MASSACHUSETTS FOREST RESERVES
LONG TERM ECOLOGICAL MONITORING PROGRAM

CUNNINGHAM POND FOREST RESERVE

A report on the baseline characteristics of the Cunningham Pond Forest Reserve and the proposed Intensive Monitoring Areas of the Cunningham Pond Forest Reserve and the Ware River Watershed Protection Forest

Prepared for the
Massachusetts Executive Office of Energy and Environmental Affairs

June 2009

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Cover: Cunningham Pond (photo by Avril de la Cretaz).

PREFACE

The Cunningham Pond area within Ware River Watershed Protection Forest is the site of one of eight large Forest Reserves in the Commonwealth of Massachusetts (Fig. 1). The Forest Reserves were established by the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) to create areas where forest development is the product primarily of natural succession and natural disturbance. The Forest Reserve management goal is to increase the area of late seral forest and to protect and conserve species that depend on this habitat, while allowing the effects of natural disturbances to create variation in successional trends in some areas. Only passive management is used in the Forest Reserves, mainly focusing on restoring native habitat by removing invasive species. Sustainable forest management, including timber harvesting, will be implemented on state lands outside the Forest Reserve system (EOEEA 2009).

The Cunningham Pond Forest Reserve is one of three Forest Reserves in the state with a matched non-Reserve state forest area that will continue to be actively managed. Within each Forest Reserve and matching non-Reserve area, an area of 800 – 1,000 acres has been proposed for intensive monitoring. These Intensive Montoring Areas (IMAs) will provide data for a statistical comparison of forest condition in Forest Reserve and non-Reserve state forests. Forest land located within the Ware River Watershed Protection Forest, but outside the designated Forest Reserve area, has been selected as a non-Reserve match for the Cunningham Pond Forest Reserve. The Ware River Watershed Protection Forest is under the supervision of the Massachusetts Department of Conservation and Recreation (DCR) - Division of Water Supply Protection (DWSP). Prior to 2003, the watershed forest property was managed by the Massachusetts Metropolitan District Commission (MDC). The Cunningham Pond Forest Reserve is also part of the Hubbardston Wildlife Management Area established through a cooperative agreement between the MDC and the Department of Fish and Game in 1956. The specifics of this agreement are currently being renegotiated.

Section 1 of this report begins with a description of the Cunningham Pond Forest Reserve. Topics include physical features, disturbance history, land use history, and forest communities. Following this, baseline data on tree density, size distribution, and species composition from Continuous Forest Inventory (CFI) data (DWSP 1999) are summarized and discussed. Several sections of this report, especially those on land use history and forest management, have been summarized from the Ware River Watershed Land Management Plan, 2003-2012 (DWSP 2003).

Section 2 presents a comparison of topography, bedrock, soils, and forest condition in the proposed Intensive Monitoring Areas in the Cunningham Pond Forest Reserve and Ware River Watershed Protection Forest. Analyses of baseline CFI data for these two areas are also included.

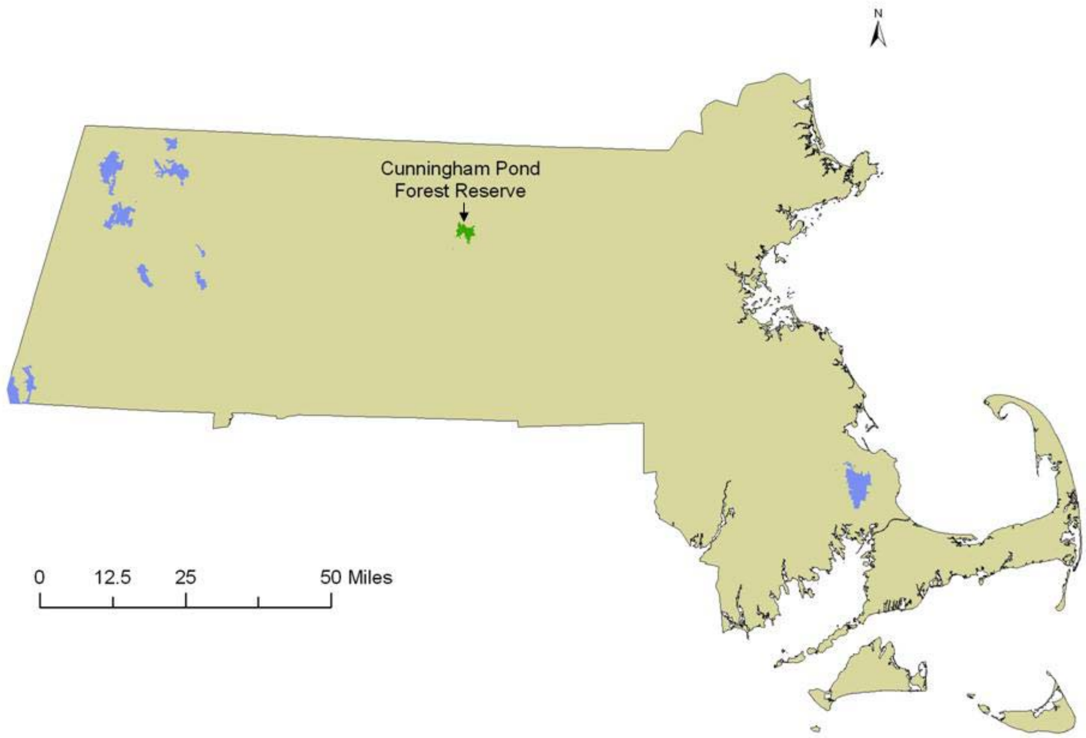

Fig. 1. Cunningham Pond Forest Reserve (green). The other large Forest Reserves are shown in blue (DWSP 2006, DCR 2008). All GIS analyses were completed in ArcGIS 9.3 (ESRI 2008).

SECTION 1

INTRODUCTION

The Cunningham Pond Forest Reserve is located in the Central Uplands of Massachusetts on the Worcester Plateau. The Forest Reserve is part of the Ware River Watershed Protection Forest, owned and managed by the Massachusetts Department of Conservation and Recreation-Division of Water Supply Protection (DWSP) (Fig. 2). The DWSP owns 23,694 acres and conservation restrictions on an additional 787 acres, slightly more than a third of the total watershed area, in the towns of Hubbardston, Princeton, Barre, Rutland, and Oakham. The area designated as Forest Reserve covers almost 3,000 acres in the town of Hubbardston (Fig. 3). (Areas related to the Forest Reserve are based on GIS analysis). The Ware River watershed is a component of the active water supply system for the Boston Metropolitan Area and lies mid-way between the Quabbin Reservoir and the Wachusett Reservoir. Water from the Ware River Watershed is normally directed westward to the Quabbin Reservoir via aqueducts, but may also be sent to Wachusett Reservoir to the east (DWSP 2003).

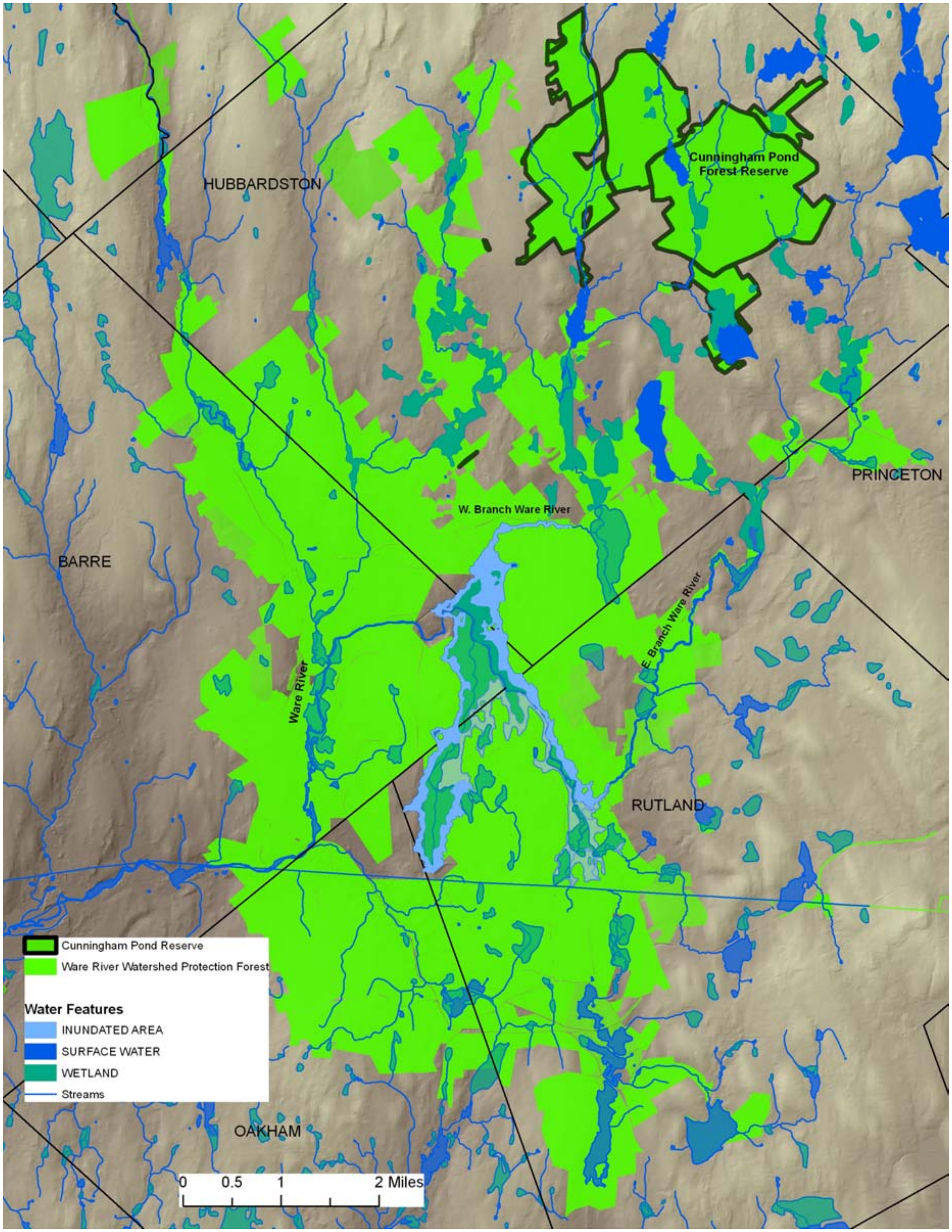

Fig. 2. Ware River Watershed Protection Forest with the Cunningham Pond Forest Reserve (MassGIS 2000, 2009(a), 2009(b)).

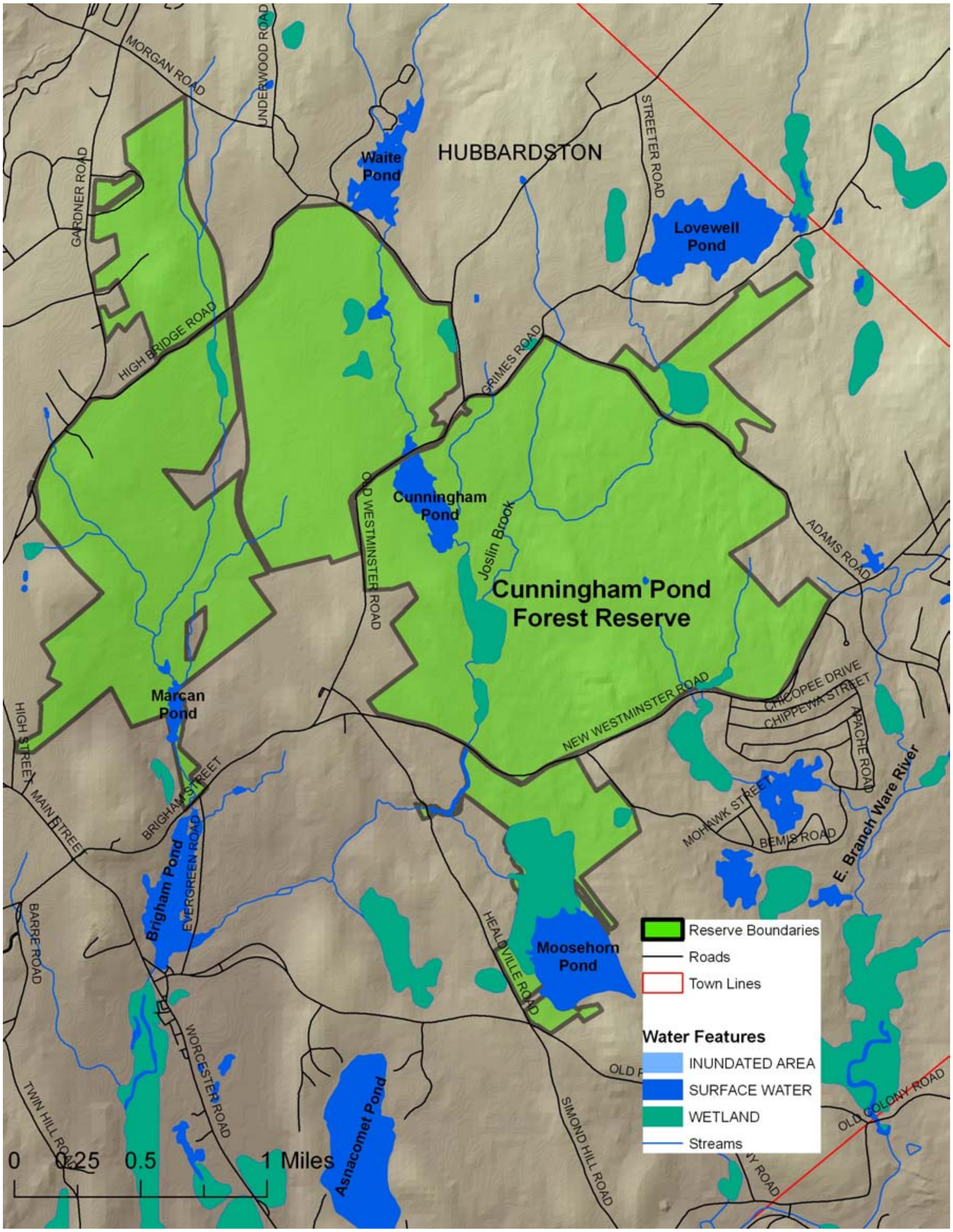

Fig. 3. Cunningham Pond Forest Reserve, Hubbardston, MA (Reserve Boundary DWSP 2006, MassGIS 2000).

PHYSICAL FEATURES

Topography

The Ware River Watershed lies in a region of rolling hills separated by broad river valleys. Elevations within the Cunningham Pond Forest Reserve range from 865 feet to 1,120 feet. Slopes rarely exceed 25% (Fig. 3, Fig. 4). This is a region of generally low relief without dramatic variations in slope and aspect.

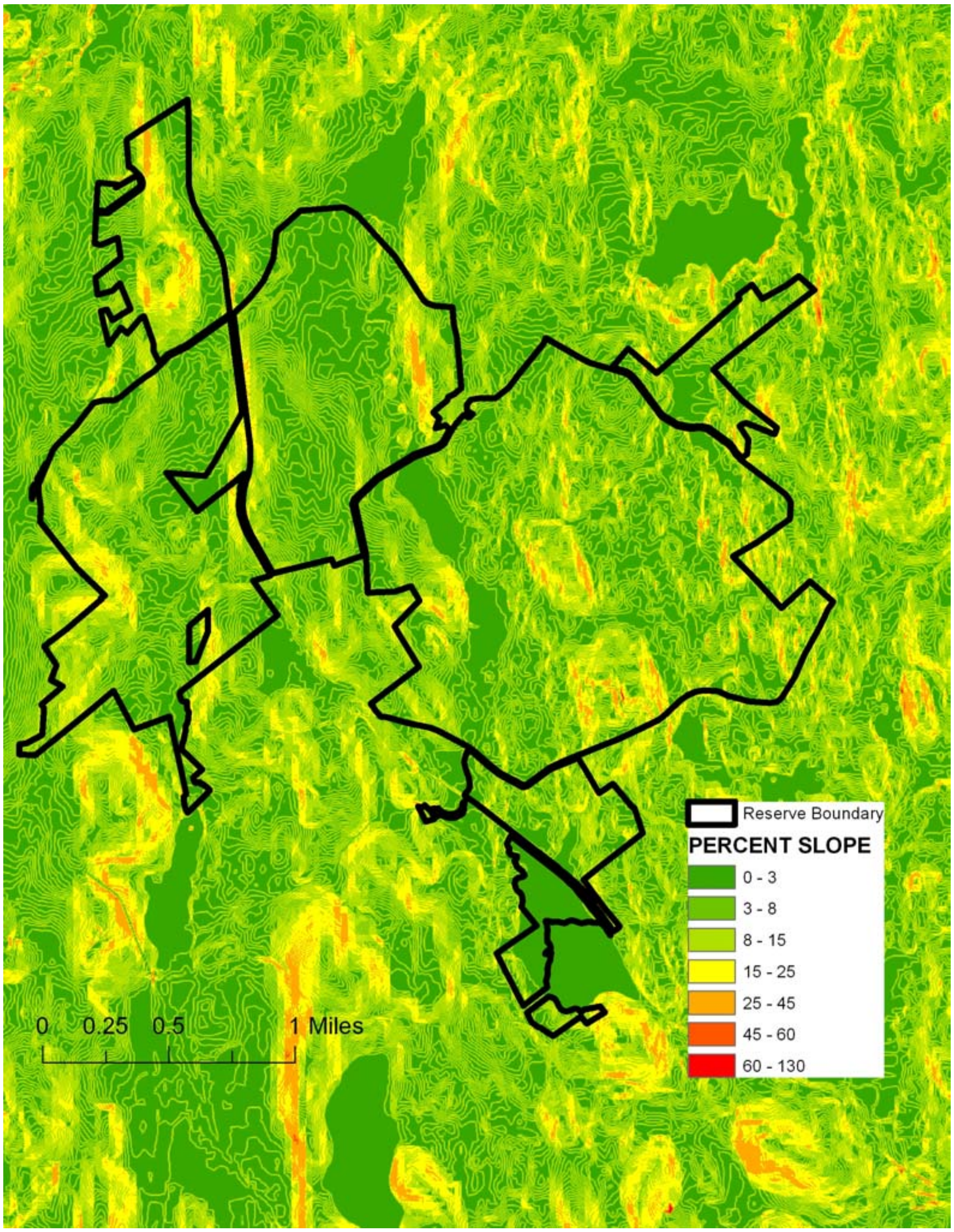

Fig. 4. Percent Slopes, Cunningham Pond Forest Reserve.

