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SUMMARY

In 2001, the New Hampshire Natural Heritage Bureau (NH Heritage) conducted a landscape analysis of all state-owned properties in New Hampshire, in order to determine the highest priority sites for ecological inventory. As a result of this process, Pawtuckaway State Park was identified as having the highest priority, due to its unique geologic features and potential to support rare plant species and exemplary natural communities.

NH Heritage conducted the ecological inventory of the park during the field seasons of 2002, 2003, and 2004. The purpose of this was to provide the Division of Forests and Lands and the Division of Parks and Recreation with an in-depth accounting of the biodiversity of the property, in order to inform future management and planning decisions. As a result of this survey, 6 exemplary natural community systems, 18 exemplary natural communities, and 29 rare plant populations were documented in the park. For 4 of the rare plant species, the Pawtuckaway occurrences represent the only known extant populations in New Hampshire.

The vast majority (85%) of these species, community, and community system occurrences are found in the Pawtuckaway ring-dike system, a unique geologic feature (over 1700 acres) that is the result of ancient volcanic activity. This ring-dike system harbors one of the highest concentrations of rare species and exemplary natural communities and systems in the state.



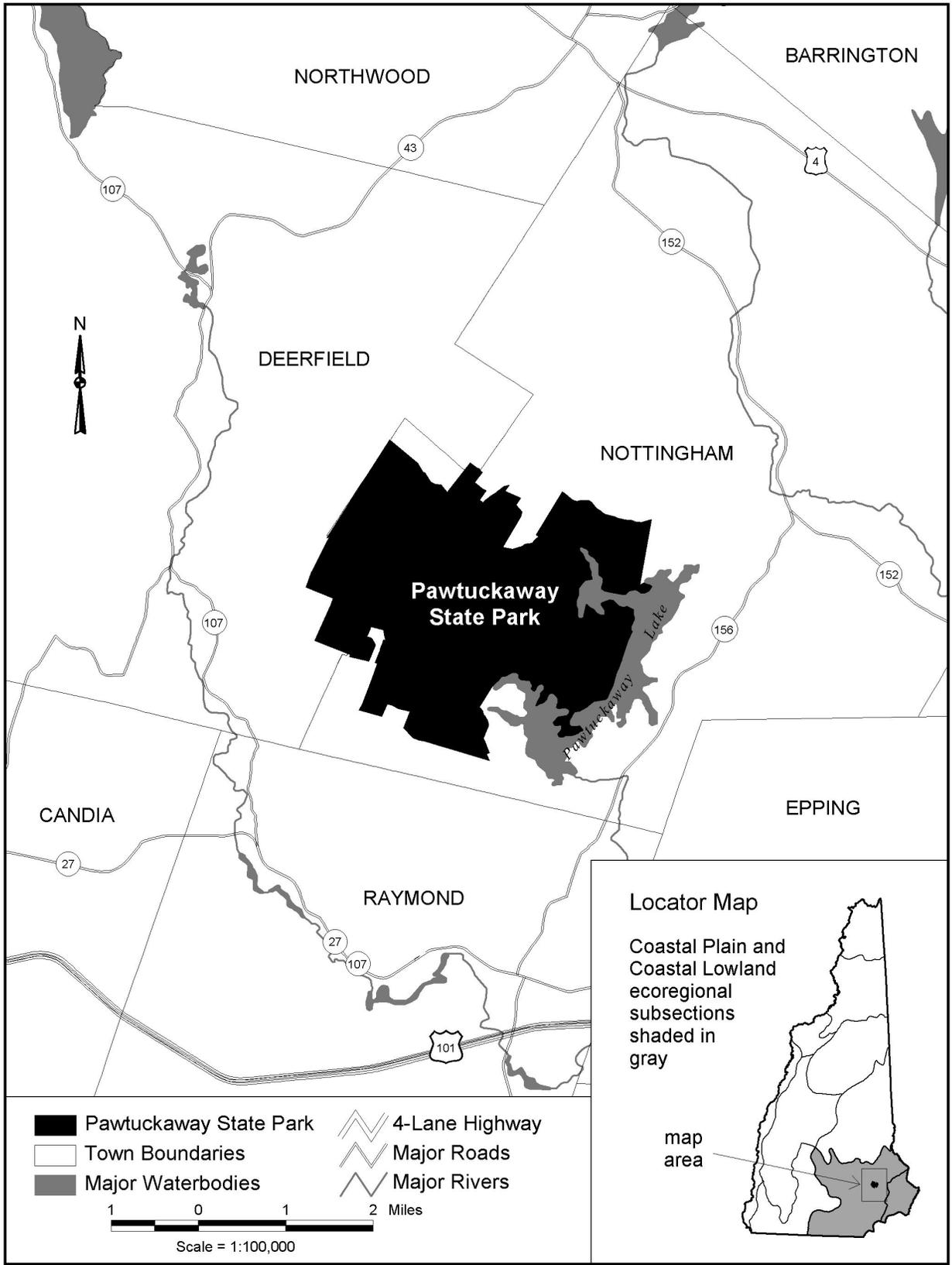


Figure 1. Location map for Pawtuckaway State Park in southeast NH, with ecoregional context.

INTRODUCTION

The NH Natural Heritage Bureau (NH Heritage) has completed an ecological inventory and assessment of Pawtuckaway State Park in southeastern New Hampshire (Figure 1). This park was identified as an extremely high priority for inventory in *Ecological Analysis of NH State Lands* (Crowley and Sperduto 2001).

Our goal was to survey all areas identified in the “Detailed Landscape Analysis of Pawtuckaway State Park” section of *Ecological Analysis of NH State Lands* (Crowley and Sperduto 2001). Many rare plant populations and exemplary natural communities were re-visited or discovered, and our understanding of the park’s remarkably rich and varied ecology improved dramatically. This final report presents the findings of surveys in the park in the field seasons of 2002, 2003, and 2004, as well as management recommendations to promote ecologically sound management of biodiversity on the property.

While this inventory is not the first inventory of a state lands property, it is the pilot project for the intended comprehensive, prioritized biological inventories recommended by NH Heritage and the New Hampshire Forest Resources Plan (Forest Resources Plan Steering Committee and NH DFL 1996) for all state lands managed by DRED. Targeted surveys are the most efficient way to increase our knowledge of biodiversity on state lands and therefore facilitate ecologically sound management.

This work was conducted for the State of New Hampshire and was funded by the NH Division of Forests and Lands, Department of Resources and Economic Development.

PAWTUCKAWAY STATE PARK

The area now occupied by Pawtuckaway State Park was first settled in the late 18th century. Much of the land within the Pawtuckaway Mountains was cleared for pasture, most of which was subsequently abandoned in the middle 19th century. Private residences on the land were occupied well into the 20th century.

In addition to the local residents, visitors have come to experience the natural world of the Pawtuckaway Mountains for over one hundred years. As early as 1878, a large party, including the state geologist and the governor, came to see the Pawtuckaway Boulder Field, a collection of gigantic, glacially-deposited boulders that is considered one of the world’s largest. The area’s unique natural and scenic qualities were recognized early in the twentieth century, and in 1923, the state purchased a 60-acre property on Middle Mountain, the first parcel in what would become Pawtuckaway State Park.

Today, the park encompasses approximately 5500 acres in the towns of Nottingham and Deerfield. The focal point of the park remains the Pawtuckaway Mountains, which at 1101 ft. includes the highest point in Rockingham County. These mountains comprise a unique geologic feature termed a “ring-dike,” and are essentially the remains of an ancient volcano. The unusual geology of this formation gives rise to a particularly high level of diversity of plant species and



natural communities. Prior to this study, the NH Heritage database contained twelve rare plant and five natural community records for the park. As a result of the inventory process, these numbers have increased dramatically, as has our understanding of the conservation importance of Pawtuckaway State Park.

METHODS

PRIORITIZATION OF STATE LANDS

A number of factors went into the selection of Pawtuckaway State Park as the highest priority for ecological inventory (Crowley and Sperduto 2001). The park was known to harbor 12 rare plant populations, which indicated a high diversity of potential habitat types that could support additional rarities. Several of these plant species are indicative of nutrient-rich soils, and in New Hampshire the species are at the northern edge of their geographic range. Analysis also indicated a high diversity of ecological land units (ELUs), suggesting a wide variety in bedrock, landform, and elevation that could in turn support a high diversity of vegetation. Bedrock with intermediate weathering potential is extensive (supporting the potential for additional areas of rich soil) and occurs in coves, wet/moist flats, and upper slopes/summits that could harbor rare plants or exemplary natural communities. Very poorly drained, organic soils are also abundant. It was this combination of known and potential rare species and natural community occurrences that led to Pawtuckaway being selected for the first state lands inventory.

LANDSCAPE ANALYSIS

The NH Natural Heritage Bureau uses a process called "landscape analysis" to target and inform subsequent field surveys. For the inventory of Pawtuckaway State Park, all available site data were examined to prioritize survey areas and to increase the efficiency of field visits in potential study areas. We interpreted aerial photographs and various map resources to predict potential locations and patterns of rare plants and natural communities, including National Wetland Inventory maps, surficial (Goldthwait 1950) and bedrock geology maps (Lyons et al. 1997), Natural Resource Conservation Service soil survey maps (as provided by the GRANIT system, 1999), and U.S. Geological Survey (USGS) topographic quadrangles. A review of the NH Natural Heritage database identified rare species and natural communities that were known to occur within or nearby Pawtuckaway State Park. Historical land use information was assessed when available. We then categorized areas as high-to-moderate or moderate-to-low priority for field surveys, depending on their projected likelihood of supporting target exemplary natural communities and rare plant populations (Crowley and Sperduto 2001).

FIELD INVENTORY

NH Heritage conducted field ecological inventories to ground-truth and collect detailed data on significant biodiversity features, using standard Natural Heritage Program methodologies. Significant biodiversity features may include, but not necessarily be limited to, exemplary small-



patch, large-patch, and matrix-forming natural communities, exemplary ecological systems, significant wildlife habitats, and any rare species occurring therein.

Data were collected throughout the park at specific locations, or observation points (OPs) (see Figure 2). The following information was collected at most natural community observation points:

1. natural community type, following Sperduto and Nichols (2004);
2. a) percent coverage or general abundance estimates for all plant species, or
b) population and habitat data for rare plants;
3. estimated average and maximum diameter-at-breast height (DBH) of canopy trees;
4. other descriptive notes, including soil descriptions and other physical site characteristics, evidence of human disturbance, size of the community, and wildlife evidence.

Most plants were identified in the field during the inventory or collected and keyed out using the resources available at NH Natural Heritage. Vascular plant nomenclature generally follows the Flora of North America Editorial Committee (1993a, 1993b, 1997, 2000, 2002a, 2002b, 2002c, 2003), then Gleason and Cronquist (1991), and occasionally Fernald (1950), with common names generally following George (1998). Natural community system type follows Sperduto (2005)

Garmin Global Positioning System (GPS) units were used at selected sites to determine the location of plots and geographic information. The accuracy of the data points collected by the GPS units is 15 m. Field data and site locations of exemplary natural communities and rare plant populations were catalogued and incorporated into the NH Natural Heritage database.

In 2002, we selected a cross-section of the high-to-moderate priority areas with potential for containing significant features, including 1) areas that represented a broad range of the natural community variation within the project area; and 2) areas with a high potential for containing rare plant species with short flowering windows (e.g. spring ephemeral species). In 2003 and 2004 we surveyed all remaining high-moderate priority areas.

A more detailed description of NH Heritage's ecological approach can be found in Appendix 1.

DATA ANALYSIS AND DATA MANAGEMENT

DATA ANALYSIS OF FIELD INVENTORY

Using standard Natural Heritage Program methodologies, NH Heritage compiled and analyzed data collected through the field inventory. We identified, mapped, and documented attributes of all significant biodiversity features, and assigned viability (or Element Occurrence) ranks based on size, condition, and landscape context (see Appendix 1).



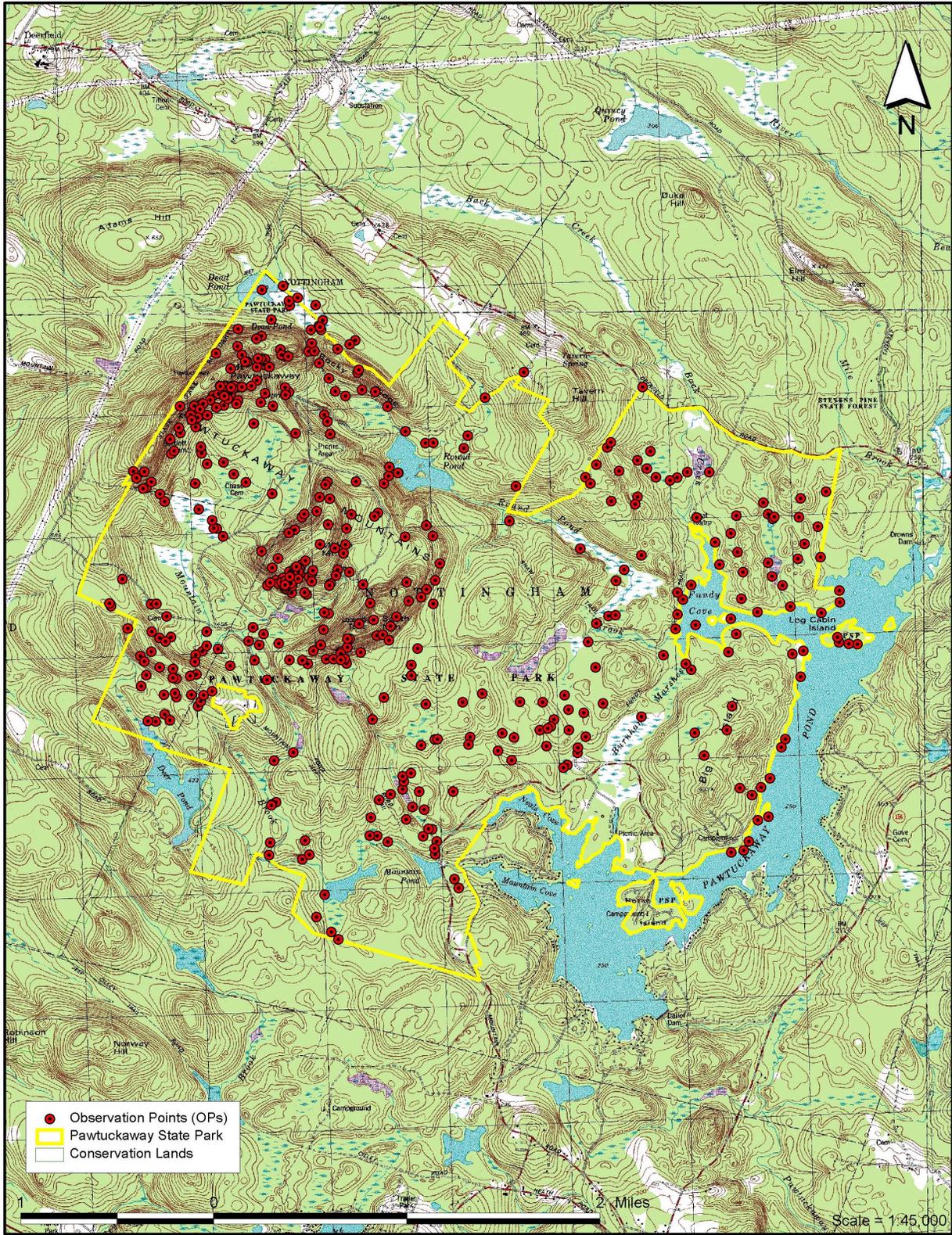


Figure 2. Observation points from field surveys at Pawtuckaway State Park.

DATA MANAGEMENT

Data about Heritage element occurrences (rare plants and animals, exemplary natural communities, and exemplary ecological systems) were entered into GIS and BCD (or successor) data management systems.

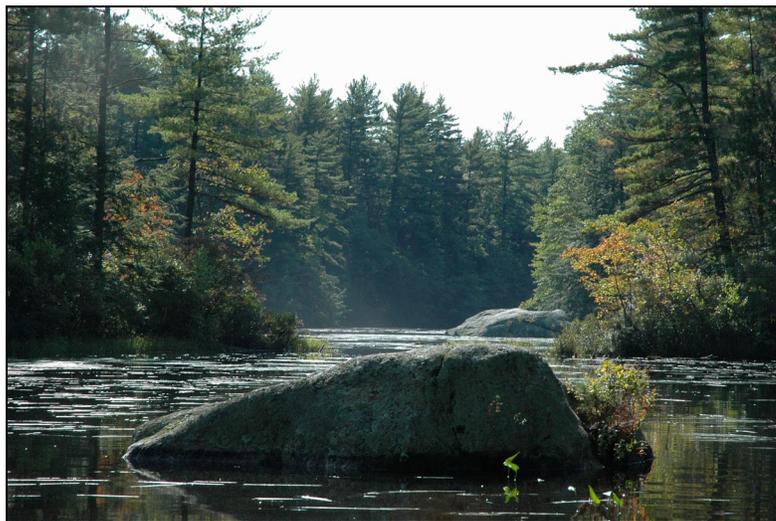
LIMITATIONS OF STUDY

The main goal of this project was to identify rare plant species and intact, high quality natural communities, to guide future conservation and help inform management decisions. This project was a *prioritized* inventory designed to focus survey attention on those portions of the landscape that have the greatest potential to contain significant features. It was not intended to be, nor can it replace, a more resource-intensive and detailed botanical survey of all lands. It is also beyond the scope of this project to document or map all natural community occurrences and their boundaries, although we recognize a definite management utility to mapping natural communities across entire ownership units.

RESULTS

NATURAL SETTING OF PAWTUCKAWAY STATE PARK

Pawtuckaway State Park is located in southeastern New Hampshire, within the US Forest Service Lower New England Section (Keys and Carpenter 1995). The Lower New England Section consists of an area extending from southwest Maine to the northern New Jersey/Pennsylvania border. This section is distinguished from the surrounding area by particular climatic, geomorphological, and vegetative characteristics. The Lower New England Section is further divided into 12 subsections using finer scale physical and biological criteria. Pawtuckaway SP is located entirely within the Gulf of Maine Coastal Plain subsection.



Fundy Cove, an arm of Pawtuckaway Lake. Photo by Ben Kimball.



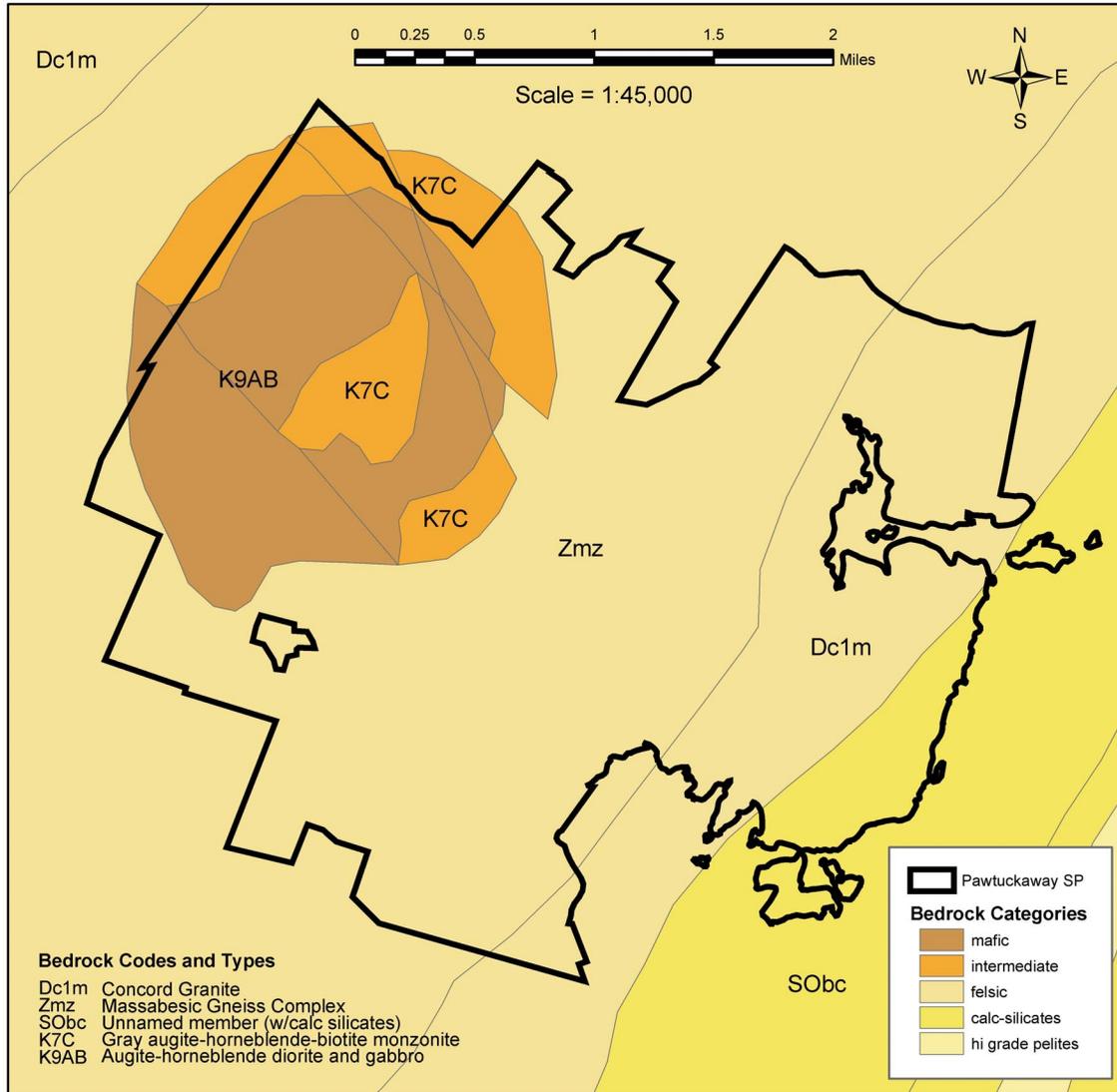


Figure 3. Bedrock geology of Pawtuckaway State Park.

GEOLOGY AND SOILS

The geologic setting of Pawtuckaway State Park is unique, and is the underlying reason for the park’s conservation significance (see Figure 3). The defining feature of the park is the Pawtuckaway Mountains, a circular formation of steep hills that occupies the western third of the property. This type of formation is known as a ring-dike, and is the result of the volcanic intrusion of igneous rock into the surrounding metamorphic and sedimentary layers, roughly 300 million years ago (Freedman 1950). These igneous intrusions pushed up through circular cracks in the overlying bedrock, creating the ring-like ridges that are present today as North and South Mountains, as well as Middle Mountain, a similar steep-sided hill within the interior of the ring.

But it is the bedrock of these mountains that drives the ecology on the surface. Bedrock mineralogy (mineral content) and weathering rates have an important influence on soil



characteristics, including soil fertility levels (or “richness”) that are so important to plants. Pawtuckaway SP contains four broadly classified bedrock types categorized according to their mineralogy. The four broad bedrock types in the park are 1) mafic; 2) intermediate; 3) felsic; and 4) calc-silicates.

Both the mafic and intermediate bedrock types are restricted to the Pawtuckaway Mountains. The mafic rocks (gabbro) and intermediate rocks (diorite) are mapped together in one lithological unit on the south slopes of North and Middle Mountains, as well as the lowlands within the ring-dike. These rocks are characterized by a relatively high level of magnesium and iron, compared to other rock types, and sometimes more calcium and other base-cations than intermediate or felsic rocks. As they weather, they tend to yield circumneutral soils in which these base-cations are available to be used by plants. It is the mafic and intermediate bedrock that supports many of the rarest and most significant species and natural communities in the park.

A second intermediate bedrock is represented by monzonite, a gray, coarse-grained igneous rock similar to granite. Monzonite primarily underlies the north slopes of North, Middle, and South Mountains, although it also extends to lowland areas adjacent to Middle Mountain. Additionally, monzonite is the material that comprises the famous Pawtuckaway boulders, which arrived at their present locations after being plucked from the mountains by glacial movements. These intermediate rocks are so-named because they have an intermediate amount of silica (50-60%) and less than 10% quartz, compared to felsic rock (>60% silica, >10% quartz) and mafic rock (<50% silica). At Pawtuckaway, it is the intermediate diorite and mafic gabbro rocks that appear to yield less acidic, more base-rich soils upon weathering, and support so many rare species and communities.

The vast majority of the park area outside the Pawtuckaway Mountains is underlain by felsic bedrock. The felsic rocks in this area are represented by granite and gneiss, and have a higher silica content than other rock types. Weathering of felsic rocks tends to produce acidic soils with low base cation availability for plants.

The final bedrock type, calc-silicates, is present at Pawtuckaway as the Berwick Formation. In these rocks, the essential plant nutrient calcium is bound up with silica, and is released very slowly through the weathering process. At the park, this bedrock type is found only beneath the eastern half of Big Island, along the shores of Pawtuckaway Lake. Because of its slow weathering rate and the influence of till from surrounding bedrock types, the calc-silicates are not reflected through the presence of enriched-site vegetation.

Soils at Pawtuckaway are primarily sandy loams in the Canton, Chatfield and Hollis soil series. These soils vary in their depth to bedrock, but in most cases are very stony or bouldery. On the upper slopes and summits of the mountains, there are large areas of exposed bedrock in the form of ledges and cliffs. Soils in the park’s wetlands are typically of the Greenwood and Ossipee soil series, and are mucks to depths of several feet.

It is important to note that the soil types as they are mapped do not have any obvious relationship with the underlying bedrock. Soil types are similar throughout the park, regardless of the local



geology. For this reason, these soil maps also do not provide useful information for predicting the locations of rare species or natural communities. It is the bedrock and its influence on the chemical composition of soils at a microtopographic level that is the driving force of the vegetation dynamics at Pawtuckaway.

VEGETATION

The vegetation at Pawtuckaway is a diverse mix of upland and wetland communities. Throughout much of the park, the dominant natural community is **hemlock – beech – oak – pine forest**. This is the characteristic forest type across central and much of southern New Hampshire and much of central New England, and forms the background “matrix,” in which other large and small patch communities are nested. Within this forest, *Tsuga canadensis* (hemlock), *Fagus grandifolia* (American beech), *Quercus rubra* (red oak), and *Pinus strobus* (white pine) are the primary tree species, with hemlock and beech becoming more prominent in older stands.

While the **hemlock – beech – oak – pine forest** is typical of the region, southeastern New Hampshire also features forests that have a more southern influence. Trees that are more characteristic of the central Appalachian and mid-Atlantic regions, such as *Quercus velutina* (black oak), *Quercus coccinea* (scarlet oak), *Quercus alba* (white oak), *Quercus prinus* (chestnut oak), *Carya ovata* (shagbark hickory), and *Carya glabra* (pignut hickory), are present in a number of natural communities in the park. This southern influence is particularly prevalent on the ridges and slopes of the Pawtuckaway Mountains, and is represented by the **Appalachian oak rocky ridge** and **rich Appalachian oak rocky woods systems**. In portions of the park, the **hemlock - beech - oak - pine forest** includes a low abundance of these southern trees as well, which is indicative of the transition zone that Pawtuckaway occupies.

There are also a wide variety of wetland types in the park, including peatlands, herbaceous marshes, and forested swamps. Because wetland communities tend to be smaller and more discrete than many upland communities, it is difficult to describe broad patterns that encompass their diversity.

SITE DESCRIPTIONS

For organizational purposes, Pawtuckaway has been divided into eastern and western sections. The western section is more properly described as the Pawtuckaway ring-dike and its immediate surroundings, with the eastern section encompassing the lowlands between the mountains and Pawtuckaway Lake. Within the western section are multiple sites, which are individually described below, while the eastern half is described more generally. A map delineating rare and exemplary natural communities is provided for each site, and a locator map for site maps is presented in Figure 4. For detailed inventory data on each exemplary natural community and rare species, see Appendix 7.



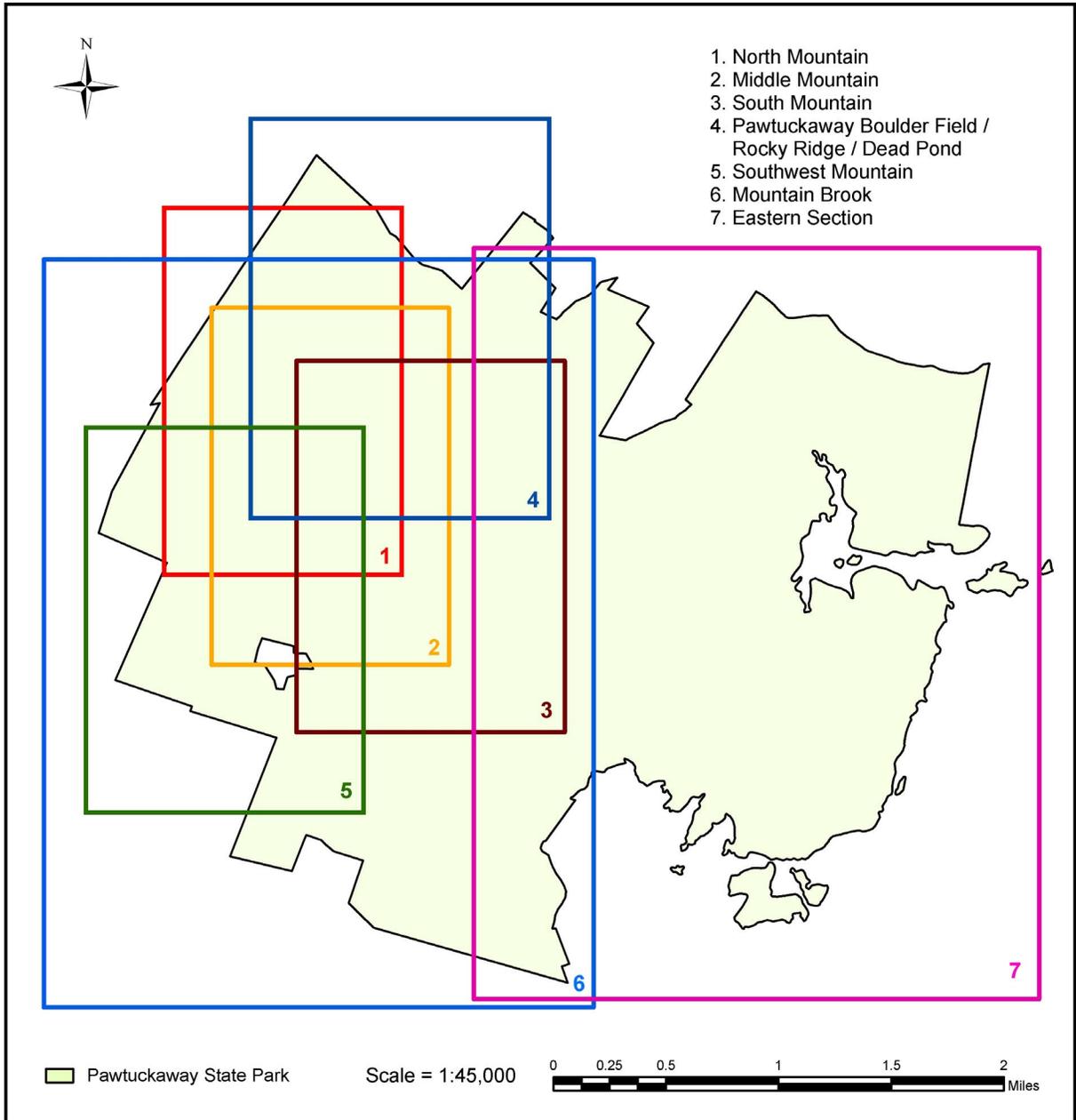
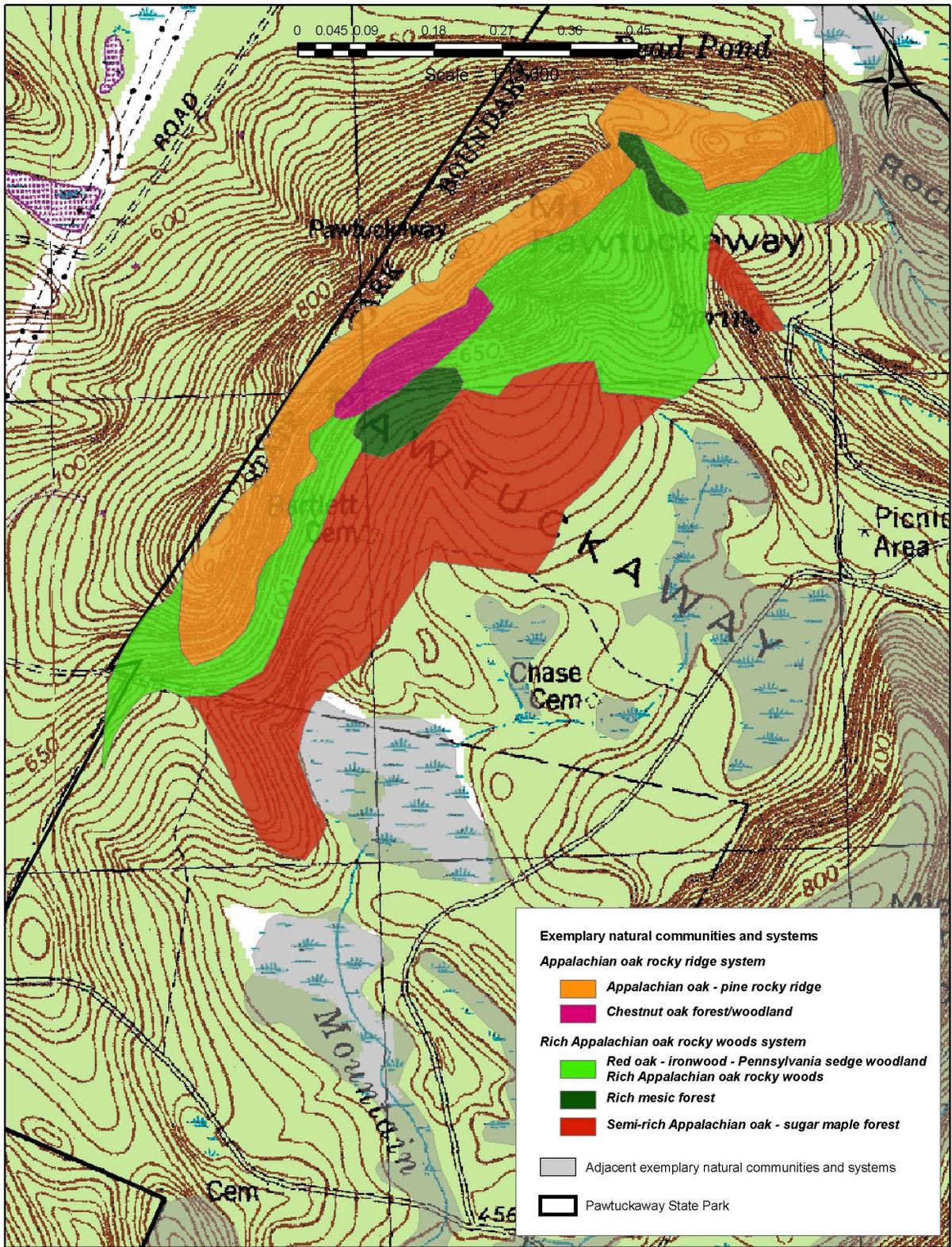


Figure 4. Orientation of individual site maps.





