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# Ecological Inventory of Coleman State Park

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A report prepared by the
New Hampshire Natural Heritage Bureau
DRED Division of Forests & Lands and The Nature Conservancy, Concord, NH

**A Quick Overview of the NH Natural Heritage Bureau's Purpose and Policies**

The Natural Heritage Bureau is mandated by the Native Plant Protection Act of 1987 (NH RSA 217-A) to determine protective measures and requirements necessary for the survival of native plant species in the state, to investigate the condition and degree of rarity of plant species, and to distribute information regarding the condition and protection of these species and their habitats.

The Natural Heritage Bureau provides information to facilitate informed land-use decision-making. We are not a regulatory agency; instead, we work with landowners and land managers to help them protect the State's natural heritage and meet their land-use needs.

The Natural Heritage Bureau has three facets:

***Inventory*** involves identifying new occurrences of sensitive species and classifying New Hampshire's biodiversity. We currently study more than 600 plant and animal species and 200 natural communities. Surveys for rarities on private lands are conducted only with landowner permission.

***Tracking*** is the management of occurrence data. Our database currently contains information about more than 4,000 plant, animal, and natural community occurrences in New Hampshire.

***Interpretation*** is the communication of Natural Heritage Bureau information. Our goal is to cooperate with public and private land managers to help them *protect* rare species populations and exemplary natural communities.

Cover: Dense colony of wood nettle (*Laportea canadensis*), a rich forest indicator species, at Coleman State Park in Stewartstown, NH. (Photo by Pete Bowman).

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**SUMMARY**

In 2008, the New Hampshire Natural Heritage Bureau conducted an ecological inventory of Coleman State Park (Coleman), a 1,539-acre property in the town of Stewartstown in northern New Hampshire. The purpose of the survey was to gather data on the floristic and ecological diversity of Coleman to inform the management of the property by the Division of Forests and Lands. Natural Heritage identified three exemplary natural communities and four rare plant populations at Coleman State Park.

## INTRODUCTION

The NH Natural Heritage Bureau (NHB), in the NH Division of Forests and Lands, facilitates the protection of New Hampshire's rare plants, exemplary natural communities (which are outstanding examples of different types of forests, wetlands, grasslands, etc.) and natural community systems. Our mission, as mandated by the Native Plant Protection Act of 1987 (RSA 217-A), is to determine protective measures and requirements necessary for the survival of native plant species in the state, to investigate the condition and degree of rarity of plant species, and to distribute information regarding the condition and protection of these species and their habitats.

In 2001, the NHB conducted an *Ecological Analysis of NH State Lands* (Crowley and Sperduto) in order to identify state-owned lands that were the highest priority for ecological inventory. One of the properties identified as the highest priority (Tier 1), was **Coleman State Park** (Coleman), a 1,539-acre property in the town of Stewartstown in northern New Hampshire. In 2008, NHB conducted an ecological inventory and assessment of Coleman, with the goal of locating and identifying occurrences of rare plant species, and exemplary natural communities and natural community systems on the property.

## METHODS

### LANDSCAPE ANALYSIS

NHB conducted an initial landscape analysis to identify areas that have greater potential to contain features of interest than other parts of the landscape. This process allowed us to prioritize survey areas to increase the efficiency of field visits. Information sources used during the landscape analysis included National Wetland Inventory (NWI) maps, surficial (Goldthwait 1950) and bedrock (Lyons *et al*. 1997) geologic maps; soil surveys (Natural Resources Conservation Service [NRCS] 2001), land cover data (GRANIT 2001), and USGS topographic quadrangles. Digital layers of some of these data, used with GIS computer mapping software (ArcView), allowed rapid comparison and integration of information from different sources. We also queried the NHB database to identify specific locations of known rare species and exemplary natural communities within potential study areas. NHB then reviewed aerial photographs to determine vegetation patterns and conditions, and assessed available information from DRED Division of Forests and Lands regarding stand type and condition (see Appendix 3).

NHB examined the geographic context of the site, including its location within the state and elevation gradients within the property. This step narrows the range of natural communities and plant species that have the potential to occur on the property. Next, NHB looked for patterns of dominant communities and embedded features. The combination of aerial photographs, topographic maps, soil surveys, elevation range, and stand data helped form a picture of the dominant forest cover (hardwood, mixed, conifer) and probable corresponding natural community types. Air photos are particularly useful for identifying evidence and distribution of past forest management, agricultural activity, and general stand maturity. Forested areas with fewer indicators of recent management, and/or that correspond to unusual settings or conditions, are of greater interest, as they are more likely to harbor exemplary natural communities or rare species.

The distribution, abundance, and characteristics of small patch features embedded in the dominant forest matrix were of particular interest from an ecological perspective. These features represent relatively small parts of the landscape, but often constitute a large proportion of species diversity. Small patch features examined include wetlands, drainages, floodplains, enriched forests, rocky ridges, steep slopes, and sand plains, among others.

NHB also identified rich sites (mineral enriched areas). Rich sites support numerous uncommon and rare plants and communities, and occur where various combinations of factors contribute to the nutrient enrichment of the soil intersect on the ground. Rich site factors include bedrock type, topographic position, soil moisture, and the accumulation of organic matter (colluvium). The mineral most associated with enriched conditions is calcium, and bedrock types with carbonate-bearing lithology have the greatest potential to provide this nutrient to the soil. Rock types that undergo chemical weathering at higher rates, and rocks in the intermediate and mafic lithologic categories, can also produce enriched soils. Topographic maps are used to identify various features often associated with enriched conditions on the ground. The bases of steep slopes, benches on slopes, and "coves" are of interest because they are accumulation zones for organic matter, water, and nutrients. Steep, rocky slopes with highly fractured bedrock near the surface are also of interest because they may support rich site plants adapted to rocky conditions. Finally, soil survey data can also be useful in identifying soil types that may have elevated levels of mineral enrichment, such as silt or loam soils.

In addition to supporting enriched communities, steep slopes may indicate the presence of a number of uncommon cliff and talus communities. Because of the difficulty of conducting timber management activities on steep terrain, these slopes may also support areas of undisturbed (old-growth) forest condition. NHB identifies areas of steep slopes through the visual examination of topographic maps.