Bedrock Geology

Bedrock in the Ware River Watershed consists of the eroded remnants of mountains formed when the supercontinent Gondwana collided with the North American continent of Laurentia, between 425 and 370 million years. Rocks at the edge of Gondwana came from geologic formations that now underlie South America and West Africa. The collision, known as the Acadian orogeny formed mountains as high as the Swiss Alps. Bedrock in the area today consists of the eroded remnants of these mountains. When the continents moved apart, parts of these Amazonian and West African rock formations remained, melded on to the North American Continent, creating the complexly folded rock structures that now form the base of central and eastern Massachusetts. There are two major bedrock formations in the Cunningham Pond Reserve area. The Paxton Formation dates from the Silurian Age (443 – 417 million years ago). There are two rock types within the Paxton Formation. The first, mapped in dark gray in Fig. 5, consists of gray granulite splitting into thin layers. The second, mapped in dark yellow consists of sulfidic schists with basal quartzites. The Littleton Formation was formed during the Devonian Period (417 -360 million years ago) and consists of gray graphitic schist. Both the Paxton and Littleton Formations are heavily intruded by pegmatite, a coarse grained granite. There is also a small area of biotite granitic gneiss (Fig. 6, Table 1) (Zen et al. 1983, Skehan 2001, DWSP 2003).

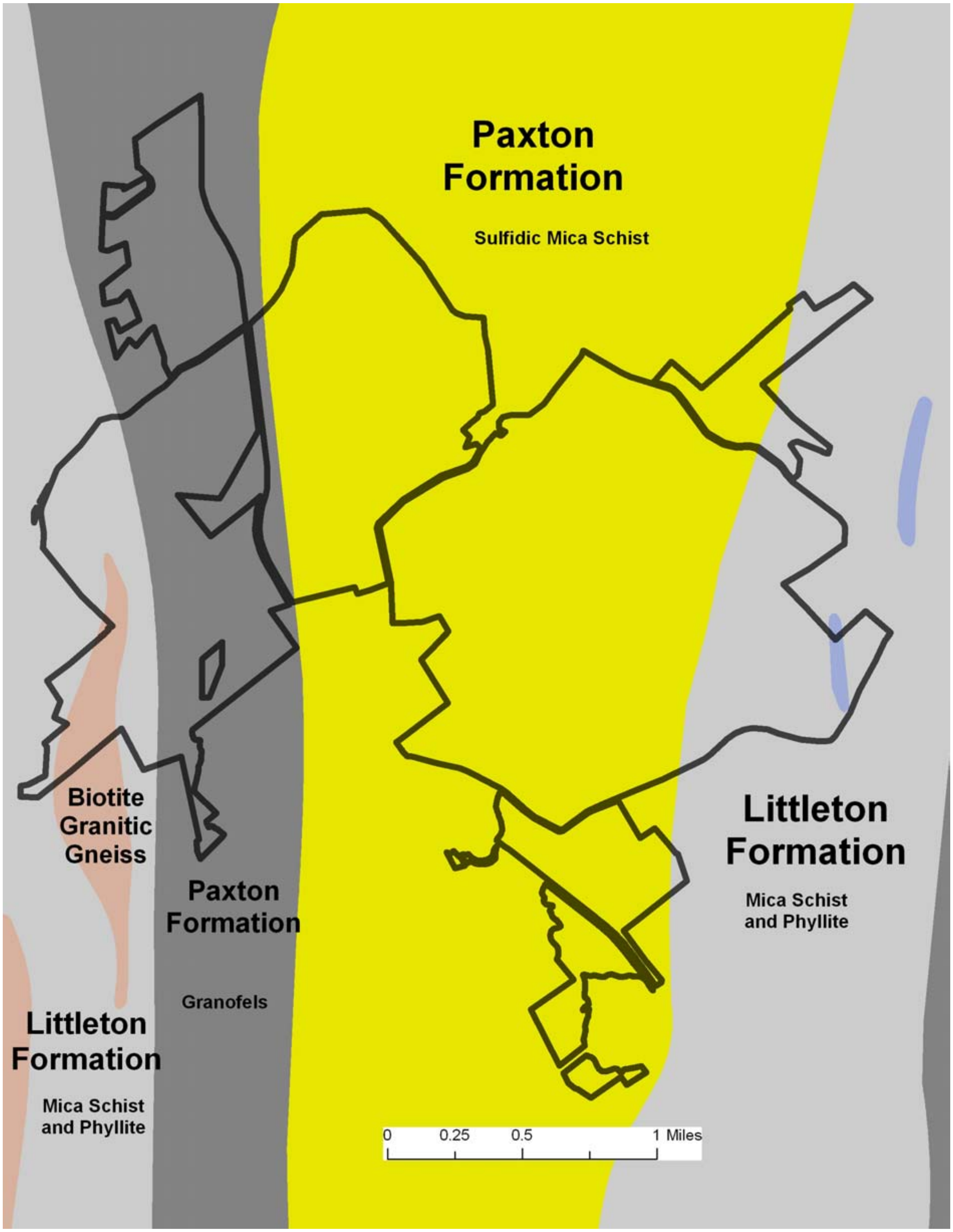

Fig. 5. Bedrock Formations and primary rock types in the Cunningham Pond Forest Reserve area. Forest Reserve boundaries are shown in black. Small blue polygons represent minor deposits of silicified fault breccia, a conglomerate rock (Zen et al. 1983).

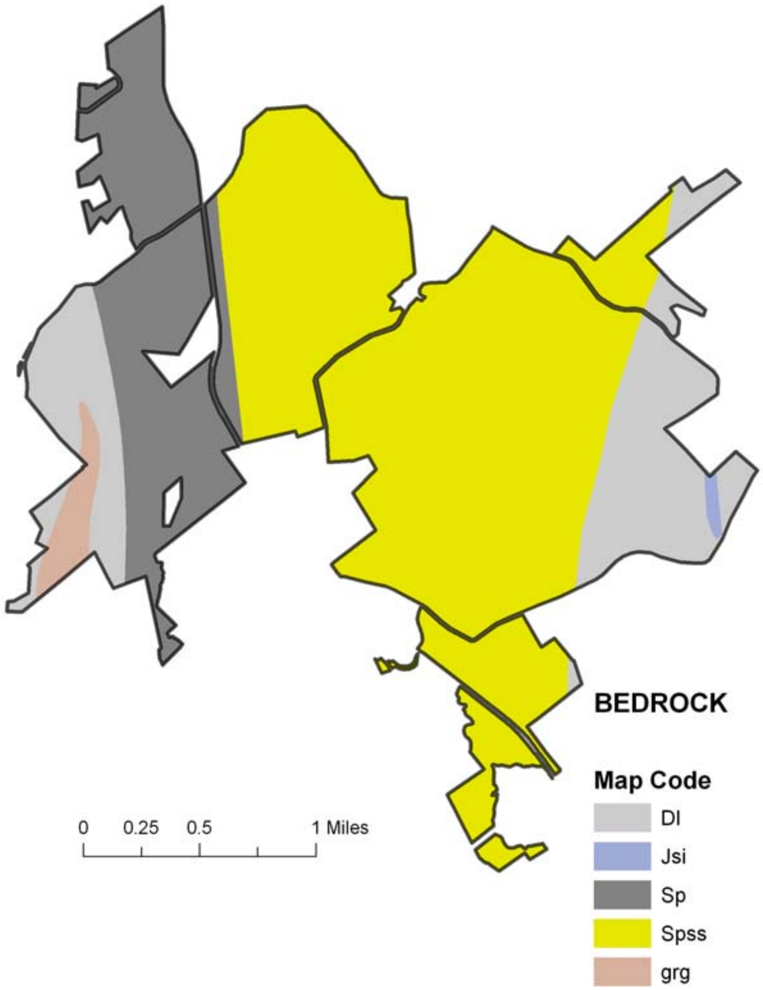

Fig. 6. Cunningham Pond Forest Reserve bedrock (Zen et al., 1983).

Table 1. Bedrock Description, Cunningham Pond Forest Reserve (Zen et al. 1983).

Map Code	Description	Area (%)	Formation	Rock Type
Dl	Aluminous mica schist, quartzose schist, and aluminous phyllite	18	Littleton Formation	Metamorphic
Jsi	Silicified fault Breccia or strongly silicified metamorphic rocks	<1	Silicified fault Breccia intrusion	Tectonic
Sp	Undifferentiated biotite granofels, calc-silicate granofels, and sulfidic schist	20	Paxton Formation	Metamorphic
Spss	Sulfidic mica schist	60	Paxton Formation	Metamorphic
grg	Biotite granitic gneiss, small lenses	2	Biotite granitic gneiss	Igneous

Surficial Geology and Soils

There have been repeated episodes of glaciation in New England during the past million years. Mountains of ice, thousands of feet high have advanced, scraping the bedrock bare, and retreated, leaving massive amounts of debris, known as glacial drift, behind. The last glacial maximum occurred about 18,000 years ago. The recession of the glaciers, which continued until about 12,000 years ago, exposed a landscape covered with thick deposits of glacial drift consisting primarily of till and outwash. Glacial till, created by the grinding movement of the glaciers over bedrock consists of unsorted material, particles of many different sizes, including larger rocks and boulders. Till was left in upland areas and forms the parent material for well drained and moderately well drained till soils. Water from the melting glaciers created Glacial Lake Nashua, located approximately at the current site of the Wachusett Reservoir to the east in the towns of Boylston, West Boylston, and Clinton. Fast moving meltwaters carried particles of sand and clay that were deposited in low-lying areas. The current slowed as it entered the lake, leaving the larger sand particles on the shores and carrying the smaller clay particles into the still, deep water, where they drifted to the lake bottom. When the glacial lakes drained, these deposits were left behind. Within the Ware River watershed, there are large areas of outwash soils, till in drumlins, and other tills of varying degrees of drainage, all of varying depth. Outwash deposits consist of sorted sand and gravel, and provide the parent material for sandy, excessively drained soils, that can limit forest species diversity and productivity. In some areas outwash material slows drainage, creating wetlands (DWSP 2003). Outwash deposits are found at several locations within the Forest Reserve (Fig. 7). Moist upland till soils tend to form more productive sites.

There are 34 different soil series and 16 soil series associations in the Cunningham Pond Forest Reserve area. These soil series consist of outwash soils, till soils, and organic soils. We have grouped the soil series and series associations by drainage class: excessively drained (outwash), well drained thin, well drained thick, moderately well drained (mostly till, some outwash) and poorly to very poorly drained (till, outwash, and organic soils) (Fig. 8, Table 2). A complete list of the soil series and series associations, soil characteristics, and corresponding drainage classes can be found in Appendix B.

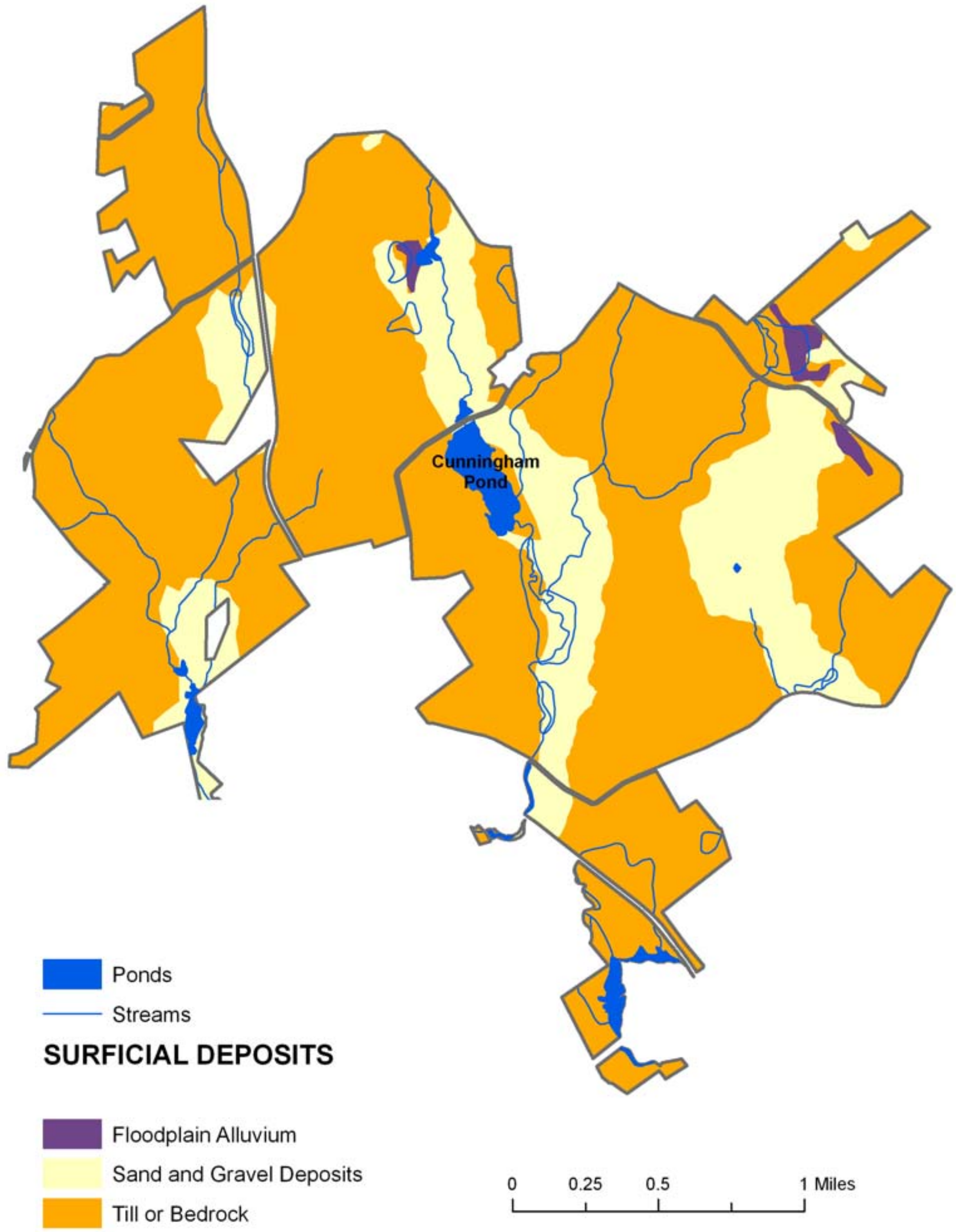

Fig. 7. Surficial geology of the Cunningham Pond Forest Reserve (MassGIS 1999).

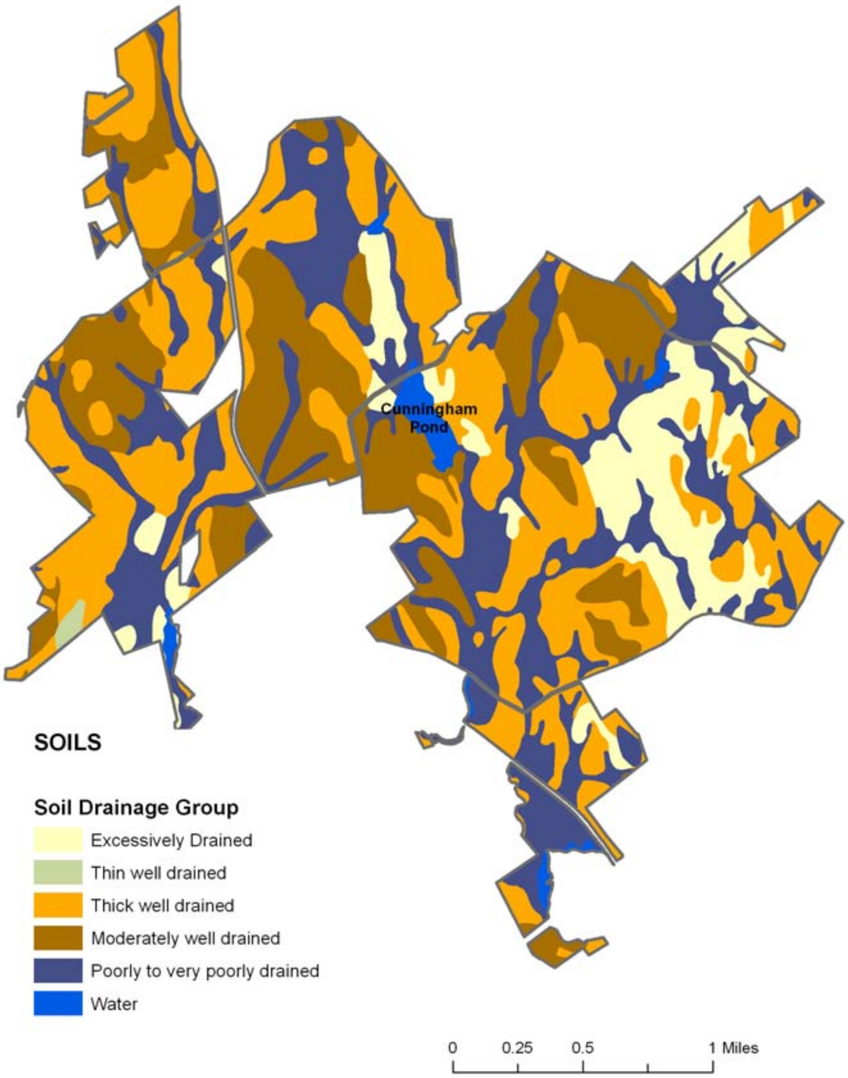

Fig. 8. Soil drainage groups, Cunningham Pond Forest Reserve (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 2007).

Table. 2. Soil Drainage Groups – Area, Cunningham Pond Forest Reserve (NCSS 1997-2008).

Soil Drainage Group	Area (%)
Excessively drained	11
Thin well drained	<1
Thick well drained	37
Moderately well drained	22
Poorly to very poorly drained	28
Water	2

Climate

Winters in the Worcester County area are cold and summers are moderately warm with occasional hot spells. Precipitation is well distributed throughout the year. The nearest weather station is located at the Worcester Municipal Airport, 16 miles south of the Cummington Pond Reserve (elevations 984 ft.).

Table 3. Mean Temperatures and Precipitation totals, Worcester, MA (World Climate 1996).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temp. (°F)[1]	22.8	24.8	33.6	44.2	55.4	64.0	69.6	68.0	60.1	50.0	39.4	27.5	46.6
Precip. (inches)[2]	3.6	3.3	4.1	4.0	4.1	3.7	3.8	4.3	4.1	4.3	4.6	4.1	48.0

[1]Temperature Worcester Municipal Airport, Worcester County data derived from National Climatic Data Center NCDC TD 9641 Clim 81 1961-1990 Normals – Temperature Data, 30 years between 1961 and 1990
[2]Precipitation: Worcester Municipal Airport, Worcester County data derived from NCDC Cooperative Stations. 44 complete years between 1948 and 1995.

The 2003 Ware River Watershed Land Management Plan (DWSP 2003) gives an average annual precipitation of 43.25 inches based on data recorded since 1931.

