# HISTORICAL INFLUENCES ON THE LANDSCAPE OF MARTHA'S VINEYARD

## PERSPECTIVES ON THE MANAGEMENT OF THE MANUEL F. CORRELLUS STATE FOREST


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Front cover: Post oak *(Quercus stellata)*

Back cover: Expanse of scrub oak *(Quercus ilicifolia)*

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## SUMMARY


1. Over the past 90 years, the Commonwealth of Massachusetts has acquired approximately 5200 acres of land on the Great Plain of Martha's Vineyard, representing the largest and most important parcel of open space and conservation land on the Island. Vegetation on the Manuel F. Correllus State Forest (MFCSF) includes several thousand acres of globally uncommon sand-plain communities dominated by scrub oak, white, black, and post oaks, ericaceous shrubs, and pitch pine, as well as more than 1200 acres of planted forests dominated by non-native conifers. The area also supports numerous rare or uncommon plant and animal species.

2. In response to changing cultural, biological, and economic conditions and increased understanding of sand-plain ecosystems, management objectives for MFCSF have changed markedly over time from early efforts to protect the heath hen, to management for timber and wood products, to recent emphasis on recreation and conservation. Throughout the 20th century, fire control has been an important concern that has increased with the recent and rapid development of housing in surrounding areas.

3. In 1998, we were commissioned to undertake an historical and ecological assessment of MFCSF in order to develop an understanding of past environmental conditions as background for establishing future conservation and management objectives. Our specific objectives included: (1) to document the vegetation, natural disturbance, and land-use history of the State Forest and surrounding areas from pre-European to modern times; (2) to assess the ecological value of MFCSF based on consideration of historical and modern conditions; and (3) to propose management directions based on this interpretation.

   Our assessment was based on extensive fieldwork and archival studies, our prior experience with sand-plain ecosystems, and in particular, our understanding of the importance of historical factors such as past agriculture, forestry practices, and fire in controlling modern landscape patterns. Our results and interpretations will be strongly complemented by an ongoing assessment of fuel loading and fire ecology by W. A. Patterson of the University of Massachusetts.

4. The detailed pre-historical and historical record provided by excellent paleoecological, cartographic, and historical data for Martha's Vineyard and the Great Plain confirm that the area of MFCSF was wooded with scrub and tree oaks at the time of European settlement. The area remained predominantly wooded and relatively undisturbed by intensive land-use practices into the 20th C as a result of its low quality for agriculture and the low availability of water.

   - Paleoecological data suggest that the central plain was oak woodland or scrubland for at least the past 1,000 to 2,000 years; pine and graminoids were of only limited importance. High charcoal values suggest that fire was common, probably as a result of the high Indian population that was concentrated around the Island margin.
   - Through the Island-wide peak of agricultural activity, deforestation, and natural resource use in the 19th C, the central and northern portions of the Great Plain remained oak woodland and scrubland, with fire and fuelwood cutting the predominant disturbances. No evidence exists for the occurrence of sand-plain grasslands in or near MFCSF; pitch pine was restricted to scattered occurrence, and intensive land-use (e.g., agriculture) was remarkably limited. In strong contrast to the other portions of Martha's Vineyard and most of New England, woodland clearing in the area of MFCSF did not occur until the late 1800s when 48 ac (<1%) were in fields. A total of less than 90 acres have been cleared and plowed for agriculture, representing <2% of the total area of the State Forest.

5. The most significant and intensive land use alterations of MFCSF have occurred in the 20th century under public ownership and management.

   - Following unsuccessful attempts to protect the heath hen, the Commonwealth of Massachusetts committed considerable financial and personnel resources to the establishment and management of conifer plantations in the early and mid-20th century in anticipation of strong financial return and to develop a significant timber resource on land that was perceived as worthless at the time.
   - Approximately 23% of MFCSF was converted to conifer plantation in two major periods: 500 acres from 1925–41 and over 625 acres in the mid 1960s. In contrast to most of New England, less than 4% of these plantations were established on old fields. The early plantings were established by directly planting seedlings in scrub thickets, whereas planting in the 1960s used a Lother planter to plow a furrow in the scrub for conifer seedlings. Importantly, both methods involved only modest soil disturbance and allowed the widespread persistence of native herbs, shrubs, and trees in the resulting plantations.
   - Over 30 miles of roads and firebreaks (generally 25–75' wide) were established in a rectilinear grid

through plowing and harrowing, and have been maintained through a regular regime of mowing.

6. Despite expectations early in the century, conifer plantations on MFCSF have proven to be economically unfeasible and have generally produced poor quality timber as a result of poor growth, widespread disease, and wind damage. Today, conifer plantations on MFCSF threaten native vegetation, represent a significant fire hazard, and are poised for increasing damage from winter storms, hurricanes and pathogens.

    - Attempts to conduct commercial sales in the 1960s yielded no bids over a five-year period.
    - A contract to Vineyard Pine Lumber Company in the 1970s to 1980 yielded little to no profit to the Commonwealth or contractor.
    - A sale exceeding 300,000 BF in the early 1980s yielded unclear results.
    - Salvage logging of 420,000 BF of sawlogs after Hurricane Bob in 1991 was completed at a cost to the Commonwealth of $49,400 plus timber rights.
    - A persistent lack of local operators and markets, generally poor timber quality, and high frequency of damaging storms make plantation forestry on MFCSF economically unfeasible. It is not anticipated that the prospects for profitable plantation forestry on MFCSF will improve in the future.

7. Over the past century as fire and intensive cutting of native woodlands have declined, the forests and scrubland have aged and increased in height relative to historical conditions. The vegetation and land cover of MFCSF is currently: 56% hardwood forest, 23% plantations, 12% scrub oak, <7% pitch pine and oak, <4% fire breaks, roads, and grassland.

8. Our management recommendations are based on the following considerations:

    - Due to it's large size, history of minimal agriculture and soil disturbance, widespread dominance by native vegetation, and public ownership, the MFCSF presents an unusual opportunity to protect and restore an extensive sand-plain ecosystem dominated by scrub oak, tree oak, and pitch pine communities. Through proposed restoration efforts, this landscape could become a functioning example of a globally uncommon vegetation harboring numerous uncommon species.
    - The MFCSF has a remarkable history of fire, low intensity land-use, and plantation establishment that has enabled the widespread persistence of native vegetation and provides an opportunity to conserve large expanses of sand-plain woodland and scrubland.
    - The conifer plantations are unprofitable, threaten native communities and uncommon plant and animal species, and will be increasingly subject to windthrow and disease through time.
    - The physical, cultural, and biological setting of MFCSF mandate pro-active fuel management through mechanical means and prescribed fire.
    - Extensive sand-plain grasslands, although historically absent on the central plain, currently provide habitat for several rare plant species and may be maintained through coordinated management of the airport, existing fire lanes, and additional fire breaks that may be necessary at the northern and eastern boundaries of MFCSF.
    - The unusually small area of historical soil disturbance, the remarkably intact condition of the native vegetation, and the increase in weedy and non-native species in hurricane salvaged areas and other sites of recent soil disturbance, mandate that management activities conducted on MFCSF should minimize soil scarification, particularly in areas that have not been plowed historically.

9. In order to restore a functioning sand-plain landscape, increase the area of dominance by native vegetation, minimize future damage to plantations and economic loss to the Commonwealth, and improve fire control, we propose the following:

    - Eliminate all young (10–35 yr old) plantations by stem cutting or fire, thereby releasing native vegetation.
    - Convert older, open plantations with native understories to native dominance by cutting or girdling of planted conifers (minimizing soil disturbance), followed by controlled fire to eliminate white pine regeneration.
    - Establish small-scale experiments to evaluate appropriate treatments for vigorous, older plantations that lack native understories, and wind-damaged and salvaged plantations with extensive soil disturbance and weedy species.
    - Expand firebreaks along the northern and eastern boundaries of MFCSF using tree cutting, scrub mowing and/or controlled fire to reduce fuels and improve access without substantial soil disturbance.
    - Conduct comprehensive inventories to determine the distribution, abundance, and habitat requirements of rare plant and animal species on MFCSF.
    - Maintain and restore a sand-plain ecosystem consisting of extensive scrub-oak bottoms, white, black, and post oak woodlands (especially those with ancient oak stools), and pitch pine stands.

## INTRODUCTION

Throughout the northeastern United States, sand-plain ecosystems are priorities for conservation because they are uncommon, support numerous rare or uncommon plant and animal species, serve important aquifer recharge and groundwater storage functions, and are highly threatened by development. Within the region, sand plains are most widespread along the coast, particularly on Cape Cod, the Islands, Long Island, and in the Pinelands of southern New Jersey. Increased pressure to develop these areas for tourism and for industrial, commercial, and residential purposes poses a significant threat to several globally imperiled species and natural communities. In addition, because many sand-plain communities are highly flammable, development in and near these areas increases the potential for extremely dangerous and costly wildfires. Thus, strategies for conserving sand-plain ecosystems in the Northeast must address both ecological and public safety concerns.

The challenge of protecting functioning sand-plain ecosystems while accomodating tourism and development and reducing wildfire hazard is particularly acute on the island of Martha's Vineyard. The Great Plain that forms much of Martha's Vineyard supports an unusual concentration of rare species and extensive examples of several uncommon sand-plain communities, including grasslands, heathlands, barrens, and woodlands. The area also serves critical groundwater protection and open space functions. However, the unprecedented growth in the year-round and seasonal populations of Martha's Vineyard since 1970 and the associated increase in developed land significantly threaten the natural sand-plain ecosystems of Martha's Vineyard while increasing the potential for catastrophic damage to human life and property from wildfire. Thus, there is a critical need to integrate long-term land-use, conservation, and wildfire hazard reduction planning on the Island. Fortunately, several thousand acres of the Great Plain of Martha's Vineyard are owned by the Commonwealth of Massachusetts and by private conservation organizations, forming one of the largest permanently protected sand-plain landscapes in the Northeast and supporting extensive scrub oak and tree oak natural communities. Appropriate management of these protected lands is critical in order to acheive conservation and public safety objectives.

In the current study, which was commissioned by the Massachusetts Biodiversity Initiative in cooperation with the Massachusetts Department of Environmental Management, we review the ecological and land-use history of the 5,200 acre Manuel F. Correllus State Forest on Martha's Vineyard as background for management recommendations that are intended to accomodate ecological considerations as well as public safety concerns. Because the State Forest represents the largest and most significant area of protected land on Martha's Vineyard, the Commonwealth of Massachusetts has an unusual opportunity and responsibility to manage these lands in a manner that will ensure their long-term ecological integrity while protecting public safety.

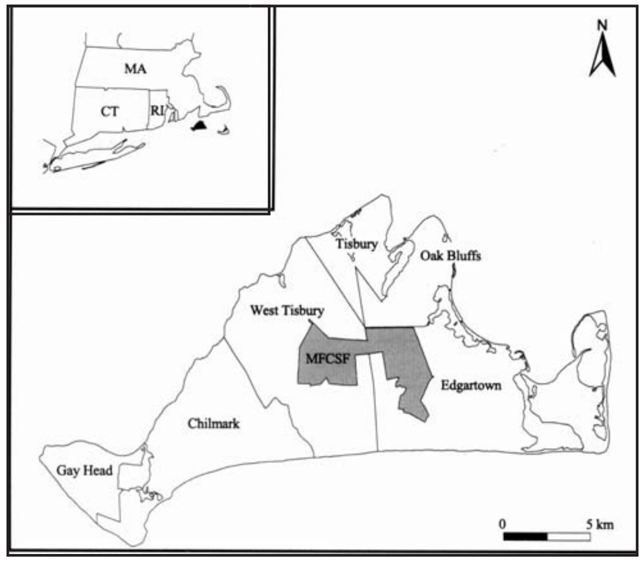



**Figure 1**. The Island of Martha's Vineyard depicting town boundaries and the location of Manuel F. Correllus State Forest (shaded).

## BACKGROUND

In 1908, the Commonwealth of Massachusetts purchased 612 acres of land in the center of Martha's Vineyard in an attempt to protect habitat for the heath hen, an eastern subspecies of the prairie chicken that was threatened with extinction. Although efforts to preserve heath hens were ultimately unsuccessful, the importance of protecting and managing the Reservation for other resource, conservation, and recreation objectives was recognized, and in the following 90 years, additional land was purchased to form what is now the ~5,200–acre Manuel F. Correllus State Forest (MFCSF; Fig. 1) managed by the Department of Environmental Management (DEM). Management objectives for this property have changed over time in response to changing cultural, biological, and economic conditions, and increased understanding of sand-plain ecosystems.

Early management by the Division of Forestry focussed on the establishment of large conifer plantations and firebreaks in the hopes of converting land that was perceived as worthless into a productive source of timber. Considerable effort and financial resources were dedicated to expansion and management of these plantations over subsequent decades. However, since at least the 1970s, serious concerns have developed regarding the feasibility of timber production on the Island. Although many of the plantations had grown well initially, substantial effort was required to develop merchantable trees, and local markets for forest products were extremely limited. In addition, pathogens, winter storms, and hurricanes damaged hundreds of acres of plantations, rendering them valueless, aesthetically undesirable, and increasingly prone to fire. Simultaneously, changing conservation perspectives prompted consideration of the value of State Forest lands for non-timber purposes, especially protection of rare species and communities.

As early as 1962, the Department of Natural Resources emphasized the importance of the area for recreation, wildlife, and groundwater protection. The Martha's Vineyard State Forest Advisory Council was established in 1975 in order to identify long-term objectives and to develop management guidelines for the State Forest. A draft management plan emphasized management for wildlife and recreation and questioned the advisability of further plantation establishment and maintenance (Whiting 1976). In the early 1990s, extensive damage to plantations from Hurricane Bob prompted DEM to establish the MFCSF Technical Advisory Committee in order to develop a management plan that addressed the need for wildfire hazard reduction as well as ecological and recreational values. Based on the considerable expertise of members of the Committee, a draft ecosystem management plan was developed (DEM 1994b). However, adopting specific guidelines for wildfire and ecological management has subsequently proved difficult, in part because limited information on potential wildfire behavior, land-use and vegetation history, and restoration potential has contributed to lack of agreement on appropriate ecological priorities and restoration objectives.

In 1998, two studies were commissioned to address the ecological status of MFCSF and fire management. Dr. William Patterson III is investigating fuel characteristics and potential wildfire behavior to provide specific guidelines for wildfire hazard reduction with support by the U.S. Forest Service and DEM. In the current study, funded by the Massachusetts Biodiversity Initiative and in collaboration with DEM, we investigated vegetation, land-use history, and modern landscape conditions of MFCSF in order to propose ecological objectives and management guidelines. Together, these studies are intended to facilitate the development of an ecosystem management plan that will protect important ecological values while reducing fire hazards.

In previous studies of sand-plain communities in the Connecticut Valley of Massachusetts, we determined that historical land use, particularly agriculture, exerts a strong and persistent influence on modern vegetation, even many decades after farm abandonment and reforestation, and after subsequent disturbances such as fire (Motzkin *et al.* 1996, 1999). These results suggest that conservation, restoration, and management of such sites must be based on a detailed understanding of the history of local and regional land-use (Foster *et al.* 1998; Foster and Motzkin 1998). Thus, specific objectives for the current study include: 1) to document the pre-European to modern history of vegetation and land-use on MFCSF; 2) to assess the ecological value of MFCSF based on this history and modern conditions; and (3) to propose management alternatives based on this history and ecological values. Although our study focusses on MFCSF, we first place the State Forest in the context of the Great Plain and Martha's Vineyard, and then consider aspects of the pre-European landscape that relate to our more detailed discussion of historical land-use and vegetation of MFCSF.

## MARTHA'S VINEYARD AND THE GREAT PLAIN

Martha's Vineyard and the outwash plain that contains MFCSF (Fig. 2) offer among the best historical records of land cover and land-use change in New England. The Island was settled early in the region's history and its limited area and historical and geographical importance for commerce, science, and recreation have resulted in the development of extensive federal, state, municipal, and private documentation of its marine and terrestrial resources. In particular, excellent cartographic sources document land cover and land use changes on the outwash plain relative to the surrounding morainal regions over a 300-year period. These sources include: early

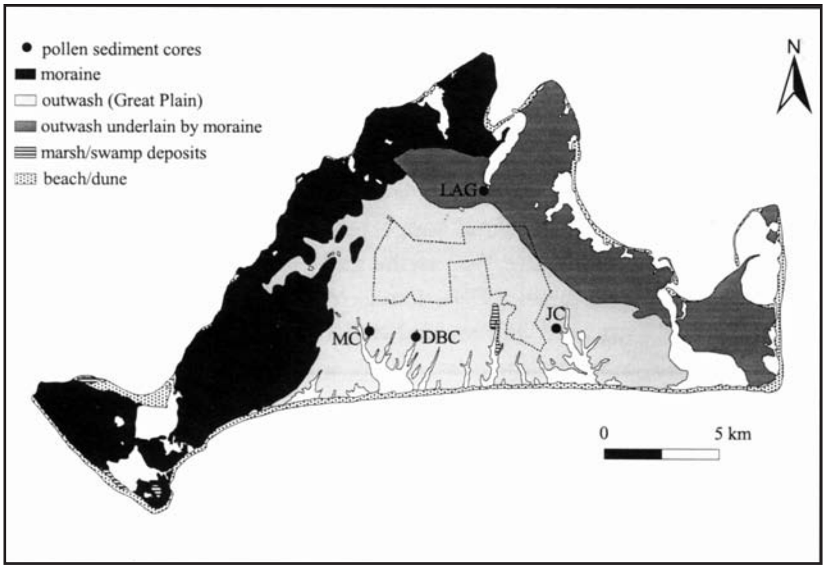



**Figure 2.** Generalized surficial geologic map of Martha's Vineyard showing the location of Stevens' (1996) sediment core sites referred to in the text in relation to MFCSF: Deep Bottom Cove (DBC), Lagoon Pond (LAG), Jane's Cove (JC) and Muddy Cove (MC). Surficial geology modified from Oldale and Barlow (1986).

explorer maps and accounts, coastal and geodetic surveys, geological studies, state-mandated surveys, Commonwealth management records, and aerial photographs. Using these records it has been possible to develop a very robust interpretation of the history of vegetation cover, fire, and land-use practices in MFCSF that control current characteristics of the area and provide guidance to future management objectives and approaches.

**Overview of Historical Transformations**

Like most of New England, Martha's Vineyard underwent a remarkable transformation in cultural activity and appearance over the past 350 years (O'Keefe and Foster 1998). Following an early period of settlement and subsistence activity, the land was progressively cleared for agriculture, and woodland areas were cut for fuelwood and other wood products as an expanding population lived off the natural resources of the land and surrounding water. This activity reached a peak in the 19th C when the population was well-distributed around the perimeter of the island in an agrarian landscape dominated by agricultural lands, grazing animals, and sprout woodlands (Crevecoeur 1784; Dunwiddie 1994; Foster 1999). Although the population continued to grow through the 19th C and increased significantly in the second half of the 20th C, cultural activity changed markedly as food, fuel, and other resources were increasingly imported from other regions, and as people became less tied to the land and the sea. As a consequence of the decline in agricultural activity, farmlands reverted to shrubland and woodland, and trees in the woodlands grew older and larger (Dunwiddie 1994). In this section of the report, we document the unique characteristics of this general pattern for Martha's Vineyard, examine the extent to which MFCSF was affected by agricultural, industrial, and woodland land-use activities, and evaluate the influence of this lengthy history on the modern landscape.

