HISTORICAL CHANGES IN THE PINE BARRENS OF CENTRAL SUFFOLK COUNTY, NEW YORK

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ABSTRACT - Soils, vegetation, fossil pollen and charcoal, disturbance history, early documents and maps, and insects were used to interpret past changes in the central Suffolk County, Long Island, New York pine barrens. Before Euro-American settlement pitch pine-oak-heath woodland, pitch pine-scrub oak barrens, and dwarf pine plains probably covered portions of the broad outwash plain south of the Ronkonkoma Moraine. These communities would have occurred on deep, coarse-textured, excessively drained, nutrient-impoverished, acidic, fire-prone sandy soils. Logging, land clearance, and repeated human-caused fires promoted the expansion of barrens vegetation through much of central Suffolk County during the 17th-19th centuries. Pitch pine became established on the disturbed loamy, sandy, and gravelly soils. Scrub oak sprouted profusely on these soils in response to repeated burning of the undergrowth. The seed for this expansion dispersed from trees and shrubs growing in adjacent oak-pitch pine and pitch pine-oak woodlands. With 20th century fire suppression, pine barrens reverted to oak-hardwood forests in northcentral Suffolk County and oak-pine and pine-oak forests in southcentral Suffolk County. Pine barrens persisted in sections of eastcentral and southcentral Suffolk County in response to periodic burning.

INTRODUCTION

Pine barrens is a term widely used for several types of related woodland, savanna, and barrens communities (Anderson and Sneddon 1994, Reschke 1990, Schweitzer and Rawinski 1988). Pitch pine (*Pinus rigida* Mill.)-oak (*Quercus* spp.)-heath (Ericaceae) woodland, pitch pine-scrub oak (*Quercus ilicifolia* Wangenh.) barrens, and dwarf pine plains have all been referred to as "barrens" vegetation (New York Natural Heritage Program 1997, Olsvig et al. 1979, Reschke 1990) (Fig. 1). These communities are called barrens because of their depauperate tree cover on nutrient-impoverished, droughty soils.

Pine barrens are an imperiled ecosystem in the northeastern United States. They have been destroyed or altered substantially by land clearance, development, and fire suppression. Of the acreage remaining, only the New Jersey pinelands have large contiguous tracts of pitch pine-oak-heath woodland, pitch pine-scrub oak barrens, and dwarf pine plains (Good 1982). The 19th century Suffolk County, Long Island, New York

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pine barrens were once the second largest barrens area in the Northeast, but most of these barrens were destroyed during the 20th century (Cryan 1985). Present-day Suffolk County pine barrens are largely fragmented by residential, industrial, and commercial development (Fig. 2).

The pine barrens of central Suffolk County were identified recently by The Nature Conservancy (TNC) as habitat worth saving. In 1995 a core of 21,266 ha including 2,170 ha of pitch pine-oak-heath woodland, pitch pine-scrub oak barrens, and dwarf pine plains was set aside by the Long Island Pine Barrens Preservation Act (M.J. Jordan 1998 pers. comm.) (Fig. 2). These communities provide habitat for many endangered, rare, and threatened plant and animal species (New York Natural Heritage Program 1997). Much of the protected barrens is located on the

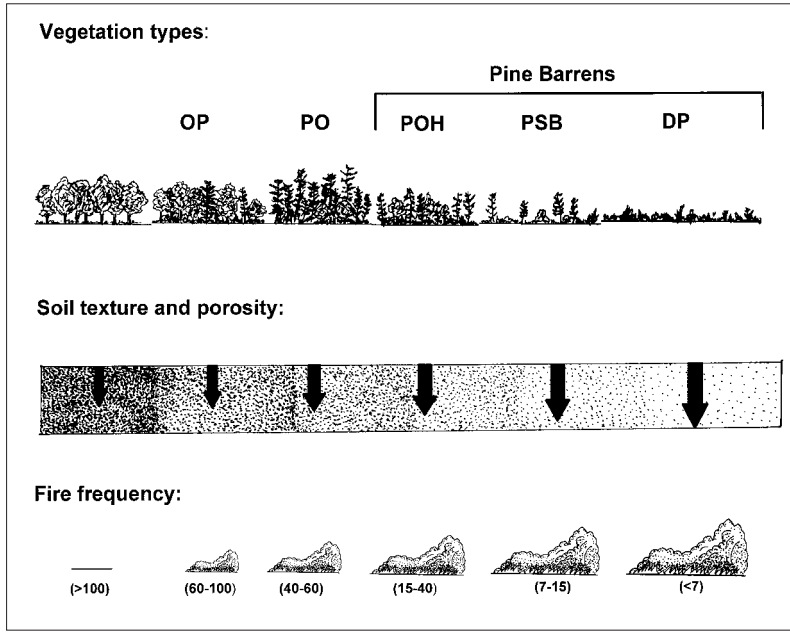

Figure 1. Central Suffolk County oak-pine vegetation types arranged from mesophytic (left) to xerophytic (right): O, oak forest; OP, oak-pitch pine forest; PO, pitch pine-oak forest; POH, pitch pine-oak-heath woodland; PSB, pitch pine-scrub oak barrens; DP, dwarf pine plains. These vegetation types are often correlated with soil texture ranging from fine-grained loam (darkest stippling) to coarse-grained sand and gravel (lightest stippling), soil porosity ranging from moderately permeable with more water and nutrient retention (smallest arrow) to rapidly permeable with less water and nutrient retention (largest arrow), and fire frequency ranging from virtually none (blank) to frequent (largest flame and smoke). Parentheses contain number of years between large fires for each vegetation type averaged from Central Pine Barrens Joint Policy and Planning Commission (1995), Olsvig et al. (1979), Reschke (1990), and Windisch (1992).

outwash plain between the Ronkonkoma Moraine and the towns of Westhampton and Quogue (Figs. 2, 3).

