CHAPTER 2:
AFFECTED ENVIRONMENT

Great spangled fritillary: USFWS

- Introduction
- The Physical Landscape
- The Cultural Landscape Setting and Land Use History
- Current Climate
- Air Quality
- Water Quality
- Special Use Permits, including Research
- Refuge Natural Resources
- Refuge Biological Resources
- Refuge Visitor Services Program
- Archealogical and Historical Resources

Introduction

This chapter describes the physical, biological, and social environment of the Rappahannock River Valley refuge. We provide descriptions of the physical landscape, the regional setting and its history, and the refuge setting, including its history, current administration, programs, and specific refuge resources. Much of what we describe below reflects the refuge environment as it was in 2007. Since that time, we have been writing, compiling and reviewing this document. As such, some minor changes likely occurred to local conditions or refuge programs as we continued to implement under current management. However, we do not believe those changes appreciably affect what we present below.

The Physical Landscape

Watershed

Our project area is part of the Chesapeake Bay watershed, a drainage basin of 64,000 square miles encompassing parts of the states of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. The waters of that basin flow into the Chesapeake Bay, the nation's largest estuary.

The watershed contains an array of habitat types, including mixed hardwood forests typical of the Appalachian Mountains, grasslands and agricultural fields, lakes, rivers, and streams, wetlands and shallow waters, and open water in tidal rivers and the estuary. That diversity supports more than 2,700 species of plants and animals, including Service trust resources such as endangered or threatened species, migratory birds, and anadromous fish (www.fws.gov/chesapeakebay/coastpgm.htm).

The Rappahannock River is one of several rivers that flow into the western-side of the Chesapeake Bay; others are the Potomac, York, and James rivers. The Rappahannock is the geographic feature that defines the heart of our project area. The river journeys 185 miles from its source in Chester Gap, a mountainous region near Front Royal, Virginia, to its mouth where, at 3.5 miles wide, it flows into the bay.

Although the entire Rappahannock River watershed comprises about 2 million acres, our project area includes only its lower reaches, near where it enters the bay (see chapter 1, map 1.1). The upstream boundary of our project area starts below Fredericksburg, Virginia, and includes the geographic regions often referred to as the Middle Peninsula and Northern Neck, encompassing the river shore up to the drainage divides on each side. The downstream boundary of our project area ends around Belle Isle State Park. Our entire project area, excluding the river, is approximately 268,000 acres.

Notable Physiographic and Landform Features

Geomorphic regions or "physiographic provinces" are broad-scale subdivisions based on terrain texture, rock type, and geologic structure and history. Our project area lies in the Virginia portion of the Atlantic Coastal Plain delineated by the U.S. Geological Survey (http://tapestry.usgs.gov/physiogr/physio.html). The Virginia Department of Game and Inland Fisheries (VDGIF 2005) also uses that regional delineation in their wildlife action plan. The Virginia coastal plain consists of a series of terraces sloping downward toward the coast, with each terrace or scarp representing a former shoreline (Wilson and Turbeville 2003). It is the youngest physiographic province in the state, and consists of sedimentary deposits of sand, clay, marl, and shell. Its principle characteristics are its low topographic relief (except for occasional steep ravines), extensive marshes, and tidally influenced rivers and creeks.

The "Fall Line" separates the Virginia coastal plain physiographic region from the Appalachian Piedmont physiographic region to the west. That line is a low, east-facing cliff that extends from New

Jersey to the Carolinas, parallel to the Atlantic coastline. It separates the hard, Paleozoic metamorphic rocks of the Appalachian Piedmont on the west from the soft, gently dipping Mesozoic and Tertiary sedimentary rocks of the Coastal Plain on the east. That erosional scarp, the site of many waterfalls, hosted flume- and water-wheel-powered industries in Colonial times, and thus, helped determine the location of such major cities as Philadelphia, Baltimore, Washington, and Richmond. Fredericksburg marks the fall line on the Rappahannock River.

The Virginia Natural Heritage Program (VNHP) further subdivides the coastal plain region into "northern," "southern," "inner" and "outer" Virginia coastal plain to account for the rich variety and distinction of natural community types in the area (http://192.206.31.52/cfprog/dnh/naturalheritage/select_prov.cfm; Wilson and Turbeville 2003).

Those distinct natural community types are the result of local landforms and geographic features that may appear subtle, but vary widely across the landscape. From the main driving routes along either side of our project area boundary (routes 3 and 17), the topography of two major landforms, the Northern Neck and Middle Peninsula, would appear to casual observers as flat to gently rolling.

Although that is true along the roads where farm fields are visible, beyond the fields in the direction of the Rappahannock River or the many creek drainages, observers can see a dramatic change in topography. The highly erodible soil layers give way to steep ravines, some of which plummet to depths of 80 feet or more. That is particularly true of the Fones Cliffs section of the river, where the shoreline is breaching the Essex scarp soil type, creating steep-faced cliffs of about 100 feet.

Both the flat uplands and the network of steep ravines are geomorphic features that dictate the character of the Northern Neck and the Middle Peninsula. The flat uplands are dominated almost entirely by anthropogenic uses such as crop agriculture, pine plantation, and landscaping nurseries, leaving very little natural forest.

On the other hand, the rough terrain of the ravines prohibited substantial logging, farming or development. As a result, those areas tend to be shady, forested, and often contain spring seeps or perennial streams that eventually flow into the river. They have become their own microcosm of plant and animal communities, quite distinct from the surrounding uplands.

The rich topography of the Northern Neck and Middle Peninsula supports some unique or increasingly rare vegetation and significant natural communities. The Nature Conservancy (TNC) of Virginia's Chesapeake Rivers Site Conservation Plan identifies some of these as targets for conservation (TNC 2001). We utilized this document and other TNC and VDGIF data to help us assess the biological diversity and integrity of the refuge's habitats, and consider their contribution to those values across the larger landscape. Service policy (601 FW 3) requires us to consider the biological diversity, integrity, and environmental health of refuge lands during the CCP planning process to ensure the protection of a broad spectrum of fish, wildlife, and habitat resources within refuge ecosystems, to prevent additional degradation of environmental conditions, and to evaluate the potential to restore lost or severely degraded components of the environment. Natural community areas of conservation concern that occur, or could occur, in the refuge area include bald cypress forests, seepage wetlands, calcareous forests, and fluvial terrace woodlands. Large blocks of terrestrial upland forests and tidal freshwater ecosystems also occur there. A detailed description of those natural communities can be found in the Virginia Natural Heritage Program (VNHP) First Approximation classification of ecological community groups of Virginia, or through personal communications with Natural Heritage ecologists (TNC 2001).

The VNHP also identifies ecologically important sites in or next to our project area, many of which are similar to the TNC plan. Three hundred forty-eight conservation sites and stream conservation units have been mapped in this physiographic region (Wilson 2003). Conservation sites are the locations of a natural resource element of conservation concern (e.g., an endangered plant or animal species). For

elements that inhabit streams, rivers, or other large bodies of water, the boundary is called a stream conservation unit.

Those likely to be found in our project area include coastal plain calcareous forest and woodland, fluvial terrace woodland, coastal plain/piedmont bottomland forest, floodplain pond and pool, coastal plain depression pond, non-riverine wet hardwood forest, coastal plain basic seepage swamp, tidal shrub swamp, tidal bald cypress forest and woodland, and tidal hardwood swamp. Another natural community not listed in the plan, but believed to be important from a unique ecological and biological diversity standpoint, is coastal plain acidic seepage swamp, which is associated with sand deposits (Allen Beldon, DNH, personal communication 2004).

Major Historical Influences Shaping Landscape Vegetation

Estimating what the historic natural vegetation types were, how they were distributed, and what ecological processes influenced them prior to major, human-induced disturbance, can help us evaluate future management options. However, many ecologists caution against selecting one point in time, and instead, recommend evaluating the "historical range of variation" for each habitat type.

According to noted ecologist Robert Askins of Connecticut College, "This approach recognizes that the proportions of grassland, shrub land, young forests, and old-growth forests have shifted constantly over the past few thousand years as the climate changed and people have modified the land by hunting, burning, and farming. Preserving the biological diversity of any region requires a range of habitat types, including those created by natural disturbances. If there are no natural or artificial disturbances generating grassland, shrub lands, and young forest, then not only will early succession obligates be in trouble, but so will mature forest specialists that use early succession habitats at key points in their life cycles. Only large public lands like refuges, parks, preserves can sustain the full range of early succession and forest habitats, so in most regions land managers will need to cooperate to ensure that these habitats are adequately represented across the regional landscape" (Askins 2002).

A brief summary of influences on natural vegetation patterns across the landscape follows.

Pre-History Influences

Ten to twenty million years ago, the Chesapeake Bay region was a place of grasslands and shallow coastal waters, evidenced by the fossil record preserved in Maryland's Calvert Cliffs. That gradually gave way to spruce forests and marshy tundra as the ice age of the colder Pleistocene period began 2 million years ago (Grumet 2000). Sea levels rose and fell with the advance and retreat of each of the four ensuing ice ages, causing the coastal plain to extend eastward, at least 100 miles farther than the present day shoreline. Each melting glacier deposited vast sheets of sand, silt, gravel and clay. Those weathered into deep layers of acidic, sandy or silty soils of light to medium texture, which rain easily penetrated.

Barn swallow nest: USFWS

In addition, river and seawater formed vast underground aquifers that today lie from several hundreds to more than 1,000 feet deep along the western and eastern shores of the bay (Grumet 2000). The Wisconsinan Glaciation was the last glaciation which retreated from its maximum extent 18,000 years ago. At that time, the bay region was a branching network of rivers and streams traversing a rolling terrain about 300 feet above present-day sea level (Grumet 2000).

When humans (Paleo-Indian) made their first appearance in the region between 18,000 and 11,500 years ago, evidence from carbon 14 and other radiometric tests of cores drilled into ice age lakes and swamps, such as the Great Dismal Swamp, suggest a colder, wetter, and largely flooded coastal plain. The evidence also shows that massive climatic changes transformed the region during Paleo-Indian times, particularly in the transition from softwood to hardwood forests on the upland portions of the Coastal Plain (Grumet 2000). Bones, teeth, and horns found in coastal plain soils indicate that present-day wildlife residents, such as white-tailed deer, beaver, and black bear, lived side by side with mammoths and mastodons (Grumet 2000), caribou, long-nosed peccaries, and sharp-tailed grouse, a species now associated with the western prairie (Askins 2002). Even sea mammals such as walruses and seals thrived in the seas that periodically covered the Coastal Plain (Grumet 2000).

Soil strata and coatings of ash on tree rings indicates that Paleo-Indians used fire, but that did not significantly alter the bigger trend of forest transformation from softwoods to hardwoods as the last Ice Age withdrew (Grumet 2000). Beginning about 10,000 years ago, oak-hickory forests began to dominate in the east as climatic conditions became increasingly warm and dry. The coastal plain continued to extend far beyond its current shoreline, but as glaciers melted and sea levels rose, the inward progression of the sea coupled with an uprising of about 160 feet of coastal plain uplands. Rising sea levels caused considerable widening of the rivers in the Chesapeake Bay ecosystem about 8,000 years ago. In the parts closest to the ocean, the rivers changed into tidal estuaries, which widened further between 5,000 and 3,000 years ago and formed what is now the Chesapeake Bay (Grumet 2000).

The continued moderation of the region's climate encouraged the growth of mixed hardwood forests. It promoted conditions under which freshwater wetlands and low salt marshes could form, and submerged aquatic vegetation could thrive and support anadromous fish, migratory shorebirds and waterfowl. Fire (whether natural or started by humans) and drought during this period created park-like woodlands and stretches of open grasslands throughout the bay area (Grumet 2000). This is the setting in which eastern Native American cultures grew and thrived, and which facilitated English settlement.

More Contemporary Influences on Vegetation Patterns

The upland forests that originally covered much of the Virginia coastal plain have been so extensively and intensively altered or cleared that it is difficult now to determine with any certainty which species were most prevalent (Fleming 2006). We describe in the next section some of the human activities that caused the current vegetation composition. Pine and oak now dominate much of the forests, but those are early to mid-successional species that probably attained dominance because of their adaptability to fire and other disturbance (Abrams and Black 2000).

Forest succession on the coastal plain typically involves pine, followed by early successional hardwoods, then later successional hardwoods. Pine species also invade old fields after agricultural abandonment, but later successional, shade-tolerant tree species will then increase in dominance in uplands where fire has been suppressed. Black gum and American holly (*Ilex opaca*) are examples of such species. Older stands of black gum, a fire-sensitive species, indicated a long period of fire suppression (Abrams and Black 2000). Sweetgum is also an early invader of old fields, but loses dominance over time from heavy mortality, due to its shade-intolerance. It can grow to be a canopy-dominating tree during the late-succession phase (Abrams and Black 2000). Tulip-tree invasion occurs

in high abundance in forest stands disturbed by timbering and logging, but very little in abandoned fields. Unlike the adjacent Piedmont region, the endpoint of old-field succession in the Virginia coastal plain is not oak-hickory, but would more likely resemble the beech and white-oak rich southern mixed hardwood forests farther south (Monette and Ware 1983).

Much of the contemporary forest on the uplands in our project area consists of successional or silvicultural stands of loblolly pine or the secondary pine-hardwood forests that follow agricultural abandonment. This supports the premise that the project area and surrounding landscape has undergone extensive, continued disturbance except in the less accessible areas, such as bottomlands and ravines, where later succession stands have established.

Alternating periods of drought-like years, years of high rainfall, or occasional hard winters, are the climatic conditions that have had the most far-reaching impacts in the project area and the Chesapeake Bay watershed. Each of those conditions has its respective effect on the landscape, primarily in instigating flooding and wildfires, which historically were the principal natural ecological processes influencing the type, age classes, and distribution of natural community types. The project area is not as affected by hurricanes as lands farther south, nor by tornados as in the mid-west, although severe weather can deliver spikes in rainfall and high winds here that lead to localized flooding and tree damage.

The average maximum temperature over the past 54 years was 68.7°F, and the average minimum temperature for the same period was 47.0°F. The average total precipitation in inches over the same years was 43.3 (Southeast Regional Climate Center; http://radar.meas.nscu.edu/cgi-bin/sercc/cliMAIN.pl?va8894; accessed August 14, 2007). In the past 3 years, record-breaking heat waves have reached temperatures as high as 102°F, as in August 2007.

Flood information over the last 50 years for the three counties that contain most of the refuge tracts—Essex, Richmond, and Westmoreland counties—show two major floods in Richmond County in July 1995 and September 1999. Essex County experienced three floods from 1994 to 1999. Four floods were reported for Westmoreland County from 1999 to 2004, including the flooding from Hurricane Floyd in 1999 (National Climatic Data Center, (http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms; accessed March 27, 2006).

In the past 10 years, several droughts have been reported in the project area for the same three counties. Richmond County experienced drought-like conditions from July through November 1998. Essex County experienced a dry period from May through September 1997, and Westmoreland County experienced drought that same year from July through November. Dry conditions prevailed throughout our project area in the summer and fall of 2002, although they were not listed in the National Climatic Data system, followed by a record wet season from April to June 2003 (NCDC 2006). Another dry period occurred in 2007.

Hurricane Isabel struck the project area in September 2003 with sustained wind speeds of 40 to 60 mph. The ensuing storm surge pounded and flooded the north- and northeast-facing shorelines of the Northern Neck and Middle Peninsula, destroying residences and businesses. It blew down thousands of trees across the western side of the Chesapeake Bay. Approximately 10,000 trees fell in the city of Richmond (Richmond Times Dispatch, Sept. 28, 2003). Foresters and other scientists suggested that more trees fell than expected because of root damage caused by the 2002 drought, which weakened the root systems, and because of the heavy rains of 2003, which loosened the soils (Richmond Times Dispatch, 2003; Watts 2003, personal communication). The trees succumbed to the long duration of wind pressure and the resulting storm surge.

Hurricane Ernesto had become a tropical depression by the time it arrived in Virginia in September 2006, but it held sustained winds of about 60 mph, damaging homes, shorelines, and trees. The tree loss due to storms is likely a normal event; however, ever-dwindling habitat amplifies the loss of bald eagle nesting and roosting territory due to storms.

Spring 2004 was abnormally cool and rainy, which may account for the poor seed crop of American holly and eastern red cedar throughout the Northern Neck in the winter of 2004–2005 (Spencer, personal observation), as extremely damp conditions can cause poor pollen viability and decreased seed production.

No major wildfires are listed for the three major counties in the refuge project area in the past 50 years. However, the first few months of 2006 witnessed a prolonged period of drought-like conditions that prompted state authorities to issue red-flag fire warnings and burn bans. Several small wildfires ignited throughout central and northern Virginia, Northern Neck, and Middle Peninsula in February and March (Spencer, personal observation; and, general news media). Drought like conditions and wildfires hazards also occurred in 2007.

The Cultural Landscape Setting and Land Use History

Early Native American and European Influences

During the Late Woodland Era (about 1,100 years ago), a variety of southern mixed hardwood forests grew in the Coastal Plain, containing giant trees hundreds of years old forming a closed canopy and an open understory. Native American populations began to live in larger communities around this time, and large villages appeared, supported by the farming of beans, squash, and corn. Most were situated near sources of water and fertile soils. Where forests grew on fertile land, trees and vegetation were cut and burned to make crop fields. Certain plants were allowed to grow between cultivated mounds, which helped hold the soil in place, reduce erosion, and divert bird and insect pests.

The growing population likely affected the natural biological community greatly through hunting, farming, clearing land, and starting fires. In the borderlands between chiefdoms, dense undergrowth likely flourished and was used as game preserves, and the trails and corridors connecting those with settled areas increased the heterogeneity of the landscape (Grumet 2000; Hammet 1992). Algonquin Indians lived on the Northern Neck from 1300 to 1650, and early Europeans documented their slash and burn agriculture and selective burning as common practices (Abrams and Black 2000).

At the time of European contact, the forest landscape in much of the east contained open stands of trees and some savannahs (Davis 1981) shaped by short-interval, low-intensity fires. Fire-influenced oak-hickory forests in Virginia were prevalent (Orwig and Abrams 1994, Kirwan and Shugart 2000).

Mature old growth forests covered as much as 95 percent of the Chesapeake Bay region in 1500, but by 1775, European colonists had cut and burned as much as 30 percent of the coastal plain forests (Grumet 2000). During the 18th and 19th centuries, 70 percent to 80 percent of the original forest cover was cleared in the Chesapeake Bay area (Langdon and Cronin 2003). Not only were forests felled for farmland and pastureland, but also for firewood, fencing, construction and the ever-increasing demand for iron furnaces, which needed wood for charcoal.

The most significant impacts from European settlement on regional vegetation were cash crops like tobacco and the introduction of Old World field crops. Tobacco quickly depleted soil fertility and growing it had to be abandoned. Abandoned farmsteads left a depleted landscape, which allowed for the massive invasion of weeds and pests. Contemporary accounts describe increasing erosion and sedimentation clouding the region's rivers. Because of the high demand for timber, and without a sustainable harvesting program to ensure an adequate supply of seed trees and the recruitment of host species, young pines and grasses took over where mature oaks, hickories, and other valuable tree species once stood. Free-ranging cattle, horses, and hogs that fed on woody plants, young saplings, grasses, and mast further compounded those impacts on forests. Overgrazing was a major problem by 1820. The colonial population grew from 700,000 in 1775 to more than 1.3 million by 1820, while

Native American populations shrank to fewer than 500 individuals living in rural enclaves in unwanted swamplands and pine barrens (Grumet 2000).

Agriculture and commerce continued to dominate the regional economy in the early 1800's. Maneuverable flat-bottomed sailing ships and barges capable of navigating shallow, winding waters carried cargoes through the Coastal Plain waterways. Farther inland, wagons drawn by horses and oxen continued to haul commodities. However, both soil exhaustion and the increasing local demand for fresh farm produce convinced many tidewater farmers to switch from cultivating tobacco intensively to producing a wider variety of agricultural products.

Advances were made in agrarian technology, such as Thomas Jefferson's moldboard plow, which was capable of breaking up hard, densely packed soils; John Binn's mixture of locally mined gypsum to increase soil fertility; and Ruffin's experiments with marl (lime rich mud) to discover an abundant, cheap, effective, and locally available additive for exhausted soils which further fueled the economy and population growth. The population and distribution of plants and animals changed significantly during this period. Beaver, white-tailed deer, black bear, wild turkey, and songbird populations declined as farmers destroyed their habitats and hunters thinned their numbers. The effects spread westward as pioneers, traveling on the ever-expanding network of new roads and turnpikes threading the region, transformed forests into fields (Grumet 2000).

Wood remained the nation's primary material for light, heat and construction until the 1860s, but the late nineteenth to early twentieth centuries brought unprecedented transformations to all aspects of life in this region, with the advent of coal, steel, steam, and industrial expansion. During that period, many factors radically transformed the environments in Chesapeake Bay: industrialization, urban growth, and shifts in agricultural production, gas engines, coal mills, electrification, and transportation improvements. New crops were introduced and old ones were farmed in new ways. Wheat began to supplant corn and tobacco as the major cash crop. The country's growth meant more agriculture, industry, and residential communities, more demands on the water supply, more sewage, pollution, and erosion into Coastal Plain waters and skies. By the 1870s, the steep declines in the bay's oyster, crab, and other fisheries began to alarm fish and wildlife officials.

Cultural Influences over the past 100 years

By 1900, less than 30 percent of the original forests remained in the Chesapeake Bay watershed. The chemical alteration of the soils from clear-cutting also made it harder for young trees to reclaim logged tracts, especially in hilly areas, and foreign tree diseases, such as Dutch elm and chestnut blight, began to appear. People also drained wetlands to create more farmlands and destroy the breeding grounds of mosquitoes and other insect pests. Such activities also changed the composition of tidewater forests. Two bird species that once thrived in the region became extinct in the early 1900s: the Carolina parakeet and the passenger pigeon (Grumet 2000).

By 1930, the regional population reached 5 million. In rural areas, farming advanced again with new reapers, tractors, fertilizers, and pesticides. Ironically, the Great Depression of the 1930s actually spurred rural development by bringing New Deal public work projects, such as dams, highways, bridges, and rural electric lines into the bay area and the nation, but much more growth occurred because of the post-World War I economic revival. Intensive development, spurred by population growth and changing real estate values, has changed as much as 70 percent of the total land area in regional metropolitan centers. Overall, agricultural, residential, and industrial development has affected more than 40 percent of all lands in the region. The 1.2 million acres of wetlands remaining in the region today represent only a fraction of their former acreage (Grumet 2000).

Current Climate

General Climate Description

The climate of the lower Rappahannock River Valley is humid subtropical, as determined by latitude, topography, prevailing westerly winds, and the influence of the Atlantic Ocean (Commonwealth of Virginia 1988). The prevailing winds are westerly, with highest wind speeds in the spring (Robinette and Hoppe 1982). Average annual precipitation is approximately 43 inches, with approximately 3–4 inches average monthly rainfall throughout the year. The average temperature ranges from 55° F to 58°F, with a growing season that generally lasts between 185 and 229 days (McNab and Avers 1994).

