FIRE MANAGEMENT PLAN

FOR

MONTAGUE PLAIN

WILDLIFE MANAGEMENT AREA

Fire Management Plan
for
Montague Plain Wildlife Management Area

prepared for

Massachusetts Dept. of Fisheries, Wildlife, and Environmental Law Enforcement
Division of Fisheries and Wildlife
Natural Heritage and Endangered Species Program
Route 135
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SUMMARY

Montague Plain Wildlife Management Area (MPWMA) is a 1,512 acre property in western Massachusetts owned and managed by the Massachusetts Division of Fisheries and Wildlife. The primary purposes of the site are to protect and preserve an outstanding example of a xeric outwash pitch pine-scrub oak barren natural community and to provide public access for hunting, fishing, wildlife observation and compatible recreational activities. This fire management plan (FMP) is a strategic plan that defines a program to manage wildland fire on MPWMA for ecological health and public safety. Fire management is needed at MPWMA to sustain and restore the health of the ecosystem and its component biota, and to protect on-site and off-site infrastructure and lives from wildfire.

MPWMA encompasses a glacial outwash sandplain with droughty soils supporting a pitch-pine - scrub oak community. The site also includes a hill with shallow, sandy loam soils that supports an oak dominated forest. One rare natural community and a number of rare plant, insect, and reptile species are known from the site. Pitch pine - scrub oak communities are the most fire-prone vegetation types in New England, and significant evidence exists suggesting that fire was an important influencing factor on the vegetation of MPWMA for many years before European settlement. There are numerous fire and smoke sensitive areas surrounding the site including individual residences, businesses, highways, villages, and a small airport.

Three general fire management goals were developed for MPWMA:

(1) Manage the Montague Plain Wildlife Management Area so as to protect lives and property from threats of wildfire, ensuring that firefighter and public safety is the highest priority in every fire management activity.

(2) Perpetuate an ecologically viable pitch pine - scrub oak barren complex with special emphasis on restoring and maintaining rare, threatened, and endangered species and imperiled natural communities.

(3) Make the site available to and encourage its use for fire ecology and fuels management research and for fire suppression and prescribed fire training.

Several specific objectives were developed for each goal. Wildfire control, prescribed fire use, and mechanical fuel reduction issues are discussed in the plan. Wildfire control issues addressed include prevention, detection, response, personnel, equipment, training, water resources, initial attack, extended attack, minimum impact suppression tactics, wildland-structure interface, burned area rehabilitation, public education, and wildfire control strategies. Prescribed fire use and mechanical fuel reduction issues addressed include objectives, planning, techniques, and monitoring.

Five fire management zones are delineated for MPWMA. General description, fuels, hazards, constraints, special concerns, areas of high ignition risk, and fire management strategies are discussed for each fire management zone.

INTRODUCTION

Purpose of the Site

The Montague Plain Wildlife Management Area (MPWMA) is owned and managed by the Massachusetts Division of Fisheries and Wildlife (DFW) in cooperation with Northeast Utilities (NU). The primary purposes of the site are to protect and preserve an outstanding example of a xeric outwash pitch pine-scrub oak barren natural community, its associated biota, and ecological processes and to provide public access for hunting, fishing, wildlife observation and compatible recreational activities. Pitch pine-scrub oak barrens, also known as "pine plains," "sand plains," "pinelands," and "pine bush," occur throughout the Northeast from New Jersey to Maine (Finton 1998). These barrens are characterized by excessively drained soils and by several plant species which are highly flammable and/or have adaptations to survive or regenerate after fire (Finton 1998, Motzkin *et al.* 1999). Pitch pine-scrub oak barrens are among the rarest and most imperiled natural community types in the United States (Patterson and White 1993, Swain and Kearsley 2001), and they support a number of rare species, especially rare lepidoptera such as Gerhard's underwing moth (*Catocala herodias gerhardi*) and barrens buckmoth (*Hemileuca maia*) (Swain and Kearsley 2001). The Montague Plain WMA also provides an area for scientific research and limited public recreation, including hunting and wildlife viewing. Additionally, part of the property protects the water supply (groundwater recharge area) for the Bitzer Fish Hatchery and the Town of Montague water supply.

Purpose of the Plan

This fire management plan (FMP) is a strategic plan that defines a program to manage wildland fire on Montague Plain WMA for ecological health and public safety. Prevention of and response to wildfires and the use of prescribed burning to reach resource management objectives are addressed. This plan supercedes or incorporates any and all other fire management plans for the site including *Fire Management Plan: Bitzer Wildlife Management Area* (Richburg and Patterson 1997).

Justification

Fire management is needed at Montague Plain WMA to sustain and restore the health of the ecosystem and its component biota, and to protect on-site and off-site infrastructure and lives from wildfire. The vegetation of Montague Plain WMA is comprised largely of fire-prone types. Species such as pitch pine (*Pinus rigida*), scrub oak (*Quercus ilicifolia*), huckleberry (*Gaylussacia baccata*), and blueberry (*Vaccinium* spp.) are abundant on the property, and have adaptations which allow them to survive fires or quickly regenerate after fires (Motzkin *et al.* 1999). Some species (*e.g.*, huckleberry, pitch pine) have highly flammable foliage that contributes significantly to fire intensity. Montague Plain also contains rare species which are dependant upon periodic fires to maintain their habitat, for example, the state threatened barrens buckmoth (MNHESP 2002). Paleoecological evidence suggests that pre-European fires were common on the Montague Plain, perhaps ignited by a large regional Indian population (Motzkin *et al.* 1996). Records of fires on the Montague Plain during the 1900's indicate fire was quite common with dozens of small (<2.5 ac) fires and at least 19 large (≥2.5 ac) fires, some of which

caused significant damage to nearby villages (Motzkin *et al.* 1996). The presence of fire-prone vegetation and the extensive history of fire indicates that the Montague Plain will continue to experience fires. Although detection and suppression efforts have become more efficient, more people are living around the area and utilizing the site for recreation, increasing the probability of ignitions. Several communities and numerous, scattered individual residences surround Montague Plain. Several power transmission lines occur on the site. Wildfires could pose a substantial risk to these structures and, more importantly, the human lives associated with them. Without an active fire management program, fuels would continue to accumulate to very hazardous levels, ignitions could become more frequent due to uncontrolled human use of the site, fire-adapted natural communities and their component rare species would degrade, and human lives and homes would face the risk of catastrophic wildfire.

SITE DESCRIPTION AND RESOURCES

Location

Montague Plain Wildlife Management Area is located in the Connecticut Valley of western Massachusetts in the Franklin County town of Montague (Figure 1). The area lies on the Greenfield, Massachusetts, U.S. Geologic Survey 7.5 minute quadrangle (at approximately 42°34'N latitude and 72°32'W longitude). Greenfield is approximately two miles west-northwest of the area, Turner's Falls approximately one mile northwest, and Montague Center approximately one-half mile south of the property boundary. Major roads in the vicinity include U.S. Interstate Highway 91 (2.5 miles west of the area running north-south), Massachusetts Route 2 (1 mile north running east-west), Massachusetts Route 63 (¼-½ mile east running north-south), Montague-Turner's Falls Road (running north-south close to the western boundary), and Miller's Falls Road (running east-west just north of the site).

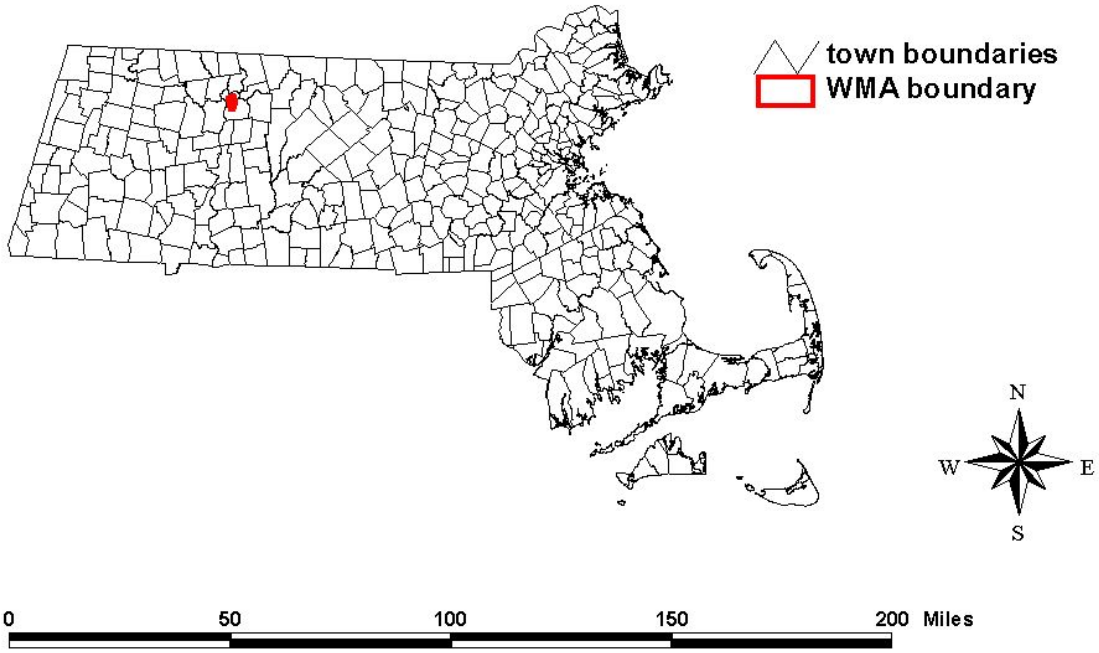
Boundaries

Montague Plain Wildlife Management Area is comprised of 1,512 acres (Figure 2). The first tract was acquired in 1949 and the most recent in 1999. A smaller WMA (76 ac) on the Montague Plain, Bitzer Wildlife Management Area, was acquired previously (1949 and 1983), and has been integrated into the Montague Plain WMA. The property has an external boundary perimeter of approximately 10 miles. It has a high perimeter to area ratio due to irregular shaped boundaries. . Some of the boundary has been marked with Division of Fisheries and Wildlife boundary markers, and entrance signs have been placed at key access points (Plains Road, Old Northfield Road, and Miller's Falls Road).

Facilities

Several unpaved roads and numerous paths and trails dissect the property (Figure 3). Plains Road and Bartlett Road, both gravel/sand roads, are perhaps the most traveled. They traverse the MPWMA running roughly east-west, and connect Turner's Falls Road in the west to Lake Pleasant Road in the east. Bartlett Road is gated at Turner's Falls Road, but can be accessed from the property's interior. Old Northfield Road, another well-traveled unpaved road, is town-maintained and runs southwest-northeast in the southern portion of the MPWMA, and also

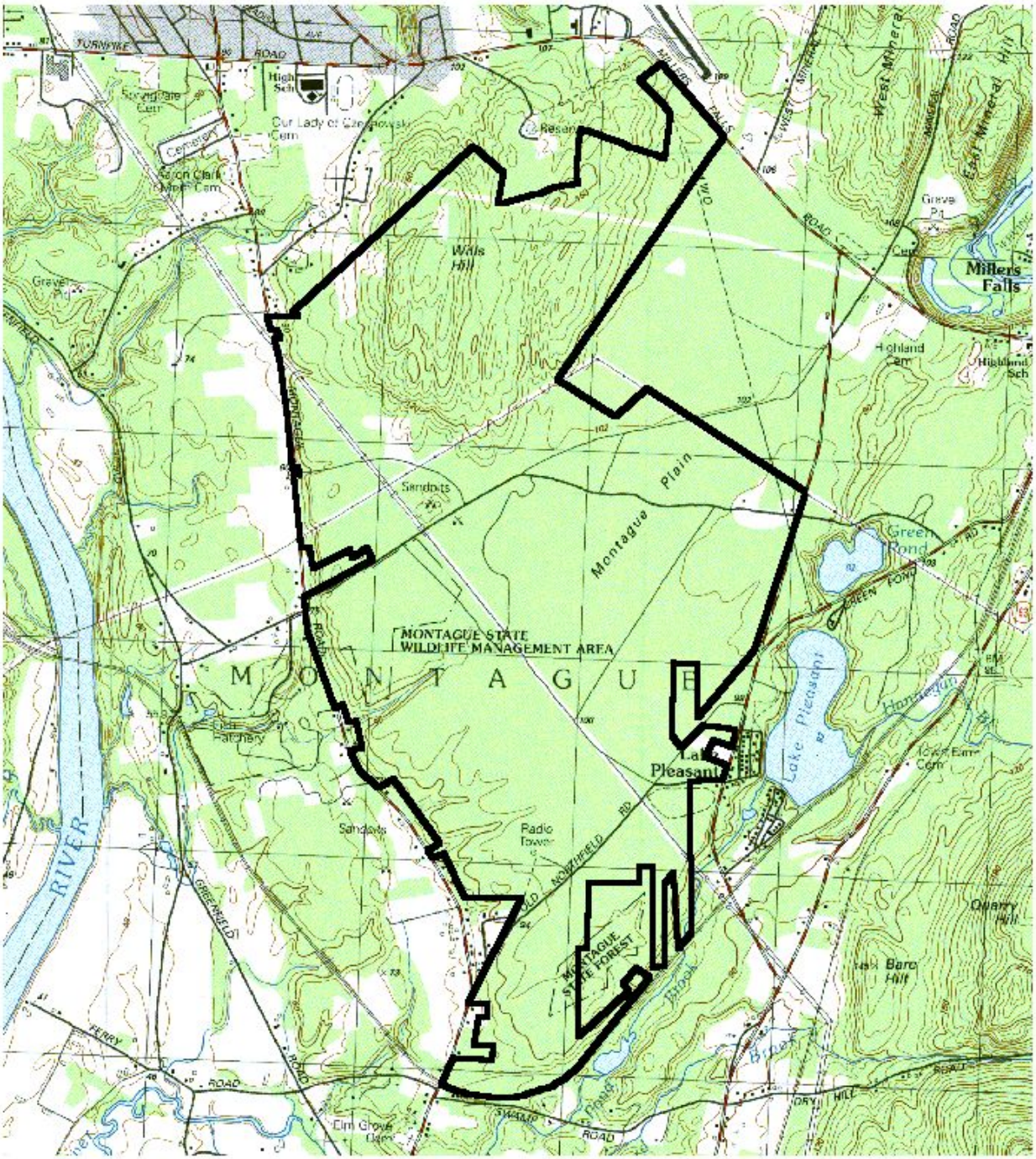
Figure 1: Location of Montague Plain Wildlife Management Area in Massachusetts



connects Turner's Falls Road with Lake Pleasant Road. The utility corridors which cross the property have access roads associated with them. There are a number of old jeep trails and other dirt roads on the property, as well as an extensive network of foot/bike/motorcycle trails. Many of these trails and roads are kept open by public use, rather than DFW maintenance efforts.

Five active utility corridors cross the MPWMA. Each is approximately 50 to 100 yards wide (although the easement may allow a wider corridor in some areas). A large southeast-northwest electrical line and pipeline corridor runs approximately 2 miles across the property, roughly bisecting it into northeast and southwest halves. A large east-west electrical line runs approximately 1.5 miles across the property roughly bisecting the MPWMA into a northern third and southern two-thirds. A third electrical line runs about 0.75 miles east-west across the northern end of the property. A north-south water supply pipeline runs for a total of 0.5 miles across two different parts of the MPWMA near its eastern edge. A small electrical line runs southwest-northeast 0.5 miles across the southern end of the MPWMA. At least three other utility easements including a pipeline, electrical line, and railroad run across the property, but are not used.

