be degrading the shoreline habitat for resources at this site. Although not a problem presently, common reed (*Phragmites australis*), an aggressive, invasive grass is known from nearby marshes, and often thrives in disturbed (e.g. ditched, dredged) areas.

Management Recommendations: The site should be monitored for common reed and if necessary, control measures should be taken to remove the plant from the area. Rare plant populations should be periodically monitored to track health and long-term viability. Effects of boat wakes and recreational use should be monitored for direct or indirect impacts to natural resources here.

Protection Recommendations: Landowner contact is recommended to inform landowners of rare plant proximity and compatible and incompatible activities.

SOUTHERN MARSHES

Locality: City of Virginia Beach

Quadrangle: Creeds - 3607651

Location: The site includes the wetland on west side of the North Landing River, mostly east of Blackwater Road; north of the North Carolina border, and south of the Blackwater River.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Mid-height herbaceous palustrine wetland	
Plants:	
Cladium jamaciensis	sawgrass
Chamaecyparis thyoides	Atlantic white cedar
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Physostegia leptophylla	slender-leaved dragon-head
Spiranthes odorata	sweetscent ladies tresses
Stewartia malachodendron	silky camellia

Site Description: The site experiences regular water level fluctuations resulting from wind tides and is part of the large wetland ecosystem along the North Landing River (see Figure 3). The water is fresh to very-slightly brackish. Plant species diversity is very high, and wetland vegetation types form a complex mosaic. Marsh vegetation is dominated by robust emergents such as big cordgrass (*Spartina cynosuroides*), common reed (*Phragmites australis*), broad-leaf cattail (*Typha latifolia*), narrow-leaf cattail (*Typha angustifolia*), black needlerush (*Juncus roemerianus*), and the rare sawgrass (*Cladium jamaciensis*). Areas of low marsh contain a diverse mix of plants, including several rare species.

Many of the marshes are being invaded by woody species such as red maple (*Acer rubrum*), swamp rose (*Rosa palustris*), and waxmyrtle (*Myrica cerifera*). Cecil Frost, who studied this wetland system, believes that the lack of frequent fire in the marshes is a major reason for the woody plant increase (personal communication). The swamp forests are characterized by bald cypress (*Taxodium distichum*), black gum (*Nyssa biflora*), loblolly pine (*Pinus taeda*), sweet

gum (*Liquidambar styraciflua*), and red maple. Some upland forest is included in this site, providing habitat for the rare shrub, silky camellia (*Stewartia malachodendron*).

Threats: Common reed, which can be invasive, may be threatening the natural vegetation of the marshes. Logging threatens the forest vegetation. Woody species encroachment into the marsh, possibly resulting from less frequent fire, is cause for concern.

Management Recommendations: Monitor woody species and common reed in the marsh. Prescribed burning should be conducted on a regular basis.

Protection Recommendations: This site is part of the significant North Landing River ecosystem, and protection actions here will have direct bearing on the larger landscape unit.

Appendix E – Site Conservation Plans: Back Bay

Back Bay Watershed – an overview

The Back Bay Watershed covers the southeastern quarter of the City of Virginia Beach, comprising a total area of approximately 67000 acres (refer to Figure 1 in the body of the document). In Virginia, the watershed boundaries are approximated by the Atlantic Ocean on the east, Princess Anne Road on the west, Birdneck Road on the north, and the North Carolina/Virginia state line on the south. The Back Bay watershed includes Back Bay, several smaller waterbodies such as Redwing Lake, Black Gut, and Lake Tecumseh, and extensive agricultural lands. Like the North Landing River and the Northwest River, Back Bay and its many small tributaries are actually part of a much larger estuarine ecosystem known as Pamlico Estuary, which lies behind the Outer Banks of North Carolina. Back Bay 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). 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. Uplands in most of this watershed are predominantly agricultural, rural residential, or large tracts of publicly owned lands. The Division of Natural Heritage has identified many rare or endangered species or exemplary vegetative communities from the area, making this ecosystem one of the most diverse and extensive in southeastern Virginia.

Recreational activities in the Back Bay watershed include boat and shore fishing, water skiing, power boating, camping, canoeing, hunting, birding, and wildlife observation. Land in this area is presently held by both public and private landowners. In Virginia, large public tracts include: Back Bay National Wildlife Refuge, owned and managed by the U.S. Fish and Wildlife Service; False Cape State Park and Natural Area Preserve, owned and managed by the Virginia Department of Conservation and Recreation; Princess Anne Wildlife Management Area (formerly Trojan Wildlife Management Area and Pocohontas Wildlife Management Area), owned and managed by Virginia Department of Game and Inland Fisheries. Back Bay is an important wintering ground for a number of game waterfowl, and the watershed has been designated as the Back Bay Focal Area, a component of the North American Waterfowl Management Plan. Additionally, because of the unique location and ecological attributes, this area, especially large, unfragmented forests in the watershed, serve as critical stopover locations for neotropical migratory songbirds and migrating shorebirds.

In this conservation planning document, 17 existing sites in the Back Bay watershed (refer to Figure 3 in the body of the document) are listed and mapped. Additional survey work has recently been completed by DCR-DNH which will likely result in the delineation of additional conservation sites.

The Back Bay Subbasin was identified in the Nonpoint Source Pollution Watershed Assessment Report as a high priority (H1, 95-100%) for pollution potential from nutrient loadings from agricultural land. The report specifically mentions agricultural and urban lands as being sources for water quality problems, including shellfish condemnations and the loss of submerged aquatic vegetation. The same report assessed the Back Bay Subbasin as a high priority (H1) for overall urban nutrient load pollution (Wilson, 1993). Recent visits by DCR-DNH ecologists confirm that two invasive plants, alligatorweed (*Alternanthera philoxeroides*) and Asiatic sand sedge (*Carex kobomugi*) have increased in the Back Bay watershed in recent years and should be closely monitored in the future (Walton, personal communication).

LOVETTS MARSH

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach – 3607578

Location: This site straddles the line between Camp Pendleton and Fleet Combat Training Center Dam Neck, in eastern Virginia Beach.

