Wildland Fire Protection and Preparedness Plan

for

The Town of Mashpee River Woodlands

Mashpee, Massachusetts

Prepared By: Ross M. Garlapow, Northeast Forest and Fire Management, LLC

for

The Town of Mashpee and the Cape Cod Cooperative Extension

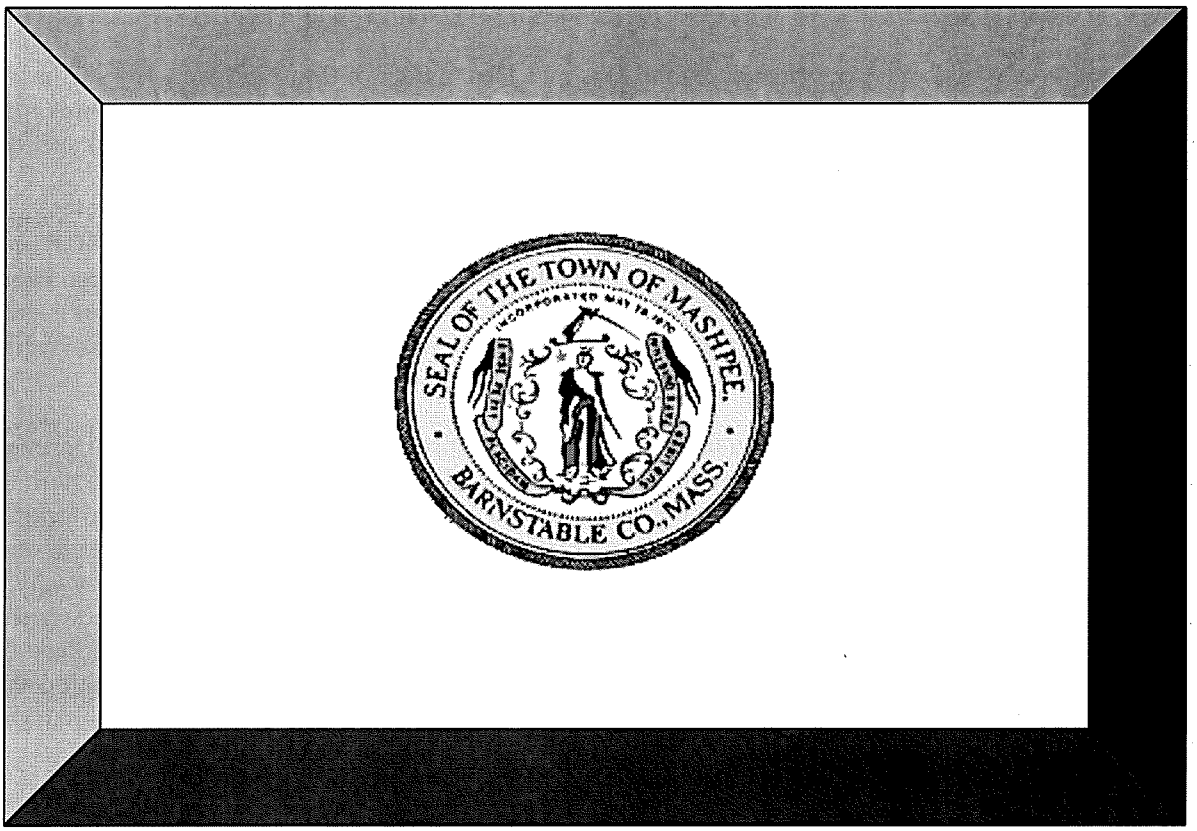
22 October, 2008

Wildland Fire
Protection and Preparedness Plan

for

The Town of Mashpee River Woodlands

Mashpee, Massachusetts



Prepared By: Ross M. Garlapow, Northeast Forest and Fire Management, LLC

for

The Town of Mashpee and the Cape Cod Cooperative Extension

22 October, 2008

WILDLAND FIRE PROTECTION AND PREPAREDNESS PLAN
FOR
THE TOWN OF MASHPEE RIVER WOODLANDS

EXECUTIVE SUMMARY

The purpose of this plan is to identify actions intended to reduce wildfire hazard at the Mashpee River Woodlands in the Town of Mashpee. It is one of many similar plans being prepared in a county-wide effort to mitigate wildfire impacts on town-owned lands in Barnstable County.

The Town of Mashpee nominated the areas outlined in this document as having a high priority for wildfire assessment and preparedness planning. The 255 acres that comprise the Mashpee River Woodlands are adjacent to residential areas within the Town of Mashpee, and create a potentially hazardous situation at the Wildland Urban Interface. Flammable conditions of existing vegetation and the potential for wildfires in the planning area justify the need and urgency of an integrated and coordinated planning approach.

The Mashpee River Woodlands are managed by the Mashpee Department of Conservation. The site has multiple natural resource values, including significant ecological features and serves as a water source for the town of Mashpee. The site is bound to the north by Quinaquesset Avenue, to the west by the Mashpee River, south by houses on Mutiny Way, and to the east by developments and Mashpee Neck Road.

The area is composed of riparian wetlands, oak woodlands, and pitch pine forest. All the vegetation types are susceptible to wildfire. Areas with black huckleberry and pitch pine are especially vulnerable to high intensity fire due to the natural volatility or dense arrangement of these fuels and the potential of the pine dominated areas to sustain a crown fire. The prevailing threat is from surface fires carried through the shrub or grass layers and crown fires are possible where pitch pine and ladder fuels are dense.

Prevention, early detection, and suppression of wildfires remain priorities for the Mashpee Fire Department. Access points and roads should be well maintained and marked to allow for adequate fire control within the properties and the surrounding areas. Resource managers are advised to reduce fuel loads in fire prone areas of the Mashpee River Woodlands. Wider zones of reduced fuels and increased access along certain roads and boundaries may be achieved through a combination of mechanical treatment. Mowing understory brush in designated areas will reduce fuel loads and thus the hazard from wildfires. These fuel reduced zones or shaded fuel breaks allow suppression forces a higher probability of safely and successfully attacking a wildland fire. The risk of wildland and residential interface fires may also be lessened through cooperative education and fire prevention strategies on private lands.

This plan presents the following recommendations:

GOALS:

A. Increase firefighter and public safety by decreasing wildland fire risk in and around the Mashpee River Woodlands identified in the Wildland Fire Protection and Preparedness Plan.

B. Reduce wildfire hazard within the Wildland Fire Protection and Preparedness Planning area for the Mashpee River Woodlands using an integrated and proactive land management program.

C. Reduce the threat of wildfire to property and life on lands adjacent to the Wildland Fire Protection and Preparedness Planning area for the Mashpee River Woodlands using education and awareness programs.

OBJECTIVES:

1. Establish a Mashpee River Woodlands Fire Management Team that will focus on management actions, implementation schedules, and future planning that relate to fire management at the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area.

2. Establish an understanding of the importance of management actions to be taken by the Town at the Mashpee Town Forest Lands Wildland Fire Protection and Preparedness Planning Area.

3. Educate property owners on the issues associated with defensible space, the hazards of wildfire, and the measures they can take to prevent damage to life and property in the neighborhoods that surround the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area.

4. Improve and maintain defensible space around structures within the town lands.

5. Establish fuel reduction zones 30 to 60-feet in width along selected interior roads and trails.

6. Establish fuel reduction zones 100 to 200-feet in width at strategic locations based on prevailing winds that occur during wildfires, on property lines immediately adjacent to residential structures at the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area.

7. Remove overhanging branches and other impeding vegetation that may hinder fire apparatus or contribute to fire behavior on town owned and maintained roads and trails in and adjacent to the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area. This includes creating safe access and egress points at strategic locations.

WILDLAND FIRE PROTECTION AND PREPAREDNESS PLAN
FOR
MASHPEE RIVER WOODS

TABLE OF CONTENTS

WILDLAND FIRE PROTECTION AND PREPAREDNESS PLAN FOR THE MASHPEE RIVER WOODLANDS

SITE INFORMATION

Site: Mashpee River Woodlands
Total Acres: 255
Town, County, and State: Mashpee, Barnstable Co., MA
U.S.G.S. Quadrangles: Falmouth, MA and Cotuit, MA
Latitude: 41^{0}36'44" N **Longitude:** 70^{0}28'23" W
Elevation: 10-60 Feet
Ownership: The Town of Mashpee
Managed by: Mashpee Department of Conservation

General Description: This planning report encompasses the cumulative 255 acres of the Mashpee River Woodlands that are located south of Quinaquisset Avenue, east of the Mashpee River, north Mutiny Way, and generally west of Mashpee Neck Road. The Town of Mashpee's Department of Conservation is responsible for the management of the properties.

The Mashpee River Woodlands are composed of riparian wetlands, oak woodlands, and pitch pine forest; and have several non-paved trails and structures within the boundary. Quinaquesset Avenue binds the site at the north end, to the west by the Mashpee River, south by houses on Mutiny Way, and to the east by developments and Mashpee Neck Road.

Terrain is generally flat throughout the site with some small hills. Soils are classified within the Barnstable County Soil Survey as being Carver coarse sand (CdD), Carver loamy coarse sand (CcB), and Enfield silt loam (EnA). The soil types that dominate the area are primarily those that are very deep, excessively drained, and generally are in broad areas on outwash plains or on small hills and ridges in areas of ice-contact deposits and on the side slopes of swales on outwash plains.

Oak woodlands and Pitch Pine forest are the dominant vegetation types within the property. Various expressions of the vegetation reflect local site conditions such as slope, slope position, aspect, land use history, and past disturbance events. Understory vegetation is primarily shrubby vegetation, including black huckleberry and low bush blueberries.

