Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

Task 3 Literature Review
Book 10 Part 1: Freshwater Wetlands

Prepared for:

Suffolk County Department of Public Works
Suffolk County Department of Health Services
Suffolk County, New York

CASHIN ASSOCIATES, P.C.

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SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

CWA	Clean Water Act
CWPPRA	Coastal Wetlands Planning Protection and Restoration Act
ESA	Endangered Species Act
Ft.	Feet
NAWCA	North American Wetlands Conservation Act
NEPA	National Environmental Policy Act of 1969
NYSDEC	New York State Department of Environmental Conservation
PPT	Parts per Trillion
SCDPW	Suffolk County Department of Public Works
SCVC	Suffolk County Department of Public Works, Division of Vector Control
SEQR	New York State Environmental Quality Review Act
TEA-21	Transportation Equity Act for the 21st Century
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

Executive Summary

Freshwater wetlands play a significant role in the ecology of Suffolk County, New York. These unique ecosystems support a variety of plants and animals including several at risk species, such as the State endangered eastern tiger salamander and State threatened banded sunfish. Wetlands are generally described as those areas where water and land meet to create highly productive habitats that support a wide range of species adapted to survive in the wet/dry cycles. Wetlands are further classified by the amount of salinity found within their waters. Freshwater wetlands are often defined by vegetation and soil types, indicative of moisture laden, non-saline environments.

Freshwater wetlands are often categorized into several different communities that reflect differences in geology, vegetation, and tidal influence. Major freshwater wetland ecosystems include:

- Tidal
- Riverine
- Lacustrine
- Palustrine

Tidal freshwater wetlands are those wetlands that are found at the mouths of large tidal rivers. The boundaries between fresh and saltwater wetlands in these systems are often difficult to define and are constantly changing due to the influence of tidal cycles and influxes in freshwater inputs. In most cases, these wetlands are identified by vegetation and soil types due to the fact that they exhibit less variability than salinities and animal species present. Freshwater tidal communities are divided into two categories: low elevation, broad leaf emergent zones; and, higher, gramonoid zones.

Riverine systems are defined as riverside wetlands and deeper water habitats contained within a channel and are generally classified by water flow rates, substrate composition, and faunal and vegetative species present. Classes of vegetation found in riverine systems include:

- emergent and submergent bryophytes
- hydrophytic vascular plants
- submergent vegetation

Lacustrine communities are defined as those freshwater wetlands and deeper water habitats situated in topographical depressions or dammed river channels. Lakes and ponds are characteristic of this group and are identified by low directional flow and characteristic life such as:

- peat moss
- algae
- pickerel
- tiger salamander
- muskrat

Palustrine wetlands include a variety of freshwater swamps, marshes and bogs. These communities are often dominated by a variety of trees, shrubs, persistent emergents, emergent mosses and lichens.

In Suffolk County several types of freshwater wetland communities exist, including many rare systems that are found in few places on earth. This is due, in part, to the glacial development of the region and, secondarily, to the coastal influences of the surrounding tidal waters. Freshwater wetlands identified within Suffolk County include:

- freshwater tidal marsh
- intermittent stream
- coastal plain stream
- coastal plain pond

- eutrophic pond
- shallow emergent freshwater marsh
- shrub swamp
- coastal plain pond shore
- maritime freshwater interdunal swales
- Pine Barrens vernal pond
- Pine Barrens shrub swamp
- coastal plain poor fen
- sea level fen
- highbush blueberry bog thicket
- red maple – black gum swamp
- vernal pool
- coastal plain Atlantic white cedar swamp
- pitch pine – blueberry peat swamp

Mosquitoes utilize freshwater wetland habitats for feeding, breeding and overwintering in Suffolk County. Fourteen species, representing six genera that inhabit freshwater wetlands, have been identified as mosquito species that may be potential public health risks in Suffolk County. This includes the following species:

- *Aedes vexans*
- *Anopheles quadrimaculatus*
- *Culex pipiens*

- *Culex restuans*
- *Culex salinarius*
- *Culex territans*
- *Culiseta melanura*
- *Coquillettidia perturbans*
- *Ochlerotatus stimulans*
- *Ochlerotatus abserratus*
- *Ochlerotatus cantator*
- *Ochlerotatus trivittatus*
- *Ochlerotatus canadaensis*
- *Ochlerotatus triseriatus*

Each mosquito species has preferences for particular types of freshwater wetlands due to breeding and feeding requirements. However, these preferences are not always well-defined. Better understanding of the habitat preferences of these species could allow for better targeted mosquito control in Suffolk County.

1. Introduction

Wetlands are defined as those areas where land and water meet to create distinctive and often highly productive aquatic habitats. Wetlands are divided generally into two categories: estuarine and freshwater. Estuarine wetlands are described as those areas containing salt and brackish water communities associated with maritime environments. Freshwater wetlands indicate regions with waters that are derived from groundwater and rainfall, and, thus, have little to no salt content. The boundaries between estuarine and freshwater wetlands often fluctuate, resulting in transitional habitats that often retain characteristics of both systems.

The term freshwater wetlands collectively describe a range of non-saline ponds, bogs, fens, swamps, and marshes found throughout North America (Holst et al., 2003). These areas are identified by hydric soils, saturated for a sufficient time during the growing season to develop anaerobic conditions in the soil's upper reaches (Metzler and Tiner, 1992). The United States Fish and Wildlife Service (USFWS) classifies freshwater wetlands into three categories: riverine, lacustrine, and palustrine (Cowardin et al., 1979). Riverine wetlands generally refer to those habitats associated with rivers and streams, while lacustrine wetlands describe areas such as lakes and ponds. Palustrine wetlands are identified as shallow bodies of water with minimal water flow and can include swamps, marshes and bogs. Freshwater systems have unique plant and animal communities specially adapted to constantly changing levels of water and salinity.

Suffolk County, which comprises the eastern half of Long Island, New York, falls within the Coastal Lowlands ecozone as identified by Edinger et al. (2002). The Atlantic Ocean, Long Island Sound, Hudson River, New York – New Jersey Harbor, and several other major bodies of water play a large role in the characteristics of this ecological zone. In addition, because Long Island was shaped by continental glaciers whose terminal moraines and outwash plains created distinctive geological attributes it is a unique region within this ecozone (Stewart and Springer-Rushia, 1998). Consequently, the freshwater wetlands of Suffolk County are remarkably diverse and include rare habitats with high levels of biodiversity. This includes several endangered and threatened species, such as the New York State endangered eastern tiger salamander that is found within ponds, lakes, and streams throughout the region.

Freshwater wetlands in Suffolk County are also home to many invertebrate species, including at least six major genera of mosquitoes (Stewart and Springer-Rushia, 1998; CA/CE, 2004). The mosquito genera include:

- *Aedes*
- *Anopheles*
- *Culex*
- *Culiseta*
- *Coquillettida*
- *Ochlerotatus*

These mosquitoes may inhabit distinct freshwater wetlands habitats. However, due to the variability that exists between species, habitats often overlap and, thus, preferences are often difficult to delineate.

This report describes freshwater habitats of Suffolk County, New York, and the associated plant and animal species found in riverine, lacustrine, and palustrine wetlands. In addition, this report characterizes wetlands communities found within several distinct ecological zones: the North Shore, South Shore Outwash Plain, Peconic River - Pine Barrens, and East End of Suffolk County. Ecological case studies identify and describe notable communities, such as red maple swamps, coastal plain ponds, and environmentally managed systems. Finally, this report describes the six mosquito genera of concern in the freshwater wetlands of Suffolk County, Long Island, and identifies their major habitats.

1.1. Overview of Freshwater Wetlands

The formation, persistence, and size of freshwater wetlands are often a factor of hydrologic processes that affect the movement of water through the system (Carter, 1996). In some cases, freshwater wetlands can be affected by tidal influences from marine environments. Due to the variety of wetlands that can exist, wetland scientists tend to define these areas as places where land and water meet and support a preponderance of characteristic wetlands plants that out-

compete upland species (NYSDEC, 2004a). For wetlands that occur due to the presence of water beneath the visible land surface, delineation can be confirmed by soil types.

1.1.1 Hydrology

Hydrology plays a large role in the distribution and characteristics of freshwater wetlands. Wetlands are often identified by their underlying soil types, known collectively as hydric soils. Hydric soils have been defined by the US Department of Agriculture as those soils saturated, ponded, or flooded for a sufficient time during the growing season to develop anaerobic conditions in the upper part of the soil (Metzler and Tiner, 1992). This condition is generally fostered by the hydrology of the immediate area.

Distribution and differences in soils and vegetation in wetlands are influenced by varying geologic, topographic, and climactic factors (Carter, 1996). Differences can also be attributed to the movement of water throughout wetlands, water quality, and the impacts of human disturbances. The differing hydrology of each unique wetland plays an important role in the water quality and quantity within each system.

Major components of the hydrological cycle include precipitation, surface water flow, groundwater flow, and evapotranspiration (Carter, 1996). Wetlands depend exclusively on either precipitation or groundwater flow for sustaining the hydric soils indicative of this ecosystem. Over the long-term, the inputs of water into the system are generally counterbalanced by the loss of freshwater to surface water flow and evapotranspiration (Carter, 1996). Tidal flows can also have significant impacts on the inputs and outputs of freshwater wetlands.

1.1.2 Ecology

Plant and animal species found within freshwater wetlands are highly dependent on hydrology and soil characteristics. Wetland plants have adapted to thrive in conditions that most upland plants are unable to survive (Holst et al. 2003). For example, some species of wetland vegetation are able to move oxygen from the air above to their root systems embedded in the surrounding hydric soils (Holst, 1996).

A variety of plant types have evolved to exploit varying levels of moisture found within freshwater wetlands. Wetland plant species found exclusively in the saturated soil conditions are

known collectively as obligate wetland hydrophytes. In contrast, plants that grow in saturated soils, but may also be found outside wetlands, are described as facultative wetland species. Indicative plant species of freshwater wetlands include trees, shrubs, persistent emergents, and emergent mosses or lichens among others (Holst, 1996). Due to the complexities found within the wetlands in Suffolk County, specific wetland plant species are identified in Section 2.0.

