

Marsh-Billings-Rockefeller National Historical Park

Woodstock, Vermont

Natural Community Report

January, 2002



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Prepared for:
National Park Service
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Table of Contents

Executive Summary.....	1
Purpose	1
Results	1
Recommendations	3
Introduction	4
Natural Communities and Natural Community Mapping	4
Natural Communities and the Park.....	6
Landscape Description	8
Climate	8
Physiography	8
Hydrology.....	8
Bedrock and Surficial Geology	9
Soils	10
Methods	12
Existing Data Compilation and Interpretation.....	12
Field Methods.....	13
Community Classification and Assessment	13
Plots	14
Natural Communities.....	16
Upland Communities.....	16
Wetland Communities	17
Conclusion	36
References	37
Appendix A - Plant List	38
Appendix B - Plot Data Sheets	39

Executive Summary

To inform management decisions at Marsh-Billings-Rockefeller National Historical Park (the Park), I inventoried and mapped natural communities during the summer of 2001. The Northern Hardwood Forest community, along with several closely related communities including Hemlock-Northern Hardwood Forest, Sugar Maple-White Ash-Jack-in-the-Pulpit Forest, and Rich Northern Hardwood Forests dominate the Park. Smaller areas of Hemlock Forest, wetland communities, and cliff/outcrop communities also occur.

Purpose

Natural communities are interacting assemblages of species and their environment. Inventorying and mapping natural communities on a site provides a rich representation of the diversity of species and ecological processes that occur there. Natural community maps are created through a combination of remote-sensing and field techniques, and incorporate the physical and biological characteristics of an area.

Natural community maps may be useful to land managers because these maps depict site- to landscape-scale ecological variation. As an example, land managers may recognize rank certain communities as high priority, and may focus conservation or restoration efforts on these communities. Such high priority communities may be those that are rare on the site or in the region, or those that may contain rare species.

Results

Sixteen natural communities were identified during this inventory. Of the natural stands, which comprise 340 acres of the area of the Park, the following communities cover the most area:

- 136 acres of Hemlock-Northern Hardwood Forest
- 57 acres of Northern Hardwood Forest
- 55 acres of Hemlock Forest
- 43 acres of Sugar Maple-White Ash-Jack-in-the-Pulpit Forest
- 14 acres of Rich Northern Hardwood Forest
- 8 acres of Red Maple-Black Ash Swamp
- 6 acres of Red or Silver Maple-Green Ash Swamp

Many of these communities are influenced by the bedrock that serves as their foundations. Much of the Park is underlain by a calcareous bedrock that contributes nutrients to the soil and vegetation in the area. This enrichment is reflected in the neutral to alkaline conditions, as well as in the diverse herbaceous vegetation observed in many communities.

Of the 340 acres of natural stands in the Park, more than half of the area consists of the Northern Hardwood Forest natural community type, or a closely-related type. The Northern Hardwood Forest is the quintessential forest of Vermont, comprising of yellow birch, American beech, and sugar maple. Generally, other natural community types found in the Park vary from this basic type by two traits: the abundance of hemlock, and the degree of enrichment. Areas with a somewhat larger hemlock component are classified as Hemlock-Northern Hardwood Forest, while areas that are dominated by hemlock (and frequently without beech or sugar maple) are classified as Hemlock Forest. Also, broadly, somewhat enriched areas are classified as Sugar Maple-White Ash-Jack-in-the-Pulpit Forest, while areas of greater enrichment are classified as Rich Northern Hardwood Forest.

Plantations have been established at various times, covering an area of approximately 155 acres of the Park. Species planted include Norway spruce, red pine, white pine, European larch, and European ash. None of these species are important components of the understory regenerating within the plantations. Over time, unless maintained or replaced, the plantations will die out, to be replaced with similar forest as occurs in the adjacent natural stands: Northern Hardwood Forest, Hemlock-Northern-Hardwood Forest; and Sugar Maple-White Ash-Jack-in-the-Pulpit Forest. Similar succession will occur on the approximately 50 acres of maintained pastures, fields, and meadows, unless these are also maintained.

Wetlands occur throughout the Park, and cover approximately 15 acres, mostly in the central and northwestern sections of the Park. These wetlands are mainly Red Maple-Black Ash Swamps or Red or Silver Maple-Green Ash Swamps. Several of these wetlands receive water through groundwater seepage. Due to the calcareous bedrock in the area, groundwater entering these wetlands is alkaline and raises the pH of the wetland. High pH wetlands are uncommon in Vermont and may host unusual plant and animal species.

Recommendations

The natural community map is a starting point for understanding the ecology of the Park, and can be used to inform management decisions, guide research, and educate the public. Uses of the map include:

- Creating a brochure for visitors to understand the diversity of natural communities in the Park;
- Incorporating natural community information into existing research efforts (such as the University of Vermont's long-term forest dynamics study, and the Vermont Institute of Natural Science's blue-spotted salamander study);
- Targeting focused botanical inventories in enriched communities, such as the Rich Northern Hardwood Forest, Red Maple-Black Ash Swamp, and Hemlock Swamp, where rare species may occur; and
- Assigning priorities for restoration or other management activities within the plantations.

Introduction

The Park is located in Woodstock, Vermont, in the hills above the Ottauquechee River (Figure 1). The 560-acre Park encompasses a varied landscape. In many ways, the Park is typical of the Southern Vermont Piedmont, the region in which it lays. The landscape's diversity results from complex interactions between the bedrock, soils, vegetation, animals, and water, as well as from its culture, both historical and modern.

The natural community concept provides one means of understanding the landscape's diversity. Though based primarily on the distribution of vegetation and soils in an area, the concept condenses a wide range of physical and biological characteristics into a relatively simple classification scheme. Essentially, natural communities are a way of organizing the landscape into categories that encompass both environmental conditions and the organisms those conditions support.

Natural Communities and Natural Community Mapping

Natural communities are the interacting assemblages of organisms, their physical environment, and the natural processes that affect them (Thompson and Sorenson 2000). Simple examples are the natural communities that hikers pass through when climbing in the Green Mountains. On the lower slopes of the mountain, the forest generally consists of American beech, yellow birch, and sugar maples—all components of Vermont's classic Northern Hardwood Forest community type. But toward the top of the mountain, the forest consists predominantly of red spruce and balsam fir—indicative of the Montane Spruce-Fir Forest community type. The species that occur in these two communities are adapted to life under certain physical conditions. Physical factors that affect species distribution include climate, hydrology, bedrock and surficial geology, slope, and aspect. Time, as well as disturbance and other processes, also play important roles. Natural communities consist of both the biotic and abiotic features of a place. The inclusion of the abiotic features and processes in the natural community scheme is how this scheme differs from other possible approaches to organizing landscapes (such as the Society of American Foresters' cover typing).

Mapping natural communities is a way to capture a lot of information about the ecology of an area: what species occur, what processes are taking place, and what bedrock and soil conditions are present. Most importantly, a map shows how all these features are distributed across a landscape. It is, however, important to realize that natural communities are dynamic systems; lines drawn on maps do not reflect complex interactions between adjacent areas, nor do they indicate possible changes over time. Despite these limitations, natural community mapping can be used as a tool for management and education.

The natural community map is a powerful management tool. To maintain the overall diversity of an area, for instance, development could be targeted in natural communities that cover large areas, and avoided in under-represented natural communities. Or, if certain communities support rare species, researchers will be able to focus their search on those areas.

The natural community concept allows a land manager to learn a lot about the environment and species that occur in a certain place without an exhaustive inventory. For example, patches of maidenhair fern and blue cohosh growing under a canopy of sugar maples, basswood, and white ash indicate that the area is enriched; it is a Rich Northern Hardwood community, in fact.

Furthermore, this information can then be used to inform management decisions. For instance, a Rich Northern Hardwood site could be a good place to plant a new plantation: trees placed there would get plenty of nutrients, helping them to grow straight, tall, and fast. At the same time, rare species such as American ginseng occur in the Rich Northern Hardwood community, so perhaps this site would deserve a careful vegetation inventory before planting. Ecosystem restoration provides another example. The first step in any restoration project is identifying the desired conditions. A natural community map can help with this step because it represents how a place might look under natural conditions.