The Mashpee River Woodlands primary functions are to provide the town of Mashpee with drinking water, and open space for recreation and conservation.

EMERGENCY ASSISTANCE INFORMATION

Fire:	**Mashpee Fire Department** Chief George Baker 20 Frank Hicks Drive Mashpee, MA 02649	(508) 539-1454
Law Enforcement:	**Mashpee Police Department** Chief Rodney Collins 19 Frank Hicks Drive Mashpee, MA 02649	(508) 539-1480
Medical:	**Mashpee Fire Department**	(508) 539-1454
	Cape Cod Hospital	(508) 771-1800
Site Managers:	**Mashpee Department of Conservation:** Andrew McManus 16 Great Neck Road North Mashpee, MA 02649	(508) 539-1400 ext. 539
	Mashpee Water District: 79 Industrial Drive Mashpee, MA 02649	(508) 477-6767

All emergency numbers can be reached through 911; the above numbers are direct lines.

JUSTIFICATION FOR MANAGEMENT

This Wildland Fire Protection and Preparedness Plan is funded through the Cape Cod Cooperative Extension in cooperation with the Town of Mashpee, as part of a county-wide initiative to address wildfire hazards on town-owned or town administered open space tracts. The Town of Mashpee nominated the Mashpee River Woodlands area as being among their highest priority for wildfire assessment and preparedness planning. These properties are important town water supply and recreation sites and are primarily comprised of oak woodlands and pitch pine forest. These vegetation types are highly flammable especially in certain areas of the properties that contain heavy fuel accumulations. Residential development has increased within this Wildland urban interface area over the past two decades, warranting assessment of wildfire risks and hazardous fuels.

The Mashpee River Woodlands are a socially valuable forested ecosystem within the Town of Mashpee. The forested land provides important habitat for many wildlife species and serves as a water supply/recharge area for the town.

There are hundreds of homes immediately adjacent to the Mashpee River Woodlands. These properties situated adjacent to wildland fuels greatly increase the potential for dangerous and costly wildfires to start in or near developed areas and then spread onto the town land or for wildfires to start in these town owned properties and impact neighboring residential areas. National studies have shown that increased human activity within wildland settings generally increases the potential for wildfire ignitions. Managing the Mashpee River Woodlands for their recreation, conservation, and water source values, reducing wildfire hazards, and protecting public safety are priorities for the Town of Mashpee.

Prevention, detection, and suppression of wildfires should remain a very high priority for local fire control organizations, but resource managers must, at the same time, actively work to reduce heavy and highly flammable fuel loads in fire-prone areas through prescribed burning and mechanical cutting methods. Suppression alone will not eliminate the risk of wildfires. Although fires may occur less frequently, fires will eventually occur as long as fuels exist. Dependent on weather and fuel conditions, these fires can be expected to

burn with intensities that may escape initial fire control and threaten human resources, both within the management site and on adjacent public and private property.

Existing fuel breaks on the Mashpee River Woodlands consist of dirt foot paths within the properties, areas of reduced fuel loading or consisting of vegetation that is not highly flammable, and existing public roads along the peripheries of the properties. As a result of prevailing winds, most fires will spread from the south and west to the north and east. Several residential areas are at risk. Improved access for fire control is needed, in addition to treatment of fuel concentration on town property and public education of residents in the adjacent neighborhoods. Wider zones of reduced fuel loadings and increased access along certain boundaries and interior dirt roads could be achieved through a combination of mechanical treatment with minimal soil disturbance. Fuel treatments are proposed to reduce the threat of wildfires.

Several public agencies and conservation organizations on Cape Cod (including the National Park Service, US Fish and Wildlife Service, Massachusetts Division of Fisheries and Wildlife, Massachusetts Department of Conservation and Recreation, The Nature Conservancy, Nantucket Conservation Foundation, Trustees of Reservations, and Massachusetts Audubon Society) use a combination of prescribed fire and mechanical treatments to reduce hazardous fuel loads and maintain the ecological integrity of coastal plain forested ecosystems. Prescribed burns are carefully planned and executed to minimize escapes and smoke impacts, which are often a hazard associated with unplanned fires. Fire ecologists recommend burning designated fire-prone areas at regular periodic intervals. A program of periodic low to moderate intensity prescribed burns is designed to reduce accumulations of fine fuels and produce a long-term reduction in larger fuels.

It should be noted that although fire is a natural component of this forested ecosystem, the use of natural fire (e.g. non-management ignited fire) will not be permitted. Due to the close proximity of residential areas and transportation routes, all unplanned ignitions that occur within the Mashpee River Woodlands will be aggressively suppressed using methods and means consistent with protecting lives and property.

FIRE HISTORY AND PAST LAND USES

Paleo-ecological records show that fire has been part of the Cape Cod landscape for thousands of years (Winkler 1985, Patterson and Sassman 1988, Stevens 1996, and Patterson 1999). In modern times, fire continues to influence the vegetation of Cape Cod to the extent that fire adapted natural communities predominate over most of the area. Cores taken from Duck Pond on Cape Cod National Seashore, dating back 12,000 years and 4,800 years respectively, found abundant charcoal throughout the stratigraphic column suggesting that fire has played an important role in maintaining pine and oak forests on the Cape throughout the Holocene (Winkler 1982 and 1985, Bachman 1984, Clark 2002, Patterson and Crary 2004). A sediment core taken by Patterson (1999) from Mary Dunn Pond in Barnstable supports the evidence that fire was an important influence within the pre and post European settlement landscape of Cape Cod.

By the early 1800's, almost all forested areas were divided into firewood lots and extensive fuel wood cutting and sheep grazing occurred on the landscape. Fires during this time were extensive, often thousands of acres. Descriptions of the Cape Cod landscape during this time, report widely spaced pitch pines and coppice oak sprouts.

With the expansion of railroad activities on Cape Cod in the late 1800's, forest fires increased. Drifting embers from steam locomotives started most fires (Thompson 1928). During the early 1900's on Cape Cod, fires were abundant and Thompson (1928) reported an average of 8,500 acres of woodland burned annually. Tourism was becoming an important trade on Cape Cod by the early 1900's and public opinion began to favor the suppression of all fires, although some people still continued the practice of burning blueberry patches to increase berry yields.

The first fire tower on Cape Cod was erected in 1913 in the Town of Barnstable to watch for fires and communicate fire locations to local fire fighters. The Massachusetts Department of Conservation started patrolling the Cape in the 1920's along with local patrol trucks, which were equipped with water, hose, and

tools. In the late 1930's, Cape Cod led the way in developing the first brush breakers to fight forest fires (Crosby 2003). After this period, forest fires tended to burn for shorter periods of time and consumed fewer acres.

Very large wildfires may still occur on Cape Cod every 30 to 50 years, instead of intervals of 10 to 20 years (Patterson and Ruffner 2002). Long intervals between fires may heighten the danger to the public, as fuels build up and people are prone to forget about the risk of wildfire and become complacent about controlling flammable accumulations of fuels around dwellings and other structures.

THE FIRE ENVIRONMENT

Fires, like many natural events, are cyclic. The fire cycle is governed by conditions such as climate, storm events, insect outbreaks, topography, soils, existing vegetation, and human activities. The climate of Cape Cod is humid and continental characterized by a moderate to large annual temperature range and well-developed winter and summer seasons. Precipitation is ample in all months and favors development of forests (Strahler 1966). The vegetation exhibits a maritime influence due to its proximity to the Atlantic Ocean. Prevailing winds are out of the southwest from April through October and out of the northwest from November through March. Winds from the northeast are associated with storm events, bringing high winds, driving rain, and cold damp air. Precipitation maximums occur during the winter months and a minimum usually occurs in late May through July (Fletcher 1993).

Most wildfires are likely to occur in late spring and early summer, associated with southwesterly winds. The potential for fire is highest during periods of low precipitation and humidity, when fine fuels can ignite easily. Relative humidity levels are usually lowest in March through May. Wildfires occurring during periods of low humidity can create sparks and embers carried aloft in the rising hot air above the fire and cause spot fires downwind of the main fire. Strong northwesterly winds associated with changing frontal systems in early spring or fall flame many large and hard to suppress wildfires. In high winds, embers may be carried hundreds of feet from the main fire and cross barriers such as roads and water bodies.

The sandy soils found throughout the management site tend to dry quickly and create conditions ripe for severe fires during dry periods in the spring, summer and fall. Drought conditions in the summer can reduce live fuel moisture. Such conditions in the summer can also reduce moisture in soil and duff layers, so that the potential for severe fires increases (Patterson and Ruffner 2002).

The Keetch-Byram Drought Index (KBDI) is currently used in fire planning to evaluate the effects of extended drying on the duff layer. The index increases for each day without rain and the amount of increase depends on the daily high temperature. The scale ranges from 0 (no moisture deficit) to 800. A prolonged drought creates a high KBDI, making more fuel available for combustion and increased smoldering and difficulty in fire suppression. This mathematical system helps relate current and recent weather conditions to potential or expected fire behavior (Keetch and Byram 1988, Melton 1989). The National Park Service tracks the KBDI at Cape Cod National Seashore.

Major tropical storms occur every 30 to 40 years on Cape Cod and the Islands (Foster and Boose 1995, Foster and Motzkin 1999). Salt exposure and intense wind events may damage vegetation. Pines are especially susceptible to windthrow, uprooting, crown and branch damage. Increased available fuels and the potential for more severe wildfires result from hurricanes and tropical storms. Cape Cod has a long history of severe winter storms, blizzards, and nor'easters. Most winter storms bring the Cape storm surges and high winds.