Site: North Mountain



Western Section

North Mountain

Also known as Mt. Pawtuckaway, North Mountain represents the highest point in the park at 1011 ft. It is essentially a narrow, curving ridge that is oriented from northeast to southwest, and forms the northwest portion of the ring-dike. Geologically, it is distinctly divided, with the northwestern half consisting of intermediate rock, and the southeastern face mafic. These differences in bedrock have a significant impact on the richness of the soils, and are reflected in the vegetation of the site. Ecologically, North Mountain has the greatest variety of habitats of any site in the park, and is also home to a greater number of rare plant species.

The northwest-facing slopes are comprised of the intermediate monzonite bedrock, and support **hemlock – beech – oak – pine forest**, which is typical of the surrounding lowlands as well. There are also areas of pure **hemlock forest**, which may be due primarily to the steep slopes and northern aspect.

The top of North Mountain can be characterized as an **Appalachian oak rocky ridge system**. Within this system, the predominant community is the **Appalachian oak – pine rocky ridge**, which is an open woodland dominated by *Quercus rubra* (red oak), *Pinus strobus* (white pine), and *Ostrya virginiana* (ironwood), and includes a number of southern oak species such as *Quercus alba* (white oak) and *Q. velutina* (black oak). This community also harbors the rare herb *Aureolaria pedicularia* var. *intercedens* (fern-leaved false foxglove). Also present in this rocky ridge system is the **Chestnut oak forest/woodland** community, which is similar to the previous community type, but has *Quercus prinus* (chestnut oak) as one of the dominant tree species.

On the southeast-facing slopes, below the **Appalachian oak rocky ridge system**, are areas in which the soils have received some nutrient enrichment from the underlying diorite and gabbro bedrock. The natural communities on these slopes are grouped into the **rich Appalachian oak rocky woods system**. On the dry upper portions of the slopes, there is a mosaic of two natural community types: **rich Appalachian oak rocky woods** and **red oak – ironwood – Pennsylvania sedge woodland**. Both of these communities have a partially open canopy, characterized by *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Quercus alba* (white oak), *Fraxinus americana* (white ash) and *Ostrya virginiana* (ironwood). The former community tends to harbor a greater number of rare herb species, including *Arabis canadensis* (sickle-pod), *Arabis missouriensis* (Missouri rock-cress), *Ranunculus fascicularis* (early buttercup), *Carex backii* (Back's sedge), *Carex retroflexa* (reflexed sedge), *Bromus pubescens* (hairy brome grass), *Conopholis americana* (American cancerroot), *Adlumia fungosa* (climbing fumitory), *Polygonum tenue* (slender knotweed), *Carex siccata* (hay sedge), and *Woodsia obtusa* (blunt-lobed woodsia), as well as the uncommon *Asplenium trichomanes* (maidenhair spleenwort). The latter community does not generally contain these rarities, but is distinguished by dense “lawns” of *Carex pennsylvanica* (Pennsylvanian sedge), that give it an open, park-like appearance.

Below these drier slopes, where the enriched soils hold more moisture, is the **semi-rich Appalachian oak – sugar maple forest**. This community is characterized by a diverse tree canopy, which includes *Acer saccharum* (sugar maple), *Carya ovata* (shagbark hickory),



Quercus rubra (red oak), and *Fraxinus americana* (white ash), among others. These forests have a fairly diverse array of herbaceous species, with some of the more common being *Polystichum acrostichoides* (Christmas fern), *Actaea rubra* (red baneberry) and *Tiarella cordifolia* (foamflower), as well as the rare *Carex sparganioides* (bur sedge). Nested within this community are small pockets of **rich mesic forest**. This community has fewer oaks and hickories in the canopy and an even greater diversity of herbaceous plants. Particularly noteworthy is the discovery of *Carex hitchcockiana* (Hitchcock's sedge) in 2002, marking the first recorded occurrence of this species in New Hampshire.



Above: Exemplary **Red oak – ironwood – Pennsylvania sedge woodland** community on the western slope of North Mountain. Photo by Bill Nichols. Below: Same community. Photo by Dan Sperduto.



Middle Mountain

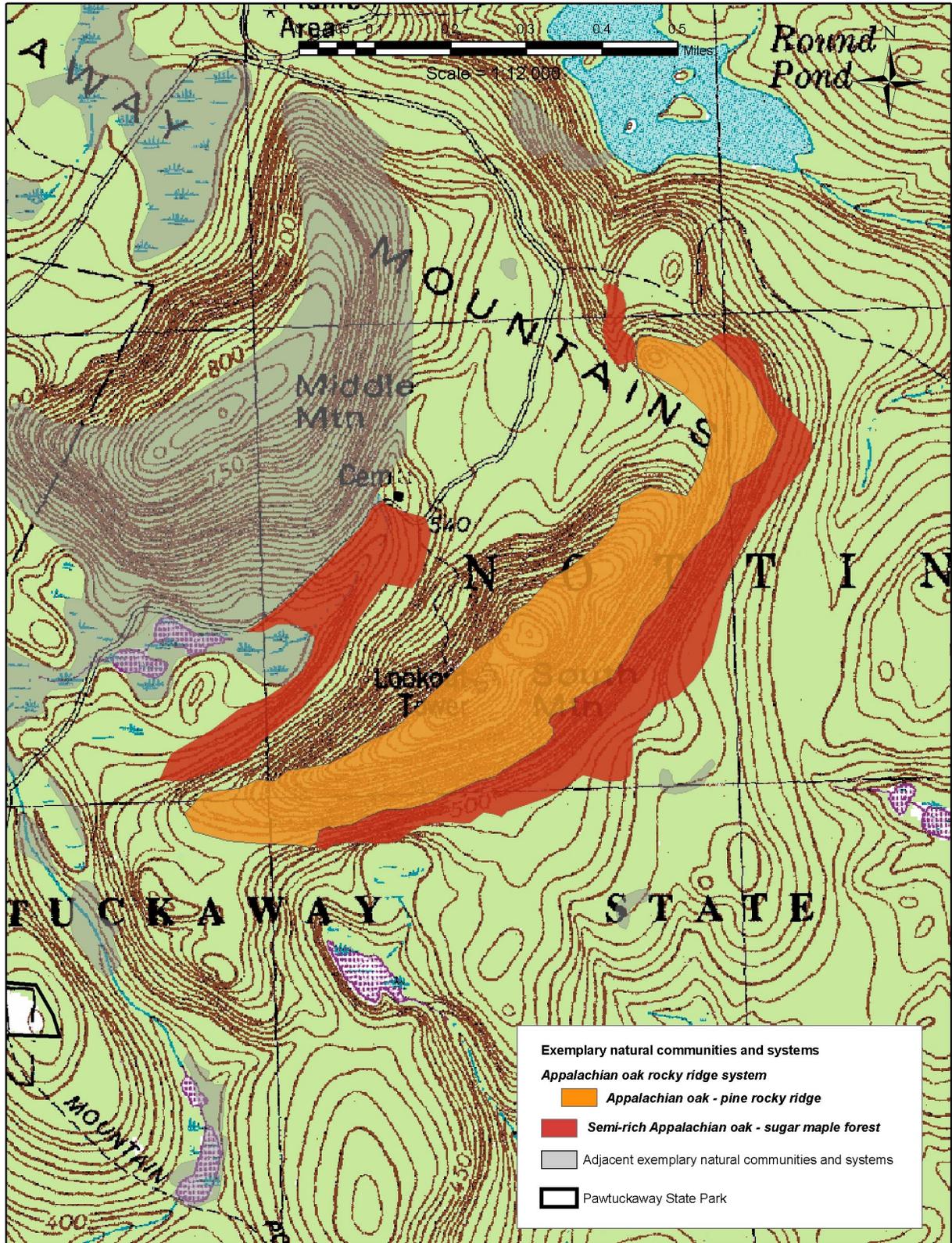
The bedrock of Middle Mountain (860 ft.) is primarily gabbro (mafic) and diorite (intermediate), and the *rich Appalachian oak rocky woods system* covers all but the north-facing slopes. Like on North Mountain, the dominant communities in this system are the *rich Appalachian oak rocky woods* and *red oak – ironwood – Pennsylvania sedge woodland*. This system also includes the *semi-rich Appalachian oak – sugar maple forest*, which is characterized by a mix of oaks, hickories, sugar maple, and white ash, and indicates a moderate degree of soil enrichment. Some of the rare species that occur on North Mountain are also found here, including *Arabis canadensis* (sickle-pod), *Ranunculus fascicularis* (early buttercup), *Bromus pubescens* (hairy brome grass), *Carex retroflexa* (reflexed sedge), and *Woodsia obtusa* (blunt-lobed woodsia), as well as a species that is restricted in the park to Middle Mountain, *Paronychia canadensis* (smooth-forked chickweed).

On the north side of Middle Mountain, in a small stream drainage on the slopes above Round Pond, is a patch of *rich mesic forest*. Like the *rich mesic forest* on North Mountain, this site contains species typical of the habitat, such as *Adiantum pedatum* (northern maidenhair fern), *Phegopteris hexagonoptera* (broad beech fern), and *Carex platyphylla* (flat-leaved sedge).



View to the southeast from ledge at summit of Middle Mtn. Photo by Sara Cairns.





Site: South Mountain



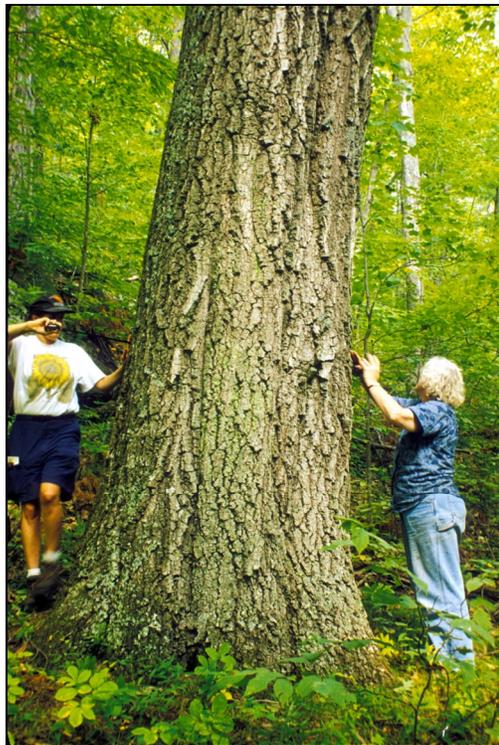
South Mountain

Unlike North and Middle Mountains, the geology of South Mountain (940 ft.) includes almost no gabbro or diorite bedrock. The northwestern half of the mountain consists of the intermediate monzonite, while the southeastern side is made up of the Massabesic gneiss that typifies the remainder of the park.

The northeastern slope is occupied primarily by *hemlock – beech – oak – pine forest*, with some areas consisting almost exclusively of *Tsuga canadensis* (hemlock) in the canopy. The natural community on the upper slopes and crest of the ridge is the *Appalachian oak – pine rocky ridge*. On the south side of mountain, this rocky ridge community includes large areas of exposed rock in the form of ledges and slabs, as well as small cliffs. This community on South Mountain is noteworthy as the only location in the park for *Carex cumulata* (piled-up sedge).

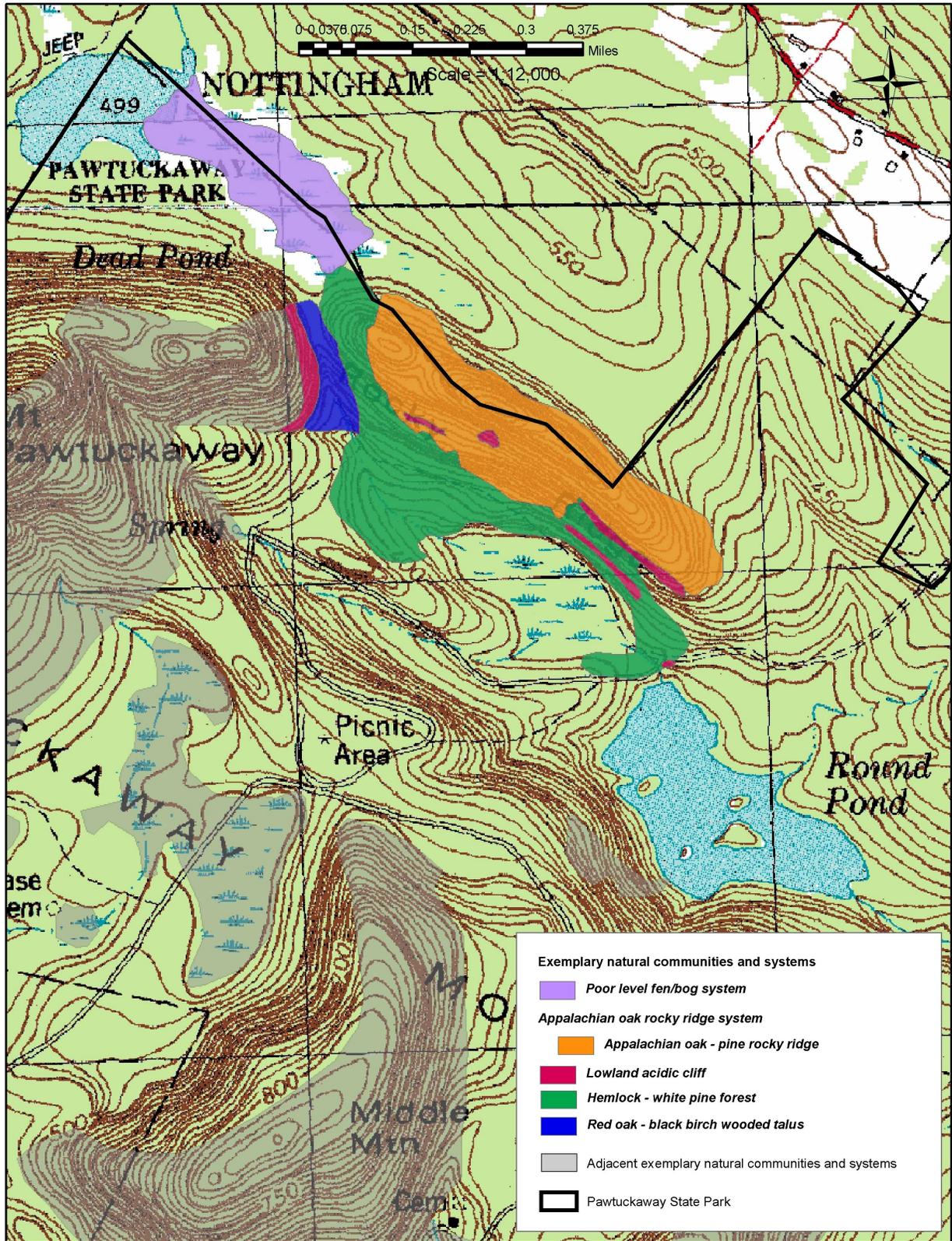
Below the *Appalachian oak – pine rocky ridge*, on the eastern and southeastern sides of the mountain, is a large zone of *semi-rich Appalachian oak – sugar maple forest*. Like on Middle Mountain, this community has a mix of tree species, including hickories, sugar maple, and white ash, and indicates a moderate degree of soil enrichment, despite the site's relatively nutrient-poor bedrock. Portions of this community with higher levels of enrichment support the rare species *Adlumia fungosa* (climbing fumitory) and *Bromus pubescens* (hairy brome-grass).

To the east and south of the *semi-rich Appalachian oak – sugar maple forest*, the communities are typical of the eastern interior of the park, with small herbaceous and forested wetlands surrounded primarily by *hemlock – beech – oak – pine forest*.



Measuring a large northern red oak tree. Photo by Dan Sperduto.





Site: Pawtuckaway Boulder Field / Rocky Ridge / Dead Pond



Boulder Field

Nestled in the notch between North Mountain and Rocky Ridge is the area of huge boulders known simply as the Boulder Field. According to Freedman (1950):

These constitute one of the largest aggregations of large boulders in the world. Individual boulders of greater size than any in the Pawtuckaway Boulders have been reported elsewhere in New Hampshire and in foreign countries, but nowhere have so many large boulders been reported together. Numerous boulders here range up to 50 feet in their greatest dimensions.

This boulder field is the result of glaciers “plucking” these huge rocks from the northern end of North Mountain. In addition to being a popular recreation site for rock climbers, the boulder field harbors an exemplary **hemlock - white pine** forest, which. Tree coring in this community identified several trees over 150 years old, suggesting that this site was never cleared for pasture.

The “boulder train” stretches from the valley floor to the base of a steep cliff on North Mountain. This **lowland acidic cliff** is over 100 ft. high, and supports plants typical of the surrounding forests, as well as species characteristic of cliffs, such as *Cystopteris fragilis* (fragile fern), *Cystopteris tenuis* (Mackay's brittle fern), and *Carex communis* (colonial sedge). At the base of this cliff, the boulders have piled up to form a talus slope, which supports the **red oak - black birch wooded talus** community. This forest is characterized by hardwoods such as *Betula lenta* (black birch), *Betula alleghaniensis* (yellow birch) and *Quercus rubra* (red oak), and supports dense colonies of *Polypodium virginianum* (rock polypody) on the rock surfaces, as well as the herbaceous vine *Fallopia cilinodis* (fringed bindweed). Near the top of this talus at the base of the cliff is a small cave known as Devil’s Den, which has historically harbored an unusual bryophyte, *Schistostega pennata* (luminous moss), which may be rare.



Pawtuckaway Boulder Field. Photos by Dan Sperduto and Bill Nichols.

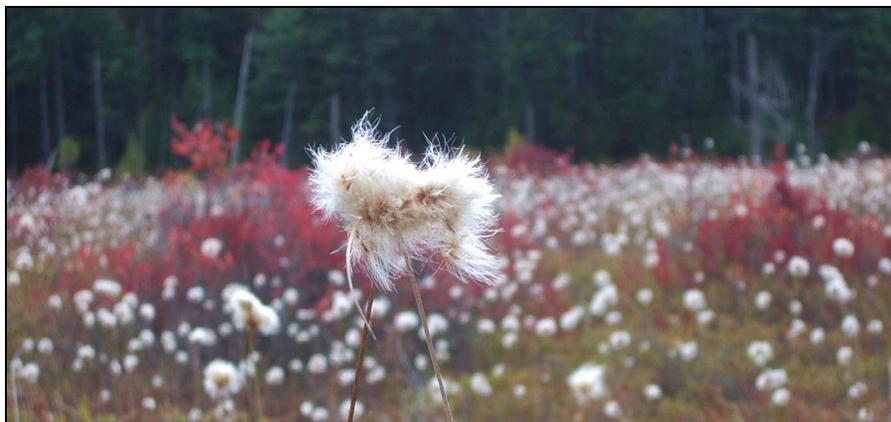


Rocky Ridge

Separated by a gap containing the Boulder Field (see below), Rocky Ridge is essentially an eastward extension of North Mountain. However, Rocky Ridge does not have the gabbro and diorite geology of North Mountain, and thus does not support the type of enriched-site vegetation found there. The same *Appalachian oak rocky ridge system* that is found on North Mountain is continued on Rocky Ridge, where there are a particularly large number of cliffs and open ledges. These *lowland acidic cliffs* are not as dramatic as the one above the Boulder Field, being generally less than 40 ft. high, but many of them support similar vegetation. At the tops of some of these cliffs, and on rocky ledges, the rare plant *Aureolaria pedicularia* var. *intercedens* (fern-leaved false foxglove) can be found, which occurs in similar habitat on North Mountain.

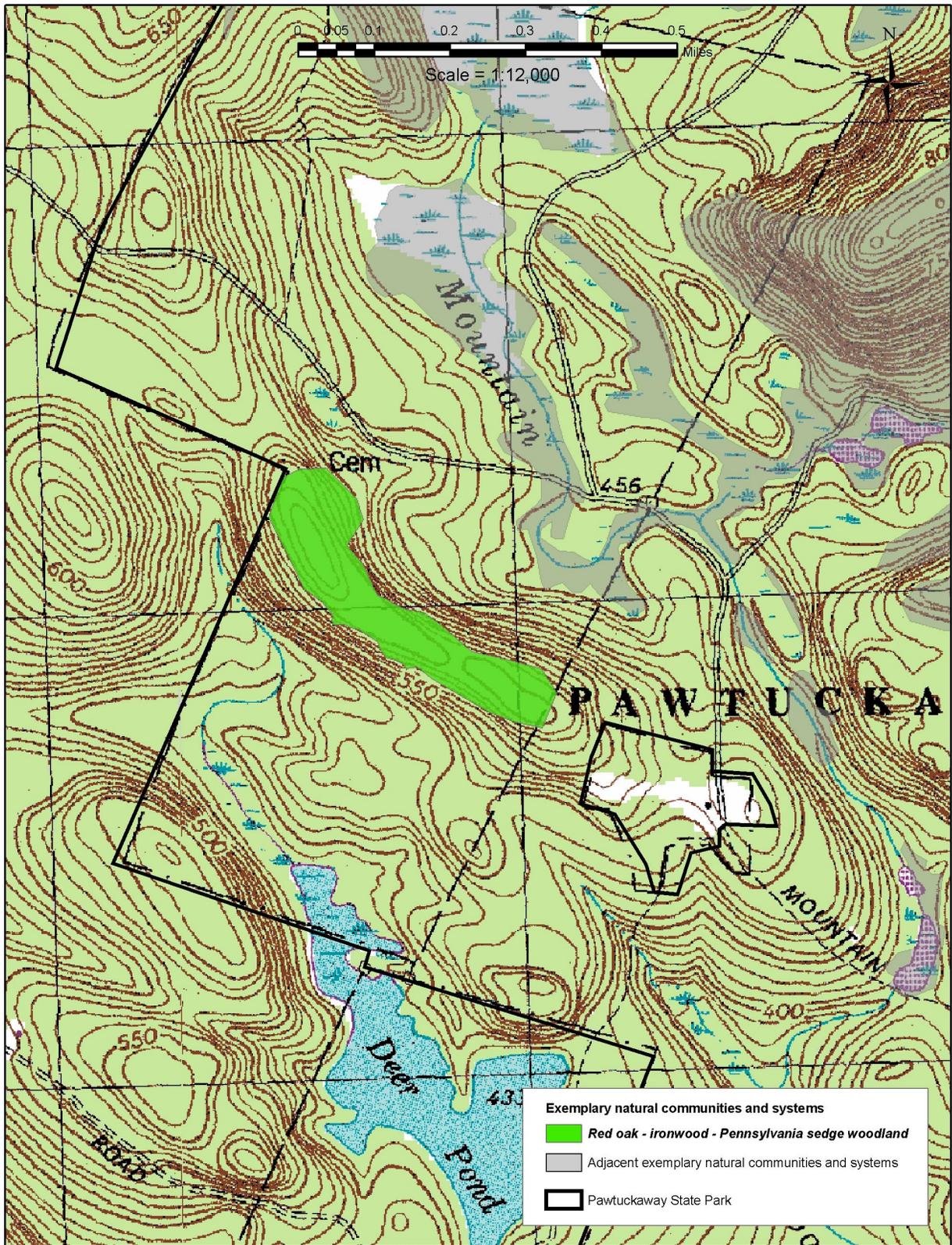
Dead Pond

In the northwest corner of the park, straddling the boundary between state property and land owned by the town of Deerfield, is a water body known as Dead Pond. Currently, approximately half of the pond's surface area is occupied by a floating peat mat. This peatland fills most of the eastern half of the pond, and falls into the category of a *poor level fen/bog system*. This system is characterized by acidic, nutrient-poor conditions, with the *leather-leaf – sheep laurel dwarf shrub bog* being the dominant community type. This is a species-poor fen, with dense cover of *Chamaedaphne calyculata* (leather-leaf), along with *Eriophorum virginicum* (tawny cotton-grass), *Vaccinium corymbosum* (highbush blueberry) and *Myrica gale* (sweet gale). However, at the eastern end of the wetland the conditions are somewhat wetter and more minerotrophic, and communities such as *large cranberry – short sedge moss lawn* and *bog rosemary – sweet gale – sedge fen* are more prevalent. These communities have a slightly higher diversity of plant species, which include the species listed above, as well as *Andromeda glaucophylla* (bog rosemary), *Vaccinium macrocarpon* (large cranberry), *Decodon verticillatus* (water willow), and *Gaylussacia baccata* (black huckleberry). Between the peat mat and the shore of the pond is a *marshy moat* community, which is a narrow zone of open water and emergent marsh vegetation. This pond has been impacted by beaver activity in the recent past, which may have affected the vegetative composition of the peatland.



Eriophorum virginicum (tawny cotton-grass) at Dead Pond. Photo by Pete Bowman.



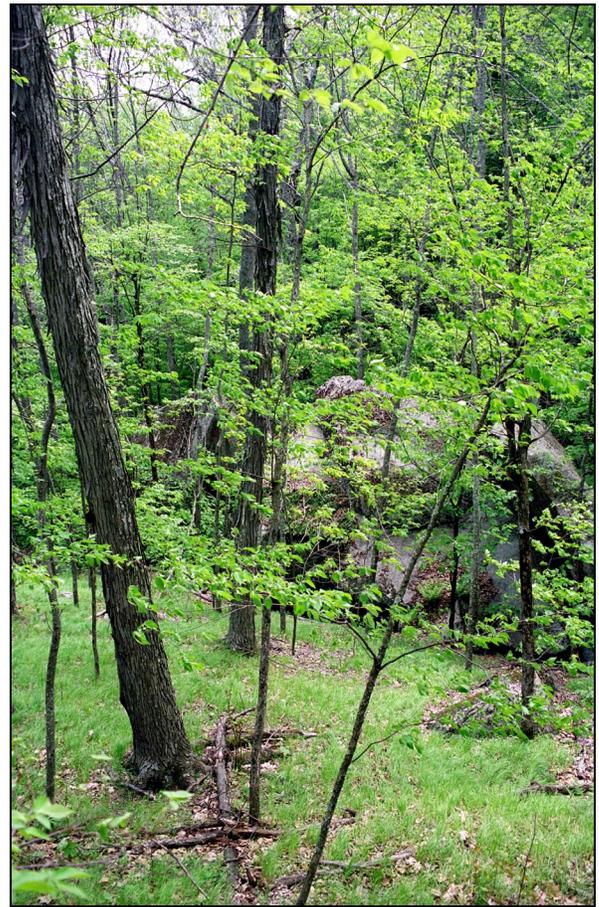


Site: Southwest Mountain



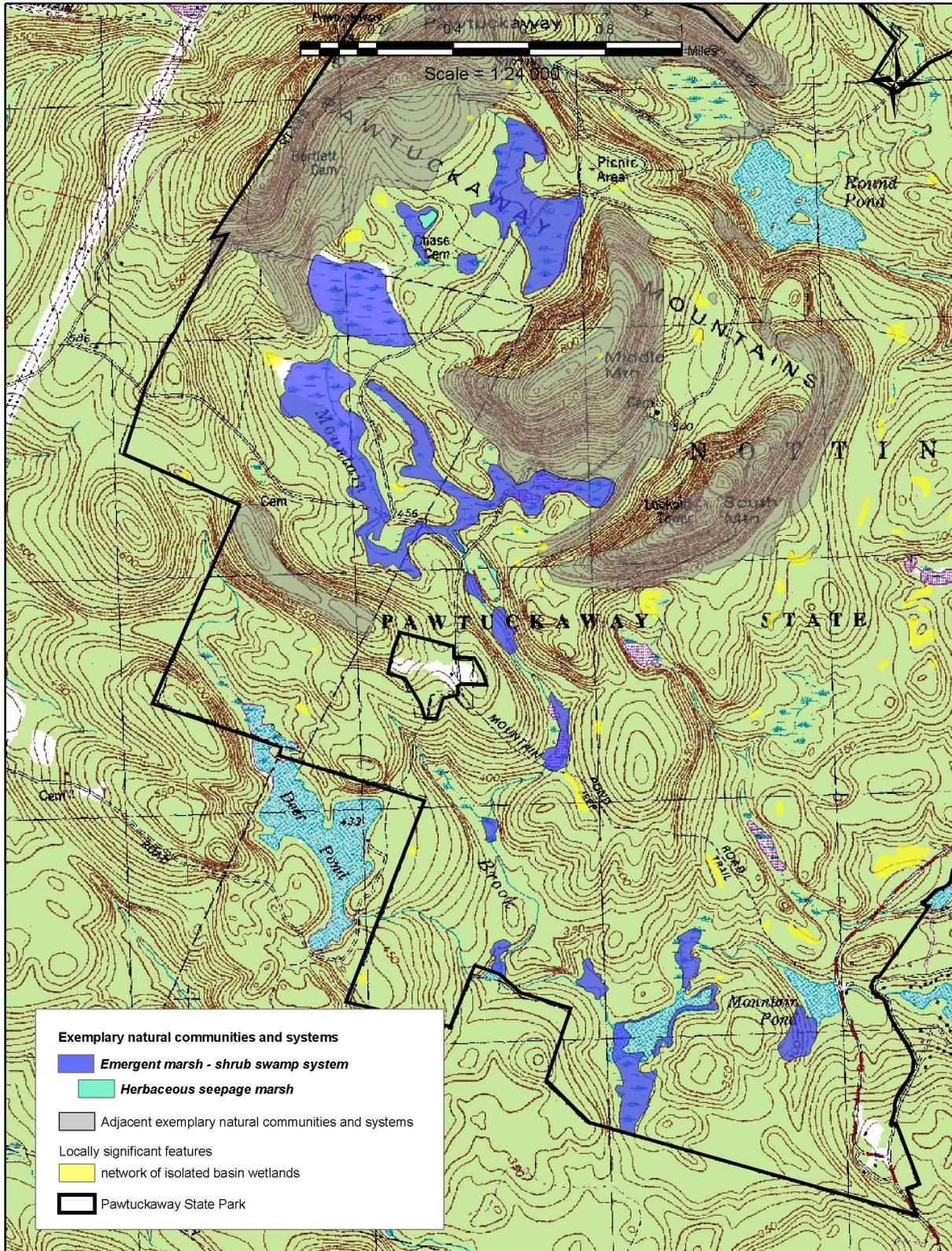
Southwest Mountain

In the southern portion of the Pawtuckaway Mountains, the ring-dike is expressed as a lower ridge, with elevations not exceeding 650 ft. This ridge, known simply as Southwest Mountain, includes some gabbro and diorite bedrock, and supports some of the same enriched-site communities that are found on North and Middle Mountains. On portions of the ridgetop and the north slope of the Arc is *red oak – ironwood – Pennsylvania sedge woodland*, while *semi-rich Appalachian oak – sugar maple forest* is present on the south slope.