NHB targeted wetlands for surveys, including stream and river corridors, because of the diversity of communities and species they support. NHB consulted NWI and soil maps to identify wetland locations, broad vegetation types and hydrologic classifications. The maps are useful for predicting natural communities, although they are not diagnostic. NHB used topographic maps to determine wetland size, landscape position, and setting (e.g., degree of isolation, connectedness to streams, and association with water bodies). Aerial photo signatures were used to predict probable natural community types. NHB selected wetlands for inventory work because of the potential for uncommon or rare community types, or because they had the potential to be exemplary occurrences of more common communities.

## FIELD SURVEY

NHB initiated field data collection in the areas prioritized by the landscape analysis process as having higher potential for exemplary natural communities or rare plants. However, to reduce oversights due to the inherent limitations of remote landscape analysis, and to gain a better overall property context, additional field inventory effort was conducted to obtain representative information on all of the geographic sections and apparent natural communities of the property.

Field survey routes were designed to cover specific destinations and to maximize intersection with representative areas or polygons of medium and lower priority areas en route. During the field survey, NHB collected data at specific locations considered representative of the surrounding natural community based on observations and interpretation of the composition and structure of the community. Data were collected when there was an apparent change in community type, or there were significant changes in apparent ecological condition, as evidenced by changes in physical structure or species composition. As the survey progressed, NHB ecologists used their knowledge and experience to identify the portions of the study area that were most interesting ecologically, and focused attention on these locations (i.e., rare or uncommon communities, or large, high-integrity examples). The specific route of travel was modified on the ground to investigate smallscale habitat conditions not apparent from landscape analysis (i.e., seeps, small areas of enrichment, rocky outcrops, and species indicative of particular conditions of interest).

NHB collected data at specific locations called observation points (OPs) during field surveys. The following information was collected at most of the 635 observation points at Coleman:

- Natural community system type, following Sperduto (2005)
- Natural community type, following Sperduto and Nichols (2004)
- Identification of all native and non-native plant species
- Percent coverage estimates for all plant species
- Other descriptive notes, including information on soils and other physical site characteristics, evidence of human disturbance, size of the community, and wildlife evidence

NHB identified most plants in the field during the inventory; others were collected, pressed, and keyed out using the resources available at NHB. 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). Voucher specimens of rare plants were retained for deposit at the University of New Hampshire Hodgdon Herbarium (NHA). NHB took photographs of representative and noteworthy features with a digital camera, and stored them in the NHB photo archive. A Global Positioning System (GPS) was used to determine the location of observation points in each natural community type and the location of rare plant populations in the study area. The accuracy of the data collected by the GPS was generally within 15 meters. Field data and site locations of exemplary natural communities and systems and rare plant populations were catalogued and incorporated into the NHB database.

Appendix 1 contains a more detailed description of NHB's ecological approach.

## RESULTS

### NATURAL SETTING OF COLEMAN STATE PARK

Coleman State Park (Coleman) is located in northern New Hampshire, and mapped within the U.S. Forest Service's White Mountain Section (Figure 1)[1]. This section encompasses the White Mountains and most of Coos County to the Canadian border. Beyond New Hampshire, it includes a portion of northeastern Vermont and extends into far northern Maine. The section is distinguished from surrounding areas by particular climatic, geomorphological, and vegetative characteristics, and has been further divided into "subsections" using finer-scale physical and biological criteria (Keys and Carpenter 1995). Coleman falls into the Connecticut Lakes subsection, which is characterized by the rolling topography of glacial landscape features such as drumlins, kames, and eskers. The bedrock geology of this subsection is complex, with metasedimentary rocks like phyllites and slates intermingled with granitic rocks. The low-grade pelite bedrock typically weathers to form silty soils, which retain moisture well and frequently offer good nutrient availability for plants.

The shape of Coleman State Park is roughly rectangular, with an L-shaped arm branching off to the east. South of this eastern arm is a 110-acre disjunct parcel, separated from the rest of the park by about a third of a mile. The park is draped across the slopes of a series of low mountains. The western half of the park occupies the eastern slopes of Dead Water Ridge, with the summit of this hill (2,654 ft) lying just off property. The eastern arm extends onto the northern and western slopes of a ridge with the named peaks of Sugar Hill and Tumble Dick Mountain. The southern park boundary just clips the summit of Sugar Hill at 2,985 ft, the highest point in the town of Stewartstown. The southern parcel is on the southwestern slope of Sugar Hill.

Coleman sits on the watershed divide between the Connecticut and Androscoggin River drainages. The streams in the southern part of the park flow south into the East Branch of the Mohawk River, which then flows to the Connecticut. The streams on the north-facing slopes

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[1] **Sections** are landscape divisions developed by the U.S. Forest Service that cover tens of thousands of square miles and have similar biological and physical characteristics – particularly climate, topography, and soils – and broad distribution patterns of plants and animals (Keys and Carpenter 1995). New Hampshire lies within three sections: White Mountains; Lower New England/Northern Piedmont; and Vermont-New Hampshire Uplands. Sections consist of aggregations of finer-scale subsections that share numerous natural communities uncommon in or absent from adjacent sections.