Periodic defoliation of trees (especially oaks) by forest insects such as the gypsy moth or the newly arrived winter moth increases the exposure of sunlight to understory fuels. Downed tree branches, fine fuels in the understory, and leaf litter tend to dry out more quickly. Prolonged hot and dry conditions during episodic insect outbreaks increase fire danger and the potential for fire starts.

Topographic relief at the Mashpee River Woodlands consists of gently rolling hills consistent with other local lands found in outwash plains of moraines.Topography is an important factor considered in fire management planning. Generally, fire will move up slope more rapidly and with greater intensity than it will move down

slope. Fire moving up slope will preheat fuels, thereby increasing fire intensity and rates of spread. Fire intensity and rates of spread moving down slope behave much like backing fires on flat terrain. Topography can effect wind and cause local changes in fire direction, intensity, and rates of spread. Wind moving upslope may be diverted around a hill, resulting in a change in direction. On moving from flat ground to sloping ground, wind may eddy and become turbulent, resulting in updrafts and downdrafts and increased fire behavior.

Fuels are made up of various components of the vegetation, both live and dead. The effect that fuels have on the ignition, spread, intensity, and duration of fire varies according to plant species, size, amount, compactness, condition (live or dead fuels), moisture content, mineral content, horizontal continuity, and vertical arrangement of those fuels. For instance, fuel load, size class distribution, and arrangement of fuels control ignition and whether a fuel will sustain a fire. Horizontal continuity influences whether a fire will spread or not and how steady that rate of spread may be. Fuel loading and vertical arrangement influence flame length and the ability of the fire to "torch" in the overstory. With the proper horizontal continuity in the overstory (such as within dense pitch pine), the fire may develop into a crown fire.

Wildland fires are typically spread by fine fuels such as leaves, needles, and twigs on the surface and in tree canopies. These are known as one-hour time lag fuels (material < ¼ inch in diameter) that can quickly absorb moisture from the air or lose that moisture if humidity decreases. They are capable of drying out or losing two-thirds of their moisture content in about one hour. For example, on a sunny spring day, these fine fuels can rapidly dry and increase in flammability from early morning to mid day as humidity decreases. Ten-hour time lag fuels (twigs and small branches between 1/4 inch to 1 inch in diameter) are ready to burn within 10 hours of drying time. They also help spread wildland fires because they ignite and burn quickly. 100-hour time lag fuels (branches and slash between 1 to 3 inches in diameter) equilibrate over the course of many days and are slower to ignite. 1000-hour time lag fuels (> 3 inches in diameter) are basically trees and slash that need 1000 hours of dry time before they would combust. Long periods without rain can significantly affect the ability of 100-hour and 1000-hour fuels to burn. They may contribute to the intensity of a wildland fire creating local pockets or jackpots that may flare up and cause problems with mop-up but these larger fuels contribute little to the rate of spread.

Several plant communities within the management site are prone to wildfires; having formed on extremely acidic and excessively drained soils. This dry and acidic environment slows the decay of organic matter and leads to thick accumulations of litter and duff. Many of the constituent plants of these communities, such as black huckleberry, scrub oak and pitch pine produce volatile substances in their leaves and stems; these live fuels contribute to the spread and intensity of fire. The dense black huckleberry or scrub oak understory tends to form a horizontally continuous layer of fine fuel through which fire spreads. The retention of dead branches on stems and the trapping of fallen twigs and branches within the shrubs provide well-aerated fuels. The dense shrub layer along with ladder fuels such as greenbrier and bittersweet, contribute to the vertical arrangement of fuels, thereby increasing the possibility of scorching of canopy foliage or crowning of fires within the canopy.

Pitch pine and other conifers tend to carry fire through the tree canopy more readily than oaks. From a distance, pine stands look fresh and green. Closer inspection generally reveals that the greenness is enveloping a core of dry needles, twigs, and branches. Pine needles contain a combination of flammable organic compounds produced in the green needles during photosynthesis. If black huckleberry, scrub oak, and pitch pine vegetation are left to accumulate increased fuel loads; the increased loading of volatile fuels may significantly contribute to increased fire behavior and high intensity wildfires that threaten not only the ecosystem's functionality, but also private property in the surrounding areas.

PLANT COMMUNITIES AND CORRESPONDING FUEL MODELS

Plant communities at the Mashpee River Woodlands fit into three general types and were described based on fieldwork completed during the Fall of 2008 (Garlapow 2008). These generalized groupings of plant communities were completed to evaluate current vegetative conditions, wildland fuel conditions, and wildfire risk. Brief fuel discussions and fire behavior predictions accompany the plant community descriptions. An outline of plant communities or vegetation types, along with corresponding fuel models, topographic position,

and approximate size is provided. Figure 2 is a map of the management site depicting vegetation from available orthophotography.

Fuels are discussed in terms of standardized fuel models developed by the U.S. Forest Service (Anderson 1982, Rothermal 1983, Scott and Burgan 2005) to help estimate fire behavior. Corresponding fuel models that "best fit" plant communities within Thompson's Field Conservation Area are discussed after each plant community description. Fuel models are important tools for land managers to assess wildfire risk and to determine prescribed fire parameters. Fuel models are used in mathematical modeling of fire behavior and fire danger rating. They are presented in fuel groups: grassland, shrubland, timber, and slash. The BehavePlus Fire Modeling System is a software application designed to predict wildland fire behavior for fire management purposes. The program is designed for use by fire managers who are familiar with fuels, weather, topography, and wildfire situations. For more information, the BehavePlus fire behavior prediction system may be downloaded from the Internet (Appendix A.). Following is a general summary of the three primary vegetative communities found on the site and associated fire behavior models.

Pitch Pine-Oak Forest/Woodland (Oak Dominant)

TOTAL – 198 acres/ 78 Percent

This woodland type has an overstory with oak being dominant and some pines. The understory has a component of black huckleberry, with occasional concentrations of scrub oak, and other shrubs. The shrub layer is low and relatively sparse.

Pitch Pine-Oak Forest/Woodland (Oak Dominant) is represented by Fuel Model 5 – Shrubs for growing seasons and Fuel Model 6 – Dormant Brush for dormant seasons. During the growing season the increased amount of volatiles increase flame lengths while the increased live fuel moistures decrease rate of spread. During dormant season fires the rate of spread is usually greater with a relatively lower flame length. Crown fires or torching is unlikely in this vegetation type. In areas that the shrub layer is sparse Fuel Model 9 – Oak Litter may better represent fire behavior. Oak litter under wildfire can generate relatively high rates of spread with moderate flame lengths, however if high winds occur significant spotting from blowing leaves often occurs.

Pitch Pine-Oak Forest/Woodland (Pine Dominant)

TOTAL - 57 acres / 22 Percent

This woodland type has an overstory dominated by pitch pine and/or white pines, while tree oak species comprise a lesser proportion of the overstory. Some of the pines may have a considerable amount of lower branches. The understory has a significant component of black huckleberry, with occasional concentrations of scrub oak, and other shrubs.

Pitch Pine-Oak Forest/Woodland (Pine Dominant) is represented by Fuel Model 5 – Shrubs for growing seasons and Fuel Model 6 – Dormant Brush for dormant seasons. During the growing season the increased amount of volatiles increase flame lengths while the increased live fuel moistures decrease rate of spread. During dormant season fires the rate of spread is usually greater with a relatively lower flame length. If ladder fuels are present, under certain weather conditions involving drought, high winds, high temperatures, and/or low humidity, surface fires may move into the overstory and create extensive torching and in some cases crown fires.

Wetlands (Shrub Swamps and Bogs)

ACRES CALCULATED AS PART OF OTHER COVER TYPES

Shrub dominated wetlands comprised of highbush blueberry, winterberry, swamp azalea, and leatherleaf may form a continuous shrub layer with sweet pepperbush and sheep laurel occurring to a lesser extent. Young red maple, tupelo, and pitch pine trees are scattered throughout the wetlands. Low herbaceous vegetation is sparse. Virginia chain fern, marsh fern, wool-grass, reed canary grass, and large bog cranberry often occur over sphagnum moss.

The shrub swamp is represented by Fuel Model 5 - Brush during the growing season and 6 Dormant Brush during the dormant season. The leaf litter is generally compact above sphagnum or muck and fire tends to move very slowly on the surface. During high water periods, which may last for several months of the year, fire will

not carry through these wetlands and they may serve as firebreaks. However, under extreme weather conditions involving drought, high winds, high temperatures, and/or low humidities surface fires may move into the shrub layer and flare up in heavy fuel concentrations. In addition, severe and difficult to extinguish ground fires may occur in peat deposits during drought periods.

SURROUNDING LANDSCAPE AND INHOLDINGS

The wildland/urban interface is defined as the area where combustible homes and other facilities meet combustible vegetation. This interface includes a wide variety of situations, ranging from individual houses and isolated structures to subdivisions and rural communities surrounded by wildlands. Hundreds of homes are located in close proximity to management site (Figure 1). In many cases, concentrations of wildland fuels border private and town-owned land, separated only by narrow open spaces around homes. Very few homes have adequate buffers of non-burnable material around them.