A second application of the natural community map is toward education. George Perkins Marsh reminds us that “in general, [the eye] sees only what it seeks” (Marsh 1864). Most people walk through the forest without noticing how it changes

from one place to another. A natural community map highlights patterns in the landscape, and may help people to recognize differences in vegetation and substrate, or cause them to wonder about why those patterns exist. By raising awareness and provoking curiosity, the natural community map is a good education tool.

Also, although I did not focus on them, animals are an important part of many natural communities. A natural community map represents different habitats that certain animals may use. For instance, several species of mole salamander can be found in hardwood communities near vernal pools, both of which are represented on a natural community map. Other species, such as deer, may not be so tied to natural communities—though conifer stands that may provide overwintering habitat are also represented on a natural community map.

Natural community mapping is probably most useful at intermediate scales--too large, and small pockets of variation are lost; too small, and the map is useless as a means of understanding a landscape. The Park is therefore an ideal place to conduct this type of work. Its modest size allows a thorough mapping effort, yet it is large enough to include a diversity of communities.

Natural Communities and the Park

Today, according to a strict interpretation of the definition, there are no natural communities in the Park, because effectively all of its area has been altered by recent human activity. In some cases, this activity is obvious, as in the plantations and fields. Generally less obvious are the management activities the forest has experienced in the past few decades. Logging (stand thinning or single-tree removal), brush removal, and other activities that have taken place throughout the Park over the past several decades have left signs, such as tree stumps and skid roads, that indicate human use of the land. Although there is no hard-and-fast rule, areas that have not been significantly disturbed by humans for 70 years may be considered "natural" for the purposes of natural community inventory and mapping (Thompson, personal communication). To me, the signs of management are recent

and frequent enough to disqualify most of the Park's natural stands from being true natural communities.

Despite these considerations, the natural community concept remains applicable to this landscape. Even the most altered areas have a natural community type associated with them—they have certain soils, topography, bedrock, and other characteristics that tend to support specific communities. The natural community concept therefore provides a way of “seeing through” management activities. Some ecologists and managers in Vermont have addressed this issue by distinguishing between “potential” natural communities and actual natural communities. This distinction can be applied to any early-successional area, whether of human origin or not.

With these considerations in mind, I have created two maps. One maintains the plantations and fields, which is likely to be the case for the foreseeable future. The other portrays one possible outcome if the fields and plantations were allowed to senesce. The natural community designations within these areas reflect my judgement of which communities would develop there over time if management takes a hands-off approach.

Landscape Description

The physical components of the Park's landscape, including physiography, hydrology, and geology, shape the natural communities that occur there. These components are described below.

The Park is located in the Southern Piedmont region of Vermont, an area characterized by warm temperatures, carbonaceous bedrock, rolling hills, and many streams and rivers. The Park is representative of this region in some ways, but is atypical of the region in others—especially in its cultural history. For instance, like much of the area, most of the land within the Park was cleared for sheep and crop farming before the mid-1800s. Atypically, however, active land restoration efforts began around the 1870s. This early attention to environmental degradation makes the Park unique in the region.

Climate

The Southern Piedmont is one of Vermont's warmest regions, with average summer temperatures of 70 degrees Fahrenheit and highs in the 90s. In winter, subzero temperatures are common, and lows can reach -20 degrees (NPS 1998). Precipitation near the Park is approximately 40 inches annually, with even distribution throughout the year (NPS 1998).

Physiography

The Park rises from approximately 800 feet at the eastern end to 1,220 feet in the central portion, then drops back to 940 feet in the northwest corner. The highest elevation in the Park occurs on the West Ridge (1,440 feet), at the western end of U-shaped basin that opens to the east. The North Ridge (1,320 feet) and the northern slope of Mt. Tom (approximately 1,340 feet) form the northern and southern arms of the U, respectively.

Hydrology

The entire Park is within the Connecticut River watershed. The surface hydrology of the Park consists of a pond, a perennial stream, four wetland systems, numerous

intermittent streams, and several seeps. Runoff from most of the Park flows in a northerly direction, eventually entering Barnard Brook. Barnard Brook flows to the Ottauquechee River and then to the Connecticut River.

The shallow, 14-acre pond known as the Pogue is in the center of the Park. The Pogue receives water from rainfall and unchannelized runoff, and from two intermittent streams/seeps that flow off the West Ridge near the Pogue's southwestern corner. The Pogue is a manmade waterbody, impounded by a dam in its southeastern corner. Pogue Hole Brook, the Park's only perennial stream, flows easterly from the dam. Pogue Hole Brook also receives water from a wetland complex located east of the Pogue.

Several intermittent streams flow down the northern slope of Mt. Tom. A few of these begin south of the main carriage road near the southern property boundary, and are carried under the road via culverts. Others begin at the road, receiving water from the road's drainage ditches.

Additional intermittent streams flow down the lower, northern slope of the West Ridge, north of McKenzie Road. These streams begin as seeps discharging groundwater to the surface. These seeps were continuously wet from May through August 2001, though during dry periods flow became intermittent further down the stream channels.

The major wetland complex in the Park occurs east of the Pogue, north and west of the Summer Pasture. This complex consists of four wetlands, which receive water from runoff and groundwater seeps, and discharge water to Pogue Hole Brook via intermittent streams. Portions of these wetlands provide habitat for vernal pool-breeding amphibians (Jones, personal communication).

Bedrock and Surficial Geology

Bedrock underlying the Park is mainly Waits River Formation, a limestone/marble complex (Doll 1961). A small portion of the Park is underlain by Standing Pond Volcanics. Both of these rock types are of Silurian or Devonian age (440 to 360 million years old).

The Waits River Formation is composed of thick-bedded, metamorphosed, impure limestone and black garnetiferous phyllite (Chang *et al.* 1965). However,

"near the contact with the Standing Pond Volcanics [as in the Park] the amount of impure limestone in the black phyllite becomes less and less. Locally, even though thin-bedded impure limestone is still present in small amounts, the rock is very quartzose and rich in garnet porphyroblasts." (Chang *et al.* 1965)

Waits River rock crops out throughout the Park, especially in the southern half.

Two major outcrop/cliff complexes occur in the Park, on the eastern slope of Mt. Tom, and on the eastern face of the West Ridge.

Standing Pond rock crops out on the slope immediately west of the cottages and Carriage Barn. Standing Pond Volcanics are characterized by

"the association of bedded amphibolite and garnet-hornblende-quartz-mica schist. Many of the garnet porphyroblasts in these beds are as much as two inches in diameter. The hornblende also forms large prismatic crystals one to four cm long lying in the schistosity." (Chang *et al.* 1965)

These striking garnets and hornblende crystals are especially evident in the outcrop west of the cottages.

Surficial materials within the Park are primarily glacial tills (Doll 1969), of a sandy texture and more or less stony. Boulders are abundant on the land surface on the east shoulder of Mt. Tom, in the vicinity of the cemetery road.

Soils

Although the Natural Resources Conservation Service (NRCS) is in the process of updating the Windsor County Soil Survey, the Park has draft soil mapping information from the NRCS available in its GIS database. Soils occurring within the Park are mapped as inceptisols, and developed within a frigid temperature regime. Inceptisols are relatively young soils that do not display strong horizon development. The Park's soils are primarily loamy, have developed from till material, and vary in depth (from very deep to shallow) and drainage characteristics (from poorly drained to excessively drained). Much of the Park is mapped as being very stony or rocky, indicating that stones are present over the ground surface. Field observations generally support the draft mapping, though areas of developing

spodosols occur. Spodosols are soils that have a horizon in which metal compounds, primarily iron and manganese oxides, accumulate, making the horizon brightly colored. Generally this bright horizon is overlain by a bleached layer of gray soil, from which the metal compounds have been removed.

The NRCS maps the tops and upper slopes of Mt. Tom, the West Ridge, and the North Ridge as Trow-Bartlett fine sandy loams. Dummerston, Trow, and Pomfret series fine sandy loams make up most of the remaining Park area. These soils developed in till derived from schist, limestone and/or phyllite.

Methods

I generated the present-condition and natural community maps following a four-step process outlined by Thompson and Sorenson in *Wetland, Woodland, Wildland* (2000), and developed by the Nature Conservancy in conjunction with the Vermont Agency of Natural Resources and state natural heritage programs. The four steps are information gathering, mapping by photo-interpretation, accuracy assessment, and final map production. These steps are not necessarily linear. Rather, mapping is an iterative process in which field observations allow a greater understanding of features on the aerial photographs and vice versa.