Figure 2: Montague Plain Wildlife Management Area



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N
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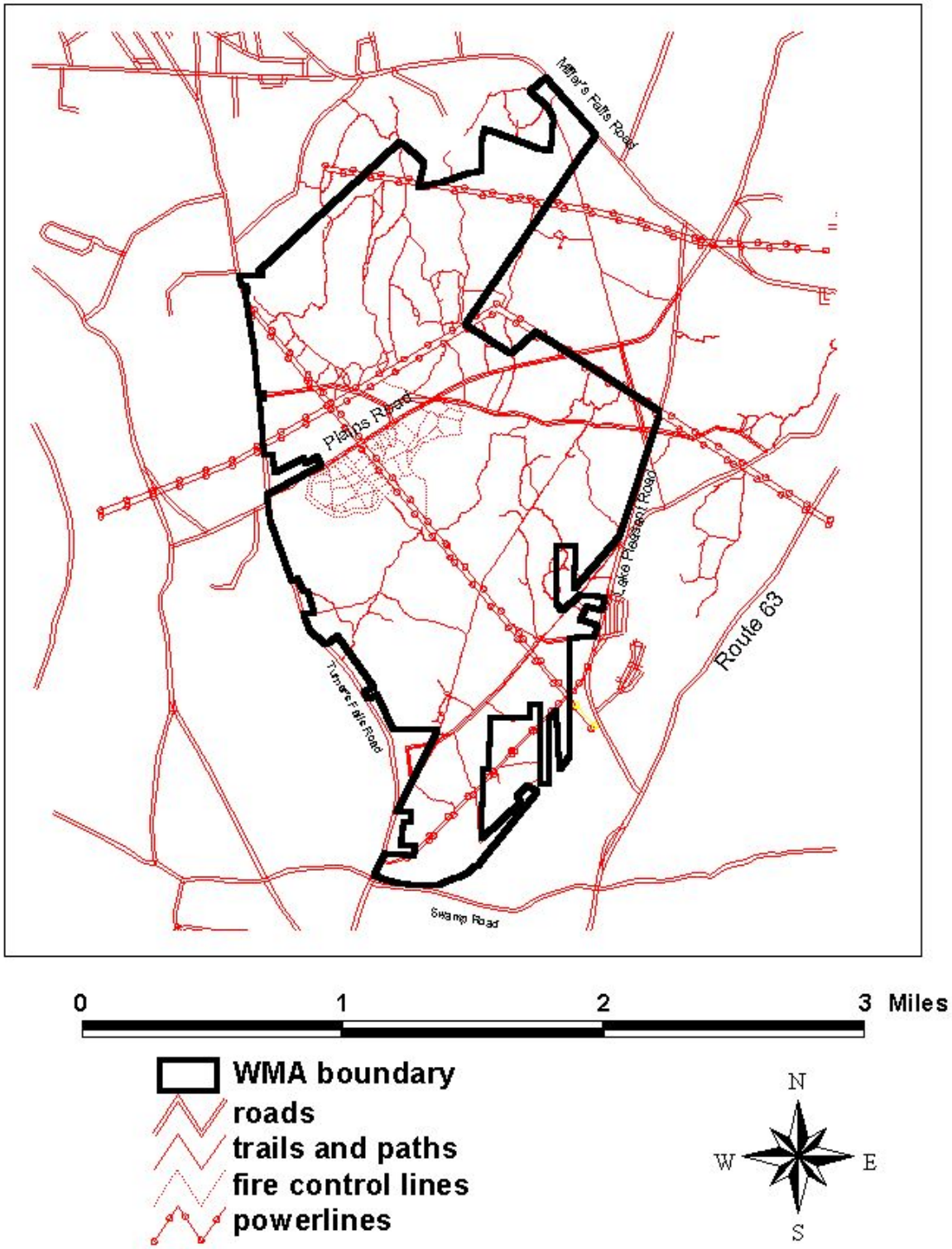
WMA boundary

Figure 3: Roads and Trails of Montague Plain Wildlife Management Area



Only one building currently stands on the MPWMA. It is located next to Plains Road on the east end of the property, and is leased from DFW by *The Mohawk Rambler's Motorcycle Club* for use as a clubhouse.

Historical, Demographic, and Economic Context

Direct evidence (*i.e.*, known archaeological sites) of aboriginal occupation or use of what is now the Montague Plain WMA is sparse. It is reasonable to conjecture, based on paleoecological evidence, that a relatively large population of aboriginal peoples at least intermittently used the area for thousands of years prior to European settlement (Motzkin *et al.* 1996). At the time of European contact (around 1660), the Pocumtuck Nation (an Algonquin people) lived in the area of the Montague Plain (Montague 2002). The Pocumtuck's economy was largely based on fishing in the Connecticut River, and presumably also on small-scale farming, hunting, and gathering. The first European settlers arrived in what is now the Town of Montague around 1720 and the Pocumtuck's were completely displaced by about 1770 (Montague 2002). The Town of Montague was chartered in 1754, and five villages were eventually founded within it: Montague Center, Montague City, Miller's Falls, Turner's Falls, and Lake Pleasant (Montague 2002, DHCD 2002).

The modern Town of Montague encompasses a 36 square mile area (almost 75% of which is forested), and has a population of approximately 8,400 people (DHCD 2002). The town is largely rural in character with an average population density of 273 people per square mile, although higher than average densities are associated with the Town’s five villages (DHCD 2002). The northern end of the Town, Turners Falls in particular, is the most thickly settled area. The closest urban center is the Town of Greenfield which is contiguous to the east of Turners Falls, and has a population of 18,666 (DHCD 2002). For 1990 (the latest figures available) the per capita income was $13,491 and the median family income was $35,112 (DHCD 2002).

Land Use

Historical Land Use

Motzkin *et al.* (1996) present an extensive treatment of pre-historic and historic land-use of the Montague Plain to which the reader is referred for detailed information. They summarize the historic land use as follows:

> "Paleoecological data suggest that pre-European fires were common on the [Montague Plain], perhaps ignited by a large regional Indian population. The area was noted historically as an extensive pine plain and was used for wood products [*e.g.*, tar, turpentine, fuelwood] from the 18th to the mid-19th centuries. Eighty-two percent of the area was subsequently plowed for agriculture before being abandoned in the early 20th century."

Motzkin *et al.* (1996) note that by 1939, only 3% to 9% of the Montague Plain was in agricultural use, the rest in forest or scrub. Within the last 50 or so years (based on estimated tree ages), sand mining has taken place at a few locations on the Plain as evidenced by several

sandpits in the northern part of the property. Much of the plain was purchased by a large corporation, Northeast Utilities, in the mid-20th century. Unsuccessful attempts were made to convert the area to industrial use including a nuclear power plant and a regional landfill. Unregulated recreation, illegal dumping, and vandalism became widespread on the Plain. DFW first acquired land on the Montague Plain in 1949 and 1983 through the purchase of two separate areas totaling 76 acres. This area, known as Bitzer Wildlife Management Area, was originally acquired to protect the groundwater recharge area for the Bitzer Fish Hatchery. In 1999, DFW acquired an additional 1,490 acres adjacent to Bitzer WMA from Northeast Utilities. The new areas were merged with Bitzer WMA to form Montague Plain WMA.

Current Land Use

Montague Plain Wildlife Management Area is currently in forest or scrub, except for the active utility corridors, road and trail network, several old sandpits, and a few small old fields and lawns. According to Motzkin *et al.* (1996), 73% of the Montague Plain was forested in 1985. That figure encompasses the entire Plain (including developed areas beyond the MPWMA boundaries), and does not include Wills Hill, an almost entirely forested knoll within the MPWMA boundaries, therefore complete forest and scrub cover within the MPWMA probably exceeds 90%.

Current activities on the property include hiking, birding, hunting, bicycling, ORV use (including motorcycles, ATV's, snowmobiles, and automobiles), dumping, and "partying." The MPWMA is open to hunting year-round in accordance with state hunting laws and seasons. Hunting is prohibited on Sundays. Since 2000, DFW, in cooperation with the University of Massachusetts at Amherst, has conducted prescribed fire research in an area of scrub oak on unplowed land on and near the original Bitzer WMA. A total of 38.5 acres has been burned (as of 30 June 2002) with prescribed burning activities ongoing.

Physical Features

Topography

The southern three-fourths of the MPWMA lies on a glacial lake delta (the Montague Plain) characterized by low topographic relief (Motzkin *et al.* 1996, USGS 1990). Over most of this southern area the elevation does not change more than 20 feet (USGS 1990). The plain slopes gently north to south (NRC 1977). The western edge of the MPWMA corresponds to the edge of the delta (the foreset beds) where the elevation drops 50 to 60 feet with slopes of up to 60%. The plain lies at an elevation of 280 to 300 feet above sea level (USGS 1990).

The northern end of the property is dominated by Wills Hill which rises 200 or more feet above the plain (USGS 1990). Wills Hill has a maximum elevation of about 520 feet above sea level and a maximum slope of about 30%.

Geology

The Montague Plain Wildlife Management Area is within the Connecticut Lowland subdivision of the New England Upland Section of the New England Physiographic Province (NRC 1977). Bedrock underlying the MPWMA (including the Plain and Wills Hill) is Mount Toby conglomerate, a fine to coarse conglomerate and talus breccia (Willard 1952). Motzkin *et al.* (1996) succinctly describe the surficial geology of the Montague Plain: "Montague Plain in central Massachusetts is an outwash delta of primarily sand and gravel deposited into Glacial Lake Hitchcock, which occupied much of the Connecticut Valley for several thousand years after the Wisconsin glaciation." The surficial geology of Wills Hill is ground moraine (glacial till) consisting of an unsorted mixture of sand, silt, clay, and gravel (Jahns 1966).

Soils

The Montague Plain's soils consist of sandy loams developed in stratified sand and gravel from glacial outwash (Mott and Fuller 1967). The soils are excessively drained with rapid permeability and low water holding capacity, and are, therefore, very droughty. Parent material (usually sand) can usually be found within 16 inches (40.6 cm) of the surface. Most of the Plain's soil shows a plow horizon, but about 18% of the Plain was never plowed (Motzkin *et al.* 1996). See Motzkin *et al.* (1996) for a detailed discussion of the physical and chemical properties of the soil and its influence on vegetation.

Wills Hill soils consist of fine and very fine sandy loams derived from either compact glacial till or wind-deposited silts and fine sands (Mott and Fuller 1967). Most of these soils are very-to-extremely stony or rocky with many stones and boulders on the surface, and are very shallow with bedrock exposures in many places. Most have a moderate moisture holding capacity, but are droughty due to their shallowness. Certain areas, such as in ravines or where a subsurface hardpan exists, are poorly drained and saturated for much of the year (Mott and Fuller 1967).

Hydrology

There are only two perennial surface water bodies on the property: a small stream on the western side of the MPWMA (USGS 1990) and a forested wetland on Wills Hill perched between its two peaks (NRC 1977). The stream is intermittent, with flowing surface water on, during, or soon after heavy rains. Most precipitation that falls on Montague Plain percolates swiftly, although a few less permeable areas become ponded during very wet periods. Some of the more significant surface water bodies close to the MPWMA include the Connecticut River 0.5 to 1.5 miles to the west and north, Miller's River 1.0 mile east, and Green Pond and Lake Pleasant immediately east (USGS 1990). These ponds are partial sources of municipal water for the Town of Montague (NRC 1977).

A lake-bed aquifer underlies the highly permeable sediments of the Montague Plain at a depth of 40 to 70 feet (NRC 1977). A bedrock aquifer is contained within crystalline bedrock underlying both the Plain and Wills Hill. Groundwater movement is generally towards the southwest to the Connecticut River except in the northeastern part of the Plain where groundwater flows southeast

towards Green Pond and Lake Pleasant (NRC 1977, Motts 1971). There are numerous small domestic wells in the vicinity that provide water for individual residential and farm use.

Climate and Weather

The climate of Montague is characterized by long, cold, moderately severe winters; short, warm summers; and ample, well-distributed precipitation (Mott and Fuller 1967, NRC 1977). Although maritime (Atlantic Ocean) air masses occasionally affect the weather of Montague, continental air masses are most influential (Mott and Fuller 1967). Changes in weather are frequent and often rapid (NRC 1977).

The mean annual daily temperature is 46°F (Mott and Fuller 1967), and the normal July and January temperatures are 71.9°F and 23.6°F, respectively (Montague 2002). At least five months per year, the mean monthly temperature is 50°F or greater (Mott and Fuller 1967). On average, temperatures reaching or exceeding 90°F occur 10 days per year, and temperatures of 0°F or lower are reached 7 days annually (NRC 1977). Two out of ten years are predicted to have four or more days where the temperature is less than -17°F or more than 95°F (Mott and Fuller 1967). Extreme temperatures recorded at Westover Air Force Base (approximately 20 miles south of Montague) are 102°F and -22°F (NRC 1977). The average length of the freeze-free season is 142 days with five years out of ten having a last freeze date of May 12 or earlier and a first freeze date of October 1 or later (Mott and Fuller 1967).

The average annual precipitation is 42 inches to 44 inches (Montague 2002, Mott and Fuller 1967). Precipitation is distributed evenly throughout the year, although it is common to have short dry spells (Mott and Fuller 1967, NRC 1977). One year out of ten is predicted to have less than 37.4 inches or more than 56.9 inches of precipitation (Mott and Fuller 1967). The average annual snowfall is 50 inches, but the figure varies widely (Mott and Fuller 1967). In most years (25 out of 31), the ground is covered continuously with at least 1 inch of snow from early January through late March, but continuous snow cover may persist from as early as late November to as late as mid-April in some years (Mott and Fuller 1967).

Wind directions vary considerably, but are predominantly from the southwest during summer and northwest during winter (Mott and Fuller 1967). Wind directions were recorded on site for one year during 1974 and 1975 (NRC 1977). At the 33 foot level, north-northeast and south-southeast were the most frequent wind directions, while at the 150 foot level, south and north-northeast winds were the most frequent. At Westover Air Force Base, prevailing winds were from the south and south-southwest during spring, summer, and fall months and from the north and west-northwest during the winter (NRC 1977). The mean annual windspeed at Westover was 8 mi/hr.

Humidity information was not available for the site, but Westover Air Force Base has a mean annual 0400 relative humidity of 82% and a mean annual 1300 relative humidity of 56% (NRC 1977). The driest month was May with a mean monthly 1300 relative humidity of 49%.

Severe weather affects Montague mostly in the form of thunderstorms and large-scale winter storms (NRC 1977). Thunderstorms occur on average 15 to 25 days per year in Montague, most

frequently in June and July (Mott and Fuller 1967). Tropical storms and hurricanes bringing high winds and heavy rains occur in the area about 1 year in 10 (Mott and Fuller 1967). Tornadoes occur more frequently in the area, but usually affect only small areas (Mott and Fuller 1967). From 1955 through 1967, 28 tornadoes were reported within 1 degree of latitude or longitude of Wills Hill (NRC 1977).

Vegetation

Motzkin *et al.* (1996) characterized the modern vegetation of the Montague Plain from sampling and analysis of 121 0.1-acre plots. They identified seven distinct vegetation types using TWINSPAN analysis. These seven vegetation types are simplified into five general vegetation (or fuel) types for the purpose of this plan (Figure 4). A comparative summary of the Motzkin *et al.* vegetation types and the types used in this plan is provided in Table 1. Motzkin *et al.* (1996) did not sample any plots on Wills Hill, but the vegetation there is similar to their Type 5.