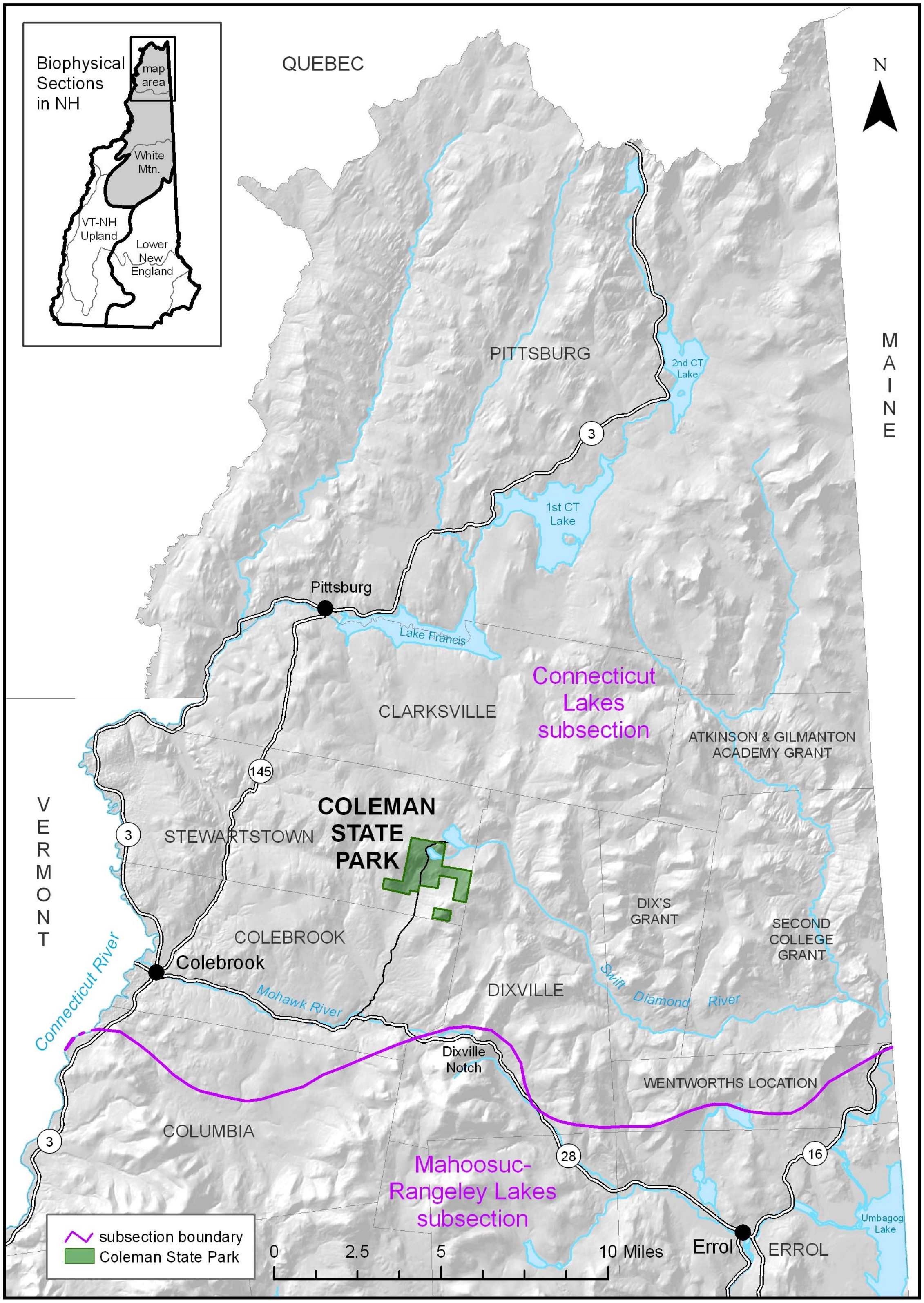



**Figure 1.** Regional context of Coleman State Park in northern New Hampshire. The property lies entirely within the Connecticut Lakes subsection.

flow into Little Diamond Pond, which is contained entirely within the park, and then drains into the larger Diamond Pond to the north of the property. Diamond Pond is drained by the Swift Diamond River, a tributary of the Androscoggin.

### *Geology and Soils*

The geology of Coleman State Park is complex, and includes bedrock types from several different formations (Figure 2). The dominant formation across the central and western portions of the park is the Frontenac Formation. Most of this formation consists of low-grade pelites, which are comprised of metamorphosed, fine-grained, sedimentary rocks such as phyllites and schists. Low-grade pelites weather to produce silt loam soils, which have a number of qualities that enable them to support high plant species diversity. They generally have higher concentrations of mineral nutrients such as calcium than soils derived from felsic volcanic rocks. In addition, silt loams have a higher moisture-holding capacity than soils with coarser texture, and many are poorly drained with perched water tables. These hydrologic influences tend to produce abundant areas of seepage, bringing mineral-enriched groundwater to the surface.

Within the Frontenac Formation are narrow sills of intrusive, metamorphosed, volcanic basalt. Basalt is a mafic rock, which has elevated concentrations of magnesium and iron, and frequently high levels of calcium. Soils derived from weathered mafic rock are often enriched, and can support unusual natural communities and high species diversity.

The bedrock under the southern parcel and eastern arm of the park consists of two geologic units: the Rangely and Ironbound Mountain Formations. Lithologically, these formations are classified as high-grade pelite and felsic, respectively. In general, both of these rock types tend to weather slowly, and to produce soils that have relatively low nutrient availability for plants. However, the glacial till within the park, including in areas mapped as felsic, is probably derived from low-grade pelites, due to glacial deposition from areas to the north and west.

According to the NRCS (2001), the most common soil type at Coleman is the Tunbridge-Plaisted-Lyman Complex, which covers just over 40% of the property. This is actually a mosaic of three soil types that is so complex that it is not practical to map them separately. The Tunbridge and Plaisted soils are silt loams, and the Lyman is a sandy loam, all of which occur on moderately steep slopes. Other important soils at Coleman include Howland Silt Loam, Cabot Gravelly Silt Loam, and the Glebe-Saddleback-Sisk Association, all of which are primarily silt loam types. As noted above, silt loams have a number of qualities that are conducive to the development of a diverse flora.