Animal species found within freshwater wetlands are equally diverse. Wetlands are some of the most biologically productive ecosystems with a variety of animal species that live and feed within them (USEPA, 2001). The abundance of vegetation and shallow water makes this habitat ideal for fish and wildlife. Many species utilize freshwater habitats for protection and refuge, while others seek out wetlands for breeding, nesting, and feeding grounds (NYSDEC, 2004b). These areas are known for supporting diverse assemblages of waterfowl, fish and shellfish, reptiles, and amphibians, especially. Due to the complexities found within these wetlands, specific wetland animal species are explored in Section 2.0.

1.1.3 Functions

Freshwater wetlands provide numerous beneficial qualities for the ecosystem and, in turn, for the health of humans. Wetland functions include water quality improvement, floodwater storage, fish and wildlife habitat, aesthetics, and biological productivity (USEPA, 2001). In addition to the ecological functions of wetlands, recreation and tourism often account for a significant portion of local and regional economies. The total value of the ecotourism activities, such as hunting, fishing, bird watching, and photography, adds as much as $60 billion annually to the domestic economy, a good deal of which is associated with various freshwater wetlands (USEPA, 2001).

Water storage is often cited as one of the major beneficial attributes of freshwater wetlands. During floods from precipitation or tidal variations, wetlands absorb excess fluid, slowing the movement of water through the ecosystem (NYSDEC, 2004b). The ability of wetlands to store floodwaters reduces the occurrence of costly property damage and loss of life (USEPA, 2001). Wetland vegetation also assists the absorption process, acting as a buffer to surrounding ecosystems by retaining water while reducing erosion downstream by decreasing flow rates (NYSDEC, 2004b).

Water quality maintenance is another important ecological role of freshwater wetlands. Microorganisms in wetlands break down and use nutrients, significantly reducing the levels of natural and human-related pollutants (NYSDEC, 2004b). In addition, freshwater wetland vegetation filters nutrients from fertilizers and septic systems allowing water to leave wetlands cleaner than when it entered (USEPA, 2001). In wetlands that percolate to groundwater, filtration allows for increased drinking water quality.

Biological productivity is a key characteristic of freshwater wetlands, as they are generally accounted as being among the most productive ecosystems in the world (USEPA, 2001). Abundant vegetation and shallow waters provide diverse habitat for fish and wildlife to breed, nest, and feed (NYSDEC, 2004b). Juvenile fish are able to find shelter and food in tidal freshwater wetlands, while shellfish and crustaceans use these same areas during their life cycles. Migratory bird species often find refuge in freshwater wetlands during their annual journeys.

1.1.4 Trends

Inventories of freshwater wetlands are closely monitored by state and local agencies to help implement "no net loss" management policies. In New York State, it was estimated in the middle of the 1990s that 2.4 million acres of wetlands existed throughout the state (NYSDEC, 2004c). Of those 2.4 million acres, 21,000 were located in the Coastal Lowlands ecozone, an area including Long Island and portions of southeastern New York State. The NYSDEC studies found that 65 percent of the Coastal Lowlands ecozone wetlands were forested covertype, while 23 percent were identified as open water covertype. Emergent covertype and shrub/scrub covertype accounted for 8 and 3 percent respectively.

NYSDEC found that wetlands in the Coastal Lowlands ecozone remained relatively the same, gaining 70 acres or 0.3 percent in the 10 years preceding the mid-1990s survey (NYSDEC, 2004c). Statewide gains and losses of wetlands were attributed variously to agricultural conversion, urbanization, development, mining, increased runoff, beaver activity, and plant succession.

1.2 Management of Freshwater Wetlands

Management of freshwater wetlands is the responsibility of Federal, state, county, and local natural resource agencies in the United States. A variety of regulations assist these agencies in

their mission to conserve wetlands. At the Federal level, the Clean Water Act (CWA) is the most prominent of the regulations affecting wetlands management. In New York State, the Freshwater Wetlands Act, the Tidal Wetland Act, and the State Environmental Quality Review Act (SEQR) contribute to the overall management framework. In addition, towns and counties have regulations and management plans that help to conserve wetland ecosystems.

1.2.1 Federal

The CWA is responsible for establishing a management framework for wetlands at the Federal level. A 1977 amendment to the Federal Water Pollution Control Act created the CWA and set a basic structure for regulating discharges of pollutants to waterways (USEPA, 2004a). CWA Section 404 establishes programs that regulate discharges of dredged and fill materials into wetlands. Activities directly affected by Section 404 include fill for development, water resources projects (dams and levees), infrastructure development such as highways and airports, and conversion of wetlands for farming and forestry. Section 404's guiding principle is that no discharge of dredged or fill material will be permitted in wetlands if it significantly degrades wetlands resources (USEPA, 2004b). A permit process accompanies Section 404 and is a cooperative effort between the Unites States Army Corps of Engineers and USEPA.

In addition to the CWA, other Federal regulations that affect the management of wetlands include:

- Endangered Species Act (ESA)
- National Environmental Policy Act of 1969 (NEPA)
- Federal Agriculture Improvement and Reform Act of 1996
- Transportation Equity Act for the 21st Century (TEA-21)
- Coastal Wetlands Planning Protection and Restoration Act (CWPPRA)
- North American Wetlands Conservation Act (NAWCA).

1.2.2 New York State

In New York State, the Freshwater Wetlands Act, Tidal Wetlands Act, and SEQR, represent the major regulations affecting freshwater wetlands. The Freshwater Wetlands Act, Article 24 of the Environmental Conservation Law, provides NYSDEC with the authority to regulate freshwater wetlands in the state (NYSDEC, 2004d). The Freshwater Wetlands Act protects wetlands larger than 12.4 acres in size by implementing a series of monitoring and permitting programs. Within the monitoring program, the NYSDEC is required to keep updated maps of all freshwater wetlands in the State and notify landowners of existing or emerging wetlands on their property. The permit programs examine any activities that have potential to significantly alter existing ecosystems.

Freshwater wetlands that are smaller than 12.4 acres in size are administered under Title 6 of the Codes, Rules and Regulations of the State of New York (6NYCRR, Part 644). The regulation states that wetlands of less than 12.4 acres in size may be registered on the NYSDEC wetland maps if they are of unusual local importance (Browne et al., 1995). On Long Island, significant freshwater wetlands smaller than 12.4 acres are identified by county, town and local municipalities for inclusion in the New York State register of freshwater wetlands (Janet Dietrich, Town of Huntington, personal communication, September 27, 2004).

1.2.3 Suffolk County

Suffolk County does not have direct responsibilities in regulating freshwater wetlands in New York State. However, the Suffolk County Department of Public Works, Division of Vector Control (SCVC), is responsible for controlling mosquito infestations that are of public health importance in fresh and saltwater wetlands. Under its charter for mosquito management, the County has a responsibility to manage these systems to minimize health impacts from these pests. These management activities consist primarily of ditch maintenance and chemical applications intended to alleviate the risks of mosquito-borne diseases (SCDPW, 2002).

1.2.4 Local Government

Through zoning regulations, local town and village governments in Suffolk County have a greater ability to impact the management of freshwater wetlands. Many local governments have established setbacks for development near wetlands in order to prevent degradation of these

resources. For example, in the Town of Brookhaven, a comprehensive plan incorporated the planning frameworks of local municipalities and recommended that land use development criteria be used to protect freshwater wetland systems. In addition, local governments can implement local open space initiatives that purchase sensitive freshwater wetlands and upland buffers. The Town of Brookhaven's Land Use Plan explicitly outlines a methodology for acquisition, restoration, and preservation of wetlands (Town of Brookhaven, 1996).

2. Freshwater Ecological Communities

Several types of ecological communities are found within freshwater wetlands. Differences in precipitation, ground water inflows and outflows, and tidal effects all play a role in defining wetland characteristics. Annual and seasonal variations in hydrological factors affect vegetation; thus, these factors are important for habitat classifications (Stewart and Springer-Rushia, 1998).

Ecologists divide wetlands into five broad categories: marine, estuarine, riverine, lacustrine, and palustrine. Marine and estuarine wetlands are associated with saltwater communities and are not included in freshwater ecosystems. The freshwater tidal marsh falls under the estuarine category as defined by Edinger et al. (2002), due to its connection to deepwater tidal habitats and adjacent tidal wetlands. For the purposes of this report, the freshwater tidal marsh will be treated as a freshwater system, despite the estuarine classification. Generalized freshwater wetlands as characterized by Edinger et al. (2002) and MacDonald and Edinger (2000) are shown in Appendix A.

2.1. Tidal

Freshwater wetlands falling under the tidal community definition include freshwater tidal marshes found at the mouth of tributaries of large tidal rivers systems (Edinger et al., 2002). These areas have waters with salinities less than 0.5 ppt and are normally less than 6 ft. deep. Freshwater tidal marshes can be divided into two sub-systems: low elevation, broad leaf emergent zone; and, higher, gramonoid zone. Indicative species of tidal freshwater wetlands include:

- spatterdock
- pickerel-weed
- narrowleaf cattail
- marsh wren
- red-winged blackbird

Freshwater tidal marshes can be found near the mouths of tidal rivers in Long Island.

2.2. Riverine

Freshwater wetlands falling under the riverine community definition include intermittent streams and coastal plain streams. Cowardin et al. (1979) defined riverine wetlands as the wetlands and deeper water habitats contained within a channel, except those that contain persistent emergent vegetation, trees, shrubs, or having more than 0.5 ppt salinity. Community types are generally classified by water flow rates, substrate composition, and faunal and vegetative species present (Holst et al., 2003). Plants found in riverine freshwater wetlands include:

- emergent and submergent bryophytes
- hydrophytic vascular plants
- submergent vegetation such as pondweeds and naiads

Common animals include:

- American eel
- eastern banded killifish
- Asiatic clams

Riverine freshwater wetlands are found along the streams and rivers of Suffolk County.

2.3. Lacustrine

Freshwater wetlands falling under the lacustrine community definition include coastal plain ponds and eutrophic ponds. Lacustrine wetlands are defined as the wetlands and deeper water habitats situated in a topographical depression or dammed river channel, lacking trees, shrubs, persistent emergent vegetation, and emergent mosses (Holst et al., 2003). Lakes and ponds falling under this category have low directional flow (Stewart and Springer-Rushia, 1998). Characteristic life found in lacustrine freshwater wetlands includes:

- white water-lily
- bladderwort, pondweed

- peat moss
- algae
- pickerel
- sunfish
- tiger salamander
- muskrat

Lacustrine freshwater wetlands can be found along streams and rivers (often formed by dams), where groundwater is perched along moraines, or where the water table has filled kettle holes or other isolated depressions throughout the County.