Landscaping within residential areas is mixed deciduous and coniferous. Common ground covers are short grass, mixed vegetation, and softwood mulch. Most structures do not have 30 feet of defensible space on all sides. There are heavy ladder fuels often within 30 feet of dwellings. Natural forest vegetation is often within close proximity to dwellings. Pitch pine and other flammable vegetation may be within 30 feet of many structures. Firewood and fuel storage is commonly found within 20 feet of structures.

In addition to the direct threat of wildfire; smoke associated with a wildland fire could impact sensitive resources in the surrounding area. Hundreds of homes are located on all sides of the properties, with the majority of the dwellings being within a 0.5 mile radius. Beyond health impacts, smoke can impair visibility. At high relative humidity's, small concentrations of smoke can create fog. Also, at high humidity's and fuel moisture levels, vegetation burns poorly, creating more smoke than when the same vegetation would burn in low humidity's and low fuel moisture levels. Major roads within a mile radius of the Mashpee River Woodlands would likely be impacted by a large wildfire event. Included in these roads are Routes 28, 130, and 151.

The Mashpee River Woodlands have numerous structures adjacent to the property boundary in residential areas to the east and south (Figure 1).

NATURAL RESOURCES & SPECIES OF CONCERN RESPONSE TO FIRE

The oak woodlands and pitch pine forests of the management site are adapted to survive low to moderate intensity fire. Black and white oak trees are capable of surviving low intensity fire due to thick bark. When oaks are top-killed by moderate intensity fire, trees may sprout readily from stumps (Abrams 2005, Abrams 1992, Lorimer 1993, and Rawinski 2000). Severe and high intensity fire, generally associated with wildfire, may consume the duff, injure root systems, and kill trees. Severe wildfires may also scorch acorns in the duff layer, preventing their germination. Periodic low to moderate intensity prescribed fire is likely to open up the understory temporarily, allowing enhanced growth of black oak and white oak sprouts and increasing the importance of oak within these mixed oak and pine forests. Native herbaceous species in the grasslands will be invigorated and increase in dominance following spring prescribed fires if fire is applied every 2 to 5 years.

Pitch pine with its thick corky bark and many dormant buds is also adapted to survive fire. Even after foliage and leaves are killed, epicormic shoots may be released along the bole and provide new foliage. Older trees tend to survive moderate to high intensity fires. Fires during the growing season are more likely to kill pines, especially if feeder roots are damaged. Pines are more susceptible to turpentine beetle attack following fire. Severe wildfires are likely to promote germination of pitch pine because the duff layer is consumed and mineral soil exposed. Therefore, severe fires tend to increase the importance of pitch pine in the community and the likelihood of serious crown fire in future unplanned ignitions (Patterson and Ruffner 2002).

High severity and intensity fires may cause actual tree mortality and local extirpation of populations. Although many oaks exhibit the ability to be top-killed and sprout vigorously after fire, fires that are too intense or severe will kill trees completely. Arson fires during drought years may create high severity and intensity fires. Fuel loadings within the forest – residential ecotone are exceptionally high due to extensive build-up of shrubs and

thick vines which create laddered fuels and unusually intense fire behavior. Fuel treatments on town property and public education of the threat of wildfire and the measures that can be taken to improve defensible space around structure on private property will greatly reduce the risk of wildfire impacting structures.

The Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife reports the following rare species occurrences (Table 1) for the Towns of Mashpee (MA-NHESP 2008). Species listed in Table 1 may potentially occur at the Mashpee Town Lands, but are not confirmed.

Table 1. Massachusetts Natural Heritage and Endangered Species Program Rare Species Occurrences for the Town of Mashpee

Scientific Name	Common Name	State Status
Vascular Plants		
Corema conradii	Broom Crowberry	SC
Crocanthemum dumosum	Bushy Rockrose	SC
Dichanthelium dichotomum ssp. mattamuskeetense	Mattamuskeet Panic-grass	E
Dichanthelium ovale ssp. pseudopubescens	Commons's Panic-grass	SC
Dichanthelium wrightianum	Wright's Panic-grass	SC
Lachnanthes caroliana	Redroot	SC
Lipocarpha micrantha	Dwarf Bulrush	T
Polygonum puritanorum	Pondshore Knotweed	SC
Rhynchospora inundata	Inundated Horned-sedge	T
Sagittaria teres	Terete Arrowhead	SC
Utricularia subulata	Subulate Bladderwort	SC
Invertebrates		
Hemileuca maia	Barrens Buckmoth	SC
Papaipema sulphurata	Water-willow Stem Borer	T
Anax longipes	Comet Darner	SC
Enallagma laterale	New England Bluet	SC
Enallagma pictum	Scarlet Bluet	T
Enallagma recurvatum	Pine Barrens Bluet	T
Vertebrates		
Ammodramus savannarum	Grasshopper Sparrow	T
Bartramia longicauda	Upland Sandpiper	E
Botaurus lentiginosus	American Bittern	E
Charadrius melodus	Piping Plover	T
Circus cyaneus	Northern Harrier	T
Parula americana	Northern Parula	T
Sterna dougallii	Roseate Tern	E
Sterna hirundo	Common Tern	SC
Sternula antillarum	Least Tern	SC
Tyto alba	Barn Owl	SC
Malaclemys terrapin	Diamond-backed Terrapin	T
Terrapene carolina	Eastern Box Turtle	SC

State Listing Abbreviations: E – Endangered, T – Threatened, SC – Special Concern

The portions of the management site (Figure 2) have been designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) of the MA Division of Fisheries and Wildlife, as Priority and Estimated Habitat of Rare Species (NHESP 2006) or as having potential vernal pools. The Priority Habitats of Rare

Species mapped areas represent the geographic extent of habitat of state-listed rare species in Massachusetts, including both plant and animal, based on observations documented within the last 25 years in the database of the NHESP. The Estimated Habitats of Rare Wildlife mapped areas are a subset of the Priority Habitats of Rare Species. They are based on occurrences of rare wetland wildlife observed within the last 25 years and documented in the NHESP database. Priority Habitats and Estimated Habitats of Rare Species are the filing trigger for proponents, municipalities, and other stakeholders for determining whether or not a proposed project must be reviewed by the NHESP for compliance with the Massachusetts Endangered Species Act (MESA) (NHESP 2008).

Designated habitat for the above listed rare species requires a filing for regulatory review by the Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife under the Massachusetts Endangered Species Act (MESA). The Conservation Commission will review any proposed management actions in the Commission's role in protecting the Town's natural resources and in its responsibility of overseeing the property that is designated as protected open space.

Lacking detailed baseline information on wildlife within the area, one can only speculate as to possible changes in wildlife use resultant from prescribed fire or mechanical treatments to reduce fuel loads within designated areas the management site. Plant species composition will likely remain the same or increase slightly within these properties. Structural changes within the plant community are expected. Such changes will reflect changes in soft mast and hard mast production and mid-story cover for wildlife. Selective thinning of pine will increase canopy gaps providing increased light to oak trees and the herbaceous layer. Reduction in height and cover of invasive vines and understory shrubs will provide increased light for forest herbs and low growing shrubs. Prescribed burning will increase dominance and cover of native herbaceous species. The first year following prescribed fire or mowing within the understory shrub layer, soft mast (berries) production will decrease. By the third year, soft mast production will increase.

Most healthy, mature birds and mammals can escape the active flame front in a prescribed burn. Prescribed burn rates of spread do not generally exceed 15-20 feet per minute and flame lengths are low. Most animals are able to flee from the fire or find safety in a burrow. Very young gray fox and other small mammals that have shallow dens may be more susceptible to fire during the reproductive season. Amphibians and reptiles are also more vulnerable depending on the time of year and the specific species. Eastern Box Turtles have been observed burrowing under the leaf litter in oak forests in advance of a flaming front during a prescribed fire at the Massachusetts Military Reservation and then re-emerging unharmed after the passage of flames.

Box Turtles are common in fire adapted ecosystems. Populations are most vulnerable to severe wildfire events during the growing season. Populations are likely to respond favorably to low intensity prescribed fire when applied during appropriate times of year ensuring adequate soil moisture and on a rotation schedule that ensures adequate portions of the habitat remain undisturbed and available for box turtles.

Vertebrates and invertebrates that cannot escape the direct path of fires or mowing equipment may be injured or in some instances killed. This includes relatively immobile organisms such as eggs or fledglings. Timing prescribed burning or mechanical operations for late growing season and dormant season and using lightweight equipment, which minimizes soil compaction, will greatly reduce direct impacts to wildlife from treatments. Also, prioritizing treatment zones and establishing a rotation of treatment blocks will accommodate many wildlife species. Setting a goal that no more than one third of a given habitat type on a property (depending on conservation targets, as well as logistical and financial constraints) is under mechanical or prescribed fire treatment within a given year is necessary to balance competing resource objectives.

LOCAL PREPAREDNESS AND FIREFIGHTING CAPABILITIES

The Mashpee River Woodlands are within the jurisdiction of the Mashpee Fire Department. The Mashpee Fire Department headquarters is located at 20 Frank Hicks Drive and is 1.5 miles northwest of the site. The

department has a total of 31 personnel; 30 career and 1 call. The department has 16 pieces of apparatus, of which 6 are engines (4 structural and 2 wildland brush breakers) and 2 are ambulances. The Mashpee Fire Department had 2,823 fire and EMS runs in 2007 (Crosby 2008). The department has wildland fire initial and extended attack responsibilities for the entire 24 square miles that Mashpee encompasses.

The Mashpee Fire Department utilizes the Barnstable County Control Mutual Aid System for Cape Cod, which provides assistance from other area fire departments on Cape Cod in suppressing large forest fires and structural fires. The Mutual Aid Center is located in the Barnstable Sheriff's Department Communication Center at the Otis Air National Guard Base.

