

## Chapter 2



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*Breakwater marsh restoration*

## Affected Environment

## Introduction

This chapter describes the natural and human environment of the Chesapeake Bay (Bay) and Chester River ecosystems, with particular emphasis on the refuge's environmental setting and its programs and administration. It provides a context in which the reader can evaluate current and proposed management actions, and consider the implications of those actions.

## International and National Context

Eastern Neck refuge is internationally and nationally important for wildlife in several ways. It provides important migration, breeding, and wintering habitat for migratory birds, namely waterfowl, along the Atlantic Flyway. The waters surrounding the refuge are a staging area for one percent of the world's population of tundra swans, which is one reason the refuge has been designated as a Globally Important Bird Area by the American Bird Conservancy (ABC). The ABC's Important Bird Areas Program identifies and documents the world's most significant sites that serve as a link along a migratory bird pathway or support significant populations of Endangered, Threatened, Watch List bird species, or bird species with a limited range. Sites may also be designated as Important Bird Areas if they—like Eastern Neck refuge—support significant populations of breeding, migrating, or wintering birds, including waterfowl, seabirds, wading birds, raptors and landbirds.

The Bay estuary, with its component wetlands that include the tidal marshes of the refuge, is listed on the Ramsar List of Wetlands of International Importance. The Ramsar List was established in response to Article 2.1 of the Convention on Wetlands (Ramsar, Iran, 1971), which reads:

*“Each Contracting Party shall designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance, hereinafter referred to as “the List” which is maintained by the bureau [secretariat of the Convention] established under Article 8.”*

The Convention establishes that “wetlands should be selected for the List on account of their international significance in terms of ecology, botany, zoology, limnology or hydrology.”

Wetlands included in the List acquire a new status at the national level and are recognized by the international community as being of significant value not only for the countries in which they are located, but on a global scale as well (Ramsar Convention 2007).

## Regional Setting

Eastern Neck refuge is an island situated at the southern tip of Kent County on the upper Eastern Shore of Maryland (see map 1.2, Chapter 1) at the confluence of the Chester River and the Bay. It is on the Delmarva Peninsula, which includes Delaware and the portions of Maryland and Virginia east of the Bay in the Mid-Atlantic Coastal Plain Physiographic Area.

## The Chesapeake Bay

The Chesapeake Bay, the largest and most biologically diverse estuary in the U.S., is home to more than 3,600 species of plants, fish, and animals. For more than 300 years, the Bay and its tributaries have sustained the region's economy and defined its contemporary traditions and culture. It is a resource of extraordinary productivity and beauty that merits the highest levels of protection and restoration. Accordingly, in 1983, 1987, and 2000, the States of Virginia, Maryland, and Pennsylvania, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency (EPA) signed historic agreements that established the Chesapeake Bay Program (CBP) partnership to protect and restore the Bay's ecosystem. The refuge plays an important role in supporting the Chesapeake Bay Watershed Partnership, and in protecting the diversity of living resources that the Chesapeake 2000 Agreement

was developed to protect. In a regional context, the refuge hosts a vital part of the Bay's living resources and is an important factor in protecting the entire natural system.

Approximately half of the Bay lies in the State of Maryland; the other half in the Commonwealth of Virginia. It is the largest (2,500 square miles) and the longest (195 miles) estuary in the U.S., with the greatest number of tributaries (150). It has more miles of shoreline (4,000) than the entire West Coast. Its watershed encompasses more than 64,000 square miles, and more than 498,000 wetland acres.

The Bay and its tributaries provide rich grounds for commercial and recreational fisheries. Crabbing and angling are popular activities among Bay residents, and increased demand for seafood has spurred on commercial catches of many aquatic species. However, fishing pressure combined with pollution, diseases and other stressors have impacted the populations of many signature Chesapeake fish and shellfish. It is estimated that more than one-third of the nation's blue crab catch comes from the Chesapeake Bay. Blue crabs have the highest value of any Chesapeake commercial fishery, bringing in more than \$50 million per year. For more than a century, oysters made up one of the Bay's most valuable commercial fisheries. Over-harvesting, disease, sedimentation and poor water quality have since caused a severe decline in their numbers. American shad once supported the most valuable finfish fishery in the Chesapeake. But stocks in the Bay and along the Atlantic coast are now low compared to historic levels and no longer support commercial fisheries (CBP 2007).

### **The Chester River and Watershed**

The Chester River begins in Delaware, flows west 60 miles through Kent and Queen Anne Counties in Maryland, and then empties into the Bay. The river, which is fed by 43 tributaries and drains watersheds totaling 390 square miles, provides habitat for a wide variety of birds, including ducks, geese, and bald eagles, as well as spawning and nursery areas for many fish species such as shad, blue-back herring, and striped bass (CRA 2006). The refuge is involved in the efforts of the Chester River Association (CRA) and Maryland's Upper Tributary Team to address the health of the river.

The refuge is located in Maryland's Upper Eastern Shore Tributary Basin at the lowest reach of the six watersheds that comprise the Chester River drainage: the Upper Chester River, Middle Chester River, Southeast Creek, Corsica River, Langford Creek, and Lower Chester River Basin (see chapter 1, map 1.3).

### **Climate and Weather**

The influence of the Atlantic Ocean and the Bay gives the Eastern Shore generally mild winters, and summers with high humidity and relatively warm days and nights. Summer temperatures normally reach the upper 80's and occasionally climb into the 90's, although 102 F has been recorded. The daily high temperature in July averages 87 F. Winters are usually short, with an average daily low temperature in February of 26 F. The watershed has a frost-free period of approximately 183 days (CPB, 2007).

From October through March, frequent high- and low-pressure systems alternate cold dry air from the north with warm humid air from the south. That pattern tends to break down in the summer, as warm moist air spreads northward from the south and southwest and remains over the area for much of the season. Intense low-pressure areas (hurricanes and northeasters) can bring torrential rains and winds of hurricane force to the Eastern Shore, especially during August, September, and October. Thunderstorms occur on about 28 days

each year; most occur in July. Annual rainfall averages 43 inches. The growing season for most crops also falls within that period. Normally, August is the wettest month, and October the driest (CPB, 2007).

### **Climate Change And The Effects of Relative Sea Level Rise**

Global climate change has already had an observable impact in the Chesapeake Bay, including an increase in the average air and water temperatures, more-extreme weather events (including flooding, droughts and heat waves) and sea level rise (NWF, 2008). During the last century air temperatures have risen 1 degree Fahrenheit, while there has been a 10% increase in precipitation (EPA, 2008). The warmer air temperatures have also correlated with warmer ocean temperatures in the Bay. In 2005 there was a major die off of eelgrass, an important habitat for blue crabs, in the Bay due higher water temperatures (CPF, 2007). As noted in chapter 1, the Chesapeake Bay is extremely vulnerable to global climate change, and sea-level rise in particular, because of natural subsidence, low-lying topography, extensive land-development and associated human population growth (NWF, 2008).

The Bay attained its present configuration by the time the first European and colonial maps were prepared, but as tide gauges and the continued inundation of low-lying areas indicate, relative sea level in the Bay is still rising. Sea levels have varied greatly from region to region in the past 10,000 years. Sea level is measured relative to fixed points on land, but the elevation of the land also changes due to natural subsidence and uplift of the Earth's crust. If the land surface is subsiding at the same time that ocean volumes are increasing, then the rate of submergence will be greater than it would be due to changes in ocean volume alone. If the land area is rising relative to the sea, apparent sea level may fall.

Historic tide-gauge records document that sea level is rising in Mid-Atlantic waters and the Bay at an average rate of 3 to 4 millimeters (mm) per year (DNR, 2007). There has been approximately one foot of sea level rise in the Bay over the past 100 years. This rate is nearly twice that of the global historic average, as reported in the Intergovernmental Panel on Climate Change (IPCC) report (IPCC, 2007). At least half of this increase is attributable to global warming, while the remaining increase is likely due to the natural subsidence of coastal lands (NWF 2008). The natural subsidence may be accelerated by excessive groundwater withdrawals in the region (EPA, 2008). Land is currently subsiding in the Bay region at a rate of approximately 0.05 inches/year resulting in significant losses to tidal and shoreline habitats. The IPCC report projects that global sea levels will rise between 7 and 23 inches by the year 2099. For Maryland waters, regional land subsidence must be factored into the equation in order to estimate relative sea level rise. This means that the State could experience an additional 5 or more inches of sea level rise, over and above what is being experienced globally, in the next 100 years. At the very least, a continuation of the current sea level rise trend (0.12 to 0.16 inches/year) or one foot over the next century is expected to occur in the Mid-Atlantic region. This is the most conservative and low-end estimate. The IPCC report documents that the global rate of sea level rise has started to accelerate. This means that Maryland could see as much as 2 or 3 feet of rise by 2099.

The rise in sea level has led to the inundation and erosion of coastal marshes and islands throughout the Bay, including the loss of 13 small islands in the centuries since European settlement (EPA, 2008). Shoreline development and armament is further exacerbating erosion of beaches and marshes (EPA, 2008).

**Erosion and Sedimentation**

Eastern Neck refuge has a history of severe shoreline erosion—between 1867 and 2005, the Island lost 291 acres of land to the Bay (Cronin, 2005). In the late 1980s, the refuge’s western shoreline retreated by as much as 10 feet per year. Unlike barrier islands along the coast that lose shoreline on one end but gain land on the other, when Bay islands erode the material is lost in the Bay—and once lost to erosion, the islands are gone forever. Senator Barbara Mikulski was instrumental in obtaining a \$2.9 million Congressional appropriation in 1989 to study, develop, and construct an erosion control project to protect the western shore of the refuge.

In 1991, a project was implemented to construct erosion control structures consisting of five stone breakwaters fabricated out of 1.5- to 3-ton<sup>2</sup> stones along the western shore. The purpose of the breakwaters is to “break” or absorb the waves’ energy before they reach the beach. The project involved installing off-shore and near-shore stone



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*Breakwater project at refuge*

breakwaters. Where bluffs are located along the shoreline, offshore breakwaters were constructed approximately 100 to 200 feet from shore. Offshore breakwaters are 75 feet long, six feet above mean high tide, and are placed 75 feet apart in a semi-circle. Where the shoreline is closer to sea level, near-shore breakwaters were constructed in dimensions similar to the offshore breakwaters. In addition to the breakwaters, the shoreline itself was also lined with small stones to absorb the energy of any waves that make it through the breakwaters’ gaps. Approximately 1.5 miles (7900 ft) of severely eroding shoreline were protected by this project, which was finished in early 1993 at a final cost of \$2.75 million. In 2005, dredged material from Kent Narrows—a navigation channel of the Chester River—was deposited behind the breakwaters.

Despite the success of the breakwater project, elsewhere along its shoreline, erosion continues to be a problem for Eastern Neck Island. In 2006, riparian land use and bank and buffer conditions were analyzed throughout Kent County by the Virginia Institute of Marine Science (Berman et al, 2006). Bank conditions (Table 2.1) were categorized as experiencing either low rates of erosion, high rates of erosion, or as undercut, meaning that erosion is apparent at the base of the bank but that the bank face otherwise appears stable. Eastern Neck Island was surveyed in two parts—northern and southern—for the analysis. Combining the results from low (0-5 foot), medium (5-10 foot), and high (10-30 foot) bank heights, the northern end of the island is experiencing more total erosion along its length. Fortunately, no undercutting was observed. Future restoration of island shoreline depends on both funding and the availability of dredge material.

Table 2.1. Bank Height and Erosion Status (miles of shore) on Eastern Neck Island

Bank height	0-5 feet			5-10 feet			10-30 feet		
	Low	High	Undercut	Low	High	Undercut	Low	High	Undercut
<b>Northern Portion of Eastern Neck Island</b>	8.33 miles	0.07 miles	0.00 miles	0.33 miles	0.10 miles	0.00 miles	0.23 miles	0.00 miles	0.00 miles
<b>Southern Portion of Eastern Neck Island</b>	7.35 miles	0.39 miles	0.00 miles	0.15 miles	0.00 miles				

Source: Berman et al. 2006

### Salinity and Tides

An estimated average of 522,780 gallons of water flows into the Bay every second from all its tributary sources. Although this freshwater flow only represents one-ninth of the total seawater volume flowing in the Bay at any time, the influence of this ratio of fresh to salt water has a profound influence on the estuary and its natural resources. This is predominantly because of two important factors: storms and the size of the watershed relative to the volume of the brackish water basin.

The watershed spans 64,000 square miles in six states. Thus, any storm can have significant influences on the Bay's water quality. Of the 150 rivers, creeks, and streams draining the watershed, 40 are considered major tributaries, and eight of these provide 90 percent of the freshwater inflow. Six of these, previously mentioned, drain the western shore. The Susquehanna River, which flows from the north, provides 48 percent of the freshwater in the Bay; the Potomac and James rivers, flowing west and south into the Bay, provide 19 and 14 percent respectively, of the freshwater input (Bue, 1968).

Salinity varies according to the amounts of freshwater these eight major tributaries contribute to the Bay. Generally, salinity increases seaward as mixing slowly takes place. Circulation and mixing are slow, because the fresh water is more buoyant than salt water. The resulting salinity contours, or isohalines, shift according to seasons of the year and freshwater input, and have significant seasonal effects on the Bay's living resources. In April, for example, salinity of the water near the Bay Bridge may be as low as 7 ppt (parts per thousand), but by October following a dry summer, the salinity can be almost twice that amount.

A natural phenomenon known as the "Coriolis force," (Persson, 1998) causes flowing waters in the northern hemisphere to be deflected to the right due to the earth's rotation. This condition has a significant impact on the Eastern Shore because the saltier waters moving north up the estuary are pulled towards the eastern side of the Bay, where there is less freshwater input. The combined power of the western rivers and the Coriolis force create a counterclockwise circulation in the Bay, with the incoming salt water entering along Cape Charles and hugging the Eastern Shore, and freshwater exiting along Cape Henry and the western shore. This circulation and salinity pattern has definite influences on the estuary and its ecosystem.

Tides, too, have great influences on the ecosystem. The vertical range of tides in the Bay is greatest at the capes (2.5 feet), intermediate through the main Bay where it averages two feet, and lowest along the upper reaches of tidal streams (one to two feet). Twice each day these natural forces expose and submerge shorelines and transport nutrients. On average, it takes a parcel of water about two to three weeks to cycle along the Bay's 195-mile length, and each second, the surface stream discharges nearly 700,000 cubic feet of brackish water into the ocean; 10 times greater than the average freshwater input.

### **Regional Hydrology**

Unconsolidated sediments underlie the Coastal Plain, including all of the estuarine wetlands. The area derives its groundwater recharge mainly through infiltration of precipitation. Discharge occurs through seepage to streams, estuaries, and the ocean. Coastal wetlands are found in these discharge zones. These wetlands have complex hydrology, in which stream flow, groundwater flow, and tidal flow all play a part. Forested wetlands occur along the stream channels, and are sustained by local and regional groundwater flow and flooding during storms. The poorly drained interior of the Delmarva Peninsula has a system of depressional palustrine wetlands, narrow bands of palustrine wetlands along rivers and ditches that drain from inland to the coasts.

### **Water Quality**

Section 303(d) of the Federal Clean Water Act requires Maryland to: (1) identify waters, known as water quality limited segments (WQLSs), where technology-based effluent limitations and other required controls cannot achieve water quality standards; (2) for each listed water, establish Total Maximum Daily Loads (TMDLs) for pollutants preventing the attainment of water quality standards; and (3) offer an opportunity for public review and comment on the proposed TMDLs.

As a coordinating framework for Maryland's TMDL program, the Maryland Department of the Environment (MDE) has developed a watershed cycling approach. This approach focuses on protecting Maryland's water quality by developing and implementing TMDLs in a comprehensive fashion by drainage basin (watershed). By adopting watersheds as the primary management units, MDE addresses the appropriate natural spatial domain and is able to consolidate the necessary resources with sufficient spatial focus.

An updated report from MDE (MDE, 2007) compiles data collected in 1999 from Maryland's Upper Western and Upper Eastern Shores. In the Upper Western Shore the major watersheds are the Lower Susquehanna and Bush Rivers. In the Upper Eastern Shore the major watersheds are the Elk and Chester Rivers.

The Chester River sub-basin drains 547 square miles of Kent, Queen Anne's and Talbot Counties in Maryland to the Delaware line. More than 64 percent of the land in the Chester River sub-basin is used for agriculture; less than 27 percent of the land is forested. Urban areas comprise only seven percent and wetlands only two percent of the drainage area. Chestertown, located in the middle Chester River, is the sub-basin's largest community although the Kent Island and US Route 50 corridor extending eastward from Kent Island to Queenstown and then south to Easton are rapidly developing areas. Other major communities include Stevensville, Grasonville, Queenstown and Rock Hall.