Table 1: General Vegetation Types of Montague Plain Wildlife Management Area

Vegetation Type	**Motzkin *et al.* Equivalent**
grassland	type 1
pitch pine forest	type 3
hardwood forest	type 5
mixed pine - hardwood forest	types 2 and 4
scrub oak thicket	types 6 and 7

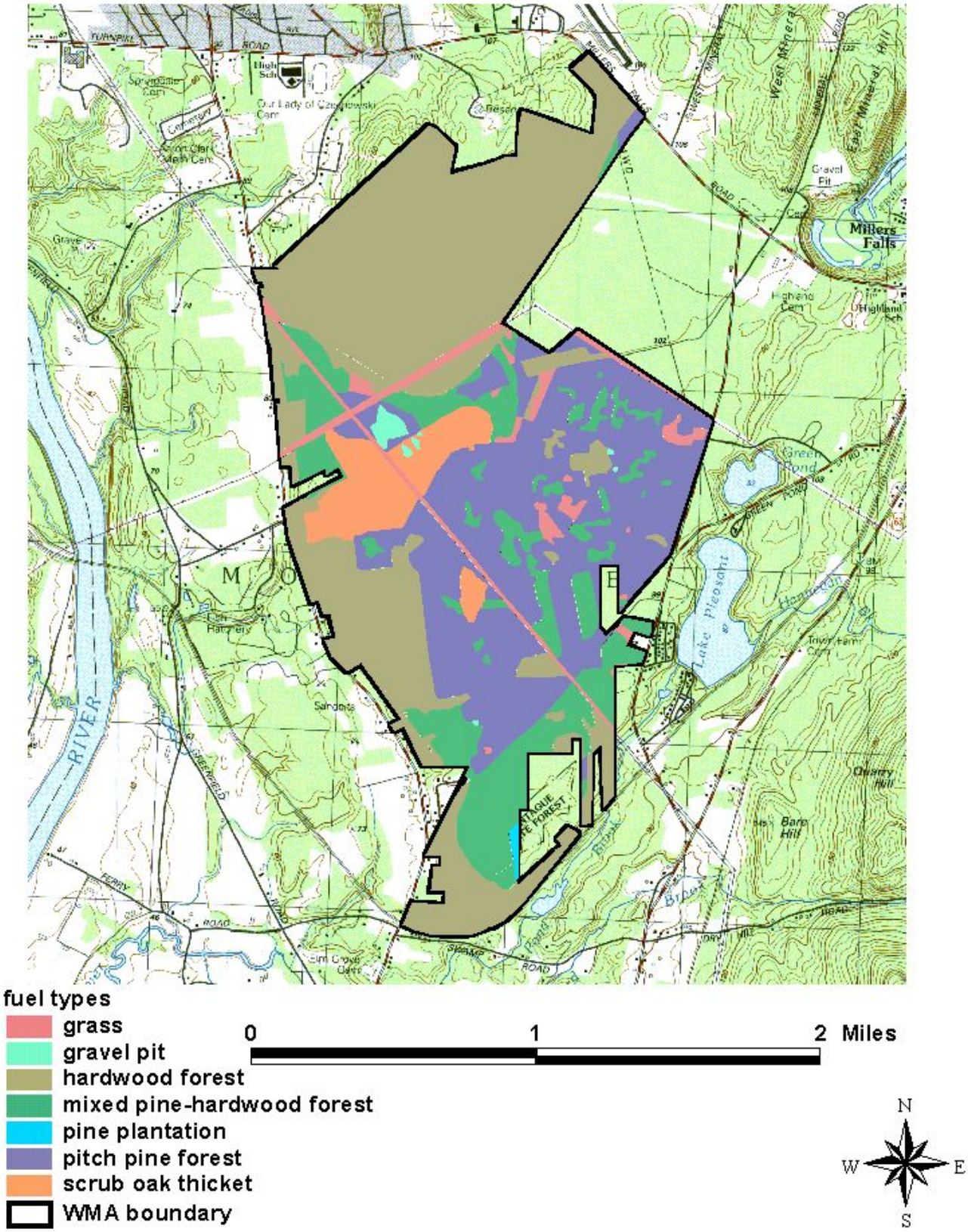
Grassland

This vegetation type is dominated by graminoids with abundant forbs, and has few or small trees. It corresponds with Motzkin *et al.* Type 1. Little bluestem (*Schizachyrium scoparium*) and spiked wild oat grass (*Danthonia spicata*) are the most common graminoids while perforated Saint John's-wort (*Hypericum perforatum*), goldenrod (*Solidago juncea*), and whorled loosestrife (*Lysimachia quadrifolia*) are common forbs. Characteristic shrubs include meadow-sweet (*Spiraea alba*) and common juniper (*Juniperus communis*). Canopy is normally nonexistent, but there may be a very open canopy of aspen (*Populus* spp.). Numerous seedlings and saplings of tree species common to the area can normally be found in this vegetation type. Grasslands occur in old fields and along utility corridors on the MPWMA.

Pitch Pine Forest

Pitch pine forest covers a majority of the MPWMA. This vegetation encompasses Motzkin *et al.* (1996) Type 3. Pitch pine is the dominant (and often only) species of the canopy. Other canopy species may include gray birch (*Betula populifolia*) in open, early successional stands, or white pine (*Pinus strobus*), and other hardwoods, especially oak (*Quercus* spp.) in older stands. Well-established stands often have a significant sub-canopy dominated by regenerating oaks, red maple (*Acer rubrum*), and white pine. The shrub layer is usually sparse, but may include scrub oak, pin-cherry (*Prunus pensylvanica*), blueberry (*Vaccinium* spp.), brambles (*Rubus* spp.), and oak and pine saplings. The herb stratum is generally sparse and low in species richness, but moss (*Polytrichum* spp.) is ubiquitous. The total mean basal area is 94 ft^2/ac, 85% of which is pitch pine at 80 ft^2/ac (Parrott 2002). The average tree height is 57 feet and the mean canopy closure is

Figure 4: General Fuel Types of Montague Plain Wildlife Management Area



65% (Parrott 2002). The vegetation type occurs almost exclusively on land which was plowed during circa 1850 to 1925.

Hardwood Forest

The hardwood forest vegetation type is roughly equivalent to Motzkin *et al.* (1996) Type 5 (although it is defined here more broadly). Hardwood forest occurs on Wills Hill, at the edge of the Montague Plain on the foreset bed slopes, and at a few other isolated locations on the property. The hardwood forests are generally dominated by tree oaks. Scarlet oak (*Quercus coccinea*) is most common on the most xeric sites (*e.g.*, on the Plain), with northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and black oak (*Quercus velutina*) more common on the less xeric sites (*e.g.*, Wills Hill). Other common canopy species include pitch pine, white pine, red maple, gray birch, hickory (*Carya* spp.), and hemlock (*Tsuga canadensis*). The normally sparse sub-canopy and shrub layers contain regenerating trees of the canopy species and often shadbush (*Amelanchier* spp.), black cherry (*Prunus serotina*), scrub oak, blueberry, chestnut (*Castanea dentata*), huckleberry, and mountain laurel (*Kalmia angustifolia*). In the herb layer wintergreen (*Gaultheria procumbens*), pink lady's slipper (*Cypripedium acaule*), cow-wheat (*Melampyrum lineare*), Pennsylvania sedge (*Carex pensylvanica*), and bracken (*Pteridium aquilinum*) are common. The total mean basal area is 84 ft^2/ac, 84% of which are oak species at 71 ft^2/ac (Parrott 2002). Mean canopy closure is 77% and the average tree height is 57 feet (Parrott 2002).

Mixed Pine-Hardwood Forest

The mixed pine-hardwood forest includes Motzkin *et al.* (1996) Types 2 and 4. It is essentially a combination of the pine and hardwood vegetation types. The canopy commonly includes pitch pine, gray birch, oaks, and white pine. In the shrub and herb layers, indian pipe (*Monotropa uniflora*), clubmoss (*Lycopodium* spp.), and bracken frequently are found under shady closed canopies; and sweet fern (*Comptonia peregrina*), little bluestem, and dogbane (*Apocynum androsaemifolium*) are common in the more open stands. Other common herbs in this vegetation type include pink lady's slipper, cow-wheat and Pennsylvania sedge. Mean canopy closure is 76%, and the average tree height is 59 feet (Parrott 2002). The total mean basal area is 111 ft^2/ac of which pitch pine accounts for 17% at 19 ft^2/ac, white pine accounts for 46% at 51 ft^2/ac, and oak species account for 27% at 30 ft^2/ac (Parrott 2002).

Scrub Oak Thicket

The scrub oak thicket vegetation type consists of shrublands dominated by scrub oak and corresponds with Motzkin *et al.* (1996) Types 6 and 7. This vegetation type is found on unplowed areas of the Montague Plain. Trees (mostly pitch pine and scarlet oak) are very sparse to absent although pitch pine canopy may reach 25% cover in some areas. The vegetation is dominated by dense tall shrubs. Usually scrub oak dominates with an understory of huckleberry, blueberry, and bracken. In some areas, scrub oak overtops or is co-dominant with blueberry, dwarf chestnut oak (*Quercus prinoides*), and sweet-fern. Other common species include black cherry, red maple, shadbush, chokeberry (*Aronia* spp.), wintergreen, cow-wheat, Pennsylvania

sedge, and reindeer lichen patches (*Cladonia* spp.). Most of the rare species known from the MPWMA occur in this vegetation type.

Barrens Successional Patterns

Finton (1998) conducted a study of succession in five pitch pine - scrub oak barrens sites in the Northeast, including the Montague Plain. Finton compared past and present vegetation at these sites using aerial photographs and field surveys, then developed models to predict succession in pitch pine - scrub oak barrens of the Northeast. He found that it was difficult to produce a generalized model that accurately predicted successional trends at all sites. Differences among sites in original distribution of the vegetation types, land use history, and disturbance history seemed to account for the inter-site successional differences. Succession was strongly influenced by human activity at all sites. Major influencing factors on succession were development (or conversion to another use such as utility right-of-way), cultivation (and subsequent abandonment), logging, charcoaling, blueberry production, and fire (or fire exclusion). Motzkin *et al.* (1996) also found that prior land use strongly influenced succession at Montague Plain.

The general successional trend observed by Finton was a loss of diverse open-canopy scrub oak vegetation. Much scrub oak was lost to development, but on undeveloped lands, scrub oak barrens and thickets were replaced by one of several closed-canopy forest types dominated by either pitch pine or hardwoods. At Montague Plain, both Finton and Motzkin *et al.* found that land that had been cultivated then abandoned followed a sere characteristic of "typical" old-field succession, growing into forest rather than the pre-agricultural open-canopy scrub oak barren vegetation. Fire exclusion contributed to open-canopy vegetation loss on at least four of Finton's five sites. Open-canopy scrub oak communities converted to forest types in the absence of frequent, large fires. Finton concluded that fire exclusion and post-fire vegetation development have been primary influencing factors on the succession of Northeast pitch pine - scrub oak barrens for many decades.

Rare Species and Communities

Twenty-two declining, rare, or imperiled species and one rare natural community are known to occur on the Montague Plain Wildlife Management Area. Table 2 lists these resources and provides some basic information regarding each. Most of the rarities are lepidoptera plus one community, two reptiles, and seven plants. Some of these resources are discussed in more detail below. Information on the species comes from the Massachusetts Natural Heritage and Endangered Species Program website (MNHESP 2002) unless noted otherwise.

Pitch Pine - Scrub Oak Community

This rare community is comprised of the scrub oak thicket vegetation described above. Swain and Kearsley (2001) describe this community's environmental setting as follows:

> "Pitch pine - scrub oak communities develop on droughty, low nutrient soils - usually deep, coarse, well-drained sands derived from glacial outwash - in the coastal plain, the

> Connecticut River Valley, and other scattered areas throughout the Northeast. Pitch pine - scrub oak communities are a fire maintained and fire dependent community; most species in the community recover well from fire."

Pitch pine - scrub oak communities are rare within the Commonwealth, and are among the rarest and most critically imperiled in the United States (Swain and Kearsley 2001, Finton 1998). These communities typically support a number of rare species, particularly rare lepidoptera (Swain and Kearsley 2001) Threats include development, fragmentation, and fire exclusion (Swain and Kearsley 2001).

Eastern Box Turtle (*Terrapene carolina carolina*)

The eastern box turtle is a small, terrestrial turtle ranging from 4 to 8 inches in length. The species ranges from southeastern Maine south to northern Florida and west to Michigan, Illinois, and Tennessee. The eastern box turtle prefers open deciduous woodlands and forests. Declining in numbers throughout its range in Massachusetts, the species is listed as a "Species of Special Concern" in the Commonwealth. The greatest threats to its survival are fragmentation and destruction of its habitat. Fire may benefit box turtle populations by restoring or maintaining habitat, but individual turtles may perish if caught above ground during a fire. Russel *et al.* (1999) cite reports of box turtles surviving prescribed burns by burrowing, but note that further research is needed.

Barrens Buck Moth (*Hemileuca maia*)

The barrens buck moth is a diurnal moth with a wingspan of about 2 inches. The wings and body of the moth are black except for a bright white band across each wing. Caterpillars of the species are mostly black, but may have yellow markings, and bear large spines. Barrens buck moth populations can be found throughout much of the eastern United States in appropriate habitats. In Massachusetts, barrens buckmoths are restricted to large tracts of pine - oak barrens. Although there are more than a dozen populations of the species in the coastal part of the state, the Montague Plain population is the only one in the western part of the Commonwealth. Scrub oak and dwarf chestnut oak are the primary host plants (in New England) for the species though they will also use new shoots from burned or cut black and scarlet oak if there is no canopy. The species is listed as "threatened" within Massachusetts, but is common in other parts of its range (e.g. the southern states). Habitat destruction and alteration, especially from lack of fire, are the principle threats to the species, with pesticide use another major concern. Populations are also threatened by parasitoids introduced as biological control agents for gypsy moths, *Lymantria dispar* (Boettner *et al.* 2000).

The inland barrens buck moth is representative of most of the other rare lepidoptera species found in the MPWMA. Most require or prefer pine - oak barren habitats, although are generally less obligatory in their habitat or host plant requirements. Disturbance, especially fire, is essential to the restoration and management of core habitats critical to the conservation of these species. Larger areas generally support greater species diversity of barrens dependent lepidoptera.

Table 2: Rare Species and Natural Communities of Montague Plain Wildlife Management Area					
Common Name	**Scientific Name**	**Natural Heritage Ranks**	**Federal Status**	**State Status**	**General Habitat**
rare natural communities					
pitch pine - scrub oak community	N/A	S2	none	N/A	glacial outwash sands
rare plants					
Nantucket shadbush	*Amelanchier nantucketensis*	G3QS3	none	special concern	pine barrens and pond shores
New Jersey tea	*Ceanothus americanus*	G5S3	none	watch-list	dry, open woods and thickets
spreading tick trefoil	*Desmodium humifusum*	G1G2QS1	none	endangered	dry woods
fringed gentian	*Gentianopsis crinita*	G5S4	none	watch-list	open to semi-open wetlands; stream margins
wild lupine	*Lupinus perennis*	G5S3	none	watch-list	sunny areas in sandy soils
white rattlesnake root	*Prenanthes alba*	G5S4	none	watch-list	moist to wet woodlands
spring rock spikemoss	*Selaginella rupestris*	G5S4	none	watch-list	rock outcrops or sunny gravelly soil
rare lepidoptera					
blueberry sallow	*Apharetra dentata*	G4S2S3	none	watch-list	
New Jersey tea inchworm	*Apodrepanulatrix liberaria*	G4S1S2	none	threatened	
frosted elfin	*Callophrys irus*	G3S2S3	none	special concern	
pine woods underwing	*Catocala* sp1	G5S3	none	special concern	pine barrens
northern hairstreak	*Fixsenia ontario*	G4S3	none	special concern	
a geometer moth	*Glena cognataria*	G4S3	none	watch-list	
William's tiger moth	*Grammia williamsii*	G4S1	none	threatened	
slender clearwing sphinx moth	*Hemaris gracilis*	G4S2	none	special concern	
barrens buckmoth	*Hemileuca maia*	G5S1	none	threatened	pitch pine barrens
pine barrens itame	*Itame* sp1	G3S2S3	none	special concern	pine barrens
barrens metarranthis moth	*Metarranthis apiciaria*	GUS1	none	endangered	pine barrens
pink sallow	*Psectraglaea carnosa*	G3S2S3	none	special concern	
pine barrens zale	*Zale* sp1	G3QS2S3	none	special concern	pitch pine - scrub oak barrens
pine barrens zanclognatha	*Zanclognatha martha*	G4S2	none	threatened	maturing pitch pine stands
rare reptile					
eastern box turtle	*Terrapene carolina carolina*	G5S3	none	special concern	forests, esp. moist open deciduous

Spreading Tick Trefoil (*Desmodium humifusum*)

Spreading tick trefoil is an herb of the bean family which grows prostrate (spreading low to the ground), has compound leaves with three leaflets each, bears small purple to pink flowers in late summer, and produces "hitchhiker" or "beggar's tick" fruits in the fall (Magee and Ahles 1999, Gleason and Cronquist 1991). The species typically grows in xeric woodlands or other dry soils.