Site Description: Prior to its drainage, Lovetts Marsh (refer to Figure 3 in the body of the document) was a community with many species of plants and animals now considered rare. The documentation of M. L. Fernald (1935 and 1937) illustrates that the habitat was in a natural condition at the time of his surveys. Ditching of the marsh in the late 1930's resulted in a lowering of the water level, increased drainage rate, and other hydrological changes that allowed the rapid succession from marsh to forested wetland that is apparent today. From aerial photographs, it is apparent that some open marsh habitat still occurred as late as 1965, although greatly reduced in area. The rare species that once occurred at Lovetts Marsh have not been found for many years, nonetheless, components of the system are still present, at least in nearby habitats. These remnants will undoubtedly be eliminated in the near future unless restoration actions are taken. Restoration and future protection will not only benefit the rare species nearby, and which may persist in a seed bank, but would provide exceptional waterfowl habitat. King rails (*Rallus elegans*) would likely find optimum habitat in a properly restored Lovetts Marsh.

Management Recommendations: Primary management actions needed here are restoration of natural surface water movements, especially by removing restrictions of water flow from man-made ditches. We recommend that a study be undertaken to determine the most practical means of returning a natural flow of surface water to the area. Should such an action be taken, the marsh would, through time, reestablish itself and its rare species populations. Encroaching woody species would be flooded out and an herbaceous and graminoid dominated community could develop. Through time, with the aid of natural dissemination of plants, and a seed source that may still exist in the soil, many of the rare plant species observed by Fernald may return. We note that great care would be necessary to prevent the invasion of common reed (*Phragmites australis)* into the marsh. This species appears to thrive on disturbance, and can outcompete and displace native plant and animal species. Common reed is presently found at this facility and may be an invasive problem. Monitoring and the pursuit of a control program are recommended.

Protection Recommendations: This area is presently in public ownership. It's recommended that surrounding areas be protected from further disturbance, particularly if restoration efforts proceed.

NORTHERN DUNE AND SWALE

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach - 3607578

Location: The site is located within the Fleet Combat Training Center Dam Neck.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
maritime forest	
Plants:	
Erigeron vernus	white-top fleabane

Juncus crassifolius	a rush
Quercus incana	blue jack oak
Rhynchospora fascicularis	fasciculate beakrush
Drosera intermedia	spoon-leaved sundew
Quercus virginiana	live oak

Site Description: Northern Dune and Swale (refer to Figure 3) contains the Fleet Combat Training Center's most significant maritime forest vegetation, a small interdunal swale, and populations of four rare plant species, white-top fleabane (*Erigeron vernus*), a rush (*Juncus crassifolius*), blue jack oak (*Quercus incana*), and fasciculate beakrush (*Rhynchospora fascicularis*). This area also contains two plants on the watchlist, spoon-leaved sundew (*Drosera intermedia*) and live oak (*Quercus virginiana*).

Threats: White-top fleabane and fasciculate beakrush are threatened by succession of the small, interdunal swale community from an open, herbaceous swale to a shrub-dominated wetland. This succession appears natural and further research is recommended to determine if the succession should be controlled through burning or other techniques.

Management Recommendations: If the land within this area is not developed further, the long-term viability of rare plants and ecological communities may be good. A monitoring program is recommended for rare plants, ecological communities and ecosystem health. Results of this monitoring may uncover other threats which could be ameliorated, or prevented in the future.

Protection Recommendations: This area is presently in public ownership. It's recommended that this site and surrounding lands be protected from further disturbance.

UPPER REDWING LAKE

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach - 3607578

Location: The site is located within the Fleet Combat Training Center Dam Neck.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Hottonia inflata	featherfoil

A site conservation plan has not been completed for this site.

SOUTHEAST REDWING LAKE

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach - 3607578

Location: The site is located within the Fleet Combat Training Center Dam Neck.

Natural Heritage Resources

Element (scientific) name	Common name
Animals:	
Siren lacertina	greater siren

Site Description: Southeast Redwing Lake (refer to Figure 3) is located immediately west of housing units # 205, 222, and 204, and provides habitat for the greater siren (*Siren lacertina*). The boundaries of this area include the larger wetland immediately to the south. This larger wetland, located immediately west of housing units # 219-223, is currently not considered optimal habitat for the greater siren due to human created impacts, including sewage and road runoff. The smell of sewage was evident in this wetland during field surveys in Summer 1990. However, should the water quality be improved, this wetland should become suitable habitat. The two wetlands are likely connected hydrologically, so there is concern that the wetland with the known greater siren population could be adversely impacted.

Threats: Degraded water quality in this area and adjacent areas presents a threat to long-term health and viability of the greater siren population here.

Management Recommendations: Measures should be sought to avoid water contamination by sewage and road runoff. If this can be accomplished, natural surface water flow should be restored where possible.

Protection Recommendations: This area is presently in public ownership. It's recommended that this area and surrounding lands be protected from further fragmentation and disturbance.

MIDDLE BEACH DUNES

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach - 3607578

Location: The site is located within the Fleet Combat Training Center Dam Neck.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Atlantic beach dune system	
Animals:	
Peromyscus leucopus easti	Pungo mouse

Site Description: An area of relatively unimpacted coastal dune habitat is contained within the Middle Beach Dunes site. The area encompasses an Atlantic beach dune system (see Figure 3), which is a rare habitat in southeastern Virginia. Additionally, the Pungo mouse (*Peromyscus leucopus easti*) is found in this habitat. Protection from human disturbance and allowing natural dynamic beach forces is the only likely management necessary for maintaining this habitat and its native species. Should loggerhead sea turtles *(Caretta caretta*) nest on FCTC Dam Neck beaches, this area would provide suitable habitat.

A site conservation plan has not been completed for this site.

HELICOPTER PAD WETLANDS

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach - 3607578

Location: The site is located within the Fleet Combat Training Center Dam Neck.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Limnobium spongia	American frog's-bit
Animals:	
Siren lacertina	greater siren

Site Description: The Helicopter Pad wetlands (see Figure 3 in the body of the document) support a rare plant species and a rare animal species, American frog's-bit (*Limnobium spongia*) and the greater siren (*Siren lacertina*). Careful attention needs to be paid to preventing spills of gasoline and oil from the adjacent helicopter landing pad and repair facilities. This Special Interest Area is at high risk due to the presence of roads on all sides.

A site conservation plan has not been completed for this site.