The Massachusetts Department of Conservation and Recreation's (DCR) District 1 has wildland fire detection, education, fighting responsibilities for Cape Cod and the Islands. DCR District 1 operates Fire Towers in Brewster, Sandwich, Dennis, and Wellfleet. Any given day during fire season depending on fire danger, staffing, and the District's budget one or more of these towers may be operated. Fire towers can be instrumental in quickly spotting, locating, and reporting wildfires within their jurisdiction to respective fire departments. Other detection methods include adjacent neighbor phone calls. During periods of high fire danger, DCR's District 1 conducts ground patrols and works closely with the Town of Mashpee. Staffing levels for DCR District 1 varies by season. As of 2007, year round District staff was one District Warden and two District Patrolmen (one stationed full time on Martha's Vineyard). Starting mid spring slightly after fire season begins additional staff are added through seasonal hire. These staff operate the Fire Towers and assist full time staff in fire and non-fire related activities. The seasonal staff are usually laid off mid fall slightly before the fire season ends. Wildland suppression equipment for District 1 consists of 2 brushbreakers, and 2 patrol trucks in addition to other miscellaneous equipment.

Cape Cod National Seashore has a Fire Management Program that has local and national wildland fire suppression responsibilities. In addition to suppression responsibilities a high level of expertise resides in the program in the areas of education, prevention and mitigation, and prescribed fire. The National Seashore maintains a year round fire staff consisting of a Fire Management Officer, an Engine Foreman, and a Fire Management Program Assistant. The National Seashore's three Wildland fire engines are staffed by seasonal crew and the year round staff.

The Cape Cod National Seashore tracks the Keetch Byram Drought Index (KBDI) and the National Fire Danger Rating (NFDRS) based on weather collected at fire weather sites located in Truro and Wellfleet. The KBDI relates current and recent weather conditions to potential or expected fire severity. NFDRS is a system that integrates the effects of existing and expected states of selected fire danger factors into one or more qualitative or numeric indices that reflect an area's protection needs (NWCG FDWT 2002). DCR's Bureau of Forest Fire control using a fire weather station in Plymouth, and local fire weather forecasts, determines a locally derived Fire Danger Class similar to NFDRS and uses this information for determining staffing levels for any given day. The National Weather Service's Taunton office during fire season issues World Wide Web based fire weather forecasts and Red Flag Warnings/Watches. The office additionally will issue site specific Spot Weather forecasts for Wildland fire suppression activities.

ACCESS AND INTERIOR DIRT ROADS

Roads and trails in and around the Mashpee River Woodlands are important for access to the site in the event of a fire and may be used as a fire break to help stop a fire. They also serve as egress for the public to exit an area that may be in jeopardy of burning. Roads that are too narrow for fire apparatus or that dead end and can create a problem for equipment to turn around in and can also be dangerous for fire personnel due to the potential entrapment situation, but often can impact the public in the same way by restricting their egress.

GOALS, OBJECTIVES, AND RECOMMENDED ACTIONS

GOALS:

A. Increase firefighter and public safety by decreasing wildland fire risk in and around the Mashpee River Woodlands identified in the Wildland Fire Protection and Preparedness Plan.

B. Reduce wildfire hazard within the Wildland Fire Protection and Preparedness Planning area for the Mashpee River Woodlands using an integrated and proactive land management program.

C. Reduce the threat of wildfire to property and life on lands adjacent to the Wildland Fire Protection and Preparedness Planning area for the Mashpee River Woodlands using education and awareness programs.

OBJECTIVES:

1. Establish a Town of Mashpee Fire Management Team that will focus on management actions, implementation schedules, and future planning that relate to fire management on Mashpee town-owned lands within the Wildland Fire Protection and Preparedness Planning Area.

   The establishment of a Town of Mashpee Fire Management Team will facilitate the strategic implementation over time of recommendations outlined within the Wildland Fire Protection and Preparedness Plan for the site (Figure 1). Representatives from the Mashpee Fire Departments, Water District, and Department of Conservation should comprise the team. Representation from the surrounding neighborhoods should be sought if the need and/or interest arises. For proposed work within mapped priority and estimated habitat of rare species, the Massachusetts Natural Heritage and Endangered Species Program will be consulted and, if necessary, an application shall be filed under MESA.

2. Establish an understanding of the importance of management actions to be taken by the Town at the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area.

   A public understanding of the importance of fire management at the site (Figure 1) can be established through public meetings, brochures, and/or other methods so as to ensure public acceptance of proposed treatments (Figure 1) targeted at reducing fire hazard and maintaining ecological integrity. The recommendations and justifications for those recommendations put forth by the Wildland Fire Protection and Preparedness Plan should be disseminated to key communities within the town of Mashpee.

3. Educate property owners on the issues associated with defensible space, the hazards of wildfire, and the measures they can take to prevent damage to life and property in the neighborhoods that surround the Mashpee Town Lands Wildland Fire Protection and Preparedness Planning Area.

   The education of private property owners adjacent to the site (Figure 1) on issues related to defensible space will enable the property owners to effectively mitigate conditions on their properties that will greatly reduce the likelihood of property loss during catastrophic wildfires. Additionally, firefighter safety and effectiveness will be greatly enhanced in neighborhoods and on individual properties that have been educated in, and that have taken action on mitigation strategies. FIREWISE and the Massachusetts Department of Conservation and Recreation's (DCR) Forest Fire Control produce educational materials and have well established education programs and resources. DCR Forest Fire Control often provides guidance and assistance in administering these programs. Towns, counties, and states in some areas of the country have assisted private property owners in property hazard assessments, treatment planning, and the application of treatments through technical assistance and/or by subsidizing work through small community grants. Dependent on funding sources, such incentives may be beneficial for the area.

4. Improve and maintain defensible space around structures within the town lands.

Remove overhanging vegetation from around buildings and remove debris from roofs and surrounding area. Establish a 30 foot radius around structures free of combustible fuels. Another 100 feet beyond the 30 foot buffer reduce or breakup surface fuels and thin pine stands.

More detail can be acquired from the FireWise web site (see Appendix A).

Annual inspections of the defensible space should be conducted so that vegetation maintenance needs can be identified.

5. Establish fuel reduction zones 30 to 60-feet in width along select interior roads and trails.

   The reduction or breaking up the surface fuel bed along interior roads/trails (Figure 1) will increase firefighter safety and effectiveness, and reduce fire behavior. This can be accomplished with mechanical treatments and/or prescribed fire.

   Option A:
   Mechanical treatment of 30 to 60 foot wide fuel reduction zones along both sides of road and trail edges may be accomplished with a walk behind brush mower or a heavier hydraulic ride on brush cutter. If using the heavier equipment care should be taken so as not to damage over story trees or create excessive soil compaction. The primary goal of mowing operations within the zones should be to reduce shrub height and break up the continuous shrub cover. Shrubs reduction does not need to be to the base of trees but rather in manner that removes horizontal continuity of the shrubs between the tree trunks.

   Option B:
   Prescribed burning will reduce fuel loads and fuel continuity. A benefit of using prescribed fire by itself or in combination with other treatments is that it greatly reduces fine fuel loads unlike mechanical treatments by themselves. Additionally, if applied under appropriate conditions many ecological benefits can be derived from the use of prescribed fire. All prescribed fire should be coordinated and approved by the Mashpee Fire Department. A prescribed burn plan should be created by a qualified individual for any planned prescribed burn. A qualified and experienced burn boss should be consulted in the planning of any prescribed burn and should be used to conduct any prescribed burns. Care should be taken with regards to potential escapes resulting from prescribed burns and impacts on surrounding communities from the smoke associated with a prescribed burn.

   The approximate acres to be treated, assuming a 60 foot wide buffer (30 feet on each sire of the road) is approximately 2 acres.

   Regardless of the treatment used, the necessity for follow-up treatments needs to be reassessed every 3 to 6 years.

6. Establish fuel reduction zones approximately 100 feet in width at strategic locations based on prevailing winds that occur during wildfires, on property lines immediately adjacent to residential structures at the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area.

   The reduction or breaking up the surface fuel bed along strategic property boundaries (Figure 1) will increase firefighter safety and effectiveness, and reduce fire behavior that could potentially impact adjacent private properties. This can be accomplished with mechanical treatments and/or prescribed fire.

Option A:
Mechanical treatment of 100 foot wide fuel reduction zones may be accomplished with a walk behind brush mower or a heavier hydraulic ride on brush cutter. If using the heavier equipment care should be taken so as not to damage over story trees or create excessive soil compaction. The primary goal of mowing operations within the zones should be to reduce shrub height and break up the continuous shrub cover. Shrubs reduction does not need to be to the base of trees but rather in manner that removes horizontal continuity of the shrubs between the tree trunks.

Option B:
Prescribed burning will reduce fuel loads and fuel continuity. A benefit of using prescribed fire by itself or in combination with other treatments is that it greatly reduces fine fuel loads unlike mechanical treatments by themselves. Additionally, if applied under appropriate conditions many ecological benefits can be derived from the use of prescribed fire. All prescribed fire should be coordinated and approved by the Mashpee Fire Department. A prescribed burn plan should be created by a qualified individual for any planned prescribed burn. A qualified and experienced burn boss should be consulted in the planning of any prescribed burn and should be used to conduct any prescribed burns. Care should be taken with regards to potential escapes resulting from prescribed burns and impacts on surrounding communities from the smoke associated with a prescribed burn.