Surface waters are classified as Use I (water contact recreation and aquatic life) or Use II (shellfish harvesting) (COMAR 26.08.02.08). For the most recent information regarding specific use classes in this watershed, the reader is referred to the Code of Maryland Regulations (<http://www.dsd.state.md.us/comar/getfile.aspx?file=26.08.02.08.htm>.)

MDE routinely monitors water quality at three Bay tributary stations and at one CORE/Trend Station located in the lower Chester River. One fixed Long Term Benthic Macroinvertebrate program station is monitored for estuarine benthos in addition to randomly selected Long Term Benthic Macroinvertebrate program sites. The Maryland Biological Stream Survey (MBSS) collected water quality samples in the watershed at 39 stations in 1996 and at three stations in 1997. MDE indicated TMDLs will be developed to address the nutrient impairments to water quality in the Eastern Bay (02130501), and the Miles (02130502), Wye (02130503) and Lower Chester (02130505) Rivers, following completion of the CBP Phase V Watershed and Water Quality Model (MDE, 2007).

MDE created a restricted shellfish harvesting area in Lower Chester River Basin, Southeast Creek Basin, and Middle Chester River Basin in Kent and Queen Anne's Counties, Maryland and on Sept 24, 2007 established a TMDL for fecal coliform ([http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Pub\\_Notice/TMDL\\_PN\\_Chester\\_FC.asp](http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Pub_Notice/TMDL_PN_Chester_FC.asp)).

The restricted shellfish harvesting area in Chester River is located in three 8-digit basins: Lower Chester River (basin number 02130505), Southeast Creek (basin number 02130508), and Middle Chester River (basin number 02130509). These three basins were all first identified on the 1996 303(d) List submitted to U.S. EPA by the (MDE). The designated uses in Lower Chester River were listed as impaired by sediments (1996), nutrients (1996), fecal coliform in tidal shellfish harvesting portions of the basin (1996), toxics (2002), impacts to biological communities (2002, 2004), and bacteria in public beaches (2006). The TMDL of fecal coliform will allow for the attainment of the shellfish harvesting designated use in the restricted shellfish harvesting area in the Chester River mainstem. The listings for other impairments within the Lower Chester River Basin, Southeast Creek Basin, and Middle Chester River Basin will be addressed at a future date.

The TMDL sets the maximum load limit for the impairing substance. The TMDL also reflects load allocations to point sources, nonpoint sources and a margin of safety that accounts for uncertainty in the procedures used to estimate the TMDLs. Once established by the State, the TMDLs will be subject to approval by the United States Environmental Protection Agency (EPA). The established TMDLs will support measures needed to attain water quality standards in the Lower Chester River Basin, Southeast Creek Basin, and Middle Chester River.

## Bay Wetland Ecology

The Bay's salinity gradient and topography control the distribution of life and the number of species within the Bay. Within each zone, species composition varies depending on local shifts in salinity, elevation (depth), sediments, and topography of the substrate. While not all of the following Bay communities occur on the refuge, they are all important components of the ecology.

### Deep Open Water

The open Bay is seasonal habitat: a summer haven for marine fishes and a winter refuge for migratory waterfowl. True estuarine species that remain in the basin year-round, such as the Bay anchovies, retreat to deepwater channels in winter. In spring, they return to forage along channel edges, and serve as prey for visiting bluefish and other large predatory fish that return from their Atlantic winter retreat. The biannual migrations of marine and anadromous fishes into and out of the Bay are well known to fishermen. Ten anadromous species migrate through the Bay to spawn in freshwater tributaries in early spring. Also, 152 marine species may visit the estuary in summer as foraging adults or juveniles, but most depart by autumn. Six marine species are regular visitors in winter.

Only 27 estuarine species (and two marine species) are permanent residents. No deep water habitat occurs on the refuge.

### Shallow Water Habitats

Shallow waters are where much of the Bay’s remarkable productivity occurs. The Bay averages 21 feet (6.4 meters) deep. Additionally, much of the basin is covered by less than 10 feet (3 meters) of water. These shoal areas allow sunlight to reach the Bay floor, permitting photosynthesis in both the water and benthos. These shallow waters host three important plant communities: phytoplankton, benthic algae, and submerged aquatic vegetation.

#### *Submerged Aquatic Vegetation*

An important plant community, consisting of up to 15 plant species that live in shallow waters of rivers, streams, and the Bay proper, are collectively known as “submerged aquatic vegetation,” or SAV. As we mentioned in chapter 1, under issue area 1, the presence of SAV beds is one of the most significant determinants for sustaining waterfowl populations in the Bay. They provide a highly nutritious forage for these birds, as well as for many other waterbirds. Nutrients entering the Chester River from farm fields, septic systems, and other sources stimulate algae growth, which blocks sunlight required by SAV for photosynthesis. Subsequent plant decay consumes the water’s dissolved oxygen—a process that can result in “dead zones” where oxygen-dependent organisms can no longer survive. Map 2.1, which shows the Virginia Institute of Marine Science’s (VIMS) results from mid-July surveys of the SAV present in the Chester River at Eastern Neck refuge sites, indicates that SAV beds at the refuge that were depleted in 1999 had begun to recover by 2005. The higher the density class, the more productive the habitat is and the higher its wildlife resource value.

### Wetlands Habitat

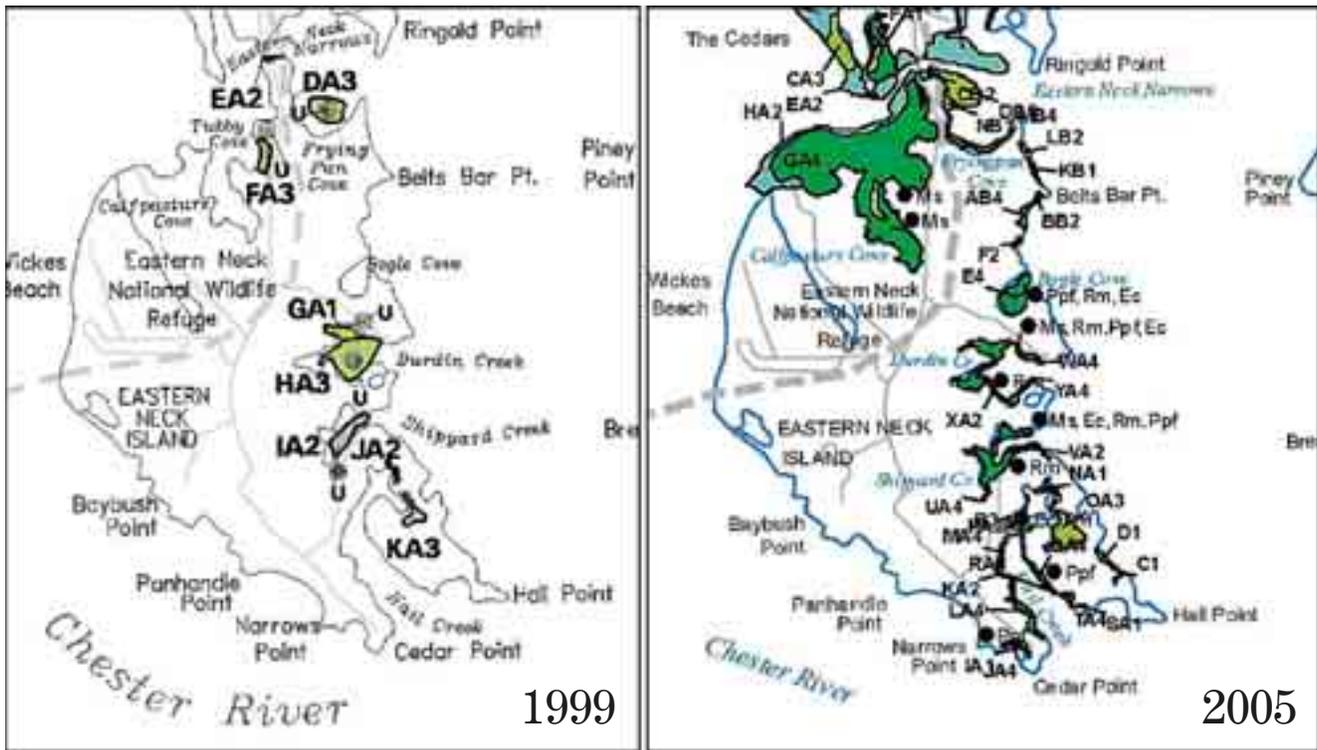
498,000 acres of emergent wetlands surround the Bay. These wetlands are kept saturated by runoff, groundwater seepage, adjacent stream flow, and tides; these habitats range from shrub swamps and cattail marshes along secluded streams to the open salt marshes of the lower Bay. In addition to trapping sediments, recycling nutrients, and providing numerous other hydrologic and energetic benefits, these wetlands are some of the most productive plant communities in the world. Overall wetland acreage has remained relatively stable in the Bay watershed in the past 25 years, averaging about 2.9 million acres since 1982 (CBP, 2006).

*Evaluating the refuge wetlands*



Jonathan Priddy/USFWS

Map 2.1. Field Observations of SAV from surveys of the Chester River at Eastern Neck refuge in 1999 and 2005 (VIMS, 1999, 2005).



*Brackish Marsh Habitat*

More than 45 major rivers flow directly into the Bay. Each river has a salinity gradient that can vary greatly along its length. The marsh habitats associated with these estuarine rivers and tidal creeks, are important breeding and nursery grounds for fish and many bird species.

SAV Density Classes	
0-10%	
10-40%	
40-70%	
70-100%	

Most of the refuge’s 858.8 acres of marsh habitat is considered brackish marsh. Brackish waters are broadly defined as the middle range of the salinity gradient between tidal fresh water and marine (between 0.5–30.0 parts per thousand). The brackish salinity gradient is further divided into three zones: oligohaline zone (low or slightly brackish—0.5–5 ppt), mesohaline zone (moderately brackish—5–18 ppt), and polyhaline zone (highly brackish—18–30 ppt). Much of the Bay falls into this range and during autumn the entire Chesapeake Bay, including some of its shorter tributaries, may be brackish.

Brackish marsh indicator species include narrow-leaved cattail, Olney three-square, switchgrass and common reed, along with associated species such as hibiscus, tidemarsch water hemp, and saltbushes. Additional plant communities include big cordgrass and black needlerush. These plants must be able to survive a wide range of salinities. For example, the most characteristic brackish-wetland species, Olney three-square, can grow in waters from 1 to 18 parts per thousand. These marshes are home to muskrats and other wetland mammals.

The middle of the Bay is dominated by brackish marshes. In these moderately brackish waters, there is the transition from the taller plants of the freshwater marshes to the low-lying salt meadows of the lower Bay. Most of these brackish wetlands are three-square meadows, with taller big cordgrass or narrow-leaved cattail along the margins of tidal creeks and ponds.

These marshes differ from brackish river marshes in having a broad, ill-defined drainage system. Slight changes in the marsh topography and waterfowl, or muskrat “eatouts” may foster shallow tidal pools, or marsh ponds. These ponds are important habitat for migratory waterfowl because SAV, particularly pondweed, grows here. Brackish bay marshes dominate areas inundated by slightly brackish (oligohaline) to moderately brackish (mesohaline) waters. The most important plant indicators include Olney three-square which grows in peaty soils with saltmarsh bulrush, hightide bush, dwarf spikerush, black needlerush in the sandier soils, switchgrass, big cordgrass, and common reed.

#### *Salt Marsh Habitat*

No salt marsh occurs on the refuge, but it is a hugely important habitat type for the Bay. A salt marsh may be defined quite simply as “Spartina- and Juncus-dominated wetland.” Typically, only three species predominate: saltmarsh cordgrass (*Spartina alterniflora*), saltmeadow cordgrass (*Spartina patens*), and black needlerush (*Juncus roemerianus*). Saltmarsh cordgrass grows in tall colonies along tidal creeks below mean high tide (MHT) and in shorter stands at or above MHT. The tall form characterizes what is often referred to as the “regularly flooded salt marsh,” or low marsh, while the short form of cordgrass (growing behind this zone) intergrades with the salt meadows of the irregularly flooded salt marsh, or high marsh. Saltmeadow cordgrass grows in large meadows in the high marsh where the soil is well drained; in wetter (lower) areas of the high meadow, saltgrass (*Distichlis spicata*) may persist.

The waters that flood these wetlands typically have salinities in the upper mesohaline range (10 to 18 ppt) and above. In this range, black needlerush and saltmarsh bulrush (*Scirpus robustus*) can still survive and compete with *Spartina*. The transition to pure cordgrass meadows takes place at a point farther north on the Eastern Shore than the western shore due partly to the Coriolis force. These salt marshes are among the most productive plant communities on earth, producing a range of 4 to 10 tons of organic matter per acre per year.

## **Regional Socioeconomic Setting**

### **Regional Overview**

Estuaries are among the most productive environments on earth, creating organic matter and providing habitats that support a diverse community of plants and animals. The Bay is the largest of the 130 estuaries in the U.S. and, as noted above, is extremely rich in species and habitat diversity. These attributes contribute to its high human value and affect the surrounding human environment both socially and economically. Most of the present population of the Bay watershed, about 16.6 million people, affects the Bay and is affected by it. Populations are densest and clustered in the urban and suburban centers of Washington, D.C. and Baltimore. Many live along the Bay’s shores in hundreds of small cities, towns, and villages that arose because of the presence of the Bay. The quality of life of the residents of these smaller communities is inextricably tied to the Bay and its rivers (Lippson and Lippson, 1984).

The area of tidal influence connecting Maryland, Virginia, and Washington D.C. is collectively referred to as the “Tidewater” area. This Tidewater area encompasses the Chesapeake Bay. Of Maryland’s 23 counties, only 7 are unaffected by tidal influence. In Tidewater Maryland, the counties are almost

entirely water-bounded. These peninsulas are often locally called “necks,” such as Eastern Neck. Kent County, where the refuge is located, has 209 miles of waterfront. The abundance of water in the area has had a strong influence on the socioeconomic characteristics of the region.

### **Bay Environmental Challenges**

There are many environmental challenges in the Bay region. Many human-induced changes have had profound effects on the Bay and its tributaries. The cities of Baltimore and Washington, both at the Bay’s headwaters, produce many tons of wastes, silts, and chemicals, which ultimately flow into the Bay. The Bay’s location near several major cities also makes it an important shipping channel. Current levels of rapid human growth demand additional space for development. By 2020, scientists project the watershed population will grow an additional 2.5 million to a total of 18 million. The various uses of the Bay are beginning to conflict. Entire species of fish and shellfish are no longer commercially viable. Some, like oysters, remain, but at a mere one percent of their former abundance. Major environmental challenges in the Bay region include urbanization, habitat loss, excess nutrients, sediments, toxic chemical contaminants, and air pollution (NRCS, 2006).

Local and regional governmental and grassroots groups, recognizing the Bay’s environmental problems, have organized to reduce the amount of pollution that enters the Bay and improve water quality. Perhaps the most prominent of these groups is the Chesapeake Bay Program (CBP), a regional partnership of local, state, and Federal agencies along with non-governmental organizations that has directed the restoration of the Bay since 1983.

Impressively, the Bay has the highest land to water ratio of any estuary in the U.S. — thus, land-based activities heavily and directly influence the condition of the Bay (NRCS, 2006). About 25 percent of the Bay watershed is in crop and pasture uses. Non-federal forest land accounts for 47 percent, while developed land has risen to 12 percent. Conversion of land from agricultural to other uses creates a complex interaction among resource concerns, including increased runoff. Urban and suburban areas deliver the highest pollutant loads on a per acre basis and occupy over 5 million acres of the watershed. Agriculture is identified as another top contributor of non-point source pollutants because it occupies such a large share of the non-forested portion of the watershed, approximately 10 million acres (NRCS, 2006).

An estimated 23,000 confined livestock and poultry operations are within the Bay watershed. The combination of livestock concentration and soil and land use factors in certain areas make manure management a priority to prevent potential water quality problems. Nutrient loading could cause impairment to the SAV beds and shallow water habitats so valuable to many species of fish and wildlife. The CBP has set a goal to establish nutrient management plans on 4.5 million acres of cropland to support achievement of the nutrient reduction goal. According to data collected from participating state and Federal agencies, 3.42 million acres of cropland and hay land in the Bay watershed were placed under nutrient management plans between 1985 and 2003 (NRCS, 2006).