2.4. Palustrine

Freshwater wetlands falling under the palustrine community definition include a variety of swamps, marshes, and bogs. Palustrine wetlands are defined as non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, and lichens, in shallow waters generally no deeper than six feet (Cowardin et al., 1979). Palustrine freshwater wetlands found to occur in the Coastal Lowlands ecozone include:

- shallow emergent marshes
- shrub swamps
- coastal plain pond shores
- maritime freshwater interdunal swales
- Pine Barrens vernal ponds
- Pine Barrens shrub swamps
- coastal plain poor fens

- sea level fens
- highbush blueberry bog thickets
- red maple - black gum swamps
- vernal pools
- coastal plain Atlantic white cedar swamps
- pitch pine - blueberry peat swamps

2.4.1. Swamps

Swamps are characterized by a dense growth of tress in wet soil, peat or standing water (Stewart and Springer-Rushia, 1998). Water pH may range from very acidic to nearly neutral. A variety of swamps are found in Suffolk County and include:

- coastal plain Atlantic white cedar swamps
- pitch pine - blueberry peat swamps
- red maple - black gum swamps
- Pine Barrens shrub swamps

These swamps all have vegetation specific to their ecosystems; however, some generic species found throughout swamps systems include:

- Atlantic white cedar
- red maple
- pitch pine
- water-willow
- swamp azalea

- cinnamon fern
- black gum (tupelo)
- common yellowthroat
- American bittern
- alder flycatcher
- white-tailed deer

2.4.2. Marshes

In addition to several species of herbaceous plants, marshes are dominated by grasses, sedges, or rushes. Shrubs may also be present, but trees are often not found in this ecosystem. As a result, marshes are characterized as relatively open environments. Marshes may be further subdivided into: rich fens, which contain an abundance of nutrients, or poor fens, where nutrients are scarce. In Suffolk County, marshes include:

- shallow emergent marshes
- coastal plain poor fens
- sea level fens

Indicative life in freshwater marshes includes:

- herbaceous plants
- rushes
- sedges
- toads
- frogs
- great blue heron

- spotted turtle

2.4.3. Bogs

Bogs are highly acidic wetlands where peat accumulates due to the decay of plant material. In these habitats the peat is covered by a layer of sphagnum mosses. Due to a combination of low nutrients, high acidity, and low levels of dissolved oxygen, an unusual variety of herbaceous plants occupy this niche (Stewart and Springer-Rushia, 1998). An example of a bog in the Coastal Lowlands ecozone would be the highbush blueberry bog thicket. Bogs tend not to be as open as marshes due to a greater presence of shrubs. Indicative species found in bogs include:

- highbush blueberry
- cinnamon fern
- swamp azalea
- marsh St. John's-wort
- swamp sparrow
- meadow jumping mice
- southern red-backed vole
- green frog

3. Classification of Suffolk County's Freshwater Wetland Habitats

Suffolk County falls on the eastern half of Long Island, New York, an area formed primarily by continental glaciers that existed some 21,000 years ago (Stewart and Springer-Rushia, 1998). The northern portion of the island, the North Shore, was formed by terminal moraines of glacial till. Outwash plains formed in the southern portion of the island, where sediments were carried southward by melted glacial waters. The two forks on the eastern end of the island are thought to have been shaped by two different moraines.

Freshwater wetlands in Suffolk County are mapped in Figure 3.1.

As the glacial systems retreated north, a variety of freshwater wetlands were formed in the region. Kettlehole ponds and lakes formed on the north shore when large pieces of glacial ice were trapped under layers of sediment and subsequently melted, leaving large, water-filled depressions (Stewart and Springer-Rushia, 1998). In addition, the flowing waters of the outwash plain created numerous deltas and riverine systems, some of which exist today as streams and tidal rivers.

Due to the glacial composition of Suffolk County's freshwater wetlands, they have some characteristics not found elsewhere on the North American continent. The variety of soil types and glacial features create a high diversity of habitats and species, while the interaction with the region's coastal waters further add to the unusual nature of Suffolk County's freshwater wetland ecosystems. The combined influences of tidal systems and seasonal and annual freshwater inputs have led to highly adaptable plant and animal species rarely found elsewhere.

Different plant species can be found with each representative freshwater wetland community; however, there are some species that are found in a variety of systems. Plant and animal species common to multiple freshwater ecosystems in Suffolk County can be found in Appendix B (Stewart and Springer-Rushia, 1998).

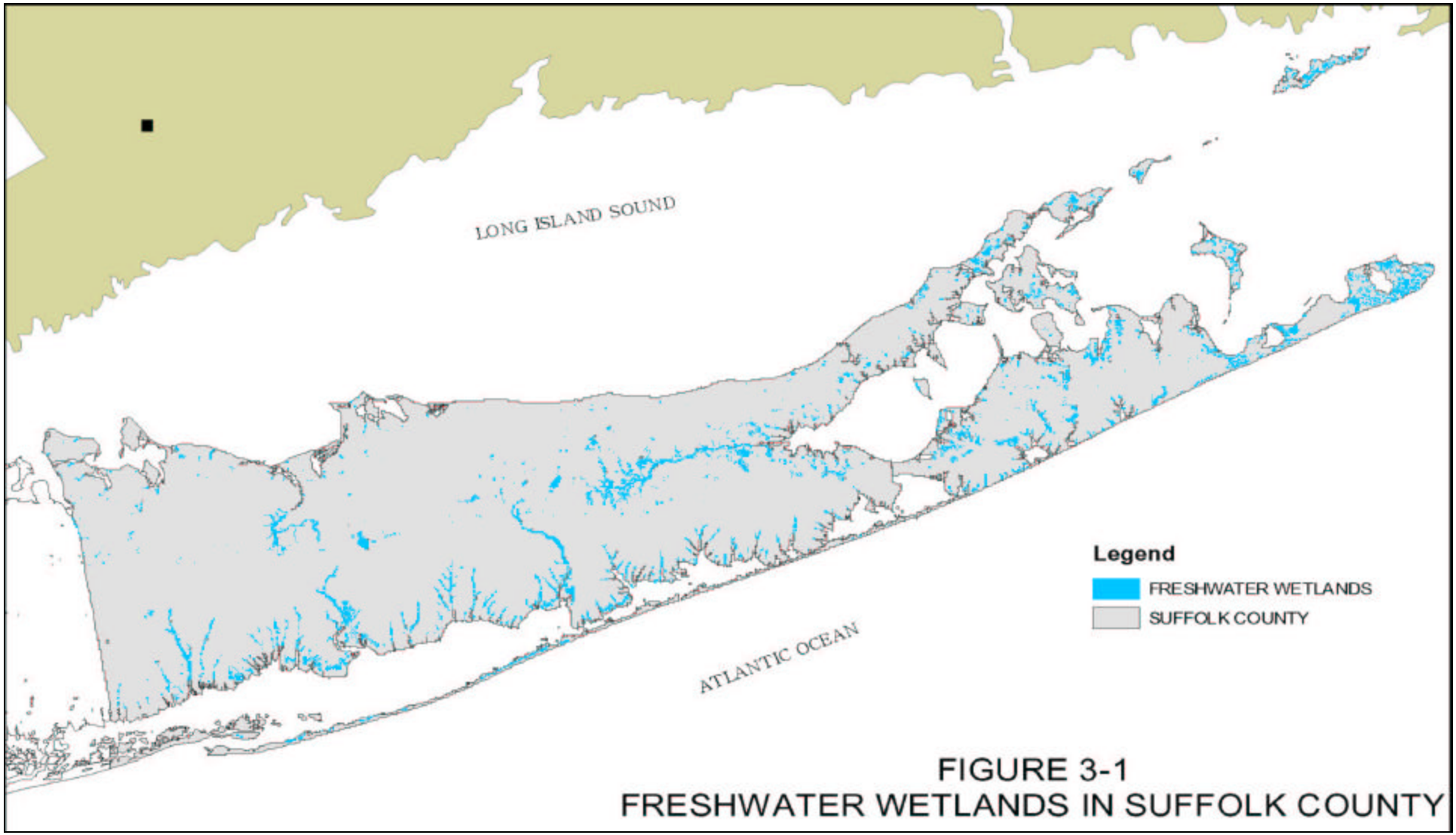

FIGURE 3-1
FRESHWATER WETLANDS IN SUFFOLK COUNTY

3.1 North Shore

The Suffolk County portion of the north shore extends from the Nassau–Suffolk County border eastward to Orient Point, located on the north fork. It is largely structured by moraine deposits. The moraines that created the hilly topography of the north shore also resulted in kettlehole ponds. The area is bounded by the Long Island Sound to the north and, thus, any streams in this area eventually combine with the salt water of the Sound. Freshwater wetlands found on the north shore include:

- freshwater tidal marsh
- intermittent stream
- coastal plain kettlehole pond
- eutrophic pond
- shallow emergent marsh
- shrub swamp
- highbush blueberry bog thicket
- red maple – black gum swamp

The Nissequogue River is the north shore's only major river, with its headwaters originating near Hauppauge. Hauppauge Springs and other groundwater-fed bodies of water can be found at the southernmost reaches of the River and freshwater marshes and swamps can often be found on their fringes (Native America, 2004). In vicinity of the Nissequogue are a variety of ponds including: A 15-acre pond adjacent to the former Kings Park Psychiatric Center; Willow Pond located in Caleb Smith Park; Webster Pond; Mill Pond; and Millers Pond.

Other minor streams flow down the steeply-sloped valleys into the north-south harbors, including streams at Cold Spring Harbor, Huntington Harbor, Centerport Harbor, Northport Harbor, Port Jefferson Harbor, and Stony Brook Harbor. Sewering or other channeling of streams was often the result of development. Such development often directly impacted or even

led to the loss of streams. Many of these watercourses may have been intermittent, flowing only under run-off conditions or when the groundwater table was elevated.

