MASSACHUSETTS FOREST RESERVES
LONG TERM ECOLOGICAL MONITORING PROGRAM

MIDDLEFIELD/PERU FOREST RESERVE

A report on the baseline characteristics of the Middlefield/Peru Forest Reserve and the proposed Intensive Monitoring Areas of the Middlefield/Peru Forest Reserve and the Peru State Forest

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Cover: Middlefield/Peru Forest Reserve, Middlefield State Forest (photo by Matthew Kelty).

PREFACE

State Forest land located in the towns of Middlefield and Peru 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 reserve system (EOEEA 2009).

The Middlefield/Peru 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 800-1000 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. The Peru State Forest has been selected as a non-Reserve match for the Middlefield/Peru Reserve. Both the Middlefield/Peru Forest Reserve and the Peru State Forest are under the supervision of the Massachusetts Department of Conservation and Recreation-Division of State Parks and Recreation (DCR).

Section 1 of this report begins with a description of the Middlefield/Peru 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 are summarized and discussed.

Section 2 presents a comparison of topography, bedrock, soils, and forest condition in the Middlefield/Peru Reserve and Peru State Forest Intensive Monitoring Areas. Analyses of baseline CFI data for these two areas are also included.

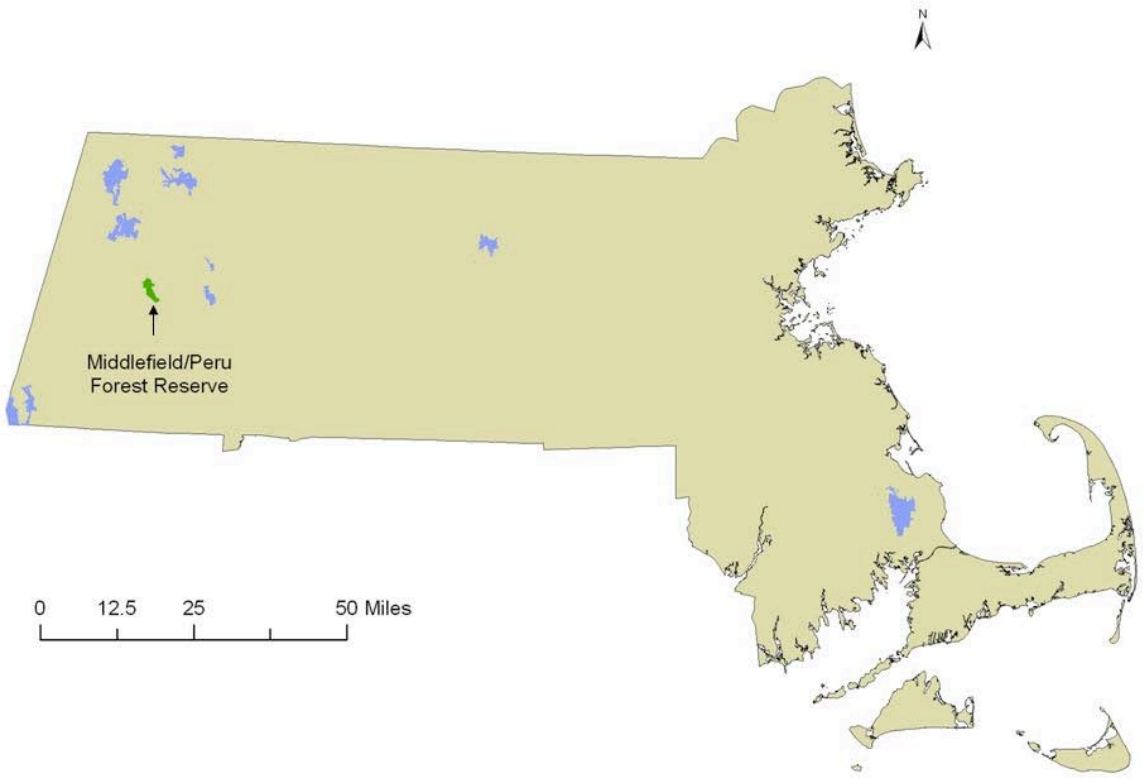

Fig. 1. Middlefield/Peru Forest Reserve (green). The other Large Forest Reserves are shown in blue (DCR 2008). All GIS analyses were completed in ArcGIS, version 9.3 (ESRI 2008).

SECTION 1: THE MIDDLEFIELD/PERU FOREST RESERVE

INTRODUCTION

The Middlefield/Peru Reserve is located on the Berkshire Plateau, primarily in the towns of Middlefield in Hampshire County and Peru in Berkshire County (Fig. 2). The Reserve occupies 3,165 acres within Middlefield State Forest and Peru State Forest (all area estimates are based on GIS analyses, unless otherwise noted). The largest Forest Reserve parcel covers 2,570 acres in Middlefield State Forest. There are seven additional Reserve parcels, one 33 acre parcel in the western portion of Peru State Forest, four in the eastern portion of Peru State Forest in the town of Worthington (from east to west measuring 47, 98, 229, and 28 acres) and two in smaller sections of the Middlefield State Forest to the south (146 and 11 acres). This report focuses on the 2,570 acre Forest Reserve parcel. Peru State Forest is located to the east, in Middlefield, Peru, and Worthington, and is separated from Middlefield State Forest by Middlefield Road (Skyline Trail). The Middlefield State Forest and Reserve area are drained by Factory Brook, which forms the eastern boundary for a part of the Reserve (MassGIS 2000).

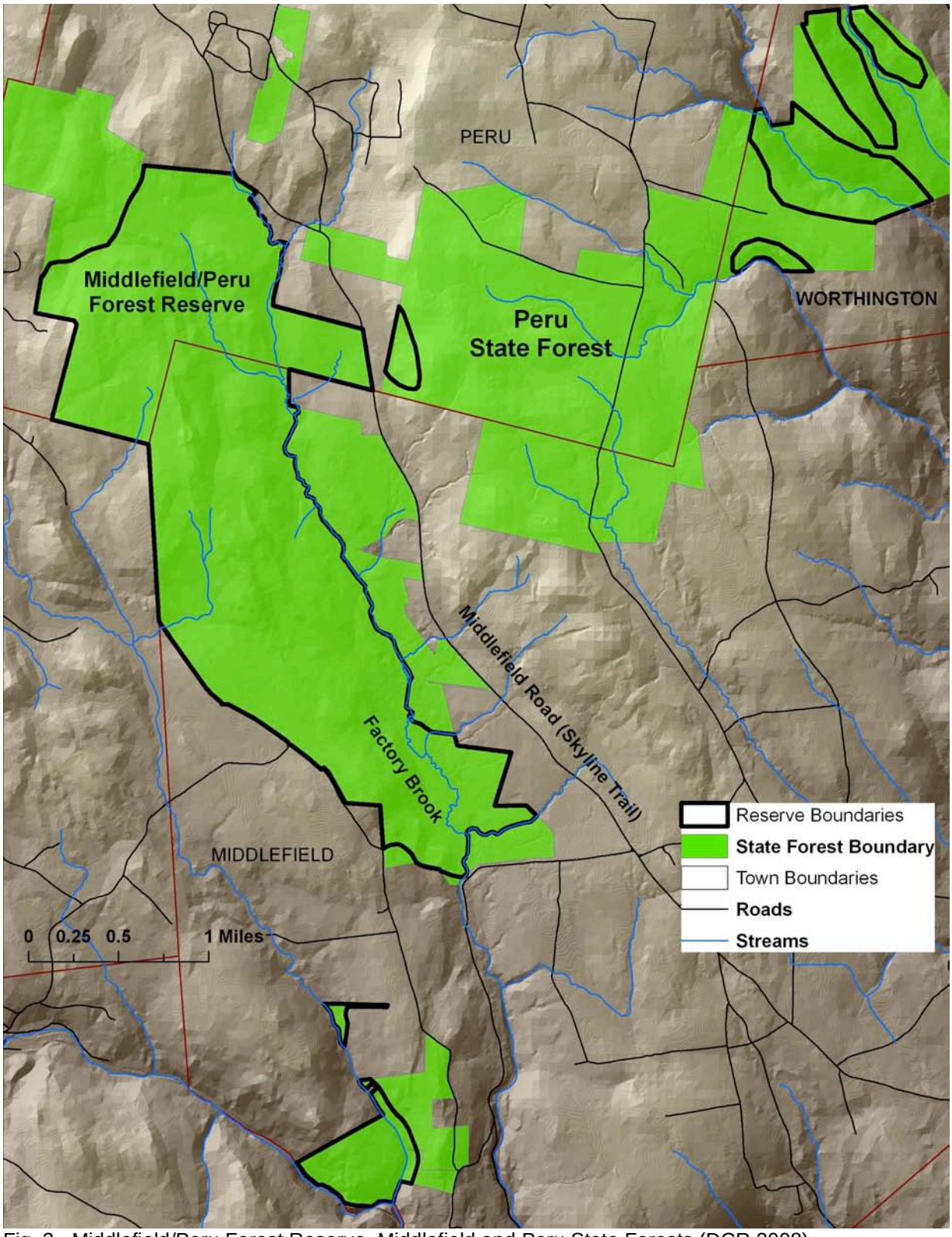

Fig. 2. Middlefield/Peru Forest Reserve, Middlefield and Peru State Forests (DCR 2008).

The Middlefield/Peru Forest Reserve falls within the Berkshire-Vermont Uplands Subsection, an ecoregion classification of the U.S. Forest Service and the basis for Massachusetts state ecoregions (Fig. 3). Finer scale divisions within the subsections are identified as Land Type Associations (LTAs). The Middlefield/Peru Forest Reserve covers parts of two LTAs: the Berkshire Uplands Mid-Elevation (1,000 – 1,800 ft.) LTA and the Berkshire Uplands Upper-Elevation (>1,800 ft.) LTA. These LTAs correspond to the Northern Hardwoods-Hemlock and Northern Hardwoods-Spruce forest types respectively (Keyes and Carpenter 1995, de la Crétaz and Kelty 2008).

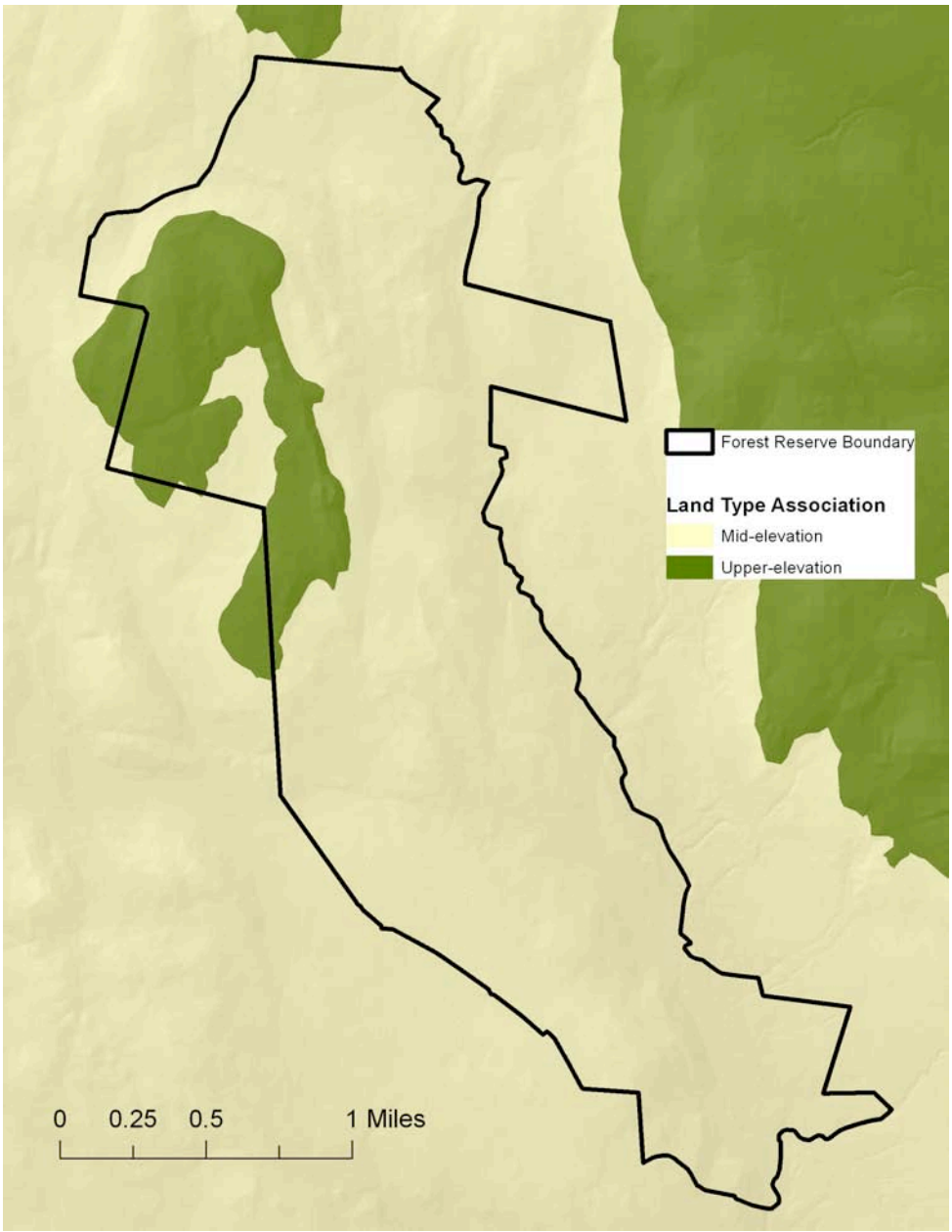

Fig. 3. Land Type Associations of the Middlefield/Peru Forest Reserve (de la Cretaz and Kelty 2008).

Associated Open Space

Within a 2-mile buffer extending from the outer boundary of the Forest Reserve, 27% of the area (5,870 acres) is permanently protected open space (Fig. 4) (MassGIS 2009(a)). This includes 5,160 acres that are owned by the State. Of this area, 2,945 acres, including Peru State Forest, are managed by the Department of Conservation and Recreation (DCR) and 2,215 acres are managed by the Department of Fish and Game – Division of Fish and Wildlife. The remaining 710 acres are owned and managed by NGOs, including the New England Forestry Foundation and The Nature Conservancy and a number of private landowners who have protected their land through the Berkshire Natural Resources Council.