Disturbance History

Hurricanes are the most common and the most potentially disruptive, large, natural disturbances that affect forest structure in central Massachusetts. Smaller windstorms and thunderstorms can create small canopy gaps. Winter ice storms are a potential hazard. Fire, often related to human activity, has influenced forest composition in the past. At the present time, wildfires do not pose a serious threat to Central New England forests, except during periods of extreme drought. “In recent decades, fires have impacted only very small areas of DWSP watersheds. These fires ranged from light burns where only the understory was impacted to intense burns that killed mature trees, but all of these recent fires were rapidly controlled either naturally or through human intervention…” (DWSP 2003). Controlled burns are now conducted annually on DWSP property in the watershed to “maintain open non-forested habitat conditions, and may in the future be used to establish regeneration or control invasive species in forest stands” (DWSP 2003).

Insects and disease are occasionally capable of large-scale infestation and damage. Early in the 20th century, chestnut blight (*Cryphonectria parasitica*), a fungal pathogen eliminated American chestnut from the forest overstory. Between 1980 and 1982, Gypsy moths (*Lymantria dispar*) defoliated the entire Cunningham Pond Forest Reserve area, part of a state-wide outbreak (MassGIS 1997). Larch sawfly (*Pristiphora erichsonil*) and cherry scallop shell moth (*Hydria prunivorata*) have caused periodic damage of larch and black cherry trees at other locations within the Ware River Watershed Protection Forest (MassGIS 1997).

Pest and Pathogen Information

Gypsy moth caterpillars prefer hardwoods, especially oaks, basswood, gray and white birch, and poplar. Older larvae feed on several species of hardwoods plus hemlock, pines and spruces. They tend to avoid ash, butternut, balsam fir and mountain laurel, but will feed on almost anything during a population outbreak. Outbreak populations return to low levels that do not visibly affect the forest canopy after 2 to 3 years. Wasps, flies, ground beetles, and ants; many species of spiders, birds, and many small woodland mammals (mice, shrews, chipmunks, squirrels, and raccoons) all prey on gypsy moth larvae when population density is low, but this predation does not prevent outbreaks (McManus et al. 1989, Elkinton et al. 2004). Population outbreaks are eventually controlled by density-dependent mortality. A virus (*Nucleopolyhedrovirus*) usually causes outbreak population collapse. Recently an entomopathogenic fungus species (*Entomophaga maimaiga*) has prevented population outbreaks. The fungus has spread rapidly since it was first observed in 1989, partially the result of intentional introduction into gypsy moth infested areas as a biological control (Hajek et al. 1996, Liebhold 2003).

The larch sawfly was first recorded in North America in 1880 and now occurs in all of the northern states plus Maryland, North Carolina, and West Virginia. The young larvae feed on tufts of needles. Feeding is completed in about three weeks; mature larvae drop to the ground, enter the litter layer, and spin papery, brown cocoons. Heavily defoliated trees commonly refoliate after a few weeks. Repeated defoliation can result in trees with thinned foliage, branch mortality, and a significant growth loss. Larch growing on poor sites that have been defoliated for consecutive years may die. Normally, harsh winter weather with below normal snowfall and parasitism of the overwintering stage are the most important natural control for larch sawflies. Insectivorous birds also consume sawfly larvae during the summer (USDA Forest Service 2001).

Larvae of the cherry scallop shell moth feed on the leaves of black cherry trees. If severe defoliation occurs along with other stresses, crown dieback and tree mortality may result. Cherry crown dieback occurs following two or more years of heavy defoliation. Natural enemies often control populations after two or more years of heavy defoliation; however, this may be too late to prevent significant growth loss and (or) tree mortality (Division of Natural Resources, Ohio Department of Natural Resources 2006).

Hemlock woolly adelgid (*Adelges tsugae*), an aphid-like insect from Japan that feeds on hemlock needles, has caused considerable mortality to eastern hemlock trees from North Carolina to Connecticut (Orwig et al. 2002). The presence of hemlock woolly adelgid has been noted at both the Quabbin and Wachusett Reservoirs, to the west and east respectively of the Ware River Watershed Protection Forest. The 2003 Ware River Watershed Management Plan recommends “a long-term study to track the extent of the invasion and infestation and monitor the impacts....”

LAND USE HISTORY

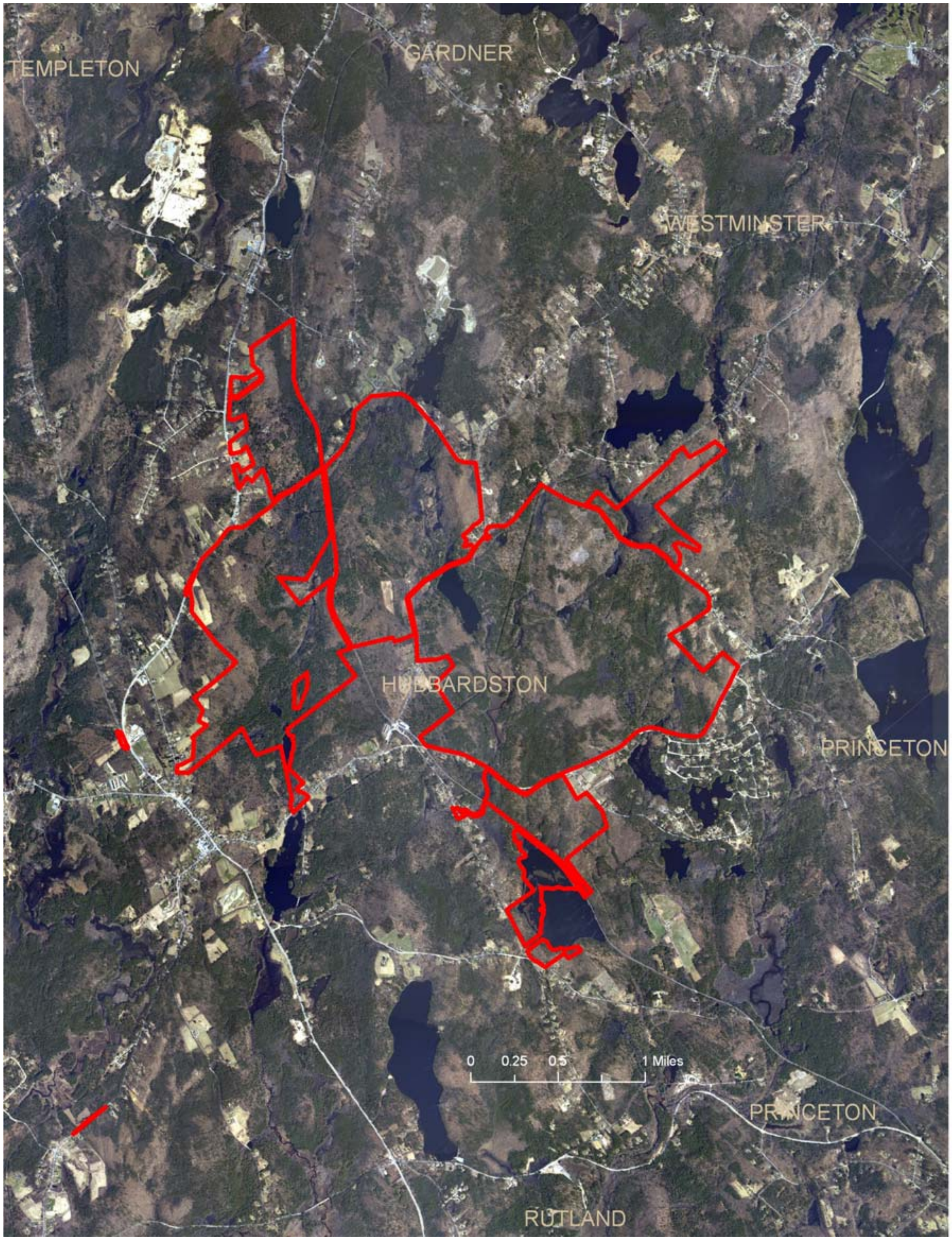

Fig. 9. Orthophotos of Hubbardston, and parts of Princeton, Rutland, Westminster, Gardner, and Templeton (MassGIS 2005).

(This section is taken from the Ware River Watershed Management Plan 2003-2012, DWSP 2003).

In 1686, an area called “Naquag” was purchased from the Native Americans for twenty-three pounds sterling by Lancaster residents Henry Willard, Joseph Foster, Benjamin Willard and Cyprian Stevens. This area consisted of 93,160 acres and contained the present towns of Rutland, Oakham, Barre, Hubbardston, and parts of Princeton and Paxton. The entire DWSP holdings are part of this original purchase. In 1713, the proprietors petitioned the General Court for confirmation of their deed. It was granted the following year with the stipulation that within seven years, sixty families be settled on the property. Lots were surveyed in Rutland, and within two years permanent homes were built. Over the next three decades, the towns of Oakham, Barre, and Hubbardston were settled. All four communities were situated on hilltops surrounding the Upper Ware River Valley. The natural meadows along Longmeadow Brook in Pine Plains (south of Hubbardston) and along the Ware River were held as common land for grazing, while land closer to the settlements was being cleared. The abundance of high quality timber in close proximity to streams with the capacity to generate power drew the settlers to the forest. According to historic records, the Pine Plains area contained vast quantities of high quality white pine and pitch pine favored in building. Sawmills and gristmills were built along several streams, and primitive roads were constructed to move materials to and from the Valley. Only the largest and best quality trees were removed. These products were for local use and served only the few settlers that rimmed the Valley.

In the late 18th century, settlement of the Valley accelerated. The forest was cleared on the bottom lands. The completion of the Massachusetts highway connecting Northampton and Worcester simplified the transport of goods. The agricultural operations grew in number and size, and the forest area was reduced. During the first half of the 19th century, an estimated seventy percent of the Central Massachusetts land was in agricultural use. The remaining forests were used for lumber and for fuelwood. The best quality trees were removed for building and the small trees for fuelwood. During this period, practically all the land was altered in some way by human land use.

In 1815 and 1821, minor hurricanes swept through the area, leveling portions of the remaining forested lands. Hemlock was a major component of these mixed stands because the pine and hardwood had been removed. Following the disturbance events, hemlock seedlings and hardwood sprouts were released maintaining the previous forest type.

A decline in agriculture began about 1840. The completion of the Erie Canal and the expansion of the railroads into the rich farmlands of the Midwest increased agricultural production from those markets and reduced the commercial viability of New England farms. At the same time, industrial development in cities and towns throughout the region provided new forms of employment. These factors led to the abandonment of farmland throughout New England.

The Upper Ware River Valley was part of this trend. Many farms were abandoned, while other farming operations ceased when the owners found work in the growing industrial communities nearby. The availability of water power made the valley attractive to industry. The completion of the Central Massachusetts Railroad and Ware River Branch of the Penn Central Railroad in the 1870s facilitated the supply of raw materials and the distribution of products over a large area. In 1872, William Stearns purchased a mill in West Rutland to manufacture bed comforters and cotton batting. By 1900, the mill employed one hundred people. New Boston in North Rutland was the site of the Moulton Brothers shoddy mill (shoddy was a lower-quality material woven from reclaimed wool). A gristmill and a sawmill were situated in Coldbrook, on the western side of the watershed. These industrial communities were still in operation in the late 1920s when the Commonwealth purchased the area for drinking water supply protection.

Farm fields, abandoned during this period of industrialization, quickly reverted to forest. The sod and grasslands of open fields furnished an ideal seed bed for white pine. Large numbers of white pine seedlings were rapidly established. Hardwoods including oak, chestnut, red maple, and grey birch, also germinated, but few of these trees were able to grow to maturity in the dense white pine stands. This second-growth white pine was vastly inferior in quality to the original old-growth white pine. In the late 19th and early 20th century, industries based on the use of inferior quality pine grew up all over Worcester County. These industries manufactured wooden boxes, pails, matches, heels and other woodenware, consuming millions of board feet.

Many old-field stands within the Ware River watershed were removed during this period. The stand density made clear-cutting the most practical means of harvesting. All trees of sufficient size with some value as lumber were removed. These operations released the understory hardwoods. Early successional, light-seeded, shade-intolerant species such as gray birch and poplar dominated the landscape at first. These were later overtaken by larger, slower-growing, more shade tolerant hardwoods. American chestnut, red, and scarlet oak predominated on moist sites, forming high-quality stands. On dry sites, black oak, white oak, and some red oak formed the major component of slow-growing, low-quality stands. As a result of the heavy slash left from logging, fire destroyed many young hardwood stands. Where the fires were not particularly hot, the hardwoods resprouted and continued to develop. White pine seedlings and low-quality hardwoods were reestablished. These stands have developed slowly and only the pine component has economic value.

In 1903, the introduction of the chestnut blight led to the elimination of American chestnut trees from forests in central Massachusetts and the rest of New England. Oaks became the dominant tree species in Ware River watershed forests. Recent changes in forest cover in the Ware River watershed as a whole and within the Cunningham Pond Forest Reserve in particular have been the result of increased beaver activity. During the 1990s and continuing into the present decade, beavers have converted many areas of coniferous and deciduous wooded wetlands to shrub and open wetlands (DWSP 2003).

The Cunningham Pond Forest Reserve is currently located in an area of low-density mixed-land use (Fig. 9). The population of Hubbardston was 3,909 in the 2000 Census. This represented an increase of 100% from 1980 when the population was 1,891. Gardner is the largest town in the area with a population of 20,770. Populations of the remaining four towns range between 3,353 (Princeton) and 6,907 (Westminster). Populations in all of these towns increased in the 20-year period from 1980 and 2000: Princeton 27%; Rutland 40%, Templeton 14%;and Westminster 30% (MassGIS 2009(b), U.S. Census 2000).

Forest Management History

The Ware River Watershed Management Plan (2003 -2012) describes the forest that presently covers most of the DWSP holdings as a product of

1) natural succession following agricultural abandonment,
2) heavy cutting (mostly white pine) 60-100 years ago, and
3) MDC forest management activities over the past 30 years.

The majority of the present state owned property on the Ware River Watershed, including the Cunningham Pond Forest Reserve was purchased between 1927 and 1940 for drinking water supply protection. At the time of the purchase land use/land cover in the area was a combination of active agricultural land, abandoned fields, and forest land. The removal of most structures from the purchased land was completed by 1932. Softwoods, primarily red pine, were planted on open agricultural land between 1931 and 1945. Other planted species included white pine, Scotch pine, Norway and white spruce, and European larch. Most of these plantations have since been converted to open land or regenerated to natural stands.

The first timber harvesting conducted on the watershed lands following state acquisition consisted of salvage operations following the hurricane of 1938. During the 1940s, a program was instituted in cooperation with the U.S. Department of Agriculture to eradicate white pine blister rust by removing all currant and gooseberry bushes (*Ribes spp.*) on the watershed. As a result, blister rust is now only a very minor problem on the watershed. Silvicultural operations began in the late 1950s. Low thinnings were conducted in a number of red pine plantations to improve growth and quality.

Bruce Spencer, the first MDC Chief Forester was hired in 1965 to work at both the Quabbin Reservoir Forest and Ware River. He began the removal of low quality, second growth, white pine stands at Ware River. Ware River foresters, Jim Joslyn (1969 – 1972) and Chuck Walker (1972 – 1977) continued this program. Stephen Drawbridge, was hired in 1978 and began a program to improve thousands of acres of low quality pasture pine across the Ware River watershed. These were either regenerated to mixed oak/pine and oak/hardwood stands via overstory removal cuts, or left as pine stands but improved by cutting the least vigorous or most poorly formed trees.

The first formal forest management plan for the Ware River was written by Stephen Drawbridge in 1983 and covered the period from 1980 to 2000. This plan emphasized the role of timber harvesting in maintaining sufficient water yield from the watershed. Between 1983 and 2000, about 2,300 acres on watershed land received some type of partial cut. Within the Cunningham Pond Reserve, cutting plans were filed for 588 acres on 20 parcels between 1985 and 2003 (Table 4). White pine, red oak, white oak, and red maple were harvested in the Reserve. The second plan (2003 – 2012) calls for "the creation and maintenance of a watershed protection forest, defined by the Society of American Foresters as "an area, wholly or partly covered with woody growth, managed primarily to regulate streamflow, maintain water quality, minimize erosion, stabilize drifting sand or exert other beneficial influences" (DWSP 2003).

Table 4: Timber Harvests 1984 – 2003,
Cunningham Pond Forest Reserve (McDonald et al. 2006).

Year	**Acres Reported**
2001	19
2001	23
1998	18
1997	42
1996	15
1995	23
1994	25
1994	25
1993	103
1993	33
1993	40
1992	60
1991	25
1990	6
1990	32
1988	29
1988	13
1987	36
1985	6
1985	15
Total	588

Management goals for the watershed protection forest outside the Cunningham Pond Forest Reserve include the following:

- Provide a vigorous forest cover, diverse in species composition and tree sizes and ages, and therefore able to resist and recover from disturbance and to retain available nutrients.

- Maintain the ability of the forest to regenerate following disturbance.

- Prevent erosion of sediments and nutrients from the watershed forest through carefully applied Conservation Management Practices.
- Provide long-term water quality protection with minimal intervention by developing a vigorous, low-maintenance forest.

- Comply with or exceed all environmental regulations governing forest management activities and water resources protection on DWSP watershed properties.

- Apply forest management practices that maintain current water yields from the watershed.

- Without compromising primary goals for water quality protection, promote the secondary goals of improving the growth and quality of the forest resource, protecting and enhancing habitat for native wildlife species and maintaining and enhancing biological diversity.

Because the DWSP's primary forest management objective is water quality protection, silivicultural treatments are designed to create and maintain vigorous forest cover that both resists and recovers from a wide range of disturbances. Improving the structure and composition of stands will reduce their susceptibility to disease, insects, and disturbance, creating a low-maintenance, persistent forest cover. In the present management period (2003 – 2012) treatments are planned to:

- Increase the structural diversity of the forest.

- Establish regeneration as necessary, and release advance regeneration.

- Regenerate approximately 1% of the managed forest annually.

- Replace softwood plantations with diverse mixes of native species.

Forest management operations will follow three strategies: strategy one will eliminate silvicultural operations in sensitive portions of the forest; strategy two will employ appropriate silvicultural treatments in areas where silviculture is limited by regulation, including riparian filters and roadside buffer areas; in strategy three, all described types of silviculture will be employed to address a range of management and habitat goals, in which water quality protection is paramount (DWSP 2003).

As mentioned in the Preface, much of the Cunningham Pond Forest Reserve has also been designated as a Wildlife Management Area since the mid-1950s. Since the 1980s wildlife management activities have consisted primarily of pheasant stocking (Herm Eck, personal communication, Nov. 2008).