### *Vegetation*

Upland forests cover most of Coleman State Park. The most common natural community type on these uplands is the ***northern hardwood - spruce - fir forest***, which is dominated by a mixture of sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), balsam fir (*Abies balsamea*), and white spruce (*Picea glauca*). In typical examples, understory species diversity is low, with hobblebush (*Viburnum lantanoides*) as a common shrub and intermediate

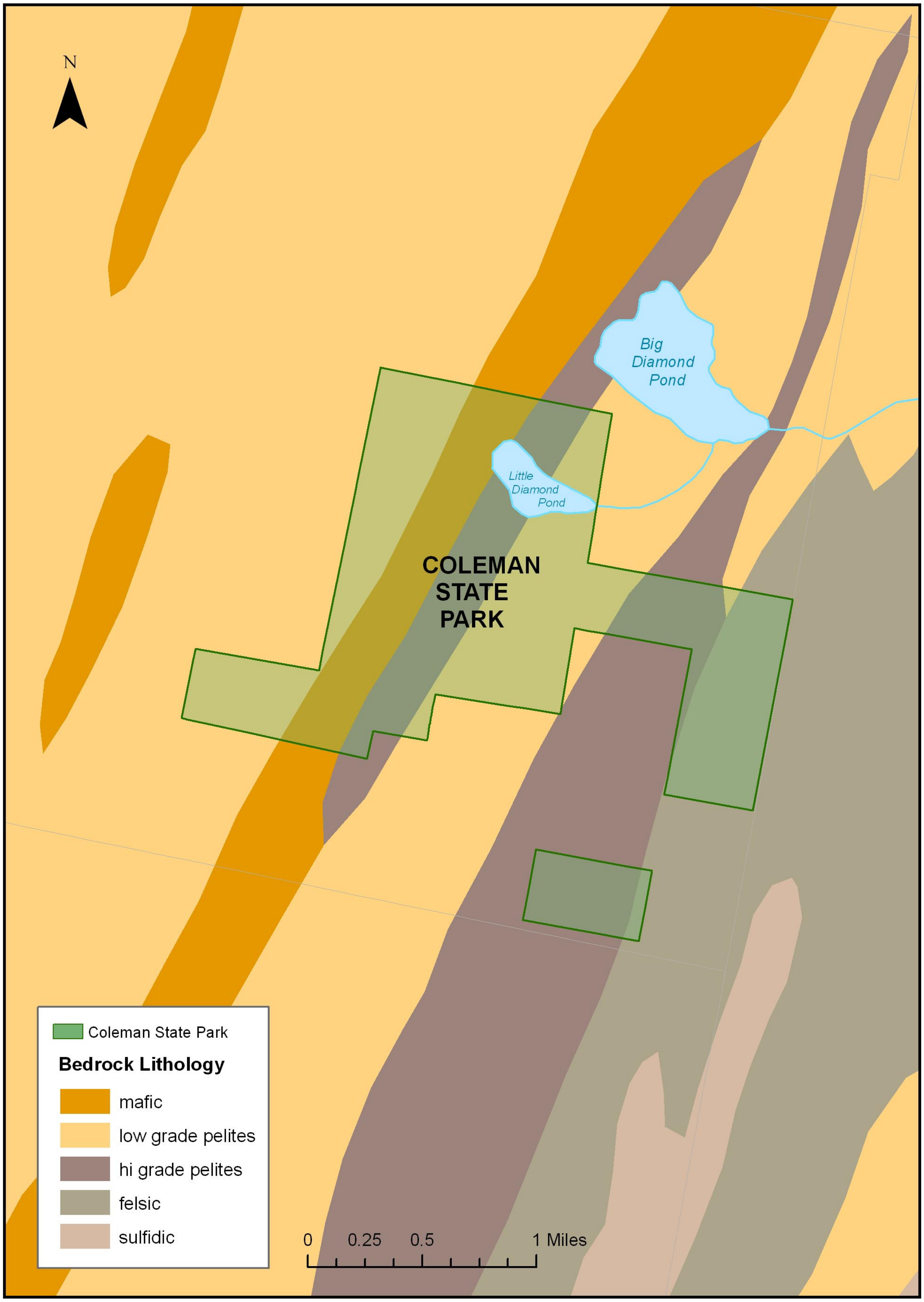



**Figure 2**. Bedrock geology at Coleman State Park.

wood fern (*Dryopteris intermedia*) and northern wood sorrel (*Oxalis montana*) in the herbaceous layer.

Enriched soil conditions are common at Coleman, and support the ***rich mesic forest*** community (see Exemplary Natural Communities below). Sugar maple dominates the rich mesic forest canopy, and the herb layer is lush and noteworthy for its diverse suite of species. Some of the rich-site indicator species common in the park include blue cohosh (*Caulophyllum thalictroides*), Christmas fern (*Polystichum acrostichoides*), wood nettle (*Laportea canadensis*), silvery spleenwort (*Deparia acrostichoides*), Braun's holly fern (*Polystichum braunii*), zigzag goldenrod (*Solidago flexicaulis*), and the rare Goldie's fern (*Dryopteris goldiana*). Early in the growing season, spring ephemeral herbs appear in large numbers to take advantage of the abundant sunshine before the canopy trees leaf out. After flowering, these species die back, leaving no indication of their presence above ground. Some of the spring ephemerals in this community include Virginia spring beauty (*Claytonia virginica*), trout lily (*Erythronium americanum*), and the rare squirrel corn (*Dicentra canadensis*).

Not all of the uplands at Coleman are in natural forest cover. In the center of the park, surrounding a private campground, are roughly 115 acres of conifer plantations. These plantations are primarily white spruce, along with some European larch (*Larix decidua*).

Across Coleman State Park, the movement of groundwater through the silty soils produces numerous forest seeps. Most of these wetlands are very small (<1/4 acre), with a dense herb layer that is shaded by trees in the surrounding forest. Some of the common herbs in forest seeps include northeastern mannagrass (*Glyceria melicaria*), spotted touch-me-not (*Impatiens capensis*), false hellebore (*Veratrum viride*), cow parsnip (*Heracleum maximum*), rough sedge (*Carex scabrata*), and purple avens (*Geum rivale*), among many others. Discharged groundwater brings mineral nutrients to the surface; consequently herbs of rich mesic forest conditions are also present in these seeps.

The most extensive wetland areas in the park are associated with the inlet stream to Little Diamond Pond. Along this stream is a ***medium level fen system***, a type of peatland, consisting of a thick accumulation of organic matter (peat) with a dense cover of sedges and low shrubs. South of and adjacent to this peatland is an exemplary ***northern hardwood - black ash - conifer swamp*** (see Exemplary Natural Communities below). This is a seepage swamp supplied with mineral-enriched groundwater from the adjacent slope, and which supports a diverse assemblage of seepage indicator species.