INTERDUNAL SWALE

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach - 3607578

Location: The site is located within the Fleet Combat Training Center Dam Neck.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Erigeron vernus	white-top fleabane
Rhynchospora fascicularis	fasciculate beakrush
Cladium mariscoides	twig rush
Drosera intermedia	spoon-leaved sundew
Rhynchospora rariflora	few-flowered beakrush
Animals:	
Rallus elegans	king rails
Sylvilagus palustris	marsh rabbit

Site Description: This site contains FCTC Dam Neck's most significant interdunal swale vegetation and large populations of two rare plant species, white-top fleabane (*Erigeron vernus*) and fasciculate beakrush (*Rhynchospora fascicularis*)(refer to Figure 3). The wetlands protected in this area also have a number of uncommon plants including grasspink (*Calapogon tuberosa*), twig rush (*Cladium mariscoides*), spoon-leaved sundew (*Drosera intermedia*), and few-flowered beakrush (*Rhynchospora rariflora*).

Marsh rabbits (*Sylvilagus palustris*) are abundant in this area and breeding king rails (*Rallus elegans*) were also observed. Both of these animal species require that the freshwater wetland portion of this special interest area be managed as a natural open marsh system. Drainage ditches have allowed some marshes to succeed to young swamp forest in some areas, a trend that is desirable to reverse.

Threats: The most immediate threat to the interdunal swale area is a planting of pine trees through the most significant interdunal swale vegetation. These pines shade out the rare species and change the area's vegetation from species adapted to an open canopy to species adapted to shaded conditions. Immediate corrective action, removing the pines in a manner that will not damage herbaceous vegetation, is recommended to protect the natural interdunal vegetation.

To detect long-term threats such as succession to scrub vegetation, a program is recommended to monitor rare plants and health of the natural communities. This monitoring may uncover other threats in addition to succession which may need to be ameliorated.

It should be recognized that negative data provided by rare species surveys cannot show that species do not occur, simply that no evidence was found of their presence. In many cases, such as that of the red-cockaded woodpeckers (*Picoides borealis*), there is little appropriate habitat and the nesting cavities are highly visible to trained observers. Therefore, there is little likelihood that this species was misses. On the other hand, several rare bat species could be present and using hollows of a few snags and old trees on FCTC Dam Neck. A likely habitat might be the bald cypress forest on the northwestern shore of Lake Tecumseh. Future inventory efforts could be directed at bats. It is also possible that several species are present but so rare that they were not detected during this inventory. It is possible that the eastern glass lizard (*Ophisaurus ventralis*) occurs here. If they are present, their likely habitat is already included in the Northern Dune and Swale Special Interest Area and the interdunal Swale, Dune, and Freshwater Marsh Special Interest Area.

BLACK GUT

Locality: City of Virginia Beach, Virginia

Quadrangle: Virginia Beach – 3607578, North Bay - 3607568

Location: The site is located approximately 1 mile NW of the town of Sandbridge, north of Sandbridge Road and south of Tecumseh Lake.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
Oligotrophic semi-permanently flooded herbaceous wetland	cattail/spikerush tall freshwater marsh
Oligotrophic semi-permanently flooded herbaceous wetland	spikerush short freshwater marsh
Plants:	
Fimbristylis caroliniana	Carolina fimbristylis
Ludwigia brevipes	long beach seedbox
Eleocharis vivipara	viviparous spikerush
Animals:	
Epitheca costalis	stripe-winged baskettail
Rallus elegans	king rail
Poanes aaroni aaroni	saffron skipper
Ixobrychus exilis	least bittern
Enallagma durum	a damselfly (big bluet)

Site Description: Black Gut, characterized by a small pond and extensive marshes (refer to Figure 3), supports two rare marsh communities. These rare communities are broadly classified as low herbaceous palustrine wetland and tall herbaceous palustrine wetland. The low herbaceous wetland is found closer to the waters edge, and is described as the spikerush short freshwater marsh association. Eelgrass (*Vallisneria americana*) and water lilies (*Nympha odorata)* dominate in open water areas along the marsh edge. It is within the low marsh 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, and where historic records suggest that carolina fimbristylis (*Fimbristylis caroliniana*) could be found.

Rare animals at the Black Gut site, king rail (*Rallus elegans*) least bittern (*Ixobychus exilis*) big bluet (*Enallagma durum*), saffron skipper (*Poanes aaroni aaroni*), and the stripe-winged baskettail (*Epitheca costalis*) are found scattered throughout the marshes, surrounding wetlands, and swamp forests. These animals are of course, mobile and may use a variety of habitats for resting, foraging, breeding and reproduction.

Threats: Black Gut is bordered on the east by Sandbridge Beach, a large residential and seasonal use development. Agriculture, silviculture and additional residential developments comprise the remaining land uses in this area. Soybeans, wheat, and field corn are primary crops grown in the area. 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. Poorly planned farming activities could impact water quality in Black Gut, and ultimately the Back Bay estuarine system.

Many farms in the southern portion of the city are being abandoned due to hard economic times, and consequently, more and more rural open space is being replaced by residential and tract housing developments, or other intensive land uses such as golf courses. This type of development may have significant secondary impacts on sensitive natural areas, such as increased toxic run-off, increased sedimentation, and habitat destruction and loss.

Pesticide and herbicide use within 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. Non-resident visitors and renters in the nearby beach development should be educated about these wetlands and advised about appropriate use and care. 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. To protect rare vertebrates and invertebrates at this site, as well the refugia that Black Gut offers for migrating neotropical songbirds and shorebirds, activities which further fragment existing continuous habitat (e.g. forests, marshes or swamps) should be avoided. If unavoidable, these activities should be monitored closely to ensure that: 1) proper buffers are established to protect sensitive resources and water quality; 2) corridors for wildlife movement are provided; 3) the Southern Watersheds Management Ordinance is adhered to; 4) natural hydrology and vegetation remain intact.

The Black Gut site falls within 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 does not, however, afford the bay or the immediate surrounding lands any additional protection from development or land use alteration.

Also cited in the Comprehensive Plan for the City is a "Southern Watersheds Management Ordinance." This is cited 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 2500 square feet of development within fifty feet of any shoreline or wetland, and the use of best management practice facilities for controlling stormwater runoff."

Management Recommendations: Invasive species such as common reed (*Phragmites australis*) and nutria (*Myocastor coypus*) are problem species throughout the watershed, requiring biological monitoring and specialized control programs. 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.