FOREST TYPE

Digital forest type maps (DCR Quabbin Forestry 1999) are available for all DCR properties within the Ware River Watershed. DCR Quabbin Forestry delineated the 36 forest types on mylar film overlayed on 1:5,000, leaves off black and white orthophoto imagery (MassGIS 1993 http://www.mass.gov/mgis/oqdesc.htm). The individual mylar sheets were scanned by Mass. DNR Resource Mapping Unit in 1999 and complied by DCR Quabbin.

Oaks and white pine dominate the overstory of the Cunningham Pond Forest Reserve. White pine mixed with oak, hemlock, and hardwoods covers over half of the forest (56%). Oak and mixed oak-hardwood stands cover another 19 percent of the forest area. An additional 14% of the Forest Reserve area is occupied by forested wetlands, open wetlands, and open water.

Forests in the Cunningham Pond Forest Reserve are categorized both by site type (Fig. 10) and dominant forest overstory species (Fig. 11, Table 5). Dry site forests are located on excessively drained soils that developed on sand and gravel outwash deposits (Fig. 7 and Fig. 8). Most of the soils in Reserve dry sites belong to the Colton and Allagash soil series. Colton soils have a Cation Exchange Capacity (CEC) of 12 meq/100g, typical of sandy outwash soils. Loamy soils that develop on glacial till typically have a CEC of 16 to 20 meq/100g (Cornell University 2007, Dairy One 2007). CEC is an indication of the capacity of the soil to retain mineral nutrients; lower CEC implies lower nutrient concentrations. Trees growing on dry soils with low nutrient concentrations have generally lower growth rates and reduced vigor compared to trees growing on mesic sites. There are two dry site forest types on the Cunningham Pond Reserve. The white pine/ oak forest consists of white pine with red oak, scarlet oak, and black oak. Scarlet, black, and white oak predominate in mixed oak, dry site forests, with red and chestnut oak, white pine, and red maple in fewer numbers (Fig. 12). White pine is better suited to dry sites than oak. Dry site oak forests are more vulnerable to Gypsy Moth infestations than mesic site oak forests. Mesic sites in the Forest Reserve contain oak and white pine with a more diverse mix of hardwood species and hemlock. High quality white pine and hemlock are concentrated in valleys along streams and rivers (Fig. 13, Fig. 14) (DWSP 2003).

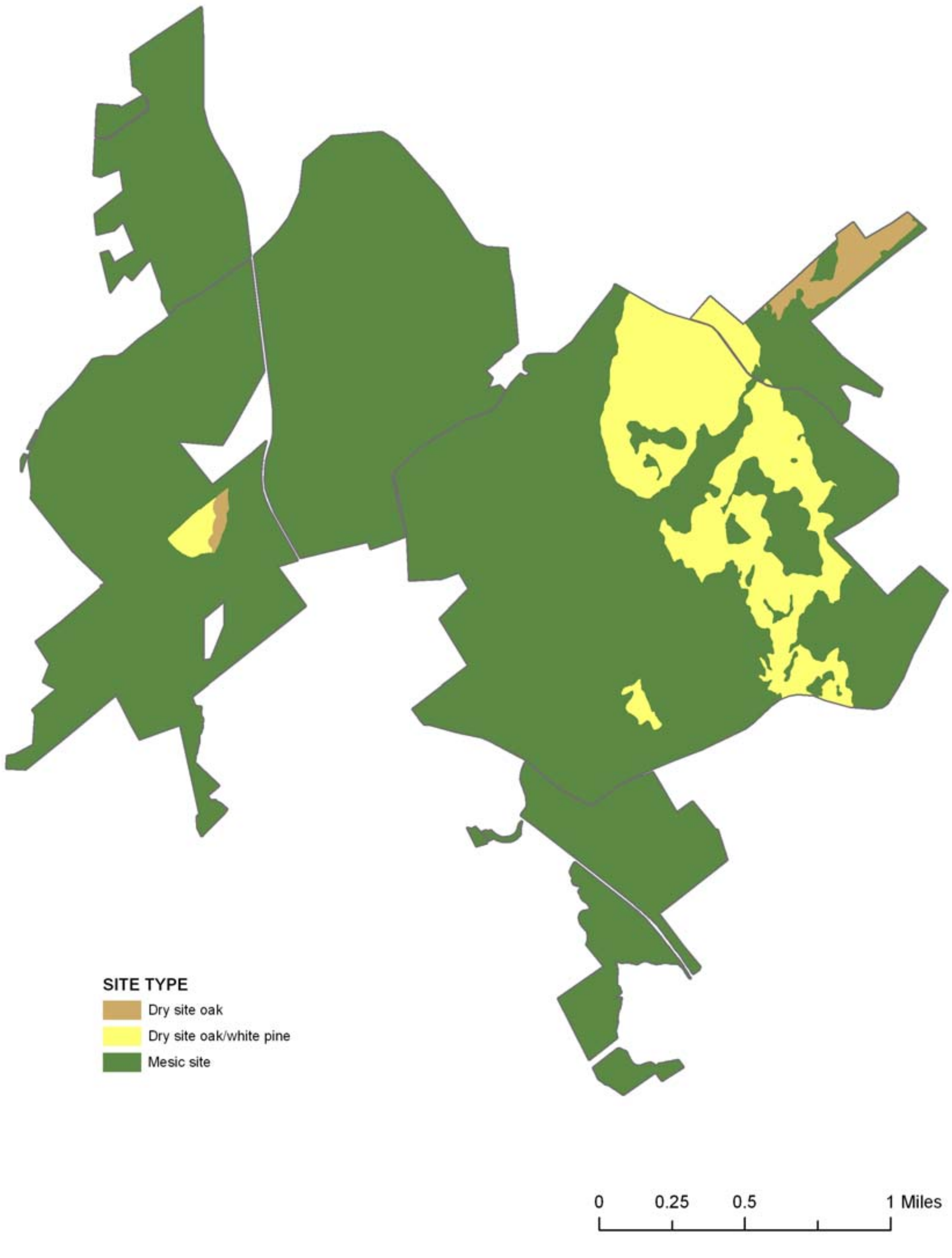

Fig. 10. Forest site types in the Cunningham Pond Forest Reserve (DCR Quabbin Forestry 1999).

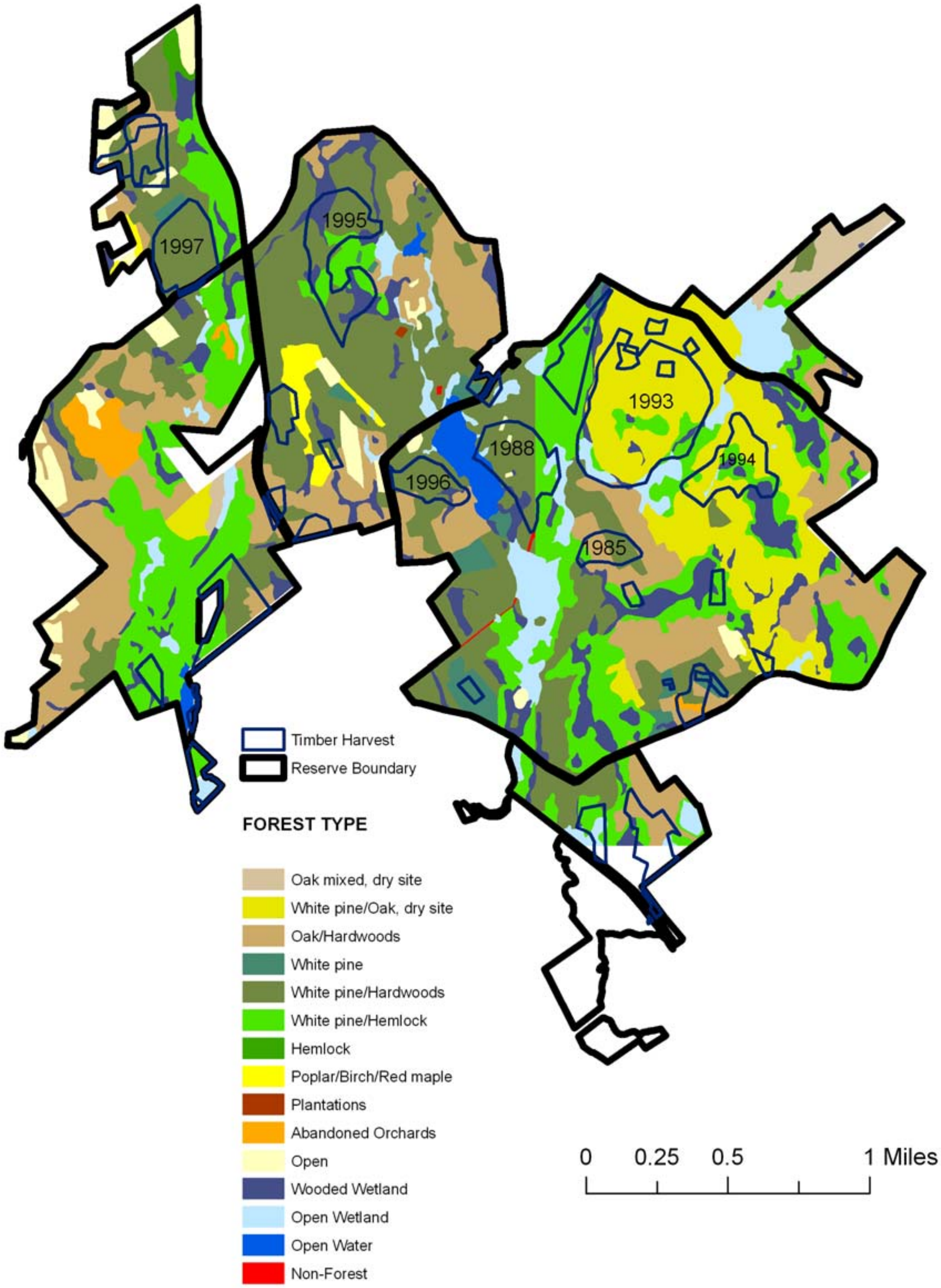

Fig. 11. Forest type map, Cunningham Pond Reserve, indicating predominant overstory species and timber harvests 1984-2003 (DCR Quabbin Forestry 1999, McDonald et al. 2006). Timber harvest dates are shown for selected larger parcels.

Table 5. Forest Types, Cunningham Pond Forest Reserve (DCR-Quabbin Forestry 1999).

Forest Type	**Area (%)**
Oak mixed, dry site	1
White pine-Oak, dry site	11
Oak-Hardwoods	19
White pine	2
White pine-Hardwoods	26
White pine-Hemlock	19
Hemlock	0
Poplar, Birch, Red maple	1
Plantation[1]	<1
Abandoned Orchard	1
Open	3
Forested Wetland	9
Open Wetland	6
Open Water	1
Non-Forest	<1

[1]Plantations consist of red and white spruce, Norway spruce, and red pine.

Fig.12. Dry site white pine forest (photo by Lena Fletcher).

Fig. 13. White pine growing near the shore of Cunningham Pond on a mesic site, well drained till soil (photo by Lena Fletcher).

Fig. 14. Red oak growing on well drained till soil near Cunningham Pond (photo by Lena Fletcher).

A comprehensive list of plant species found on the Ware River Watershed, developed by Karen Searcy of the UMass Herbarium can be found in Appendix C.

CONTINUOUS FOREST INVENTORY (CFI DATA).

CFI plots were installed throughout the Ware River watershed DWSP property in 1962. These are permanent 0.20-acre plots laid out on a 0.5-mile square grid (Fig.15). Plots were re-measured in 1979, 1989, and 1999. New plots have been added as new land is acquired and plots that have been converted to treeless wetlands have been and will be eliminated (DWSP 2003). There are currently 6 active CFI plots (129,134, 136, 137, 138, and 139) within the Cunningham Pond Forest Reserve. Data for these plots include species, status, dbh (diameter at breast height), total height and for all trees ≥ 5.6 inches dbh and merchantable height for sawlogs. Plot age, disturbance history, deadwood, and understory data (available for the other seven Forest Reserves) were not collected in past datasets for the Ware River Watershed Protection Forest. Future sampling is planned at 10-year intervals. Except where otherwise noted, all analyses are based on the 1999 CFI dataset (DWSP 1999) The CFI data was analyzed using SAS 9.1.3 statistical software (2004).

Fig.15. CFI plot locations, Cunningham Pond Forest Reserve. Plot #s 127, 128, 133, and 135 are shown on the map of CFI points, but do not exist in the data record.

Live Trees

Size distribution in the Cunningham Pond Forest Reserve follows a typical inverse-J curve with larger numbers of trees in the smaller size classes (Fig. 16). The number of trees declines progressively as dbh increases. Mean stand density based on data from 6 plots for the Cunningham Pond Forest Reserve for trees ≥ 5.6 in. dbh is 201.7 ± 175.3 stems/acre (95% confidence interval). Mean stand density for large trees (greater than 20 in. dbh) is 2.5 ± 5.7 stems/acre. The large confidence intervals can be attributed to the small number of plots and wide range of stem densities (17 - 65 stems per plot). Only 3 of the 6 plots had any trees greater than 20 in. dbh and there was only one tree of this size on each of these plots.

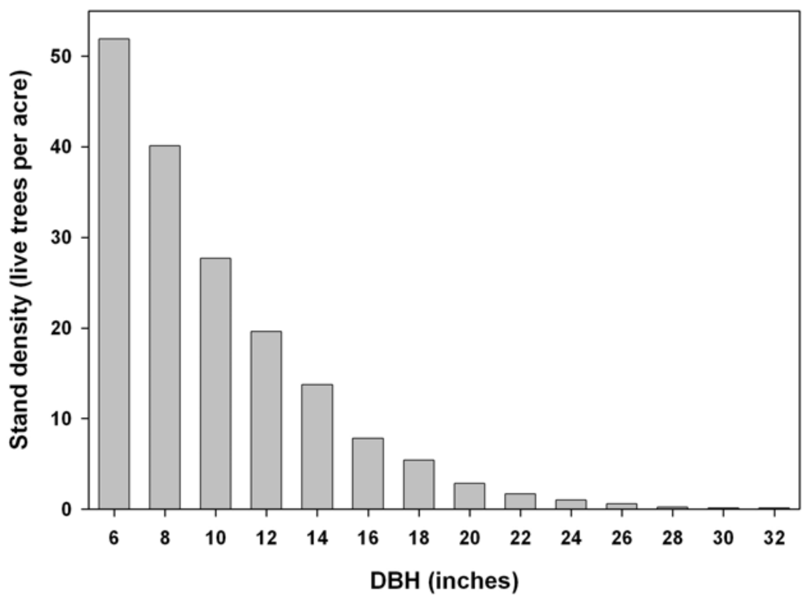

Fig. 16. Mean stand density (trees/acre) by 2-inch dbh class (DWSP 1999) Cunningham Pond Forest Reserve (N = 6 plots).

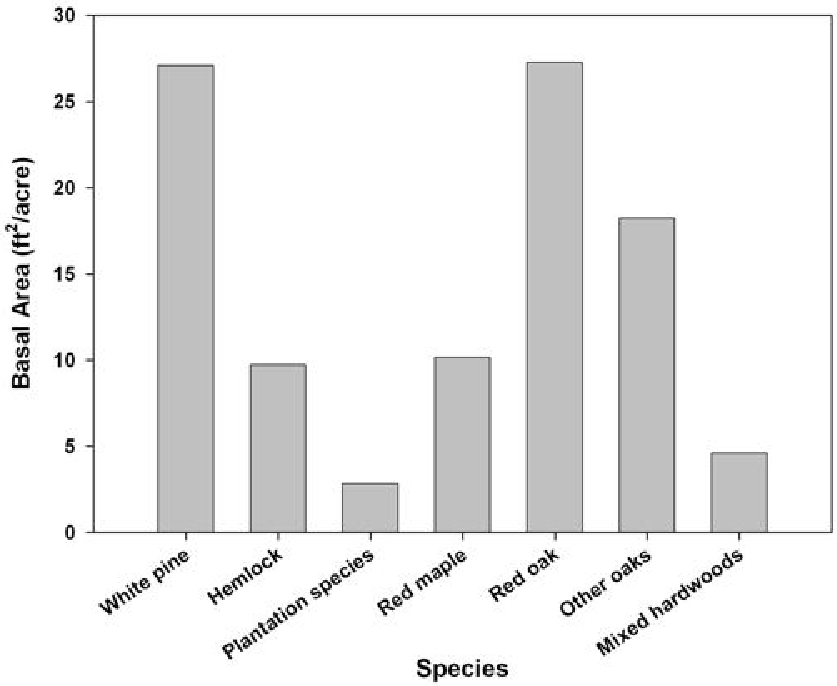

Fig. 17. Mean basal area (ft^2/acre) by species (DWSP 1999), Cunningham Pond Forest Reserve (N = 6 plots).

Data from 1999 CFI dataset indicate that the primary species in the Reserve are white pine and red oak (Fig. 17). White pine and red oak each account for 27% of the basal area on CFI plots or 54% of the total basal area. Other oak species, black, white, scarlet, and chestnut oak, are also commonly present and constitute 18% of basal area combined. Red maple and hemlock each account for 10% of the basal area. Plantation species consist of red and white spruce, Norway spruce and red pine. Mixed hardwoods on the Forest Reserve CFI plots consist primarily of black cherry with a few paper birch and grey birch.

Live tree biomass was 61.3 ± 17.5 tons/acre (N = 6 plots). This is not significantly different from the estimate derived from the 1989 CFI sampling, which was 62.7 ± 4.1 tons/acre.

SECTION 2: CUNNINGHAM POND FOREST RESERVE AND WARE RIVER WATERSHED PROTECTION FOREST PROPOSED INTENSIVE MONITORING AREAS

INTRODUCTION

The area selected as a managed match for the Cunningham Pond Forest Reserve lies within the Ware River Watershed Protection Forest in the town of Barre, approximately 5 miles southwest of the Forest Reserve (Fig. 18). Within the proposed Intensive Monitoring Areas (IMAs), the CFI plot density will be increased from a 0.5 mile to a 0.25 mile grid. Each IMA will have a total of 20 plots. The IMAs were selected based on similarities in topography, surficial geology, soils, and forest types.