The origin of the central Suffolk County pine barrens has been debated for nearly a century. Are they an indigenous plant community of ancient lineage resulting from natural disturbance (fires, windthrow, drought, plant disease, insect attacks) on nutrient-poor, xeric soils (Conard 1935, Cryan 1980, Englebright 1980, Harper 1908, Svenson 1936, Welch 1996)? Or, are they an anthropogenic legacy linked to centuries of Euro-American disturbance, especially land clearance and fires (Black 1996, Black and Pavacic 1997, Turano 1983)?

We may never find the evidence to satisfactorily answer these questions. There are no 17th or early 18th century maps detailing the vegetation of central Suffolk County. Initial land surveys postdated the settlement of Long Island. Logging, land clearance, and indiscriminate burning altered much of the original vegetation. The most informative and

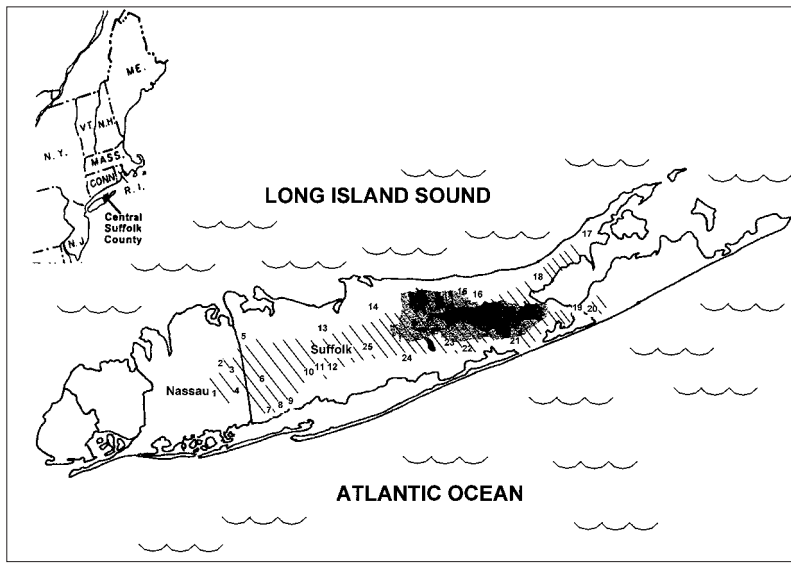

Figure 2. Extent of historic pine barrens (oblique lines) in Nassau and Suffolk Counties. Place names are indicated by numbers as follows: (1) Merrick, (2) Hicksville, (3) Central Park, (4) Farmingdale, (5) Cold Spring Harbor Station, (6) Pinelawn, (7) Amityville, (8) Babylon Station, (9) Babylon, (10) Edgewood, (11) Brentwood, (12) Central Islip, (13) Smithtown, (14) Port Jefferson Station, (15) Rocky Point, (16) Wading River Junction, (17) Southold, (18) Great Peconic Bay, (19) Canoe Place (Shinnecock Canal), (20) Shinnecock Hills, (21) Westhampton, (22) Moriches, (23) Millville (Yaphank), (24) North Patchogue, (25) Lake Ronkonkoma (Anonymous 1797?, Dwight 1822, Harper 1908, Hulse 1797, Records of the Town of Brookhaven 1932, Svenson 1936, Tredwell 1912). Gray and black areas are existing pine barrens, while black areas are preserved.

reliable historical accounts of the region were written after the landscape was significantly changed. The impact of native American land use in the interior of Suffolk County is unknown. There are no palynological studies for the outwash south of the Ronkonkoma Moraine. Interpreting modern insect assemblages as indicative of natural habitat is problematic because insecticide use may have destroyed or deleteriously affected the insect fauna. Modern development and fire suppression altered the role of fire in the region. Despite these limitations, we can infer something of the original vegetation of central Long Island using several lines of evidence.

The purpose of this paper is to examine the hypothesis that pine barrens in central Suffolk County expanded during the past 300 years in response to human disturbance. We use soil surveys, inferences about pre- and post-settlement vegetation, fossil pollen and charcoal profiles, disturbance history, early documents and maps, and knowledge of insect populations in an attempt to test the hypothesis that Long Island pine barrens are mainly of recent origin. We draw heavily from existing