Existing Data Compilation and Interpretation

To begin, I compiled existing information from various sources, including the State Mapping Project orthophoto, NRCS soil survey, bedrock and surficial geology maps, the National Wetlands Inventory map, and the 7.5-minute USGS quadrangle (North Woodstock quadrangle, 1985). I reviewed GIS layers generated by the University of Vermont for the Cultural Landscape Report (Wilcke *et al.* 2000), such as the digitized versions of aerial photographs, the Wiggin (1993) stand map and historical surveys. I also reviewed GIS layers generated by other sources, and the vegetation inventory report prepared by Hughes and Cass (1997). All of this information guided my initial fieldwork in the Park. Conversations with Kyle Jones, former Park Resources Manager, also helped me to identify various features found in the Park.

The second phase of the project was creating a map through photo-interpretation. I imported the National Aerial Photography Program digital ortho-quadrangle (DOQ), dated April 27, 1992, into ArcView 3.2. This aerial photograph has been orthorectified by the USGS. Orthorectification is a process of "stretching" the image, which is flat, so that it more accurately relates to the three-dimensional landscape. I also imported the 1993 Vermont State Mapping Project orthophoto. Although due to differences in their orthorectification processes these images do not perfectly match each other in all locations, I felt they were adequate for the purposes of mapping natural communities. Using these images as bases, I created

polygons on-screen, attempting to encapsulate areas of similar vegetative cover. I looked for differences in textures, shades, and patterns to distinguish between cover types.

Field Methods

Fieldwork occurred in two phases: community classification and accuracy assessment, and gathering plot information.

Community Classification and Assessment

I gathered descriptive data for each polygon by visiting each portion of the site, and relating field conditions to features on the aerial photograph and USGS quadrangle. Data gathered for each polygon at this time included canopy, understory, and herbaceous dominants, slope, aspect, soils information and general notes.

Boundaries between communities were adjusted as necessary.

Sometimes, as at the edge of plantations, the cover type boundary was not hard to discern. Other times, as in some of the hemlock/northern hardwood dominated areas, distinctions between cover types were indistinct. In either case, vegetative data informed my decisions about naming each community, using the nomenclature given in Thompson and Sorenson (2000).

As mentioned previously, the mapping process is not linear. Rather, visits to the field help clarify patterns seen on the aerial photographs, or uncover new patterns that photographs don't capture. Where appropriate, I adjusted the boundaries between polygons, or created new ones, to more closely resemble conditions observed in the field. Thus, I really took the third step, accuracy assessment, in conjunction with the second step. As I visited areas in the field I revised the polygons in that area both in extent and classification as needed.

To delineate and classify communities in the field, I relied primarily on vegetation and soils. Descriptions of the field methods I followed to describe these features and other site characteristics are below.

Vegetation

I split vegetation into four categories: herbaceous, shrub, saplings and trees. The herbaceous layer included all non-woody species and any woody species less than 2 feet tall. The shrub layer included woody species between 2 and 15 feet tall, as well as woody vines regardless of height. The sapling layer included all non-climbing woody species greater than 3 inches and less than 6 inches in diameter at breast height (dbh--4.5 feet above the ground) and greater than 15 feet tall. The tree layer included all non-climbing woody species 6 inches in dbh or greater. Although all saplings are tree species, I split these categories to generally differentiate between canopy and sub-canopy trees.

Soils

I described soils through pH, color and texture. I used a Dutch auger to investigate sub-surface features and to approximately measure horizon thickness and depth.

I used a Hellige-Truogg soil reaction/pH test kit to determine the pH of soils at the mineral soil surface and 10 cm below the surface, estimating pH to the nearest half-unit using the kit's color chart. To determine soil color, I used an EarthColors color book. Interpreting soil color is partially subjective, and results can vary depending on lighting and moisture. I judged all colors using moist soil and in as strong light as possible, given canopy and weather conditions. I determined apparent texture in the field through the standard ball/ribbon/feel method, again using moist soil.

Other Characteristics

I measured slopes, in percent, using a Suunto clinometer. Landscape position was judged based on field characteristics and the USGS topographic map. Aspect was measured using a compass and grouped into one of 16 directions (clockwise, North through North-northwest). I visually estimated the amount of ground surface occupied by surface stones and/or pillow-and-cradle microtopography.

Plots

To describe the communities quantitatively, and to allow comparison between this natural community survey and others in Vermont, I established plots within many community types. Plots measured 20 meters by 25 meters (500 meters squared),

with the longer axis extending cross-slope. Data gathered from plots included species composition and percent cover from tree, sapling, shrub, and herbaceous layers; slope; aspect; soil pH at the surface and at 10 centimeters; and color and texture of soil horizons from the surface to approximately 36 inches (if possible). I estimated percent cover visually; herbaceous species with one or two individuals covering almost no area were noted as "trace" occurrences. Appendix A lists the plant species identified in the plots.

Other notes included information on hydrology, pillow and cradling, bedrock outcrops, surface stones, and logging evidence. I established 39 plots in the Park, and one immediately south of the Park boundary on the northern side of Mt. Tom, all within natural stands. Plot data are provided in Appendix B.

Natural Communities

I identified 16 natural communities within the Park; three of these comprise most of the Park's area, while the remainder form small patches within the general matrix (Table 1). The natural community map (Figure 2) depicts the extent and distribution of the actual and potential natural communities occurring in the Park, while the present conditions map (Figure 3) retains the plantations and fields.

Table 1.
Natural Communities mapped at Marsh-Billings-Rockefeller National Historical Park, Woodstock, VT, Summer 2001.

<u>Community Type</u>	<u>Distribution</u>	<u>Total Area* (ac)</u>
Northern Hardwood Forest	Northern and western portions	57
Sugar Maple-White Ash-Jack-in-the-Pulpit Forest	North Ridge, West Ridge	43
Rich Northern Hardwood Forest	West Ridge	14
Northern Hardwood Limestone Forest	West Ridge	9
Hemlock Forest	Pogue Hole Brook Valley	55
Hemlock-Northern Hardwood Forest	Eastern portion	136
Dry Oak Forest	Mt. Tom ridge	0.1
Hemlock-Oak Forest	Shoulder of Mt. Tom	6
Temperate Calcareous Outcrop	Eastern face of Mt. Tom	0.5
Temperate Calcareous Cliff	Southern end of West Ridge	1.5
Red Maple-Black Ash Swamp	Wetlands east of the Pogue	8
Red or Silver Maple-Green Ash Swamp	Wetlands near Prosper Road	6
Hemlock Swamp	Wetland west of North Ridge	3
Seep	Rare	1
Vernal Pool	Scattered	N/A
Shallow Pond	The Pogue	14

Sources: Thompson and Sorenson (2000); Tom Lautzenheiser

* Only includes natural stands; an additional 155 acres of land are in plantation

Thompson and Sorenson (2000) describe 80 natural communities occurring in Vermont, including information on vegetation, soils, wildlife, disturbance, and distribution. The community descriptions below are intended to complement those descriptions by focusing on how these communities are expressed at the Park.

Upland Communities

Upland communities occurring in the Park include the Northern Hardwood Forest, Hemlock-Northern Hardwood Forest, Rich Northern Hardwood Forest, Hemlock Forest, and Temperate Calcareous Cliff/Outcrop. These communities (especially the

Northern Hardwood Forest and the Hemlock-Northern Hardwood Forest) dominate the Park's area.

The majority of the Park is underlain by the Waits River Formation, limestone-marble bedrock that weathers to a nutrient-rich soil. It is not surprising, therefore, that plants that inhabit rich woods, such as maidenhair fern, Jack-in-the-pulpit, and wild ginger, among others, occur almost ubiquitously throughout the Park.

Wetland Communities

Wetlands and streams are important components of the landscape at the Park. The major wetland system occurs east of the Pogue, and wraps to the north side of the Summer Pasture. This necklace of wetlands and intermittent streams provides a very different environment from the surrounding uplands. Green and black ashes dominate different portions of these wetlands, with hemlock, yellow birch, and red maple also occurring. Intermittent streams, many forming badly eroding gullies, are common to the north of the main carriage road and also to the north of McKenzie Road. While these streams support their own natural communities, I did not map these communities due to their small size.

