



NEW HAMPSHIRE NATURAL HERITAGE INVENTORY

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Old Forests and Rare Plants at the Mount Sunapee Ski Lease Area



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New Hampshire Natural Heritage Inventory
& The Nature Conservancy
Concord, New Hampshire

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Department of Resources & Economic Development

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

The Natural Heritage Inventory 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 Inventory 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 Inventory 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 120 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 Inventory information. Our goal is to cooperate with public and private land managers to help them *protect* rare species populations and exemplary natural communities.

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EXECUTIVE SUMMARY

The NH Natural Heritage Inventory conducted an ecological inventory of the forested sections and lower ski run areas of the Mount Sunapee ski lease area in Mount Sunapee State Park to provide information to facilitate informed land use decisions for the ski area. The Department of Resources & Economic Development, through its Division of Forests & Lands and Division of Parks & Recreation, is responsible for managing State Forests and State Parks for timber production, recreation, and conservation. This responsibility requires the two divisions to consider and balance these activities based on the site specific characteristics and needs of each property.

Our study area, due to funding limitations, was restricted to the ski area leased to a private operator in 1998. We had two objectives in the project: (1) identify and assess exemplary forest natural communities — specifically mature forest old growth stands — and rare plant populations that had been previously reported within the ski lease area; and (2) provide management alternatives based on ecological considerations of areas that are important for the protection of New Hampshire's natural heritage.

More than 650 acres of Mount Sunapee were protected by the Society for the Protection of New Hampshire Forests in 1911 to protect "primeval forests" on the mountain from logging (Ayres 1915). These forests have remained uncut through the decades except for ski runs in the current ski lease area. We know, therefore, that nearly 100 years have passed with no cutting since these old growth stands were first recognized and protected. Today, these old growth stands are the only old growth forest remnants known in Merrimack County, NH.

NH Natural Heritage ecologists conducted three field visits to the ski lease area during the summer of 1998. We identified five distinct forest natural community types within the ski lease area. We characterized the condition of these communities in forest stands between cleared ski runs (referred to as "polygons") at three levels: (1) those with a relatively high concentration of old growth; (2) those with high-quality forest and small patches with old growth conditions; and (3) those with high-quality forest and little if any evidence of human disturbance, but lacking other facets of old growth forests.

Old growth in the Northeast is generally a mosaic of forest types and conditions (C. Cogbill, pers. comm.). The mosaic at the ski lease area is characterized by the various forested natural community types, various age classes, and differing forest conditions among forested polygons separated by ski runs. Compared to other old growth sites in New Hampshire and the Northeast, the ski lease area contains the same variability of forest age classes, patches of very old trees, diverse canopy structure, naturally regenerating forest species, and abundant dead woody material, as other confirmed old growth sites.

The presence of significant human influence (i.e. ski runs) at the ski lease area increases fragmentation, increases forest edge area, and reduces the overall area of intact, interior forest. The lack of human influence *within* polygons, however, supports its overall status as a good quality old growth site. Forested polygons surrounding and/or adjacent to confirmed old growth areas may serve an ecologically functional role in buffering old growth stands from disturbance. Because little is known about old growth, buffer dynamics, and the impact of ski-run development on old growth, NH Natural Heritage believes it is best to take a conservative approach and protect all elements of the forest mosaic.

We found one population of bog twayblade (*Liparis loeselii*), a state-threatened orchid, in the Duckling Slope below the Spruce Triple Chairlift. This wildflower grows in circumneutral seeps and other damp soils in or near wooded habitats. They are most likely surviving on the ski slope due to the seepy soils and open sunlight in part caused by management of the open ski run, and perhaps by locally enriched soil conditions. This population will most likely persist as long as these conditions remain unchanged, and as long as ski run mowing is limited to late summer, after the orchid has flowered and produced fruit. We did not find adder's-tongue fern (*Ophioglossum pusillum*), a plant that will be added to the NH Natural Heritage rare plant tracking list in 1999. This fern has been reported in the ski area in the past, and could still occur in seepy areas on ski runs.

Based on our findings, we have four primary recommendations for protection activities within the ski lease area:

1. **Protect old growth areas within the ski lease area.** The most effective alternative for long-term conservation is protection of the entire old growth and high-quality forest mosaic throughout the upper slopes of the ski lease area. A less conservative approach would be protection of a smaller forest mosaic that includes the densest concentration of old growth hardwoods.
2. **Develop a better understanding of the old growth forest matrix's role in the broader context of the State Park** by conducting a complete natural features inventory of the Mount Sunapee State Park with an emphasis on old growth.
3. **Limit cutting of all forested polygons to edges.** There will undoubtedly be instances where management of ski slopes is necessary. Managers can best protect broad forest processes by limiting alterations to forest edges only, and conducting clearing, ski trail and road maintenance, etc. in a way that minimally impacts interior forest conditions.
4. **Protect the bog twayblade population** by mowing the ski run after mid-August so the rare orchid has time to flower and disperse its seeds. Censusing the population annually or every few years will help us understand the influence of ski run management on the viability of this population's viability.

INTRODUCTION

The Department of Resources & Economic Development, through its Division of Forests & Lands and Division of Parks & Recreation, is responsible for managing state forests and state parks for timber production, recreation, and conservation. This responsibility requires the two divisions to consider and balance these activities based on the site specific characteristics and needs of each property. The NH Natural Heritage Inventory's ecological inventory of the forested sections and lower ski run areas of the Mount Sunapee ski lease area in Mount Sunapee State Park was designed to provide information to facilitate informed land use decisions for the ski area.