Aquilegia canadensis (wild columbine) and *red oak - ironwood - Pennsylvania sedge woodland*.
Photos by Dan Sperduto.





Site: Mountain Brook



Mountain Brook

Mountain Brook is a small perennial stream that originates within the Pawtuckaway Mountains and flows south out of the ring-dike. It passes into the eastern section of the park, eventually ending in Mountain Pond, just west of Mountain Cove, an inlet of the southern end of Pawtuckaway Lake. Along the course of the brook are a series of wetlands, which collectively form an **emergent marsh – shrub swamp system**. This is a complex system which includes many different community types. The hydrology of these wetlands is determined by a combination of seasonal flooding and groundwater seepage. In several places, beavers have impounded the stream, and created or expanded open wetlands. Often, these open wetlands were at one time peatlands, but have since undergone a transformation to this system as a result of the hydrologic alteration. After these impoundments are abandoned by the beavers, they undergo succession through several wetland types, which are all represented to varying degrees in this system.

The composition of the communities changes with depth and duration of flooding. In areas of permanent water, primarily associated with beaver ponds, is the **aquatic bed**, which is characterized by floating-leaved species such as *Nymphaea odorata* (white waterlily). Where the water is somewhat shallower and the soil may be exposed later in the growing season, **deep emergent marsh - aquatic bed** and **cattail marsh** communities are found. These natural communities are dominated by spongy-leaved plants such as *Typha latifolia* (common cattail), *Peltandra virginica* (arrow arum) and *Sparganium americanum* (lesser bur-reed).

In places where the creation or drainage of a beaver impoundment has caused a change in the hydrology, the **peaty marsh** is often present where a peatland once existed. This community has the layer of *Sphagnum* spp. (peat mosses) that is characteristic of peatlands, but is dominated by graminoid species, such as *Carex utriculata* (bottle-shaped sedge) and *Carex stricta* (tussock sedge), which are more typical of marshes. In areas where a beaver pond has recently drained, the **short graminoid - forb emergent marsh/mud flat** is frequent, and has a sparse growth of low herbs such as *Lindernia dubia* (false pimpernel) and *Gratiola aurea* (golden pert).

In wetland areas along the undammed stream, there is a gradient of natural communities from deep water to the shallows, starting with **deep emergent marsh - aquatic bed** in the deepest water, transitioning to **medium-depth emergent marsh** in shallower conditions. The composition of the **medium-depth emergent marsh** is a mix of species from both deep water and shallow areas, including *Sagittaria latifolia* (common arrowhead), *Pontederia cordata* (pickerel weed) and *Schoenoplectus tabernaemontani* (softstem bulrush). Continuing toward shallower waters, there is the **tall graminoid emergent marsh**, and finally the **mixed tall graminoid - scrub-shrub marsh** at the transition to scrub shrub areas. In the tall graminoid communities, species such as *Calamagrostis canadensis* (bluejoint) and *Carex stricta* (tussock sedge) are common. The latter of these two communities is often a transition to the **highbush blueberry - winterberry shrub thicket**, and both of these shrublands are characterized by the shrubs *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (winterberry). Along the lower reaches of the stream, where there is increased temporary flooding, the **alder - dogwood - arrowwood alluvial thicket** is the more abundant shrub community.



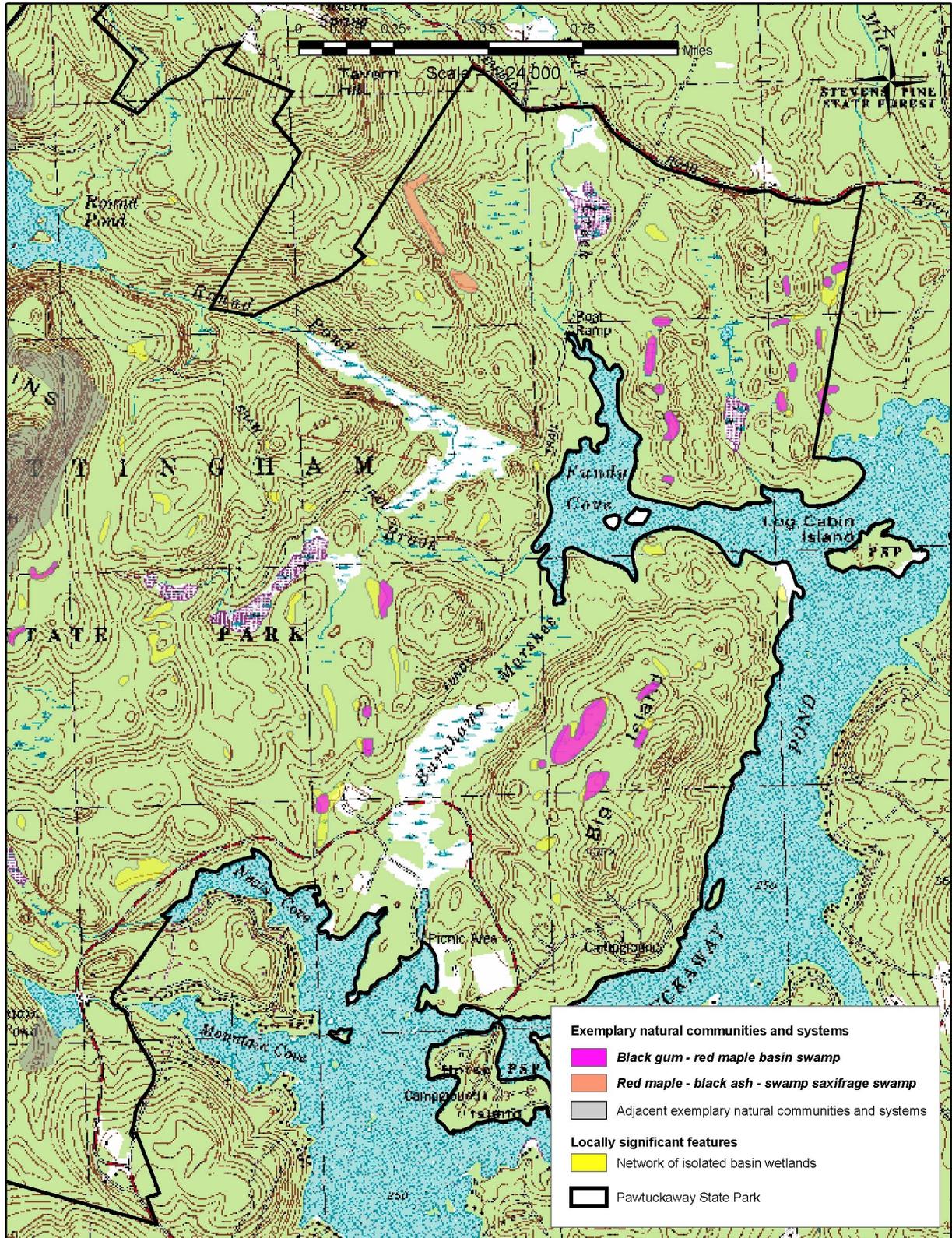
In the upper reaches of small tributaries and in narrow bands along the upland edge of some open wetlands is the *seasonally flooded red maple swamp*, which has *Acer rubrum* (red maple) over an herbaceous layer of typical marsh species.

The only individually exemplary community component of this system is the *herbaceous seepage marsh*. This community occurs as long, narrow emergent marshes adjacent to the stream, where a thin organic layer covers alluvial silt deposits, which channel seepage flow over the surface. These marshes are dominated by *Carex lacustris* (lake sedge). Other prevalent species include *Carex utriculata* (bottle-shaped sedge) and *Boehmeria cylindrica* (false nettle).



Emergent marsh communities in a beaver pond. Photo by Pete Bowman.





Eastern section of Pawtuckaway



Eastern Section

Unlike the Western Section, the Eastern Section of Pawtuckaway does not have the mountains or other dramatic landmarks to distinguish individual sites. Instead, it is characterized by low, rolling uplands that are pock-marked with dozens of small basin wetlands. These basins are small (usually less than 1 acre, although they can be as large as 6 acres), isolated (they generally do not have regular surface water inlets or outlets), relatively shallow, and seasonally flooded. They are occupied by a variety of wetland natural communities, including herbaceous, shrubland and forested community types, as well as unvegetated **vernal woodland pools**. The depth and duration of flooding is primarily responsible for the communities that are present. The soils of the basins generally have a fairly thin layer of organic material, although some (particularly the vernal pools) may have almost none. The isolated basin wetlands that make up this network are unusual in their density and abundance, and collectively, this network constitutes a feature of local significance that may have significance at the state level.

The **black gum – red maple basin swamp** is an exemplary community, and is known from approximately 25 basins. *Nyssa sylvatica* (black gum) is characteristic, and may or may not be co-dominant with *Acer rubrum* (red maple). Other frequent species in this community include *Vaccinium corymbosum* (highbush blueberry), *Ilex verticillata* (winterberry), and *Osmunda cinnamomea* (cinnamon fern). In one basin, the uncommon tree *Chamaecyparis thyoides* (Atlantic white cedar) is frequent in the canopy.

The **red maple – Sphagnum basin swamp** is characterized by a thin canopy of *Acer rubrum* (red maple), with many of the same associates as the **black gum – red maple basin swamp**. *Sphagnum* mosses are frequent, but generally patchy.

The **highbush blueberry – winterberry shrub thicket**, which may be the most frequent community in the basin network, is dominated by the tall shrubs *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (winterberry). Scattered trees may be present, particularly red maple and *Tsuga canadensis* (hemlock). Herbs are generally sparse, but include *Osmunda cinnamomea* (cinnamon fern), *Carex trisperma* (sedge), and *Carex canescens* (silvery sedge).

The **buttonbush basin swamp** is dominated by *Cephalanthus occidentalis* (buttonbush), with some emergent red maple, and a scattered sparse herbaceous layer. This community is typically found in wetter conditions than other basin communities, in depressions where standing water is present for most of the year.

Vernal pools are very small (usually <0.25 acres) depressions that are shaded by trees in the surrounding forest. They are generally unvegetated, but serve as critical breeding habitat for many amphibian species.

In addition to the network of isolated basin wetlands, in the northeast portion of the park is a separate exemplary wetland community, the **red maple - black ash - swamp saxifrage swamp**. This forested wetland is associated with a long, fairly narrow area of groundwater seepage on the lower slopes of Tavern Hill. The canopy of this community is a mixture of *Tsuga canadensis* (hemlock), *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch) and *Fraxinus nigra* (black ash). *Lindera benzoin* (northern spicebush) is abundant in the shrub layer, and the



herbaceous layer is lush, with such species as *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* var. *spectabilis* (royal fern) and *Chrysosplenium americanum* (golden saxifrage).

The vegetation of the surrounding uplands throughout the eastern section is predominantly the **hemlock – beech – oak – pine forest** that is typical of the region. One other noteworthy species that is peripherally associated with this forest is *Betula nigra* (river birch). This rare tree occurs along the shoreline of Pawtuckaway Lake, and is found as single trees or in small clumps of three or four stems.



Black gum - red maple basin swamp. Photo by Ben Kimball.



Nyssa sylvatica (black gum). Photo by Ben Kimball.



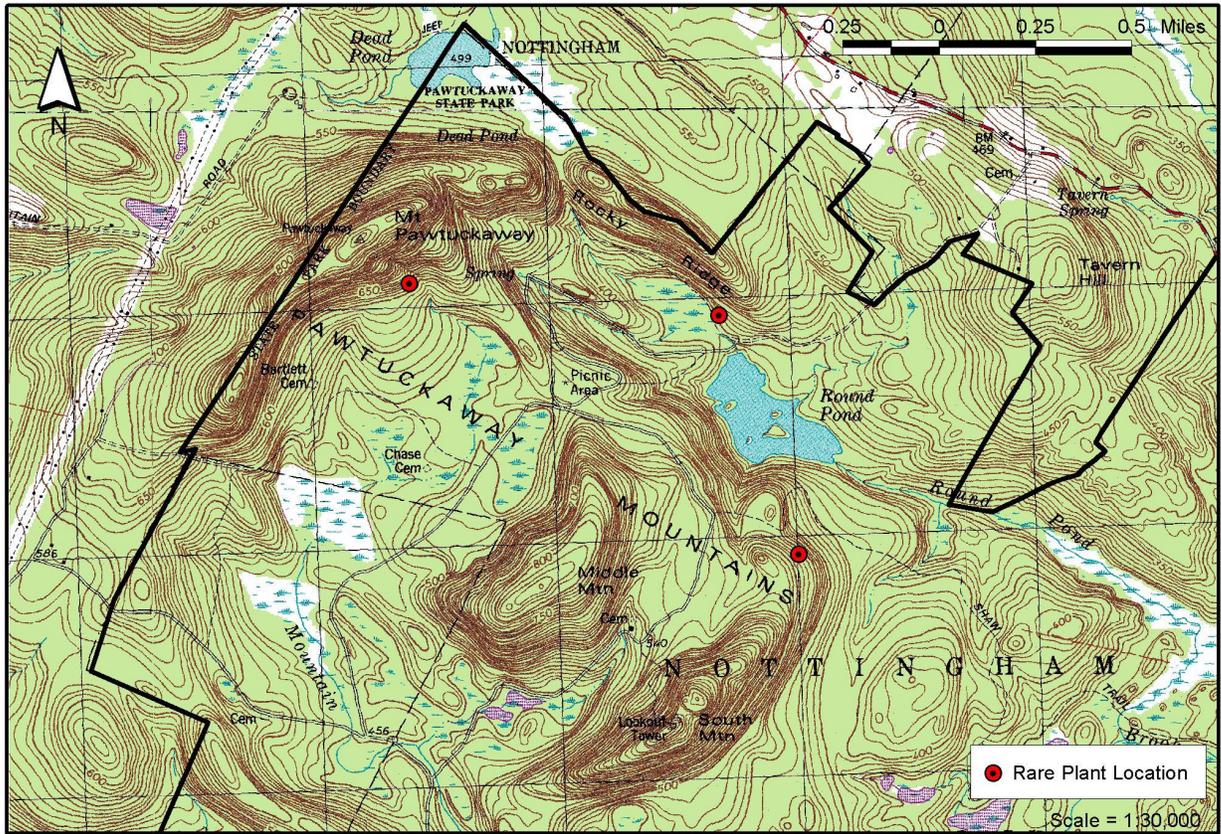
RARE PLANT SPECIES

Eighteen rare plant species were found during surveys of Pawtuckaway, accounting for 29 total populations. Of these 18 species, four have their only known extant populations in the park (*Bromus pubescens*, *Carex hitchcockiana*, *Carex retroflexa*, and *Polygonum tenue*). A brief occurrence description of 16 of these species is presented below, along with a map displaying points at which the plant was observed. Two of the 18 species are considered sensitive because of the threat of collection, and their occurrence data is not for public distribution. Finally, there are four rare plant species for which there are historic records at Pawtuckaway, but were not relocated during this survey (*Gaylussacia dumosa*, *Geranium carolinianum* var. *confertiflorum*, *Muhlenbergia sobolifera*, *Rotala ramosior*). A brief description of these species is presented at the end of this section.



Carex hitchcockiana (Hitchcock's sedge) at North Mountain. Photo by Bill Nichols.



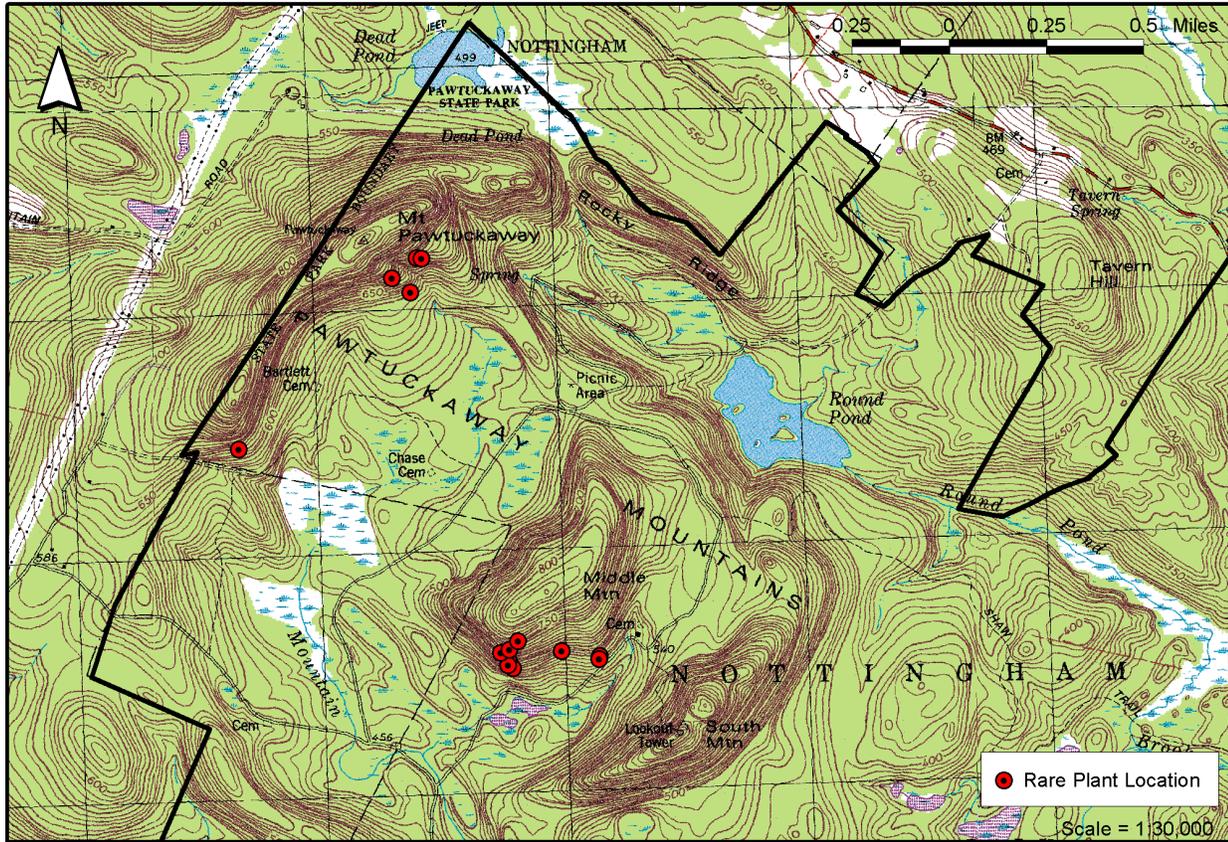


Adlumia fungosa (climbing fumitory) (Endangered)

Climbing fumitory is an unusual plant with a very scattered distribution in New Hampshire. It is an herbaceous perennial vine that grows in moist woodlands, often on hillsides. At Pawtuckaway, it was found at three locations—North Mountain, South Mountain, and Rocky Ridge—all centered around rock outcrops. Both the North and South Mountain occurrences had only one or two individuals, while the Rocky Ridge occurrence had 18 plants. This species is known to seed-bank for long periods, and may require fire or other disturbance to germinate.



Adlumia fungosa (climbing fumitory) at North Mountain. Photos by Dan Sperduto.



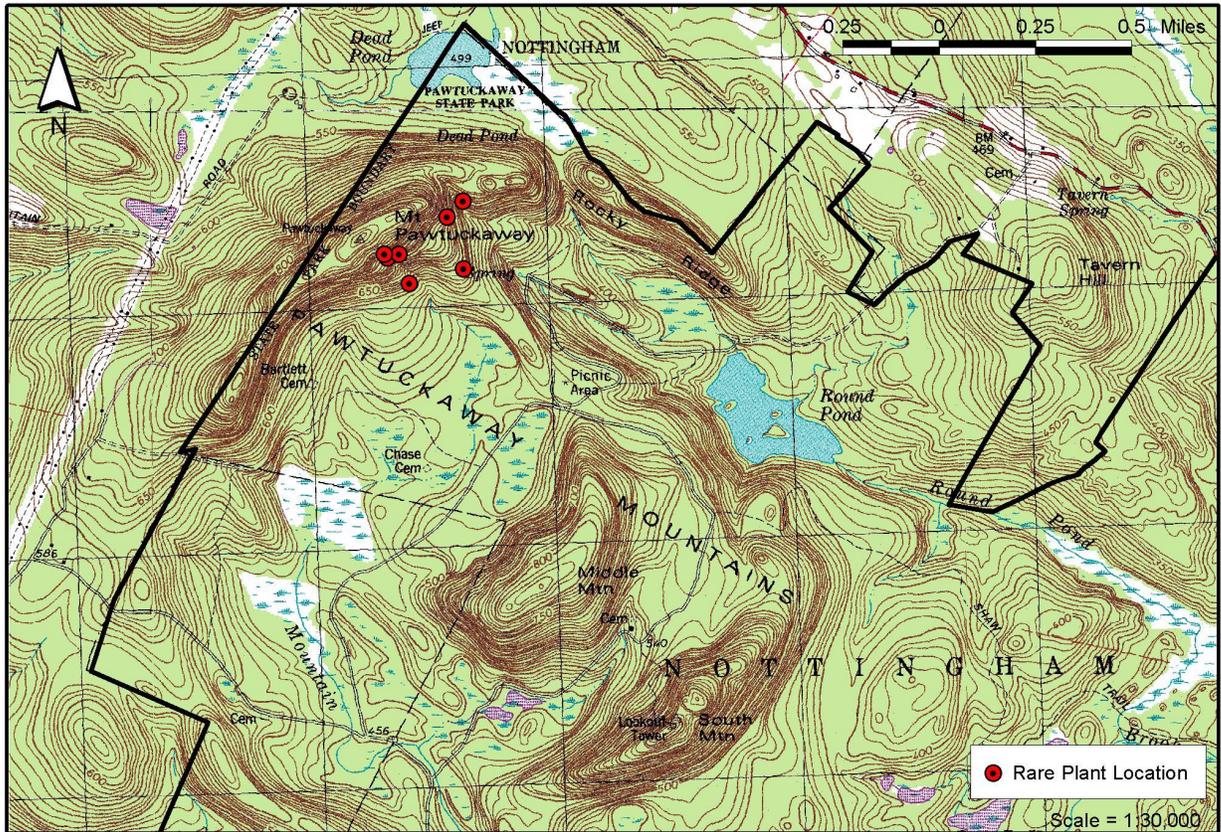
Arabis canadensis (sickle-pod) (Threatened)

Sickle-pod is a biennial herb found in dry habitats, particularly sites with some enrichment. In New Hampshire, it is found at only a few locations in the southeastern portion of the state. At Pawtuckaway, it is found in the **rich Appalachian oak rocky woods system** on both North and Middle Mountains. On both mountains, the plants occur as scattered individuals, often on rock outcrops or in small openings.



Arabis canadensis (sickle-pod). Photo by Pete Bowman.





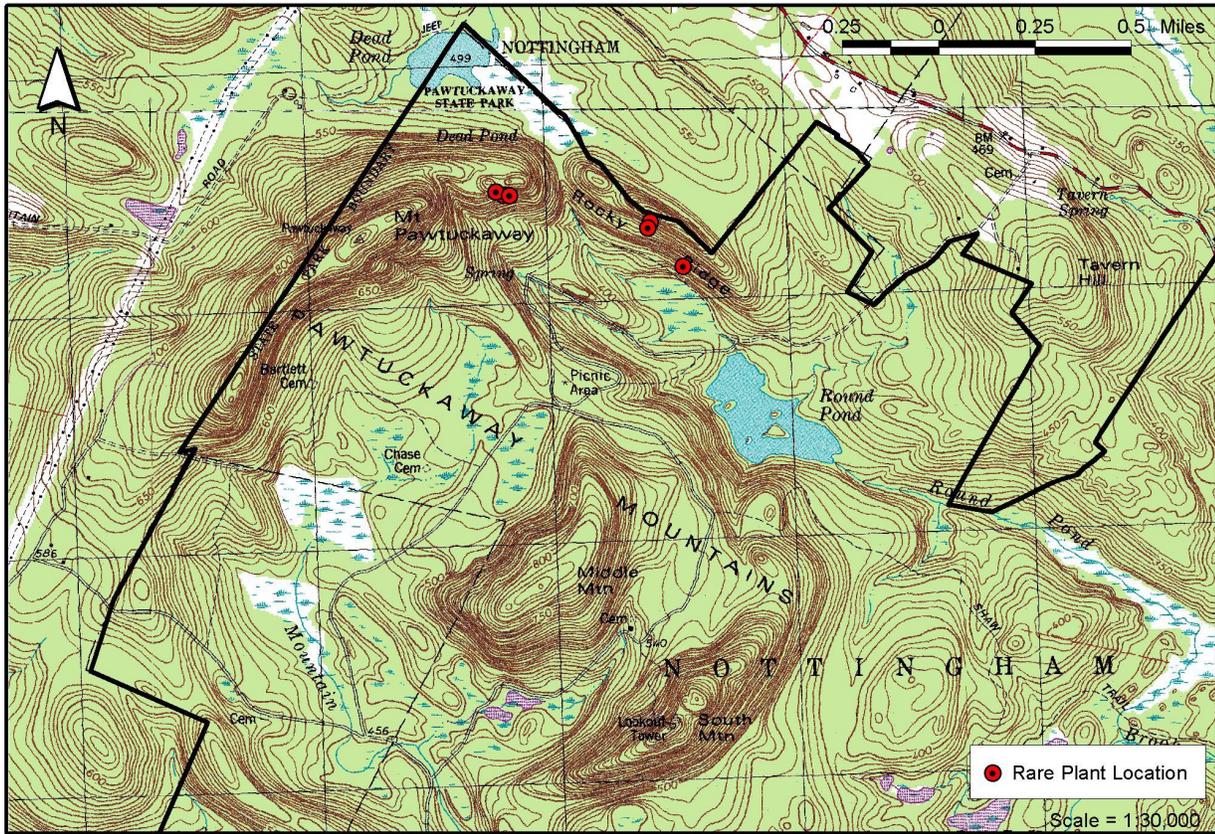
Arabis missouriensis (Missouri rock cress) (Threatened)

This species has a very scattered range, with large populations in the Ozarks, but rare or uncommon throughout the rest of the eastern US. In New Hampshire, it occurs at a few locations in the southeastern and central portions of the state. At Pawtuckaway, it is found on North Mountain, in the *rich Appalachian oak rocky woods system*. Like *Arabis canadensis* (sickle-pod), it occurs as scattered individuals on outcrops or in sunny openings.



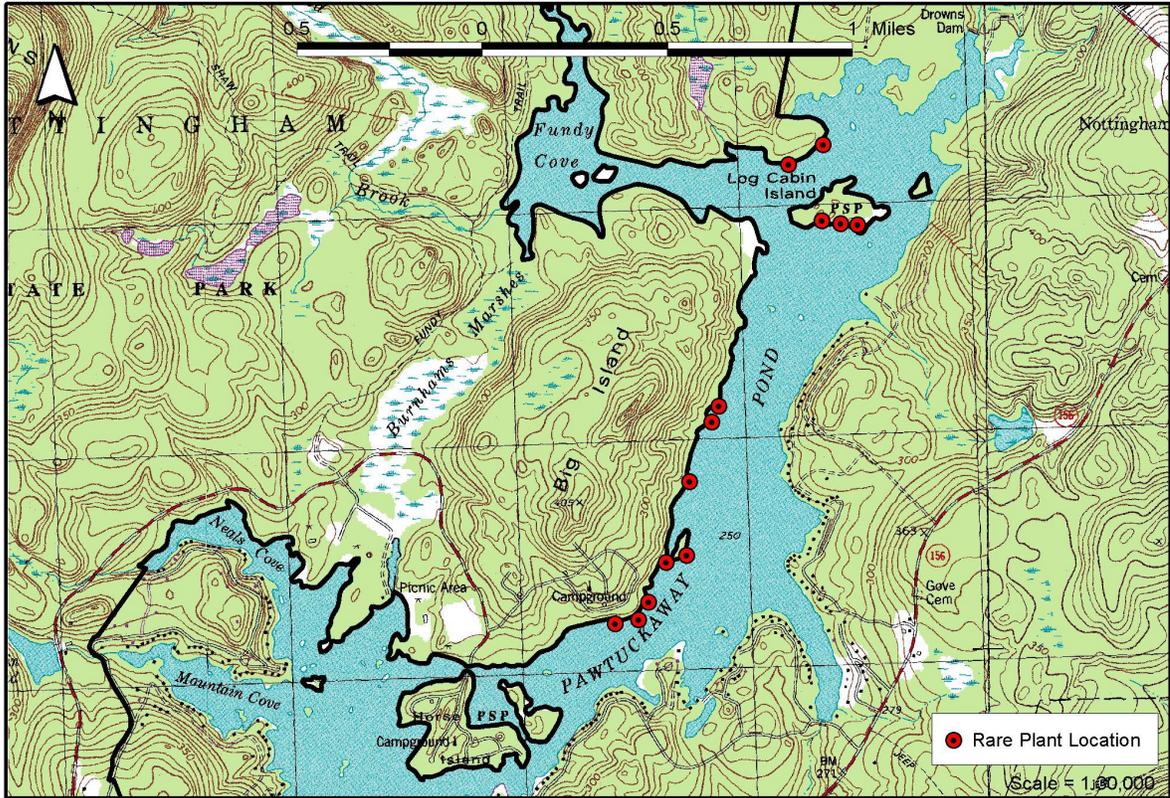
Arabis missouriensis (Missouri rock cress) on North Mountain. Photo by Pete Bowman.





Aureolaria pedicularia var. *intercedens* (fern-leaved false foxglove) (Threatened)

Fern-leaved false foxglove is an herb of open, rocky habitats like cliffs and ridgetops, and occurs at scattered locations in New Hampshire. At Pawtuckaway, it is found in the *Appalachian oak - pine rocky ridge* community on both North Mountain and Rocky Ridge. Plants are scattered in sunny openings, and are vulnerable to trampling from hikers and rock climbers.