Other wetlands at Coleman State Park are small marshes or shrub swamps, generally less than two acres in size. These ***emergent marsh - shrub swamp systems*** are dominated by herbaceous species such as bluejoint (*Calamagrostis canadensis*), three-nerved Joe-pye-weed (*Eupatorium dubium*), northern blue flag (*Iris versicolor*), perfect-awned sedge (*Carex gynandra*), and spotted touch-me-not. In some areas, a tall shrub layer comprised of speckled alder (*Alnus incana* ssp. *rugosa*) forms dense thickets, often along the margins of small streams.

## Exemplary Natural Communities

### *Rich mesic forest*

This exemplary forest community occurs on the northeast-facing slopes of Dead Water Ridge, above the inlet stream for Little Diamond Pond (Figure 3). Sugar maple (*Acer saccharum*) is the sole dominant species in the canopy, although yellow birch (*Betula alleghaniensis*) is also present in small amounts. The herbaceous layer is lush and very diverse. Wood nettle (*Laportea canadensis*), blue cohosh (*Caulophyllum thalictroides*), Braun's holly fern (*Polystichum braunii*), silvery spleenwort (*Deparia acrostichoides*), zigzag goldenrod (*Solidago flexicaulis*), Clayton's sweet cicely (*Osmorhiza claytonii*), plantain-leaved sedge (*Carex plantaginea*), false hellebore (*Veratrum viride*), downy yellow violet (*Viola pubescens*), white baneberry (*Actaea pachypoda*), and wakerobin (*Trillium erectum*) are some of the more common herb species in the community. There is also a large population of Goldie's fern (*Dryopteris goldiana*), a state-rare species, within this community, with hundreds of plants observed. In late April and May, spring ephemerals are abundant, and include Virginia spring beauty (*Claytonia virginica*), trout lily (*Erythronium americanum*), Dutchman's breeches (*Dicentra cucullaria*), broad-leaved toothwort (*Cardamine diphylla*), wild leek (*Allium tricoccum*), and the rare species squirrel corn (*Dicentra canadensis*).

Although this community occurrence is exemplary because of its size and diversity, it is not pristine. Cut stumps and small to medium size canopy trees (6-10" dbh) attest to a history of past timber harvesting. The surrounding upland forests also have evidence of recent logging activities, particularly skidder trails that have not yet succeeded to a forested condition.

Spring ephemerals in the exemplary ***rich mesic forest*** community. Photo by Ben Kimball.