Our study area, due to funding limitations, was restricted to the ski area leased to a private operator in 1998. We had two objectives in the project: (1) identify and assess exemplary forest natural communities — specifically old and old growth stands — and rare plant populations that had been previously reported within the ski lease area; and (2) provide management alternatives based on ecological considerations of areas that are important for the protection of New Hampshire's natural heritage.

"OLD GROWTH"

"Old growth" forests in the Northeast are difficult to define. Some currently recognized elements of old growth forests include multiple age classes of trees, no known evidence of human disturbance, evidence of a future generation in the understory (regeneration), a large enough stand to sustain inherent ecological processes and native species, and a large percentage of trees near or at half their natural age limit, including shade tolerant species (Vermont Natural Heritage Program 1990). Other ecological facets of old growth forests generally include standing and fallen dead logs in all stages of decomposition, pit and mound topography from past tree tip-ups and decomposing logs and root masses, diverse structural components, and evidence of past natural disturbances (blow-downs, storm damaged trees, etc.) (Leverett 1996). Of the total forested acreage in the Northeast, only 0.4% is estimated to be "primary forest" (i.e. old growth) (Davis 1996). "Old growth" is used in this report to describe exemplary forest natural communities that exhibit a high number of the characteristics listed above.

A conference convening scientists and land managers to discuss eastern old growth (Harvard Forest, Petersham, MA, November 6–7, 1998) underscores the growing interest in studying and protecting ancient forests. While there are other known old growth sites in the Northeast today, recurring themes of the conference were that (1) old growth patch size is usually very small, (2) there are no universally accepted definitions of old growth, but most ecologists agree on the need for multiple definitions, each specific to particular types of forest and their inherent processes, (3) because we know of so few sites, there is a need to be conservative in our approach for protecting suspected old growth sites, and (4) old growth forests provide opportunities for scientific study, community classification, and education.

OLD GROWTH AT MOUNT SUNAPEE

The opportunity for protection, research, and education make old growth at Mount Sunapee unique in southern New Hampshire. This is the case for several reasons: (1) the old growth is on



publicly-owned land; (2) the mountain has a history of protection for the primary purpose of saving "primeval forest"; and (3) the old growth in Mount Sunapee State Park is currently the only known in Merrimack County.

In 1915, Philip Ayres of the Society for the Protection of New Hampshire Forests (SPNHF) described sections of the forests on Mount Sunapee as "primeval":

Wherever large spruce trees are found, either in pure stands or mingled with large hardwood trees, one may realize that he is in a primeval forest. No ancient stumps are found. A primeval forest is one in which no work has been done with the axe; not even the underbrush has been cut away. . . (Trees near the North Peak) are four feet or more in diameter, and probably more than one hundred and fifty years old. Everyone should be glad that these splendid trees have been saved.

While "most of the spruce trees had been removed [prior to 1909] . . . the hardwoods remained" (Ayres 1915). It was these remaining hardwoods, particularly on the north slope of the main mountain and on the north peak (Figure 1), that were considered old growth in the early 1900's. These forests have remained uncut through the decades except for ski runs in the current ski lease area. We know, therefore, that nearly 100 years have passed with no cutting since these old growth stands were first recognized and protected.

The original purchase of 656 acres in 1911 by SPNHF was initiated to protect land from extensive logging which started in 1906 (Ayres 1915). By 1934, SPNHF owned 1,185 acres, including cut-over and old growth forests. In 1948, the state took ownership of the mountain and opened the Mount Sunapee State Park with a ski area on the north face of the mountain (MacAskill 1981).

PROFILE SKETCH OF RESERVATION

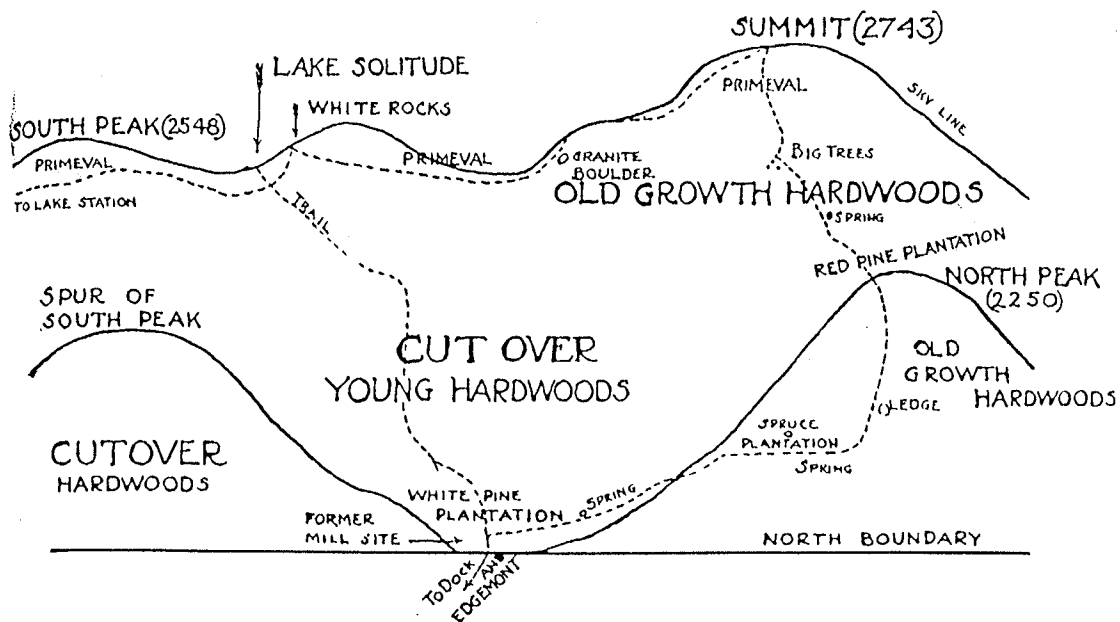


Figure 1. Profile sketch of the northern slope of Mount Sunapee (Ayres 1915).



