Mamacoke Important Bird Area

Conservation Strategy

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Summary

The National Audubon Society has recognized the shoreline of the Thames River between Harrison's Landing and Smith Cove in Quaker Hill (Waterford) as an Important Bird Area for Connecticut. Important Bird Areas constitute a network of sites in the United States and other countries that provide critically important habitat for bird populations. The site on the Thames River centers on Mamacoke Island, which is a designated natural area within the Connecticut College Arboretum. It includes three coves and two salt ponds that provide important habitat for a variety of ducks that spend the winter in Connecticut. Smith and Mamacoke coves are especially important as feeding areas for ducks during periods of intense cold during mid winter when freshwater lakes, reservoirs and rivers in the surrounding region are covered with ice. The brackish water of the Thames River generally does not freeze completely and thus provides an open-water refuge for Hooded Mergansers, Black Ducks, Canvasbacks and other waterfowl species. Although large flocks of ducks only concentrate in these coves for a few weeks each year, this section of the Thames River may still be critically important for their survival through the winter. The coves also support Bald Eagles, Pied-billed Grebes and American Coots during the winter, and Ospreys and a variety of species of herons during the summer. The adjacent upland areas within the Connecticut College Arboretum are also important for birds. Several open fields are maintained with controlled burning or periodic mowing. In 2004 a 12-acre parcel in the Arboretum was restored to open grassland with scattered trees to improve habitat for species that require open areas. This restored area should provide better habitat for Screech Owls, American

Woodcocks, Blue-winged Warblers, Orchard Orioles, and other species that require meadows or park-like savannas.

As part of the Important Bird Area program, Glenn Dreyer, Robert Askins and Scott Peterson of Connecticut College have drafted a conservation plan that describes the history and ecology of the area, and proposes goals for research and management. The entire plan is available on-line at the Connecticut College Arboretum web site. (http://arboretum.conncoll.edu/)

Natural habitats in much of the Mamacoke Important Bird Area are already protected in the Connecticut College Arboretum. Protection of a couple of small, undeveloped parcels of land along the river shore would help protect the coves. Our main goals, however, concern better management of conservation land and public waterways that make up the bulk of the Important Bird Area. Key goals are to reduce sewage infiltration and runoff of sediments into the coves and river, and to continue active maintenance of meadows. We also plan to erect nest boxes and nest platforms at the site, and to expand our program for monitoring bird populations. Another high priority is to inform local residents about the importance of this section of the river for conservation, and to ask for their advice and help in protecting the area

I. Introduction

The purpose of the this report is to assemble all pertinent information to facilitate conservation planning for the Important Bird Area centered on Mamacoke Island in the Thames River, Waterford, Connecticut (Figure 1). Of primary conservation importance are the brackish coves in this IBA that harbor large numbers of waterfowl in winter during periods when freshwater bodies are frozen. Since the IBA was first proposed in this location, however, the Connecticut College Arboretum has increased the acreage of early successional habitat very near the river coves, and these areas and adjacent uplands have been incorporated into an expanded IBA because of their importance for early successional bird species.

II. The Important Bird Area Program

The National Audubon Society is the official Partner of BirdLife International for the IBA Program in the United States and is working to identify a network of sites that provide critical habitat for birds throughout the country. The IBA Program is a global effort to identify sites that are most important for maintaining populations of birds and to focus conservation efforts toward protecting these sites. The IBA Program recognizes that habitat loss and fragmentation are the most serious threats facing populations of birds across America and around the world. By working through partnerships, principally the

Figure 1. A 2004 aerial photograph showing significant roads and physical features. The core IBA area is outlined in red with the upland buffer area shown in yellow.

North American Bird Conservation Initiative (NABCI), to identify and draw public attention to those places that are critical to birds during some part of their life cycle (breeding, wintering, feeding, migrating), the IBA program's goal is to minimize the effects that habitat loss and degradation have on bird populations at these sites. Unless we can slow the rapid destruction and degradation of habitat, populations of many birds may decline to dangerously low levels. In the U.S. the IBA program has become a key component of many bird conservation efforts including Partners in Flight (PIF), North American Waterbird Management Plan (NAWMP), and the U.S. Shorebird Conservation Plan (USSCP) (Audubon 2006).

Important Bird Areas may be small or large, may include public or private lands, and may or may not already have any level of protection. To qualify as an IBA, sites must satisfy at least one of a set of standardized criteria relating to species, their distributions and their habitats. Generalized IBA criteria are listed below. Additional more specific criteria exist for IBAs in Connecticut (see subsequent section "Relevant IBA Criteria"):

- Species of conservation concern (e.g. species listed as threatened and endangered at the federal or state level),
- Restricted-ranges species (species vulnerable because they are not widely distributed),
- Species that are vulnerable because their populations are concentrated in one general habitat type or biome,
- Species or groups of similar species (such as waterfowl or shorebirds) that are vulnerable because they occur at high densities because they congregate in large numbers.

In setting conservation priorities, the IBA program focuses on using scientifically defensible data. Specifically, the program provides mechanisms for prioritizing conservation actions and allocating limited conservation dollars to ensure the maximum benefit to birds. Species targeted by the IBA program include those that occur on Audubon's WatchList, which targets those species with particular conservation needs. Audubon's WatchList includes all species that the International Union for the Conservation of Nature (IUCN) recognizes as species of global conservation concern, and all federally endangered or threatened species, as well as additional species that are facing population declines and/or threats such as habitat loss on their breeding and wintering grounds, or that have limited geographic ranges. A centerpiece of conservation at Audubon, the WatchList is a science-based system that focuses attention on at-risk bird species so that limited resources are spent where they are most needed. Additional species considered by state IBA programs include those identified as having regional priority by Partners in Flight, have a significant percentage of their population dependent upon a given bird conservation area, or species recognized as in danger of extirpation from a given region of the country, i.e. state-listed species. By working within partnerships, the IBA program can aid these species, many of which spend different parts of their life cycle in different hemispheres.

Finally, the IBA program also promotes local stewardship and advocacy by raising awareness of the importance of the site and by providing opportunities for participation by volunteers and citizen scientists in projects such as monitoring programs and habitat management. Overall, the IBA program is a starting point for site-based conservation efforts, and stakeholders are included in the process at many levels.

III. Site Background

Site Description

The Mamacoke IBA and surrounding buffer zone comprises sections of the Thames River and both developed and undeveloped land on its west bank in the Quaker Hill section of Waterford, Connecticut, opposite the US Naval Submarine Base in Groton. The irregularly shaped area of 317 acres (within both red and yellow lines in Figure 1) is bounded by Scotch Cap Road and Best View Road on the north (Figure 1). While the core IBA area mainly follows shorelines, the western edge of the buffer zone follows Mohegan Avenue (Route 32) or the rear boundary of residential lots east of this road, and the Waterford-New London town line forms the southern boundary. The IBA boundary extends east into the Thames River from the Waterford-New London town line and follows the approximate western margin of the dredged river channel north until reaching the terrestrial IBA boundary again northwest of Smith Cove. With this approximate aquatic boundary to the east, the IBA encompasses all tidal coves and waterways surrounding Mamacoke Island and north just beyond Smith Cove. In addition, 12 acres of early successional Arboretum land adjacent to Benham Avenue near the river are part of the IBA. Elevations range from about 160 feet on the Arboretum Avery Tract to about 2 feet at the river's edge (Figure 2).

Of the total 168 terrestrial acres, 114 are owned by Connecticut College. College property comprises a number of parcels within the Connecticut College Arboretum: Mamacoke Island and associated marsh land, the George S. Avery Tract, the Katherine Matthies Tract, the Hempstead Tract, and the Espinosa House & Lot (Figure 3). These five properties were acquired by the college separately between 1944 and 1963; a complete summary of parcel history, including previous owners, buildings, uses, method

of acquisition and costs, can be found in Goodwin's (1991) history of the Arboretum. Mamacoke Island and Marsh were designated as the Arboretum's second Natural Area when they were acquired in 1955 (Goodwin 1991). Arboretum Natural Areas are

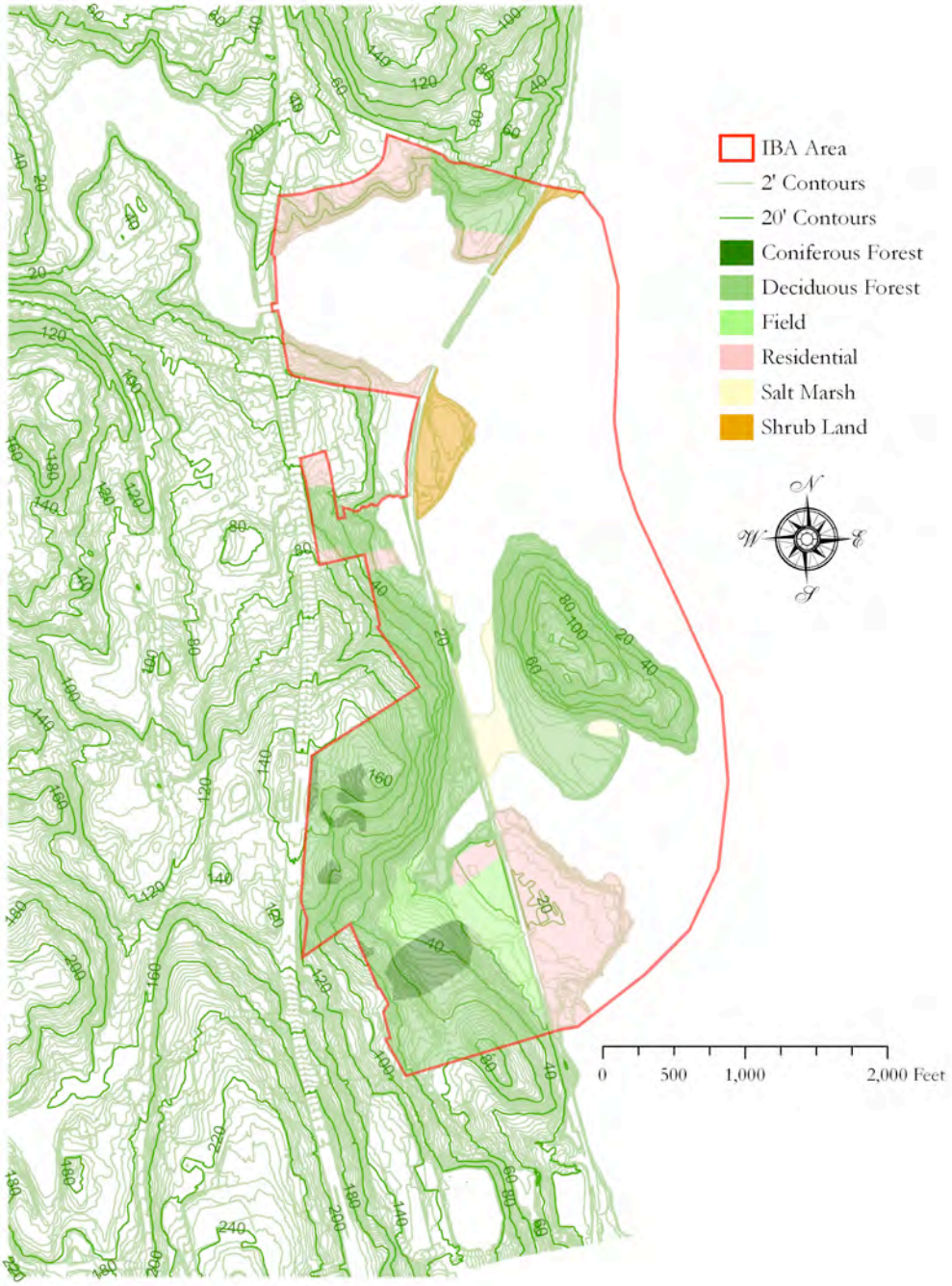

Figure 2. Vegetation cover types and topography of the Mamacoke IBA.

Figure 3. Mamacoke IBA and buffer zone (yellow line) showing college tracts in white and other land holdings in blue outline.

primarily reserved for research and teaching, and managed to minimize human influence as much as possible. In practical terms this means no planting, cutting, or harvesting of plants, destructive experimentation, or active recreation. Limited removal of invasive exotic plant species has recently occurred in some locations, however.

The Mamacoke IBA includes five noteworthy water bodies, listed here from north to south: Smith Cove (portion east of Rt. 32 only); a small pond west of the railroad tracks and north of the Hempstead Tract connected to the river via a culvert: Mamacoke North Cove; Mamacoke South Cove; and the Brackish Pond west of the railroad right-of-way and connected to Mamacoke South Cove by a culvert. These water bodies are important shallow, tidal, aquatic habitats that support numerous bird species throughout the year, and are especially important for waterfowl during winter (Askins 1990). Together with portions of the Thames River, the aquatic area of the IBA is 149 acres.