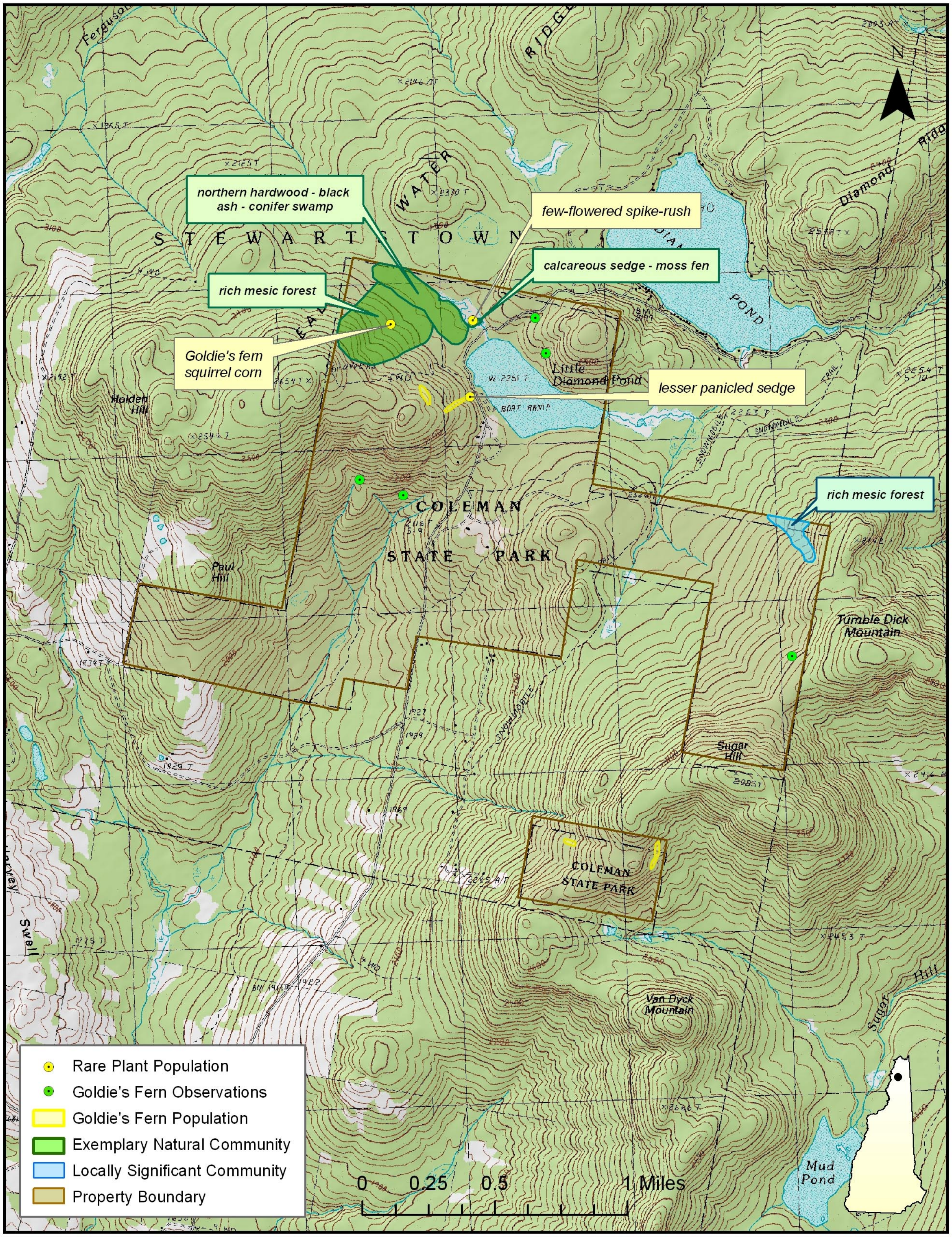



**Figure 3**. Rare plant and exemplary natural community locations at Coleman State Park.

***Northern hardwood - black ash - conifer swamp***

This exemplary forested wetland community occurs directly downslope of the exemplary ***rich mesic forest***. It is enriched by groundwater and surface water flow carrying nutrients from the adjacent slope. This large swamp is dominated by balsam fir (*Abies balsamea*), with some black ash (*Fraxinus nigra*) and white spruce (*Picea glauca*) in the canopy. Seeps and hummocks are abundant and blowdowns are common. Speckled alder (*Alnus incana* ssp. *rugosa*) is frequent in the shrub layer. The herbaceous layer is rich and lush, and includes foamflower (*Tiarella cordifolia*), dwarf raspberry (*Rubus pubescens*), bunchberry (*Cornus canadensis*), long beech fern (*Phegopteris connectilis*), purple-stemmed aster (*Symphyotrichum puniceum*), intermediate wood fern (*Dryopteris intermedia*), white turtlehead (*Chelone glabra*), spotted touch-me-not (*Impatiens capensis*), purple avens (*Geum rivale*), and northeastern mannagrass (*Glyceria melicaria*). Bryophytes are abundant.

Exemplary ***northern hardwood - black ash - conifer swamp*** community. Photo by Ben Kimball.

***Calcareous sedge - moss fen***

Little Diamond Pond's primary inlet stream enters from the northwest. This stream is flanked by a **medium level fen system** dominated by wire sedge (*Carex lasiocarpa*) and the shrubs leatherleaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*). The waters of this natural community system are generally moderately acidic with low levels of mineral nutrients. However, at the lower end of the system, near the connection to Little Diamond Pond, is an exemplary ***calcareous sedge - moss fen***, a rare natural community defined by elevated levels of mineral nutrients and circumneutral water chemistry. Species found in this enriched wetland include yellow sedge (*Carex flava*), Michaux's sedge (*Carex michauxiana*), and the rare few-flowered spike-rush (*Eleocharis quinqueflora*).

**Medium level fen system** which contains the exemplary ***calcareous sedge - moss fen***. Photo by Ben Kimball.

### RARE PLANT SPECIES

*Dryopteris goldiana* (Goldie's fern) (S2)

Goldie's fern is a species of enriched forests, and is the largest wood fern in the state. NHB observed hundreds of individual plants at numerous locations scattered across Coleman State Park. The site with the greatest number of plants is the exemplary ***rich mesic forest*** northwest of Little Diamond Pond. The ferns occur throughout this exemplary community as a component of the diverse herbaceous flora.

The other site where Goldie's fern is particularly abundant is in the northwest corner of the southern disjunct parcel of the park. NHB observed hundreds of plants at this location, on an east-facing slope near the park boundary. Numerous other rich-site indicator species are present at this location, but the community is too small to be considered a noteworthy occurrence of ***rich mesic forest***.

*Dryopteris goldiana* (Goldie's fern). Photo by Ben Kimball.

Goldie's fern growing with maidenhair fern (*Adiantum pedatum*) in the exemplary ***rich mesic forest***. Photo by Ben Kimball.

*Dicentra canadensis* (squirrel corn) (S2)

Squirrel corn is a spring ephemeral wildflower with finely divided compound leaves and small, heart-shaped white flowers. Spring ephemerals appear early in the spring, taking advantage of the abundant sunlight before canopy trees leaf out. After flowering, the leaves of this plant die back, leaving no trace of their presence above ground for most of the growing season. It is frequent in the exemplary ***rich mesic forest*** occurrence, with hundreds of plants scattered in numerous patches throughout the community.

*Dicentra canadensis* (squirrel corn).
Photo by Ben Kimball.

*Carex diandra* (lesser panicled sedge) (S1)

This rare sedge was first observed in 1994, but was not relocated during this survey. It is a species of rich soils, and was observed in 1994 growing with Goldie's fern (*Dryopteris goldiana*) along rich seeps just south of Little Diamond Pond. Few plants were observed in the original survey, but it is possible future inventory work will relocate this plant.

*Eleocharis quinqueflora* (few-flowered spike-rush) (S1)

This rare sedge was also observed in 1994, but was not relocated during this survey. It was located in the ***calcareous sedge - moss fen*** west of Little Diamond Pond. The occurrence record data do not provide information on population size, but an unusually wet summer during the current inventory led to the inundation of the likely location of the species, resulting in an absence of diagnostic material. Future surveys in drier conditions may permit the relocation of this plant.

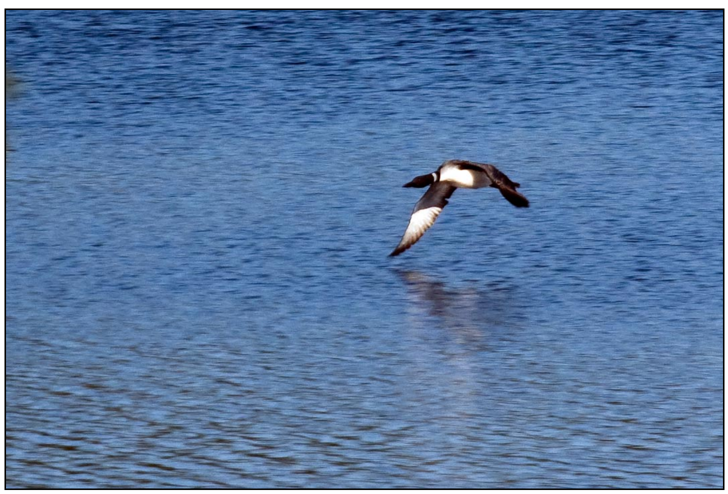
## FEATURES OF LOCAL SIGNIFICANCE

### *Rich mesic forest*

Near the bend in the eastern arm of the property is an occurrence of ***rich mesic forest*** that is not large enough to be considered exemplary, but is still of noteworthy size. It is located on northwest-facing slopes of Tumble Dick Mountain, and is strongly influenced by groundwater seepage. As in other rich mesic forests, the dominant tree is sugar maple, although balsam fir is also present in the canopy in low numbers. The herbaceous layer is completely dominated by wood nettle, to the point where few other herbs are present. Some other herbs that are present in low numbers are foamflower, intermediate wood fern, and false hellebore. A single clump of Goldie's fern was also observed within this community.