Fall colors on the refuge: USFWS

Global Climate Change

Global climate change is a significant concern to the Service and to our partners in the conservation community. Scientists are predicting dramatic changes in temperature, precipitation, soil moisture and sea level, and an increased frequency and magnitude of storm-surge flooding and coastal erosion due to storms, all of which could adversely affect the function of ecological systems and modify vegetation and wildlife distributions (US CCSP 2009). We expect that species' ranges will shift northward or toward higher elevations as temperatures rise, but responses likely will be highly variable and species-specific. Under those rapidly changing conditions, migration, not evolution, will determine which species are able to survive (USFWS 2006). Species that cannot migrate will suffer the most. For example, plants, mussels, and amphibians are more vulnerable to shifts in temperature that may affect their ability to survive, grow, and reproduce.

Sea-level rise is one of the most potentially serious consequences of global climate change on coastal ecosystems such as the Chesapeake Bay, including the lower Rappahannock River. Stevenson, of the University of Maryland, has described the ecological collapse of the Chesapeake Bay tidal wetlands as result of sea level rise (Stevenson 2002). It occurs when marsh grasses cannot build up fast enough to keep abreast of rising sea level in locations where inorganic sediment inputs are low. This impact will be exacerbated by the predicted increased frequency and magnitude of storm-surge flooding and coastal erosion due to storms in response to sea-level rise. Eventually, plant productivity decreases because excessive submergence effectively drains carbon reserves, thereby reducing peat formation and converting marshes to un-vegetated mudflats. Moreover, a rise in ambient temperature, in part from global warming, reduces oxygen concentrations in the water column of eroded marsh

embayments, rendering them poor habitat for most fish and shellfish species. Rising sea level also has the potential to cause saltwater intrusion into estuaries and threaten freshwater resources.

An example of that consequence is the case of the Blackwater Marsh, once the most extensive marsh area of Chesapeake Bay. Approximately 5,680 acres were lost to open water from 1938 to 1979, resulting in an export of more then 719,000 metric tons of organic sediment per year to surrounding waters (Stevenson, et al. 1985). Furthermore, the loss of fringe marshes was documented as driving up the amount of nitrate in groundwater entering the bay by reducing the de-nitrification at the land/sea interface. Thus, marsh losses and erosion will make the nutrient cleanup of Chesapeake Bay area all the more difficult in the future. The highly organic sediment resulting from eroding tidal marshes presents problems for submerged aquatic vegetation (SAV) downstream. As sea-level rise advanced rapidly in the 1990s (>0.4 inches per year, representing a transitional rate) SAV beds in the center of the bay also declined, in part due to increased sedimentation from marshes nearby. The loss of SAV beds is a huge impact on the ecology of the bay. SAV beds represent a critical habitat component for such species as waterfowl, fish, and other aquatic species, including the economically important blue crab. We provide additional details on the importance of SAV in our water quality discussion, below.

Massive marsh collapse and erosion also has been documented in Delaware Bay and other parts of the Mid-Atlantic coastline, where incoming sediment supplies are limited and sea level rise is significant (Kearney, et al. 2002). Our concern is that those adverse impacts are likely to be similar in the tidal marshes of the Rappahannock River. Refuge uplands generally are much higher in elevation and not as susceptible to sea-level rise as marshes at or near current sea level. However, if saltwater intrusion increases, coupled with sea-level rise, then there is the potential to kill standing trees and other vegetation at higher elevations.

Air Quality

The Department of Environmental Quality monitors levels of ozone and particle pollution from several stations in Virginia. The Air Quality Index is a measurement of air quality that is calculated from measurements of those pollutants over several hours. A higher rating indicates a higher level of air pollution and, consequently, a greater potential for health risk. Since no monitors are located in the immediate vicinity of the refuge, we are using the data for Caroline County (located to the north) and the Richmond area (located to the south) for the evaluation of refuge air quality. In Caroline County, in 2005, air quality monitors recorded two instances when ozone concentrations exceeded 84 parts per billion, the health-based air quality standard. The Richmond area monitor recorded nine instances (www.deq.state.va.us/airquality).

The U.S. EPA collects emissions data for three criteria air pollutants—carbon monoxide, sulfur dioxide, and particulate matter—and three precursors/promoters of criteria air pollutants—volatile organic compounds, nitrogen oxides, and ammonia. That data is summarized in the Air Quality System database, the EPA repository of criteria air pollutant monitoring data, which reports the number of days when air quality was good, moderate, unhealthy for sensitive groups, or unhealthy, by stationed county (counties with air quality monitoring stations).

The following data was collected in 2005 from these counties: Caroline County—82 percent good, 16 percent moderate, and less than 1 percent unhealthy for sensitive groups (0 unhealthy days); and Henrico County—61 percent good, 37 percent moderate, and 1 percent unhealthy for sensitive groups (0 unhealthy days) (www.epa.gov/air/data).

Please note that the data above from Caroline County to the north and the Richmond area to the south, including Henrico County, also include the cities of Richmond and Fredericksburg, where populations are considerably higher and pollution emission sources are more numerous than in the refuge area. Although those emissions affect the air quality of the refuge area, we may surmise that air quality improves in this area of lower vehicle usage and fewer emission sources.

The Class I air quality area closest to the refuge is Shenandoah National Park, which, at its closest point lies 65 miles northwest of the refuge. That national park has one of the most comprehensive air quality monitoring and research programs of all national parks and wilderness areas that are afforded special protection under the Clean Air Act. Over the last 20 years, monitoring and research show that the park's air quality has severely degraded its scenic and most sensitive aquatic resources. Furthermore, the park's air quality does not currently meet the 8-hour ground-level ozone standard set by the EPA to protect public health and welfare. A technical report from the Park Service provides a detailed assessment of air quality and related values in the park (USDI May 2003). However, please note that the park's geographic location, coupled with the prevailing winds, results in no direct influence on the air quality at the refuge.

Water Quality

Summary of the General Condition of the Rappahannock River Basin

The entire Rappahannock River Basin covers 2,715 square miles, or approximately 6.8 percent of Virginia's total area. Two USGS hydrologic units (HUCs) compose the basin: HUC 02080103–Rapidan–Upper Rappahannock; and HUC 02080104–Lower Rappahannock. Those two hydrologic units are divided further into 26 bodies of water or watersheds.

The tidal influence extends to the fall line in Fredericksburg and up many of the creeks in the Lower Rappahannock HUC. Its last dam, the Embrey Dam, located a couple of miles above Fredericksburg, was removed in 2004. The river is now completely open and free flowing from its source to its mouth. The Environmental Assessment for the Embrey Dam removal (U.S. ACOE 2002) shows that the sediments behind the dam had levels of targeted metals and organics generally below detection limits (Lingenfelser, pers.comm. 2005).

The Rappahannock River has the lowest percentage of wetlands and shoreline with a riparian buffer of all the Virginia river tributaries of the Chesapeake Bay. Perhaps related is the fact it has the second-highest total area and percentage of agricultural land at 31.4 percent (Dauer, at al. 2005). However, it has the lowest population density and the smallest area and percentage of developed land. In addition, it also has the smallest percentage of area with an impervious surface of all the Virginia tributaries. Finally, compared to other eastern Virginia rivers, the Rappahannock River has only one EPA Superfund site that is outside the refuge boundary in Montross, and few other point sources of contamination or historical chemical or oil spills.

Influences on Water Quality

Chemical Pollution

The Arrowhead Associates, Inc./Scovill Corporation site is the only Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) site in the project area. The EPA manages the Superfund program, which cleans up hazardous waste sites to protect human health and the environment. The Arrowhead site occupies 25 acres in Montross, a rural area of Westmoreland County, Virginia. The activities of a former electroplating facility led to the contamination of soils and groundwater with metals and volatile organics. The EPA listed the site as a National Priority in 1990. Since then, the entire physical cleanup has been completed. No cleanup sites are listed in our project area, according to the Resource Conservation and Recovery Act database administered by the EPA.

Although the history of the project area shows a low number of chemical or oil spills, current threats of contamination remain. A high percentage of land in the area is in agricultural use, which historically may have provided a source of bioaccumulative pesticides to the land and the river. Those pesticides no longer are registered for use. Most pesticides in use today have shorter half-lives and target specific species, compared to the organochlorines and organophosphates previously in use.

Sediments

The erosion of upland land surfaces and stream corridors (banks and channels) are the two most important sources of sediment coming from the watershed. Although that is a natural process, it may have increased significantly over the past few centuries because of human impact. These are two general observations on the mass and rate of sediment accumulation in the project area.

- For the entire Chesapeake Bay region, river basins with the highest percentage of agricultural land use have the highest annual sediment yields, and basins with the highest percentage of forest cover have the lowest annual sediment yields.

- Urbanization and development can more than double the natural background sediment yield; the increase in sediment yield is highest in the early development stages (Langdon and Cronin 2003).

During the 18th and 19th centuries, nearly 70 percent or 80 percent of the original forest cover was cleared, which increased erosion rates in the watershed. Although reforestation followed 20th-century farm abandonment, high erosion rates continue. That may be attributable to development and the remobilization of deposits of previously eroded material.

Furthermore, much of the sediment eroded from cleared land during Colonial times may still be stored in upland areas, in stream corridors, channels and tributaries. What proportion of that "legacy" sediment actually has reached the bay is unknown, but ultimately it will make its way to the bay. Such quantities of stored sediment mean that future improvements in water clarity may take years to decades after implementing changes in land-use in the watershed (Langdon and Cronin 2003). A USGS report in 2003 describes the relative concentrations of total suspended solids during the winter and spring of 1992–1993 in the Chesapeake Bay and its tributaries (USGS 2003). Sediment loads were in the 105–150 mg/liter range in the project area.

Long-Term Trends and Status of Water Quality for the Rappahannock River (1985–2004)

In 2005, the VA DEQ released a water quality summary on the Chesapeake Bay and tributaries (Dauer, et al. 2005). It describes the long-term trends and status of water quality and living resource conditions since 1985, with recent updates in 2003 (www.chesapeakebay.odu.edu; "Reports"). The DEQ Quality Assurance Project Plan describes its field sampling procedures for water quality (http://www.chesapeakebay.net/qatidal.htm). The abiotic measures for water quality include total suspended solids, nitrogen and phosphorus load, chlorophyll a, temperature, salinity, and dissolved oxygen. The biotic parameters of quality include

- the phytoplankton community (floating organisms that can do photosynthesis for energy);

- the benthic community (organisms that dwell or feed on the bottom—the benthic index of biotic integrity is used to measure overall quality and identification of impaired waters);

- abundance/biomass ratios as a measure of pollution due to organic enrichment; and

- submerged aquatic vegetation (SAV).

Sampling stations placed at the fall line in Fredericksburg and below in the tidal fresh, transitional, and brackish zones started at about Payne's Island and extended to the river's mouth. The tidal fresh and transitional zones are most relevant for our project area.

Approximately 291,000 metric tons per year of the non-point source runoff of nitrogen and phosphorus combined enter the Rappahannock River. The application of best management practices resulted in a 23-percent reduction in sediments from 1985 to 2005. However, the point source runoff of nitrogen is higher below the fall line. The point source runoff of phosphorus typically had been higher above the fall line until 1995, when it fell back to levels comparable to those of phosphorus below the fall line.

Annual mean flow was higher than the grand mean during the last 2 years. Improving trends in flow adjusted concentrations of total nitrogen and total phosphorus above the fall line. The relative status of nutrients was good in nearly all segments of the river (including the refuge boundary area); while in others, it was fair. In the tidal fresh and transitional zones, the trends in the relative status of most non-nutrient parameters (chlorophyll a, suspended solids, temperature, salinity) were fair, poor, or unchanged, except bottom dissolved oxygen, which was good.

Although most SAV habitat requirements for nutrients were met in all applicable segments, degrading long-term trends in surface total nitrogen were detected in the transitional zone, and the water clarity requirements for chlorophyll a, total suspended solids, and secchi depth[1] either were not met or were borderline in the tidal fresh and transitional zones.

Although the status of phytoplankton (diatom, chlorophyte, cryptophyte) biomass was good and the ratio of biomass to abundance was poor throughout the river, an improvement is detected moving downstream from the transitional to the lower river. Degrading trends in cyanophyte biomass and abundance were detected throughout the river.

The benthic community met restoration goals only at the transitional zone station, and became more degraded moving downstream. An analysis of probability-based monitoring of benthic samples showed impairment of the tidal fresh zone (7 percent of the samples) and brackish zone (37 percent of the samples). Benthic degradation appears to be the result of contamination from human sources in the tidal fresh zone, but may be the result of contamination and low dissolved oxygen (DO) in the lower river. An insufficient abundance/biomass of benthos is indicative of low dissolved oxygen (DO).

Based on the results of the two Old Dominion University-DEQ reports (2004 and 2005), the Rappahannock River has lower sediment, total phosphorus and total nitrogen loads than the James River. The Rappahannock River has lower total nitrogen loads than the York River, but higher sediment and total phosphorus. (The Rappahannock is lower in point-source phosphorus loading, but higher in non-point source.) The total point and non-point source nitrogen and sediment loads were less in 2004 than 2001 showing a good trend. The total load of non-point source phosphorus also was lower in 2004 than 2001, but the point-source phosphorus load went up.

Overall, the combined phosphorus load in 2004 is lower than in 2003 (and the data in the 2003 report was already on a downward trend compared to the 1985 baseline loads—also good). The 2003 report states that the primary concern is water clarity (relating to chlorophyll a) in the upper two study segments of the Rappahannock. The 2005 report also shows that the upper segments are more degraded, but low dissolved oxygen is becoming a problem at 33 sites, leading to insufficient benthic communities in those areas (a downward trend). The 2003 report also reveals that dissolved oxygen is improving, and that dissolved oxygen (DO) conditions were good in most river segments. The report suggests that the sediment contamination may be more extensive than previously thought, although it is not relative to contaminants (perhaps just sediment loads).

The 2005 report suggests that water quality problems appear to be more severe in the tidal fresh segment of the river, and include poor status and violations of SAV habitat criteria for both suspended solids and secchi depth, with increasing trends in either the total or dissolved concentrations of nitrogen. The increased biomass and abundance of cyanobacteria are negatively affecting the phytoplankton community. With respect to living resources, and with all parameters combined,

probability-based monitoring resulted in a classification of unimpaired for the upper river (tidal fresh zone) and impaired for the lower river (brackish zone).

State-reported Impaired Waters in the Lower Rappahannock River [2]

In August 2004, the DEQ released the 305(b)/303(d) Water Quality Assessment Integrated Reports (report). It combines both the 305(b) Water Quality Assessment and the 303(d) Report on Impaired Waters for each river basin. The DEQ, with the assistance of the DCR, compiled those reports and submitted them to the EPA and Congress, to satisfy the Federal reporting requirements under section 305(b) of the Clean Water Act.

Much of the data in those reports comes from citizen-generated water quality monitoring at designated sites. The Alliance for the Chesapeake Bay (ACB) coordinates with several affiliate organizations in the Rappahannock River Basin to monitor a conventional suite of ambient parameters including dissolved oxygen, temperature, pH, salinity and water clarity. Affiliate organizations in the basin include the Cat Point Creek Group, Friends of the Rappahannock, and the Tidewater Resource Conservation and Development Council. Trained volunteers conducted 1,263 samplings at 13 stations in the Rappahannock River Basin during the 5-year data window of the report for this basin (VA DEQ 2004). The monitoring stations that have been used over the past decade (not all are currently active) are at Kendale Farm Dock, Daingerfield Landing, Piscataway Creek, Wares Wharf, Port Royal, Hoskins Creek, Cat Point Creek (four stations), Little Totuskey Creek, and Totuskey Creek (four stations).

The report on impaired waters in the state describes segments of streams, lakes, and estuaries that exhibit violations of water quality standards, details the pollutant responsible for the violation(s) and the cause and source of the pollutant, if known. Most impairments of water quality in the Rappahannock River watershed come from fecal coliform, which could be related to agriculture and livestock practices, wildlife sources (e.g., deer or geese), or residential sources (e.g., failing septic tanks, dogs or other pets) (Lingenfelser 2005; personal communication). On one stream segment close to the mouth of the river, the recorded dissolved oxygen (DO) was also a concern. That possibly is caused by a naturally occurring ridge in the riverbed that prevents tidal flushing of the lower water column in this segment of the river. The low DO bottom water causing the DO violations is believed to be bottom water from the Chesapeake Bay. That bottom water flows into the river with the incoming tide, and then is trapped by the ridge. Thus, natural conditions are considered the main source of the recorded violations. However, it is possible that nutrient loadings in the water body exacerbate the low DO condition. The DEQ report is available from refuge headquarters upon request.

Submerged Aquatic Vegetation (SAV) as an indicator of water quality

SAV is a critically important component of the aquatic environment in the Chesapeake Bay, and its presence and robustness are indicators of good water quality. SAV can only thrive in shallow depths where light reaches the benthic zone. The rooted aquatic beds provide shelter and food for numerous aquatic invertebrates, and blue crabs need their protective cover during their molt. SAV also recycles nutrients and oxygenates the water. A great number of waterfowl and aquatic mammals (e.g., muskrats) feed on SAV. SAV beds on the Rappahannock River are a primary reason the area is an attractive wintering area for waterfowl (White 1989).

SAV composition varies with salinity. In the moderately brackish zones of bay tributaries (such as the middle Rappahannock River), redhead pondweed *(Potamogeton perfoliatus)* supports a mix of estuarine and marine invertebrates. In the fresher portions of the river, wild celery *(Vallisneria americana)* should flourish. Other common species in fresh to moderately brackish waters include common waterweed *(Elodea canadensis)*, coontail *(Certaophyllum demersum)*, water milfoil *(Myriophyllum spicatum)*, sago pondweed *(Potamogeton pectinatus)*, horned pondweed *(Zannichellia palustria)*, wigeon grass *(Ruppia maritima)*, and eelgrass *(Zostera marina)*.

In the last few decades, the bay has experienced declines in SAV coverage due to turbidity, siltation, and nitrification, which all block sunlight. Other causes include the installation of piers, docks, and marinas that block light, or from props, which tear up vegetation. SAV provides the important function of stabilizing shores by diffusing wave action. Yet today, the development on the shoreline of the Northern Neck and Middle Peninsula produces more and more revetments and retaining walls instead of natural shoreline. Since 1971, the Virginia Institute of Marine Science has surveyed SAV in the Chesapeake Bay and its tributaries annually (VIMS 2005). However, SAV flight transects generally do not cover the upper Rappahannock River due to limited SAV beds (Forsell 2005, personal communication).

The 2005 VIMS SAV flight survey on the lower Rappahannock River noted small beds along the north shore at Windmill Point, Mosquito Islands, at the mouth of Carters Creek, along the shoreline from Carters Creek to the mouth of the Corrotoman River, and along both shorelines of the Corrotoman. Most of the beds in this system are dominated by wigeon grass, with eelgrass found primarily at the mouth of the river in the bed off Windmill Point. No significant changes appeared in the beds in this system, although some of the wigeon grass beds appeared a little larger and denser than in 2004. Eelgrass planted between 1996 and 2001 off Sanders Cove just above the Route 3 bridge all died out in 2003. There were no beds noted along the south shore, similar to previous years (Orth 1995).

An accessible trail on the refuge: USFWS

Small patches of wigeon grass or eelgrass were noted further upriver in Occupacia Creek, Mount Landing Creek, Brockenbrough Creek, and Sluice Creek between 2002 and 2004 (S. Spencer personal observation). Brockenbrough Creek, one site of the Federal-listed endangered sensitive joint-vetch (Aeschynomene virginica), also had thick beds of hydrilla, an invasive aquatic plant, in 2005 (Spencer, personal observation).

The Regional Socio-Economic Setting

Socio-economic Factors: Regional Economic Setting

We enlisted the aid of the U.S. Geological Survey, Fort Collins Science Center, Policy Analysis and Science Assistance Team in developing a regional socioeconomic profile. We have included their report in this CCP as appendix I. We recommend it for a good overview of the regional economic setting and the relationship between it and the refuge.

Refuge Administration

Refuge Establishment and Land Acquisition

In May 1996, we acquired the first 1,100 acres for the refuge. Our acquisition of land has been relatively steady since then: a total of 7,711 acres composed of 6,352 acres we own in fee simple and 1,359 acres of conservation easements as of September 30, 2007. Our Regional Director's decision in 1995 approving the refuge boundary allows us to acquire up to 20,000 acres within a boundary of more than 260,000 acres. The original EA establishing the refuge identifies four resource concentration complexes (A, B, C, and D) and delineates individual focus areas based on their important habitat and wildlife values in need of protection. We are to protect those 20,000 acres through a combination of fee title purchase and easement acquisition of development rights, with monies authorized primarily under the Land and Water Conservation Act and the Migratory Bird Conservation Act. We base all of our land acquisition on our policy of working only with willing sellers. Originally, we anticipated protecting at least 50 percent of that land, or 10,000 acres, by acquiring conservation easements.

The Eastern Virginia Rivers NWR Complex and Staffing

When the refuge was established, we administered it as a satellite of the Presquile and James River refuges from their headquarters in Prince George, Virginia. In 1999, we assigned its first three staff members: a wildlife biologist, a biological technician, and an assistant refuge manager.

In 2000, the refuge manager at the Presquile refuge transferred elsewhere. Our regional NWRS supervisors decided to shift the focus of existing staff resources to the Rappahannock River Valley refuge, where the development and growth of land acquisition and public use programs required more attention. The new refuge manager reported to the new refuge headquarters in Warsaw, Virginia, in June 2000. When the administrative assistant at the Presquile refuge retired in 2001, we also moved that position to the new headquarters office in Warsaw, and added a maintenance worker and a law enforcement officer in 2004. A transfer in 2001 vacated the biological technician position, which remains vacant. We have hosted a Student Career Experience Program (SCEP) position at the refuge since 2001.

We use the term "refuge complex" to describe two or more individual refuges, typically in the same region of a state or adjoining states, administratively combined under a single refuge manager's responsibility. When we redirected staff and other resources in 2000, the management responsibility for the Presquile and James River refuges remained with the refuge manager stationed at the Rappahannock River Valley refuge. We renamed those refuges as the Eastern Virginia Rivers National Wildlife Refuge Complex. In 2003, we added the management responsibility for a fourth refuge, the Plum Tree Island refuge in Poquoson, Virginia, to the refuge complex.

Its present staffing is seven positions: six in Warsaw at the Rappahannock River Valley refuge headquarters, and one in Charles City, VA. As part of our "2006 Regional NWRS Strategic Workforce Plan," the position at the Charles City sub-office primarily will support visitor services at the James River, Plum Tree Island, and Presquile refuges. Nevertheless, all positions in the refuge complex share the responsibility of managing all four refuges. The refuge manager is responsible for determining how to distribute staff time to accomplish priority work.