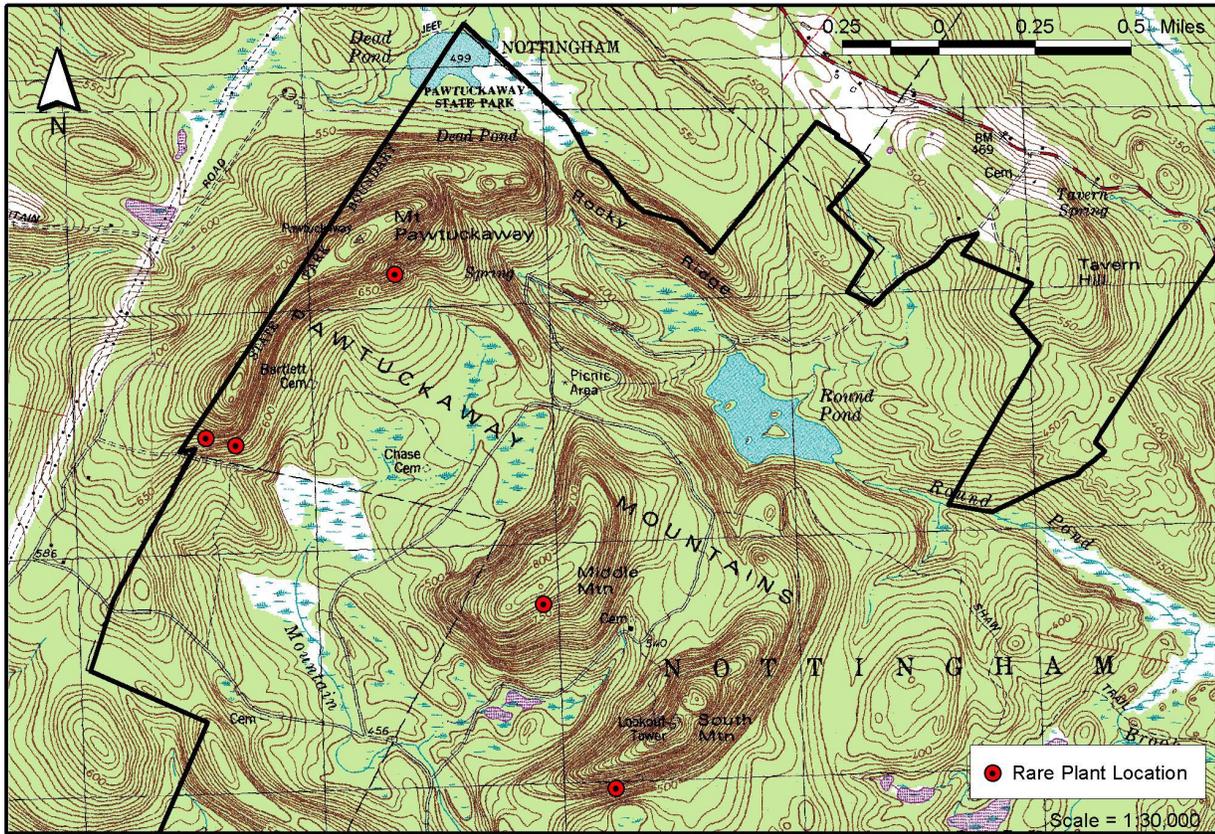


Betula nigra (river birch) (Threatened)

River birch is a small- to medium-sized tree that grows along the edges of rivers and streams, and is distinguished by its distinctive pink and orange peeling bark. It is currently known from only 12 locations in the southeastern portion of the state. At Pawtuckaway, it grows as scattered individual trees or small clumps along the shore of Pawtuckaway Lake, and is found on both the mainland and Log Cabin Island. Approximately 30 individual stems were located at 13 different points along the shoreline.



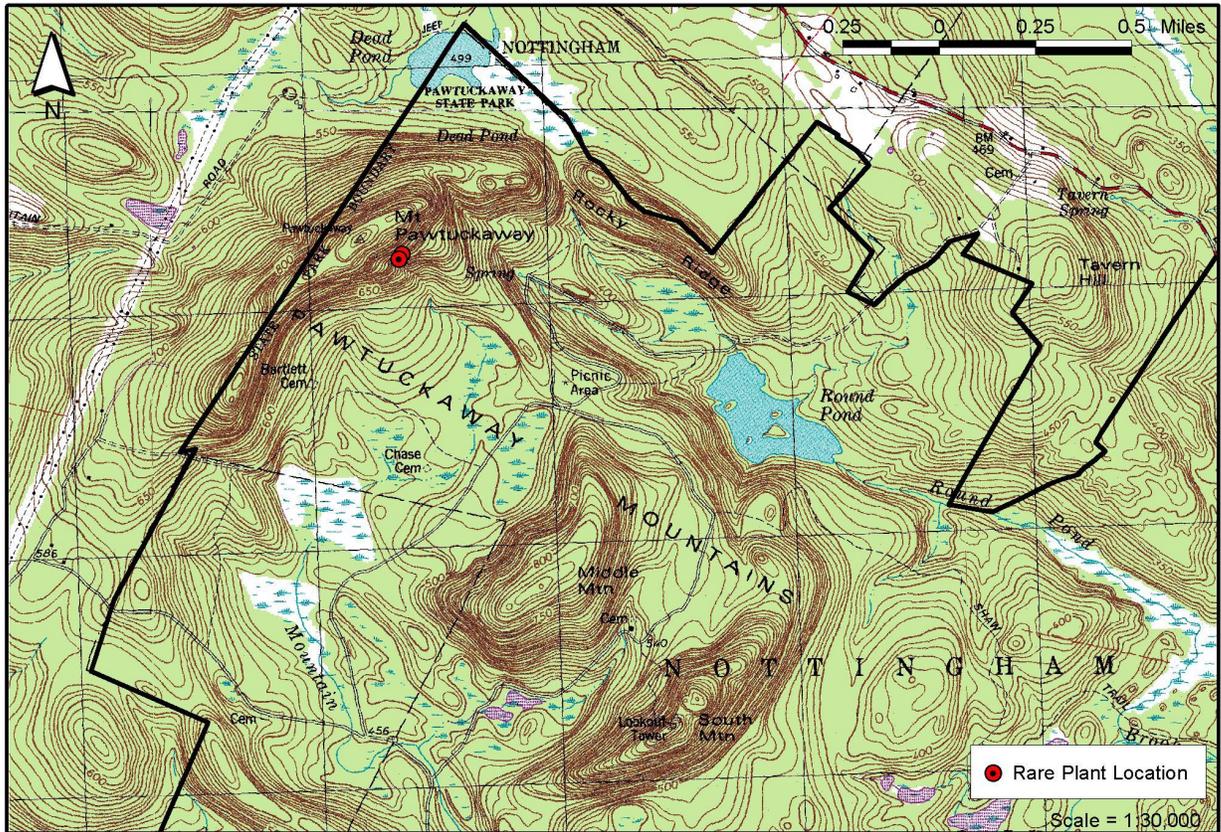
Betula nigra (river birch) at Pawtuckaway Lake. Photos by Ben Kimball.



Bromus pubescens (hairy brome grass) (Endangered)

Hairy brome grass is a grass that grows in enriched woods and slopes, and is known from only four sites in New Hampshire. At Pawtuckaway, there are occurrences on North, Middle and South Mountains, and these represent the only populations in the state that are not considered historic. On North and Middle Mountains, the plant occurs in the *rich Appalachian oak rocky woods system*. On South Mountain, it is found in the *semi-rich Appalachian oak - sugar maple forest* on the eastern slopes of the mountain.



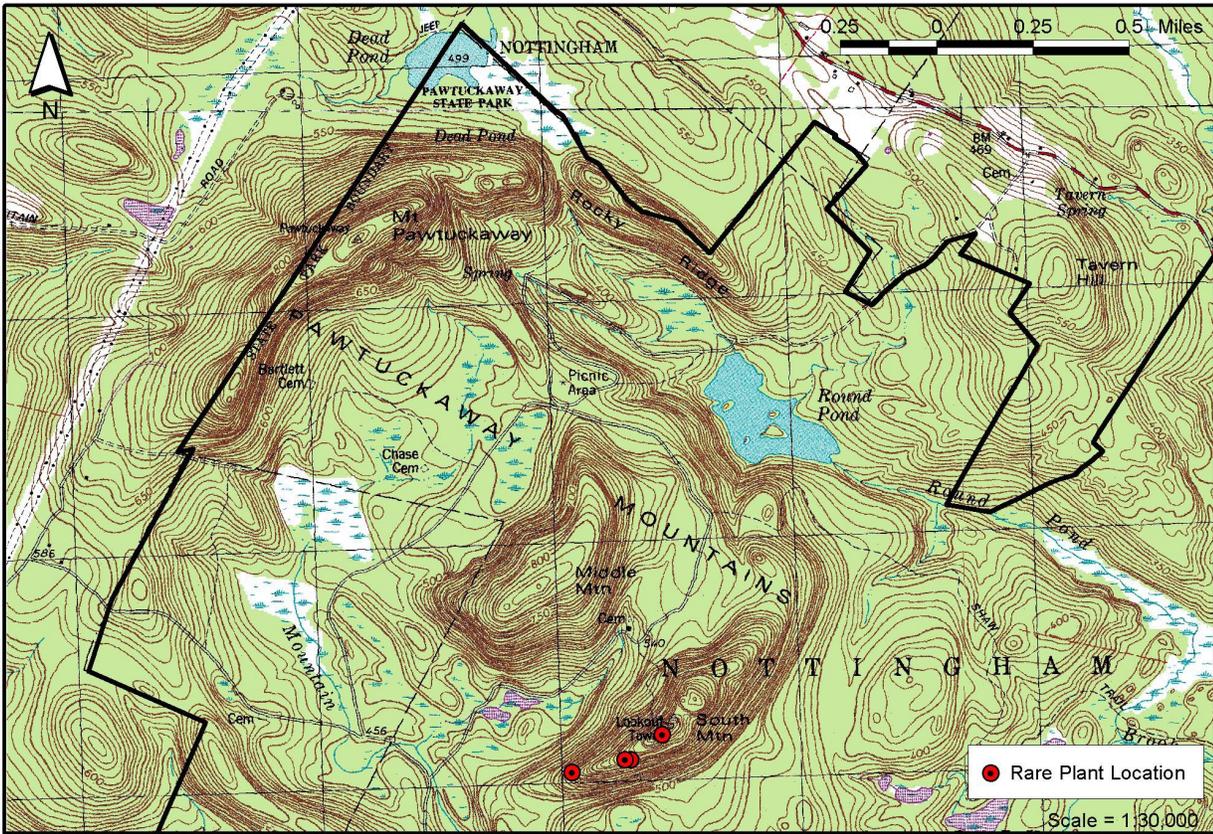


Carex backii (Back's sedge) (Threatened)

Back's sedge grows on partially shaded outcrops and rock ledges. The occurrence at North Mountain is on an outcrop in the *rich Appalachian oak rocky woods system*. This species has been recently listed in New Hampshire, and is the first record for this species in the NH Heritage database. It is a very small population of less than 10 individuals, and should be monitored to gauge changes in the status of this occurrence.



Carex backii (Back's sedge). Photo by Dan Sperduto.



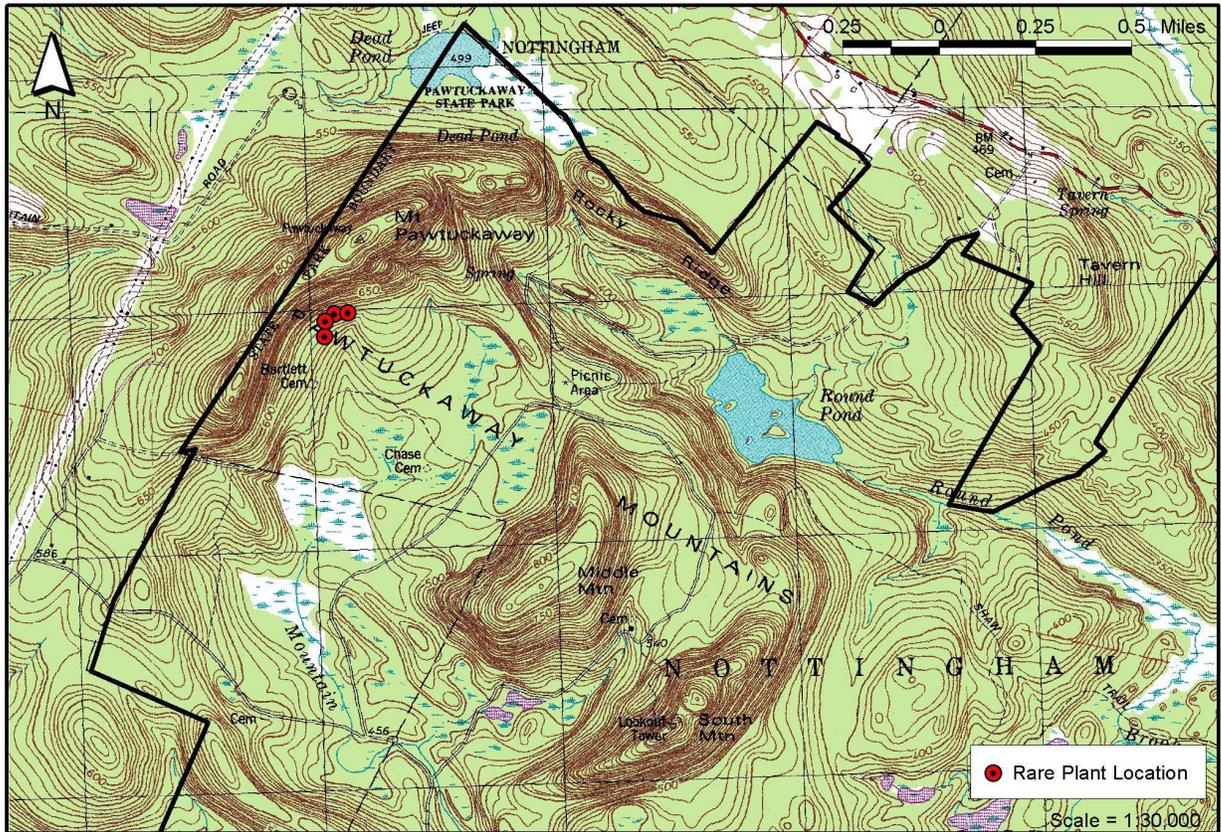
Carex cumulata (piled-up sedge) (Endangered)

Piled-up sedge occurs in the *Appalachian oak - pine rocky ridge* on South Mountain. This sedge favors dry, open habitats, and is scattered at less than ten sites throughout the state. On South Mountain, it occurs in sunny openings, especially along trails, making it particularly vulnerable to trampling.



Carex cumulata (piled-up sedge) at South Mountain. Photo by Dan Sperduto.



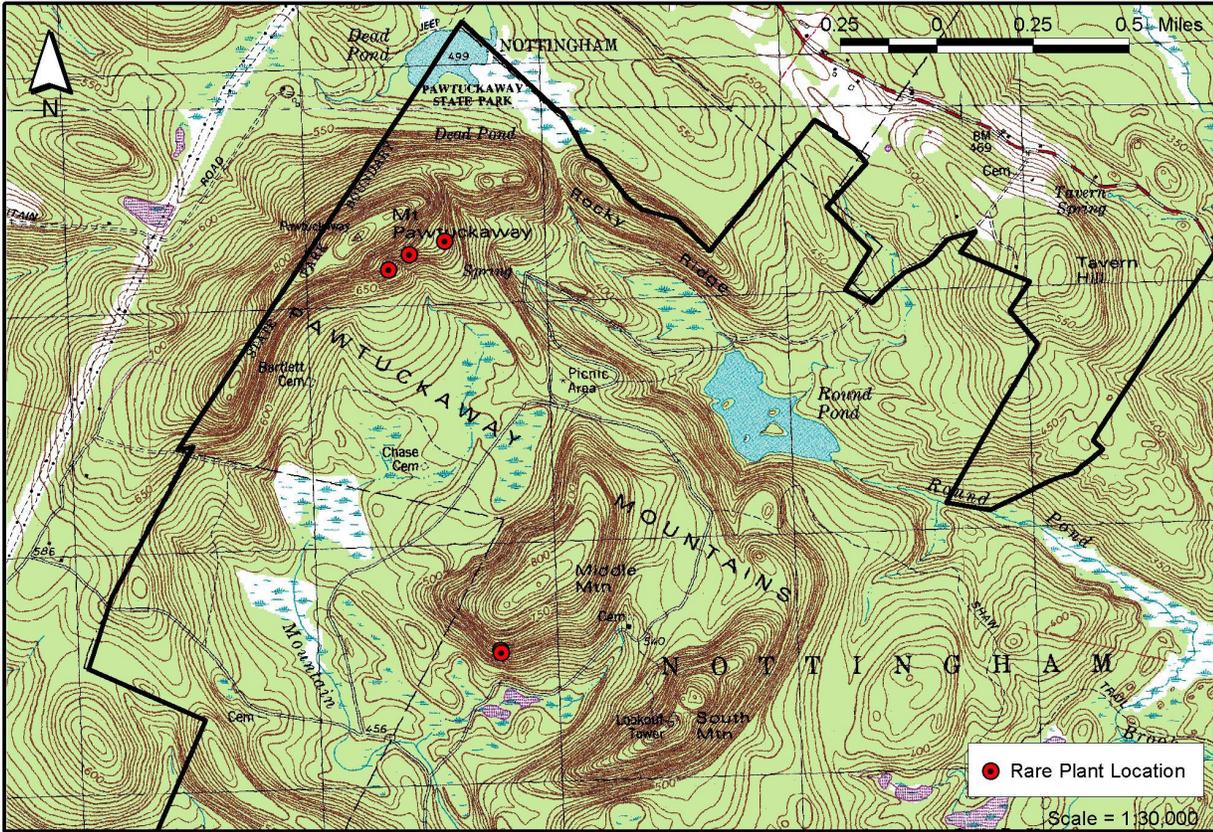


Carex hitchcockiana (Hitchcock's sedge) (Endangered)

The occurrence at North Mountain represents the first record for Hitchcock's sedge in New Hampshire. An apparently healthy population of over 300 plants was found in the *rich mesic forest* on the lower portion of the eastern slope of the mountain.



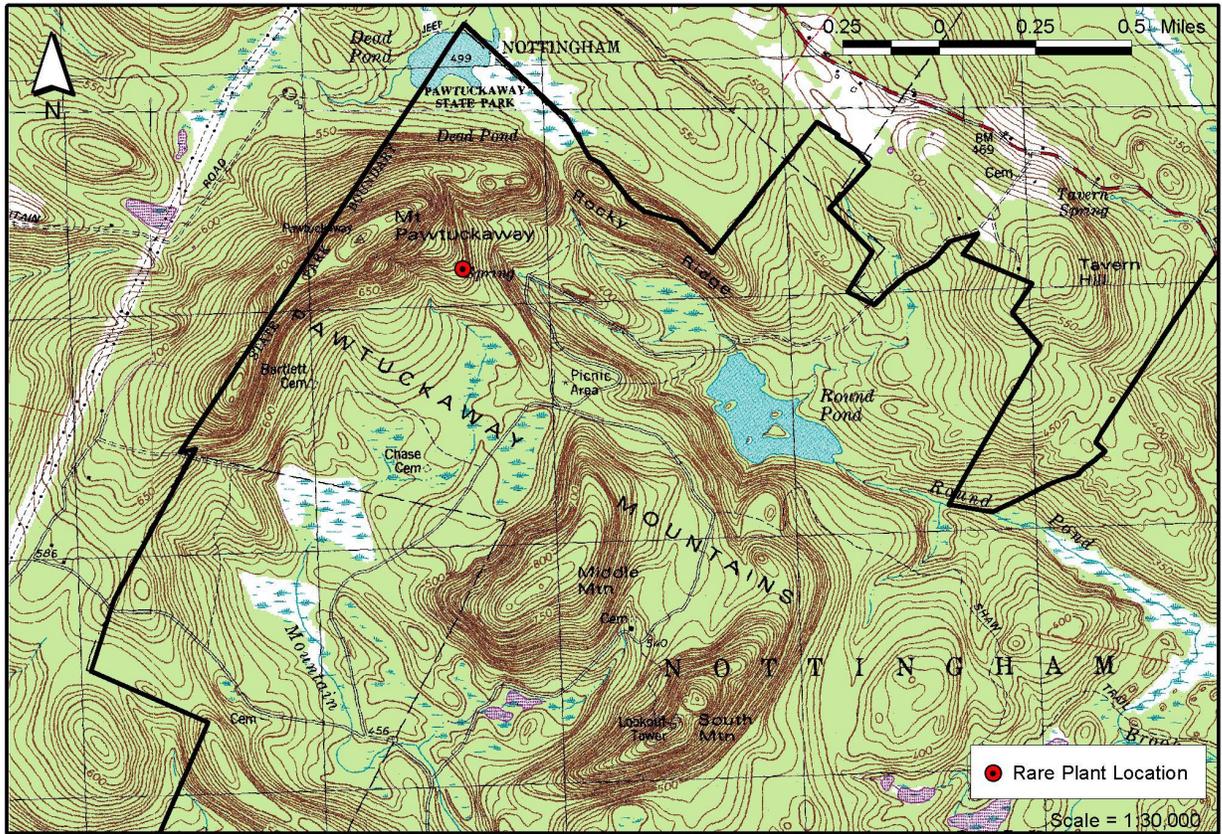
Carex hitchcockiana (Hitchcock's sedge) at North Mountain. Photo by Bill Nichols.



Carex retroflexa (reflexed sedge) (Endangered)

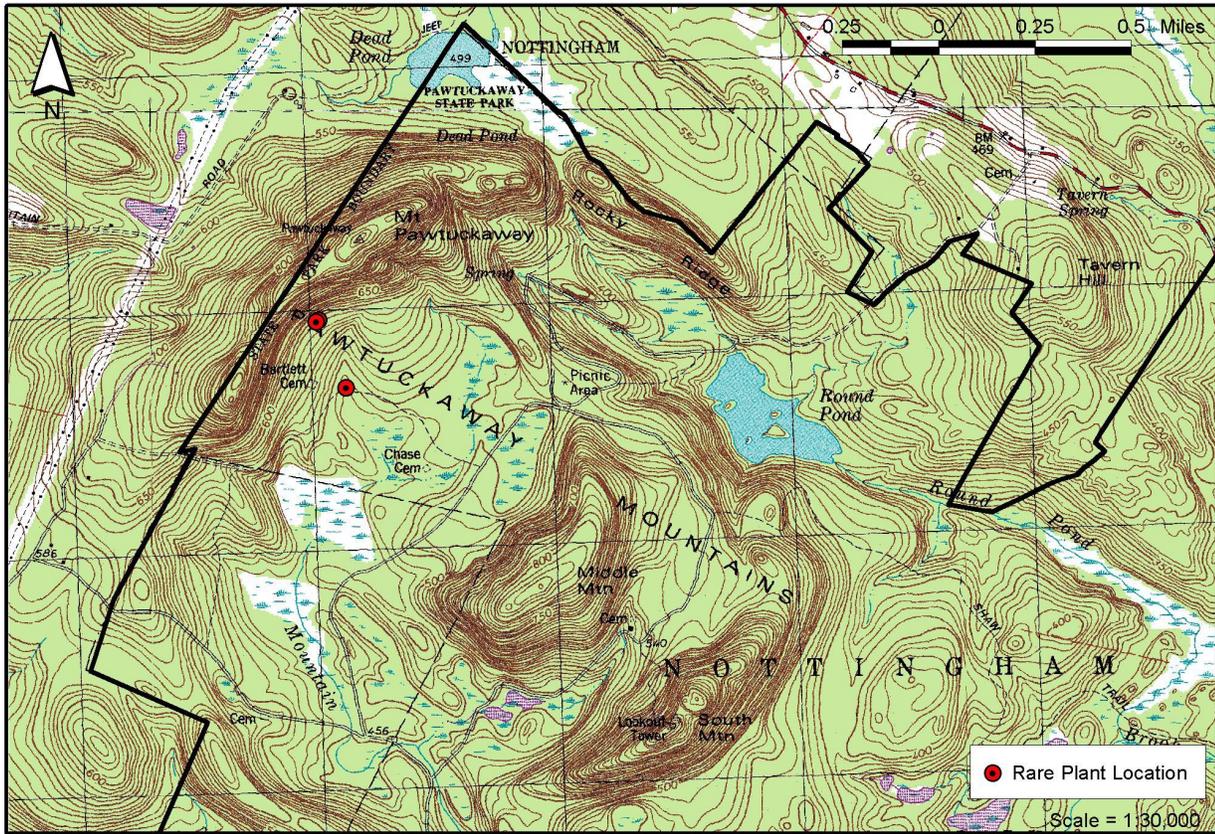
Prior to its rediscovery at Pawtuckaway, reflexed sedge had not been seen in New Hampshire since 1972 had a rank of SH (historic). There are healthy populations on both North and Middle Mountains, with an estimated 800-1600 individuals at Middle Mountain. On both mountains it occurs in the *rich Appalachian oak rocky woods system*.





Carex siccata (hay sedge) (Endangered)

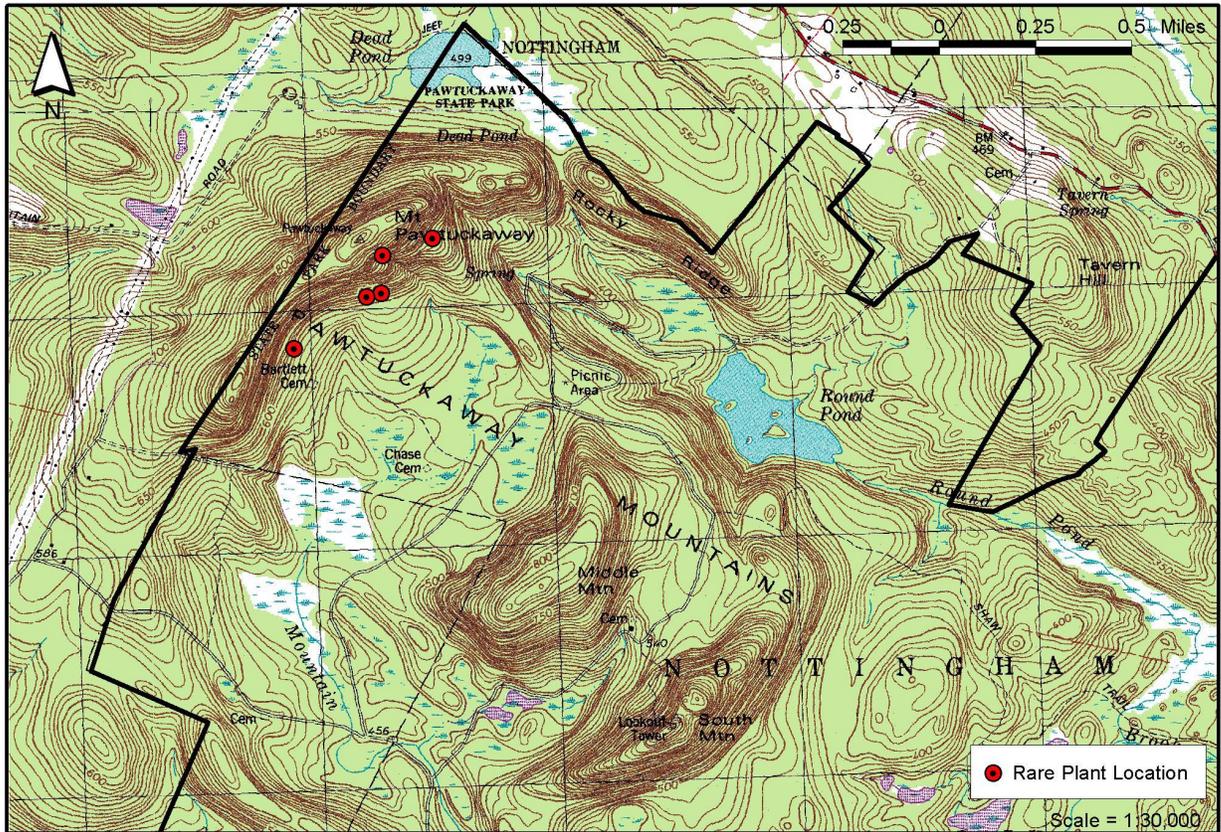
Hay sedge is a plant that NH Heritage has only recently begun tracking, and this occurrence represents the first record of the species in the database. At North Mountain, it occurs in the *rich Appalachian oak rocky woods system*, and appears healthy, with over 50 flowering individuals observed.



Carex sparganioides (bur sedge) (Endangered)

Bur sedge is a plant of enriched forest habitat that is very rare in New Hampshire. With the exception of Pawtuckaway, all of the occurrences of this species are in the western part of the state, near the Connecticut River. In the park, it is found in the *rich mesic forest* and *semi-rich Appalachian oak - sugar maple forest* communities on North Mountain. These locations did not contain a large number of individuals, but the population is probably healthy considering the quality of the surrounding habitat.



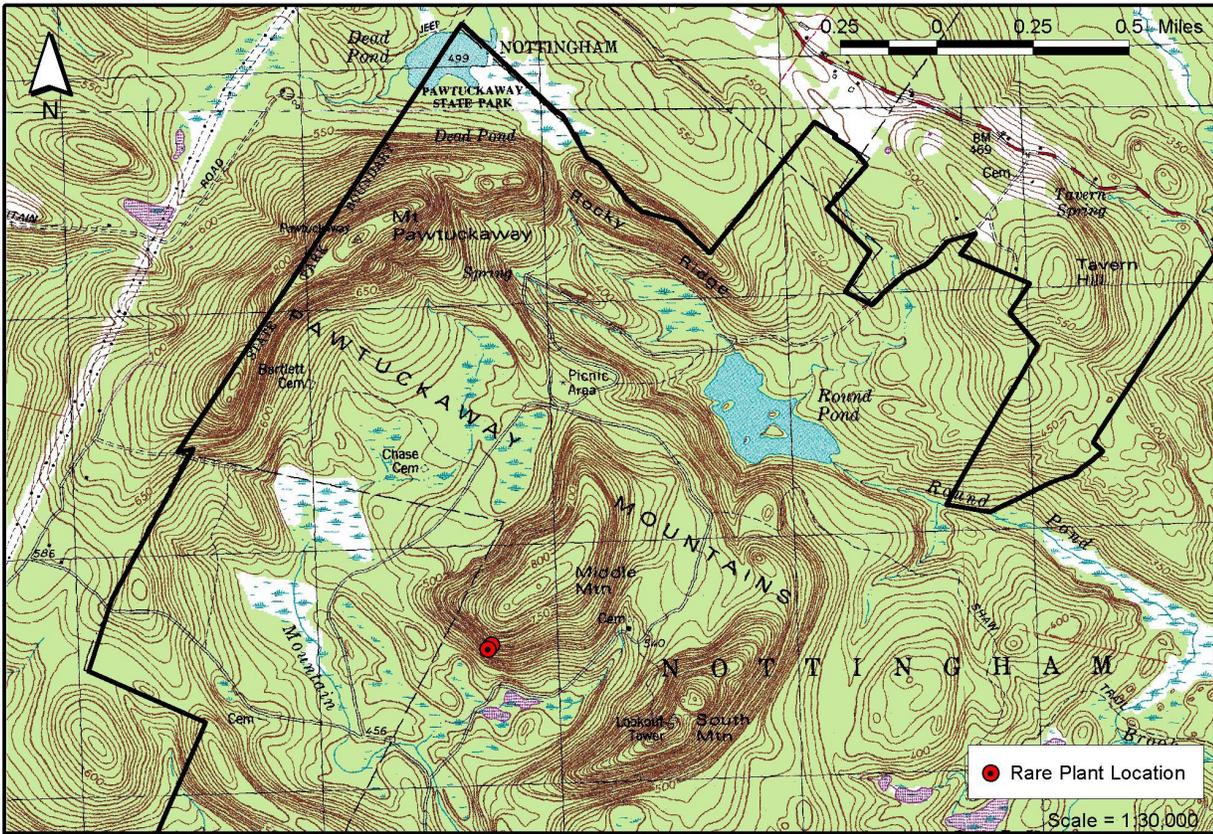


Conopholis americana (American cancerroot) (Threatened)

American cancerroot is an achlorophyllous root parasite, meaning that it does not use chlorophyll to produce its own food, but rather absorbs nutrients from the roots of other plants. It is an unusual looking plant that somewhat resembles a group of pine cones emerging from the soil. This species is generally restricted to enriched habitats, and on North Mountain, is found in both the *rich mesic forest* and the *rich Appalachian oak rocky woods system*, where dozens of plants were observed. It is found at scattered locations in enriched habitats throughout New Hampshire.