## WILDLIFE

There are no records in the NHB database for tracked wildlife species at Coleman State Park. However, there is a record for common loon (*Gavia immer*) at Diamond Pond, just north of the park, and loons were observed on Little Diamond Pond within the park during both spring and fall field visits. No observations were made of nesting activity, but given the proximity to a known breeding area, there is the possibility of nesting at Little Diamond Pond.



Common loon flying over Little Diamond Pond. Photo by Ben Kimball.

## INVASIVE PLANT SPECIES

Invasive plant species are not currently a significant problem at Coleman State Park. Despite the preponderance of enriched soil conditions in the park, favored by invasive plants, there are only a few species present, and they only occur in very low abundances. The only species noted were glossy or alder-buckthorn (*Frangula alnus*), which occurred occasionally along wetland margins, and coltsfoot (*Tussilago farfara*), a weedy herb found in moist, seepy soils. Buckthorn in particular has the potential to spread, but is not currently abundant.

## MANAGEMENT CONSIDERATIONS

### TIMBER MANAGEMENT

With the exception of Little Diamond Pond and the designated campground areas, all of Coleman State Park is zoned for timber management, and evidence of past management activities can be found throughout the park. The Division of Forests and Lands has expressed a commitment to integrate timber operations with ecological conservation, historical preservation, wildlife management, and recreation. To this end, NHB endorses timber operations by the Division of Forests and Lands in non-exemplary forest areas using practices that meet or exceed best management practices described in *Good Forestry in the Granite State* (New Hampshire Forest Sustainability Standards Work Team 1997; revision pending). Because groundwater seepage is so pervasive in Coleman State Park, NHB recommends that timber operations be conducted on frozen ground whenever possible, in order to minimize damage to these soft, wet soils. NHB also endorses practices that protect wetlands through the establishment of buffers, which take into consideration soil type, buffer vegetation type, adjacent land use, slope, runoff particle size, wetland quality, and indigenous wildlife. *Good Forestry in the Granite State*, NHB, or an experienced wetland scientist can provide guidance.

NHB recommends that commercial timber management activities be excluded from exemplary natural communities. This applies to the exemplary ***rich mesic forest*** and ***northern hardwood - black ash - conifer swamp*** communities west of Little Diamond Pond. In addition, for occurrences of rare plant populations outside the exemplary natural communities, we recommend these populations and adjacent suitable habitat be buffered from logging activity by a suitable distance. Specific buffer widths may vary depending on the type of management, the intensity of impacts, and local site features.

### RECREATION

The primary recreational areas at Coleman State Park are Little Diamond Pond and the adjacent campground. Winter recreation includes snowmobile trails that cross the property, including two primary corridor routes. One possible area of recreation expansion in the park is the creation of opportunities for hiking and nature study.

Since 2003, NHB has been developing interpretive site guides for the "Visiting New Hampshire's Biodiversity" series. These brochures are designed to direct visitors to sites where they can observe rare plant species or exemplary natural communities, and provide information on the ecology of the area. One of the targets of this program since its inception has been to identify a ***rich mesic forest*** occurrence on conservation lands that is exemplary and easily accessible. The quality of the ***rich mesic forest*** at Coleman State Park, combined with its proximity to the road and campground, presents an excellent opportunity for developing a new hiking trail in conjunction with a brochure that would educate visitors about the community and the variety of plant species found there.

### All-Terrain Vehicles (ATVs)

Illegal use of ATVs at Coleman State Park does not appear to be particularly problematic. However, considering the potential for damage to wet, seepy soils in the park, the property should be monitored for signs of ATV trespass. Numerous studies have shown that use of ATVs on and off trails can have serious negative impacts, including soil erosion and compaction, sedimentation of streams and wetlands, spread of invasive plant species, and destruction of virtually all forms of vegetation (Natural Trails and Waters Coalition 2005).

### Invasive Plant Species

As noted above, invasive plants have a very limited presence in Coleman. However, these current low abundances should not be taken for granted, and opportunities to control these plants should be utilized when they are available.

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# Appendix 1. NH Natural Heritage Bureau Ecological Approach.

## NATURAL COMMUNITIES

The NH Natural Heritage Bureau (NHB) describes the landscape using "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 nutrient availability, soil drainage, and climate variables). Natural communities include both wetland types (e.g., red maple basin swamp) and uplands such as woodlands (e.g., red oak – black birch wooded talus) 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 forest seeps) while others may cover large areas (such as montane spruce - fir forests). 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 fen community is important information for land managers to consider when planning management activities.

The classification takes into account that communities have different size ranges. Some common communities tend to cover large areas and form the "matrix" of a landscape. Other communities are imbedded in this matrix as large or small patches. The great majority of the landscape area consists of relatively few common community types, whereas the majority of the community types occupy a minority of the area. Large areas occupied by common communities may harbor relatively low community and plant species diversity, but they contribute important ecosystem processes and functions.

The classification of natural communities in New Hampshire is based on data from more than 10 years of ecological research by ecologists with NHB and The Nature Conservancy, plus extensive reviews of scientific literature (Sperduto and Nichols 2004). 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 red spruce - northern hardwood 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 “montane 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/*Sphagnum* basin 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

Cowardin et al. (1979) produced a classification scheme for the U.S. Fish and Wildlife Service (USFWS) for application to wetland and aquatic systems. In this classification, wetlands and deepwater habitats are defined primarily by their flood regime, substrate, and dominant vegetation structure. This classification system is useful because of its applicability to broad geographical regions and because it can be readily applied in conjunction with aerial photography interpretation. It was the basis for wetland typing in the National Wetland Inventory (NWI) mapping effort.