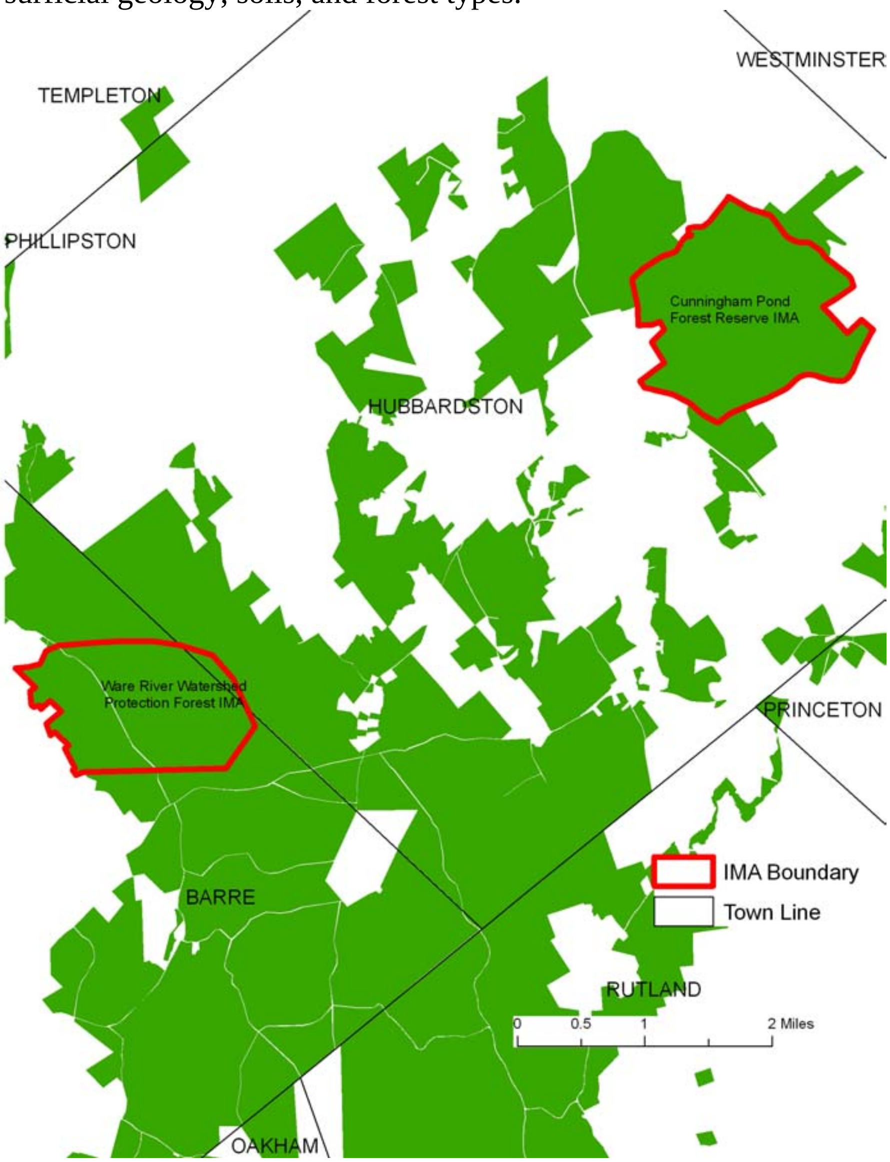

Fig. 18. Proposed Intensive Monitoring Areas (IMAs) in the Cunningham Pond Forest Reserve and the Ware River Watershed Protection Forest.

In other Forest Reserve and non-Reserve IMA pairs (Mount Greylock Forest Reserve and Taconic Trail State Forest, Middlefield/Peru Forest Reserve and Peru State Forest), the IMA area has been limited to approximately 800 acres, adequate area for 20 plots on a 0.25 mile grid. The IMA in the Cunningham Pond Reserve is about 1,300 acres. The area of the actively managed Ware River Watershed Protection Forest IMA is about 940 acres. This was necessary due to the potentially changing wetland areas, especially beaver meadows, within both IMAs (Fig. 19). In the Forest Reserve IMA, four of the original plots have been discontinued, leaving only 3 active plots. Fig. 19 shows the location of the 3 active CFI plots and possible locations for 20 additional plots, assuming that at least 17 of these locations will be feasible plot sites.

Data was collected on all of the original plots in the area designated for the active management IMA in 1999, a total of 7 CFI plots. Locations on a 0.25 mile grid have been identified for 16 additional plots (Fig. 19). This will increase the likelihood that a total of 20 CFI plots can be maintained within the active management IMA, despite changes in wetland patterns due to beaver activity.

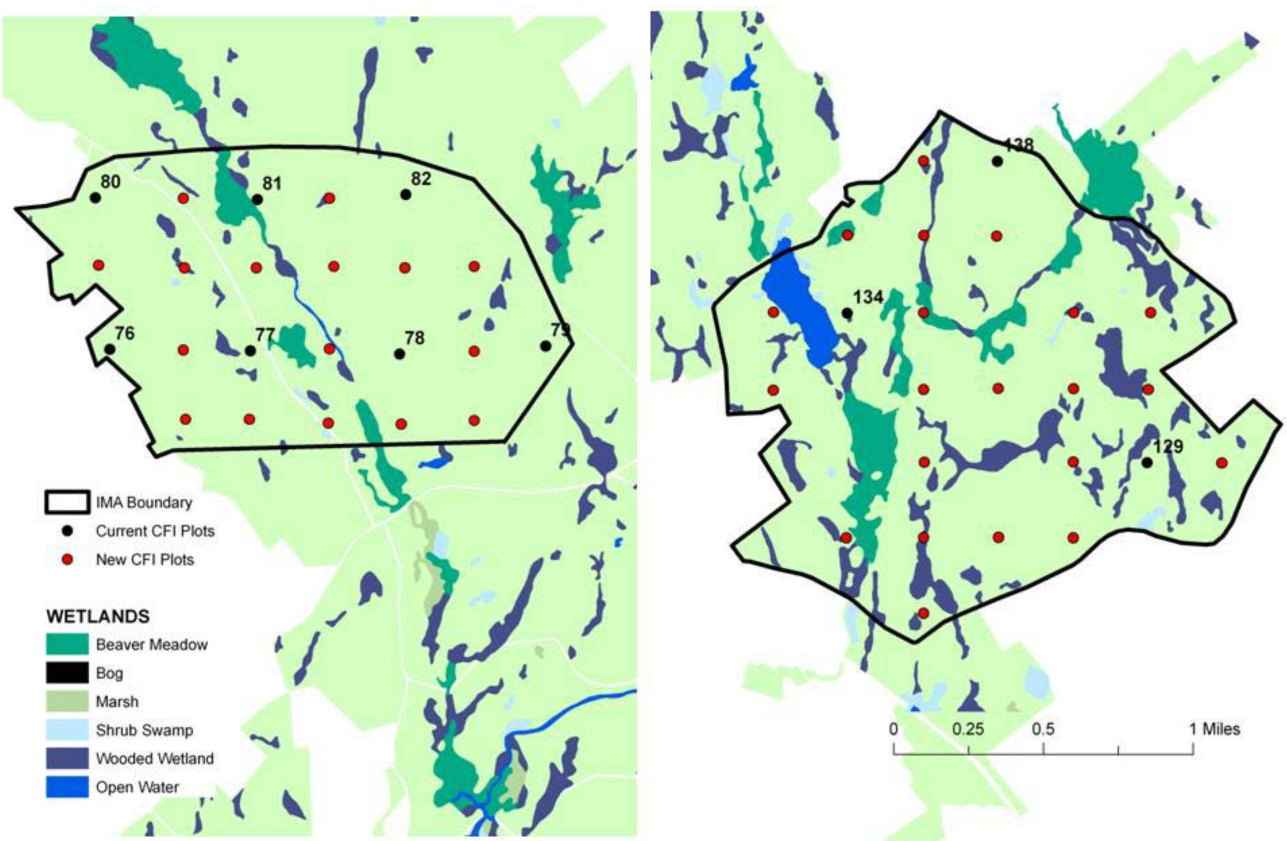

Fig. 19. Existing CFI plots and proposed locations for new CFI plots in the Ware River active management area (left) and Cunningham Pond Forest Reserve (right) IMAs. Note: more than 20 plot locations are shown to account for the possibility of plot locations being flooded (MassGIS 2000).

PHYSICAL FEATURES

Topography

Elevation on the Ware River Watershed Protection Forest IMA varies between 690 and 975 feet. Elevations at the Cunningham Pond Reserve IMA are slightly higher, between 865 and 1,120 feet (Fig. 20). These are areas of generally low relief without dramatic variations in slope and aspect (Fig. 21). The Burnshirt River, a tributary of the Ware River, flows through the center of the Ware River Watershed Protection Forest IMA. Various branches of Joslin Brook, another Ware River tributary, flow through the Cunningham Pond IMA.

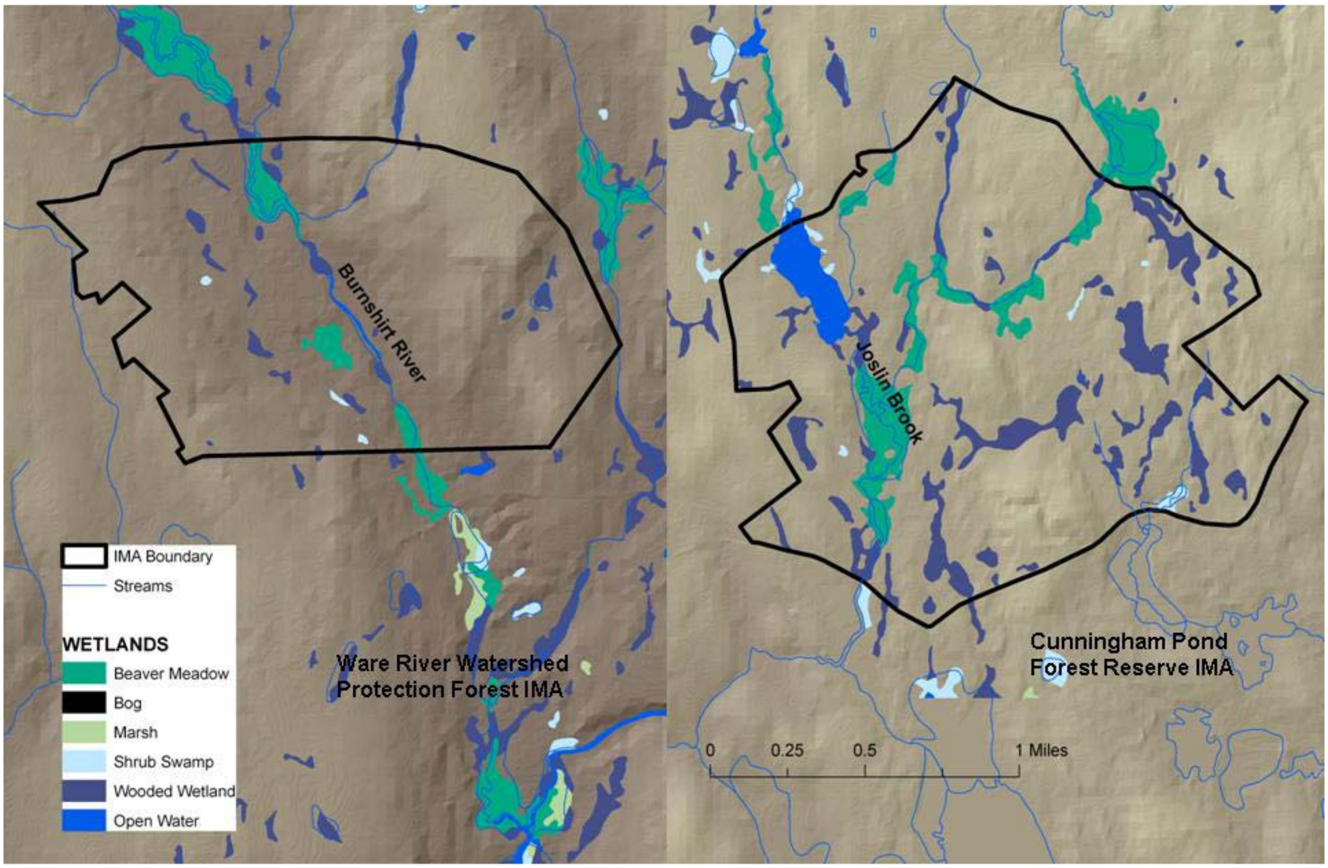

Fig. 20. Elevation, Cunningham Pond Forest Reserve and Ware River Watershed Protection Forest IMAs (images on left and right are mapped at the same scale for this and all following IMA figures).

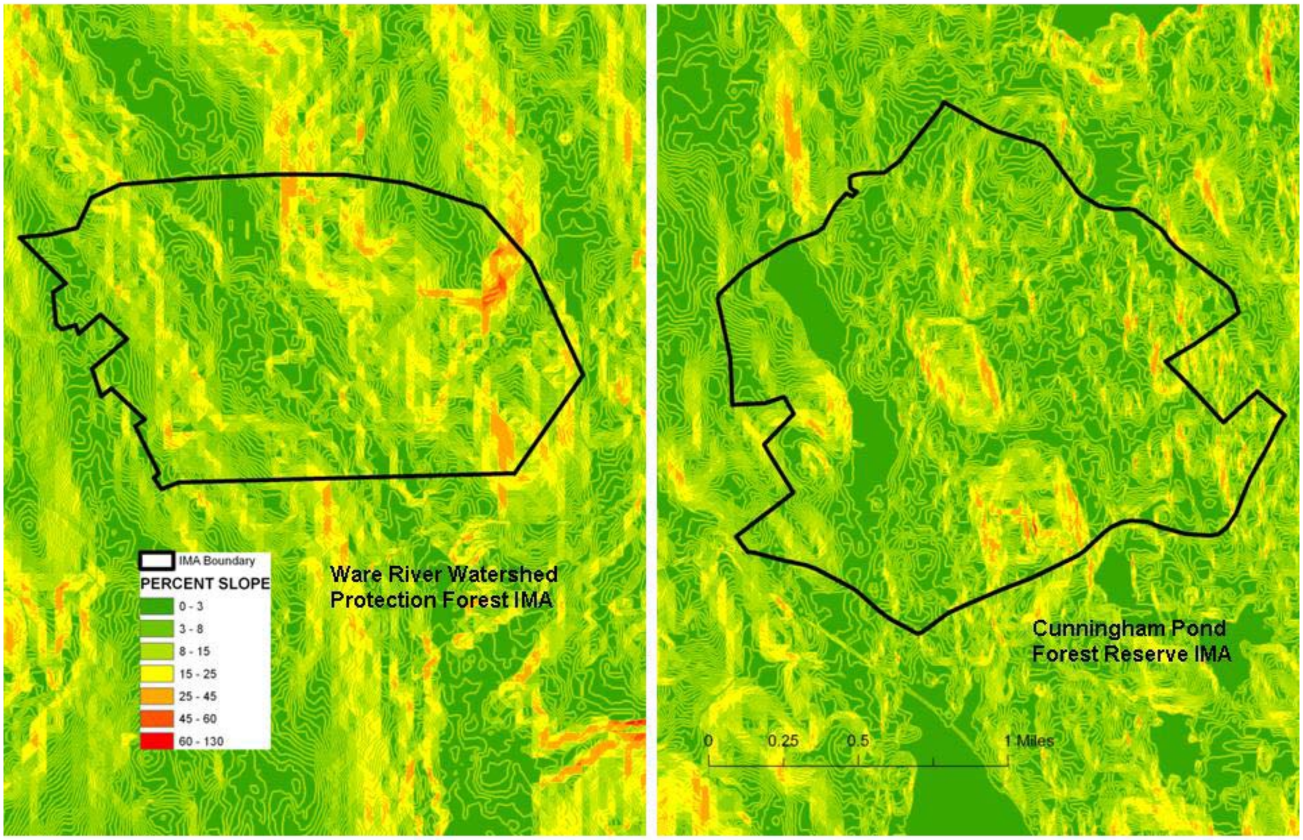

Fig. 21. Slope comparison, Ware River Watershed Protection Forest and Cunningham Pond Forest Reserve IMAs. (Images mapped at the same scale).

Bedrock Geology

Bedrock in both areas is primarily composed of schist and phyllite of the Littleton and Paxton Formations (Fig. 22, Table 6). Biotite granitic gneiss is found in one area of the Ware River Watershed Protection Forest IMA. Bedrock in both IMAs is primarily acidic.

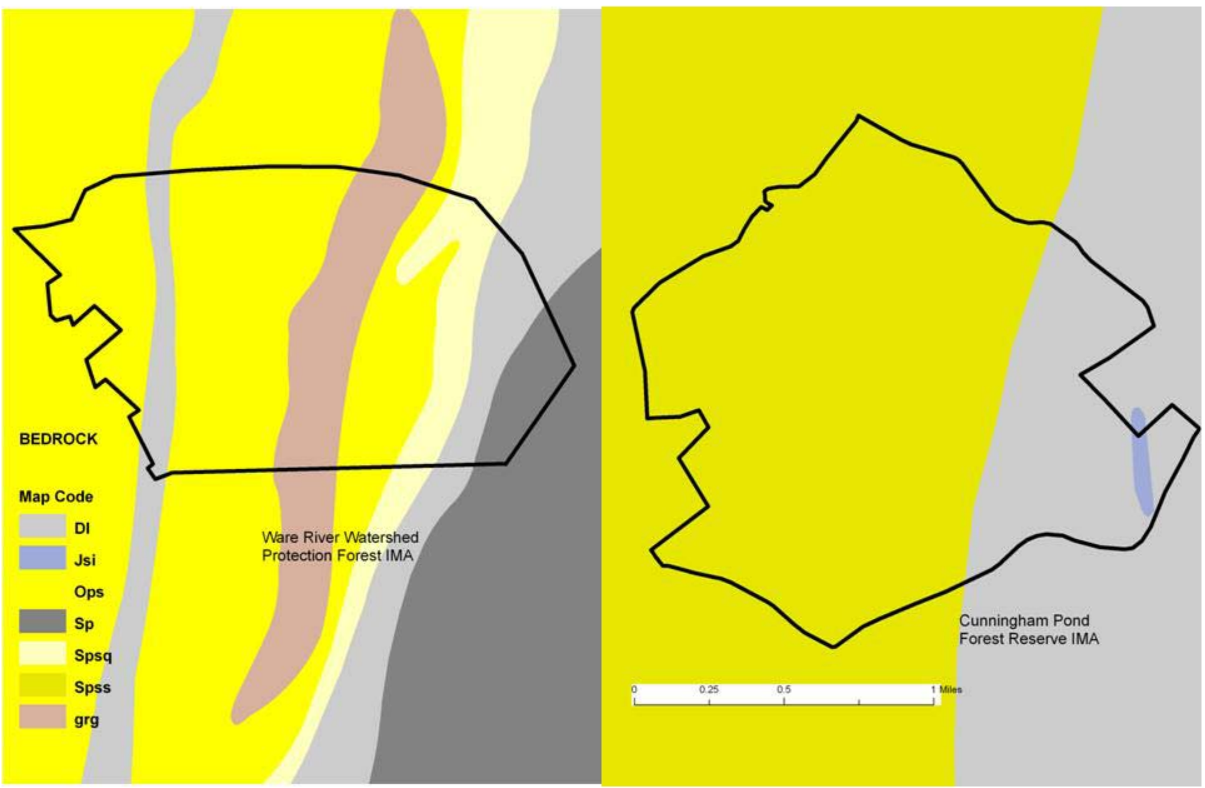

Fig. 22. Bedrock comparison, Ware River Watershed Protection Forest IMA and Cunningham Pond Forest Reserve IMA (Zen et al. 1983).