Edgartown, the first permanent European settlement on Martha's Vineyard, was established in 1642 and the proprietors rapidly commenced dividing and settling the land. Documents from this early period refer to fields, corn hills, and scattered population centers along the coast, confirming that pre-historical activity undoubtedly influenced the vegetation and the landscape that the Europeans encountered. Historical and archaeological sources indicate that as many as 3,000–3,500 Indians inhabited the Island in the early 17th century, a density greatly exceeding that of the upland areas of New England (Cook 1976). This pre-historical population had the potential to modify the landscape locally around the four or five main villages through firewood collection and woodland clearing, and to alter vegetation composition and structure more extensively across the island through the use of fire. Recent archaeological syntheses suggest, however, that Late-Woodland period Indians throughout coastal New England including Martha's Vineyard were largely dependent on marine-resources, with relatively limited maize agriculture (Bragdon 1996). As the European population grew in the 17th C and as disease decimated the native population, the size and influence of the Indian culture dwindled in absolute and relative terms.

The towns of Chilmark, Takemmy (Tisbury), and

West Tisbury were settled in the second half of the 17th century, and coastal areas along the south and north shores and the better agricultural soils on the moraines were progressively settled and cleared. As the population grew, the land changed dramatically as a result of increasing pressure on natural resources. By 1670, the European population on the Island was estimated to be 180 (Banks 1911) and by the 1680s the proprietors of Edgartown voted to limit the taking of firewood on town common lands (Dunwiddie and Adams 1994). During the first two-thirds of the 18th C, the island population increased seven-fold and inhabitants came to feel that the capacity of the island was being reached, as indicated by a letter from 1762 stating that "[The] Island has now as many inhabitants as the Land will comfortably support" (Banks 1911). Although the sea provided many resources, obvious intensive impacts occurred first on the land where the forests were cleared for grazing and tillage and the remaining wooded areas were repeatedly cut for wood.

Agriculture focussed extensively on sheep and cattle grazing with animals remaining outside through much of the winter in this maritime climate. The number of domestic livestock grew to a peak in the early 1800s when the Island supported approximately 15,000 sheep, 2,800 cattle, 800 swine and 400 horses (Freeman 1807; Van Tassel 1974). Land clearance for agriculture, housing, and commercial activity was concentrated on the morainal areas extending from Gay Head to Tisbury to Oak Bluffs and Edgartown, and along a narrow stretch of the coastal fringe on the southern outwash plain. In contrast, the consistent appraisal of the broader outwash plain comprising the Great Plain and the MFCSF was that it was worthless and uninhabitable. As a consequence, a clear division of land-use activity and land-

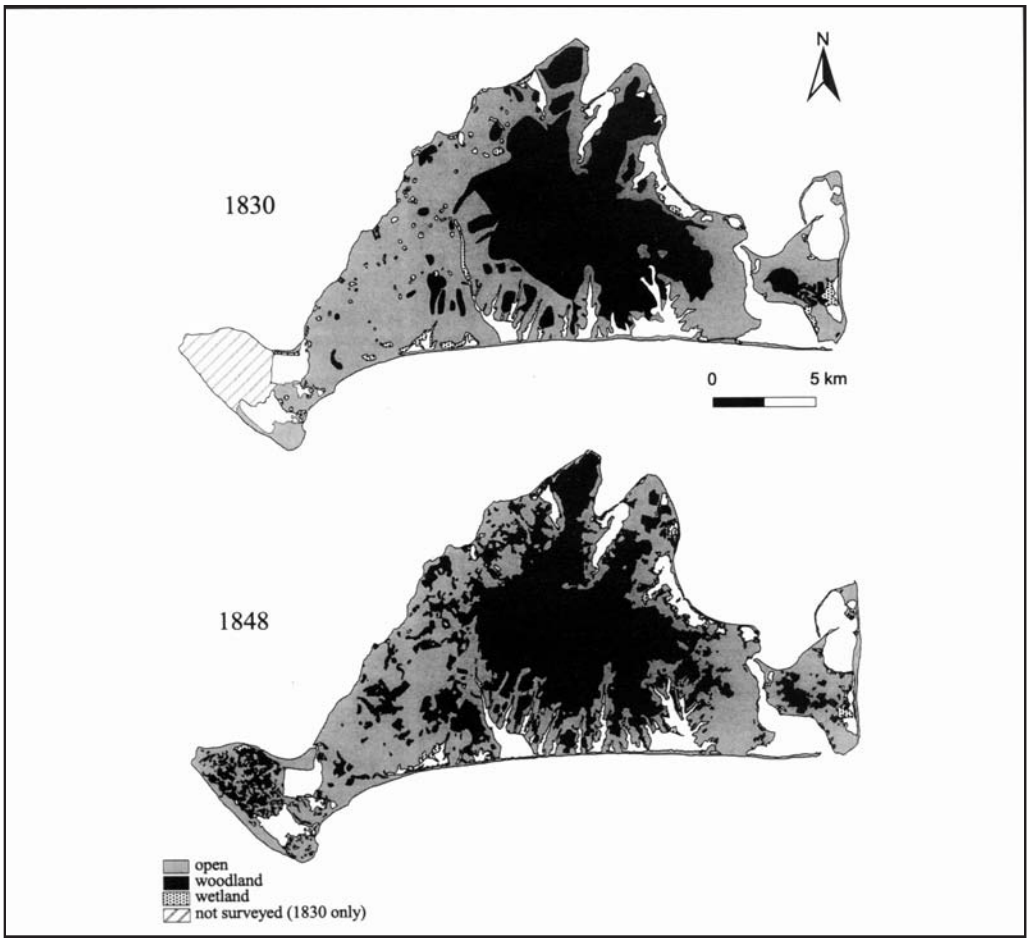



**Figure 3.** Land cover on Martha's Vineyard in 1830 and 1848 illustrating the historical extent of woodland and the striking agreement between maps that were developed independently. From Massachusetts Archives (1830) and U.S. Coast and Geodetic Survey (1848).

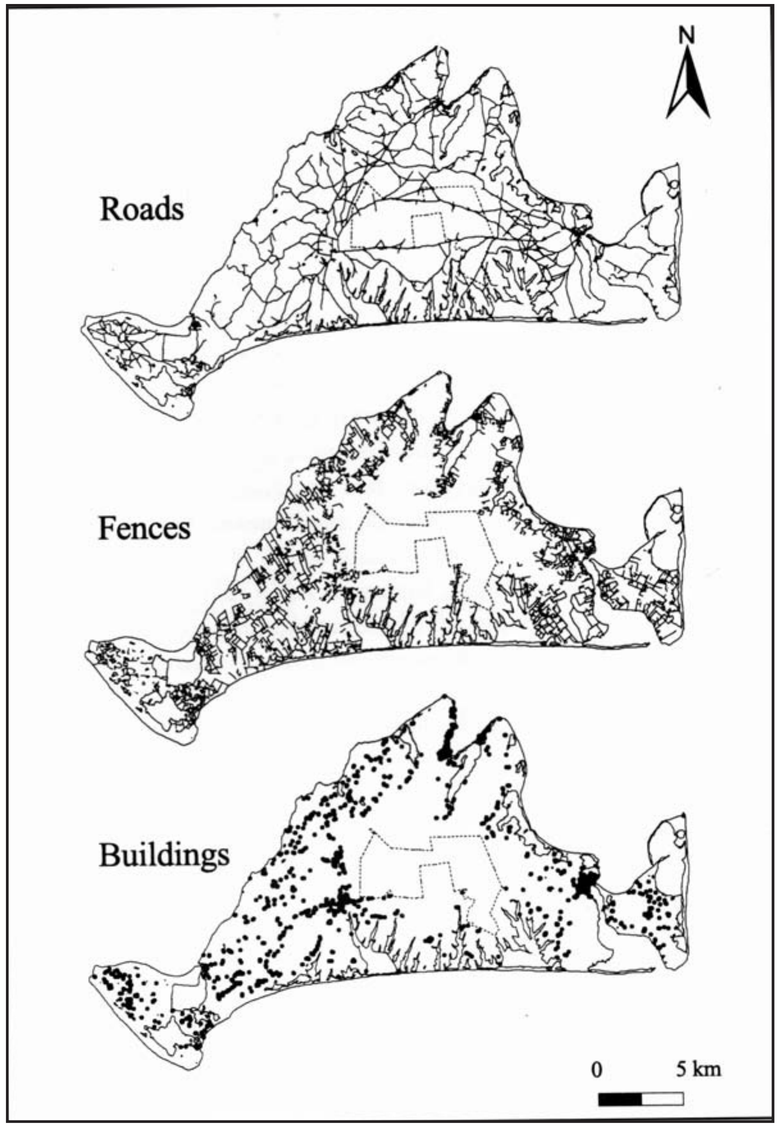



**Figure 4.** Location of roads, fencelines, and buildings on Martha's Vineyard in 1848. Note the absence of fences or buildings in the central portion of the Great Plain that includes MFCSF (dashed line). From U.S.Coast and Geodetic Survey (1848).

cover patterns developed across the Island, as indicated on mid-19th C maps (Fig. 3; Massachusetts Archives 1830; USCGS 1848). Woodland and shrubland cover was largely confined to the central and northern outwash plain, extending north into Tisbury with limited areas on Chappaquidick and Gay Head. In contrast, the hills of Chilmark, West Tisbury, Tisbury, and Edgartown were cleared and enclosed by a dense pattern of fencing and thickly settled with houses (Fig. 4). Throughout the 17th, 18th, and 19th C, few fences or dwellings were indicated on historical maps for the central portion of the outwash plain. Thus, much of the Great Plain came through the agricultural period as woodland or shrubland, albeit cut intensively and repeatedly for fuel.

The landscape pattern during the period of widespread agricultural activity is well described in an 1860 travelogue published by Harper's Magazine in which the contrasting views from a hill in West Tisbury are striking. In the direction of the State Forest the view was of "a plain, chiefly covered with a growth of stunted shrubbery...", whereas towards Chilmark "is a tumult of hills, grass covered, specked with flocks of sheep and broken with numerous and detached rocks" (Strother 1860).

In the 19th century, agriculture on Martha's Vineyard began the same decline that occurred across the northeastern U.S., and the extent of actively managed grazing and tillage land declined as broad areas reverted to shrubs and trees. Although the population continued to increase, there was a shift towards denser housing in villages. Outlying farms fell into disrepair, creating a scene that Nathaniel Shaler described in 1874: "agriculture here is in decay...One never sees a field newly won

**Table 1.** Major fires on Martha's Vineyard from 1855 to 1990. Data compiled from the *Vineyard Gazette* (VG) newpaper, DEM (1994a,b), and unpublished data of Tom Chase (TC) and Steve VanCour (SV) as modified from Dunwiddie and Adams (1994). Fires <100 acres are generally excluded prior to 1950. After 1950, all fires >20 acres are listed.

| Year | Date | Size (ac.) | Location - landform |
|---|---|---|---|
| 1855 | 4/6 | large | Willis Plain (Great Plains) (SV) — outwash |
| 1867 | 4/26 | 4000 | near Lagoon (SV) |
| 1875 | 7/9 | 7-10,000 | Quompacha Bottom (SV) — outwash |
| 1883 | 8/11 | | Vineyard Haven town fire — moraine |
| 1885 | 4/3 | small | Gay Head-Chilmark boundary — moraine |
| 1886 | 5/2 | 1000s | near Vineyard Haven, West Tisbury |
| 1889 | 3/24 | 4000 | Quampeche Bottom — outwash |
| 1892 | 4/8 | 5-8000 | near Middletown (VG), Lagoon Heights (SV) |
| 1894 | June | large | Location unknown (DEM 1994b; Gross 1928) |
| 1900 | 4/26 | 5000 | Scrubby Neck toward Edgartown — outwash (DEM 1994b) |
| 1906 | 5/17 | | Innisfail Hotel (Oklahoma) burns in forest fire |
| 1909 | 7/22 | 10000 | on Plains (DEM 1994b) |
| 1914 | 12/24 | 1200 | western Great Plains to Katama — outwash |
| 1916 | 5/18 | 12000 | West Tisbury to Farm Neck, Ocean Heights, and Edgartown — outwash |
| 1920 | 8/5 | | large Vineyard Haven fire |
| 1926 | 5/13 | 6400 | West Tisbury toward Ocean Heights — outwash |
| 1927 | 4/29 | 6400 | from Dr. Fisher Road to Edgartown — outwash |
| 1927 | 5/23 | 6400 | from Dr. Fisher Road toward Edgartown — outwash |
| 1928 | 4/27 | small | Indian Hill Road — moraine |
| 1929 | 4/5 | 2500 | Watcha to Tiah's Cove, Waldron's Bottom, to Oyster Pond — outwash |
| 1929 | 5/3 | 2560 | Waldron's Bottom — outwash |
| 1929 | 7/2 | small | Tashmoo/Herring Creek — moraine |
| 1930 | 5/9 | 200 | West Chop - moraine |
| 1930 | 5/16 | 5000 | between Edgartown and Oak Bluffs — outwash |
| 1930 | 6/6 | 1000 | North to Northeast through State Forest — outwash |
| 1932 | | | Two fires in State Forest (DEM 1994a) |
| 1935 | 3/29 | 4000 | Edgartown Great Pond to Katama — outwash |
| 1936 | | | 8 Fires, none in State Forest (DEM 1994a) |
| 1937 | | | Chappaquidick (DEM 1994a) |
| 1939 | 3/31 | 4000 | Quampacha Bottom on Dr. Fisher Road to Vineyard Haven Road (TC) — outwash |
| 1940 | 5/17 | 1000 | State Forest near Edgartown - Vineyard Haven Road — outwash |
| 1942 | 5/26 | 350 | Job's Neck Pond to Jayne's Cove, G. Flynn — outwash |
| 1942 | | 1200 | near Edgartown Great Pond (DEM 1994b) |
| 1944 | | 240 | in MFCSF (DEM 1994b) |
| 1946 | 4/19 | 5120 | Head of Tisbury Great Pond towards Edgartown/Oak Bluffs — outwash |
| 1948 | 9/3 | 300 | South & West towards Clevelandtown/Edgartown Airport — outwash |
| 1951 | | | 10 fires on the Island (DEM 1994b) |
| 1954 | 4/9 | 1000 | between Barnes Road, Wing Road and Edgartown-Vineyard Haven Road —outwash |
| 1954 | 5/29 | 2500 | Tiah's Cove, West Tisbury to Edgartown — outwash |
| 1954 | 7/16 | 100 | Chappaquiddick near four corners — eastern moraine |
| 1957 | 4/19 | 35 | near State Highway at Deep Bottom — outwash |
| 1957 | 5/3 | 100 | North of Chilmark cemetery, toward Chilmark Pond — western moraine |
| 1958 | 6/13 | | east and north from State Forest — outwash |
| 1959 | 4/24 | 25 | between Old Courthouse Road and State Highway — outwash |
| 1959 | 5/8 | 500 | West Tisbury Road near Deep Bottom — outwash |
| 1960 | 4/22 | 25 | Katama — outwash |
| 1963 | 10/25 | 300 | Quampache Bottom to West Tisbury Road — outwash |
| 1965 | 12/18 | 1200 | Great Plains to Katama (TC) — outwash |
| 1971 | 5/14 | 20 | Oklahoma, Tisbury |
| 1975 | 4/25 | 50 | Northeast from Edgartown dump |
| 1976 | 12/31 | 85 | Edgartown: Herring Creek Road Katama Airfield — outwash |
| 1987 | 7/31 | 20 | Oak Bluffs behind Crosslands Nursery (TC) — outwash |
| 1987 | July | ~8 | State Forest |

from the forest, while on every side there are signs of the gains of the woods on the fields. There are many deserted houses...[The plains] along the south shore...were once cleared and cultivated but now the fences are falling away and...a few sheep...are all that mark the presence of man." Agricultural decline is documented in the dwindling number of sheep: from the maximum of 15,000 in 1807, there were 9225 reported in 1880, 1940 in 1931, and only 611 in 1938 (Freeman 1807; Banks 1911, Dunwiddie and Adams 1994). Food from off-island, coal from the mid-west, and a wide range of products that were produced in the factories of the industrial revolution brought competition with old ways of life on the Island and both compelled and allowed islanders to reduce their need to work the land. Gradually, the countryside increased in woodland cover and the forests became older, more dense and more wild, as is well-documented in Peter Dunwiddie's *Martha's Vineyard Landscapes: the Nature of Change* (1994).

This process has continued throughout the 20th C, despite the recent development boom. In the mid 1950s, Pete Ogden concluded in his survey of the vegetation of Martha's Vineyard that although there were many woodlands (i.e. areas of small trees) at that time, there were no forests of large trees on the entire Island (Ogden 1958). Some forty years later, the woodlands have grown and aged, forests of mature trees are now widespread, and many panoramic vistas are obscured. However, recent pressure for additional housing and recreation has led to the current trend of widespread development, fragmentation of properties and natural areas, and a decline in the total area of natural woodland, shrubland, and grassland (The Nature Conservancy 1997).

### Disturbance Processes

Through much of the historical period, three important disturbance processes strongly influenced the structure of woodlands on Martha's Vineyard: fire, hurricanes, and forest cutting.

***Fire.*** From the early historical period onward, the Great Plain in the center of the Island has experienced numerous fires. A fairly comprehensive record of fire activity extends from the mid-19th C to the present and documents the characteristics of the historical fire regime (Table 1). Although detailed information is unavailable for most historical fires, a number of notable conclusions emerge: fires were frequent and typically occurred in the spring from late March to early June; many fires were large, exceeding one thousand acres; the predominant direction of movement for large fires is from southwest to northeast; and during the last four decades there has been a substantial decline in area burned (Table 1). As a consequence of the general pattern of spread, many large fires that were ignited in the inhabited parts of the coastal plain or western moraine subsequently spread eastward and northward onto the Plain where the highly flammable vegetation, level terrain, and unbroken expanse allowed fires to spread rapidly. This pattern is well-illustrated for fires in 1930 and 1946 that are visible on aerial photographs from 1938 and 1952 (Fig. 5). In both cases the fires ignited south of the State Forest and spread to the north and east, eventually burning as broad fronts that crossed large portions of MFCSF. Due to the size of the State Forest and the continuity of highly flammable fuel that it has supported though the historical period, it has presumably received the highest fire frequency on the Island. In contrast, the western moraine, with it's rolling terrain, mesic vegetation, large number of firebreaks, and relatively protected position near the coast, is among the areas least susceptible to fire.

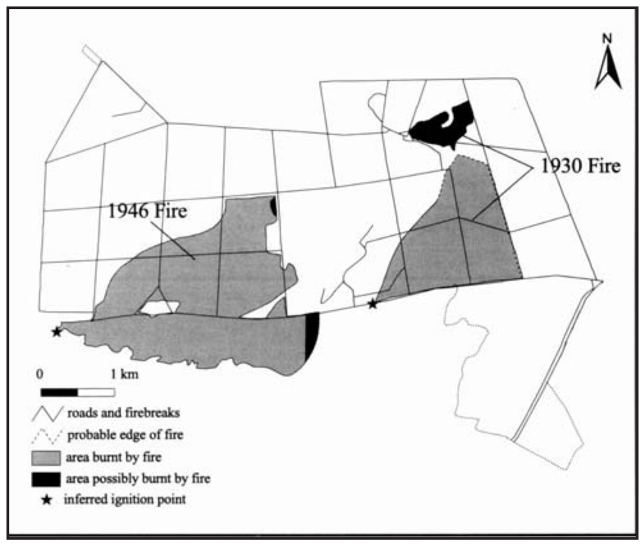



**Figure 5.** Approximate location of 1930 and 1946 fires in MFCSF, as interpreted from 1938 and 1952 aerial photographs.