The CBP also has a goal to re-establish or establish 25,000 acres of wetland by 2010. To date, 40 percent of this goal has been achieved (NRCS, 2006). The Service has actively participated in this restoration.

### **Land Use**

Maryland’s Upper Eastern Shore — comprised of Kent, Caroline, Queen Anne’s, and Talbot Counties — covers more than 1,200 square miles of scenic farmland,

coastline, forests, and colonial towns. All four counties possess a rich potential for heritage and nature tourism, and are connected by a rural corridor that includes the newly designated Chesapeake Country National Scenic Byway which leads to Eastern Neck refuge. The refuge serves as a land use model within the Bay watershed through its sustainable agriculture, native natural landscapes, and renewable energy.

Land use on the Upper Eastern Shore is dominated by agriculture and forest. In all counties, developed urban land accounts for less than five percent of total land use. Of all Maryland counties, Caroline County has the greatest change in land use due to development pressure. More than six percent of its agricultural and forest land has been converted to residential or urban use since 1973.

Some of the most productive land in the Bay region has already been lost. The U.S. EPA estimates that the state of Maryland has lost over 70% of its wetlands since European settlement (EPA, 2009). Additionally, 50 percent of forests have also been lost (MD DNR, 2005). Currently, open space is being lost on an average of 90,000 acres annually (USFWS CMCCP, 2005).

The social environment in the Bay is changing alongside the physical environment. In the past 50 years, the human population in the watershed has doubled to its current level of nearly 16.8 million individuals (CBP 2009). Increased population demands additional development and urbanization, leading to habitat and open space loss and fragmentation. Human attitudes are also changing with changing demographics and a loss of ties to the land due to increased urbanization. The economy is slowly shifting away from land and water-based professions such as agriculture, forestry and fishing. These professions are being replaced with service, industry, retail and tourism jobs (KCDPZ, 2006). Places to relax and play are increasingly in demand, and many people want to live on or near the water.

Maryland's remaining marshes, including those on the refuge, have become increasingly valuable as a public resource because the distribution and functional health of this habitat has been drastically reduced. Loss of critical wetlands not only affects the health of the Bay ecosystem, but also impacts state and local economies. The natural resources of the Bay significantly contribute to the economic well-being of Maryland, and also enhance the quality of life of Maryland's citizenry. Maryland's marshes are used for multiple purposes, including fishing, hunting, trapping, bird watching, and observing and photographing wildlife.

These marshes also serve as important spawning or nursery sites for many finfish and shellfish. The Bay provides more than \$60 million annually in commercial finfish and shellfish catches. Major tributaries of the Bay account for about 90 percent of the striped bass spawned on the East Coast (Bergren and Lieberman, 1977). In 1995, the catch of blue crab, Maryland's most abundant and valuable shellfish, was 40.3 million pounds valued at \$29 million (Holiday and O'Bannon, 1996). In addition, \$275 million was spent directly on recreational fishing with a total economic impact to Maryland of \$524 million. More than 4,500 jobs and \$31 million in state and Federal tax revenues are directly related to hunting and non-consumptive activities associated with migratory waterfowl and bird use in Maryland (Southwick Associates 1995). Waterfowl hunting boosted Maryland's economy by \$15.6 million in 2001 (USFWS, 2005) while a statewide 2006 survey (USFWS, 2007) showed that Maryland expenditures for recreational fishing were \$547 million, for hunting \$200 million, and for wildlife watching \$596 million.

## Kent County Demographics—Current and Projected

### *Current Demographics*

Kent County, which includes Eastern Neck refuge, is a predominantly rural area that is home to about 19,197 residents (USCB, 2006). The County is bordered by Cecil County to the north, Queen Anne’s County to the south, the State of Delaware to the east and the Bay to the west. Founded in 1642, Kent County is the second oldest county in Maryland (KCDPZ, 2006) and currently has a total area of 414 square miles—279 square miles of land and 135 square miles of water—or 179,480 acres. Land cover in the County varies from historic waterfront towns to stretches of rolling farmlands and tidewater tributaries of the Chesapeake River.

Farming has been a way of life on Maryland’s Upper Eastern Shore for nearly four centuries, and maintaining open spaces through traditional agricultural uses and conservation reserves is a local legacy. Though development is occurring throughout the area, much of Kent County remains open and is comprised of 65 percent forest, wetland, and agricultural land. Only seven percent of County land is developed (KCDPZ, 2006).

In recent years, the economy of Kent County has grown from chiefly farm-based and water-related to include industry, retail, tourism, and other service-oriented businesses. In 2004, Kent County had the fifth largest increase in jobs in the state (KCDPZ, 2006). The County covers five incorporated towns: Betterton, Galena, Chestertown, Millington, and Rock Hall. Each town has its own independent planning and zoning boards, plans, and ordinances.

### *Projected Regional Growth*

The Eastern Shore is currently experiencing an unprecedented level of change. Historic growth rates and patterns are being drastically changed by rapid suburban development. Although Kent County currently has the lowest population of any county in Maryland, the County population grew by eight percent between 1990 and 2000. Between 1973 and 2002, the amount of developed land increased by almost 135 percent according to the Maryland Department of Planning’s Land Use/Land Cover data. The County is determined to preserve the present quality of life by planning for a manageable rate of growth that does not exceed its historic growth rate. The County intends to allow only limited growth in specific locations in a manner that complements and enhances the character of each community (KCDPZ, 2006).

*Organizing for a refuge project*



Jonathan Priddy/USFWS

### **Recreation and Tourism**

Regional parks and conservation lands of the upper eastern shore are illustrated in Map 2.2 Kent County has an extensive park system with eight County parks (managed by the Kent County Parks and Recreation Department), and two State parks (KCDPR, 2009). The refuge is the only protected federal land. Of the numerous county parks, only Cann Demonstration Woodlot and Turners Creek Park provide the types of natural environments and wildlife-related opportunities also available at the refuge. Two state management areas also provide nearby wildlife-related recreational opportunities.

Map 2.2. Regional parks and Conservation Lands



## Eastern Neck Refuge Environment

**Location and Size of Refuge** The refuge is one of four refuges that make up the Chesapeake Marshlands refuge complex, which also includes Blackwater, Susquehanna, and Martin refuges (see chapter 1, map 1.1). Located within a short drive of several major metropolitan areas, this 2,286 acre island-refuge is one of the most popular nature tourism destinations on Maryland’s Upper Eastern Shore. At the mouth of the Chester River, it is separated from the mainland to the north by a 620-ft wide shallow channel between the river and bay. The island is accessed via Route 445—Eastern Neck Island Road—which branches off and ends in the refuge.

**Land Cover and Soils** The refuge landscape (map 2.3) features a high degree of habitat interspersion and diversity, ranging from croplands and woodlots to brackish tidal marsh and freshwater ponds (see Table 2.2 for current land type acreages). The refuge has approximately 15 miles of shoreline.

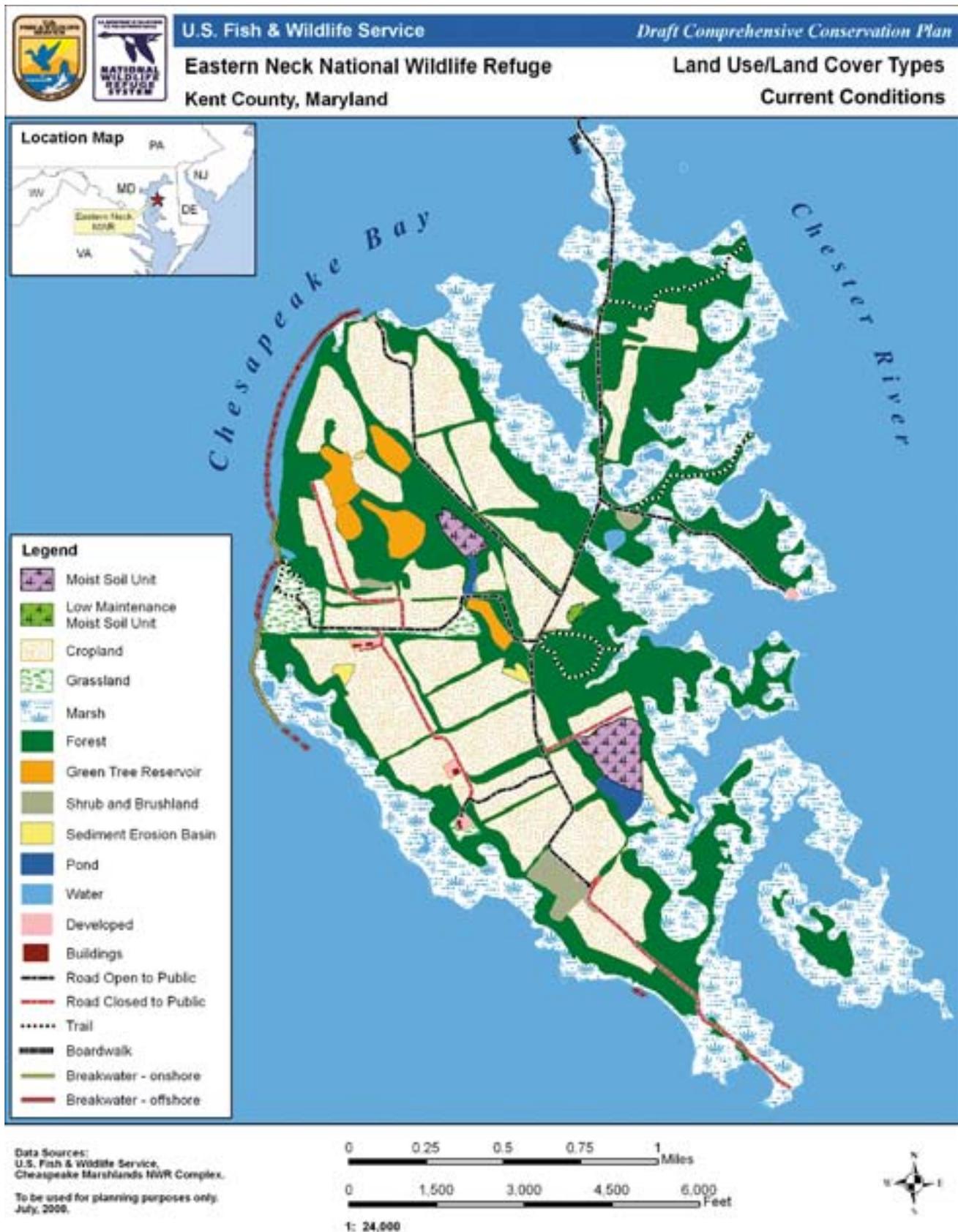
**Table 2.2. Acreage by Land Use and Land Cover Types Existing on Eastern Neck Refuge**

Land Use/Land Cover Type	Acreage*
Shrub and Brushland	18.1
Cropland	557.1
Forest**	708.1
Grassland	30.7
Marsh	858.8
Developed	10.5
Managed Moist Soil Unit	28.4
Low Maintenance Moist Soil Unit	1.3
Sediment Erosion Basin	4.2
Pond	8.3
Open Water	60.5
<b>TOTAL</b>	<b>2,286.6 acres</b>
Green Tree Reservoirs**	
GTR #1	5.5
GTR #2	9.6
GTR #3	11.6
GTR #4	4.7
GTR #5	6.6
Total GTRs	38.0 acres

\*Acres are approximate; they are based on a combination of GIS interpreted acres, survey acres; and deed acres

\*\*Green Tree Reservoirs are managed within the “Forest” land cover type and, therefore, those acres are not additive to total refuge acres.

Map 2.3. Existing Land Use and Land Cover Types on Eastern Neck Refuge.



Moderate to poorly drained, silty soils of the Mattapex-Othello association are found throughout Eastern Neck Island. Refuge land is relatively flat with a range in elevation from zero to 20 feet above sea level.

### **Refuge Establishment and Acquisition History**

On December 27, 1962, President John F. Kennedy authorized the acquisition of Eastern Neck Island in Kent County, Maryland as a refuge under the authority of the Migratory Bird Conservation Act of 1929 as “an inviolate sanctuary, or for any other management purpose, for migratory birds.” Acquisition of the entire island except for a tenth acre parcel owned by Kent County at Bogles Wharf was completed in 1967.

### **Administrative Staff and Budget**

Since 2006, the refuge’s staff and budgets have been administered from the CM Refuge Complex Headquarters in Cambridge, Maryland on Blackwater refuge. Refuge Complex staff transfers, reassignments, and retirements have caused the Refuge Complex Project Leader to reevaluate staffing. In 2008, the Project Leader established three permanent positions based at Eastern Neck refuge. While the plan is to station these three staff at the refuge, they will also occasionally work on other refuges in the Refuge Complex as needed. The three positions are: a wildlife refuge operations specialist; a maintenance worker; and, a visitor services specialist. Other Refuge Complex staff will frequent Eastern Neck refuge, but will continue to be based out of the Refuge Complex headquarters. Seasonal staff positions at Eastern Neck refuge will typically vary between one and five each year.

### **Refuge Management Facilities**

#### **Refuge Headquarters (HQ) and Visitor Facility**

The refuge headquarters and visitor facility is currently located on refuge lands in a former hunting lodge that was originally built in 1933. This building is eligible for the National Register of Historic Places. The lodge was renovated in 2005 to national historic preservation standards and to allow for year round occupancy by refuge staff. The building is used not only as the refuge office, primary visitor contact facility and Friends bookstore, but also for meetings, seminars, and training sessions.

#### **Cape Chester House Quarters and Staff Residence**

There are two houses on the refuge. One is the former refuge headquarters and is referred to as the “Cape Chester House.” This facility is now used by seasonal staff, volunteers and researchers. The second home was originally built in 1934 for the caretaker of the hunting club property. It is now used as a year round private residence by refuge staff. Both houses are regularly maintained for occupancy.

#### **Alternative Energy Facilities**

A 60-foot-tall wind turbine was installed and commissioned in 2002 at the Cape Chester House; one of the first on a refuge in the Region. Over the course of its first three years in place, an extensive monitoring program was initiated to detect any avian interactions with the wind turbine. Components of the monitoring program include pre-construction site surveys to determine avian species of concern, and the development and implementation of a protocol to ensure that any avian-tower interactions are detected and documented. During the three year study, 17 bird carcasses were found in the search area. 15 of the 17 carcasses could be attributed to the wind turbine and 14 out of the 15 were invasive European starlings. The other three were a catbird, a bank swallow, and an unidentifiable bird. Unfortunately, the wind turbine has not operated as efficiently as originally hoped and annual maintenance has proved expensive. However, we believe that maintaining the turbine at the Cape Chester House provides a source of backup power to the facility during the Island’s frequent power outages. The turbine also provides the refuge with a high-visibility

opportunity to demonstrate that the Service is committed to alternative energy sources and to reducing its carbon footprint.

Two sets of solar panels, with a capacity of 2.5 kilowatts (kW) each, were installed in 2004 at the Cape Chester House. These have been functioning well. However, given that there is only seasonal occupancy of the Cape Chester House, we are currently running an annual electrical surplus. Given Maryland’s net metering laws, we are currently unable to use this surplus to offset electric usage at other locations/meters on the refuge. Therefore, this surplus is not benefiting the refuge and is being sent back to the electric utility to be sold on the open market. Hence, we are considering ways to shift electric usage from other buildings on the refuge to the Cape Chester House. We are also considering whether to replace the House’s current oil furnace with a high efficiency heat pump (powered by electricity). An electric heat pump would be more efficient, reduce the refuge’s carbon footprint and utilize our entire electrical surplus.

**Public Recreation Facilities**

The refuge has facilities to support a wide variety of wildlife-dependent recreation opportunities. These facilities include: two boardwalks, six walking trails with interpretive panels, and four observation blinds to facilitate wildlife observation, wildlife photography, and self-guided interpretation and a water trail for canoeing and kayaking. These facilities and visitor program opportunities are described in more detail below under the section “Visitors Services.”

**Refuge Revenue-Sharing Payments**

Since the Federal government does not pay property taxes, a refuge revenue sharing program was established under the Refuge Revenue Sharing Act (16 U.S.C. 715s) to reimburse local taxing authorities and help defray the loss of those taxes. The Service makes refuge revenue sharing payments to Kent County based on the total acreage and the appraised value of refuge lands. These annual payments are calculated by formula determined by, and with funds appropriated by, Congress.

**Table 2.3. Revenue-sharing Payments to Kent County, MD**

Fiscal Year	Payment
2002	\$31,638
2003	\$31,638
2004	\$30,408
2005	\$26,896
2006	\$28,114
2007	\$28,434

Table 2.3 provides a multi-year comparison of the refuge’s compensation to its community.