The approximate acres to be treated, assuming a 100 foot wide buffer is 17 acres.

Regardless of the treatment used, the necessity for follow-up treatments needs to be reassessed every 3 to 6 years.

7. Remove overhanging branches and other impeding vegetation that may hinder fire apparatus or contribute to fire behavior on town owned and maintained roads and trails in and adjacent to the Mashpee River Woodlands Wildland Fire Protection and Preparedness Planning Area. This includes creating safe access and egress points at strategic locations.

   Removal of vegetation to a height and width that will facilitate emergency vehicle access and movement on roads leading to, around, and in (Figure 1) the property will improve response time, facilitate egress of the public, and increase firefighter safety. This includes creating areas for apparatus to turn around at strategic places. Vegetation should be cleared to a width and a height that will enable emergency equipment to pass freely. All debris created by the clearing of roads should be removed from the area. The Mashpee Fire Department should be consulted concerning exact specifications for roads. Gates should be placed at the entrance to the property to prevent public vehicle access.

   Annual inspections of the roads should be conducted so that vegetation maintenance needs can be identified and road conditions can be assessed and addressed.

REFERENCES AND LITERATURE CITED

Abrams, M.D. 2005. Prescribing Fire in Eastern Oak Forests: Is Time Running Out? Journal of Applied Forestry 22(3): 190-196.

Abrams, M.D. 1992. Fire and the development of oak forests. Bioscience 42:346-53.

Agee, J.K., B. Baker, M.A. Finney, P.N. Omi, D.B. Spasis, C.N. Skinner, J.W. Van Wagtendoule, and C.P. Weatherspoon. 2000. The use of shaded fuelbreaks in landscape fire management. Forest Ecology and Management. 127:55-66.

Altpeter, L.S. 1937. A history of the forest of Cape Cod. MS Thesis. Harvard Forest, Harvard University, Petersham, MA.

Anderson, H.E. 1982. Aids to determining fuel models for estimating fire behavior. Gen. Tech. Report. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 20 p.

Barbour, H. T. Simmons, P.C. Swain, H. Woolsey. 1998. Our Irreplaceable Heritage: Protecting biodiversity in Massachusetts. A technical report produced by the Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife and the Massachusetts Chapter of The Nature Conservancy. 83 p.

Batcher, M. S. 2004. Fire Management Plan for the Ossipee Pine Barrens. Unpublished report prepared for The Nature Conservancy, New Hampshire Chapter, Concord, New Hampshire. 110 p.

Brose, P., Schuler, T., Van Lear, D. and J. Berst. 2001. Bringing Fire Back. The changing regimes of the Appalachian mixed-oak forests. Journal of Forestry. 2001:30-35.

Cape Cod Commission. 2004. Cape Cod Emergency Preparedness Handbook. Are You Ready? A publication of the Cape Cod Commission's Project Impact Cape Cod Program. 32 p.

Cape Cod Commission. 1998. Massachusetts Military Reservation Master Plan Final Report.

Clark, J.S. and W.A. Patterson III. 1997. Background and local charcoal sediments: Scales of fire evidence in the paleorecord. Pp.23-48 in J.S. Clark, H. Cachier, J.G. Glodammer, and B. Stocks (eds.) Sediment Records in Biomass Burning and Global change. NATO ASI series. Series I, Global Environmental Change; No. 51. Springer-Verlag, Berlin.

Clark, K.H. and D.A. Crary, Jr. 2001. Cape Cod National Seashore Fire Management Plan – Draft. U.S. Department of Interior, National Park Service. 83 pp.

Compact of Cape Cod Conservation Trusts, Inc. 1998. Thompson's Field Conservation Area Management Plan.

Core, J.E. and J.L. Peterson. 2001. Public health and exposure to smoke. In Hardy, C.C., R.D. Ottmar, J.L. Peterson, J.E. Core and P. Seamon. Smoke Management Guide for Prescribed and Wildland Fire: 2001 Edition. National Wildfire Coordinating Group Publication NFES 1279, National Interagency Fire Center, Boise, ID.

Crary, D. A. Jr., personal communications from David Crary, Fire Management Officer, Cape Cod National Seashore, National Park Service to C. Caljouw, 2005 and 2006.

Crosby. B.W. 2003. Images of America. Cape Cod Firefighting.

Deyo, Simeon L. 1890. The History of Barnstable County Massachusetts. New York, H.W. Blake and Company.

Finch, R. 1983. The Primal Place. W.W. Norton and Co., New York.

Fletcher. 1993. Soil Survey of Barnstable County, Massachusetts. Technical report of the U.S. Department of Agriculture, Soil Conservation Service.

Foster, D.R. and E.R. Boose. 1995. Hurricane disturbance regimes in temperate and tropical forest ecosystems. Pp.305-339 in M.P. Coutts and J. Grace, eds. Wind and Trees. Cambridge University Press.

Foster, D.A. and G. Motzkin. 1999. Historical Influences on the Landscape of Martha's Vineyard. Harvard Forest Paper No. 23. Harvard Forest, Harvard University, Petersham, Massachusetts, 48 p.

Hessburg, P. F., K. M. Reynolds, R. E. Keane, K. M. James, and R. B Salter. 2007. Evaluating Wildland fire danger and prioritizing vegetation fuels treatments. Forest Ecology and Management. 247 1 – 17.

Institute for Business and Home Safety Wildfire Committee. 2001. Is your home protected from wildfire disaster? A Homeowner's Guide to Wildfire Retrofit. A booklet produced by the Institute for Business and Home Safety in cooperation with Firewise Communities, Tampa, Florida. 20 p.

Johnson, Keith. 2006. Field assessment of Goose Pond Tract for Wildland Fire Protection and Preparedness Plan funded through the Cape Cod Cooperative Extension.

Keetch, J.J. and G.M. Byram. 1988 (revised from 1968). A drought index for forest fire control. USDA Forest Service Research Paper SE-38. U.S. Department of agriculture, U.S. Forest Service Southeastern Forest Experiment Station, Asheville, NC.

Lorimer, C.G. 1993. Causes of the oak regeneration problem. In Oak regeneration: Serious problems, practical recommendations, 14-39. General technical Report SE-84, Asheville, N.C: USDA Forest Service.

Melton, M. 1989. Keetch-Byram Drought Index: A Guide to Fire Conditions and Suppression Problems. Fire Management Notes 50:30-34.

Motzkin, G., W.A. Patterson III, and N.E. Drake. 1993. Fire history and vegetation dynamics of a Chamaecyparis thyoides wetland on Cape Cod, Massachusetts. Journal of Ecology 81:391-402.

Natural Heritage and Endangered Species (NHESP). 2006. NHESP Regulatory Layers. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, Westborough, MA

Nikula, B. 1997. Breeding Bird Survey Results for Punkhorn Parklands, 1993-1996. Letter to T. Balog, Brewster Conservation Administrator.

NWCG Fire Danger Working Team (FDWT) 2002. Gaining an Understanding of the National Fire Danger Rating System - NFES 2665; National Interagency Fire Center, Boise, Idaho.

Oldale, R.N. and R.A. Barlow. 1986. Geologic Map of Cape Cod and the Islands, Massachusetts. U.S. Geological Survey Map I-1763, Reston, Virginia.

Patterson, W.A. III and D.A. Crary, Jr. 2004. Managing Fuels in Northeastern Barrens. Written report for a field tour sponsored by the Joint Fires Sciences Program. Also available on the web at www.umass.edu/nrc/nebarrensfuels.

Patterson, W.A. III and C.H.Ruffner. 2002. Updated Fire Management Plan for the Camp Edwards Training Site of the Massachusetts Military Reservation. Unpublished report prepared for the Natural Resources and Environmental Readiness Center, MAARNG.

Patterson, W.A. III. 1999. Preliminary Pollen and Charcoal Analysis for Mary Dunn Pond, Hyannis, Massachusetts. Unpublished report submitted to Massachusetts Field Office of The Nature Conservancy and Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, Westboro, Massachusetts.

Patterson, W.A.III. and K.E. Sassaman. 1988. Indian fires in the prehistory of New England. Pages 107-135 in G.P. Nicholas, editor. Holocene Human Ecology in Northeastern North America. Plenum, New York.

Rawinski, T.J. 2000. Fire-maintained Oak Woodlands in the Area of Worcester, Massachusetts: Vegetation Ecology, Wildlife, and Conservation. Report prepared for the Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement, Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. 82 p.

Rothermal, R.C. 1983. How to predict the spread and intensity of forest and range fires. NFES # 1573. Gen. Tech. Rep. INT-143. Intermountain Forest and Range Experiment Station, Ogden, UT. A publication of the National Wildfire Coordinating Group for the U.S. Department of Agriculture, U.S. Department of Interior, and National Association of State Foresters. 161 p.

Scott, J. H. 2003. Canopy Fuel Treatment Standards for the Wildland-Urban Interface. USDA Forest Service Proceedings RMRS-P-29.

Simmons, T. 2006. Personal communications from Tim Simmons, Restoration Ecologist, Massachusetts Natural Heritage and Endangered Species Program, Division of Fisheries and Wildlife, to C. Caljouw.

Smith, J.K. ed. 2000. Wildland fire in ecosystems: effects of fire on fauna. Gen. Tech. Rep. RMRS-GTR-42-vol. 1. Ogden, Ut: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 83 p.

Stevens, A. 1996. The paleoecology of coastal sandplain grasslands on Martha's Vineyard, Massachusetts. Ph.D. Thesis. University of Massachusetts, Amherst, MA.