Funding

The funding for the Rappahannock River Valley refuge is embedded in the budget for the entire refuge complex. Operational funding includes salaries, supplies, utilities, fuel, and all other operational activities (wildlife and habitat surveys and management) that are not funded by special projects. Base maintenance funds are used to repair vehicles, equipment, and facilities generally have been stable over the past 5 years. The replacement of vehicles, larger pieces of equipment (e.g., tractor, backhoe), or larger facilities (buildings) are funded as projects. Our annual funding fluctuates according to the

number and size of special projects funded that year (e.g., vehicle or equipment replacement, visitor service enhancements, and facility improvements). Appendix I summarizes refuge funding levels, using fiscal year 2006 as the base year, in the section "Economic Contribution from Alternative A (Current Management), Refuge Administration".

Refuge Facilities and Maintenance

The facilities now in use include the refuge headquarters (the Wilna house, circa 1830, eligible for the National Register of Historic Places), six barns and sheds, one maintenance shop, one public rest room, one multi-purpose building and two houses (refuge residences, of which one is also considered historically significant). Additional facilities not in use, and in disrepair, include approximately 20 barns and sheds, 9 grain bins, and 1 house. Although the Service owns them, we acquired them with land purchases; they are not crucial in accomplishing the purposes of the refuge or the mission of the Service.

We removed 11 dilapidated barns, sheds, or houses from the Tayloe, Wellford, and Hutchinson tracts in 2006. Two of those were replaced: the Hutchinson house was replaced with a multipurpose building located on the Wilna tract; and, the Tayloe house was replaced with a refuge residence located on the same tract. A third house on the Laurel Grove tract is being rehabilitated for eventual use as staff residence or administrative building. The maintenance staff of the refuge complex is responsible for preventive maintenance and repairs on all facilities.

The refuge also has a fishing pier, dock, boardwalk, accessible trails, six interpretive signs, four water control structures, nine gates, and numerous informational signs (such as boundary, entrance, and directional signs). In 2007, we installed a 150-foot radio tower to facilitate refuge communications. Our maintenance staff is responsible for the upkeep of these facilities, including clearing trails, replacing or posting boundary signs, and repairing or replacing other interpretive signs. We gratefully accept volunteer assistance for maintenance as well.

The refuge owns one small mobile trailer and one large office trailer. Through a memorandum of agreement, the VDGIF uses and maintains the office trailer on the Wellford tract. Operating as their sub-office, this facility serves the area wildlife biologist and conservation police. The small mobile trailer, which has a permanent hook-up on the Wilna tract, temporarily houses interns or researchers.

The refuge owns and maintains 13.75 miles of dirt, gravel, and paved roads on 10 different tracts (9.4 miles are open to the public). The refuge maintenance staff is responsible for clearing and mowing the roadsides, repairing 14 culverts, and graveling and grading the roads. The Federal Highway Administration is rehabilitating 9.4 miles of refuge roads on the Wilna, Tayloe, and Hutchinson tracts.

Refuge step-down plans

Seven step-down plans are now in place at the refuge:

- Fire Management—2002; is planned to be updated in 2009
- Public Deer Hunting—2002
- Public Fishing—2003
- Environmental Education—2004
- Avian Influenza—2007
- Hurricane Action Plan—2008 (updated annually)
- Chronic Wasting Disease Plan—2008
- Findings of Appropriateness and Compatibility Determinations

Chapter 1 describes these two decision processes in detail. The list below includes compatibility determinations (CDs) that are currently approved for the refuge and the dates of their approval. See also the discussion below on special use permits.

- Cooperative Farming—12/08/06
- Public Deer Hunting—01/28/02
- Recreational Fishing—01/24/03; reviewed and proposed revision in CCP (re: appendix B)
- Environmental Education, Interpretation, Photography, and Wildlife Observation—03/26/03; reviewed and proposed revision in CCP (re: appendix B)
- Research—03/23/07

Partnerships

During its first 12 years, the refuge has combined its resources with others to form a wide array of outstanding partnerships. Some partners have joined us to complete a single project or compete for a grant, while others became engaged prior to refuge establishment and continue today. Naming all that we have worked with over the past 12 years to advance common conservation objectives would be difficult. However, we should recognize at least some for their longevity and significant contributions.

Land Protection Partners

Our most enduring partnership involves several regional, state, and national organizations who have worked with the refuge to protect nearly 8,000 acres of fish and wildlife habitat. They include the Chesapeake Bay Foundation, The Conservation Fund, The Nature Conservancy, Trust for Public Land, and the Virginia Outdoors Foundation. They have generated grants, served as interim owners of land that is now part of the refuge, sought acquisition funding from Congress, and acted as liaisons with the community. Our newest land protection partner is Fort A.P. Hill. We are working together to protect valuable wildlife habitat and an undeveloped buffer of land between the refuge and military training activities.

Rappahannock Phragmites Action Committee

This ad hoc committee of Federal, state, and county agencies, conservation organizations, and landowners formed in 1999 is dedicated to halting the spread of invasive populations of Phragmites in the lower Rappahannock River watershed. In recent years, the refuge and refuge volunteer Alice Wellford have assumed lead roles in the annual control program. To date, we have treated several hundred acres of Phragmites, mostly on private land, using grants, Service funds, and contributed funds.

State Agencies and Universities

We have strong ties to state agencies in achieving mutual conservation objectives. We cooperate closely with the VGDIF in population and habitat management programs and law enforcement, especially in the areas of public fishing and deer hunting. The State Conservation Police and the regional biologist occupy an office trailer on refuge land through a memorandum of agreement, allowing close collaboration with refuge staff. We also collaborate with the department's Wildlife Diversity division on non-game wildlife conservation, including bald eagle surveys, protecting habitat, and conserving other migratory birds, reptiles, and amphibians.

We have a cooperative agreement with the Virginia Department of Conservation and Recreation, through which we received an initial survey of natural heritage resources on the refuge. We renewed the agreement in 2006 to include a project to map Phragmites in the entire tidal portion of the river. We continue to collaborate on conserving rare animal and plant communities, burning prescribed fires, and controlling Phragmites.

We have also worked closely with four state universities: The Center for Conservation Biology at the College of William and Mary, the Conservation Management Institute at Virginia Polytechnic and State University, and the biology departments at Virginia Commonwealth University and the University of Mary Washington. The topics of collaboration include surveying and conserving bald eagles, conserving other migratory birds, mapping vegetation and habitat, conserving reptiles, and researching Lyme disease.

Rappahannock Wildlife Refuge Friends Group

The Rappahannock Wildlife Refuge Friends (Friends) group formed in August 2004. Its mission is to "support the National Wildlife Refuge System and promote awareness of the refuge through education and support." In March 2006, its membership included 53 individuals or families, including a six-member board. The board, one or two refuge staff, and several members attend its monthly coordination meetings. Presentations by quarterly guest speakers are open to the public. The Friends completed several projects in their first year, including the installation of informational signs at Wilna Pond and the Hutchinson tract. They staffed several community events, and were instrumental in gaining the refuge acceptance into the Chesapeake Gateways Network in March 2006. The Friends group continually grows in membership, stature, and effectiveness.

Chesapeake Bay Program Agricultural Day: USFWS

Volunteer Program

The refuge Volunteer Program consists of members of the Friends group, other groups, and individuals, including Boy Scout troops, Eagle Scouts, St. Margaret's School, the Governor's School, Northern Neck Audubon Society, Virginia Herpetological Society, Virginia Native Plant Society, interns, students, and retirees. Whether community-service-oriented, career-oriented, or just because they wanted to get involved with the refuge, volunteers have donated valuable time and energy toward accomplishing many worthy projects. Thus far, volunteers have offered their assistance in coordinating and staffing special events, writing public use facility grants, following up the coordination and construction of facilities, installing and monitoring nest boxes, and conducting refuge and volunteer outreach, botanical and wildlife surveys, invasive species control, and numerous maintenance projects. Since the Friends group formed in August 2004, volunteer hours dramatically increased (see table 2.1, below).

Table 2.1. Refuge volunteer hours, 2004–2008

Project Description	2004	2005	2006	2007	2008
Habitat and Wildlife	153	191	272	386	416
Maintenance	23	345	11	247	29
Wildlife-oriented Recreation	203	219	659	157	1,008
Cultural Resources	8	0	0	0	0
Environmental Education	0	4	0	24	8
Other		249	168	366	327
Hours Total	**390**	**1,007**	**1,110**	**1,180**	**1,787**

Community Outreach

Relating to the communities in the refuge area is very important to us. We provide numerous on-site and off-site programs throughout the year. Community events at which our staff or volunteers have staffed displays, performed outreach, or presented programs include Rivahfest, Warsawfest, and Welcome Home to Westmoreland County (county fairs);Down on the Farm Tour, and Forestry/ Wildlife Management Tour (habitat management guidance for private landowners); schools, and other local interest group meetings (e.g., Virginia Ornithological Society, Garden Clubs, Virginia Native Plant Society, Northern Neck Audubon Society, Northern Neck Land Conservancy, Rotary Club, Lions Club, etc.).

On-site activities include guided bird walks and interpretive tours. In addition, the refuge hosts popular events such as Kid's Fishing Day and, in 2007, offered the first community workshop on invasive species.

We conduct outreach through the media. Newspaper articles inform the public about upcoming special events, CCP meetings, habitat management activities, and other current issues at the refuge. We maintain an informative website, and contribute to Friends Group publications.

In the spring and summer of 2006, we enlisted the Policy Analysis and Science Assistance Branch of the U.S. Geological Survey/Fort Collins Science Center to help us conduct a survey of community residents adjacent to the refuge. We felt the results of a survey would help our planning team collect baseline information to use as we identify issues, characterize current visitor services and experiences, develop management options, and improve our outreach program. Specifically the purposes of the survey were to

- gain a broader understanding of community recreation use of the Rappahannock River,
- determine community preferences for wildlife-dependent recreation activities and services that could potentially be provided by the refuge in the future,
- determine community knowledge and understanding of the refuge purpose, the mission of the NWRS, and land acquisition issues,
- provide insight into community communication and interaction regarding river issues, and
- determine community preferences for land management on the refuge.

We sent the survey to a randomly selected group of 1,200 residents in a defined study area; the response rate was 35 percent. Appendix G is an executive summary of the results of the survey.

Special Use Permits, including Research

Special use permits are issued to individuals, organizations, and agencies that request the use of refuge facilities or resources beyond what is available to the public. In order to ensure that wildlife disturbance is minimized, special conditions and restrictions are identified for each request. On average, we issued five permits each year on the refuge, with specified periods ranging from one day to one year, depending on the nature of the request. We evaluate each request individually. Table 2.2 identifies some of the permits we have issued since 2002. You may obtain additional details from the refuge headquarters.

Table 2.2. Sample of special use permits approved since 2002

Year Issued	Permittee	Purpose
2002	Virginia Commonwealth University	To collect macro-invertebrate and fish samples as part of a water bio-monitoring project.
2002	Northern Neck Soil and Water District	To collect acorns to use in reforestation project.
2003, 2004 & 2005	Chesapeake Bay Foundation	To conduct wetland and reforestation projects, and to conduct monitoring.
2003	Natural Resources Conservation Service	To conduct plant identification course.
2003	York University	To conduct research on the conservation genetics of Acadian flycatchers.
2004	Verizon	To install underground telephone cable.
2004 & 2005	Boy Scout Troop	To conduct ceremonial “Crossing Over” per formal agreement with the Boy Scouts of America.
2004	Virginia Society of Ornithology	To conduct annual foray (bird survey).
2004	W.B. Boyle Farms	To allow access through the refuge during periods when primary access is hazardous.
2004	St. Margaret’s School	To conduct early succession grassland and forest vegetation survey.
2005	Virginia Herpetological Society	To conduct reptile and amphibian survey.
2005	Virginia Commonwealth University	To conduct snake lesion study (July – September).
2005	Virginia Department of Game and Inland Fisheries	To band mourning doves as part of a state-wide study.
2006	Virginia Department of Game and Inland Fisheries	To harvest white tailed deer for use in training course for Game Wardens.
2006	Deer hunting dog owners	To permit retrieval of trespass dogs during the deer hunt season.
2007	Northern Neck Electric	To install underground electric service to Wilna Lodge
2007	Individual	To remove excess buildings for reuse
2007	Center for Conservation Biology	To conduct research on the relationships between pine forest management and breeding birds
2008	Virginia Department of Game and Inland Fisheries	To conduct research on movements of black ducks via satellite telemetry
2008	Individual	To use a trailer to launch a non-motorized boat for fishing access at Wilna Pond

We support research activities on the refuge, when they are compatible with the refuge purposes, and help us gain knowledge and understanding to benefit our management goals and objectives. Refuge staff, graduate students, conservation organizations, and others have conducted numerous research projects on the refuge. A sampling of those follows. You may obtain additional information on these studies from the refuge headquarters.

Region 5 Grassland Breeding Bird Pilot Study, 2001–2004

Thirteen refuges with grassland management units in Region 5 participated in this three-year study, which examined the response of obligate grassland birds to three different management treatments (no treatment, mow, or burn) of fields in fallow cool season and planted warm season grasses, and with respect to vegetation height-density, percent grass-forb frequency, and species composition. We enrolled seven fields in this study. Although height-density and percent grass were important in determining obligate grassland bird presence and density, landscape context was the single most important factor in determining presence of obligate grassland birds.

Fields situated in landscapes of high agricultural use were more likely to attract grassland birds than those in predominately forested landscapes, regardless of the quality of the field. In 2004, we conducted a follow up study, which examined more closely obligate grassland bird use of fallow vs. warm season grass fields and again measured vegetation height-density, percent grass-forb frequency and species composition. Obligate grassland bird density or abundance was negatively correlated with vegetation height density, and particularly negatively affected in fields of dense switch grass.

Winter Grassland Bird Pilot Study, 2003–2005

The use of the refuge in the winter or non-breeding seasons by land birds is understudied, particularly that of grassland species. This pilot study sought to find a robust yet affordable methodology for surveying grassland birds so that more refuges could contribute data.

In the first year, single vs. double observers, the use of long poles to flush birds out of dense cover, and the most effective transect layout were examined.

- The double observer method was found to be significantly more reliable than single observer method;
- Two observers walking side by side along a transect was found to be equally as effective for flushing birds as was using thrashers; and,
- Full field coverage of transects about 100 meters apart was found to be the most effective for detecting birds compared to a few randomly scattered transects.

In the second year, the number of survey bouts, the number of run days per survey bout, and the time of winter were examined for the most effective yet minimal effort. Based on preliminary analysis, only one bout of 4 to 5 days in January was sufficient for obtaining an adequate sample size of data for this latitude and this region. That also was conducted at the Prime Hook refuge.

In 2005, the third and final year of the pilot study, the difference in detection probability of expert surveyors and non-experts was compared at Rappahannock to determine whether winter grassland studies could be conducted by amateurs with reasonable quality and accuracy of data. Non-experts had significantly higher recordings of “unknown sparrow species” for bird identification, yet were comparable to experts with respect to overall abundance detections. The refuge continues to employ these modified techniques to survey winter grassland birds.

Effects of Salinity on the Distribution of *Phragmites australis* along the Rappahannock River Valley National Wildlife Refuge, 2004–2005

Phragmites is a plant species that grows in wetlands worldwide. In North American wetlands, both native and non-native sub-species have been identified. The non-native sub-species M is rapidly expanding and displacing native marsh vegetation, including the native Phragmites sub-species. Along the Rappahannock River, native and non-native populations appear to be spatially isolated along a salinity gradient.

This experiment studied the effects of salinity on the growth of native sub-species F individuals grown in a greenhouse in varying salt solutions. Those plants exhibited a significant decrease in growth between 0 practical salinity units (psu) and 5 psu; however, the non-native sub-species did not show a significant decrease in growth until 20 psu. This study also determined the effects of salinity on the establishment of native and non-native sub-species in wetlands along the Rappahannock River through a GPS mapping project. Native populations were found only in environments with salinity levels of 0 psu, while non-native populations were established in wetlands with salinity ranging from 0 to 10 psu. These results are useful in identifying wetlands of primary concern for controlling non-native expansion and protecting native populations.

Snake Lesion and Amphibian Investigation 2005–ongoing

In June 2005, the Virginia Herpetological Society held their annual spring meeting in the project area, and used the refuge for their field trips to search for herpetofauna. On that weekend, a number of captured snakes had skin lesions and eye infections; this occurred across species. The principal investigator, a pathologist from Virginia Commonwealth University (VCU), organized a team to conduct periodic histological samplings from the snake population at the refuge over the next couple of years to determine the scope and cause of that problem. The unusually cool and wet spring of 2005 was offered as a possible explanation, partially substantiated by the fact that subsequent collection in drier parts of the year did not produce any further cases of snakes with lesions. There is little data on diseases of snakes in the wild (most is on captive or pet snakes). The study effort continues into 2009 and expanded to include the James River and Presquile refuges.

Refuge Natural Resources

Physical and Vegetation Resources

Soils—General description

In 2006, newly digitized county soil databases from NRCS and GIS software (ArcMap, ArcView 9.1) made it possible for us to summarize the different soil types within the project area and within refuge tracts. The digitized soil maps per county were clipped to the refuge boundary and then ranked in descending order by acreage. A copy of this soils information for the refuge is available upon request from refuge headquarters. The most prevalent four soil types on the refuge, composing well over 50 percent of its area, include Rappahannock muck, Rumford soils, Tomotely fine sandy loam, and Nansemond fine sandy loam. A summary of their characteristics appears in table 2.3, below. You may obtain additional information from the refuge headquarters.

Table 2.3. Summary and characteristics of the four most prevalent soil types on refuge-owned tracts

Soil Type	Local Landform	Hydric, Traits	Suitability
Rappahannock Muck	Tidal flats, Floodplains, Depressions	Floods, and ponds	Agriculture: No Silviculture: No
Rumford 15-50% slopes	Depressions and Seeps	May saturate or pond if Bibb or Levy components present	Agriculture: No Silviculture: Well to moderately suited
Tomotely fine sandy loam	Marine terraces	Saturates	Agriculture: Prime Silviculture: Well suited
Nansemond fine sandy	Marine terraces Depressions	Saturates	Agriculture: Prime if drained Silviculture: Well suited

Refuge Vegetation

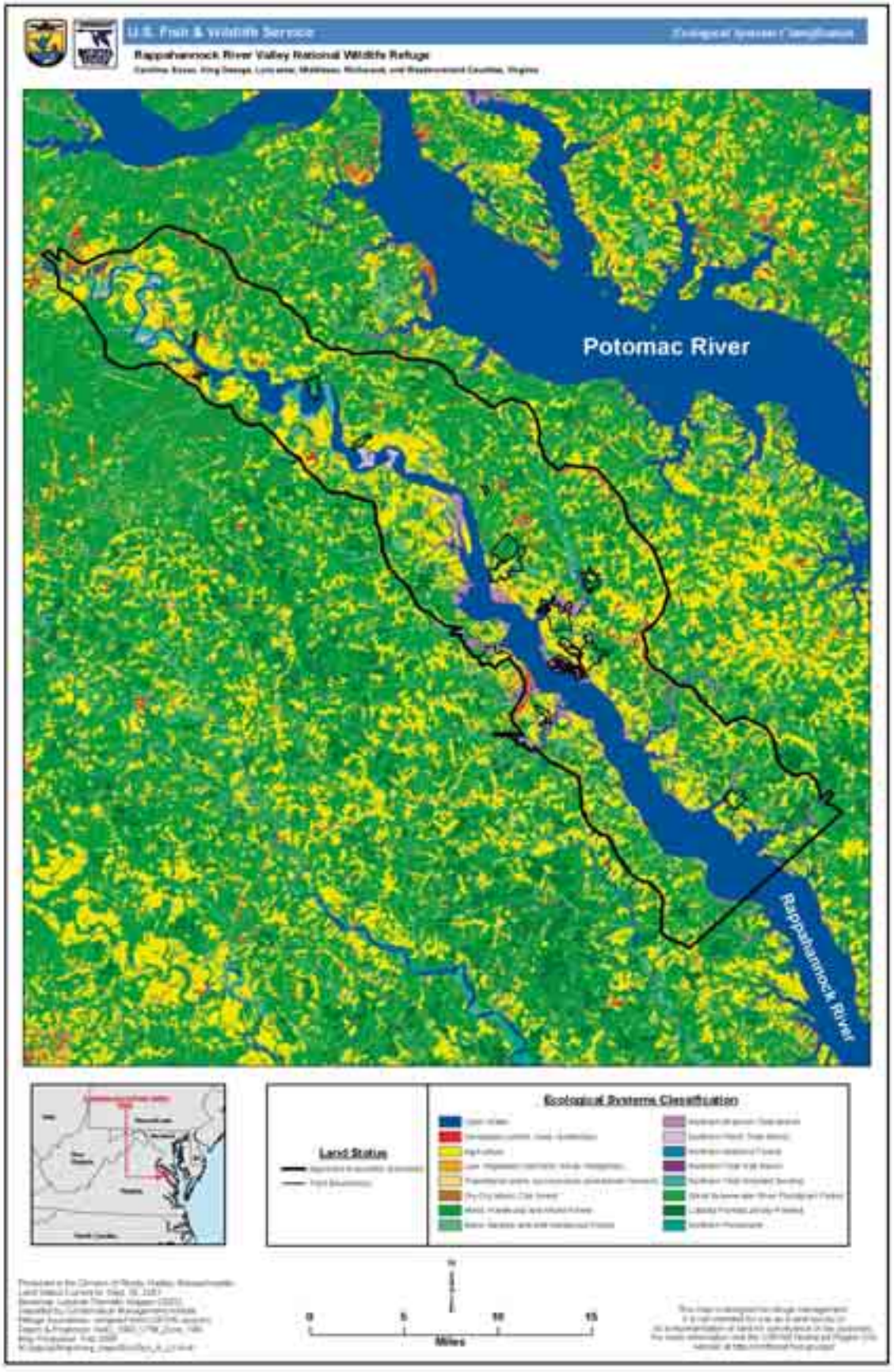
Habitat Type Descriptions

We define habitat types for the refuge based on two vegetation-mapping projects we conducted in support of the CCP. We enlisted the expertise of the VA Tech GIS/Remote Sensing Project office to complete the photo interpretation and digital mapping. Aerial photography from 2002 was used as the base year for this interpretation.

All refuge tracts were mapped according to the National Vegetation Classification System (NVCS), which is the Federal standard. That system is based on a relatively fixed hierarchy of floristic units, including associations and alliances, which are the recommended level to apply to refuge mapping projects. An association is the most basic floristic vegetation classification unit within the NVCS. It is a plant community of definite floristic composition, a defined range of species composition, diagnostic species, uniform habitat conditions and physiognomy. An alliance is a group of associations which share floristic characteristics, but is more compositionally and structurally variable, more geographically widespread, and occupies a broader set of habitat conditions (ESA 2004). Additional information on the NVCS and mapping standards is available at www.esa.org.