Nutria (*Myocastor coypus*) is a large rodent introduced from South America in 1899 into southern U.S. marshes to bolster the fur trade and as an additional food source. In the Back Bay watershed, this species has increased and is outcompeting 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: 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 the land buffering the natural heritage resources.

Much of the land in the Back Bay area is owned and managed by a variety of state and federal agencies. The beach, dunes and lands east of Lake Tecumseh are currently owned by the Department of Defense. South and west of Black Gut, some of the lands have recently been acquired by Back Bay National Wildlife Refuge (USFWS). Still further south there are additional Back Bay NWR lands, as well as False Cape State Park (VADCR), and several Wildlife Management Areas (VADGIF).

The land which borders the Black Gut site is subject to some development pressures. A public education program for current residents, developers, and builders might enhance public awareness about this estuarine system and the tremendous biodiversity it supports. The City of Virginia Beach should encourage the designation of greenways and open space and the development of interpretive facilities in areas appropriate for public access, and discourage activities which further fragment habitat or alter land use of natural areas. The establishment of programs to encourage environmentally sensitive planning and construction practices will help protect sensitive natural heritage resources.

NORTH BAY MARSHES

Locality: City of Virginia Beach, Virginia

Quadrangle: Knotts Island - 3607558

Location: This site is located at the north end of Back Bay, roughly 2 miles southwest of Sandbridge.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
three-square bulrush-cattail oligohaline marsh / estuarine herbaceous vegetation	
Plants:	
Ludwigia alata	winged seedbox
Lilaeopsis carolinensis	Carolina lilaeopsis

(***** tentatively identified as ***L. carolinensis***, but further taxonomic work needed to resolve the ID of the ***Lilaeopsis*** found a long the shorelines of Back Bay)

Site Description: This site lies at the north end of Back Bay and includes a series of open-water channels and ponds surrounded by marshes (refer to Figure 3). Extensive areas of the marshes are dominated by black needlerush or common reed. Elsewhere are patches variously composed of three-square bulrush, big cordgrass, saltmarsh cordgrass, cattails, and other grass-like plants. Some of the channels have been dredged to allow boats to enter the ponds. The resulting dredge spoil has been placed alongside the channels, allowing woody plants such as wax myrtle, loblolly pine, and red bay to take hold. Dredging appears to have allowed common reed to get established within the marshes, and this aggressive grass has displaced many acres of other species.

PORPOISE POINT

Locality: City of Virginia Beach, Virginia

Quadrangle: North Bay - 3607568

Location: Porpoise Point is located on the northwest shore of Back Bay between Ashville Bridge Creek and Beggar's Bridge Creek. It is roughly five miles southeast of Pungo.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
three-square bulrush – cattail oligohaline marsh / estuarine herbaceous vegetation	
Plants:	
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Animals:	
Rallus elegans	king rail

Site Description: This site lies at the northwest end of Back Bay and includes a series of open-water channels and ponds surrounded by marshes (see Figure 3). Extensive areas of the marshes are dominated by black needlerush or common reed. Elsewhere are patches variously composed of big cordgrass, saltmarsh cordgrass, cattails, and other grass-like plants. Some of the channels have been dredged to allow boats to enter the ponds. The resulting dredge spoil has been placed alongside the channels, allowing woody plants such as wax myrtle, loblolly pine, and red bay to take hold. Dredging appears to have allowed common reed to get established within the marshes, and this aggressive grass has displaced many acres of other species. This site includes upland pine forests, some of which have been logged in recent years. Nestled within the forest is a small freshwater pond.

WASH FLATS

Locality: City of Virginia Beach, Virginia

Quadrangle: North Bay - 3607568

Location: The site is located on the eastern side of Back Bay, along the barrier beaches.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Hydrocotyle bonariensis	coastal water-pennywort
Lilaeopsis carolinensis	Carolina lilaeopsis
Lipocarpha maculata	American lipocarpha
Erigeron vernus	white-top fleabane
Iva imbricata	sea-coast marsh-elder
Vaccinium macrocarpon	large cranberry
Ludwigia brevipes	long beach seedbox
Ludwigia repens	creeping sandbox
Phyla nodiflora	common frogbit
Verbena scabra	sandpaper vervain
Rhynchospora debilis	savannah beakrush
Rhynchospora fascicularis	fasiculate beakrush
Rhynchospora colorata	white-topped sedge
Juncus elliottii	bog rush
Juncus megacephalus	big-head rush

Site Description: The Wash Flats site consists of coastal dunes and interdunal swales, which have historically, and continue to support many rare plants.

There is no site conservation plan completed for this site.

BACK BAY NATIONAL WILDLIFE REFUGE

Locality: City of Virginia Beach, Virginia

Quadrangle: North Bay - 3607568
Knotts Island - 3607558

Location: Back Bay National Wildlife Refuge is located in the Back Bay watershed, on both sides and throughout much of the Bay (refer to Figures 3 and 5).

Site Description: Many of the sites included here are actually located within the boundaries of the Refuge, and new sites will likely be delineated based on analysis of recently completed work in the area (Walton, personal communication). Although a comprehensive site conservation plan has not been completed by DCR-DNH for Back Bay National Wildlife Refuge, in 2001 and 2002 the U.S. Fish and Wildlife Service will begin an extensive planning process for many of their mid-Atlantic refuges, including Back Bay (See text for **Future Considerations** for more details.) Back Bay National Wildlife Refuge supports state, federal, and globally rare natural communities, plants, and animals, and is a biologically significant area not just in Virginia, but in the entire mid-Atlantic region.

NAWNEY CREEK

Locality: City of Virginia Beach, Virginia

Quadrangle: North Bay – 3607568

Knotts Island - 3607558

Location: The Nawney Creek site lies in the center of the western shore of Back Bay; it is bounded on the north by Hill Landing and on the south by Mill Landing Road.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Lilaeopsis carolina	Carolina lilaeopsis

(***** tentatively identified as ***L. carolinensis***, but further taxonomic work needed to resolve the ID of the ***Lilaeopsis*** found a long the shorelines of Back Bay)

Site Description: Nawney Creek (often spelled Nanney Creek, and pronounced the same way) is a small tributary on the western shore of Redhead Bay/Back Bay (refer to Figure 3 in the body of the document). Most of the creek is lined by a broad band of marshes. There are similar, more extensive marshes north of the mouth of the creek. Upper reaches of the creek are lined by trees and agricultural fields. The Nawney Creek site supports an excellent occurrence of a state and globally rare plant.