Mamacoke Island is actually a rocky peninsula connected to the mainland by an unditched, 2.5-acre salt marsh. The center of Mamacoke is an ellipsoidal upland dome of gneiss rising 130 feet above the Thames River, with outcrops, glacial erratic, ledges, and pockets of glacial till supporting scattered trees, thickets, and small grassy ridge tops. There is a second, smaller salt marsh covering less than 1 acre on the southern side of Mamacoke at the head of a small cove.

Land Use History

Artifacts and other evidence of settlement indicate that Native Americans inhabited much of the land within the Mamacoke IBA as early as 4000 years ago (Juli 1992). There are four main Native American archeological sites within the

Arboretum section of the IBA that Juli designated as the Graves Rockshelter site, the Mamacoke Cove site, the Harrison's Landing site, and the Arboretum Field site.

Covering an area of 500 square meters, a shell midden at the Harrison's Landing site was the first to be archeologically studied, beginning in the early 1970s. Harrison's landing is actually the small, residential development east of the railroad tracks and south of Mamacoke Island. The archeological site of this name is located in southeast corner of the Arboretum Avery tract, at the head of the Brackish Cove west of the railroad and Mamacoke South Cove. Middens are areas of food remains, including bones and artifacts, and most commonly (especially in coastal regions) an abundance of shell refuse, often resulting from years of prehistoric meals in one place. At Harrison's Landing 95% of the midden deposit is represented by the common eastern oyster (*Crassostrea virginica*), with clams, mussels, and scallops also present (Juli 1992). This site and other middens within the Arboretum represent evidence of seasonal inhabitance by Native Americans from the late Archaic period up until colonial times. Snow (1980, in Juli, 1992) estimated that approximately 13,300 people inhabited the Thames drainage and eastern Long Island prior to European contact in 1600 A.D. His population density findings suggest that the local Mohegan-Pequot tribe had 266 persons per 100 square km, constituting the highest density in New England for pre-colonial times.

The Mamacoke Cove archeological site, located on a hill on the southern side of the island, was discovered by a Connecticut College undergraduate in 1975. Yielding remains of shell, bone, stone tools, and prehistoric ceramics, the site suggests inhabitants were present during the Middle to Late Woodland stage (ca. 1-1600 A.D.). A midden here was composed of much of the same deposit material as the Harrison's Landing site, and also included remains of deer, raccoon, beaver, rabbit, muskrat, porcupine, wild

turkey, gray and red fox, gray squirrel, vole, mouse, chipmunk, otter, duck, and turtle, as well as some bird and fish bones. A large Woodland village was probably located across the river on the current site of Naval Submarine Base in Groton, and perhaps the Mamacoke site served as a seasonal shellfishing station (Juli 1992).

In 1980 a man named John Graves reported that as a boy in 1927 he had found the remains of two human skeletons and a small collection of projectile points on the northern upland part of Mamacoke Island under a small rock overhang (subsequently named Graves Rockshelter). Only one skull from the two skeletons remains, and it is apparently from an adolescent aboriginal female. Some projectile points have been recovered from the field on the Matthies tract south of Benham Avenue as well (Juli 1992).

Colonial settlement of the Thames drainage began in the early 1600s. The salt marsh connecting Mamacoke to the mainland was first mowed in 1645, the first year of true colonial settlement here (Goodwin, 1991). The Mamacoke marsh and lowland terrace were part of the Mamacock Farm, an operation that belonged to the John Rogers family for 198 years beginning in 1647, and encompassed all of the land between Mamacoke and Williams Street as well as some 70 acres west of Williams Street (now also part of the Arboretum). In the late 1800s, the Mamacoke terrace, already cleared for pasture, was the site of a small shipyard for schooner construction. Some evidence of quarrying by the Merritt-Chapman & Scott Corp. (from whom the Arboretum purchased the land) in the 1940s still exists today on the eastern shore of Mamacoke (Goodwin 1991). Until the 20th century, major human impacts on the Mamacoke IBA were mainly agricultural, with the land being variously devoted to pasture, mowed fields, orchards and row crops. The steep, east facing slopes of the ridge running north-south through the

center of the Avery tract comprised some of the first post-agricultural, oak-dominated forest to grow back on the original Mamacock Farm.

Relatively little information is available about the history of the land outside of the Arboretum boundary, but maps that show details such as individual houses were examined for the years 1850 and 1893. The railroad was first built through the study site in 1848 (Bachman 1967). It cut off the two small bays, creating the current ponds, north and south of Mamacoke marsh, and also mostly closed the eastern mouth of Smith Cove. Since 1995 this exclusively freight line has been owned by the New England Central Railroad, St. Albans, VT.

In the early 1900s, Mohegan Avenue was a dirt road that led to a few farms and ended at Smith Cove (Figure 4). Old Norwich Road, to the west of the study site, was the only road between Norwich and New London, and it skirted the western edge of Smith Cove. A trolley line connecting New London and Norwich followed Mohegan Avenue and bridged Smith Cove in 1900 (Bachman 1967). A photograph from 1934 (Figure 5) shows Mohegan Avenue paved only from the college property south, and a dirt track proceeding north beyond college frontage. This was the year the trolley was discontinued and Mohegan Ave., later designated Route 32, was extended across Smith Cove.

Harrison's Landing, a small settlement east of the railroad tracks at the end of Benham Avenue in the southeastern corner of the study area, had 3 houses in 1850, and five houses are shown on the 1893 map. No houses appear to be at the north end of the IBA around Smith Cove in the 1850s and only one by 1893. Intensive development in this area did not begin until Mohegan Avenue was extended across the cove.

During World War II the US Army installed a gun emplacement on the highest point of the Avery Tract overlooking Mamacoke and the river. A gun emplacement was

Figure 4. View early in the 20th Century (1920s?) from near Mohegan Avenue south of Benham Avenue. Benham crosses diagonally down to Harrison's Landing on the Thames. A mostly deforested Mamacoke Island and glimpses of the Mamacoke North and South Coves are visible. (CC Archives)

Figure 5. A 1934 aerial photograph of Connecticut College Campus (foreground). Mamacoke Island, its coves and the Brackish Pond are all visible. Mohegan Ave. a dirt road north of the college.

also located at the south end of the Matthies Tract. In the late 1940s a system of bridal paths for the Connecticut College riding program was developed through the Avery and Matthies tracts; these trails have been maintained and are currently used by the College and Coast Guard Academy cross-country running programs, as well as individuals hikers and runners. In the 1940s the Arboretum planted a one-acre white pine stand on the Avery Tract as well as a larger area on the north side of Benham Avenue in the Matthies Tract (Goodwin, 1991).

The meadow at the head of the Brackish Pond, located between the Espinosa Tract to the south and the Avery Tract to the north, was the site of a prescribed burn once in the 1970s, and many other prescribed burns have been carried out in open fields and forest understories of the Avery and Matthies tracts since 1968. Originally begun with a grant to Professors Niering and Goodwin from the National Science Foundation (Niering et al. 1970), these burn and control plots are part of an ongoing research and demonstration project. They were last burned in 2003. Herbicides have been very selectively used in other areas in the Avery and Matthies Tracts since the 1950s as part of research and demonstration projects aimed at slowing vegetation change and maintaining open, "early successional" habitats. These vegetation manipulations have also helped maintain populations of birds dependent on open, low vegetation (Askins 1990).

Connecticut College faculty and students have used the Avery, Matthies, and Mamacoke tracts for studies relating forest size to bird community composition and small mammal population density; old field succession; avian dispersal of Oriental bittersweet: foraging in honeybees; the stability of shrub communities; population genetics of white-footed mice; and a variety of other ecological, natural history and geological subjects (Goodwin, 1991 and Arboretum Annual Reports 1992-2008). Starting in 1974, the parts

of the Matthies Tract fields next to the railroad were used to test various applications of fungal mycelium derived as waste from Pfizer Inc. operations downriver (Niering, et al. 1981). Previously viewed as industrial waste, the recycled mycelial material can actually serve as an effective soil amendment, potentially reducing dependence on commercial fertilizer. The field south of Benham Avenue and adjacent to the railroad right-of-way served as a college nursery from 1955 until about 1985, and has served as a site for composting of leaves removed from the campus grounds since 1970. The field north of Benham Avenue was used as a Waterford Little League baseball field from 1956 to 1978 (Goodwin, 1991).

The U.S. Navy Submarine Base is located directly across the Thames River from the entire IBA. Established in 1868 as a dry dock and coaling station for naval ships on 112 acres in Groton, it became the first US submarine base in 1916 (Bishop 2005). It has grown substantially to include various schools and commands, and is currently one of a few homeports for U.S. nuclear submarines.

Stakeholders

Individuals and organizations who may be interested in this project include:

Land Owners. The heart of this IBA is owned by Connecticut College (Figure 3). Connecticut College owns Mamacoke Island and much of the shoreline of North Mamacoke Cove. The shoreline of South Mamacoke Cove shoreline is about 2/3 Connecticut College property and 1/3 multiple residential lots at Harrison's Landing. Smith Cove is bordered by a railroad causeway, Mohegan Ave. (State Rt. 32) and many individual residential lots. After many years of opposition from local residents, a condominium development called Thames Landing was recently built at the western end

of Scotch Cap Road, on the northern edge of the IBA. While this is just outside the IBA border, an associated marina has two parallel docks projecting into the Thames River and the IBA. United Building Supply operates a lumber and hardware retail store on the south side of Richards Grove Road where it dead-ends at the railroad tracks. The New England Central Railroad owns the train tracks running along the river shore.

Local Government. Town of Waterford: Conservation and Inland Wetlands; Planning and Zoning; Water Pollution Control Authority, Shell Fish Commission, Public Works Department.

State of Connecticut. Department of Environmental Protection: (Wildlife Division, OLISP, Geologic and Natural History Survey, Marine Fisheries), Thames River Basin Partnership; Department of Transportation.

Federal Government. U.S. Fish and Wildlife Service; U.S. Navy; USDA Natural Resources Conservation Service; U.S. Coast Guard; U.S. Army Corp of Engineers.

Non-governmental Organizations: Connecticut College Arboretum; West Farms Land Trust; Concerned Citizens of Quaker Hill; Ducks Unlimited; Audubon Connecticut; Sierra Club; The Nature Conservancy; Connecticut College groups (Arboretum Volunteers; student clubs; Botany, Biology, Environmental Studies, and Athletics departments); Connecticut Waterfowl Association, Connecticut Ornithological Association, Pequotsepos Nature Center, Connecticut Audubon Society, Naturescapes (Robert Dewire).

IV Natural Resource Inventory

Basis for Designation

Mamacoke Island and adjacent coves was proposed for inclusion in the IBA program by Robert Askins, Professor of Biology at Connecticut College, in 1999. The reasons were the presence of high conservation priority species and the presence of 500+ waterfowl in winter. Important species are American Black Duck, Canvasback, Hooded Merganser, Great Egret and Snowy Egret.

A meadow restoration project was initiated in 2004 by the Arboretum on approximately 12 acres of the upland near South Mamacoke Cove. The goals were to restore early successional habitat and control invasive plant species. Thanks to funding from the USDA Natural Resources Conservation Service's Wildlife Habitat Incentive Program (WHIP), major woody plant encroachment on seven acres of existing old field was reversed. In addition, about five acres of pine plantation and early deciduous forest heavily impacted by invasive plant species were completely cleared in 2004 and 2005, and this site was planted with native grasses and forbs during the summer of 2006.

Birds present in the fields prior to meadow expansion that are likely to increase include American Woodcock, Orchard Oriole, Field Sparrow, Common Yellowthroat, Blue-winged Warbler, Prairie Warbler and White-eyed Vireo. With the increase of meadow area, Savannah Sparrow, Eastern Bluebird and Eastern Meadowlark may be able to breed there as well. Since we will also be increasing the amount of woodland edge, additional insect and fruit-eating birds should also be attracted, especially during spring and fall migration. Given the importance of early successional habitat for conservation of biological diversity in New England, the extent of the originally proposed IBA was

expanded to include the meadow and all upland Arboretum property between the river and Mohegan Avenue.

Aquatic Features

There is a natural spring on the southern border of the George S. Avery tract, just east of the dirt road, which feeds a stream that travels through an alder thicket, a beech grove on the steep bank, and a wet meadow before emptying into the Brackish Pond (Figure 1). There is also an intermittent stream that has formed from storm water runoff from Mohegan Avenue that runs in a northeast direction down to the head of the Brackish Pond. This small water body is actually an extension of Mamacoke's South Cove, and is tidally influenced through a culvert that runs under the railroad embankment, which was constructed in 1848. The water entering through the culvert is high enough in salt content so that typical salt marsh plants grow at the eastern perimeter of the cove. The western end receives freshwater from the spring and intermittent stream and is vegetated with typical freshwater species. A report prepared by consultants Brown and Root for the Naval Submarine Base used the brackish pond near Mamacoke for comparison to Goss Cove just south of the Navy base. Pond depth averaged 2-3 feet, except near the middle, which was 4.5 feet deep. They noted that salinity in the pond was generally higher than that observed in the river and dip netting produced "live softshell clams and Atlantic ribbed muscles along the shore (near the box culvert) … unidentified marine shrimp and live barnacles were noted attached to fallen branches.... no minnows observed or captured" (Starkel and Cubbage 1996).