Over the years, the presence of old growth on the mountain was largely forgotten until brought to the Division of Forests & Land's attention by Chris Kane (1997, Appendix 7) in response to the State's proposal to lease the ski area to a private operator. "The ancient forest on Mount Sunapee would appear to be not so much a discovery as a re-discovery" (Kane 1997). The state now has the opportunity to cooperate with individuals and organizations on many levels to study, evaluate, and continue the protection efforts that began at the beginning of the century and are consistent with protection objectives in the NH Forest Resources Plan (NH Division of Forests & Lands 1996) and recommended voluntary forest management practices (NH Forest Sustainability Standards Work Team 1997).

MOUNT SUNAPEE LEASE AREA LANDSCAPE DESCRIPTION

The ski lease area encompasses approximately 968 acres of forested and developed land on the northern slopes of Mount Sunapee, in Newbury and Goshen, NH. Ranging from approximately 1300' elevation at the base of the ski slopes to 2743' at the summit, forested natural communities follow a typical elevation-driven transition from hardwood forests at the lower and mid-slopes to subalpine spruce-fir forests at the summit. Mount Sunapee's slopes fall directly to the southwestern shore of Lake Sunapee, while Lake Solitude, Mountainview Lake, and Rand Pond circle the mountain on southwestern, northern, and western sides, respectively. Pillsbury State Park lies to the south, and is connected to Mount Sunapee State Park by the Pillsbury-Sunapee Corridor. Nearby peaks include Bald Sunapee to the east, Goves Mountain to the south, Thompson and Chandler Hills to the west, and Blueberry Mountain to the north. Overall, the area surrounding the ski lease area has a rich blend of topographic diversity (such as steep slopes, wetlands, and ponds) which supports an extensive array of plant and wildlife habitats.

A suite of environmental and physical processes influence canopy and understory species, particularly climate, weather, bedrock, surficial geology, and soils. The dominant bedrock type, early Devonian period (~400 million years old) Kinsman Granodiorite, is a mix of foliated granite and quartz diorite (Lyons *et al.* 1997). These igneous rocks are typical of central New Hampshire, and were formed deep under the earth's surface and only relatively recently exposed through uplift and erosion. At the height of the most recent glaciation (~20,000 years ago), Mount Sunapee bedrock surfaces were rounded, and a thin veneer of glacial till was deposited on slopes and valleys along the mountainside. Today, Hermon and Canaan-Hermon extremely stony sandy loams are the two dominant soil types (Soil Conservation Service 1965). These are characterized as highly acidic, granite-, gneiss-, and schist-derived till-based, somewhat excessively drained, thin soils that occur on 25–60% slopes. Several steeply entrenched intermittent streams cascade down the north slope in and around the ski slopes, and a small forested wetland sits along the side of the Sun Bowl chairlift's maintenance road at the headwaters of Johnson Brook (National Wetlands Inventory 1995).

The effects of weather are evident in the twisted trunks and broken branches of some trees. The major ice storm on January 7–16, 1998 was the most recent natural disturbance "event" evident in the ski lease area.



In between cleared ski runs, several forested natural community types follow an elevation/climate driven transition. The base and mid-slopes include a mix of northern hardwood tree species, including sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula allegheniensis*), American white ash (*Fraxinus americana*), and red oak (*Quercus rubra*). Subcanopy trees grow throughout most stands, and hobblebush (*Viburnum alnifolium*) and striped maple (*Acer pensylvanicum*) are common shrub associates in intact stands. Typical forest herbs include Canada mayapple (*Mainthemum canadense*) and intermediate fern (*Dryopteris intermedia*). Slopes are steep, with occasional areas of extremely steep ground with talus-like substrate (broken, loose rocks and boulders) supporting moss and fern species.

At higher elevations, red spruce (*Picea rubens*) becomes a major forest component, and between 2600' and 2743' elevation, stunted red spruce and balsam fir (*Abies balsamea*) (about 40 feet tall or less) are the dominant forest cover species. Sub-canopy and herbaceous species at high elevations included heartleaf birch (*Betula papyrifera* var. *cordifolia*), mountain ash (*Sorbus americana*), bunchberry (*Cornus canadensis*), and goldthread (*Coptis trifoliata*). Forest soils are thin or absent near the summit, and lichens dot the exposed bedrock. Early successional tree species, such as paper birch (*Betula papyrifera* var. *papyrifera*), grey birch (*B. populifolia*), and quaking aspen (*Populus tremuloides*) are common sub-dominant species, especially in forest gaps and along ski run edges.

The East Bowl Area (Appendix 7) extends to the east of the lease area. Old growth was reported from this area (Appendix 7), and views of large softwood crowns sticking up high above the hardwood canopy are evident from the midslope of several ski runs (Appendix 5). Although we did not visit or attempt to classify old growth in those areas, there is good evidence that more old growth forest is present in Mount Sunapee State Park outside of the ski lease area.

METHODS

NH NATURAL HERITAGE INVENTORY APPROACH

NH Natural Heritage inventories rare species throughout New Hampshire and classifies the natural community types in which these and other species occur. Natural communities and our approach to ranking significance are described below.

Natural communities are interacting assemblages of organisms that recur in particular physical environments. They are defined by NH Natural Heritage in cooperation with The Nature Conservancy (Sperduto 1994, 1996). "Exemplary" natural communities are rare types, such as rich mesic forests, and common types that have experienced little human influence. Exemplary natural communities represent the best remaining examples of New Hampshire's flora, wildlife habitat, and intact underlying ecological processes.