Relatively little information is available concerning the ecological effects of fire on Martha's Vineyard but substantial information exists for other sand-plain vegetation from which to derive a general notion of its role on the State Forest (Patterson *et al.* 1983 and unpublished data). Intense surface fires, which are characteristic of these areas, tend to kill the above-ground vegetation and, depending on season and fire frequency, may reduce the surface organic matter substantially. However, essentially all of the dominant and common trees, shrubs, and herbs in this vegetation have effective means of vegetative or sexual regeneration and regrow rapidly following most burns. Consequently, fire has the effect of creating new age classes of above-ground stems and is partly responsible for the complex pattern of vegetation structure and age distribution that currently exists across the Plain. Many questions remain regarding site-specific fire histories and impacts on the State Forest that are beyond the scope of this study, notably: contrasting pre-European and historical fire frequencies; attempting to decipher the actual pattern of individual fires and their relationship to current vegetation patterns; evaluating the current and projected distribution of fuel loading and its influence on fire patterns (Patterson in prep); and assessing the changing response of vegetation to fire as the interval between fires exceeds what it was historically.

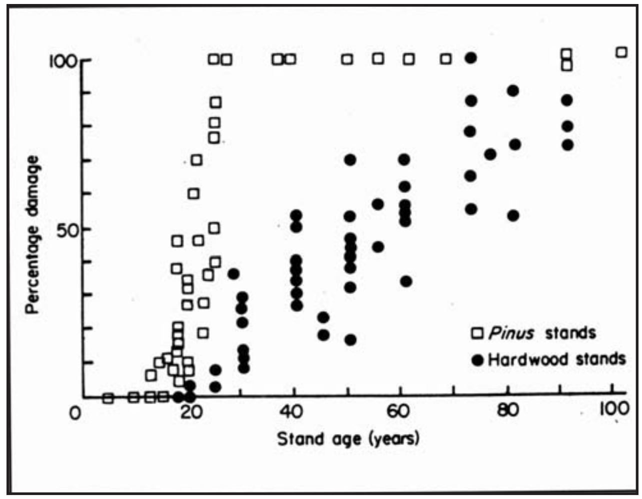



**Figure 6.** Relationship between the age (and therefore height) of forest stands and damage suffered in the 1938 hurricane in central New England. Notably, pine stands are much more susceptible to wind damage and damage from all types increases greatly with age. From Foster (1988).

***Wind.*** Hurricanes and other intense wind events, especially northeasters, have the potential to influence island vegetation through direct wind damage and through stress and mortality from salt-loading. Wind damage is strongly controlled by species composition and vegetation height (Fig. 6; Foster 1988) and, in general, the low, shrubby, and oak-dominated vegetation of the Plain has probably been highly resistant to uprooting or breakage throughout the historical period. However, with the decline in forest cutting, fire, and farming, the height and extent of forest have increased and the potential for wind damage has undoubtedly increased. On MFCSF, wind susceptibility has been greatly accentuated over the past 50 years through the extensive development and growth of conifer plantations. Many conifers are highly susceptible to uprooting and breakage and their tendency to overtop nearby hardwoods increases this vulnerability. The overall threat of wind damage and the differential susceptibility of native species versus the introduced conifers (including white pine) is well-illustrated by the damage patterns resulting from Hurricane Bob in 1991. Across MFCSF extensive windthrow, uprooting, and crown and branch damage occurred in plantations of white, red and Scots pines, leading to the need for widespread and ongoing salvage logging and clean-up. In contrast, scrub-oak stands were undamaged, tree oaks suffered minor damage, and only scattered uprooting and crown damage occurred in stands of pitch pine and pitch pine-oak.

Salt spray is a chronic stress for coastal plants, whereas farther inland, salt exposure is much more episodic and associated with intense wind events. Although the impact of salt spray on broad-scale patterns of vegetation structure and composition is conjectural, observations of plant mortality and extensive crown die-back of white pines on Martha's Vineyard and Nantucket after major storms (P. Dunwiddie pers. comm.) suggest that this is another important, though subtle consequence of wind impacts that may influence the vegetation.

Results from a regional analysis of hurricane history for New England from 1635 to the present (Boose *et al.* 1994, Foster and Boose 1995) provide a perspective on the relative importance of tropical storms on Martha's Vineyard. Coastal areas ranging from Narragansett Bay through Cape Cod have experienced among the highest frequency of damaging storms within this 360 year-period. Although two of the strongest storms in New England history, those of 1815 and 1938, were centered west of the islands and had a greater impact on southern and central New England, major storms that had a substantial impact on Martha's Vineyard occurred in 1635, 1727, 1761, 1804, 1815, 1841, 1869, 1938, 1944, 1960, and 1991 (Fig. 7). Thus, major tropical storms have occurred on average every 30 to 40 years, a return interval that is much shorter than the rotation time required to grow merchantable timber. In addition, since damage is very strongly affected by the nature of the vegetation, we would expect that the ecological and economic impact of these storms will continue to increase substan-

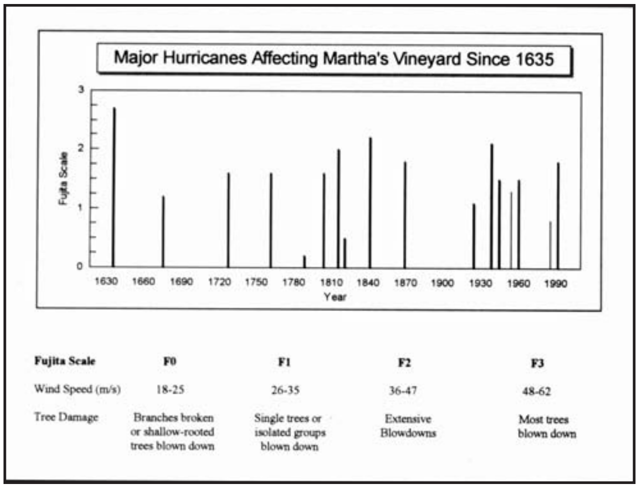



**Figure 7.** Major hurricanes affecting Martha's Vineyard since 1635. The HURRECON model (Boose *et al.* 1994) was used to reconstruct storms affecting Martha's Vineyard. The Fujita Scale of wind speed and damage describes the relative intensity of damage of hurricanes. The 1635 hurricane is estimated as the most powerful and would have blown down most tall trees. These estimates are corroborated by eye-witness accounts by Governor William Bradford of the 1635 storm in Plymouth.

tially as the forests grow and mature. In particular, the high frequency of hurricanes and winter storms and the great vulnerability of the conifer plantations indicates that the plantations will be increasingly damaged in the future.

***Forest Cutting.*** Beginning in the 17th century, settlers harvested a wide range of forest products, leading to early concern over wood shortages. The widespread depletion of firewood in the remaining woodlands is suggested by Rev. James Freeman's 1807 description that "most swamps are covered with brush, some are cleared for meadows...some contain peat which, as wood has grown scarce, begins to be much used." Freeman further documented the extent of wood shortages, stating that "In Chilmark there is not half enough fuel for the inhabitants...most of Edgartown's firewood is brought from Buzzard's Bay, Waquoit and Coxit." Along the north shore, wood was depleted for home use and increasingly through the 1800s to fire a large brickworks. Based on an immense clay deposit, this brickmaking operation produced up to 600,000 bricks annually until the 1870s when the exhaustion of the local firewood forced its closure (Banks 1911). Unfortunately, as is the case through much of New England, detailed and site specific data on firewood and timber harvests on Martha's Vineyard are not available throughout most of the historical period. In fact, the only relevant data on wood cutting that we have been able to find are derived from state censuses for several decades in the mid-19th century that record fuewood harvested for home use or sale (Table 2). These data indcate that 500 to greater than 1,800 cords of wood werecut each year, during a period when much of the landscape was open for agriculture. Thus, although data are limited, based on anecdotal and documentary evidence it is clear that as the forest area decreased on Martha's Vineyard through the historical period, the remaining woodlands were heavily and frequently cut.

**Table 2**. Cords of fuelwood cut on Martha's Vineyard in years recorded in state censuses. No data were recorded for other time periods.

| Year | Chilmark | Oak Bluffs | Edgartown | Tisbury | Gayhead | Total |
|---|---|---|---|---|---|---|
| 1845 | | | 168 | 500 | | 668 |
| 1855 | | | 100 | 470 | | 570 |
| 1865 | 30 | | 250 | 950 | | 1230 |
| 1875 | 233 | | 324 | 502 | 8 | 1067 |
| 1885 | 557 | 189 | 381 | 736 | | 1863 |

### Vegetation Through the Period of Intensive Agriculture and Deforestation

As the rest of the Island was transformed by agricultural land use, what happened to the central portion of the outwash plain that has become MFCSF? From the many sources that we have uncovered there appears consistent support for the conclusion that essentially the entire central plain remained wooded with forest, woodland, or shrubland from European settlement to the time of state ownership (Table 3). Throughout this period, the area of MFCSF comprised a large portion of the vast interior that was considered worthless by island inhabitants and characterized as scrubby and barren by travellers across the plain. With highly drought-prone soils, the land was poor for cultivation, and with only one or two small waterbodies, the area could not support abundant grazing animals. By default, the Great Plain became a source of fuelwood and perhaps other wood products, important resources but inadequate to render specific value to the land or to warrant the town's effort to tax owners of parcels on the central Plain (Banks 1911).

The cartographic record for the Plain offers a

**Table 3.** Historical quotes pertaining to the vegetation and appearance of the Great Plain on Martha's Vineyard that contains Manuel F. Correllus State Forest.

**1669** "...land (at) Meeshackett containing I judge 63 acres more or Less Bound with the Shrubed plain or Comon Land on the North..." (A deed reference to T. Buchard's holdings; Banks 1911. Note: Meeshackett is on the southeastern portion of the Great Plain, on the eastern side of Edgartown Great Pond. This represents one of the earliest references to shrub plains in the northeastern U.S.).

**1698** "a barren ragged plain of no town." Athearn (1698), referring to the central portion of the Great Plain

**1784** "Tisbury Wood Land." Crevecoeur (1784)

**1794** "...vast plains of bitter oaks between Edgartown and Tisbury." "Waste Land, Tisbury." Smith (Massachusetts Archives 1794)

**1807** "The soil of Edgartown is not as good as that of Tisbury and Chilmark: it is sandy and dry, but not unfavourable to the growth of corn. The soil of Tisbury is in general a heavy, gravelly loam; a portion of it is sandy, and a smaller portion inclining to clay. More than one half of these two townships is covered with shrub oak and bitter oak, is of little or no value, and is not enclosed [i.e., fenced]." Freeman (1807)

"All the houses are within a mile or two of the sea coast: the internal parts of the island will probably always remain without inhabitants. . . . they are destitute of water and left in common." Freeman (1807)

"Many goats were formerly kept on the island [sic]; but they were of little profit to their owners, and have been greatly injurious to the present generation, by preventing the growth of trees on that vast plain of bitter oaks, which lies between Edgartown and Tisbury. These mischievous animals are still to be found in the same places, but their number is unknown." Freeman (1807)

**1830** "rather thick and interspersed with short stunted oak shrubbery with the exception of a small part thereof which may be termed woodland..." Crapo (Massachusetts Archives 1830)

**1859** "Having passed from the township of Holmes Hole into Tisbury, the road lay through what would have been an oak forest, except none of the trees [exceeded] some four feet in height—[our guide] affirming this to be their mature growth, and that no larger ones had grown since the forest was cleared by the original settlers." Anonymous (1859)

**1860** [From West Tisbury] "Toward the south and east it is a plain, chiefly covered with a growth of stunted shrubbery..." Strother (1860)

**1888** "The aspect of the two islands differs greatly on account of the peculiarity of the vegetation. Nantucket is essentially treeless, while the greater part of Martha's Vineyard is forest-clad. This difference is probably owing to the greater exposure to the sea winds suffered by Nantucket, which is due to its smaller size and greater distance from the shore. In part the deforested condition of Nantucket may be attributable to the fact that for nearly two centuries its fields were used as open sheep pastures and the young trees were constantly browsed down by the flocks. Martha's Vineyard, on the contrary, has held its woods; only a small strip on the southern shore shows any tendency to become sterilized in respect to forest growth by the action of the sea winds. On the sand plain the woods are of stunted oaks and other dwarf varieties of trees. but the growth is vigorous enough to give a wooded aspect to the surface and thereby to distinguish it in a very marked way from the neighboring and otherwise similar island of Nantucket." Shaler (1888)

"In plowing, this protective covering [of vegetation and humus] is broken up and destroyed; hence very thin soils frequently do well in timber when they will make no return to tillage. This generally untillable area [the terrace drift or plain] of Martha's Vineyard has an extent of about thirty-three thousand acres. At present about twenty-five thousand acres of this area is covered by low, scrubby woods, principally composed of varieties of small oaks; the remainder consists of abandoned fields which are slowly returning to the condition of forest. Frequent fires sweep over the district, destroying the parts of trees which are above ground, but not injuring the roots, from which a tangle of stems quickly springs up. Originally this region was heavily wooded, mainly with coniferous trees, the present prevalence of the deciduous species being due to the peculiar endurance of their roots in the fires, a capacity which does not exist in the conifers." Shaler (1888)

"This woodland [across the plain] is the growth which has sprung up since the pine forests, which originally covered nearly the whole Island [sic], were swept away by the ax. Now a pine is a rare object; we may ride ten miles without seeing a specimen. But in the mysterious succession of the forest, there has come an amazing variety of oaks. The trees are all young; in most cases, from the saddle ...the eye ranges above their tops for miles over a billowy sea of deepest green. The shape of the leaves vary in a confounding fashion...The extent and unbroken character of the forest is amazing; in one direction we may journey through the woods for ten miles without a trace of habitation or culture. Through it runs a maze of paths made before the rich foliage could bar the way. The oaks seem to disdain to grow wherever a wheel has run, so the disused wood roads remain unencumbered...” Shaler (1888)

**1890** “...wide, level, sandy plains, covered with a growth of bear, chincapin and post oak scrub from knee to waist high, so stiff and matted as to be almost impenetrable.” (Brewster, in Gross 1928)

**1894** “The most conspicuous element in the vegetation is the large number of oaks which in many places form square miles of low dense woods. *Q. ilicifolia* is the most abundant species, but *Q. stellata*, *Q. tinctoria*, *Q. palustris* and *Q. alba* are also plentiful...” “All are stunted in stature, although this may be due to the fact that the timber throughout the island is second growth, and possibly the original trees may have been much larger.” Hollick (1894)

**1908** “Another track through this scrub oak wilderness is a half moon known as Doctor Fisher’s Road, built by a gentleman of the name to connect his mill in Tisbury, where water power is to be had, with Edgartown.” (Hine 1908)

**1911** “Oaks, great and small, are the principal constituents of our forests, and the great plain land is a dense jungle of the “scrub oak” which thrives despite repeated devastating fires covering large areas.” Banks (1911)

“The hills and meads of the island were clad in a rich covering of evergreen that is now all gone, and its place taken by the walnut and hickory and the endless prospect of dwarf oaks that now struggle for a parched existence on the great plains of Tisbury and Edgartown.” Banks (1911)

“Several miles of “ragged plain” separated West Tisbury, Holmes Hole [Vineyard Haven] and North Tisbury...” Banks (1911)

**1915–16** “A great plain makes up the remainder of the Island. Most of it is barren and uninhabited and is covered with scrub oaks.” Woodsworth and Wigglesworth (1934)

**1928** [the view from the old fire tower in MFCSF presents] “...an uninteresting waste with a lure and attractiveness that I could not at first appreciate...to the westward, scrub oak for miles, unbroken to the hills of West Tisbury and Chilmark...” Gross (1928)

“When you examine the miles of scrub oaks that occupy the center of the Island you readily note the very uneven surface caused by the interspersal of the taller black and white oaks which at present range from four to ten feet in height. The scrub-oak growth which occupies the bulk of the area is less than three feet in height. As one views these plains from the top of the tower there seems to be little more than the oaks already mentioned but when I traversed them on foot in quest of the Heath Hen I met with a diversity of shrubs and plants. In certain places there were dense growths of aspen, black alders, and gray birches with here and there a few scraggly specimens of scrub pine. More rarely a *Crataegus* and a wild-cherry were seen. There were numerous patches of sumac and on the plains bordering the south shore impenetrable thickets of bayberry more or less overgrown with tangles of vines. All through the scrub oaks there were masses of sweet fern and blueberries and huckleberries abounded everywhere.” Gross (1928)

“The black scrub oak, *Quercus ilicifolia* Wang., is the commonest form of the scrub oak on the plains of Martha’s Vineyard but several specimens...proved to be *Quercus prinoides* Willd. The white oak, *Quercus alba* (Linné), and the black oak, *Quercus velutina* Lam., are also common in certain parts of the island and a few are interspersed here and there throughout the plains.” Gross (1928)

**1930** “...the Great Plain, thickly grown over with scrub oak that barely reaches the height of an average man. Lonely, wind-swept and haunted by swooping hawks... the Great Plain has always been looked upon as a waste place. Scarcely anyone has ever lived there and succeeded in wresting a livelihood from the soil, not because it is infertile, but because of the early frost.” Vineyard Gazette (1930)

“Hardly a spring passes that does not see a fire started somewhere on the plains.” Vineyard Gazette (1930)

**1936** “Once the Great Plain had been wooded with conifers, but it had been cut and burned over, so that even a hundred years ago it supported a scraggly growth of scrub oak, not much larger than brush. Here and there a deformed pine or blasted oak of larger size stood above the scrub, roosting place for hawks, eagles or crows. On the Great Plain the sweet fern grew, wild flowers in profusion, and, especially after a spring fire, blueberries and huckleberries of large size and succulence!” Hough (1936)

**1969** “The Great Plain is, perhaps, the largest uninhabited stretch of land in the State of Massachusetts.” Huntington (1969)

**1994** Great Plain — “never very desirable for grazing or cultivation, was distant from settlements and had very few natural barriers to prevailing winds and the spread of fire. This area seems to have had the highest fire frequency of any area on the Cape or Islands. The resulting landscape changed little over the period documented here. Since the earliest description in 1794 the outwash plain has had a stunted, second-growth oak forest.” Dunwiddie and Adams (1994) compelling case for continuity of "worthless" shrubland and woodland (Fig. 8). The earliest map depicting the interior of the Island was compiled by Simon Athearn in 1698 and clearly identifies the broad central region as "a barren ragged plain of no town." A subsequent map by Des Barres in 1776 indicates houses and fenced fields around the perimeter of the Island, but no farms or fields on the central outwash plain. Crevecoeur (1784) depicts a broad area in the north-central part of the Island as "Tisbury Wood Land", and in 1794 Benjamin Smith mapped a somewhat smaller area in the current State Forest as "Waste Land, Tisbury" (Massachusetts Archives 1794). Interestingly, Crevecoeur's map agrees fairly well with the wooded areas represented in the more detailed 1830 and 1848 maps (Fig. 3). These maps are followed by subsequent U.S. Coast and Geodetic Survey maps from 1897 that show the woodland/shrubland area expanding onto some former agricultural lands, and depict only very limited clearing in the vicinity of MFCSF (see below).

Although these maps indicate a continuity of woodland cover across the plain, they provide little detail on the actual structure and composition of the woody vegetation or the reasons for the absence of intensive human activity and habitation. Insights into these issues, however, come from a remarkably consistent series of quotes that describe the appearance and environment of the Plain in great detail (Table 3).