Northern Hardwood Forest

Location

Western portion of the Park

Community Patch Size

Large/matrix

Vegetation

Dominant: sugar maple, yellow birch, and American beech

Common to occasional: white ash, basswood, red maple, hemlock, black cherry, red oak, big-toothed aspen, white birch, striped maple, alternate-leaved dogwood, marginal and intermediate wood ferns, Christmas fern, long beech fern, beech drops



Notes

The Northern Hardwood Forest forms the background natural community throughout much of Vermont.

This community differs from the closely related Hemlock Northern Hardwood Forest, which I mapped mainly in the eastern portion of the Park, in generally having less hemlock.

Much of the area I mapped as Northern Hardwood Forest is within the present day fields or plantations. In plantations, I based this classification on understory vegetation and the loamy texture of underlying soils. For the most part, regeneration under the red and white pine plantations consisted of sugar and striped maples, beech, yellow birch, and white ash—all components of the Northern Hardwood Forest. Regeneration of conifers, including white pine, red pine, red spruce and hemlock, was minor under most of the plantations. The herbaceous layer under the plantations commonly includes white ash and sugar maple seedlings, Canada mayflower, wild sarsaparilla, marginal and intermediate wood ferns, bracken fern, and hayscented fern.

Sugar maple seedlings and small shrubs were often especially dense—forming a continuous carpet—in areas where old maple trees were left within the matrix of the plantation, as in the red pine plantation south of the Elm Lot. As the old trees drop branches, more light reaches the ground and allows these seedlings to thrive. Other species, including white ash, raspberries, beech, black cherry, and wild sarsaparilla, also take advantage of these light gaps.

Other areas I mapped as Northern Hardwood Forest are relatively young stands. Based on aerial photographs, most of the area south of the Pogue was open pasture until the 1950s. This area includes the Elm Lot, the red pine plantation south of the Elm Lot, adjacent plantations of Norway spruce and white pine, as well as natural stands. This area also includes the Crop Tree Release demonstration site. Although Crop Tree Release site is being managed, the species and soils occurring in this area are characteristic of the Northern Hardwood Forest community type. Similarly, I mapped an early successional area south of the Elm Lot as Northern Hardwood Forest. This area occurs on a steep, east-facing hillside that is vegetated dominantly by dense sugar maple saplings. Other tree species occurring in the area include white pine, yellow birch, white ash, black

cherry, and quaking aspen. The herbaceous layer in this area is sparse, and includes sugar maple seedlings, as well as Christmas fern and large scouring rush.

The south-facing hillside south of the Crop Tree Release site also supports a relatively young forest. This area has recently been thinned, and slash has been left in place. Toward the lower part of the hill, near the “Ashes Ashes” ski trail, grow several huge old trees, including sugar maple, white ash and basswood. These trees appear to have been planted, as they form a regular pattern. Other large planted or remnant sugar maples are scattered throughout the area, along the property line occasionally marking the edges of plantations.



Sugar Maple-White Ash-Jack-in-the-Pulpit Northern Hardwood Forest

Location

Western and Northern portions of the Park

Community Patch Size

Large

Vegetation

Dominant: sugar maple, white ash,

Common to occasional: basswood, butternut, Jack-in-the-pulpit



Notes

The Sugar Maple-White Ash-Jack-in-the-Pulpit Northern Hardwood Forest is a variant of the Northern Hardwood Forest community type. In contrast to the standard Northern Hardwood Forest community type, the Sugar Maple-White Ash-Jack-in-the-Pulpit Northern Hardwood Forest variant occurs in areas of slight to moderate enrichment, such as on gentle slopes, hill tops and shoulders, and where carbonate bedrock crops out frequently. Soils in this variant may be moist, where enriched groundwater is at or near the surface, or may be well drained, as on the ridges and sideslopes. This forest tends to have less beech and yellow birch, and more basswood and white ash, than the standard Northern Hardwood Forest. I have included this community in the map because it contains more rich-site species than the standard Northern Hardwood Forest, but generally has a sparser and less diverse herb layer than the Rich Northern Hardwood Forest.

Areas mapped as Sugar Maple-White Ash-Jack-in-the-Pulpit Northern Hardwood Forests have inclusions of standard Northern Hardwood Forest, Rich Northern Hardwood forest, and Hemlock-Northern Hardwood Forest. Isolated outcrops within this unit on the northern slope of the West Ridge support patches of hemlock.

Rich Northern Hardwood Forest

Location

West and North Ridges

Community Patch Size

Small

Vegetation

Dominant: sugar maple, white ash, blue cohosh, maidenhair fern, white snakeroot

Common to occasional: red-berried elder, wild leek, rattlesnake fern, bloodroot, wild ginger, herb-Robert, wood nettle, clearweed, plantain-leaved sedge, Dutchman's britches, Jack-in-the-pulpit



Notes

The steep (average of more than 60 percent slope) east-facing slope of the West Ridge (elevations from 1240 to 1400 feet) supports a profusion of rich site species. The band of enrichment extends from the West Ridge up the western side of the North Ridge, and down to a fern-dominated wetland, as well as to the west. Although there are many other rich or semi-rich areas in the Park, this is the most extensive.

Soils on the lower slope of the West Ridge's eastern face have a deep, black surface horizon. The pH of the soil is circumneutral to alkaline. Downslope movement of litter and surface stones is obvious. Some of these surface stones react violently to acid, indicating their carbonaceous composition.

Other patches of Rich Northern Hardwood Forest occur throughout the Park, mostly in concavities that collect leaf litter and soil that wash down slopes. One of these patches is on the southern face of the North Ridge. The herbaceous layer of this area is dominated by wild leek, which can be smelled from a little distance away. Another characteristic of Rich Northern Hardwood Forests evident in this area is the patchy leaf litter layer. The high pH (approximately 8.0) of the soil leads to rapid decomposition of organic material. I also found snail shells in the leaf litter in this area, which I did not notice elsewhere in the Park.

Another patch of Rich Northern Hardwood Forest occurs in a small basin north of the North Ridge, in the area around a fern glade. Vegetation in this area includes sugar maple, basswood, butternut, red-berried elder, wild ginger, wild leek, Virginia waterleaf, baneberry, Jack-in-the-pulpit, sweet cicely, ostrich, interrupted, Goldie's, intermediate wood, and maidenhair ferns. This basin is open, with very few shrubs, and exuberant ferns.

I have also mapped a small area of Rich Northern Hardwood Forest at the western end of one of the Black Ash Swamps east of the Pogue. Groundwater breaks out from the slope in this area and seeps down to the wetland. Vegetation in this area includes sugar maple, basswood, Goldie's fern, silvery glade fern, maidenhair fern, wild ginger, blue cohosh, plantain-leaved sedge, and Jack-in-the-pulpit.

Northern Hardwood Limestone Forest

Location

West Ridge

Community Patch Size

Medium

Vegetation

Dominant: sugar maple, hophornbeam

Common to occasional: white ash, white snakeroot



Notes

The Northern Hardwood Limestone Forest, a variant of the Rich Northern Hardwood Forest, also occurs within the Park.

On the upper, eastern slope of the West Ridge, soils are drier and shallower than lower down the slope; gravity tends to remove leaf litter and debris from this area, and this material accumulates downslope. The vegetation on the West Ridge reflects this process. Hophornbeam dominates the understory on the shoulder and upper portion of the West Ridge's eastern face, and heart-leaved aster and blue-stemmed goldenrod dominate the herbaceous layer. Other herbaceous plants occurring in this area include white snakeroot, big-leaved aster, and blackseed-ricegrass.

Hemlock-Northern Hardwood Forest

Location

Eastern portion of Park

Community Patch Size

Large/matrix

Vegetation

Dominant: hemlock, American beech, yellow birch, sugar maple

Common to occasional: red maple, red oak, basswood, white ash



Notes

Hemlock is an important, often dominant, component of the natural stands on the eastern slopes of Mt. Tom (north and south of the main carriage road to the Pogue). In the western portion of the Park, hemlock is dominant in areas north of McKenzie Road, but is uncommon south of this carriage road.

Hemlock-Northern Hardwood Forest is, as the name implies, similar to the Northern Hardwood Forest community type, but hemlock is a more important component of this community.