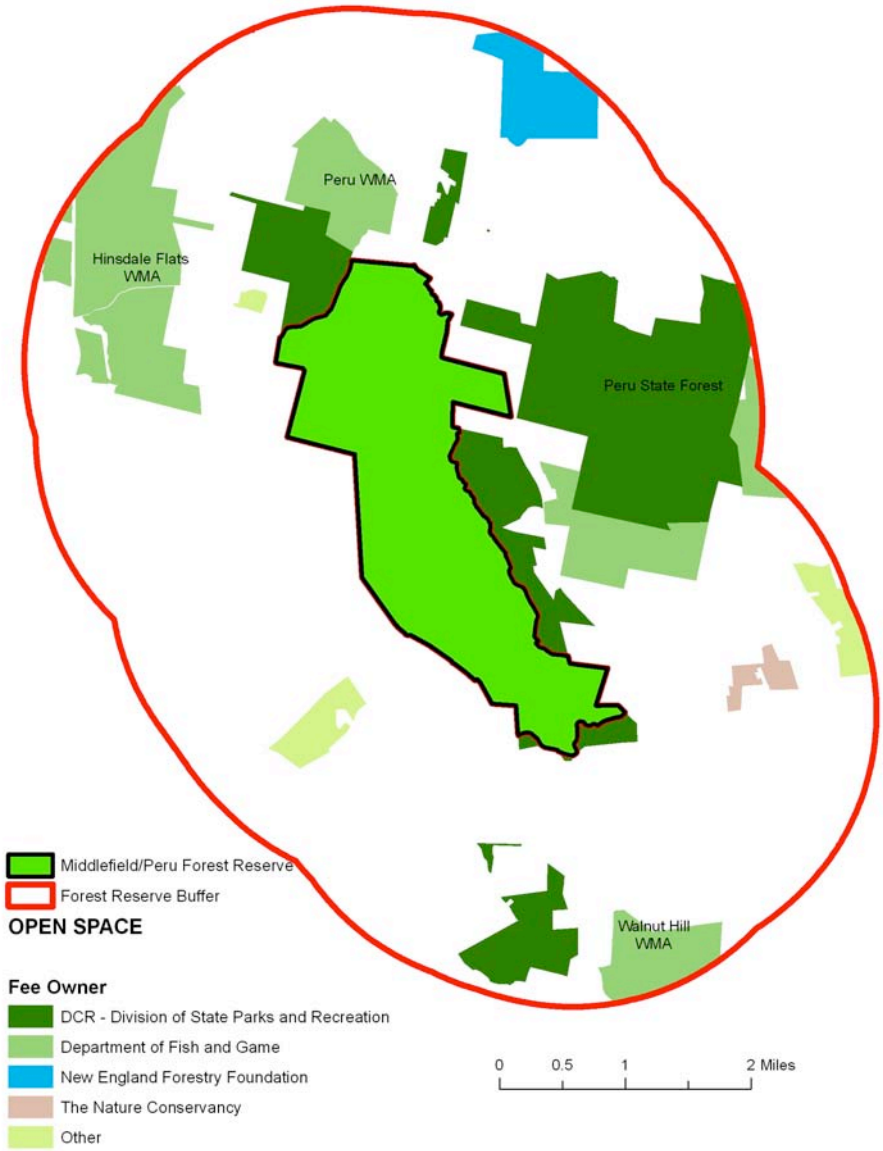

Fig. 4. Permanently protected open space within a buffer area extending 2 miles from the Middlefield/Peru Forest Reserve boundary (MassGIS 2009(a)).

PHYSICAL FEATURES

Topography

Elevations within the Reserve range from 1,310 feet at the southern boundary of the Reserve to the 1,940 feet in the northwest corner of the Forest Reserve, a difference of 630 feet between the lowest and highest points in the Reserve. Relief also is limited in scale. Slopes are less than 25% for the most part with occasional inclines between 25 and 60% (Fig. 5). Only rarely do slopes exceed 60%.

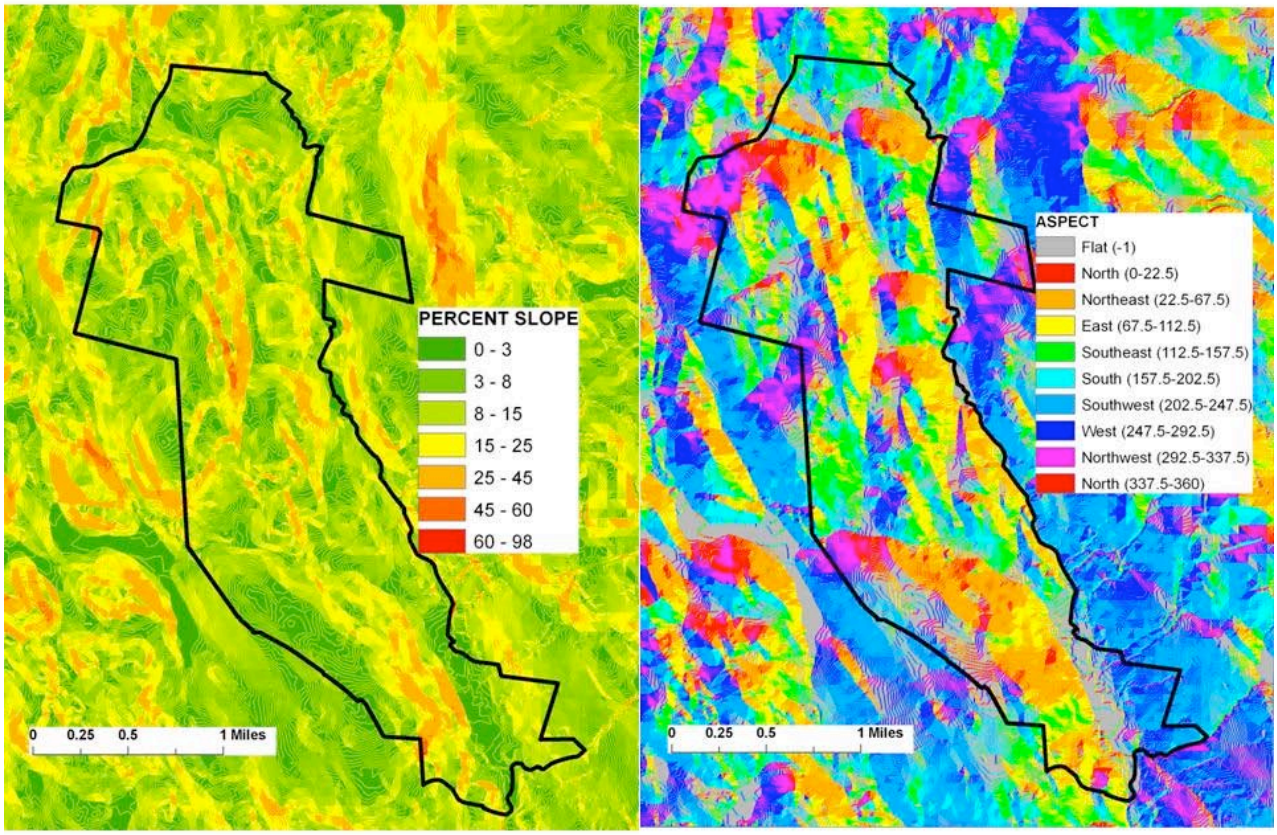

Fig. 5. Percent slopes (left) and aspect (right), Middlefield/Peru Forest Reserve.

Bedrock Geology

The Middlefield/Peru Reserve is located at the eastern edge of a geologic formation known as the Berkshire Massif. The Berkshire Massif is composed of rocks that formed over 1 billion years ago during the Grenville mountain-building event. During this time, Laurentia, the core of the North American continent collided with other continental plates to form the supercontinent of Rodinia. The immense pressure of the colliding continents metamorphosed volcanic and sedimentary material, lying deep below the surface into gneiss. Magma intruded into pockets in the rock formations, producing new granite deposits. Five-hundred million years later, Rodinia had broken up as Laurentia and the other continents drifted apart.

Four hundred and fifty million years ago, during the Taconic mountain-building event, Laurentia collided with a series of off-shore volcanic islands chains. The collision pushed the Precambrian Grenville gneiss upwards. These ancient, erosion-resistant rocks underlie the upland forests of the Berkshire Massif. To the east of the Berkshire Massif, successive thrust sheets of sedimentary and volcanic material, pushed up against the erosion resistant gneiss, forming a series of north-south oriented, eastward-sloping geologic formations (Fig. 6).

The Middlefield/Peru Forest Reserve lies primarily on the granitic gneiss of the Berkshire Massif (Fig. 6, Fig. 7, Table 1). To the east, the Hoosac Formation is composed of mica schist, gneiss and phyllite (Zen et al. 1983, Skehan 2001). The bedrock in this area is primarily acidic and there are no dramatic differences in forest type attributable to bedrock characteristics.

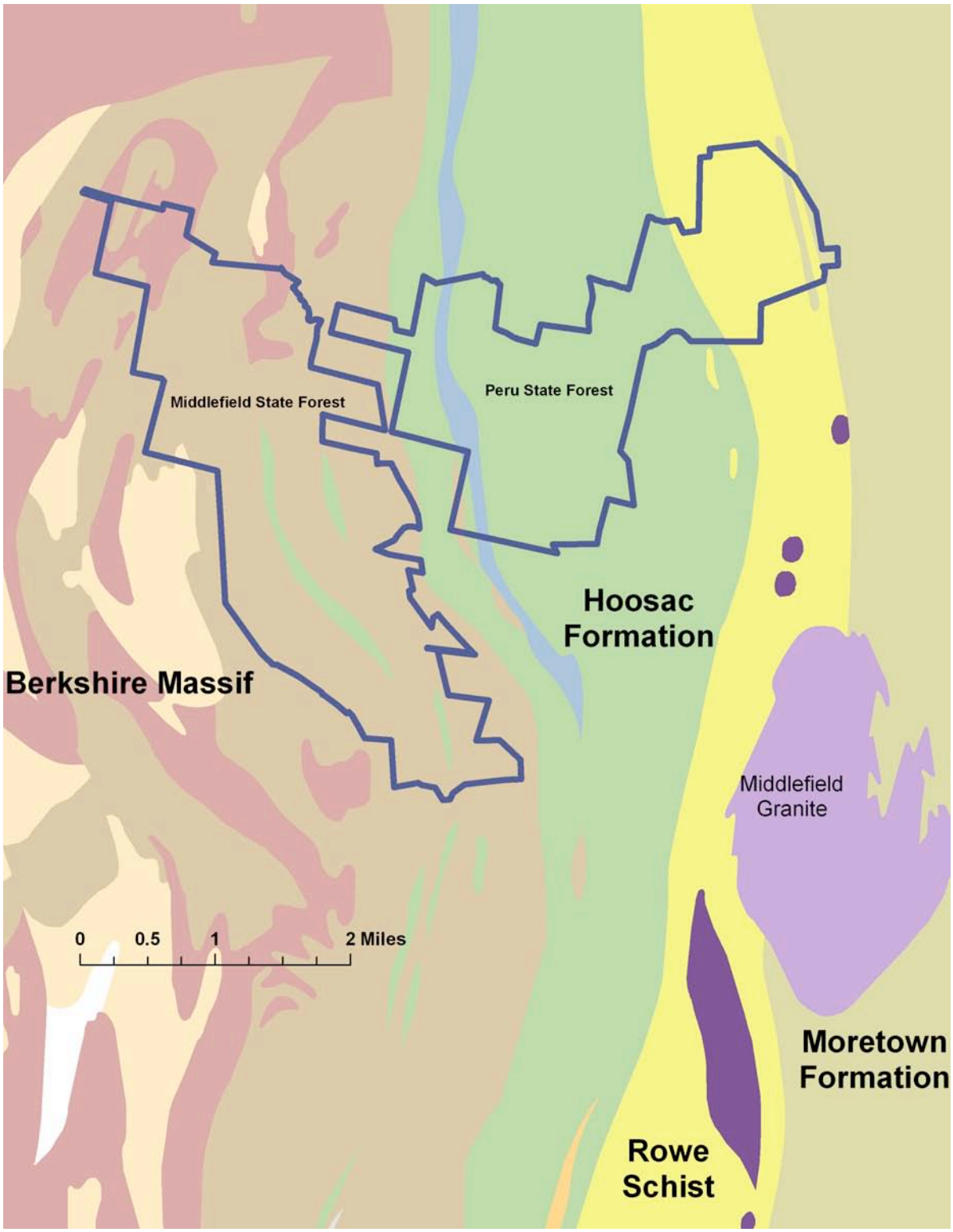

Fig. 6. Bedrock of the Berkshire Plateau. The Berkshire Massif (tan and pink) is composed of erosion resistant, Precambrian, granite, gneiss, and schist. The Hoosac Formation (green), Rowe Schist (yellow) and Moretown Formation (light tan) to the east are composed of metasedimentary schist with volcanic intrusions (shown in purple) (Zen et al. 1983).

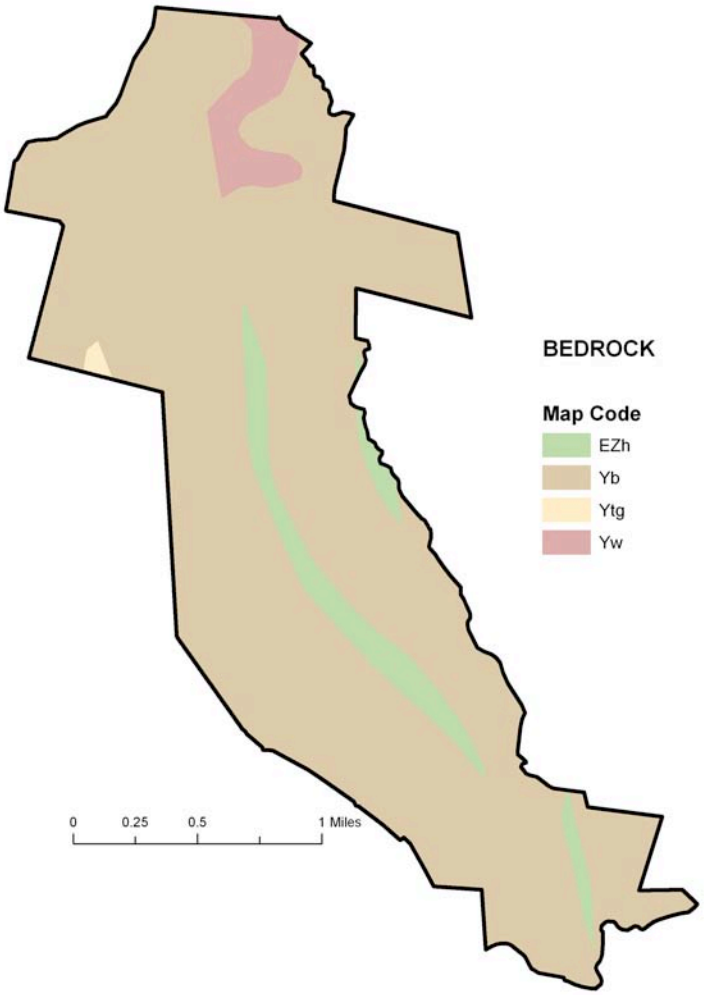

Fig. 7. Middlefield/Peru Forest Reserve Bedrock (Zen et al., 1983).

Table 1. Middlefield/Peru Reserve Bedrock Description (Zen et al. 1983).

Map Code	Rocktype	Area (%)	Formation	Rock Type
EZh	Schist, gneiss, phyllite, conglomerate, granofels, calc-silicate rock	6	Hoosac Formation - undifferentiated	Metamorphic
Yb	Granitic gneiss, amphibolite, quartzite, gneiss	90	Gray, well-layered biotite-plagioclase-quartz gneiss	Igneous
Ytg	Granitic gneiss	<1	Tyringham Gneiss	Igneous
Yw	Mica schist, conglomerate	4	Washington Gneiss	Metamorphic

Surficial Geology and Soils

There have been repeated episodes of glaciation in New England during the past one million years. Mountains of ice have advanced from the north, scraping away existing material and retreated, leaving massive amounts of debris behind (glacial drift). During the last glaciation, the Hudson Valley lobe, an extension of the Wisconsinan ice sheet, moved south into Massachusetts, covering the Berkshire Hills to a depth of more than 1,000 feet. At its greatest extent, 23,000 to 22,000 years ago, the southern border of the ice sheet reached Northern New Jersey and Long Island, NY. The glacial lobe moved in a southeasterly direction and melted back in the opposite direction. Current river drainages in the Berkshires and the Berkshire foothills flow generally to the southeast following the path of glacial advance and recession (Skehan 2001).