Nawney Creek flows from north to south and takes a southeasterly turn near the intersection of Mill Landing Road and Nawney Creek Road. The creek then continues its path, flowing from west to east and empties into Redhead Bay. Although the creek was apparently dredged and channelized approximately 30 years ago, the channel hasn't been altered in recent years.

The lower stretches of Nawney Creek are lined primarily by narrow-leaved cattail and big cordgrass, but there are large patches where three-square sedge or common reed dominate. The rare Carolina lilaeopsis is found at the mouth of Nawney Creek, and along the western shore of Redhead B ay, north of Nawney Creek. The plant is often found on mud flats and scattered near the water line. Carolina lilaeopsis was observed growing near and under the narrow-leaved cattail and big cordgrass, but was absent where common reed dominates. Further upstream, sections of Nawney Creek are lined by young baldcypress and red maple.

Threats: Best management practices designed to minimize sedimentation and agricultural runoff should be adhered to in this watershed, as farming activities could influence water quality. Pesticide and herbicide use within the area should be carefully planned to minimize negative impacts on sensitive wetlands. Pesticides used for lawns, gardens, farms, or forests could inadvertently jeopardize invertebrates, as could pesticides and anti-parasitic chemicals for use on and around livestock. Buffers to wetlands should be maintained and biocides must be carefully chosen and applied by skilled certified applicators.

Current logging practices do not appear to threaten natural heritage resources, 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.

Nutria (*Myocastor coypus*) is a large rodent which was introduced to southern U.S. marshes from South America in 1899. Reasons for the introduction were to bolster the fur trade and to provide an additional food source. In the Back Bay watershed, this species has increased and is outcompeting native muskrats for marsh habitat and food. Studies are needed to determine the status of nutria in the Back Bay system, and the most effective means of control if necessary.

Management Recommendations: Long-term monitoring is recommended for the population of Carolina lilaeopsis to ensure continued health and productivity of the existing population. Monitoring of invasive or problematic species is recommended as well.

MUDDY CREEK

Locality: City of Virginia Beach, Virginia

Quadrangle: North Bay - 3607568

Location: The Muddy Creek site is located along the western shore of Back Bay, approximately 2.5 miles southeast of Pungo.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Lilaeopsis carolina	Carolina lilaeopsis
Ophioglossum petiolatum	long stem adder's-tongue

Site Description: This site merges with Ashville Bridge Creek approximately one half mile before emptying into the North Bay, of Back Bay (refer to Figure 3). The mouth of Muddy Creek is bordered by estuarine herbaceous marshes, and further upstream the creek narrows and is lined by trees. This site supports portions of two tributaries to Back Bay, and associated estuarine marshes which support a globally rare plant.

Lower stretches of Muddy Creek are lined by mid-height, herbaceous estuarine marshes dominated by narrow-leaved cattail, bulrush, and spikerush, with small patches of diverse, low marsh vegetation. Common reed, an aggressive invasive grass, dominates in some areas forming extensive clones in these marshes. It is within the mid-height marshes at the creek mouth that Carolina lilaeopsis is found. Historically, the rare long stem adder's-tongue and crow-poison were found near the mouth of Muddy Creek as well, although exact locations of past plants are not known. Crow-poison has recently been moved from the state rare plant list to the state watchlist, but both this plant and long stem adder's-tongue are considered by botanists to be "lawn plants." Both plants characteristially are found on "cultivated, wet lawns".

Upstream sections of Muddy Creek are lined by young baldcypress and red maple. Many marshes south of the locality of Sigma (Ashville Bridge Creek and Muddy Creek) are dominated by sweetflag.

Carolina lilaeopsis is rare throughout its range, from Virginia to northern Florida. Only 11 occurrences of this plant are known from Virginia (Ludwig, 1993), and it is a candidate for listing as State Threatened or Endangered by VA Department of Agriculture and Consumer Services. This low, perennial herb, bears small, dainty, white flowers and is customarily found in shallow water, marshes, and swamps (Godfrey and Wooten, 1981). Carolina lilaeopsis is threatened directly by loss of habitat, and indirectly by changes in water quality and hydrologic regime.

Threats: Primary surrounding land uses in this area are agricultural and residential. A large golf course lies north of this site, on both sides of Ashville Bridge Creek. Soybeans, wheat, field corn, and hogs are primary crops and products of the area. Farming practices may represent a threat to sensitive natural areas, by increasing nutrient runoff, increasing toxic runoff, and increasing sedimentation. Especially in the southern portion of the City of Virginia Beach, many farms are being abandoned due to hard economic times and consequently, more and more rural, open space is being replaced by residential and tract housing developments, or other intensive land uses. This type of development could also have

significant impacts on sensitive natural areas, by increasing nutrient and toxic runoff, increasing sedimentation and by disruption of normal hydrology.

Best Management Practices designed to minimize sedimentation and agricultural runoff should be adhered to in this watershed, as farming activities could influence water quality as well. The Back Bay Subbasin was identified in the Nonpoint Source Pollution Watershed Assessment Report as a high priority (H1, 95-100%) for pollution potential from nutrient loadings from agricultural land, in the forms of animal waste and fertilizer runoff. The report specifically mentions agricultural and urban lands as being sources for water quality problems, including shellfish condemnations and the loss of submerged aquatic vegetation. The same report assessed the Back Bay Subbasin as a high priority (H1) for overall urban nutrient load pollution (Wilson, 1993).

Management Recommendations: Pesticide, herbicide and fertilizer use should be carefully planned to minimize negative impacts on sensitive wetlands, water quality and non-target floral and faunal species. Some chemicals used for lawns, gardens, golf courses, or forests could inadvertently jeopardize rare plants and animals. Buffers to wetlands should be maintained and biocides must be carefully chosen and applied.

Current logging practices do not appear to threaten natural heritage resources, 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.

Nutria (*Myocastor coypus*) is a large rodent which was introduced to southern U.S. marshes from South America in 1899. Reasons for the introduction were to bolster the fur trade and to provide an additional food source. In the Back Bay watershed, this species has increased and is outcompeting native muskrats for marsh habitat and food. Studies are needed to determine the status of nutria in the Back Bay system, and the most effective means of control if necessary.