**Refuge Step-Down Management Plans**

The refuge is currently operating under the following step-down plans. All are available for review by contacting refuge headquarters. Chapter 3 outlines scheduled plan updates.

- Integrated Pest Management Plan for the Refuge Complex (under review)
- Fire Management Plan for the Refuge (1994)
- Deer Hunt Plan 1985 (reviewed annually)
- Turkey Hunt Plan (reviewed annually)
- Croplands Management Plan (1981)
- Chronic Wasting Disease Plan for the Refuge Complex (2007)

- Avian Influenza Plan for the Refuge Complex (2007)
- Public Use Management Plan (1993)

**Special Use Permits**

Over the last five years, we have issued the following special use permits.

- Baltimore City Community College—Collection of insect specimens
- Maryland Wood Duck Initiative — Installation and monitoring of wood duck boxes
- Kent County Bird Club—Various meetings and/or field trips/ annually
- Individual—Survey and collection of moths
- U.S. Geological Survey—Diamondback terrapin research study
- New Milleneum Development —Remove common reed (*Phragmites australis*) to use in the green building industry
- Individual—To collect fecal samples of geese and waterfowl to determine if they carry a the intestinal parasite *Cryptosporidium* which may impact water quality in the Bay
- Boy Scout Troop 200—Overnight camping and shoreline clean up at Ingleside
- Patuxent Wildlife Research Center, U.S. Geological Survey—Establish and regularly monitor wetland stability stations on the refuge from July 2005 — July 2010
- Individuals— Removal of downed wood for personal use firewood

**Eastern Neck Refuge Partners**

We have established many partnerships over the years with a variety of organizations to accomplish refuge programs and objectives. These relationships are integral to managing, monitoring, and evaluating the projects and programs we undertake:

- |  |   |
|--|---|
| ■ American Legion of Rock Hall             | ■ National Wild Turkey Federation           |
| ■ Chesapeake Alliance                      | ■ Kent County Bird Club                     |
| ■ Chesapeake Paddlers Association          | ■ Kent County Dept. of Parks and Recreation |
| ■ Chester River Association River Keepers  | ■ U. S. Army Corps of Engineers             |
| ■ Friends of Eastern Neck                  | ■ Kent County Dept of Tourism               |
| ■ Maryland Department of Natural Resources | ■ Kent County Roads Dept                    |
| ■ Maryland Department of the Environment   | ■ Ducks Unlimited                           |
| ■ Maryland Energy Administration           | ■ University of Maryland                    |
| ■ National Aquarium in Baltimore           | ■ University of Delaware                    |
| ■ National Renewable Energy Laboratory     | ■ U. S. Geological Survey                   |

### Friends of Eastern Neck

The Friends of Eastern Neck, Inc. (FOEN) was established in 1997 as a cooperative association to support our public outreach and wildlife management programs. In 1999, the FOEN took charge of a bookstore on the refuge. FOEN also hires a hunt coordinator for the deer hunt program. Co-located in the refuge visitor contact station, the bookstore produces supplemental funding for public use activities and facilities. FOEN is a 501 (3)(c) organization, which makes their funds particularly valuable when leveraged as matches to grant proposals for various projects throughout the refuge.

### Volunteer Program

Volunteers are essential participants in every aspect of our management. Our biological, maintenance, and visitor service's programs are enhanced each year by volunteer projects. We discuss some of the volunteer-led visitor activities further under the 'Visitor Services and Programs' section. In 2007, 160 citizens conducted volunteer work on the refuge, donating over 9,000 hours to improving wildlife habitat, maintaining facilities, environmental education, supporting other recreational programs, protecting or cataloging cultural resources, and making other improvements of the refuge. Our volunteers have taken the lead on the following annual events and programs which have been on-going for years. We simply could not offer these programs, or participate in these community events, without volunteer assistance:

- Rock Hall Business Expo in February
- Owl Prowl in March
- Earth Day bird walk in April
- Earth Day shoreline clean up in April
- International Migratory Bird Day in May
- Chestertown Tea Party in May
- Youth Fishing Derby in June
- Rock Hall Fall Fest in September
- Chestertown Wildlife Festival in October
- The Big Sit in October
- Waterfowl Watch in December

### Wetland habitats

The refuge encompasses 858.8 acres of tidal marsh adjacent to the refuge shoreline. Other wetlands described below include green tree reservoirs, moist soil units, and refuge ponds.

#### Tidal Marsh

Tidal brackish marshes are transitional wetlands between tidal freshwater systems and salt marshes. They are the most extensive wetland type in

Maryland occurring along the many miles of rivers and shores where the salinity of water ranges from 0.5-18 ppt. Plant species diversity in brackish marshes



*Eastern Neck refuge tidal wetlands*

USFWS

is low and dominated by graminoids that often form extensive dense patches (MD DNR 2005). Vegetation growing in the refuge's tidal marsh includes Olney three-square (*Scirpus olneyi*), narrow-leaved cattail (*Typhus angustifolia*), and saltmarsh cordgrass (*Spartina alterniflora*). Saltmarsh cordgrass, which dominates the marsh, is the most important species of marsh plant in the Bay estuary. The plant composition of the refuge tidal marsh as classified according to the National Vegetation Classification System is shown in Table 2.4.

**Table 2.4. National Vegetation Classification of Eastern Neck Refuge Tidal Marsh**

National Vegetation Classification System – Associations in the Tidal Marsh	NVCS Code	Acres
<i>Baccharis halimifolia</i> - <i>Iva frutescens</i> / <i>Spartina patens</i> (e.g. Shrubland)	3921	28.5
<i>Juncus roemerianus</i> (e.g. Herbaceous Vegetation)	4186	0.6
<i>Phragmites australis</i> (e.g. Tidal Herbaceous Vegetation)	4187	270.1
<i>Spartina alterniflora</i> / ( <i>Ascophyllum nodosum</i> ) (e.g. Acadian/Virginian Zone Herbaceous Vegetation)	4192	56.7
<i>Spartina cynosuroides</i> (e.g. Herbaceous Vegetation)	4195	1.8
<i>Spartina patens</i> - <i>Distichlis spicata</i> - <i>Juncus roemerianus</i> (e.g. Herbaceous Vegetation)	4197	67.9
<i>Typha angustifolia</i> - <i>Hibiscus moscheutos</i> (e.g. Herbaceous Vegetation)	4201	30.9
<i>Morella cerifera</i> - <i>Rosa palustris</i> / <i>Thelypteris palustris</i> var. <i>pubescens</i> (e.g. Shrubland)	4656	5.7
<i>Schoenoplectus americanus</i> - <i>Spartina patens</i> (e.g. Herbaceous Vegetation)	6612	214.2

### Green Tree Reservoirs

Green tree reservoirs (GTRs) are forested lowlands that are temporarily flooded during the fall and winter to attract waterfowl. Flooding occurs when trees are dormant, but when waterfowl are still present in high numbers and can forage on the acorns, seeds, and macroinvertebrates. Water control structures in GTR areas allow water levels to be manipulated.

The refuge currently maintains five GTRs which were constructed in 1979 to flood the bottomland hardwood forest and provide resting and feeding habitat for migrating and wintering waterfowl such as wood ducks, mallard ducks, black ducks, and teal. At full pool level, these GTRs provide approximately 38 acres of habitat within the Durdin Creek drainage which flows from west to east into the Chester River. The GTRs flood with natural precipitation in the winter when trees are dormant, and drained in the spring before leaves grow back to prevent stressing and/or drowning the trees. The annual flooding schedule varies from year to year to more closely emulate natural water regimes; not all impoundments are flooded each year.

GTR#2 has a stop-log water control structure while the other four GTRs have screw-gate water control structures for water level management. All the water control structures need to be evaluated, and possibly replaced, in order for the GTRs to function most efficiently. A deep well with a turbine pump provides the capability to flood all GTRs except GTR#4. Water level manipulations for each GTR are incorporated into an annual Habitat Management Plan. Table 2.5 describes the green tree reserves units at the refuge.

**Table 2.5. Green Tree Reservoir Characteristics on Eastern Neck Refuge**

Unit	Waterfowl Usage*	Acres	Water Control Structure Type	Dominant Tree Species**
GTR#1	BL, ML, WD, GT	5.5	Screwgate	RM, SG, BG, SC
GTR#2	BL, ML, WD	9.6	Stop-log	RM, SG, RO
GTR#3	BL, ML, WD	11.6	Screwgate	RM, SG, BG, RO
GTR#4	BL, ML, WD	4.7	Screwgate	RM, SG, BG, RO, WO
GTR#5	BL, ML, WD	6.6	Screwgate	RM, SG, BG, SC, RO, WO
* <i>Waterfowl species:</i> BL Black ducks ML Mallards WD Wood ducks GT Green-winged teal		** <i>Tree species:</i> RM red maple ( <i>Acer rubrum</i> ) SG sweet gum ( <i>Liquidambar styracflua</i> ) BG black gum ( <i>Nyssa sylvatica</i> ) SC swamp chestnut oak ( <i>Quercus michauxii</i> ) RO southern red oak ( <i>Quercus falcata</i> ) WO willow oak ( <i>Quercus phellos</i> )		

**Moist Soil Units**

MSUs are low-lying, naturally wet non-forested areas, where water is impounded seasonally. On the refuge, late summer precipitation is held by earthen berms to create flooded areas, primarily to benefit fall migratory and wintering waterfowl, and to a lesser extent shorebirds and wading birds. Decomposing vegetation and invertebrates provide a rich foraging area.

The refuge currently has three moist soil units (MSUs), comprising 29.7 acres (map 2.2), which provide feeding habitat for wintering and migratory waterfowl species such as AP Canada geese, black ducks, mallards, teal, and pintails.

The Headquarters Pond Moist Soil Unit is approximately 10 acres, which includes a small pond on the lower portion of the unit. A drainage ditch runs from the pond to the MSU for efficient water level management. Water levels are manipulated using a stop-log type water control structure which is situated between the pond and a GTR. Winter (full pool) gauge readings range at approximately 4’ to 5’ depending on rainfall, while summer drawdown readings are maintained at 3’ or below. The water gauge is located in the pond, and water levels are much lower in the MSU providing suitable habitat for migrating waterfowl in the fall and winter, and substrate for wetland plant species throughout the spring and summer. This impoundment is dominated by smartweed, millet and various sedges.

Shipyards Creek Moist Soil Unit is located northwest of Shipyards Creek, and constructed in 2007 by Ducks Unlimited. This entire moist soil unit is approximately 18.4 acres, with the flooding potential of approximately 6.8 acres. The stop-log water control structure is located on the southeast portion of the impoundment, and is dependent on rainfall and water that overflows from Cedar Point Pond. This impoundment was not completed in time for the fall waterfowl migration, therefore vegetation and waterfowl use data is unavailable.

Wildlife Trail Moist Soil Unit is approximately 1.3 acres, and located near the Wildlife Trail. It is surrounded by an agricultural field which is planted in corn, wheat and clover over a rotation. The stop-log water control structure is located in a very low dike on the southeastern portion of the impoundment. This structure remains closed throughout the year, allowing water to collect naturally from autumn precipitation and dissipate through soil percolation, transpiration, and evaporation throughout the rest of the year. It is dominated by smartweed, sedges and various grasses.

### **Refuge Ponds**

The Headquarters Pond is approximately 8 acres. This pond was formed prior to refuge establishment when the road into the former refuge headquarters area was constructed to access the planned Cape Chester housing development over thirty years ago. A portion of the road forms the pond dike, which contains a stop-log type water control structure. This structure allows for water level manipulation of the MSU and GTR.

The Cedar Point Pond is approximately 0.3 acres and was built before the refuge was established. We have no records on its creation, but assume it was created and used by the Cedar Point Hunt Club.

## **Upland Habitats**

### **Forest**

The refuge contains 708 acres of forested habitat, comprised primarily of loblolly pine, hardwoods, and mature oak-sweetgum forest. Forested acres occur in relatively small woodlots scattered throughout the Island and are interconnected by hedgerows consisting primarily of black cherry and locust. The pine areas are successional, and the understory is comprised of holly, green briar and poison ivy. The hardwood areas contain mixtures of maple, paw-paw, spicebush, and various ferns in the understory and shrub layers. Some of the oak-sweetgum associations are slowly succeeding to the climax oak-hickory communities.

Forest stands range from one to more than 100 years old, and function as buffer zones and corridors utilized by a variety of species. Forested habitat also provides nesting trees and roosting areas for the bald eagle, two high priority PIF species—wood thrush and Eastern wood pewee, and six moderate- or low-priority PIF species.

The U.S. Forest Service conducts regular surveillance of the refuge and, as of 2003, found the refuge's forests to be in good health, with no imminent outbreaks expected of gypsy moths, pine beetles, or other pests or pathogens.

### **Grassland**

The refuge maintains approximately 30 acres of grassland. The largest single grass field is approximately 22 acres and extends east from the refuge's western shoreline near the Cape Chester House and former headquarters. This field benefits migratory Monarch and other butterflies, migratory birds, foraging raptors, and is a popular viewing area and destination for refuge visitors. Field communities are dominated by low cudweed, fleabane, smartweed, and crabgrass. The refuge's grasslands also support a variety of wildflower species. The grassland is managed using a combination of mowing and prescribed burning.

### Managed Cropland

The refuge currently contains approximately 557 acres of cropland in any given year. Managed croplands provide a valuable food source for wintering AP Canada geese and other waterfowl. The refuge’s farming program also showcases sustainable farming techniques that prevent sediment, chemical, and nutrient runoff from agricultural fields into the Bay and its tributaries. Best-management farming practices include crop rotation, cover crops, no-till planting, utilization of grass waterways and field borders, and the use of nitrogen-fixing, weed-controlling crops to reduce the need for chemical fertilizers and herbicides. Crop rotation enables the refuge to use 40 to 50 pounds less fertilizer per acre than standard farming practices. The refuge does not use insecticide, unless absolutely necessary, and only those that are approved for use on the refuge by the Regional Contaminants Coordinator. Refuge sediment erosion basins assist in management of cropland by retaining runoff from cropland areas. The croplands are managed through a cooperative agreement with a local farmer. The present agreement allows the farmer to harvest 80% of the crop each year, while leaving 20% of the crop in the field for wildlife.

In the 1970s, the refuge farmed over 1,000 acres of cropland primarily to benefit migrating and wintering waterfowl. Farming practices were discontinued from 1974 to 1982 because of concerns that area-wide farming practices were leaving a large amount of grain in the fields and disrupting the movement of migrating waterfowl. The concern was these croplands were keeping waterfowl farther north than they have stayed historically, thereby exposing them to harsher winter conditions and reducing over-winter survival. The refuge’s cropland management program was reinstated on fewer acres in the 1980s after a determination that the mid-Atlantic farming on refuges was not disrupting waterfowl distribution further south along the Atlantic Flyway. As farming once again became an important refuge program for waterfowl, we also incorporated the objective to provide habitat for the endangered DFS. In 1981, fenced food plots were established to benefit the endangered DFS population, who typically feed on crops left along hedgerows; however, the recovery team also a recommended ratio of 2:1 forest to crops, which was deemed to be an ideal mix of habitat types for DFS.

Crops currently grown on the refuge include corn, soybeans, and clover. Map 2.4 depicts the location and type of crops grown in 2007 on the refuge. In addition, winter wheat is often planted as a cover crop after harvesting corn or soybeans. Table 2.6 provides a summary of crops planted on the refuge from 2004-2007.