Although the species ranges south to Maryland, in New England, the spreading tick trefoil is known only to occur in Connecticut and Massachusetts where it is state-endangered in both.

Historic Resources

Information regarding archeological sites on Montague Plain Wildlife Management Area is limited. A single paleo-Indian campsite is known to occur adjacent to the Montague Plain, and Indian trails are reported to have crossed the site (Motzkin *et al.* 1996). There is potential for additional archeological sites on the property (NRC 1977), but proposed management activities should not affect them if they do exist, as soil disturbing activities will be avoided. If any soil disturbing or other activities which may affect archeological resources are proposed for the MPWMA, the State Archaeologist will be consulted.

There are no historic sites or National Register of Historic Places sites on or near the MPWMA (NRC 1977).

Fire History

Paleoecological evidence strongly suggests fire was a common occurrence on the Montague Plain from 500 to at least 2,000 years before European settlement (Motzkin *et al.* 1996). Sediment cores from Green Pond, Lake Pleasant, and Dead Frog Pond adjacent to the property showed high charcoal-to-pollen ratios (Motzkin *et al.* 1996). Most pre-historic fires were probably human-caused. Lightning-caused wildfires are rare in New England today, and are assumed to have been rare during recent prehistoric periods (Patterson and Sassaman 1988). Lightning-caused fires may have been more common in southern New England during the mid-Holocene, however, due to warmer and drier conditions (Patterson and Sassaman 1988). Throughout North America, prehistoric Native Americans used fire as a landscape management tool to increase browse and mast for game species, drive game, increase production in certain food-bearing plants, ease travel through the wilderness by clearing underbrush, communicate among groups, facilitate effective defense of their communities and territories, and, once agriculture was adopted, to clear and fertilize crop lands (Lewis 1982, Patterson and Sassaman 1988). There are many references to fire-maintained landscapes and the use of fire by Native Americans in southern New England (Patterson and Sassaman 1988, Dunwiddie and Adams 1995, Bromley 1935, Cronon 1983, Day 1953). These general trends and the paleoecological evidence specific to the Montague Plain suggest that prehistoric Native American burning on the Montague Plain was practiced for a sufficient length of time to profoundly influence ecosystems.

Research regarding fire history of the post-settlement/pre-agricultural period (roughly 1720 to 1850) is not available. Since the Plain was utilized mostly for forest resources during this period, it is not unreasonable to conjecture that the pre-settlement fire regime persisted either out of accident or design. During the period from 1850 through 1925, agriculture was widespread on the Montague Plain (Motzkin *et al.* 1996), and fire occurrence is presumed to have been associated with the maintenance of agricultural fields and grazed woodlands.

The early 1900's saw the decline of agriculture on the Plain, the regeneration of forest and scrub fuels, and the development of aggressive suppression approach to fire management. Historical

records indicate that extensive fires (some larger than 1,000 acres) burned through the Plain in the early and middle 20th century followed by numerous smaller fires (less than 5 acres) after about 1950 (Motzkin *et al.* 1996). The last large fire (approximately 460 acres) occurred in 1957. Motzkin *et al.* (1996) note, "A similar pattern of large fires early in [the 20th] century followed by many small fires in recent decades has been noted elsewhere in the northeastern United States, and is interpreted as resulting from improved fire detection and suppression capabilities and an increase in accidental fires." Recreational use of the site appears to have increased dramatically since corporate ownership in the 1960's, and numerous fires have been ignited accidentally (or sometimes intentionally) by people using the area for recreation.

Fires have occurred in every month of the year, but are most frequent in April and May (Motzkin *et al.* 1996). This pattern is consistent with the fact that the lowest average relative humidities in the region occur in April and May, that leaf-out of deciduous species on the Plain has not occurred leading to very low fuel moisture conditions, and that this period corresponds with the Massachusetts legal open burning season.

Starting in 2000, small prescribed burns have been conducted on a portion of the Montague Plain WMA for ecological management and training purposes. There are no records of intentional burning to accomplish resource management objectives prior to 2000.

Fuels

Fuels are discussed in terms of standard NFFL ("Northern Forest Fire Laboratory") fuel models as described in Anderson (1982) and Rothermel (1983). In many cases on the Montague Plain WMA there is not a perfect fit between NFFL models and fuels which occur on the MPWMA. Closest fit or best fit models are used, but they may have limitations as to the accuracy of their predictions. Custom fuel models have been developed for some of the vegetation types found at Montague Plain. These custom fuel models are suggested as a possible alternative for predicting fire behavior under the fuel type to which they apply. Most of the custom fuel models should be adjusted to account for recent improved understanding of fuel cover percentages used by BEHAVE before being applied to MPWMA fires.

General fire behavior predictions come from Anderson (1982) and are for standard (moderate) conditions of fine fuel moisture content of 8%, mid-flame windspeed of 5 miles/hour, and live fuel moisture (if applicable) of 100%. Fuels are discussed according to vegetation type below. Table 3 summarizes the fuels information. Figure 4 shows a map of the fuel types. Specific fuels discussions and fire behavior predictions will be provided in the individual prescribed burn plans for any management units in which prescribed burning is proposed.

Grassland

Fuel model 1 ("short grass") best represents Montague Plain grasslands. Fire ignition and spread are governed by fine herbaceous fuels that have cured or are nearly cured. Fires in these fuels are often intensely burning and fast moving, but short-lived. Typically, the grasslands are open and fully exposed with shrub or tree cover less than one third of the area. Fuel model 1 has an

average total fuel loading of 0.74 tons/ac and predicts rapid rates of spread (78 ft/min) with moderate flame lengths (4 feet).

Table 3: Fuels of Montague Plain Wildlife Management Area

Fuel Type	Fuel Model(s)	Typical Flamelengths (ft)*	Acres	% of WMA
grass	1	4	59	4
pitch pine forest	9, custom	2.6 (FM9), 7.5 (custom)	451	30
hardwood forest	9	2.6	662	44
mixed pine - hardwood	8, 10	1 (FM8), 4.8 (FM10)	238	16
scrub oak thicket	6, custom	6 (FM6), 7-12 (custom)	91	6
pine plantation	8	1	3	<1
sand pits	N/A	N/A	8	<1

* predicted flamelengths with fine fuel moisture content of 8%, mid-flame windspeed of 5 miles/hour, and live fuel moisture (if applicable) of 100%

Pitch Pine Forest

This is the most complicated of the vegetation types in terms of fuel models because no model fits it exactly. Fire behavior is predicted by fuel model 9 ("litter"). Unlike the hardwood stands, the potential for crown fire development exists where ladder fuels are present. Fires are propagated primarily by fine surface fuels of uncompacted pine straw and hardwood litter. Ice damaged areas result in abundant dead aerial fuels and open areas where fire intensity can increase abruptly. Concentrations of shrubs or down dead wood contribute to possible torching and spotting. Small branches and cones from torching trees are notorious causes of short-range and long-range spotting in this fuel type. Total fuel loading for fuel model 9 averages about 3.5 tons/acre while rates of spread and intensity are generally moderate to low (7.5 feet/minute and 2.6 foot flame lengths). A down woody fuel inventory (note that down woody fuel inventories do not measure litter, grass, or live fuels) conducted at 25 plots in this fuel type on the WMA found a mean down woody fuel load of 0.75 tons/acre and an average down woody fuel depth of 40.1 inches (Parrott 2002).

Many areas of the pitch pine forest have higher total fuel loadings than that represented by fuel model 9. There may be a thick accumulation of litter and much down dead wood. Although no standard fuel model fits these areas well, custom fuel models have been developed for similar vegetation on other sites (Patterson 1998, Patterson 1999, Patterson 2001). Most recently, Patterson (2001) developed custom fuel models using BEHAVE for two pitch pine - scrub oak forest stands on Ossipee Pine Barrens of New Hampshire. These stands consisted of areas dominated by pitch pine with canopy closure of 60% or more. Pitch pine stands at MPWMA have less understory fuels (probably due to the agricultural land use history) than at Ossipee and abundant Polytrichum moss (which may retard surface fire intensity). Although the pitch pine stands at Ossipee have a much denser shrub layer, the custom fuel models developed there are the closest match to the closed-canopy pitch pine stands at Montague Plain. Patterson found that fuel loadings were around 8 tons/acre. BEHAVE predicted fire behavior (under conditions slightly "hotter" than "standard") in these custom models to be 7.3 to 7.5 foot flame lengths and rates of spread at about 10 chains/hour. This behavior exceeds the intensity and spread rates for fuel model 7 ("southern rough"), one of the most intensely burning fuel types in North America, under the same conditions. Although opportunities to compare the custom fuel model predictions with actual fire behavior have not occurred yet, Woodall (1998) found that initial fuel models

built for pine barrens vegetation underestimated fire behavior. It is clear that fire behavior can be very intense in this vegetation type if a significant shrub layer is present.

There is potential for crowning in this vegetation type, especially in dense "dog-hair" pitch pine stands or anywhere significant ladder fuels are present. Pitch pine foliage has low live fuel moisture in late spring and contains flammable oils, therefore crown fires can spread readily in closed canopy situations under high winds. Crowning in this vegetation type could lead to fire of a catastrophic scale and intensity, and is the most serious fire-related threat to the lives and property of those living in the area surrounding the MPWMA. There is no NFFL fuel model for crownfires, and BEHAVE does not predict crown fire behavior, although FARSITE models fire spread at the landscape level.

Hardwood Forest

Fuel model 9 ("litter") fits this vegetation type well. Fires are propagated primarily by fine surface fuels comprised mostly of hardwood litter. Concentrations of shrubs or down dead wood contribute to possible torching and spotting. Windblown burning leaves are notorious causes of short-range spotting in this fuel model. Total fuel loading averages about 3.5 tons/acre while rates of spread and intensity are generally moderate to low (7.5 feet/minute and 2.6 foot flame lengths). A down woody fuel inventory (note that down woody fuel inventories do not measure litter, grass, or live fuels) conducted at 11 plots in this fuel type on the WMA found a mean down woody fuel load of 3.2 tons/acre and an average down woody fuel depth of 25.2 inches (Parrott 2002).

Mixed Pine-Hardwood Forest

Because this vegetation type includes several sub-types, no single NFFL fuel model fits the entire vegetation type. Closed canopy stands dominated by birch, maple, aspen, and white pine are usually well-predicted by fuel model 8, because surface fuels are shaded, compacted, and shallow. Fuel model 8 exhibits low intensity fire behavior under all but the most extreme conditions with flame lengths of 1 foot and spread rates of 1.6 chains/hour under standard conditions. Stands dominated by oaks accumulate more surface fuels and burn as fuel model 9 (described for the hardwood forest). Where there is considerable downed dead wood or a significant shrub layer such as where pitch pine is more common and/or the canopy more open, this fire behavior may be better predicted by fuel model 10 or by a custom fuel model developed for similar fuels at Cape Cod National Seashore (Woodall 1998). A down woody fuel inventory (note that down woody fuel inventories do not measure litter, grass, or live fuels) conducted at 9 plots in this fuel type on the WMA found a mean down woody fuel load of 3.7 tons/acre and an average down woody fuel depth of 22.6 inches (Parrott 2002). Model 10 leads to moderately intense fire behavior with rate of spread predicted as 7.9 chains/hour and flamelengths predicted as 4.8 feet under standard conditions.

Scrub Oak Thicket

Fires in this fuel type are propagated primarily by abundant fine surface fuels, chiefly oak leaves, pine straw, and cured herbaceous material. Fires usually also spread in the shrub layer except

under low wind or high moisture conditions. The scrub oaks and ericaceous shrubs found in this vegetation type have many attached dead branches and twigs that carry the fire. The scrub oaks often retain their dead leaves which contribute to fire behavior. The ericaceous shrubs have flammable oils in their stems and foliage and will burn vigorously even when green. Fire behavior can be extreme even under moderate conditions, and has been compared to the extremely dangerous chaparral fuel type of southern California.

Fuel model 6 ("dormant brush") is commonly used for this fuel type, however, it does not predict fire behavior well in this vegetation type (Patterson 1998, Patterson 2001). For fuel model 6, total fuel loadings are around 6 tons/acre. Fire behavior is characteristically intense in this fuel type with rates of spread at 32 feet/minute and flamelengths of 6 feet. Fire during the growing season will have notably reduced rates of spread due to high live fuel moistures associated with the oak leaves.

Custom fuel models have been developed for similar vegetation on other sites (Patterson 1998, Patterson 1999, Patterson 2001). At the various sites, Patterson found fuel loadings 30% to 100% higher than for the fuel model 6. Custom fuel models predicted fire behavior (under conditions slightly "hotter" than "standard") with flamelengths of seven to 12 feet and rates of spread from eight to 29 chains/hour (Patterson 2001). These fire behavior predictions are intermediate between those for fuel models 4 ("chaparral") and 6 ("dormant brush") (Patterson 1998). Patterson (1999) notes that predicted rates of spread are comparable to fuel models 6 and 7, but that predicted intensities are substantially higher - approaching the intensities of the highly dangerous chaparral fuel type (FM 4). Woodall (1998) developed a custom fuel model for similar scrub oak thicket vegetation on Martha's Vineyard that may be applicable to this fuel type.

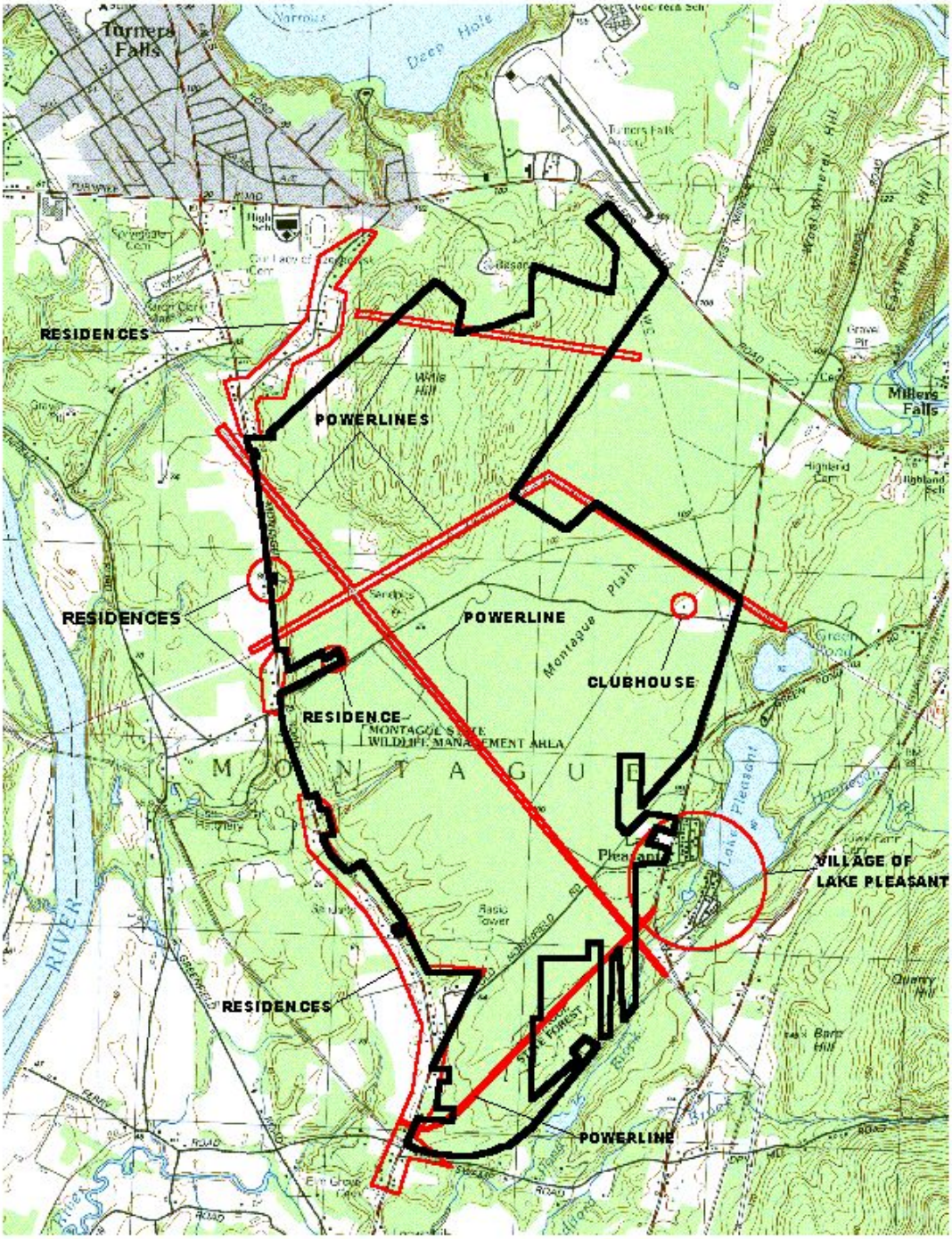
Sensitive Areas

Fire Sensitive Areas

There are two fire-sensitive areas on MPWMA (Figure 5). There is a clubhouse building along Plains Road on the eastern side of the MPWMA. This approximately 800 square foot structure has concrete block construction and an asphalt shingle roof. Defensible space is minimal behind the structure (west), but excellent on all other sides. There is an exterior above-ground propane tank adjacent to the west exterior wall. A dense stand of pitch pine to the west of this structure puts it at considerable risk from wildfire. Electrical transmission lines are the other fire sensitive areas of the property. Most of the lines that cross the MPWMA have wooden poles which could be damaged or consumed by a wildfire causing power outages in the region and electrical and structural hazards at the site. Only the largest powerline, running northwest-southeast across the property has metal towers.