We also mapped vegetation within the entire project area using the "ecological systems" classification system developed by NatureServe. An ecological system is a group of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. A given ecological system typically will manifest itself in a landscape at intermediate geographic scales of tens to thousands of hectares and will persist for 50 or more years" (Comer, et al. 2003). These units form a cohesive, distinguishable unit on the ground. Map 2.1, below, depicts ecological systems for the project area.

In deriving our habitat types for this CCP, we considered the detailed vegetation information we now have on hand from the VA Tech project, the scale on which we wanted to present our management of refuge lands, our capabilities to map and monitor vegetation changes in the future, and the ability to do landscape-level analyses. None of these considerations precludes detailed mapping, monitoring and inventories of vegetation in the future, if we determine a need.



Map 2.1. Ecological Systems on and near the Rappahannock River Valley National Wildlife Refuge

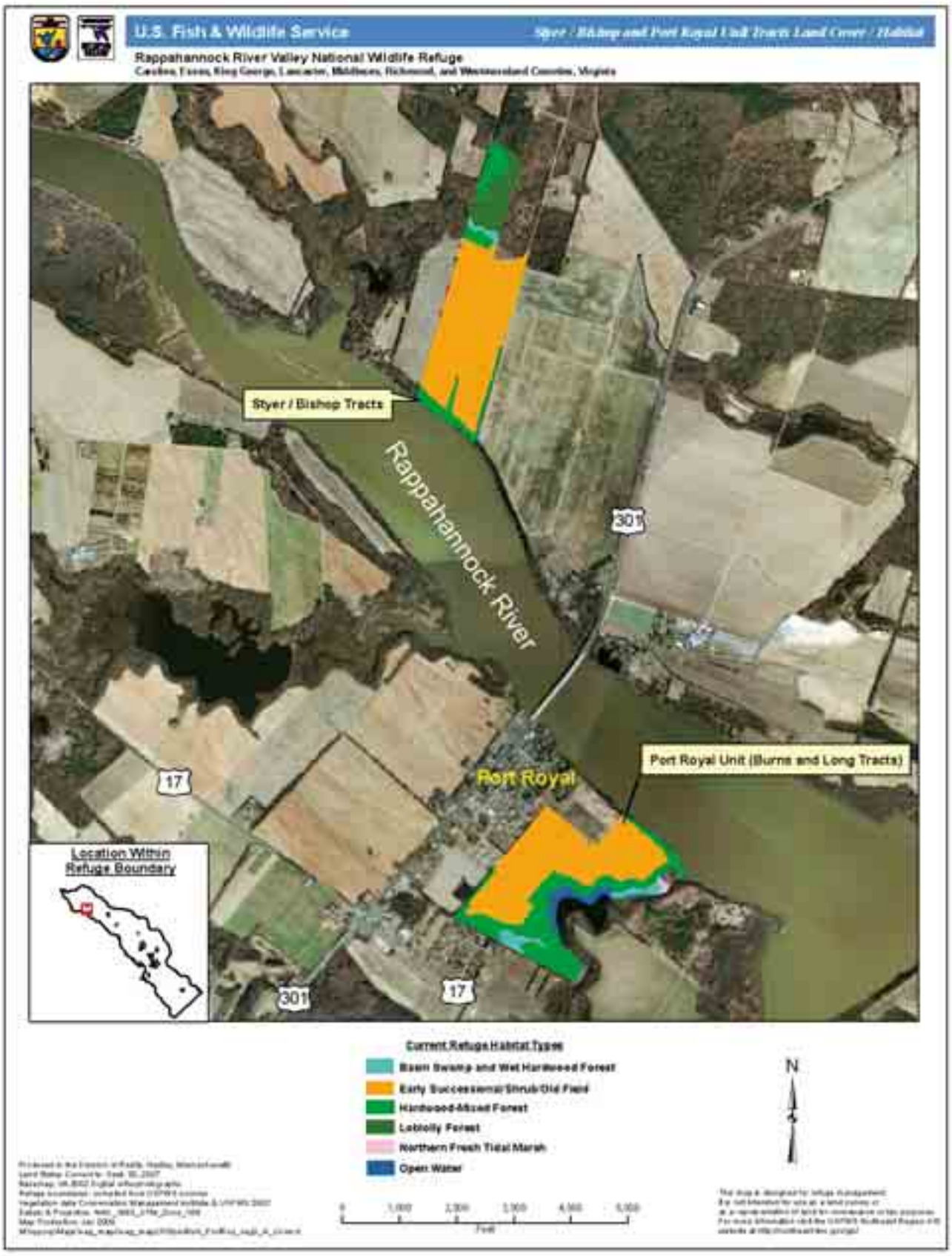
Table 2.4, below, represents how we chose to delineate refuge habitat types. Also, please refer to appendix H, which provides a table showing the relationship between NVCS mapping units, ecological systems units, the national wetlands inventory system units, and our habitat types.

Table 2.4. Present number of acres of each refuge habitat type

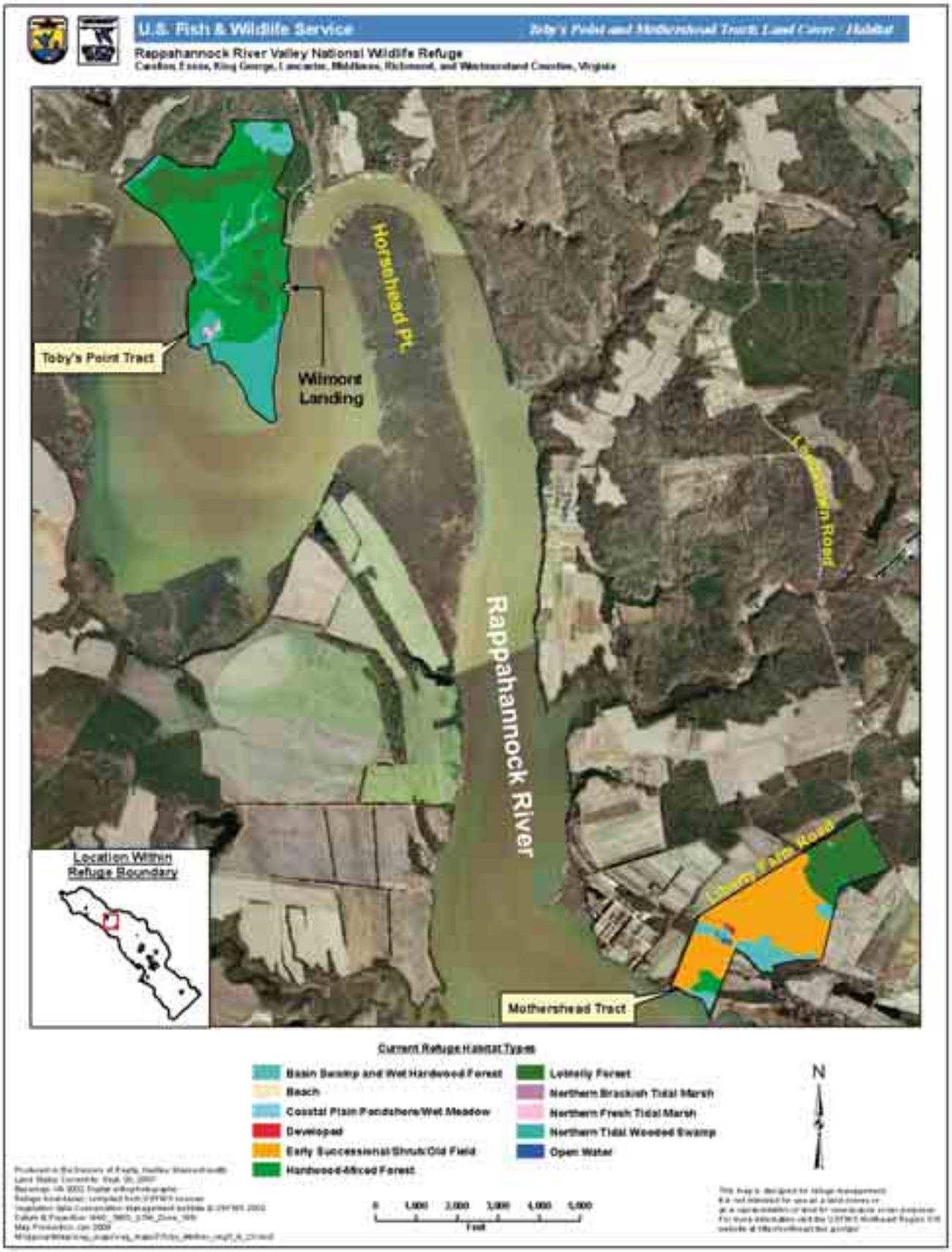
Refuge Habitat Types	Refuge Acres
Agricultural	738
Basin Swamp and Wet Hardwood Forest	453
Beach	3
Coastal Plain Pond shore/Wet Meadow	57
Developed	55
Early Successional/Shrub/Old Field	1558
Hardwood-Mixed Forest	1563
Loblolly Forest	1771
Northern Brackish Tidal Marsh	936
Northern Fresh Tidal Marsh	259
Northern Tidal Wooded Swamp	76
Open Water	242
Total	**7,711 acres***

*Note. This table approximates total acres and acres by habitat type, based on summing up habitat polygons delineated from 2002 aerial photo interpretation. The sum of these habitat type delineations is not exactly the same as the sum of our land tract surveys conducted in the field; the latter is our official source for acres. Nevertheless, the difference is less than 10 acres. The totals in this table include both easement and fee title properties, as of September 30, 2007.

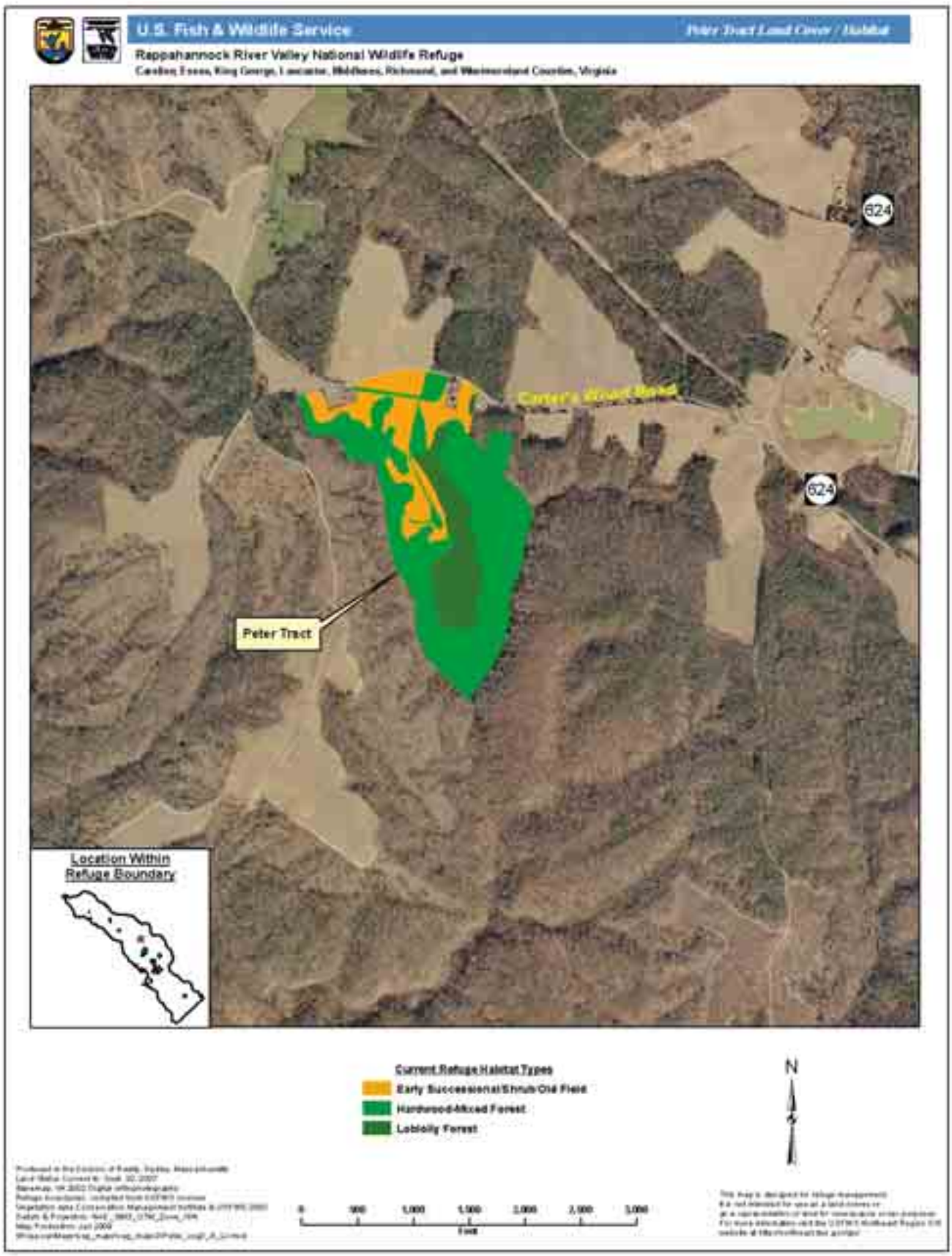
Maps 2.2 - 2.9, below, show the different habitat types of each refuge tract acquired as of September 30, 2007, including easement tracts. As noted above, the habitats are based on interpretation of aerial photographs taken in 2002. Although we have made some updates based on known changes since 2002, the maps do not capture all of our most recent habitat management. They represent the habitat conditions in approximately 2005.



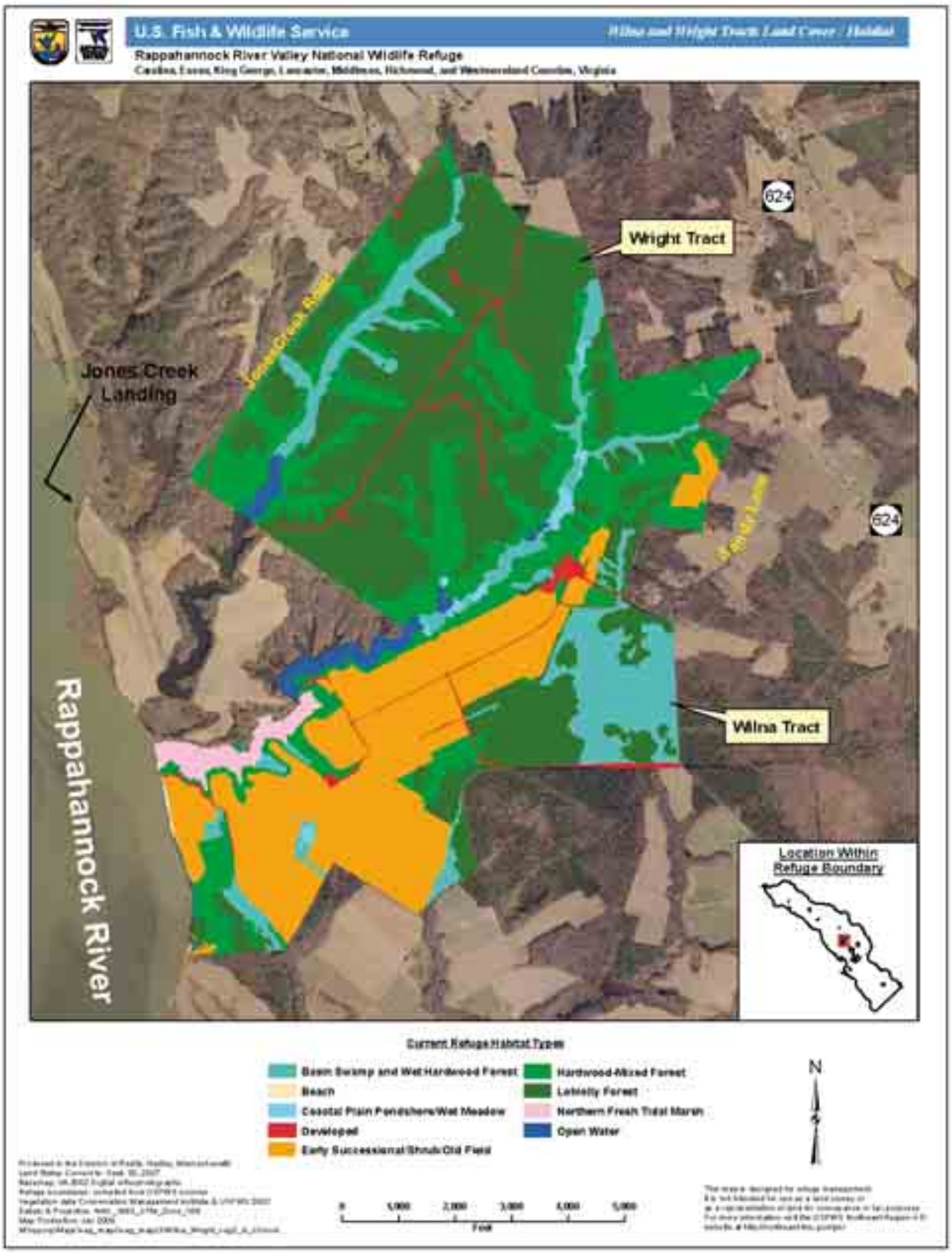
Map 2.2. Habitat Types on the Styer/Bishop and Port Royal Unit Tracts



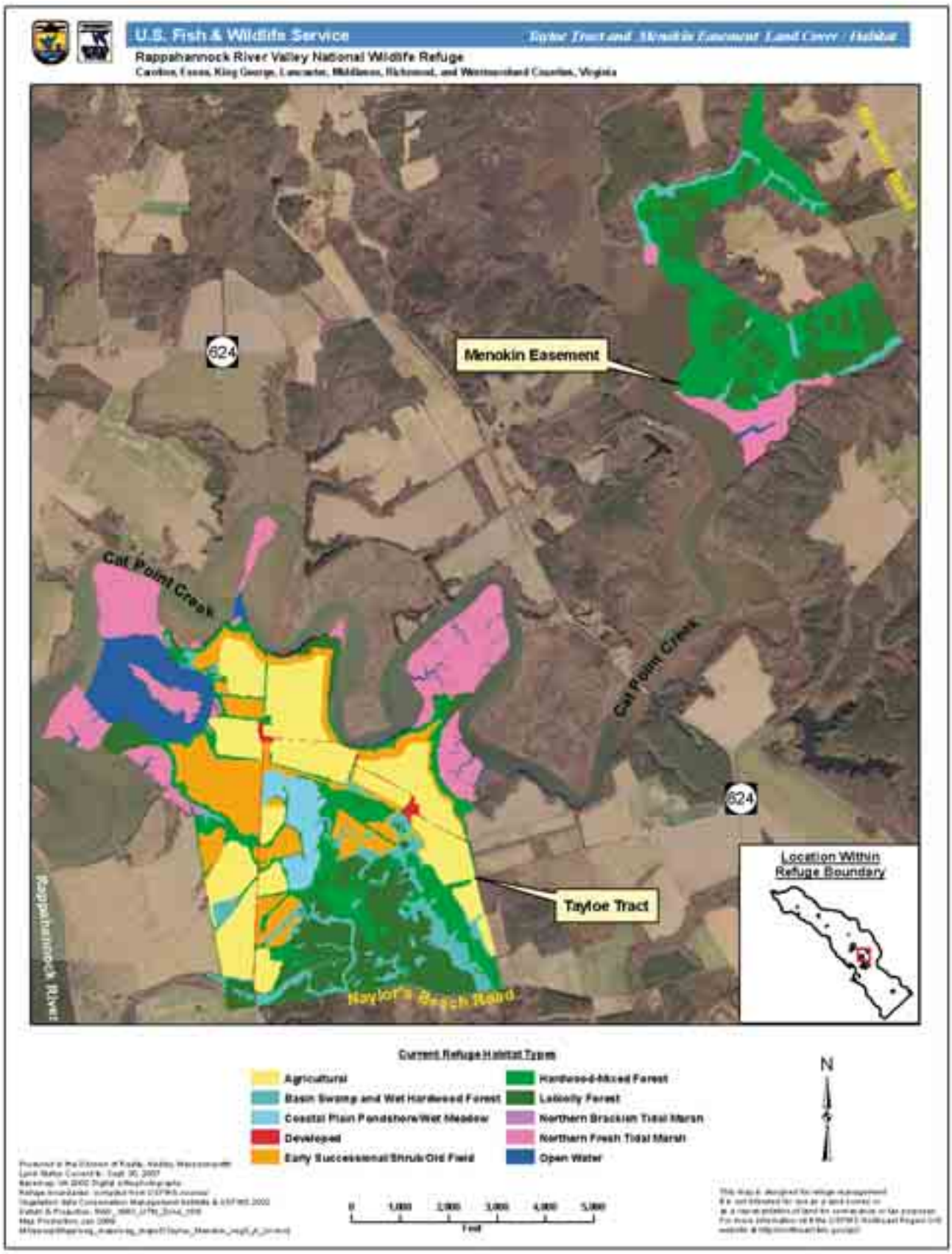
Map 2.3. Habitat types on Toby's Point and Mothershead Tracts



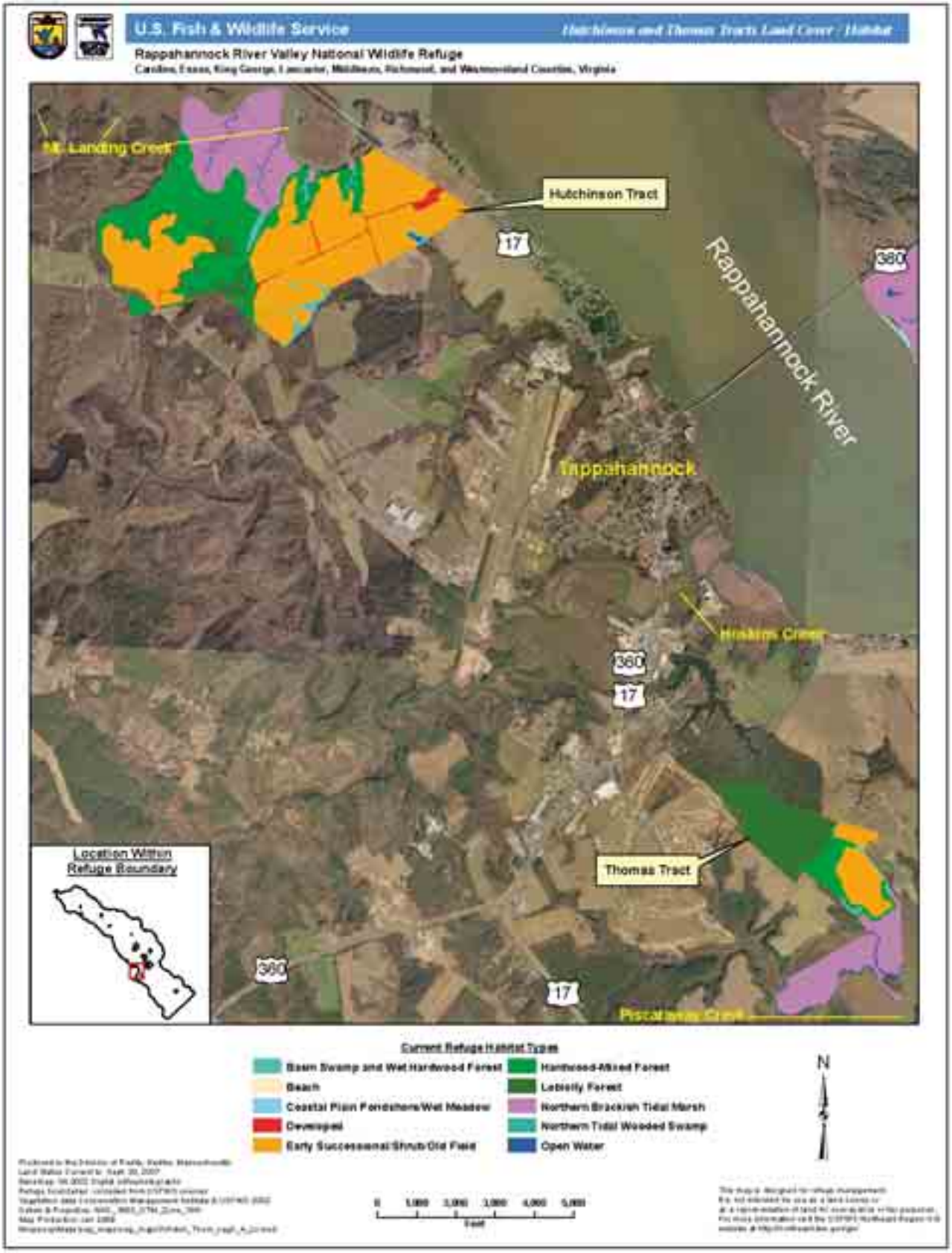
Map 2.4. Habitat types on the Peter Tract