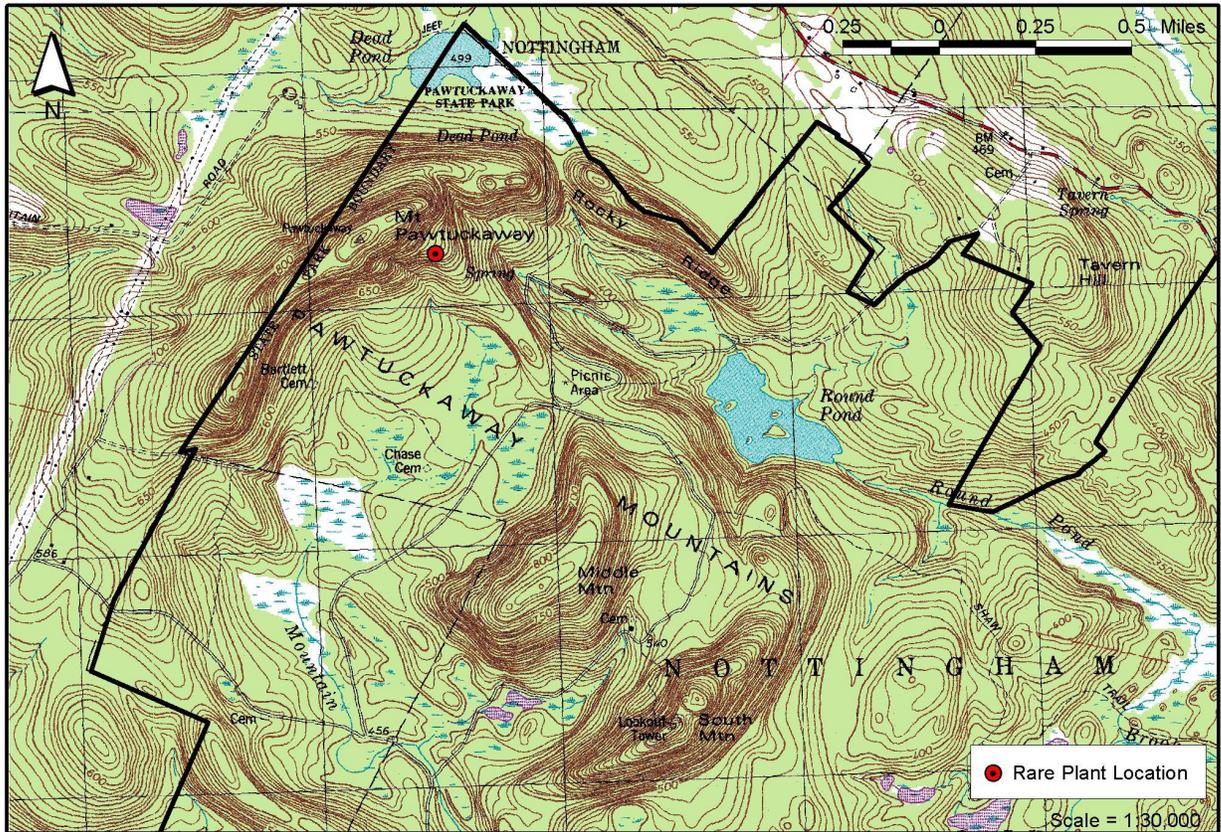
Conopholis americana (American cancerroot). Photo by Bill Nichols.



Paronychia canadensis (smooth-forked chickweed) (Threatened)

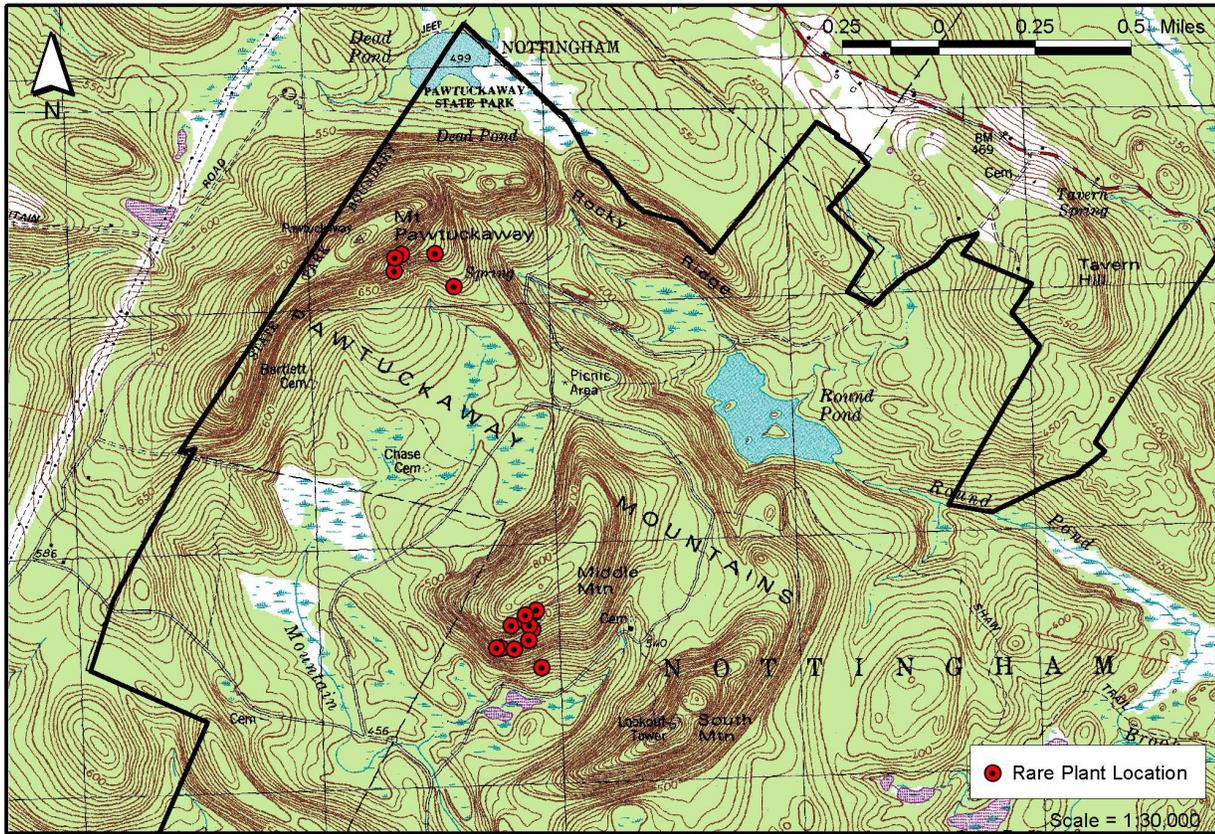
Smooth-forked chickweed is a small herb found in dry open habitats. With the exception of Pawtuckaway, all of the occurrences in the state are in the border towns of Hudson, Pelham and Windham. In the park, there is a robust population on open rocky ledges and ramps within the *rich Appalachian oak rocky woods system* on Middle Mountain, with over 1700 plants observed.





Polygonum tenue (slender knotweed) (Endangered)

Prior to this survey, slender knotweed had not been seen in New Hampshire since 1952, and was ranked SH (historic). The observed population at North Mountain contained approximately 100 plants on an open outcrop in the *rich Appalachian oak rocky woods system*.



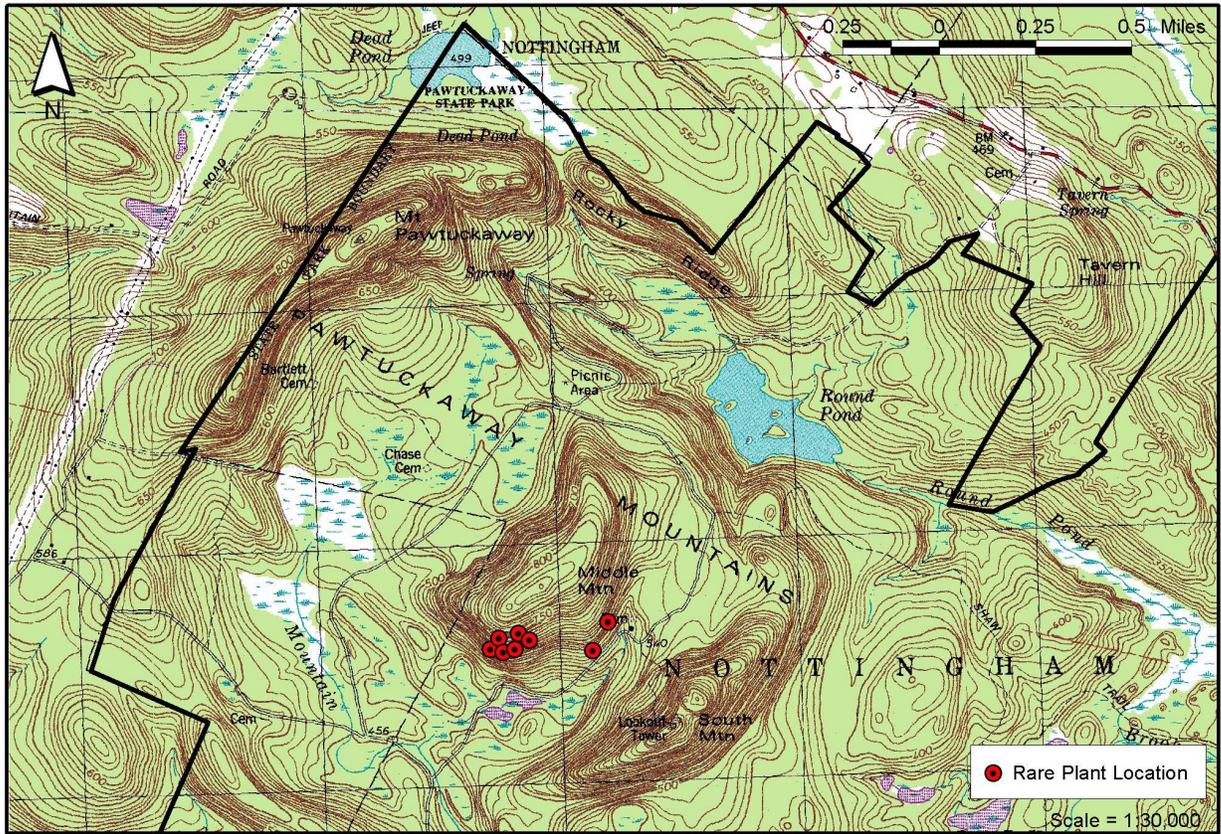
Ranunculus fascicularis (early buttercup) (Endangered)

Early buttercup is a small herb that is found in the *rich Appalachian oak rocky woods system* on both North and Middle Mountains. Outside Pawtuckaway, there is only one other known population of this plant in the state. Observations of the occurrences on both mountains in the park recorded between 100 and 200 plants in apparently healthy populations.



Ranunculus fascicularis (early buttercup) at Middle Mountain. Photo by NH Heritage.





Woodsia obtusa (blunt-lobed woodsia) (Endangered)

Blunt-lobed woodsia is a small fern that grows on cliffs and other exposed rock faces, and is known from less than 10 populations in the state. At Pawtuckaway, it is present on both North and Middle Mountains in the *rich Appalachian oak rocky woods system* as scattered individuals on rock outcrops and shaded ledges.

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The following plant species are known from historic records at Pawtuckaway. They were not relocated during this survey.

Gaylussacia dumosa (dwarf huckleberry) (S2)

Dwarf huckleberry is a short shrub that is found in peatlands near the coast, and is restricted to coastal settings throughout its range. The only record of this species at Pawtuckaway is from an herbarium specimen dated 1899, in the vicinity of Middle Mountain, and was not relocated during this survey. Based on the habitat requirements of this plant, the only possible locations for it near Middle Mountain are large wetlands that have been impacted by beavers, and no longer retain their peatland character. It is likely that this species has been extirpated from the park.

Geranium carolinianum var. *confertiflorum* (cranesbill) (S1)

Cranesbill is an herb of dry, rocky habitats that was last seen on Middle Mountain in 1948, and is known from only three sites in New Hampshire. Although the plant was not located during this survey, it may still be present in the park. It is an annual, and may appear in different locations from year to year in small numbers.

Muhlenbergia sobolifera (sprout muhlenbergia) (S1)

Sprout muhlenbergia is a grass that occurs in rocky woods and on outcrops, and is found at only a few sites in southern New Hampshire. It was last seen on Middle Mountain in 1969, and was not relocated during this survey. Considering the amount of suitable habitat at Pawtuckaway, it is possible that this species may still be found in the park.

Rotala ramosior (toothcup) (S1)

This herb was found once at Pawtuckaway Lake in 1944. This specimen represents the only known observation of this species in New Hampshire. It was not seen during this survey, and it is unlikely to be relocated at this site.



Rare Animal Species

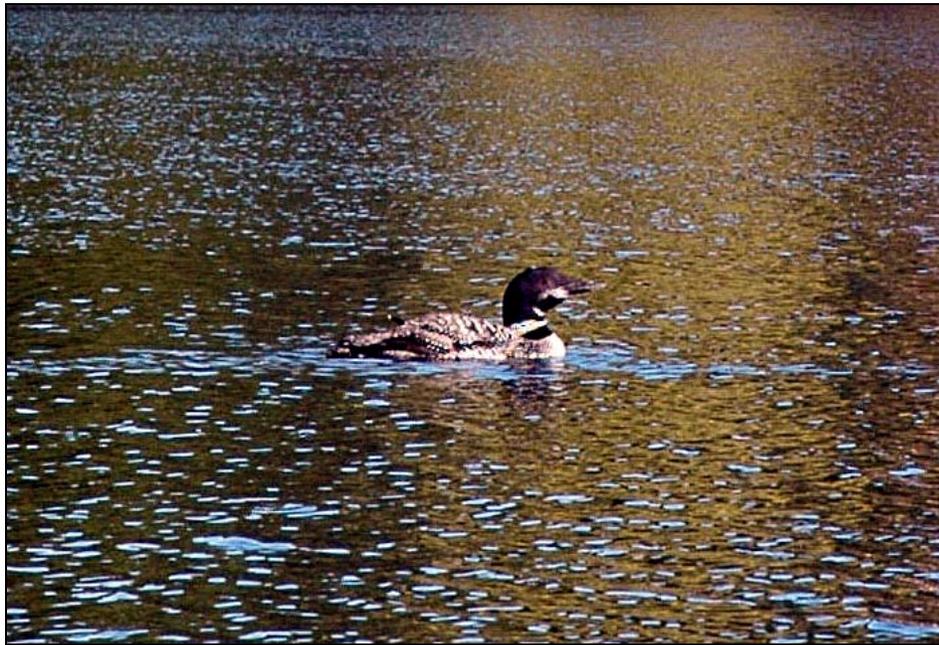
The NH Heritage database contains records for several rare animal species at Pawtuckaway State Park, including Cerulean warbler (*Dendroica cerulea*) and Common loon (*Gavia immer*).

Cerulean warbler (*Dendroica cerulea*)

The most noteworthy animal in the park is the cerulean warbler, for which Pawtuckaway is the only known breeding location in New Hampshire. In 2002, at least four territorial males were identified, all in hardwood forests in the vicinity of the Pawtuckaway Mountains (Hunt 2002).

Common loon (*Gavia immer*)

Two pairs of common loons nested on Pawtuckaway Lake in 2002. Only one nest was successful (Hunt 2002).



Common loon (*Gavia immer*) on Pawtuckaway Lake at Pawtuckaway State Park. Photo by Ben Kimball.



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Hemlock forest on the north slope of North Mountain. Photo by Ben Kimball.



APPENDIX 1. NH Natural Heritage Ecological Approach

Natural Communities

NH Heritage classifies the landscape with "natural communities," which are recurring assemblages of species found in particular physical environments. Each natural community type is distinguished by three characteristics: (1) a definite plant species composition; (2) a consistent physical structure (such as forest, shrubland, or grassland); and (3) a specific set of physical conditions (such as different combinations of nutrients, drainage, and climate conditions). Natural communities include both wetland types (e.g., *red maple - Sphagnum basin swamp*) and uplands such as woodlands (e.g., *red oak - ironwood - Pennsylvania sedge woodland*) and forests (e.g., *hemlock - beech - oak - pine forest*).

Across the landscape, natural communities form a mosaic of patches of different sizes. Some tend to be small (such as *circumneutral hardwood forest seeps*) while others may cover large areas (such as *high-elevation spruce - fir forest*). Further, boundaries between natural community types can be either discrete (and therefore easily identified in the field) or gradual (thus making some areas difficult to map). Below we describe how and why natural communities are classified and explain the concept of "exemplary" natural communities and their importance to conservation.

NATURAL COMMUNITY CLASSIFICATION

Classifying natural communities enables ecologists, land managers, and others to communicate effectively and to make management decisions regarding ecological systems. Community classification is a powerful tool because it provides a framework for evaluating the ecological significance of pieces of the landscape in both state and regional contexts. Understanding both the rarity of a community within the state and region and the quality of each example is critical to informed conservation planning. As landscape units that share physical and biological characteristics important to many species, natural communities help focus management and conservation attention in an efficient manner, particularly since our knowledge of the individual species in a particular community is often incomplete. In addition, use of a natural community classification can help us understand how ecological processes in one community may affect neighboring communities. For example, knowing that the surrounding upland forest soils are a primary source of nutrients flowing into a *poor level fen/bog system* is important information for land managers to consider when planning management activities.

The classification of natural communities in New Hampshire is based on data from more than 10 years of ecological research by ecologists with NH Heritage and The Nature Conservancy, plus extensive reviews of scientific literature (Sperduto 1994, 1997a, 1997b, 2000). These data have been compiled and used to define natural community types in part through the application of ordination and classification techniques. Most state natural heritage programs continually update their classifications and cooperate with The Nature Conservancy's regional and national ecologists to ensure that natural community types are comparable across state lines.



The names of natural community types generally begin with the dominant or most characteristic plant species, and may include the name of a landscape feature or vegetative structure that is typical of that community. For example, the community type “**black gum - red maple basin swamp**” refers to a basin swamp (a specific landscape feature, as opposed to a streamside swamp) with black gum *and* red maple in the canopy. In addition, like all Society of American Foresters (SAF) forest cover types, forested natural communities may have many overlapping species and other characteristics, but they are defined by distinct and diagnostic combinations of species and physical characteristics. For example, the **northern hardwood - spruce - fir forest** natural community has considerably more red spruce in the overstory, and is generally higher in elevation, than the standard northern hardwood forest (**sugar maple - beech - yellow birch forest** natural community) despite many species that occur in both.

NATURAL COMMUNITIES COMPARED TO OTHER CLASSIFICATION SYSTEMS

Many classification schemes are used to define vegetation types or other land units. While many of them have utility for certain purposes, most differ from the natural community classification in terms of their founding principles, attributes, and goals. In the following paragraphs, several of these classification schemes are contrasted with the natural community classification used by NH Heritage.

SAF COVER TYPES

While natural community names can be similar to the names of SAF forest cover types, natural communities are defined using a broader range of considerations. SAF forest cover types are primarily based on dominant tree species, while natural communities are based on all plant species, the structure of these species, and the specific physical environment. Trees are often subtle indicators of their environments. A number of natural communities can be distinguished based largely on trees, and in some cases a difference in tree composition is the main difference between two community types. However, some trees are so broadly adapted that their presence does not precisely indicate site conditions (e.g., white pine or red maple). Differences in tree canopy composition may also primarily relate to cutting or other disturbances.

For example, there are four SAF spruce-fir cover types that correspond to the “**high-elevation spruce - fir forest**” natural community type. These different cover types primarily relate to stand disturbance history or the successional stage rather than to major environmental differences. The four cover types also do not differentiate between upland spruce-fir forests and spruce-fir swamps. When one considers understory species and soils, upland spruce-fir forests are markedly different from the **red spruce swamp** natural community. In fact, the differences between these two natural communities are more dramatic than the internal differences among the four SAF spruce-fir cover types. SAF cover types are useful, however, for timber management purposes.

NATIONAL VEGETATION CLASSIFICATION SYSTEM

At a national level, The Nature Conservancy has published a National Vegetation Classification System (NVC; Grossman et al. 1998; Anderson et al. 1998) that uses a formal classification hierarchy emphasizing differences in both vegetation structure and floristic composition. This



system is periodically updated to include new information from more specific natural community classifications developed at the state level, such as the New Hampshire natural community classification. The Federal Geographic Data Committee has adopted a vegetation classification standard derived from the NVC for use by federal agencies, and future development of the classification is expected to be a collaborative effort (Grossman et al. 1998). Natural communities are synonymous in scale and in concept to the “association” level of the NVC. The primary difference between the two classifications is that the New Hampshire classification uses environmental characteristics directly in the organizational hierarchy (e.g., floodplain forests and talus slopes), whereas the NVC hierarchy is based primarily on vegetation characteristics alone.

USFWS WETLAND CLASSIFICATION

A classification scheme frequently used in wetland and aquatic systems was produced by Cowardin et al. (1979) for the U.S. Fish and Wildlife Service (USFWS). In the USFWS system, wetlands and deepwater habitats are defined by their vegetation, substrate, and frequency of flooding in a hierarchy that emphasizes flooding regimes and attributes of vegetation at a coarse scale (e.g., vegetation structure, life-form, persistence, etc.). This classification system is useful because of its applicability to broad geographical regions and because it can be readily applied in conjunction with aerial photograph interpretation. It was the basis for wetland typing in the National Wetland Inventory mapping effort.

Natural community types can typically nest within the hierarchical structure of the USFWS system. In addition to the flooding regimes and coarse vegetation characteristics used to distinguish USFWS types, however, the natural community classification considers factors such as nutrient regime, water source, and geomorphic setting, as indicated by specific differences in floristic composition. For example, under the USFWS system, *red maple - Sphagnum basin swamps* and *red maple - black ash - swamp saxifrage swamps* would both be considered saturated, palustrine broad-leaved deciduous forested wetlands. This grouping does not reflect important differences between the two communities, including differences in species composition (ground cover by *Sphagnum* versus forb species), nutrient levels (species indicative of nutrient-poor versus minerotrophic conditions), water sources (upland runoff versus groundwater seepage), geomorphic settings (basin depression versus headwater seepage area), and soils (deep peat versus shallow peat over silt). The natural community classification provides additional detail regarding ecological conditions and processes that helps clarify the distribution of biological diversity across the landscape.

ECOLOGICAL LAND TYPES

Defined to date only for national forest lands in New Hampshire, the U.S. Forest Service’s Ecological Land Types (ELTs) emphasize particular soil features, including depositional environment, soil texture, and soil depth. Although some ELTs correspond reasonably well to groups of communities, they are not easily compared to natural communities for five primary reasons. First, ELTs in New Hampshire are limited to uplands. Second, they are mapped as units of 100 or more acres, so natural communities that occur as smaller patches are not detected and often occur within many ELT types. Third, ELTs can be related to general tree species composition, but the composition of other plant species is not considered directly. Fourth, ELTs



do not directly reflect the mineral composition of soil and bedrock, whereas natural communities do. Finally, ELTs describe some fine-scale soil characteristics that may have silvicultural significance but sometimes have no known corresponding floristic expression.

EXEMPLARY NATURAL COMMUNITIES

NH Heritage places particular emphasis on and gives conservation priority to "exemplary" natural communities. Exemplary natural communities include all examples of rare types (such as a rich mesic forest) and high-quality examples of common types. High-quality natural communities are identified as having relatively little human impact. These areas have greater potential to contain or achieve natural dynamics that are characteristic of the original community types. A forested natural community need not be "old growth" to obtain exemplary status. Typical exemplary forested natural communities have a variety of characteristic species, natural regeneration within forest gaps, multiple age classes, diverse structural characteristics, abundant standing and fallen woody debris, intact soil processes, and little direct evidence of human disturbance. Such characteristics can only be studied, preserved, and understood by having appropriate reference sites. Further, exemplary natural communities represent the best remaining examples of New Hampshire's flora, fauna, and underlying ecological processes.

The effects of natural disturbances, such as the 1998 ice storm, do not preclude any natural community from being designated exemplary. Damages caused by natural disturbances, including ice storms, blowdowns, and fire, are part of the suite of natural processes influencing natural community dynamics. We take disturbance such as heavy ice damage into account when assessing natural communities, but if a community also displays exemplary attributes, including minimal human influence, then we are likely to classify it as such.

NATURAL COMMUNITY SYSTEMS

Natural community systems are repeating associations of natural communities. An example is a ***medium level fen system***. Systems can be useful for the following reasons: (1) they can be used as a tool to track locations and compare entire sites without having to refer to all communities at a site, particularly when these communities may intergrade and be difficult to map; (2) they allow general classification of a system when detailed information is not available or detailed surveys are not feasible; (3) systems can provide a more practical scale for conservation planning and site comparisons; and (4) systems may be more suitable mapping units than communities for integrating wildlife occurrence data and habitat needs with plant information. The classification and mapping of exemplary ecological systems can therefore be effective at identifying conservation targets of the highest priority.

RARITY

NH Heritage considers the rarity of a natural community or a species both within New Hampshire and across its total range. We identify the degree of rarity within New Hampshire with a state rank and throughout its range with a global rank. Ranks are on a scale of 1 to 5, with a 1 indicating critical imperilment, a 3 indicating that the species or natural community is uncommon, and a 5 indicating that the species or natural community is common and demonstrably secure. Species and natural communities considered to be globally rare or state



rare are those designated G1-G3 or S1-S3, respectively. Some species are rare both globally and in New Hampshire (e.g., G2 S1), while others are common elsewhere but rare in New Hampshire (e.g., G5 S1). Many communities have not been assigned global ranks at this time, pending a comprehensive review of their status and distribution range-wide.

QUALITY RANKS

In addition to considering the rarity of a natural community or species as a whole, NH Heritage ranks the quality of individual natural community occurrences and rare plant populations. These "Quality Ranks" give a more detailed picture of significance and conservation value. Quality ranks are based on the *size*, *condition*, and *landscape context* of a natural community or rare species population. These terms collectively refer to the integrity of natural processes or the degree of human disturbances that may sustain or threaten long-term survival. There are four quality ranks:

Rank Description

- A Excellent Occurrence:** An A-ranked natural community is a large example nearly undisturbed by humans or which has nearly recovered from early human disturbance and will continue to remain viable if protected. An A-ranked rare species occurrence is large in both area and number of individuals, is stable, exhibits good reproduction, exists in a natural habitat, and is not subject to unmanageable threats.
- B Good Occurrence:** A B-ranked community is still recovering from early disturbance or recent light disturbance by humans and/or may be too small in size to be an A-ranked occurrence. A B-ranked population of a rare species occurrence is at least stable, grows in a minimally human-disturbed habitat, and is of moderate size and number.
- C Fair Occurrence:** A C-ranked natural community is in an early stage of recovery from disturbance by humans and/or a small sized representative of the particular type of community. A C-ranked population of a rare species is in a clearly human-disturbed habitat and/or small in size and/or number, and possibly declining.
- D Poor Occurrence:** A D-ranked natural community is severely disturbed by humans, its structure and composition are greatly altered, and recovery is unlikely. A D-ranked occurrence of a rare species is very small, has a high likelihood of dying out or being destroyed, and exists in a highly human-disturbed and vulnerable habitat.

For example, consider a population of a rare orchid growing in a bog that has a highway running along one border. The population may be large and apparently healthy (large *size* and intact *condition*), but the long-term threats posed by disturbance at the bog's edge – its low-quality *landscape context* (pollution from cars and roads, road-fill, garbage, altered hydrology, reduced seed dispersal, etc.) – may reduce the population's long-term viability. Such a population of orchids would receive a lower rank than a population of equal *size* and *condition* in a bog completely surrounded by a forest (i.e., with a higher quality *landscape context*).

NH Heritage, in collaboration with other state heritage programs and The Nature Conservancy, is working to develop quality rank specifications for all of New Hampshire's natural communities



and rare plant species. Unfortunately, limited time and incomplete knowledge, both on local and global scales, have prevented the development of thoroughly tested and peer reviewed quality rank specifications for most of New Hampshire's natural communities and rare species.

In the absence of rank specifications for each natural community, NH Heritage uses broad guidelines for assigning preliminary quality ranks. The guidelines for assessing the size, condition, and landscape context for natural communities are described below.

SIZE

Occurrence size is a quantitative measure of area occupied by a species or natural community and accounts for such factors as population abundance, fluctuation, density, and area of occupancy for species. All else being equal, the larger a natural community is, the more viable it will be. Large size is correlated with increased heterogeneity of internal environmental conditions, integrity of ecological processes, species richness and size of constituent species populations and their respective viability, potential resistance to change, resilience against perturbations, and ability to absorb disturbances. Size is used in a relative sense with respect to the range of sizes exhibited by the particular natural community type.

CONDITION

Condition is a combined measure of the quality of reproduction (for species), development/maturity (for communities), degree of integrity of ecological processes, species composition, biological and physical structure, and abiotic physical factors within the occurrence. For example, old growth forests with little anthropogenic disturbance and intact biotic and abiotic factors, structures, and processes, would warrant an "A" rank for condition regardless of size.

1. **Excellent Condition:** Old growth or minimally disturbed by human impacts with recovery essentially complete, or in the case of disturbance-maintained communities (e.g., pitch pine/scrub oak barrens), the natural disturbance regime has prevailed continuously with no significant or irreversible alterations by humans; ecological processes, species composition, and structural features are intact.
2. **Good Condition:** Mature examples with only minor human impacts or good potential for recovery from relatively minor past human impacts; ecological processes, species composition, and structural features are largely intact.
3. **Fair Condition:** Immature examples or those with significant human impacts with questionable recovery potential or in need of significant management and/or time to recover from present condition; ecological processes, species composition, and structural features have been altered considerably but not to the extent that the occurrence is no longer viable if managed and protected appropriately.
4. **Poor Condition:** Little long term viability potential.



LANDSCAPE CONTEXT

Landscape context is a combined measure of (a) the quality of landscape structure, (b) the extent (including genetic connectivity), and (c) the condition of the surrounding landscape that influences the occurrence's condition and viability. Dynamic natural community occurrences have a better long-term viability when they are associated with large areas of diverse habitat that support dynamic ecosystem processes. Potential factors to be considered include: (a) the degree of landscape fragmentation; (b) the relationship of a natural community to contiguous wetland or upland natural communities; (c) the influence of the surrounding landscape on susceptibility to disturbance; (d) the relative position in a watershed; (e) susceptibility of the occurrence to pollutants and hydrologic change (Chase et al. 1995); and (f) the functional relationship of the natural community to surrounding natural landscape features and larger-scale biotic and abiotic factors. For example, open peatlands are extremely sensitive to nutrient input, basin swamps are moderately sensitive, and streamside/riverside communities and seepage swamps are less sensitive.

In general, landscape condition is weighted towards the immediate 30-300 m (100-1000') buffer area around the natural community where direct impacts of land use may be most significant. The adjacent 1.6-3.2 km² (1-2 mi²) area or relevant watershed area around the natural community is considered to a lesser degree. In turn, the larger area beyond the relevant watershed receives the least consideration. The actual size applied for a natural community varies according to the characteristics of the particular natural community and the specific context of the occurrence in the landscape.

1. **Excellent Landscape Context:** Natural community is embedded in a matrix of undisturbed, unfragmented surrounding natural communities that have functional connectivity to the occurrence; past human disturbances that potentially influence the community are minimal or negligible.
2. **Good Landscape Context:** Surrounding landscape is largely intact and minimally fragmented, or human disturbance/fragmentation is of a configuration and magnitude that is consistent with maintaining the current condition of the occurrence, or disturbances can be managed to achieve viability.
3. **Fair Landscape Context:** Significant human impacts, development, fragmentation, and other disturbances characterize the landscape around the natural community and may affect the long term viability and condition of the occurrence.
4. **Poor Landscape Context:** Functional human impacts, fragmentation and loss of natural communities dominate the surrounding landscape; the occurrence is probably not viable, even with management.



PROTECTING NEW HAMPSHIRE'S BIODIVERSITY

WHAT IS AND WHY SHOULD WE PROTECT BIODIVERSITY?

WHAT IS BIODIVERSITY?

Biodiversity can be defined as the variety and variability of all living organisms (Taylor et al., eds. 1996). Biodiversity includes the entire combination of organisms, their genes, the natural communities in which they live, and the complex interactions among and between organisms and their physical environment. Natural levels of biodiversity may be very high, as in tropical regions with favorable growing conditions and high species counts per unit area. Natural levels of biodiversity can also be very low, where conditions are harsh and few species can survive (such as in deserts and arctic regions). The biodiversity in a given area decreases when species suffer local extinctions, when invasive species form a monoculture that displaces a variety of native species, and when natural habitats (which support the local species) are fragmented or destroyed. On a landscape scale, unique components of biodiversity (such as species or natural communities that only occur within a limited area) are a focal point for conservation efforts.

WHY SHOULD WE PROTECT BIODIVERSITY?

Reasons for biodiversity protection include the following:

- **Direct benefits:** Both individual species and functioning natural communities provide a large array of direct economic and other benefits. These include, but are not limited to: flood prevention, water quality improvement, fire prevention, food, medicines and herbal remedies, genetic resources, recreation, crop pollination, and pest control.

Due to the extensive interactions among all species, even species with no obvious direct benefits to humans may play a critical role in the survival of beneficial species or in the suppression of harmful ones. The loss of a single species, or the disturbance of a natural community, can have extensive and unpredictable consequences.