Natural communities form a mosaic across the landscape, and the ecological processes in one community influence those in neighboring communities. Land managers therefore cannot consider a given natural community occurrence in isolation. Further, boundaries between natural community types can be either discrete (and therefore easily identified in the field) or gradual (thus making some areas difficult map).



NH Natural 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 is uncommon, and a 5 indicating that the species or natural community is stable and common. Some species, such as Jesup's milk-vetch (*Astragalus robbinsii* var. *jesupi*), are critically imperiled both globally and in New Hampshire. This species has three known populations on the planet, all on a 16-mile stretch of the Connecticut River. Other species, such as small yellow lady's-slipper (*Cypripedium parviflorum*), are very rare in New Hampshire (S1) but quite common in other parts of their range (G5).

In addition to considering the rarity of a natural community or species as a whole, NH Natural Heritage ranks the quality of 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 *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 site 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 and/or may be too small in size and viability to be an A-ranked occurrence. A B-ranked population of a rare species occurrence is at least stable, grows in a minimally 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 and/or a small sized representative of the particular type of community. A C-ranked population of a rare species is in a clearly disturbed habitat and/or small in size and/or number, and possibly declining.
- D Poor Occurrence:** A D-ranked natural community is severely disturbed, its structure and composition are greatly altered, and recovery is essentially impossible. 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 disturbed and vulnerable habitat.

For example, consider a population of orchids growing in a bog that has a highway running along one border. The population may be large and apparently healthy (large *size* and secure *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*).



FIELD INVENTORY

Foresters with the Division of Forests & Lands conducted a rapid forest assessment in April, 1998 to inventory timber quality, species, and age in the ski lease area (Appendix 6). They assigned polygon numbers to each forest patch bounded by ski trails (Figure 3). NH Natural Heritage ecologists selected polygons with the highest potential for old growth forest characteristics, or with high potential for other high quality natural community characteristics, for further field work based on the foresters' polygon descriptions (Figure 2). We paid relatively less attention to polygons noted as second growth forests (Appendix 6).

We conducted field work on June 25 and 30, and July 1, 1998. We focused on natural community types and the characteristics relevant to evaluating old growth and exemplary status.

During field surveys, we recorded all plant species and estimated percent cover in several forest strata (canopy, subcanopy, shrub, herb layers) to classify forest natural community types. Descriptive notes were tallied in each polygon, including:

- average diameter at breast height (DBH), DBH range, and tree height for all canopy trees;
- relative ice storm damage;
- relative canopy health;
- relative standing and fallen dead woody material within the polygon;
- landscape position (e.g. slope and aspect);
- relative soil enrichment (based on the presence of enriched soil indicator species); and
- structural components, including relative dominance of canopy, subcanopy, shrub, and herb species.

We cored representative trees within stands to determine age structure and minimum old age of forest stands. A running species list for each of five forest community types was tallied as well. Finally, we searched base slopes for rare plants, especially in the wetter, seepy areas where the ski runs flatten near ski-lift sheds and lodges. We did not conduct field work outside the ski lease area boundaries as depicted in Figure 2.

Taxonomy follows Gleason and Cronquist (1991), and Flora of North America (1993). All natural community names are based on Sperduto (1996).

RESULTS

OVERVIEW

Five distinct natural community types were present in the forested polygons at the ski lease area (Appendices 1 & 2). We identified three levels of forest condition by polygon: (1) those with a relatively high concentration of exemplary old growth, (2) those with high-quality forest and small patches with old growth conditions, and (3) those with high-quality forest and little if any direct evidence of human disturbance (Figure 3, Appendix 1). These three levels of forest condition create a mosaic that is similar to other old growth sites in the Northeast — a mosaic of patches with variable age structure, variable physical canopy structure, and diverse species composition patterns. Among areas of extremely old trees, there are also areas of forest recovering from various natural disturbances. In most cases, there is little direct evidence of human influence, except in polygons with previous agricultural activity (Appendix 6) and the cleared ski runs between forest polygons.



Overall, forest polygons at the ski lease area were characterized by: a moderately mature to old structure; considerable dead wood — both standing and fallen — in various stages of decay; a mix of age classes; occasional pit and mound topography from tip-ups; considerable edge area along the ski-run borders; highly variable dominance by common northern hardwood species (sugar maple, beech, yellow birch); occasional mature red spruce trees within a hardwood matrix; and occasional pockets of soil enrichment with semi-rich indicator herbs and tree species. These features indicate a series of stands with fairly intact ecological processes and little recent observable human disturbance (except for fragmentation from ski run clearing and access roads). The summit stands were typical subalpine spruce-fir forests with more extensive fragmentation and clearing disturbance, mostly from ski and hiking trails, and various development (i.e. cable and snow-making pipes, ski-lifts, lodge impacts, etc.).

There was moderate to heavy ice-storm damage, as well as evidence of previous crown damage from prior storm events on the eastern portion of the ski area (Figure 4). Trees in the stands with moderate to heavy ice-storm damage also tended to show evidence of previous crown damage from natural disturbances, including gnarled, broken, or twisted trunks and crown branches. Otherwise, timber quality in mature stands was highly variable, from poor to high quality. There was considerably more ice damage in the southeastern portion of the park (Figure 4). In some cases, more than half of the trees had 50–75% crown damage, leaving a broken canopy, elevated light levels in the lower canopy and ground level, possibly relatively drier soil conditions, and an abundant network of broken branches and trunks on the ground.

We recorded 138 plant species (Appendix 4) throughout the study area, primarily in forested natural communities and in cleared ski runs. Natural communities were not classified in cleared areas.