Long-term monitoring is recommended for the population of Carolina lilaeopsis to ensure continued health and productivity of the existing population. Monitoring of invasive or problematic species is recommended as well. Management activities should always be preceded and followed by additional surveys.

CAMPBELL LANDING

Locality: City of Virginia Beach, Virginia

Quadrangle: North Bay – 3607568
Knotts Island - 3607558

Location: Campbell Landing lies on the western shore of Back Bay, and is bounded on the north by Mill Landing Road, and on the south by the main boat canal of Trojan Wildlife Management Area.

Natural Heritage Resources

Element (scientific) name	Common name
Plants:	
Lilaeopsis carolina	Carolina lilaeopsis
Ludwigia brevipes	long beach seedbox

Heliotropium curassavicum	seaside heliotrope
Animals:	
Synaptomys cooperi helaletes	southern bog lemming

Site Description: The Campbell Landing site includes a band of herbaceous wetlands (marshes) along the western shore of Back Bay (refer to Figure 3). Within the marshes are low spots of open water or short sedges on soupy muck. These marshes are crossed in places by ditches or canals, which have served as a point of invasion for common reed. Elsewhere the native vegetation is reasonably intact and the marshes are dominated by cattails, three-square bulrush, and black needlerush, or big cordgrass with a variety of subordinant species.

There is no site conservation plan completed for this site.

SEDGE ISLAND

Locality: City of Virginia Beach, Virginia

Quadrangle: Knotts Island - 3607558

Location: Sedge Island is located in the southern portion of Back Bay, just north of the State line.

Natural Heritage Resources

Element (scientific) name	Common name
Communities:	
wind-tidal oligohaline marsh	
Plants:	
Lobelia elongata	elongated lobelia
Animals:	
Ixobrychus exilis	least bittern

Site Description: Sedge Island is an irregularly-shaped marsh island, dominated by waist-high grasses. The edge of the island is lined by switchgrass and big cordgrass. In the interior are shallow ponds and marshes covered by low-growing sedges. A rare plant and a rare bird inhabit these high-quality marshes. Similar wetlands appear to occur on the adjacent Mackay Island National Wildlife Refuge. Future inventories of this area are likely to reveal additional natural heritage resources.

There is no site conservation plan completed for this site.

FALSE CAPE

LOCALITY: City of Virginia Beach

QUADRANGLE: Knotts Island - 3607558
North Bay - 3607568

LOCATION: The site includes all of False Cape State Park - located north of the North Carolina state line and south of Back Bay National Wildlife Refuge.

NATURAL HERITAGE RESOURCES

Element (scientific) name	Common name
Communities:	
Low herbaceous palustrine wetland	
Mid-height herbaceous upland vegetation	

Mid-height herbaceous palustrine wetland
Oligotrophic forest
Oligotrophic scrub

Plants:

Aster elliottii	Elliott's aster
Carex reniformis	reniform sedge
Dichromena colorata	white-topped sedge
Eleocharis halophila	salt-marsh spikerush
Eleocharis radicans	rooted spikerush
Eleocharis rostellata	beaked spikerush
Erigeron vernus	white top fleabane
Euphorbia ammannoides	a spurge
Fimbrystylis caroliniana	Carolina fimbry
Galium hispidulum	coast bedstraw
Heterotheca gossipyna	cottony golden aster
Iresine rhizamatosa	eastern bloodleaf
Iva imbricata	sea-coast marsh elder
Juncus elliottii	bog rush
Juncus megacephalus	big-head rush
Lilaeopsis carolinensis	Carolina lilaeopsis
Limosella subulata	mudwort
Lippia nodiflora	nodding frog-fruit
Lobelia elongata	elongated lobelia
Ludwigia alata	winged seedbox
Ludwigia brevipes	long-beach seed box
Paspalum distichum	joint paspalum
Phalaris caroliniana	May grass
Physalis viscosa	sticky ground-cherry
Quercus hemispherica	Darlington's oak
Rhynchospora fascicularis	fasciculate beakrush
Spiranthes odorata	sweetscent ladies-tresses
Tillandsia usneoides	Spanish moss
Vaccinium macrocarpon	large cranberry

Animals:

Ardea herodias	Great Blue Heron
Ixobrychus exilis	Least Bittern
Caretta caretta	loggerhead sea turtle
Ophisaurus venteralis	eastern glass lizard
Peromyscus leucopus easti	Pungo mouse

SITE DESCRIPTION: False Cape State Park (refer to Figures 3, 4 and 5) is managed by the Virginia Department of Conservation and Recreation's Division of State Parks. The Park is without question an ecological treasure, and represents one of the most significant undisturbed barrier beach systems along the Atlantic coast. The northern portion of the Park is somewhat disturbed, however, as a result of intensive wildlife management practices. Vegetation forms complex patterns of interdigitating zones, and beyond the unvegetated sandy beach lies a primary dune dominated by sea oats (*Uniola paniculata*). The next zone is dominated by beach grass (*Ammophila breviligulata*), beach panic grass (*Panicum amarum*), seabeach evening primrose (*Oenothera humifusa*), and spurge (*Euphorbia polygonifolia*). Toward the center, dune and swale topography creates alternating upland and wetland habitats. Active dunes here are sparsely vegetated with beach heather (*Hudsonia tomentosa*) and other species tolerant of the very dry, shifting sand environment. Seasonally-inundated pools, known as interdunal swales,

contain a very rich assemblage of plant life. Prevalent species in these wetlands are narrow-leaved goldenrod (*Euthamia tenuifolia*), Carolina willow (*Salix caroliniana*), beak-rushes (*Rhynchospora* spp.), and the carnivorous plant, spatulate-leaved sundew (*Drosera intermedia*). Tyndall and Levy (1978) provide an excellent description of the swale vegetation. Dune scrub thickets with live oak (*Quercus virginiana*), waxmyrtle (*Myrica cerifera*), and bayberry (*Myrica pensylvanica*) are common between the high dunes and low swales.

A large and somewhat interrupted maritime forest dominated by loblolly pine (*Pinus taeda*) and live oak is interspersed with dune thicket vegetation. The maritime forest is one of the regions' finest. Swamp forests with diverse woody vegetation grade into the marshes of Back Bay. The marsh vegetation indicates somewhat brackish conditions, and a variety of dominance types exist. Prevalent marsh species include big cordgrass (*Spartina cynosuroides*), narrow-leaved cattail (*Typha angustifolia*), Olney's bulrush (*Scirpus olneyi*), common reed (*Phragmites australis*), and black needlerush (*Juncus roemerianus*).