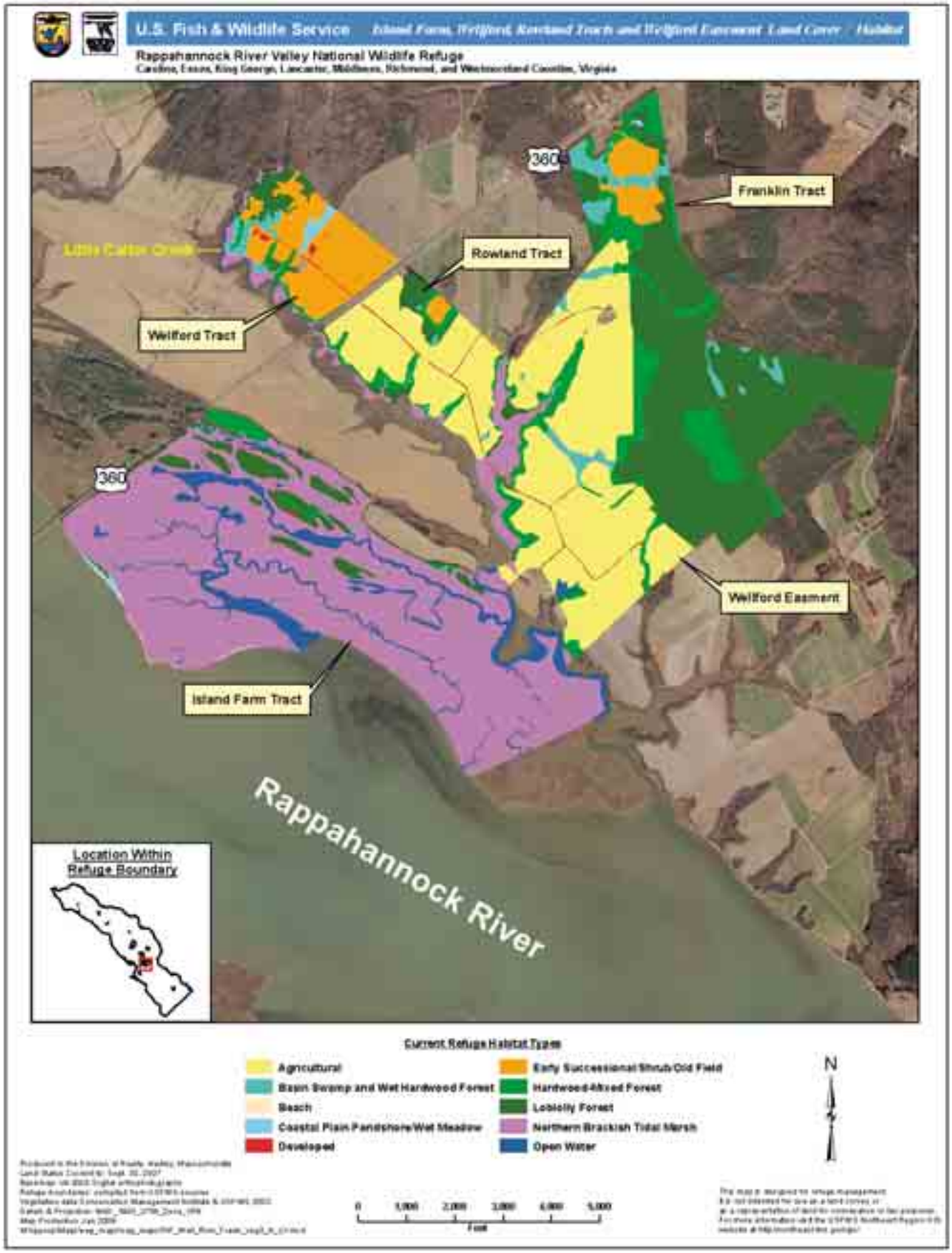
Map 2.5. Habitat types on Wilna and Wright Tracts



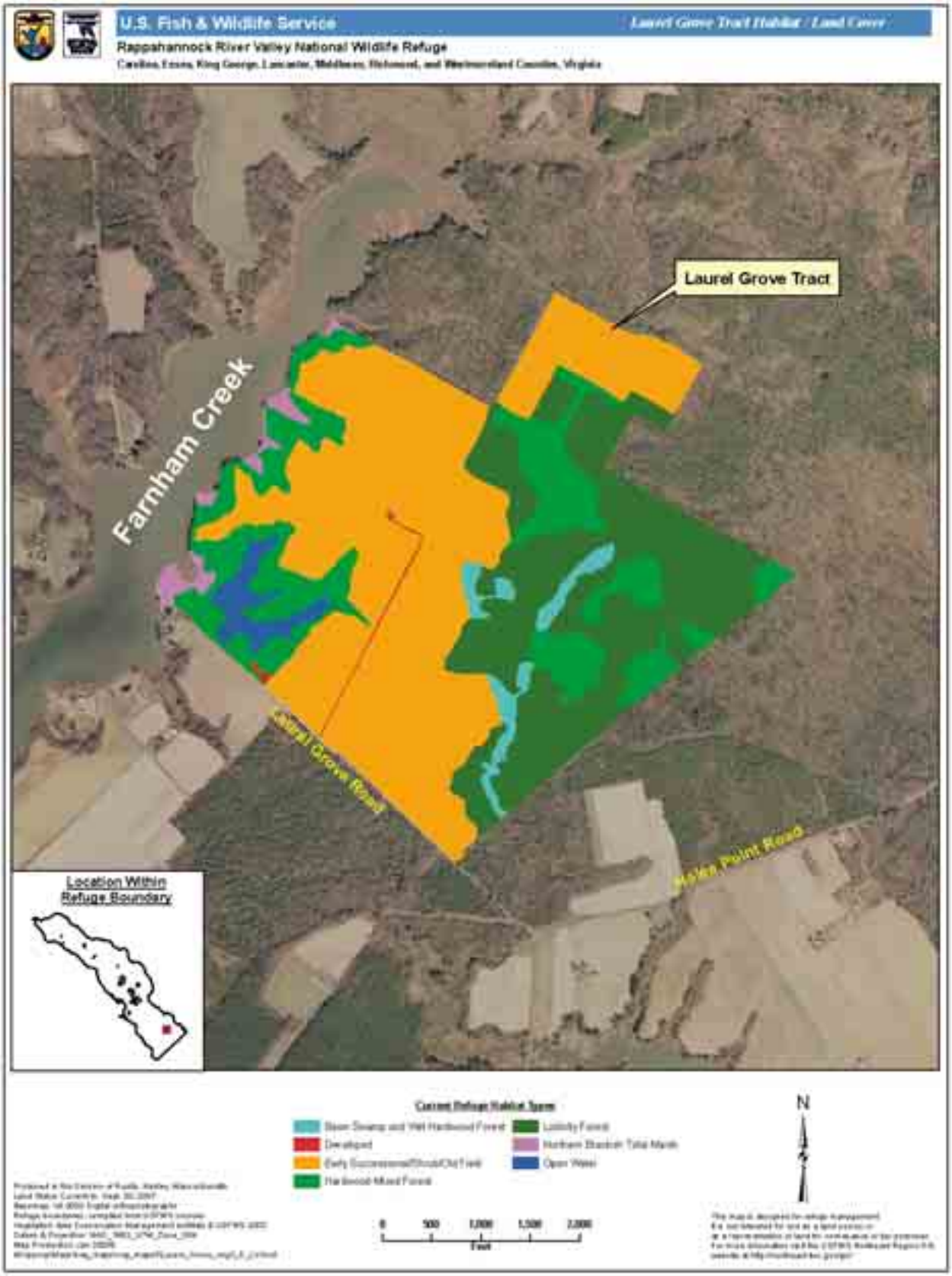
Map 2.6. Habitat types on Tayloe Tract and Menokin Easement



Map 2.7. Habitat types on Hutchinson and Thomas



Map 2.8. Habitat types on the Island Farm, Wellford and Rowland Tracts and Wellford



Map 2.9. Habitat types on the Laurel Grove

Federal- and State-Listed Plants

In 2001, we contracted with the Virginia Natural Heritage Program (VNHP) to conduct a natural heritage inventory in the project area. Most of the following information derives from the summary report of that survey (Belden, et al. 2002) and other reports from the VNHP (such as First and Second Approximations), and from observations of the refuge biologist, staff, and trusted sources.

We list after each plant its Natural Heritage Program ranking. NatureServe and its natural heritage member programs developed that ranking system to promote a consistent method for evaluating the relative imperilment of species and ecological communities. In Virginia, the VNHP maintains the database and rankings.

Determining which plants and animals are thriving and which are rare or declining is crucial for targeting conservation toward those species and habitats in greatest need. The rankings provide an estimate of extinction risk, while for ecological communities they provide an estimate of the risk of elimination. Conservation status rankings are based on a one-to-five scale, ranging from critically imperiled (1) to demonstrably secure (5). Status is assessed and documented at three distinct geographic scales: global (G), national (N), and state/province (S). Those status assessments are based on the best available information, and consider a variety of factors, such as abundance, distribution, population trends, and threats. Appendix A provides further definitions. See also (http://www.natureserve.org/explorer/ranking.htm#interpret).

- Sensitive joint-vetch (*Aeschynomene virginica, L.*) (G2, S2, Federal threatened): This plant is Federal-listed as threatened. Scattered populations have been discovered along the marshy edges of the Rappahannock River brackish tidal zone, mostly in protected creeks, such as Piscataway, Occupacia, Brockenbrough, and Mount Landing Creek, and a few individuals were observed on Mulberry Point on the Rappahannock River. Where it is known to grow on the refuge, we are actively monitoring and protecting it from disturbance.
- River bulrush (*Bolboschoenus fluviatilis* I and II) (G5, S1): This type of sedge plant has been located in four sites in and around Cleve Marsh and in tidal marsh opposite Nanzatico Bay.
- Lake-bank sedge (*Carex lacutris*) (G4, S1): This plant has been located in Cleve Marsh.
- Parker's pipewort (*Eriocaulon parkeri*) (G3, S2): This plant has been located in Drakes Marsh.
- American ginseng (*Panax quinquefolius* L.) (G4, S4): This species occasionally is encountered in forested ravines and hollows (Spencer, personal observation).
- Fragrant ladies' tresses (*Spiranthes odorata* Nutt.) (G5, S3): A small population of this orchid was found adjacent to a freshwater tidal marsh in upper Mount Landing Creek near a stand of *Aeschynomene virginica*.
- Freshwater cordgrass, prairie cordgrass (*Spartina pectinata*, Link) (G5, S2): A small population was found about 500 meters downstream from Carters Wharf (same side) and reported in 2001.
- Common reed, native (*Phragmites australis* subsp. *americanus*) (recently described, not yet ranked): This plant recently has been described (Saltonstall, et al. 2004). A few stands have been identified in the refuge area on Cat Point Creek, Occupacia Creek, and Peedee Creek, all of which are tidal, brackish-to-fresh creeks.
- Quillwort species (*Isoetes* spp.) (G2, G3, S1): A specimen was collected by Allen Belden, Jr. in 2001 from a tidal freshwater mudflat along the Rappahannock River about 0.06 mile (0.1 kilometer) north of Owl Hollow, and tentatively identified by Dr. Rebecca Bray of Old Dominion University as *Isoetes hyemalis*, or winter quillwort, which is both a globally rare and state rare species. Confident identification awaits a site visit when the plant's spores, the primary means of identification, are mature (Belden, et al. 2002).

The following list is of plants that may occur on the refuge, but we have not documented them yet.

- Swamp pink (*Hellonias bullata*) (G3, S2/S3, Federal threatened). This plant is associated with the coastal plain acidic seepage swamp natural community type (over sand and gravel deposits).
- Small-whorled pogonia (*Isotria medeoloides*, Pursh) (G2, S2, Federal threatened). Typically, it is found in mature forest stands with a sizable component of white oak (*Quercus alba*), other *Quercus* species, and American beech (*Fagus grandifolia*). It favors forests with open shrub and herb layers, and often is found near small canopy gaps caused by tree mortality. The refuge area has substantial quantities of these habitat conditions, so the prospects are good that it may be present.
- Kentucky lady's slipper (*Cypripedium kentuckiense*) (G3, S1): This state-listed orchid is associated with coastal plain basic seepage swamp natural community type. It was found first on Northern Neck in 1955, in Lancaster County just east of the refuge project area, and 285 miles from the nearest known locality in what is now an Audubon natural area, Hickory Hollow (Belden, et al. 2002). It has been blooming there annually in recent years, and has attracted many visitors.
- Virginia least trillium (*Trillium pusillum* Michx. *var virginianum Fern.*) (G3, T2, S2) was recently found blooming in a small marshy area of a golf course in Kilmarnock (Tom Teeples, Northern Neck Audubon Society, personal communication 2006) and near Fredericksburg (Ann Messick, Northern Neck Chapter of Virginia Native Plant Society, personal communication). The "T2" addition to the ranking indicates that it is this particular variety of trillium which is of global concern due to its very limited range and small population.

Unique and Significant Natural Plant Community Types

Tidal Freshwater Marsh

In 2002, the VNHP listed tidal freshwater marsh, if extensive in size, as a significant natural community (Belden, et al. 2002). This marsh type occurs in the uppermost portion of the estuarine zone of the Rappahannock River, where a much larger volume of freshwater from upstream dilutes the inflow of saltwater from tidal influence. Salt concentrations are generally <0.5 ppt, but pulses of higher salinity may occur during spring tides and periods of low river discharge. The report named two such marshes, the Drakes and Otterburn marshes, but others exist along the river and in tributary creeks.

The most common species are wild rice (*Zizania aquatica*), pickerelweed (*Pontederia* spp.), rice cutgrass (*Leersia oryzoides*), tearthumbs (*Polygonum* spp.), and beggar ticks (*Bidens* spp.), and scattered patches of sweet flag (*Acorus calamus*) and southern wild rice (*Zizaniopsis miliacea*) may be found. Outstanding examples of these diverse communities occur on the Potomac, Rappahannock, Chickahominy, and James rivers. These marshes provide the principal habitat for globally rare sensitive joint vetch (*Aeschynomene virginica*). Chronic sea level rise is advancing the salinity gradient upstream, which may result in the conversion of some into oligohaline marshes. The invasion of the exotic marsh dew flower (*Murdannia keisak*) also threatens these marshes (Fleming, et al. 2001).

Mixed Mesic Hardwood Forest

When this type occurs in extensive, unfragmented stands, it is a significant natural community. Forests in this group occupy mesic uplands, ravines, lower slopes, and well-drained "flatwoods" on acidic, relatively nutrient-poor soils (Fleming, et al 2001). Typical tree composition includes flowering dogwood (*Cornus florida*), American holly (Ilex opaca), and American hornbeam (*Carpinus caroliniana* ssp. *Virginiana*) in the understory, and hickories (*Carya* spp.), tulip-poplar (*Liriodendron tulipifera*), oaks (*Quercus* spp.), and American beech (*Fagus grandifolia*) as the dominant canopy species. Although this coverage type is still sizable in eastern Virginia, repeated logging has reduced their quality and extent (Fleming, et al. 2001). The Natural Heritage Inventory cites the forests along the Fones Cliff and Brockenbrough Creek as exemplary, although many more such sites exist in the project area.

Coastal Plain/Piedmont Acidic Seepage Swamp

This is a saturated wetland community fed by groundwater seepage discharged in a series of springs along the base of the adjacent ravine slopes. Soils are very nutrient-poor (Belden, et al. 2002). Characterized by diffuse drainage with braided channels and sphagnum-covered hummocks in a sandy or peaty substrate, the habitats are generally wet and protected from fire. The Natural Heritage Inventory noted such a community at Balls Branch Swamp, a tributary of Lancaster Creek. The vegetation is usually a mosaic of shrubs and graminoid-dominated herbaceous patches (Fleming, et al. 2001).

Typical dominant woody species include red maple (*Acer rubrum*), fringetree (*Chionanthus virginicus*), sweet bay (*Magnolia virginiana*), possum-haw (*Viburnum nudum*), sweet pepperbush (*Clethra alnifolia*), winterberry (*Ilex verticillata*) (Belden, et al 2002) and black gum (Fleming, et al 2001). Herbs include (at least locally) cinnamon fern (*Osmunda cinnamomea*), Atlantic sedge (*Carex atlantica*), bristlystalk sedge (*Carex leptalea*), skunk cabbage (*Symplocarpus foetidus*), small green wood orchid (*Platanthera clavellata*) (Belden et al 2002) Collins sedge (*Carex collinsii*), twining bartonia (*Bartonia paniculata*), and the Federal-listed swamp pink (*Helonias bullata*).

If those species and geologic conditions are diagnostic, then the potential for more such sites within the project area exists, as plant communities and conditions such as these do occur in the upper reaches of the steep ravines along the Northern Neck and Middle Peninsula (Spencer, personal observation). This natural community type is relatively small, and threatened by beaver activities, agricultural pollutants, hydrologic disturbances and logging (Fleming, et al. 2004). A state-listed rare herb, pineland squarehead (*Tetragonotheca helianthoides*), was located at the Balls Branch Swamp in 1940, but neither that nor the swamp pink were found in 2002.

Coastal Plain Basic Seepage Swamp

Although mostly in Caroline County (Belden, personal communication 2002), some of the characteristic plants, soils, and hydrology used to describe these seepage swamps (Fleming, et al. 2004), are also found in the less studied ravines and drainages (Spencer, personal observation) of the Northern Neck and Middle Peninsula. Hence, the likelihood is high that this type may occur in the narrow, shady drainages and ravines that fringe the Northern Neck and Middle Peninsula.

Cat Point Creek marsh: USFWS

This type is described as saturated deciduous forests occurring in the bottoms of Coastal Plain ravines that have downcut into Tertiary shell deposits or lime sands. These are naturally rare, small-patch, communities known from the dissected inner Coastal Plain of Surry, Isle of Wight, York, and James City Counties, but there is at least one outlying occurrence in Lancaster County. Mucky, braided ravine bottoms and hummock-and-hollow micro-topography are prevalent. Green ash (*Fraxinus pennsylvanica*), red maple (Acer rubrum), and tulip poplar (*Liriodendron tulipifera*) are common canopy species. Small trees and shrubs include spicebush (*Lindera benzoin*) and southern bayberry (*Myrica cerifera*). Kentucky lady-slipper (*Cypripedium kentuckiense*) and American false hellebore (*Veratrum viride*) are rare diagnostic plants, while lizard's tail (*Saururus cernuus*), brome sedge (*Carex bromoides*), smooth bur-marigold (*Bidens laevis*), and wood reedgrass (*Cinna arundinacea*) are more common herb species. The exotic grass *Microstigeium vimineum* (Japanese stiltgrass) easily invades this community. The globally rare interstitial amphipod, *Stygobromus araeus*, is closely associated with the groundwater in shell marl deposits (Fleming, et al. 2001).

Invasive Plants

The presence of invasive plants can have a major adverse impact on the biological integrity, diversity and environmental health of refuges and other natural areas. We list several plants below that occur on the refuge and are affecting native habitats. We remain vigilant to their presence and spread, and have an active program to control many of them.

Upland Terrestrial Habitats

Table 2.5 below shows the most frequent, broadly occurring invasive species that have the potential to cause stand replacement in our upland terrestrial habitats.

Table 2.5. Invasive plants in upland terrestrial habitats

Invasive Plant	Scientific Name
Tree of heaven	*Ailanthus altissima*
Autumn olive	*Eleaganus umbellate*
Multiflora rose	*Rosa multiflora*
Japanese honeysuckle	*Lonicera japonica*
Kudzu	*Pueraria lobata*
Japanese stiltgrass	*Microstigeium vimineum*
Princess tree	*Paulownia tomentosa*
Johnsongrass	*Sorghum halepense*
Lespedeza	*Lespedeza cuneata*
Chinese privet	*Ligustrum sinense*
Japanese knotweed	*Polygonum cuspidatum*
Canada thistle	*Cirsium arvense*

Wetland Habitats

Common reed (*Phragmites australis*) is the most frequent and broadly occurring invasive species in our wetlands habitats, and we have an aggressive control program in place. Chapter 3 describes it more fully. Marsh dew flower (*Murdannia keisak*) is another wetlands species of priority concern that is prevalent at Drakes Marsh.

Aquatic Habitats

Hydrilla (*Hydrilla verticillata*) is found in scattered locations within the project area (Belden, et al. 2002; S. Spencer, in Brockenbough Creek, Mount Landing creek, personal observation). This could threaten diminutive mudflat plant species when mats of decaying hydrilla wash up along the shores and mudflats during fall senescence (Belden 2002).

Refuge Biological Resources

As in our discussion of plant species, we refer to the VNHP ranking in describing some of the wildlife, fish and aquatic invertebrates in the discussions below.

Federal-listed endangered or threatened species

The shortnose sturgeon (*Acipenser brevirostrum*), Federal-listed as endangered, is likely extirpated from Virginia waters (Jenkins and Burkhead 1994). No longer are any populations known from Chesapeake Bay tributaries, and only a few individual collections have been recorded in recent years.

Historically, this sturgeon probably inhabited all of the waters between the Delaware River in New Jersey and the Cape Fear River in North Carolina (VA WAP 2005). It spawns in freshwater, typically above tidal influence, in areas with swift current and gravel or pebble bottom and water temperatures are between 9° C and 12°C.