DESCRIPTION OF FORESTED POLYGONS

We consider a portion of the ski lease area to be old growth (Figure 3). Old growth in the Northeast is generally a mosaic of forest types and conditions (C. Cogbill, pers. comm.). The mosaic at the ski lease area is characterized by the various forested natural community types, various age classes, and differing forest conditions among polygons. Compared to other old growth sites in New Hampshire and the Northeast, the ski lease area contains the same variability of forest age classes, patches of very old trees, diverse canopy structure, naturally regenerating forest species, and abundant dead woody material, as other confirmed old growth sites. The presence of significant human influence (i.e. ski runs) increases fragmentation, increases forest edge area, and reduces the overall area of intact, interior forest. The lack of human influence *within* polygons, however, supports its overall status as a good quality old growth site. Forested polygons surrounding and/or adjacent to confirmed old growth areas may serve an ecologically functional role in buffering old growth stands from disturbance. Because little is known about old growth, buffer dynamics, and the impact of ski-run development on old growth, NH Natural Heritage believes it is best to take a conservative approach and protect all elements of the forest mosaic.



We identified two polygons within the lease area that contained a relatively high proportion of exemplary old growth conditions. Six polygons contained smaller patches with old growth conditions and high-quality forest, and 15 others (including the summit) contained elements of high-quality forest condition with little or no evidence of human disturbance, but few if any other old growth characteristics (Figure 3). High-quality forest conditions include multiple age classes, standing and fallen dead wood, and other intact forest patterns and processes. These polygons are locally important for protection because they represent the best remaining forest in the ski lease area, they provide a necessary forest buffer for nearby old growth stands, and they contain small patches of old growth conditions that, in combination with the old growth throughout the State Park, contribute to the overall conservation value of the Mount Sunapee area.

In all cases, field notes from Forests & Lands foresters John Accardi and Ken Desmaris were similar with our assessment, and indeed, were instrumental in preliminary identification of old growth areas (Appendix 6). In addition, the best examples of old growth we found at the ski lease area corresponded to Chris Kane's initial old growth assessment (Appendix 7).

Although old growth conditions do not persist throughout entire forested polygons, each polygon is treated here as a distinct unit for mapping purposes. Ski runs delineate mapping units while also imposing a distinct barrier in the landscape influencing forested condition and landscape context (i.e. ecological patterns and processes). While they may be useful landscape units for management purposes, they may not be the best ecological units for delineating forest condition. However, as intact units they not only help us locate old growth areas, but also provide a minimal buffer of intact forest surrounding old growth areas.

Polygons with high proportion of exemplary old growth

Polygon 23 / North Peak Area

This polygon coincides closely with the North Peak area identified by Chris Kane (1997) as containing areas of old growth (Appendix 7). It is a relatively large polygon that extends from the Sun Bowl chairlift's maintenance road (approximately 1700' elevation) to the North Peak (2250' elevation). The central portion of the polygon, a northeast facing steep band between 1700' and 2050' elevation, supports a semi-rich mesic sugar maple-beech forest.

Large, old trees grow along this steep section, with fewer old trees and more acidic conditions on the northwest portion of the polygon. Indicators of enrichment include dominance by white ash and sugar maple, alternate leaf dogwood (*Cornus alternifolia*) in the shrub layer, and a relatively high species richness of herbaceous plants, including Christmas fern (*Polystichium acrostichoides*), sweet cicely (*Osmorhiza claytoni*), and doll's-eyes (*Actaea pachypoda*). Black cherry (*Prunus serotina*) also occurs in the canopy. Other old growth characteristics in this portion of polygon 23 include evidence of previous crown damage, abundant standing snags and coarse woody debris, and pit and mound microtopography. This polygon was heavily damaged by the January 1998 ice storm, and there are many broken tree limbs and shattered canopies throughout the polygon.

Superlative tree sizes (based on DBHs) include sugar maple with 29–36" DBHs, a 30" yellow birch, and a 34" white ash. Some of the oldest cored trees revealed ages for sugar maple (90,



108, 153, 178 years old) and a 31" tree with a rotten core that we estimated close to 330 years old, white ash (90 years old), red spruce (103 years old), and an estimate of 150–165 years old for other hardwoods (Appendices 6 & 7).

Ayres (1915) also mentions the North Peak area as containing "some of the original hardwoods, trees sixty to seventy feet tall, very large, and standing thick together." In addition, "one passes through a fine bit of primeval forest in climbing the steep ascent after leaving North Peak" (Ayres 1915).

Polygon 20 / East Bowl Area

The East Bowl, the "amphitheatre" described by Ayres (1915) below the South Peak, also contains "primeval" forest. Polygon 20 represents the portion of the East Bowl within the ski lease area. It is cradled between the two straight sections of the Williamson Trail (formerly the Porky Trail) and extends from the end of the Sun Bowl chairlift's maintenance road (1660' elevation) up to 2450', only 300' below the summit. The oldest sections we encountered were near the middle of the polygon on steep northeast facing slopes. The relative scarcity of semi-rich indicator species, as well as the presence of red spruce in the canopy, classified this polygon as primarily a northern hardwood-spruce-fir forest.

Typical northern hardwood species (sugar maple, beech, yellow birch) and red spruce were the dominant canopy species; with beech and red spruce the most common regenerating species. Hobblebush and striped maple were common shrubs, while intermediate wood fern, blue-bead lily (*Clintonia borealis*), whorled aster (*Aster acuminatus*), and wood sorrel (*Oxalis acetosella*) were among the common woodland herbs.

Among the larger (based on DBH) and older trees in the East Bowl area (including areas not within the ski lease area but still on state land) were yellow birches of 41" and 30" (228 years old from only 8" of intact core), and a 29" red spruce (249 years old) (Appendix 3 & 7). Tree cores from polygon 20 included an 85 year old sugar maple and a 160 year old red spruce (Appendix 6).