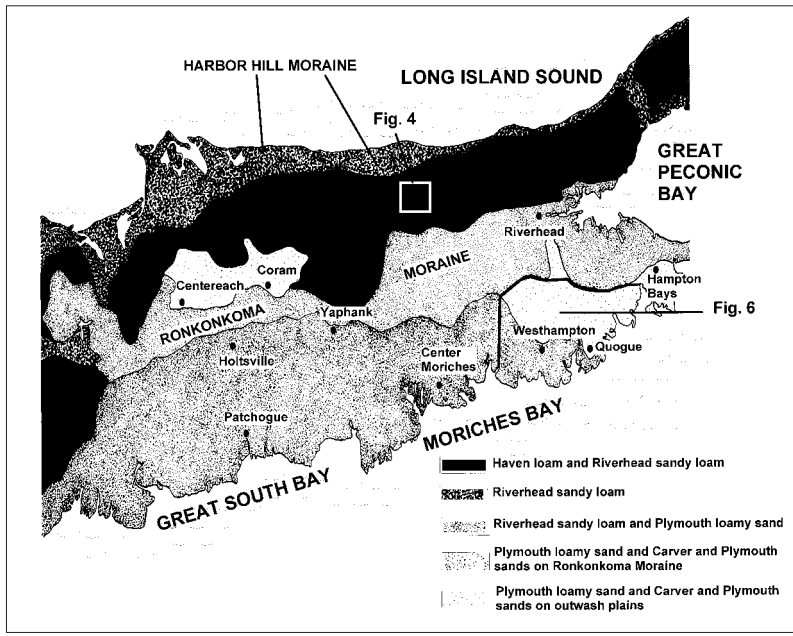

Figure 3. Major soil associations of central Suffolk County arranged in order of decreasing moisture and nutrient retention: Haven loam and Riverhead sandy loam, Riverhead sandy loam, Riverhead sandy loam and Plymouth loamy sand, Plymouth loamy sand and Carver and Plymouth sands on Ronkonkoma Moraine, and Plymouth loamy sand and Carver and Plymouth sands on outwash plain. Barrier island off southern shore is omitted (USDA 1972). Areas encompassed in Figures 4 and 6 are outlined.

literature, although the interpretations and conclusions reached are mostly our own. The section on insects contains information based on the senior author's research in other barrens areas.

THE PINE BARRENS ECOSYSTEM

Modern Vegetation

Pitch pine and white oak (*Quercus alba* L.) are the dominant trees in pitch pine-oak-heath woodland. Scarlet oak (*Q. coccinea* Muenchh.) and black oak (*Q. velutina* Lam.) may be present in the open canopy. The shrublayer is dominated by scrub oak and/or dwarf chestnut oak (*Q. prinoides* Willd.), black huckleberry (*Gaylussacia baccata* (Wangenh.) K. Koch), and hillside blueberry (*Vaccinium pallidum* Aiton). Characteristic groundcover species include bearberry (*Arctostaphylos uva-ursi* (L.) Spreng.), Pennsylvania sedge (*Carex pensylvanica* Lam.), golden heather (*Hudsonia ericoides* L.), beach heather (*H. tomentosa* Nutt.), and pinweed (*Lechea villosa* Ell.). The presence of scattered tree oaks distinguishes this community from pitch pine-scrub oak barrens (Reschke 1990).

The dominant tree in pitch pine-scrub oak barrens is pitch pine. Scrub oak, lowbush blueberry (*Vaccinium angustifolium* Aiton), hillside blueberry, black huckleberry, forbs, and grasses grow abundantly in the understory (F. K. Seischab 1998 pers. comm.). Grassy or herbaceous openings are prevalent, while tree oaks are rare or absent in this community (Reschke 1990).

Dwarf pine plains are characterized by depauperate pitch pine and scrub oak. A low shrub layer of black huckleberry, hillside blueberry, golden heather, bearberry, and wintergreen (*Gaultheria procumbens* L.) often grows beneath the pines and oaks. Foliose and fruticose lichens frequently cover what would otherwise be bare sand.

Soils

The soils of central Suffolk County were deposited and modified by several glacial advances and retreats during the Pleistocene. The effects of the recent Wisconsinan glaciation are plainly visible as the Harbor Hill Moraine along the northern shore and the Ronkonkoma Moraine running from west to east through central Suffolk County (Fig. 3). Vast deposits of outwash sand and gravel extend south of the Ronkonkoma Moraine for about 15 km. This outwash is nearly level, coarse-textured, excessively drained, and infertile.

Riverhead sandy loam (22,925 ha), Plymouth loamy sand (18,626 ha), and Carver and Plymouth sands (6,806 ha) are the dominant soils on this outwash plain (USDA 1972, 1975, Fig. 3; Table 1). Riverhead sandy loam (RdA, 0-3% slope) is associated mainly with oak-pine and pine-oak forests but also supports pine barrens following disturbance

(F. K. Seischab 1998 pers. comm.). Plymouth loamy sand (PlA, 0-3% slope) is associated predominantly with oak-pine and pine-oak forests and pitch pine-oak-heath woodland but supports pitch pine-scrub oak barrens following disturbance (Central Pine Barrens Joint Policy and Planning Commission 1995, Olsvig et al. 1979, F. K. Seischab 1998 pers. comm.). Plymouth loamy sand occupies a variety of landscapes south of the Ronkonkoma Moraine including broad outwash fans with few natural firebreaks. Carver and Plymouth sands (CpA, 0-3% slope) are associated with oak-pine and pine-oak forests, pitch pine-oak-heath woodland, pitch pine-scrub oak barrens, and dwarf pine plains (Backman and Patterson 1988, Winkler 1985, Olsvig et al. 1979, W. A. Patterson III 1998, pers. comm.). Because of their droughtiness, Carver and Plymouth sands were prone to fires that promoted and maintained pitch pine-scrub oak barrens and dwarf pine plains. Relatively flat terrain, widely spaced drainageways, and a paucity of natural firebreaks enhanced the spread of such fires (A. Windisch 1997 pers. comm.).