Natural community and USFWS types often do not correspond to one another in direct (1:1) and consistent ways, primarily because the two classification systems are based on and emphasize different ecosystem attributes and have different ranges of variation within categories. The natural community classification considers and integrates a broader range of factors (other than flood regime and coarse vegetation structure). Differences in nutrient regime, water source, and geomorphic setting, which are not directly incorporated into the USFWS system, are often important determinants of natural community type (and indicated by differences in floristic composition). For example, red maple - *Sphagnum* basin swamps and red maple - black ash swamps would both be considered saturated, palustrine broad-leaved deciduous forested wetlands (PFO1). This common 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*

NHB evaluates the ecological significance of individual natural community occurrences by assigning a quality rank to each one. Quality ranks are a measure of the ecological integrity of a community relative to other examples of that particular type. These ranks are based on three main criteria: community size, ecological condition, and the surrounding landscape context of the community. Each of these factors affects the integrity of natural processes and the viability of plants and animals within a community.

To help inform conservation decisions, NHB identifies and keeps track of "exemplary" natural communities. Exemplary natural communities are the highest quality occurrences of each type in the state. For rare natural community types, all viable occurrences are considered exemplary (those of "fair" or better quality). For more common community types, only higher quality examples are designated exemplary (those of "good" or "excellent" quality). As the best occurrences of their types, exemplary natural communities are among the best remaining examples of New Hampshire's natural diversity.

## **Rarity**

NHB 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 (ECOLOGICAL INTEGRITY ASSESSMENT)

In addition to considering the rarity of a natural community or species as a whole, NHB 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*).

NHB, 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, NHB 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.

> **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.

**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.

**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.

**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 $km^2$ (1-2 $mi^2$) 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.

**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.

**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.

**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.

**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.

## NATURAL COMMUNITY SYSTEMS

Natural community systems are repeating associations of natural communities (Sperduto 2005). 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 natural community systems can therefore be effective at identifying conservation targets of the highest priority.

## PROTECTING NEW HAMPSHIRE'S BIODIVERSITY

### *WHAT IS BIODIVERSITY AND WHY SHOULD WE PROTECT IT?*

#### 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 Sperduto *et al*. (2001) (see “Protecting Biodiversity on IP Lands in Northern New Hampshire”).

*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.

NHB 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 NHB'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.

# 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). |

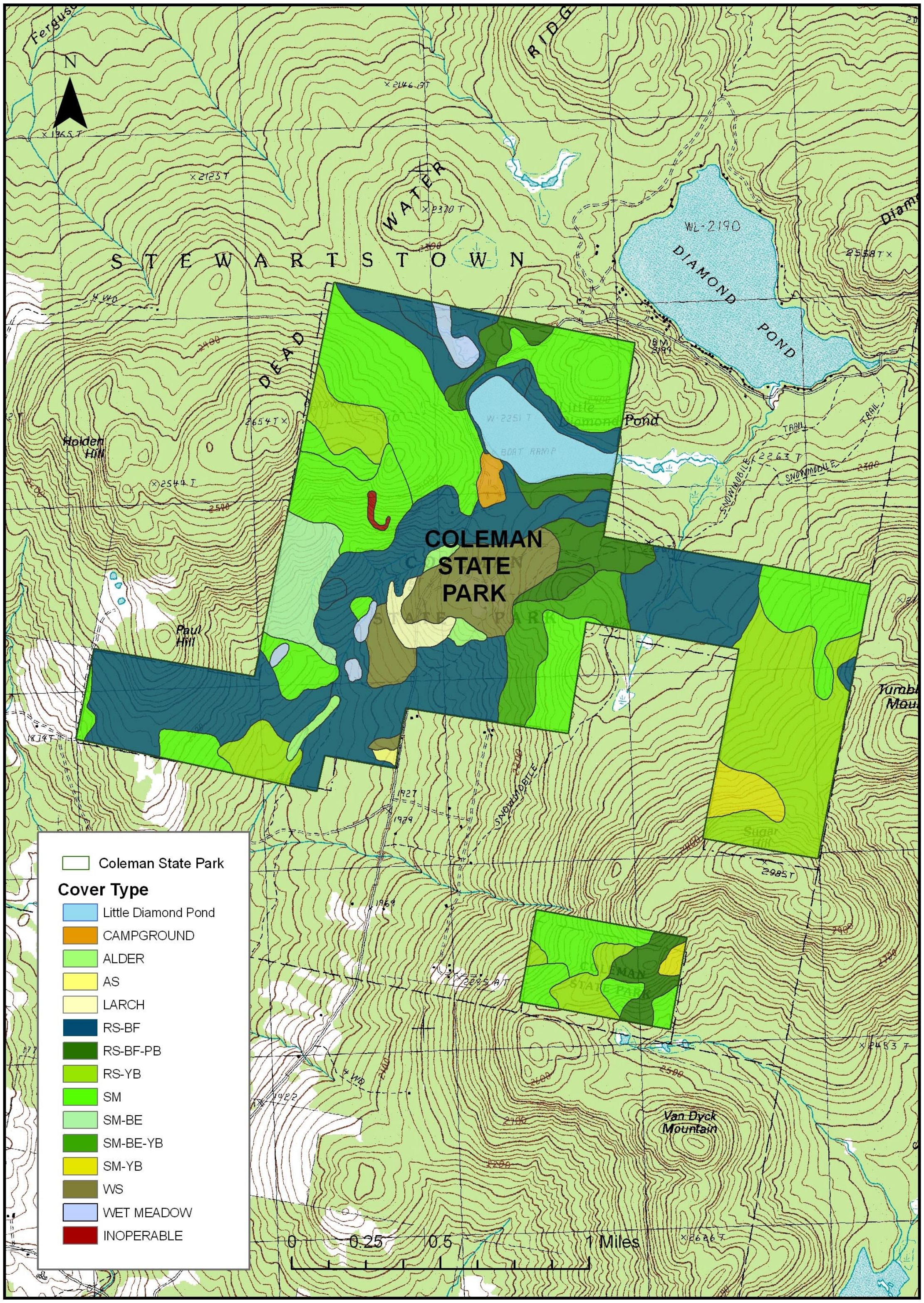
Modifiers are used as follows.

| *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.  Forest Cover Types at Coleman State Park.




Data source: Forest Type Map done by DRED staff (1997), based on a 400' grid plot. Complex Systems Research Center digitized stands into geo-referenced ACAD maps.  Map scale = 1:50,000.