Table 6. Bedrock comparisons, Ware River Watershed Protection Fores and Cunningham Pond Forest Reserve IMAs (Zen et al. 1983).

Map Code	Rocktype	Area (%)	Formation
Cunningham Pond Forest Reserve IMA			
Dl	Black to grey aluminous mica schist, quartzose schist, and aluminous phyllite	22	Littleton Formation
Jsi	Silicified fault breccia or strongly silicified metamorphic rock	1	Silicified fault breccia or strongly silicified metamorphic rock
Spss	Sulfidic mica schist	77	Paxton Formation
Ware River Protection Forest IMA			
Dl	Black to grey aluminous mica schist, quartzose schist, and aluminous phyllite	13	Littleton Formation
Ops	Sulfidic mica schist and subordinate amphibolite	57	Partridge Formation
Sp	Undifferentiated biotite granofels, calc-silicate granofels, and sulfidic schist	6	Paxton Formation
Spsq	Sulfidic mangnesian biotite and magnesian cordierite schist, and sillimanite schist	9	Paxton Formation
grg	Biotite granitic gneiss	15	Biotite granitic gneiss

Surficial Geology and Soils

Thick deposits of glacial drift, till, outwash, and small areas of floodplain alluvium cover bedrock throughout this area. In each of the IMAs, outwash sand and gravel deposits cover about 30% of the area with most of the remaining area covered by glacial till. Alluvial deposits are relatively small, less than 1% of the total Reserve IMA area and about 3% of the Ware River IMA area (Fig. 23).

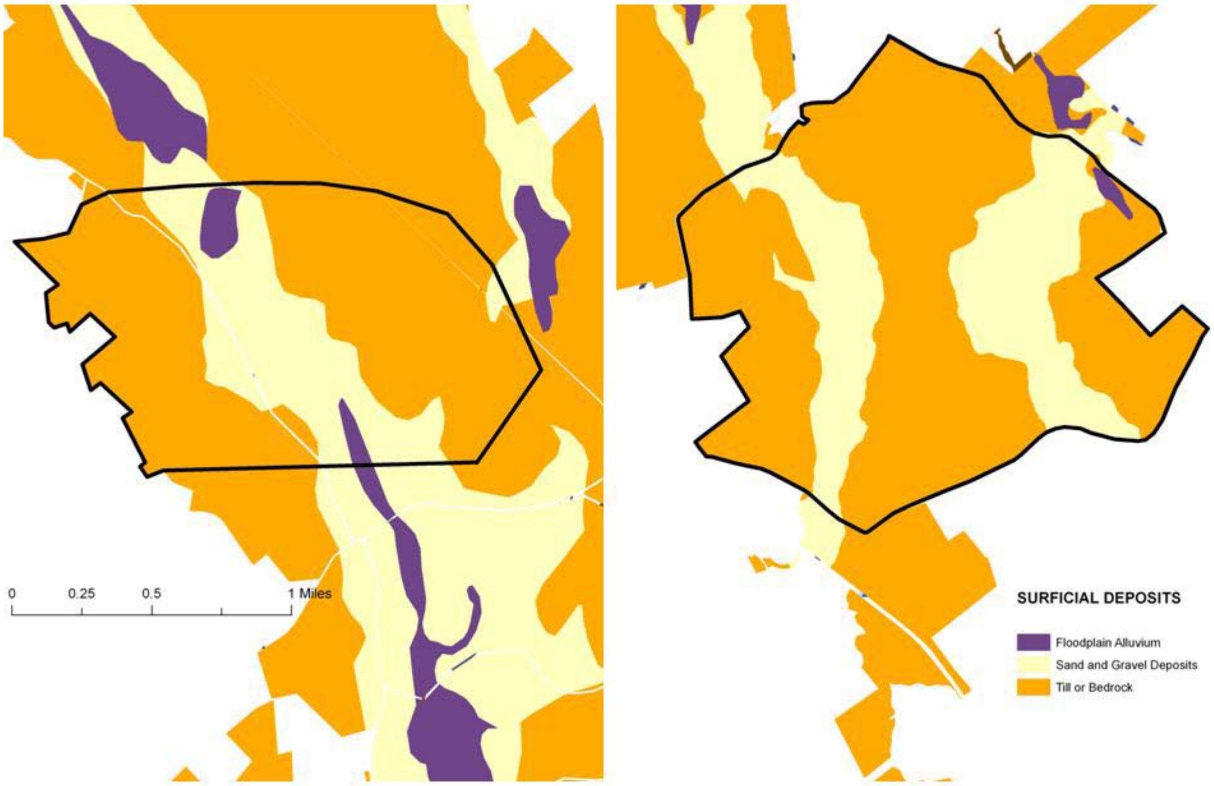

Fig. 23. Surficial deposits, Ware River and Cunningham Pond Forest Reserve IMAs (MassGIS 1999).

Soil drainage classes reflect the underlying parent material, with most of the excessively drained soils located on sand and gravel outwash deposits (Fig. 24). Both IMAs have substantial areas of poorly to very poorly drained soils. These soils constitute a somewhat larger percentage of the Cunningham Pond Forest Reserve area (Table 7).

Table 7. Soil drainage classes, Ware River Watershed Protection Forest IMA and Cunningham Pond Forest Reserve IMA (NCSS 1997-2008).

	Ware River IMA	**Cunningham Pond Forest Reserve IMA**
Soil Drainage Group	**Area (%)**	**Area (%)**
Excessively Drained-Outwash	21	18
Thick well drained	30	34
Moderately well drained	37	20
Poorly to very poorly drained	11	26
Water	<1	2

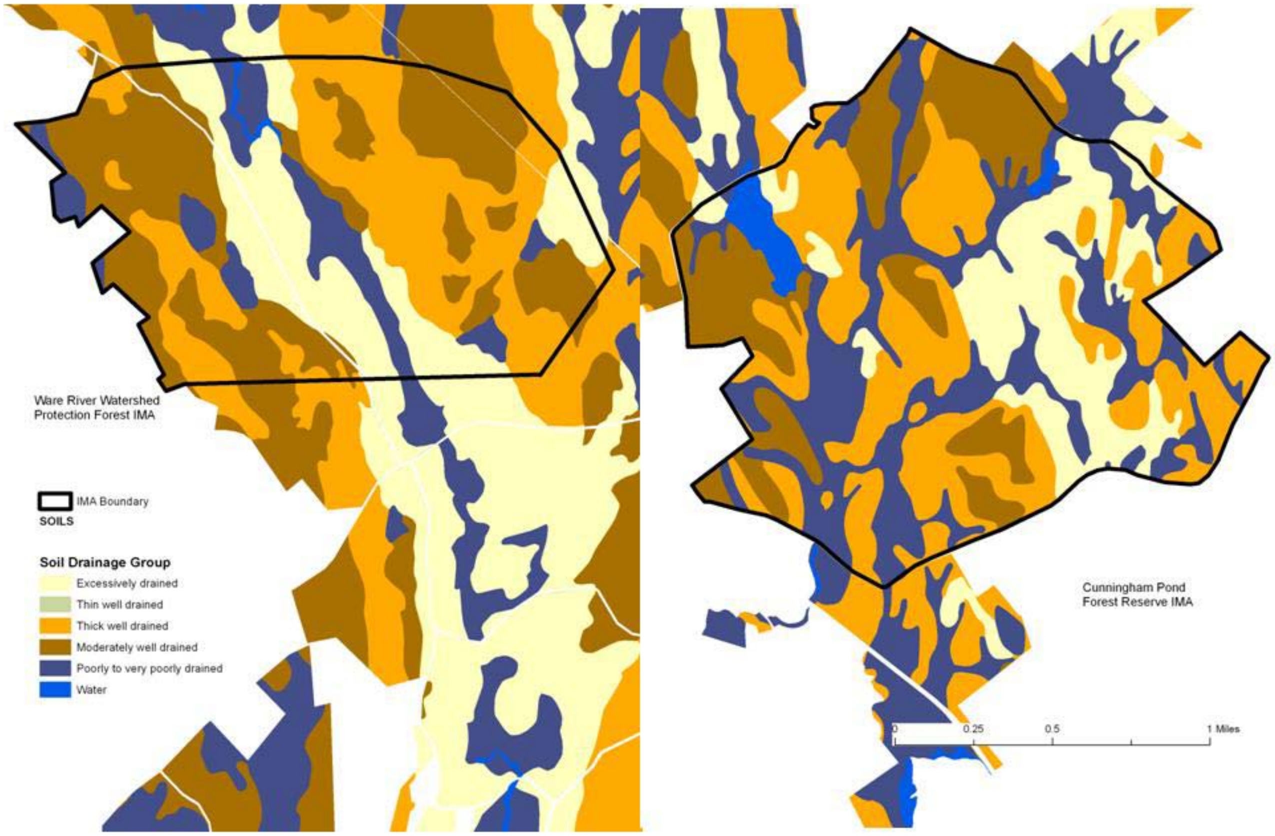

Fig. 24. Soil drainage classes, Ware River Watershed Protection Forest and Cunningham Pond Forest Reserve IMAs (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 2007).

Disturbance History

In addition to the gypsy moth outbreaks, affecting the entire Ware River watershed described in section I, there were outbreaks of larch sawfly in the 1970s and in 1994 and cherry scallop shell Moth in 1991 that affected the Ware River Watershed Protection Forest IMA.

LAND USE HISTORY

(See Section 1 Land Use History)

There have been 14 timber harvests reported within the area chosen for the Ware River Watershed Protection Forest IMA between 1984 and 2003, affecting a total of about 425 acres or slightly less than half of the entire IMA area. This compares to 331 acres on 13 parcels in the Cunningham Pond Forest Reserve IMA, about a quarter of the Reserve IMA area (Fig. 25, Table 8). A comprehensive discussion of forest management goals for the Ware River Watershed as a whole can be found in the Ware River Watershed Land Management Plan 2003-2012.

Table 8. Timber Harvests in the Ware River Watershed Protection Forest and Cunningham Pond Forest Reserve IMAs, 1984-2003 (McDonald et al. 2006)

Ware River Watershed Protection Forest IMA		**Cunningham Pond Forest Reserve IMA**	
Year	**Acres Reported**	**Year**	**Acres Reported**
2000	11.0	2001	19.0
2000	6.0	2001	23.0
1999	9.0	1998	18.0
1998	14.0	1996	15.0
1997	10.0	1995	10.0
1996	135.0	1994	30.0
1995	15.0	1994	25.0
1992	32.0	1993	103.0
1991	45.0	1990	6.0
1988	51.0	1990	32.0
1987	58.0	1988	29.0
1986	36.0	1985	6.0
1985	50.0	1985	15.0
1985	9.0		
Total	481[1]		331.0

[1]The actual total is closer to 425 acres in the Ware River IMA. The cut recorded in 1987 involved multiple parcels, several of which lie outside the boundary of the proposed IMA.

FOREST TYPES

Although the area of outwash deposits and excessively drained soils is similar in both IMAs, the proportion of forest classified as white pine/oak, a typical dry site forest, is much greater in the Cunningham Pond Forest Reserve IMA than in the Ware River Watershed Protection Forest IMA (Fig. 25). Overall however, both IMA forests consist predominantly of various white pine, oak, and hemlock with a mix of other hardwood species. Wetland areas, both forested and open, constitute a larger proportion of the Forest Reserve IMA than of the Ware River IMA (Table 9).

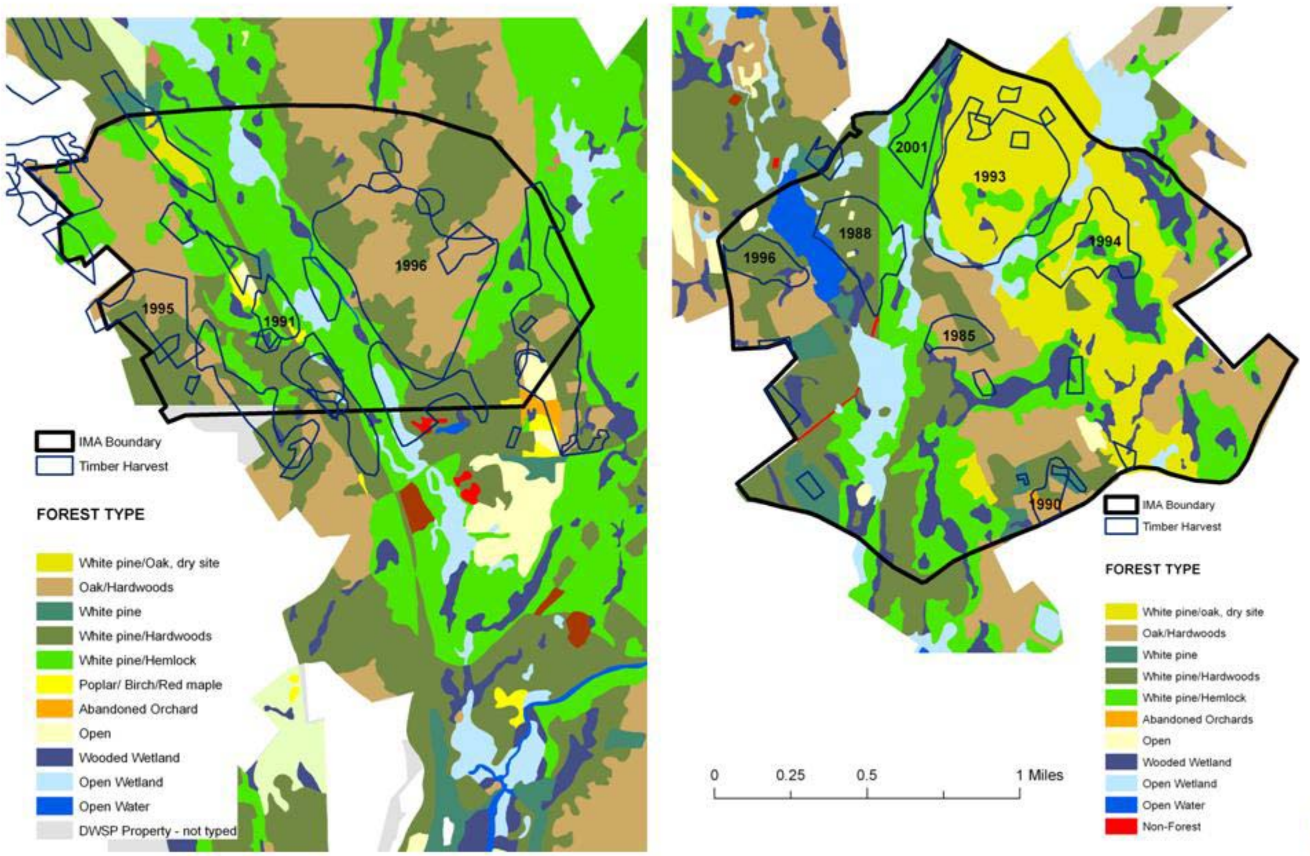

Fig. 25. Forest types, Ware River and Cunningham Pond Forest Reserve IMAs and timber harvests 1984-2003 (DCR Quabbin Forestry 1999).

Table 9. Forest types, Ware River Watershed Protection Forest and Cunningham Pond Forest Reserve IMAs (DWSP 1999).

Cunningham Pond Forest Reserve IMA	
Forest Type	**Area (%)**
White pine/Oak, dry site	23
Oak/Hardwoods	15
White pine	3
White pine - Hardwoods	19
White pine - Hemlock	21
Abandoned Orchards	<1
Open	1
Forested Wetlands	10
Open Wetlands	6
Open Water	2
Non-Forest	<1
Ware River Watershed Protection Forest IMA	
Forest Type	**Area (%)**
White pine/oak, dry site	1
Oak/Hardwoods	30
White pine	1
White pine/ Hardwoods	31
White pine/Hemlock	31
Poplar/birch	1
Abandoned Orchard	<1
Open	1
Forested wetland	2
Open Wetland	3
Open Water	<1

CFI DATA

There are currently three CFI plots (129, 134, and 138) located within the Cunningham Pond Forest Reserve IMA. As noted previously, other plots have been discontinued as plot sites have converted from forest to treeless wetlands. There are seven CFI plots (76, 77, 78, 79, 80, 81, and 82) in the Ware River Watershed Protection Forest IMA.

Live Trees

It is difficult to make meaningful comparisons of the Forest Reserve and Ware River Watershed Protection Forest IMAs given the small number of Cunningham Pond Forest Reserve IMA CFI plots. Analysis of data from the Reserve IMA, and the Ware River Watershed Protection Forest IMA, indicate that the tree density for all trees ≥ 5.6 inches dbh is greater in the Forest Reserve IMA than in the Ware River Watershed Protection Forest IMA, but that there are more large trees (dbh ≥ 20 inches) within the area of the Ware River IMA (Table 10, Fig. 26). As can be seen from the confidence intervals shown in Table 10, the variability of these estimates, especially for the Forest Reserve IMA, is very high.

Table 10. Stand density (trees/acre) in the Cunningham Pond Reserve, Reserve IMA and Ware River Watershed Protection Forest IMA (1999 CFI data).

Forest	Trees/acre		Trees/acre	
	DBH ≥ 5.6 inches	CI	DBH ≥ 20 inches	CI
Cunningham Pond Forest Reserve IMA	203.3	±609.7	3.3	±14.3
Ware River Watershed Protection Forest IMA	171.4	±88.2	5.7	±12.4

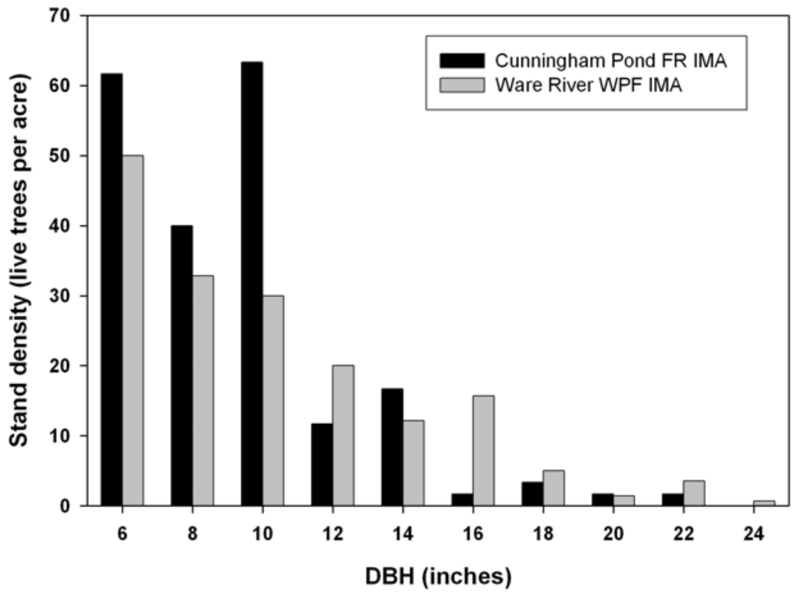

Fig. 26. Mean stand density (trees/acre) by 2-inch dbh class (DWSP 1999), Cunningham Pond Forest Reserve and Ware River Watershed Protection Forest IMAs.