- **Scientific knowledge:** To understand how ecosystems work, and how human activities impact them, scientists need to be able to study undisturbed systems and the full array of naturally occurring species.
- **Ethics:** Many people believe that all life has an intrinsic right to exist, and humans have a moral obligation to uphold that right.
- **Aesthetics:** Many people value species and their habitats simply for the opportunity to look at them. For these people, quality of life is diminished by the loss of a favorite species or natural area.

WHY FOCUS BIODIVERSITY PROTECTION ON NATURAL COMMUNITIES?

Since communities by definition are assemblages of multiple species (animal and plant), protecting a community provides protection for many individual species. Therefore, if we protect an adequate number of viable examples of each natural community type, we can protect the majority of New Hampshire's species. This is sometimes referred to as a "coarse-filter" approach to protecting biodiversity.



Because the coarse filter can miss some important species, however, it needs to be augmented with a finer filter. The "fine-filter" approach generally focuses on specific rare species whose habitats have not been included in "coarse-filter" areas. By locating populations of these species, and then protecting the natural community examples where they are found, we can successfully protect the full range of biodiversity.

In addition to the living species in a community, "biological legacies" are important elements of natural systems. Biological legacies are organic materials that accumulate over time, such as seed banks, coarse woody debris, and soil nutrients. Topsoil, the layer of mineral earth that contains a large quantity of organic material from the growth, death, and decomposition of plants, is an example of a biological legacy. These legacies take years to develop, yet can be rapidly lost if natural communities are disturbed or natural processes are interrupted. Successful protection of a natural community will usually protect these important landscape features, which would otherwise take many years to replace.

In many cases, protection of one natural community may require protection of groups of adjacent communities within a larger landscape. With the possible exception of large matrix communities, no community is completely self-sufficient. Processes such as erosion, windfalls, fire frequency, and nutrient accumulation are all strongly affected by what happens in adjacent communities. In addition, animal species typically depend on having access to a combination of communities, usually in close proximity: different natural communities provide critical shelter and food at different times of the year.

Even when intact adjacent communities are not required to protect a particular example of a natural community, overall biodiversity protection is greatly enhanced when protected areas include a variety of adjacent and connected communities. In general, long-term community viability increases with the size of protected areas, and certain wide-ranging animals can be supported that would not occur in smaller areas. Edge effects (such as infiltration by invasive species) are also reduced. The importance of scale to effective biodiversity protection is discussed in more depth in the section of this report titled "Protecting Biodiversity on IP Lands in Northern New Hampshire: Representation and Replication at Multiple Scales."

PROTECTING NEW HAMPSHIRE'S BIODIVERSITY

In 1994, the Northern Forest Lands Council (1994) concluded that "maintaining the region's biodiversity is important in and of itself, but also as a component of stable forest-related economies, forest health, land stewardship, and public understanding." In response to recommendations by the Northern Forest Lands Council, the NH Division of Forests and Lands and the NH Fish and Game Department established the Ecological Reserves System Project. One of the project's primary objectives was to "assess the status of biodiversity in New Hampshire and the extent to which it is protected under the current system of public and private conservation lands" (NH Ecological Reserve System Project 1998a). This question was then explored by a 28-member Scientific Advisory Group, who took the question beyond the northern forest and considered it in a statewide context. The conclusions of the group indicated that there



was a serious need for continued biodiversity conservation in New Hampshire (NH Ecological Reserve System Project 1998b):

Though conservation lands comprise approximately 20% of the land area in New Hampshire, the current system of conservation lands in New Hampshire does not appear to provide comprehensive, long-term protection of biodiversity at the species, natural community, or landscape levels.

NH Heritage strives to facilitate protection of the state's biodiversity through the protection of key areas that support rare species, rare types of natural communities, and high quality examples of common natural community types. Exemplary natural communities are particularly important because we assume that, if we protect an adequate number of viable examples of each natural community type, we can protect the majority of New Hampshire's species. This is sometimes referred to as a "coarse-filter" approach to protecting biodiversity.

The coarse filter can miss important species, however, so it needs to be augmented with a finer filter. The "fine-filter" approach generally focuses on specific rare species. For example, the rare, federally threatened *Isotria medeoloides* (small whorled pogonia) occurs in a variety of second-growth hardwood forests in southern New Hampshire. This orchid's habitat may not be captured by the coarse-filter approach, so we need to employ a fine-filter approach (i.e., survey for the plant itself) to ensure that the species is protected.

Long-term protection of New Hampshire's species, natural communities, and ecological processes requires a variety of conservation approaches. The goal of NH Heritage's coarse- and fine-filter approaches is to inform management decisions by identifying those sites that have a relatively greater potential for maintaining the natural diversity within the state.

The foundation for successful biodiversity protection is a series of representative, high-quality examples of all the state's natural community types, with their constituent species and their underlying ecological processes. The best option for this kind of protection would be a series of connected, high-quality natural community types; this series would ensure that ecological processes that connect natural communities remain functionally intact within a broader landscape context. In short, there is a need for reserve areas with natural communities protected within a diverse landscape, not just in isolation.

NH NATURAL AREAS

The Department of Resources and Economic Development (DRED) places the lands it manages into four principal categories based on general land use: agricultural lands, conservation easements, forestry lands, and recreation lands. Within DRED, the Division of Forests and Lands (NH DFL) actively manages and classifies forestry lands, and occasionally recreation lands, into resource areas according to recognized resource values or dominant natural features. During forest inventory and forest management work when this zoning is established, NH DFL may designate particular sections of a property as belonging to a natural preserve area.

A natural preserve area, or natural area, is defined as an area that "has retained its natural character, although not necessarily completely undisturbed, and/or which contains floral, faunal,



ecological, or geological features of global, national, regional, and/or statewide significance of scientific and/or educational interest” (NH DRED 1996). Beyond this definition, formal specifications have not yet been developed for the establishment of natural preserves on DRED lands. Proposed criteria to govern these designations include the following (NH DRED 1995):

- A. Sites which provide habitat for rare or endangered species;
- B. Sites that contain a rare natural community or high quality representative of a common natural community, or larger landscape units containing important combinations of communities and/or species;
- C. Sites largely undisturbed by humans or largely recovered from human disturbance;
- D. Sites which provide habitat for large numbers or uncommon associations of native plant and animal species; and

Sites with special geological or paleontological significance.





APPENDIX 2. Explanation of Global and State Rank Codes

Ranks describe rarity both throughout a species' range (globally, or "G" rank) and within New Hampshire (statewide, or "S" rank). The rarity of sub-species and varieties is indicated with a taxon ("T") rank. For example, a G5T1 rank shows that the species is globally secure (G5) but the sub-species is critically imperiled (T1).

Code Examples Description

1	G1	S1	Critically imperiled because extreme rarity (generally one to five occurrences) or some factor of its biology makes it particularly vulnerable to extinction.
2	G2	S2	Imperiled because rarity (generally six to 20 occurrences) or other factors demonstrably make it very vulnerable to extinction.
3	G3	S3	Either very rare and local throughout its range (generally 21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction because of other factors.
4	G4	S4	Widespread and apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5	G5	S5	Demonstrably widespread and secure, although the species may be quite rare in parts of its range, particularly at the periphery.
U	GU	SU	Status uncertain, but possibly in peril. More information needed.
H	GH	SH	Known only from historical records, but may be rediscovered. A G5 SH species is widespread throughout its range (G5), but considered historical in New Hampshire (SH).
X	GX	SX	Believed to be extinct. May be rediscovered, but evidence indicates that this is less likely than for historical species. A G5 SX species is widespread throughout its range (G5), but extirpated from New Hampshire (SX).

Modifiers are used as follows.

Code Examples Description

Q	G5Q	GHQ	Questions or problems may exist with the species' or sub-species' taxonomy, so more information is needed.
?	G3?	3?	The rank is uncertain due to insufficient information at the state or global level, so more inventories are needed. When no rank has been proposed the global rank may be "G?" or "G5T?"

When ranks are somewhat uncertain or the species' status appears to fall between two ranks, the ranks may be combined. For example:

G4G5	The species may be globally secure (G5), but appears to be at some risk (G4).
G5T2T3	The species is globally secure (G5), but the sub-species is somewhat imperiled (T2T3).
G4?Q	The species appears to be relatively secure (G4), but more information is needed to confirm this (?). Further, there are questions or problems with the species' taxonomy (Q).
G3G4Q S1S2	The species is globally uncommon (G3G4), and there are questions about its taxonomy (Q). In New Hampshire, the species is very imperiled (S1S2).





APPENDIX 3. Explanation of State Listing Codes

In 1987, the New Hampshire state legislature passed the Native Plant Protection Act (RSA 217-A) and formally recognized that “for human needs and enjoyment, the interests of science, and the economy of the state, native plants throughout this state should be protected and conserved; and . . . their numbers should be maintained and enhanced to insure their perpetuation as viable components of their ecosystems for the benefit of the people of New Hampshire.” To compile a list of the species requiring protection, the NH Natural Heritage Bureau collaborated with knowledgeable botanists and identified the most imperiled taxa as “endangered” and those likely to become endangered as “threatened.” A total of 288 taxa were listed, 144 as endangered and 144 as threatened.

In addition to endangered and threatened categories, a state watch category exists for taxa appearing vulnerable to extirpation where current information does not justify designating them endangered or threatened.

Endangered

Native plants documented as having five or fewer natural occurrences in the state observed within the last 20 years, or plants with more than five occurrences that are, in the judgment of experts, critically imperiled by extirpation due to other important rarity considerations (number of individuals, area of population occupancy, restrictiveness and distribution of species’ geographic range, habitat rarity, population trends, population viability, and degree of protection).

Threatened

Native plants documented as having 6-20 natural occurrences in the state observed within the last 20 years, or plants with more than 20 occurrences that are, in the judgment of experts, imperiled by extirpation due to other important rarity considerations (number of individuals, area of population occupancy, restrictiveness and distribution of species’ geographic range, habitat rarity, population trends, population viability, and degree of protection).

Watch

Native plants documented as having 21-100 natural occurrences in the state observed within the last 20 years, or plants that are, in the judgment of experts, vulnerable to extirpation due to other important rarity considerations (number of individuals, area of population occupancy, restrictiveness and distribution of species’ geographic range, habitat rarity, population trends, population viability, and degree of protection). Native plants whose status is uncertain, but are possibly in peril, may be designated state watch as well.





APPENDIX 4. Element Occurrence Data for NH Heritage Records at Pawtuckaway State Park

Dead Pond

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Poor level fen/bog system	2004-10-21	18	GNR	S3		B

Poor level fen/bog system

General Description

2004: Dead Pond is located on the north side of North Mountain and the Boulder field. The surrounding forests are generally **hemlock - beech - oak - pine forest**. At the west end of the pond is some low-density residential development and an unpaved road, which is unlikely to directly affect the fen system.

Feature Description

2004, 2002: This **poor level fen** occupies the eastern two-thirds of Dead Pond. It is a large floating peat mat that is separated from the uplands by a broad moat. Most of the fen is fairly homogenous, and dominated by *Chamaedaphne calyculata* (leatherleaf), with *Vaccinium macrocarpon* (large cranberry) and *Kalmia angustifolia* (sheep laurel), and underlain by *Sphagnum* spp. Scattered within the **leather-leaf - sheep laurel dwarf shrub bog** are patches of **highbush blueberry - mountain holly wooded fen**, in which the shrubs are slightly taller than the surrounding community, and include *Vaccinium corymbosum* (highbush blueberry) and *Myrica gale* (sweet gale). At the eastern end of the peatland, the conditions are somewhat more minerotrophic, and communities more typical of **medium level fens** are present. The **bog rosemary - sweet gale - sedge fen** is dominated by *Myrica gale* (sweet gale), *Andromeda polifolia* var. *glaucophylla* (bog rosemary) and *Vaccinium macrocarpon* (large cranberry). There is also the **large cranberry - short sedge moss lawn**, which is characterized by low growing species such as *Vaccinium corymbosum* (highbush blueberry), *Carex canescens* (silvery sedge) and *Rhynchospora alba* (white beak-rush). Surrounding the entire peat mat is a **marshy moat** community, which contains such deep water species as *Nuphar variegata* (variegated yellow pondlily) and *Nymphaea odorata* (white waterlily).



Middle Mountain

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Red oak - ironwood - Pennsylvania sedge woodland	2004-07-14	118	GNR	S2		
Rich Appalachian oak rocky woods	2004-07-14	118	GNR	S1		
Rich Appalachian oak rocky woods system	2004-07-14	118	GNR	SNR		
Rich mesic forest	2004-07-29	4	GNR	S3		BC
<u>Rare Plant</u>						
<i>Arabis canadensis</i> (Sickle-pod)	2002-05-15		G5	S2	T	A
<i>Bromus pubescens</i> (Hairy Brome-grass)	2002-09-19		G5	S1	T	BC
<i>Carex retroflexa</i> (Reflexed Sedge)	2002-06-18		G5	SH	T	AB
<i>Paronychia canadensis</i> (Smooth-forked Chickweed)	2002-06-12		G5	S1	T	AB
<i>Ranunculus fascicularis</i> (Early Buttercup)	2002-05-15		G5	S1	E	
<i>Woodsia obtusa</i> (Blunt-lobe Woodsia)	2002-06-18		G5	S2	T	B

Red oak - ironwood - Pennsylvania sedge woodland

General Description

2004, 2003, 2002: The **red oak - ironwood - Pennsylvania sedge woodland** community covers much of the south and east slopes of the Mountain in combination with **rich Appalachian oak rocky woods**. At the bases of the mountain there are relatively small patches of **semi-rich Appalachian oak - sugar maple forest**. These three communities comprise the **rich Appalachian oak rocky woods system** at the site. The bedrock of Middle Mountain (860 ft.) is primarily mafic (gabbro) and intermediate (diorite). Patches of **Appalachian oak - pine rocky ridge** are part of the mosaic, but overall this community is not nearly as extensive as on North and South Mountains. The northwestern slope of the mountain is dominated by **hemlock - beech - oak - pine forest**, with smaller areas of **Appalachian oak - pine rocky ridge** and **red oak - black birch wooded talus**.

Feature Description

2004, 2003, 2002: The soils and corresponding vegetation here have apparently been substantially influenced by mineral inputs from underlying diorite and gabbro bedrock. On average this community occurs on middle and upper slope positions, where as the rich Appalachian oak rocky woods tends to occur on the middle and lower slopes, although the boundary transitions are complex in places, with fingers of the Pennsylvania sedge woodland jutting into the rocky woods below. The dominant trees are *Quercus rubra* (red oak), *Ostrya virginiana* (ironwood) and *Carya ovata* (shagbark hickory). Common associates include *Acer saccharum* (sugar maple), *Pinus strobus* (white pine), *Q. alba* (white oak), *Fraxinus americana* (white ash). *Juniperus virginiana* (eastern red cedar) is occasional. *Carex pensylvanica* (Pennsylvanian sedge) forms a dense matrix in the herb layer (40-75% cover). Other herbs contribute little cover (1% or less), and the diversity of herbs is generally (relatively high in some locations). Other characteristic herbs include *Maianthemum racemosum* (false Solomon's seal), *M. canadense* (Canada mayflower), *Anemone americana* (blunt-lobed hepatica), *Antennaria plantaginifolia* (pussy-toes), *Galium circaeazans* (wild licorice), *G. lanceolatum* (lance-leaved wild licorice), *Polygonatum pubescens* (hairy Solomon's seal), *Deschampsia flexuosa* (common hairgrass), *Solidago caesia* (blue-stemmed goldenrod), *Piptatherum racemosum* (blackseed mountain rice), *Dryopteris marginalis* (marginal wood fern), *Amphicarpaea bracteata* (hog-peanut), and *Carex cephalophora* (headed sedge).



The large number of other rare herbs on the mountain are concentrated in rocky areas more characteristic of the **rich Appalachian oak rocky woods** community or are found in association with small, fractured outcrop exposures embedded within Pennsylvania sedge woodland. One exception may be *Carex retroflexa* (reflexed sedge), which was abundant in sections of this community. Other occasional rare species include *Arabis canadensis* (sickle-pod), *Arabis missouriensis* (Missouri rock-cress), *Ranunculus fascicularis* (early buttercup), *Bromus pubescens* (hairy brome grass), and *Woodsia obtusa* (blunt-lobed woodsia).

Rich Appalachian oak rocky woods

General Description

2004: This community covers much of the south and east slopes of the Mountain in combination with **red oak - ironwood - Pennsylvania sedge woodland**. At the base of the mountain there are relatively small patches of **semi-rich Appalachian oak - sugar maple forest**. These three communities comprise the **rich Appalachian oak rocky woods system** at the site. The bedrock of Middle Mountain (860 ft.) is primarily mafic (gabbro) and intermediate (diorite). Patches of **Appalachian oak - pine rocky ridge** are part of the mosaic, but overall this community is not nearly as extensive as on North and South Mountains. The northwestern slope of the mountain is dominated by **hemlock - beech - oak - pine forest**, with smaller areas of **Appalachian oak - pine rocky ridge**, and **red oak - black birch wooded talus**.

2002: Bordered by several open water wetlands and a dirt road to the southeast, and less rich woods to the north and west.

Feature Description

2004, 2003, 2002: The soils and corresponding vegetation here have apparently been substantially influenced by mineral inputs from underlying diorite and gabbro bedrock. The dominant trees in this community is *Quercus rubra* (red oak), *Ostrya virginiana* (ironwood) and *Carya ovata* (shagbark hickory), and occasional *Quercus alba* (white oak), *Fraxinus americana* (white ash), *Acer saccharum* (sugar maple), and *Pinus strobus* (white pine). There is a large number of rare herb species, particularly in areas with frequent small outcrop exposures, including *Arabis canadensis* (sickle-pod), *Arabis missouriensis* (Missouri rock-cress), *Ranunculus fascicularis* (early buttercup), *Ranunculus fascicularis* (early buttercup), *Bromus pubescens* (hairy brome grass), *Woodsia obtusa* (blunt-lobed woodsia), and *Paronychia canadensis* (smooth-forked chickweed). Other characteristic species include *Deschampsia flexuosa* (common hairgrass), *Aquilegia canadensis* (wild columbine), *Woodsia ilvensis* (rusty woodsia), *Solidago caesia* (blue-stemmed goldenrod), *Campanula rotundifolia* (harebell), *Piptatherum racemosum* (blackseed mountain rice), *Saxifraga virginensis* (early saxifrage), *Carex pensylvanica* (Pennsylvanian sedge), *C. pedunculata* (long-stalked sedge), *C. platyphylla* (flat-leaved sedge), and *Toxicodendron radicans* (climbing poison ivy).

1994: No details.

1988: No details.

1984: A dry, rocky slope dominated by deciduous trees such as shagbark hickory, hop-hornbeam, red oak and sugar maple. Many characteristic species including *Specularia* [*Spergularia?* (sand-spurrey)], *Arabis canadensis* (sickle-pod), *Saxifraga virginensis* (early saxifrage), *Hepatica* [*Anemone*] *americana* (blunt-lobed hepatica), *Carex platyphylla* (flat-leaved sedge), *Carya ovata* (shagbark hickory), and *Desmodium paniculatum* (panicked tick-trefoil). Bedrock is base-rich diorite.

1977: Rocky woods with talus and some ledges. Oak hickory forest. Below the top [of the hill] but above the steeper part there was an open woods mostly of hop hornbeam with a dense undercover of the sedge *Carex pensylvanica*.

Rich Appalachian oak rocky woods system

General Description

2004: This system covers the mountain top and south and east slopes of the mountain. There are patches of



more *Appalachian oak - pine rocky ridge* community, but overall this community is not nearly as extensive as on North and South Mountains. The northwestern slope of the mountain is dominated by hemlock - beech - oak - pine forest, with smaller areas of *Appalachian oak - pine rocky ridge* and *red oak - black birch wooded talus*.

Feature Description

2004, 2003, 2002: The bedrock of Middle Mountain (860 ft.) is primarily mafic and intermediate (gabbro and diorite), and the *rich Appalachian oak rocky woods system* covers all but the north-facing slopes. As on North Mountain, the dominant communities in this system are the *rich Appalachian oak rocky woods* and *red oak - ironwood - Pennsylvania sedge woodland*. This system also includes the *semi-rich Appalachian oak - sugar maple forest* in relatively small patches at the base of the mountain, which is characterized by a mix of oaks, hickories, sugar maple, and white ash, and indicates a moderate degree of soil enrichment.

The two dominant communities occur on the steep, rocky, dry-mesic slopes, with *red oak - ironwood - Pennsylvania sedge woodland* predominating on the middle and upper end of the mountain. Both of these communities have a partially open canopy, and contain an abundance of *Quercus rubra* (red oak), *Ostrya virginiana* (ironwood) and *Carya ovata* (shagbark hickory), and occasional *Quercus alba* (white oak), *Fraxinus americana* (white ash), *Acer saccharum* (sugar maple) and *Pinus strobus* (white pine). The *rich Appalachian oak rocky woods* tends to harbor a greater number of rare herb species, particularly in areas with frequent small outcrop exposures, including *Arabis canadensis* (sickle-pod), *Arabis missouriensis* (Missouri rock-cress), *Ranunculus fascicularis* (early buttercup), *Woodsia obtusa* (blunt-lobed woodsia), and *Paronychia canadensis* (smooth-forked chickweed). The rare *Carex retroflexa* (reflexed sedge) appears to be most abundant in the Pennsylvania sedge community, which is distinguished by dense "lawns" (40-60%) of *Carex pensylvanica* (Pennsylvanian sedge) that give it an open, park-like appearance. It contains some of these rare species as well, but the density of rarities is lower, and herbs other than Pennsylvania sedge are in low abundance.

Rich mesic forest

General Description

2004: The *rich mesic forest* occurred on a steep slope with an orientation of 140 degrees. This community transitions to *rich Appalachian oak rocky woods* and Pennsylvania sedge woodland upslope.

Feature Description

2004: Associates of the dominant *Acer saccharum* (sugar maple) in the canopy were *Fraxinus americana* (white ash) and to a lesser extent *Tilia americana* (basswood). Herbs were *Dryopteris marginalis* (marginal wood fern), *Actaea pachypoda* (white baneberry), *Piptatherum racemosum* (blackseed mountain rice), *Arisaema triphyllum* (Jack-in-the-pulpit), *Adiantum pedatum* (northern maidenhair fern), *Geranium robertianum* (herb Robert), *Athyrium filix-femina* var. *angustum* (northern lady fern), *Carex platyphylla* (flat-leaved sedge), *Impatiens capensis* (spotted touch-me-not), *Circaea lutetiana* (large enchanter's nightshade), *Anemone americana* (blunt-lobed hepatica), *Ranunculus abortivus* (kidney-leaved buttercup), *Carex laxiflora* (loosely-flowered sedge), *Phegopteris hexagonoptera* (broad beech fern), and *Dirca palustris* (leatherwood). The rare plant *Asplenium trichomanes* (maidenhair spleenwort) also occurred here. Sugar maple dbh reached up to 28 inches.

Rare Plants

Arabis canadensis (Sickle-pod)

General Description

2004: All patches found within exemplary *rich Appalachian oak rocky woods*.

1985: *SNE dry forest on calcareous bedrock or till*. Enriched, dry soil.



1969: Moist slope below ledges.
1956: Rocky deciduous woods.

Feature Description

2004: Several scattered patches, generally with 1-2 plants at each point, although one had 5 individuals.
2002: No details.
1985: Same as 1984.
1984: Between 11-50 mature, fruiting plants on over 2 acres of population area.
1969: Locally fairly common. Specimen collected.
1956: Specimen collected.

***Bromus pubescens* (Hairy Brome-grass)**

General Description

2002: Population occurred on the southeast-facing slope near the top of the mountain. Associated herbs were *Carex pensylvanica* (Pennsylvanian sedge), *Solidago caesia* (blue-stemmed goldenrod), *Galium circaezans* (wild licorice), and *Symphotrichum undulatum* (wavy-leaved aster). *Acer saccharum* (sugar maple), *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), and *Ostrya virginiana* (ironwood) were overhead in the canopy.
1958: Rich shaded rocky southern slope.

Feature Description

2002: 50 or more culms were seen. Vigor was normal.
1984: No details.
1958: Specimen collected.

***Carex retroflexa* (Reflexed Sedge)**

General Description

2002: The plants occur within a **rich Appalachian oak rocky woods system**. Characteristic species in the area include *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood) and *Deschampsia flexuosa* (common hairgrass).
1969: Rich, dry woods. West slope.

Feature Description

2002: Estimate of 800-1600 plants based on observation of approximately 5-10 plants in any given 5x5 meter patch (plants denser in several areas). This frequency seemed to hold over the minimum 1 acre population area.
1969: Specimen collected.

***Paronychia canadensis* (Smooth-forked Chickweed)**

General Description

2002: Plants occur within exemplary **rich Appalachian oak rocky woods system**, on colluvial ramps and other microhabitats associated with ledges, particularly (most abundant) in drip zone of ledge. Soils are sandy loam with some organics. Characteristic associated species include *Quercus rubra* (red oak), *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood), *Carex laxiflora* (loosely-flowered sedge), and *Antennaria plantaginifolia* (plantain-leaved pussytoes).



Feature Description

2002: Approximately 1700 plants.

Ranunculus fascicularis (Early Buttercup)

General Description

1983: Rocky slope, grassy with open hickory - hornbeam woods.

1962: Upper slope in mossy ledges, with *Krigia* [*virginica* (dwarf dandelion)] and *Specularia* [*Spergularia?* (sand-spurrey)].

1951: South slope.

1949: Rocky woods.

1948: Mixed hickory - hornbeam woods, growing with sweet-cicely.

Feature Description

2002: Minimum count of 144 plants counted. 1994: Specimen collected. 1993: Specimen collected. 1983: 11-50 plants observed, in flower. 1962, 1951, 1949, 1948: Specimen collected.

Woodsia obtusa (Blunt-lobe Woodsia)

General Description

2002: The primary community in which the *Woodsia* occurs is **rich Appalachian oak rocky woods**, and perhaps some areas of the **red oak - ironwood - Pennsylvania sedge woodland**. It prefers somewhat rocky habitats.

1997: Lots of *Rumex* sp. (sorrel) and *Schizachne* sp. (oat-grass).

1985: SNE acidic rocky summit community. Associated species include *Desmodium paniculatum* (panicled tick-trefoil), *Galium lanceolatum* (lance-leaved wild licorice), and *Asplenium platyneuron* (ebony spleenwort).

Feature Description

2002: A minimum of 50 plants have been counted at eight different observation points. Most of these plants were found below and around the lunch ledge overlook area. There are undoubtedly more plants than this, and conservatively the population probably supports at least 50-100 plants.

1997: At least 50 plants.

1993: Specimen collected.

1992: Observed in clumps.

1985: 11-50 genets, mature fruit, vigorous, spore-dispersing. Specimen collected.

1900: Specimen collected.



Mountain Brook

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Emergent marsh - shrub swamp system	2004-07-29	170	GNR	SNR		NR
Herbaceous seepage marsh	2004-07-29	2	GNR	S3		B

Emergent marsh - shrub swamp system

General Description

2004, 2003: This system follows Mountain Brook from its headwaters to its outlet at Mountain Pond, traveling the entire length through a forested landscape. The headwaters are within the Pawtuckaway ring-dike, on the slopes of North Mountain. The stream eventually passes between South Mountain and the Southwest Arc, and then flows south and east to Mountain Pond. There are numerous beaver impoundments along its course, some of which are quite large.

Feature Description

2004, 2003: This natural community system consists of a series of wetlands associated with Mountain Brook, extending from the upper reaches of the stream near North Mountain to Mountain Pond, just west of the southern portion of Pawtuckaway Lake. This is a complex system which includes many different community types. The hydrology of these wetlands is determined by a combination of seasonal flooding and groundwater seepage. In several places, beavers have impounded the stream, and created or expanded open wetlands. Often, these open wetlands were at one time peatlands, but have since undergone a transformation to this system as a result of the hydrologic alteration. After these impoundments are abandoned by the beavers, they undergo succession through several wetland types, which are all represented to varying degrees in this system.

The composition of the communities changes with depth and duration of flooding. In areas of permanent water, primarily associated with beaver ponds, is the ***aquatic bed***, which is characterized by floating-leaved species such as *Nymphaea odorata* (white waterlily). Where the water is somewhat shallower and the soil may be exposed later in the growing season, ***deep emergent marsh - aquatic bed*** and ***cattail marsh*** are found. These communities are dominated by spongy-leaved plants such as *Typha latifolia* (common cattail), *Peltandra virginica* (arrow arum) and *Sparganium americanum* (lesser bur-reed).

In places where the creation or drainage of a beaver impoundment has caused a change in the hydrology, the ***peaty marsh*** is often present. This community has the layer of *Sphagnum* spp. (peat mosses) that is characteristic of peatlands, but is dominated by graminoid species, such as *Carex utriculata* (bottle-shaped sedge) and *Carex stricta* (tussock sedge). In areas where a beaver pond has recently drained, ***short graminoid - forb emergent marsh/mud flat*** is frequent.

In wetland areas along the undammed stream, there is a gradient of natural communities from wettest to driest, starting with ***deep emergent marsh - aquatic bed*** in the deepest water, transitioning to ***medium-depth emergent marsh*** in shallower conditions. Continuing toward shallower waters, there is the ***tall graminoid emergent marsh***, and finally the ***mixed tall graminoid - scrub-shrub marsh*** at the transition to scrub shrub areas. In the tall graminoid communities, species such as *Calamagrostis canadensis* (bluejoint) and *Carex stricta* (tussock sedge) are common. The latter of these two communities is often a transition to the ***highbush blueberry - winterberry shrub thicket***, both of which are characterized by the shrubs *Vaccinium corymbosum* (highbush blueberry) and *Ilex verticillata* (winterberry). Along the lower reaches of the stream, where there is increased temporary flooding, the ***alder - dogwood - arrowwood alluvial thicket*** is the more abundant shrub community.

In the upper reaches of small tributaries and in narrow bands along the upland edge of some open wetlands is the ***seasonally flooded red maple swamp***, which has *Acer rubrum* (red maple) over an herbaceous layer of typical marsh species.



The only exemplary community component of this system is the *herbaceous seepage marsh*. This community occurs as long, narrow emergent marshes adjacent to the stream, where a thin organic layer covers alluvial silt deposits, which channel seepage flow over the surface. These marshes are dominated by *Carex lacustris* (lake sedge). Other prevalent species include *Carex utriculata* (bottle-shaped sedge) and *Boehmeria cylindrica* (false nettle).

Herbaceous seepage marsh

General Description

2004: This community is a component of the exemplary Mountain Brook *emergent marsh - shrub swamp system*. A wide variety of wetland types occur along this stream, and this community is a very small percentage of the overall system. The surrounding uplands are primarily *hemlock - beech - oak - pine forest*, although there is a significant Appalachian oak influence.

Feature Description

2004: This community consists of herbaceous marshes along Mountain Brook, where groundwater seepage is held near the surface of the wetland by a layer of silt beneath a thin veneer of organic material. Soils consist of roughly 10 cm of mucky material over gray silt. The two occurrences on either side of Reservation Road are roughly 10 m wide by 200-300 m long. The dominant species in both polygons is *Carex lacustris* (lake sedge). On the eastern side of the road, *Carex utriculata* (bottle-shaped sedge) is co-dominant, while *Boehmeria cylindrica* (false nettle) is significant on the western side. Other species that are present include *Calamagrostis canadensis* (blue-joint), *Scutellaria lateriflora* (mad-dog skullcap), *Carex stricta* (tussock sedge), *Triadenum virginicum* (marsh St. John's-wort), and *Impatiens capensis* (spotted touch-me-not). The third occurrence is part of a larger wetland area just east of North Mountain. At this site, *Typha latifolia* (common cattail), and *Impatiens capensis* (spotted touch-me-not) are the dominant species, and *Hydrocotyle americana* (water pennywort) is frequent.