*Managed croplands on the refuge*



Jonathan Priday/USFWS

Table 2.6. Cropland management on Eastern Neck Refuge from 2004-2007

Crop*	2004	2005	2006	2007
Corn	169.2	182.5	177.1	210.3
Soybeans	179.5	186.4	207	189.3
Clover	70.6	70.7	46.9	37.5
Wildlife food plot	64.1	66.7	75.9	64.1
Sunflowers	8.1	7.5	--	--
Total	491.5	513.8	506.9	501.2

\*Winter wheat is sometimes used as a cover crop on these same units

### Special Management Areas

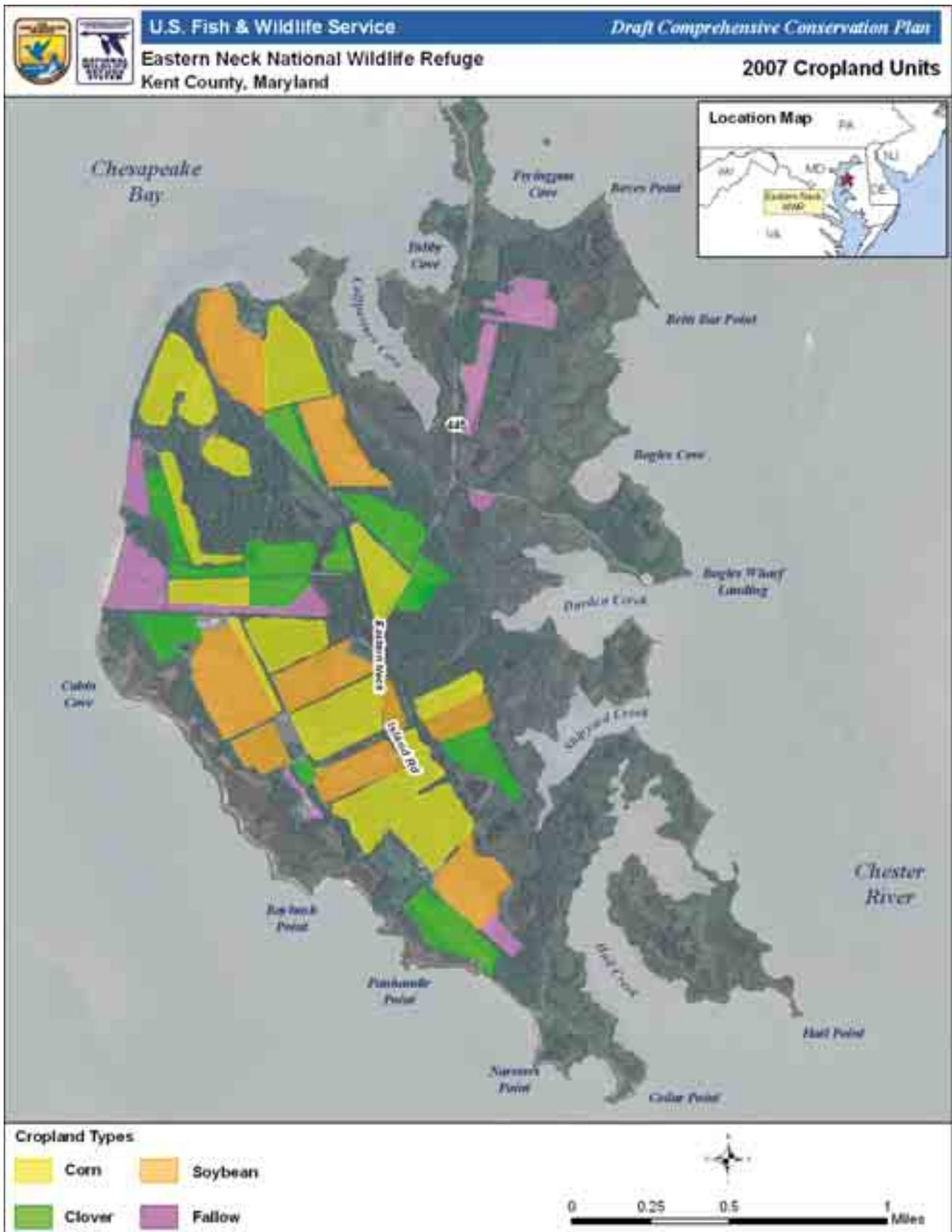
The Service administratively designates research natural areas (RNAs) and Public Use Natural Areas (PUNAs) on refuges. RNAs are part of a national network of reserved areas under various federal land ownerships. Other federal land management agencies also have designated RNAs. They are intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. PUNAs are a separate designation used only by the Service and the Refuge System. The network of PUNAs across the country were established to assure the preservation of a variety of significant natural areas for public use with certain restrictions and which, when considered together, illustrate the diversity of the Refuge System natural environments, and preserve these environments as essentially unmodified by human activity for future use.

The refuge features the Hail Point RNA (see map 1.4). In 1975, the Service designated the 149-acre tidal salt marsh at Hail Point as an RNA because it was considered a relatively undisturbed, naturally-functioning intact tidal marsh and because it contained an unusual plant association, a 20-acre loblolly pine-American holly forest. In addition, at the time it was designated, there was a 50 nest great blue heron colony and an osprey nest site. At present, there are no intensive research projects being pursued.

This RNA is located in the most isolated portion of the refuge and thereby minimally affected by human factors, except for occasional boaters traveling around the southern end of the refuge. This area of the refuge is experiencing significant erosion from the Chester River-side. The area is also known as a Monarch butterfly staging area where the butterflies can be observed resting in their fall migration before attempting their flight across the Bay.

The Tubby Cove PUNA was established in 1975 (see map 1.4) because it provided a relatively undisturbed natural setting that was accessible to the public, and affords exceptional educational and interpretive opportunities. The established trail allows people to view wildlife and marsh habitat, while minimizing impacts to resources by requiring people to stay on the trail and in the viewing area/platform.

Map 2.4. Cropland Fields Map for Eastern Neck Refuge during 2007



## Fauna

### Birds

The refuge provides habitat for over 240 bird species including 143 species listed as of conservation concern by the Service, BCR-30, Partners in Flight, or MD DNR. A complete list of birds of conservation concern found at the refuge is included as Appendix A.

#### *Waterfowl*

Each winter, ducks, geese and swans are counted along Maryland's Bay shoreline and Atlantic coast during the Midwinter Waterfowl Survey. The survey is conducted by pilots and biologists from the Service and MD DNR. The list includes a large variety of migratory waterfowl. The lower Chester River Basin is a major staging and wintering area for ducks, geese and tundra swans. The Chester River winters tens of thousands of AP Population Canada geese and many of those use the refuge, which offers sustenance as well as sanctuary.

The 2007 survey was flown between December 27, 2006 and January 4, 2007. A total of 478,900 birds were counted, which was a substantial decrease from the year 2006 count of 577,100. In 2007 tributaries and bays along the Chesapeake were completely ice-free. Since the Maryland Midwinter Waterfowl Survey only covers the tidal, estuarine waters, it is likely that many ducks and geese remained inland on open freshwater reservoirs, lakes and ponds that are normally ice covered.

Low numbers were recorded for several diving ducks in 2007 as well. Most notable was a record low count of canvasbacks (13,800), down from 33,800 in 2006. The previous low count of canvasbacks was from 1988 when only 23,200 were recorded. Scaup (25,700) showed a substantial decrease, down 53,800 from 2006 (79,500). Mergansers (1,700) also decreased markedly from 2006 (7,000). The low number of diving ducks was probably related to the warm winter and ducks remaining north of traditional wintering areas. High counts of canvasbacks, scaup, long-tailed ducks, redheads, and mergansers were recorded during the Midwinter Waterfowl Survey of the Great Lakes where habitats were relatively ice-free January 2007.

In Maryland, mallard numbers were greater during 2007 (39,700) than in 2006 (32,500). The number of black ducks counted in 2007 (13,800) was similar to 2006 (13,300), but the 2007 count was substantially below counts made prior to 2005.

Canada goose numbers (285,700) in 2007 were slightly below the 305,400 counted in 2006. The tundra swan count (8,700) was similar to the record low of 8,200 in 2006. Recent banding studies have shown that tundra swans spend less time in Bay and most now winter further south in North Carolina.

The Maryland Midwinter Survey numbers from 2003–2007 are listed in Table 2.7 below.

Waterfowl populations on the refuge have been regularly surveyed by refuge staff and volunteers since 1996. Survey points include the refuge impoundments, and croplands, as well as adjacent tidal waters of the lower Chester River Basin and the Bay that are visible with binoculars from the refuge. Survey numbers are measured over waterfowl seasons—October through March. Peak waterfowl populations for individual species over four seasons—2003-04 to 2006-07—are listed in table 2.8. Total counts are not displayed in table 2.8 because the table represents the daily peak count for an individual species for the stated year. These daily peaks did not occur on the same day for each species, so therefore, providing a total would not reflect an actual number that occurred on any given survey day. This refuge survey is separate from the State of Maryland midwinter aerial waterfowl survey that covers the entire lower Chester River basin and other parts of the Bay supporting wintering waterfowl.

Table 2.7. Maryland midwinter waterfowl survey counts 2003 to 2007.

Species	2003	2004	2005	2006	2007
Mallard	39,000	48,200	52,800	32,500	39,700
American Black Duck	22,500	31,700	23,600	13,300	13,800
Gadwall	3,700	2,500	1,400	1,200	1,400
Widgeon	800	6,000	2,000	300	400
Green-winged Teal	1,000	1,200	1,000	400	3,300
Northern Shoveler	0	100	100	0	100
Pintail	1,300	4,600	1,900	2,500	500
<b>Total Dabbling Ducks</b>	<b>68,400</b>	<b>94,300</b>	<b>82,800</b>	<b>50,300</b>	<b>59,200</b>
Redhead	5,100	6,100	9,300	1,800	1,100
Canvasback	40,000	30,800	39,400	33,800	13,700
Scaup Spp.	66,600	106,300	189,800	79,500	25,700
Ring-necked Duck	300	200	1,000	500	900
Common Golden-eye	2,100	1,000	3,000	700	700
Bufflehead	13,100	9,800	22,000	11,800	12,000
Ruddy Duck	42,700	34,000	36,100	12,100	19,800
<b>Total Diving Ducks</b>	<b>169,900</b>	<b>188,200</b>	<b>300,600</b>	<b>140,200</b>	<b>73,900</b>
Scoter Spp.	2,300	8,100	40,600	10,000	2,100
Long-tailed Duck	100	400	4,100	700	500
Merganser Spp.	6,500	18,700	5,100	7,000	1,700
<b>Grand Total Ducks</b>	<b>247,300</b>	<b>215,400</b>	<b>433,200</b>	<b>208,400</b>	<b>137,400</b>
Brant	1,500	1,300	1,700	2,400	500
Snow Goose	75,600	93,900	54,900	49,200	46,600
Canada Goose	452,900	355,200	383,400	305,400	285,700
Tundra Swan	15,100	17,900	13,200	8,200	8,700
<b>Total Waterfowl</b>	<b>798,000</b>	<b>781,300</b>	<b>889,900</b>	<b>577,100</b>	<b>478,900</b>

Table 2.8. Fall-Winter Peak Waterfowl Counts by Year at Eastern Neck Refuge\*

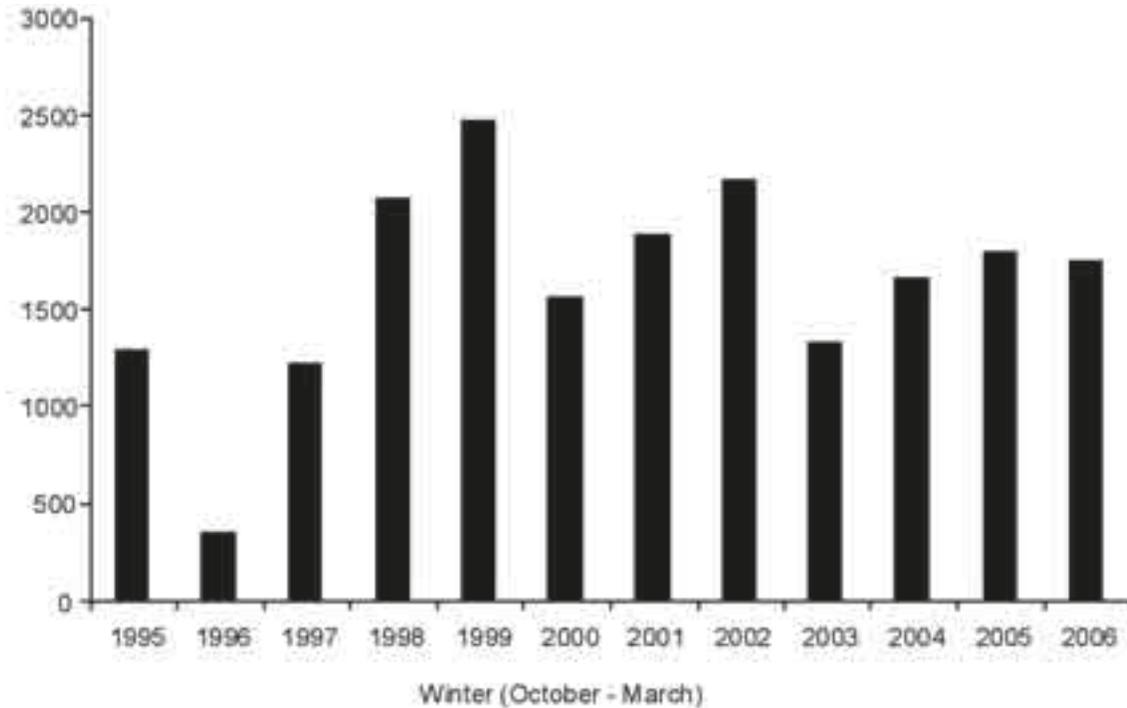
Species	2003-04	2004-05	2005-06	2006-07
Tundra Swan	2251	959	815	729
Canada Goose	5069	11461	15534	8415
Snow Goose	1	14	0	0
American Black Duck	752	1375	674	831
Bufflehead	479	491	852	402
Ruddy Duck	13125	5098	1175	1400
Scaup Sp.	12482	45568	24878	7201
Canvasback	4335	1406	1200	613
Common Golden-eye	404	252	534	161
Long-tailed Duck	11	1	16	0
Hooded Merganser	9	15	30	6
Red-breasted Merganser	19	244	48	18
Wood Duck	16	13	46	139
Mallard	2498	4027	3596	2757
Northern Pintail	910	385	226	41
Gadwall	4	130	36	47
American Widgeon	10	283	373	61
Northern Shoveler	8	3	2	2
Blue-winged Teal	0	0	0	0
Green-winged Teal	35	22	12	1
Redhead	0	8	69	1
Ring-necked Duck	65	98	76	6
Unknown Waterfowl	2000	749	1025	370
Surf Scoter	0	0	98	27

\*Note: Some of these counts include birds in state waters immediately adjacent to the refuge. These figures represent the peak daily count recorded for individual species over the season.

#### *Atlantic Population Canada Geese*

Over the last decade, we averaged about 1,800 AP Canada geese per day using our refuge croplands with as many as 5,000 geese counted on a single field on one survey day. The fields also are used occasionally by black ducks and mallards and recently tundra swans have been seen using the fields. We believe that active management of croplands is important to sustaining healthy wintering waterfowl since their natural food source, including SAVs, has been severely depleted.

Maintaining croplands is especially important during harsh winters because it becomes the only forage around when other farm fields are empty and water is frozen. Figure 2-1 provides a summary of crop field use by Canada geese on the refuge between 1995 and 2006.



**Figure 2.1. Average weekly count of AP Canada geese in crop fields at Eastern Neck Refuge**

*Diving Ducks*

Diving ducks, such as canvasbacks, scaup and red-breasted mergansers rely on SAV, clams, invertebrates and small fish. The refuge is one of few protected areas in the Bay to provide a safe and undisturbed haven for these birds. The island's creeks and coves shelter SAV beds which have declined drastically throughout the Bay. These submerged plants are not only a food source, but provide habitat for invertebrates and small fish, also an important food resource.

*American Black Ducks*

The American black duck and mallard are the most abundant dabbling ducks in the Bay. Although the population of mallards is increasing, black ducks are declining. Black ducks have been identified on every regional bird list of conservation concern, including the Atlantic Coast Joint Venture. The Refuge is especially significant as wintering areas for black ducks. In the Bay, uninhabited offshore islands and remote marshes are the best black duck production areas. Development throughout the watershed has limited these habitats. The refuge provides these habitats, and most importantly, in a setting undisturbed by human development.

*Tundra Swans*

The refuge is a major staging site for the tundra swan on their annual migration between the Arctic tundra and North Carolina marshes. The refuge and

surrounding waters is also a Global International Birding Area (IBA) for the tundra swan. Just over one percent of the global population of tundra swans have been known to spend the early part of winter on or adjacent to the refuge, feeding on SAV and clams in shallow tidal waters (NAS, 2004). Many of these swans stay on or adjacent to the refuge throughout the winter, while some continue to wintering grounds in North Carolina. The refuge conducted a “Tundra Swan Watch” satellite tracking project until 2004.

#### *Marsh and Wading Birds*

Eighteen species of marsh and wading birds have been observed on the refuge (see Table 2.9) though only three are known to breed here. The refuge is considered a likely foraging area for herons from nearby rookeries.