Climate

Humid continental weather was the rule for Long Island including Suffolk County during the late Holocene, and such climatic conditions favored the development of predominantly deciduous forests in the region. The climate of central Suffolk County was mild due to the moderating influence of the Atlantic Ocean and Long Island Sound. Annual temperatures from 1896 through 1938 averaged -0.5˚C in January and 21.9˚C in July. The frost-free period ranged from 172 to 211 days (USDA 1941). Early 20th century annual precipitation ranged from 1120 (Patchogue) to 1342 mm (Lake Ronkonkoma) (Dethier 1966).

Table 1. Comparison of physical and ecological characteristics of Riverhead sandy loam (RdA), Plymouth loamy sand (PlA), and Carver and Plymouth sands (CpA) in central Suffolk County*.

Characteristics	RdA, 0-3% slope	PlA, 0-3% slope	CpA, 0-3% slope
Areal extent	22,925 ha	18,626 ha	6,806 ha
Solum texture	Sandy loam	Loamy sand	Medium/coarse sand
Acidity (pH)	Strong (5.0) ‡	Strong-very strong (4.8) †	Very strong (3.9) ⁜
Permeability	Moderately rapid	Rapid throughout	Rapid throughout
Available moisture capacity	Moderate (.11-.15) ❊	Low-very low (.04-.08) ❊	Very low (.02-.04) ❊
Natural fertility	Low	Low	Very low

* Soil name and location of sample from USDA 1975
‡ Camp Wilderness, Boy Scouts of America
† Carmans River Conservancy
⁜ Quogue Wildlife Refuge
❊ Inches per inch of soil

VEGETATION HISTORY

Pollen Records

No palynological data are available for central Suffolk County south of the Ronkonkoma Moraine, although two studies were conducted for sites north of this moraine: a core spanning the last 10,000 years from Sunken Lake (Sirkin 1971), and one covering the past 4,160 years from Deep Pond (Backman 1984). Both sites are located northeast of the Brookhaven National Laboratory, near Wading River in the Town of Riverhead. They are separated by only 0.5 km and, although nestled in Carver and Plymouth sands, are surrounded by a mosaic of Haven loam, Riverhead sandy loam, and Plymouth loamy sand (USDA 1975) (Fig. 4).

The pollen diagram for Sunken Lake, referred to as Scuttle Hole, a small bog (Welch 1996), shows little herb pollen and abundant arboreal pollen inferring dense woods. The pollen percentages of pine, grasses, and Asteraceae increased noticeably only after initial Euro-American settlement about 1680. The pollen percentages of mesophytic tree species such as hemlock (*Tsuga canadensis* (L.) Carr.), American beech (*Fagus grandifolia* Ehrh.), hickory (*Carya* spp.), and American chestnut (*Castanea dentata* (Marsh.)) were low after the terrain was cleared (Sirkin 1971).

The pollen profile for Deep Pond, a relatively large body of water, shows increases in pitch pine pollen and decreases in (tree?) oak pollen following Euro-American settlement. However, after 1920, both pitch pine and bracken fern (*Pteridium aquilinum* (L.) Kuhn), another indicator of disturbance, declined as oak increased in conjunction with fire suppression and cessation of the cordwood industry. Without logging and frequent fires, oak gradually reestablished its dominance over the fire-adapted and shade-intolerant pitch pine. Prior to 1680, the abundance of oak, hickory, and other deciduous species at Deep Pond place this plant assemblage near the mesic end of a vegetation gradient (Backman 1984). Pitch pine probably persisted as a minor component in this forest throughout the late Holocene. Pre-settlement pollen diagram values of only 10-15% for pitch pine compared to values of 40-50% for oak support this contention.

Historic Maps and Early Accounts of Vegetation

Much of central Suffolk County was mapped as “pine plains” in the early 1800s (U.S. Coast Survey 1838) (Fig. 5). However, most of the region was probably forested before Euro-American settlement. Using evidence of soil type (USDA 1975), ground water, surficial geology, potential evapotranspiration rates, and historical records, Turano (1983) concluded that the northern shore, north of the Harbor Hill Moraine (Fig. 3), was covered in 1640 with a mesophytic oak-hickory forest composed of yellow poplar (*Liriodendron tulipfera* L.), hickory, north-