North Mountain

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Appalachian oak - pine rocky ridge	2004-10-21	50	GNR	S3		
Chestnut oak forest/woodland	2002-09-10	7	GNR	S1S2		
Red oak - ironwood - Pennsylvania sedge woodland	2002-09-10	73	GNR	S2		AB
Rich Appalachian oak rocky woods	2002-09-19	73	GNR	S1		
Rich Appalachian oak rocky woods system	2002-09-19	161	GNR	SNR		
Rich mesic forest	2002-06-11	8	GNR	S3		B
Semi-rich Appalachian oak - sugar maple forest	2002-09-19	81	GNR	S2S3		
<u>Rare Plant</u>						
<i>Adlumia fungosa</i> (Climbing Fumitory)	2002-06-03		G4	S1	T	NR
<i>Arabis canadensis</i> (Sickle-pod)	2004-08-24		G5	S2	T	B
<i>Arabis missouriensis</i> (Missouri Rock-cress)	2004-08-24		G5?Q	S1S2	T	B
<i>Bromus pubescens</i> (Hairy Brome-grass)	2002-09-10		G5	S1	T	BC
<i>Carex backii</i> (Rocky Mountain Sedge)	2002-06-04		G4	S1		
<i>Carex hitchcockiana</i> (Hitchcock's Sedge)	2002-06-07		G5	S1		B
<i>Carex retroflexa</i> (Reflexed Sedge)	2002-07-09		G5	SH	T	B
<i>Carex siccata</i> (Hay sedge)	2002-06-03		G5	S1	E	B
<i>Carex sparganioides</i> (Bur Sedge)	2002-07-11		G5	S1	E	
<i>Conopholis americana</i> (Squaw-root)	2004-07-09		G5	S3	T	B
<i>Polygonum tenue</i> (Slender Knotweed)	2002-06-03		G5	SH	E	B
<i>Ranunculus fascicularis</i> (Early Buttercup)	2002-06-03		G5	S1	E	

Appalachian oak - pine rocky ridge

General Description

2004: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle of the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units: the northwestern half consists of intermediate rock, and the ridgetop and southeastern face of mafic rock (diorite and gabbro). These differences in bedrock, in combination with aspect, appear to have a significant impact on the richness of the soils and the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number of rare plant species.

The **Appalachian oak - pine rocky ridge** is the dominant community in the **Appalachian oak rocky ridge system** here. Other associated communities in this system include **dry Appalachian oak - hickory forest** where relatively more forested conditions predominate (65-85% cover); small to moderately sized **lowland acidic cliffs** scattered on the steep slopes; a **Chestnut oak forest/woodland** marked by a concentration of *Quercus prinus* (chestnut oak); and on portions of the ridge on North Mountain, fingers of **red oak - ironwood - Pennsylvania sedge woodland** that creep up from the slopes below. Below on the south and south east slopes of the mountain there is an exemplary **rich Appalachian oak rocky woods system** consisting of four communities: **rich Appalachian oak rocky woods, red oak - ironwood - Pennsylvania sedge woodland, semi-rich**



Appalachian oak - sugar maple forest, and *rich mesic forest*. On the steep north and northwest-facing slopes (comprised of the intermediate monzonite bedrock) and lowlands surrounding the mountain, *hemlock - beech - oak - pine forest*. Some steep north facing slopes have areas of pure *hemlock forest*.

Feature Description

2002: The *Appalachian oak - pine rocky ridge* community is dominated by a mix of various oaks, eastern red cedar, pine and hickory trees. Overall there is a woodland structure with 25-65% tree cover created by numerous rock outcrop and slab openings with lots of heath shrubs, graminoids, and lichens. In contrast to Rocky Ridge, the ridgetop here is mapped as diorite and gabbro. This more mafic influence may explain the greater prominence of plants such as *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood), and *Carex pensylvanica* (Pennsylvanian sedge) on the ridgetop that are absent or less frequent on Rocky Ridge. *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Carya ovata* (shagbark hickory) are abundant; other common associated tree species include *Q. alba* (white oak), *Q. prinus* (chestnut oak), *Juniperus virginiana* (eastern red cedar), *Acer rubrum* (red maple), and *Fraxinus americana* (white ash). The dominant shrubs are *Vaccinium angustifolium* (early low blueberry) and *Gaylussacia baccata* (black huckleberry). Graminoids are the most abundant herbs, and include *Deschampsia flexuosa* (common hair-grass), *Carex lucorum* (distant sedge) and probably *Carex pensylvanica* (Pennsylvanian sedge) in some areas. Forbs are sparse, but those found here that are characteristic of the community include *Corydalis sempervirens* (pale corydalis), *Maianthemum canadense* (Canada mayflower), *Comandra umbellata* (bastard toad-flax), *Melampyrum lineare* (cow-wheat), *Schizachyrium scoparium* var. *scoparium* (little bluestem), *Aralia nudicaulis* (wild sarsaparilla), *Lysimachia quadrifolia* (whorled loosestrife), *Panicum depauperatum* (impoverished panic-grass). One rare plant of xeric ridgetops, *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove), is found at the east end of North Mountain and west end of Rocky Ridge. Lichens are abundant and in many outcrop openings the most dominant life-form.

1983: A dry woodland with about 75% canopy closure due to areas of bedrock (syenite) outcrops. Trees such as *Ostrya virginiana* (ironwood), *Carya ovata* (shagbark hickory), *Quercus alba* (white oak), *Tsuga canadensis* (hemlock), *Fraxinus americana* (white ash), and *Juniperus virginiana* (eastern red cedar) dominant but appear stunted due to dryness. Herb layer includes *Carex pensylvanica* (Pennsylvanian sedge), *Deschampsia* sp. (hair-grass), *Oryzopsis asperifolia* (rough-leaved rice-grass), and some Hepatica.

Chestnut oak forest/woodland

General Description

2002: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle of the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units: the northwestern half consists of intermediate rock, and the southeastern face of mafic rock. These differences in bedrock, in combination with aspect, appear to have a significant impact on the richness of the soils and the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number of rare plant species.

The *chestnut oak forest/woodland* occupies a relatively small portion (7 acres) of the *Appalachian oak rocky ridge system*, which is elsewhere dominated by *Appalachian oak - pine rocky ridge*. Directly below the *chestnut oak forest/woodland* is a cliff and *rich mesic forest* on talus. Elsewhere on the side slopes of North Mountain is an extensive *rich Appalachian oak rocky woods system: rich Appalachian oak rocky woods, red oak - ironwood - Pennsylvania sedge woodland, semi-rich Appalachian oak - sugar maple forest, and rich mesic forest*. On the steep north and northwest-facing slopes (comprised of the intermediate monzonite bedrock) and lowlands surrounding the mountain, *hemlock - beech - oak - pine forest*. Some steep north facing slopes have areas of pure *hemlock forest*.



Feature Description

2002: Centered around a steep outcrop ridge-brow above a cliff and talus slope. Distinguished from the more extensive **Appalachian oak - pine rocky ridge** community by a concentration of *Quercus prinus* (chestnut oak). Otherwise the community is very similar at this site. Chestnut oak is dominant or co-dominant (10-20%) along with *Quercus rubra* (red oak) (5-10%) among open outcrops where tree cover totals only about 30-40% overall. Chestnut oak diminishes in abundance towards the edge of the community and eventually becomes scattered and disappears. *Quercus alba* (white oak), *Pinus strobus* (white pine), and *Juniperus virginiana* (eastern red cedar) are also common here. The dominant understory plants are heath shrubs, graminoids, and abundant lichens, particularly in outcrop openings. Species include *Vaccinium angustifolium* (early low blueberry), *Gaylussacia baccata* (black huckleberry), *Deschampsia flexuosa* (common hair-grass), *Carex lucorum* (distant sedge) *Corydalis sempervirens* (pale corydalis), *Maianthemum canadense* (Canada mayflower), *Comandra umbellata* (bastard toad-flax), *Melampyrum lineare* (cow-wheat), *Aralia nudicaulis* (wild sarsaparilla), and *Lysimachia quadrifolia* (whorled loosestrife). Lichens are abundant and in many outcrop openings are the most dominant life-form.

Many of the trees are stunted and old, particularly those on the steep outcrop, cliff edge, and on a bench between the cliff and ridgetop. One chestnut oak measured 30 inches DBH. Ages of trees here exceed 160 years. Four cores were taken with the following ring counts (minimum ages): ca. 24 inch red oak, 160 years; 16 inch white oak, 142 years; 12 inch white oak, ca. 103 years; 24 inch chestnut oak, 107 years in the outer 4 inches (rotten center).

Red oak - ironwood - Pennsylvania sedge woodland

General Description

2002: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle formed by the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units, with the northwestern half consisting of intermediate rock, and the southeastern face of mafic rock. These differences in bedrock in combination with aspect appear to have a significant impact on the richness of the soils, and are reflected in the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number of rare plant species.

The **red oak - ironwood - Pennsylvania sedge woodland** community is one of four communities that make up the **Appalachian oak rocky ridge system** on the south and southeast-facing slopes of the mountain. It intermixes with the **rich Appalachian oak rocky woods** community on the steep side slopes, and is found above the **semi-rich Appalachian oak - sugar maple forest** and **rich mesic forest** communities, which occur in ravines and along the slope-base of the mountain. The sedge woodland community extends higher on the mountain to upper slope and ridgetop positions in places, but generally these positions are dominated by the **Appalachian oak rocky ridge system**. The two dominant communities here are **Appalachian oak - pine rocky ridge** and **chestnut oak forest/woodland**. The northwest-facing slopes on the opposite side of the mountain is comprised of the intermediate monzonite bedrock, and support **hemlock - beech - oak - pine forest**, which is typical of the most of the surrounding lowlands, and **hemlock forest** as well.

Feature Description

2002: The **red oak - ironwood - Pennsylvania sedge woodland** and **rich Appalachian oak rocky woods** communities are apparently influenced by mineral inputs from underlying diorite and gabbro bedrock. The steep, rocky soils here are on average dry-mesic. The Pennsylvania sedge woodland community is marked by dense "lawns" of *Carex pensylvanica* (Pennsylvanian sedge) that give it an open, park-like appearance. It tends to be less rocky and occurs on average it occurs on higher slope positions than the **rich Appalachian oak rocky woods** (primarily middle to upper slopes and occasionally ridgetop). Ridgetop locations of this community appear to be more xeric and acidic and may consist mostly or entirely of *Carex lucorum* (distant sedge), which is outwardly similar to Pennsylvania sedge but more typical of sterile, dry sites.

Small fractured outcrops tend to be concentration zones for rare species; less-fractured, massive outcrops from



higher on the rocky ridge sometimes extend finger-like down into the Pennsylvania sedge woodland and rich rocky woods communities.

The overstory contains *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Acer saccharum* (sugar maple), *Quercus alba* (white oak), *Fraxinus americana* (white ash), and *Ostrya virginiana* (ironwood). Remnant *Juniperus virginiana* (eastern red cedar) are occasional in the subcanopy, a legacy of the pasture history of the mountain in the 19th century. Shrubs are generally sparse to absent but include occasional *Viburnum acerifolium* (maple-leaved viburnum), *Acer pensylvanicum* (striped maple), and *Toxicodendron radicans* (climbing poison ivy) in some locations. The herb layer is dominated by Pennsylvania sedge and has a fairly diverse but generally has relatively low cover of other herbs. It harbors some of the rare species with southern affinities that occur in adjacent areas of rich Appalachian oak rocky woods or embedded outcrops, but generally in lower densities. These include *Carex retroflexa* (reflexed sedge), *Carex siccata* (hay sedge), *Ranunculus fascicularis* (early buttercup), *Woodsia obtusa* (blunt-lobed woodsia). This community appears to be the primary habitat for reflexed and hay sedge, each known from only two other sites in the state. Other characteristic species include *Hepatica acutiloba* (sharp-lobed hepatica), *Carex platyphylla* (flat-leaved sedge), *Carex pedunculata* (long-stalked sedge), *Anemone quinquefolia* (wood anemone), *Solidago caesia* (blue-stemmed goldenrod), *Oryzopsis racemosa* (blackseed rice-grass), *Parthenocissus quinquefolia* (Virginia creeper), and *Carex radiata* (stellate sedge).

Rich Appalachian oak rocky woods

General Description

2002: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle formed by the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units, with the northwestern half consisting of intermediate rock, and the southeastern face of mafic rock. These differences in bedrock in combination with aspect appear to have a significant impact on the richness of the soils, and are reflected in the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number of rare plant species.

The **rich Appalachian oak rocky woods** community is one of four communities that make up the **Appalachian oak rocky ridge system** on the south and southeast-facing slopes of the mountain. It intermixes with the **red oak - ironwood - Pennsylvania sedge woodland** community on the steep side slopes, and is found above the **semi-rich Appalachian oak - sugar maple forest** and **rich mesic forest** communities, which occur in ravines and along the slope-base of the mountain. The sedge woodland community extends higher on the mountain to convex ridgetop positions in places. The convex ridgetop and upper slopes are mostly dominated by **Appalachian oak rocky ridge system**. The two dominant communities here are **Appalachian oak - pine rocky ridge** and **chestnut oak forest/woodland**. The northwest-facing slopes on the opposite side of the mountain is comprised of the intermediate monzonite bedrock, and support **hemlock - beech - oak - pine forest**, which is typical of the most of the surrounding lowlands, and **hemlock forest** as well.

Feature Description

2002: The **rich Appalachian oak rocky woods** community is apparently much influenced by mineral inputs from underlying diorite and gabbro bedrock. The steep, rocky soils are on average dry-mesic, with embedded dry and mesic micro-habitats. The substrate is variable but generally rocky, ranging from talus to scattered, loose stone, to relatively smooth slopes with scattered to abundant bedrock outcrops. The small fractured outcrops tend to be concentration zones for rare species; less-fractured, massive outcrops from higher on the rocky ridge sometimes extend finger-like down into the rich rocky woods.

The overstory of the rich rocky woods contains *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Acer saccharum* (sugar maple), *Quercus alba* (white oak), *Fraxinus americana* (white ash) and *Ostrya virginiana* (ironwood). Conifers are uncommon to rare. Shrubs are generally sparse, but may include *Cornus alternifolia* (alternate-leaved dogwood), *Viburnum acerifolium* (maple-leaved viburnum), and *Cornus rugosa* (round-leaved dogwood). The herb layer is very diverse and harbors a great number of rare species with southern affinities,



particularly in areas with frequent small outcrop exposures or steep ravines (which may correspond to dike intrusions). Rare plants characteristic of this community found on the mountain include *Arabis canadensis* (sickle-pod), *Arabis missouriensis* (Missouri rock-cress), *Ranunculus fascicularis* (early buttercup), *Carex backii* (Back's sedge), *Carex retroflexa* (reflexed sedge), *Polygonum tenue* (slender knotweed), *Woodsia obtusa* (blunt-lobed woodsia), and *Asplenium trichomanes* (maidenhair spleenwort). Other characteristic species include *Carex pensylvanica* (Pennsylvanian sedge), *Carex platyphylla* (flat-leaved sedge), *Carex pedunculata* (long-stalked sedge), *Anemone quinquefolia* (wood anemone), *Solidago caesia* (blue-stemmed goldenrod), *Cystopteris tenuis* (Mackay's brittle fern), *Woodsia ilvensis* (rusty woodsia), *Campanula rotundifolia* (harebell), *Triodanis perfoliata* (Venus's looking-glass), *Oryzopsis racemosa* (blackseed rice-grass), *Dryopteris marginalis* (marginal wood fern), *Parthenocissus quinquefolia* (Virginia creeper), and *Carex radiata* (stellate sedge). The rocky woods community transitions to **red oak - ironwood - Pennsylvania sedge woodland** on generally less rocky and higher slope positions, and is marked by a shift to dense "lawns" of *Carex pensylvanica* (Pennsylvanian sedge) that give it an open, park-like appearance. This sedge woodland community contains some of these rare species as well, particularly reflexed sedge, but generally the density of rarities is lower.

Rich Appalachian oak rocky woods system

General Description

2002: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle formed by the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units, with the northwestern half consisting of intermediate rock, and the southeastern face of mafic rock. These differences in bedrock in combination with aspect appear to have a significant impact on the richness of the soils, and are reflected in the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number of rare plant species.

On the convex ridge top above the **rich Appalachian oak rocky woods system** is an **Appalachian oak rocky ridge system**. The two dominant communities here are **Appalachian oak - pine rocky ridge** and **chestnut oak forest/woodland**. The northwest-facing slopes are comprised of the intermediate monzonite bedrock, and support **hemlock - beech - oak - pine forest**, which is typical of the surrounding lowlands as well. There are also areas of pure **hemlock forest**, which occur on steep north-facing slopes.

Feature Description

2004: The **rich Appalachian oak rocky woods system** occurs on the south and southeast-facing slopes below the **Appalachian oak rocky ridge system**. The soils and corresponding vegetation here have apparently been greatly influenced mineral inputs from underlying diorite and gabbro bedrock. The four natural communities on these slopes occur in different topographic positions. On the dry to dry-mesic middle and upper slopes, there is a mosaic of two natural community types: **rich Appalachian oak rocky woods** and **red oak - ironwood - Pennsylvania sedge woodland**. Both of these communities have a partially open canopy, characterized by *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Quercus alba* (white oak), *Fraxinus americana* (white ash) and *Ostrya virginiana* (ironwood). The former community tends to harbor a greater number of rare herb species, particularly in areas with frequent small outcrop exposures, including *Arabis canadensis* (sickle-pod), *Arabis missouriensis* (Missouri rock-cress), *Ranunculus fascicularis* (early buttercup), *Carex backii* (Back's sedge), *Carex retroflexa* (reflexed sedge), *Polygonum tenue* (slender knotweed), *Woodsia obtusa* (blunt-lobed woodsia), and *Asplenium trichomanes* (maidenhair spleenwort). The latter community is distinguished by dense "lawns" of *Carex pensylvanica* (Pennsylvanian sedge) that give it an open, park-like appearance. It contains some of these rare species as well, but the density of rarities is lower.

Below these rocky, drier hillsides, where the enriched soils at the base of the slope hold more moisture, there is an extensive **semi-rich Appalachian oak - sugar maple forest**. Small pockets of **rich mesic forest** are embedded within the semi-rich forest in certain slope-base positions and deep ravine entrenchments. The semi-rich forest has a diverse tree canopy, including *Acer saccharum* (sugar maple), *Carya ovata* (shagbark hickory), *Quercus rubra* (red oak), *Tilia americana* (basswood), and *Fraxinus americana* (white ash), among others.



There is a fairly diverse array of herbaceous plants. Species indicative of the semi-rich conditions include *Polystichum acrostichoides* (Christmas fern), *Actaea rubra* (red baneberry), and *Tiarella cordifolia* (foamflower). In contrast, the **rich mesic forest** areas have few or no oaks and hickories in the canopy and rich-site herbaceous indicator plants that are absent in the semi-rich forests, such as *Adiantum pedatum* (northern maidenhair fern). Particularly noteworthy is the discovery of *Carex hitchcockiana* (Hitchcock's sedge) in the **rich mesic forest** in 2002, marking the first recorded occurrence of this species in New Hampshire.

Rich mesic forest

General Description

2002: Area 1: This stand of **rich mesic forest** occurred in the talus at the base of a steep slope. This community graded into **semi-rich Appalachian oak - sugar maple forest** at either end across slope, **semi-rich Appalachian oak - sugar maple forest** and **hemlock - beech - oak - pine forest** downslope, and **lowland acidic cliff** and **red oak - black birch wooded talus** upslope. Area 2: This narrow stand is found along a small drainage and intermixes with **semi-rich Appalachian oak - sugar maple forest** within the polygon. A small circumneutral **cliff seep** occurred a short distance upslope on the west side of the drainage. A woodland dominated by *Fraxinus americana* (white ash), *Quercus rubra* (red oak), and *Carya ovata* (shagbark hickory) occurred upslope to the east.

1983: An exemplary **Appalachian oak - pine rocky ridge** occurs on the ridge above.

Feature Description

2002: Area 1: Associates of the dominant *Acer saccharum* (sugar maple) in the canopy were *Fraxinus americana* (white ash) and *Betula lenta* (black birch). Frequent herbs were *Polygonum cilinode* (fringed bindweed), *Impatiens capensis* (spotted touch-me-not), *Dryopteris marginalis* (marginal wood fern), and many others including several that are diagnostic of rich site conditions. Rare species that occurred in this stand of **rich mesic forest** were *Carex sparganioides* (bur sedge), *Carex hitchcockiana* (Hitchcock's sedge), and *Phegopteris hexagonoptera* (broad beech fern). This talus woodland/forest contained some large boulders, several sizable blowdowns, and many large, aging sugar maple.

Area 2: *Acer saccharum* (sugar maple) dominated the canopy in this area. Associates were *Fagus grandifolia* (American beech), *Tsuga canadensis* (hemlock), and *Fraxinus americana* (white ash). Sugar maple regeneration in the understory was high. Other frequent woody species in the understory were American beech, *Acer pensylvanicum* (striped maple), and *Betula lenta* (black birch). The most frequent herbs were *Polystichum acrostichoides* (Christmas fern), *Maianthemum racemosum* (false Solomon's seal), *Dryopteris marginalis* (marginal wood fern), *Symphyotrichum cordifolium* (heart-leaved aster), *Aralia nudicaulis* (wild sarsaparilla), and *Carex pedunculata* (long-stalked sedge).

1983: Dominant species include: *Acer saccharum* (sugar maple), (to 27" DBH), *Quercus rubra* (red oak), *Fagus grandifolia* (American beech), and *Carya ovata* (shagbark hickory). Characteristic species include *Tilia americana* (basswood), *Cornus florida* (flowering dogwood). Herbaceous species include: *Hepatica americana* (blunt-lobed hepatica), *Hystrix patula* [*Elymus hystrix*] (bottlebrush grass), *Oryzopsis racemosa* (blackseed rice-grass), *Geranium robertianum* (herb Robert), and *Ranunculus abortivus* (kidney-leaved buttercup).

Semi-rich Appalachian oak - sugar maple forest

General Description

2002: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle formed by the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units, with the northwestern half consisting of intermediate monzonite rock, and the southeastern face of mafic gabbro and intermediate diorite rock. These differences in bedrock in combination with aspect appear to have a significant impact on the richness of the soils, and are reflected in the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number



of rare plant species.

The semi-rich forest is part of and occurs along the lower slope portions of the **rich Appalachian oak rocky woods system** that dominates the southeast side of the mountain. It transitions to **rich Appalachian oak rocky woods** community higher on the slope, to **rich mesic forest** in some adjacent ravine entrenchments and colluvial slope-bases, and to **hemlock - beech - oak - pine forest** in the surrounding lowlands. The ridgetop above is dominated by an *Appalachian oak rocky ridge system*. Small pockets of **rich mesic forest** are embedded within the semi-rich forest differ by having few or no oaks, hickories, and ironwood, but do contain at least a few rich-site and wet-mesic site herbaceous indicator plants that are absent in the semi-rich forests (i.e., *Adiantum pedatum* (northern maidenhair fern), *Circaea alpina* (small enchanter's nightshade), and *Impatiens capensis* (spotted touch-me-not). One of the embedded rich mesic forest patches has *Carex hitchcockiana* (Hitchcock's sedge), a species new to NH in 2002.

Feature Description

2002: The **semi-rich Appalachian oak - sugar maple forest** occupies slope-base and entrenched colluvial positions that are somewhat more moist than the dry-mesic rocky slopes above. The forest has a diverse tree canopy, including *Acer saccharum* (sugar maple), *Carya ovata* (shagbark hickory), *Quercus rubra* (red oak), *Tilia americana* (basswood), *Fagus grandifolia* (American beech), *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood), and *Betula lenta* (black birch), among others. There is also a fairly diverse array of herbaceous plants. Species indicative of the semi-rich conditions include *Polystichum acrostichoides* (Christmas fern), *Actaea rubra* (red baneberry), and *Tiarella cordifolia* (foamflower), *Dirca palustris* (leatherwood), *Carex platyphylla* (flat-leaved sedge), and *C. pedunculata* (long-stalked sedge). The rare *Carex sparganioides* (bur sedge) occurs in this forest near and around an old foundation next to the woods road that was once part of the Chase family farm. It also occurs at the base of the steep slope of North Mountain.

Rare Plants

Adlumia fungosa (Climbing Fumitory)

General Description

2002: **Semi-rich mesic forest**. Opening in the woodland on an outcrop ridge between the talus ravine and small cliff to west and an oak - hickory woodland to the east on thin soils just below and on ridge crest. Associated species include *Fraxinus americana* (white ash), *Acer saccharum* (sugar maple), *Polygonum cilinode* (fringed bindweed), *Ranunculus abortivus* (kidney-leaved buttercup), *Smilacina racemosa* (false Solomon's seal), *Polygonatum pubescens* (hairy Solomon's seal), and *Dryopteris marginalis* (marginal wood fern).

Feature Description

2002: 14 mature genets observed, normal vigor, in 2 small patches (5/24).

Arabis canadensis (Sickle-pod)

General Description

2004: All of the points occur in dry-rich conditions, within an exemplary **rich red oak rocky woods system**. This system occurs along much of the east-facing slope of North Mountain.

Feature Description

2004: Plants in fruit were observed Areas 2-4. Each point had 3-5 plants.

2002: 16 individual plants observed at Area 1.



Arabis missouriensis (Missouri Rock-cress)

General Description

2004: The subpopulations occur in southeast-facing **rich Appalachian oak rocky woods**. Associated species are *Solidago caesia* (blue-stemmed goldenrod), *Deschampsia flexuosa* (common hairgrass), *Polygonatum pubescens* (hairy Solomon's seal), *Dryopteris marginalis* (marginal wood fern), *Asplenium platyneuron* (ebony spleenwort), *Galium lanceolatum* (lance-leaved wild licorice), *Carex pensylvanica* (Pennsylvanian sedge), *Corydalis sempervirens* (pale corydalis), *Adlumia fungosa* (climbing fumitory), *Carex siccata* (hay sedge), *Anemone americana* (blunt-lobed hepatica), *Carex pensylvanica* (Pennsylvanian sedge), *Poa compressa* (Canada bluegrass), *Acer saccharum* (sugar maple), and other tree species.

Feature Description

2004: 5 plants (Area 4) and 2 plants, 12+ stems on one (Area 5).

2002: Several scattered subpopulations form a somewhat small-sized population in the rich woods on the southeast facing slopes of North Mtn. Flowering or fruiting individuals total at least 27; 20 first-year plants were seen as well. Vigor and reproduction was normal.

Bromus pubescens (Hairy Brome-grass)

General Description

2002: Both subpopulations occurred in **rich Appalachian oak rocky woods**. Area 1: Dry, rich, south-facing slopes at the southern end of North Mtn. Area 2: Southeast-facing slopes near the northern end of North Mtn.

Feature Description

2002: Area 1: Two groups of plants in this subpopulation were separated by approximately 75 meters. Dozens of stems were observed. Vigor was normal. Associates included *Arabis canadensis* (sickle-pod), *Carex rosea* (star sedge), and many others.

Area 2: Associates for this subpopulation included *Carex retroflexa* (reflexed sedge), *Triodanis perfoliata* (Venus's looking-glass), *Desmodium glutinosum* (cluster-leaved tick trefoil), *Elymus hystrix* (bottlebrush grass), and many other species.

Carex backii (Rocky Mountain Sedge)

General Description

2002: The population occurred on an outcrop opening in the **rich Appalachian oak rocky woods**. Associated species were *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Acer saccharum* (sugar maple), *Carex platyphylla* (flat-leaved sedge), *Dryopteris marginalis* (marginal wood fern), *Polygonatum pubescens* (hairy Solomon's seal), *Solidago caesia* (blue-stemmed goldenrod), and *Parthenocissus quinquefolia* (Virginia creeper).

Feature Description

2002: Population had nine genets of normal vigor, with one genet in leaf and the remaining eight with immature fruit. The population occurred in a 5 x 5 meter area with the sedge occupying 1% of the area. All the plants were growing on the same outcrop, either on thin soil or out of cracks. Each plant was moderately to densely tufted and subtended by last year's dead leaves.



Carex hitchcockiana (Hitchcock's Sedge)

General Description

2002: The population occurred in a **rich mesic forest**. Associated species were *Acer saccharum* (sugar maple), *Polystichum acrostichoides* (Christmas fern), *Actaea pachypoda* (white baneberry), *Arisaema triphyllum* (Jack-in-the-pulpit), and many others including several that are diagnostic of rich site conditions. Other rare species that occurred in the **rich mesic forest** were *Carex hitchcockiana* (Hitchcock's sedge), and *Phegopteris hexagonoptera* (broad beech fern).

Feature Description

2002: Approximately 312 plants of normal vigor were counted in a 100-meter long stretch at the slope base. Where tree seedling and sapling density was high there were only a few plants, none of which fruited. Fruiting was normal for the rest of the population.

Carex retroflexa (Reflexed Sedge)

General Description

2002: The population occurs in a pocket of **rich Appalachian oak rocky woods**. Associated species are *Arabis* spp., *Polygonatum pubescens* (hairy Solomon's seal), *Anemone americana* (blunt-lobed hepatica), *Carex pensylvanica* (Pennsylvanian sedge), *Poa compressa* (Canada bluegrass), *Brachyelytrum septentrionale* (northern short husk grass), *Aralia nudicaulis* (wild sarsaparilla), *Aquilegia canadensis* (wild columbine), *Clinopodium vulgare* (wild basil), *Bromus pubescens* (hairy brome grass), and *Acer saccharum* (sugar maple).

Feature Description

2002: A moderately-sized population in rich woods. Vigor and reproduction was normal.

Carex siccata (Hay sedge)

General Description

2002: The population occurs in a pocket of **rich Appalachian oak rocky woods**. Associated species are *Arabis missouriensis* (Missouri rock cress), *Deschampsia flexuosa* (common hairgrass), *Polygonatum pubescens* (hairy Solomon's seal), *Anemone americana* (blunt-lobed hepatica), *Carex pensylvanica* (Pennsylvanian sedge), *Poa compressa* (Canada bluegrass), *Rosa carolina* (pasture rose), and *Acer saccharum* (sugar maple).

Feature Description

2002: Population locally abundant; probably 50+ flowering/fruited culms. Vigor and reproduction was normal.

Carex sparganioides (Bur Sedge)

General Description

2002: Subpopulation 1: Occurred in a roadside clearing and extends northward in a 50 x 100' swath into young woods adjacent to two old house foundations. Dominant associates were *Osmunda claytoniana* (interrupted fern) and *Athyrium filix-femina* var. *angustum* (northern lady fern). Subpopulation 2: In a **rich mesic forest**. Associated species were *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Betula lenta* (black birch), *Polygonum cilinode* (fringed bindweed), *Impatiens capensis* (spotted touch-me-not), *Dryopteris marginalis* (marginal wood fern), and many others including several that are diagnostic of rich site conditions. Other rare species that occurred in the **rich mesic forest** were *Carex hitchcockiana* (Hitchcock's sedge), and *Phegopteris hexagonoptera* (broad beech fern).



Feature Description

2002: Subpopulation 1: 28 ramets/12 genets. Vigor was normal. Subpopulation 2: A few plants occurred in a small area in the **rich mesic forest**. Vigor was normal.

Conopholis americana (Squaw-root)

General Description

2002: Area 1: Semi-**rich mesic forest**. Associated species were *Acer saccharum* (sugar maple), *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Ostrya virginiana* (ironwood), *Viburnum acerifolium* (maple-leaved viburnum), *Parthenocissus quinquefolia* (Virginia creeper), *Dryopteris marginalis* (marginal wood fern), *Polystichum acrostichoides* (Christmas fern), *Uvularia sessilifolia* (sessile-leaved bellwort), *Aralia nudicaulis* (wild sarsaparilla), *Smilacina racemosa* (false Solomon's seal), *Solidago caesia* (blue-stemmed goldenrod), *Anemone americana* (blunt-lobed hepatica), *Galium lanceolatum* (lance-leaved wild licorice), *Carex* spp. (sedges), and others. The aspect of the 25-degree slope was southeast. Area 2: Base of steeper slope. Area 3: Narrow drainage gully.

1983: Area 5: in leaf litter of sugar maple. On a rather level area.

Feature Description

2004: Area 4: Approximately 40 stems in 9 clumps.

2002: Area 1: Ten genets with 49 immature stems occurred in a 5 x 25 meter area. The stems were pushing up through moderately thick leaf litter and were half or less exposed. Vigor was normal. At least five clumps from the year before were without new stems. Area 2: 1 small patch. Area 3: Observed.

1983: Area 5: about 8 dried stalks from previous year observed.

Polygonum tenue (Slender Knotweed)

General Description

2002: On an outcrop opening in **rich Appalachian oak rocky woods**. Associated species on the outcrop opening included *Silene* spp., *Danthonia* spp., *Cardamine parviflora* (dry-land bitter-cress), *Geranium* spp., *Carex pensylvanica* (Pennsylvanian sedge), *Krigia virginica* (dwarf dandelion), *Solidago caesia* (blue-stemmed goldenrod), *Saxifraga virginensis* (early saxifrage), and *Polygonatum pubescens* (hairy Solomon's seal).