Another, unnamed, brackish pond that appears to have been formed by railroad track construction, is located south of Richards Grove Road.

Little is known about the physical or biological features of the three coves (Smith, Mamacoke North and Mamacoke South) that comprise the most significant features of this IBA. Their most important qualities for birds are that they contain enough salt to remain unfrozen during almost all winters, and they are shallow enough for waterfowl to forage in.

Geology & Soils

Bedrock in the IBA consists completely of various types of gneiss (Goldstein 1967). The majority is mapped as the Mamacoke Formation, with a small area south of Smith Cove and east of Mohegan Ave. categorized as New London Gneiss. Although the bedrock is mostly below ground, outcroppings occur on Mamacoke Island and on the Avery Tract along the steep ledges west of Mamacoke Marsh.

Mamacoke Island contains several interesting geologic features. The Thames River valley and island are part of a horst and graben system. The island represents a horst, or protruding section of bedrock bounded on two sides by normal faults, and the remainder of the valley is part of the graben system that dates back to the breakup of Pangaea approximately 200 million years ago. A graben is a section of rock that drops down between two normal faults.

More recently, the island was shaped by glacial activities. The distinct shape of Mamacoke with a smooth northern slope and an abrupt, cliff bounded, southern slope is a result of glacial smoothing and plucking. The resulting landform is referred to as a roche mountonnée. During the period of glacial retreat, a block of ice was also melted in place on the south portion of the island to form a small glacial kettle hole that is now the small salt marsh. The large flat southern section of the island also represents a river terrace

formed when the Thames River was a larger system full of glacial meltwater and sediments from the retreating glaciers.

Surficial geology maps identify the flat areas along the river from the south boundary of the IBA to Mamacoke North Cove as deposits of sediment dammed lakes (Figure 6). Such sediments also occur around Smith Cove, except at it mouth, where the deposits were from glacial meltwater streams. The remaining uplands are covered in glacial till.

Upland soils in the study area (Figure 7) are primarily of the Charlton-Chatfield and Canton and Charlton complexes. The terrace areas near water are Hinckley Gravely Sandy Loams, and portions of this soil type directly west of Mamacoke Marsh were historically mined for sand and gravel (Goodwin, 1991). All of soils in the IBA, with the exception of the tidal marshes, are at least in the well-drained category, with many excessively well drained.

Vegetation/Flora

The Connecticut Natural Diversity Database (NDD) was consulted for information about known occurrences of and Endangered, Threatened or Special Concern Species within the IBA. The database held historic records for six rare plants, none of which have been seen in the area for at least 70 years. One currently existing rare plant, the sedge *Bolboschoenus maritimus* (formerly *Scirpus paludosus* var. *atlanticus*), was last noted in the NDD in 2005, with only 1 individual present. This appears to be a decline in the population since it was first observed at about 125 stems in 1989. The site is in the Arboretum, originally in marshes along both sides of the railroad embankment near

Figure 6. Surficial geology map of the Mamacoke IBA and buffer zone (outlined in red).

Figure 7. Simplified soils map of the Mamacoke IBA and buffer zone.

Mamacoke Marsh. In 2006 a single stem was relocated in the Brackish Pond west of the RR and Mamacoke South Cove.

The forested portions of the Mamacoke IBA can generally be classified as Oak Hickory Forest, part of the Central Hardwoods Vegetation Zone of Egler and Niering (1965) (Figure 2). Red (*Quercus rubra*) and Black (*Q. velutina*) oaks predominate, and hickory (usually Mockernut -*Carya tomentosa*), Red Maple (*Acer rubrum*) and Black Birch (*Betula lenta*) are common. Other hardwoods, including White Oak (*Q. alba*), American Beech (*Fagus grandifolia*) and Sassafras (*Sassafras albidum*) are occasionally present in the canopy. Flowering Dogwood (*Cornus florida*), Black Cherry (*Prunus serotina*) and saplings of canopy trees sometimes form a middle stratum. Shrub cover can be sparse, with the heaths Lowbush Blueberry (both *Vaccinium angustifolium* and *vacillans*) and Black Huckleberry (*Gaylusaccia baccata*) common, as are thickets of the shrub/vine Greenbrier (*Smilax rotundifolia*). Mountain Laurel (*Kalmia latifolia*), which was removed on most of this former pastureland, is occasionally present. The only location with a dense Mountain Laurel understory is the northwest sector of Mamacoke Island, which was presumably too steep and remote for the farmers to bother clearing. On the drier, rockier sites the sparse herb layer includes Pennsylvania Sedge (*Carex pensylvanica*) and Hair Grass (*Deschampsia flexuosa*) as common components.

In 1948, Red Pine (*Pinus resinosa*) and White Pine (*Pinus strobus*) were planted on about 5 acres of former orchard in the Matthies tract on the north side of Benham Road. The Red Pines succumbed to red pine scale in the 1980s, but the White Pines are now mature and are the source of the increasing pine population south of Benham. White Pine were also planted on the Avery tract in 1949 along Mohegan Ave. and on a one acre plot on the higher, flatter ground (Goodwin 1991).

Directly west of Mamacoke Marsh small-scale gravel and sand excavation ended about 1990, and bare mineral soil is exposed in many locations. Scots Pine (*Pinus sylvestris*), of unknown origin, has an expanding, naturalized population in this location. Progressing north, this site becomes the most mature, best-developed (possibly oldest) forest locally, with trees up to 20" DBH, and a more dense and diverse shrub layer than other nearby forests. Saplings of American Beech (*Fagus grandifolia*) and Maple-leaved Viburnum shrubs (*Viburnum acerifolium*) are present in the understory.

Mamacoke Marsh somehow escaped the widespread ditching of coastal marshes for mosquito control. Located 4 miles up river from Long Island Sound, the water here is brackish, but with high enough salinity levels so the marsh has a complement of the typical tidal salt marsh species. A long-term vegetation study was established in the marsh in 1957 using a 15 x 15 m grid (Niering 1961). Multiple resurveys of the vegetation were conducted through 2002. The general vegetation pattern begins with an upland border of Marsh Elder (*Iva frutescens*) and Switch Grass (*Panicum virgatum*) both at the railroad embankment and along the stonewall on the eastern border of the marsh. Saltwater Cordgrass (*Spartina alterniflora*) forms a slender band along both the north and south cove edges. In some locations Blackgrass (*Juncus gerardii*) forms patches inside the *S. alterniflora*. In other locations large expanses of Saltmeadow Cordgrass (*Spartina patens*) and Spikegrass (*Distichlis spicata*) are found. A fairly large depression in the middle of the marsh is occupied mainly by a stunted form of *S. alterniflora*.

Mamacoke also contains a much smaller marsh (circa 0.5 acre) on the south side of the peninsula. The historic development of marsh vegetation here was studied by Combs and Orson (1983) using systematic peat coring. Maximum depth to bedrock was

found to be approximately 7 meters. Brackish peat deposits at 6 meters had Carbon 14 dates of 3,500 years before present.

An interesting freshwater wetland sits at the head of the Brackish Pond west of Mamacoke South Cove. Fed by the previously mentioned spring and highway runoff stream, it contains Alder (*Alnus* sp.) thickets, a diversity of wet meadow forbs, and a colony of Narrow-leaved Cattail (*Typha angustifolia*) at the top of the Pond. It is heavily impacted by invasives, especially Multiflora Rose (*Rosa multiflora*). The vegetation of this wetland has yet to be surveyed or described.

By 1968 the Arboretum was experimentally managing some locations on the Matthies and Avery tracts to retain early successional habitat (Niering, et al. 1970; Niering and Dreyer 1989). Small plots in post-agricultural old fields have been subject to controlled burning in both locations for 35 years, most recently in 2003. Forest understory plots were also burned during this period.

As previously mentioned, approximately 12 acres of early successional habitat has recently been restored north and south of Benham Avenue, just west of the railroad tracks. Seven acres on the flat ground closest to the tracks and bounded by stone walls on the north and west borders were still partially open, and management included cutting encroaching woody plants and spraying herbicides on invasive plants, especially Oriental Bittersweet (*Celastrus orbiculatus*). Little Bluestem (*Schizachyrium scoparius*) is common in the field north of Benham Avenue, and is one of a handful of preferred native grasses appropriate for this site. Annual mowing during late winter and semi-annual, selective spraying during the growing season to control invasives and other woody plants will continue. Mature Red Cedar (*Juniperus virginiana*) and occasional Flowering Dogwood, Crabapple (*Malus* sp.) and Pear (*Pyrus* sp.) were left in the north-most sector

of these fields in an effort to maintain savanna-like conditions preferred by some target birds species such as Orchard Oriole and Eastern Bluebird. To the northwest of the fields an approximately five-acre area of pine, young hardwoods and invasive vines and shrubs was cut and herbicided in 2004 and 2005. During late June 2006, 100 lbs. of a customized mixture of native grass and forb seed was planted in this five-acre site to create a new meadow (Appendix 1).

Early successional habitat is also present on a 5.8-acre lobe of undeveloped land located at the end of Richards Grove Road and east of the lumberyard and railroad tracks. This parcel, owned by the New England Central Railroad, juts into the river between the north end of Mamacoke and the mouth of Smith Cove. The upland vegetation is savannah-like with scattered Red Cedar, and young black and red oaks and red maple in a matrix of Little Bluestem, Switch Grass, Bayberry (*Myrica pensylvanica*) and Smooth Sumac (*Rhus glabra*). Well-established invasive plants include Oriental Bittersweet, Autumn Olive (*Eleagnus umbellata*) and Japanese Honeysuckle (*Lonicera japonica*). At the river edge is a slender band of tidal marsh grasses and forbs with some Marsh Elder at the upper border. Depressions near the tracks and elsewhere contain large patches of Giant Reed (*Phragmites australis*), some of which are monospecific clones.

Little is known about the vegetation in the coves or in the river, but based on the feeding behavior of waterfowl, plant life is clearly present. A study in 1994 showed that Sea Lettuce (*Ulva lactuca*) covers the bottom of shallow areas and the diatom *Melosira* covers many rocks in these areas. (See the waterfowl section for additional information.)

Munger (2005) produced a report on the flora and plant communities of the West Farms Land Trust's 65-acre George Avery Preserve, a forested tract located north of

Scotch Cap Road between Mohegan Avenue and the River. While just north of the IBA boundary, this report may be helpful in future planning efforts.

Birds

Our assessment of birds in the Mamacoke IBA are based on regular surveys of waterfowl by Robert Askins during the winter (October to April), student research projects on waterfowl ecology and behavior, and field notes from regular visits to the site throughout the year. We especially focus on species included on the following lists:

1. Connecticut List of Endangered, Threatened and Special Concern Species: http://www.ct.gov/dep/cwp/view.asp?a=2702&q=323462&depNav_GID=1628&depNav
2. Audubon WatchList (http://www.audubon.org/bird/watchlist/index.html)
3. Partners in Flight Bird Conservation Plan for Southern New England (http://www.blm.gov/wildlife/pl_09sum.htm).

Winter-resident Waterfowl. The Mamacoke/Smith Cove area was designated an Important Bird Area primarily because of the large numbers of ducks of several species that feed in Smith Cove and the coves west and south of Mamacoke Island during the winter. The largest concentrations of ducks occur during extremely cold periods when freshwater lakes, reservoirs, and many stretches of rivers in southeastern Connecticut freeze. Because the Thames River is a brackish estuary, it does not freeze completely and thus provides an open-water refuge for ducks during these periods. Although some ducks (especially Hooded Mergansers, Black Ducks, Mallards, and Canvasbacks) use Smith Cove and the Mamacoke coves regularly throughout the winter (October to early April), large concentrations of ducks only occur during extended periods of severe cold.

Since 1982 Robert Askins has completed informal counts of waterfowl approximately once each week during the winter in the area between Smith Cove and the U.S. Coast Guard Academy. Ducks, geese and swans frequently move back and forth along this stretch of the river, and there are relatively few winter-resident ducks north of this stretch (where there is relatively little shallow water) or south of this stretch (which is heavily developed with port facilities). Typically the largest concentrations of waterfowl are between the South Mamacoke Cove and the northern end of Smith Cove, but the abundance estimates in Figures 8 - 12 are for the entire census area. The estimate for a particular year is the maximum number recorded for a species, which typically reflects the situation when ducks were heavily concentrated on the Thames River because of long periods of cold weather that forced ducks out of other sites.