There are numerous fire sensitive areas off-site (Figure 5). The village of Lake Pleasant lies adjacent to the MPWMA to the southeast just across Lake Pleasant Road. A large, uninterrupted area of closed canopy pitch pine occurs west of the village of Lake Pleasant (Motzkin 2001). Due to the arrangement and flammability of the fuels, a crown fire could sweep across the southern part of the MPWMA and into the village when winds are high and humidity is low. The

Figure 5: Fire Sensitive Areas on/near Montague Plain Wildlife Management Area



0 1 2 Miles

N W E S

WMA boundary

fire sensitive areas

village of Lake Pleasant has been affected by wildfires on several occasions in the past, and during at least one incident houses were destroyed (Motzkin 2001). There are a number of houses and other buildings adjacent to or near the property boundary to the north, northwest, west and southwest along Miller's Falls Road, Hillside Road, and Turner's Falls/Montague Road. While still at some risk of being affected by fires from the Montague Plain, these areas are at substantially less risk than the village of Lake Pleasant, because they occur at the bottom of slopes and are adjacent to mixed or hardwood forests (which do not support crown fires). A single residence lies in an inholding north of Plains Road at the western edge of the site. This residence is at particular risk to fire because it is surrounded by scrub oak thicket and pitch pine fuel types.

Smoke Sensitive Areas

Smoke from fires can become a nuisance to people downwind, may exacerbate existing respiratory problems of some individuals, and can cause serious visibility hazards on public roads. The goal of smoke management is to minimize impairment of visibility and air quality (especially suspended particulates) from smoke to the surrounding area in general and to areas which are especially susceptible to smoke ("smoke-sensitive areas") in particular. Smoke management is addressed here at a programmatic level, and will be addressed at a project level in individual prescribed burn unit plans.

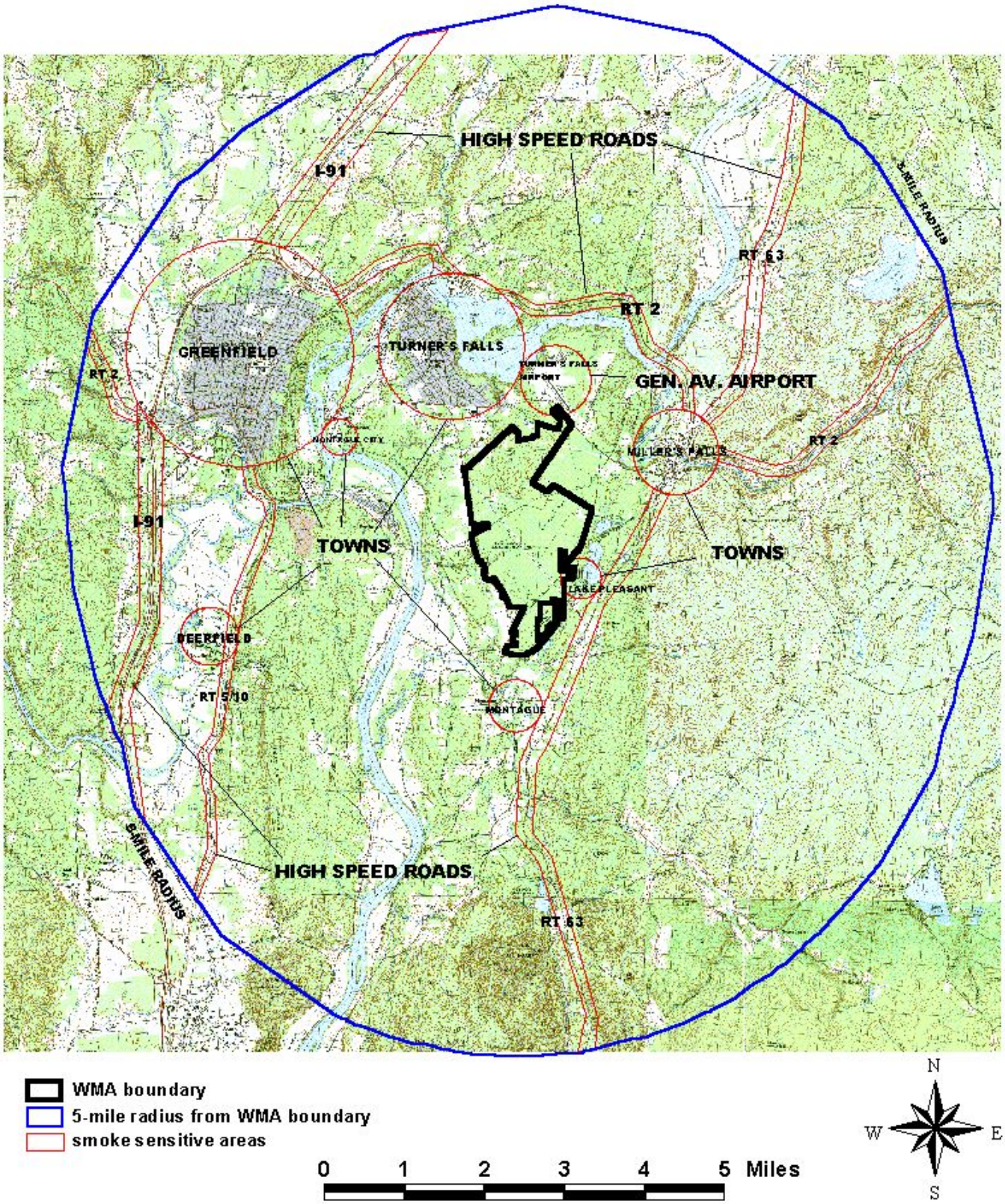
There are numerous large-scale smoke sensitive areas within 5 miles of the MPWMA (Figure 6). The communities of Greenfield, Turner's Falls, Miller's Falls, Lake Pleasant, and Montague Center all lie within 5 miles of the site's boundaries. These communities include schools, churches, industries and other gathering places which may be particularly sensitive to smoke. There is a community hospital (Franklin Medical Center) in Greenfield and a long-term care facility (Farren Care) in Montague City approximately 3 miles and 1.5 miles northwest of the MPWMA boundary, respectively. A general aviation airport and small industrial park lies approximately two miles north. Several high speed-limit roads including State Routes 63 and 2, and Interstate 91 run within 5 miles of the MPWMA.

The general wildfire strategy for the site is suppression, and there is little that can be done to minimize smoke from wildfires which are being actively suppressed. Fuel reduction will help to reduce the amount of smoke generated should a wildfire occur, and will facilitate control. Thorough mop-up after a wildfire has been brought under control will help minimize residual smoke.

Smoke management strategies for prescribed fires will follow smoke management plans and prescriptions developed for each burn unit. Fire and smoke behavior computer models such as BEHAVE, V-SMOKE, and SASEM will be used to help develop smoke management plans. A number of general smoke management strategies will be used to minimize smoke problems during prescribed burning:

(1) Burn unit sizes will be kept small, usually under 5 acres, so that the duration of smoke generation will be short and the volume of smoke will be small on any given burn day.

Figure 6: Major Smoke Sensitive Areas around Montague Plain Wildlife Management Area



(2) Advanced and day-of-burn notifications will be made to residents within 0.5 miles downwind of the burn unit, so that they may take appropriate steps to minimize nuisance (bring in laundry, close windows, *etc.*).

(3) Smoke warning signs will be posted on any paved roads potentially affected by smoke in the vicinity of burn units.

(4) During burns, smoke will be monitored visually. Unacceptable smoke effects will be addressed by altering firing tactics, actively directing traffic, or terminating burns.

(5) Each burn unit plan will have a "smoke-screening" or smoke plume map and specific minimum atmospheric criteria for smoke dispersal (mixing heights, transport winds, category day, *etc.*). Daily fire weather forecasts including smoke dispersal information such as Haines Index, mixing height, transport wind speed/direction, and ventilation rates are available on the World Wide Web at http://tgsv5.nws.noaa.gov/er/box/fcsts/BOSFWFBOS.html. Reasonable minimum conditions for adequate smoke dispersal on prescribed burns are mixing height $\geq$ 1,600 feet, transport winds $\geq$ 9 mph, and background visibility $\geq$ 5 miles. These guidelines may be different in some burn prescriptions, however, depending upon a number of factors in and around the burn unit.

(6) Thorough mop-up of the burn unit will be conducted to minimize residual smoke production.

MANAGEMENT

Fire Management Goals and Objectives

Goals are the broad conditions that resource management actions are intended to achieve. They define, in a general sense, the desired fire regime, fuels situation, and public safety vision for the site. Objectives are more specific statements describing a desired end result related to the goals. Montague Plain Wildlife Management Area has three fire management goals which are listed below with the related fire management objectives. Objectives for individual activities (e.g. prescribed burns, overstory thinning, mechanical manipulation of surface fuels) will be specific and quantifiable, with pre and post-treatment sampling protocols established to determine if objectives are met.

Goal 1

Manage the Montague Plain Wildlife Management Area so as to protect lives and property from threats of wildfire, ensuring that firefighter and public safety is the highest priority in every fire management activity.

Objectives Related to Goal 1

A. Actively suppress, control, and extinguish all wildfires (*i.e.*, non-management ignited fires) on the MPWMA to the smallest size reasonably possible.

B. Continue to build capacity to prevent, detect, and respond to wildfires on the site by developing relationships with local and state fire agencies, Northeast Utilities, and local communities.

C. Judiciously use mechanical techniques and prescribed burning to reduce hazardous loadings of fuels with particular emphasis on dangerous fuel types and near structures.

D. Increase public awareness about wildfire and interface fire in the communities surrounding the MPWMA.

E. Control access to and increase patrol of the site in order to minimize ignitions and facilitate early detection.

F. Manage smoke from prescribed burns to minimize impacts on the surrounding community.

G. Conduct prescribed burns only in accordance with approved prescribed burn plans which include acceptable weather and fuel parameters, a smoke management strategy, and contingency provisions.

H. Conduct monitoring of fuel management units to determine if fuel management objectives are being met.

Goal 2

Perpetuate an ecologically viable pitch pine - scrub oak barren complex with special emphasis on restoring and maintaining rare, threatened, and endangered species and natural communities.

Objectives Related to Goal 2

A. Conduct all fire management activities in a manner which will minimize adverse impacts on rare species populations and rare natural communities.

B. Conduct all fire management activities in a manner which will minimize adverse impacts on game species and other wildlife of conservation concern.

C. Judiciously use mechanical techniques and prescribed fire to manage rare species and natural communities, control invasive species, and benefit game and regionally declining species.

D. Conduct monitoring of rare species, game species, and rare natural communities to determine if management objectives are being met.

E. Manage smoke from prescribed burns to minimize undesirable effects to the community.

F. Conduct prescribed burns in accordance with prescribed burn plans which include acceptable weather and fuel parameters, smoke management strategy, and contingency provisions.

Goal 3

Make the site available to and encourage its use for fire ecology and fuels management research and for fire suppression and prescribed fire training.

Objectives Related to Goal 3

A. Continue and expand the research prescribed burning program conducted by DFW and the University of Massachusetts (UMass) at Amherst.

B. Continue and expand the prescribed fire/fire suppression training activities cooperatively conducted by DFW, Bureau of Forest Fire Control, and UMass; expand the training program to include local municipal fire departments.

C. Seek funding and recruit researchers to initiate original research on fuels management and fire effects on rare species known from the site.

D. Re-sample on a regular basis a portion of the research plots on the Montague Plain originally established by Harvard Forest research staff (Motzkin 2001); establish additional plots on Wills Hill using the same protocol.

Fire Management Practices

Wildfire Control

Wildfires are any fires in wildland fuels not ignited intentionally by site managers (*i.e.*, all fires except prescribed burns). A policy and practice of active suppression of all wildfires on the MPWMA is followed. Expedient control of wildfires is a management strategy for every fire management zone on the site.

Prevention

The objective of the fire prevention program is to reduce the occurrence of human-caused wildfires. This is accomplished through identifying risks, and then applying actions in education, engineering, or enforcement.

Wildfire prevention will focus on public education and site access control. Campfires, *etc.* are prohibited on the site. A public education program including on-site signage, a brochure or fact sheet, and periodic public meetings in surrounding communities will encourage users of the MPWMA to prevent wildland fuel ignitions either on-site or near the MPWMA. Blocking or gating woods roads and jeep trails to control access will help to minimize intentional and unintentional ignitions by visitors. During periods of high fire danger, public access to the site will be restricted for similar reasons. DFW will request either informally or through a formal cooperative agreement that state and local law enforcement agencies, particularly environmental law enforcement officers, make periodic patrols of the site, especially at night, to enforce visitation and fire regulations.

Detection

Wildfires will most likely be detected by area residents, aviators, or visitors to the MPWMA and reported to local fire authorities via the 911 system. During periods of extremely high fire danger, DFW will patrol the MPWMA daily as staffing allows.

The Massachusetts Bureau of Forest Fire Control (BFFC) operates a network of fire observation towers throughout the Commonwealth during the fire season. The closest tower to Montague Plain WMA is on Mount Toby in the University of Massachusetts' Mt. Toby Demonstration Forest in Sunderland - approximately five miles south of the MPWMA. There are also towers in Pelham, Shelburne, and Warwick that might be able to detect suspicious smoke from the MPWMA. During periods of high fire danger, BFFC conducts ground patrols, contracts fixed wing aircraft for fire detection, and works with the Massachusetts Air National Guard for additional aerial patrols for fire detection.

Response

Several municipal fire stations are close to the MPWMA, and would likely be the first to respond to a wildland fire. Lake Pleasant Fire Station (now operated by the Montague Center Fire Department) is located in the village of Lake Pleasant immediately east of the MPWMA. The Montague Center Fire Station is located in Montague Center approximately one mile south of the MPWMA. Turner's Falls Fire Station #2 is located at the intersection of Turnpike Road and Montague Road approximately one mile northwest of the MPWMA.

The Massachusetts BFFC will normally respond to wildfires on the MPWMA. Montague lies in BFFC District 9 with headquarters in Erving approximately 6 miles northeast of the site. Resources from other BFFC districts can also respond to Montague.