1958: In thin soil over ledges with *Carex foenea* (bronzy sedge), *Hedeoma*, *Geranium bicknellii* (northern geranium), and *Specularia*.

Feature Description

2002: Approximately 100 seedlings were growing with normal vigor in a small area of an outcrop.

1958: Specimen collected.

Ranunculus fascicularis (Early Buttercup)

General Description

2002: Area 1: With *Arabis* sp., and *Asplenium trichomanes* (maidenhair spleenwort). Area 2: 3-8% mid-slope, partial light. Associated species include *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Saxifraga virginensis* (early saxifrage), *Poa compressa* (Canada bluegrass), *Carex pensylvanica* (Pennsylvanian sedge), *Solidago caesia* (blue-stemmed goldenrod), and *Polygonatum pubescens* (hairy Solomon's seal). Area 3: **Rich Appalachian oak rocky woods**; outcrop opening with *Polygonum tenue* (slender knotweed) and *Woodsia obtusa* (blunt-lobed woodsia) nearby. Area 4: **Rich Appalachian oak rocky woods**.



Feature Description

2002: Observed at 4 stations. Area 1: 8 plants counted. Area 2: 50 plants. Area 3: 80 plants, a quarter to a third fruiting. Area 4: Observed.

North Mountain / Rocky Ridge

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Appalachian oak rocky ridge system	2004-10-21	95	GNR	SNR		
<u>Rare Plant</u>						
<i>Aureolaria pedicularia</i> var. <i>intercedens</i> (Fern-leaved Foxglove)	2002-09-19		G5T4T5	S1	E	AB

Appalachian oak rocky ridge system

General Description

2004, 2002: North Mountain comprises the northwestern quarter of a ring dike that forms the nearly continuous circle of the Pawtuckaway Mountains. Geologically, it consists of two major lithologic units: the northwestern half consists of intermediate rock, and the southeastern face of mafic rock. These differences in bedrock, in combination with aspect, appear to have a significant impact on the richness of the soils and the vegetation of the site. Ecologically, North Mountain has the greatest variety of communities and habitats of any site in the park, and is also home to a great number of rare plant species.

On the south and south east slopes of the mountain below the rocky ridge system there is an exemplary *rich Appalachian oak rocky woods system* consisting of four communities: *rich Appalachian oak rocky woods*, *red oak - ironwood - Pennsylvania sedge woodland*, *semi-rich Appalachian oak - sugar maple forest*, and *rich mesic forest*. *Appalachian oak - pine rocky ridge* and *Chestnut oak forest/woodland*. On the steep north and northwest-facing slopes comprised of the intermediate monzonite bedrock, there is much *hemlock - beech - oak - pine forest*, which is typical of the surrounding lowlands, and areas of pure *hemlock forest*.

Feature Description

2004, 2002: The most extensive community on the ridge and upper slopes of North Mountain is *Appalachian oak - pine rocky ridge*, with a mix of various oaks, eastern red cedar, pine and hickory trees (generally 25-65% tree cover) and lots of heath shrubs, graminoids, lichens, and rock outcrops. In some areas the woodland structure transitions to relatively more forested conditions (65-85% cover) classified as *dry Appalachian oak - hickory forest*. Small to moderately sized cliffs are scattered on the steep slopes. One portion of the ridge-brow supports a *Chestnut oak forest/woodland* marked by a concentration of *Quercus prinus* (chestnut oak). The *red oak - ironwood - Pennsylvania sedge woodland* community is most abundant in and diagnostic of the *rich rocky woods system* further downslope, but occasional patches occur on the ridge top as well. This contrasts with Rocky Ridge, which appears to be more acidic and lacks the Pennsylvania sedge community. The lawn forming sedges on these more xeric ridgetops may actually be formed of *Carex lucorum* (distant sedge), which is more typical of acidic sites than *Carex pensylvanica* (Pennsylvanian sedge). The ridgetop patches tend not to have the rich-site rare plants found on the sideslopes. However, one rare plant of xeric ridgetops, *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove), does occur at the east end of North Mountain and west end of Rocky Ridge.



Rare Plants

Aureolaria pedicularia var. *intercedens* (Fern-leaved Foxglove)

General Description

2002: On both North Mountain and Rocky Ridge, this plant occurs in the *Appalachian oak - pine rocky ridge* community. Associated species include *Quercus ilicifolia* (scrub oak), *Quercus rubra* (red oak), *Carex* cf. *lucorum* (distant sedge), *Deschampsia flexuosa* (common hairgrass), *Juniperus communis* var. *depressa* (ground juniper), and *Pinus strobus* (white pine).

Feature Description

2002: On North Mountain, 119 stems were counted in about 5 patches within 100 m of each other. Scattered clusters of stems along this section of ridge, on brows of open ledges, and on steep woodland ramp between outcrops. On Rocky Ridge, 12 dry and brittle prior year plants observed, 1 in bud. 6 flowering plants. About 220 new rosettes.



Pawtuckaway Boulder Field

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Hemlock - white pine forest	2005-06-21	35	GNR	S4		B
Lowland acidic cliff	2002-07-11	5	GNR	S4		B
Red oak - black birch wooded talus	2002-07-11	5	GNR	S3S4		

Hemlock - white pine forest

General Description

2005: The boulder field is a result of glacial movement plucking boulders from the slopes of North Mountain and depositing them in the ravine between North Mountain and Rocky Ridge. At the upper end of the ravine is Dead Pond and Devil's Den. At the lower end is a large open wetland.

Feature Description

2005: This is a mature ***hemlock - white pine forest*** that occupies the Pawtuckaway Boulder Field, which is known for its concentration of extraordinarily large boulders. The community is characterized by mature *Tsuga canadensis* (hemlock) and *Pinus strobus* (white pine), with a variety of scattered hardwoods, especially *Quercus rubra* (red oak), although *Betula alleghaniensis* (yellow birch), *Fraxinus americana* (white ash), and *Acer rubrum* (red maple) were also present in the canopy. Understory species were sparse, with many of the herbs restricted to moist areas on a transition zone to seepy wetlands. *Polypodium virginianum* (rock polypody) was frequent on the boulders, while *Aster divaricatus* (white wood aster), *Clintonia borealis* (blue-bead lily) and *Dryopteris marginalis* (marginal wood fern) were scattered in the herb layer. During field surveys, 2 hemlocks were cored, and one was aged based on a cross-section from a fallen tree. All three were around 150 years old. Two white pines were also cored, and preliminary ring counts indicated ages of 160 and 190 years. It is likely that the presence of the boulders kept this area from being pastured, and allowed for the development of this mature forest community.

Lowland acidic cliff

General Description

2002: The cliffs of Devils Den loom as much as 100 feet high above a ***red oak - black birch wooded talus*** community. The community at the top is ***Appalachian oak - pine rocky ridge***. The cliffs are mapped as diorite and gabbro. On nearby Rocky Ridge, several sets of monzonite cliffs are embedded within ***hemlock - white pine*** and ***hemlock - beech - oak - pine forests*** on the middle and lower slopes, and monzonite or diorite cliffs within ***Appalachian oak - pine rocky ridge*** on the upper slopes. These are probably the biggest and most extensive set of cliffs in southern NH, although most are less than 40 feet high.

Feature Description

2002: All of these cliffs in this part of Pawtuckaway are solid, massive, generally dry, and not finely fractured. Major fractures and cracks are evident, but crumbly, highly fractured rock is not characteristic. The sparse vegetation that clings to cracks is indicative of acidic conditions. Plants include some common species of the surrounding forests and cliff-tolerant plants such as *Cystopteris fragilis* (fragile fern) and/or *Cystopteris tenuis* (Mackay's brittle fern), *Polypodium virginianum* (rock polypody), and *Carex communis* (colonial sedge). A few small cliffs elsewhere in the Park have *Asplenium trichomanes* (maidenhair spleenwort) growing in crumbly fractures, one of the few apparent indicators of mineral enrichment found on Pawtuckaway cliffs. Boulder caves (overhangs) can be found at the top of the talus slope near the trail that climbs onto North Mountain from



Devil's Den. These caves are a well-known location for luminous moss (*Schistostega pennata*) and uncommon moss in southern NH. There is evidence that this moss has been significantly reduced from previous historic population levels. "The Dome" cliff on Rocky Ridge is home to the rare *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove) within the *Appalachian oak - pine rocky ridge* community.

Red oak - black birch wooded talus

General Description

2002: The talus ravine here grades down-drainage into the boulder field within the *hemlock - white forest*. *Hemlock -beech - oak - pine forest* occurs elsewhere in the surrounding lowlands. *Hemlock forest* occurs nearby on the north slope of North Mtn. A large *lowland acidic cliff* looms above the talus, and *Appalachian oak - pine rocky ridge* extends along the ridgelines above on North Mtn. and Rocky Ridge. Luminous moss (*Schistostega pennata*) is found in a boulder cave where the cliff meets talus at the top of the talus slope.

Feature Description

2002: This community occurs along the narrow boulder ravine below the cliffs and steep rocky slope of Devil's Den. The talus boulders here are huge and jumbled, making for difficult walking. The lower and upper ends of the talus field here have some *Tsuga canadensis* (hemlock), but hardwoods including *Betula lenta* (black birch), *B. alleghaniensis* (yellow birch), *Quercus rubra* (red oak), and *Acer saccharum* (sugar maple), are generally more prominent than in the *hemlock - white pine forest* characteristic of the boulder field to the south. *Polypodium virginianum* (rock polypody) festoons the boulders, and *Fallopia cilinodis* (fringed bindweed) climbs and hangs from the rocks. Moist areas between the boulders where soil has accumulated have plants such as *Impatiens capensis* (spotted touch-me-not), *Sambucus racemosa* (red elderberry), *Dryopteris intermedia* (intermediate wood fern), *Carex arctata* (contracted drooping wood sedge), and *Piptatherum racemosum* (blackseed mountain rice). *Viburnum lantanoides* (hobblebush), quite uncommon in Rockingham County, is found just below the cliff.

Pawtuckaway Lake

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
Rare Plant						
<i>Betula nigra</i> (River Birch)	2004-10-01		G5	S2	T	C

Betula nigra (River Birch)

General Description

2004: Lakeshore, at immediate transition zone between lake and upland. Flat aspect with open light in mesic conditions. Associated species in some locations include white pine, red maple, and various shrubs.
 1986: Low, wet area on island. Also on lake shore.
 1945: Island in lake.

Feature Description

2004: Ca. 30 total stems counted in 13 separate locations. Trees occurred as scattered individuals or small clumps along water's edge. Most small (<4 inches dbh) or in poor condition
 1986: Eight or ten trees on and island. Several dozen observed on an adjacent shoreline. Specimen collected.
 1945: 4-5 feet high. Specimen collected.



Pawtuckaway State Park

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Black gum - red maple basin swamp	2004-10-08	26	G3G4?	S1S2		A

Black gum - red maple basin swamp

General Description

2002: Like on Big Island, most of the upland forests surrounding these basins is *hemlock - beech - oak - pine forest*.

1997: Big Island is characterized by mature *hemlock - beech - oak - pine forest*, some of which may be old. There is a state park campground on the south end. An extensive emergent marsh lies along the western shore of Big Island while Pawtuckaway Pond surrounds most of the rest of the island. The canopy reaches heights of over 80 feet in places. *Tsuga canadensis* (hemlock), *Pinus strobus* (white pine), *Quercus rubra* (red oak) are most abundant.

Feature Description

2004: One new basin observed in the central portion of the park.

2002: One new basin observed on the lower slopes of Middle Mountain. Three other basins observed, scattered between Burnhams Marsh and South Mountain. These basins are quite similar in composition to the previously documented sites, with *Nyssa sylvatica* (black gum) and *Acer rubrum* (red maple) being the dominant species in the canopy. *Vaccinium corymbosum* (highbush blueberry) is also present in most of the basins.

1997: The Big Island site consists of 13 known basin swamps and vernal pools, three of which contain considerable amounts of mature *Nyssa sylvatica* (black gum), and two of which have a few scattered black gum. The largest basin (4-6 acres) contains an estimated 60-70 mature black gum, concentrated at the southwest and northeast ends. A second basin, deeply entrenched with a cliff along the west side, has 40% cover of black gum in one area. A third basin has several black gum concentrated at the southern end. The Fundy Cove site consists of 14 known basin swamps with at least a few black gum trees. At least 150 black gum occur at this site. Ages of gum cored at Fundy Cove are 328 years (19" dbh), 306 years (19.8"), and 225 years (12.5"). Basins at both Big Island and Fundy Cove fall into the boggy woodland/tall shrub thicket variant of the *black gum - red maple basin swamp* community.



Rocky Ridge

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Appalachian oak - pine rocky ridge	2002-09-19	38	GNR	S3		A
<u>Rare Plant</u>						
<i>Adlumia fungosa</i> (Climbing Fumitory)	2004-09-08		G4	S1	T	

Appalachian oak - pine rocky ridge

General Description

1983: A dry woodland with about 75% canopy closure due to areas of bedrock outcrops.

Feature Description

2002: The *Appalachian oak - pine rocky ridge* community is dominated by a mix of various oaks, pine and hickory trees. Overall there is a woodland structure with 25-65% tree cover created by numerous rock outcrop and slab openings with lots of heath shrubs, graminoids, and lichens. It is somewhat more acidic and xeric than portions of the subEO on North Mountain, perhaps in response to the predominance of monzonite bedrock and absence of diorite and gabbro on the ridgetop. *Quercus rubra* (red oak), *Pinus strobus* (white pine), *Carya ovata* (shagbark hickory) are dominant and *Q. alba* (white oak) is occasional. The dominant shrubs are *Vaccinium angustifolium* (early low blueberry) and *Gaylussacia baccata* (black huckleberry). Graminoids are the most abundant herbs, and include *Deschampsia flexuosa* (common hair-grass), *Carex lucorum* (distant sedge). Forbs are sparse, but those found here that are characteristic of the community include *Corydalis sempervirens* (pale corydalis), *Maianthemum canadense* (Canada mayflower), *Comandra umbellata* (bastard toad-flax), and *Aralia nudicaulis* (wild sarsaparilla). One rare plant of xeric ridgetops, *Aureolaria pedicularia* var. *intercedens* (fern-leaved false-foxglove), is found at the east end of North Mountain and west end of Rocky Ridge. Lichens are abundant and in many outcrop openings the most dominant life-form.

1983: Has *Quercus rubra* (red oak), *Quercus alba* (white oak), *Pinus strobus* (white pine), *Pinus rigida* (pitch pine), *Fraxinus americana* (white ash), a few *Juniperus virginiana* (eastern red cedar) and an understory of characteristic herbs such as *Danthonia spicata* (poverty oatgrass), polypody, Andropogon, Corydalis, and *Carex pennsylvanica* (Pennsylvanian sedge).

Rare Plants

Adlumia fungosa (Climbing Fumitory)

General Description

2004: Large flat rock in a *hemlock forest* with little other vegetation.

Feature Description

2004: At least 12 flowering vines, 4 to 8 feet long, scattered in a 3-foot square area. Also at least 6 seedlings scattered under the vines near their base. The plants were of normal vigor. Last year's dead vines were present.



South Mountain

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Appalachian oak - pine rocky ridge	2003-09-22	70	GNR	S3		
Appalachian oak rocky ridge system	2003-09-22	70	GNR	SNR		
Semi-rich Appalachian oak - sugar maple forest	2004-06-09	58	GNR	S2S3		
<u>Rare Plant</u>						
<i>Adlumia fungosa</i> (Climbing Fumitory)	1999-08-19		G4	S1	T	C
<i>Bromus pubescens</i> (Hairy Brome-grass)	2004-06-09		G5	S1	T	BC
<i>Carex cumulata</i> (Piled-up Sedge)	2002-09-19		G4?	S2	T	BC

Appalachian oak - pine rocky ridge

General Description

2003, 2002: The *Appalachian oak rocky ridge* transitions to the relatively more forested conditions of *dry Appalachian oak - hickory forest* (65-85% cover) on portions of the ridge. The rocky ridge transitions to a *semi-rich Appalachian oak - sugar maple forest* on the mountain's lower south slope and to *hemlock - white pine* and *hemlock - beech - oak - pine forests* on the north slope and surrounding lowlands. Unlike North and Middle Mountains, the geology of South Mountain (940 ft.) includes almost no mafic bedrock. The northwestern half of the mountain consists of the intermediate monzonite, while the southeastern side is made up of the Massabesic gneiss that typifies the remainder of the park. A large *Appalachian oak - pine rocky ridge* is also found nearby on North Mountain and to a more limited extent on Middle Mountain.

Feature Description

2003, 2002: The ridge top and upper slopes of South Mountain are dominated by a *Appalachian oak - pine rocky ridge* community with a thin cover of oak, hickory, and pine woods and frequent outcrops and small cliffs. Overall the ridge has a woodland structure (25-65% tree cover) with embedded openings dominated by heath shrubs, graminoids, lichens, and bare rock outcrops. Small *lowland acidic cliffs* are scattered on the steep slopes, often at the lower end of steep slabs or outcrops. The most frequent species in the wooded areas and in and around the rocky openings are *Juniperus virginiana* (eastern red cedar), *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Pinus strobus* (white pine), *Vaccinium angustifolium* (lowbush blueberry), *Deschampsia flexuosa* (common hair-grass), *Panicum depauperatum* (impoverished panic-grass), *Carex lucorum* (distant sedge) [may be *C. pennsylvanica* (Pennsylvanian sedge) in places], *Dryopteris marginalis* (marginal wood fern), lichens, and bryophytes. Less frequent trees were *Quercus alba* (white oak) and *Fraxinus americana* (white ash). Forbs in general are sparse but include rocky ridge regulars *Comandra umbellata* (bastard toad-flax), *Corydalis sempervirens* (pale corydalis), *Geranium robertianum* (herb Robert), and several others. Lichens are abundant and dominant in many areas. The ledges were steep in many areas, and the larger examples were open for stretches of 50 meters or more. This rocky ridge community on South Mountain is noteworthy as the only location in the park for the rare *Carex cumulata* (piled-up sedge). This plant was originally collected here on South Mountain more than 100 years ago.

Appalachian oak rocky ridge system

General Description

2003: The extensive rocky ridge system on South Mountain transitions to a *semi-rich Appalachian oak - sugar maple forest* on the mountain's lower south slope and to *hemlock - white pine* and *hemlock - beech - oak - pine*



forests on the north slope and surrounding lowlands. A large ***Appalachian oak - pine rocky ridge*** is also found nearby on North Mountain and to a more limited extent on Middle Mountain. Unlike North and Middle Mountains, the geology of South Mountain (940 ft.) includes almost no mafic bedrock. The northwestern half of the mountain consists of the intermediate monzonite, while the southeastern side is made up of the Massabesic gneiss that typifies the remainder of the park.

Feature Description

2003, 2002: The ridge top and upper slopes of South Mountain have a thin cover of oak, hickory, and pine woods with frequent outcrops and small cliffs. The dominant community here is ***Appalachian oak - pine rocky ridge***, which overall has a woodland structure (25-65% tree cover) with embedded openings dominated by heath shrubs, graminoids, lichens, and bare rock outcrops. The woodland structure transitions to the relatively more forested conditions of ***dry Appalachian oak - hickory forest*** (65-85% cover) in some areas. Small ***lowland acidic cliffs*** are scattered on the steep slopes, often at the lower end of steep slabs or outcrops. The most frequent species in the wooded areas and in and around the rocky openings are *Juniperus virginiana* (eastern red cedar), *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), *Pinus strobus* (white pine), *Vaccinium angustifolium* (lowbush blueberry), *Deschampsia flexuosa* (common hair-grass), *Panicum depauperatum* (impoverished panic-grass), *Carex lucorum* (distant sedge) or *C. pensylvanica* (Pennsylvanian sedge), *Dryopteris marginalis* (marginal wood fern), lichens, and bryophytes. Less frequent species were *Quercus alba* (white oak), *Fraxinus americana* (white ash), *Corydalis sempervirens* (pale corydalis), *Geranium robertianum* (herb Robert), and several others. The ledges were steep in many areas, and the larger examples were open for stretches of 50 meters or more. This rocky ridge community on South Mountain is noteworthy as the only location in the park for the rare *Carex cumulata* (piled-up sedge). This plant was originally collected here on South Mountain more than 100 years ago.

Semi-rich Appalachian oak - sugar maple forest

General Description

2003: This community quickly graded into ***hemlock - beech - oak - pine forest*** downslope. Both ***lowland acidic cliff*** and ***Appalachian oak - pine rocky ridge*** communities occurred upslope.

2002: Unlike North and Middle Mountains, the geology of South Mountain (940 ft.) includes almost no mafic bedrock. The northwestern half of the mountain consists of the intermediate monzonite, while the southeastern side is made up of the Massabesic gneiss that typifies the remainder of the park. The north and western slopes of the mountain consists primarily of ***hemlock - beech - oak - pine forest***, with some areas dominated almost exclusively of *Tsuga canadensis* (hemlock) in the canopy. The natural community on the upper slopes of the south and east sides and on the crest of the ridge is the ***Appalachian oak - pine rocky ridge***, which is also found nearby on North Mountain and to a more limited extent on Middle Mountain. On the south side of mountain, this rocky ridge community includes some large areas of exposed rock in the form of ledges and slabs, as well as small cliffs. To the east and south of the ***semi-rich Appalachian oak - sugar maple forest***, the communities are typical of the eastern interior of the park, with small herbaceous and forested wetlands surrounded primarily by ***hemlock - beech - oak - pine forest***.

Feature Description

2004: Area 1: Overall, mesic to dry-mesic, but some areas dry to dry-xeric; other areas with mesic-wet runs. Includes small pockets of ***rich Appalachian oak rocky woods*** and one small area with ***red oak - ironwood - Pennsylvania sedge woodland***. Large canopy DBHs/over-mature trees occur in large boulder talus areas at slope base. At the northeastern extent of the semi-rich forest observed in 2004, two white pine trees stand over 100' tall.

2003: Area 1: The most frequent species in the canopy of this talus forest were sugar maple, ironwood, and red oak. Less frequent were white ash, shagbark hickory, and *Betula lenta* (black birch). The most frequent herbs included *Dryopteris marginalis* (marginal wood fern), Pennsylvanian sedge, and *Polystichum acrostichoides*



(Christmas fern). The shrub layer, other than areas of regenerating sugar maple, was sparse. This stand is mature and has a noteworthy number of trees with diameters in the 18-22 inch range. This community occurred mostly in a 50-100 meter wide band along the base off the cliff. Small, richer pockets occurred within the stand. Area 3: This is a band of semi-rich mesic forest along the base of the slope on the north side of South Mountain that extends to the drainage and road between South and Middle Mountains. Sugar maple, white ash, red oak, *Carex pedunculata* (long-stalked sedge), and *Carex laxiflora* (loosely-flowered sedge) are found here. 2002, 1991: Area 1: This community is characterized by a mix of oaks, hickories, sugar maple, ironwood, and white ash. Overall, these are very rocky woods (including some talus areas), although in places the lower slopes have relatively few surface rocks. The most abundant tree species include *Quercus rubra* (red oak), *Acer saccharum* (sugar maple), *Ostrya virginiana* (ironwood); *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), and *Fagus grandifolia* (American beech) are also common. The herb layer is fairly sparse and has only a few species indicative of rich or semi-rich conditions. Semi-rich site herbs include *Carex pensylvanica* (Pennsylvanian sedge), *Piptatherum racemosum* (blackseed mountain rice), *Polystichum acrostichoides* (Christmas fern), *Saxifraga virginiana* (early saxifrage), *Carex platyphylla* (flat-leaved sedge), *Elymus hystrix* (bottlebrush grass), *Geranium robertianum* (herb Robert), and at one location, *Carex laxiculmis* (lax sedge). Area 2: This is a mesic drainage/ravine area on the north side of the mountain that drains into Round Pond. A trail goes by this area, and a woods road crosses lower down. Species here include sugar maple, *Tilia americana* (basswood), *Deparia acrostichoides* (silvery spleenwort), *Actaea* sp. (baneberry), and *Osmorhiza claytonii* (Clayton's sweet cicely).

Rare Plants

***Adlumia fungosa* (Climbing Fumitory)**

General Description

1999: Forest with sugar maple, sweet birch [= black birch], beech, paper birch, basswood, and white pine. Nettles [*Urtica dioica*?] dominant in the understory. Associated species include *Sambucus* [*racemosa* ssp.] pubens (red elderberry), *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), and *Dryopteris marginalis* (marginal wood fern). 1960: Draping over moist ledges.

Feature Description

1999: One climbing vine on dead maple branch. Numerous fruits. 1991: Specimen collected. 1960: Specimen collected.

***Bromus pubescens* (Hairy Brome-grass)**

General Description

2004: The population occurs in a pocket of **rich Appalachian oak rocky woods** embedded within **semi-rich Appalachian oak - sugar maple forest**. Associates are *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), *Quercus rubra* (red oak), other woodies, and numerous herbs.

Feature Description

2004: A small population in a pocket of rich woods. Vigor was normal.



Carex cumulata (Piled-up Sedge)

General Description

2002: The ridge top and upper slopes of South Mountain are dominated by a *Appalachian oak - pine rocky ridge* community with a thin cover of oak, hickory, and pine woods and frequent outcrops and small cliffs.

Overall the ridge has a woodland structure (25-65% tree cover) with embedded openings dominated by heath shrubs, graminoids, lichens, and bare rock outcrops. Small *lowland acidic cliffs* are scattered on the steep slopes, often at the lower end of steep slabs or outcrops.

1991: Trail-less areas of the summit.

1984: SNE acidic rocky summit/rock outcrop community, dry, open, southfacing crest. With *Pinus strobus* (white pine), *Schizachyrium scoparium* (little bluestem), and *Carex pensylvanica* (Pennsylvanian sedge).

Feature Description

2002: Total of 36 clumps (individual genets with many fruiting culms each) were observed on the southwestern third of the South Mountain ridgetop. Area 1 (WP 45): This was the former station for the *Carex* around which the trail was relocated in 1991 and brush was stacked at either end of the former route to discourage hiking traffic that might eliminate the sedge. This did not work. The sedge has apparently been eliminated from the location immediately along the trail; the other plants just east of the trail were also not observed in 2002, although more careful surveys are warranted. Area 2 (WP 46 and 47): This was one of the stations noted in 1991 found at the end of a side trail to a view from a ledge. WP46 at end of side trail has 9 fruiting clumps in 1m² area that were heavily trampled and drought-stricken (only 3 clumps had some green vegetative leaves remaining). Sixty feet to the south (WP 47) there are about 15 big clumps found in a 6 m² area in full fruit (this is almost certainly the area described as being "to the west" in 1991). Area 3 (WP48): One big clump at the waypoint and another 60 feet further down the ridge.

1991: 19 total plants observed. Area 1: Just to south of summit tower along trail (within 100 m or so of summit) and outcrops just east of trail in this area. Two clumps (genets) of plants (10 culms total) immediately along trail (small trail reroute attempted). Also two large clumps on outcrop just east of the trail (ca. 50 fruiting culms) and a bit closer to summit. Area 2: Pullout/side trail to an old lookout at ca. 820 ft. elevation and 150-200 m south along the trail from the summit. 5 large clumps (65 fruiting culms) on top ledge here, and 10 large clumps (105 fruiting culms) 50 feet to the west.

1984: 5-10 vigorous, immature fruiting plants.

1900: Collected by A.A. Eaton on June 20. Label data: "Nottingham. Lower Puntuckay Mt." <*Carex albolutescens*>



Southwest Mountain

Feature	Last Seen	Size (ac)	Global Rank	State Rank	State Status	Rank
<u>System or Natural Community</u>						
Red oak - ironwood - Pennsylvania sedge woodland	2003-09-25	23	GNR	S2		

Red oak - ironwood - Pennsylvania sedge woodland

General Description

2003: The *red oak - ironwood - Pennsylvania sedge woodland* on the ridge top transitions rapidly to *hemlock - beech - oak - pine forest* on the northeast side of the ridge and parts of the southwest side of the ridge. A portion of the southwest side consists of *semi-rich Appalachian oak - sugar maple forest*. Small *red maple - sensitive fern swamps* and a *subacid forest seep* occur below the ridge in headwater positions that drain into Mountain Brook. Vernal woodland pools occur around the mountain as well, and four Blandings turtles have been observed in these pools.

Feature Description

2003,1997: On the ridgetop of the unnamed southwest mountain there is an open, park-like stand of hardwoods with a lawn of *Carex pensylvanica* (Pennsylvanian sedge). Presumably the gabbro and diorite bedrock or till has contributed to the formation of this community in a ridgetop setting with a number of species indicative of somewhat enriched conditions such as *Fraxinus americana* (white ash), *Ostrya virginiana* (ironwood), *Acer saccharum* (sugar maple), and *Anemone americana* (blunt-lobed hepatica). The dominant trees here are ironwood, *Quercus rubra* (red oak), *Carya ovata* (shagbark hickory), white ash, and sugar maple. *Pinus strobus* (white pine), *Juniperus virginiana* (eastern red cedar), and scattered *Tsuga canadensis* (hemlock) are occasional. Canopy heights are 30-40 ft. and the forest is early- to mid-successional. The mountain was undoubtedly pastured during the 19th and possibly early 20th century. Other than Pennsylvania sedge, and in places possibly the very similar lawn-forming *Carex lucorum* (distant sedge), shrubs and herbs are sparse. These include *Maianthemum canadense* (Canada mayflower), blunt-lobed hepatica (observable early in the year), *Solidago caesia* (blue-stemmed goldenrod), *Symphotrichum undulatum* (wavy-leaved aster), *Juniperus communis* var. *depressa* (ground juniper). On sloped sections at the northeast end of the community wide-leaved sedges were abundant, probably including *Carex platyphylla* (flat-leaved sedge).



Tavern Hill, SE of

<u>Feature</u>	<u>Last Seen</u>	<u>Size (ac)</u>	<u>Global Rank</u>	<u>State Rank</u>	<u>State Status</u>	<u>Rank</u>
<u>System or Natural Community</u>						
Red maple - black ash - swamp saxifrage swamp	2002-09-06	6	GNR	S2		B

Red maple - black ash - swamp saxifrage swamp

General Description

2002: The dominant community on the surrounding hillside is a *hemlock - beech - oak - pine forest*. Lower in the drainage there is a *peaty marsh*.

Feature Description

2002: Area 1: This is a long, narrow swamp in a shallow, bench-like entrenchment on the hillside of Tavern Hill. It is a few hundred meters long and on average 40-50 m wide. Seepage indicators are abundant and the soil is very well decomposed muck. The tree canopy has about 50% cover of hardwoods and 30% softwoods, the shrub layer an abundance of *Lindera benzoin* (northern spicebush), and the herb layer is dense and with numerous indicators of minerotrophic seepage. Trees include *Tsuga canadensis* (hemlock)(30%), *Acer rubrum* (red maple)(25%), *Betula alleghaniensis* (yellow birch) (20%), *Fraxinus nigra* (black ash) (ca.4-5%). There is a minor amount of *Fraxinus americana* (white ash) and a few *Nyssa sylvatica* (black gum), including one 16 inch tree. There is a very high abundance of *Lindera benzoin* (northern spicebush) in the shrub layer (ca. 10%+). The herb and dwarf shrub layer are also dense (ca. 50% cover). The most abundant species are *Onoclea sensibilis* (sensitive fern), *Osmunda regalis* (royal fern), *Chrysosplenium americanum* (golden saxifrage), *Coptis trifolia* var. *groenlandica* (goldthread), *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (climbing poison ivy). Occasional but characteristic seepage swamp species include *Hydrocotyle americana* (common water pennywort), *Rubus pubescens* (dwarf raspberry), *Impatiens capensis* (spotted touch-me-not), *Boehmeria cylindrica* (false nettle), *Viola* sp. (violets), and *Saxifraga pensylvanica* (swamp saxifrage). Non-*Sphagnum* bryophytes are abundant and contribute 10-60% cover depending on locality. *Sphagnum affine* and other "fat" *Sphagnum* (those of section *Sphagnum*) range from 0-10% cover. Area 2: This is a second swamp basin slightly below and to the southeast of the long, narrow swamp of area 1. The composition is similar. Two species noted here but not from area 1 were *Dryopteris cristata* (crested wood fern) and *Cardamine pensylvanica* (Pennsylvania bitter-cress), both diagnostic of seepage swamps.