Because of great year-to-year variation in duck numbers (which partly reflects variation in ice conditions), we used three-year running averages to plot changes in duck populations. The graphs of running averages provide evidence for major changes in abundance for particular species. These data cannot be analyzed statistically, however, because there is a single value (the maximum value) for each winter. Weekly counts for particular species could be used in statistical analysis, but these numbers would understate the conservation value of the site, which peaks with occasional periods of severely cold.

Two introduced species of waterfowl, the Mute Swan and the Canada Goose, have shown substantial population increases in the study site since 1982 (Figure 8). The Mute Swan was introduced from Europe in the late 1800s and did not become established in the wild in Connecticut until the 1930s (Zeranski and Baptist, 1990: Askins, 2009; Elphick, 2009). Canada Geese originally were found in Connecticut only during

migration and winter, but there is now an introduced breeding population (Zeranski and Baptist, 1990). Mute Swans feed on aquatic vegetation and may compete for food with vegetarian ducks such as Canvasback, so they represent a threat to some native waterfowl species. In contrast, Canada Geese usually do not feed when they are swimming in the coves in the study area. They occasionally forage on the banks of the river, but usually commute to distant locations to feed. If they affect native ducks, it would be indirectly through fecal contamination of the water when large flocks of geese are concentrated in a cove.

Another introduced species, the Mallard, has also increased substantially since 1982 (Figure 9). Mallards were rare migrants in Connecticut in the 1800s, but later they were introduced to many parts of the state and are now a common breeding species (Zeranski and Baptist, 1990). Two other species of dabbling ducks, the American Black Duck and the Gadwall, have fluctuated in abundance, but have not shown distinct long-term trends (Figure 9). The American Black Duck (non-breeding, winter population) is a Partners-in-Flight "high continental priority species" for southern New England, and is on the Audubon WatchList. Another dabbling duck, the American Wigeon, has declined, but was never common in the IBA.

Among the diving ducks, Canvasbacks and Greater Scaups showed substantial declines in abundance since the 1980s (Figures 10 and 11). Hooded Mergansers showed a much less steep decline in abundance, while Red-breasted Mergansers increased in abundance (Figure 12).

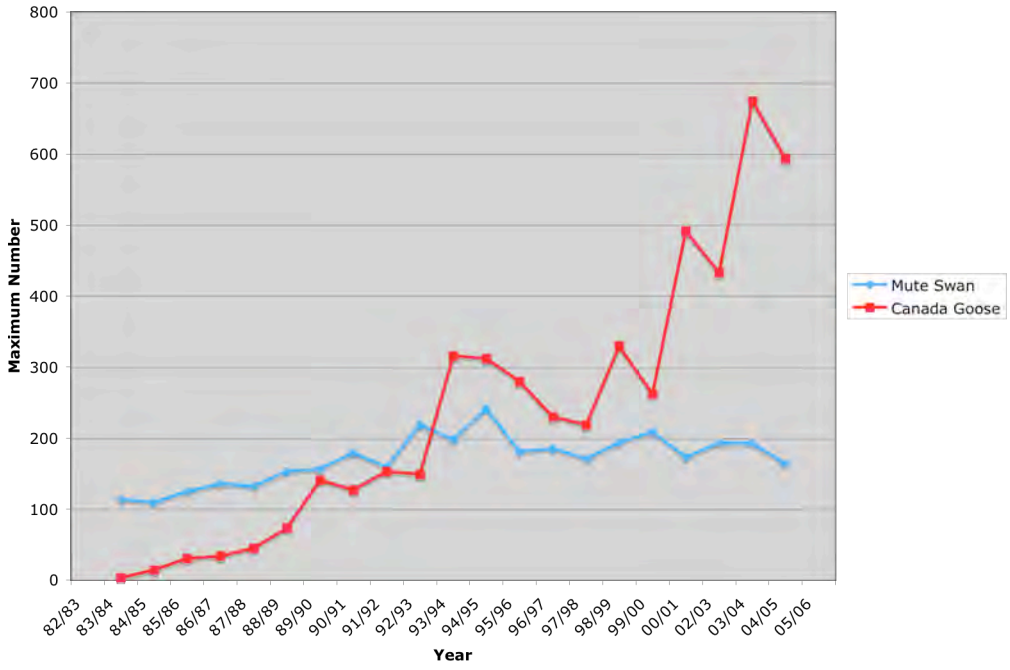

Figure 8. Changes in maximum numbers of Mute Swans and Canada Geese counted during winter in the Mamacoke Island IBA. The three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1982 and 2006.

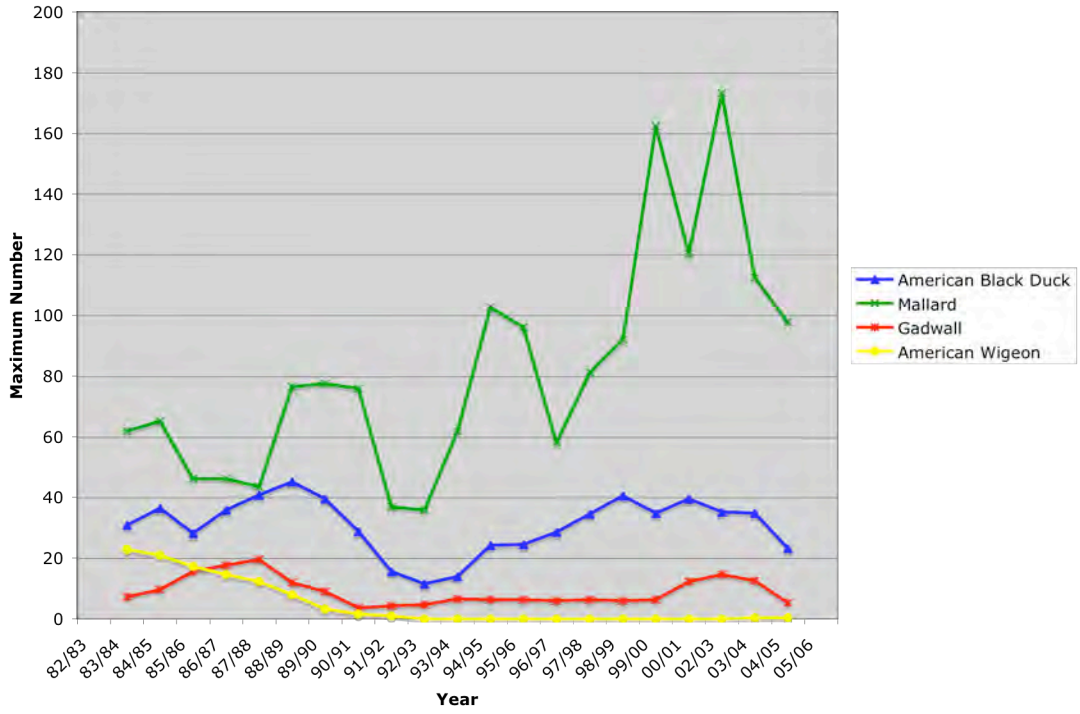

Figure 9. Changes in maximum numbers of four species of dabbling ducks counted during winter in the Mamacoke Island IBA. The three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1982 and 2006.

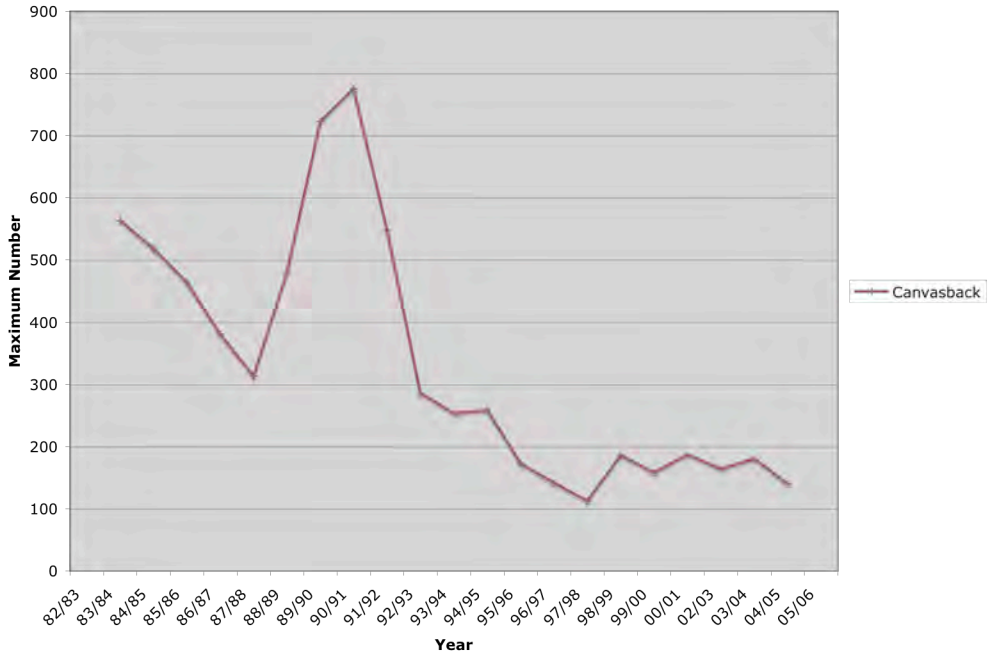

Figure 10. Changes in maximum numbers of Canvasbacks counted during winter in the Mamacoke Island IBA. The three-year running averages for the maximum number of individuals detected are shown for the period between 1982 and 2006.

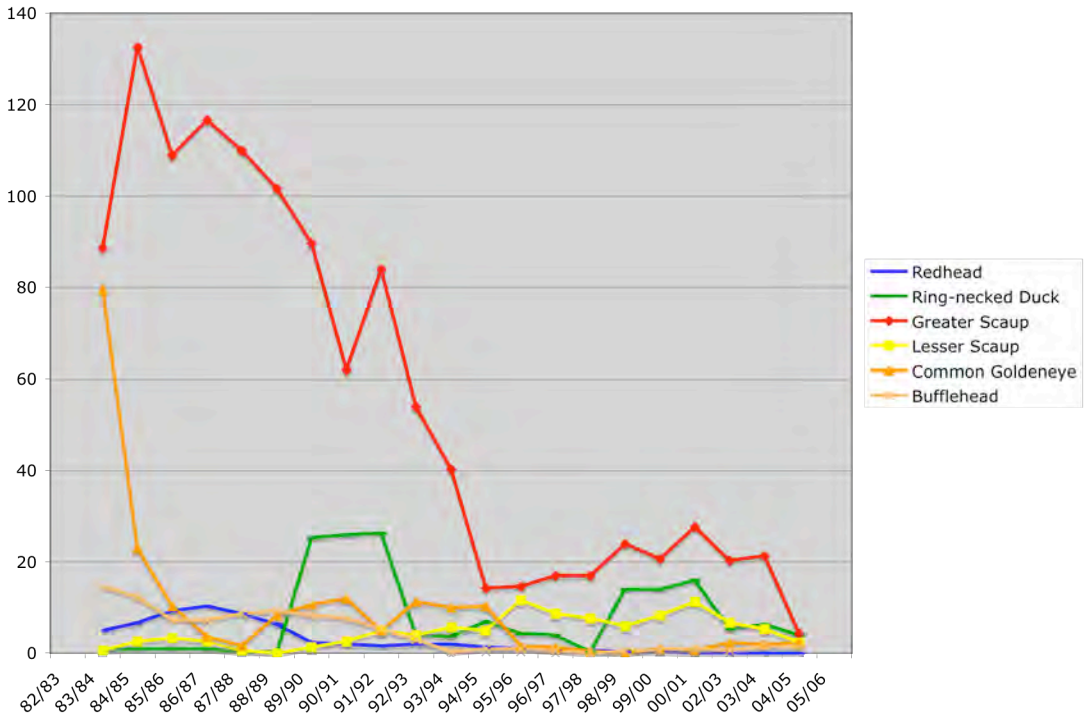

Figure 11. Changes in maximum numbers of six species of diving ducks counted during winter in the Mamacoke Island IBA. The three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1982 and 2006.