The recession of the glaciers, which continued until about 12,000 years ago, exposed a landscape covered with thick deposits of rocks, sand, and gravel left behind by the melting ice. Glacial drift can be divided into different types, based on the size and range of sizes of the particles. Glacial till, created by the grinding movement of the glaciers over bedrock, consists of poorly-sorted material, particles of many different sizes, including clay, sand, gravel, rocks and boulders. Glacial outwash is deposited by fast-flowing meltwater and consists of well-sorted sand and gravel of fairly uniform size. The Middlefield/Peru Reserve is covered with deposits of glacial till (Skehan 2001). Glacial meltwaters created a small area of sand and gravel outwash deposits along the Factory Brook stream channel in the southern portion of the Reserve (MassGIS 1999).

Soils in the Middlefield/Peru Reserve developed on glacial till derived from granite, gneiss, and schist. Soils belonging to the Lyman-Tunbridge-Peru Association cover approximately 75% of the area in the Middlefield/Peru Reserve (Fig. 8, Table 2). The Lyman, Tunbridge, and Peru soil series are classified as spodosols. Spodosols are acid, sandy, nutrient poor, leached soils that form in acidic glacial till in cold, wet environments, typically under forests. Spodosols are characterized by an E or eluviated horizon, below the organic (O) horizon at the surface. Clay, iron, and aluminum oxides have leached out of the E horizon, leaving a soil layer that is light-colored and contains only resistant minerals such as quartz (Scanu 1995, Brady and Weil 2002).

Lyman soils are shallow (depth-to-bedrock range, 10 to 20 inches) and somewhat excessively drained. They are typically found on rocky hills, mountains, and high plateaus (NCSS 2007). Tunbridge soils are moderately deep with a depth to bedrock of 20 to 40 inches and well drained (NCSS 2008). Peru soils are very deep and moderately well drained with a dense substratum at 24 to 65 inches (NCSS 1998). The Marlow soil series is also classified as a spodosol and covers less than 1 percent of the land area (NCSS 2001). The Pillsbury soil series covers most of the remaining area. Pillsbury soils are very deep, poorly drained soils that form on uplands. They are classified as inceptisols – young soils showing little soil development (NCSS 1997). The Palms soil series, very poorly drained soils that developed on outwash deposits, cover less than an acre in the northwest corner of the Reserve area (NCSS 2003). Soils in the outwash area at the southern tip of the Reserve are classified as Pillsbury soils.

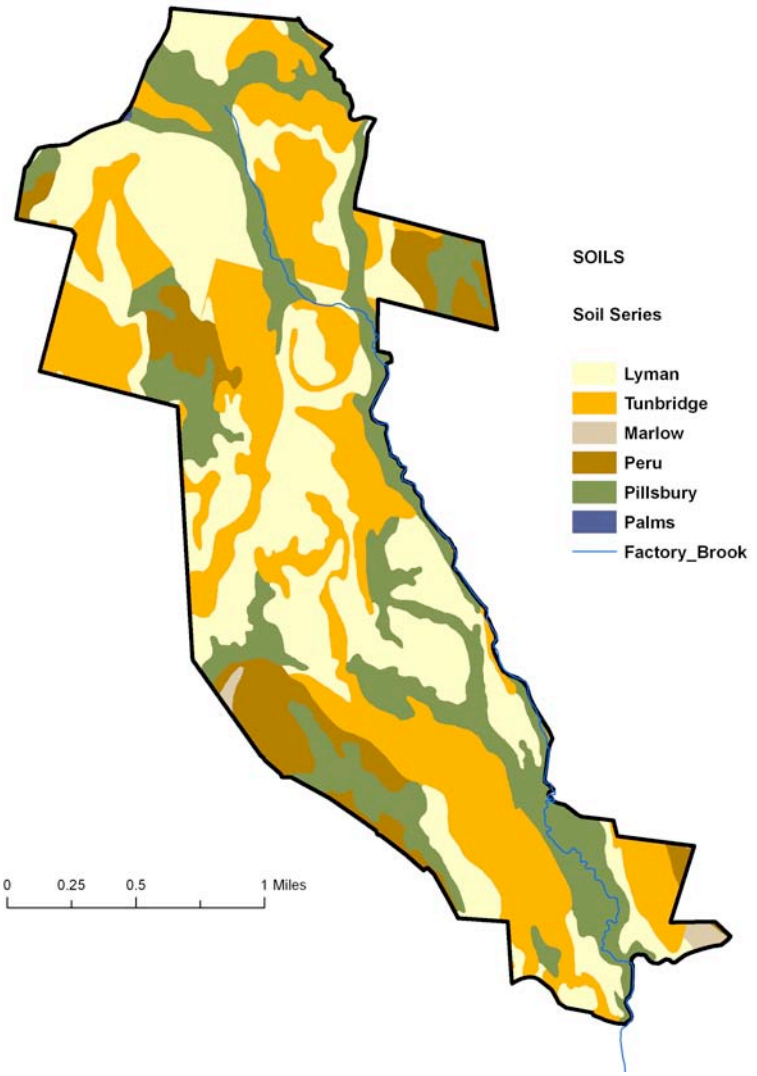

Fig. 8. Soils, Middlefield/Peru Forest Reserve. (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 1999, 2004).

Table 2. Soil Series, Middlefield/Peru Reserve (NCSS 2007, 2008, 1998, 2001, 1997, 2003).

Series Name	Soil Characteristics	Area (%)
Soils formed in glacial till		
Lyman	Shallow, somewhat excessively drained	34
Tunbridge	Moderately deep, well drained	33
Peru	Very deep, moderately well drained	8
Marlow	Very deep, well drained	<1
Pillsbury	Very deep, poorly drained	24
Soils formed in outwash deposits		
Palms	Moderately deep, very poorly drained	<1

Climate

Climate on the Berkshire Plateau is characterized by cold winters and moderately warm summers with occasional hot spells. The nearest weather station is in Cummington Hill (elevation 1,607 feet) located 18 miles to the north and east of the town of Middlefield.

Table 3. Mean Temperature and Precipitation, Cummington Hill MA (World Climate 1996).

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
[1]Temp.˚F	19.9	22.1	31.5	42.4	54.0	62.6	67.3	65.7	58.3	48.2	37.0	24.6	44.4
[2]Precip. Inches	3.6	2.9	3.0	4.0	5.0	3.6	4.9	4.6	4.0	3.9	3.9	3.7	47.2

[1]Temperature derived from National Climatic Data Center, NCDC TD 9641 Clim 81 1961-1990 Normals. 30 years between 1961 and 1990.
[2]Precipitation from NCDC Cooperative Stations.16 complete years between 1963 and 1994.

Disturbance History

As in other areas of the Berkshires, the Middlefield/Peru Forest Reserve and surrounding forest are subject to damage from windstorms (hurricanes) and winter snow and ice. The Middlefield-Peru area has been relatively free from natural disturbance (CFI Data 2000, MassGIS 1997). Some damage from pear thrips was observed in 1987 and 1988 affecting about 300 acres in the northern portion of Middlefield State Forest in 1987 and 150 acres in the southern portion in 1988. CFI sampling of individual trees has recorded damage from beech bark disease, cherry black knot, sawflies, white pine weevil, and birds (DCR 2000).

Pest and Pathogen Information

Beech bark disease results when bark, attacked and altered by the beech scale insect (*Cryptococcus fagisuga*), is invaded and killed by fungi, primarily *Nectria coccinea* and sometimes *Nectria galligena*. Beech bark disease causes significant mortality (Houston and O'Brien 1983).

Cherry black knot (*Apiosporina morbosa*) is a fungal disease affecting black cherry that causes the development of warty black galls ranging in length from ½ inch to more than 1 ft. The infected trees decline and become more symptomatic with each growing season. The infection stresses the entire tree causing it to weaken, decline, and possibly die. The stress placed on the tree may also make it susceptible to infections by other pathogens. Occasionally knots grow large enough to girdle a branch and kill it. Trees with multiple infections become dwarfed and misshapen (Cornell Plant Diagnostic Clinic 2007).

Pear Thrips (*Taeniothrips inconsequens*) were first identified as agricultural pests that attacked fruit trees. They have been considered a serious forest pest since 1979. Adult pear thrips emerge from the soil in the spring. They feed on the buds and emerging leaves of sugar maple, birch, ash, black cherry, and beech, and then lay their eggs in the veins and petioles of the leaf epidermis leaving brown scars. Symptoms can include fallen green leaves, leaves that are smaller than normal, and cholorotic and tattered leaves. The leaf margins are frequently browned or wilted. Trees generally recover once the pear thrip population crashes. Growth decline and crown dieback can occur during especially long-lasting outbreaks (O'Brien and Snowden 1989).

Sawflies are a group of insects related to wasps and bees. Their name is derived from the saw-like ovipositor the adult female uses to lay eggs. Adult sawflies are inconspicuous wasp-like insects that do not sting. Sawfly larvae look like hairless caterpillars. There are a number of sawfly species, each preferring specific plants or groups of plants. The larvae often feed in groups and can quickly defoliate portions of trees (Wawrzynski 2009)**.**

White pine weevil (*Pissodes strobi*) is a native insect attacking eastern white pine. Adults hibernate in the duff underneath host trees, emerge in early spring, and crawl up the trunk of the host tree, where males and females begin feeding just below the terminal bud cluster. Females lay their eggs in egg cavities starting just below the terminal bud cluster and extending down the upper half of the terminal shoot. After the eggs hatch, larvae burrow under the bark of the terminal shoot where they continue feeding. Following metamorphosis, the adult beetles emerge from the pupae and continue feeding on the buds and bark tissue of stems and branches. Weevil attacks result in growth reduction (each weevil attack reduces tree height growth by 40 to 60% in that year), stem deformation, increased susceptibility to wood decay organisms, and tree mortality, although mortality is rare and usually occurs only in small trees (less than 4 ft tall) (Hamid et al. 1995).

LAND USE HISTORY

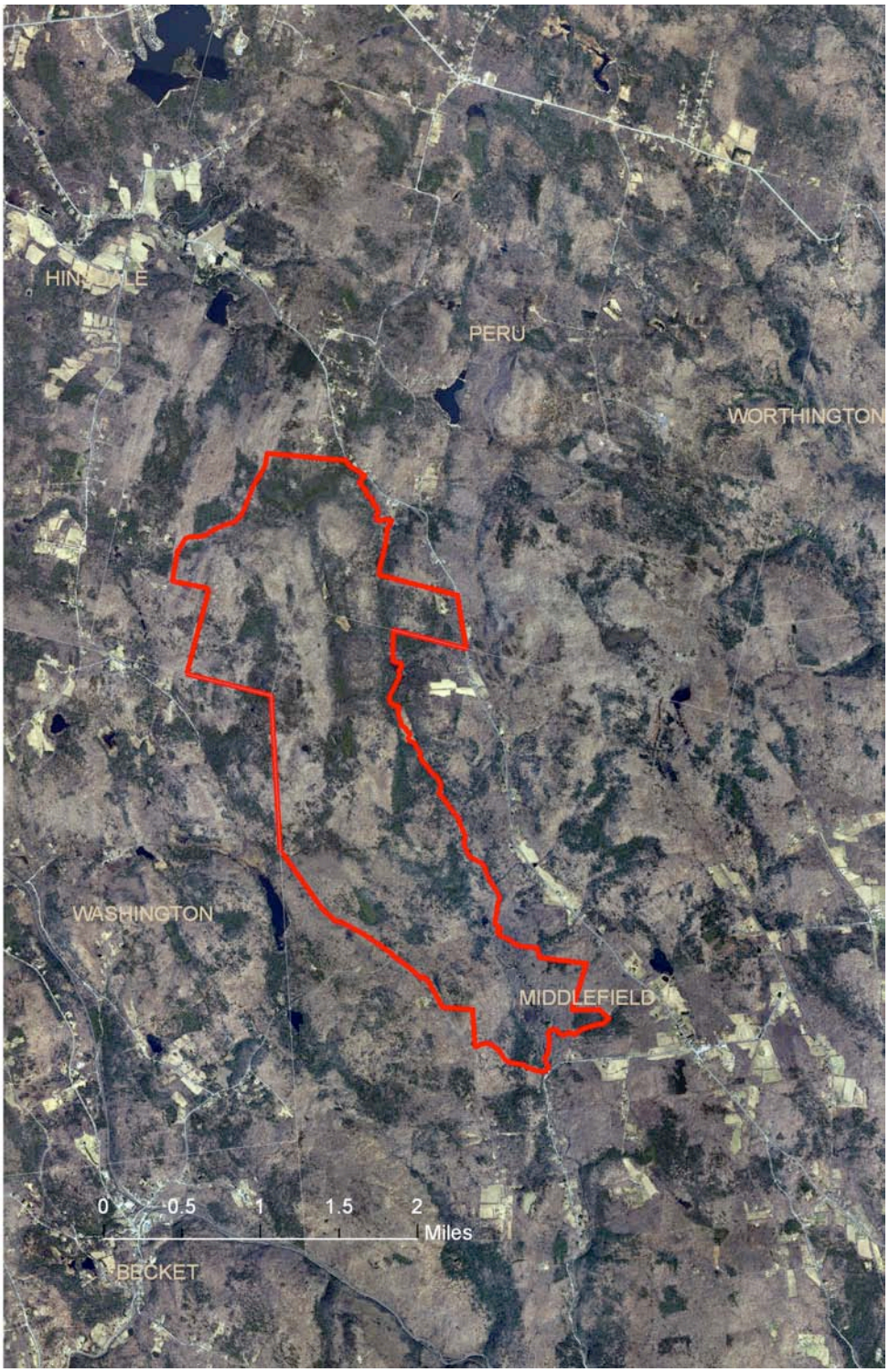

Fig.9. Orthophotos of the towns of Middlefield, Peru, Washington, and Hinsdale (MassGIS 2005) with the Forest Reserve boundary shown in red.

The towns of Middlefield and Peru were originally used by the indigenous Mahican and Woronoake peoples, primarily for hunting. There are no lakes or navigable streams and it is unlikely that this area, high on the Berkshire Plateau, was ever home to large or permanent settlements of indigenous peoples. In 1760, the General Court of Massachusetts purchased a tract of land for 10 townships, in eastern Berkshire and western Hampshire Counties from a Mahican tribe based in Stockbridge for £1700 (Cook and Cook 1964).

The town of Middlefield was incorporated on March 12, 1783 with a population of 60 settlers, described as farmers of moderate means. The population grew rapidly with an influx of settlers in the late 18th century, reaching 877 in 1800. The forest was cleared and much of the land was used as pastureland for cattle and sheep (Fig. 10). There were 9,849 sheep in the town in 1845. Local industries included a dozen sawmills, woolen mills, a paper mill, facilities for making charcoal, and four sets of broadcloth machinery. A dam was built in Blush Hollow, 0.4 miles south of the Reserve border to provide water power for the many local industries. The reservoir created by the dam covered 50 acres. When it burst in 1874, most of the manufacturing plants were washed away. The dam was rebuilt, but washed away again in 1901 and was never replaced (Cook and Cook 1964). Much of the former reservoir land is now included in the State Forest. Following the flood of 1901, the population declined from a high of slightly over 1,000 persons in the late 1800s. A town history written in 1964 (Cook and Cook), described the town as follows:

> *As a farming community, Middlefield seems to have gone into a decline. More and more young people who have had the advantage of higher education are seeking futures in other fields, while those outside the community who purchase property here are looking for homes rather than farms. Some of the land, so carefully cleared by the forefathers of Middlefield is growing up to brushland.*

Peru was originally known as Northern Berkshire Township No. 2, Partridgefield. The land was purchased by Governor Francis Bernard, Oliver Partridge and Elisha Jones as a land speculation in 1762. It was divided into 63 lots and was incorporated in 1771. It remained Partridgefield until 1805 when the name Peru was selected (New-England Historic Genealogical Society 1902, The BerkshireWeb no date given). Like Middlefield, it was a town of small farms and local industry, including sawmills and a cheese factory. Peru was described in 1939 as one of three dwindling towns along with Windsor and Savoy that exemplified the life of "old New England". At that time, Peru was still a farming community although on a diminished scale; the population had dropped to 151 from a high of 1,361, recorded in 1800 (Federal Writer's Project 1939).