A few important conclusions emerge from these historical quotes. One consistent observation throughout the historical period is that the vegetation was wooded but shrubby, composed largely of shrub and young or stunted tree oaks that provided a clear and open view to a person on horseback. The impression of "visual expanse" is notable, with many observers remarking on the miles of apparently endless or boundless plain of low wooded vegetation. The absence of any references to grassland in the central expanse of the plain is also significant and is consistent with the 1830 and 1848 maps that depict no open areas. In this regard, Nathaniel Shaler's (1888) contrast of Martha's Vineyard with Nantucket is important, because he distinguishes

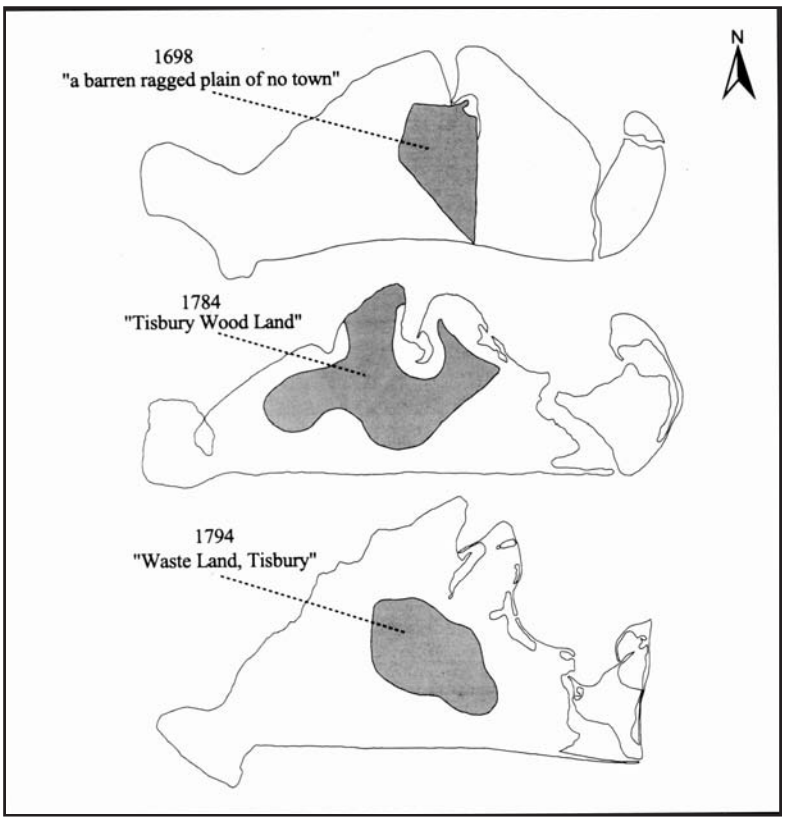



**Figure 8.** Early historial maps of Martha's Vineyard that refer to the Great Plain. Maps were simplified for clarity, but features indicated follow the original depictions. From Athearn (1698), Crevecoeur (1784), and Massachusetts Archives (1794).

between the treeless and unforested condition of Nantucket's interior as opposed to the continuously forested condition of the Vineyard's central Plain. These historical observations suggest that open grassy areas were never important across the scrub and tree oak dominated center of Martha's Vineyard. Interestingly, there is but a single reference to grazing on the central Plain, that by Freeman (1807) referring to free-ranging goats. In contrast, most observers emphasize the unenclosed (i.e. unfenced) nature of the area, and its poor quality for grazing animals. Indeed, it is difficult to imagine many animals struggling through a continuous cover of scrub oak in search of forage, especially in the absence of any surface water. Throughout the quotes we find the suggestion that trees were once more common and that cutting and fire reduced a taller cover to a second-growth sprout condition. Finally there is abundant reference to the harsh environment on the plain, including sandy soil, exposure to wind and repeated fire, and short growing seasons resulting from early and late frost. Presumably all of these factors discouraged intensive land use of the Great Plain and led to the history of dominance by low, shrubby vegetation.

The abundance of woodlands and shrublands on the Great Plain of Martha's Vineyard apparently contributed to the persistence of heath hens on the Island long after they had been extirpated elsewhere in the Northeast. A. Gross, who studied the heath hen on Martha's Vineyard in the early 20th century, described the extensive woodlands and brushy areas dominated by tree oaks and 'acorn bushes' as the primary habitat of the heath hen, in contrast to the prairie chicken, which relies more heavily on grasslands (Gross 1928). In fact, Gross (1928) refers to scrub oak acorns as "the bread" of the heath hen, providing a critical and abundant winter food source.

In summary, all historical records and descriptions from the 17th C to the present consistently describe the outwash plain in the area of MFCSF as being dominated by forest, woodland, or shrubland. Other than the farms developed along the south shore and across the moraine and its margin, there are no references to, or evidence for habitation, woodland clearing, grasslands, or fields until the development of the small farm at the site of the Forest Headquarters in the late 19th century (discussed below) and the subsequent expansion of fields by the Commonwealth of Massachusetts in an attempt to conserve the heath hen and to develop fire lanes and roads.

## Pre-historical Vegetation and Environment of the Plain

For a longer perspective on the vegetation history of MFCSF and surrounding areas, the paleoecological record provides information that extends back to the end of the last glacial period, more than 12,000 years ago. For our purposes, a record covering the last 1,000 to 2,000 years is extremely useful because it enables us to evaluate: (1) the vegetation and environment during the prehistorical period before extensive alteration by European land-use practices, (2) the extent of changes that were generated by anthropogenic activity during the last 350 years, and (3) the development of the current landscape. Specific questions addressed by pollen, charcoal, and sediment stratigraphies that are relevant to management and restoration of MFCSF include: What was the relative importance of forest and shrublands versus grasslands prior to European settlement? How abundant was pine in the pre-European landscape and how has this changed through the historical period? What was the relative frequency and influence of fire in the pre-European landscape, and how did this change with European settlement?

***Paleoecological Information — Sources and Perspectives.*** Paleoecological studies provide insights into ecosystem dynamics that are temporally continuous over a period of time (e.g., the last 500-2000 years) that is interesting from ecological and conservation perspectives and about which standard historical or archaeological approaches offer little information. However, some limitations to the approach have direct bearing for the current study. Paleoecological sites are not randomly or evenly distributed across a landscape, but are biased towards wet environments where organic sediments accumulate and are preserved. As a result of the xeric nature of the Great Plain, there are no suitable paleoecological sites within the boundaries of MFCSF (Little Pond, the only waterbody in MFCSF, dries completely during extended droughts and has been extensively disrupted by human activity; J. Varkonda, pers. comm.). In addition, there are significant taxonomic limitations inherent in pollen analysis due to the broad overlap in structural characteristics of the pollen and spores from related taxa. For example, all oak pollen is very similar, making it impossible in the present analysis not only to differentiate among red, black, white, and post oak, but eliminating the possibility of discriminating scrub-oak shrublands from forests dominated by mature oak trees. Similarly, related taxa with identical pollen may differ substantially in their ecological preferences such as upland and marsh grasses or sweet gale (*Myrica gale*), bayberry (*Myrica pensylvanica*), and sweet fern (*Comptonia peregrina*); the latter are grouped together by palynologists as *Myrica/Comptonia*. This is an unfortunate limitation given the type of ecological information that we seek. Finally, it must be emphasized that paleoecological results are often open to multiple interpretations.

Until recently, paleoecological data on Martha's Vineyard were limited to a handful of sites explored by J. Odgen, many of which provide only a snapshot view of vegetation immediately before and after European settlement or a somewhat longer term perspective on the early post-glacial landscape (Odgen 1958, 1959, 1961). Many of Ogden's studies are further complicated by the fact that they are not supported by good radiocarbon dating and relied on wetland sediments that contain a strong record of lowland vegetation that may confuse the interpretation of the surrounding upland vegetation. However, the thesis by Andrea Stevens (1996) provides an extensive series of new, continuous, and well-dated records from lake sediments that cover the period from immediately before European settlement to the present. Stevens' sites are distributed more broadly around the Island than Ogden's, particularly in areas that have more direct bearing on MFCSF. Sites utilized by Stevens (1996) include coastal ponds along the southern and northern shores and an ice-block depression in the moraine.

In the present study, we utilize the results from four of Stevens' (1996) sites that are closest to MFCSF (Fig. 2) and most relevant to the vegetation, disturbance history, and management of the State Forest (Table 4). The four sites all lie within 1–2 km of MFCSF, with three along the southern boundary (Muddy Cove, Deep Bottom Cove, Jane's Cove) and one to the north (Lagoon Pond). All are coastal ponds, which introduces some complications

**Table 4.** Mean pollen and charcoal values (S.D.) from four basins on Martha's Vineyard near Manuel F. Correllus State Forest. Data are organized according to pollen zones identified by Stevens (1996). "Pre" and "Post" refer to before and after European settlement. C:P is charcoal:pollen.

**Muddy Cove**

| | Pre | | Post I | | Post II | |
|---|---|---|---|---|---|---|
| Pine | 5.5 | (1.7) | 5.0 | (1.3) | 5.1 | (1.6) |
| Birch | 6.1 | (1.0) | 6.0 | (2.1) | 4.7 | (1.4) |
| Oak | 32.9 | (6.2) | 14.4 | (.5) | 13.3 | (2.0) |
| Grass | 5.1 | (2.4) | 22.6 | (3.1) | 30.4 | (3.1) |
| Beech | 4.6 | (.7) | 2.4 | (1.2) | 2.1 | (1.0) |
| Hickory | 2.3 | (.8) | 1.1 | (.5) | .5 | (.4) |
| Black gum | 3.0 | (2.1) | 1.3 | (.4) | .9 | (.3) |
| Myrica | 6.5 | (1.8) | 4.8 | (.7) | 4.0 | (1.1) |
| C:P | 322.0 | (366.0) | 427.0 | (138.0) | 270.0 | (234.0) |
| Unidentified | 28.1 | (6.6) | 22.9 | (2.7) | 18.6 | (3.7) |
| # Samples | 5 | | 4 | | 11 | |

**Deep Bottom**

| | Pre | | Post I | | Post II | | Post III | |
|---|---|---|---|---|---|---|---|---|
| Pine | 10.4 | (1.4) | 9.5 | (1.5) | 14.8 | (5.0) | 29.8 | (2.1) |
| Birch | 7.4 | (1.7) | 7.0 | (2.1) | 5.9 | (2.2) | 6.0 | (1.6) |
| Oak | 29.0 | (3.5) | 16.6 | (3.1) | 19.6 | (2.0) | 14.1 | (3.7) |
| Grass | 3.1 | (1.1) | 18.0 | (1.9) | 18.7 | (1.9) | 13.7 | (2.0) |
| Beech | 4.2 | (2.9) | 2.4 | (1.1) | 2.2 | (.4) | 5.4 | (2.6) |
| Hickory | 1.1 | (.4) | .7 | (.4) | .6 | (.6) | .6 | (.4) |
| Black gum | 6.3 | (.8) | 1.5 | (.5) | 1.3 | (.2) | .9 | (.7) |
| Myrica | 19.2 | (.6) | 8.5 | (1.8) | 8.1 | (.9) | 8.5 | (1.6) |
| C:P | 1101.0 | (275.0) | 363.0 | (357.0) | 701.0 | (504.0) | 359.0 | (323.0) |
| Unidentified | 32.7 | (1.8) | 19.9 | (2.7) | 16.7 | (3.2) | 11.7 | (2.9) |
| # Samples | 2 | | 8 | | 5 | | 4 | |

**Jane's Cove**

| | Pre | | Post | |
|---|---|---|---|---|
| Pine | 14.3 | (10.5) | 19.4 | (3.4) |
| Birch | 4.4 | (.2) | 4.0 | (.6) |
| Oak | 40.2 | (3.0) | 34.1 | (6.9) |
| Grass | 16.0 | (2.3) | 6.1 | (2.1) |
| Beech | .9 | (.4) | 1.3 | (1.0) |
| Hickory | .5 | (.2) | .8 | (.6) |
| Myrica | 7.3 | (4.4) | 12.5 | (3.2) |
| Ericaceae | 1.0 | (1.1) | 5.2 | (3.9) |
| Black Gum | .7 | (.3) | 3.8 | (1.1) |
| C:P | 3403.0 | (1008.0) | 1410.0 | (783.0) |
| Unidentified | 15.3 | (4.2) | 20.9 | (5.8) |
| # Samples | 3 | | 5 | |

**Lagoon Pond**

| | Pre | | Post I | | Post II | | Post III | |
|---|---|---|---|---|---|---|---|---|
| Pine | 24.8 | (4.4) | 17.1 | (3.1) | 8.4 | (1.4) | 19.8 | (3.2) |
| Birch | 5.7 | (1.5) | 4.8 | (1.6) | 2.1 | (1.1) | 3.4 | (1.3) |
| Oak | 33.3 | (5.5) | 17.6 | (2.4) | 9.7 | (4.4) | 30.5 | (2.8) |
| Grass | 1.2 | (1.1) | 8.5 | (2.4) | 24.9 | (3.6) | 12.1 | (4.1) |
| Beech | 1.3 | (.7) | 1.3 | (.4) | .8 | (.6) | 2.1 | (.6) |
| Hickory | 3.3 | (1.0) | 1.1 | (.7) | .5 | (.1) | .6 | (0.0) |
| Myrica | 1.4 | (.7) | 1.4 | (.5) | 1.0 | (.3) | .9 | (.6) |
| Ericaceae | .1 | (0.1) | .06 | (.1) | 0.0 | (0.0) | .1 | (.02) |
| Black Gum | .2 | (.2) | .05 | (.1) | 0.0 | (0.0) | .2 | (.2) |
| C:P | 1333.0 | (793.0) | 1435.0 | (1238.0) | 984.0 | (796.0) | 1696.0 | (2069.0) |
| Unidentified | 21.5 | (3.9) | 18.4 | (2.6) | 21.0 | (2.1) | 12.4 | (2.0) |
| # Samples | 10 | | 12 | | 4 | | 3 | |

Note: (1) Jane's Cove only includes the upper pre-settlement zone (JC-IV) which dates from less than 2000 years BP according to Stevens' (1996) C–14 dating. (2) Average unidentified pollen is 20.1%.

because these ecosystems are not well understood from a sedimentological perspective, they have been disturbed by natural and human processes, and they are occasionally connected (breached) to the ocean (Stevens 1996). The dynamic environment of these coastal systems may be more hostile to the preservation and identification of pollen and spores than the more tranquil lake environments that paleoecologists are accustomed to using. For example, in the four records used in the current study there is an average of 20% unidentifiable pollen grains, which is two to three times the average from most studies, raising the possibility that differential preservation of particular taxa may bias the record and interpretation. Furthermore, although Stevens collected material from the narrow heads of coves in an effort to increase the record of surrounding local vegetation, the sites are part of extensive waterbodies, which tends to increase the source area for pollen deposited in the basins to include vegetation from greater distances. Despite these limitations, Stevens' investigation provides critical information on the pre-European landscape and the changes that have ensued over the past 350 years in areas adjacent to MFCSF.

***Pre-European Forest Versus Grassland Cover.*** Although MFCSF is currently dominated by shrublands and woodlands, the possibility exists that under a different environmental regime involving, for example, greater disturbance by fire or Indian activity, grasslands may have been more extensive during pre-history. This emerges as a relatively important issue because modern sand-plain grasslands support numerous rare species and are globally threatened (Vickery and Dunwiddie 1998, Stevens 1996), prompting the MFCSF Technical Advisory Committee to consider the possibility of creating extensive sand-plain grasslands in the State Forest (DEM 1994b). As background to this discussion and consideration of this option, it is useful to evaluate the evidence concerning the relative abundance and distribution of grass-dominated vegetation during the period before European settlement.

Stevens' (1996) data from the sites closest to MFCSF suggest that woodland or shrubland conditions prevailed throughout the pre-historical period (Table 4). In all cases except one (Jane's Cove), the abundance of arboreal pollen (tree taxa, including oak, pine, beech, etc.) is extremely high before European settlement (80–90%) whereas the abundance of grass, weed, and herb pollen is quite low (generally <5%). Similarly, in all cases except Jane's Cove, the relative abundance of oak pollen dropped significantly with European settlement whereas the abundance of weed (*Ambrosia, Plantago*, etc.) and grass pollen greatly increased. This major change corresponds to the widespread cutting and deforestation that directly affected the watersheds producing these pollen records (Stevens 1996). Thus, with the exception of Jane's Cove, Stevens' (1996) data strongly suggest that the central outwash plain on Martha's Vineyard, including MFCSF, was dominated by woody vegetation prior to European settlement. As mentioned above, however, the paleoecological record does not allow us to determine the relative importance of oak shrubland versus oak woodland in the pre-European landscape.

Jane's Cove differs from the three other sites in having very high pre-European grass pollen percentages (16%). However, several factors make the interpretation of the paleoecological record from Jane's Cove highly problematical. For instance, the sediments from Jane's Cove have indications of major hiatuses (discontinuities in sedimentation), pollen percentages from this record exhibit "wild" fluctuations (Stevens 1996), and pollen changes across the settlement boundary are somewhat enigmatic; for example, pine, beech, *Myrica*, Ericaceae, and black gum increase, grass decreases, and oak decreases slightly. Thus, while it is possible that grasslands may have existed prior to European settlement in the vicinity of Jane's Cove, caution is warranted in using data from this site as definitive evidence of pre-European grasslands. Several of Stevens' other sites closer to the coast also have high pre-European grass values (e.g., Black Point Pond, Long Cove Pond, Watcha Pond, Jobs Neck Pond, and Slough Cove), supporting her interpretation that grasslands may have occurred in the more extreme, near-coastal environment.

***The Historical Importance of Pitch Pine.*** Paleoecological reconstructions may be used to resolve speculation in the historical record on the abundance of pine prior to European settlement. Currently, pitch pine is much less abundant on Martha's Vineyard than on many parts of Cape Cod, where it forms extensive pure or mixed pine-oak stands. Although native pines are not currently widespread on MFCSF and some of these stands established as a result of documented planting activities in the early 20th C or the indirect effect of seedbed creation in areas of intensive human disturbance (discussed below), the historical literature does contain suggestions that the Island's outwash plain was once extensively covered with conifers (Shaler 1888, Hough 1936). Importantly, however, we found no early documentary evidence to support this assertion. Of particular significance is the lack of references to 'pine plains', 'pine barrens', or extensive pine-based industries in the early historical period. In the Connecticut Valley of Massachusetts and elsewhere in New England, early maps and other historical sources frequently refer to extensive pine plains (Motzkin *et al.* 1999), leading us to expect similar references for Martha's Vineyard. However, we found no such references, suggesting that pine was not widespread on the central Plain in the early historical period. Banks (1911) does record two 17th century references to pine on Martha's Vineyard, although it is unclear whether they refer to areas within MFCSF:

> William Weeks...on April 10, 1655, was granted land "near the pines in the middle of the island."
>
> "The Woodland Lots...on Feb. 27, 1684, when a tract in the northwest part of the town, towards the Tisbury line, called the Woodland was divided into lots, being 42 shares. It is supposed that East Pine and West Pine lots are comprised in this division."

In addition, Banks (1911) refers to the 'Tarkill (Tarkiln) Path' that crosses the northeastern portion of the State Forest, noting that "there were kilns for extracting tar from wood in the Penny Wise region [east of MFCSF], and this path ran to that locality as early as 1738." We have been unable to find additional references to tar production on Martha's Vineyard.