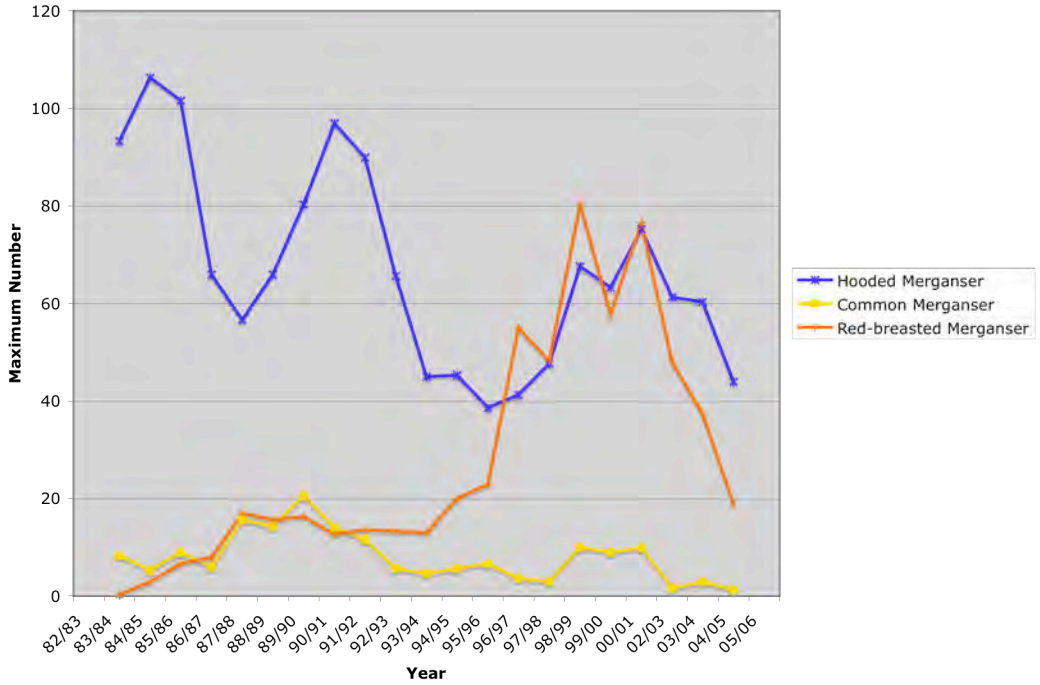

Figure 12. Changes in maximum numbers of three species of mergansers counted during winter in the Mamacoke Island IBA. The three-year running averages for the maximum number of individuals detected for each species is shown for the period between 1982 and 2006.

Some of these population trends probably reflect regional or even continental changes in waterfowl numbers. For example, Canvasback (Figure 13) and scaup (Figure 14) numbers for the state declined on midwinter counts in Connecticut between 1982 and 2005, the same period during which they were declining in the Mamacoke IBA. The statewide data also indicate the Canvasbacks were not very common before the early 1980s, however, while scaup have been declining since the 1960s. Breeding population counts from aerial surveys across North America indicate that the continental population of scaups has declined since the early 1980s but that continental populations of Canvasbacks have not shown a consistent, overall change (U.S. Fish and Wildlife Service, 2006).

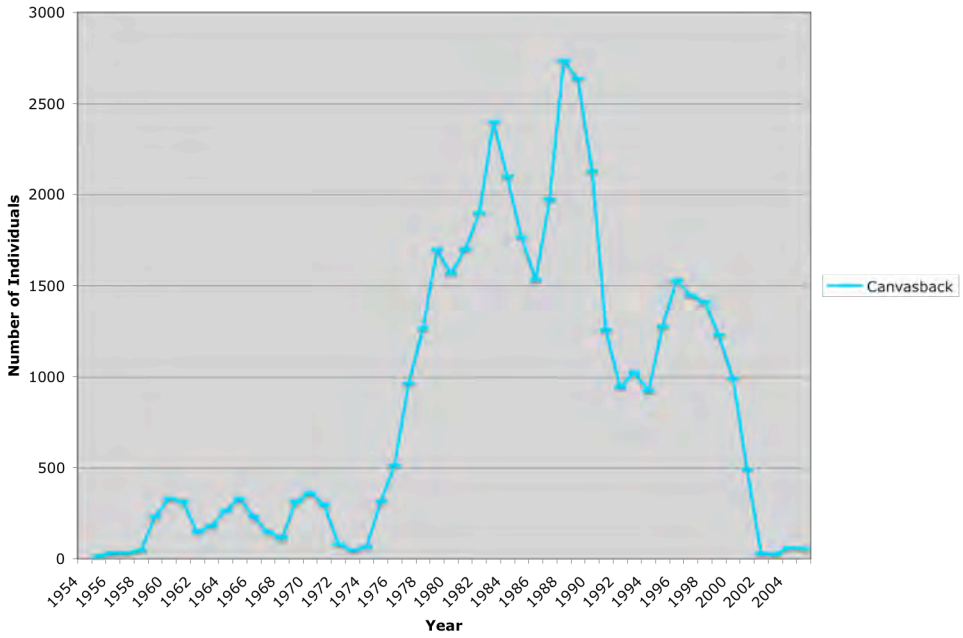

Figure 13. Changes in the number of Canvasbacks counted in Connecticut during midwinter aerial surveys (Connecticut DEP Wildlife Division, unpublished data). Three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1954 and 2005.

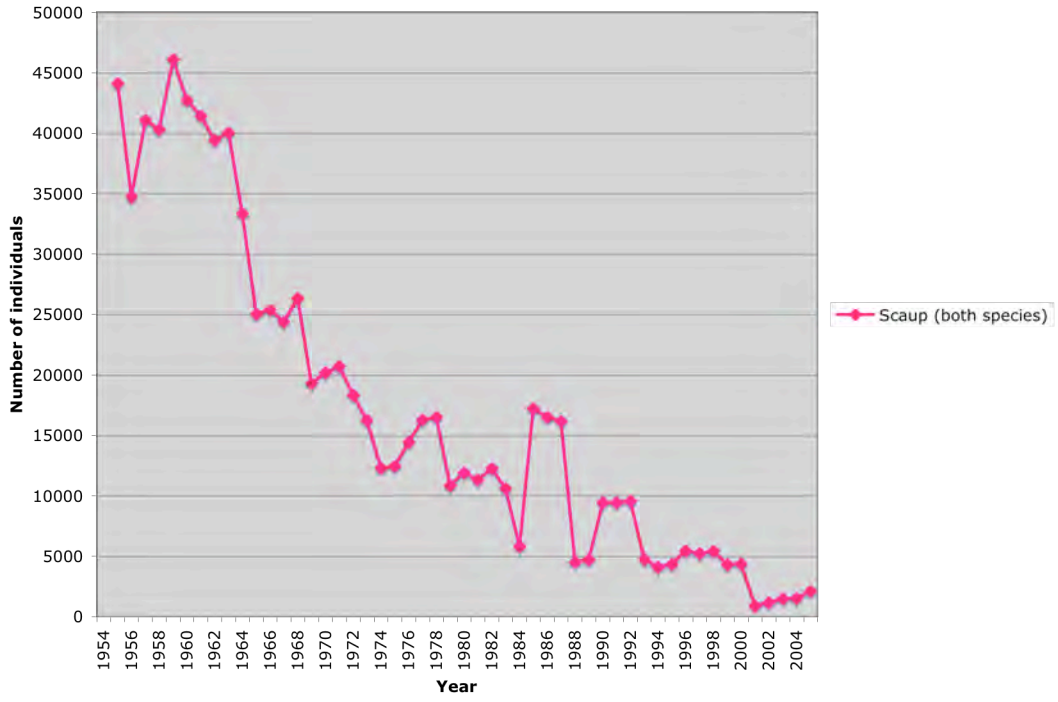

Figure 14. Changes in the number of scaups counted in Connecticut during midwinter aerial surveys (Connecticut DEP Wildlife Division, unpublished data). Both Greater and Lesser scaups are included in these estimates, but Greater Scaups greatly outnumber Lesser Scaups in winter in Connecticut (Zeranski and Baptist, 1990). Three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1954 and 2005.

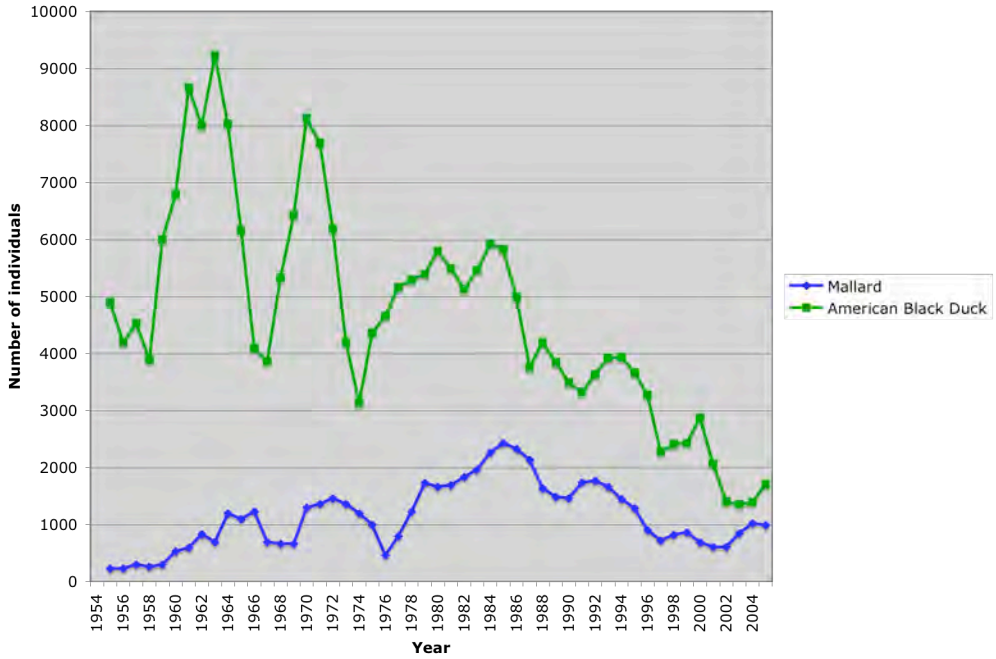

Figure 15. Changes in the numbers of Mallards and Black Ducks counted in Connecticut during midwinter aerial surveys (Connecticut DEP Wildlife Division, unpublished data). Three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1954 and 2005.

Changes in abundance of some other waterfowl species in the Mamacoke IBA do not reflect statewide trends. American Black Ducks declined steeply throughout Connecticut (Figure 15), but were relatively stable at Mamacoke. Mallards showed a moderate decline in the statewide surveys, but increased greatly at Mamacoke (Figure 15). Black Duck counts have declined continentally since 1982 on midwinter aerial surveys, while overall Mallard counts have not changed greatly during the same period (U.S. Fish and Wildlife Service, 2006). Mute Swans and Canada Geese both increased at Mamacoke, but showed no overall change between 1982 and 2005 in the state surveys (Figure 16).

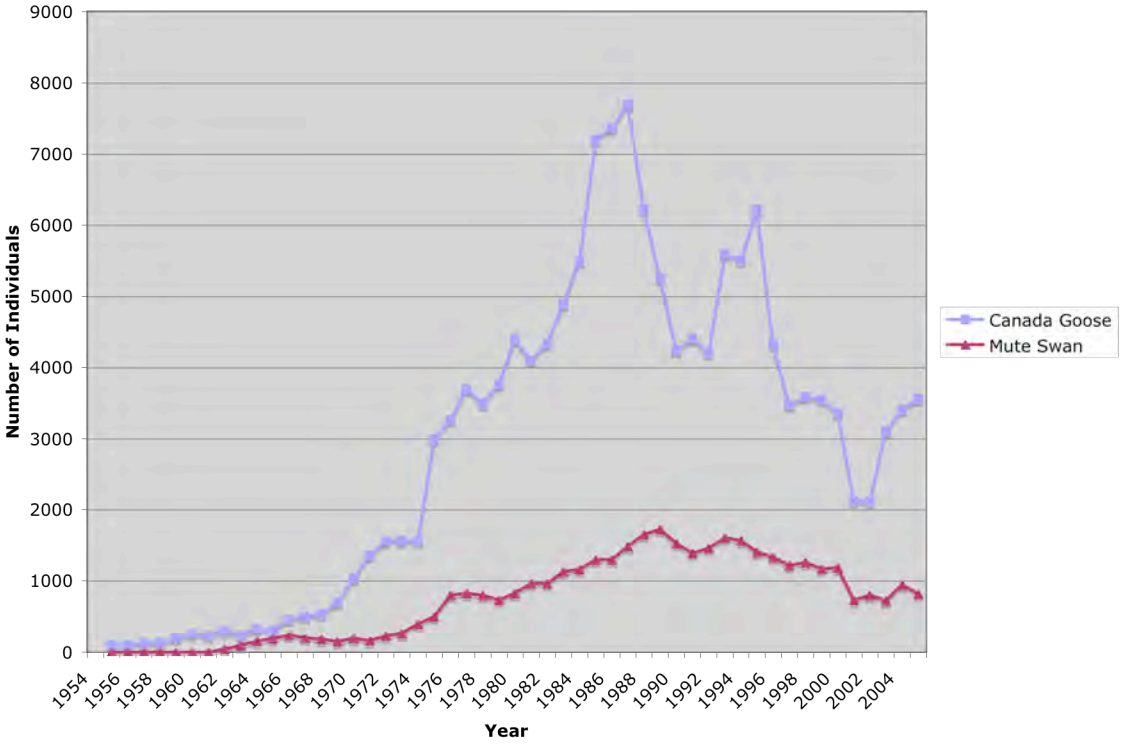

Figure 16. Changes in the numbers of Mute Swans and Canada Geese counted in Connecticut during midwinter aerial surveys (Connecticut DEP Wildlife Division, unpublished data). Three-year running averages for the maximum number of individuals detected for each species are shown for the period between 1954 and 2005.