According to Thompson and Sorenson's (2000) description, Hemlock-Northern Hardwood Forests occur in less nutrient-rich areas such as on sandy or gravelly outwash plains. However, in the Park, hemlock occurs even where nutrients are abundant (as indicated by the relatively high soil pH, even under pure hemlock stands, of around 6.0, and the diverse herbaceous layer throughout much of the area). The Hemlock-Northern Hardwood Forests in the Park may be an enriched variant of this community type, or, alternatively, may be a hemlock-rich variant of the Rich Northern Hardwood Forest community type.

I mapped most of the northern slope of Mt. Tom as Hemlock-Northern Hardwood Forest, though, from the top to the bottom of the slope, differences in bedrock, soils, slope and moisture are marked enough to break this large unit into at least three recognizable variants. These are most aptly split according to landscape position.

Near the top of the property, the slope is steep, soils are very shallow and relatively dry; and bedrock crops out frequently. Hemlock forms pure stands on particular outcrops or convexities in this area. Herbaceous vegetation includes the wood ferns, but the richer species that occur at lower levels (described below) are absent.

In the mid-slope area, the slope is gentle, soils become deep, moisture increases, and bedrock outcrops are infrequent. A few interrupted fern-dominated pockets occur at the headwaters of the intermittent streams that extend down to Pogue Hole Brook. While the canopy remains a mixture of hemlocks and northern hardwoods, the herbaceous layer includes some rich-site species, including maidenhair fern, Christmas fern, and plantain-leaved sedge.

On the lower slope of Mt. Tom, above the Pogue Hole Brook ravine, once again the slope steepens. Bedrock is very deep in this area. The soils in much of this area are moist, receiving both

surface flows and groundwater discharge. Again, while the canopy continues to be a mixture of hemlocks and northern hardwoods, the herbaceous layer becomes dominated by rich-site species. Patches of maidenhair fern and plantain-leaved sedge occur in the moist areas.

Another variation in the Hemlock-Northern Hardwood Forest occurs on the lower southeastern slope of Mt. Tom, where boulders cover significant areas of the ground surface. Vegetation in this area includes hemlock, beech, white ash, yellow birch, and occasional red oaks. Bedrock crops out in this area as well. A seep, described in the Wetland Community section below, also occurs in this area.

Areas mapped as Hemlock-Northern Hardwood Forest have inclusions of Northern Hardwood Forest, Rich Northern Hardwood Forest and Hemlock Forest communities.



Hemlock Forest

Location

Central portion of Park

Community Patch Size

Medium to small

Vegetation

Dominant: hemlock

Common to occasional: yellow birch, American beech



Notes

The largest Hemlock Forest community is that which flanks Pogue Hole Brook and the wetlands east of the Pogue. Although this entire area has the trait of being dominated by hemlock, most other conditions are quite variable. Immediately east of the Pogue, hemlock is mixed with beech in a well-drained soil. Around the wetlands, hemlock is creeping out into the permanently saturated areas, as well as reaching up to the drier places.

A striking variation is in the Pogue Hole Brook ravine, north of the main carriage road and east of the Spring Lot. This ravine, averaging approximately 40 feet deep, has extremely steep sides. Landslides are the major disturbance here. Evidence of past slides can be seen, including an excellent example of an old rotational slump on the north side of the brook, as well as a more common slide on the south side. Hemlock and yellow birch are the dominant tree species in the ravine.

A nearly pure hemlock stand occurs in the northwestern portion of the property, flanking an intermittent stream west of the North Ridge. A portion of this area is a hemlock-dominated sloping seepage swamp, described in the Wetland Communities section below. Other species occurring with hemlock in this area include beech, white birch, and shadbush.



Temperate Calcareous Outcrops/Cliff

Location

West Ridge, east side of Mt. Tom

Community Patch Size

Small

Vegetation

Dominant: white ash, herb-Robert,

Common to occasional: wild millet, clearweed, Jack-in-the-pulpit, maidenhair fern



Notes

While bedrock crops out frequently throughout much of the Park (especially in the southern half), two areas are large enough to be mapped. A temperate calcareous outcrop occurs on the eastern slope of Mt. Tom, south of the upper carriage road, and a temperate limestone cliff occurs on the southern end of the West Ridge, west of the Pogue.

The bedrock that forms these features is not a strong limestone, but, as is typical of the eastern edge of the Waits River Formation, is a mix of schist and impure limestone. Locally the rock may react with acid, but in general no visible reaction occurs, even on a fresh face. Certainly these rocks are not acidic, though they are better described as circumneutral rather than alkaline. Nonetheless, these rocks are contributing nutrients to the area, and the vegetation growing both on the rock and immediately downslope reflects this enrichment.

The outcrop on the eastern slope of Mt. Tom creates an interesting ecological gradient. Conditions are harsh at the top of the outcrop. The convexity of the slope causes the area to be droughty, and soil-building materials tend to wash away. The trees here are stunted, and most of the area is bare rock, with patches of grasses, sedges and hayscented fern. On the bottom, however, small concavities in the rock accumulate soil and organic matter; these pockets are highly enriched. This juxtaposition of conditions over a short distance is in contrast to the situation over much of the Park, where gradients tend to be less pronounced. Vegetation on the lower portion of this outcrop includes white ash, herb-Robert, maidenhair fern, Christmas fern, wild millet, clearweed, blue cohosh and Jack-in-the-pulpit.

Many of these species are typical of the smaller outcrops that occur throughout the Park. Other species found on outcrops in the Park include maidenhair spleenwort, miterwort, Canada mayflower, alternate-leaved dogwood, sugar maple, and a bedstraw.

Hemlock-Oak Forest

Location

Mt. Tom

Community Patch Size

Medium

Vegetation

Dominant: hemlock, red oak

Common to occasional: hophornbeam, Canada mayflower



Notes

Within the Park, the Hemlock-Oak Forest community type occurs on the northern and eastern shoulders and mid-slope of Mt. Tom. The slope in this community is moderate to steep, though it varies due to the shallowness of the schistose bedrock. Bedrock crops out frequently throughout the area. Hemlock and red oaks, some quite large in diameter, dominate the canopy of this community, and red maples also occur. Hophornbeam joins these species as a member of the sapling layer. Shrubs and herbs are sparse. The herbaceous layer includes Canada mayflower, bracken fern, red maple seedlings, and wood ferns.

Soils in this community are more or less shallow, and in some places have developed an albic horizon. The pH of the soil is relatively low for the Park, at approximately 4.5.

Dry Oak Forest

Location

Mt. Tom

Community Patch Size

Small

Vegetation

Dominant: red oak

Common to occasional: striped maple, hairgrass



Notes

A very small area of Dry Oak Forest occurs in the eastern portion of the Park on the shoulder of Mt. Tom. This area is the eastern limit of the larger community, most of which occurs on a ridge on the adjacent town-owned land. Stunted red oak, hophornbeam, and white ash form a thin canopy, and striped maple dominates the shrub layer. The herbaceous layer is grassy, and includes hairgrass, path rush, and Pennsylvania sedge. The soil is very shallow, and bedrock crops out abundantly throughout the area. With this community's dry conditions, shallow soil, and relatively exposed position, fire may play a role in its long-term dynamics.

Shallow Pond

Location

The Pogue

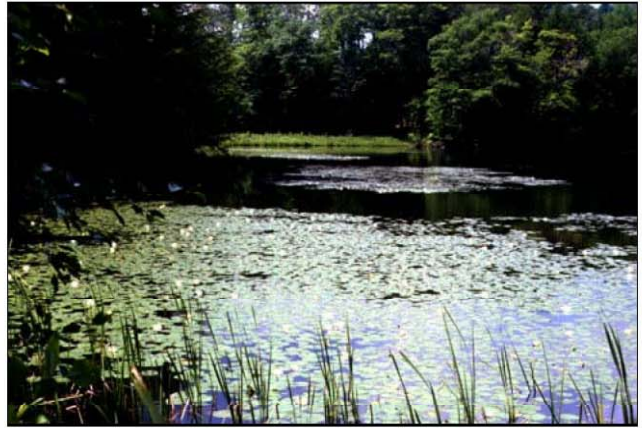
Community Patch Size

Medium

Vegetation

Dominant: water lily

Common to occasional: broad-leaved cattail, steplebush, willows



Notes

Although the Pogue is a man-made waterbody (elevation 1220 feet), it has existed for more than a century and is likely to remain essentially as it is for the foreseeable future. Therefore, I included it as a natural community. Small patches of Cattail Marsh occur near the perimeter of the pond, and waterlilies are abundant throughout. The bank of the Pogue is generally less than 2 feet tall, steep, and consists of gravelly sand held in place by vegetation (except at the dam, where a sandy, beach-like section occurs). Vegetation in the shallows and on the bank includes European alder, willows, steplebush, broad-leaved cattail, blue-flag iris and grasses and sedges.