The botanical significance of False Cape was first noted by M.L. Fernald (1935; 1936; 1940; 1947). Presently, the large number of rare plant species recorded from the Park confirms Fernald's assessment; very few areas of similar size in Virginia can boast such a richness of rare plants (29 species in all). Furthermore, most of the rare plant populations at False Cape are thriving, as indicated by the numerous occurrence ranks of A and B in the natural heritage resources summary table, shown above.

Rare animals include Virginia's only breeding site for the loggerhead sea turtle (*Caretta caretta*), one of four sites in the world for the Pungo mouse (*Peromyscus leucopus easti*), and the only known Virginia population of eastern glass lizards (*Ophisaurus ventralis*).

Threats: Common reed may pose a threat to some of the rare marsh plants. This grass quickly invades disturbed wetlands and has formed dense, scattered stands throughout the Park's marshes. Rare plants of the interdunal swales might be threatened by rooting activities of feral hogs, and grazing by deer and horses. These impacts are currently being assessed.

A long-term threat to the herbaceous vegetation and its rare plants is succession to scrub and forest vegetation. Observations suggest that sand movement and dune migration are critical processes which maintain the open, herbaceous vegetation. Any activities that interfere with these natural processes (such as berm construction) therefore constitute serious threats.

A final threat may be generally referred to as land use. False Cape State Park has tremendous recreational development potential, but intensified human use would likely place the natural heritage resources at greater risk. Fortunately, the current level of recreational use does not appear to threaten the long-term maintenance of natural heritage resources at the site.

Management Recommendations: To reduce the threat of common reed expansion, mechanical disturbance to wetland habitats should be kept at a minimum or avoided altogether; such disturbance is favorable to the rapid spread of this invasive plant. Common reed should be closely monitored. Feral hog impacts are not precisely known, but since the hogs (and horses) are not native to the barrier beach ecosystem, their activities may threaten the natural heritage resources. Currently, recreational hunting is being used to keep the hog population in check, and we recommend that this activity be continued. Adjustment to the hunting regulations may be necessary if intensified hog impacts threaten vegetation at the site. Lastly, the interdunal swales should be monitored to determine if the herbaceous species are threatened by succession to woody vegetation.

False Cape State Park is managed as a park for nature study and low-impact recreation. A small number of buildings including a contact station, park personnel dwellings, and an environmental

education center are located within the park. The northern portion of the site has been somewhat disturbed to enhance waterfowl habitat. The remainder of the site is remarkably pristine, except for a few sand roads, trails, and a powerline right-of-way.

Protection Recommendations: The Virginia Department of Conservation and Recreation is considering recommendations that portions of False Cape State Park be Dedicated as a Natural Area Preserve.

Appendix F – Conservation Corridor Land Use Summary

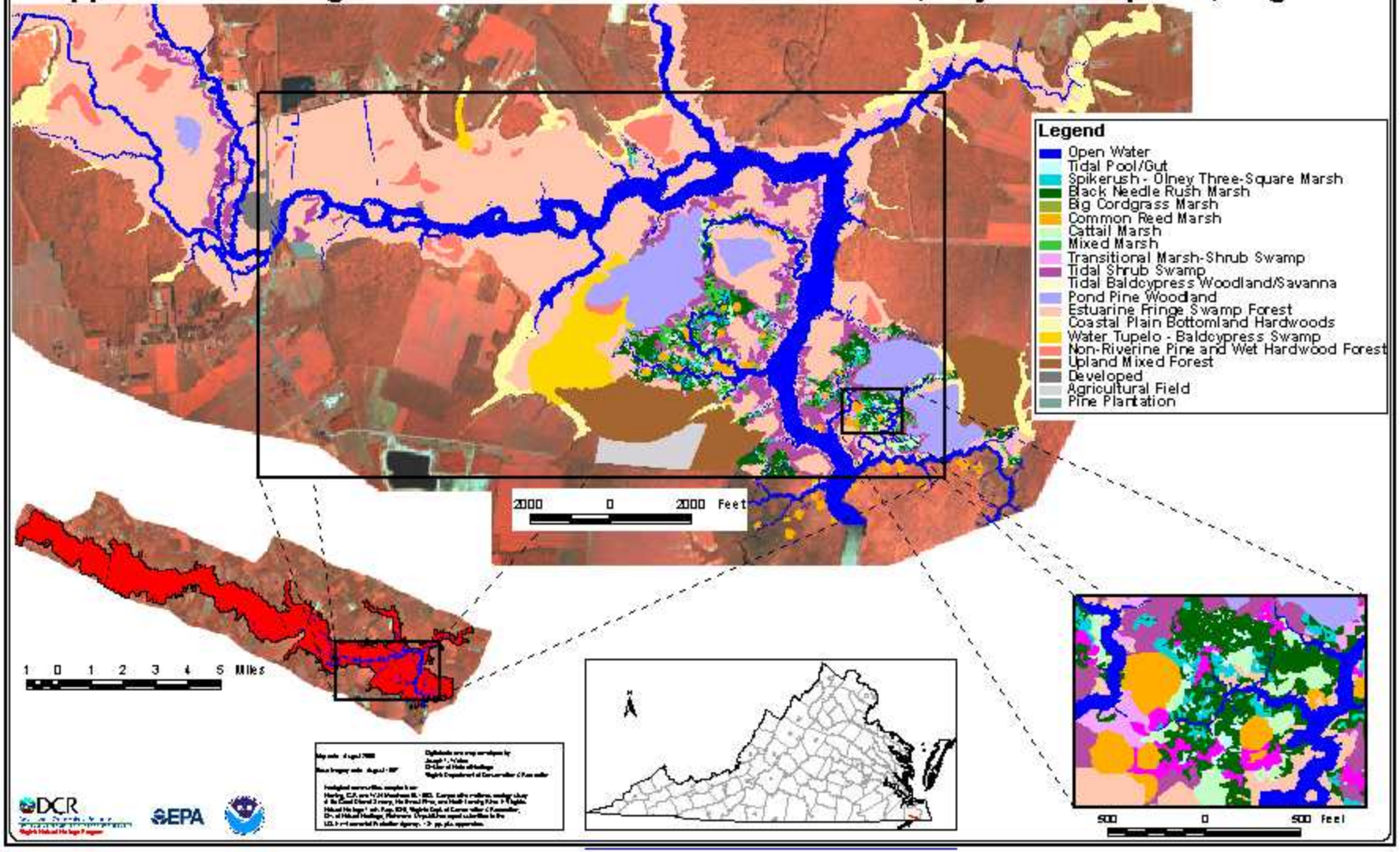
Appendix G – Ecological Communities of the Northwest River, City of Chesapeake, Virginia