Lake Ronkonkoma is one of the largest kettlehole ponds in Suffolk County, with its depths reaching into the water table and tapping into a constant source of available freshwater. Spectacle Pond is located near Lake Ronkonkoma, as are other small kettleholes ponds such as Gould Pond. Other kettlehole lakes can be found throughout the north shore. Twin Ponds Nature Park near Route 25-A in Centerport is host to two freshwater ponds and streams and adjacent tidal freshwater marshes. Route 25, from the Nassau-Suffolk border east to the Greenlawn area, is often bordered by small, perched ponds in the folds and hollows of the hilly terrain. Other isolated ponds pock the landscape.

3.2 South Shore Outwash Plain

The south shore outwash plain community extends from the Nassau-Suffolk border east to the Carmans River and is bounded by the moraine to the north. This region's topography and geology is a product of meltwaters that carried sediments from the terminal moraines in the north to the bay and ocean to the south. As result, the area is typified by several deltas that have subsequently formed in the mouth of tidal rivers, streams and marshes throughout the region. The generally flat relief has a series of fluves carved into it – relict river valleys from the glacial melting, or floodings of glacial lakes dammed behind the moraines. In addition, the barrier islands to the south represent unique habitats that fall between the Great South Bay to the north and the Atlantic Ocean to the south. Freshwater wetland communities found in the south shore outwash plain include:

- freshwater tidal marsh
- coastal plain stream
- intermittent stream
- coastal plain pond
- shallow emergent freshwater marsh

- shrub swamp
- maritime freshwater interdunal swales
- red maple – black gum swamp
- vernal pool
- coastal plain Atlantic white cedar swamp
- pitch pine – blueberry peat swamp

Groundwater-fed streams are common on the south shore outwash plain and include (Dowhan et al., 1997a):

- Orowoc Creek
- Champlin Creek
- Connetquot River
- Swan River
- Beaverdam Creek

The Connetquot River, part of Connetquot River State Park, is a 4,500 acre, undeveloped coastal watershed system fed by several natural cold water streams to the north. A tidal freshwater marsh and red maple swamps can be found along the Connetquot River. The headwater of the Connetquot falls only 1.9 miles from the headwater of the Nissequogue River on the north shore and, thus, the two bodies of water form a nearly continuous habitat from the Great South Bay to the Long Island Sound.

Champlin and Orowoc Creeks represent two freshwater coastal streams that also are home to freshwater marshes upstream (Dowhan et al., 1997a). Several unique communities, including pitch pine swamps, peat bogs, and shallow ponds, can be found in this complex. Swan River and Beaverdam Creek are other examples of freshwater stream habitats occurring in the south shore

outwash plain. At the headwater of Yaphank Creek extensive emergent freshwater marshes have been observed.

Many streams located in the south shore outwash plain are dammed. As a result, several ponds and other lacustrine environments exist along these streams. There also exist some small ponds that appear in small depressions where the ground surface intercepts the water table. Many of these are not natural features, but were constructed to enhance local real estate values. This trend continues today.

3.3 Peconic River - Pine Barrens

The Peconic River – Pine Barrens community describes an area that stretches south and east from the headwaters of the Carmans River and Peconic River to the Shinnecock Canal. A rich diversity of freshwater habitats is associated with this region and several unique habitats occur in, and around, the Pine Barrens. Freshwater ecological communities found in the Peconic River – Pine Barrens community include (Long Island Pine Barrens Commission, 1995; Cashin Associates, 2004):

- coastal plain Atlantic white cedar swamp
- coastal plain stream
- coastal plain poor fen
- coastal plain pond
- coastal plain pond shore
- Pine Barrens shrub swamp
- red maple – black gum swamp
- intermittent stream
- shallow emergent marsh
- freshwater tidal marsh

Overall, the Peconic River – Pine Barrens system represents 4,300 acres of NYSDEC regulated freshwater wetlands with the Peconic River accounting for over 2,000 of those acres and the Carmans River covering nearly 1,000 acres (Long Island Pine Barrens Commission, 1995). The Carmans and Peconic Rivers, as with the smaller streams in this area, have been dammed to create ponds and lakes of various sizes. This means that many of the well-established habitats of the region are actually anthropogenic in nature.

Besides the two major river systems, another 162 mapped wetlands account for the remainder of the region's freshwater acreage with seven wetlands falling between 15 and 100 acres and the other 155 being smaller than 15 acres. The most common wetland found throughout the system is the red maple – black gum swamp (Long Island Pine Barrens Commission, 1995). A variety of coastal plain ponds and pond shores have unusual habitats, formed where water levels fluctuate greatly, and often having low levels of nutrients and high acidity. Examples of coastal plain ponds found within the Peconic River – Pine Barrens region include:

- Calverton Ponds
- Sweezy Pond
- Prestons Pond
- Fox Pond
- McKay Lake
- Overton Pond
- Currans Road South Pond
- Randall Road North Pond
- Lake Panamoka
- Artist Lake
- Coreys Pond

White cedar swamps, formerly extensive in the Peconic River – Pine Barrens region, have been reduced to a few scattered remnants due to historical logging and draining. The largest white cedar swamp remaining in Suffolk County occurs in Cranberry Bog County Park in Southampton Town between the Peconic River and Moriches Road (Long Island Pine Barrens Commission, 1995). In addition, Cranberry Bog County Park is also home to one of the largest coastal plain poor fen in Long Island.

Intermittent streams are found throughout the upper portions of the Peconic River and can be found adjoining red maple swamps, tussock-sedge marshes and wet meadows. These habitats are prevalent west of Wading River – Schulz Road (Cashin Associates, 2004). Pine barren shrub swamps may also be found in the uppermost reaches of the Peconic River – Pine Barrens watershed. Shallow emergent marshes are found on the edges of shallows of ponds, lakes, and streams within the region, while freshwater tidal marshes are often located in the tidal portions of the larger river systems, often in their tidal tributaries.

3.4 East End

The east end of Suffolk County can be divided into two distinct geographic areas. The North Fork lies to the north and east of Riverhead and the South Fork to the south and east of Riverhead. Moraines deposited during glacial periods shaped both forks. The Long Island Sound in the north and the Peconic Bay in the south border the North Fork, while the South Fork is bordered by the Peconic Bay to the North and the Atlantic Ocean to the south. In between, and to the east of, the two forks several major islands can be found including: Shelter Island, Gardiner's Island, Plum Island, and Fishers Island. Block Island also is in this general area, but is not part of Suffolk County.

The freshwater wetlands found on the North and South Forks are generally similar in nature. The following freshwater communities can be found in the east end of Suffolk County:

- coastal plain Atlantic white cedar swamp
- vernal pool
- red maple – black gum swamp

- highbush blueberry bog thicket
- sea level fen
- coastal plain poor fen
- maritime freshwater interdunal swales
- Pine Barrens shrub swamp
- coastal plain pond shore
- shrub swamp
- shallow emergent freshwater marsh
- eutrophic pond
- coastal plain pond
- coastal plain stream
- intermittent stream

The USFWS and others have identified several significant freshwater habitats on the east end of Suffolk County that include (Dowhan et al., 1997b):

- Long Pond Greenbelt
- South Fork Atlantic beaches
- Montauk Peninsula
- Mashomack Preserve

The Long Pond Greenbelt habitat is composed of a network of contiguous ponds, streams, wetlands, and adjacent upland woods along the south shore from Sagaponack Inlet to Sag Harbor on the Peconic Bay. Coastal plain ponds occurring between Bridgehampton and Sag Harbor include (Dowhan et al., 1997c):

- Poxabogue Pond
- Little Poxabogue Pond
- Slate Pond
- Black Pond
- Crooked Pond
- Long Pond
- Lily Pond
- Round Pond

This network of coastal plain ponds is connected by a series of freshwater streams that lead to a red maple – black gum swamp in its southernmost reaches near Sagaponack Pond. Also, found within this system are Pine Barrens shrub swamps, wetland shrub thickets, and coastal plain pond shore communities.

The Montauk Peninsula, the component of the east end region that is furthest east, is exposed to greatly different climatic conditions than western Suffolk County. Differences include moderated temperatures, higher winds, and greater precipitation. Within the region, several types of freshwater wetlands can found including: coastal plain ponds, intermittent streams, maritime freshwater interdunal swales, maritime heathlands, and red maple – black gum swamps (Dowhan et al., 1997d). Little Reed Pond is a transitional habitat between brackish and freshwater, while Big Reed and Fort Ponds are freshwater coastal plain ponds. Napeague beach contains one of the largest remaining areas of undeveloped beach on Long Island with extensive dunes and maritime interdunal swale habitats.

The South Fork Atlantic Beach community is identified as the area between the eastern end of Shinnecock Bay and the Amagansett National Wildlife Refuge in East Hampton. This area of Suffolk County is unique in that the coastal areas are connected directly to the mainland and are not separated by barrier beaches, as is much of western Suffolk County and Long Island. As a result, the Atlantic Beach complex contains several backbarrier freshwater coastal plain ponds

and maritime freshwater interdunal communities (Dowhan et al., 1997e). The backbarrier coastal plain ponds of the complex include:

- Halsey Neck Pond
- Coopers Neck Pond
- Agawam Lake
- Old Town Pond
- Wickapogue Pond
- Phillips Pond
- Sayre Pond
- Jule Pond
- Channel Pond
- Wainscott Pond
- Lily Pond

Mashomack Preserve on Shelter Island falls between the North and South Forks of the east end. Mashomack is a natural area of over 2,000 acres that was preserved by the Nature Conservancy in 1980 (Shelter Island, 2004). Mashomack contains a variety of freshwater habitats including: coastal plain streams, freshwater tidal marshes, and pitch pine swamps. The Pine Swamp complex at the western edge of the Preserve is designated a freshwater wetland of unique local importance by the NYSDEC.

Salt marshes along the Peconic Bay system on both forks often grade into freshwater wetlands along their upper reaches. There are no major stream systems draining these narrow peninsulas, but small, groundwater-fed streams are occasionally found at the upland edge of the salt marsh systems. In one or two cases, the freshwater portion of a coastal marsh system has been isolated

tidally by roads or other impoundments. It is not clear if these wetlands were originally dominated by salt marsh or fresh marsh prior to the restriction of tidal flows.