Several Connecticut College students have completed semester-long research projects on the behavior of waterfowl in Smith Coves and the coves adjacent to Mamacoke Island. In 1989 Daniel Kluza developed a research protocol that was followed by Jonathan Alegranti in the winter of 1993-1994 and Julie Groce during the winter 2000-2001. In all of these projects, the feeding behavior of individual ducks was described and their locations were recorded on a gridded map of the study area several times each week during mid to late winter. The results from their unpublished reports are summarized in Figures 17 and 18, which was compiled by Adam Zeender as a project for a GIS class under the direction of Beverly Chomiak. The map indicates that both dabbling ducks and diving ducks are normally concentrated in the shallow waters of Smith Cove and North Mamacoke Cove. During the winter of 1994, however, exceptionally cold weather

forced diving ducks into deeper water and apparently forced most dabbling ducks to leave the IBA area. North Mamacoke Cove was covered with ice for the entire period of the study (February 2 to March 15), and the shallow-water areas of Smith Cove were only open sporadically. In general, both the dabbling ducks and diving ducks forage in water < 3 feet deep (Figure 19).

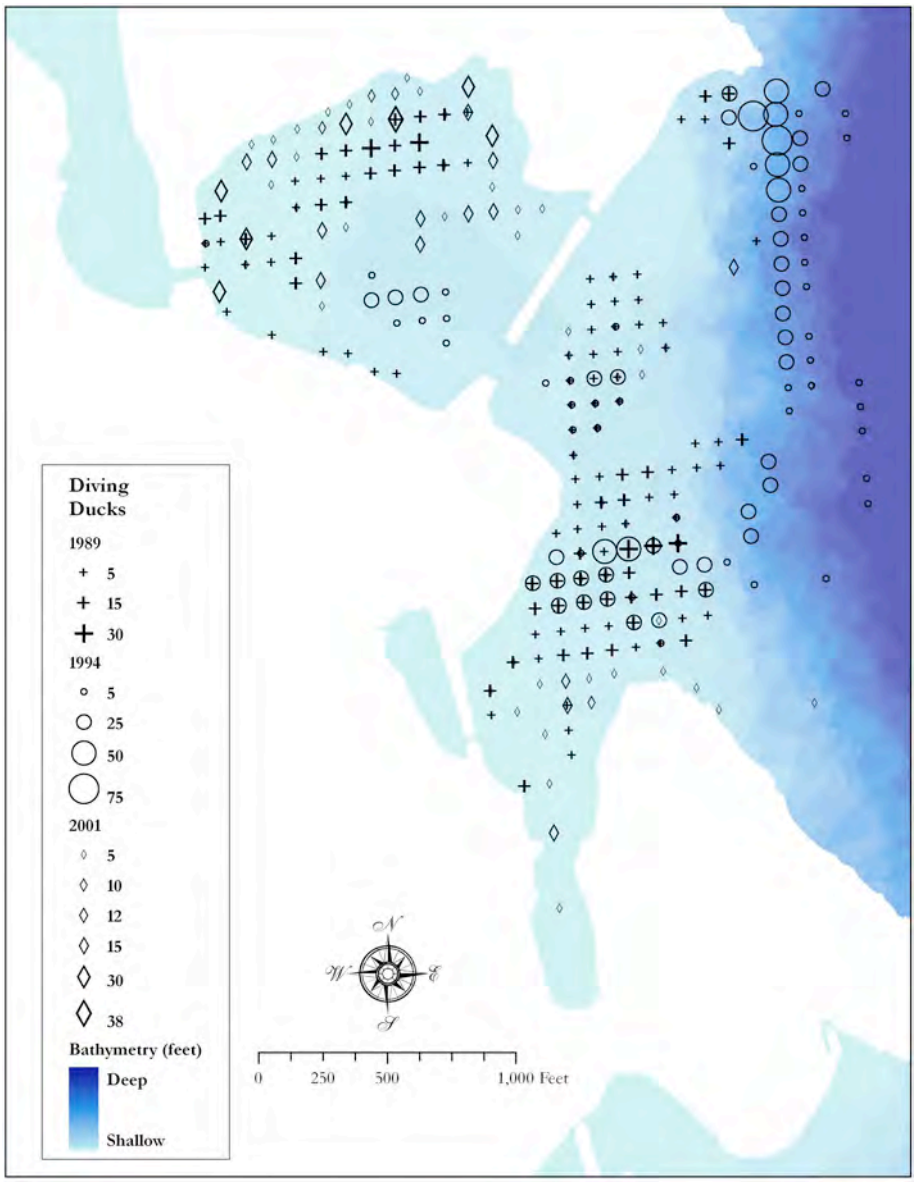

Figure 17. Distribution of diving ducks at Smith and North Mamacoke coves during three winters (1989, 1994 and 2001). Relative water depth indicated by shading, with darker blue indicating deeper water. Land is white in this map, with Mamacoke Island at bottom right. Prepared by Adam Zeender.

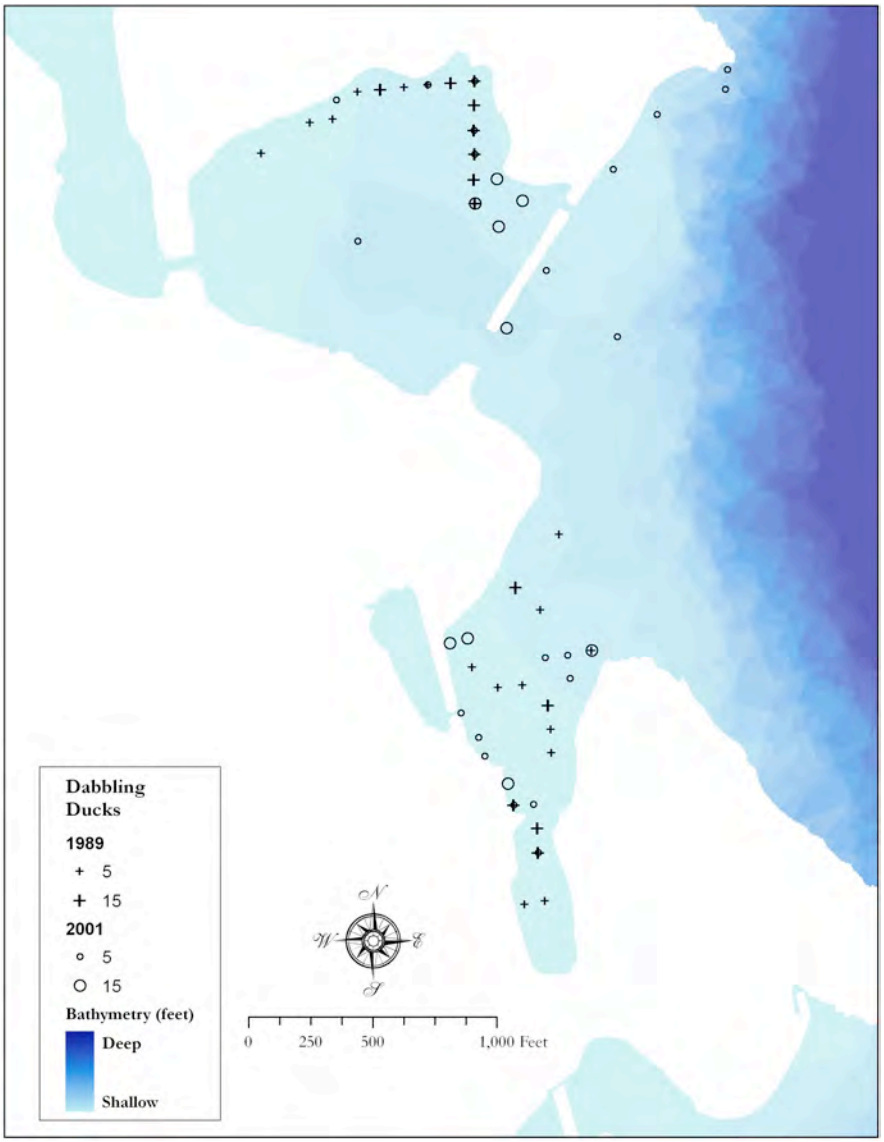

Figure 18. Distribution of dabbling ducks at Smith and North Mamacoke coves during two winters (1989 and 2001). Relative water depth indicated by shading, with darker blue indicating deeper water. Prepared by Adam Zeender.

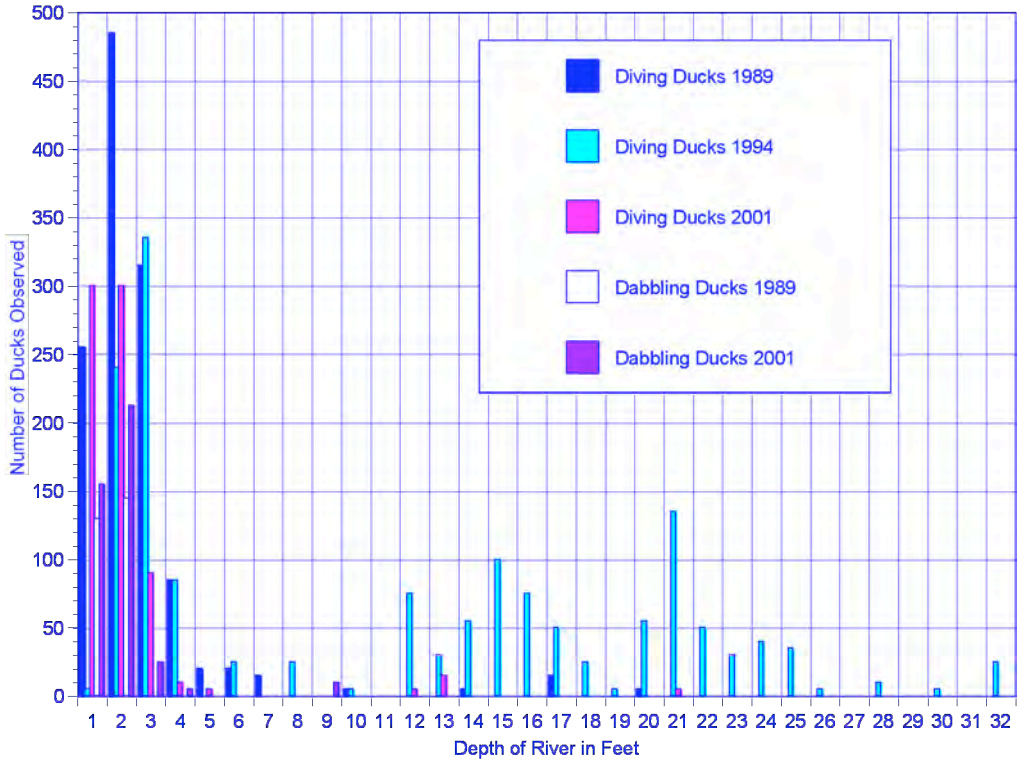

Figure 19. Water depth at points where dabbling ducks and diving ducks were feeding at Smith and North Mamacoke coves during three winters (1987, 1994 and 2001). Prepared by Adam Zeender

The dabbling ducks and Canvasbacks were observed feeding on Sea Lettuce (*Ulva lactuca*). In 1987 vegetation surveys using a grab sampler on five transects across North Mamacoke Cove showed that the entire bottom of the cove was covered with a dense carpet of Sea Lettuce. Sea Lettuce also covered the shallow water along a single transect in Smith Cove, but no bottom vegetation grew in deeper water. In 1994 SCUBA surveys by Jonathan Alegranti along transects at the northern and southern ends of Smith Cove showed that Sea Lettuce covered much of the bottom, and was especially dense at the entrance of North Mamacoke Cove, which is an important feeding area for ducks (Figures 17 and 18). Many rocks on the transects were covered with the alga *Melosira*.

Other birds associated with the coves and marshes. The estuarine and tidal marsh habitats Mamacoke Island are frequently used by waterbirds and Ospreys during the

summer. Particularly in the mid and late summer, various species of herons forage in the shallow water on the edge of the Mamacoke Salt Marsh. Great Egrets, Snowy Egrets, Great Blue Heron, Green Heron and Black-crowned Night Heron occur regularly at this site, although none of these species are numerous. Little Blue Heron occurs occasionally in late summer. All of these heron species other than the Green Heron are listed as either threatened or special concern species in Connecticut. We have not completed systematic surveys of these species.