Scott, J.H. and R.E. Burgan. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins: USDA Forest Service, Rocky Mountain Research Station. 72 p.

Sorrie, B.A. and P. Somers. 2000. The vascular plants of Massachusetts: A county checklist. Technical report prepared for the Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, Westborough, MA. 186 p.

Strahler, A.N.1966. A Geologist's View of Cape Cod. Garden City, N.Y.: Natural History Press.

Swain, P.C. and J.B. Kearsley. 2000. Classification of Natural Communities of Massachusetts. Draft technical report prepared for the Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, Westborough, MA. 200 p.

Thompson, E.S. 1928. History of Plymouth, Norfolk, and Barnstable Counties, Massachusetts. Lewis Historical Publishing Company, Inc. New York.

Winkler, M. 1982. Late-Glacial and Post-Glacial Vegetation history of Cape Cod and the Paleolimnology of Duck Pond, South Wellfleet, Massachusetts. MS. Thesis, University of Wisconsin, Madison.

Whitney, G.G. 1994. From coastal wilderness to fruited plain. Cambridge University Press, Cambridge, UK.

APPENDIX A - FIRE MANGEMENT WEB RESOURCES

Aid to determining fuel models - http://www.fs.fed.us/rm/pubs_int/int_gtr122.pdf

BehavePlus - http://www.fire.org

Cape Cod Cooperative Extension - http://www.capecodextension.org/home.php

Cape Cod Emergency Preparedness Handbook: A Guide to Natural Disasters - http://www.capecodcommission.org/projectimpact/handbook.htm

Department of Conservation and Recreation, Forest Fire Control - http://www.mass.gov/dcr/stewardship/firecont/index.htm

Establishing Fire Prevention Education Cooperative Programs and Partnerships - http://www.nwcg.gov/pms/pubs/cooppart.pdf

Fire Education Exhibits and Displays - http://www.nwcg.gov/pms/pubs/exdispla.pdf

FireWise - http://www.firewise.org/index.php

Firewise - Be Firewise Around Your Home - https://www.cmsassociates.com/Firewise/12434.pdf

Firewise Construction/Landscape Checklist - https://www.cmsassociates.com/Firewise/9053.pdf

Firewise Developing a Cooperative Approach to Wildfire Protection - https://www.cmsassociates.com/Firewise/9872.pdf

Firewise Insiders Guide - Facilitator's / Operators - https://www.cmsassociates.com/Firewise/9080.pdf

Firewise Participant Workbook - https://www.cmsassociates.com/Firewise/9042.pdf

Glossary of Wildland Fire Terminology - http://www.nwcg.gov/pms/pubs/pubs.htm

Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide - http://www.nifc.gov/fire_policy/rx/rxfireguide.pdf

Managing Fuels in Northeastern Barrens - http://www.umass.edu/nrc/nebarrensfuels/ne_barrens/index.html

National Weather Service, Fire Weather - http://www.erh.noaa.gov/box/firewx.shtml

Natural Heritage and Endangered Species Program - http://www.mass.gov/dfwele/dfw/nhesp/nhesp.htm

Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model - http://www.fire.org/downloads/behaveplus/3.0.0/rmrs_gtr153.pdf

Wildfire Prevention and the Media - http://www.nwcg.gov/pms/docs/wpsandmedia.pdf

Wildfire Prevention Event Management Guide - http://www.nifc.gov/preved/event_guide.html

Wildfire Prevention Marketing Guide - http://www.nifc.gov/preved/mark_guide.html

Wildfire Prevention Sign & Poster Guide - http://www.nwcg.gov/pms/pubs/nfes2753/nfes2753.pdf

Wildfire Prevention Strategies - http://www.nwcg.gov/pms/docs/wfprevnttrat.pdf

APPENDIX B - CONTACTS FOR FIRE & ECOLOGICAL ISSUES

Name: George Baker, Fire Chief
Affiliation: Mashpee Fire Department
Address:
20 Frank Hicks Drive
Mashpee, MA 02649
Telephone: (508) 539-1454
Area of Expertise: Fire Suppression, Emergency Medical Services, Fire Education Detection, and Public Safety.

Name/Affiliation: David W. Crary Jr., Fire Management Officer
Affiliation: National Park Service - Cape Cod National Seashore
Address:
National Park Service
99 Marconi Site Road
South Wellfleet, MA 02667
Telephone: (508) 349-3785 x 247
Area of Expertise: Wildland Fire Management, Fire Ecology, Wildland Fire Training, Mechanical Treatments of Fuels, and Prescribed Fire.

Name/Affiliation: Joel Carlson, Certified Forester – Consultant
Affiliation: Northeast Forest and Fire Management, LLC
Address:
29 Moody Drive
Sandwich, MA 02563
Telephone: (508) 274-2234
Area of Expertise: Wildland Fire Management, Fire Ecology, Mechanical Treatments, Wildland Fire Planning, Wildland Fire Training and Education, and Prescribed Fire.

Name/Affiliation: Caren Caljouw, Conservation Biologist - Consultant
Address:
921 New Braintree Road
Oakham, MA 01068-9669
Telephone: (508) 274-2234
Area of Expertise: Wildland Fire Management Planning, Fire Ecology, Monitoring, General Ecology, Wildland Fire Training and Education, and Prescribed Fire.

Name/Affiliation: William A. Patterson III, Fire Ecologist/Professor
Affiliation: University of Massachusetts
Address:
Department of Forestry and Wildlife Management
Amherst, MA 01003
Telephone: (413) 545-1970
Area of Expertise: Forest Ecology, Fire Ecology, Wildland Fire Research, Fire Management Planning, Mechanical Treatments of Fuels, and Prescribed Fire.

Name/Affiliation: Tim Simmons, Restoration Ecologist
Affiliation: Massachusetts Natural Heritage & Endangered Species Program
Address:
Massachusetts Division of Fisheries and Wildlife
Route 135
Westborough, MA 01581
Telephone: (508) 792-7270 x 126
Area of Expertise: Fire Ecology, General Ecology, Monitoring, Mechanical Treatments of Fuels, Fire Management Planning, and Prescribed Fire.

Name/Affiliation: Josh Nigro, District 1 Fire Warden
Affiliation: Massachusetts Department of Conservation and Recreation
Address:
District 1 – Bureau of Forest Fire Control & Forestry
PO Box 621
Sandwich, MA 02563
Telephone: (508) 888-1149
Area of Expertise: Wildland Fire Suppression, Wildland Fire Detection, Wildland Fire Prevention, and Wildland Fire Awareness.

Name/Affiliation: Ronald Aseltine, District 2 Fire Warden – FIREWISE Coordinator
Affiliation: Massachusetts Department of Conservation and Recreation
Address:
District 2 – Bureau of Forest Fire Control & Forestry
P.O Box 66
South Carver, MA 02366
Telephone: (508) 866-4996
Area of Expertise: Fire Wise Programs and Education, Wildland Fire Suppression, Wildland Fire Detection, Wildland Fire Prevention, and Wildland Fire Awareness.

APPENDIX C - GLOSSARY OF TERMS

(For additional terms see the National Wildfire Coordinating Group's Glossary of Wildland Fire Terminology web link in Appendix A.)

Basal Area – a measure, similar to cover, being the proportion of ground surface occupied by a species.

BehavePlus Fire Modeling System - a software application to predict wildland fire behavior for fire management purposes.

Canopy Closure – the distance between the tree tops if one were to look straight up. If the canopy closure is very dense, then the spacing is very tight with very little sunlight able to pass through.

Chain – a unit of measure in land survey and forestry, equal to 66 feet (20 meters). Commonly used to report fire perimeters, fireline distances, and rates of spread.

Tract – two or more properties or sites falling under a single name for administrative purposes or two or more individual incidents located in the same general area which are assigned to a single incident commander or unified command.

Cover – the vertical projection of above ground parts onto the ground. Ecologists recognize many types of cover: crown cover, vegetative cover, ground cover, forest cover etc.

Crown Fire – a fire that advances from top to top of trees or shrubs more or less independently of the surface fire. Sometimes crown fires are classed as either running or dependent, to distinguish the degree of independence from the surface fire.

Defensible Space – a designated area around a home or building that is intentionally maintained so as to be free of any features that would tend to increase the risk of damage from wildfire.

Density – the number of individuals per unit area.

Density Board – a post or board used to measure cover and height of vegetation by obstruction to vision.

Drought Index – a number representing net effect of evaporation, transpiration, and precipitation in producing cumulative moisture depletion in deep duff or upper slope soils. The Keetch-Byram Drought Index (KBDI) is used in fire planning to evaluate the effects of extended drying on the duff layer.

Duff – the partly decomposed organic material sandwiched between the litter of freshly fallen twigs, needles, and leaves and the mineral topsoil.

Fine Fuels – small diameter fuels such as grass, leaves, draped pine needles, and twigs, which when dry, ignite readily and are rapidly consumed.

Fire Behavior – the manner in which fire reacts to the variables of fuel, weather, and topography.

Fire Danger – resultant of both constant and variable fire danger factors, which affect the ignition, spread, and difficulty of control of fires and damage they cause.

Fire Frequency – the number of fires per unit time in a designated area.

Fire Intensity – generally refers to flame length and rates of spread in surface fires. High intensity fires have long flame lengths and high rates of spread but may not burn down into the litter and duff layers.

Fire Severity – generally refers to fire burning into the litter and duff layers, associated with certain surface fires or ground fires. Severe fires occur when temperatures are high and humidity and precipitation are low for long periods of time, duff and litter dry out and fire can reside for long periods of time, resulting in reduction or loss of organic material down to mineral layers.