The land use history of both Middlefield and Peru follows a scenario that is typical for upland forest communities in western Massachusetts and much of New England. Forests were cleared for agriculture in the latter part of the 18th and beginning of the 19th century as settlers moved into these areas. The growth of upland communities was followed by the development of local industry and associated use of forest products.

Industrial development produced wide-spread deforestation as woodlots were harvested for fuel, timber, and charcoal. The development of new technology that allowed the use of wood pulp as the basic material in paper manufacturing led to more harvesting in the 1870s and 1880s (Gordon 1998). The high level of commercial activity in the mid-19th century was followed by a period of decline as resources were depleted and competition from agricultural and industrial products produced in the Mid-West increased. This led to farm abandonment, factory closings, and declining populations. Populations have grown somewhat in recent years as more people with jobs in the larger cities and towns in the Housatonic, Hoosic, and Connecticut River valleys, east and west of the Berkshire Plateau have established homes in these rural areas. The area remains however, relatively sparsely populated. In the 2000 Census the population of Middlefield was 542 and the population of Peru was 821 (Fig. 9) (MassGIS 2009(b)), U.S. Census 2000). Much of the brushland described in 1964, has become second-growth forest. In 1999, the town of Middlefield was 90 percent forested; Peru was 92 percent forested (MassGIS 2002; Berkshire Links 2007).

The Commonwealth of Massachusetts acquired a few hundred acres of land in the Middlefield area in the 1930s. Between 1958 and 1967, 5 parcels ranging in size from 85 to 350 acres were added to the Middlefield State Forest. A single acquisition of 1,143 acres in 1973 increased the total area of the State Forest to 2,540 acres. Since that time additional small parcels have been added increasing the total area of the forest to almost 3,300 acres. The land that now makes up Peru State Forest was acquired earlier, in the 1920s and 1930s. By 1932, the State Forest area totaled 2,600 acres, resulting from the acquisition of 14 parcels of land. An additional 714 acres in Worthington were added to the State Forest between 1958 and 1969. This, plus 107 acres purchased in 1992 has brought the current acreage to about 3,400 acres (DCR Deed Database 2008).

There have been two timber harvests greater than five acres within the Middlefield/Peru Reserve boundaries since 1984 (McDonald et al. 2006). The larger of the two cuts covers 176 acres and took place in 1987. A smaller area (15 acres) was cut in 2003. Both cuts were located in the southern portion of the forest (Fig. 11). Two additional areas on the Reserve boundaries, one covering three acres and another of less than one acre are also identified in the cutting plan records.

Fig. 10. Stonewalls and early successional forest in the Middlefield/Peru Forest Reserve are evidence of past clearing and agricultural landuse (photo by Lena Fletcher).

FOREST TYPES

In 2003, the DCR completed the "Land Cover Classification Project", including forest type mapping of all Massachusetts State Forests. GIS digital forest-type data were derived from 1:12,000 scale, leaves-on, color infrared aerial photographs. The digital data and aerial photography were provided by the James W. Sewall Company of Old Town, Maine (DCR 2003). Forest cover for the Middlefield/Peru Reserve is summarized by area in Table 4 and illustrated in Figure 11.

The forest within the Middlefield-Peru Forest Reserve falls predominately within the northern hardwoods-hemlock-white pine forest type with a few areas of red spruce and spruce-fir at higher elevations. There is one oak-hardwood stand covering about 13 acres. Sugar maple is shown separately from other northern hardwoods in Figure 11 because this species is considered a rich site indicator.

Descriptions of Core Habitats and rare species (NHESP 2004) are provided in Appendix C.

Table 4. Forest Types, Middlefield/Peru Forest Reserve (DCR 2003).

Forest Type	Area (%)
Northern Hardwoods	59
Sugar Maple	3
Oak-Hardwoods	1
Hemlock-Hardwoods	21
Red spruce	8
Spruce-Fir	1
White pine-Hardwoods	3
Forested wetland	1
Open wetland	4

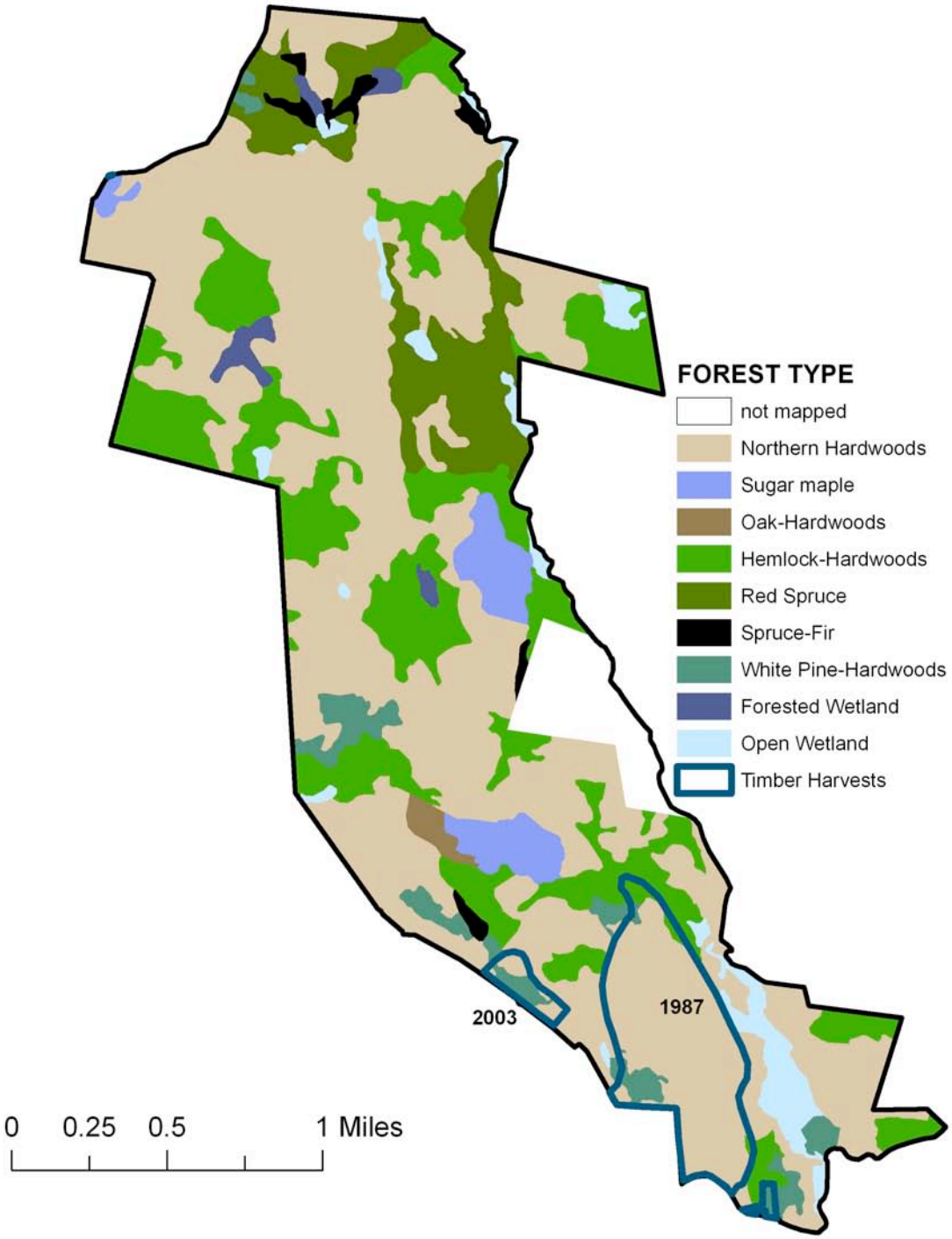

Fig. 11. Middlefield/Peru Forest Reserve, Forest Type Map, indicating predominant overstory species and timber harvests 1984-2003 (DCR 2003, McDonald et al. 2006). The white area was not part of the State Forest at the time the mapping was done.

CONTINOUS FOREST INVENTORY (CFI) DATA

The Continuous Forest Inventory (CFI) plots were established by Massachusetts state forestry agencies in the late 1950s. These are permanent 0.20-acre plots, laid out on a 0.5-mile square grid on all state forests and most state watershed protection land (Rivers 1998) (Fig. 12). Plot measurements were completed in 1960, 1965, 1980, and 2000. Data include plot descriptors and measurements of all trees > 5.0 inches dbh (diameter at breast height). Deadwood and understory sampling were added in 2000 (Rivers 1998). Future sampling is planned at 10-year intervals. All analyses are based on the 2000 CFI dataset (DCR 2000). The CFI data were analyzed using SAS 9.1.3 Statistical Software (2004).

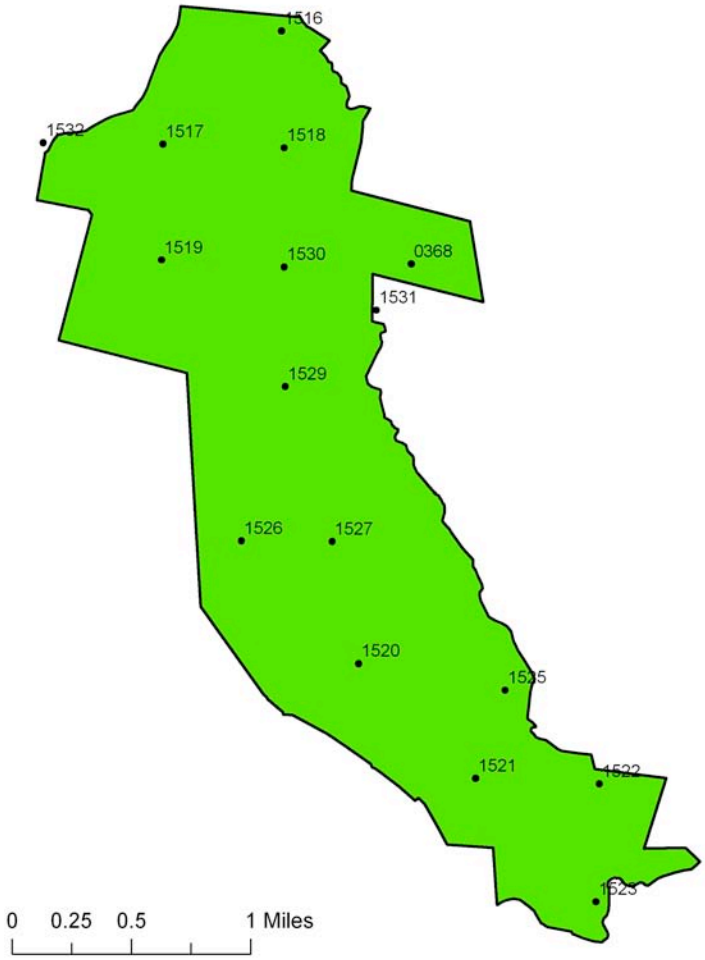

Fig. 12. Continuous Forest Inventory (CFI) Plots, Middlefield/Peru Forest Reserve. There are 15 plots that fall within the boundaries of the Middlefield/Peru Forest Reserve. Three of the 15 plots were established in 1960. Plot 1516 is shown on the map but there is no data recorded for this plot.

Forest Age and Disturbance History

CFI plot ages are determined by coring 1-3 overstory trees located just outside the boundaries of each plot (Table 5). CFI plots in the Middlefield/Peru Forest Reserve are between 62 and 91 years old, reflecting the area's recent agricultural history.

Table 5. Plot age summary, Middlefield/Peru Forest Reserve CFI plots (DCR 2000).

Age (years)		**# Plots**
60-70		7
71-80		3
81-90		2
91-100		2[a]
	Total Plots	14[b]
	Age Range	62 - 91

[a]Plot 1527 (Middlefield/Peru) age listed as 915 (assume this is 91).
[b]Plot 1531 (Middlefield/Peru) – is identified as a beaver pond, no age given.

The CFI methods allow only one disturbance to be entered for each plot at each measurement date. The disturbance recorded may be the most recent disturbance or the most important disturbance to have affected the plot (e.g., if a plot was damaged by a windstorm in 1970 and then harvested in 1990, the recorded disturbance would have been changed from "wind" to "harvest cut" in the 2000 sampling). Therefore, the data do not represent a complete disturbance history of the plot. Two dates are given for disturbances in the Middlefield/Peru Forest Reserve. One plot was affected by disease in 1999 and a harvest cut occurred on one plot in 1985. Dates for the other two plots affected by disease were not entered in the data. A complete disturbance record by plot is given in Appendix B.

Table 6. Summary of disturbances, Middlefield/Peru Forest Reserve (DCR 2000).

Disturbance Type			
Code	**Description**		**# Plots**
0	None		11
1	Fire		0
2	Wind		0
3	Snow & Ice		0
4	Other use, cleared		0
5	Other use, pastured		0
6	Insects		0
7	Disease		3
8	Timber stand iMPFRovement		0
9	Harvest cut		1
		Total Plots	15

Live Trees

Size distribution in the Middlefield/Peru Forest Reserve follows a typical inverse-J curve with larger numbers of trees in the smaller size classes (Fig. 13). The number of trees/acre declines progressively as dbh increases. Mean stand density based on data from 15 plots for the Middlefield/Peru Forest Reserve for trees >5 inches dbh is 213.2 ± 30.3 stems/acre (95% confidence interval). Mean stand density for large trees (greater than 20 in. dbh) is 3.0 ± 2.4 stems/acre.

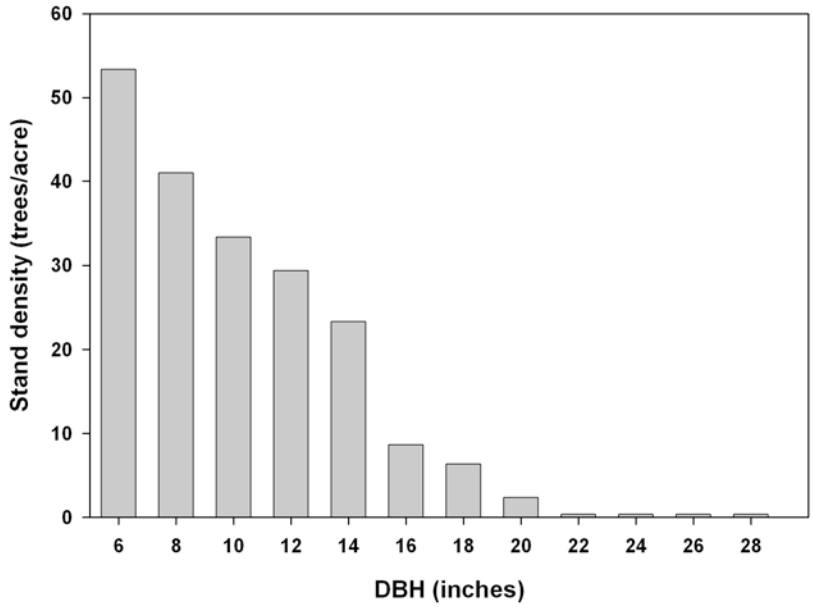

Fig. 13. Mean stand density (trees/acre) by 2-inch dbh class (DCR 2000), Middlefield/Peru Forest Reserve (N=15 plots).