Before the Pogue was dammed in the late 1800s, a smaller area of open water and a quaking fen or marsh occupied its present footprint (Wilcke 2000). Given the high pH of the present pond, the calcareous bedrock underlying the area, and landscape position and topography, the basin occupied by the Pogue was also enriched. In the natural community classification scheme, the wetlands in the basin probably would have been classified as Intermediate or Rich Fens. Intermediate Fens are rare in the state; Rich Fens are rare both statewide and globally (Thompson and Sorenson 2000). No remnants of these communities remain.

Red Maple-Black Ash Swamp

Location

Central portion of Park

Community Patch Size

Small to medium

Vegetation

Dominant: black ash, green ash, red maple, sugar maple, yellow birch, hemlock, spotted touch-me-not, ferns, mosses

Common to occasional: American elm, striped maple, steplebush, alternate-leaved dogwood, broad-leaved cattail, nightshade, Jack-in-the-pulpit, grasses, sedges, horsetails



Notes

The wetland system east of the Pogue consists of four Red Maple-Black Ash Swamps. The swamp between the Pogue and the Summer Pasture drains south via an intermittent stream to Pogue Hole Brook. Two abandoned wells are located near this swamp. Three other swamps, connected by intermittent streams, wrap around the north side of the Summer Pasture, and eventually flow to Pogue Hole Brook near the Spring Lot.

Vegetation in the Red Maple-Black Ash Swamps include black and green ashes, red and sugar maples, yellow birch, hemlock, basswood, American elm, speckled alder, striped maple, steplebush, alternate-leaved dogwood, spotted and pale touch-me-not, broad-leaved cattail, nightshade, Jack-in-the-pulpit, royal, interrupted, cinnamon, sensitive, and lady ferns, horsetails, grasses and sedges, and mosses. Herbaceous vegetation is dense and covers virtually the entire ground surface, except where standing water is persistent. Shrub and tree species are restricted to hummocks or nurse logs above the level of permanent saturation or flooding.

Soils in these wetlands are saturated to the surface for most of the year, and pockets of standing water may persist for months. The soil is generally a deep or very deep organic muck. The pH of the soil in at least one of the wetlands is between 8.0 and 8.5. Wetlands this alkaline are uncommon in the state; a focused botanical inventory of these areas may find some interesting species.

Hemlocks dominate the vegetation around the perimeter of these wetlands. Over time, hemlocks may encroach into the more open and/or hardwood-dominated areas.

These wetlands provide breeding habitat for vernal pool amphibians (Jones, personal communication).

Red or Silver Maple-Green Ash Swamp

Location

Northwestern corner of Park

Community Patch Size

Medium

Vegetation

Dominant: green ash, red maple

Common to occasional: American elm, speckled alder, ferns, goldenrods



Notes

A Red or Silver Maple-Green Ash Swamp wetland system occurs in the northwestern corner of the site, north of the Prosper Road parking lot. Fed by seeps and surface flows, this wetland is mostly open. Portions of the wetland have been disturbed by human activity. Vegetation in this community includes green ash, American elm, red maple, speckled alder, royal fern, sensitive fern, spotted touch me not, foamflower, and goldenrods. Soils in the area are loamy fine sands or silt, and have redoximorphic features (mottles and depletions) below 10 inches from the soil surface.

A narrow arm of this wetland extends south along the eastern edge of the parking lot. Vegetation in this area includes common reed, willows, and red maple. This is the only occurrence of common reed, an invasive species, that I found in the Park.

According to Thompson and Sorenson (2000) the Red or Silver Maple-Green Ash Swamp natural community type is found most commonly in the Champlain Valley and along Otter Creek in western Vermont. Its presence at the Park, therefore, is somewhat surprising. I included these wetlands in this community type because it seems to be the closest match described at this time, mostly due to the abundance of green ash and the deep, very poorly drained soils. However, the wetland and its immediate surroundings have been altered by human activity (indicated by the plantations that abut the wetland complex). Future natural community work may lead to reclassification of this community.

Hemlock Swamp

Location

West of the North Ridge

Community Patch Size

Medium

Vegetation

Dominant: hemlock

Common to occasional: yellow birch



Notes

A Hemlock Swamp occurs north of McKenzie Road, west of the North Ridge. This community is on a gentle (20 percent) slope to the north; the ground is saturated to the surface and surface water trickles in small channels in the area. Hemlock is the dominant tree in the area, with yellow birch a distant second. Sugar maple and green ash also occur. The trees in the area are extremely shallow-rooted, forming a dense mat that in places is suspended above the mucky, mineral soil.

Windthrown hemlocks are scattered throughout the area. The herbaceous layer is diverse, and moss covers most of the surface, roots, and stones in this area. The area is shallow to bedrock or densipan. This community is highly enriched, with a pH of approximately 8.0.

Seep

Location

Eastern portion of Park near Cemetery Road, otherwise scattered

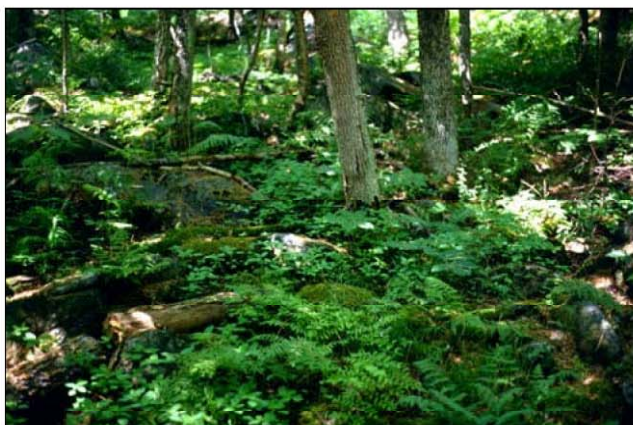
Community Patch Size

Small

Vegetation

Dominant: sensitive fern, interrupted fern

Common to occasional: ostrich fern, spotted touch-me-not, royal fern



Notes

I have mapped several seeps in the eastern portion of the Park, near the cemetery road. This wetland complex consists of three wetlands occurring in small, shallow depressions linked by intermittent stream channels. Seeps contribute water to these wetlands. These wetlands do not fit neatly into the Seep community type as described by Thompson and Sorenson (2000); further natural community work may assign them elsewhere.

The westernmost of these wetlands is extremely bouldery. Vegetation in the wetland grows mostly between the boulders. Woody vegetation includes red maple, white ash, basswood, yellow birch, American elm, beech, and speckled alder, but the dominant woody species is hophornbeam. (This is rather surprising, since hophornbeam typically occurs in dry soils.) Herbaceous vegetation is more typical of wet sites, and includes sensitive, royal, and cinnamon ferns, spotted touch-me-not, Jack-in-the-pulpit, and Virginia creeper. Mosses cover over half of the ground surface. Pockets of standing water occur in this area. The mucky, loamy soils in the wetland are fairly shallow (averaging approximately 1 foot deep), and are saturated to the surface for much of the year.

The other two wetlands are more open, and are dominated by herbaceous vegetation, including spotted touch-me-not and interrupted and sensitive ferns, as well as Jack-in-the-pulpit. Vegetation around the margin of these wetlands includes hemlock, white pine, red oak, basswood, beech, sugar maple, and white birch.

At least four other Seeps occur on the property. The first is a small (approximately 30-foot diameter), probably man-made depression located at the southern property boundary adjacent to the King Farm (south of the Elm Lot red pine plantation). Sensitive fern dominates this depression, with stinging nettle, long beech fern, and goldenrods also present. A barely detectable intermittent stream channel extends southwest to the property line from the depression, which contained 3 inches of standing water in June. The ground in this area was saturated to the surface in August.