Personnel

DFW has no permanent or seasonal staffing at Montague Plains WMA. Management activities are conducted or supervised by regional and state-wide DFW staff. DFWELE environmental law enforcement officers and local police frequently patrol the site (DFWELE's Environmental Police has a barracks/office located within a half mile of the WMA on Turners Falls Road). The area is also monitored by part-time staff and district staff operating out of the Belchertown DFW office.

BFFC District 9 has two permanent staff (the District Warden and one firefighter), and hires a seasonal staff of several firefighters usually from April through September (depending on the annual budget situation). There is also a Forest Warden for the Town of Montague who works with District 9 and the local fire chiefs on wildland fire suppression and the enforcement of open burning laws. Additional personnel can be called in from other districts for large fires.

Apparatus and Equipment

DFW has no wildland fire apparatus available for use at Montague Plain WMA. DFW does have a number of fire-fighting handtools, waterpacks, drip torches, and personal protective equipment (PPE) sufficient to outfit a 6 person crew. The UMASS prescribed fire program also has a cache of hand tools, pumps, hose, and PPE that are used during prescribed burns at the site.

The surrounding local fire departments all have structural engines and water tenders ("tankers"). Some of the local fire departments also have wildland fire engines ("brush trucks"). Table 4 summarizes the apparatus of the local fire departments near the MPWMA.

Table 4: Area Fire Fighting Apparatus

BFFC District 9 (Erving and Charlemont, MA)	Town of Montague Fire Department
water tender (1,000 gal.)	structural engine (500 gal.)
wildland engine (~150 gal.)	wildland engine (150 gal.)
wildland engine (~150 gal.)	water tender (2,000 gal.)
wildland engine (~150 gal.)	water tender (1,000 gal.)
wildland engine (~150 gal.)	
crew bus	

District 9 of BFFC maintains three wildland fire engines and a 1,000 gallon tanker at their Erving headquarters. BFFC also has several utility vehicles and a crew transport bus based at the Erving station. BFFC maintains one wildland fire engine at their Mohawk Trail station in Charlemont. Each apparatus carries appropriate handtools, water handling equipment, and PPE. Additional apparatus and equipment can be called in from other BFFC districts.

Training

Ideally, all personnel who engage in wildfire control or prescribed burning at the site will be trained and currently certified as a National Wildfire Coordinating Group (NWCG) Firefighter Type 2 at a minimum. This certification, known as a "red card," involves a 40-hour training course, an annual 8-hour refresher course, and an annual work capacity test (the "pack test"). Alternatively, fire personnel may substitute appropriate structural fire training in the case of municipal fire department personnel, standard BFFC training for BFFC personnel, or DFW prescribed fire training for DFW personnel working on prescribed burns only. Some fire personnel will have less experience as the site is identified as a training resource.

Water Resources

There are no on-site sources of water suitable for drafting at Montague Plain WMA. Lake Pleasant and Green Pond are large enough to supply water for firefighting needs, but steep banks at the access points make drafting directly into engines or watertenders difficult. Good accessibility to Lake Pleasant for drafting exists at the Turner's Falls Water Works pumping station off of Green Pond Road, but the entrance drive is gated. Hydrants can be found in the village of Lake Pleasant; along Swamp Road, Lake Pleasant Road, Miller's Falls Road, Hillside Drive, and Montague/Turner's Falls Road; at Turner's Falls Fire Station #2, and at Lake Pleasant

Fire Station. There are no access points to the Connecticut River suitable for drafting near MPWMA. Figure 7 shows the major water resources around the MPWMA.

Initial Attack

Because the MPWMA has no wildland firefighting force, initial attack of wildfires will be handled by the local fire departments and the BFFC. Generally, a minimum of two personnel are sent on a first response engine (usually a "brush truck") to a wildfire incident. As sufficient additional personnel arrive at the fire station to staff additional apparatus, they respond to the incident. If all apparatus is already at the scene or if firefighters are closer to the scene than to the fire station, personnel may respond to the incident directly in personally owned vehicles.

All wildfire suppression activities on the WMA will utilize the incident command system (ICS). The ranking fire department officer or BFFC firefighter on scene shall be the Incident Commander (IC) until relieved or reassigned by the local fire chief, Montague Fire Warden, or District 9 Fire Warden. Due to response times, the ranking fire department officer usually will be IC during initial attack.

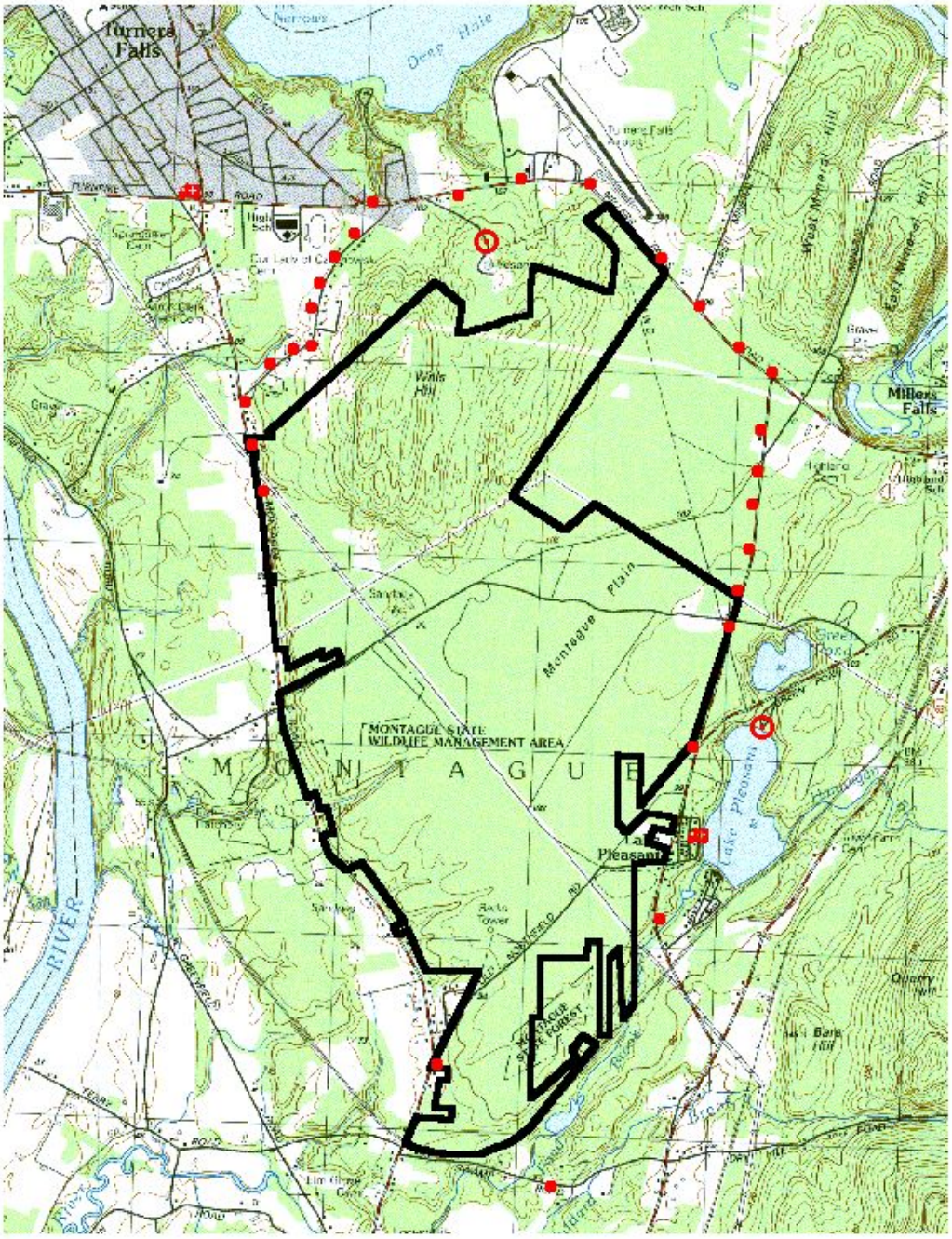
Extended Attack

If extended attack becomes necessary, the ICS will be expanded and the District 9 Fire Warden will assume IC (if not IC already). The IC will direct suppression activity, request and direct additional resources, and manage the logistics of the fire operation, delegating duties as needed or appropriate. One of the local municipal fire stations will be used as an Incident Command Center, if needed, or a mobile command center will be brought to the site. Because of the potential for large, high intensity fires on the Plains, suppression organizations should plan in advance for a response coordinated among several organizations. Under some potential fire scenarios, evacuation of residences down wind of a spreading crown fire should take priority over what might prove to be a futile attempt at direct attack.

Minimum Impact Suppression Tactics

Minimum impact suppression tactics (MIST) will be utilized for all fire management activities on the MPWMA. Generally, soil or humus (duff) disturbance will be avoided during fire control activities except when absolutely necessary. Wildland fires will be controlled predominantly using direct attack with engines, and prescribed fires will be controlled mostly using wetlines, mowed lines, and existing barriers to fire spread (*e.g.*, roads). Brush-cutting/chopping to establish control lines around prescribed burn units is acceptable as long as surface soil disturbance is minimized. Under certain conditions, soil or humus-disturbing tactics may be used. If direct attack with engines has failed to control a fire, and it is imminently threatening life, structures, or other valuable resources, temporary hand-lines or, under extreme conditions, mechanically installed control lines may be used to control a fire. Mop-up should be conducted exclusively with water whenever possible, but hand tools may be used if smoldering in humus or organic soils poses a containment problem or smoke hazard.

Figure 7: Water Resources of Montague Plain Wildlife Management Area



0 1 2 Miles

- hydrants
- drafting sites (gated)
- fire stations
- WMA boundary

N W E S

Wildland-Structural Interface

The term “wildland-structural interface” refers to any area where wildland fuels are found adjacent to developed areas such that there is a clear, linear boundary between an area of wildland fuels and an area of improved land (buildings, agriculture, *etc*.). "Intermix" is a term used to describe areas where structures or other improvements are found embedded in a matrix of wildland fuels. Both interface and intermix situations occur in and adjacent to the MPWMA. "Interface" is used in this discussion as a general term for both situations. Fires occurring in these areas, either a wildland fire igniting a building or a structure fire igniting a wildland fire, are called "interface fires." As more people build houses and other structures in wooded settings, interface fires have increased in number and impact across the United States (Cohen 2000).

Interface fires are of great concern on the MPWMA because the potential for loss of human life and catastrophic property damage is high. The presence of numerous houses and other structures around the perimeter of the MPWMA in close proximity to large stands of pitch pine and scrub oak fuels which could support extreme fire behavior presents significant risk for disastrous interface fires. Substantial efforts should be made to educate the public and community as to this risk, and to ameliorate the risk to the extent practical.

One step that can be taken by the DFW to help attenuate the risk of interface fires is hazard fuel reduction in critical areas. Under the tenets of this FMP, the DFW will engage in a program to reduce hazard fuels near structures and communities as identified in the Fire Management Zones. Both mechanical techniques and prescribed fire will be used. Fuel reduction will not prevent wildland fires, but will reduce fire intensity in target areas making interface areas more defensible.

Cohen (2000) presents an argument, based on his structure-ignitibility research,that responsibility for structural loss in interface situations ultimately lies with the home or business owner and the community. Decades of fire ecology research has shown that exclusion of fires from fire-adapted vegetation is not a realistic expectation, and owners of structures built in interface or intermix situations should assume wildland fires will occur sooner or later. Structure loss in interface fire situations is directly linked to construction materials and landscaping. Owners, under the direction of community and state fire agencies, should take responsibility for assuring adequately low home ignitibility (Cohen 2000). *FireSmart: Protecting Your Community from Wildfire* (Partners in Protection 1999) is an excellent guide to protecting communities from interface fires, and is readily available from Partners in Protection (P.O. Box 45047, Landstowne Postal Station, Edmonton, Alberta, T6H 5Y1). Another resource is FireWise, a coalition of federal and state wildland fire agencies designed to help communities reduce the risk of interface fires (www.firewise.org). A brief summary of the key structure loss reduction strategies is presented in the paragraphs below.

FireSmart recommends communities complete an assessment of structure and site hazards (type of building construction, presence and nature of vegetation close to buildings, *etc.*), area hazards (fuel types and loading, terrain, *etc.*), potential ignition sources (chimneys, overhead powerlines, *etc.*), and suppression readiness (accessibility for suppression apparatus, water sources, *etc.*).

One of the more important steps that can be taken to reduce the risk to structures during interface fires is to assess and ameliorate, if necessary, certain building construction factors. Many buildings that burn during interface fires are ignited by firebrands that land on the roof ahead of the main fire. Roofing material (metal, tile, and asphalt are most fire resistant; untreated wooden shakes or shingles are the most fire-prone) and roof cleanliness (leaf litter and twigs accumulating on the roof and in the gutters increase fire risk) are two of the most important factors to consider. Other factors related to structure design and construction include type of siding, protection of roof and eave vents, presence and composition of balconies and decks, and window size and type. There are some simple and inexpensive steps that can be taken to reduce fire risk on the building itself, such as semi-annual roof and gutter cleaning, screening over roof vents, and covering openings under decks.

Perhaps the most important step that can be taken to reduce interface fire risk is the creation of a "defensible space" - an area free of combustible fuels around any building. “Free of fuels” means without any significant wildland fuels such as cured grass, shrubs, or trees, **and** free of any other flammable materials such as firewood, debris piles, or wooden fences. Generally, the defensible space should be landscaped with turf grass and low flammability shrubs such as deciduous hardwoods. The defensible space should be a minimum of 30 ft wide on flat ground, but should be wider on or near slopes. The defensible space provides two advantages. First, defensible space provides at least a minimal buffer or firebreak from oncoming wildland fires. Second, the defensible space provides space for firefighters to carry-out suppression activities on an oncoming fire while it is still in wildland fuels (*i.e.*, before the building catches on fire).

Burned Area Rehabilitation

Burned area rehabilitation is a procedure to restore and revegetate areas which have been severely damaged by wildfire. There is generally little need for rehabilitation of burned areas on MPWMA. Many of the woody and herbaceous perennial species found on the site re-sprout quickly after a fire. Rainfall is generally abundant throughout the year, so natural revegetation proceeds quickly. Prescribed burns rarely and wildfires only infrequently consume allof the organic duff layer, exposing mineral soil.

Public Education

DFW in cooperation with DEM/BFFC, Montague Fire Departments, and UMass (as available) will initiate a public education program targeted at visitors to the site and area residents. Topics will include wildfire prevention, interface fire risk, and use of prescribed burning as a management tool. Through informational signs, a simple brochure, and presentations to the community, DFW, BFFC, and UMASS educators will increase public awareness and address concerns of the public related to prevention, interface fires, prescribed burning, and other important wildland fire issues.

Wildfire Control Strategies

The overall approach to meeting the wildfire control objectives will be to implement an efficient program of planning, preparation, readiness, and suppression while keeping the protection of

human life and public safety as the first priorities during all activities. Following are wildfire control strategies to be applied to Montague Plain WMA:

(1) Every fire management activity will be conducted with firefighter and public safety as the first and highest priority.

(2) All wildfires on the MPWMA will be met with aggressive and prompt suppression action.

(3) The Incident Command System (ICS) will be used during all aspects of emergency fire management operations, prescribed burning, and fire training exercises.

(4) DFW will control access points to jeep trails and woods roads with barriers or gates.

(5) Campfires, warming fires, and debris burning are prohibited on the MPWMA by regulation.

(6) DFW will help the Town initiate a public education program focusing on wildfire prevention, interface fire risk, and prescribed burning.

(7) DFW will develop cooperative agreements with BFFC and local fire departments regarding wildfire prevention, detection, and suppression, resource sharing, public education, and joint training activities.

(8) DFW will engage in a program to reduce hazard fuels near structures and communities as identified in the Fire Management Zones through the use of mechanical techniques and prescribed fire.

(9) All fire management activities on the MPWMA will use minimum impact suppression tactics except under extreme circumstances where life, property, or other high value resources are threatened.