The de-listing of the bald eagle

During the development of this plan, the bald eagle was removed from the list of threatened species, but the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, the National Bald Eagle Guidelines (May 2007) and the Virginia bald eagle management guidelines still afford it special protection. It will retain its threatened status under the Virginia Endangered Species Act. Protecting and enhancing eagle habitat on the river remains a priority on this refuge, and consistent with one of the purposes for establishing it. The bald eagle nests and roosts on refuge lands.

Ecology and importance of the bald eagle on this refuge

The Chesapeake Bay–Virginia population of bald eagles favors mature, super-canopy trees that overlook a broad expanse of marsh, river, or fields with relatively clear understory below and in close proximity to water bodies where fish are abundant. In Virginia, bald eagles more frequently use pines, but nests also appear in beeches, sycamore, and bald cypress. Pines, hardwoods, or snags with extended branches free of obstructing vegetation are favored perches. The forested riparian habitats along the tidal portion of the Rappahannock River are ideal bald eagle habitat.

The Rappahannock River continues to be one of the most important geographic areas for the eastern population of breeding bald eagles, based on the results of the Virginia Bald Eagle Breeding Survey. The survey is now in its 31st consecutive year, and covers the tributaries of the Chesapeake Bay up to their fall lines. It determined that bald eagles occupied 453 territories in Virginia during the 2005 breeding season. Compared to 2004, that represents a 5.8-percent increase in the breeding population. That rate generally is lower than the one documented throughout most of the history of the survey. More than 90 new nests were mapped in 2005. Many of those represent relocations within existing territories, although a substantial number of new territories were discovered. The number of active nests increased by 7.0 percent compared to the previous year (Watts and Byrd 2005). By comparison, the survey determined that 435 bald eagle territories were occupied in Virginia during the 2003 breeding season. When compared to 2002, that represents a 19.8-percent increase in the breeding population. More than 120 new nests were mapped in 2003. The number of active nests increased by 12.8 percent compared to a 5.1 percent increase for the previous year (Watts and Byrd 2003). By 2007, the number of occupied territories jumped to 560 (Watts and Byrd 2007).

Most of the occupied territories continue to be found in the coastal plain (Watts and Byrd 2005). Breeding densities vary considerably over the survey area, with tidal fresh reaches of the major tributaries supporting three to four times the breeding density of areas around more saline waters (Watts, et al. in press). Despite high breeding densities around less saline waters, much of the growth in the breeding population continues to be along these same waters (Watts and Byrd 2005).

The Rappahannock River portion of the breeding Virginia bald eagle population mirrors the overall growth trend. In 2007, 143 territories were occupied (adults associated with a nest) and 139 active nests (birds incubating or eggs in nest) (Watts and Byrd 2007). In 2005, 120 territories were occupied and 113 nests were active on the river. In 2004, 109 territories were occupied and 100 nests were active. In 2003, there were 116 and 84, respectively, and in 2002, 91 and 86, respectively (Watts and Byrd 2005 and 2003). Westmoreland, King George, Richmond, Essex, and Charles City counties continue to support the highest number of pairs in the state. Those five counties alone account for 37.1 percent of the state population (Watts and Byrd 2005). All but Charles City County are in the refuge project area.

The Rappahannock River is also important for wintering bald eagles. River surveys by boat conducted in December, January, and February over the past 10 years show an astonishingly high density of wintering eagles, ranging between 141 and 395 eagles along a 30-mile stretch from Tappahannock to Rappahannock Academy above Port Royal. The highest concentration of eagles is found in Cat Point Creek (Portlock, upublished data; Portlock, Cooper, and Spencer, 2005–2006, unpublished survey data). Increasing concentrations of eagles along the oligohaline (brackish-fresh) portion of the river has prompted the State Non-Game Wildlife Division to revise earlier maps of the bald eagle concentration area to include the Tappahannock section of the river and Cat Point Creek.

Abundant food resources (catfish, perch, wintering waterfowl) may account for the high concentration of eagles along this stretch of the river, which attracts wintering populations from the north and juveniles from the south (Watts, personal communication, 2005).

Shoreline development, the removal of trees for residential vistas, and the replacement of natural shoreline vegetation with revetments threaten the quality of riparian habitat of the bald eagles. Development and rezoning is increasing rapidly in Lancaster and Northumberland counties, just south of the project area, and in Stafford County, just north of the project area. Richmond County approved preliminary applications for four major subdivisions on Totuskey Creek.

We protect bald eagle habitat in various ways. One is fee simple acquisition or purchase of conservation easement in riparian habitat, when such properties become available from willing landowners. We recently acquired a conservation easement over a large tract of mature forest, with 5,884 feet of frontage on Cat Point Creek.

However, the appropriation process generally is too slow and funds generally too limited to keep pace with the changing real estate market. On the tracts we own or manage, we evaluate the need for maintenance, creation, or enhancement of existing or potential riparian habitats. For example, we recently conducted an understory burn in the bald eagle roost area at the Wilna tract to create a more open understory and release the larger trees from competition. We are also restoring former crop fields next to the river to forested riparian habitat through tree-planting and natural succession.

Other protective measures include

- Observing time-of-year restrictions for any disturbing public use or other types of activities occurring on the refuge;
- Recommending to Virginia Department of Transportation (VDOT) some modifications for a new bridge across Cat Point Creek that would limit impacts to bald eagles from boat traffic;
- Supporting bald eagle surveys on the river to obtain data on the status and changes in eagle concentration areas; and,
- Exploring techniques for shoreline erosion protection.
- Involving our outreach and education in informing the public and local government officials about bald eagle habitat needs.

Birds

The bird assemblage in the project area is as diverse as its habitats. Some of this species diversity can be attributed to the fact that the project area lies at the geographic southern limits for many northeastern species, and at the northern limits for many southeastern species. The project area lies near the Chesapeake Bay, which is a significant migratory pathway. Of all the breeding bird species in the Mid-Atlantic Coastal Plain, approximately 75 percent are migratory (Watts 1999).

Approximately 204 species have been confirmed to use the refuge project area throughout the year, distributed among 39 families. Of those 107 are known or likely breeders. Warblers compose the most species-rich family, with 31 species observed breeding, migrating, or wintering on the refuge or its environs (Spencer, unpublished). The bulk of the information on which birds are using the refuge and project area is obtained from several sources: point count surveys on the refuge during the breeding season; refuge marsh bird surveys; refuge winter grassland surveys; the regional grassland breeding bird surveys; Christmas Bird Counts; mid-winter flight surveys of waterfowl; and migration counts. Additional information comes from less formalized searches such as the Virginia Society of Ornithology (VSO) Foray in 2004, the VSO Annual Event on the Northern Neck 2007, bird walks, and casual observations from trusted sources. Those are all sources from which we derive our refuge bird checklist, and from which we evaluate the birds of conservation concern that could be management priorities.

Blue grosbeak: ©Les Brooks

In developing this CCP, we compiled a list of species of conservation concern for the project area, which includes birds on the VA WAP list, the 2007 BCR 30 Plan, the PIF Area 44 plan list, the Atlantic Coast Joint Venture Plan, our regional BCC list, and the Audubon State of the Birds watch list. Appendix A provides a summary of individual species rankings in various plans, including the BCR 30 and VA WAP. Sixty-five bird species on the refuge are identified as species of concern, that utilize forest, grassland and other early successional habitats, wetlands, and shoreline habitats. Some of those birds are found in multiple habitat types. Our land bird and marsh bird survey data will provide a resource for evaluating the refuge's potential contribution to, or responsibility for, birds of conservation concern in a broader landscape or regional context once the databases for those surveys are finalized, the data entered, and then rolled up to broader spatial scales for analysis. For example, relative frequencies can be reviewed with respect to species ranges, abundance, and seasonal distributions nationally and regionally, and estimations of the refuge's potential contribution, in numbers or uniqueness, to these species can be calculated.

Land birds

Since 2000, we have conducted our land bird point counts following regional standardized protocols on various tracts of the refuge. With at least 5 years of data, rough indices of trends, relative abundance, and simple presence-absence information can be obtained. The discussion below highlights a few species of interest for each broad habitat type.

Forests (Riparian, mixed deciduous, coniferous, early successional forest, hardwood bottomlands)

At least 37 bird species of birds of conservation concern use these habitats on the refuge and in the project area. During the breeding season (May-June-July), bald eagle, Louisiana water thrush, ovenbird, worm-eating warbler, yellow-throated vireo, wood thrush, scarlet tanager, chuck-will's widow, whip-poor-will, eastern towhee, and brown thrasher are frequently observed. Kentucky warbler is less frequently observed. The largest group of birds of conservation concern use forest habitat in the mid-Atlantic Coastal Plain. Our management to date in this habitat type has focused on protection

through acquisition or easements, enhancement by culling invasive species, or reforesting breaks to join fragments or create corridors to benefit these species of conservation concern.

Grasslands and other early successional habitats, shrub habitats—Migrants constitute about 71 percent of bird species using farmland or agricultural setting in North America, and 86 percent of bird species nest there (Rodenhouse, et al. 1993). Twenty species of birds of conservation concern use the grasslands, early successional or shrubby fields and edges on the refuge or project area, including breeders such as the American woodcock (also see discussion under "shorebirds" below) bobwhite quail, grasshopper sparrow, dickcissel, field sparrow, eastern meadowlark, and whip-poor-will. Fields converted from row crops to managed grasslands have attracted sedge wrens and dickcissels. The sedge wrens (only 2 or 3 at a time) appeared for 2 years in a row at the Hutchinson tract (on August 10, 2004 and 2005). Dickcissels are an irruptive species that have appeared more frequently than expected—at first only every couple of years but in the past 4 years, annually with increasing numbers and locations. They appear to be attracted to the taller emergent vegetation in the early succession fields. Wilna had the largest population of about 10 individuals, including a breeding pair, first observed in 2007 (Spencer personal observation). Current management actions that benefit this group of birds include maintaining the early successional structure (either short grass-forb or tall grass-forb), culling out stand replacing invasive species, setting back woody encroachment, and a mowing regime that creates structural diversity in fields that are structurally uniform. The grasshopper sparrow and bobwhite quail population increased where tall, dense stands of warm season grasses were spot mowed before the growing season, creating pockets within the tall standing dead grass from the previous season, where in the previous 2 years there were none (Spencer unpublished report).

Grasshopper sparrows, although still common, are declining rapidly in the core of their range in the prairie states (Rich, et al. 2004). Because the refuge project area lies in a landscape-scale agricultural context, grasshopper sparrows are locally abundant during the breeding season in suitable grassland habitat, but have been declining in the state as modern agricultural practices over the past 45 years have reduced the amount of idle land available for nesting and foraging (Watts 1999).

Other noteworthy occurrences are LeConte's sparrow, Swainson's warbler, Canada warbler, and Bicknell's thrush.

- The LeConte's sparrow first was detected on the Wilna tract during the Christmas Bird Count on December 19, 2004 by our refuge biologist and then later by several birders throughout the month of January 2005. That species has made sporadic appearances in northern Virginia at the Occoquan Bay refuge, about 75 miles to the north.

- The Swainson's warbler was heard singing and was seen throughout the bird survey season on the Hutchinson tract in 2004 (J. Drummond, 2004 unpublished survey data). That species also appears almost every year in the spring along Jericho Road at Great Dismal Swamp (R. Ake, 2007 personal communication). Targeted searches at four forested bird survey points in the project area in 2007 using playbacks (Cornell Lab of Ornithology 2001) did not produce further observations. However, a small breeding population may be in the heavily forested ravines on the Northern Neck and Middle Peninsula (B. Watts 2007 personal communication).

- The Bicknell's thrush song and call also was detected in spring 2003, along with other migrating thrushes at the Wilna tract (J. Drummond, unpublished survey data).

- Two bird surveyors observed the Canada warbler three times on the refuge in 2002 and 2005 during spring migration (D. Lee and J. Drummond, unpublished survey data).

Wetlands (Estuarine emergent marshes, shrub wetlands, beaver meadows wet meadows, forested wetlands)

Thirty-one species of birds of conservation concern use different wetland types on the refuge or project area throughout the year. Of those, species that are not wetland obligates that also occur in upland habitats are treated as land birds here. Those include breeders such as the eastern wood peewee, gray catbird, willow flycatcher, northern parula, redheaded woodpecker, prothonotary warbler and, in the winter, rusty blackbird.

Waterfowl

Eighteen species of waterfowl of conservation concern for which the refuge or project area provides habitat are listed below, along with their conservation priority based on the 2007 BCR 30 plan and including the seasons they occur in our project area. Two of the species listed below are common breeders here: wood duck and mallard. The VA WAP also ranks most of these species as a conservation concern using their tiering system. The Atlantic Coast Joint Venture Focus Area Report (draft 2005) for the Rappahannock River identifies as priority conservation species for this area several species not listed below, the redhead (M, W), ring-neck duck (M, W), blue-winged teal (M, W), gadwall (M, W) and northern shoveler (M, W) – (Season of Occurrence code: M – Migrating; W – Winter). The redhead does not occur in large numbers in our area. Appendix A lists how each waterfowl species of concern is ranked in various state and ecoregional plans, and defines the ranking systems for each plan.

American black ducks, the waterfowl species of greatest concern, may breed here, as occasional observances of pairs or small groups in spring/summer and fall show, in addition to the much greater wintering population (Spencer, personal observation; Atwood, personal communication). In the winter, great rafts of the waterfowl that winter here can be observed on the river, bays, and coves.

The limited surveys available from which to obtain count or abundance data make it difficult to estimate how many individuals of each species on average use the river. Canada geese, ruddy ducks, buffleheads, and scaup spp. can be seen in the hundreds or thousands from the river during winter bald eagle surveys (Spencer, personal observation). Species that use forested swamps, marshes, and narrow wetlands are likely to be greatly undercounted.

These main sources of data provide information on waterfowl abundance in the project area: the Midwinter Waterfowl Inventory (aerial), refuge aerial surveys in 2001–2002, and Christmas Bird Count reports.

Table 2.6. BCR 30 waterfowl priority species on the refuge or project area

Species	Seasons*	BCR 30 Plan Priority
American black duck	B, M, W	Highest
American wigeon	M, W	Moderate
Bufflehead	M, W	High
Canada goose (Atlantic)	M, W	Highest
Canada goose (North Atlantic)	M, W	High
Canvasback	M, W	High
Common goldeneye	M, W	Moderate
Gadwall	M, W	Moderate
Greater scaup	M, W	High
Green-winged teal	M, W	Moderate
Hooded merganser	M,W	Moderate
Lesser scaup	M, W	High
Mallard	B, M, W	High
Northern Pintail	M, W	Moderate
Red-breasted merganser	M, W	Moderate
Ruddy duck	M, W	Moderate
Tundra swan (eastern)	M, W	High
Wood duck (eastern)	B, M, W	Moderate
*Season of occurrence codes: B=breeding; M=migrating; W=wintering		

The most abundant waterfowl by far in the winter are the Canada geese, which raft by the hundreds along the river's shallow bays, on open water or in the numerous creeks and marsh openings. One of the largest rafting sites within the project area is the Nanzatico (Land's End) and Portabago Bay and the Occupacia Bay portions of the river. Survey data lacks the relative proportion of the Atlantic population to the North Atlantic population. However, the latter likely are concentrated more on the western shores of the Delaware Bay and lower Chesapeake Bay (BCR 30 Plan, 2007).

Mallards and black ducks are found year-round in the shallow tidal marshes and ponds. Northern shoveler, gadwall, teal, and wigeon also are found in those habitats during migration and in winter, feeding on the invertebrates, seeds, and SAV in the shallow marshes along the river and its tributaries. Diving ducks, such as scaup, ruddy ducks, redheads, canvasbacks, ring-necked ducks and mergansers, use the open river and sheltered ponds and coves along it, especially where SAV are present. Wood ducks appear to be locally abundant in the numerous forested wetlands and marshy tidal creeks in the project area. Hundreds of tundra swans are seen in the open river and in favored agricultural fields along the river.

The threats to waterfowl throughout their range include

- habitat loss and degradation;
- shoreline and waterfront development;
- invasive exotic plants (e.g., Phragmites) and animals;
- historic and current ditching, dredging or draining;
- urbanization and sprawl, resulting in either landscape fragmentation or the loss of the upland forests, grassland and shrubland that buffer wetlands and palustrine systems;
- mismanagement of habitat buffers;
- disturbance (e.g., jet-skis, recreational boating);
- decreased water quality from non-point-source runoff, sewage pollution, industrial pollution, and erosion and sedimentation;
- algal blooms (red and brown tides);
- conversion of row crops to pine plantation or cash crops;
- oil spills; and,
- the overuse of water resources by municipalities (ACJV Waterfowl Focus Area Reports for BCR 30, 2004).

Yellow-bellied chat: ©Les Brooks

One invasive, exotic species that is a threat to native waterfowl is the mute swan. Most reports and observations of mute swans in the project come from the tip of the Northern Neck and north side of the Potomac River shore. Mute swans are aggressive, voracious consumers of aquatic vegetation, and compete or interfere with native waterfowl using an area.

Current management practices at the refuge for the benefit of waterfowl include protecting wetlands through purchase or easement, providing or advocating for upland buffers around wetlands, and controlling Phragmites the most prevalent invasive species affecting the marshes of the project area.

Shorebirds

Compared to the outer coastal plain, relatively few species of shorebirds use the inland habitats of the project area. Nine species of shorebirds of conservation concern (BCR 30 list) live on the refuge or project area (see table below). Appendix A also provides a summary of how these species rank in the VA WAP and other ecoregional bird plans.

- The killdeer is the most familiar species frequently seen in the project area. Small groups of killdeer scattered throughout plowed crop fields are a common sight in winter.

- At low tide, spotted sandpiper, solitary sandpiper, greater yellowlegs, and lesser yellowlegs can be seen working the intertidal flats in the brackish emergent marshes or riparian sand flats within the project area.

- American woodcock, classified morphologically as a shorebird (i.e. it is in the *Scolopacidae* or "Sandpiper" family of birds), but using a variety of upland and wetlands habitats, is probably the most important species for which the project area could provide some regional or state-level responsibility in the winter and breeding season. In particular, there are many opportunities for the refuge to provide open-field, early succession, moist shrub habitats that would benefit woodcock. The species is present year-round (Spencer, personal observation).

- Wilson's snipe occurs in small flocks in the marshes during the winter and spring (Spencer, personal observation)

Breeding killdeer likely are impacted by the increasing population of ring-billed and laughing gulls combing recently plowed and planted farm fields. Another threat is the gradual loss of farmland altogether to succession or other incompatible land uses (residential development, tree farm conversion). We seek to protect farmlands through purchase or easement as opportunities or funds allow, and as long as the tract lies within the acquisition boundary, but on a larger scale, there is more sprawl than our pace of acquisition can address.

Table 2.7. BCR 30 shorebird priority species on the refuge or project area

Species	Seasons*	BCR 30 Plan Priority
American woodcock**	B, M, W	Highest
Killdeer	B, M, W	Moderate
Greater yellowlegs	M, W	High
Least sandpiper	M, W	Moderate
Lesser yellowlegs	M, W	Moderate
Solitary sandpiper	M, W	High
Semi-palmated plover	M, W	Moderate
Spotted sandpiper	B, M, W	Moderate
Wilson's snipe	M, W	Moderate

*Season of occurrence codes: B=breeding; M=migrating; W=wintering

**American Woodcock are in the *Scolopacidae* (or Sandpiper) family of birds

Waterbirds and Marshbirds

The BCR 30 plan identifies 11 species of waterbirds and marshbirds of conservation concern. They use the marshes, creeks, ponds, river shores of the refuge and our project area. Appendix A also provides a summary of how these species rank in the VA WAP and other ecoregional bird plans.

Table 2.8. BCR 30 waterbird and marsh bird priority species on the refuge or project area

Species	Seasons	BCR 30 Plan Priority
American bittern	B, M	Moderate
Black-crowned night-heron	B, W	Moderate
Coastal plain swamp sparrow	B	Moderate
Common tern	Su occ.	Moderate
Forster's tern	M, S	High
King rail	B, M	Moderate
Least bittern	B, M	Moderate
Marsh wren	B, M, W	High
Royal tern	M, Su	Moderate
Seaside sparrow	B, M	Highest, Tier IV
Sora	M	Moderate
*Season of occurrence codes: B=breeding; M=migrating; Su=Summer; W=wintering		

Of the species of concern listed, the most visible are the Forster's and royal terns, summer residents on the brackish/fresh reaches of the river, where they are often seen perched on fish trap poles by the dozens. Marsh wrens are another highly detectible species in the cattail and big cordgrass marshes of the river and tributaries, but finding them requires venturing far out from the upland. Finding the king rail, sora, American bittern, and least bittern also requires more effort, and may require late-evening or pre-dawn forays by water into the low marsh vegetation of the freshwater tidal marshes. Least bittern and Virginia rail (not listed) were nearly always observed during the marsh bird surveys of the refuge (Spencer, unpublished) and, less frequently, the king rail and sora. Black-crowned night-herons usually are detected infrequently each spring in the alder swamps and beaver marshes. American bittern are a rare sighting during the breeding season, and are not heard calling.

Worthy of mention is the recent discovery of a small breeding population of a rarer subspecies of swamp sparrow, the coastal plain swamp sparrow (*Melospiza georgiana nigrescens*) in three marshes in the project area, one of which is protected by the refuge. Their presence initially was discovered at Mulberry Island (private land) by Fred Atwood in 2004 during the Virginia Society of Ornithology Annual Foray hosted by the refuge, and confirmed the following year, when 14 individuals were found by a team from the College of William and Mary Center for Conservation Biology. Wildlife biologist Sandy Spencer also led the CCB to another potential location, Island Farm Marsh, which proved fruitful. About five individuals were heard or seen in that location, and more singing males have been detected during marsh bird surveys in subsequent years at the Island Farm Marsh and Mulberry Island (Spencer unpublished).

The first coastal plain swamp sparrow was described from a specimen taken in 1940 along the Nanticoke River on the Eastern Shore of Maryland. Breeding bird atlas work in the 1980s showed that populations existed on the Eastern and Western shores of the upper Chesapeake Bay, but the center of abundance is in southern New Jersey and Delaware along the Delaware Bay. Recent surveys have shown a dramatic decline. Other than a few observations at Dyke Marsh on the Potomac River, there are no modern breeding records for Virginia until those recent sightings on the Rappahannock River. These two groups represent the largest concentration of breeding birds now known throughout the Chesapeake Bay (Bryan Watts, June 14, 2005, posted on Virginia Bird Listserve). Both Mulberry Point and Island Farm Marsh are tidal marshes in the oligohaline section of the river. The sparrows were in vegetation dominated by rushes, big cordgrass, and scattered *Halimifolia* spp. (saltbush or groundsel tree).