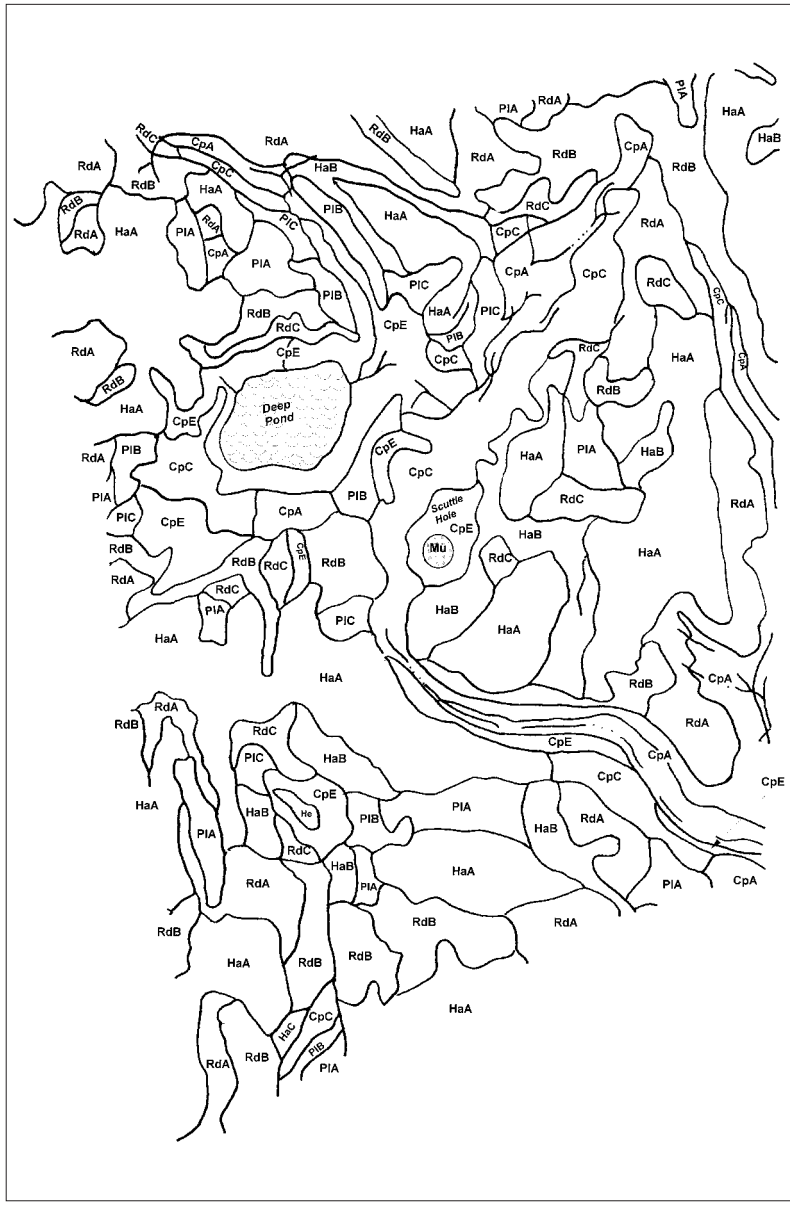

Figure 4. Mosaic of Haven loam (HaA, 0-2% slope; HaB, 2-6% slope; HaC, 6-12% slope; He, thick surface layer); Riverhead sandy loam (RdA, 0-3% slope; RdB, 3-8% slope; RdC, 8-15% slope); Plymouth loamy sand (PlA, 0-3% slope; PlB, 3-8% slope; PlC, 8-15% slope); Carver and Plymouth sands (CpA, 0-3% slope; CpC, 3-15% slope; CpE, 15-35% slope); and Muck (Mu) around Deep Pond and Sunken Lake (Scuttle Hole). Streams are shown as interrupted or uninterrupted lines (USDA 1975).

ern red oak (*Quercus rubra* L.), black oak, and occasional walnut (*Juglans nigra* L.), sweetgum (*Liquidambar styraciflua* L.), and American beech. The crests of the Harbor Hill and Ronkonkoma Moraines running eastward to Orient and East Hampton were dominated by a drier oak-American chestnut forest containing American chestnut, chestnut oak (*Quercus prinus* L.), black oak, white oak, scarlet oak, northern red oak, and, less so, pignut hickory (*Carya glabra* (Mill.)), American beech, and yellow poplar. Across the dry southern outwash plain and between the Harbor Hill and Ronkonkoma Moraines the ancestral forest probably resembled the present oak or oak-pitch pine forest with scarlet oak, black oak, white oak, pitch pine, and lesser amounts of American chestnut and pignut hickory growing in a rather open canopy. Increased pitch pine characterized Suffolk County south of the Ronkonkoma Moraine with a maximal amount growing north of Westhampton and Quogue (Turano 1983).

Historical evidence supports Turano's (1983) conclusion of oak-dominated forests growing on a mosaic of loamy and sandy soils in central Suffolk County at the time of initial Euro-American settlement (ca. 1640-1680). Several-hundred-year-old white oak, American chestnut, and other deciduous hardwoods as large as 1.8-2.7 m in diameter

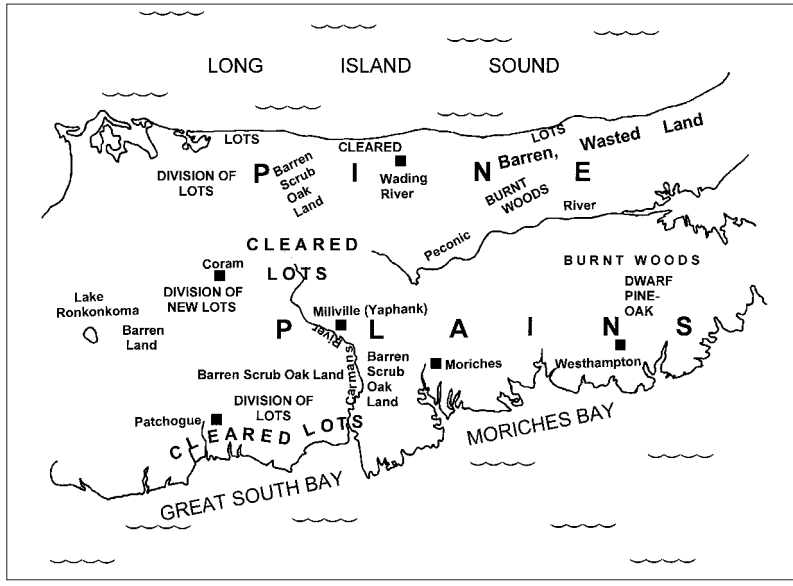

Figure 5. Composite map of central Suffolk County late 18th and early 19th century land cover and topographic features. Pine-oak and oak-pine forests, woodlands, marsh, and barrier island are omitted. (Anonymous 1797?; Dwight 1822; Hulse 1797; U. S. Coast Survey 1838).