The second Seep is located in a depression near the northern property line in the central area of the Park, north of the North Ridge. Surrounded by Rich Northern Hardwoods, this seep also reflects strong enrichment, with vegetation dominated by lush ferns, including ostrich fern, interrupted fern, and Goldie's fern. A few yellow birches occur around the margin of the depression. An intermittent stream flows northeast out of the depression.

A third Seep occurs on the southeastern slope of Mt. Tom, near the southern property line, immediately west of the cemetery carriage road. This area is within a bouldery Hemlock-Northern Hardwood Forest. Water seeps at or near the ground surface, trickling down the slope to enter the Red Maple-Black Ash Swamp described above. Vegetation in this area is dominated by spotted touch-me-not, and also includes interrupted, maidenhair and sensitive ferns. Sugar maple, white ash, basswood, hemlock, and witch hazel also occur around the margins of the area.

Another Seep is located in a wetland west of the woodshed. This area receives water both from groundwater discharge and from surface flows. Vegetation in the wetland is dominated by interrupted fern, and also includes ostrich and sensitive ferns, Jack-in-the-pulpit, spotted touch-me-not, and white snakeroot. Soils in this area are mucky loams, and are permanently saturated to the surface. Some of this area has been altered by human activity, and silt from the nearby carriage road is collecting here as well.

Vernal Pools

Location

Scattered

Community Patch Size

Small

Vegetation

Dominant: variable

Common to occasional: variable



Notes

Several vernal pools are located in the Park, especially concentrated in the wetland systems east of the Pogue (described above under "Red Maple-Black Ash Swamp"). A few other pools, too small to be mapped as separated polygons, also occur. Two of these small depressions are in the hemlock community east of the Pogue. One of these areas covers approximately 400 square feet, and has a sparse herbaceous layer. The other is adjacent to the carriage road and is dominated by ferns.

The locations of known vernal pools were previously mapped for the Cultural Landscape Report using a GPS receiver. I have used this data layer for this natural community map.

Researchers from the Vermont Institute of Natural Science (VINS) have inventoried amphibians in the Park, and are conducting a focused study on the blue-spotted salamander population in the vernal pools east of the Pogue.

Conclusion

Through field work and photointerpretation, I identified 16 natural community types within the Park, and created maps showing their distribution. These maps are a starting point for incorporating ecological information into management at the Park, as well as for coordinating scientific research, and educating the public.

Future work on natural communities within the Park should link with University of Vermont Professor Bill Keeton's long-term forest dynamics study, which established permanent forest monitoring plots in the Park during the summer of 2001. These plots provide a superb opportunity to study maturing natural communities, or, potentially, the effects of various management activities on communities.

Additionally, several of the natural communities that occur in the Park merit closer examination. The wetland systems, the Rich Northern Hardwood Forest, and the Temperate Calcareous Cliff/Outcrops are likely to support unusual species. The enriched Hemlock-Northern Hardwood Forest also should be described in more detail. Opportunities to investigate the connection between natural communities and wildlife also exist.

A natural community map is a representation of the physical and biological features of a landscape; the basic purpose of the map is to describe the diversity and distribution of these features. The lines drawn on the map, and the names assigned to the various communities, provide a framework for our understanding, but are not as important as the description of real variation in a place. In applying the natural community concept to management, managers must understand that, often, ecological boundaries are diffuse, and the reality of the situation may be fuzzier than the map implies. Nonetheless, the natural community map is a valuable tool for scientists, managers and educators who want to better understand the ecology of a landscape.

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Appendix A - Plant List

Appendix B - Plot Data Sheets

Marsh-Billings-Rockefeller National Historical Park

Woodstock, Vermont



Figure 3: Present Conditions Map

Marsh-Billings-Rockefeller National Historical Park

Woodstock, Vermont

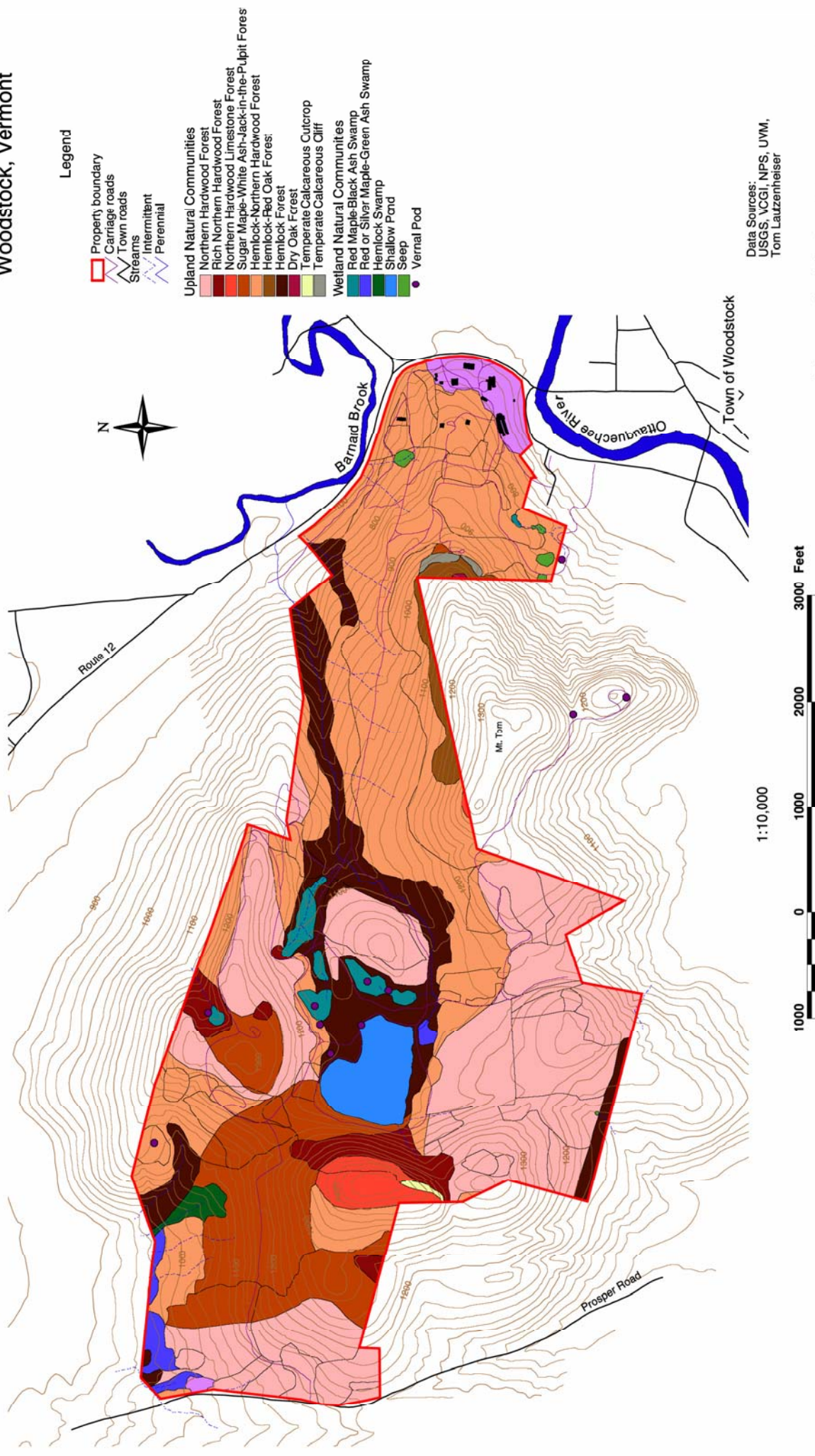
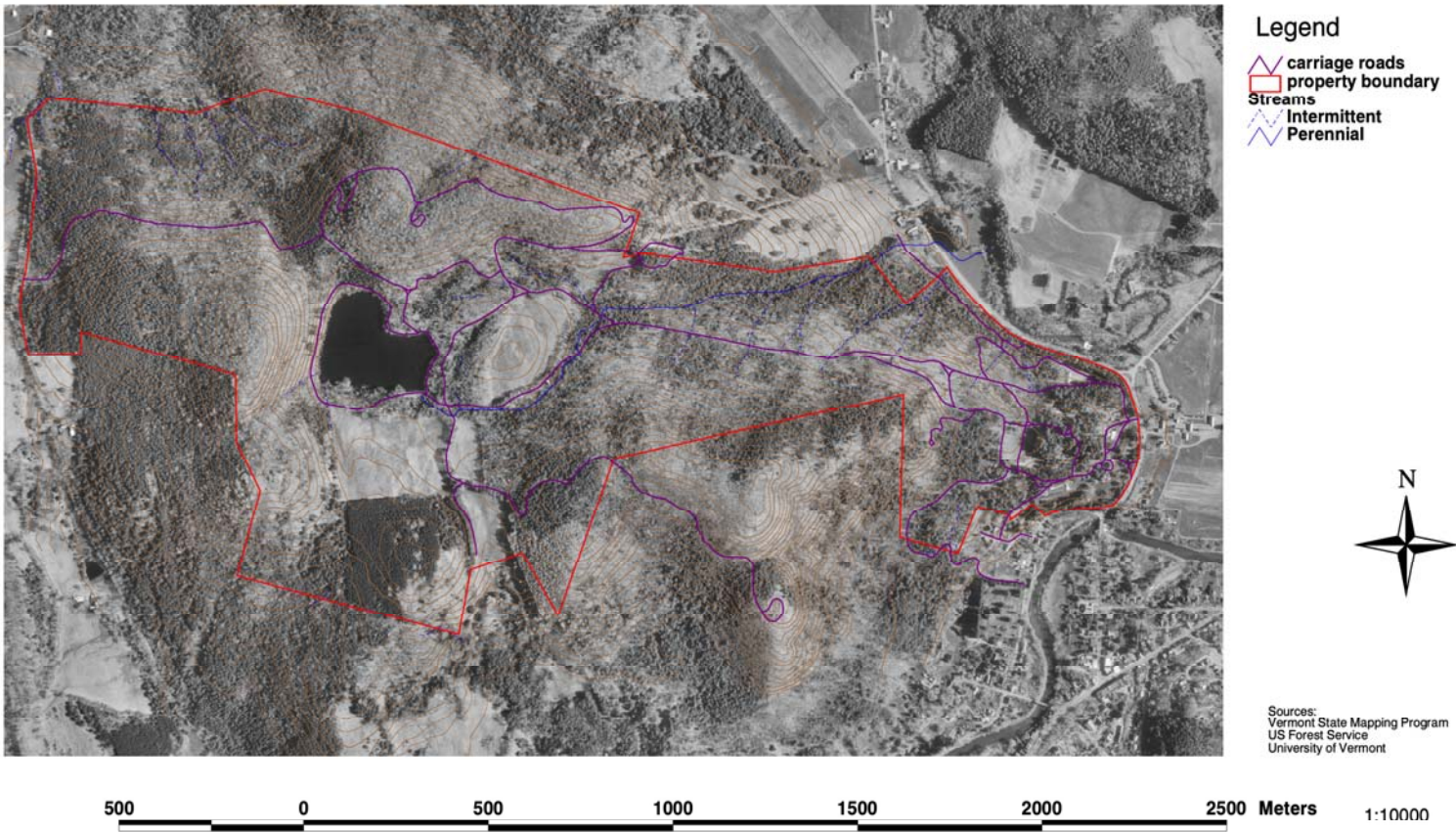