Polygons with high-quality forest and smaller areas with old growth conditions

Many other polygons exhibit elements of old growth conditions, but there is currently not enough conclusive evidence to know for certain whether these are old growth stands or simply old forest. For example, we extracted cores of old individual trees (Appendix 3), but few other classic old growth characteristics were observed. Several polygons had small patches of old growth conditions within a less mature forest matrix. In addition, there is mention of "primeval" forest in various sections in historical literature but we have little evidence to substantiate old growth *per se*. For example, Ayres (1915) writes "only a few of these [red spruce] trees [at the summit] are more than one foot through; yet many of them are more than two centuries old." However, many of these areas have been heavily impacted by management of the ski area, thereby lowering their quality as components of the landscape-level forest ecosystem.



Polygon 18

This forest patch sits directly to the northwest of polygon 20, between the Wingding ski trail and the Sun Bowl chairlift. The fairly linear polygon is dumbbell shaped from upslope to downslope, ranging from 2025' to 2370' in elevation. Because it is a narrow and relatively small polygon, there is considerably more edge effect reaching into interior forested portions.

Polygon 18 is primarily a sugar maple-beech-yellow birch forest, with occasional red spruce in the canopy. Canopy DBHs range up to 28" for hardwoods, with dead yellow birch snags as large as 30". Many large, old rotting stumps (mostly yellow birch) are scattered throughout the polygon from trees that have died and fallen, contributing to the coarse woody debris and pit and mound topography on the forest floor. Beech was the most prominent regenerating tree, with a well developed shrub layer consisting of hobblebush and striped maple. Herb cover was similar to polygon 20. Ice storm damage appeared moderate to heavy, with occasional wide open gaps from broken trunks or branches, with older coarse woody debris mixing with dead branches fallen during the storm.

One hundred thirty and 101 year old red spruces were cored, while dead yellow birches may have been as old as 150 years before falling over or rotting into current standing snags (Appendix 6).

Polygon 21

This polygon sits at the watershed break between the East Bowl and North Peak old growth areas, and was identified as second growth timber by Forests & Lands foresters (Appendix 6), but there are elements of high quality natural community dynamics present throughout the polygon. Both northern hardwood-spruce-fir forest and semi-rich mesic sugar maple-beech forest natural communities are present, with enriched conditions most prevalent in the concave topography, which produces a broad, sloping drainage to the east. Large white ash (one 32" DBH individual was approximately 130 years old) shared dominance in the canopy with sugar maple, while beech and sugar maple were the dominant regenerating species. Timber quality was high in this stand before the ice storm (Appendix 6), with moderate amounts of dead woody debris throughout.

Polygons 30 and 32

We treated these two polygons as one. They are separated by a linear swath of regenerating hardwoods left over from an abandoned chairlift to the summit, but the forest canopy is currently closing over this corridor. To the west, the two polygons are bound by the Chase Ledges ski trail, and to the east by an abandoned chairlift corridor parallel with the Upper Flying Goose ski trail. Taken together, they extend from the North Peak Lodge at 1320' elevation to the top of North Peak at about 2250' elevation. There are two distinct swaths of older forests near the mid-elevation and near the top of the polygons, and numerous smaller areas of high quality and old forest characteristics warrant special attention.

These polygons are primarily a northern hardwood-spruce-fir forest, with red spruce more common than balsam fir throughout. Early successional species at the lowest elevations give way to more mature canopy conditions upslope. Northern hardwood trees are dominant throughout the canopy, with DBH's ranging to 22". A slightly enriched assemblage of tree and herb species along the lower elevations quickly graded into a typical, acidic northern hardwood



forest. Patches of thick shrubs and subcanopy trees were common throughout, while tree DBH's increased with increasing elevation. The mid-elevation swath contained many large hardwood trees and red spruce, while near the top of polygon 30, large sugar maple and beech dominated the overstory. Gnarled, paper birch were common in the steepest sections near the top as well.

The oldest tree cores included a 29.5" DBH sugar maple near the highest portion of polygon 30 at approximately 183 years old, another sugar maple at 150 years old, and a 180 year old red spruce.

Polygon 2

Polygon 2 was identified as second growth (Appendix 6), but it is a high quality sugar maple-beech-yellow birch forest. Large hardwoods, with DBHs exceeding 30" (one white ash was cored yielding 85 years), slightly enriched condition along the drainage, and the polygon's relatively large size make this a noteworthy stand.

Polygon 3

Polygon 3 was highly variable in forest cover and condition. A spruce-fir flat forest growing in somewhat wet soil near the base of the polygon graded into a northern hardwood-spruce-fir forest higher up in the polygon. Several old trees were cored from this polygon, including a 150 year old sugar maple and a 180 year old spruce. There appear to be patches of old red spruce and "forest primeval" with abundant dead woody debris and multiple age classes (Appendix 6). Beech and red spruce appear to be the most common regenerating trees throughout the polygon.

Polygons with little or no evidence of human disturbance

The remaining polygons we surveyed (polygons 5, 10, 11, 14-17, 19, 22, 24-26, 28, 51-54) appeared to be recovering from previous disturbances, but had no clear evidence of recent human influence except ski runs on the edges (Figure 3). These forests had little, if any, clear evidence of old growth. They may, however, serve a functional role in protecting old growth areas as buffer, either by maintaining important forest ecosystem processes with adjacent polygons, or by protecting adjacent polygons from potential disturbances. It is difficult to predict the effects of human activities on old growth stands, and thus define protective buffers, because so little is known about the dynamics of these forests, especially when the stands are within a network of ski runs. The ski lease area therefore offers an unprecedented opportunity for studying these effects in New Hampshire.

Appendix 7 contains descriptions of polygons not visited by NH Natural Heritage ecologists.