In fact, most references to the early dominance of pine on the outwash plain of Martha's Vineyard may be traced back to a solitary remark by Nathaniel Shaler in 1888, that "originally this region was heavily wooded, mainly with coniferous trees, the present prevalence of the deciduous species being due to the particular endurance of their roots in the fires, a capacity that does not exist in the conifers." The origins of Shaler's firm belief in the former abundance of conifers is unknown and, as far as we have been able to determine, is not supported by any evidence. His rationale that hardwoods such as oak are more capable of surviving and sprouting after fire may be sound, although the ability of pitch pine to survive, re-sprout, or regenerate following the intense fires that occurred in the past century is well-documented. Thus, today we are left with the same question that confronted C.E. Banks in 1911 when he wrote that "The evergreen trees...have scattered growth still on the island, but their early extent is problematical." Information on the long-term abundance of pine (and other conifers) on MFCSF is important for it would provide some guidance for our interpretation of existing pitch pine stands and for future management of forest composition.

Stevens' (1996) data indicate that across the major cultural and vegetation boundary corresponding to European settlement and marked by changes in oak and herbs, the relative abundances of the next two most abundant pollen types, birch and pine, change very little. Pre-European pine pollen percentages are relatively low (5–15%, except at Lagoon Pond where they are 25%), and pine actually increases after European settlement at two of the four nearby sites (Deep Bottom Cove and Jane's Cove) and only decreases substantially at Lagoon Pond. As suggested by Stevens (1996), the absence of change in the pollen percentage for a tree taxon in a landscape that is undergoing major forest cutting and clearing activity suggests that the pollen signal for that particular taxon is derived from regional rather than local sources. In the case of an island like Martha's Vineyard, it is probable that such pollen is derived from mainland sources (note that Stevens makes this argument for birch, but it should pertain to pine as well, as both species produce abundant, well-distributed pollen). Thus, we may infer that neither birch nor pine was common around most of the sites investigated. In contrast, the major decline in oak pollen at the time of European settlement documents it's former abundance and subsequent decline as forests were cut and cleared in the 17th and 18th C. The site with the highest pine pollen percentages and the only one showing a major decrease with settlement is Lagoon Pond, which is located to the north of MFCSF and is bordered by moraine to the west and outwash-covered moraine to the east. These results lead to the interesting possibility that pine was more abundant at morainal sites at the time of European settlement (e.g. Lagoon Pond and Lake Tashmoo) than on the outwash plain.

Taxonomic information provides some corroboration for the interpretation that pine was uncommon and that the source of pine pollen may have been primarily regional and off-island. Although Stevens (1996) was unable to assign a large percentage of the pine pollen to haploxylon (white pine) or diploxylon (pitch pine/red pine) types, it is notable that during the pre-settlement period the majority of grains identified were assigned to the white pine group. It is only during the recent, post-settlement period that percentages of pitch pine/red pine type predominate. Since white pine is much more sensitive to fire and salt spray than pitch pine and would be expected to be uncommon on coastal islands during the pre-settlement period, this reinforces the conclusion that most of the pre-European pine pollen was derived from mainland sources. During the 20th C, when diploxylon pine species were planted extensively, including red pine, pitch pine, Japanese black pine, and Scot's pine, it is not surprising that this local source led to an increase in diploxylon grains and an overall increase in pine pollen at some sites.

***The Role of Fire.*** As indicated by the Shaler (1888) quote above and documented elsewhere in this and other reports (e.g., Dunwiddie and Adams 1994), fire has been and will presumably remain an important environmental factor on Martha's Vineyard, especially on the outwash plain. The incomplete historical record of fire clearly indicates a high frequency of intense burns in the area of MFCSF since European settlement (see Table 1) and paleoecological data may be used to extend this record back in time in order to relate the recent history of fire to fire frequency and importance during periods of contrasting human land-use practices and different environmental settings.

The charcoal:pollen ratio, which is an indicator of the relative importance of fire, shows an unusual pattern on Martha's Vineyard relative to other sites across New England. Overall, values from Martha's Vineyard are among the highest for any landscape in the region. In addition, in the four sites examined (and most of Stevens' sites), charcoal values generally decline after European settlement, suggesting a decrease in fire as the land was cut, cleared, and farmed. Given the substantial evidence for large and intense fires in the last two centuries, this suggests that fire activity was even greater before European settlement. Assuming that the pre-European vegetation was similar in composition, if not structure, to the modern vegetation of highly flammable tree oak, scrub oak, huckleberry, and other understory plants, this record suggests a history of frequent and presumably intense surface fires. Although the source of ignitions remains conjectural, the low frequency of lightning ignitions and high Indian population densities on Martha's Vineyard suggest that many of these fires may be attributable to Indian activity (cf. Patterson and Sassaman 1988).

### Summary

Martha's Vineyard supported one of the densest pre-European Indian populations in northeastern North America, estimated at 3,000–3,500 by Gookin (1947) and Richardson (1983). These values represent a population density (35 people per $mi^2$) that is 5–10 times higher than those for other portions of coastal New England, including Cape Cod, Narragansett Bay, and the Connecticut Valley. It is likely that the major impact of this culture on the sandy, central Plain was through the ignition of relatively frequent fires that favored a woodland of fire-adapted, sprouting species dominated by tree and scrub oaks. Remarkably, despite the major cultural upheaval that ensued with European arrival and the dramatic transformations that have occurred in land cover, land-use practices, and disturbance processes, paleoecological results indicate that vegetation composition in the area immediately surrounding MFCSF has not been altered substantially from that which existed before European arrival. Although the extent of open-land and grass and weed species are higher today, and pine has increased particularly in areas where it was planted, oak has been and remains the dominant taxon in the pollen record and across the landscape. Major changes may have occurred in the structure of the vegetation (e.g. the relative amounts of scrubland vs low sprout forest and tall mature forest) and the relative abundance of particular oak species may have varied; however, the paleoecological record does not allow us to address these questions. Overall, there is strong support for Stevens' (1996) interpretation that "the historic landscape of Martha's Vineyard was characteristically forests and woodlands dominated by oak or mixed oak-pine, and occasional pine-dominated stands, interrupted by localized grassy clearings associated with Indian land uses along the shorelines of coastal ponds."

## MANUEL F. CORRELLUS STATE FOREST

### Ownership History

Although the early history of ownership of lands that are currently part of MFCSF has not been investigated in detail, Banks (1911) provides information that indicates the relative value and perception of these lands. As in much of New England, lands in West Tisbury and Edgartown were assigned through a series of land divisions, with individual proprietors frequently granted several non-contiguous parcels for varying purposes, including meadows, planting fields, 'thatch lots' (for roofing), woodlands, etc. Although West Tisbury was initially settled about 1670, lands that were later incorporated into MFCSF were among the last areas in the town to be divided, indicating that they were viewed as having limited value. The so called 'Additional Purchase', which includes the southwestern portion of MFCSF, was not divided until 1750, and areas to the north and east in the West Tisbury portion of the State Forest were not divided until the last division of common lands in 1836 (Fig. 9; Banks 1911). Portions of MFCSF in Edgartown may have been divided as early as the late 17th century, although it appears that these divisions occurred several decades later than the earliest land divisions in Edgartown in the 1640s and 1650s (Banks 1911).

After these initial divisions, little is known of the ownership history of lands in MFCSF until the mid to late 19th century. However, several references suggest that the land was little used or valued. For instance, Whiting (1976) notes that in 1870 there was a "land development boom on Martha's Vineyard...small lots, many of which were to become the State Forest, (were sold) for revolvers, jackknives or given away with the purchase of goods from Vineyard Haven stores. All the new owners had to do was to pay for execution of a deed and record it."

In 1908, 612 acres were purchased for the Heath Hen Reservation, including "the taking of the Andrews and Smith farms, plus the purchase of 2 small pieces on the northeast of the Airport Road from Mellen" (Fig. 10; Whiting 1976). DEM (1994a) indicates the former owners of the Heath Hen Reservation as Mayhew, Mellen, and Andrews. An additional 1,000 acres were leased for $400 per year (Gross 1928). In 1914, according to Whiting (1976, p. 4), "Baron Louis von Horst bought up much of the center of the Island. Rumor had it that he had done so to establish a station to signal the German operators during WWI. He also started raising hopes (hops) on the Island. A large portion of the land von Horst bought was never paid for and went on the open market. It was picked up by Mr. Swift who did the surveying for him and eventually became part of the State Forest." Substantial increase in State owned lands occurred in the mid 1920s (Fig. 10). In 1925, 1040 acres abutting the Heath Hen Reservation were taken for the State Forest (MA Chapter 132, section 33), primarily by eminent domain (Whiting 1976; DEM 1994b). "Lots with unknown title were posted for taking. This whole area was considered wetlands [sic] so those who did come to claim got only between $2 and $2.50 per acre. Some of this land was old medicine lots which were given away with the purchase of a bottle of the patented medicine" (Whiting 1976). In 1926, 2,832 acres were added to the State Forest, and the first survey showed 4,472.75 acres including the Reservation (note: DEM 1994b indicates 4072 acres). In 1939, the Heath Hen Reservation was transferred to the Division of Forestry, and in 1942, the U. S. Navy took 660 acres, which became the airport after WWII (Fig. 10; DEM 1994b indicates 683 acres taken by the Navy). No additional major land transfers involving MFCSF occurred until 1995 when the ~800 acre Pohoganot tract was acquired, bringing the current size of MFCSF to approximately 5200 acres.

**Land-use History and Management: mid-19th Century to the Present**

As mentioned above, large-scale (1:10,000) USCGS maps from 1846–8 indicate the entire area of MFCSF as brushland or woodland, with no fields, buildings, or fence lines (Figs. 3 and 4) and few roads (Fig. 11). Similarly, smaller scale USCGS maps from the 1860s, 1870s and 1880s indicate no agricultural fields, although these maps may have been based on land cover data from the 1846–8 series without additional field surveys. The first maps to indicate land clearing for agriculture on MFCSF are 1897 USCGS maps, which indicate a few fields, fence lines, roads, and buildings near the Forest Headquarters,

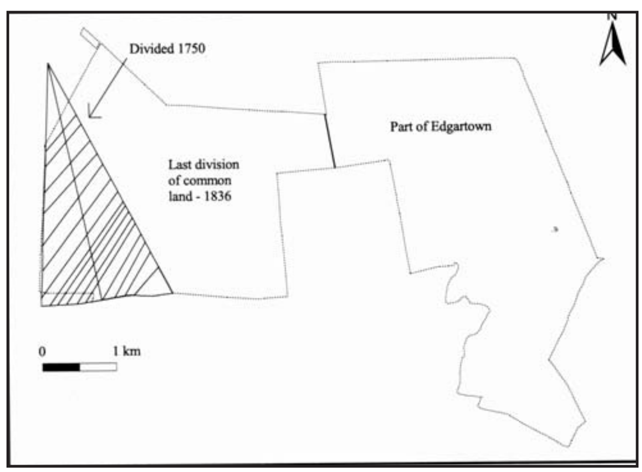



**Figure 9.** Approximate locations of West Tisbury land divisions from 1750 and 1836 in relation to MFCSF. Similar maps may have been compiled by C. E. Banks for Edgartown, but could not be located for the current study. From Dukes County Historical Society (unpublished data).

as well as a single field and building in the western portion of the State Forest in the area known as the Von Horst place or the Boch Pines (Fig. 12). The 1897 map corresponds well with historical records that indicate that the farm house that currently serves as the Forest Headquarters and nearby barns were built between 1886 and 1900 (Whiting 1976; DEM 1994b). The fields indicated on the 1897 map total ~48 acres, or <1% of MFCSF.

Comparison of the 1897 USCGS map with our field map of areas that have well-developed plowed (Ap) soil horizons (indicative of sites that were plowed historically for crop cultivation), shows remarkable correspondence (Fig. 12). With the exception of the 1897 field indicated in the western portion of MFCSF, we found evidence of historical cultivation in all other areas indicated as fields in 1897. Perhaps more interesting, we found evidence of plowing for historical agriculture in only a few additional areas, primarily adjacent to fields that existed in 1897. This expansion of the 1897 fields apparently occurred in the early years of the 20th century, as some were already planted to conifers in the mid-1920s (Appendix). Some of these fields were apparently managed as part of the Heath Hen Reservation (Fig. 13). Although we did not find well-

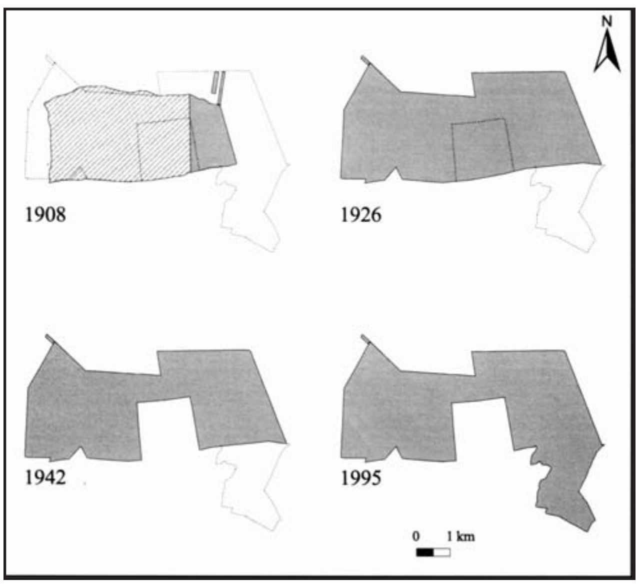



**Figure 10.** History of land acquisition of the Manuel F. Correllus State Forest by the Commonwealth of Massachusetts. The lightly shaded area indicated for 1908 was originally leased as a sanctuary abutting the Heath Hen Reservation (Gross 1928) and was acquired, along with additional lands, in 1925–26. In 1942, >650 acres in the central part of the State Forest were acquired by the Navy, and eventually became the airport. In 1995, the Pohoganot Tract was added to the southeastern portion of MFCSF and is managed through cooperation between DEM and The Nature Conservancy.

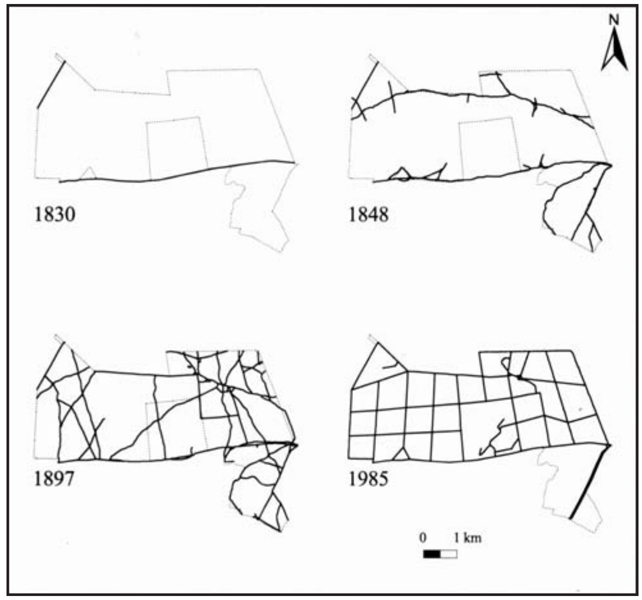



**Figure 11.** The development of the road network in MFCSF. The rectangualr grid indicated for 1985 represents the network of firebreaks established in the 1920s and 1930s.

developed plow horizons in the westernmost 1897 field, we did find evidence of former use of this area, including cellar holes and other earth-works. In addition, pitch pines were apparently planted in portions of this area (the so-called Boch pines), and the abundance of poison ivy and bayberry suggests former disturbance.

Based on these results, we estimate that 70–90 acres, representing <2% of MFCSF, were cleared and plowed for historical agriculture. We found no references to the crops grown on these fields prior to the establishment of the Heath Hen Reservation. According to A. O. Gross (1932), the Heath Hen Reservation was "systematically improved to make it attractive for the birds." Corn, clover, buckwheat, millet, and sunflowers were the primary crops planted for the heath hens and these were frequently left in the fields through the winter (Gross 1928). This practice was apparently discontinued in the 1920s because the grain attracted rats and crows. Other vegetables planted include squash and pumpkins, and in 1926, beets, carrots, peas, and beans were planted in areas that were heavily fertilized with manure (Gross 1928). In addition, beans and potatoes were apparently grown for 'the war effort' (DEM 1994b), and records at MFCSF refer to an early 20th century strawberry bed. More recent references to crops grown on State Forest lands include 100 pounds of rye and 50 pounds of winter wheat sown as food for rabbits in 1939 and a one-acre strip in Compartment 3 planted with crown vetch, red fescue#1, and partridge pea in 1976 (Whiting 1976).

## History of Plantation Management

The history of conifer plantation management on State Forest lands has gone through several major stages over the past 90 years. Although some planting occurred in the second decade of the 20th century on the Heath Hen Reservation, most conifer plantations were established between 1925–1941 (Table 5; Fig. 14). By 1925, a nursery was established on the State Forest with 600,000 conifer seedlings (Table 5). The primary species planted were red, white, and Scots pines, and white spruce. In addition, lesser amounts of Spanish, Austrian, Japanese black, jack, ponderosa, pitch, and hybrid loblolly-pitch pines have been planted, as well as some larch, Norway spruce, and hardwoods (Whiting 1976; DEM 1994a, 1994b). Approximately 600 acres were established between 1926–1934 (Appendix; DEM 1994b), averaging >115,000 seedlings annually (Table 5). Based on an estimate of 1200 seedlings per acre, 115,000 seedlings represent planting of >95 acres per year, although this includes some replanting of areas where seedlings apparently failed. In 1933–34 alone, CCC camp S–57 planted 409 acres of conifers on the State Forest and conducted release cuttings on 400 acres of previously established plantations (Fig. 15). No new conifer plantations were apparently established between 1942 and 1963, although substantial effort was dedicated to releasing earlier plantings from hardwood competition and, as the plantations matured, to pruning and/or thinning (Table 5). The next major plantings occurred in the mid-1960s, when several hundred acres were machine-planted (Figs. 16 and 17). DEM (1994a) indicates that 395 acres were machine-planted in 1964–1967, but our analysis of 1970 aerial photos indicate that a total of ~627 acres received such treatment. Subsequently, two small experimental plantations were established in the 1970s, and some additional planting occurred as recently as 1990. Based on available plantation maps, we estimate that ~1703 acres (33% of the current MFCSF) were planted to conifer plantations in the 20th century.

In contrast to much of New England where conifer plantations were typically established on abandoned agricultural land, only 3–4% of conifer plantations in MFCSF were established on old fields. Instead, most early plantations were established by crews of workers planting seedlings manually in thick scrub-oak stands on sites that had never been in agriculture (Lee 1982). The extensive plantings of the mid-1960s were also established in scrub-oak and hardwood stands on non-agricultural

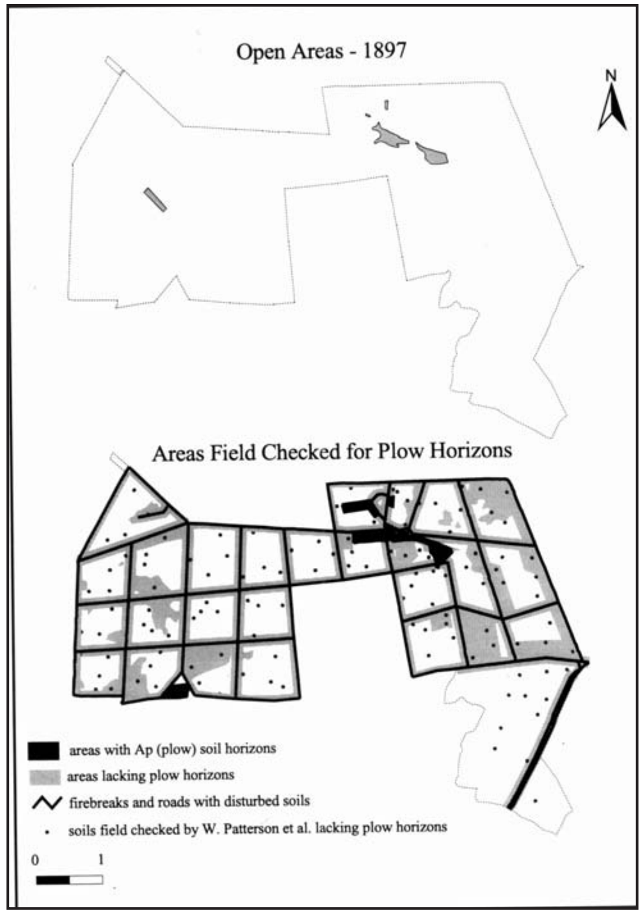



**Figure 12.** Historical agricultural fields on MFCSF. Top: fields indicated on United States Coast and Geodetic Survey (1897) maps. Bottom: areas in which Ap soil horizons, indicative of historical plowing, were indentified in the current study.