4. Ecological Case Studies

4.1 Red Maple – Black Gum Swamp: Upton Ecological Research Reserve

Upton Ecological Research Reserve contains a red maple – black gum swamp with characteristics indicative of this habitat type throughout Suffolk County. Red maple – black gum swamps often occur in inorganic soils, within poorly drained depressions similar to the one found at Shultz Road in Upton (Cashin Associates, 2004). The red maple – black gum swamp in the Upton Ecological Reserve is shown in Figure 4.1.

The red maple – black gum swamp occurs on the narrow transitional zone between the headwaters of the Peconic River and adjacent Pine Barrens uplands and occupies a poorly-drained topographic depression (Cashin Associates, 2004). The soils of the marsh are saturated organic muck with *Sphagnum* mosses appearing on the drier fringes.

This community may be anthropogenic in origin, as the construction of dams on the Peconic River may have elevated the water table in the vicinity of the current swamp, thus, causing the saturated soils. These dams are not recent features, dams along the Peconic River were installed beginning in the 1600s, and the swamps are well integrated into the landscape.

Plant species found in the red maple – black gum swamp of the Upton Ecological Research Reserve include 17 well known species of plants and 8 well-known species of animals. A detailed list of the plant and animal species found in the red maple – black gum swamp of the Upton Ecological Research Reserve can be found in Appendix C.

4.2 Coastal Plain Pond: Long Pond Greenbelt

The Long Pond Greenbelt contains 12 coastal plain ponds within the habitat complex. The Natural Heritage Program considers each individual waterbody within the complex to be an excellent, or good, representation of this community type in New York State (Dowhan, 1997c). Crooked Pond is considered one of the best representations of a coastal plain pond in the greenbelt with high plant diversity, while Long Pond and Little Long Pond are also very good examples. The coastal plain ponds in the Long Pond Greenbelt are shown in Figure 4.2.

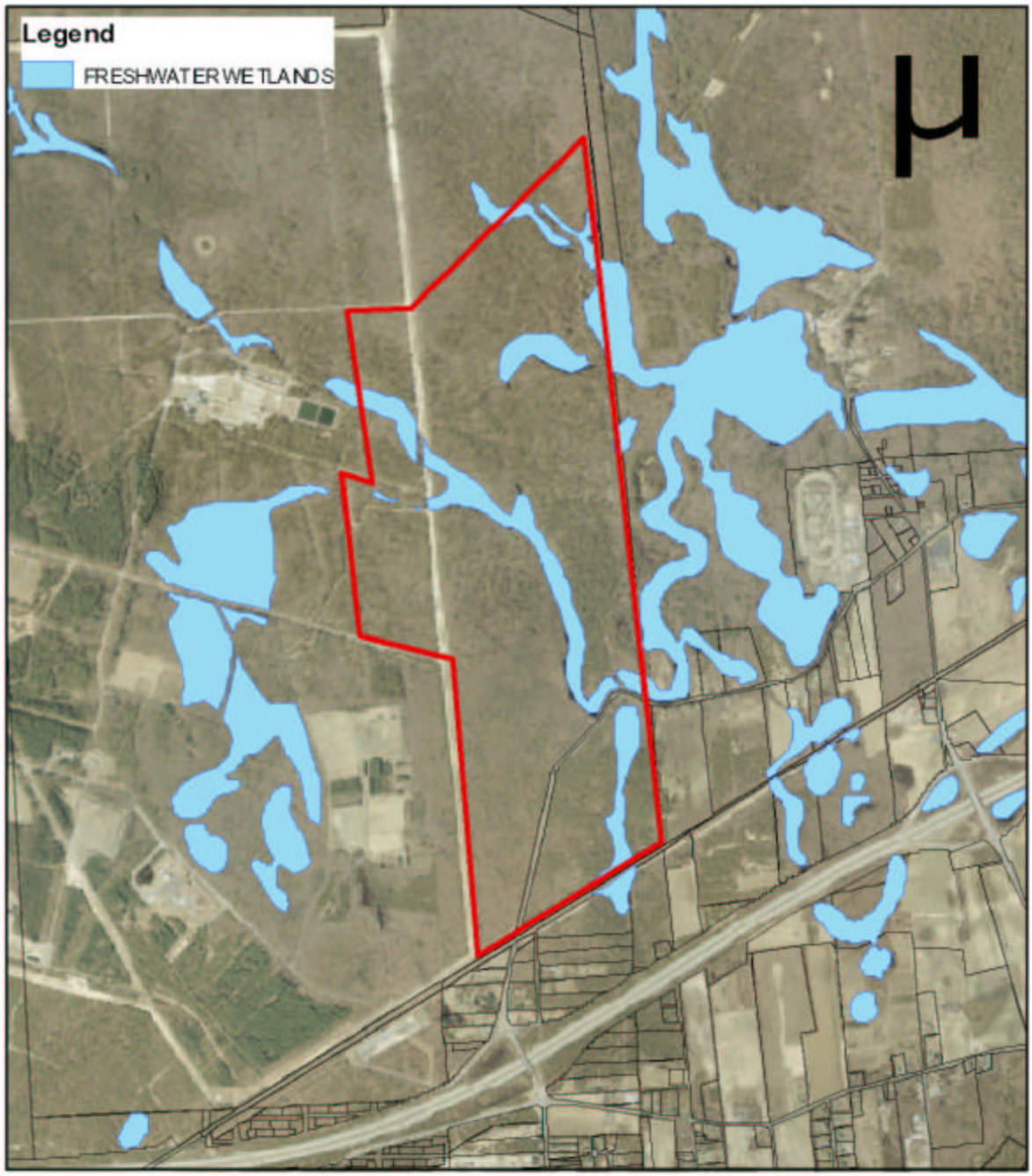

FIGURE 4-1
RED MAPLE - BLACK GUM SWAMP
UPTON ECOLOGICAL RESEARCH RESERVE

The coastal plain ponds of the Long Pond Greenbelt are characterized by gently sloping shores occurring in shallow kettlehole depressions. The ponds are groundwater fed, with water levels that fluctuate seasonally and annually with the height of the water table. Fluctuating water levels lead to a variety of transitional habitats adjacent to the coastal plain ponds including: pitch pine – oak forest, shrub swamps, coastal plain pond shores, and wetland shrub thickets (Dowhan, 1997c). As with many marginal communities, they seem less well-established and more at-risk from relatively moderate changes in surrounding environments.

Several plants are associated with the Long Pond Greenbelt freshwater coastal plain pond communities and at least 13 species are known to exist (Dowhan, 1997c). In addition, a variety of animal species are associated with the Long Pond Greenbelt coastal plain pond system including 30 well know species (Dowhan, 1997c). A total of 88 bird species have also been observed in the Long Pond Greenbelt including the State-listed endangered least tern and the State-listed threatened osprey. Detailed information on the plant and animal species found in the Long Pond Greenbelt's freshwater communities can be found in Appendix C.

4.3 Managed System: Mastic - Shirley Peninsula

The Mastic – Shirley Peninsula is a highly developed and managed habitat that lies between the Pine Barrens to the north, the Great South Bay to the south, and the south shore outwash plain to the west. The Mastic – Shirley peninsula is comprised primarily of sediment that was deposited from meltwaters of the Wisconian ice sheet and is considered part of the outwash plain (Cashin Associates, 2003). The Mastic – Shirley habitat complex includes areas of:

- freshwater tidal marsh
- coastal plain streams
- intermittent streams
- coastal plain ponds
- red maple – black gum swamp