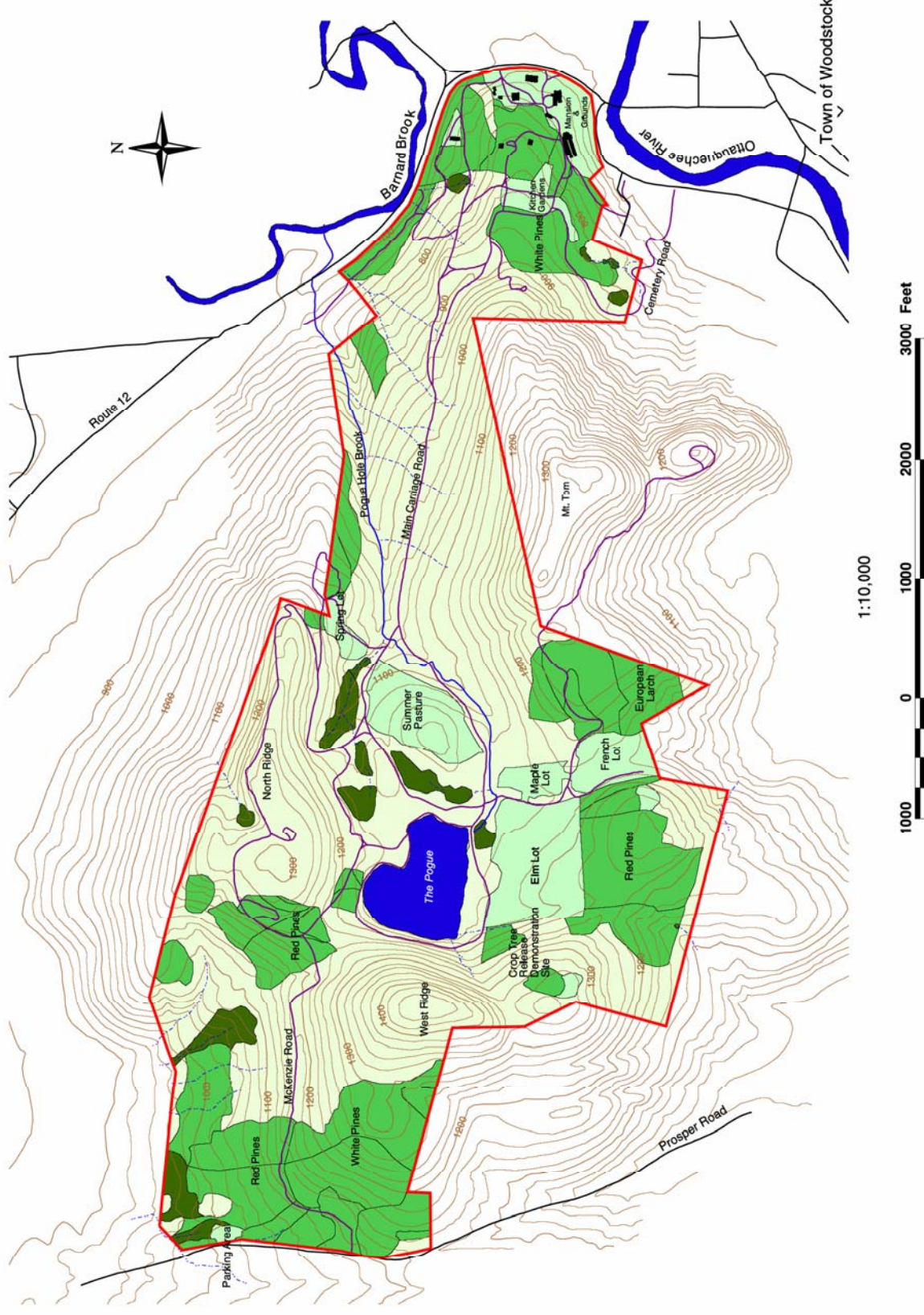
Figure 2: Natural Community Map

Marsh-Billings-Rockefeller National Historical Park Orthophoto



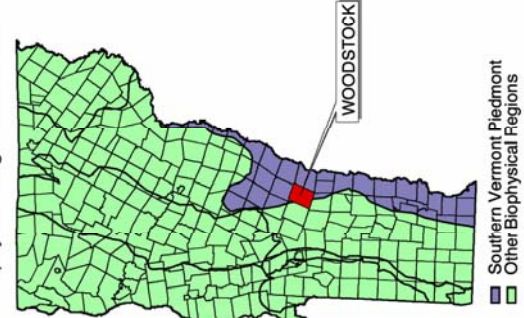
Marsh-Billings-Rockefeller National Historical Park

Woodstock, Vermont



- Legend**
- Property boundary
 - Park buildings
 - Town roads
 - Carriage roads
 - Forest
 - Fields and grounds
 - Plantations
 - Wetlands
 - Water
 - Streams
 - Intermittent
 - Perennial

Location Map
&
Biophysical Regions of Vermont



Data Sources:
USGS, VCGI, NPS, UVM,
Tom Lautzenheiser

Figure 1: Site Map