Prescribed Fire Use

Prescribed burning is the intentional ignition of wildland fuels by qualified land managers under specified weather and fuels conditions within a confined area during a predetermined time frame under the guidance of a carefully formulated plan for the purpose of accomplishing one or more resource management objectives. Prescribed burning will be used as a resource management tool at Montague Plain WMA for four general purposes: hazard fuel reduction, ecological management, scientific research, and training. Concerns with prescribed fire use include escaped fires, adverse smoke impacts, and undesired ecological effects. Burning on the MPWMA will always be in accordance with prescribed fire plans that contain provisions for minimizing the chances of escaped fires, for contingency responses if fires do escape, and for minimizing adverse smoke effects on smoke sensitive areas. Prescriptions will be developed to meet quantifiable ecological objectives, and monitoring will be conducted to ensure that objectives are met. If they are not, management techniques will be adapted to meet those objectives.

Mechanical Fuel Reduction

Mechanical techniques will be used in specified areas of the MPWMA to reduce hazardous fuel loadings, especially near structures and residential areas where dangerous fuels increase the risk of interface fire. Mechanical fuel reduction will be used on forest and shrub fuels, and as with prescribed fire use, will be monitored to ensure that resource management objectives are met. Mechanical techniques may be used independently or in combination with prescribed fire.

The primary objective of fuel reduction in forest fuels is to prevent crown fires from developing by decreasing canopy cover. Surface fires may continue to spread through the treated area, and individual trees may "torch," but fast spreading, high intensity crown fires should stop before they reach structures or other fire-sensitive areas. Closed canopy pitch pine forests with touching or overlapping tree crowns can propagate a crown fire under high wind conditions and low humidities. Generally speaking, canopy closure should be reduced to less than 50% with at least ten feet between tree crowns (Partners in Protection 1999). Timber harvesting will be used to reduce fuel loading in specified areas of the forest (see Fire Management Zones). "High-utilization" harvest which leaves a minimum of slash and unused logs on the site is preferred to maximally reduce fuel loadings. If the timber is marketable, it should be removed. Unmarketable timber and slash may be chipped and left on-site. Thinning will have to be repeated periodically to maintain an open canopy. With the increased sunlight reaching the surface after thinning, the shrub layer and herb layer will likely increase in density. These fuels will have to be periodically treated with mechanical or prescribed fire methods.

No timber harvesting has occurred on the WMA since its creation, but a 50 to 100 acre harvest is tentatively planned to take place early in 2004 on the east side of the property. The goal of the harvest is to reduce fuel loadings near structures by reducing pitch pine stem density to 10 to 20 stems per acre.

The primary objective of fuel reduction in shrub fuels is to reduce fuel bed depths so that wildfires will spread on the surface only, and not in the shrub "canopy." There are a number of machines that have been used successfully in similar fuel types. "Grinders" such as the Fencon BullHog are large machines that can remove small trees as well as brush and shred or chip the material into mulch. Several types of mowers have been used on shrub fuels including tractor-pulled bush-hogs, Davco rotary brush-mowers mounted on rubber-tracked vehicles, walk-behind brush-mowers such as the Gravely or DR, and even power brush-saws or brush-cutter (essentially a weed-eater with a saw blade attached). Davco brush-mowers mounted on ASV rubber-tracked vehicles have been used successfully for several years at Montague Plain WMA to install fire control lines in scrub oak fuels. In 2003, they were also used to conduct fuel reduction cuts on a small scale. Table 5 shows a comparison of the Davco versus brush-saws at the site. Prescribed burning will be used in combination with mechanical means to reduce shrub fuels at the site.

A fuel reduction experiment on Manuel Correllus State Forest on Martha's Vineyard is currently underway in fuels similar to those found on Montague Plain. Additionally, a grant from the Joint Fire Science Program has been received by the University of Massachusetts and Cape Cod National Seashore that will expand this fuel reduction research. The studies will assess the

effectiveness of several mechanical techniques, such as thinning, grazing, and brush-grinding, used in conjunction with prescribed fire to reduce fuel loads and decrease fire intensity. The results of those projects will be applicable to mechanical fuel reduction techniques used on the MPWMA.

Table 5: Cost and Production Comparison of Brush-Saws versus Rotary Mowers in Shrub Fuels

machine type	cost, new line ($/ft)	cost, existing line ($/ft)	production rate (ft/hr)
ASV-mounted Davco brush-mower	0.25	0.16	452[1]
power brush-saw	N/A[2]	.033[3]	358

n.b.: values are for cutting new 15 foot wide fire control lines or re-cutting existing 15 foot wide control lines
1. overall production rate including both new and existing line
2. power brush-saws were not used to install new line (not practical)
3. estimated from production rate and $12/hr for labor

Cooperative Relationships

Cooperative relationships among various land management, academic, and fire control agencies will be essential to successful fire management at Montague Plain WMA. DFW has a limited capacity to conduct fire management at the site and must depend upon cooperation with other agencies to accomplish fire management goals and objectives. DFW will develop cooperative agreements in the form of Memoranda of Understanding or other formal documents with BFFC and local fire departments if necessary. An agreement regarding cooperative management of a DEM state forest inholding in the southern end of the WMA is also desirable (see FMZ 3). The cooperative agreements will clarify suppression responsibilities, resource sharing for wildfire suppression and prescribed burning, compensation for services rendered, and joint training and public education efforts.

Fire Ecology Research

Since 2000, fuel studies and experimental prescribed burning have been conducted at Montague Plain WMA. These studies provide important knowledge about fuel flammability, fire history, fire behavior, and fire effects in the vegetation types found on the MPWMA. Results will be applicable to other sites in the Northeast which have similar vegetation types. These fire ecology research studies should be continued and expanded.

Starting in February of 2003, foliar moisture content in pitch pine has been sampled at regular intervals to better track crown fire hazard in canopy fuels. This study is coupled with an intensive canopy fuels study beginning in the summer of 2003 that will characterize the available canopy fuels in pitch pine by destructively sampling several trees at the Montague Plain WMA. The sample crown fuel data will be compared to western fuel models that predict canopy fuel load by tree diameter to assess accuracy of using existing predictive equations used in available fire behavior models.

Surveys for lepidoptera have occurred and will continue to occur (Mello 2000, MNH&ESP 2002). Rare plants and plants supporting rare insects have been searched for on and near utility lines (Lindwall 2002).

Motzkin *et al.* (1996) characterized the vegetation of the Montague Plain through the sampling and analysis of 121 0.1-acre plots combined with aerial photograph interpretation and ground-truthing. During 2001 and 2002, University of Massachusetts researchers re-located and sampled 61 of those plots on the plain and added several more on Wills Hill. The new sampling design consisted of tree inventory, stand survey, and biomass sampling. The project yielded updated information on fuels and vegetation. A draft report has been prepared and is currently under review (Parrott *et al.* 2003).

Fire Management Zones

Fire Management Zones (FMZ's) define geographic areas of similar fuels and fire behavior, resource values, fire management strategies, or other fire management factors. Montague Plain WMA is divided into five FMZ's (Figure 8). Delineation is based primarily upon geographically contiguous areas of similar fuels and soils along with field-recognizable geographic features (*i.e.*, roads, topography, property boundaries). Each FMZ is discussed in detail below and summarized in Table 5.

Table 6: Fire Management Zones of Montague Plain Wildlife Management Area

FMZ	Fuel Type(s)	Notes	Acres	% of WMA
1	hardwood forest	Wills Hill	394	26
2	scrub oak thicket, mixed pine - hardwood forest with scrub oak-dominated understory	most of the unplowed areas of plain	185	12
3	pitch pine forest, hardwood forest, mixed pine - hardwood forest, small areas of grass and scrub oak thicket, red pine plantation	most of forested areas of plain	780	52
4	pitch pine forest, mixed pine - hardwood forest, small areas of grass	special zone to protect Lake Pleasant	105	7
5	grass, small patches of low shrubs	powerline corridors	49	3

FMZ 1

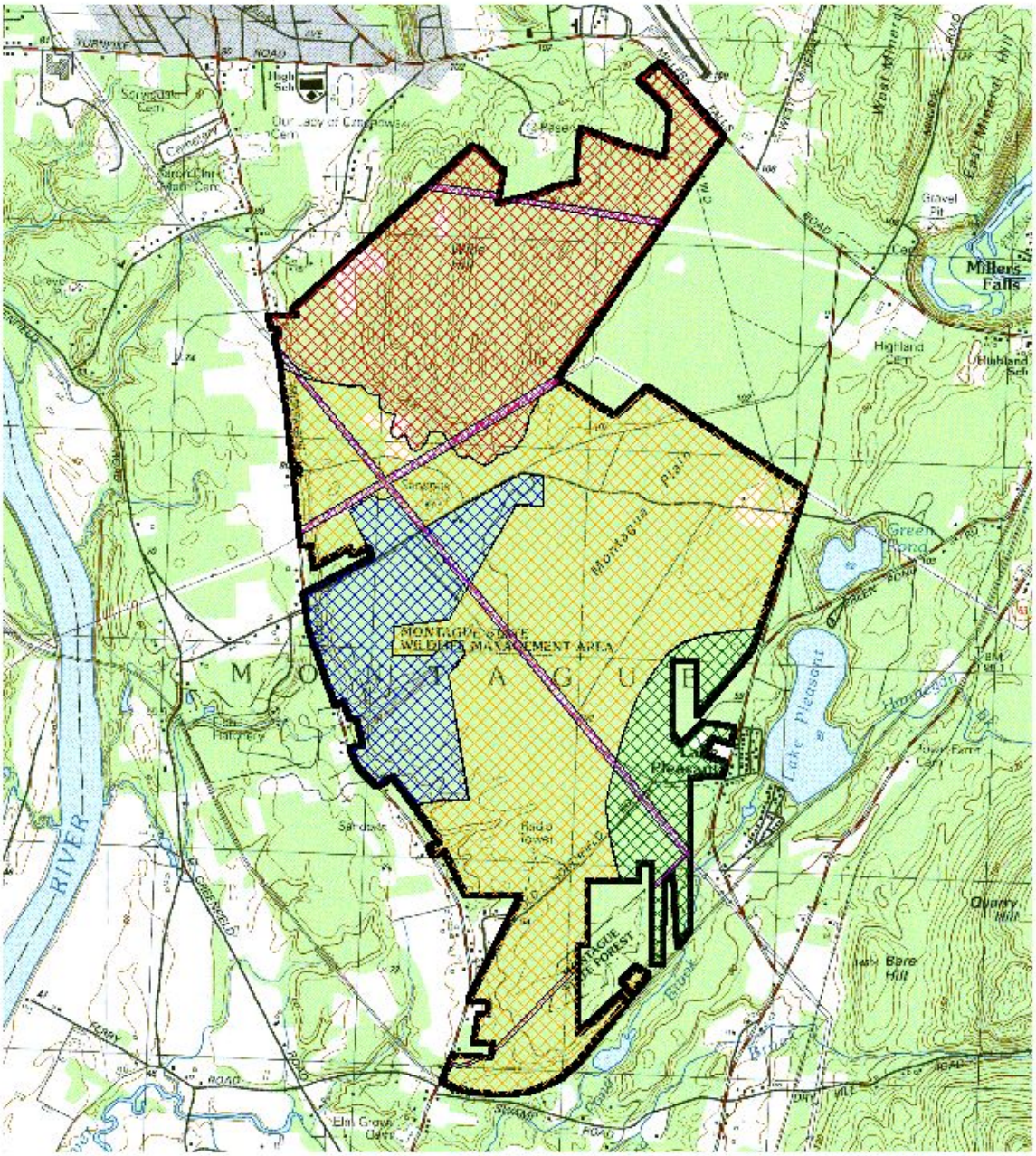
Extent

Fire Management Zone 1 encompasses 394 acres in the northern portion of the MPWMA. This FMZ includes Wills Hill, which is not part of the Montague Sandplain, and is bounded by the northern, northwestern, and northeastern property lines, and the base of Wills Hill to the south.

Description

Soils in this FMZ are sandy loams often very stony and often shallow. Fuels consist almost entirely of the hardwood forest type with oaks dominating. Maple, hickory, birch, white pine, and hemlock are also common. Powerlines cross this FMZ in two places (see FMZ 7).

Figure 8: Fire Management Zones of Montague Plain Wildlife Management Area



Fire Management Zones

- FMZ 1
- FMZ 2
- FMZ 3
- FMZ 4
- FMZ 5
- WMA boundary

0 1 2 Miles

N W E S

Hazards, Constraints, Special Concerns

Fire behavior in the fuels of this FMZ is typically of low to moderate intensity. Burning leaves may cause short-range spotting. There are no other fire behavior hazards associated with these fuels. Other than an isolated wetland with potentially mucky soils that could inhibit foot travel, there are no unusual hazards to firefighters in this FMZ. Eastern box turtles are known to occur in this zone. The power lines support habitat for New Jersey Tea Inchworm, wild lupine, false foxglove (*Aureolaria* sp) and spreading tick trefoil. One outcrop supports spring rock-spikemoss. Increased use of prescribed fire is likely to benefit habitat for several rare species associated with frequently burned oak stands.

This FMZ is closest to the community of Turner's Falls. Although fire behavior would not be expected to seriously threaten structures there, smoke from wildfires (or prescribed burns, if not properly managed) could affect the community. Turner's Falls High School is only one-half mile north of FMZ 1.

Areas of High Ignition Risk

There are numerous residences north and northwest of this FMZ. Although they are at least 1/4 mile from the property boundary, they could be a source of fires which spread onto the WMA. FMZ 1 is also the closest to the Turner's Falls airport. Fires started on the airport property could spread into FMZ 1.

Fire Management Strategies

1. Actively suppress, control, and extinguish all wildfires (*i.e.*, non management-ignited fires) in FMZ 1 to the smallest size reasonably possible.

2. Conduct experimental prescribed burning within FMZ 1 to assess effectiveness in reducing fuel loadings and enhancing habitat.

3. Control access to FMZ 1 by blocking or gating motor-vehicle accessible roads and trails except for the powerlines (see FMZ 7).

4. Establish and periodically sample permanent plots within FMZ 1 under the same protocol used by Harvard Forest research staff in 1993 (see Motzkin 2001 and Motzkin *et al.* 1996).

FMZ 2

Extent

FMZ 2 is comprised of 185 acres in the west-central portion of the MPWMA. It is bounded by the MPWMA property line to the west, mostly by Plains Road to the north, and by FMZ 3 to the east and south.

Description

FMZ 2 is characterized by scrub oak dominance. The northern half is comprised almost entirely of the scrub oak thicket fuel type. The southern half is comprised of strongly oak-dominated hardwood forest fuels with significant understory of scrub oak and ericaceous shrubs. Aerial photographs from 1939 show the southern half was scrub oak thicket at that time (Motzkin 2001). The soils are mostly unplowed sandy loams and loamy sands. Experimental prescribed burning has been conducted in FMZ 2 since 2000. Three small abandoned sandpits are located in the northern part of FMZ 2. One large powerline corridor bisects FMZ 2 (see FMZ 7). A few jeep roads and trails traverse FMZ 2.

Hazards, Constraints, Special Concerns

The scrub oak thicket vegetation in FMZ 2 is the most hazardous fuel type on Montague Plain, with wildfires having the potential to reach intensities and spread rates comparable to chaparral fuels of the southwestern U.S. Dense shrub growth also makes foot travel through the vegetation slow and difficult and restricts vehicular travel to established roads, trails, and firelines. Quick escape to safety zones from within the vegetation would be difficult. Much of the southern half still contains a dense scrub oak - heath shrub undergrowth similar to the scrub oak thicket fuel type. As with the scrub oak thicket, difficult foot travel and high fire intensity can be expected in this vegetation. There is a steep slope (up to 60%) along the western edge of FMZ 2 which could inhibit foot travel by firefighters.

A single residence on Plains Road is adjacent to this FMZ and its dangerous fuels. Several other residences lie along Turner's Falls/Montague Road adjacent to FMZ 2, but are (generally) up wind and at the bottom of a slope, and are therefore at less risk to fire than the Plains Road dwelling. Besides the residences, Turner's Falls Road is the closest and most critical smoke sensitive area.