The Department of Conservation and Recreation's Division of Natural Heritage has been funded by the U.S. Environmental Protection Agency for a project entitled, ***Development of a Comprehensive GIS Database for the North Landing/Northwest Rivers Wetland Ecosystem.*** A major focus of the project was the development and mapping of a vegetation classification scheme, consistent with statewide and national efforts, to facilitate understanding of natural processes and the threats they face. The community classification is described in detail in DCR-DNH Technical Report 98-9, June 1998, ***Comparative Wetlands Ecology Study of the Great Dismal Swamp, Northwest River, and North Landing River in Virginia***. Fine-scaled mapping of the vegetation communities was originally intended for both the Northwest River and the North Landing River wetlands, but funding constraints limited the detailed mapping to the just the Northwest River communities.

The map was derived from 1:12,000 scale, digital, color-infrared orthophotography obtained specifically for this mapping project in August 1997. Communities were digitized in ArcView GIS using photo-interpretation, field samples referenced by GPS, and spectral analysis. The mapped ecological communities correspond to the communities of the "Type" level of the vegetation classification found in DNH Technical Report 98-9, June 1998. A complete metadata file for this map is included with digital ArcView shapefiles available through the Hampton Roads PDC. Although no formal accuracy assessment has been performed, this map is considered to be highly accurate because it was developed using vast amounts of field data. Because ecological communities can change significantly in only a few years, this map should be considered a "snap-shot" of the Northwest River from 1997 (the year of the base imagery).

This map has proven a valuable management tool for a variety of DCR land stewardship projects. The map and the vegetation community classification that supports it provide considerable opportunity for SWAMP partners to prioritize wetland types for protection and restoration. The utility of this classification would be considerably expanded by extending the mapping to the North Landing River wetlands and to other isolated wetlands within the Southern Watersheds Area.

Appendix G. Ecological communities of the Northwest River, City of Chesapeake, Virginia



Appendix H – Pertinent Federal and State Natural Resource Laws

Pertinent Natural Resource Laws

LEGISLATION	CITATION	RESPONSIBLE AGENCY
Presidential Order on Introduction of Exotic Species	Executive Order # 11987	Office of the President
U.S. Noxious Weed Law	7 USC 2802-2814	U.S. Department of Agriculture (USDA)
U.S. Clean Water Act	33 USC 1344	U.S. Army Corps of Engineers (ACOE), U.S. Environmental Protection Agency (EPA)
U.S. Rivers & Harbors Act	33 USC 404	ACOE
U.S. Coastal Zone Management Act	16 USC 1451-1464	National Oceanic & Atmospheric Administration (NOAA)
U.S. Anadromous Fish Conservation Act	16 USC 757a-757g	National Marine Fisheries Service (NMFS)
Navigable Waters of the U.S.	14 USC 2	U.S. Coast Guard (USCG)
U.S. Clean Air Act	42 USC 7401-7671q	EPA
National Environmental Policy Act	42 USC 4321-4307d	all Federal agencies
Lacey Act (exotics)	18 USC 42	U.S. Department of Interior (DOI)
U.S. Endangered Species Act	16 USC 1531-1544	U.S. Fish & Wildlife Service (FWS), NMFS
U.S. Fish & Wildlife Coordination Act	16 USC 661-668s	many
U.S. Migratory Bird Treaty Act	16 USC 701-712	FWS
U.S. Aquatic Nuisance Prevention & Control Act	16 USC 4701-4751	FWS, NMFS
VA Commercial Fishing Law / Recreational Fishing Law	VA Code 28.2-100 – 1001	VA Marine Resources Comm. (VMRC)
VA Submerged Lands Law	VA Code 28.2-1200 – 1213	VMRC
VA Wetlands Act	VA Code 28.2-1300 – 1320	VMRC
VA Coastal Primary Sand Dune Act	VA Code 28.2-1400 – 1420	VMRC
VA Historic Resources Law	VA Code 10.1-2200 – 2216	VA Department of Historic Resources (VDHR)
VA Antiquities Act	VA C ode 10.1-2300 – 2306	VDHR
VA Endangered Species Act	VA Code 29.1-563 – 570	VA Department of Game & Inland Fisheries (VDGIF)
VA Fish & Wildlife Law	VA Code 29.1-100 et seq.	VDGIF
VA Endangered Plant & Insect Species Act	VA Code 3.1-1020 – 1030	VA Department of Agriculture and Consumer Services (VDACS)
VA Noxious Weed Law	VA Code 3.1-296.11 - 296.21	VDACS

Pertinent Natural Resource Laws (continued)

LEGISLATION	CITATION	RESPONSIBLE AGENCY
VA Chesapeake Bay Preservation Act	VA Code 10.1-2100 - 2115	Chesapeake Bay Local Assistance Dept. (CBLAD)
VA Water Quality Improvement Act of 1997	VA Code 10.1-2118 – 2128.B.	VDCR
VA Water Control Law	VA Code 62.1-44.2 - 44.34	VA Department of Environmental Quality (VDEQ)
VA Groundwater Management Act	VA Code 62.1-44.84 - 44.104	VDEQ
VA Environmental Quality Act	VA Code 10.1-1200 - 1221	VDEQ
VA Waste Management Act	VA Code 10.1-1400 - 1457	VDEQ
VA Open Space Land Act	VA Code 10.1-1700 - 1705	VA Outdoors Foundation (VOF)
VA Erosion & Sediment Act	VA Code 10.1-560 - 571	VDCR
VA Natural Area Preserves Act	VA Code 10.1-202 - 217	VDCR
VA Conservation Easement Act	VA Code 10.1-1009 - 1016	VDCR
VA Shoreline Erosion & Public Beach Law	VA Code 10.1-700 - 711	VDCR