**Table 2.9. Eastern Neck Refuge Marsh and Wading Birds Seasonal Abundance\***

	Breeding	Spring	Summer	Fall	Winter
<b>BITTERNS - HERONS - IBISES</b>					
American Bittern		r	r	r	r
Least Bittern		r	r		
Great Blue Heron		c	c	c	u
Great Egret		o	o	o	
Snowy Egret		o	o	o	
Little Blue Heron		r	r	r	
Tricolored Heron		r	r	r	
Cattle Egret		o	o	o	
Green Heron	X	u	u	u	
Black-crowned Night-Heron		r	o	o	r
Yellow-crowned Night-Heron		r	r	r	
Glossy Ibis			r	r	
<b>RAILS - CRANES</b>					
Clapper Rail		r	r	r	
King Rail	X	o	o	o	o
Virginia Rail	X	u	u	u	u
Sora		r		r	r
Common Moorhen		r	r	r	
American Coot		o		u	o

\***RELATIVE ABUNDANCE:** a/abundant, c/common, u/uncommon, o/occasional, r/rare.

#### *Raptors*

In addition to the bald eagle and the BCC-listed peregrine falcon and short-eared owl, 20 other raptors have been observed here (table 2.10). Seven raptors breed at the refuge: bald eagle, osprey, black and turkey vultures, red-tailed hawk, eastern screech owl, and great-horned owl.

Table 2.10. Raptors of Eastern Neck Refuge and Their Seasonal Abundance\*

Species	Breeding	Spring	Summer	Fall	Winter
Black Vulture	X	u	u	u	u
Turkey Vulture	X	a	a	a	a
Osprey	X	a	a	c	
Bald Eagle	X	c	u	c	c
Northern Harrier		u		u	u
Sharp-shinned Hawk		u		c	u
Cooper's Hawk		u		u	u
Northern Goshawk				r	
Red-shouldered Hawk		o	o	o	o
Broad-winged Hawk		o		o	
Red-tailed Hawk	X	u	u	u	u
Rough-legged Hawk		r		r	r
Golden Eagle		r		r	r
American Kestrel		u	r	u	u
Merlin		r		o	r
Peregrine Falcon		r		o	r
Common Barn Owl		r	r	r	r
Eastern Screech Owl	X	u	u	u	u
Great Horned Owl	X	u	u	u	u
Barred Owl		r	r	r	r
Short-eared Owl		r		r	r
Northern Saw-whet Owl				r	r

\***RELATIVE ABUNDANCE:** a/abundant, c/common, u/uncommon, o/occasional, r/rare.

### Forest Birds

Forested upland communities in the region provide breeding and migrating habitat for a wide array of species, including the second highest number of priority bird species in the region (USFWS, 2007). Of particular concern to researchers and land managers, are those bird species considered “forest interior dwelling” (FIDs). Virtually all have documented population declines. FIDs are Neotropical migratory birds which require large contiguous forested tracts (> 100 acres) to maintain viable breeding populations. The refuge's forested tracts are on the minimum size of, or do not meet, suitability for most breeding FIDs. However, there are a few species that breed in low densities on the refuge. These include wood thrush, eastern wood peewee, northern flicker, and scarlet tanager. Many more species seek shelter or forage on the refuge during migration. Appendix A lists species of conservation concern known on the refuge.

### Grassland Birds

The limited grassland habitat on the refuge, and its small patch size, precludes nesting by most grassland birds because many are area sensitive. Of the 20 bird

species associated with grassland habitats in Maryland and listed as of greatest conservation need by MD DNR, 10 have been observed on the refuge (table 2.11). Only one species, the field sparrow, is known to breed here. However, the refuge's grasslands do provide foraging and migrating habitat to many birds, including some noted in table 2.11 that are of conservation concern in the area.

**Table 2.11. Maryland Greatest Conservation Need grassland birds at Eastern Neck refuge.**

	Breeding	Spring	Summer	Fall	Winter
American Woodcock		o	r	o	r
Common Barn Owl		r	r	r	r
Short-eared Owl		r		r	r
Sedge Wren		r	r	r	r
Field Sparrow	X	u	u	u	u
Vesper Sparrow		r	r	r	r
Savannah Sparrow		u		u	u
Grasshopper Sparrow		o	o	o	
Bobolink		u		u	
Eastern Meadowlark		o		o	o

### Shrubland Birds

Similar to our discussion for grassland birds, the limited shrub habitat on the refuge and its small patch size, precludes nesting by most shrub-dependent birds. We know of two bird species of conservation concern that nest in low densities on the refuge, the yellow breasted chat and the white-eyed vireo. We suspect their populations are very small. As with grasslands, however, shrub habitat does provide foraging and migrating habitat to many birds.

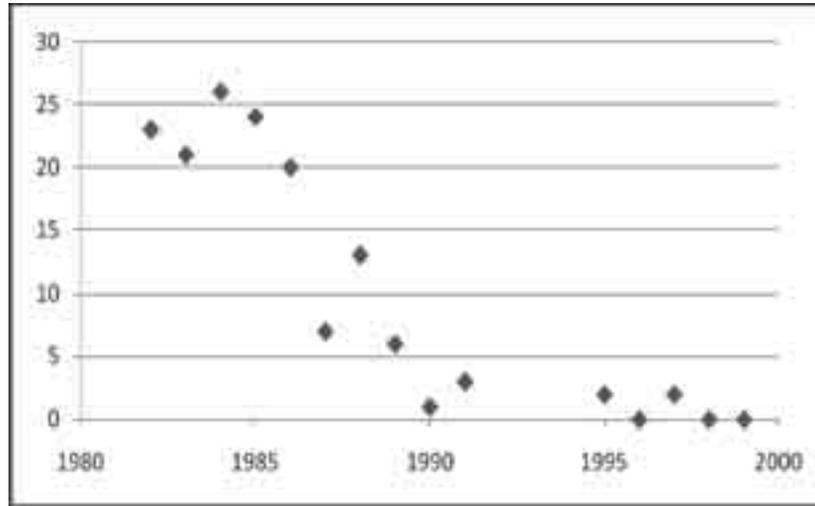
### Federal-listed Threatened and Endangered Species

The Delmarva fox squirrel (DFS) is the only Federal-listed species documented on the refuge. The recently delisted bald eagle also occurs here and remains protected under other mandates. The refuge has been evaluated for northeastern beach tiger beetle and Puritan tiger beetle, but no beetles were found, and the refuge is not considered quality habitat for either.

#### *Delmarva Fox Squirrel*

DFS were introduced on the refuge in the 1920s by local hunters. The historic range of the DFS included the entire Delmarva Peninsula, but the range was reduced over time by habitat loss and hunting. By 1967, populations were found in only four Eastern Shore counties — Kent, Queen Anne's, Dorchester, and Talbot counties, and the DFS was Federal-listed as endangered.

The squirrels were abundant on the refuge until the 1980s. While the population size through the 1980s was only estimated, they were sufficiently abundant to enable removal of 22 individuals to start the Chincoteague refuge population in 1968. A mark-recapture study of this species was conducted between 1982 and 1986 by a research graduate student; and from 1994-1998 refuge staff conducted a mark/recapture box check/trapping survey as part of a survey of benchmark sites designated by the Recovery Team. Trapping efforts (see figure 2.2) were discontinued after 1999 due to poor trapping results. Only two DFS were sighted

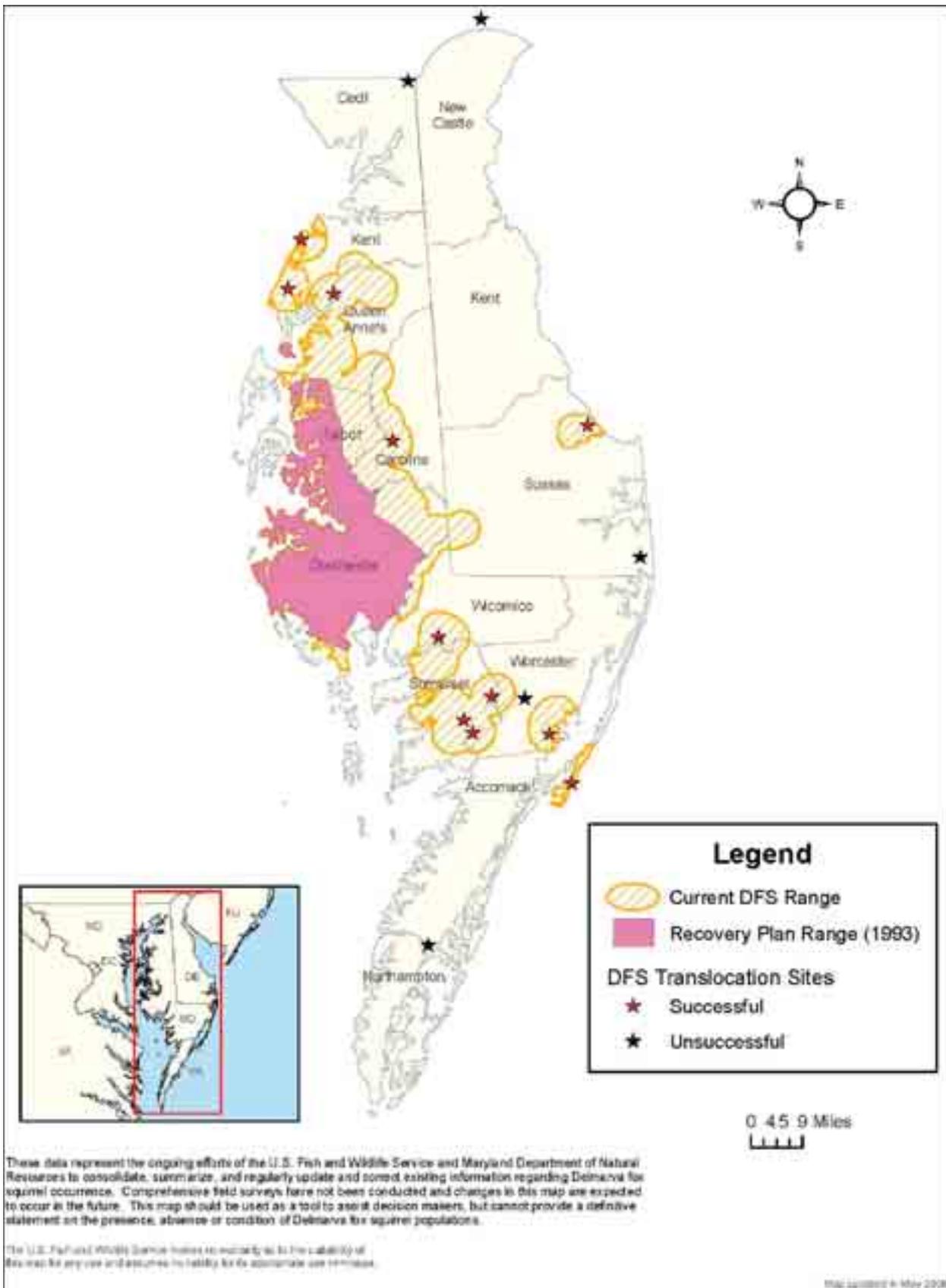


**Figure 2.2. Delmarva fox squirrels captured at Eastern Neck Refuge, 1982-1999**

in 2003. Since that time, sightings are a rare occasion, generally only 1 per year. According to the Service’s Recovery Team Leader, we do not know why the DFS population on Eastern Neck Island declined. It is hypothesized that a decrease in deer populations and/or that the removal of DFS from the refuge to seed the Chincoteague refuge population might be reasons. An average density of a healthy population of DFS is 0.3 DFS/acre of mature forest. In addition, a population viability analysis for DFS suggests that it takes at least 130 animals to provide a stable population (e.g. less than 5% chance of extinction in 100 years) (Hilderbrand et al. 2007). It is unlikely that the refuge ever sustained these numbers and densities. Also, the problem with any island population is that stochastic events can drive populations to extinction and there are no adjacent populations to recolonize the site or provide new individuals (Keller, pers comm., 2006). For these reasons, over the last five years, we have not pursued active management for this species, including translocations back to Eastern Neck refuge. Together with the DFS Recovery Team, we have determined that the refuge population is not deemed essential to DFS recovery. Any additional translocations of DFS would be more effective in other locations within its range.

While loss of the population on the refuge seems dramatic and severe, the good news is that DFS translocations to other sites in Kent County and elsewhere on the Delmarva Peninsula have been very successful (CBFO, 2007b) and those populations are expanding (map 2.5). The species is now on the brink of recovery and all of this past effort has led the way for this response.

Map 2.5. Recent changes in the range of the Delmarva fox squirrel



### Mammals

In addition to the DFS, 18 species of mammals are known to occur on the refuge (appendix A). The DFS is the only mammal species on the refuge. White tailed deer, gray squirrel, raccoon, and muskrat are the most commonly seen.

### Amphibians and Reptiles

The waters and land of the refuge are home to a wide variety of amphibians and reptiles. These are listed in appendix A and described further below.

#### Amphibians

The refuge hosts populations of green frogs, upland chorus frogs, spring peepers, wood frogs, bull frogs, green tree frogs, gray tree frogs, Northern cricket frogs, Fowler's toads, American toads, and both Northern and Southern leopard frogs. Dr. James F. White, Jr., author of the "Amphibians and Reptiles of Delmarva" field guide, reported seeing a state-listed endangered Eastern narrow-mouthed toad (*Gastrophryne carolinensis*) near the causeway at the refuge on March 13, 2003.

#### Reptiles

The refuge is inhabited by the common five-lined skink, nine common snakes, and six common freshwater/upland turtle species. The northern diamondback terrapin, which lives in brackish waters, and the box turtle are both species of greatest concern in Maryland. Two sea turtles occurring in the waters surrounding the refuge are also listed by Maryland as species of conservation concern: the federally threatened loggerhead sea turtle (*Caretta caretta*), is federal-listed as threatened, and the federally endangered leatherback sea turtle (*Dermochelys coriacea*).

Once abundant in the Bay, northern diamondback terrapins are declining due to loss of nesting habitat due to waterfront development, erosion control measures, and invasive species; loss of SAV beds providing foraging habitat; commercial harvesting in the areas in which terrapins reside during winter months; mortality from boating and fishing (physical impacts and by-catches); and rising predator populations. Until recently, terrapins represented an active commercial fishery managed by the MDDNR. In 2007, Maryland acted to protect diamondback terrapins. Effective July 1, 2007, it became unlawful to take or possess them for commercial

purposes and recreational harvest was limited to 3 per person. (Chapters 117 & 118, Acts of 2007; Code Natural Resources Article, sec. 4-902).

### Insects

#### Beetles

Prior to the 2003 release of "Beetles of Eastern Neck Island" (BENI), very little was known about insect populations on the refuge. The BENI biodiversity inventory project involved citizen-scientists as both investigators and educators in biotic surveys. BENI surveys were conducted from March through August, 2003. Collections totaled 413 species of beetles from 56 families, over half the known 102 beetle families in eastern North America. These specimens included 43 vernal pool species (nearly half of the 83 species known to occur in the Delmarva Peninsula), including one State candidate for T&E listing. Of the 11 species of tiger beetles known to occur on the Delmarva Peninsula, five were found on the refuge. The project also established a database of 1,000 records and a voucher collection of over 400 specimens.



John Mosesso, Jr./NBH

Eastern box turtle

A related study—“The Diversity and Abundance of Ground-Inhabiting Beetles in Four Different Habitats of Eastern Neck Island”—concluded that cultivated fields were the least diverse habitat and provided the lowest abundance of ground beetles. Transition zones were the most diverse habitat and with the highest abundance and species diversity. Fallow fields and woodlands were moderate in numbers of species and diversity.

#### *Ticks*

In 2003, a student investigated the prevalence of *Borrelia* (*B.*) *burgdorferi*, the bacterium responsible for Lyme disease, in ticks (*Ixodidae*) collected from deer carcasses at the refuge’s hunt check station. The study collected ticks from 31 deer during the refuge’s fall hunts. Three species of *Ixodidae* were found: dog tick (*Dermacentor variabilis*), Lone Star tick (*Amblyomma americanum*) and deer tick (*Ixodes scapularis*).

In total, 90 samples (86 ticks and 4 groups of eggs) were analyzed for *B. burgdorferi*, and 10 tested positive for the bacterium. All of the infected ticks were from the 79 samples of *I. scapularis*: 73 adults (9 positive) and 2 nymphs (1 positive). The study, therefore, represented that 13 percent of the deer ticks collected on the refuge carried the bacterium.

#### *Butterflies and Moths*

Five separate surveys conducted during 1998 and 1999 identified 36 butterfly species on the refuge. Appendix A provides a list of those observed. Two surveys in 2003 were done to identify moths on the refuge and provide specimens for the refuge collection.