Data from the 2000 CFI dataset indicate that the primary species in the Forest Reserve are northern hardwoods, hemlock, and red maple (Fig. 14). Northern Hardwoods (beech, yellow birch, and sugar maple) and northern hardwood associates (white ash and black cherry) account for 47% of the total basal area. Twenty-three percent of the basal area is hemlock and 26% percent is red maple. Red maple is displayed on the forest type map (Fig. 11) as "forested wetlands". Hemlock is also commonly found in wet areas. The large proportion of both species is likely a reflection of the large proportion of poorly drained soils within the Forest Reserve.

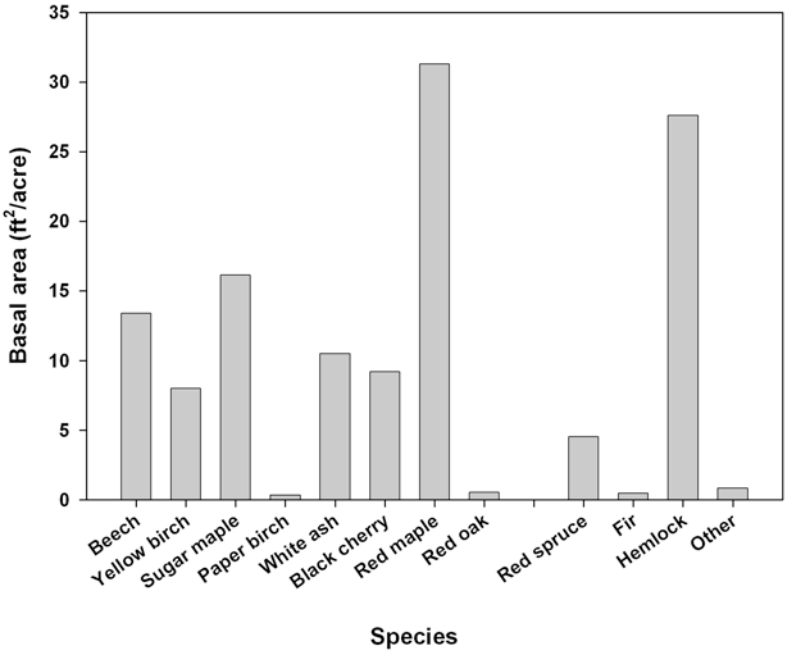

Fig. 14. Mean basal area (ft^2/acre) by species (DCR 2000), Middlefield/Peru Forest Reserve (N=15). "Other" includes white pine, poplar, elm, basswood, butternut, gray birch, and unidentified species.

The live-tree biomass estimate from 2000 CFI data was 85.7 ± 11.9 tons/acre (N=15 plots). A comparison of biomass from 1960 to 2000 was not possible as only 3 of the current plots existed in 1960.

Deadwood

Biomass of standing deadwood (snags) and down deadwood was estimated from volume calculations using specific gravity estimates by species, reduced for stages of decay (Tyrrell and Crow 1994, Chojnacky and Heath 2002, Woodall and Williams 2007). The biomass estimate for standing deadwood was 3.6 ± 1.5 tons/acre. The down deadwood biomass estimate was 0.5 ± 0.2 tons/acre (N=15). Standing deadwood was composed primarily of northern hardwoods, especially sugar maple, and red maple (Fig. 15). Forty-three percent of the standing deadwood was composed of Northern Hardwoods including sugar maple and 47% was red maple. There was very little down deadwood and almost 90% of it was red maple.

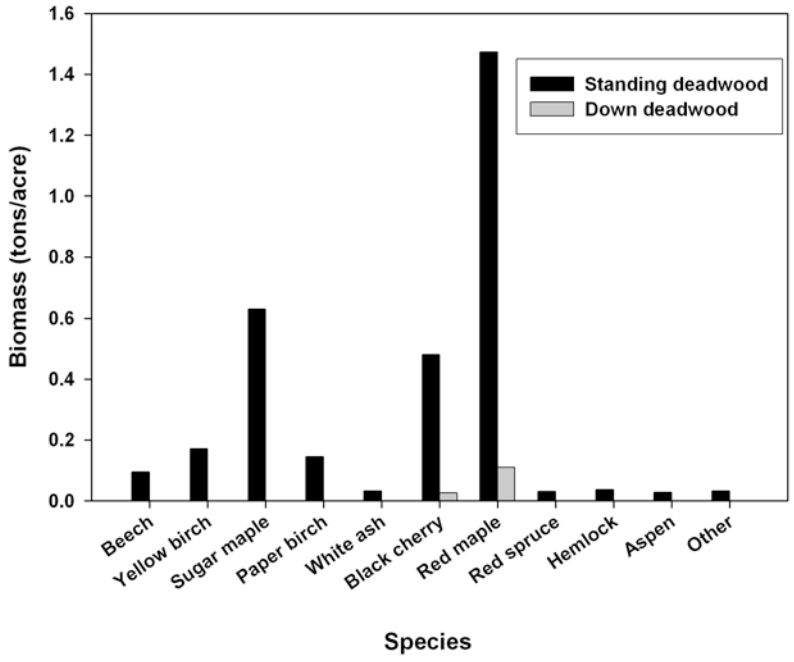

Fig. 15. Species composition of standing and down deadwood (DCR 2000) (N=15 plots), Middlefield/Peru Forest Reserve.

Understory Regeneration

Four 0.0026 acre (6 ft. radius) subplots were established within each 0.20 acre CFI plot to sample understory regeneration. Percent cover for several classes of groundcover also was estimated. Only a portion of the total data set for 2000 is available. The graphs and tables below provide a sample of this type of information (Fig. 16, Table 7). The majority of seedlings are beech and sugar maple. Larger sapling regeneration consists of beech, sugar maple, red spruce, balsam fir, and hemlock.

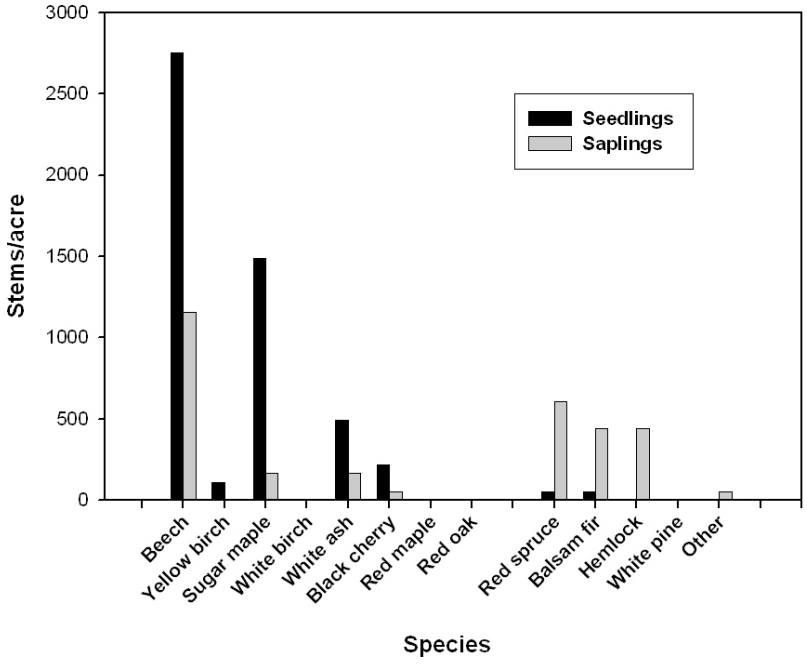

Fig. 16. Understory regeneration, Middlefield/Peru Forest Reserve (DCR 2000). Seedlings are trees less than 4.5 ft. tall. Saplings range in size from 4.5 ft. tall to 5.0 in. dbh. Data are derived from seven CFI plots (28 subplots).

Table 7. Ground cover, percent cover by number of subplots, Middlefield/Peru Forest Reserve (DCR 2000).

Code #	Species	0	1%-25%	26%-50%	51%-75%	76%-100%
315	Striped Maple	24	1	0	0	0
606	Mt. Laurel	27	1	0	0	0
995	Ferns	20	8	1	0	1
999	Other	25	0	3	0	0

SECTION 2: MIDDLEFIELD/PERU FOREST RESERVE AND PERU STATE FOREST PROPOSED INTENSIVE MONITORING AREAS

INTRODUCTION

Peru State Forest has been proposed as a non-Reserve forest match for the Middlefield/Peru Forest Reserve. Peru State Forest is located within the towns of Middlefield and Peru, to the east of the Middlefield/Peru Forest Reserve (Fig. 17). Within the 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, soils, and forest types.

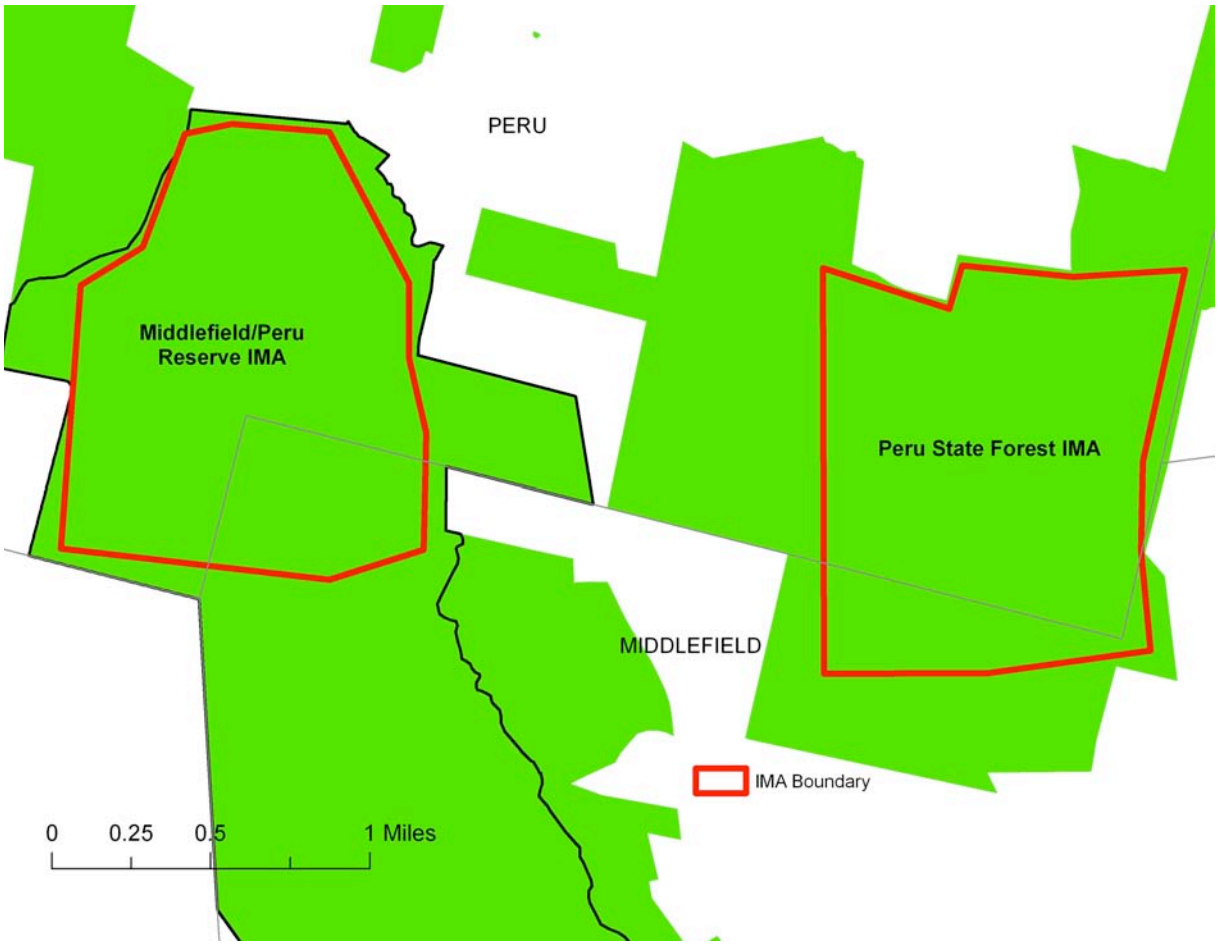

Fig. 17. Intensive Monitoring Areas (IMAs) in the Middlefield/Peru Forest Reserve and Peru State Forest.

PHYSICAL FEATURES

Topography

Elevations range from 1,500 to 1950 ft. on the Middllefield/Peru Reserve IMA and from 1,540 to 2,010 ft. in the Peru State Forest IMA (Fig. 18). Slopes in both IMAs are generally less than 30%. Slopes reach the 25-60% range in a few small areas in each IMA (Fig. 19). The low relief and relatively small range in elevations throughout this area is reflected in the mix of north, south, east, and west facing slopes (Fig. 20). There is no clear trend in aspect for either IMA.

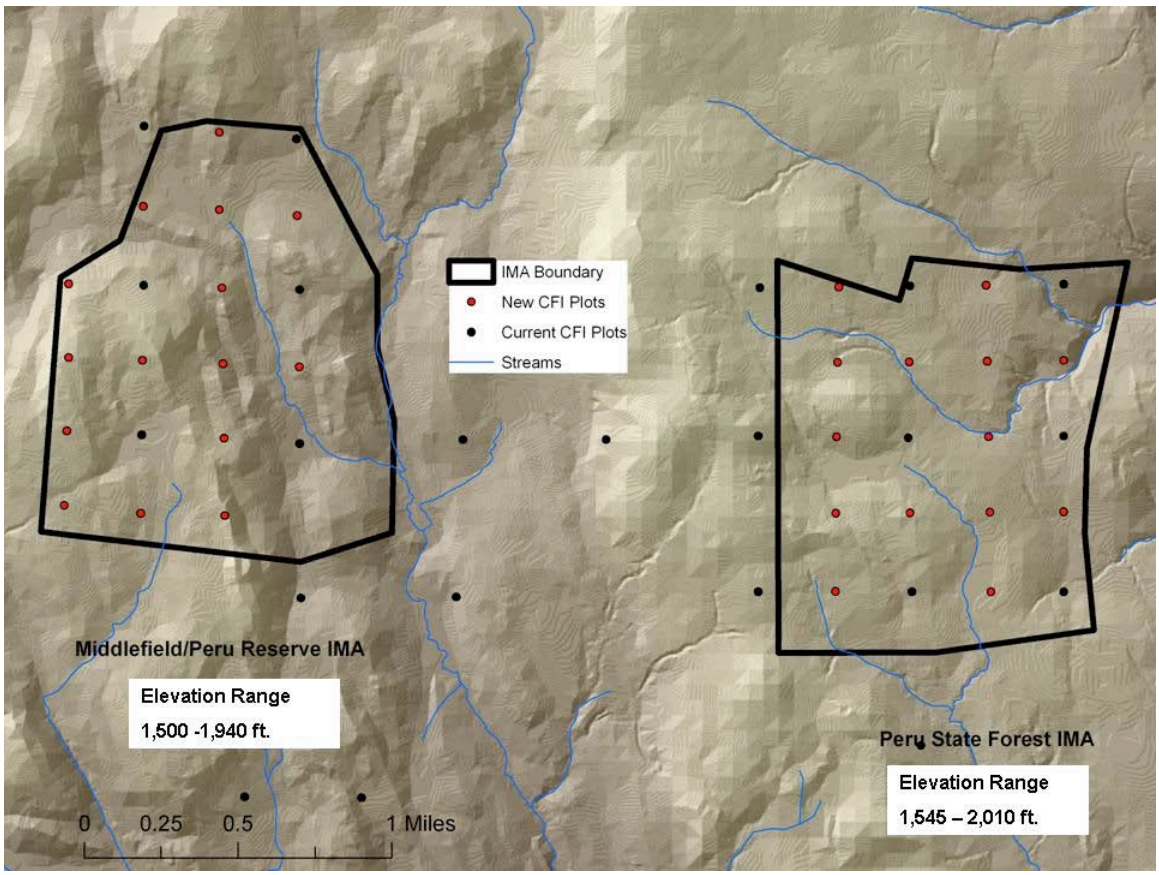

Fig. 18. Elevation, Middlefield/Peru Forest Reserve and Peru State Forest IMAs. Existing CFI plots are shown in black. Proposed new Intensive Monitoring CFI Plots are shown in red.