grew abundantly in late 19th century northcentral Suffolk County (Fullerton 1906, Murphy 1991). A former forest of oak, American chestnut, and pitch pine was inferred from large stumps in southcentral Suffolk County south of Holtsville (Watson 1860) (Fig. 3). The area across the Ronkonkoma Moraine between Yaphank and South Manor was called "Wampmissic" (place of chestnut trees) by the natives (Tooker 1911) (Fig. 3)."Timber" and large acreage (243 ha) of (presumably oak) "woodland" date to 1664-1784 in Town of Brookhaven deeds (New York State Archives).

The area near Coram contained abundant white oak, black oak, northern red oak, walnut, and American chestnut trees according to 1730-1754 land sales contracts (Records of the Town of Brookhaven 1932). However, Svenson's (1936) early 20th century illustration indicates that the vegetation had changed to pine barrens after nearly 200 years of human-caused disturbance. Svenson (1936) also portrayed the remains of an old boundary line fence of white oak stumps near Selden, just west of Coram. White oaks were numerous in the vicinity and often marked the borders of parcels of land (Murphy 1991).

Early Land Clearance

By 1750 the primeval woods of northcentral Suffolk County were mostly cut down. The area from Wading River to Southold, a distance of 37 km, was predominantly barren due to logging and subsequent brush removal (Dwight 1822, Hedges 1885) (Fig. 5). A plain of thick oak brush and sparse dead and broken pines, 10-13 km long, characterized the area in 1744 (Bridenbaugh 1948). So rapid was the destruction of this forest that laws were enacted and reenacted to prevent the denudation of the land (Tredwell 1912).

18th and 19th Century Logging

The central Suffolk County woodland was initially cut for building material, fencing, and cordwood. Long Island cordwood was the major source of fuel for heating and cooking in New York City from the earliest days of settlement. New York City exploited the woodlots of Suffolk County for this fuelwood because of their proximity, natural harbors, and ready accessibility through Long Island Sound. Wood was harvested from the interior of Suffolk County, brought to coastal moorings, loaded onto boats, and shipped expeditiously (Gabriel 1921). In 1761 it was estimated that New York City consumed 20,000 cords of wood per year (Bridenbaugh 1968). By 1815 this figure had grown to over 200,000 cords. The Town of Brookhaven alone exported 100,000 cords of wood in 1812. Even after the introduction of coal in the mid-1800s, Suffolk County woods were cut and removed to supply cordwood for New York City and surroundings (Tredwell 1912, 1917).

In addition to woodcutting for building material, fencing, and fuelwood, much timber grown in Suffolk County was used in shipbuilding. In 1770 it took 16 ha of woodland or 2,220 sizeable trees to construct a single 74-gun frigate for the naval fleet (Murphy 1991).

Hickory, oak, and other deciduous hardwoods were the preferred fuelwood because they are dense and burn uniformly. Pitch pine was generally avoided for cooking and heating because of the large amount of smoke produced, the soot that adhered to the inside of chimneys, and the associated increased risk of fire (Whitney 1994). The preferential removal of deciduous hardwoods during the 18th and early 19th centuries promoted the expansion of pitch pine-oak-heath woodland and pitch pine-scrub oak barrens in central Suffolk County. Barren areas from which deciduous trees were cut and removed were soon invaded by shade-intolerant pitch pine and scrub oak.

Post-Colonial Vegetation Development

By the late 1700s, deciduous forest with a small pitch pine component had succeeded to pine barrens throughout large sections of central Suffolk County (Dwight 1822, Flint 1896, Hart 1907, Lossing 1860) (Fig. 5). In 1790 George Washington described the region between Coram and Patchogue as "low scrubby oak, ... intermixed with small and ill-thriven pines" (Lossing 1860). Isaac Hulse's (1797) map depicts "Barren Land" east of Rockonkney Pond (Lake Ronkonkoma) (Fig. 5). "Barren Srub (Scrub) Oak Land," possibly as illustrated near Yaphank (Svenson 1936), is designated on this map northeast of Patchogue, between Carmans (misidentified as Connecticut) River and Moricha (Moriches), and in the Wadeing (Wading) River Great Lots northeast of Coram (Fig. 5). Hulse's (1797) map and Washington's (1790) observation were made more than 100 years after initial settlement and probably reflected the result of extensive logging, land clearance, and repeated human-caused fires. Both Hulse's (1797) map and a map by Simeon DeWitt (1802) indicate much post-settlement activity in the region in the form of intersecting roads (wagon trails), division of land into lots, and a forge near Patchogue that probably consumed much fuelwood (Fig. 5). Numerous "Into woods" (logging) roads are depicted throughout this region inferring considerable timber and cordwood removal (U.S. Coast Survey 1838).