#### **Aquatic Species**

Appendix A lists the aquatic species of interest that occur within the vicinity of the refuge in the Lower Chester River Basin. Fish such as shortnose and Atlantic sturgeon are included, as are American eel, alewife, American and hickory shad, and blueback herring. Shellfish species of interest that occur within the vicinity of the refuge include the American oyster, blue crab, and horseshoe crab. A brief description follows.

#### *American Oyster*

The American oyster occurs in the Chester River and resides primarily in oyster bars on the eastern side of the refuge.

#### *Blue crab*

Blue crab is an interjurisdictional species found in the Chester River. During the winter months, the blue crab occurs in low densities and is distributed in the refuge marshes and surrounding waters. In the summer, blue crab density is much higher and is distributed along the entire refuge. Spawning for this species occurs during the summer surrounding the refuge.

#### *Horseshoe crab*

The horseshoe crab is another interjurisdictional species in the area known to spawn in shallow waters just off the southern tip of the refuge. This crab is identified in the Service’s Northeast Regional Strategic Fish Plan as a species of high conservation concern. In June 2009, refuge staff began a tagging program to learn more about the local horseshoe crab population. Biologists from state and federal agencies across the range of this species participate in this cooperative tagging program. Tag return data provides information about horseshoe crab migration patterns, distribution, abundance, and mortality, which informs the management of horseshoe crab populations.”

**Invasive Species**

We describe pest species, including invasive plants and injurious and invasive wildlife species, in more detail in chapter 3, under “Actions Common to All Alternatives, subheading “Control of Pest Plants and Animals.”

*Plants*

Non-native or exotic plants introduced from other parts of the world or other parts of the country have degraded many natural ecosystems. Invasive plants can spread rapidly and smother or out-compete native vegetation. The refuge currently has 15 invasive plants; four are considered invasive species of major concern —*Phragmites australis*, Johnsongrass, Canada thistle, and mile-a-minute weed. Plants identified as invasive during a 2006 survey of the refuge are listed in table 2.12. Invasive species of concern are actively controlled by refuge management in partnership with Integrated Vegetation Management Partners, a non-profit organization, and the Chesapeake Wildlife Heritage. The refuge tracks the spread and control of invasive plants utilizing Geographic Information Systems (GIS), Global Positioning Systems (GPS), the Weed Information Management System (WIMS), permanent vegetation monitoring plots, and photo points. In 2006, 400 out of a reported 1,250 acres of land infested with invasive plants were treated on the refuge. Treatment successfully controlled invasive plants on 50 of these 400 acres. The refuge is currently conducting a study to determine the efficacy of a series of control measures on five invasive plant species by monitoring for five seasons (summer/fall) post treatment from 2007 to conclude fall 2011.

*Injurious and Invasive Wildlife*

Mute swan and resident Canada geese are present at the refuge and managed according to State of Maryland requirements for their control. Mute swan numbers have increased in recent years and we have continued our efforts, in partnership with MD DNR, to eliminate them from the refuge. Annual mute swan counts in recent years were 130 (2005–2006), 168 (2004–2005), 61 (2003–2004).

**Table 2.12. Invasive Plant Species on Eastern Neck Refuge**

Common Name	Scientific Name	Common Name	Scientific Name
Common Reed	<i>Phragmites australis</i>	Autumn Olive	<i>Cirsium arvense</i>
Johnsongrass	<i>Sorghum halepense</i>	Princess Tree	<i>Paulownia tomentosa</i>
Canada Thistle	<i>Cirsium arvense</i>	Chinese Lespedeza	<i>Lespedeza cuneata</i>
Multiflora Rose	<i>Rosa multiflora</i>	English Ivy	<i>Hedera helix</i>
Mile-a-minute	<i>Polygonum perfoliatum</i>	Garlic Mustard	<i>Alliaria petiolata</i>
Wineberry	<i>Rubus phoenicolasius</i>	Common Mullein	<i>Verbascum thapsus</i>
Japanese Stilt-grass	<i>Microstegium vimineum</i>	Tree of Heaven	<i>Ailanthus altissima</i>
Japanese Honeysuckle	<i>Lonicera Japonica</i>		

**Archeological and Historical Environment**

**Overview**

Several archaeological surveys have been performed on the refuge since 1978. However, that work was limited to an intermittent series of studies for construction of trails; improvements to office, quarters, and maintenance facilities; and, habitat improvement projects. Surveys to date have identified a total of 79 archaeological sites. Thirty-two of them date between 600 B.C. and English settlement of the island in the year 1658. Another 47 of them date

between 1658 and the 1930s. Human remains have been discovered at two sites, and it is likely that more exist. The geographic density of known pre-contact sites is remarkable for an area the size of Eastern Neck Island. Many sites of varying time periods are on slight rises of ground adjoining current or former seasonal wetlands and watercourses. However, there has never been any overview study to develop a model of likely archaeological site locations, and it is unclear how many additional undiscovered sites exist. In addition to archaeological resources, two early 20<sup>th</sup> century structures associated with a waterfowl hunting club still stand on the refuge.

Past impacts to archaeological sites on the refuge have occurred from a variety of causes. Most historic period structures on the island were demolished by private owners in the early 20<sup>th</sup> century or by the Service shortly after establishment of the refuge in the 1960s. Those activities also sometimes damaged archaeological resources associated with early plantation sites. Human remains eroding from one Pre-Contact site were recovered by archaeologists in 1980 and reburied on the refuge by a Native American group. A number of other sites recorded in a 1978 archaeological study were found to have been completely lost to coastal erosion 15 years later. Several others are actively eroding today. Further inland, many sites (including at least one burial) are in areas that were historically tilled. Some are still tilled, and exhibit deflation by wind erosion. All sites on the refuge are now protected by the Archaeological Resources Protection Act, which contains both misdemeanor and felony provisions for prosecution of looting on federally managed land. Despite that legal protection, artifact collecting in plowed fields and digging in sites along the shore have been recurring problems over at least the last 20 years, especially in the boating season and when tilling is underway. This is particularly damaging to the resource. Not only does the artifact itself disappear, but the larger story it could have told if its location had been accurately plotted is also lost forever.

### **Pre-contact Archaeological Resources**

Initial human occupation on the Eastern Shore of Maryland appears to date from about 14,000 years ago. While no archaeological sites from that period have been identified on the refuge, several have been found elsewhere on the Eastern Shore. Eastern Neck Island would have been suitable for occupation at that time, as well as in what archaeologists call the “Early Archaic Period (11,500 to 8000 years ago). The earliest sites identified so far on the refuge date to the “Middle Archaic Period” (ca. 8000 to 5500 years ago), and appear to represent small camps for fishing, plant gathering, and hunting of game and waterfowl. Some “Late Archaic Period” sites (ca. 5500 to 3000 years old) are also present. These occasionally contain oyster shell, reflecting stabilization of the nearby marine environment and exploitation of a newly reliable food resource by island inhabitants. By the Woodland Period, ca. 3000 to 350 years ago, shell-fishing had become a major activity, and corn agriculture also appeared on the island. By that time, the size and shape of the island was probably similar to today, though the acreage and configuration of portions lost to coastal erosion is unknown. One Woodland Period site on the island covers a considerable area and may have been a small village occupied year round by several families. Reconstruction of a “Townsend Style” ceramic pot from that site was arranged between Washington College’s Archeology Department and the Service’s Region 5 Museum Property Coordinator in 2003. It is currently on display in an exhibit case in the visitor contact station.

Captain John Smith explored this part of the Bay in 1608 and made the first recorded contact with the Ozinies, a branch of the Algonquin-speaking Nanticokes, at a landing point just across the narrows. Smith identified their primary village as somewhere on the lower Chester River, with a population including 60 warriors. After decades of tension, open warfare broke out between

the Ozinies and Maryland colonists in 1642 and persisted intermittently until 1678. Though warfare and diseases introduced by European contact decimated the Ozinie population, they may have descendants in Nanticoke groups on the Eastern Shore today.

### **Historic Period Archaeological Resources**

In 1658, Joseph Wickes and Thomas Hynson were granted the southern and northern halves of Eastern Neck Island, respectively, and both quickly established plantations with substantial dwellings and numerous outbuildings. Wickes' plantation was named "Wickliffe." Limited archaeological and archival research indicates that its original farmstead buildings were near the current refuge quarters.

In addition to family members, each plantation included an enslaved African American population of about a dozen adults and children, as well as indentured servants. While tobacco was a major crop in the first century of occupation, a substantial amount of corn was also grown and the farms kept a wide variety of livestock. Probate records indicate an unusually high number of riding horses, perhaps bred for sale. Both families owned a variety of vessels, ranging from log canoes to a sloop that engaged in trading voyages to the Caribbean. The Wickes' also owned a shipyard, the site of which has never been archaeologically investigated.

Both the Hynson and Wickes families were economically, socially, and politically prominent in Kent County for some time. County Court was held in Chief Justice Joseph Wickes's home until a courthouse was built in the county's first settlement at New Yarmouth. Joseph Wickes' most famous descendant was his great grandson, Captain Lambert Wickes. He carried Benjamin Franklin to France in 1776 aboard the Continental Navy brig "Reprisal" to seek French support for the American Revolution. Captain Wickes and all but one of his crew were lost at sea in 1777, after a short but distinguished career in which he captured numerous British merchantmen and engaged several enemy naval vessels. A small monument stands near the birthplace of Captain Wickes and is located near the south end of the refuge. During the course of the 18<sup>th</sup> and early 19<sup>th</sup> century, the original Wickes and Hynson plantations were eventually divided into smaller parcels by heirs or sold out of the families. The additional large plantations built during that time, such as Samuel Wickes' home and Spencer Hall, included impressive dwelling houses. By the late-19<sup>th</sup> century, there were several smaller farms and tenant houses on the island, as well as a school. A small fishing village with an oyster-shucking plant grew up at Bogles Wharf, where the Chester River Steamboat Company provided regular service to Baltimore.

### **Historic Period Structures**

In the early 20<sup>th</sup> century, wealthy individuals from surrounding cities were attracted to the area by its notable concentrations of waterfowl and bought portions of the island for hunting retreats. The only remaining waterfowl hunting lodge, built in 1933, still stands and has been determined eligible for inclusion in the National Register of Historic Places. It was recently rehabilitated for use as the refuge headquarters and visitor contact station. The current refuge quarters was built in 1934 as a year-round residence for the caretaker of the hunting club property. Although it is a fairly commonplace early 20<sup>th</sup> century house, it may be eligible for National Register inclusion because of its association with the hunting club and lodge.

In the 1950s, a developer bought a large tract on the west side of the island and subdivided it into 293 small lots for a housing development. The Service, responding to concerns over the development expressed by the local community,

acquired the entire island between 1962 and 1967 to preserve its valuable wildlife habitat. The former refuge office was built around 1960, and is now used as seasonal housing. It is the only house ever built in the “Cape Chester” subdivision. It is not National Register eligible.

### **Museum Property**

Over the years, the refuge acquired by various means a number of archeological and historical objects which are considered ‘museum property’ under Department of the Interior regulations. Some of those objects are currently stored in the Service’s regional office, while others are on display in the exhibit at the visitor contact station. In 2007, archaeological material from 1978 and 1980 studies by Catholic University was transferred to the Maryland Archeological Conservation Laboratory for rehabilitation, identification, cataloguing, and storage. They will remain there, available for examination by researchers, as part of a permanent collection stored to meet federal preservation standards.

## **Visitor Services and Programs**

The following principles have guided our management of public use on the refuge:

- Promote the refuge message, thereby enabling the visitor to have a more enjoyable experience and perhaps helping to reduce the impacts on other wildlife areas.
- Provide teacher-led environmental education opportunities.
- Increase self-service opportunities to better educate the public and promote the refuge message using informational panels, brochures, and refuge website.
- Provide compatible opportunities for wildlife observation, wildlife photography, hunting, and fishing.
- Provide professionally produced interpretive information at appropriate locations.
- Improve the training of staff and volunteers to enable them to provide quality interpretive experiences for the public that convey the refuge message.
- Maintain and improve visitor facilities to ensure that high quality experiences of different levels and abilities that are safe, enjoyable, and educational are available to the public.
- Conduct effective outreach and work with State and local organizations to provide wildlife-dependent recreational facilities that enable the visitor to enjoy the refuge without adversely affecting either wildlife or wildlife habitat.

### **Visitor Numbers**

In 2007 there were 55,000 visitors to the refuge. Refuge visitors primarily arrive by car. Bicycles are permitted on paved and gravel roads designated open to the public. Non-consumptive activities were the most popular. Most of the visitors came to walk on nature trails, observe and photograph wildlife, or enjoy the BayScape garden. Of consumptive users in recent years, approximately 420 were associated with hunting; 27 were associated with freshwater fishing in the refuge pond; and, 6,000 were associated with saltwater fishing. About 60 percent of all visits are by non-residents. Visitors are drawn primarily from the nearby metropolitan areas of Washington, D.C., Baltimore, MD and Philadelphia, PA (USFWS 2007).

### **Visitor Facilities and Programs**

The Visitor Contact Station and Friends of Eastern Neck Bookstore are located in the lodge, which also serves as the refuge administrative headquarters. The bookstore is open every day of the year except on certain Federal holidays, during deer hunts and any other special management activities. In addition to the bookstore and offices, visitors can view exhibits explaining the history of the island. A diorama also shows an example of wetlands habitat on the refuge. In the rear of the lodge, visitors can sit and relax with a reference book or request to view one of the many videos on hand. Loaner binoculars, which enhance visitors' observation experiences, are available at the Friends of Eastern Neck Bookstore. Bay Bio cards are also available at the bookstore. These cards assist visitors in learning about the variety of wildlife they may observe while on the refuge. Outside are public restrooms and a deck with chairs and a picnic table. A small conference room is at the rear of the lodge. Refuge interpretive brochures and leaflets are available here, including: refuge bird lists; an interpretive leaflet about the refuge trails; a water trail map and guide; historic information about the lodge and Eastern Neck Island; a Friends of Eastern Neck brochure and quarterly newsletter; and the results of the weekly waterfowl survey.

The refuge is part of the Chesapeake Country National Scenic Byway and Captain John Smith Chesapeake National Historic Water Trail.

We offer activities and programs in each of the six priority public use programs: wildlife observation and photography, environmental education and interpretation, and hunting and fishing. In the discussion that follows, we describe facilities that support these programs which are also depicted on map 2.6.

Tundra Swan Boardwalk. This 140-foot facility provides visitors a perfect site for watching the staging tundra swans and other waterfowl in the winter and for fishing and crabbing in the summer. Permanently mounted scopes, benches, and a seasonal waterfowl identification panel are also a part of this universally accessible boardwalk. A kiosk with two interpretive panels, brochure holder and locking display case are at the foot of the boardwalk in the parking lot.

Boxes Point Trail. Located a short distance north of the Tubby Cove parking area, this broad trail begins along the border between the forest and marsh, then bends to reveal an agricultural field on the right where migratory Canada geese often gather in the fall and winter. From there the trail enters a forest of mixed evergreens and deciduous trees with a very open under story. The forest fades to marsh as the trail nears its end at Boxes Point on the bank of the Chester River. A bench provides a resting place for hikers. Waterfowl, including tundra swans, are often visible here in the late fall, winter, and early spring. The trail is 1.2 miles round-trip.

Tubby Cove Boardwalk. From the Tubby Cove kiosk and parking area, this boardwalk extends over a healthy, diverse marsh to a wooded island. Once on the island, the boardwalk passes through a stand of loblolly pines. The main path leads to a universally-accessible enclosed observation blind. Another short trail extends from the main path to an elevated observation platform providing a view of the Bay and into Calfpasture Cove and Tubby Cove. The boardwalk is less than 1/4-mile round-trip. A kiosk with six interpretive panels, a brochure holder and a locking display case is located near the road at the parking lot. Universally-accessible restrooms are also located at the parking lot.

Duck Inn Trail. From Bogles Wharf Road., this trail begins in a wooded area dominated by loblolly pine and bordered by marshes. In this section, evidence of previous prescribed fires is visible. The trail then moves into a field dominated by tall grasses and open marsh. Finally, the trail moves through an area of scattered loblolly pine and deciduous trees before ending at the bank of the Chester River. The shore is composed of an oyster midden and looks east over the river. Waterfowl may be visible in the river during late fall, winter, and early spring. Migratory songbirds are abundant along the trail during spring and fall migrations. The trail is a 1-mile round-trip.