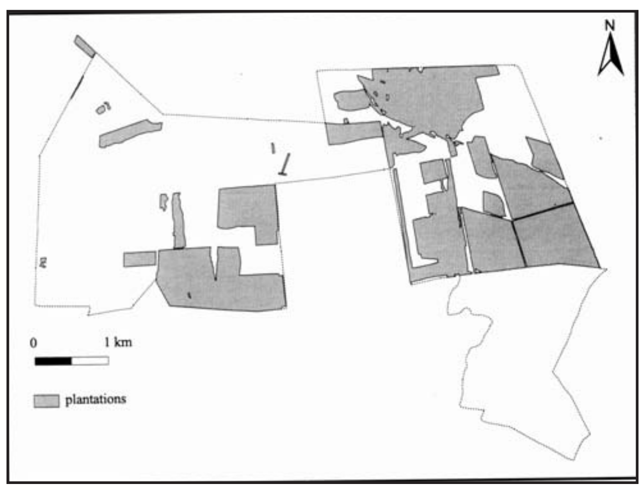



**Figure 14.** Locations of current and former conifer plantations on MFCSF based on historical maps of planting (MFCSF unpublished maps), photo interpretation of areas machine-planted in the 1960s, and location of current plantations. See Appendix for additional information.

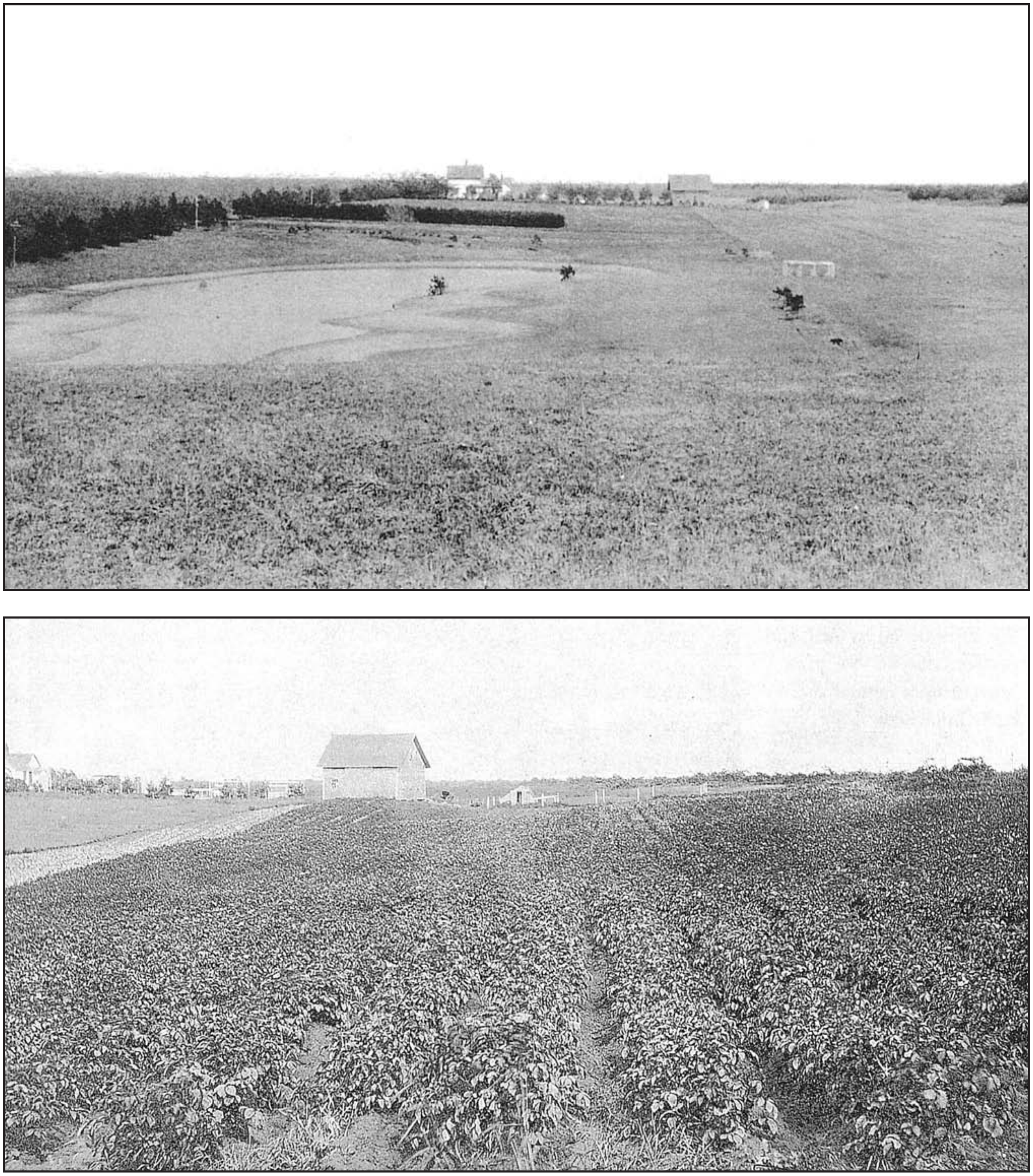


**Figure 13.** View of the Heath Hen Reservation from the west in 1923 (top), and a few years earlier (bottom). In each photo, the house on the left is the Forest Headquarters for MFCSF, and the field on the right currently supports a mature conifer plantation.
Photographs from Gross (1928) and Dunwiddie (1994).

land, with the aid of a "Lother" planting machine. This method of planting involved use of a large tractor with front and rear mounts. A large V-plow was pushed in front of the tractor in order to knock down existing vegetation, and a person sitting in a protective cage pulled behind the tractor planted seedlings in the furrows created by a small disk and plow (Fig. 18; E. Littlefield pers. comm.). This method of planting disturbed a narrow strip of soil but left most of the native vegetation intact (Fig. 19).

***Pathogens.*** Since the earliest conifer plantations were established, State Forest staff have been concerned about potential damage to these stands by wildfire and pathogens. From ~1931–1958, much effort was dedicated to white pine weevil inspection and control, both on the State Forest property and in private plantations throughout Martha's Vineyard. From 1937–1947, inspection, cutting and burning of infested tips typically required ~40 work-days per year (Table 5).

By the 1960's, the fungal pathogen *Diplodia pinea* became widespread in red pine plantations, resulting in hundreds of acres of red pine mortality over the next few decades (Fig. 20). Efforts to salvage this dying material were begun as early as the 1970s (DEM 1994b). Although several additional pathogens have occurred on the State Forest, they have apparently had less impact on conifer plantations and required only occasional management. For instance, in 1937, one-quarter acre of tip-moth infested pitch pine was cut and burned (DEM 1994a). Aerial surveys from 1968–1995 document defoliation or stand damage on Martha's Vineyard, but in most instances the pathogens responsible for the damage have not been identified (C. Burnham unpublished data). Thus, the long-term effects of gypsy moths or other pathogens are largely undocumented.

***Commercial Harvests.*** By the early 1960s, State Forest staff estimated that 50,000–100,000 BF were ready for selective harvesting, and they initiated a timber sale that guaranteed 10,000–15,000 BF per year for 5 years to prospective bidders. However, the Commonwealth did not receive any bids for this timber and no harvesting took place (Whiting 1976). In 1973, the State Forest requested bids for a contract to thin 807 acres of 35–45 year old plantations, estimated to yield 3,000,000 BF in 10 compartments on the east side of MFCSF (Fig. 15). Mr. John Shinn of Vineyard Pine Lumber Company was awarded this contract, "and the state presumed that Shinn's work would result in $40,000 for the Forest...and also that the forest would improve...in the thinned area for larger and better growth" (Whiting 1976). However, several difficulties were encountered with this project. Out of 807 acres, ~300 were found to be poorly stocked or of such poor quality as to be commercially unmerchantable. In addition, the Vineyard Pine Lumber Company had great difficulty locating suitable local or regional markets for the harvested timber, and a blue stain fungus rapidly reduced the quality of the harvested timber rendering it unmerchantable. By 1976, Whiting commented that "it appears that...(the) Vineyard Pine Lumber Company is...not actually making a profit for themselves or the Forest." The contract was finally completed in 1980, although we have not been able to locate documentation on the final harvest area and volume or an economic assessment of the operation.

In the 1980s, >1/3 million BF of timber were

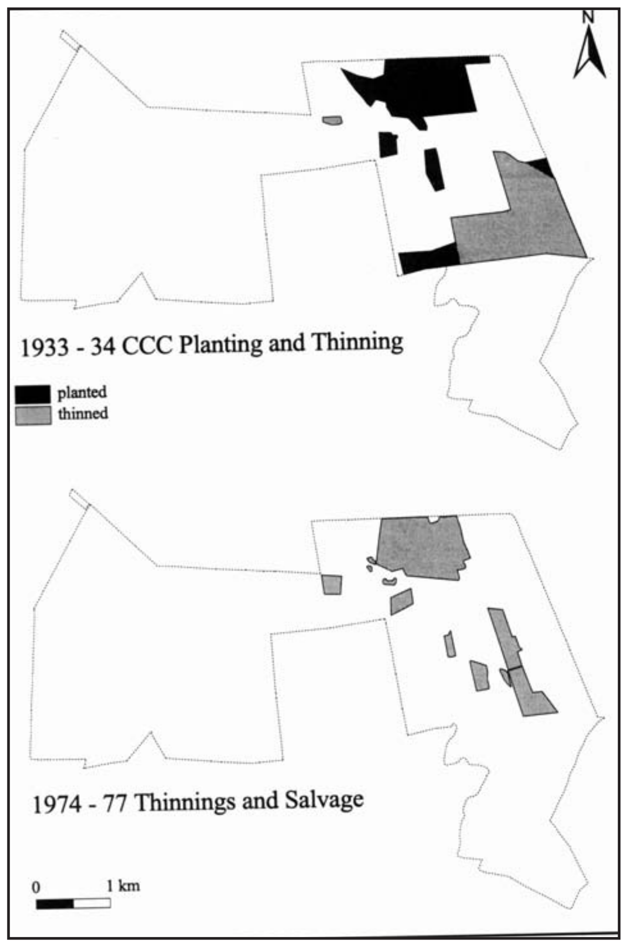



**Figure 15.** Civilian Conservation Corps (CCC) conifer plantation management in 1933–34 (top) and commerical plantation thinning and salvage operations from 1974–77 (bottom).

**Table 5.** History of forest management activities on MFCSF involving the establishment and maintenance of plantations, roads, and firebreaks. Note that inspections for white pine weevil encompassed the entire Island and were not restricted to MFCSF. Data from Whiting (1976), DEM (1994a, b) and MFCSF (unpublished data).

| | Plantation Establishment (seedlings) | Release (acres) | Pruning (acres) | Cutting (cords/ BF) | Thinning (acres) | Weevil Inspection (days) | Roads and Firebreaks (miles of construction or maintenance) |
|---|---|---|---|---|---|---|---|
| 1914 | some | | | | | | |
| 1916 | 20 ac. | | | | | | |
| 1925 | 600,000[1] | | | | | | some |
| 1926 | 104,000 | | | | | | 5.5 |
| 1927 | 160,000 | | | | | | 2 |
| 1928 | 81,000 | | | | | | 7 |
| 1929 | 125,000 | 10 | 1 | | | | 5 |
| 1930 | 100,000 | | | | | | 14.5 |
| 1931 | 126,000 | | | | | many | 17.5 |
| 1932 | 65,000 | 50 | | | | | 17 |
| 1933 | | 8.2 | | 56 cds | | | ~40 |
| 1934 | 300,500[2] | 400 | | 150 cds | | many | 30 |
| 1935 | 10,000 | | | 50 cds | | 60 | 44.75 |
| 1936 | 20,000 | 40 | | | | many | 4.5 |
| 1937 | | 32 | 1 | | | 40 | 14 |
| 1938 | | 50 | 5 | | | 125 ac. | 46 |
| 1939 | 35,000 | 450 | | | | many | 20 |
| 1940 | | | | | | ~40[3] | |
| 1941 | 7,000 | ~3 mos. | ~3 mos. | | | ~40 | many |
| 1942 | | ~3 mos. | | | | ~40 | |
| 1943 | | ~3 mos. | | | ~3 mos. | ~40 | many |
| 1944 | | | | many | | ~40 | |
| 1945 | | | | | | ~40 | many |
| 1946 | | | | | | | |
| 1947 | | 10 | 9 | 15 cds | | ~40 | 1 |
| 1948 | | | some | | some | ~30 | |
| 1949 | | 36 | 36 | | 36 | 28 | 4 |
| 1950 | | 30 | some | | some | | 25 |
| 1951 | | many | some | | some | | 6 |
| 1952 | | ~3 mos | | | | ~20 | 12 |
| 1953 | | many mos. | | | many mos. | | many |
| 1954 | | 39 | | | | | 16 |
| 1955 | | 30 | | | | 20 | 20 |
| 1956 | | 35 | 11 | | 10 | | 35 |
| 1957 | | 30 | 15 | | | | 36 |
| 1958 | | 35 | 30 | | | 8 | 9 |
| 1959 | | 6 | 29 | | 5 | | 35 |
| 1960 | | 50 | 50 | | 50 | | |
| 1961 | | | 20 | | 2 | | 35 |
| 1962 | | | | | | | |
| 1963 | | | | | | | |
| 1964 | 187 ac. | 14 | 15 | | 5 | | |
| 1965 | 99 ac. | | 30 | | 7 | | |
| 1966 | 30 ac. | | 25 | | 5 | | 57 |
| 1967 | 79 ac. | | 30 | | 10 | | |
| 1971 | | | 15 | | | | |
| 1974 | 3 ac. | | | | | | |
| 1974-80 | 3 ac. | | | 998 cds | 800 | | |
| 1980s | 15,000 | | | >330 MBF | | | |
| 1990 | 4,200 | | | | | | |
| 1991-2 | | | | 420 MBF | | | |

[1]seedings planted in nursery bed; [2]409 acres planted by CCC; [3] '~' indicates values are estimtes based on descriptions in DEM (1994a, b).

**Figure 16.** Oblique aerial view of the eastern portion of MFCSF on March 28, 1969, documenting areas that were machine-planted in the mid-1960s. Note the direction of the plow furrows in the 2 bottom compartments.


**Figure 17.** Areas machine-planted with conifers in the mid-1960s, as delineated from USCGS aerial photos from June 14, 1970.

harvested, half for improved clearance for airport approach, and the remainder as thinnings or as salvage in *Diplodia*-damaged stands (DEM 1994b). However, we have again been unable to locate detailed information on the cost or income from this operation. After Hurricane Bob blew down or damaged hundreds of acres of conifer plantations in 1991, Davis Lumber of Fitzwilliam, NH was awarded a contract for salvage of 57-acres of severely damaged Scots pine and 104 acres of white pine stands. A total of 420,000 BF of sawlogs were salvaged at a cost to the Commonwealth of $49,400 plus timber rights (DEM 1994b).

Although we have not conducted a comprehensive economic analysis of plantation management on MFCSF, several observations are warranted based on our review of the history of these plantations. Plantation management on MFCSF has not been economically profitable and has, in fact, been quite costly. Several factors have apparently contributed to the difficulty in managing these stands profitably. The persistent lack of local forestry operators and markets for forest products has been noted for decades. As early as 1947, the State Forest was unable to find buyers for cordwood (DEM 1994a), and the first attempt at a significant commercial timber harvest in 1962 failed because no bids were received (Whiting 1976). Although a significant thinning was conducted in the 1970s, this proved economically difficult in part because of lack of markets for the harvested products. Lack of local markets also resulted in difficulty attracting bidders for the Hurricane Bob salvage operation. In addition, poor timber quality as a result of pathogens (especially *Diplodia*), wind damage, overstocking, or hardwood competition has reduced the profitability of the few harvests that have been conducted. Given this history, the continued absence of local operators and markets, and the increased susceptibility of the plantations to wind damage over time, plantation forestry on MFCSF is expected to continue to be costly to the Commonwealth and to generate little merchantable timber.

### Cordwood Harvests

Although small amounts of cordwood were cut on State-owned lands since 1908, we have found no quantitative data on such uses. In the mid-1930s, 256 cords of wood were apparently cut by the CCC, and after the hurricane of Sept. 1944, much time was spent cutting an unspecified amount of cordwood from downed trees (DEM 1994a). In 1947, 15 cords of hardwood were harvested to release the

**Figure 18.** Equipment used for machine-planting conifer seedlings in the 1960s in MFCSF. Top: plow pushed in front of large tractor. Bottom: planting cage with disc and small plow.

**Figure 19.** Machine planting of conifers on MFCSF, 1964. Note dense shrubby vegetation that remains between plow furrows. Photo by H. Raup (Harvard Forest Archives).

conifers in plantations (Table 5; DEM 1994a). Similar removal of hardwoods from plantations was presumably common, although we found no documentation of the amount of wood removed or the acreage harvested.

In 1973, MFCSF (then MVSF) was one of 24 State Forests in Massachusetts to initiate the Cut-A-Cord program in which private individuals could obtain permits to cut firewood on State lands. Approximately one thousand, $2 permits were issued from 1973–1976 as part of this program, and Forest staff apparently marked areas to be cut, primarily along fire lanes and in conifer plantations as a means of reducing hardwood competition (Whiting 1976). According to DEM (1994b): "almost all of (the mixed oak) association adjacent to roads and firebreaks has experienced light tree cutting through either the Cut-a-Cord or the Home Fuelwood programs that were instituted by DEM...(in) the mid 1970s. This had little effect on the present makeup of these stands."

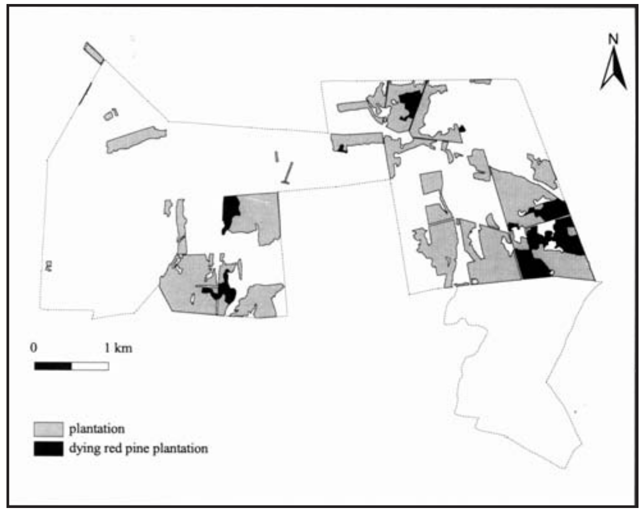



**Figure 20.** Map of plantations in 1994, indicating the location of dying red pine plantations (may include some Scots pine).