Most of the rare, threatened, and endangered species and the rare natural community (pitch pine-scrub oak barren) known from Montague Plain occur in FMZ 2 in the scrub oak thicket fuels. These rare species and communities are fire-adapted, and low-to-moderate intensity fires will generally improve the rare species' habitat and restore the rare natural community. The rare lepidoptera species are fire-sensitive. The prescribed fire regime in FMZ 2 will consist of burning small units on a rotating basis and during different seasons so only a portion of the FMZ is burned in any given year. This allows ample unburned areas to exist to provide a source of recolonization of burned areas by lepidoptera species, and a mosaic or patchwork pattern of successional states is created in the FMZ to provide a diversity of habitats.

Areas of High Ignition Risk

FMZ 2 receives much public use and has numerous areas with a high probability of ignition. Several heavily used dirt roads including Plains Road and the powerline access roads run through or adjacent to this FMZ. Motorcycles, ATV's, and off-road automobiles use these roads frequently, and could directly or indirectly start fires. FMZ 2 contains several old sand and gravel pits which are popular party spots. Illicit campfires, bonfires, and other flame-related

activities could ignite fires in wildland fuels. Dwellings along the western edge of this FMZ are also potential ignition sources.

Fire Management Strategies

1. Actively suppress, control, and extinguish all wildfires (*i.e.*, non-management ignited fires) in FMZ 2 to the smallest size reasonably possible.

2. Use mechanical techniques and prescribed fire to reduce fuels within 30 yards of residence property boundaries adjacent to southwestern portion of the FMZ and along Plains Road.

3. Use prescribed fire to restore, expand, and maintain rare species habitat and fire-adapted rare natural communities within the scrub oak thicket vegetation of FMZ 2.

4. Restore open-canopy, scrub oak-dominated conditions in the southern half of FMZ 2 using mechanical techniques, prescribed burning, and combination treatments for improvement of rare species populations and rare natural communities.

5. Continue and expand fire ecology research in FMZ 2.

6. Control access into the FMZ by blocking or gating motor-vehicle accessible roads and trails except for the Plains Road and the powerlines (see FMZ 7).

7. Periodically sample permanent plots within FMZ 3 established by Harvard Forest research staff in 1993 (see Motzkin 2001 and Motzkin *et al.* 1996) to help track long-term vegetation change.

FMZ 3

Extent

FMZ 3, the largest zone, includes 780 acres in the central and southern portions of the MPWMA. This FMZ is bounded by FMZ 1 to the north; the property boundary and FMZ 4 to the east; the property boundary to the south; and the property boundary and FMZ 2 to the west.

Description

FMZ 3 consists primarily of the forested part of Montague Plain. It is comprised mostly of the pitch pine forest, hardwood forest, and mixed pine-hardwood forest fuel types. The majority of the acreage is in pitch pine forest. There is a small island of scrub oak thicket in the southwestern portion of this FMZ and small areas of grassland scattered throughout FMZ 3. The southern end of FMZ contains an inholding, the Montague State Forest managed by the Massachusetts Department of Environmental Management. The state forest consists of an approximately 35 acre red pine (*Pinus resinosa*) plantation. Although not part of MPWMA, the state forest inholding could be included in the fire management efforts, particularly hazard fuels reduction, in cooperation with DEM. Soils are mostly previously plowed sandy loams and loamy sands, but

there are three areas of unplowed sandy soils supporting scrub oak thicket or oak-dominated hardwood forest. FMZ 3 contains a large abandoned sandpit north of Plains Road. Many roads and trails traverse this FMZ, the largest of which are Bartlett Road and Plains Road in the northern portion. FMZ 3 also contains a former radio/weather tower site in its southern end (the tower was removed in the 1970's). Three powerline corridors cross FMZ 3 (see FMZ 5).

Hazards, Constraints, Special Concerns

After the scrub oak thicket, the pitch pine forest fuel type is the most dangerous fuel type of the MPWMA in terms of wildfire, and is one of the most dangerous fuel types in New England. Under high winds and low humidities, crown fires can develop. These crown fires become conflagrations that may spread with such rapidity and burn with such intensity, that there is no way to control them until they run out of pitch pine fuel. Similar fuels exist in Plymouth County, Massachusetts, where in 1957 a firestorm consumed 15,000 acres in less than 24 hours, and stopped only when it reached Cape Cod Bay (Patterson 1998). Crown fires in this fuel type represent a significant risk to lives and property in the communities and structures surrounding the MPWMA. Risk to firefighters attempting to control such a blaze is also great. The pitch pine forest fuel type can exhibit particularly dangerous fire behavior in areas with dense understory shrub layers. Crown fires may develop under high wind conditions if ladder fuels are present. The hardwood forest and mixed hardwood-pine forests would probably not support a crown fire, but the pine plantation may under extreme weather conditions.

There is a steep slope (up to 60%) along the western, southern, and southeastern edges of FMZ 3 which could inhibit foot travel by firefighters. There are a several residences along the western boundary of FMZ 3 on Turner's Falls/Montague Road. Although the western structures are up wind of and at the base of a steep slope below FMZ 3 (reducing the fire danger), they are still at risk of interface fires and sensitive to smoke. There are no known rare species in FMZ 3, but there is potential to restore appropriate habitat.

Areas of High Ignition Risk

The areas of highest ignition probability in FMZ 3 include the numerous roads through the area (including Old Northfield Road, Plains Road, and the powerline access roads) and the residences along the western edge of the FMZ.

Fire Management Strategies

1. Actively suppress, control, and extinguish all wildfires (*i.e.*, non-management ignited fires) in FMZ 3 to the smallest size reasonably possible.

2. Use mechanical techniques to reduce fuels within 30 yards of boundaries to private property containing residences or other structures adjacent to FMZ 3.

3. Recommend to adjacent landowners that they carry out mechanical fuel reduction on their own property to protect their structures.

4. Use mechanical techniques, prescribed burning, and combination treatments within FMZ 3 to restore and maintain open-canopy scrub oak vegetation, expand rare species habitat, improve game species populations, and reduce fuel loadings in priority areas.

5. Control access into the FMZ by blocking or gating motor-vehicle accessible roads and trails except for the Plains Road, Bartlett Road, and the powerlines (see FMZ 7).

6. Periodically sample permanent plots within FMZ 2 established by Harvard Forest research staff in 1993 (see Motzkin 2001 and Motzkin *et al.* 1996) to help track long-term vegetation changes.

7. Develop an agreement with Massachusetts DEM to cooperatively manage Montague State Forest for hazard fuel reduction.

FMZ 4

Extent

FMZ 4 encompasses 105 acres in the southeastern part of MPWMA. FMZ 4 is bounded by the property line to the east and by a 500 meter radius from the Village of Lake Pleasant to the north, west, and south.

Description

FMZ 4 is a special zone designed to protect the Village of Lake Pleasant from wildfires. It is comprised of mostly pitch pine forest in its northern half and mostly mixed pine-hardwood forest in its southern half. There are a few small areas of grassland fuels along the eastern edge of FMZ 4 associated with the structures (both existing and removed) in that area. Soils include previously plowed sandy loams and loamy sands (northern half, supporting pitch pine forest) and unplowed sandy loams and loamy sands (southern half, supporting mixed forest). FMZ 4 is bisected by Old Northfield Road, two powerlines (see FMZ 5), and numerous jeep roads and trails.

Hazards, Constraints, Special Concerns

As described under FMZ 3, the pitch pine forest may support a crown fire under extreme weather conditions which would be impossible to control. The village of Lake Pleasant is immediately adjacent to FMZ 4, and wildfires spreading across the MPWMA could threaten that community. Even if the flaming front of a crown fire were somehow stopped before reaching the village, long-range spotting from pitch pine fuels could ignite structures in the village a quarter mile or more ahead of the front. FMZ 4 is delineated to manage the forest around the village to reduce the risk of interface fire there. The Village of Lake Pleasant is also a smoke sensitive area. There are no known rare species in FMZ 4

Areas of High Ignition Risk

The residences of Lake Pleasant east of the FMZ represent the highest risk of igniting wildland fuels in FMZ 4. Several roads including Lake Pleasant Road and Old Northfield Road run along or through this FMZ, as well.

Fire Management Strategies

1. Actively suppress, control, and extinguish all wildfires (*i.e.*, non-management ignited fires) in FMZ 2 to the smallest size reasonably possible.

2. Use mechanical techniques, specifically thinning/logging in pine stands that may support a crown fire, to reduce fuel loadings in FMZ 4 to protect the community of Lake Pleasant from catastrophic wildfire.

3. Recommend to adjacent landowners that they carry out mechanical fuel reduction on their own property to protect their structures.

4. Control access into the FMZ by blocking or gating motor-vehicle accessible roads and trails except for Old Northfield Road and the powerlines (see FMZ 7).

5. Periodically sample permanent plots within FMZ 2 established by Harvard Forest research staff in 1993 (see Motzkin 2001 and Motzkin *et al.* 1996).

FMZ 5

Extent

FMZ 5 includes all the powerline and other utility corridors which traverse the MPWMA. Five active utility corridors cross the MPWMA. Each is approximately 50 to 100 yards wide (although the easement may allow a wider corridor in some areas). A large southeast-northwest electrical line and pipeline corridor runs approximately 2 miles across property roughly bisecting it into northeast and southwest halves. A large east-west electrical line runs approximately 1.5 miles across the property roughly bisecting the MPWMA into a northern third and southern two-thirds. A third electrical line runs about 0.75 miles east-west across the northern end of the property. A north-south water supply pipeline runs for a total of 0.5 miles across two places near the eastern edge of the preserve. A small electrical line runs southwest-northeast 0.5 miles across the southern end of the MPWMA. The total area covered by these corridors is about 49 acres.

Description

The utility corridors occur mostly on disturbed soils and contain mostly native, warm-season grassland fuels with patches of low shrubs (chiefly *Vaccinium* spp.). All the corridors have one or more access roads running along or through them. Most of the powerlines are supported by wooden poles, but the large northwest-southeast powerline has metal towers.

Hazards, Constraints, Special Concerns

If the vegetation is dormant and dry, fires in the grass fuel type ignite easily, spread very quickly, and produce moderate to high intensity surface fires. Many firefighter fatalities have involved "flashy" grass fuels. No structures are adjacent to this FMZ, so interface fire risk is low. A number of smoke sensitive areas fall within a critical distance and could be adversely affected if smoke from prescribed burns is not properly managed. Grass fuels tend to burn out quickly, however, so smoke production is short-lived compared to the other fuel types found on the site.

The powerlines include local distribution lines and large transmission lines carrying electricity from generating stations to communities. An interruption of service at any of these powerlines could result in the blackout of a large area. Wildfires (or improperly managed prescribed burns) could ignite wooden powerline towers resulting not only in power interruption, but also in an electrical hazard on the site. It is possible that smoke, especially dense smoke with high water vapor and particulate content, may become charged and conduct electrical current ("carbon arcing") (NWCG 1989). This phenomenon could cause a power interruption and represents a significant risk to personnel on the site during a fire. Water streams (and aerial water drops) should not be directed towards powerlines, and extra caution should be taken when operating heavy equipment under powerlines. Both the potential hazard of burning poles and carbon arcing can be reduced through the use of prescribed burns. Regular prescribed burning will lower fuel loadings and reduce the risk of wooden tower burning and carbon arcing during wildfires. Prescribed burning generally produces much less smoke than wildfires so carbon arcing is less likely and igniting wooden poles would be much less likely during a prescribed burn than during wildfires. Additionally, the fuel reduced corridors act as fire breaks and safety zones for other fire management activities and are extremely important to fire management activities.

Areas of High Ignition Risk

Almost all of the powerline access roads are currently accessible to the public. Off-road automobiles, motorcycles, and ATV's frequently use these roads for access and recreation. The vehicles themselves or careless (or malicious) actions of their operators pose a high probability of ignition. Although the fine fuels of the powerline corridors are easily ignited and spread fire quickly, much of the corridors near FMZ 2 (the FMZ with the highest risk fuel type) are burned regularly under controlled conditions to reduce the fire hazard.

Fire Management Strategies

1. Actively suppress, control, and extinguish all wildfires (*i.e.*, non-management ignited fires) in FMZ 7 to the smallest size reasonably possible.

2. Use prescribed burning in priority areas to reduce fuel loadings in utility corridors.

3. Control access from utility corridors to other parts of the MPWMA by blocking or gating motor-vehicle accessible roads and trails branching off of the corridors.

FMP Amendments, Review, and Revision

This fire management plan is designed to be in effect for five years, and will be formally reviewed at the end of the five-year period. Periodic in-house reviews should determine if resource management objectives have been met. A formal review after five years will consist of an examination and discussion of the plan by the DFW, BFFC, local fire departments, Umass (if available), the Massachusetts Fire Council (if established) and other stakeholders. Recommended changes will be submitted to the DFW for inclusion into a revised FMP. The plan will be submitted to the DFW director for approval as will all revisions.

Fire management experiences, changing conditions, or evolution of policy may warrant changes to the plan before the formal review period. Amendments may be made to this plan at any time, but are subject to the formal approval of the DFW director.

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APPENDIX A: ACRONYMS

Acronyms used in this document are defined parenthetically at the point of first use and again in the list below.

BFFC	Bureau of Forest Fire Control
DEM	Department of Environmental Management
DFWELE	Department of Fisheries, Wildlife, and Environmental Law Enforcement
DFW	Division of Fisheries and Wildlife
FMP	Fire Management Plan
IC	Incident Commander
ICS	Incident Command System
MPWMA	Montague Plain Wildlife Management Area
NFFL	Northern Forest Fire Laboratory
NU	Northeast Utilities
NWCG	National Wildfire Coordinating Group
ORV	Off Road Vehicle
PPE	Personal Protective Equipment
UMass	University of Massachusetts
WMA	Wildlife Management Area

APPENDIX B: SCIENTIFIC NAMES

Generally, common names of species are used in the text of this document with scientific names provided parenthetically at the point of first use and in the list below.

aspen	*Populus* spp.
barrens buckmoth	*Hemileuca maia*
black cherry	*Prunus serotina*
black oak	*Quercus velutina*
blueberry	*Vaccinium* spp.
bracken	*Pteridium aquilinum*
clubmoss	*Lycopodium* spp.
chestnut	*Castanea dentata*
chokeberry	*Aronia* spp.
common juniper	*Juniperus communis*
cow-wheat	*Melampyrum lineare*
dogbane	*Apocynum androsaemifolium*
dwarf chestnut oak	*Quercus prinoides*
false foxglove	*Aureolaria* sp.
Gerhard's underwing moth	*Catocala herodias gerhardi*
goldenrod	*Solidago* spp.
gray birch	*Betula populifolia*
hemlock	*Tsuga canadensis*
hickory	*Carya* spp.
huckleberry	*Gaylussacia baccata*
indian pipe	*Monotropa uniflora*
little bluestem	*Schizachyrium scoparium*
meadow sweet	*Spiraea alba*
moss	*Polytrichum* spp.
mountain laurel	*Kalmia angustifolia*
northern red oak	*Quercus rubra*
oak	*Quercus* spp.
Pennsylvania sedge	*Carex pensylvanica*
perforated Saint John's wort	*Hypericum perforatum*
pin cherry	*Prunus pensylvanica*
pink lady's slipper	*Cypripedium acaule*
pitch pine	*Pinus rigida*
possum haw	*Viburnum nudum*
red maple	*Acer rubrum*
red pine	*Pinus resinosa*
reindeer lichen	*Cladonia* spp.
scarlet oak	*Quercus coccinia*
scrub oak	*Quercus ilicifolia*
shadbush	*Amelanchier* spp.
spiked wild oat grass	*Danthonia spicata*

sweet fern	*Comptonia peregrina*
white oak	*Quercus alba*
white pine	*Pinus strobus*
whorled loosestrife	*Lysimachia quadrifolia*
wintergreen	*Gaultheria procumbens*