Ospreys often hunt for fish over the Mamacoke coves in the summer and early autumn. They have not nested at the site despite the construction of two osprey stands (one on Mamacoke Island and another on the shore of the Brackish Pond) in the 1980s. Bald Eagles occasionally occur in this same area during the winter.

American Coots and Pied-billed Grebes regularly occur in Smith Cove and the coves near Mamacoke Island in the winter. American Coots have become increasingly common in recent years.

Early successional birds. Records from the Connecticut College campus and Arboretum from the first half of the twentieth century indicate that the region supported a diversity of birds characteristic of open habitats with few trees. Northern Bobwhites, Ring-necked Pheasants, Horned Larks, Yellow-breasted Chats and Eastern Meadowlarks nested in the area until the 1950s (Goodwin and Grandjouan 1958, Logan 1958, Askins 1990). As in most other regions of New England, these species declined or disappeared as open fields were replaced by closed-canopy forest (Askins 2002). This habitat change has led to major reductions in most early successional birds, especially those species that require savannah or open grassland.

The Mamacoke IBA does not include large enough expanses of grassland to support Grasshopper Sparrows, Upland Sandpipers, or other species that require extensive areas (e.g., > 50 acres) of continuous grassland. The 12-acre meadow that was recently restored at Harrison's Landing has great potential to support other species of grassland and savannah birds, however. Although Savannah Sparrow, Eastern Meadowlark and some other grassland specialists that nest in relatively small habitat patches may be attracted to the restored meadow, our main goal is to manage for savannah species. These species require grassland with scattered trees. Two savannah species, Northern Oriole and Orchard Oriole, nested at this site even before the amount of open habitat was expanded during restoration. Northern Oriole is a "high continental priority species" in the list of Partners in Flight [PIF] Priority Species for Southern New England. Screech Owls have also been recorded at the site during recent winters. Following restoration, the site has the potential of attracting additional savannah species such as Eastern Bluebirds and American Kestrels. Bluebird boxes have already been installed at the site. More of these boxes should be installed in the recently restored meadow areas, and we should add one or two boxes suitable for American Kestrels and Screech Owls. All boxes should be protected with predator guards.

Prairie Warbler and Blue-winged Warbler also have been recorded in the Harrison's Landing meadow during the summer. Both of these species are "high continental priority species" in the list of Partners In Flight Priority Species for Southern New England, and are also included on the Audubon WatchList. The meadow restoration project may have reduced the habitat quality for these species, but continued successional change toward woodland would have eliminated their habitat if left unchecked. Of the two species, the Prairie Warbler is more likely to remain at the site

and to even benefit from efforts to remove woody plants from the site. Although Prairie Warblers are associated with low, scrubby vegetation, they are found in a fairly wide range of open habitats: "barrens (pines and scrub oak [*Quercus*], often sandy and maintained by fire); abandoned fields or pastures with shrubby growth; regenerating forest; abandoned orchards; grassland-forest contacts at edge of prairie" (Nolan et al. 1999). In contrast, Blue-winged Warblers are usually found in denser shrub cover, so they may not do well at the restored site. Our goal is to manage for Blue-winged Warblers and other shrubland species in other parts of the Arboretum.

Black-billed Cuckoos (a "high continental priority species" in the list of PIF Priority Species for Southern New England) are frequent summer residents in the Harrison's Landing meadow. This species is often associated with brushy hillsides and thickets, but it is also found in orchards and forest clearings (Hughes 2001), so it isn't clear how the recent restoration of the meadow will affect it. The elimination of many deciduous trees in the meadow will probably reduce the density of forest tent caterpillars (*Malacosoma disstria*), which are a major component of the diet of Black-billed Cuckoos. The expansion of open habitat may have a positive effect on these cuckoos, however.

To assess the impact of meadow restoration on nesting songbirds, we plan to begin monitoring the meadow using point counts following the standardized protocol used by the DEP Wildlife Division for the Connecticut Grassland Bird Survey. Two surveys of birds are taken during the breeding season (one in June and the other in July). All birds that are detected within 100 meters of each survey point are recorded during two five-minute observation periods during each visit.

The Harrison's Landing meadow is also important habitat for American Woodcock, which have had mating territories here since at least 1984 (Askins, 1990). This is a "high continental priority species" in the list of PIF Priority Species for Southern New England, and is included on the national Audubon WatchList. The number of woodcock males using the site for courtship flights in March and April will be monitored to determine whether the site was enhanced for this species as a result of restoration and expansion of the meadow. In addition, we will complete evening playback surveys to determine whether Screech and Saw-whet owls are using the site. These can be completed on the same evenings as the woodcock surveys.

Large numbers of winter-resident sparrows of several species occur in the meadow and adjacent brushy edges near the railroad track during fall migration and winter (Askins 1990). These are monitored systematically only during the annual Christmas Bird Count at the end of December. We will consider adding a monitoring program for these seed-eating birds during late fall, mid winter, or both.

V. Conservation Concerns and Threats

Management concerns/issues/opportunities - Aquatic

The authors of this report have not done any research into the actual levels of pollution in the Mamacoke IBA. This section is thus based on our general knowledge of pollution. At this time it is not clear how or if current levels of pollutants are affecting the biological systems of the IBA.

There are a variety of ways that non-point-source pollution can enter the Mamacoke IBA area. Pollutants originating from many residences include lawn chemicals (herbicides, fungicides, pesticides and fertilizers) and sewerage from

individual septic systems. Runoff from lumberyard at the end of Richard's Grove Road is likely to contain pesticide residues and hydrocarbons. The railroad beds on both sides of the Thames are regularly sprayed with herbicides, using very indiscriminant application techniques, for the purpose of preventing vegetation growth on the ballast.

An obvious series of point sources of pollution are the street and highway culverts which direct salt and hydrocarbon laden water downhill toward the river. A new boat facility, the Thames Landing Marina, is located directly north and upstream of the IBA. This will be a source of hydrocarbons, trash and likely sewerage. Overflows from sewage treatment systems up river still periodically pollute the water. The massive submarine base across the river from the IBA is likely the source of point and non-point source pollutants of various kinds in the river. The base also generates large amounts of noise and light pollution.

Dredging associated with keeping the river channel deep enough for nuclear submarines suspends sediments and probably remixes chemical pollutants from bottom sediments back into the water column.

Since waterfowl are the most significant factor in this IBA, food resources for these animals are clearly of interest. They primarily feed on aquatic plants and animals, and as previously stated, little is known about the location, diversity or quantity of these food resources. Additional quantitative surveys of the cove and salt pond bottoms for physical and biological characteristics are needed. The surveys should include the identification of any invasive exotic plants or animals that may be present.

Mute Swans, which are abundant in the Mamacoke IBA, may have a negative impact on winter-resident ducks. Mute Swans were introduced to southern New England and Long Island from Europe in the late 1800s and early 1900s. Populations have grown

steadily since then. The Connecticut population increased by 50% between 1982 and 1990 (Conover and Kania, 1999). During this period swans had high reproductive success on estuaries and inland lakes and ponds, with each pair fledging an average of 3.2 young per year. The swan population in the Mamacoke IBA also increased during this period (Figure 8). In 2002 the Mute Swans population in Connecticut reached an estimated 2,082 in the winter and 1,200 during the breeding season (Huang, in press). About 10% of the state's estimated winter population was recorded in the Mamacoke IBA in 2002 (Figure 8).

Mute Swan are a threat to native ducks for two reasons: they compete with herbivorous ducks for food (submerged aquatic plants), and they aggressively defend their breeding territories against other waterfowl, potentially excluding native ducks from favorable breeding habitat (Conover and Kania, 1994; Ciaranca, et al., 1997). In the Mamacoke IBA, the primary concern is that Mute Swans might reduce the supply of winter food for plant-eating ducks such as Canvasbacks and American Black Ducks. Swans nest at the site, with typically two to three breeding territories between South Mamacoke Island and northern Smith Cove, but few ducks nest in this area. There are no recent breeding records of American Black Ducks in the Mamacoke IBA, so the aggressive behavior of breeding Mute Swans toward other waterfowl is not necessarily a problem. Large concentrations of swans during the winter could affect the food supply of ducks that depend on aquatic vegetation, however

O'Brien and Askins (1985) studied the interactions between introduced Mute Swans and native ducks at Smith Cove. Both swans and Canvasbacks primarily fed on Sea Lettuce (*Ulva*), but at Smith Cove the swans usually fed in shallower water than the Canvasbacks, which dive to feed off of the bottom. Swans are restricted to water <1 m

deep, the maximum depth at which they can reach the bottom by "neck-plunging" (reaching to the bottom with an outstretched neck). Dabbling ducks such as American Black Duck generally foraged in shallower water than swans (except when wigeons followed swans to feed on pieces of aquatic vegetation dropped by the swans). Consequently, the dabbling ducks, swans and Canvasbacks partition the habitat by water depth to a large extent, minimizing potential competition for food. We do not know, however, whether Canvasbacks originally foraged in shallower water before they had to compete for food with introduced swans. Also, the depth zone used by swans shifts location with the tides, increasingly the proportion of cove bottom affected by swan feeding. The decline in Canvasbacks after 1991 followed a period of steady increases in Mute Swan populations (Figures 8 and 10), but Canvasbacks declined throughout Connecticut during this same period even though Mute Swan populations were relatively stable across the state (Figures 13 and 16).

Conover and Kania (1994) built exclosures to exclude feeding Mute Swans on freshwater ponds and lakes in Connecticut to assess their effect on water plants used by ducks. They did not find a significant difference in density of aquatic vegetation on exclosure and control plots, indicating that swans do not have a large impact on availability of aquatic vegetation. This study was completed during the breeding season on territories occupied by single pairs of swans, however, so the results are not necessarily relevant to the situation in the Mamacoke IBA in winter, when feeding Mute Swans often congregate in feeding flocks of >100. Similar experiments should be completed in the Mamacoke IBA and other shallow estuaries with large, non-breeding flocks of swans. Also, systematic monitoring of aquatic vegetation in Smith Cove and the coves around Mamacoke Island would be instructive

Management concerns/issues/opportunities - Terrestrial

Invasive exotic plants are common in upland areas in the IBA. The most problematic plants locally are Oriental bittersweet (*Celastrus orbiculatus*), vine and shrub honeysuckles (*Lonicera japonica* and *L. morrowii*), tree of heaven (*Ailanthus altissima*), and privet (*Ligustrum* sp.). Autumn Olive and Giant Reed are locally present and are a particular problem on the undeveloped riverside parcel at the end of Richards Grove Road. Giant Reed, the primary invasive in wetland habitats, has become established in the various salt and brackish wetlands within and adjacent to the IBA. In particular, the salt pond south of the lumberyard and north of the Arboretum's Hempstead Tract is dominated by Giant Reed. The Arboretum actively manages for reduction of invasives in some locations, but has not had a policy of removing invasives everywhere due primarily to limitations in budget and labor. We are not aware of any active invasive removal on non-Arboretum property.

Increasing the amount of early successional habitat has become a conservation priority in the Northeast. As previously mentioned, the Arboretum has recently reclaimed about 12 acres of meadow in the IBA, and has also maintained another few acres in an open condition through the use of controlled burning and mowing since the late 1960s. The privately owned parcel at the end of Richards Grove Road is also currently at a fairly early successional stage, and could be maintained over the long term as meadow/shrubland cover if it were managed for conservation.

The Mamacoke tidal marsh connects Mamacoke Island to the mainland, and foot traffic is causing significant erosion of the marsh surface. Mamacoke is one of two Arboretum natural areas that are primarily managed for teaching and research. Although

Arboretum property is open to the public, efforts are made to prevent individual runners, athletic teams and other large groups from Connecticut College and the Coast Guard Academy, from accessing the marsh and island. This is accomplished primarily through signs, maps, occasional direct communication with runners, regular communication with athletic departments and intentionally not pruning back the sides of trails on the Island. It would be possible to build a boardwalk on the marsh connecting the railroad embankment to the island's upland. Materials that allow sunlight to penetrate through the walking surface to the marsh surface would minimize shading effects, and the marsh would presumably repair itself over time. One negative effect of a boardwalk would likely be increased pedestrian and probably running traffic on the island. Obtaining the necessary permits and funding for a boardwalk might also pose a challenge.

Deer overpopulation is a regional problem that affects natural plant and plant community regeneration. The effect of deer browse on forest regeneration has been documented in many locations, including a study performed in another section of the Arboretum (Hartvigsen 1987). While deer are common on Arboretum property within the IBA, the current population size or their impact on habitats is not known. For Connecticut College property, which is the only significant open space in the IBA, a comprehensive evaluation of deer populations and acceptable browse levels should be undertaken.