**Roads and Firebreaks**

From the first decade of the 20th century, attempts to protect the remaining heath hens from the effects of wildfires prompted construction of a series of firebreaks, and considerable effort has been dedicated to firebreak construction and maintenance since that time. The 1927 Annual Report for the Department of Conservation states that: "the fire hazard on this forest is extremely high and the plan is to cut up the entire area into blocks about one-half mile square by fire lines 50' wide. The fire lines are cleared of brush and on either side strips 10' are plowed and harrowed" (DEM 1994b). Substantial effort was dedicated to implementing this plan over the next few years (Table 5), and the complete network of firebreaks is visible on aerial photographs from 1938. Over the past few decades, many of the firebreaks have been maintained by brush cutting, with less frequent plowing and harrowing.

Although maintenance and management of firebreaks has varied over time, it is significant that firebreaks were established and frequently maintained through plowing and harrowing which resulted in extensive soil disturbance and the reduction or elimination of native shrub understories. These firebreaks currently harbor numerous rare plant species (Rivers 1997), many of which are characteristic of sand-plain grasslands and are apparently less widespread elsewhere in MFCSF. Thus, in MFCSF these rare 'grassland' species have become established on sites that received intensive and repeated mechanical disturbance, and are perhaps more common in these "artificial' grasslands than in the surrounding, less disturbed vegetation.

**Additional Management Activities**

Several additional practices have apparently had relatively minor influence on State Forest lands. In the mid-1930s, State Forest staff attempted to eradicate ragweed (*Ambrosia*) as part of an attempt to eliminate it from Martha's Vineyard (DEM 1994a). In 1955–1960, pine cones were gathered as a source of seed for State nurseries, including 100 bushels of white pine cones for the Amherst nursery in one year. In 1958–1959, there was a problem with "people topping pine trees on the forest plantations for Christmas trees" (Whiting 1976, p. 5). Starting in the early 1970s, the New York and Boston Mycological Clubs began harvesting mushrooms on the State Forest, with estimates of 500 pounds gathered annually by these groups (Whiting 1976).

**Current Vegetation Patterns**

Current vegetation on MFCSF has apparently developed in response to variation in environmental conditions and disturbance history. Based on interpretation of 1994 aerial photographs (color infra-red, 1:12,000 scale; W. Patterson unpubl. data), 27% of the area supports hardwood stands, primarily dominated by white, black, and post oaks (Table 6; Fig. 21). Scrub-oak stands occupy 12% of MFCSF, and an additional 29% is dominated by


**Figure 21.** Major stand types on MFCSF in 1994. Based on J. Stone's interpretation of 1994 1:12,000 aerial photos (W. Patterson unpublished data).

**Table 6.** Modern Vegetation in MFCSF based on Figure 21.

| Vegetation type | Area (ha) | Area (ac) | Total (%) |
|---|---|---|---|
| hardwood/scrub oak | 599.5 | 1481.4 | 28.5 |
| hardwood | 557.5 | 1377.6 | 26.5 |
| plantation | 477.0 | 1178.7 | 22.7 |
| scrub oak | 242.6 | 599.5 | 11.6 |
| pitch pine/scrub oak | 76.0 | 187.7 | 3.6 |
| other* | 48.8 | 120.5 | 2.3 |
| grassland | 33.6 | 83.0 | 1.6 |
| pitch pine | 32.9 | 81.3 | 1.6 |
| pitch pine/hardwood | 32.8 | 80.9 | 1.6 |
| Total | 2100.7 | 5190.6 | 100.0 |

*includes clearcut areas, firebreaks, wetlands, and developed land hardwood stands with a scrub-oak understory. Thus, hardwood and scrub-oak types combined occur on approximately two-thirds of MFCSF. Pitch pine types occupy <7% of the State Forest, and most stands with pitch pine also contain abundant scrub oak or hardwoods. Plantations occur on ~23% of the State Forest, including dying red pine plantations on ~3%. Grasslands, firebreaks, and other minor types account for <4% of MFCSF (Table 6; Fig. 21).

Hardwoods and scrub oak dominate much of the western portion of MFCSF, with scrub-oak thickets concentrated in a series of elongated topographic depressions known as frost bottoms (Fig. 21). Scrub-oak frost bottoms support numerous rare lepidopteran species and are therefore high priorities for conservation (Goldstein 1997).

Within many hardwood-dominated stands in MFCSF, a particularly notable feature is the well-developed rings of widely- spaced oak sprouts that develop from single ancient stools (Fig. 22). Although sprout hardwoods are widespread in southern New England, MFCSF contains well-developed sprout clumps that are unusually large in our experience, being similar in appearance to features in British coppice woodlands that have been managed by frequent cutting of young stems for centuries. Hardwoods sprout most prolifically when young, suggesting that the 'coppice' structure may have developed through repeated cutting or burning of young stems over very long periods of time. Although the current aboveground stems in MFCSF are frequently 3–8 inches in diameter and 50-85 years old, apparently dating to past cutting or fires, the large size (>1m) of many of the stools suggest that these trees may be hundreds of years old, probably pre-dating European settlement in some instances.

A few pitch pine stands occur in MFCSF, particularly in the western and northeastern portions of the State Forest. At least one of these stands, the so-called 'Boch Pines', includes some planted pitch pines (Whiting 1976; MFCSF unpubl. maps). Pitch pines have also frequently

**Figure 22.** Ancient oak stools around MFCSF.

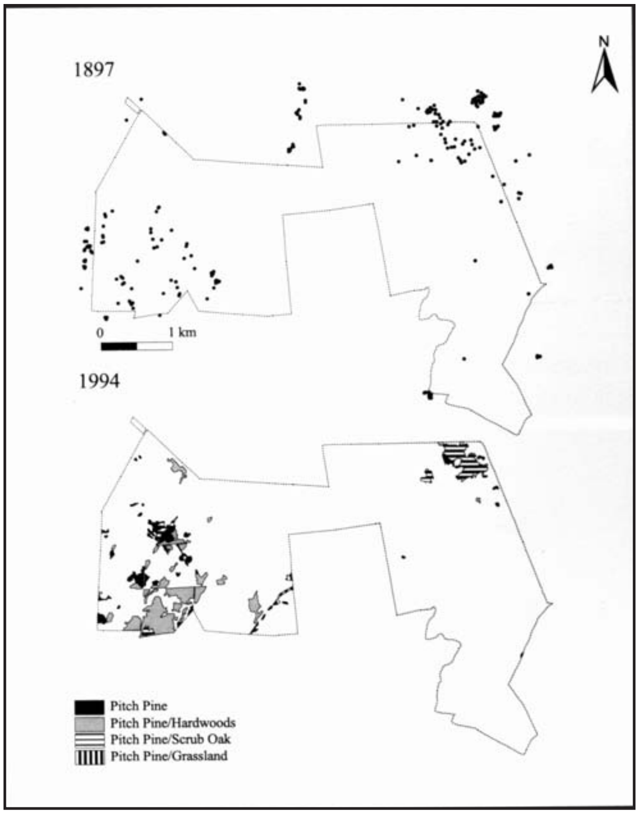



**Figure 23.** Distribution of pine in 1897 and pitch pine in 1994 in the vicinity of MFCSF. The 1897 distributions were derived from individual conifer symbols on USCGS 1897 maps, whereas the 1994 designations come from Fig. 21. Note the concentration of pine in the northeast and southwest in both 1897 and today and the general consistency between the maps.

**Figure 24.** Pitch pine regeneration on a pitch pine tip-up-mound from Hurricane Bob.

become established along old roads, firebreaks, and other areas with soil disturbance. However, unlike pitch pine stands throughout the Connecticut Valley, sites that support pitch pine on MFCSF typically lack plow (Ap) horizons and support dense ericaceous understories, indicating that these areas were never plowed for agriculture. In many stands visited, past establishment of pitch pine may be reasonably attributed to fire history (D. Foster, G. Motzkin, and W. Patterson pers. observ.), and fire history has also had widespread influence on the age structure of hardwood and scrub-oak stands. Interestingly, although most pitch pine stems aged in MFCSF are younger than 100 years, the broad distribution of modern pitch pine stands is remarkably similar to the distribution of pine in the area in 1897 (Fig. 23). In addition, although most modern pitch pine in MFCSF may be linked to past fire or human soil scarification, in a few areas where pitch pines were uprooted by Hurricane Bob, some pitch pine regeneration has occurred on tip-up mounds (Fig. 24).

Plantations are concentrated in the eastern portion of the State Forest, as well as in the compartments immediately west of the airport. As a consequence of the varied history of conifer plantation establishment followed by wind damage, disease, insect infestations, salvage logging, and forestry operations, the plantations are in a wide range of conditions. Although a detailed inventory of plantation age structure, stocking, and health was outside the scope of the current study, we were able to examine most of the larger stands and to assemble detailed impressions of their site land-use history, planting history, and current status. In particular, we examined for: presence/absence of a plowed (Ap) horizon that would indicate a previous history of agricultural plowing, evidence (on site and in aerial photographs or historical records) of planting techniques, continuity and vigor of the crowns and canopy, understory vegetation composition and density, and evidence of natural or human disturbance. Of significance to our management recommendations below, the abundance of native understory species that are characteristic of xeric woodlands (e.g. scrub oak, huckleberry, blueberries, wintergreen, etc.) varies dramatically in plantations, depending on land-use history and plantation, disease, and management history. Similar to many pitch pine stands in the Connecticut Valley (Motzkin *et al.* 1996, 1999), conifer plantations established on former agricultural fields in MFCSF typically lack dense understories of these native species. In some of these stands, understories are quite sparse, whereas in others, weedy species such as poison ivy are abundant. Similarly, in some dense, vigorous plantations that were established on non-agricultural lands, shading from conifers has apparently been sufficient to reduce the abundance of native understory species dramatically. Native understories are also greatly reduced in sites that were salvage logged after severe damage by Hurricane Bob, in part because soil disturbance apparently promoted the establishment of dense, weedy species such as poison ivy, Asiatic bittersweet, and sumac. In contrast to these stands, many conifer plantations in MFCSF support dense understories of native species. Included in this category are healthy as well as dying red and Scots pine plantations, and some young plantations that have not yet developed closed canopies capable of shading out characteristic understory species. Interestingly, many of the areas that were machine-planted in the 1960s support dense understories of native species, indicating that the physical disturbance created at the time of planting was not sufficient to eliminate sprouting species (Fig. 19).

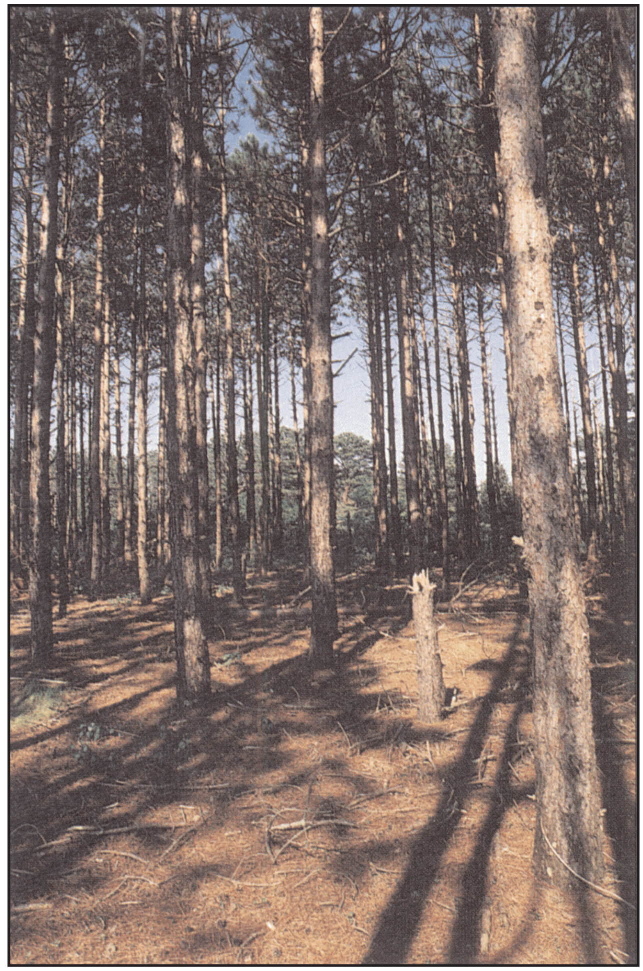
As a general guide to understanding the current conditions of the conifer plantations and as background to our recommendations for their future management, we offer the following broad classification of major types of plantations on MFCSF, based largely on stocking density, understory conditions, and land-use history.

***Young (10–35 year-old), vigorous plantations.*** Plantations of white spruce, Norway spruce, and white pine that were machine or hand-planted since 1960 in areas that had never been plowed for agriculture are generally growing vigorously, have overtopped the surrounding native vegetation, and create a sharp contrast to the adjoining areas of oaks and shrubs (Fig. 25). This is particularly true in the frost bottoms, where a number of spruce plantations were established. Although the native understory vegetation is still intact, with increased conifer height and growth these stands will gradually crowd and shade out the underlying trees, shrubs and herbs. Included in this category of vigorous plantations are the hybrid loblolly-pitch pine plantations, which were apparently established in native vegetation, lack an Ap horizon, and retain native shrub and herb understories.

**Figure 25.** Young vigorous white pine (top) and spruce (bottom) plantations in MFCSF above dense understories of native shrub species. As these plantations mature, dense shade may reduce or eliminate understory species that provide habitat for rare insect species.

***Older (60+ year-old), vigorous plantations.*** White pine, Norway spruce, and white spruce appear to maintain the best growth of the non-native (to Martha's Vineyard) species in the older plantations, and many of these stands have dense continuous canopies, large trees, and are overstocked from a silvicultural perspective. These stands were established on sites with and without Ap horizons, but in some cases the heavy shade cast by the conifers has apparently resulted in very sparse understories (Fig. 26), even on sites that were not used for historical agriculture and presumably had dense understories of native species at the time the plantations were established.

***Wind-damaged and salvaged plantations.*** Following Hurricane Bob many dense plantations were severely damaged and subsequently salvaged (Fig. 27). The result has been extensive soil disturbance through uprooting and machine operation, apparently resulting in a dense proliferation of weedy species such as poison ivy (*Rhus toxicodendron*), brambles (*Rubus* spp.), smooth sumac (*R. glabra*), Asiatic bittersweet (*Celastrus orbiculata*), Virginia creeper (*Parthenocissus quinquefolia*), black cherry (*Prunus serotina*), Hercules-club (*Aralia spinosa*), and pokeweed (*Phytolacca americana*). Native species are often uncommon in these heavily disturbed areas, either because they were previously eliminated by agricultural plowing or dense shade or because they were subsequently crowded out by the invasive species.



***Open plantations with native understories.*** Due to the lower shade tolerance and more open conditions created by red and Scots pines and the wide spacing of the original plantings, healthy stands of these species typically have somewhat open canopies with thin but fairly continuous understories of characteristic native species, including scrub oak, huckleberry, blueberry, and in some instances wintergreen. However, many of these plantations have begun to deteriorate, some badly, as a result of disease, wind, or root competition. As the crowns break-up and die in these stands and understory light levels increase, the density of the native understory shows a corresponding increase. Where these stands adjoin white pine plantations, the more shade tolerant white pine are establishing and in some cases have created a dense sapling layer under the disintegrating older trees (Fig. 28).

**Figure 26.** Older, vigorous red pine (above) and spruce (right) plantations in MFCSF with sparse understories due to shading or former agricultural use. The dense understory visible in the foreground of the picture on the right is largely absent beneath the spruce stand.

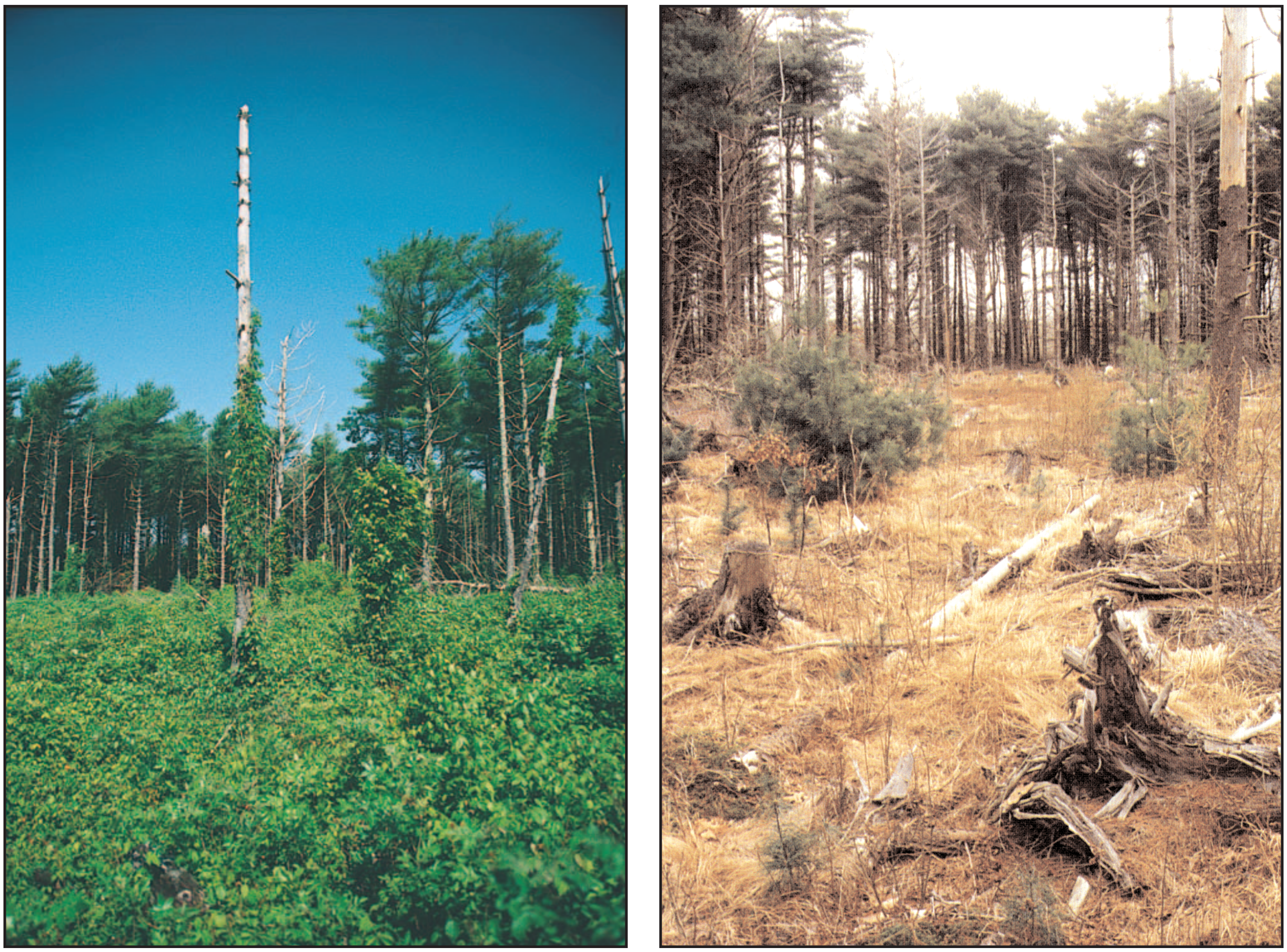


**Figure 27.** Plantations damaged by Hurricane Bob in 1991 and subsequently salvage logged. Weedy species have become widely established on these sites.