QUALITY RANK OF OLD GROWTH FOREST IN THE SKI LEASE AREA

NH Natural Heritage considers the forests at the ski lease area to be a single site with a mosaic of forest conditions and ages. We therefore assign the quality rank to the area as a whole, not to individual polygons.

Size = B-: The old growth at the ski lease area is comparable in age to other old growth northern hardwood forests in the region, and in acreage to other southern old growth. Therefore, its size is considered good.



Forest Conditions and Conservation Approaches at Mount Sunapee Ski Lease Area

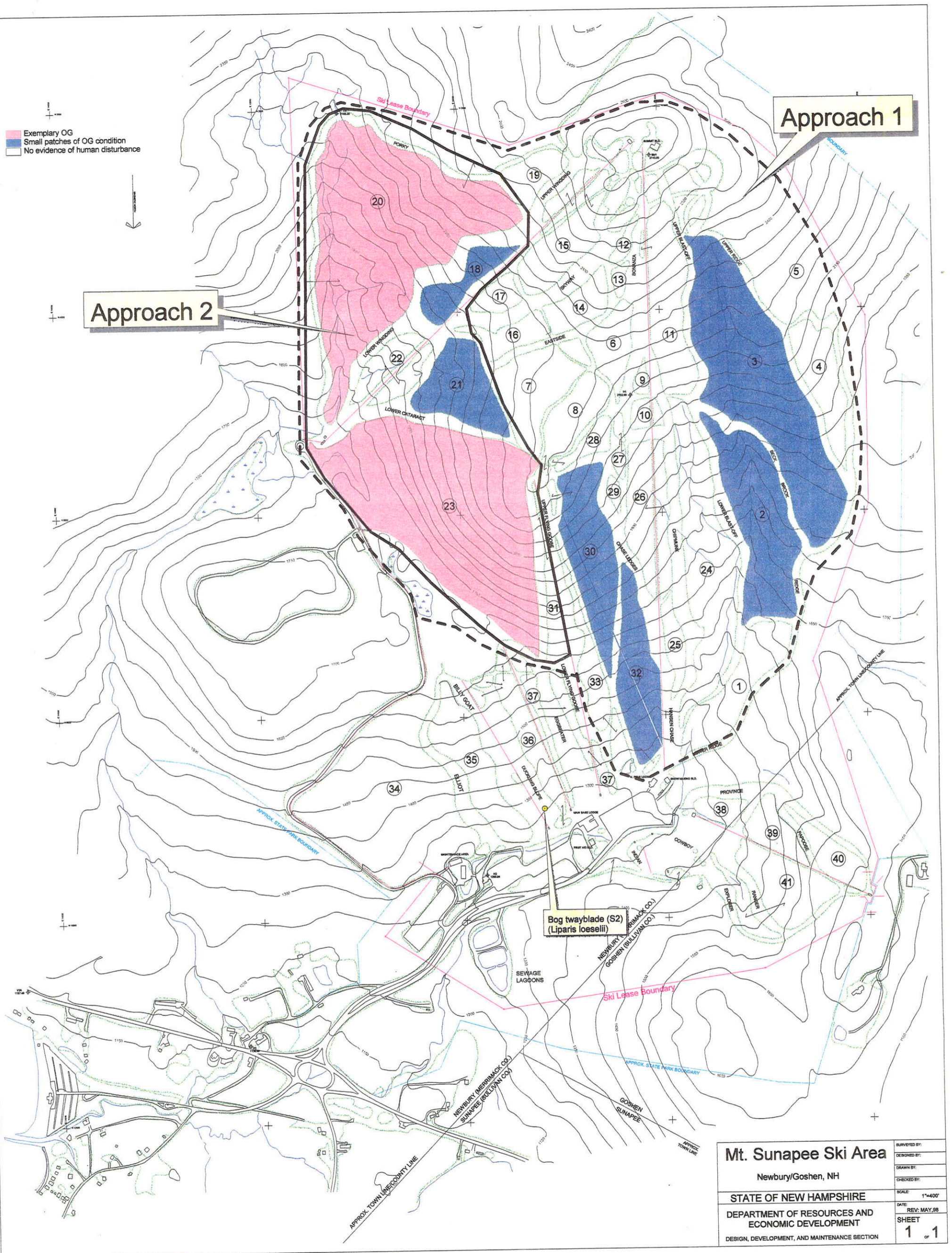


Figure 3. Map of Mount Sunapee ski lease area. Polygons within dotted line all had little or no evidence of human disturbance ("No Evidence of Human Disturbance"); blue polygons had high quality forest with small areas of old growth conditions ("Small patches of OG Condition"); and red polygons had a high proportion of exemplary old growth ("Exemplary OG"). Approach 1 (within dotted line) refers to the best conservation approach; Approach 2 (within solid line) refers to the less conservative approach (see Recommendation 1). A yellow dot marks the approximate location of bog twayblade.