Pine barrens continued as the dominant vegetation in central Suffolk County into the late 19th and early 20th centuries. Pitch pine-oak-heath woodland and pitch pine-scrub oak barrens covered large sections of land from Hicksville, Central Park, Farmingdale, and north of Merrick in eastern Nassau County to Southold, Great Peconic Bay, and Shinnecock Hills in eastern Suffolk County (Dwight 1822, Harper 1908,

Svenson 1936) (Fig. 2). The central Suffolk County pine barrens averaged 16-18 km from north to south. They extended from east to west for 70-95 km and encompassed 100,000 ha (Fig. 2).

FIRE HISTORY

There is strong evidence that the area around Deep Pond (Fig. 4) burned periodically during the past 4,160 years. Both pre- and post-settlement sediments from Deep Pond contained large quantities of charcoal. Mean values of charcoal abundance were nearly twice as high in post- as pre-settlement time (1040 vs. 650 μ^2 charcoal:pollen) (Backman 1984). Prior to settlement, fires probably occurred at lengthy intervals or with lower intensities, favoring oak-hardwood forests and only scattered pitch pine. Following settlement, fires were much more frequent, favoring the establishment of pine barrens, although not necessarily directly around Deep Pond.

In the early days of settlement, trees were girdled and burned and underbrush set ablaze to clear the land for cultivation and grazing. "Firing" the woods was an annual spring occurrence in practically every village and hamlet (Gabriel 1921). Such activity generated larger fires in the region that often burned severely and consumed much soil organic matter. Decades before the advent of the Long Island Railroad, great fires, evidently started by settlers, raged out of control in Suffolk County. In 1839, five years before the completion of the railroad that ran through the sparsely inhabited southern outwash plain (Gabriel 1921), large fires burned through the pine woodland near Farmingdale and Central Islip (Tredwell 1912).

After the inception of the railroad, fires increased in frequency and intensity (Tredwell 1917). In 1844 more than 10,000 ha of pine woodland burned near Manorville (Prime 1845). Another fire burned through woodland along the railroad track east of Farmingdale for a distance of 65 km (Rubin 1912). In 1848 19,500 ha of woodland burned continuously for a period of two weeks in central Suffolk County. In 1853 and 1858 large devastating fires again burned through the woodlands of central Suffolk County (Tredwell 1912). In 1862 a destructive fire swept through woodland from Smithtown to Brookhaven into the Towns of Riverhead and Southampton (Bayles 1873). These mid-19th century fires were so extensive and destructive that the railroad was blamed for "burning out the middle of the Island" (Turano 1983).

Fires were started by sparks thrown from the smokestacks of wood- and coal-burning locomotives; hot embers dumped along the railroad tracks; burning of brush, debris, and slash; and ashes from campfires and smoking pipes (Kurczewski 1998). Fires were also attributed to acts of incendiarism. More than 90% of all fires on Long Island at the

turn of the 20th century were of human origin (Turano 1983). By 1911 the central Suffolk County pine barrens were burned so thoroughly that the land was deemed unproductive and untaxable (Gabriel 1921). Fire suppression, largely non-existent until the advent of the gasoline powered fire engine in the early 20th century, subsequently reduced the extent of fires in the pine barrens. Whether accidental or purposeful, human-caused fires enlarged and reshaped the central Suffolk County pine barrens by gradually eliminating the mesophytic forest.

INSECT FAUNA

Species of Miridae (plant bugs) and Lepidoptera (butterflies and moths) have been used as indicators of northeastern pine barrens (Reschke 1990, Schweitzer and Rawinski 1988, Wheeler 1991). Mirids are found commonly in pine barrens and woodlands other than those on sandy soils, and their feeding habits include extra-pine barren species of plants and insects (Wheeler 1991). Most species of Lepidoptera associated with barrens dominated by pitch pine and/or scrub oak also feed on other plants, are strong fliers, and disperse readily from one site to another. *Tachysphex pechumani* Krombein, the antenna-waving wasp, is, on the other hand, a reliable indicator of pre-Euro-American settlement pine barrens occurring on sandy soils (Kurczewski 1998). Unlike most species of butterflies and moths, this insect makes low, short flights and does not have rapid long-range dispersal capability.

In lower Michigan, northwestern Ohio, northwestern Indiana, and southwestern Ontario, *T. pechumani* inhabits areas that were either oak "plains" (savanna) or pine "plains" (barrens) according to early land surveys (F. E. Kurczewski, pers. obs.). In southern New Jersey, past and present collection localities for the antenna-waving wasp are within or just outside of the early 20th century extent of pine barrens. This species does not occupy anthropogenically induced pine barrens in southeastern Ontario, New York State, or New England (Kurczewski 1998).

The current disjunct distribution of the antenna-waving wasp in sections of lower Michigan, northwestern Ohio, northwestern Indiana, southwestern Ontario, and southern New Jersey implies dependence on fire-adapted, or otherwise naturally disturbed sandy soils (F.E. Kurczewski, pers. obs.). This species does not occur in dense mesophytic deciduous or deciduous-coniferous forests (Kurczewski 1998). Its historical and present-day absence from Suffolk County may signify that pine barrens were less extensive and oak forests more extensive before settlement than today.