*Bogles Wharf at sunset*

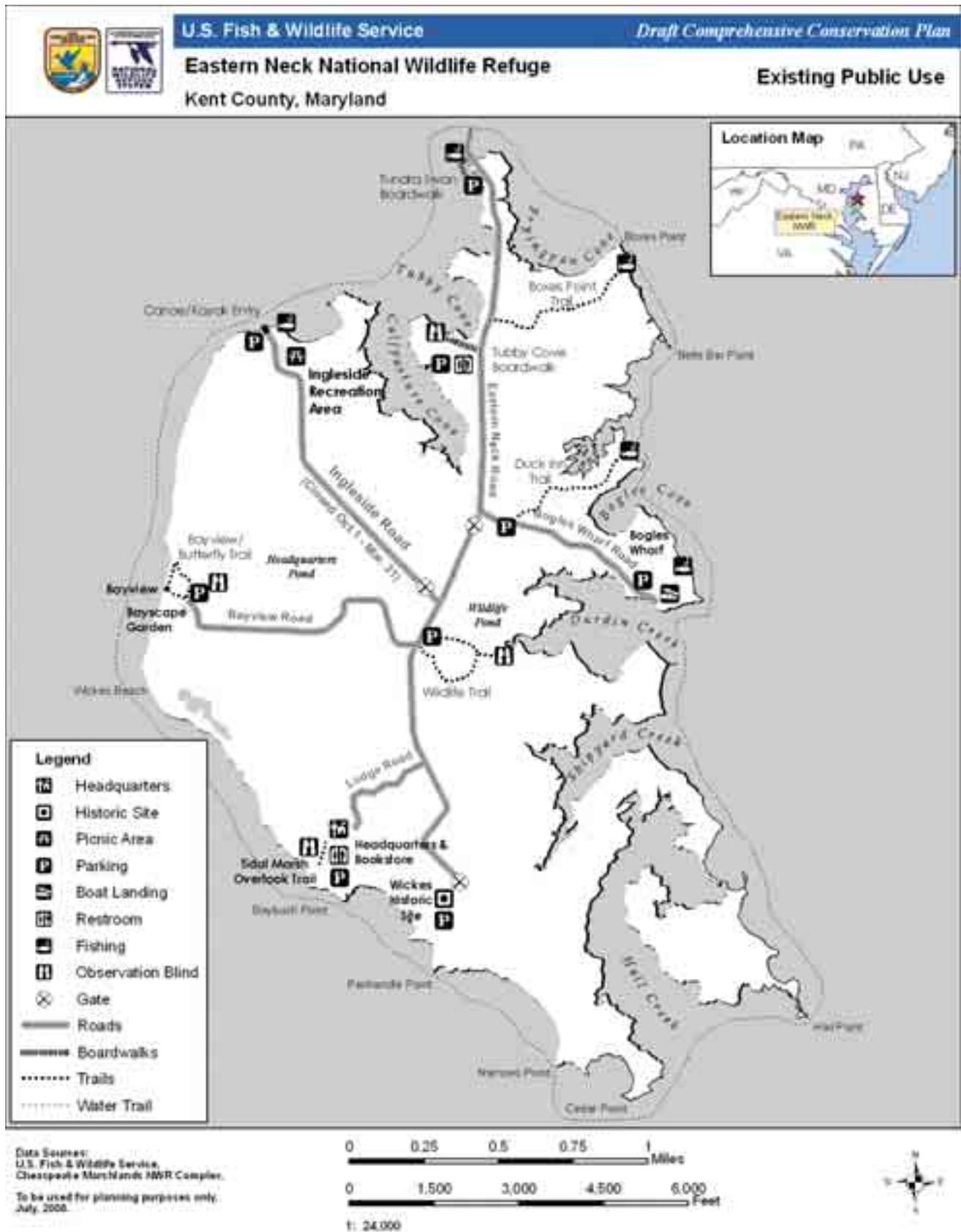


USFWS

Bogles Wharf. This area is managed by the Kent County Department of Recreation. A boat trailer permit is required to use the boat launch. Fishing piers and a shoreline area are available for fishing and crabbing. Portable restrooms, provided by Kent County, are available seasonally. This area is also one of the launch sites for the water trail around the island in state waters.

Ingleside Recreation Area. This bayshore area is managed by the Kent County Department of Recreation. Open from April 1 through September 30, this area is great for crabbing and fishing. A kiosk with two interpretive panels, a locking display case and a brochure holder is located near the picnic area parking lot. Picnic tables and portable restrooms, provided by Kent County are available seasonally.

Map 2.6. Eastern Neck Refuge visitor facilities



Wildlife Trail. This 1/2-mile loop trail begins and ends at a trailhead on the main refuge road. The trail never leaves the forest, although it passes close to wetlands in several places. A spur of the trail extends off the main path to an enclosed observation blind overlooking a marsh. Songbirds are plentiful along this wooded trail, particularly during fall and spring migrations. A kiosk is located in the parking lot.

Headquarters Pond. Located on the gravel road to the Bayview-Butterfly Trail, this pond offers visitors a variety of wildlife viewing opportunities depending on the season. Beaver, bald eagles, herons, kingfishers, and wild turkey are often reported. There are also a few osprey platforms visible along the road providing a pleasant wildlife viewing opportunity.

Bayview-Butterfly Trail. From the Cape Chester House parking lot this 1/3-mile universally-accessible loop trail extends through restored grassland to a deck overlooking the Bay and a breakwater project, complete with benches and two binocular viewers. The trail then travels to an enclosed observation blind at the edge of a wooded pond before passing through a young forest and finally through the restored grassland and back to the parking lot.

BayScape Garden and Demonstration Area. Located behind the Cape Chester House, this volunteer-tended garden was created in 2001. It also serves as a BayScape demonstration area educating visitors on how to protect the Bay by utilizing native plants and other landscaping features instead of mowed lawns, or potentially invasive ornamentals. Initial planting and subsequent maintenance of the demonstration area is funded by the Chesapeake Bay Trust. Plants are fertilized with organic “leaf-gro” to avoid runoff of excess fertilizers. Irrigation is provided through a pressure-regulated drip system that significantly minimizes water use compared to traditional sprinkler systems. Through a network of tubes under the mulch, water is delivered directly to the ground, rather than sprayed on plant leaves and ground surface, where it can evaporate. The conservation garden also offers a site for exploration and education.

In 2007 it was given the Bay Wise designation by the Master Gardeners of Queen Anne’s County MD Cooperative Extension. The garden is active most months of the year. During the spring and fall, thousands of butterflies can be seen throughout the garden.

Tidal Marsh Overlook Trail. Located behind the Refuge Visitor Contact Station, this universally accessible boardwalk meanders through a native meadow to an observation blind overlooking the Chester River and Kent Island. In early morning, waterfowl and other water birds are often visible in the pool just beyond the photo blind. This trail and viewing area is closed when the Visitor Contact Station is closed.

Wickes Historic Site. This site provides benches and has a state historic marker commemorating the life of Captain Joseph Wickes and his home “Wickliffe.”

Eastern Neck Island Water Trail. This trail actually lies in State waters, but the refuge provides car-top access at Ingleside Recreation Area. Visitors can also access the trail via the county boat launch at Boggles Wharf. The trail, established in October 2006, includes seven interpretive signs along the shoreline. Waterproof trail maps are available for purchase at the Friends Bookstore. This trail connects scenic, historic and wetland restoration sites around the island for the wildlife-dependent recreational and educational benefit of paddlers. It consists of several points of interest such as restored wetlands, historical

locations, hiking trails, access locations and other recreation areas all displayed in a map-and-guide format.

**Hunting**

Public hunting of white-tailed deer and a youth wild turkey hunt are permitted on the refuge on specific days that are annually designated by the refuge manager in cooperation with the Maryland DNR. Hunters must purchase a state license, as well as a refuge permit, to hunt on the refuge. Hunting of waterfowl is not allowed on the refuge.

*White-tailed Deer Hunt*

The refuge has held an annual white-tailed deer hunt since the refuge was first staffed in 1966. The hunt serves not only to keep the deer within the capacity of the habitat to support them, but also offers a wildlife-dependent recreational opportunity, when such opportunities are becoming harder to find as a result of increasing land development.

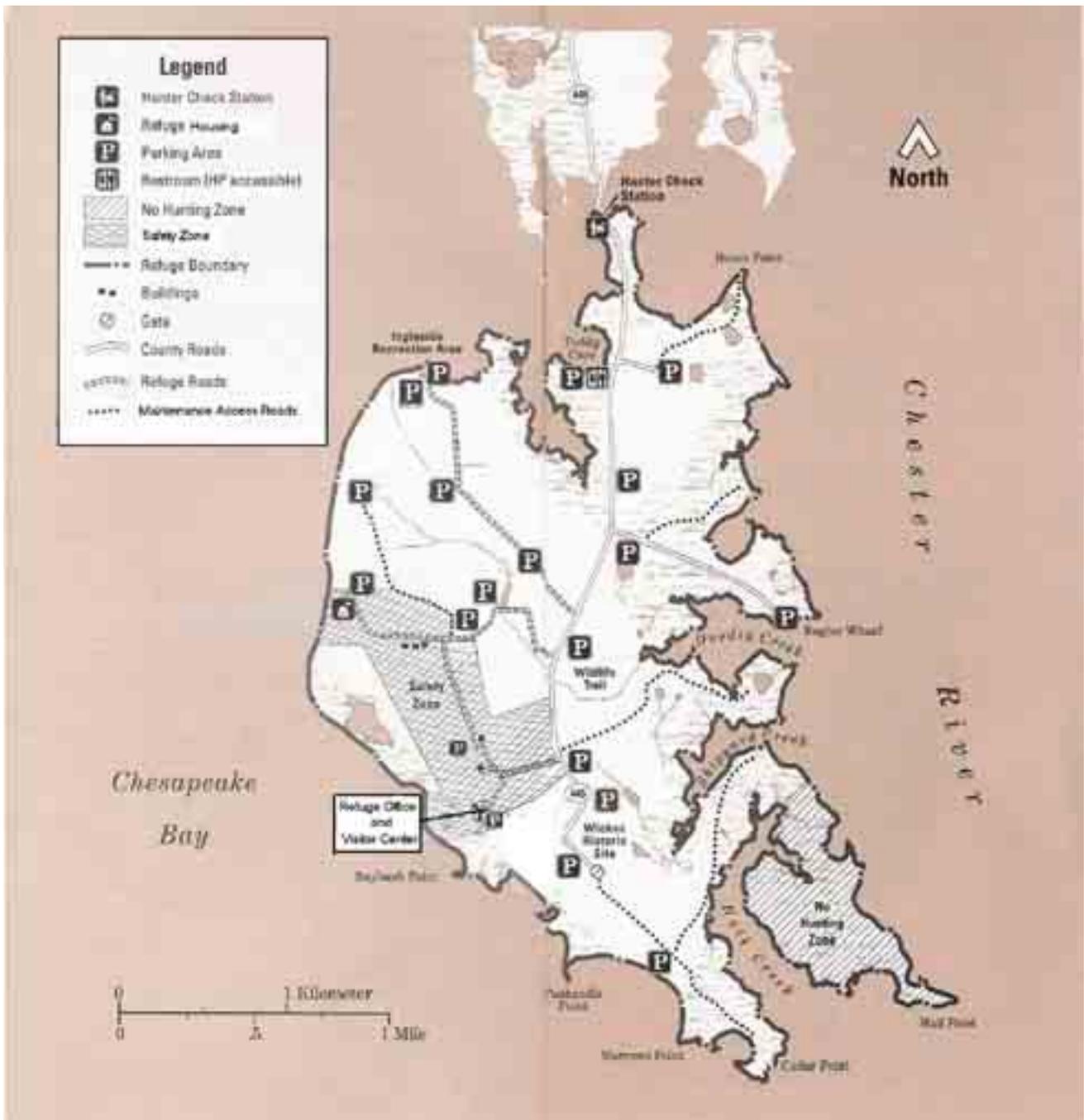
Each year the refuge submits an annual hunt program for regional review before July 1 and publishes refuge-specific regulations in the Federal Register and in 50 CFR Part 32. The annual deer hunt includes one youth day, one disabled hunt day, one archery hunt day, two shotgun hunt days and two muzzleloader hunt days. Up to 600 adult and 50 youth hunters are the maximum permitted each year. The number of hunters, deer harvested and percent success over the last 10 years is included as Table 2.13. A \$10 fee is required to apply for a refuge permit. Senior citizens receive a 50 percent discount on these fees if they possess a Senior Pass which is part of the Federal Recreational Lands Pass Program.

**Table 2.13. Number of Hunters and Deer Harvested on Eastern Neck Refuge from 1997-2008.**

Year	Number of Hunters	Deer Harvested
1997	920	242
1998	758	78
1999	702	221
2000	584	65
2001	480* (est)	66
2002	430	63
2003	480* (est)	96
2004	480* (est)	81
2005	413	74
2006	413	97
2007	462	90
2008	426	86

Hunting times and areas are regulated to eliminate conflicts with sensitive wildlife and to ensure compatibility with refuge purposes. Over 80% of the refuge is open to hunting (Map 2.7), with a ratio of approximately one hunter per 20 acres. Numerous parking areas help to distribute the hunting pressure throughout the refuge. The refuge is closed to visitors other than permitted hunters during the hunt days but access to Bogles Wharf is still allowed. Staff and volunteers operate a check station at the entrance to the island during the hunts. The hunters are given an orientation at check in and provide age, sex, and weight data of any deer harvested at check out. Hunt leaflets, regulations, and maps are published annually and distributed to hunters. No specific area is designated for wheelchair-bound or disabled hunters.

Map 2.7. Eastern Neck Refuge deer hunt program





Map 2.8. Eastern Neck Refuge turkey hunt program

#### *Wild Turkey Hunt*

The first turkey observation on the refuge occurred in 1996. Since that time, the turkey population has steadily increased. A two day youth turkey hunt was established in 1999 to provide youth hunters the opportunity to participate in a high quality wildlife-oriented public use. From 1999 to 2006, the number of youth hunters has varied from 4 to 8. On the average, one to five turkeys are harvested annually with a high of five turkeys harvested in one year (2007).

This hunt is conducted in partnership with the Wild Turkey Federation. Refuge staff advertises and selects the youth hunters and volunteers from the Wild Turkey Federation guide the young hunters. The turkey hunt is conducted in four designated refuge zones (Map 2.8). One hunt party is placed in each of the four designated zones. The refuge is closed to visitors other than permitted hunters during the hunt days but access to Bogles Wharf is still allowed. Staff and volunteers operate a check station at the entrance to the island during the hunts. The hunters are given an orientation by refuge staff on the evening prior to the hunt.

#### **Fishing**

In 2006, we estimated that 6,026 visitors used the refuge to fish. Kent County manages the Ingleside Recreation Area and Bogles Wharf landing within the refuge. The Ingleside Recreation Area is located on the northwest side of the

*Youth turkey hunt on  
the refuge*

Jonathan Priday/USFWS



refuge and has facilities for crabbing and non-motorized boat launching from April 1 to September 30. Picnic tables and portable restrooms, provided by Kent County, are available for use during these months. Bogles Wharf landing is located on the east side of the refuge and offers trailered boat launching facilities for visitors with a county boat trailer permit. In 2006, approximately 700 visitors used the boat launch. The recently constructed Tundra Swan Boardwalk was designed to run parallel to a deep channel of the Chester River to offer summer fishing and crabbing opportunities, as well as winter wildlife observation.

Additionally, the refuge hosts an annual Youth Fishing Derby each June. A universally-accessible fishing pond located on the gravel road to the Bayview-Butterfly Trail is used for the Derby. The Derby, which has occurred annually on the refuge since 1996, has an average attendance of 41 youth per day. On average, 100 fish are caught each year during the Derby. The refuge awards a variety of prizes to the Derby winners.

### **Environmental Education**

In the past, we have hosted a variety of elementary through college age school and youth groups throughout the year for environmental education programs on the Bay, migratory birds, forested habitats, and other topics as requested.

Each fall and spring, the refuge hosts a comprehensive day of environmental education for all 4th-grade students in Kent County, in cooperation with state and county natural resource agencies. Currently, only teacher and volunteer-led programs are held at the refuge. In 2007, 20 teachers and 200 Kent County 4<sup>th</sup> graders participated in this on-site education programs.

The National Aquarium in Baltimore was recently awarded a ‘Nature of Learning’ grant to support and enhance the environmental education program on the refuge. Through this grant, the Aquarium has enhanced conservation education efforts on the refuge by conducting environmental education and stewardship activities for students and teachers from Kent County. The proposal is a partnership between the Aquarium, the refuge, the FOEN, and the Kent County School District.