**Figure 28.** Red pine plantations that are heavily damaged by the fungal pathogen *Diplodia pinea*, with abundant white pine regeneration.

## ECOLOGICAL RESTORATION POTENTIAL AND PRIORITIES

Although widespread land clearing began on Martha's Vineyard soon after European settlement in the 17th century, settlement and agriculture were focussed around the perimeter of the Island, and the area that later became MFCSF remained a large, intact woodland through the historical period. Frequent cutting and burning undoubtedly influenced stand structure across the outwash plain, although many species characteristic of scrub-oak and xeric hardwood stands persisted through these disturbances. Thus, when compared with much of southern New England, MFCSF is unusual in it's very low percentage of land that was used for historical agriculture (<2%) and as a relatively large example of an ecosystem type that may have been more widespread previously. In contrast, outwash plains in the Connecticut Valley of Massachusetts were plowed extensively for agriculture in the late 19th and early 20th centuries, a practice that apparently eliminated several characteristic taxa from many sites and continues to influence vegetation patterns and ecosystem function today (Motzkin *et al.* 1996, 1999; Compton *et al.* 1998; Donohue *et al.* 1999). The combination of extensive areas of intact soils and native vegetation across broad sections of MFCSF provides a unique opportunity to protect and manage a large, functioning natural landscape that supports numerous characteristic as well as unusual species.

The historical and paleoecological records strongly and consistently indicate that the central portion of the Great Plain, including MFCSF, has been wooded with forest and scrublands for centuries, with no indication that grasslands were historically important in this area. As a result, we recommend that ecological restoration activities on MFCSF focus on maintenance of a mosaic of native woodland (tree oak and pitch pine) and scrub-oak types, with special attention to protection or enhancement of unusual features such as ancient sprout-oak stools and scrub-oak dominated frost bottoms. Although there is no historical evidence for grass-dominated vegetation in MFCSF and we do not recommend creation of extensive sand-plain grasslands, management of firebreaks and roads should incorporate consideration of rare grassland species requirements.

Recognizing the unusual opportunity to manage MFCSF as a large, functioning natural system, we further recommend significant reduction or elimination of the conifer plantations on MFCSF. The plantations were initially established with the prospect of great potential value and service to the Island population and economy; however, they have failed to meet that objective in part because of poor timber quality, lack of local markets, and a wide range of natural onslaughts, including pathogens and storm damage. In addition, although there existed strong regard for the appearance and park-like environment created by the plantations when they were vigorous, most Islanders and visitors currently consider the plantations, with the high proportion of damaged and poorly salvaged stands, to be highly undesirable (P. Van Tassel pers. comm.). The high frequency of winter storms and hurricanes and the increasing susceptibility of the planted conifers to windthrow as they increase in size ensures that such damage will increase in the future.

From an economic perspective, it appears that at no time in the past 50 years has there been, nor in the foreseeable future will there be, any prospect for profitable timber production on the Island, and the few forestry operations that have been undertaken have been costly to the Commonwealth or, at best, have produced very modest income. In addition, there is growing concern about fuel loading and fire hazard in collapsing plantations, which complicate road and fire line maintenance. In summary, we concur with the sentiment of DEM Management Forester Austin Mason's statement : "If I have anything to say about it, we won't be putting forest plantations back into Manuel Correllus State Forest. Marketing that timber costs us money. We take a loss..." (Adams 1992), and with the assessment of DEM (1994b) that: "...management for plantations and timber is not sound or practical from a silvicultural or economic perspective, and that such vegetation [plantations] exacerbate the potential for serious fires." In contrast, removal of conifer plantations would greatly enhance the potential to manage MFCSF as a large, functioning natural landscape.

Consequently, our specific management recommendations are based on the following premises:

1. There is tremendous value in creating and maintaining a large expanse of native vegetation that includes stands of different age, structure and dominants, including expanses of scrub oak and scrub-oak bottoms, pitch pine and tree oak stands, and containing unique biological structures such as ancient oak stools, scattered old post oaks, and mound and pit topography.
2. There is a need to manage highly flammable native vegetation pro-actively in order to control fuel loading and to offer access for fire control.
3. As the conifer plantations age, the extent of damage from disease and windthrow will increase as will the necessity to undertake costly timber salvage operations.
4. The absence of local markets, poor timber quality, and high frequency of damaging storms will continue to prohibit profitable long-term timber management on MFCSF.
5. The value of the native vegetation will be enhanced if the vigorous young conifers are eliminated from crowding native species and if dense and dying plantations can be converted to native vegetation.
6. The quantity of timber in current plantations may make viable the option of commercially logging the areas of good conifer timber in order to convert these stands to native vegetation at minimal cost. In the past, timber sales have been attempted primarily through local operators or as salvage operations. If the Commonwealth were willing to host a liquidation sale of a very large quantity of material, it may be possible to attract off-island operators who could transport the material to mills or plants out of the region (e.g. northern New England or Canada). These operators would present the potential for operating with new, low impact equipment that would reduce soil disturbance, work efficiently and thoroughly, and present the Commonwealth with a restoration activity that is inexpensive, cost-free (break-even), or even profitable. Such activity would need to be undertaken in the winter in order to minimize soil disturbance, to reduce the risk of wood stain, and to take advantage of the period of low population on the Island.
7. Extensive sand-plain grasslands, although historically absent on MFCSF, are valuable and may be maintained through careful and coordinated management of the airport grasslands, the fire lanes, and any additional fire breaks that may be necessary at the north and east edge of MFCSF.
8. Existing pitch pine stands provide considerable ecological and aesthetic diversity that is compatible with the natural landscape and with Islanders' appreciation for the environment and appearance of conifer stands.

In order to convert the conifer plantations to native or semi-natural vegetation, we recommend prioritizing stands that either pose the greatest immediate threat to native vegetation or are easiest to convert; to work more slowly and undertake some experimental manipulations with types that appear more difficult to restore to native vegetation due to land-use or stand characteristics that have reduced or eliminated native species; and to place a low priority on treatment of plantations that are naturally disintegrating and converting to native species. This approach results in the following specific recommendations.

**Young (10–35 year-old), vigorous plantations**

These stands create a visual and habitat disruption to the expansive areas of tree and scrub-oak vegetation, particularly in the frost bottoms, and their rapid growth will increasingly shade out and weaken native species and reduce these important natural vegetation types. Consequently, these stands create a major threat to the natural communities of MFCSF, including the rare lepidopteran assemblages in the frost bottoms, and should be a high priority for restoration. Importantly, this type represents the easiest plantations to restore to native vegetation as the conifers can be easily killed by cutting and then chipped or left in place due to their relatively small size. Through time, or with the use of controlled fire, conifer slash will be reduced and the native vegetation will respond vigorously. The major impediment to restoration of these stands (i.e., eliminating the planted conifers) is psychological. Many of these trees are growing rapidly and their removal may appear wasteful. However, past experience has demonstrated that despite rapid early growth, plantations on MFCSF are not economically viable and these stands currently jeopardize one of the unique features on the plain, the scrub-oak bottoms with their associated rare species. An alternative restoration technique would be the use of controlled fire, which would kill the conifers and allow the native vegetation to regenerate rapidly.

**Open Plantations with Native Understories**

These stands have open canopies and light conditions and therefore support a substantial component of native trees, shrubs, and herbs. Restoration to native vegetation would require the removal of the conifers with minimal soil disturbance to prohibit the establishment of weedy species. Restoration could be accomplished by logging and tree removal or killing the standing trees and leaving them in place. If logging were undertaken, it should be done with equipment that minimizes soil scarification. Following conifer removal or mortality, it would be desirable to undertake controlled fires in these stands as this would kill any understory white pine that had become established, reduce conifer slash, and promote rapid regrowth of native vegetation.

**Older (60+ year-old), Vigorous Plantations and Wind-damaged and Salvaged Plantations**

These two types are the most problematical regarding treatment and they are grouped together because many of the wind damaged and salvaged plantations were formerly older, vigorous plantations and indicate some of the problems of management and neglect. The difficulty in treating these stands is that the density of conifers, or in a few cases the history of agricultural plowing, has substantially reduced the native understory such that it is unclear whether it would become re-established if the conifers were removed. The salvaged and damaged areas provide ample evidence that if these areas are treated in ways that generate extensive soil disturbance, the result is likely to be a proliferation of weedy species. Past salvage logging has also resulted in unattractive accumulations of coarse woody debris. We suggest that small-scale experiments be undertaken to examine the response of these stands to contrasting treatments, including whole tree logging with a minimum of soil disturbance, perhaps in combination with controlled fire. It is possible that the native understory species are reduced to the point that they will not return unaided. In this case two options appear viable: attempt to re-establish native species or convert these plantations to semi-natural grasslands through plowing and planting.

As with the young, vigorous plantations there may be some resistance to eliminating these plantations, as they support the highest quality timber on MFCSF. However, the high frequency of damaging storms suggest that it is likely that these stands will be damaged in the near future. In order to derive some income and merchantable timber from these stands, and to reduce the need for costly salvage operations, it is necessary to harvest them in the near future, before additional storm damage has occurred.

**Scrub-Oak Bottoms**

Elongate topographic depressions known as frost bottoms are found in several areas of MFCSF, extending north from coastal ponds along the south shore. The xeric (upper) ends of the bottoms are typically scrub-oak dominated, supporting numerous characteristic and rare lepidopteran species (Goldstein 1997). Frost bottoms experience short growing seasons due to late spring and early fall frosts that apparently result from cold air-drainage from the surrounding uplands and extreme radiational cooling, particularly on dry, calm nights. Vegetation structure, composition, and phenology are strongly linked to local variation in climate on these sites, which in turn influence insect populations and phenology (Aizen and Kenigsten 1989; Aizen and Patterson 1995). Such frost-prone areas are characteristic of several extensive pitch pine-scrub oak barrens in the Northeast, occurring occasionally even on sites that lack topographic variation (Ciccarello 1997).

Although the development of frost bottoms is not well-documented, it is likely that the establishment of a forest canopy above the open shrubby vegetation would greatly reduce or eliminate the frost phenomenon, resulting in a significant shift in the composition, structure, and functioning of these systems. The primary threat to the scrub-oak bottoms at present is the growth and development of the 'young, vigorous plantations' , and we recommend that these be removed using techniques that will involve minimal soil scarification (discussed above). In addition, if fuel reduction in scrub-oak bottoms is warranted for fire control, mowing and/or prescribed fire may be useful. However, both mechanical and prescribed fire management should incorporate consideration of rare species requirements and life histories.

**Hardwoods Stands with Ancient Oaks**

Oak woodlands with dense ericaceous or scrub-oak understories are widespread on MFCSF. Where these stands support ancient oak stools, management may be warranted to perpetuate these features. Because the stools apparently developed as a result of repeated cutting or burning, prescribed fire or cutting may be useful management tools. However, management should not proceed until additional information has been gathered on the development and distribution of these features and on their response to fire and cutting. As described above, woody species typically sprout most prolifically when young, and it is unclear whether cutting or burning once stems have matured will allow for vigorous sprouting. A prescribed fire conducted in 1996 at MFCSF resulted in the mortality of some oaks and failure to resprout, emphasizing the need for additional information before attempting to manage for these features.

The reduced frequency of large fires in recent decades has resulted in an increase in height and extent of forest cover in MFCSF, a trend that is likely to continue into the future. Flammability is reduced is these forested stands in comparison to open shrublands due to a decrease in understory wind speed and a decline in scrub oak under shaded conditions.

**Pitch Pine Stands**

In most cases, the pitch pine stands in MFCSF are either natural or semi-natural, with the actual areas of planted trees being quite limited. Indeed, the extensive stands in the northeastern Plain and in the Boch Pine area are quite natural appearing and have nice historic trails through them. Some of these stands became established after fires in the early 20th C, although we have not attempted to determine the origin and history of each stand. We recommend that these stands be retained, recognizing that they will continue to undergo some windthrow followed by regeneration of pine or other native species. The exceptions are the hybrid loblolly x pitch pine plantations. There may be scientific justification to retain these. Otherwise they may be treated as young vigorous stands and be eliminated (see above).

**Firebreaks and Wildfire Hazard Reduction**

Although W. Patterson is currently developing detailed guidelines for fuel management and wildfire hazard reduction on MFCSF, a few observations are warranted here. As a result of prevailing winds, most fires on the central outwash plain of Martha's Vineyard spread from the south and west to the north and east. Unfortunately, such fires have the potential to threaten human life and property as significant housing development has occurred along the northern and eastern boundaries of the State Forest. It may, therefore, be necessary to improve firebreaks and access for fire control along the northern and eastern boundaries. Wide zones of reduced fuel loadings and increased access along these boundaries could be achieved through a combination of mechanical treatment and prescribed fire (W. Patterson pers. comm.).

Previous mechanical treatments on MFCSF have yielded informative results: 1) mowing in thick scrub oak has been very successful in reducing the height of woody vegetation, has not resulted in a dramatic increase in weedy species, and has allowed for efficient long-term maintenance of mowed areas (Fig. 29; J. Varkonda pers. comm.); 2) areas that have recently been disc-harrowed have highly uneven soil surfaces, making access and long-term maintenance difficult and increasing the probability of invasion by weedy species; 3) firebreaks that were established in the 1920s and 1930s were plowed and harrowed repeatedly, support numerous rare species, and may be maintained through mowing (or fire) because they do not have the uneven soil surface characteristic of sites that have been harrowed only once.

As a result of these observations, we suggest that mowing after cutting of the larger trees may be an efficient and relatively inexpensive means to establish or widen firebreaks along the northern and eastern boundaries of MFCSF. Once established, firebreaks may be maintained through a combination of mowing and prescribed fire. Establishment of firebreaks by harrowing

**Figure 29.** Experimental mowing in a scrub oak stand. Photos are from April and June 1998. The area was mowed annually for 5–6 years until the summer of 1997 (J. Varkonda pers. comm.). This treatment substantially reduced fuel depths with minimal soil scarification while maintaining the native plant species and allowing for long-term maintenance either through subsequent mowing or prescribed fire.

would require significant commitment of resources and labor for repeated plowing and disking in order to smooth soil surfaces for long-term maintenance and access.

**Rare Species**

In order to develop guidelines for the management of rare species in MFCSF, there is an immediate need to conduct a comprehensive inventory of rare species distributions throughout the State Forest. Because prior inventories in MFCSF have focused on firebreaks (plant inventories) or scrub-oak bottoms (insect inventories), significant questions remain regarding the habitat requirements of rare species and the influence of different management activities on rare species distributions. In particular, it is critical to determine; 1) the extent to which rare plant species occur outside of the firebreaks; 2) the degree to which rare lepidopteran species are associated with scrub-oak stands versus oak woodlands; 3) the influence of varying management techniques (e.g., prescribed fire and mowing) on rare species distribution and abundance.

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**Appendix.** Partial map of conifer plantations in MFCSF, 1928–1965. Map derived from unpublished maps at MFCSF. Small polygons represent areas of map overlap and may result from map error. Numbers refer to the table on page 48.

Appendix (continued). Planting information for conifer plantations in MFCSF, 1928–1965.

| ID number | Area (acres) | Area (hectares) | Year(s) planted | Species | Quantity planted (if known) |
|---|---|---|---|---|---|
| 1 | 7.1 | 2.9 | 1931, 1933 | white pine, red pine, Scots pine | |
| 2 | 189.0 | 76.5 | 1934 | red pine | |
| 3 | 2.4 | 1.0 | 1929 | red pine | |
| 4 | 12.2 | 4.9 | 1934 | red pine | |
| 5 | 8.2 | 3.3 | 1940 | red pine | |
| 6 | 5.9 | 2.4 | 1934 | red pine | |
| 7 | 14.6 | 5.9 | 1929 | white pine | |
| 8 | 7.6 | 3.1 | 1934 | red pine | |
| 9 | 2.9 | 1.2 | 1929 | red pine | |
| 10 | 38.9 | 15.7 | 1935 | red pine | |
| 11 | 2.1 | 0.8 | 1940 | red pine | |
| 12 | 27.3 | 11.0 | 1926, 1929 | red pine, Scots pine | |
| 13 | 6.9 | 2.8 | 1928, 1938 | white pine, red pine | |
| 14 | 1.3 | 0.5 | 1929 | white pine | |
| 15 | 0.9 | 0.4 | 1940 | red pine | |
| 16 | 28.1 | 11.4 | 1961 | red pine | |
| 17 | 5.6 | 2.2 | 1940 | red pine | |
| 18 | 18.0 | 7.3 | 1929 | red pine | |
| 19 | 20.4 | 8.3 | 1932 | white spruce | |
| 20 | 33.8 | 13.7 | 1965 | white spruce | 13000 |
| 21 | 4.3 | 1.7 | 1941 | red pine | |
| 22 | 19.4 | 7.8 | 1965 | Norway spruce | 10000 |
| 23 | 9.4 | 3.8 | 1931, 1932 | white spruce, red pine | |
| 24 | 12.3 | 5.0 | 1964 | red pine | |
| 25 | 123.7 | 50.1 | 1931 | white pine, Scots pine | |
| 26 | 8.0 | 3.2 | 1965 | larch | 2000 |
| 27 | 19.7 | 8.0 | 1939 | red pine | |
| 28 | 7.1 | 2.9 | 1964 | white pine | |
| 29 | 123.5 | 50.0 | 1963 | not listed | 45000 |
| 30 | 3.2 | 1.3 | 1931, 1932 | white pine, white spruce, red pine | |
| 31 | 16.9 | 6.8 | 1964 | white pine | |
| 32 | 18.4 | 7.4 | 1932 | Scots pine | |
| 33 | 43.7 | 17.7 | 1930 | red pine | |
| 34 | 2.0 | 0.8 | 1931, 1932 | white spruce, red pine | |
| 35 | 0.4 | 0.2 | 1931, 1932 | white pine, white spruce, red pine | |
| 36 | 17.9 | 7.2 | 1933, 1965 | white pine | 10000 |
| 37 | 0.9 | 0.4 | 1931, 1932 | white spruce, red pine | |
| 38 | 28.7 | 11.6 | 1933 | white pine | |
| 39 | 19.9 | 8.1 | 1933 | red pine | |
| 40 | 20.9 | 8.5 | 1964 | white spruce | 5000 |
| 41 | 86.5 | 35.0 | 1929 or 1930 | red pine | |
| 42 | 39.8 | 16.1 | 1965 | white spruce | 15000 |
| 43 | 26.4 | 10.7 | 1932 | Scots pine | |
| 44 | 1.1 | 0.5 | 1931, 1932 | white spruce, red pine | |
| 45 | 0.3 | 0.1 | 1931, 1932 | white spruce, red pine | |
| 46 | 14.4 | 5.8 | 1931, 1932 | white spruce | |
| 47 | 8.0 | 3.2 | 1931, 1932 | white spruce, red pine | |
| 48 | 21.5 | 8.7 | 1964 | white pine | |
| 49 | 43.8 | 17.7 | 1928 | white pine | |
| 50 | 37.0 | 15.0 | 1931 | white pine, Scots pine | |
| 51 | 155.3 | 62.9 | 1963 | red pine | 75000 |
| 52 | 2.1 | 0.9 | 1934, 1964 | white pine, red pine | |
| 53 | 21.0 | 8.5 | 1934 | red pine | |