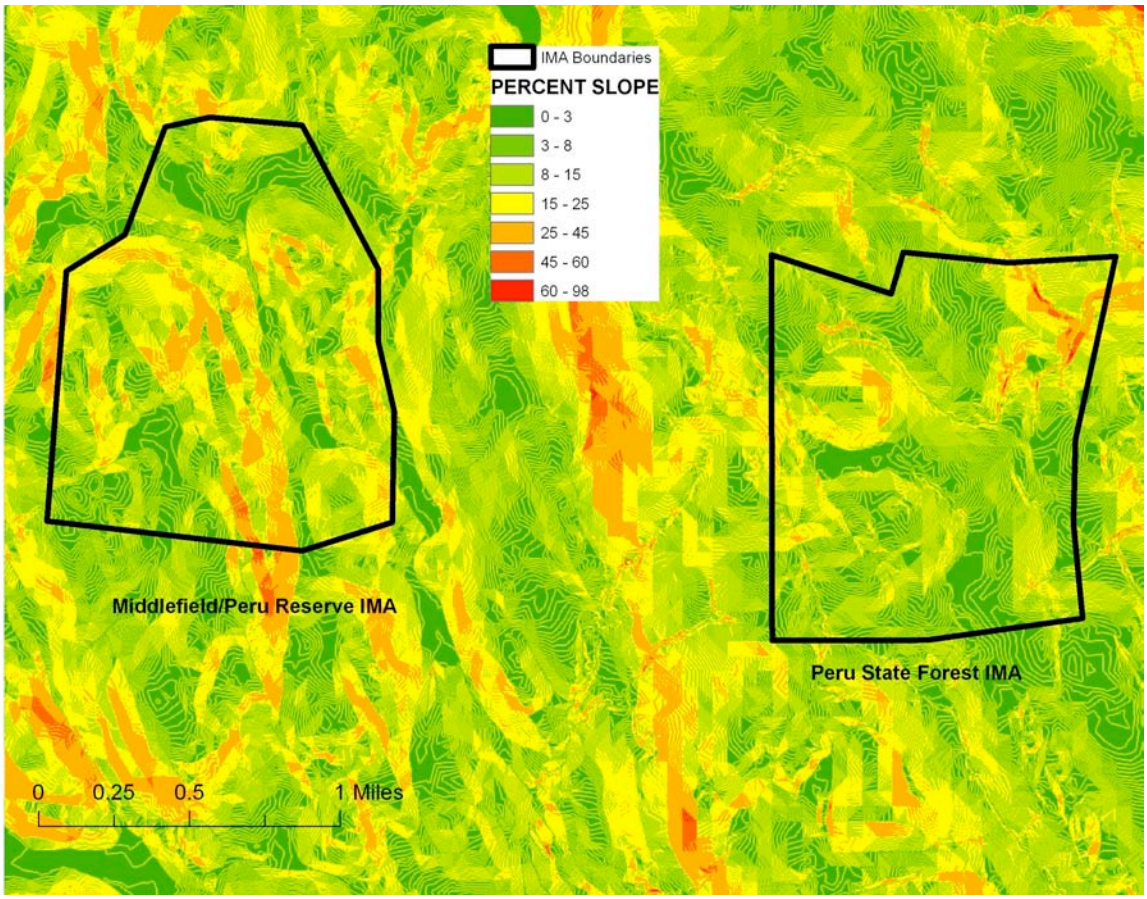

Fig. 19. Slope comparison, Middlefield/Peru Forest Reserve and Peru State Forest IMAs.

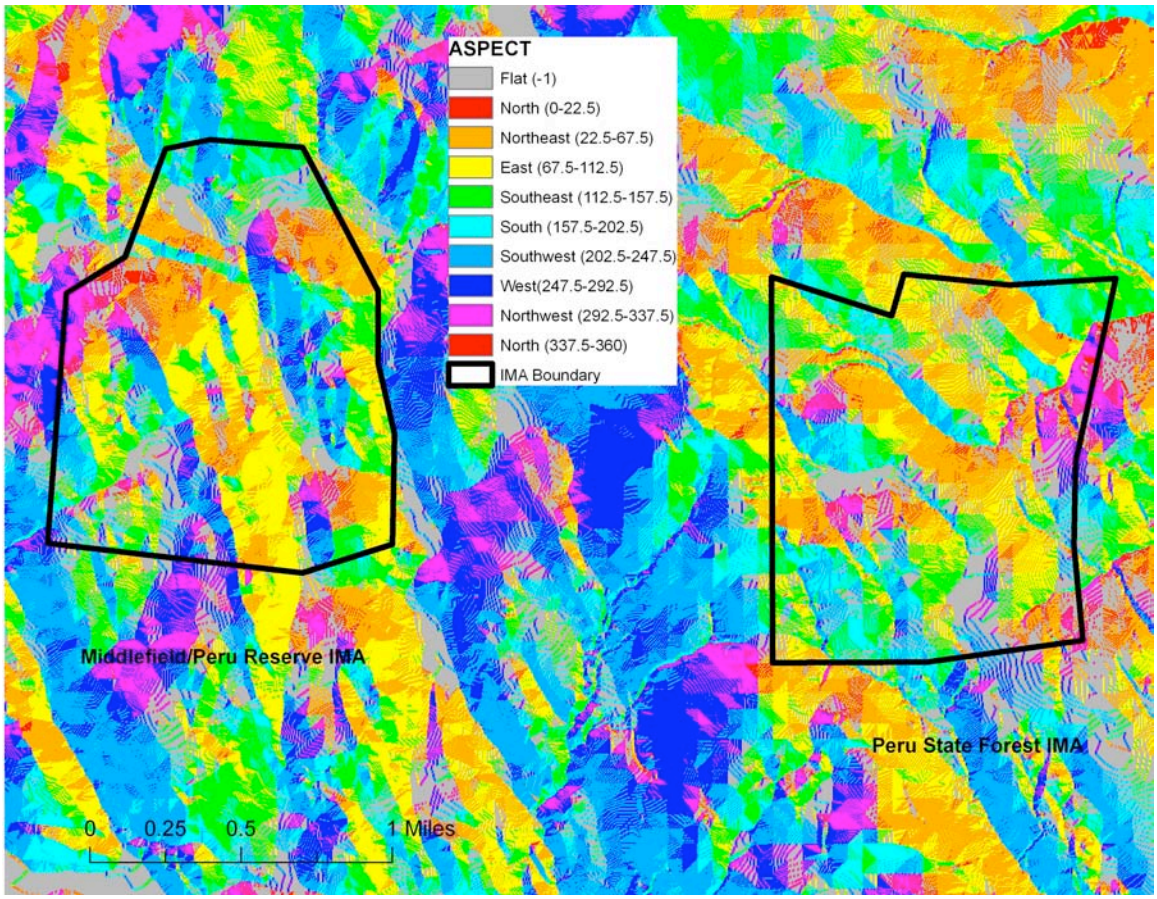

Fig. 20. Aspect, Middlefield/Peru Forest Reserve and Peru State Forest IMAs.

Bedrock Geology

Bedrock in the Middlefield/Peru Reserve IMA is part of the Berkshire Massif and is primarily composed of granite, gneiss, and schist. Bedrock in the Peru State Forest IMA is part of the Hoosac formation and is composed of schist, gneiss, and phyllite (Fig. 21). Bedrock in both areas is primarily acidic.

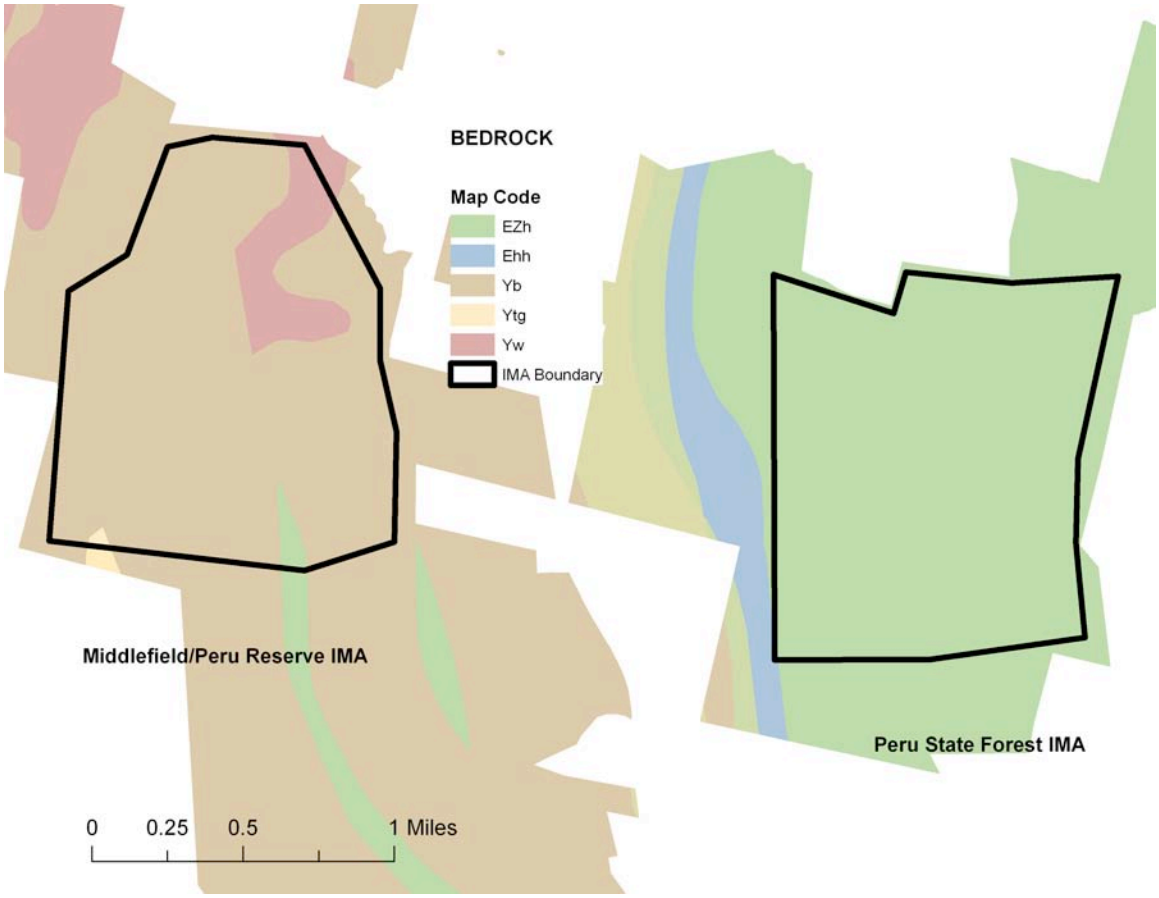

Fig. 21. Bedrock comparison, Middlefield/Peru Forest Reserve and Peru State Forest IMAs (Zen et al. 1983).

Table 8. Bedrock comparisons, Middlefield/Peru Forest Reserve and Peru State Forest IMAs (Zen et al. 1983)

Middlefield/Peru Forest Reserve IMA			
Map Code	**Rocktype**	**Area (%)**	**Formation**
EZh	Schist, gneiss, phyllite, conglomerate, granofels, calc-silicate rock	1	Hoosac Formation - undifferentiated
Yb	Granitic gneiss, amphibolite, schist, quartzite, gneiss	88	Gray, well-layered biotite-plagioclase-quartz gneiss
Ytg	Granitic gneiss	<1	Tyringham Gneiss
Yw	Mica schist, conglomerate	10	Washington Gneiss
Peru State Forest IMA			
Map Code	**Rocktype**	**Area (%)**	**Formation**
EZh	Schist, gneiss, phyllite, conglomerate, granofels, calc-silicate rock	100	Hoosac Formation - undifferentiated

Surficial Geology and Soils

Surficial deposits in both IMAs consist of glacial till. All the soil series shown in Fig. 22 are described in Section 1, with one exception. The Berkshire soil series are very deep (16 to 36 in.), well drained soils, formed in till on glaciated uplands (NCSS 2006). There is a larger proportion of the moderately well drained Peru soil series in the Peru State Forest IMA (36%) than in the Middlefield/Peru Forest Reserve IMA (5%) and a smaller proportion of the excessively drained Lyman soil series in the Peru State Forest IMA (17%) than in the Forest Reserve IMA (37%). The proportion of the poorly drained Pillsbury soil series in each IMA is similar (Table 9).

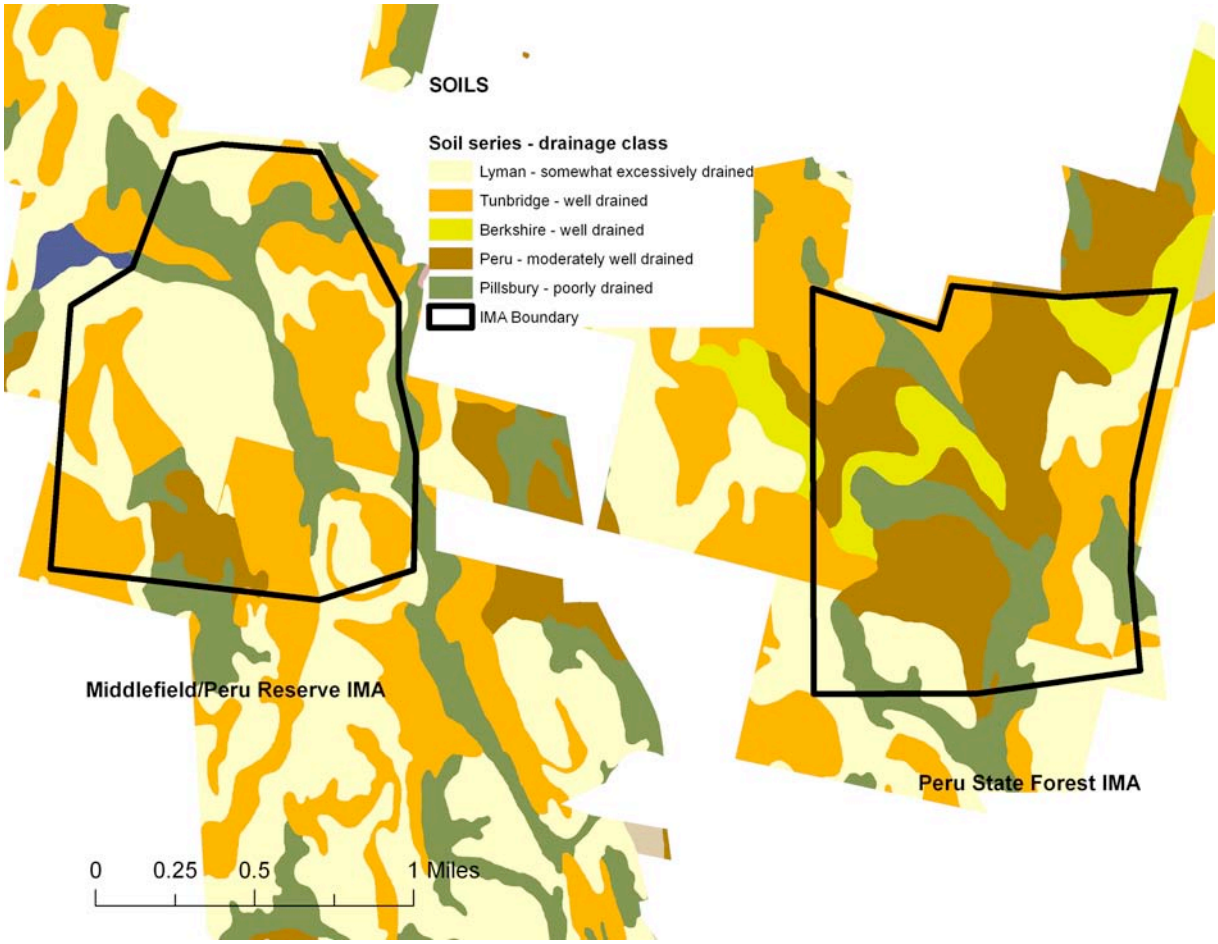

Fig. 22. Soil series and drainage classes, Middlefield/Peru Forest Reserve and Peru State Forest IMAs (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 1999, 2004).