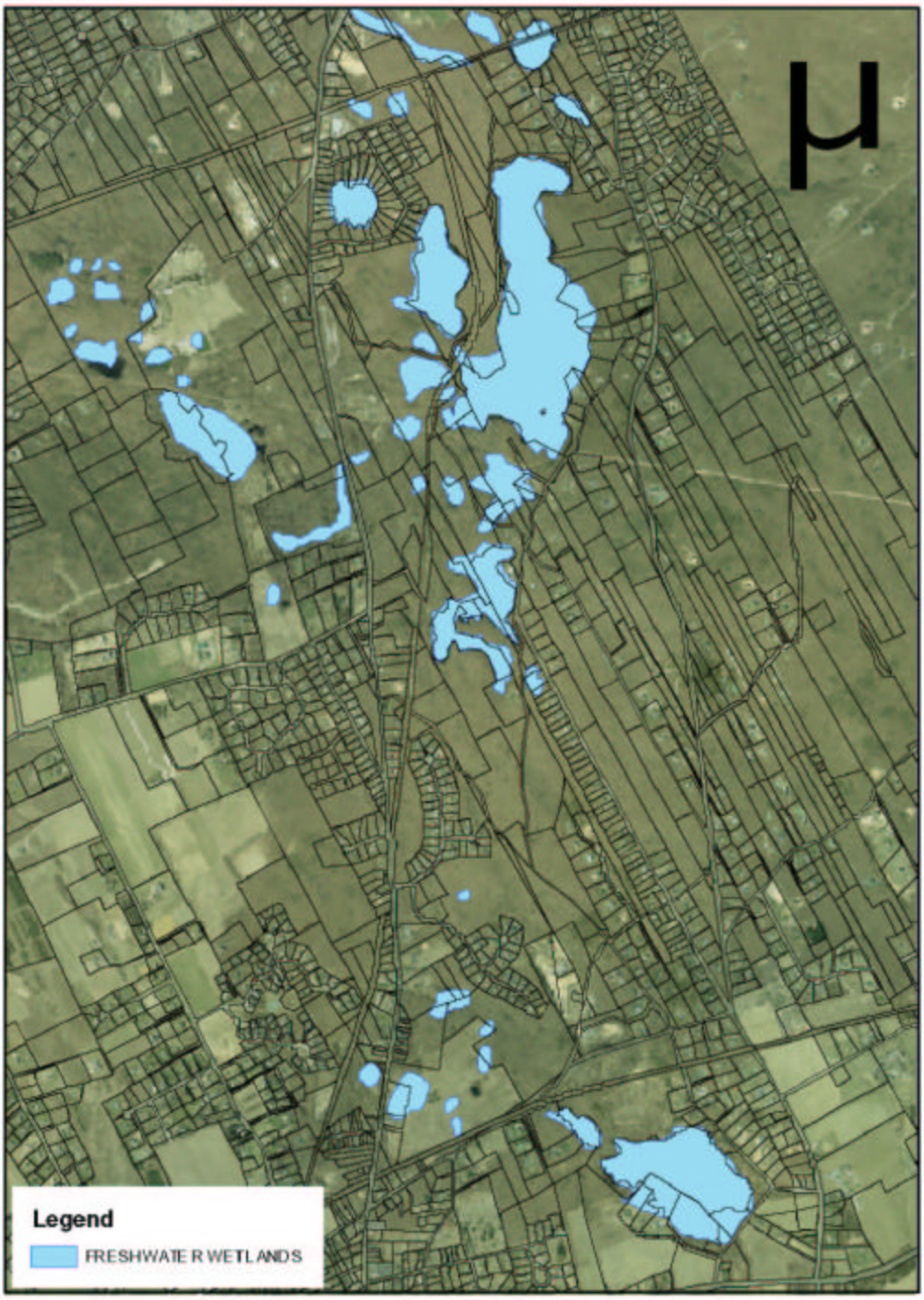

FIGURE 4-2
COASTAL PLAIN POND
LONG POND GREENBELT

The wetlands within this system are constrained by surrounding roadways and developed lots. The freshwater wetlands have been ditched, culverts augment their drainage systems, and they often serve as stormwater receptacles, as overflows from catch basins or roadside gutters. Their capacity to absorb run-off is limited, therefore, widespread flooding occurs in this area following even moderate rainfalls. The ditches are maintained for mosquito control purposes, and the culvert/catch basin systems are frequently serviced due to the frequent flooding events. The densely developed neighborhoods depend on individual septic systems, and so these groundwater-fed wetlands are probably impacted by septic nutrients, as well as roadway runoff. Not surprisingly, these wetlands often contain dense stands of phragmites. The managed system of the Mastic – Shirley Peninsula is shown in Figure 4.3.

NYSDEC mapped freshwater wetlands in the region include:

- tidal wetlands within the William Floyd Estate
- tidal wetlands at the head of Unchachogue
- Johns Neck
- Pattersquash Creek
- Home Creek
- an extensive network of wetlands in the Mastic Beach area, between Pattersquash Creek and Lawrence Creek just south of Dogwood Road

Plant species identified in the freshwater habitats of the Mastic – Shirley Peninsula include 35 well known species. A full listing of species associated with the Mastic – Shirley Peninsula can be found in Appendix C.

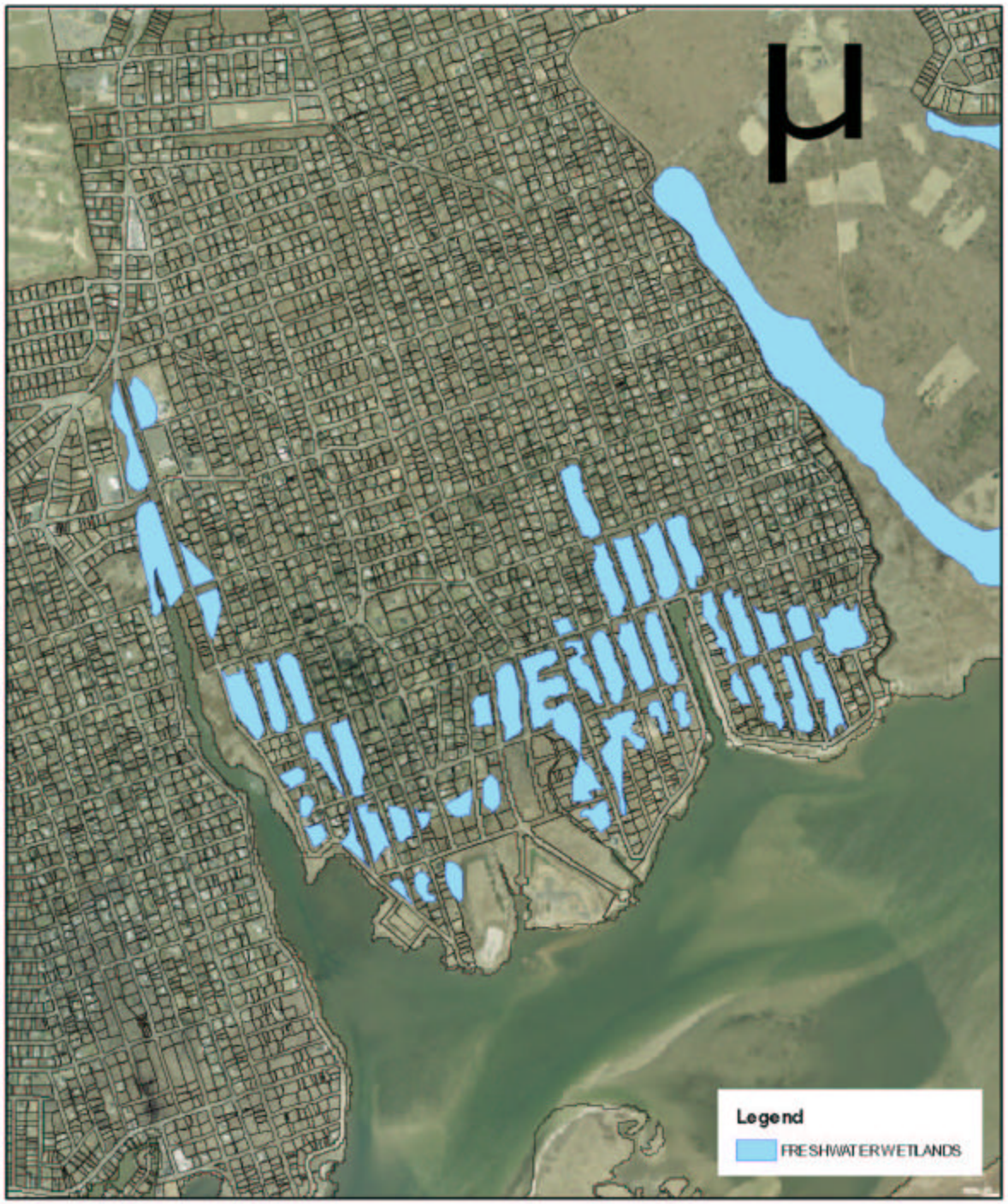

FIGURE 4-3
MANAGED SYSTEM
MASTIC-SHIRLEY PENINSULA

5. Mosquito Species of Suffolk County's Freshwater Wetlands

Mosquitoes utilize wetland habitat for a variety of functions including breeding, feeding, and overwintering. After hatching from an egg, a mosquito develops in an aquatic environment as an air-breathing, filter feeder and undergoes metamorphosis through four larval stages prior to becoming a non-feeding pupa. Mosquitoes become capable of flight after emerging from the pupal stage. Males and females tend to feed on plant nectars to fulfill daily energy needs; however, in almost all mosquito species the female requires a blood meal for her eggs to mature. Most species have general preferences of prey for blood, while some species' preferences are quite specific.

All mosquitoes require damp to wet conditions to lay their eggs. Univoltine species reproduce once a year, while multivoltine species lay eggs that hatch at various times throughout the year. Desiccation tolerant mosquitoes require that their eggs dry out prior to further development and tend to hatch in "broods" as conditions result in eggs developing at the same time. The eggs of desiccation intolerant mosquitoes do not dry out and often hatch in a more diffuse manner. Some mosquitoes prefer organically polluted water as breeding sites, some species actually require it, such as *Cx. pipiens* and *Cx. restuans,* while others can tolerate, or need, salt water.

Approximately forty-two different mosquito species actively breed in Suffolk County, New York (CA/CE, 2004a). This includes a variety of mosquito genera and species with a wide range of adult and larval habitat preferences. Thirteen species representing six genera may inhabit the freshwater wetlands in the region and are identified as being of importance to the SCVC (Dominick. Ninivaggi, SCVC, personal communication, September 28, 2004). Table 5.1 illustrates major mosquito species likely to inhabit freshwater wetlands in Suffolk County and their associated habitat preferences (CA/CE, 2004).

Table 5.1 Freshwater Mosquito Species of Suffolk County and Habitat Preferences

Species	Habitat Preferences	Estimated flight range
Aedes vexans	Fresh floodwater, upper salt marsh	5-10 miles
Anopheles quadrimaculatus	Freshwater swamps, brackish water swamps, standing polluted water, containers	Less than 1 mile
Culex pipiens/ restuans	Freshwater swamps, brackish water swamps, standing polluted water, containers, catch basins	1-2 miles, usually much less
Culex salinarius	Fresh floodwater, upper salt marsh floodwater, brackish water swamps, containers	1-2 miles, usually much less
Culex territans	Freshwater swamps with clean water and abundant herptilian populations	Less than 1 mile
Culiseta melanura	Red maple – black gum and Atlantic white cedar swamps, fresh floodwater, containers	5 miles
Coquillettidia perturbans	Woodland pools, emergent marshes, freshwater swamps, roadside ditches with emergent vegetation	1-2 miles or more
Ochlerotatus stimulans	Woodland pools, freshwater swamps, roadside ditches	Less than 1 mile
Oc. abserratus	Red maple – black gum swamps, bogs, woodland pools, roadside ditches	Less than 1 mile
Oc. trivittatus	Fresh floodwater, upper salt marsh floodwater, recharge areas	Less than 1 mile
Oc. canadensis	Fresh floodwater, especially woodland pools	Less than 1 mile
Oc. triseriatus	Fresh floodwater, saltmarsh floodwater, tree holes, containers	Less than 1 mile

The discussions that follow, except where noted, are drawn from CA/CE, 2004.