CFI data from both IMAs confirms that this is overall a pine/oak forest with lesser amounts of hemlock and mixed hardwoods (Fig. 27). Mixed hardwoods in the Cunningham Pond IMA consist almost entirely of black cherry trees with one gray birch and one paper birch. On the Ware River IMA, mixed hardwoods consisted of black cherry, black birch, yellow birch, and paper birch, with one beech and one gray birch.

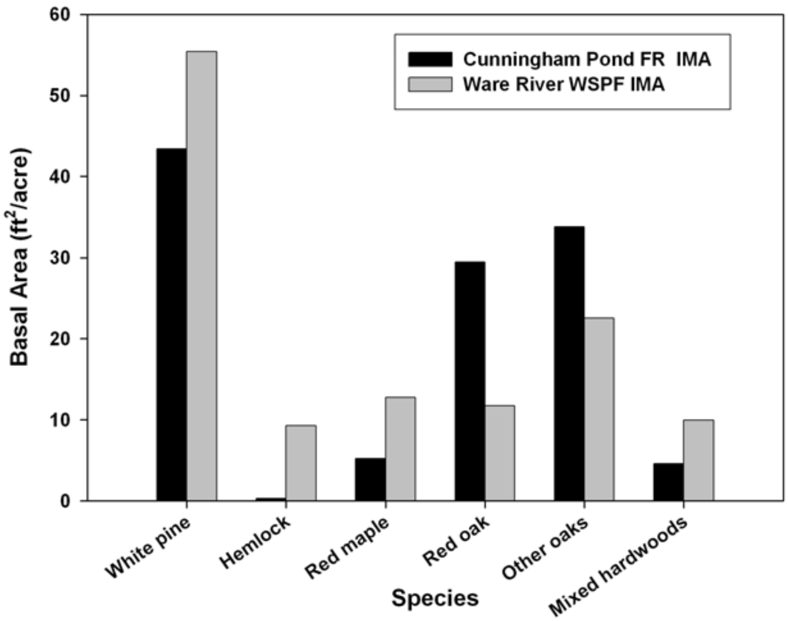

Fig. 27. Mean basal area (ft^2/acre), Cunningham Pond Forest Reserve and Ware River Watershed Protection Forest IMAs (DWSP 1999).

Mean biomass calculated from CFI data from each IMA are quite similar, 74.9 ± 15.9 tons/acre in the Ware River Watershed Protection Forest IMA and 74.0 ± 38.6 tons/acre in the Cunningham Pond Forest Reserve IMA (DWSP 1999).

SUMMARY*: *A Comparison of the Ware River Watershed Protection Forest (WRF) and Cunningham Pond Forest Reserve (CPFR) IMAs

- The area designated for the CPFR IMA (~1300 acres) is larger than that of the WRF IMA (~940 acres). This was necessary because more extensive wetland areas within the CPFR IMA made it difficult to find appropriate sites for the proposed new forested CFI plots.

- Elevation on the Ware River Watershed Protection Forest IMA varies between 655 and 855 feet. Elevations at the Cunningham Pond Reserve IMA are slightly higher, between 935 and 985 feet. These are areas of generally low relief without dramatic variations in slope and aspect.

- Bedrock in both IMAs is composed primarily of acidic schist and phyllite, overlain by thick deposits of glacial till and outwash, with small areas of floodplain alluvium.

- In both IMAs about 20 percent of the area is covered by excessively drained outwash soils. The remaining soils, primarily till with some outwash, fall into a variety of drainage categories, well drained, moderately well drained, and poorly to very poorly drained. The area of poorly to very poorly drained soils is greater in the CPFR than in the WRF IMA, 26 percent versus 11 percent.

- Forests in both areas are primarily composed of white pine and mixed oak with smaller amounts of other hardwood species. There appears to be a larger area of dry site white pine/oak forest within the CPFR.

- Biomass estimates from current CFI data for live trees are similar for the two IMAs, however the variability of the estimates is high due to the small number of CFI plots (3) currently in place on the CPFR IMA.

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Appendix A: SPECIES LIST
Species listed in this report:

Beech	*Fagus grandifolia*
Black birch	*Betula lenta*
Black cherry	*Prunus serotina*
Black oak	*Quercus velutina*
Chestnut	*Castanea dentata*
Chestnut oak	*Quercus prinus*
European larch	*Larix decidua*
Gray birch	*Betula populifolia*
Hemlock	*Tsuga canadensis*
Norway spruce	*Picea abies*
Paper birch	*Betula papyrifera*
Poplar	*Populus* spp.
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
Red pine	*Pinus resinos*
Scarlet oak	*Quercus coccinea*
Scotch pine	*Pinus sylvestris*
White oak	*Quercus alba*
White pine	*Pinus strobus*
White spruce	*Picea glauca*
Yellow birch	*Betula lutea*

Appendix B: WARE RIVER SOIL SERIES AND SOIL SERIES ASSOCIATIONS GROUPING

Group	Series Name	Parent Material	Drainage	Depth
1. Excessively Drained				
Outwash	**Colton**	Glacio-fluvial deposits	Excessively drained	Very Deep
	Hinckley	Water-sorted material	Excessively drained	Very Deep
	Merrimac	Glacial outwash	Somewhat excessively drained	Very Deep
	Allagash	Glaciofluvial deposits on outwash	Well drained	Very Deep
2. Well drained thin soils				
Till	**Chatfield**	Till on glaciated plains, hills, and ridges	Well drained and somewhat excessively drained	Moderately deep (20 to 40 inches)
	Hollis	Thin mantle of till derived from granite, gneiss, and schist on bedrock controlled hills and ridges	Well drained and somewhat excessively drained	Shallow (10 to 20 inches)
	Lyman	Glacial till on rocky hills, mountains, and high plateaus	Somewhat excessively drained	Shallow
3. Well drained thick soils				
Till	**Becket**	Loamy mantle overlying dense sandy till on drumlins and glaciated uplands	Well drained	Very deep
	Berkshire	Till on glaciated uplands	Well drained	Very deep
	Canton	Loamy mantle underlain by sandy till on glaciated plains, hills, and ridges	Well drained	Very deep
	Charlton	Till on till plains and hills	Well drained	Very deep

Group	Series Name	Parent Material	Drainage	Depth
3. Well drained thick soils (con't.)	**Marlow**	Loamy till on drumlins and glaciated uplands	Well drained	Deep to densic contact and very deep to bedrock
	Montauk	Till derived from granitic material on upland till plains and moraines	Well drained	Very deep
	Monadnock	Loamy mantle overlying sandy glacial till on upland hills, plains, and mountain sideslopes	Well drained	Very deep
	Paxton	Lodgement till on till plains, hills, and drumlins	Well drained	Very deep to bedrock and moderately deep to a densic contact
	Tunbridge	Loamy glacial till on glaciated uplands	Well drained	Moderately deep C horizon 14 to 28 inches
4. Moderately well drained soils				
Outwash	**Croghan**	Deltaic or glacio-fluvial deposits on terraces and sand plains	Moderately well drained	Very deep
	Sudbury	Outwash in slight depressions on terraces and footslopes in areas of glacial outwash	Moderately well drained and somewhat poorly drained	Very deep
Till	**Peru**	Dense, loamy, glacial till	Moderately well drained	Very deep
	Scituate	Loamy glacial till underlain by dense sandy till on glacial uplands	Moderately well drained	Very deep

Group	Series Name	Parent Material	Drainage	Depth
4. Moderately well drained (con't.)	**Skerry**	Loamy mantle overlying dense, sandy glacial till on drumlins and glaciated uplands	Moderately well drained	Very deep
	Woodbridge	Subglacial till on till plains, hills, and drumlins	Moderately well drained	Very deep to bedrock and moderately deep to a densic contact
5. Poorly to very poorly drained				
Outwash	**Naumberg**	Sandy deltaic or glaciofluvial deposits	Poorly and somewhat poorly drained	Very deep
	Scarboro	Sandy glaciofluvial deposits on outwash plains, deltas, and terraces	Very poorly drained	Very deep
	Searsport	Thick sandy deposits in pockets and depressions on outwash plains, deltas, and terraces	Very poorly drained	Very deep
	Walpole	Outwash and stratified drift on terraces and plains	Poorly drained	Very deep
Till	**Pillsbury**	Compact, loamy glacial till on glaciated uplands	Poorly and somewhat poorly drained	Shallow or moderately deep to a densic contact and very deep to bedrock

Group	Series Name	Parent Material	Drainage	Depth
	Ridgebury	Till derived mainly from granite, gneiss, and schist	Somewhat poorly and poorly drained	Shallow to a densic contact and very deep to bedrock
	Whitman	Glacial till derived mainly from granite, gneiss, and schist	Very deep, very poorly drained.	Shallow to a densic contact and very deep to bedrock
Organic	**Peacham**	Organic materials <16" underlain by dense loamy till in depressions and drainage ways on glaciated uplands	Very poorly drained	Shallow to dense basal till and very deep to bedrock
	Bucksport	Well decomposed organic soil material more than 51 inches thick in depressions in glacial ground moraines, shallow till ridges, and glaciofluvial deposits	Very poorly drained	Very deep
	Chocorua	Organic accumulations underlain by stratified sand and gravel on outwash plains, lake plains, and glacial till uplands	Very poorly drained	Very deep
	Greenwood	Organic deposits more than 51 inches thick on outwash plains, till floored lake plains, or lake plains	Very poorly drained	Very deep
	Wonsqueak	Mantle of well decomposed organic soil material over loamy mineral material in depressions in glacial ground moraine, till plains, flood plains, shallow till ridges, outwash plains, and deltas	Very poorly drained	Very deep

SSURGO Soil Polygon Associations:

Many polygons in the digital data are identified by Association, rather that as a single soil series. Associations are grouped below.

Group 2 – Well drained, shallow

Lyman-Tunbridge-Berkshire: Lyman is shallow and somewhat excessively drained, Tunbridge and Berkshire are moderately deep and very deep, respectively; both are well drained.

Group 3 – Well drained, thick:

Becket-Monadnock: Both well drained, very deep

Becket-Skerry: Well drained, and moderately well drained, respectively; both very deep.

Berkshire-Marlow: Well drained, and moderately well drained, respectively; both very deep

Charlton, Chatfield: Both well drained; very deep, and moderately deep, respectively.

Charlton-Chatfield-Hollis: All well drained; very deep, moderately deep, and shallow respectively

Charlton-Paxton: Both well drained, very deep

Montauk-Canton: Both well drained, very deep

Montauk-Scituate-Canton: All very deep, Montauk and Canton are well drained, Scituate is moderately well drained

Tunbridge-Lyman-Berkshire

Group 4 – Moderately well drained

Peru-Marlow: both very deep, Peru is moderately well drained and Marlow is well drained

Woodbridge-Paxton: Moderately well drained and well drained respectively, both very deep to bedrock and moderately deep to a densic contact.

Group 5 – Poorly and very poorly drained

Bucksport, Wonsqueak: Both very poorly drained, very deep

Greenwood, Chocorua: Both very poorly drained, very deep

Pillsbury-Peacham: Poorly and very poorly drained, shallow to densic contact and very deep to bedrock

Ridgebury-Whitman: Poorly drained and very poorly drained, both shallow to a densic contact and very deep to bed rock.

Appendix C: PLANT SPECIES OCCURRING ON THE WARE RIVER WATERSHED

Field List – Flora
1996 Survey of Proposed Harvesting Lots
Karen Searcy - U Mass Herbarium
rare species underlined and bold;
* Invasive Species
Dicots

Species	Common Name
Acer pensylvanicum	Striped maple
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Achillea millefolium	Common yarrow
Actaea pachypoda	Doll's eyes
Actaea rubra	Red baneberry
Actaea sp.	Baneberry
Amelanchier sp.	Shadbush
Amelanchier(canadensis?)	Swamp shadbush
Amelanchier bartramiana	Bartram’s shadbush
Amphicarpaea bracteata	Hog peanut
Anemone quinquefolia	Wood anemone
Apocynum androsaemifolium	Spreading dogbane
Apocynum sp.	Dogbane
Aquilegia Canadensis	Wild columbine
Aralia nudicaulis	Wild sarsaparilla
Aronia arbutifolia	Cherry
Aronia melanocarpa	Choke cherry
Asclepius sp.	Milkweed
Asclepius syriaca	Common milkweed
Aster acuminatus	Whorled aster
Aster divaricatus	White wood aster
Baptisia tinctorea	False indigo
**Berberis thunbergii*	Japanese barberry
**Berberis vulgaris*	Common barberry
Betula alleghaniensis	Yellow birch
Betula lenta	Black birch
Betula papyrifera	White birch
Betula populifolia	Gray birch
Carpinus caroliniana	Iron wood
Carya sp.	Hickory
Castanea dentata	Chestnut
Chamaedaphne calyculata	Leather-leaf
Chimaphila maculata	Spotted wintergreen
Chimaphila umbellate	Pipsissewa
Chrysosplenium americanum	Golden saxifrage
Circaea alpine	Enchanters nightshade
Circaea lutetiana var.canadensis	Canadian nightshade
Clematis virginiana	Virgin’s bower
Comandra umbellata	Umbellate toadflax
Comptonia peregrine	Sweet fern

Species	Common Name
Convolvulus sp.	Bindweed
Coptis trifolia	Goldthread
Cornus alternifolia	Alternate-leaf dogwood
Cornus amomum	Silky dogwood
Cornus canadensis	Bunch berry
Cornus racemosa	Red panicle dogwood
Cornus sp.	Dogwood
Corydalis sempervirens	Pale corydalis
Corylus americana	American hazelnut
Corylus cornuta	Beaked hazelnut
Crataegus sp.	Hawthorn
Dalibarda repens	Robin-run-away
Diervilla lonicera	Bush honeysuckle
Drossera rotundifolia	Round-leafed sundew
Epigaea repens	Trailing arbutus
Euonymus alatus	Winged spindle-tree
Fagus grandifolia	Beech
Fragaria sp	Strawberry
Fragaria virginiana.	Common strawberry
Fraxinus americana	White ash
Fraxinus pennsylvanica	Green ash
Fraxinus sp.	Ash
Galium sp.	Bedstraw
Galium trifidum	Three-cleft bedstraw
Gaultheria procumbens	Wintergreen
Gaylussacia baccata	Black huckleberry
Gaylussacia sp.	Huckleberry
Geranium maculatum	Wild geranium
Glechoma hederacea	Ground ivy
Hamamelis virginiana	Witch hazel
Hemerocallis sp.	Day-lily
Hepatica sp.	Liverleaf
Hedyotis caerula	Bluets
Hydrocotyle Americana	Water-pennywort
Hypericum sp.	St. John's wort
Ilex verticillata	Winterberry
Impatiens capensis	Jewelweed
Kalmia angustifolia	Sheep laurel
Kalmia latifolia	Mountain laurel
Leonurus cardiaca	Common motherwort
Lespedeza sp.	Bush-clover
Lindera benzoin	Spicebush
**Lonicera sp.*	Honeysuckle
**Lonicera tatarica*	Tartarian honeysuckle
Lycopus uniflorus	Northern bugleweed
Lyonia ligustrina	Maleberry
Lysimachia ciliata	Hairy loosestrife
Lysimachia quadrifolia	Whorled loosestrife
Melampyrum lineare	Cow wheat
Mimulus ringens	Gaping monkey flower

Species	Common Name
Mitchella repens	Partridge berry
Moneses uniflora	One-flowered pyrola
Monotropa hypopithys	Pine-sap
Monotropa uniflora	Indian-pipe
Myosotis scorpioides	True forget-me-not
Myrica gale	Sweet gale, meadow-fern
Nemopanthus mucronatus	Mountain holly
Nyssa sylvatica	Black gum
Orobanche uniflora	One-flowered cancer-root
Ostrya virginiana	American hophornbeam
Oxalis sp.	Wood sorrel
Parthenocissus quinquefolia	Virginia creeper
Parthenocissus sp.	Virginia creeper
Polygala paucifolia	Fringed polygala
Polygonum sagittatum	Tearthumb
Populus grandidentata	Large-toothed aspen
Populus tremuloides	Quaking aspen
Potentilla canadensis	Canadian cinquefoil
Potentilla simplex	Old-field cinquefoil
Potentilla sp.	Cinquefoil
Prenanthes sp.	Rattlesnake root
Prenanthes trifoliolata	Gall-of-the-earth
Prunus pennsylvanica	Fire cherry
Prunus serotina	Black cherry
Prunus virginiana	Choke cherry
Prunus sp.	Cherry
Pyrola elliptica	Shinleaf
Pyrola rotundifolia	Round-leafed pyrola
Pyrola sp.	Pyrola
Pyrus malus	Apple
Quercus alba	White oak
Quercus ilicifolia	Scrub oak
Quercus rubra	Red oak
Quercus sp.	Oak
Quercus velutina	Black oak
Ranunculus recurvatus	Buttercup
Ranunculus sp.	Buttercup
Rhamnus frangula	Alder-buckthorn
**Rhamnus sp*	Buckthorn
Rhododendron canadense	Rhodora
Rhododendron sp.	Rhododendron
Rhododendron viscosum	Swamp azalea
Rhus copallina	Winged sumac
Rhus glabra	Smooth sumac
Rhus sp.	Sumac
Ribes glandulosum	Skunk currant
Ribes hirtellum	Bristly currant
Ribes sp.	Currant
**Rosa multiflora*	Multiflora rose
Rubus allegheniensis	Black raspberry