A small population of breeding seaside sparrows also has been observed at Island Farm Marsh each year at least since 2002 (Refuge Bird List 2006, unpublished data). That is noteworthy, because one source claims that the world's entire population is supported by "the band of coastal salt marsh on the edge of the eastern biome" (Rich, et al. 2004), yet the collective observations of the species by birders identify it as a rare dispersant breeding up the Potomac, Rappahannock, York and James rivers (Rottenborn and Brinkley 2007).

Some other non-listed birds of interest the project area are great blue herons, which are here year-round and have numerous small rookeries along the tidal portion of the river and tributaries. Ring-billed gulls and laughing gulls are a large group in terms of flock sizes in farm fields in the winter. Although they frequently have been associated with farm fields (and now landfills) for many years, their numbers have increased (Lloyd Mundie, farmer, personal communication). Green herons also are seen year-round, although they are less common in the winter. Pied-billed grebes have been noted in the freshwater wetlands on the refuge during the breeding season (Spencer, personal observation), but their appearance varies from year to year depending on rainfall. Great egrets are somewhat sporadic in their appearance, and generally are only present in the spring and summer. In the summer, Caspian terns and an occasional common tern forage on the river and tributaries in the project area.

Fish and other Aquatic Species

A 1993 report by our Virginia fisheries program leader states that the Rappahannock River fisheries resources are very diverse; at least 62 fish species have been identified (Spells, 1993). The species it lists fall into two main groups, finfish and shellfish, then into subgroups. The table below lists some of the most prevalent species from that report, along with their current ranking in the VA WAP. We distinguish between anadromous and catadromous fish in the table. Anadromous fish are those that spend a large portion of their life cycle in the ocean and return to freshwater to breed. Catadromous fish are opposite; they spend a large portion of their life cycle in fresh water and go to the ocean to breed. Refer to appendix A for additional details on the definition of the rankings.

Table 2.9. VA WAP fisheries priority resources in the Rappahannock River

GROUP Subgroup	Species	Scientific Name	VA WAP Priority*
FINFISH			
Anadromous	Alewife	*Alosa pseudoharengus*	Tier IV
	American shad	*Alosa sapidissima*	Tier IV
	Atlantic sturgeon	*Acipenser oxyrhynchus*	Tier II
	Blueback herring	*Alosa aestivalis*	
	Hickory shad	*Alosa mediocris*	
	Striped bass	*Morone saxatilis*	
Catadromous	American eel	*Anguilla rostrata*	Tier IV
Resident	Blue catfish	*Ictalurus furcatus*	
	Channel catfish	*Ictalurus punctatus*	
	Largemouth bass	*Micropterus salmoides*	
	White perch	*Morone Americana*	
	Yellow perch	*Perca flavescens*	
	Sunfish	*Lepomis* spp.	
Migratory	Altantic croaker	*Micropogonias undulates*	
	Atlantic menhaden	*Clupea harenghus*	
	Bluefish	*Pomatomus saltatrix*	
	Spot	*Leiostomus xanthurus*	
Nursery	Atlantic croaker	*Micropogonias undulatus*	
	Atlantic menhaden	*Clupea harengus*	
	Spot	*Leiostomus xanthurus*	
SHELLFISH			
Benthic	Eastern oyster	*Crassostrea virginica*	
	Hard clam	*Mercenaria mercenaria*	
Epibenthic/migratory	Blue crab	*Callinectes sapidus*	

* Rank in the Virginia Wildlife Action Plan, 2005. See Appendix A for additional details on ranking. Tier I species are in critical need of conservation action; they are at extremely high risk of extinction or extirpation. Tier II species are in a very high need for conservation action; they are at high risk of extinction or extirpation. Tier III species are in high need for conservation action; extinction or extirpation is possible. Tier IV species are in moderate need for conservation action; they are may be rare in parts of thier range, particularly in the periphery.

The report also states that other species may be ecologically important, such as those that form the primary forage base for recreationally or commercially important fish species or terrestrial wildlife such as bald eagles, ospreys, and wading birds. Those ecologically important species include the Atlantic menhaden, bay anchovy (*Anchoa mitchilli*), gizzard shad (*Dorosoma petenense*), hogchoker (*Trinectes maculates*), mummichog (*Fundulus heteroclitus*), Atlantic silversides (*Menidia menidia*), and rough silversides (*Membras martinica*).

As major threats to the vitality of the fish assemblages of the river, the report cited non-point runoff from agricultural and residential land uses, water diversion projects, residential development, and blockages to fish passages. Because the Embry Dam across the river in Fredericksburg was removed in 2004, fish spawning and nursery areas may advance upriver, if water quality and other habitat conditions permit. In some cases, beaver dams hamper fish passage in creeks in the project area.

Anadromous fish are a Federal trust resource, and are a particular concern for many of our conservation partners. The Chesapeake Rivers Site Plan (TNC) identifies anadromous fish as a conservation target. Researchers continually generate new information about the life histories and threats to these fish species. We obtained much of our information from extensive communications with fish biologists at Virginia Commonwealth University (VCU) studying the migration and spawning patterns of Chesapeake Bay anadromous fish populations (McIninch and Garman, personal communication 1999; TNC 2001).

Spawning areas for herring, shad and alewife, both confirmed and probable, are reported for the Rappahannock River in a 1970 Annual Progress Report for the Anadromous Risk Project (Virginia Institute of Marine Science, through the Bureau of Commercial Fisheries). The creeks in the project area were designated spawning areas because field crews found running-ripe fish, spent fish, eggs, or larvae. Those creeks are the Balls, Brockenbrough, Cat Point, Farmers Hall, Gingoteague, Goldenvale, Hoskins, Jetts, Jugs, Little Carters, Little Totuskey, Millbank, Mt. Airy Mill Pond, Mt. Landing, Mount Swamp, Muddy, Nanzatico Bay, Occupacia, Peedee, Piscataway, Portobago, Richardson, Skinker, Sluice, Totuskey, Troy, Ware, Waterview, and Wilna.

With 16,000 acres of suitable spawning habitat, the Rappahannock River ranked third after the Potomac and James rivers. In 1999, VCU evaluated the essential habitats of anadromous clupeid fishes of the Chesapeake Bay and barriers to migration. Alewives were spawning over gravel and road rubble in Hazel Run at the fall line and in clean sand substrates in Occupacia Creek, which was interesting, because coarse gravel or rubble is their preferred substrate. Spawning blueback herring were associated strongly with fine sand or silt substrates in deeper tidal streams and in landscapes dominated by wetlands (McIninch and Garman 1999).

During the 2002 drought year, the Virginia Commonwealth University, Center for Environmental Studies sampled fish above County Bridge (route 637) over Cat Point Creek, in about the middle of the main stem. That sampling found a few species of concern in the VA WAP: alewife (Tier IV), American eel (Tier IV), mud sunfish (Tier IV), and least brook lamprey (Tier IV). You may obtain from refuge headquarters a complete list of species found during that study.

Alewife: Duane Raver

The Embry Dam in Fredericksburg formerly stood at roughly the fall line of the river. Below the dam site, the river is tidal with mucky bottom, and not suitable for spawning shad. Now, some of the few shad remaining may access more than 73 miles of previously blocked shad habitat according to Alan Weaver, Virginia Fish Passage Coordinator, in "People, Land and Water" (DOI, November 2003). In 2003, the VDGIF and our Harrison Lake National Fish Hatchery released about 412,000 American shad fry into the Rappahannock River at Kelly Ford above Fredericksburg.

Historically, Atlantic sturgeon (*Acipenser oxyrhynchus*) were found throughout the Chesapeake Bay and its tributaries, including the Rappahannock River. Populations began to decline in the late 19th century due to commercial overfishing. Additionally, sedimentation, dredging, and excessive nutrients have led to spawning and nursery habitat loss in the bay, which could be contributing to the species' recent decline (Secor et. al 2000). The management of Atlantic sturgeon falls under the auspices of the Atlantic States Marine Fisheries Commission interstate management plan with the goal of restoring Atlantic sturgeon spawning stock to levels that allow for sustainable fisheries and ensure viable spawning populations (VDGIF 2005). An experimental stocking program of the Chesapeake Bay led to the capture of 15 Atlantic sturgeon (seven hatchery) from the Rappahannock River in 1997. A 2007 status review of Atlantic sturgeon found that the species no longer spawns in the Rappahannock but currently uses the river as a nursery. The same report stated that the distinct population segments of Chesapeake Bay were likely (> 50 percent chance) of becoming endangered in the near future and recommends it be listed as threatened under the ESA (Atlantic Sturgeon Status Review Team 2007).

Recently, conservationists have become concerned about the decline of Atlantic menhaden, a primary food for striped bass, bluefish, sea trout, tuna and sharks, and believed to be the "breadbasket" of the bay (Chesapeake Bay Program, 2006). About 106,000 tons of the small, oily fish are harvested each year for commercial uses. The firm "Omega Protein" does most of that harvesting on the East Coast, and has a large plant in Reedville on the Northern Neck. Interest groups, such as Menhaden Matter, an alliance of conservation organizations, petitioned the Virginia General Assembly to place a five-year cap on its harvest to avert depletion (menhaden is the only fishery that this legislative body regulates). In July 2006, Virginia Governor Tim Kaine announced the capping of the industrial menhaden fishery in the Chesapeake Bay at 109,000 tons per year. The goal is to bring the state into compliance with the Atlantic States Marine Fisheries Commission objective of holding the menhaden harvest in the bay at the average level of the past 5 years, while additional research is conducted to better understand menhaden's role in the bay and determine the best way to manage the fishery to preserve it. That proposal applies only to the large-scale menhaden industry, which uses fleets of boats and spotter planes to catch whole schools of fish, and not to the commercial bait fishery, in which watermen net menhaden for use as fish and crab bait (Chesapeake Bay Foundation 2006).

The VA WAP includes 15 species of fish on their list of Species of Greatest Conservation Need. A number of those species associated with the Rappahannock River are now subject to conservation or recovery management plans to reverse declines in recruitment and viability through coordinated programs to manage the harvest and improve water quality. The Service is a partner in those programs. They include the blue crab, native oyster (*Crassastrea virginica*), American eel, Atlantic striped bass, Atlantic sturgeon, shad and river herring (*Alosa* spp.), and bluefish. The VA WAP provides a review of the individual plans at (www.vawildlifestrategies.org).

Channel catfish, although not native, are now considered naturalized. Blue catfish were introduced more recently and have the potential to displace or impact native and naturalized fisheries in sympatric waters (Odenkirk, personal communication, 2006). Other non-native species known to the project area are the common carp, largemouth bass, warmouth, bluegill, and redear sunfish.

Rare Crustaceans

The VNHP has identified and ranked crustaceans of potential interest in the project area. Little is known about extent of the full occurrence of these rare crustaceans throughout the project area, including the refuge. However, the likelihood that they may occur in other ravines with similar topography, hydrology, soils and other characteristics may be possible as only a few attempts to survey the ravines for rare species was possible during the Natural Heritage Inventory of 2001 and 2002.

Our best contribution to their conservation may be to acquire or protect the uplands surrounding the headwaters of these ravines, prevent soil and structural disturbance to these ravines, and follow or encourage private landowners to follow strict best management practices during any logging or other management activities adjacent to these ravines. A description of what we know about their occurrence in the project area follows.

- Price's cave isopod (*Caecidotea pricei*) (G3-G4, S2): Several individuals were found in 2000 in a leaf-packed seep emanating from the creek bottom at Owl Hollow. They are known mostly from cave systems in the mountains. This is the easternmost known location in Virginia for *Caecidotea pricei* (Belden, et al. 2002).

- Rappahannock spring amphipod (*Stygobromus spp.*) (G1-G2, S1S2): Approximately 5–10 individuals were found in 2000 in a leaf-packed seep emanating from the creek bottom at Owl Hollow. The *Stygobromus* species have been examined by John R. Holsinger of Old Dominion University, and provisionally recognized as a species new to science. This undescribed species is known globally from only one other location, Skinkers Corner Seep in Caroline County, where two individuals were collected in 2000 (Belden, et al. 2002).

Mammals

We have not conducted formal surveys of mammals, other than a small mammal survey in the summer of 2001 conducted as part of the study evaluating the habitat for grassland breeding birds.

The Virginia Fish and Wildlife Information Service database is a good source of information for expected and documented species, but not for abundance data, nor for cryptic species or endemic species, as this area of Virginia has received little survey work. The most familiar mammals are white-tailed deer, raccoon, red fox, gray fox, beaver, river otter, mink, Virginia opossum, groundhog, Eastern cottontail, gray squirrel, feral cats, and domestic dogs. Occasionally, anecdotal reports of bobcat, black bear and coyote are provided from local sources, and of these, bobcat is the most frequently reported. We know of five species of shrew and two moles. Little is known about the species composition and richness of the bat community in the project area without mist-netting or other bat detection and identification means. We suspect we have at least eight species of bats in the refuge project area, according to Lindzey (1998). None of the mammals known to inhabit the refuge is listed by the Virginia WAP as Species of Greatest Conservation Concern.

About 15 species of Cetaceans (whales, dolphins, and porpoises) have been recorded in Virginia and the western tributaries of the Chesapeake Bay, but these are rare occurrences and not likely in the relatively shallow and brackish waters of our project area.

Amphibians

Amphibians are sensitive to changes in water quality and quantity, acidification, nutrient and chemical pollution. They have permeable skin, a complex life cycle, and are often habitat specialists. As a group, they are also wide ranging. These traits make amphibians potentially excellent indicators of environmental health (Heyer, et al. 1994).

Since 2001, anuran (frog and toad) call surveys have been conducted on selected tracts of the refuge with the aim of broadening the taxa of survey groups of indicator species to assess habitat quality and health, and to monitor the status and distribution of this sensitive group. Amphibians are an important component of many ecosystems because their total biomass may equal small mammals in some parts of the world and are more than twice that of all bird species (Burton and Likens, 1975). Since the 1980s, scientists all over the world have been reporting a downward trend in anuran populations. In 1991, international scientists established the Declining Amphibian Populations Task Force to determine the extent and causes of all declining amphibians (DAPTF 1991). The North American Amphibian Monitoring Program (NAAMP) is part of this global DAPTF effort. In 1995, NAAMP recommended volunteer based auditory surveys as the best method for monitoring anurans. The basic methodology we follow was developed in Wisconsin and has been adopted region-wide (Mossman, et. al.1998).

All of the refuge tracts provide some habitat and refugia[3] for amphibians. Because of the abundant rainfall, the many ravines containing perennial or intermittent seeps, marshy freshwater creeks and beaver dams, and topography and soils that permit standing water to pond on the uplands meadows and forests, opportunities abound for the natural creation of vernal pools for mating and depositing egg masses. Agriculture and the timber industry are dominant land-uses in the project area and each involves practices that have negative impacts on the health and distribution of these sensitive fauna. These include applications of insecticides, herbicides and fertilizers; the disturbance of topsoil; and increased sunlight reaching the soils, all of which change their moisture levels. Providing vegetated buffers around moist soil units, ponds, drainages and observance of forestry best management practices are important steps toward integrating healthy habitats for herptofauna and intensive economic land uses.

Surveys conducted by VDGIF in 2003 recorded 17 species for the coastal plain, which is 85 percent of the 20 species recorded for the state (Schwab, Jan. 2004, unpublished data). Of those 17 species, we have documented 12 on the refuge. The missing five are not known to occur in this section of the coastal plain. To date, the surveys have detected no uncommon species; however, this is the first time these relatively common species of the western coastal plain have been documented in this rural area.

We have attempted amphibian surveys as time and staff resources permit, or with support from partners. With more than 50 river miles to cover, a complete survey that would allow population analysis of size or trends would be a huge effort. As a result, the anuran call surveys for this refuge mostly serve to determine presence/absence, which if conducted over many years, would still be useful in providing information on what is happening to anuran populations in the project area.

The call count surveys of anurans on the refuge regularly record the following 12 species (S. Spencer, unpublished data). None is state-listed.

Table 2.10. Twelve species regularly counted on anuran call surveys

Species Name	Scientific Name
American toad	*Bufo americanus*
Fowler's toad	*Bufo fowleri*
Eastern cricket frog	*Acris crepitans crepitans*
Cope's gray treefrog	*Hyla chrysoscelis*
Green treefrog	*Hyla cinerea*
Northern spring peeper	*Pseudacris crucifer*
Upland chorus frog	*Pseudacris ferarium*
American bullfrog	*Rana catesbeiana*
Wood frog	*Rana sylvatica*
Northern green frog	*Rana clamitans melanota*
Pickerel frog	*Rana palustris*
Southern leopard frog	*Rana sphenocephala*

We do not survey regularly for other amphibians and reptiles. In June 2005, our refuge biologist arranged for the Virginia Herpetological Society (VHS) to hold its annual meeting on the Northern Neck and conduct field trips on the refuge. In one weekend, they recorded 35 species of amphibians and reptiles, including 6 salamanders, 8 turtles, 2 lizards, and 9 species of snakes. Many of those were county records, previously undocumented. See appendix A for a list of reptiles and amphibians on the refuge and definitions of the Tier rankings mentioned below.

Snakes

Two state-listed species were observed on refuge property or in the project area: the hognosed snake (*Heterodon platirhinos*) (Tier IV), and the rainbow snake (*Farancia erytrogramma erytrogramma*) (Tier IV). Also added to the refuge species list after the VHS field trips are smooth earth snake (*Virginia valeriae*), and either northern or southern ring-necked snake (*Diadophis punctatus edwardsii* and *punctatus*, respectively). The project area lies in the integration zone of those two species.

We expect to find a few more species of snakes in the project area that have not been documented: the corn snake (*Elaphe guttata guttata*), mole king snake (*Lampropeltis calligaster rhombomaculata*), milk snake (*Lampropeltis triangulum triangulum*), northern scarlet snake (*Cemophora coccinea copei*), northern brown snake (*Stoneria dekayi dekayi*), and northern red-bellied snake (*Stoneria occipitomaculata*).

Snakes are usually semi-territorial and remain close to the ground in the same geography, they are potentially good indicators of environmental contamination or damage. Moreover, snakes are upper level carnivores, and thus, their illnesses may reflect infections or environmental damage to various other life forms. During the VHS 2005 field searches, a number of snakes were found to have lesions on their skin and eye infections. That phenomenon occurred irrespective of species.

That prompted one of the VHS members, a pathologist, to return with experienced volunteers to collect snakes to determine the incidence, severity, histopathology, and microbial characteristics of external skin lesions in snakes at the Rappahannock River Valley refuge and two other refuges in the complex, the James River and Presquile refuges. That study, begun in 2006 to span 3 years, surveys each site in the spring and fall of each year. Those surveys should verify whether the incidence and severity are greater among snakes living in the more industrially or agriculturally exposed locations, provide unique baseline data on snake health, and test the value of conditions observable in the field as indicators of environmental conditions.

Although the incidence of lesions declined over subsequent surveys, a few snakes had some infections. The most commonly observed external skin lesions were necrotic or swollen scales infested with fungi. In some cases, the lesions were deeper than in others. One black racer exhibited a swollen mass, which was due to infection with *Pseudomonas* spp. bacteria and no fungi.

In spring 2007, we began to pit-tag the snakes at all of the refuges, so that we can identify re-captures in the future. Among both black racers and northern water snakes, multiple *Strongyloides* parasites were found in the mouth of some snakes. Protozoan parasites (most likely Hepatozoa) infected some erythrocytes in the blood smears from most water snakes and some black racers. That is not a serious problem, unless the infection is so high as to cause anemia (Ware, unpublished data).

Invertebrates

The terrestrial and aquatic invertebrate community is a significantly important component of almost any temperate or tropical ecosystem and more than outweighs all the other taxa combined, in species richness, sheer abundance, and probably, biomass. E.O. Wilson (1992) estimated that the class contained more than 750,000 described species out of the total number of known species of all organisms (at the time) of 1,413,000. That is certainly an underestimate of the actual measure of insect species, since new ones are being discovered as previously unexplored or inaccessible areas become available to science. The total number of tropical species of insects alone might well be 30 million (Wilson 1992).

Arthropods, including insects, are so vital to the functioning of the earth's biological and nutrient cycles that, if all were to disappear, humanity would probably fade within a few months, and mammals, reptiles and birds would go extinct about the same time (Wilson 1992). This group serves vital functions as pollinators, detritivores (aiding in the decomposition of matter and returning nutrients to the soil), and as a prey base to insectivorous mammals, reptiles, fish and birds. Few formal surveys for invertebrates have been conducted on the refuge, but casual observations show a rich diversity of terrestrial invertebrates such as spiders, beetles, ants, dragonflies, butterflies, moths, flies, wasps, and bees, and certainly a healthy population of ticks, chiggers, and mosquitoes.

Searches for Odonata (dragonflies and damselflies), using sweep nets and UV-light traps, were conducted in 2001 as a component of the Natural Heritage Inventory for the refuge. The surveys were primarily conducted in the freshwater wetland and partly in the grasslands of the refuge. Four rare species were targeted: treetop emerald (*Somatochlora provocans*, G4, S2), burgundy bluet (*Enallagma dubium*, G5, S2), Southern sprite (*Nehalennia integricollis*, G5, S2), and sphagnum sprite (*Nehalennia gracilis*, G5, S2).

Of the Lepidopterans, or butterflies, three species were targeted: two-spotted skipper (*Euphyes bimacula*, G4, S1), black dash (*Euphyes conspicua*, G4, S1S3), and rare skipper (*Problema bulenta*, G2G3, S1). These rare species were not found during the searches conducted (Belden, et al. 2002). However, three watch-listed dragonflies (Division of Natural Heritage) were found: the four-spotted pennant (*Brachymesia gravida*), banded pennant (*Celithemis fasciata*), and royal river cruiser (*Macromia taeniolata*) were observed in 2001 along the Rappahannock River and its tidal marshes (Belden, et al. 2002).

Twenty-nine species of *Odonata*, dragonflies and damselflies, have been documented on the refuge; 26 are from the Natural Heritage survey. Fifty species of butterfly also have been documented on the refuge, and 16 moth species. Appendix A includes species from this class of invertebrates that have been observed here.

In 2001, as a component of the regional grassland breeding bird study, a survey of the invertebrate fauna of the seven fallow fields enrolled in the study was conducted by Virginia Tech's Conservation Management Institute to measure the prey base for insectivorous grassland birds during the breeding season. Samples were collected using pitfall and sweep techniques on fields in three different tracts of the refuge: the Mothershead, Tayloe, and Wilna tracts. More than 4,500 insects were collected. The collections were sorted and identified to the level of order, but not identified to species. Fifteen orders of insects were identified.

A summary of the total numbers of individuals by order, and rate and method of capture is available upon request from the refuge headquarters. Three of the Wilna fields had the highest overall abundance of insects, possibly because those fields recently were taken out of cropland production and were overtaken by the pioneer species horseweed (*Conyza canadensis*). There was also an accompanying irruption of two arthropod species, thrips and grasshopppers (Spencer, personal observation).