5.1 *Aedes*

Aedes vexans is a multivoltine, freshwater, desiccation tolerant mosquito. It is often found to utilize fresh floodwater habitats in Suffolk County and prefers less salty environments when compared to *Oc. sollicitans*. *Aedes vexans* lays it eggs in ground depressions inundated by fresh floodwaters and its broods tend not to emerge as frequently as *Oc. sollicitans*, often occurring in response to rainfall or river flooding. *Ae. vexans* is an aggressive biting mosquito that can fly large distances from its breeding place. Species that have similar life-cycles to *Aedes vexans* include:

- *Ps. ciliata*
- *Ps. howardi*
- *Oc. trivittatus*
- *Ps. columbiae*
- Ps. *Ferox*

5.2 *Anopheles*

Anopheles quadrimaculatus is a species of continuous breeders that lay their desiccation intolerant eggs in pristine, freshwater swamp habitats. Typical breeding habitats are similar to those inhabited by *Oc. abserratus*, however, *An. quadrimaculatus* is normally found in these environs later in the breeding season. Larvae often develop in freshwater swamps in bogs and multiple generations are produced annually. *An. quadrimaculatus* is also known as the species most likely to transmit malaria in Suffolk County. Similar species found in Suffolk County include *Cx. Territans* and *Ur. Sapphirinna.*

5.3 *Culex*

Culex pipiens and *Cx. restuans* are difficult to differentiate, and so are often grouped as "*Culex spp.*" These mosquitoes are multivoltine, desiccation tolerant mosquitoes. They breed primarily in polluted freshwater environments and do not travel far. They will also breed in drainage structures, septic ditches, and polluted ponds or puddles. Larvae thrive in polluted water habitats

with high organic content such as rotting vegetation, decaying animal wastes and septic seepage. They are not aggressive feeders on humans and, apparently, prefer to feed on birds.

Culex salinarius is a multivoltine, salt tolerant, mosquito that lays desiccation intolerant eggs in brackish or fresh water habitats. Larvae hatch after being deposited in standing waters from lunar tides. *Culex salinarius* is capable of breeding in freshwater habitats, but generally reach greatest concentrations in areas closer to the coast.

The frog feeding mosquito, *Culex territans,* is a herptilian feeder that obtains most of its blood meals from amphibian hosts. The mosquito breeds in pristine, freshwater swamps and bogs where frogs are common and emerges from hibernation earlier than most mosquito species to take advantage of the large populations of frogs that breed early in the year. Other mosquito species known to have similar life cycles in Suffolk County include *An. quadrimaculatus and Ur. sapphirinna.*

5.4 *Culiseta*

Culiseta melanura is a multivoltine, freshwater, desiccation intolerant mosquito. Eggs are laid directly on the water and larvae develop in swamps and bogs. Larvae of the species overwinter in cedar and red maple swamps of Suffolk County. The larvae are frequently found in "crypts" under the roots of trees. *Culiseta melanura* feeds exclusively on birds.

Recent studies indicate that the population of *Culiseta melanura* may be increasing rapidly in the region. This is thought to be due to a significant rebound in the numbers of red maples present throughout Suffolk County. Red maple populations were observed to be well below normal in the earlier half of the twentieth century due to logging and clearing activities. The hurricane of 1938 subsequently cleared many of the remaining red maples and other swamp species on Long Island and throughout New England. Recent decades, with the legal protections now afforded to freshwater wetlands, have seen red maples grow to maturity. Mature trees have more, and larger, crypts in their root areas. *Cs. melanura* uses the crypts under the roots of these trees for overwintering habitat. It follows then that increases in habitat and populations of *Cs. melanura* could be a significant factor in the recent increases in incidences of Eastern equine encephalitis

(EEE) in the northeast US, because *Cs. melanura* serves as the amplification vector of EEE (A. Spielman, Harvard School of Public Health, personal communication, 2004).

5.5 *Coquillettidia*

Coquillettidia perturbans is a univoltine, freshwater, desiccation intolerant mosquito. Its larvae attach themselves to the roots of emergent vegetation. The mosquito overwinters as larvae in various stages of development. It appears to generate broods, however, scattered emergences from freshwater swamps signal the timing associated with the different instars of the overwintering larvae. It can migrate several miles in search of a blood meal.

5.6 *Ochlerotatus*

Ochlerotatus stimulans is a univoltine species that utilizes woodland pool habitats. *Oc. stimulans* lays desiccation tolerant eggs in ground depressions in wooded areas and larvae develop in woodland pool habitats. Larvae are often found in a variety of leaf-lined, vernal pools that are flooded by a combination of spring rains and snow melts.

Ochlerotatus abserratus is a univoltine species found in swamps and bogs throughout Suffolk County. It is characterized by having desiccation tolerant eggs that are laid above the water line in saturated soils and larvae that develop in palustrine ecosystems. Often the species is found in specific swamp habitats such as red maple – black-gum, cattail, or sphagnum swamps.

Ochlerotatus trivittatus has a life-style akin to *Ae. vexans*, and so is a multivoltine, desiccation tolerant mosquito. It breeds in freshwater environments, and is especially common in recharge basins that retain water intermittently. It is an aggressive biter of people, but has a short flight range.

Ochlerotatus canadensis is a freshwater, desiccation tolerant mosquito that emerges in early spring, however, it may have additional broods in the summer. Eggs are laid in a variety of transient and permanent water environments and larvae develop in a wide variety of freshwater habitats. In some years, if heavy rains re-flood their freshwater wetland habitats, the species will experience multiple broods. *Oc. canadensis* does not venture far from its larval habitat, but has been described as a fierce biting mosquito.

Ochlerotatus triseriatus is a multivoltine, freshwater desiccation tolerant mosquito. *Oc. triseriatus* deposits it eggs in bands just above the waterline in natural and manmade containers. It typically uses abandoned tires, the anthropogenic equivalent to natural tree holes, as habitat, and prefers polluted waters. It does not fly far from its breeding points.

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APPENDIX A:

Freshwater Wetlands Found

in the Coastal Lowland Ecozone

APPENDIX A: Freshwater Wetlands Found in the Coastal Lowlands Ecozone: Adapted from Edinger et al. (2002) and MacDonald and Edinger (2000)

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
TIDAL					
Freshwater Tidal Marsh	Marsh community at mouth of large tidal river systems.	*Low elevation, broad leaf emergent zone:* spatterdock, pickerel-weed, arrowleaf, fowl mannagrass, narrow leaf arrowheads, mud-plantain. *Higher, gramonoid zone:* narrowleaf cattail, river bulrush, bur-reed, wild rice, blue flag.	Marsh wren, red-winged blackbird, swamp sparrow, Virginia rail, song sparrow, yellow warbler, least bittern, American goldfinch, willow flycatcher, common yellowthroat.	Tidal rivers of Long Island.	Mouth of Carmans and Peconic Rivers.
RIVERINE					
Intermittent Stream	Small, intermittent or ephemeral streambed in uppermost portions of stream systems.	Emergent and submergent bryophytes *(Bryhnia novae-angliae, Bryum psuedotriquertrum).* Hyrdophytic vascular plants: water-carpet, pennywort.	Green frog, northern two-lined salamander, water striders, water boatman, caddisflies, mayflies, stoneflies, midges, blackflies, crayfish.	Throughout Coastal Lowlands ecozone.	Upper headwaters of Carmans and Peconic Rivers. Small streams and tributaries affected by seasonal fluctuations in groundwater levels.

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
Coastal Plain Stream	Slow-moving, darkly-stained, streams of coastal plain.	Submergent vegetation: pondweeds, naiads, waterweeds, stonewort, bladderwort, duckweed, Tuckerman's quillwort, white water-crowfoot, watercress.	American eel, redfin pickerel, eastern banded kilifish, pumpkinseed, banded sunfish, swamp darter, Asiatic clam, large mouth bass, black crappie, yellow perch, chain pickerel, muskrat, mink.	Throughout Coastal Lowlands ecozone.	Carman's River, Peconic River.
LACUSTRINE					
Costal Plain Pond	Permanently and semi-permanently flooded portion of coastal plain pond that occur in kettle-holes and shallow depressions in outwash plain.	Aquatic vegetation: water-shield, white water-lily, bayonet-rush, spikerush, bladderworts, water milfoil, naiad, waterweed, pondweed, pipewort, brown-fruited rush, golden-pert, peat moss.	Chain pickerel, brown bullhead, banded sunfish, eastern mudminnow, tiger salamander, painted turtle, wood duck, muskrat.	Throughout Coastal Lowlands ecozone.	Crooked Pond, Scoys Pond, Kents Pond, Weeks Pond, Robert Cushman Murphy Pond Assemblage.

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
Eutrophic Pond	Small, shallow water, nutrient-rich pond. Winter stratified monomictic.	Aquatic vegetation: coontail, duckweeds, waterweed, pondweeds, water starwort, bladderworts, naiad, tapegrass, algae, white water-lily.	Warmwater fishes, odonates, leeches, phytoplankton, zooplankton, rotifers.	Throughout Coastal Lowlands ecozone.	Information Needed
PALUSTRINE					
Shallow Emergent Freshwater Marsh	Marsh community that occurs in mineral or deep muck soils. Saturated and seasonally flooded.	Herbaceous plants: bluejoint grass, cattails, sedges, marsh fern, manna grasses, spikerushes, bulrushes, three-way sedge, goldenrods, loosestrifes. Also, blue flag iris, sensitive fern, common skullcap, rough alder, water willow, shrubby dogwoods.	Eastern American toad, northern spring peeper, green frog, northern redback salamander, red-winged blackbird, marsh wren, common yellowthroat.	Throughout Coastal Lowlands ecozone.	Information Needed

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
Shrub Swamp	Inland wetland dominated by tall shrubs that occurs adjacent to lakes and rivers.	Alder, red osier dogwood, silky dogwood, water-willows, buttonbush, meadow sweet shrub, steeple-bush shrub, swamp azalea, highbush blueberry, sweet pepperbush, inkberry, leatherleaf.	Common yellowthroat, American bittern, alder flycatcher, willow flycatcher, Lincoln's sparrow.	Throughout Coastal Lowlands ecozone.	Along edges of kettlehole ponds in the coastal plain and edges of Peconic River wetlands.
Coastal Plain Pond Shore	Gently sloping shore of coastal plain pond with sandy or gravelly substrate and fluctuating water levels. Divided into four zones: upper wetland shrub thicket; upper, low herbaceous fringe; sandy exposed pond bottom; organic exposed pond bottom.	*Upper wetland shrub thicket*: Pine Barrens shrubs, highbush blueberry bog thickets. *Upper, low herbaceous fringe*: peat moss, yellow-eyed grass, narrow leaved goldenrod. S*andy exposed pond bottom*: beakrushes, nutrush. *Organic exposed pond bottom*: bald-rush, pipewort, gratiola.	Eastern painted turtle, muskrat, dragonflies, damselflies, chain pickerel, bluets, eastern mudminnow, tiger salamander, banded sunfish.	Coastal Lowlands ecozone on Long Island.	Peasy's Pond, Crooked Pond and Long Pond, House Pond and Division Pond, Peconic River Headwaters, Sears Bellows County Park, Long Pond Greenbelt.