Species	Common Name
Rubus flagellaris	Dewberry
Rubus hispidus	Swamp dewberry
Rubus idaeus	Raspberry
Rubus sp.	Blackberry
Rumex acetocella	Sorrel
Sambucus canadensis	Common elder
Sambucus pubens	Stinking elder
Sassafras albidum	Sassafras
Sedum purpureum	Garden orpine
Senecio aureus	Squaw weed
Solanum dulcamara	Nightshade
Solidago sp.	Goldenrod
Sorbus aucuparia	Mountain ash
Spiraea alba var.latifolia	Meadowsweet
Spiraea tomentosa	Steeple bush
Symphoricarpos albus	Snowberry
Syringa vulgaris	Common lilac
Taraxacum officinale	Common dandelion
Thalictrum polygamum	Tall meadow rue
Thalictrum sp.	Meadow rue
Tiarella cordifolia	Foam flower
Tilia Americana	Basswood
Triadenum sp.	St. John's wort
Trientalis borealis	Starflower
Ulmus americana	American elm
Ulmus rubra	Slippery elm
Ulmus sp.	Elm
Vaccinium angustifolium	Low-bush blueberry
Vaccinium corymbosum	High-bush blueberry
Vaccinium macrocarpon	American cranberry
Vaccinium sp.	Blueberry
Vaccinium pallens	Early sweet blueberry
Veronica officinalis	Common speedwell
Viburnum acerifolium	Maple-leafed viburnum
Viburnum alnifolium	Hobblebush
Viburnum cassinoides	Witherod
Viburnum dentatum var. lucidum	Southern arrow wood
Viburnum lentago	Nannyberry
Viburnum sp.	Viburnum
Viola blanda	Mild violet
Viola conspersa	Dog violet
Viola cucullata	Marsh violet
Viola macloskii ?	
Viola sororia	
Viola sp.	Violet

Monocots

Species	**Common Name**
Andropogon scoparius	Bluestem
Anthoxanthum odoratum	Sweet vernal grass
Arisaema sp.	Jack-in-the-pulpit
Arisaema triphyllum	Small jack-in-thepulpit
Brachyelytrum erectum	
Carex argyrantha	Silvery-flowered sedge
Carex (bracteosae group)	
Carex canescens	Silvery bog sedge
Carex communis	Colonial sedge
Carex crinita	Long-haired sedge
Carex debilis	Weak sedge
Carex folliculata	Follicle-bearing sedge
Carex gracillima	Slender sedge
Carex intumescens	Swelled-up sedge
Carex laxiflora	Loosely-flowered sedge
Carex (laxiflora group)	
Carex leptalea	Delicate sedge
Carex normalis	Right-angled sedge
Carex novae-angliae	New England sedge
Carex (ovales group)	
Carex pensylvanica	Penn. sedge
Carex platyphylla?	Broad-leaved sedge
Carex rosea	Rose-like sedge
Carex sp.	Sedge
Carex (stellulatae group)	
Carex stricta	Erect sedge
Carex stipata	Crowded sedge
Carex swanii	Swan sedge
Carex sylvatica	Sedge-of-the-woods
Carex trisperma?	Three-seeded sedge
Carex vestita	Clothed sedge
Carex vulpinoidea	Foxtail-flowered sedge
Clintonia borealis	Yellow clintonia
Convallaria majalis	Lily of the valley
Cypripedium acaule	Pink lady's slipper
Danthonia spicata	Junegrass
Eleocharis sp.	Spike-rush
Epipactis helleborine	Helleborine
Festuca ovina	Sheep festcue
Glyceria striata Fowl-	meadow grass
Goodyera pubescens	Rattlesnake plantain
Goodyera tesselata	Checkered rattlesnake plantain

Species	Common Name
[Grass species]	
Habenaria bracteata	
Habenaria sp.	Orchis
Iris versicolor	Blue flag
Juncus effuses	Soft rush
Lilium philadelphicum	Wood lily
Lilium sp.	Lily
Luzula sp.	Woodrush
Maianthemum canadense	Canada mayflower
Medeola virginiana	Indian cucumber root
Orchid sp.	Orchid
Oryzopsis sp.	Rice grass
Panicum latifolium	Panic grass
Polygonatum pubescens	Hairy Solomon's seal
Polygonatum sp.	Solomon's seal
Sisyrinchium sp.	Blue-eyed grass
Smilacina racemosa	False solomon's seal
Smilax herbacea	Jacob's ladder
Smilax sp.	Greenbrier
Streptopus sp.	Twisted-stalk
Symplocarpus foetidus	Skunk cabbage
Trillium cernuum	Nodding trillium
Trillium sp.	Trillium
Trillium undulatum	Painted trillium
Uvularia perfoliata	Bellwort
Uvularia sessilifolia	Wild oats
Veratrum viride	False hellebore
Fern Allies	
Equisetum arvense	Common horsetail
Equisetum sylvaticum	Horsetail
Diphasiastrum digitatum	Trailing evergreen
Diphasiastrum tristachyum	Ground pine
Huperzia lucidula	Shiny clubmoss
Lycopodium annotinum	Bristly clubmoss
Lycopodium clavatum	Common clubmoss
Lycopodium dendroideum	Northern ground pine
Lycopodium hickeyi	Hickey's clubmoss
Lycopodium obscurum	Tree clubmoss
Lycopodium sp.	Clubmoss
Ferns	
Athyrium filix-femina	Lady fern
Athyrium thelypteroides	Silvery spleen
Botrychium virginianum	Rattlesnake fern
Cystopteris fragilis	Fragile fern
Dennstaedtia punctilobula	Hay-scented fern
Dryopteris cristata	Crested wood fern
Dryopteris filix-mas	Male fern

Species	Common Name
Dryopteris intermedia	Spinulose wood fern
Dryopteris marginalis	Marginal shield fern
Dryopteris spinulosa	Spinulose wood fern
Gymnocarpium dryopteris	Oak fern
Onoclea sensibilis	Sensitive fern
Osmunda cinnamomea	Cinnamon fern
Osmunda claytoniana	Interrupted fern
Osmunda regalis	Royal fern
Polypodium virginianum	Rock polypody
Polystichum acrostichoides	Christmas fern
Pteridium aquilinium	Bracken fern
Thelypteris noveboracensis	New York fern
Thelypteris palustris	Marsh fern
Thelypteris phagopteris	Beech fern
Gymnosperms	
Juniperus communis	Common juniper
Juniperis virginiana	Red cedar
Larix decidua	Deciduous larch
Picea rubens	Red spruce
Picea sp.	Spruce
Pinus resinosa	Red pine
Pinus rigida	Pitch pine
Pinus strobes	White pine
Taxus canadensis	American yew
Tsuga canadensis	Hemlock

Appendix D: UNCOMMON PLANTS POTENTIALLY OCCURRING ON DWSP

PROPERTIES AND HABITATS IN WHICH RARE PLANT SPECIES ARE LIKELY TO BEFOUND (Searcy, 1996)

Uncommon Plants Potentially Occurring on DWSP Properties

NOTE: For Status, E = endangered, T = threatened, SC = special concern, WL = watch list

Family	**Species**	**Common Name**	**Status**	**Flowering**
Apiaceae	*Conioselium chinense*	Hemlock Parsley	SC	Jul/Sep
Apiaceae	*Sanicula trifoliata*	Trefoil Sanicle	WL	Jun/Oct
Asclepiadaceae	*Asclepias verticillata*	Linear-leaved Milkweed	T	May/Jul
Asteraceae	*Aster radula*	Rough aster	WL	Jun/Aug
Brassicaceae	*Arabis drummondii*	Drummond's Rock-cress	WL	May/Aug
Brassicaceae	*Arabis missouriensis*	Green rock-cress	T	Jul/Oct
Brassicaceae	*Cardamine bulbosa*	Spring Cress	WL	Jun/Aug
Caryophyllaceae	*Stellaria borealis*	Northern Stitchwort	WL	May/Aug
Cyperaceae	*Eleocharis intermedia*	Intermediate spikerush	T	Aug/Oct
Cyperaceae	*Scirpus ancistrochaetus*	Barbed-bristle bulrush	E	Jun/Jul
Fabaceae	*Lupinus perennis*	Wild Lupine	WL	May/Jul
Gentianaceae	*Gentiana andrewsii*	Andrew's Bottle Gentian	T	Apr/Jun
Gentianaceae	*Gentiana linearis*	Narrow-leaved Gentian	WL	Jun/Aug
Haloragaceae	*Myriophyllum alterniflorum*	Alternate leaved Milfoil	T	Jun/Aug
Juncaceae	*Juncus filiformis*	Thread rush	T	Aug
Lentibulariaceae	*Utricularia minor*	Lesser bladderwort	WL	May/Nov
Liliaceae	*Smilacina trifolia*	Three-leaved Solomon	WL	Apr/Jun
Loranthaceae	*Arceuthobium pusillum*	Dwarf mistletoe	SC	May/Sep
Orchidaceae	*Coeloglossum viride v. bracteata*	Frog orchid	WL	May/Sep
Orchidaceae	*Corallorhiza odontorhiza*	Autumn coralroot	SC	Apr/Jul
Orchidaceae	*Cypripedium calceolus v.parviflorum*	Small Yellow Lady Slipper	E	May/Aug
Orchidaceae	*Cypripedium calceolus v.pubescens*	Large Yellow Lady Slipper	WL	Jun/Sep
Orchidaceae	*Isotria medeoloides*	Small whorled pogonia	E	May/Jul
Orchidaceae	*Platanthera hookeri*	Hooker's Orchid	WL	Mar/Jun
Orchidaceae	*Platanthera macrophylla*	Large leaved Orchis	WL	Apr/Jul
Orchidaceae	*Platanthera. flava var. herbiola*	Pale Green Orchis	T	Jun/Sep
Orchidaceae	*Triphora trianthophora*	Nodding Pogonia	E	Jul/Sep
Poaceae	*Panicum philadelphicum*	Philadelphia Panic Grass	SC	Jul
Poaceae	*Trisetum pensylvanica*	Swamp Oats	T	Aug/Oct
Poaceae	*Trisetum spicatum*	Spiked False Oats	E	Jul/Sep
Ranunculaceae	*Ranunculus alleghaniensis*	Allegheny buttercup	WL	Jun/Sep
Sparganiaceae	*Sparganium angustifolium*	Narrow-leaved Bur Weed	WL	May/Nov
Urticaceae	*Parietaria pensylvanica*	Pellitory	WL	Aug/Sep

Habitats in Which Rare Plant Species are Likely to be Found

Working with the University of Massachusetts herbarium, the Division has also identified the following habitat/rare species relationships to assist in the development of more comprehensive lists.

Forested Areas:

Rich Mesic Woods (less acid - rich herbaceous layer. Indicators: *Acer saccharum*, *Fraxinus americana*, *Adiantum pedatum*, *Asarum canadense*)

Species	Common name	Comments
Acer nigrum	Black Maple	
Cerastium nutans	Nodding Chickweed	
Coeloglossum viride v. bracteata	Frog orchid	dry rocky woods
Corallorhiza odontorhiza	Autumn coralroot	dry/seasonally wet streamlets
Cypripedium calceolus v. pubescens	Large Yellow Lady Slipper	slopes and talus
Equisetum pratense	Horsetail	sandy places
Panax quinquefolius	Ginseng	talus and base of ledge areas
Platanthera hookeri	Hooker's Orchid	often rocky or swampy
Ranunculus alleghaniensis	Allegheny buttercup	rocky
Ribes lacustre	Bristly Black Current	
Sanicula canadensis	Canadian Sanicle	
Sanicula gregaria	Long-Styled Sanicle	
Sanicula trifoliata	Trefoil Sanicle	

Moist Coniferous / Pine Woods

Species	Common Name	Comments
Goodyera repens	Dwarf Rattlesnake Plantain	pine woods
Moneses uniflora	One-Flowered Pyrola	moist rich woods

Hemlock-Northern Hardwoods

Species	Common Name	Comments
Isotria medeoloides	Small whorled pogonia	vernally moist areas
Platanthera macrophylla	Large leaved Orchis	moist ravines, limey
Rhododendron maximum	Rhododendron	hemlock island in swamp
Triphora trianthophora	Nodding Pogonia	depressions under beech
Viola renifolia	Kidney Leaved Violet	damp rich woods

General Habitat:

Boulder/Talus Slope/Ledges

Species	Common name	Comments
Adlumia fungosa	Climbing Fumitory	Shaded limey talus
Amelanchier sanguinea	Roundleaf Shadbush	Ledges & ridge tops
Arabis drummondii	Drummond's Rock-cress	
Arabis missouriensis	Green rock-cress	open rock and scree
Chenopodium gigantospermum	Maple-leaf Goosefoot	shaded dry ledges
Clematis occidentalis	Purple Clematis	exposed ledges & talus
Parietaria pensylvanica	Pellitory	shaded shelves
Pinus resinosa	Red Pine	exposed, rocky ridge tops
Rosa blanda	Smooth rose	dry to mesic rocky slopes
Trisetum spicatum	Spiked False Oats	Exposed

Sandplain / Open Meadow

Species	Common name	Comments
Asclepias verticillata	Linear-leaved Milkweed	open rocky
Eragrostis capillaris	Lace Love Grass	open sandy soil
Gentiana andrewsii	Andrew's Bottle Gentian	open/meadow

Species	Common name	Comments
Liatris scariosa var novae-angliae	New England Blazing Star	sandy open pine wds.
Lupinus perennis	Wild Lupine	sandy open pine wds.
Paspalum setaceum	Paspalum	sandy soil
Penstemon hirsutus	Beard-Tongue	dry or rocky ground
Polygala verticillata	Whorled Milkwort	open woods/old field/stony shores

Aquatic Habitats:

Ponds / Streams

Species	Common name	Comments
Aster tradescantii	Tradescant's Aster	Fields/swamps
Betula nigra	River Birch	Swamps & stream banks
Cardamine longii	Long's Bitter-cress	Swampy streams
Eleocharis intermedia	Intermediate spikerush	Exposed shores
Juncus filiformis	Thread rush	Meadows/springs/riverbank
Megalodonta beckii	Water marigold	
Myriophyllum alterniflorum	Alternate leaved Milfoil	
Nuphar pumila	Tiny Cow-Lily	
Panicum philadelphicum	Philadelphia Panic Grass	Exposed shores
Scirpus ancistrochaetus	Barbed-bristle bulrush	Swales and shores
Sparganium angustifolium	Narrow-leaved Bur-Weed	
Sparganium fluctuans	Bur-Reed	
Utricularia minor	Lesser bladderwort	Seepy stream sides
Utricularia resupinata	Bladderwort	Swamps, swales, shores

Seeps / Seepage Areas

Species	Common name	Comments
Cardamine bulbosa	Spring Cress	
Conioselium chinense	Hemlock Parsley	Black ash seepage swamps
Cypripedium calceolus v. parviflorum	Small Yellow Lady Slipper	Black ash seepage swamps
Elatine americana	American Waterwort	Wet clay soil
Mimulus moschatus	Muskflower	Open seepage area
Pedicularis lanceolata	Lousewort	Open areas
Platanthera flava var. herbiola	Pale Green Orchis	Vernal streams in hardwoods
Stellaria borealis	Northern Stitchwort	
Trisetum pensylvanica	Swamp Oats	

Bogs / Boggy Areas

Species	Common name	Comments
Arceuthobium pusillum	Dwarf mistletoe	On Black Spruce
Arethusa bulbosa	Arethusa	
Aster radula	Rough aster	beaver meadows/swamp borders
Gentiana lineari	Narrow-leaved Gentian	boggy meadows
Scheuchzeria palustris	Pod Grass	
Smilacina trifolia	Three-leaved Solomon	boggy woods
Viola nephrophyll	Northern Bog Violet	
Xyris montana	Northern Yellow-eyed Grass	

Appendix E: STATE-LISTED VERTEBRATE SPECIES IN THE WARE RIVER WATERSHED

SPECIES	**SCIENTIFIC NAME**	**STATUS[1]**	**OCCURRENCE[1]**
AMPHIBIANS			
Blue-Spotted Salamander		SC	Probable
Marbled Salamander		T	Probable
Spring Salamander		SC	Probable
Four-Toed Salamander		SC	Documented
Eastern Spadefoot		T	Potential
REPTILES			
Spotted Turtle		SC	Probable
Wood Turtle		SC	Documented
Blanding’s Turtle		T	Probable
Eastern Box Turtle		SC	Documented
Copperhead		E	Historic
Timber Rattlesnake		E	Historic
BIRDS[3]			
Common Loon		SC	Potential
Pied-Billed Grebe		E	Potential
American Bittern		E	Documented
Least Bittern		E	Potential
Bald Eagle		E	Potential
Northern Harrier		T	Potential
Sharp-Shinned Hawk		SC	Probable
Cooper’s Hawk		SC	Probable
King Rail		T	Potential
Upland Sandpiper		E	Historic
Common Barn Owl		SC	Historic
Long-Eared Owl		SC	Probable
Short-Eared Owl		E	Historic
Sedge Wren		E	Historic
Golden-Winged Warbler		E	Historic
Vesper Sparrow		T	Probable
Grasshopper Sparrow		T	Probable
Henslow’s Sparrow		E	Historic
MAMMALS			
Water Shrew		SC	Probable
Southern Bog Lemming		SC	Probable

1 Species status in Massachusetts: SC= species documented to have suffered a decline that could threaten the species if allowed to
continue unchecked; T = species likely to become endangered within the foreseeable future throughout all or a significant portion of
its range; E = species in danger of extinction throughout all or a significant portion of its range.

2 Occurrence of species on Division land within the watershed: Documented =species actually observed; Probable =species not
documented, but given available habitat, species’ range, and/or observations within the watershed, they are likely to occur; Potential
=species not documented, and current habitat conditions may not be suitable, but with habitat enhancement they may occur; Historic=
species not documented, and current or future habitat conditions are not likely to support these species.

3 Occurrence of birds is limited to breeding pairs, not migratory or seasonal residents.

Appendix F: **Core Habitats and Rare Species**

Massachusetts Natural Heritage and Endangered Species Program (2004)

Core Habitat BM609

This Core Habitat contains a variety of wetlands, including a good example of a Level Bog natural community. The area also supports dragonflies, including species such as the Beaver Pond Clubtail dragonfly. Much of the this Core Habitat is within the Hubbardston Wildlife Management Area (Cunningham Pond Forest Reserve) *and further conservation of the remaining areas would help increase the amount of contiguous, protected habitat.*

Natural Communities

This Core Habitat contains a Level Bog with good-quality bog mats and an upland buffer of natural vegetation. Level Bogs are dwarf shrub peatlands, generally with pronounced hummock and hollow formations. These wetland peatlands are our most acidic and nutrient-poor, because they receive little overland water input, and are not connected to the water table.

Invertebrates

This Core Habitat delineates pond and bog habitats for rare dragonflies such as the Beaver Pond Clubtail, located in a relatively unfragmented landscape extending north from Moosehorn Pond along Mason Brook and Joslin Brook to Cunningham Pond. It is likely that this Core Habitat is inhabited by other rare invertebrates, such as the Slender Clearwing Sphinx moth and the Bog Elfin.

BM609

Natural Communites		**Status**
Level Bog		Vulnerable
Invertebrates	**Scientific Name**	**Status**
Beaver Pond Clubtail	*Gomphus borealis*	Special Concern

Appendix F. Fig. 1 Biomap and Living Waters Core Habitats in and near the Cunningham Pond Forest Reserve