In August 2008, the refuge participated in a nation-wide survey of native bees in grasslands led by the U.S. Geological Survey. Gauging the diversity of native bees will provide an indication as to the habitat diversity and quality of grasslands and their contribution to pollinator species. All surveys were conducted on the Wilna grasslands. Insect surveys in other habitat types have not been conducted. USGS notes that the *Eucerine* species (*Melissodes* and *Svastra*) indicates high quality habitat with plenty of large composites available in the landscape (especially true for *Svastra*). Also noted is that one of their relatively uncommon nest parasites was also caught (*Triepeolus lunatus)*.

Two additional species worth noting, *Lasioglossum creberri*mum and *Ptilothrix bombiformis*, are both good indicators that wetlands are in the area. *Lasioglossum creberrimum* is usually associated with low wet coastal areas and *P. bombiformis* is usually associated with Hibiscus plants, (there are tidal wetlands nearby).

Lasioglossum versatum sensu Mitchell is a species that likes southern coastal plain habitats. Its odd name comes from the fact that its taxonomic identity is being challenged and recent (but unpublished findings) indicate that this species matches what Mitchell described as *L. versatum,* but in actuality does not match the type specimen for that species. The taxonomists will work it out in the near future and a new name will be given.

With respect to patterns among fields, there is a lot of conformity among these neighboring fields as far as species types and numbers go. No field appears much different from the others except that Wilna Field 7 has elevated numbers of *M. comptoides* for some unknown reason (Droege and Shapiro, 2009). Appendix A includes known insect species for the refuge, but the native-bee survey results are provided below.

Table 2.11. Native bee species documented during native bee survey (no common names available)

Scientific Name	Wilna Field 1	Wilna Field 2	Wilna Field B	Wilna Field 4	Wilna Field 7	Grand Total
Agapostemon virescens	5	1	2	1	5	14
Augochlora pura					1	1
Augochlorella aurata			2			2
Bombus griseocollis					1	1
Halictus ligatus/poeyi	1	1	1			3
Hylaeus affinis/modestus			1			1
Lasioglossum bruneri					1	1
Lasioglossum coreopsis			2			2
Lasioglossum creberrimum				1		1
Lasioglossum versatumsensumitchell	1		2			3
Melissodes bimaculata					1	1
Melissodes comptoides	1		3	4	31	39
Melissodes denticulata					1	1
Ptilothrix bombiformis					1	1
Svastra atripes			1			1
Triepeolus lunatus		1				1
Grand Total	**8**	**3**	**14**	**6**	**42**	**73**

Where time and staff resources permit, we may also implement the Monarch Larval Survey. The monarch survey will assist the refuge in making better determinations on appropriate dates for fall mowing and burning so as not to destroy the larva of the migrating generation of monarch butterflies. There is little local data on period in the project area when last generation of the year emerges from their cocoons.

Appendix A includes known insect species for the refuge.

Insect Pests

Gypsy moth outbreaks have not yet been recorded or observed on refuge tracts. Scattered infestations of pine bark beetles have been observed on several loblollies on the Wilna tract (Spencer, personal observation).

Refuge Visitor Services Program

As mentioned in Chapter 1, the Refuge Improvement Act of 1997 listed six wildlife-dependent recreational activities as "priority uses" of the System. They are: environmental education, fishing, hunting, interpretation, photography, and wildlife observation. At Rappahannock River Valley Refuge, we currently provide opportunities for all six priority uses. When developing plans for recreational uses, we first evaluate the potential for negative impacts to wildlife, and complete a compatibility determination to ensure that the use does not materially interfere with purposes of the refuge or the mission of the Refuge System. We seek locations, and create designs, that will provide high quality wildlife experiences for visitors. We also take into account our ability to maintain programs and facilities over time with existing resources and funding. Our efforts are increased by assistance from our Friends group, volunteers, and other partners, without whose help we would be unable to develop current and proposed recreational programs.

Priority Wildlife-Dependent Recreational Uses

We identify below the current opportunities on the refuge for engaging in the six priority public uses of national wildlife refuges: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Visitors travel from within Virginia and its neighboring states to participate in those activities allowed on the refuge. The most popular are observing and photographing wildlife, hunting white-tailed deer, and fishing.

We have not conducted formal surveys of annual refuge visitation, despite our desire to do so. However, we have estimated the number of visitors by activity, from visitor contacts at refuge headquarters, road-traffic counts, program attendance, and observations by our refuge staff and volunteers. We reported the following visitor numbers by activity in 2008.

Table 2.12. Number of refuge visitors by activity in 2008

Activity	Number of Refuge Visitors
Office Visits	75
Freshwater Recreational Fishing	360
Big Game Hunting	972
Wildlife Observation	325
Nature Photography	100
Environmental Education Programs On-site	153
Interpretative Programs On-site	218
On-Site Subtotal	2,203
Environmental Education Programs Off-site	412
Interpretative Programs Off-site (includes Tappahannock RivahFest participation)	15,287
Off-site Subtotal	15,699
Total	**17,902**

We expect visitation at the refuge to increase in the coming years commensurately with statewide and regional trends, our community outreach program, which is raising greater awareness of refuge opportunities, and our planned development of additional visitor facilities.

Due to the layout of this refuge, we offer and manage public use differently on each tract. The Wilna tract is the only tract now open year-round, from official sunrise to official sunset. Other tracts, described below, are open only by reservation. At the Wilna tract, as with other properties, public closures could be implemented at any time in the case of emergency or other unforeseen events. No fees are associated with recreation on the refuge, except the white-tailed deer hunt application and permit fees. Figures 14-18 in chapter 3 depict the existing and proposed public use infrastructure on

Wilna Pond: USFWS

our existing refuge tracts. Of the combined total of 13.75 miles of roads on the refuge, 9.21 miles are open to the public. Our trail system comprises 2.40 miles.

In June 2004, we opened the Wilna tract to wildlife observation and photography, environmental education, interpretation, and recreational fishing. These programs were established in addition to previously permitted deer hunting.

- Public access is limited to designated roads and trails. You may travel the roads by vehicle, bicycle, or on foot.

- Specific refuge fishing regulations are in effect, in addition to state fishing regulations. The Refuge regulations can be found in the Code of Federal Regulations (CFR) at 50 C.F.R. § 32.66).

- Visitor facilities consist of an outdoor classroom site, which includes accessible nature trails, a 35-acre freshwater pond with an accessible fishing pier, hand-launch boat/canoe access, an accessible rest room, interpretive panels and brochures, and a parking lot that can accommodate several buses and cars. We installed interpretive panels and two additional panel frames in 2007.

- A major addition to that tract, and to the refuge, is a multi-purpose building. It provides a classroom facility for visiting school groups; a meeting room for the refuge staff, Friends group, and conservation partners; and temporary housing for refuge volunteers and researchers.

- An additional, rustic, forested trail is located near the refuge headquarters building. The Virginia Birding and Wildlife Trail, a network of wildlife trails located throughout Virginia, includes the Wilna tract.

The Tayloe tract and Port Royal Unit are included on the Virginia Birding and Wildlife Trail. Those two tracts, and the Hutchinson tract, are open by reservation for wildlife observation, photography, and interpretation. Each offers a small parking area and rustic roads or trails. Informational panels and brochure racks are scheduled for installation at each tract in 2008. One was installed at the Hutchinson tract in 2005. In addition, the Friends group is designing a canoe launch and a butterfly garden that, with grant approval, will be installed at the Hutchinson tract in 2008.

The refuge environmental education program is being developed with plans for outreach to area schools. The program will offer an educators workshop to provide refuge and program information to area teachers, and a take-home Educator's Guide. Visits will be self-guided, with educators designing their lesson plan geared toward the state's "Standards of Learning" requirements, and using refuge supplies (binoculars, microscopes, nets, water testing kits, etc.), as needed.

White-tailed deer hunting is permitted on designated dates, on specified tracts of the refuge. The refuge hunt permits include special regulations to maximize hunter safety and minimize damage to refuge resources. The fees charged for refuge hunt permits currently are $25 for two weeks of archery hunting and $10 per day for muzzle-loading and shotgun. Archery hunting is available during four weeks of the six-week state season on the Hutchinson, Thomas, Mothershead, Toby's Point, Tayloe, Laurel Grove, Wright, Franklin, and Port Royal tracts. Muzzle-loader hunting is available for three days and shotgun hunting is available for six days, both on the Hutchinson, Tayloe, Wilna, Laurel Grove, Wright, and Toby's Point tracts. In cooperation with VDGIF, our deer hunt program incorporates the use of a computer registration program that receives refuge applications and performs the lottery drawing and subsequent notifications, for a hunter application fee of $7.50.

Other Public Use Activities

Activities not allowed

In determining the appropriateness and compatibility of public uses of the refuge, we determined some activities "not appropriate," either because they were inconsistent with executive orders, Service policy, or approved refuge management plans, or because they would divert refuge resources from accomplishing priority tasks, not contribute to a better appreciation or understanding of refuge resources; or, conflict with other, priority uses.

Those are use of all-terrain vehicle use, camping, dog training and field trials, no pets on trails and roads, horseback riding, jogging off-road, bicycling off-road, picnicking, swimming and sunbathing, and use of pursuit dogs for hunting.

Law enforcement concerns

Most visitors respect the refuge rules and regulations on public uses and activities. However, some choose not to. Since we staffed the refuge in 1999, we have observed the recurrence of several unauthorized public uses at the refuge. Those include releasing or allowing the presence of free-roaming dogs (primarily deer chase hounds), camping, trespassing on refuge beaches and other areas closed to the public, setting campfires, and illegally hunting. Since the refuge was established, we have not allowed those activities for the following reasons.

- First, except for hunting, those activities are not wildlife-dependent recreational uses, nor are they necessary for the safe, practical, or effective conduct of a priority public use.
- Second, they are likely to cause the disturbance of wildlife in critical habitats. Specifically, due to the predominant choice of shoreline locations for those activities, they cause the flushing of bald eagles from roosting areas.
- Finally, they are likely to interfere with the visitors engaging in priority public uses.

The refuge hired its first full-time law enforcement officer in 2004. Through consistent outreach, education, and enforcement, we are reducing the frequency of most of those activities. However, despite refuge regulations against them, some of those activities persist, and remain significant law enforcement issues.

Hunting deer with chase hounds, a long-standing tradition in this area, involves releasing the dogs to track and chase deer. No state or county regulations require that dogs be confined to private property. Therefore, their owners allow many domestic dogs to roam free. Unfortunately, free-roaming dogs inadvertently cross the refuge boundaries, and can cause the significant disturbance and probable mortality of ground-nesting birds that use refuge grassland habitats, particularly during the breeding and nesting seasons.

To resolve that issue, we started a plan in 2006 to issue special use permits that allow dog owners or those responsible for the dog(s) access to the refuge during the state deer hunt season to *retrieve* their dogs. The permit conditions state that any dog trespassing outside of the state deer hunt season may result in the issuance of a notice of violation to the dog owner. We hope this plan will reduce the number of dogs trespassing during the critical bird breeding and nesting seasons. All unauthorized domestic animals on the refuge are subject to provisions in 50.C.F.R § 28.42 and 28.43.

Camping, trespassing on refuge beaches, and making campfires are other non-wildlife-dependent activities that have received considerable attention. Before the refuge purchased several stretches of sandy beach along the Rappahannock River, the local public regularly used those privately owned tracts for seasonal recreation.

Our increased monitoring of those properties has resulted in numerous contacts with people camping or parking their boats on refuge beaches, some apparently unaware that the property was federally owned or that their activities were illegal. By posting boundary signs along shorelines subject to trespass, and through educational contacts by law enforcement, we expect the occurrence of those activities to decrease.

Our law enforcement division suspects illegal hunting on several tracts, and is closely monitoring them in cooperation with the VGDIF Conservation Police. As before, by posting boundaries, increasing public awareness of refuge properties, the Federal regulations that apply to them, and cooperative law enforcement we expect this illegal activity to decrease.

Archaeological and Historical Resources

A number of small surveys have been done in compliance with section 106 of the National Historic Preservation Act. However, there has been no overview to identify archaeological sites in the refuge in compliance with section 110 of that act. Despite the lack of a broad survey and the small scale of the present land holding of the refuge, 36 archaeological sites are recorded on it. Of those, 16 are Native American sites dating from prior to European contact. The remaining 20 date from the late 17th to the early 20th century, and are mostly farm sites. The standing house and detached kitchen-laundry building of the Wilna Plantation were both built in the early 19th century. Both structures have been determined eligible for inclusion on the National Register of Historic Places. We use the house now as the refuge office, and the kitchen-laundry as a staff residence.

Pre-Contact Sites

The Native-American occupation of Virginia appears to have begun in what archaeologists call the Paleo-Indian Period (ca. 14,000 to 11,500 years ago). However, the oldest sites identified on this refuge date to the Late Archaic Period (ca. 5,500–3,000 years ago), and most appear to date to the Woodland Period (ca. 3000 to 400 years ago). Sea level rise and erosion were fairly rapid from Paleo-Indian times until the Late Archaic, hindering the development of shellfish beds and, perhaps, discouraging settlement on the changing floodplain of the lower Rappahannock. Erosion and shifts in the river course may have destroyed Archaic and Paleo-Indian Period sites or hidden them under later alluvium. As most current refuge lands are on the floodplain and first terrace of the river, that lack of evidence for earlier sites may reflect preference in the earlier time periods for settlement on higher ground, such as the Essex Scarp. The absence of such sites may also reflect the small amount of archaeological survey that has been done on the refuge.

Overall site density on the refuge actually may be quite high. A recent archaeological survey for minor road improvements on three refuge tracts involved only limited subsurface testing in short linear transects, but found nine Pre-Contact sites that had never been reported (Marquez et al. 2008). Few of those sites revealed datable artifacts. When datable artifacts were found, they usually included potsherds from the Woodland Period, a time when corn agriculture became widespread and the Pre-Contact population was at its peak.

Following centuries of relative stability, sea-level rise has again accelerated remarkably in recent decades, and bank erosion is probably increasing in places where vegetation is not well established. Archaeological sites at the edge of steep bluffs along the river or its tributaries would be at greatest risk, especially if on outside bends of the watercourse or exposed to strong currents and wind-driven waves. Nevertheless, we are not aware of any Pre-Contact or 17th-century Native American sites on the refuge that are now experiencing erosion. However, that may be simply because we have not searched the refuge shorelines systematically for archaeological sites.

Historic Sites

The first recorded encounter between Europeans and Native Americans in the valley happened in 1603, when the crew of Captain Samuel Mace's trading ship treacherously killed a Rappahannock chief and kidnapped several others of his tribe. While a prisoner of Opechancanough in December of 1607, Captain John Smith briefly was taken to their main village (near present-day Tappahannock) to be investigated as a suspect in that crime. In August 1608, he returned during his second expedition, and fought several skirmishes with the Rappahannock, one of which occurred along the refuge shore near the mouth of either Little Carter's Creek or Mount Landing Creek.

Smith ascended the river to the fall line, reporting substantial villages at several locations along the bank. The Rappahannock king's village was located at Cat Point Creek, or "Dancing Point" near Warsaw, perhaps on the Tayloe tract of the refuge, certainly in the acquisition boundary (Egloff and Woodward 2006:76). Smith returned to Jamestown after brokering a local peace agreement that inadvertently disrupted the indigenous political system and set the stage for further hostilities with Powhatan.

As for the Rappahannock, they managed to hold English settlers at bay until the 1640s, and then quickly began losing their lands through a series illegal encroachments followed by forced property sales and removals ordered by the colonial legislature. After nearly four centuries of struggle to regain their lands and retain their identity, the Rappahannock Tribe finally received recognition from the Commonwealth of Virginia in 1983. Federal recognition has been proposed several times, but has not yet been achieved.

In 1645, Bartholomew Hoskins obtained the first patent in the Tappahannock area for 1,350 acres, including the Hutchinson tract of the refuge, all on the south of the Rappahannock River. In 1655, John Green purchased 600 acres, including the Hutchinson tract, from Hoskins. This area became known as Greenfield (Warner 1971). By 1667, William Daingerfield owned 64 acres on the south side of the Rappahannock at Gilson's Creek (now Mount Landing Creek), likely to be on the refuge. A map surveyed in 1680 shows Mr. John Daingerfield's house on Gilson Creek, now Mount Landing Creek, on what is now the Hutchinson tract. The map also shows several neighbors' houses, the town, and a tobacco house (Morris 1680). A 1932 map in the service's realty records for the tract shows a house and barn in the John Daingerfield house location, and surface finds at the location indicate that there is an historic archaeological site there. Nearby, but off the refuge, site records and artifacts at the Virginia Department of Historic Resources document the eighteenth century home of John's son, William Daingerfield.

The 17th-century dwellings on their farms tended to be close to the river. By the early 18th century, a "tobacco aristocracy" of large landowners had risen to local and regional political and economic prominence. The wealthiest adopted a lifestyle in emulation of English nobility, building large mansions atop the scarp overlooking the river. A considerable number of those mansions now are listed on the National Register of Historic Places, and some are national historic landmarks. The valley's plantation owners and their families were drawn into the political turmoil leading up to the Revolution; a large number gathered at Leedstown in 1766 to sign one of the first protests against the Stamp Act. Francis Lightfoot Lee, the owner of Menokin plantation, was a signer of the Declaration of Independence. Menokin, on what is now Cat Point Creek, was built for Francis Lighthorse Lee and his wife, Rebecca Tayloe, in 1769, and its ruin is owned by the Menokin Foundation. The Service owns a conservation easement of 325 acres of its 500 acre property. The house was documented on the Historic American Buildings Survey in 1940, and the vicinity of the house ruin includes historic archaeological sites discovered during archaeological surveys of the property for the foundation. The Menokin Foundation property contains the house ruin and the sites of outbuildings including the slave quarters, kitchen, and office building. The Service's easement contains the plantation's landing on the Cat Point Creek, the historic road to the landing , and visible remains of "rolling roads" built to roll hogsheads of tobacco and other products to the landing (Menokin Foundation, ca. 2006).

Refuge headquarters at the Wilna house: USFWS

The Wilna tract on the north side of the Rappahannock River belonged in the late eighteenth century to Robert Carter, who lived elsewhere. The property passed to the Mitchell family as the dowry of Priscilla Carter, his oldest daughter (Ryland 1976).The existing house, currently used as the refuge's headquarters (constructed in the early 1800s), is the third house to be built on the property. The first house was closer to the Rappahannock River, according to Mary Mitchell, a descendant. The house and former kitchen still stand, and are eligible for the National Register. The tract contains several historic and prehistoric archaeological sites.

In addition to the Daingerfield house site, one of the oldest known historical sites is William Tayloe's home farm of 1682. The approximate location of that farmstead has been identified; it definitely lies in the refuge. Most homes of that time were quite modest in scale. But William Tayloe's house was built of brick, and supposedly had 20 rooms. After it burned in the early 18th century, the focus of the plantation shifted to a location on the scarp, known as Mount Airy, where an even larger and more impressive home was built.

William Tayloe's descendants still occupy Mount Airy. A farmhouse must have been rebuilt on the original tract (or perhaps a second dwelling existed, such as an overseer's quarters) as the farm continued to operate as "The Old House," a subsidiary of Mount Airy. Another farmstead on the refuge, known as "Doctor's Hall," was established by other owners before its purchase by the Tayloe family in 1801 as an additional, outlying farm. Both place-names appear in early 19th century Tayloe account books and other records, each with its population of enslaved African Americans listed separately from others on Tayloe property.

The history of those tracts appears to parallel historic trends in much of the Tidewater. The Tayloe family, along with their other prominent neighbors, achieved great wealth in the late 17th and 18th centuries by farming tobacco. As tobacco production became less viable due to soil exhaustion in the late 18th century, agriculture turned to the cultivation of grain. Trade in the small ports along the river began to decline at that time.

The lower Rappahannock was not a major battleground in the Civil War. However, both sides tried to assert control of its waters. The result was numerous small engagements in which steam-powered Federal gunboats captured sailing vessels in the river, or duels between those gunboats and Confederate artillery on the south bank took place. Military earthworks were built at several places along both banks, but none is known to have been on current refuge property. With the loss of enslaved labor and overall economic depression following the war, another economic transformation occurred as large landowners converted outlying plantation lands into tenant farms. Both of the former Tayloe tracts on the refuge continued as tenant farms into the 20th century.

A number of the southernmost refuge tracts historically were owned by the Fauntleroy and Carter families, also prominent Northern Neck landowners in the late 17th and 18th century. Although no historic period sites have been identified on those tracts, sites similar to the Tayloe farmsteads appear likely. Several additional 19th- and early 20th-century farmstead sites are on refuge tracts for which early historic ownership has not yet been studied. Some of those probably have a plantation history similar to the Tayloe tracts, while others may have always remained small farms owned by less socially prominent families. We must emphasize that most of the farmsteads discovered in archaeological surveys of the refuge are in agricultural fields, and show no surface evidence; additional ones are likely to exist in similar settings. Unmarked cemeteries are said to lie in the fields of some of the refuge tracts.

Increasing steamboat traffic in the later years of the 19th century aided a gradual economic resurgence along the river, with the establishment of several regular stopping places on the routes, sometimes connected to various industrial enterprises. The refuge contains portions of one such site, a steamboat landing and brickworks, the latter a substantial operation dating from the 1890s. The brickworks is currently the only recorded site on the refuge that is exposed to erosion, and it appears to be eroding at a substantial rate.

Aside from what we might learn from scientific archaeological excavation at refuge sites, substantial record exists in the form of account books, diaries, and public documents relating to the Carters, Tayloes, and other early landowners. A detailed study of those records could reveal much about occupation and use of refuge lands in the 17th through the 19th century. The farming of most of these tracts continued to nearly the end of the 20th century. A few hours of conversation some years ago between Service archaeologists and a former tenant of the Tayloe tract showed that interviews with long-time valley residents would lend valuable insight into life ways and farming practices of the early 20th century, and perhaps provide the locations of unknown archaeological sites.

Historic Structures

As noted earlier, the current refuge office is the Wilna Plantation House. This large frame farmhouse is noteworthy for its attractive two-story porch overlooking the river, as well as an unusual decorative arch spanning its front hallway. The house and its associated kitchen-laundry building (now serving as residence for a refuge employee) both appear to have been built sometime between 1800 and 1840, but historical research of the property has been limited and their exact dates of construction are unclear. Because of their architectural significance, both structures have been determined eligible for inclusion on the National Register of Historic Places. A substantial repair of deteriorated exterior fabric on the Wilna Plantation House was recently completed. Further work has been proposed for repairs of the house interior, as well as the kitchen-laundry. Unlike the larger plantations of the Northern Neck, such as Mount Airy, not much is known of the ownership or operation of the Wilna Plantation in its heyday. Archival research would be useful for the interpretation of its structures and archaeological remains.

The Tappahannock and Port Royal historic districts, and a considerable number of historical plantation homes either adjoin current refuge tracts or lie within the approved refuge acquisition boundary. Several of those properties are listed on the National Register of Historic Places, and some are listed as national historic landmarks. Although we do not intend to acquire any of the registered historic structures, our opportunities to ensure the long-term preservation of their scenic vistas by purchasing tracts nearby from willing sellers may benefit historical preservation.