There appear to be few options for additional residential or commercial development within or directly adjacent to the IBA. However, there are two parcels of significant size that are not protected, one of 5.4 acres at the end of Scotch Cap Road on the south and one of 5.3 acres across the railroad tracks from the end of Richards Grove

Road. Preservation of these areas would enhance protection of North Mamacoke Cove and Smith Cove, which are major areas of concentration for winter-resident waterfowl

Another potentially important issue is that Mamacoke Natural Area is the only Arboretum parcel in and near the IBA that is "deed restricted" in such a way that the college must keep it in a "wild," undeveloped state. The college has seriously contemplated development of college property outside the Arboretum on the shore of the Thames River south of Mamacoke at least twice in the past twenty years. Also, with the exception of Mamacoke, college property in the IBA is still zoned as residential.

Existing Arboretum Management Objectives

- Maintenance of early successional habitat, increasingly uncommon plants and animals.
- Nest boxes for bluebirds.
- Low impact, passive recreation, teaching and research on Mamacoke Marsh and Island
- Controlled burning and selective herbicide vegetation management research on Avery and Matthies tracts
- Maintenance of running trails in Avery and Matthies Tracts
- Composting of large amounts of leaves gathered each fall on the main campus on the Matthies Tract south of Benham Avenue directly west of railroad
- Monitoring winter-resident waterfowl populations.

VI. Current Conservation Activities

In addition to the research, teaching and management activities already detailed, the College uses the Area in the IBA for public outreach and education. For example, the Arboretum sponsors public, guided walks of archeological sites and history, the geology of Mamacoke, tidal marsh ecology, and bird life. From 1952 until approximately 2004, the Arboretum maintained a Naturalistic Landscape Demonstration Area in a formerly post-agricultural setting north of Benham Avenue on the Matthies Tract. The site is now the southwestern corner of the expanded meadow project. Past conservation activities in the IBA are documented in Arboretum Bulletins Nos. 20, 21, 22, 23, 25, 26, 27, 28, 31, 32 and 33 (Appendix 2) as well as in Arboretum Annual Reports.

VII Conservation Goals

1. Land Protection.

   a. Investigate the potential for land acquisition or easement for the Richards Grove Road end parcel and other undeveloped shoreline at Smith Cove.

   b. Rezone college property as open space.

2. Reduce pollutant load to coves and river

   a. Reduce sewerage infiltration through additional sewer hookups. Town of Waterford is planning to run a sewer line to Harrison's Landing. Check on other future projects, including those along Hunt's Brook, which empties into Smith Cove.

   b. Check adequacy of runoff and sediment control from Mohegan Avenue (Rt. 32) and other roads. Water quality monitoring is needed.

c. Reduce and eliminate overflows of combined sewerage and storm drainage systems upstream (Norwich)

3. Restore trail area on Mamacoke Marsh

4. Research and Monitoring

a. Survey Aquatic vegetation and benthic animals on cove bottoms.

b. Survey expanded early successional habitats for grassland and savannah birds and other bird species of conservation concern.

c. Continue monitoring the abundance and distribution of winter-resident waterfowl.

5. Wildlife Management

a. Continue maintaining meadow and field burn areas as early successional habitat.

b. Add nest boxes or structures for some target species including American Kestrel, Eastern Bluebird, and Osprey

6. Public Outreach and Education – In addition to current Arboretum natural history offerings, programs that highlight the importance of coves and early successional habitats to birds should be developed, such as field trips of observe wintering waterfowl.

VIII Preliminary Conservation Action Plan

During the next three years we plan to accomplish the following:

1. Place a downloadable PDF file of the Mamacoke IBA Conservation Strategy on the Connecticut College Arboretum web site so it is available to participants in an open meeting on the plan and to anyone else who is interested in conservation of this area.

2. Hold an open meeting with neighbors (people who own property close to the Mamacoke IBA) and other interested parties (e.g., representatives of the West Farm Land Trust; conservation groups such as Connecticut Audubon Society, Ducks Unlimited, and Save the Sound; members and volunteers of the Connecticut College Arboretum; and members of the Connecticut College community). Invitations will be sent to neighbors; faculty, students and staff at Connecticut College; Arboretum members; and relevant conservation organizations and agencies. We will make a brief, illustrated presentation about the importance of the Mamacoke and Smith Cove areas for conservation, describing some of the actions we are taking within the Connecticut College Arboretum to restore and protect natural habitats. We will then open a discussion about environmental threats to the critical waterways in the Important Bird Area, asking participants for their opinions about how these areas can best be protected and restored. Their recommendations can be incorporated into the final version of the Action Plan.

3. The Mamacoke Conservation Strategy will be modified and published as a bulletin in the Connecticut College Arboretum Bulletin series. This bulletin will be distributed to all Connecticut College Arboretum members as well as to anyone who participated in the open meeting or showed an interest in the IBA Conservation Strategy in other ways. The bulletin will include additional illustrations, and we will use color illustrations if we can afford it or find outside support. The text of the conservation plan will be condensed and edited to ensure that it isn't too technical for the general public. Also, we will modify the Action Plan at the end of the bulletin on the basis of comments from participants at the open meeting and from other people who reviewed our proposals.

4. Work to protect the low, sandy river terrace on the east side of the railroad tracks at the end of Richard Grove Road from development. This is adjacent to the most important waterfowl wintering area in the IBA, so protection (either through conservation easement or purchase) should be a high priority.

5. Add more bird boxes to the restored meadows next to Harrison's Landing. These may include additional bluebird boxes (with boxes arrayed in pairs to reduce competition with House Sparrows, Tree Swallows and House Wrens), Purple Martin houses (gourd-style), and one or two American Kestrel and Screech Owl boxes.

6. Remove the two unsuccessful Osprey platforms at the Salt Pond and Mamacoke Marsh. Investigate the potential for installing another Osprey platform – taller and perhaps in a different location – for attracting a breeding pair of ospreys. Check with Julie Victoria of the Connecticut DEP Wildlife Division about the best methods for installing new osprey stands.

7. Work with Douglas Thompson, who is a hydrologist on the Connecticut College faculty, and his students to study and improve runoff and sedimentation from the stream in the restored meadows of the Arboretum and in other parts of the watershed.

8. Continue active management of the restored meadows at Harrison's Landing. Currently this is accomplished with periodic late-winter mowing, but we should also investigate the possibility of periodic controlled burns.

9. Continue active management to control invasive plant species.

10. Continue winter waterfowl surveys in Smith Cove and around Mamacoke Island. Weekly surveys should be completed between October 15 and April 15. Recruit volunteers or pay student interns to complete these surveys when Robert Askins is not able to do them.

11. Continue the breeding bird survey in the restored meadows at Harrison's Landing, and initiate a spring survey of American Woodcocks and Screech and Saw-whet owls in this meadow and the prescribed bird fields on the south side of Benham Avenue.

12. Solicit proposals and provide funding for a survey in aquatic vegetation and benthic invertebrates in the main waterfowl wintering areas in Smith Cove and North Mamacoke Cove. These are important food sources for winter-resident ducks.

13. Encourage student research projects on changes in water quality of the Thames River and Hunt's Brook using data from government reports and databases and other published sources.

Other projects we should consider during this three-year period or in the future are a study of the density of deer and their impact on vegetation, and surveys of sparrows and other seed-eating birds in the restored meadows during the winter.

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APPENDIX 1

Seed mix used in June 2006 planting for the Arboretum W.H.I.P. project meadow. Seeds were provided by New England Wetland Plants, Amherst, MA

Pounds	Species
10.00	*Andropogon gerardii*, Big Bluestem
8.00	*Andropogon virginicus*, Broom Sedge
21.00	*Elymus canadensis*, Canada Wild Rye
5.00	*Schizachrium scoparius*, Little Bluestem (Albany Pine Bush ecotype)
15.00	*Schizachrium scoparius*, Little Bluestem, (CT ecotype)
10.00	*Sorgastrum nutans*, Indian grass
10.00	*Tridens flavus*, Purple Top
0.52	*Asclepias tuberosa*, Butterfly Milkweed
0.53	*Aster laevis*, Smooth Blue Aster
0.52	*Aster pilosus*, Heath Aster
1.00	*Eupatorium hyssopifolium*, Hyssop Leaved Boneset
0.52	*Eupatorium maculatum*, Spotted Joe Pye Weed
0.52	*Eupatorium purpureum*, Purple Node Joe Pye Weed
0.90	*Euthamia graminifolia*, Grass Leaved Goldenrod
2.00	*Aster nova-angliae*, New England Aster
2.00	*Desmodium canadensis*, Showy Tick Trefoil
2.00	*Lespedeza capitata*, Round Headed Bush Clover
0.50	Cowpea/Peanut/Lespedeza 100# inoculant-mixed
0.50	*Penstemon digitalis*, Tall White Beard Tongue
2.00	*Pycnanthemum virginianum*, Virginia Mountain Mint
3.00	*Rudbeckia hirta*, Black Eyed Susan
2.50	*Rudbeckia triloba*, Brown Eyed Susan
0.50	*Solidago juncea*, Early Goldenrod
1.00	*Solidago nemoralis*, Grey Goldenrod
1.00	*Solidago speciosa*, Showy Goldenrod
100.00	TOTAL

APPENDIX 2

Connecticut College Arboretum Bulletins Relevant to the Mamacoke IBA

No. 12. *Connecticut's Coastal Marshes: A Vanishing Resource.* 36 pp. 1961. Testimony of various authorities as to the value of our tidal marshes and a suggested action program. Second printing with supplement 1966.
No. 17. *Preserving Our Freshwater Wetlands.* 52 pp. 1970. Reprints of a series of articles on why this is important and how it can be done.
No. 18. *Seaweeds of the Connecticut Shore. A Wader's Guide.* 36 pp. 1972. Revised 1985. Illustrated guide to 60 different algae with keys to their identification.
No. 19. *Inland Wetland Plants of Connecticut.* 24 pp. 1973. Some 40 species of plants found in marshes, swamps and bogs are illustrated.
No. 20. *Tidal Marsh Invertebrates of Connecticut.* 36 pp. 1974. Descriptions and illustrations of over 40 species of mollusks, crustaceans, arachnids, and insects found on our tidal marshes.
No. 21. *Energy Conservation on the Home Grounds- The Role of Naturalistic Landscaping.* 28 pp. 1975. Brief descriptions of six residences landscaped without excessive lawns; description of Arboretum Naturalistic Landscape Demo. Area; list of plants "requiring minimum maintenance." b & w photographs.
No. 22. *Our Dynamic Tidal Marshes: Vegetation Changes as Revealed by Peat Analysis.* 12 pp. 1976. Description of a method for sampling peat and identifying plant remains in order to document vegetation change on tidal marshes.
No. 23. *Plants and Animals of the Estuary.* 44 pp. 1978. Descriptions and illustrations of over 70 estuarine species.
No. 25. *Salt Marsh Plants of Connecticut.* 32 pp. 1980. Illustrated guide to 22 plants which grow in our tidal wetlands.
No. 26. *Recycling Mycelium: A Fermentation Byproduct Becomes an Organic Resource.* 32 pp. 1981. Documents the role of industrial mycelial residues as soil amendments on ornamental plants, agricultural crops, and in natural vegetation.
No. 27. *Birds of Connecticut Salt Marshes.* 48 pp. 1981. Illustrations and descriptions of 24 birds commonly seen on our tidal marshes.
No.28. *The Connecticut Arboretum: Its First Fifty Years 1931-1981.* 56 pp. 1982. Historical accounts of the formation and growth of the Arboretum.
No. 31. *Birds of the Connecticut College Arboretum.* 50 pp. 1990. An annotated list with seasonal records, and an account of the bird research program. Illustrated. Replaces Bulletin No.10.
No. 32. *The Connecticut College Arboretum--Its Sixth Decade and a Detailed History of the Land*. 96 pp. 47photos. 1991. Historical accounts of the formation and growth of the Arboretum. Supplements Bulletin No. 28.
No. 33. *Archaeology in the Connecticut College Arboretum*. 56 pp. 1992. Detailed descriptions of prehistoric and historic archaeological sites in the Arboretum. Photographs and illustrations.
No. 34. *Tidal Marshes of Long Island Sound: Ecology, History and Restoration*. Describes the ecology and chronicles the history of Long Island Sound Tidal Marshes. Photographs and illustrations.

No. 36. *Amphibians and Reptiles of the Connecticut College Arboretum.* 52 pp. 1998. Field Guide, checklist and summary of research on these animals in the Arboretum. Illustrated with line drawings, tables and graphs.
No. 39. *Seaweeds of Long Island Sound*. 2006. 104 pp. User-friendly guide to about 80 of the most common Seaweeds in the Sound. Color photographs. Replaces Bull. No. 18.