Tachysphex pechumani lives only in areas of sandy soils that supported extensive acreage of pre-settlement oak savanna and pine barrens. For example, lower Michigan and adjacent northwestern Ohio and

northwestern Indiana held upward of 1,500,000 ha of oak and pine-dominated woodland (Veatch 1959). Southern Ontario contained more than 600,000 ha of sandy soils including nearly 100,000 ha of oak-pine forest, woodland, savanna, and barrens in the Norfolk Sand Plain (Kurczewski 1998). Southern New Jersey had 425,000 ha of suitable pine-oak-dominated habitat (Good 1982). In contrast, central Suffolk County contained maximally only 65,000 ha of well to excessively drained, nutrient-impoverished sandy soils during favorable (for the wasp) warm and dry climatic conditions 8,000-5,000 years ago. As a cooler and wetter late Holocene ensued, this area was gradually made unsuitable by mesophytic forest expansion, perhaps shrinking below the extent necessary to sustain a viable population of the wasp.

CONCLUSIONS

Oak-pitch pine and pitch pine-oak forests grew abundantly in central Suffolk County south of the Ronkonkoma Moraine before Euro-American settlement (1640-1680) on loamy, sandy, and gravelly soils. At the time of settlement, pitch pine-oak-heath woodland, pitch pine-scrub oak barrens, and dwarf pine plains may have covered fewer than 7,000 ha and were probably confined mainly to the deep, excessively drained, nutrient-poor Carver and Plymouth sands on the broad, nearly level

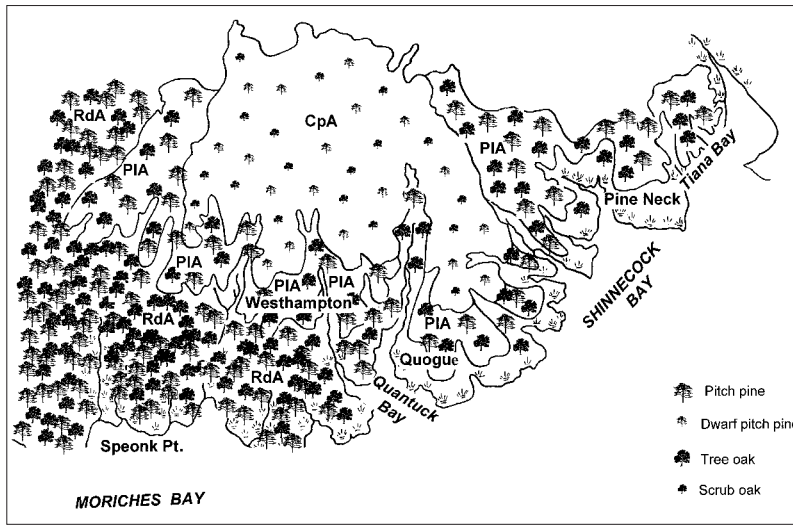

Figure 6. Predominant soils and probable pre-settlement vegetation on outwash fan north of Westhampton and Quogue: (CpA) Carver and Plymouth sands with pitch pine-scrub oak barrens and dwarf pine plains; (PlA) Plymouth loamy sand with pitch pine-oak-heath woodland; and (RdA) Riverhead sandy loam with oak-pitch pine and pitch pine-oak forests. Barrier island off southern shore is omitted. (U. S. Coast Survey 1838, USDA 1975, USDIGS 1903).

outwash fans, especially north of Westhampton and Quogue. Frequent fires or other disturbance on this coarse-textured, droughty, acidic soil with few natural firebreaks aided in maintaining these communities.

Historical evidence points to a pre-settlement origin for the dwarf pine plains north of Westhampton and Quogue. There is only a single "Into woods" (logging) road depicted for this area (U.S. Coast Survey 1838), perhaps inferring the diminutive stature and inferior quality of the timber. An anonymous map of the Town of Southampton (1797?) notes "Quag (Quogue) Plain producing no timber & ... nearly 3 mile in diameter." Dwight (1822) in 1804 recounted the description of stunted oak-pine vegetation between Westhampton and Riverhead (Olsvig 1980) (Fig. 5). Register T-77 (U.S. Coast Survey 1838) substantiates dwarf (pitch?) pine and shrubby (scrub?) oak on the outwash fan north of Westhampton and Quogue, just south of a very large area of "burnt woods" (Fig. 6).

Following initial settlement, woodland was removed, brush was cleared and burned, and, later, the railroad was established. Repeated human-caused fires and other disturbance enlarged and reshaped the central Suffolk County pitch pine-oak-heath woodland and pitch pine-scrub oak barrens from the 17th to the early 20th century. As land was cleared and burned, pitch pine germinated and scrub oak sprouted profusely on the newly exposed loamy, sandy, and gravelly soils. This invasion was promoted by trees releasing seeds from the nearby oak-pitch pine and pitch pine-oak forests following fire and land clearance. By the late 19th century, pine barrens covered 100,000 ha in Suffolk and eastern Nassau Counties (Fig. 2).

With 20th century fire suppression, pitch pine-oak-heath woodland and pitch pine-scrub oak barrens reverted to predominantly oak-hardwood forests in northcentral Suffolk County and oak-pitch pine and pitch pine-oak forests in southcentral Suffolk County. Pitch pine-oak-heath woodland, pitch pine-scrub oak barrens, and dwarf pine plains persisted on the droughty, fire-prone outwash fan north of Westhampton and Quogue.

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