Table 9. Soil series and drainage classes, Middlefield/Peru Forest Reserve and Peru State Forest IMAs (NCSS 2007, 2008, 1998, 1997, 2006).

Middlefield/Peru Reserve IMA		
Soil Series	**Drainage Class**	**Area (%)**
Lyman	Somewhat excessively drained	37
Tunbridge	Well drained	40
Peru	Moderately well drained	5
Pillsbury	Poorly drained	18
	Total	100
Peru State Forest IMA		
Soil Series	**Drainage Class**	**Area (%)**
Lyman	Somewhat excessively drained	17
Tunbridge	Well drained	19
Berkshire	Well drained	11
Peru	Moderately well drained	36
Pillsbury	Poorly drained	17
	Total	100

Disturbance History

As in the Middlefield/Peru Forest Reserve, the Peru State Forest IMA has been relatively free of disturbance-related damage in the recent past, as indicated by CFI data and defoliation data from interpreted aerial photographs (MassGIS 1997). Defoliation from unknown causes was noted in the Peru IMA in 1969, 1970, 1971, and 1976. In all cases less than a third of the IMA was affected.

LAND USE HISTORY

(See Section 1 for land use history of the area)

DCR has conducted two management projects in the Peru State Forest IMA since 1984. The first was a timber harvest in 1991 on 52 acres; an additional 32 acres were cut in 2003 (Fig. 23) (McDonald et al. 2006). While there have been timber harvests in the southern portion of the Forest Reserve in 1987 and 2003, there has been no timber harvesting in the area designated for the Forest Reserve IMA since 1984.

FOREST TYPES

Northern Hardwoods are the predominant species in both the Middlefield/Peru Reserve IMA (62%) and the Peru State Forest IMA (70%), based on data interpreted from aerial photographs (Fig. 23, Table 10) (DCR 2003). Small areas of sugar maple and oak-hardwoods were identified in the Peru State Forest IMA. There were no stands in the Middlefield/Peru Reserve IMA with this classification. Hemlock-Hardwood stands were identified in both IMAs, however site visits showed that at least some of these had been typed in error and were actually dominated by white pine. Both IMAs had small areas of spruce-fir and forested and open wetlands. There were also some early successional birch-red maple areas and several Norway spruce plantations located in the Peru State Forest IMA.

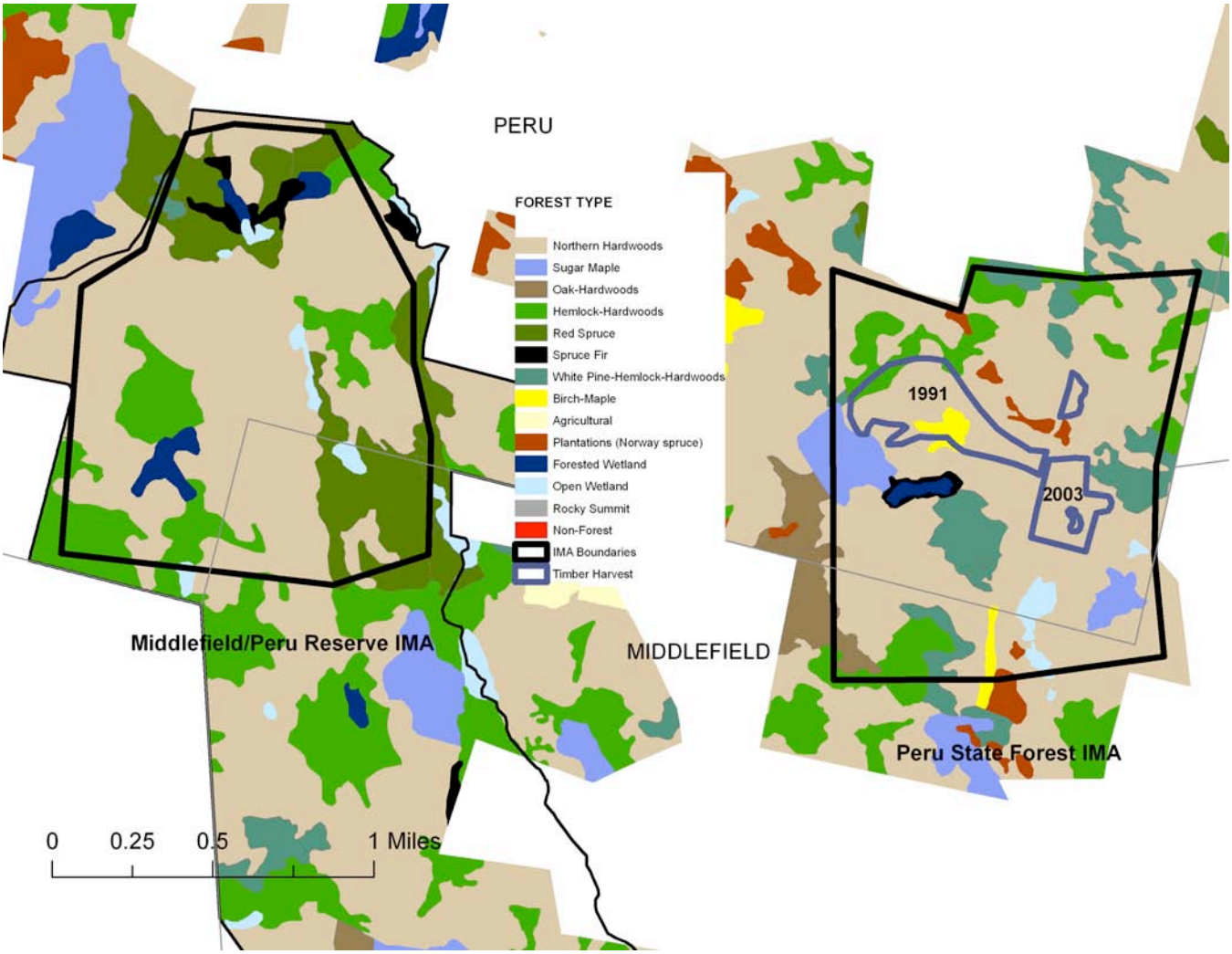

Fig. 23. Forest types and Timber harvests, Middlefield/Peru Forest Reserve and Peru State Forest IMAs and timber harvests 1984-2003(DCR 2003, McDonald et al. 2006).

Table 10. Forest Types, Middlefield/Peru Forest Reserve and Peru State Forest IMAs (DCR 2003)

Middlefield/Peru Forest Reserve IMA	
Forest Type	**Area (%)**
Northern Hardwoods	62
Hemlock-Hardwoods	14
Red spruce	18
Spruce-Fir	2
White pine	<1
Forested wetland	3
Open wetland	2
Peru State Forest IMA	
Forest Type	**Area(%)**
Northern Hardwoods	70
Sugar maple	4
Oak-Hardwoods	1
Hemlock-Hardwoods	10
Spruce-Fir	<1
White pine	10
Birch-Maple	1
Plantations (Norway spruce)	1
Forested wetland	<1
Open wetland	1

CFI DATA

There are currently five CFI plots (1517, 1518, 1519, 1529, 1530) in the Middlefield/Peru Forest Reserve IMA and five CFI plots (0354, 0355, 0356, 0360, and 0361) in the Peru State Forest IMA. The plots provide an initial estimate of forest conditions on the two IMAs. In all the analyses below N=5 plots for the Middlefield/Peru Reserve IMA and N=5 plots for the Peru State Forest IMA.

Forest Age and Disturbance History

The mean age of CFI plots in the Peru State Forest IMA is slightly older (85 years) than those in the Middlefield/Peru Reserve IMA (72 years) (Table 10). No disturbance was recorded on any of the Middlefield/Peru Reserve IMA CFI plots, while disturbances were recorded on 4 of the 5 Peru State Forest IMA CFI plots, including two harvest cuts (Table 11).

Table 10. Plot age, IMAs.

Middlefield/Peru Reserve IMA		Peru State Forest IMA	
Plot #	**Age**	**Plot #**	**Age**
1517	70	0354	73
1518	72	0355	93
1519	68	0356	82
1529	81	0360	89
1530	67	0361	86
Mean Age	72	Mean Age	85

Table 11. Disturbance records, IMAs.

Middlefield/Peru Reserve IMA			Peru State Forest IMA		
Plot #	**Disturbance**	**Year**	**Plot #**	**Disturbance**	**Year**
1517	None	0	0354	Other use, pastured	1920
1518	None	0	0355	None	0
1519	None	0	0356	Harvest cut	1990
1529	None	0	0360	Snow and Ice	1986
1530	None	0	0361	Harvest cut	1964

Live Trees

Tree density in the two IMAs is similar (Fig. 24). The Peru State Forest IMA appears to have slightly more trees per acre in the smallest size classes. Above 10 inches dbh, the results are mixed. The Reserve IMA has more trees/acre than the Peru State Forest IMA in the 14 in. dbh class, but fewer in the 16 in. and 18 in. dbh classes. Using 95% confidence intervals, the mean density for the Middlefield/Peru Reserve IMA for all trees > 5 in. dbh is 233.0 ± 81.4 stems/acre. For the Peru State Forest IMA mean density is 251 ± 91.5 stems/acre. Mean density for large trees (>20 in. dbh) is 3.0 ± 2.6 stems/acre for the Middlefield/Peru Reserve IMA and 3.0 ± 4.3 stems/acre for the Peru State Forest IMA. Additional data from the 14 new plots in both the Middlefield/Peru Reserve IMA and the Peru State Forest IMA will increase the information available for these areas and help to determine if these differences are significant.

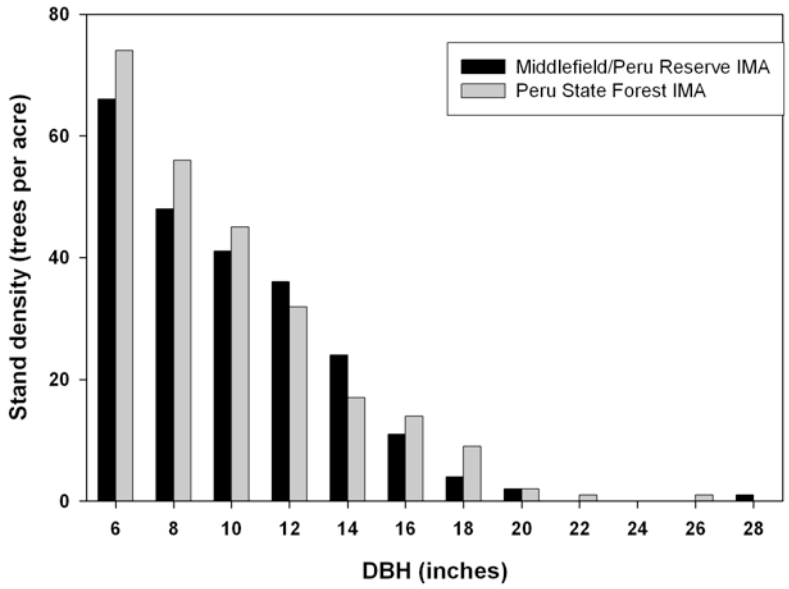

Fig. 24. Mean stand density (trees/acre) by 2-inch dbh class (DCR 2000), Middlefield/Peru Reserve and Peru State Forest IMAs.

Species composition (from CFI data) in the Middlefield/Peru Reserve and Peru State Forest IMAs is similar as well (Fig. 25). Both forests are primarily composed of Northern Hardwoods with large hemlock and red maple components. The basal area of red spruce appears to be greater in the Forest Reserve IMA than in the Peru State Forest IMA.

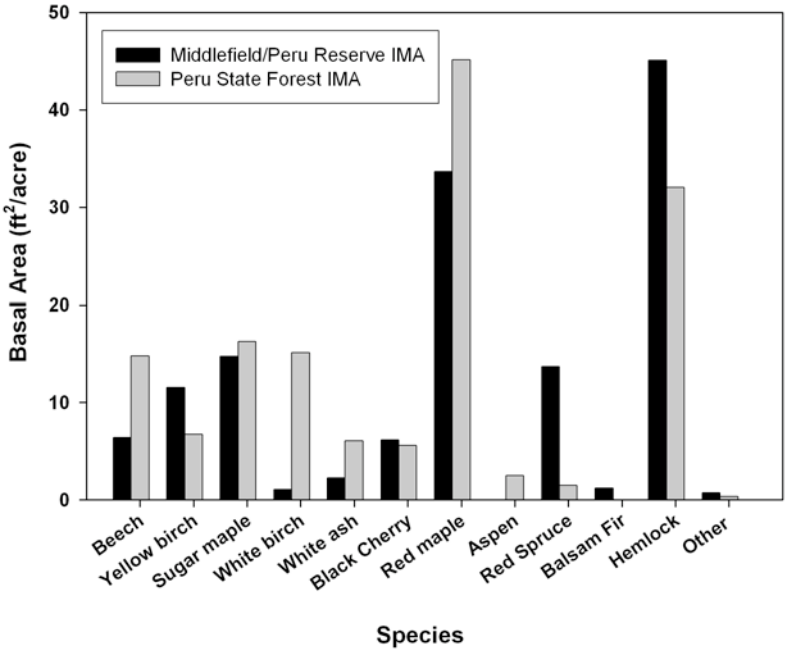

Fig. 25. Mean basal area (ft^2/acre), Middlefield/Peru Forest Reserve and Peru State Forest IMAs (DCR 2000). Other includes unidentified species only.

Based on 2000 CFI data, live tree biomass for the Middlefield/Peru Reserve IMA was 85.4 ± 31.3 tons/acre. Live tree biomass for the Peru State Forest IMA was 95.2 ± 22.1 tons/acre.

No CFI understory data were available for the Peru State Forest.