Fireline Intensity – the heat released per unit of time for each unit length of the leading fire edge. The primary unit is Btu per linear foot of fire front per second.

Fire Management – Activities required for the protection of burnable wildland values from fire and the use of prescribed fire to meet land management objectives.

FIREWISE – a multi-organizational initiative sponsored by the National Wildfire Coordinating Group's Wildland/Urban Interface Working Team. An initiative designed to work with concerned citizens, local fire departments, public land managers, and other fire safety professionals to lessen the risk of interface fires through education, prevention, and supportive mutual aid.

Flame Length – the average length of flames when the fire has reached its full, forward rate of spread, measured along the slant of the flame from the midpoint of its base to its tip.

Fuel – combustible plant material, both living and dead that is capable of burning in a wildland situation.

Fuel Arrangement – the spatial distribution and orientation of fuel particles within the fuel bed.

Fuel Bed Depth – the average height of surface fuels contained in the combustion zone of a spreading fire front.

Fuelbreak – A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled.

Fuel Continuity – the degree or extent of continuous or uninterrupted distribution of fuel particles in a fuel bed, a critical influence on a fire's ability to sustain combustion and spread. This applies both to aerial fuels and surface fuels.

Fuel Model – a characterization of the fuel properties within a typical field situation. Sets of standardized fuel models are available from the USDA Forest Service for fire behavior and fire spread modeling. (www.fs.fed.us/pnw/fera/firehouse)

Fuel Moisture Content – the quantity of moisture in a fuel expressed as a percentage of the weight when thoroughly dried at 212^0 F.

Fuel Reduction Zone – any area, strategically located for fighting anticipated fires, where the vegetation has been periodically modified or treated so that fires burning into it can be more easily controlled. Widened zones of reduced fuels decrease wildfire intensity and allow for more effective fire control.

Fuel Size Class – a category used to describe the diameter of down dead woody fuels. Fuels within the same size class are assumed to have similar wetting and drying properties, and to preheat and ignite at similar rates during the combustion process.

Ground Fire – a fire that consumes the organic material beneath the surface litter, such as a duff fire or a peat fire.

Ground Fuels – all combustible materials below the surface litter layer, including duff, tree and shrub roots, punky wood, dead lower moss and lichen layers, and sawdust, that normally support glowing combustion without flame.

Head Fire – a fire spreading or set to spread with the wind.

Hundred Hour Time Lag Fuels – dead fuels consisting of roundwood in the size range from 1 – 3 inches in diameter, estimated to reach 63% of equilibrium moisture content in one hundred hours.

Invasive Non-native Plant – a plant that exhibits rapid growth and out competes native plant species, thereby reducing species diversity. Not all non-native plants are invasive.

Ladder Fuels – any materials which allow fire to move vertically from the ground up to the tops of trees (e.g. dead fuels to lower branches to other intermediate trees and shrubs to the upper tree canopies).

Litter – loose debris such as leaves, branches, twigs, logs laying on the surface of the ground.

One-Hour Time Lag Fuels – dead fuels consisting of dead herbaceous plant materials, sticks, needles and roundwood less than 0.25 inches in diameter, expected to reach 63% of equilibrium moisture content in one hour or less.

National Fire Danger Rating System – a multiple index designed to provide fire and land management personnel with a systematic way of assessing various aspects of fire danger on a day-to-day basis.

Prescribed Burning – controlled application of fire to wildland fuels under specified environmental conditions that allows the fire to be confined to a predetermined area, and produce the fire behavior and fire characteristics required to attain planned fire treatment and resource management objectives.

Prescription – a written statement defining the objectives to be attained as well as the conditions of temperature, humidity, wind direction and speed, fuel moisture, and soil moisture, under which a fire will be allowed to burn.

Rate of Spread – the speed with which a fire moves in a horizontal direction across the landscape, usually expressed in chains per hour or feet per minute.

Relative Humidity – the ratio, in percent, of the amount of moisture in a volume of air to the total amount which that volume can hold at the given temperature and atmospheric pressure.

Slash – the remnants of tree limbing, thinning, and ground fuel reduction. May also be resultant from strong winds. Composed of branches, tops, cull logs, uprooted stumps, and broken or uprooted trees.

Spotting – production of burning embers in the mowing fire front that are carried a short distance ahead of the fire, or in some cases are lofted by convective action or carried by fire whirls some distance ahead of the fire.

Surface Area to Volume Ratio (SAV) – the ratio between the surface area of an object, such as a fuel particle to its volume. The smaller the particle, the more quickly it can become wet, dry out, or become heated to combustion temperature during a fire.

Surface Fire – a fire that burns surface litter, other loose debris, and low vegetation.

Ten-Hour Time Lag Fuels – dead fuels consisting of wood, 0.25 – 1 inch in diameter, estimated to reach 63% of equilibrium moisture content in ten hours.

Thousand-Hour Time Lag Fuels – dead fuels consisting of roundwood 3 – 8 inches in diameter, estimated to reach 63% of equilibrium moisture content in one thousand hours.

Wildfire – any fire occurring on wildland except a fire under prescription.

Wildland – an area characterized predominantly by native vegetation, in which development is essentially non-existent, except for roads, powerlines and similar facilities.

Wildland – Residential (or Urban) Interface – the area where combustible homes and other structures meet combustible vegetation. This interface may include a wide variety of situations, ranging from individual houses and isolated structures to subdivisions and rural communities surrounded by wildlands.

FIGURE 1. PROPERTY, TREATMENTS, AND ADJACENT LANDS

1271

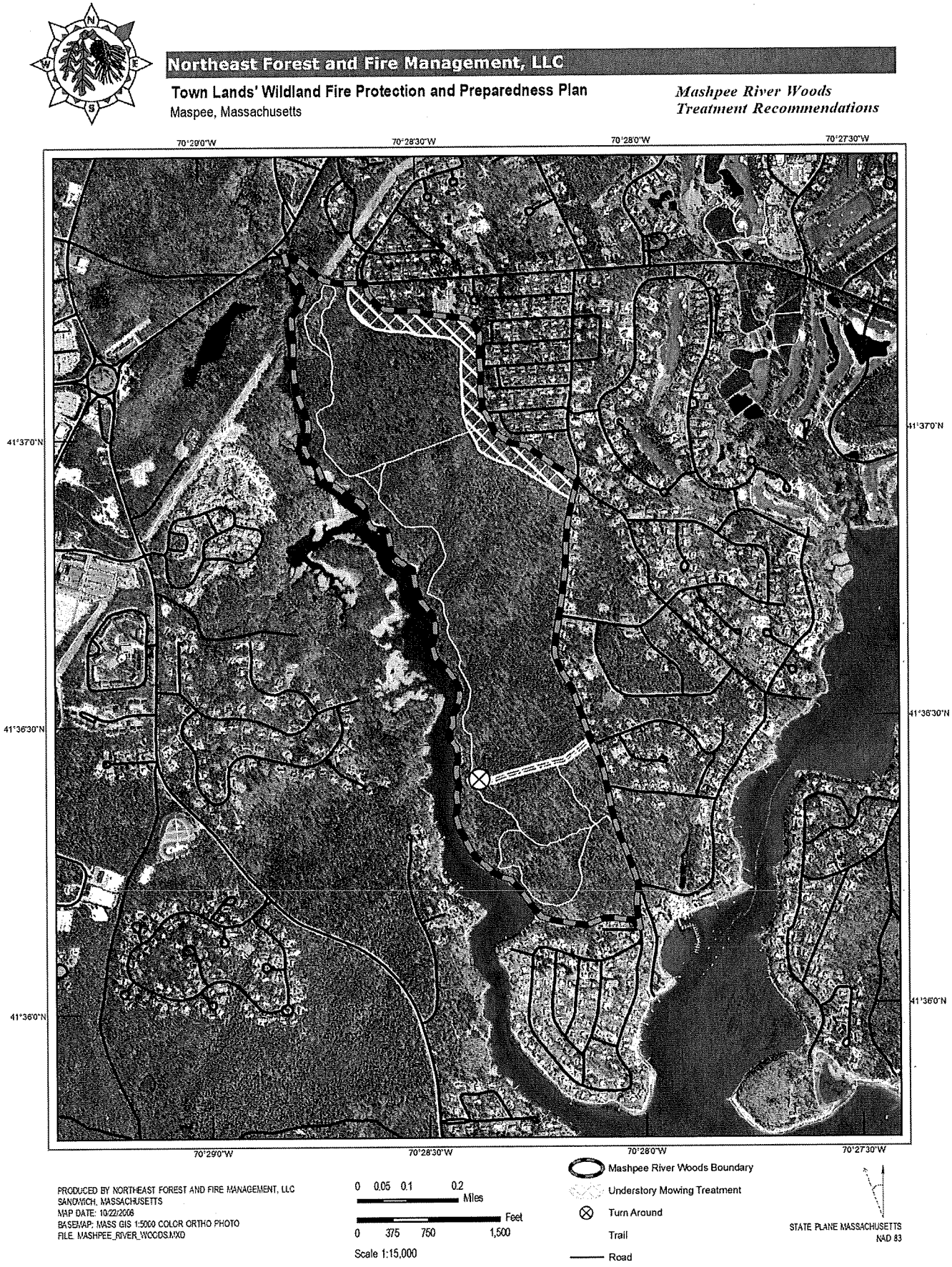


FIGURE 2. VEGETATION AND PRIORITY HABITAT

1271