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
Maritime Freshwater interdunal Swales	A mosaic of wetlands occurring in low areas between dunes along the Atlantic coast.	Twig-rush, cyperus, marsh rush, round-leaf sundew, threadleaf sundew, cranberry, stiff yellow flax, bladderwort, slender yellow-eyed grass, bayberry, sweet gale, highbrush blueberry.	Information Needed	Near the Seacoast in the Coastal Lowlands ecozone.	Napeague Dunes, Atlantic Double Dunes, Walking Dunes.
Pine Barrens Vernal Pond	Seasonally fluctuating, groundwater-fed pond and associated wetland that typically occur in kettleholes depressions or inland outwash plains within Pine Barrens.	Pondweeds, woolgrass, soft rush, tussock sedge, marsh St. John's-wort, cinnamon fern, marsh fern, Virginia chain fern, mosses, highbush blueberry, winterberry, leatherleaf, buttonbrush, black chokeberry, black huckleberry, mountain holly, meadow sweet, red maple, gray birch, pitch pine, quaking aspen.	Eastern American toad, northern spring peeper, green frog, wood frog, eastern spadefoot toad, Fowler's toad, Jefferson salamander, spotted turtle, common snapping turtle, red-winged blackbird, common yellowthroat, beetles, water striders.	Pine Barrens of Coastal Lowland ecozone.	Information Needed

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
Pine Barrens Shrub Swamp	Shrub dominated wetland that occurs in shallow depressions in the coastal plain.	Highbush blueberry, inkberry, male-berry, fetterbush, sweet pepper-bush, staggerbush, red chokeberry, bayberry, swamp azalea, leatherleaf, dwarf huckleberry, sheep laurel, large cranberry, dangleberry, Virginia chain fern, cinnamon fern, marsh fern, tussock sedge.	Information Needed	Coastal Lowlands Ecozone.	Peconic Headwaters Wetlands, Sears Bellows Wetlands.
Coastal Plain Poor Fen	Weakly minerotrophic peatland that occurs on the coastal plain, primarily with substrate of peat.	Mosses of *Sphagnum* species; shrubs including hardhack, leatherleaf, large cranberry, water willow, sweet gale, and dwarf huckleberry; herbs including twig-rush, sedges, beakrushes, rushes, cottongrass, sundews, marsh St. John's-wort,	Spotted turtle, red backed salamander, common snipe, great blue heron, green frog, bull frog, painted turtle.	From Nissequogue River and central south shore to Montauk Point. Best developed on Roanoke Point outwash plain and Ronkonkoma Moraine.	Jones Pond, Cranberry Bog, Fresh Pond, Quogue Wetland, Bow Drive Marsh.

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
		bladderworts, swamp loosestrife.			
Sea Level Fen	Small Patch sedge-dominated fen community that occurs in the upper edge of salt marsh. These fens are fed by freshwater seepage and thus palustrine.	Spikerush, twig-rush, three-square, sedge, slender blue flag, Canada rush, white beakrush, Canadian burnet, wild germander, poison ivy, large cranberry, red cedar, pitch pine, bayberry, groundsel-tree, salt-marsh elder, reedgrass.	Information Needed	Restricted to upper estuarine portion of Coastal Lowlands ecozone. Known examples confined to Peconic Bay region, although example are expected to occur in bays of south shore.	Northwest Creek, Little Northwest Creek, Hubbard Creek Marsh, Napeague Meadow, Heckscher State Park.
Highbush Blueberry Bog Thicket	Ombrotrophic or weakly minerotrophic peatland with nutrient-poor and acidic waters.	Highbush blueberry, winterberry, cinnamon fern, marsh fern, swamp azalea, ed chokeberry, maleberry, fetterbush, sweet pepperbush, water willow, buttonbush, marsh St. Johns-wort, sedges,	Common yellowthroat, swamp sparrow, song sparrow, meadow jumping mouse, masked shrew, southern red-backed vole, green frog.	Throughout Coastal Lowlands ecozone.	Sears Bellow Wetlands, Hither Hills North.

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
		Virginia chain fern, pitch pine, Atlantic white cedar, peat mosses.			
Red Maple - Black Gum Swamp	Maritime, coastal or inland hardwood swamp that occurs in poorly drained depressions, sometimes in a narrow band between a stream and upland.	Red maple, black gum, pitch pine, sweet pepperbush, highbush blueberry, swamp azalea, fetterbush, dangleberry, inkberry, greenbrier, sawbrier, Virginia creeper, poison ivy, cinnamon fern, skunk cabbage, netted chain fern, mosses.	Vireos, warblers, thrushes, white-tailed deer.	Throughout Coastal Lowlands ecozone.	Connetquot River Watershed, Lower Peconic River.
Vernal Pool	Aquatic community of one or more associated intermittently to ephemerally ponded, small, shallow depressions.	Predominately hydrophytic, combination of obligate and facultative wetland species. Mannagrass, spikerush, water purslane, naiad, duckweed, water-hemlock, bryophytes, featherfoil.	A variety of salamanders, fairy shrimp, red-spotted newt, spring peeper, gray tree frog, American toad, painted turtle, spotted turtle, snapping turtle, fingernail clams, snails, water scorpions, diving beetles, whirligig	Throughout Coastal Lowlands ecozone.	Information Needed

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
			beetles, dobsonflies, caddisflies, dragonflies, mosquitoes, leeches.		
Coastal Plain Atlantic White Cedar Swamp	A conifer or mixed swamp that occurs on organic soils along streams and in poorly drained depressions of the coastal plain.	Atlantic white cedar, red maple, black gum, pitch pine, sweet pepperbush, highbush blueberry, swamp azalea, inkberry, dangleberry, black huckleberry, sheep laurel, black chokeberry, cinnamon fern, marsh fern, wintergreen, sundew, pitcher plant, sundews, bladderworts, mosses.	Hessel's hairstreak moth.	Restricted to the Coastal Lowlands ecozone.	Cranberry Bog County Park
Pitch Pine - Blueberry Peat Swamp	A conifer swamp that occurs in shallow depressions in sand plains where peat has accumulated over a poorly drained sandy	Pitch pine, gray birch, red maple, highbush blueberry, sheep laurel, blueberry, wild raisin, black chokeberry, peat mosses, wintergreen, bracken fern, bunchberry, Canada mayflower, swamp	Information Needed.	Pine Barren of Coastal Lowland ecozone.	Information Needed

Wetland Type	Description	Characteristic Plants	Characteristic Animals	Distribution	Examples
	soil.	dewberry, bulrush.			

APPENDIX B:

Plant and Animal Species Common to

Multiple Freshwater Ecosystems in Suffolk County

APPENDIX B: Plant and animal species common to multiple freshwater ecosystems in Suffolk County (Stewart and Springer-Rushia, 1998).

Plant Species:

Atlantic white cedar	sheep laurel
red maple	swamp loosestrife
weeping willow	skunk cabbage
pitch pine	sundew
swamp azalea	spikerush
broad leafed arrowhead	common reed
common bladderwort	marsh fern
highbush blueberry	*sphagnum* mosses
yellow-eyed grass	

Animal Species:

white-tailed deer	painted turtle
Muskrat	northern water snake
red-winged blackbird	red spotted newt
northern harrier	green frog
Canada goose	largemouth bass
Mallard	common carp

great egret	American eel
Osprey	water strider
marsh wren	mosquito
common yellowthroat	crayfish
Asiatic clam	

APPENDIX C:

Ecological Case Studies Species Lists

Red Maple – Black Gum Swamp: Upton Ecological Research Reserve

Coastal Plain Pond: Long Pond Greenbelt

Managed System: Mastic-Shirley Peninsula

APPENDIX C: Ecological Case Studies Species Lists for Red Maple – Black Gum Swamp: Upton Ecological Research Reserve, Coastal Plain Pond: Long Pond Greenbelt, and Managed System: Mastic-Shirley Peninsula

Plant species of the red maple – black gum swamp in Upton Ecological Research Reserve include:

red maple	cinnamon fern
black gum	Royal fern
sweet pepperbush	skunk cabbage
highbush blueberry	greenbrier
northern arrowwood	sawbrier
swamp azalea	Virginia creeper
fetterbush	poison ivy
dangleberry	Sphagnum mosses
inkberry	

Animal species of the red maple – black gum swamp in Upton Ecological Research Reserve include:

vireos	nuthatches
warblers	woodpeckers
thrushes	titmice
kinglets	brown creepers

Plant species of the Long Pond Greenbelt coastal plain pond communities include (Dowhan, 1997c):

red-rooted flatsedge	creeping St. John's-wort
knotted spikerush	Carolina redroot
long-tubercled spikerush	round-fruited ludwigia
long-beaked bald-rush	northeastern smartweed
peanut grass	clustered bluets
rose tickseed	Pine Barrens gerardia
white boneset	

Animal species of the Long Pond Greenbelt coastal plain pond communities include (Dowhan, 1997c):

eastern tiger salamander	northern black racer
spotted salamander	eastern hognose snake
spotted turtle	ringneck snake
marbled salamander	milk snake
common red-backed salamander	northern water snake
red-spotted newt	eastern bog turtle
wood frog	snapping turtle
Fowler's toad	alewife
northern spring peeper	American eel

gray treefrog	chain pickerel
pickerel frog	pumpkinseed
bullfrog	yellow perch
green frog	banded killifish
eastern ribbon snake	ninespine stickleback
garter snake	eastern mud minnow

Plant species of the Mastic - Shirley Peninsula freshwater communities include:

red maple	swamp loosestrife
willow	sweet pepperbush
swamp white oak	marsh St. Johns-wort
silver maple	bladderwort
black gum	marsh hibiscus
dogwoods	sundews
alder	arrowhead
swamp dock	swamp azalea
buttonbush	highbush blackberry
rushes	grey birch
sedges	black willow
cattails	pitch pine

bulrushes	white pines
pondweeds	inkberry
smartweed	cinnamon fern
common reed	*sphagnum* mosses
boneset	poison ivy
pond lily	