Deadwood

Biomass of standing deadwood was 3.0 ± 2.5 tons per acre in the Middlefield/Peru Forest Reserve IMA and 5.0 ± 4.7 tons per acre in the Peru State Forest IMA. No down deadwood was recorded in the Middlefield/Peru Reserve IMA. In the Peru State Forest IMA down deadwood was estimated to be 3.3 ± 2.1 tons/acre. Increased deadwood biomass in the Peru State Forest IMA may be a result of the recent timber harvesting in that area. There is more standing dead sugar maple in the Peru State Forest IMA than in the Forest Reserve IMA and more standing dead red maple in the Middlefield/Peru Forest Reserve IMA than in the Peru State Forest IMA. Down deadwood in the Peru State Forest IMA is primarily composed of sugar maple and red maple (Fig. 26 and Fig. 27).

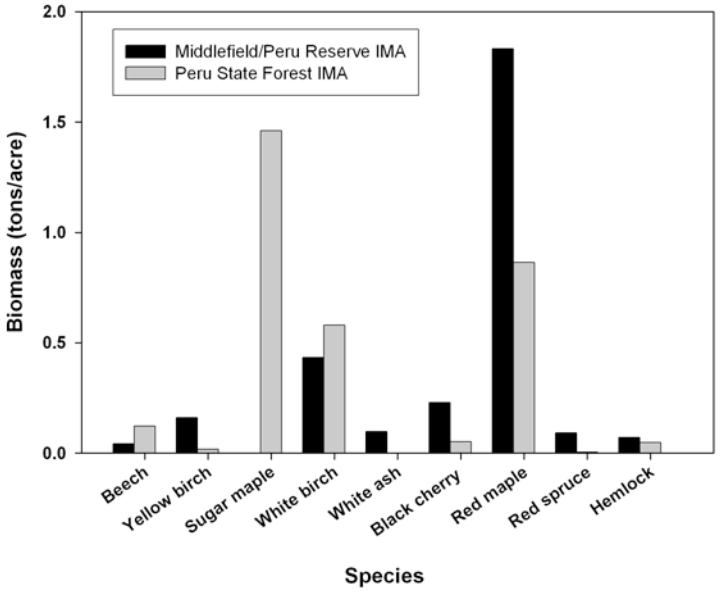

Fig. 26. Standing deadwood, comparison by species, Middlefield/Peru Forest Reserve and Peru State Forest IMAs (DCR 2000).

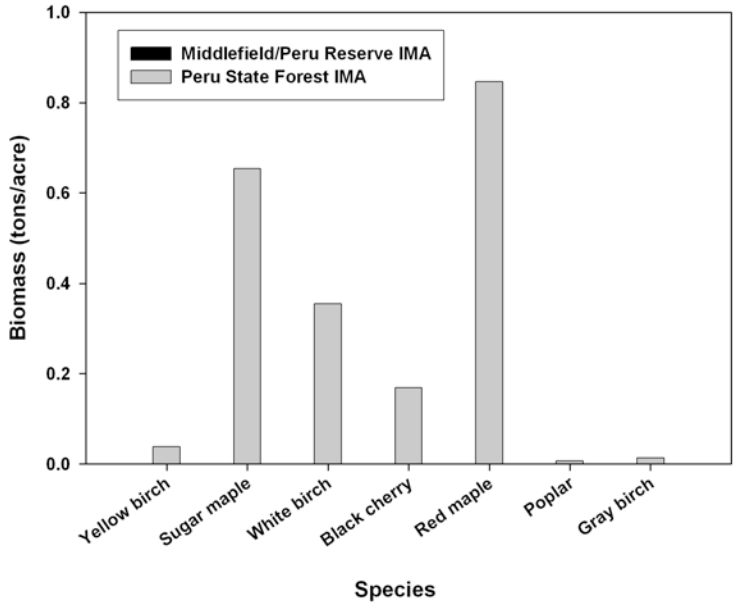

Fig. 27. Down deadwood, comparison by species, Middlefield/Peru Forest Reserve and Peru State Forest IMAs(DCR 2000).

SUMMARY: A Comparison of the Peru State Forest (PSF) and Middlefield/Peru Forest Reserve (MPFR) IMAs

- Topography is similar in the two IMAs with elevations generally between 1,500 and 2,000 feet. The maximum elevation in the PSF IMA(2,010 ft.) is slightly higher than that in the MPFR IMA(1,950 ft.). Slopes are gentle to moderate in both IMAs and aspects vary in both IMAs with no distinct pattern in aspect for either area.

- The MPFR IMAis located on the Berkshire Massif with bedrock composed of granite, gneiss, and schist. The PSF IMA lies on the Hoosac formation with bedrock composed of schist, gneiss, and phyllite. Bedrock in both areas is primarily acidic.

- The MPFR IMAhas larger areas of somewhat excessively drained soils (37% of the area) than the PSF IMA(17%) and a smaller area of moderately drained soils (MPFR 5%; PSF 36%). The area of poorly drained soils is similar (MPFR IMA 18%; PSF IMA 17%).

- Forests in both IMAs are primarily composed of Northern Hardwoods with hemlock and red maple. Site visits suggest that there may be more white pine than indicated either by aerial photo interpretation (2003) or CFI data (2000). No timber harvesting has occurred in the MPFR IMAin the last 25 years. There have been 2 cuts in the PSF IMA, one in 1991 on 52 acres and one in 2003 on 32 acres.

- Biomass estimates for live trees are similar on both IMAs. There is more standing deadwood and much more down deadwood in the PSF IMA, based on 2000 CFI measurements, possibly due to the recent timber harvesting in that area.

References

Berkshire Links. 2007. Peru, MA, History, Information, Demographics. http://www.berkshirelinks.com/peru-mass.php

Brady, N.C., and R.R. Weil. 2002. *The Nature and Property of Soils.* 13th Edition. Prentice Hall, Upper Saddle River, NJ.

Chojnacky, D.C., and L.S. Heath. 2002. Estimating deadwood from FIA forest inventory variables in Maine. *Environmental Pollution* 116:S25-S30.

Cook, H.P., and W.R. Cook. 1964. Middlefield pp. 147-157, in *The Hampshire History*: *Celebrating 300 years of Hampshire County, Massachusetts.* Compiled by the Tercentenary Editorial Committee, L.E. Wikander, H. Terry, and M. Kiley., Hampshire County Commissioners, Northampton, Massachusetts.

Cornell Plant Diagnostic Clinic. 2007. Black Knot (*Apiosporina morbosa*) Factsheet, http://plantclinic.cornell.edu/FactSheets/black_knot/blacknot.htm (accessed February 2009).

DCR (Massachusetts Department of Conservation and Recreation). 2000. Continuous Forest Inventory Data. (Unpublished dataset).

DCR. 2003. Massachusetts Department of Conservation and Recreation, Bureau of Forestry, "Land Cover Classification Project" from data provided by the James W. Sewall Company.

DCR (Massachusetts Department of Conservation and Recreation). 2008. Deed Data Base, compiled by Conrad Ohman, Management Forester, Western Region, Pittsfield, MA.

DCR (Massachusetts Department of Conservation and Recreation). 2008. Large Forest Reserve boundaries.

de la Crétaz, A.L., and M.J. Kelty. 2008. *Land Type Associations of Western Massachusetts.* Unpublished Report. USDA Forest Service, Northeastern Area State and Private Forestry, Durham, NH.

EOEEA (Executive Office of Environmental and Energy Affairs). 2009. Forest Reserves. Boston, MA. February 2, 2009. http://www.mass.gov/Eoeea/docs/eea/lf/whatare_forestreserves.pdf (accessed September 2009).

ESRI Corporation. 2007. Arc GIS, version 9.2. Redlands, CA.

Federal Writers' Project. 1939. *The Berkshire Hills.* Compiled and written by the Federal Writers' Project of the Works Progress Administration for Massachusetts, sponsored by the Berkshire Hills Conference, Inc. Funk & Wagnalls Company, New York.

Gordon, N.M. 1998. The economic uses of Massachusetts forests. *In* C.H.W. Foster (editor) *Stepping Back to Look Forward*: *a history of the Massachusetts Forest.* Distributed by Harvard University for Harvard Forest, Petersham, MA.

Hamid, A., T.M. O'Dell, and S. Katovich. 1995. White pine weevil. Forest Insect and Disease Leaflet 21, U.S. Department of Agriculture, Forest Service http://www.na.fs.fed.us/spfo/pubs/fidls/wp_weevil/weevil.htm (accessed February 2009).

Houston, D.R., and J.T. O'Brien. 1983. Beech Bark Disease, Forest Insect & Disease, Leaflet 75. U.S.D.A. Forest Service http://www.na.fs.fed.us/spfo/pubs/fidls/beechbark/fidl-beech.htm (accessed March, 2008).

Keys, J.E. Jr., and C.A. Carpenter. 1995. Ecological Units of the Eastern United States" First Approximation. Map compiled at 1:1,000,000. United States Department of Agriculture, Forest Service.

MassGIS. 1997. *Insect Infestation (BUGS)*. http://www.mass.gov/mgis/bugs.htm (accessed April 2008).

MassGIS. 1999. *Surficial Geol*ogy. http://www.mass.gov/mgis/ (accessed April 2008).

MassGIS. 2000. *Hydrography 1:100,000* http://www.mass.gov/mgis/sg.htm (accessed June 2009).

MassGIS. 2002. *Land Use*. http://www.mass.gov/mgis/ (accessed April 2008).

MassGIS. 2005. *1:5,000 Color Ortho Imagery.* http://www.mass.gov/mgis/colororthos2005.htm (accessed August 2009).

MassGIS, 2009(a). *Protected and Recreational Open Space.* http://www.mass.gov/mgis/ (accessed September 2009).

MassGIS. 2009(b). *Community Boundaries (Towns)* (U.S. Census 2000). http://www.mass.gov/mgis/ (accessed April 2009).

McDonald, R.I., G. Motzkin, M. Bank, D. Kittredge, J. Burk, and D.R. Foster. 2006. Forest harvesting and land-use conversion over two decades in Massachusetts. *Forest Ecology and Management* 227(1-2):31-41.

NCSS (National Cooperative Soil Survey). 1997 (Pillsbury Series), 1998 (Peru Series), 2001 (Marlow Series), 2003 (Palms Series), 2006 (Berkshire Series), 2007 (Lyman Series), 2008 (Tunbridge Series). http://soils.usda.gov/technical/classification/osd/ (accessed September 2009)

New-England Historic Genealogical Society. 1902. Vital Records of Peru, Massachusetts to the Year 1850, Boston, Mass. http://www.rootsweb.ancestry.com/~maberksh/towns/peru/peruintro.html (accessed July 2008).

NHESP (Massachusetts Natural Heritage and Endangered Species Program). 2004. *BioMap and Living Waters, Core Habitats of Middlefield.* Executive Office of Environmental Affairs, Massachusetts.

O'Brien, J., and P. Snowden. 1989. Pear thrips on forest trees. USDA Forest Service, http://www.na.fs.fed.us/spfo/pubs/pest_al/pt/pt.htm (accessed March, 2008).

Rivers, W.H. 1998. Manual for Continuous Forest Inventory Field Procedures. Massachusetts Department of Environmental Management. Bureau of Forestry, Division of Forests and Parks.

SAS Statistical Software, Version 9.1.3. 2004. SAS Institute Inc. Cary, NC.

Scanu, R.J. 1995. *Soil Survey of Hampden and Hampshire Counties, Western Part, Massachusetts.* United States Department of Agriculture, Soil Conservation Service in cooperation with Massachusetts Agricultural Experiment Station.

Skehan, J.W. 2001. Roadside Geology of Massachusetts. Mountain Press Publishing, Missoula MT. 379 pp.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 1999. Soil Survey Geographic (SSURGO) Database for Berkshire County, MA. Available online at http://soildatamart.nrcs.usda.gov (accessed April 2008).

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 2004. Soil Survey Geographic (SSURGO) Database for Hampden-Hampshire-West, MA. Available online at http://soildatamart.nrcs.usda.gov (accessed April 2008).

The BerkshireWeb. No date given. Peru , Massachusetts 01235.. http://www.berkshireweb.com/themap/peru/peru.html (accessed July 2008)

Tyrrell, L.E. and T.R. Crow, 1994. Structural characteristics of old-growth hemlock-hardwood forests in relation to age. *Ecology* 75(2): 370-386.

Wawrzynski, R. P. 2009. Sawflies of trees and shrubs. University of Minnesota Extension Service, College of Agricultural, Food, and Environmental Sciences. http://www.extension.umn.edu/distribution/horticulture/DG6703.html (accessed April 2009)

Woodall, C. and M. Williams. 2005. Sampling protocol, estimation, and analysis procedures for the down woody materials indicator of the FIA program. Gen. Tech. Rep. NC-256. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 47 p.

World Climate. 1996. Copyright, 1996-2008 Buttle and Tuttle Ltd. All Rights Reserved. Created by Robert Hoare. Created 1 Aug 1996. Latest Update (minor changes) 5 Jan 2005. v271. http://www.worldclimate.com (accessed June 2008).

Zen, E, editor.1983. *Bedrock Geologic Map of Massachusetts*, Compiled by R. Goldsmith, N.M. Ratcliffe, P. Robinson, and R.S. Stanley. Reston, VA: U.S. Geological Survey. Scale 1:250,000, 3 sheets.

Appendix A, Middlefield/Peru Reserve Species List

Aspen	*Populus tremuloides*
Balsam fir	*Abies balsamea*
Basswood	*Tilia americana*
Beech (American beech)	*Fagus grandifolia*
Black cherry	*Prunus serotina*
Butternut	*Juglans cinerea*
Elm	*Ulmus spp.*
Gray birch	*Betula populifolia*
Hemlock	*Tsuga Canadensis*
Mountain laurel	*Kalmia latifolia*
Norway spruce	*Picea abies*
Poplar	*Populus spp.*
Red maple	*Acer rubrum*
Red oak (Northern red oak)	*Quercus rubra*
Red spruce	*Picea rubens*
Striped maple	*Acer pennsylvanicum*
Sugar maple	*Acer saccharum*
White ash	*Fraxinus americana*
White birch	*Betula papyrifera*
White pine	*Pinus strobus*
White spruce	*Picea glauca*
Yellow birch	*Betula alleghaniensis*

Appendix B: CFI Plot Disturbance History

Plot #	Disturbance	Year
0368	Disease	0
1517	None	0
1518	None	0
1519	None	0
1520	None	0
1521	Harvest cut	1985
1522	None	0
1523	Disease	0
1524	None	0
1525	None	0
1526	Disease	1999
1527	None	0
1528	None	0
1529	None	0
1530	None	0
1531	None	0
1532	None	0

Appendix C: Massachusetts Natural Heritage and Endangered Species Program, BioMap and Living Waters

HABITATS

Core Habitat LW366

Massachusetts NHESP has not identified any core habitats within the Middlefield/Peru Reserve. Core habitat LW366 (Living Waters) encompasses a section of Factory Brook as it emerges from Middlefield State Forest.

> *This section of Factory Brook emerges from the Middlefield State Forest where it flows from a large beaver-created wetland, through a hemlock-dominated forest and is joined by a short tributary. Both Factory Brook and its tributary support a healthy community of the more ecologically sensitive aquatic insects: mayflies, stoneflies, and caddisflies. The clear waters are shaded and cold, and they flow rapidly over a mix of stone sizes that provide excellent habitat for aquatic invertebrates. The forested stream banks help maintain the high-quality habitat by shading the water to keep it cool, by providing a natural energy source to the stream ecosystem in the form of leaves, needles, and sticks, and by controlling the runoff of sediments, excess nutrients, and water. This Core Habitat lies just outside the State Forest and appears to be the only unprotected stretch of the brook* (NHESP 2004)

Appendix C, Fig. 1. Core Habitat designations within the vicinity of the Middlefield/Peru Forest Reserve (NHESP 2004).