Ice Damage at Mount Sunapee Ski Lease Area

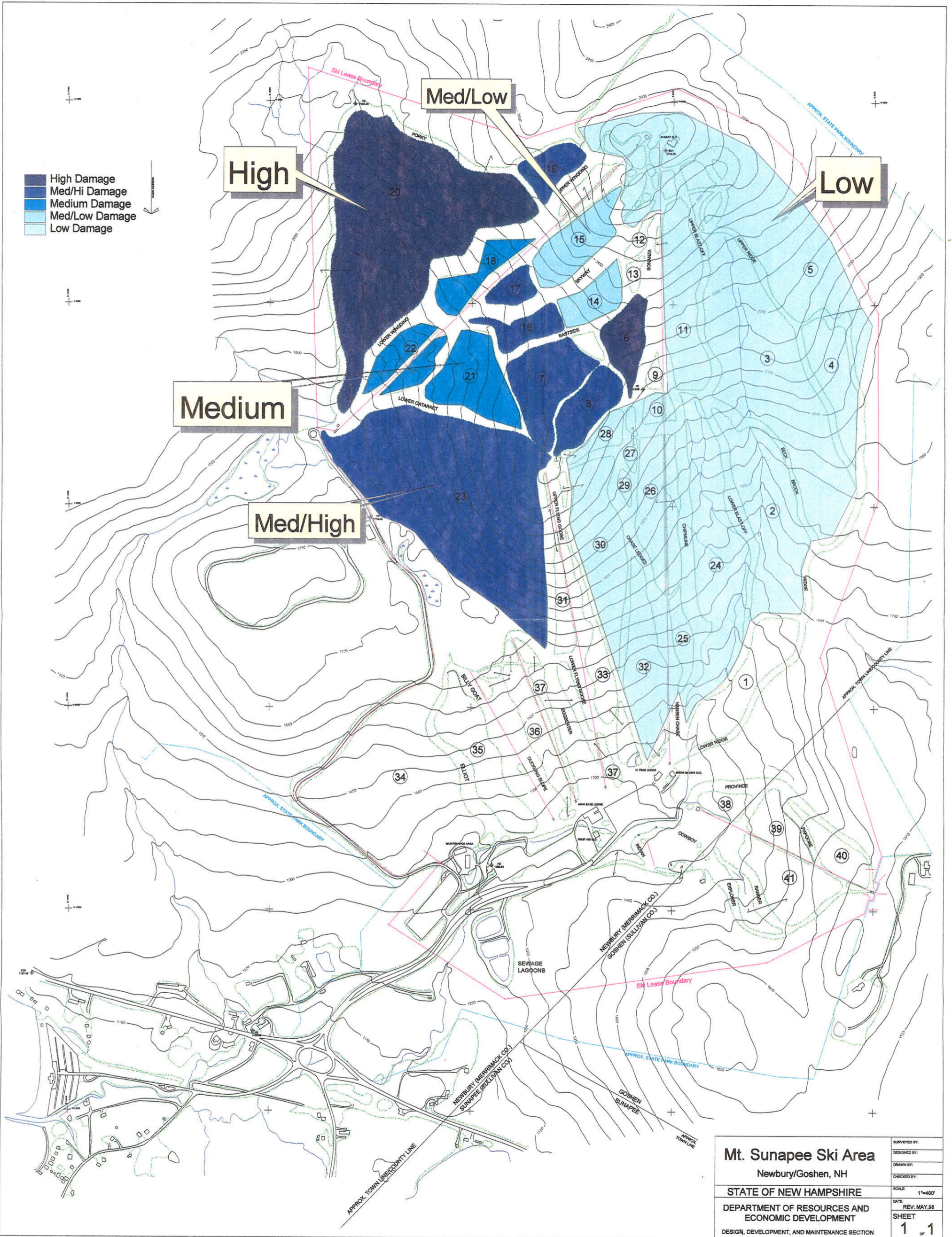


Figure 4. Relative ice damage at Mount Sunapee ski lease area, 1998. Qualitative estimates of damage to canopy trees was compared among polygons, and based on the number of trees damaged and the amount of canopy loss per tree.

Condition = B: By definition, the old growth areas have no evidence of human disturbance, and are thus considered to exhibit excellent *condition*. However, the presence and management of ski runs impose a unique series of conditions that degrade the *condition* of the site. Unfortunately, we do not currently know the extent of their influence or their impact on the current forest condition. The rank is lowered due to the obvious human influence.

Landscape Context = B-: The site has more human disturbance than other old growth sites due to ski run development, but the landscape-scale pattern of surrounding forested tracts provides the ski lease area with considerable surrounding forest. The *landscape context* rank, therefore, balances on-site disturbance with larger landscape features.

Overall Quality Rank = B-: The following is a summary of the ranking of the old growth forest mosaic at the ski lease area:

<u>Attribute</u>	<u>Rank</u>
Size	B-
Condition	B
<u>Landscape Context</u>	<u>B-</u>
Quality Rank	B-

This rank is subject to change, especially if NH Natural Heritage finds that old growth extends further into the East Bowl portion of Mount Sunapee State Park across the ski lease area boundary. There is also ample opportunity to study the effects of ski-run development on current forest conditions. Finally, because it is one of the very few old growth sites south of the White Mountains, it is highly significant from an ecological and conservation perspective.

RARE PLANTS

We found one state rare plant, bog twayblade (*Liparis loeselii*) within the lease area, near the base of the Duckling Slope just west of the lower portion of the Spruce Triple Chairlift (Figure 3). Bog twayblade is a state-threatened orchid with only six populations reported in New Hampshire in the last 20 years. This wildflower grows in circumneutral seeps and other damp soils in or near wooded habitats. They are most likely surviving on the ski slope due to the seepy soils and open sunlight in part caused by management of the open ski run, and perhaps by locally enriched soil conditions. This population will most likely persist as long as these conditions remain unchanged, and as long as ski run mowing is limited to late summer, after the orchid has flowered and produced fruit.

QUALITY RANK FOR THE BOG TWAYBLADE POPULATION

Rare plants are also ranked based on their population *size*, *current condition*, and *landscape context*. The bog twayblade at Mount Sunapee has a medium to small population, in fairly good condition, in a marginal habitat. While most individuals were flowering, we found only 17 individual plants. With careful monitoring and management, this population should persist, but its quality rank reflects its current marginal status.

<u>Attribute</u>	<u>Rank</u>
Population Size	C
Condition	B-
<u>Landscape Context</u>	<u>B-</u>
Quality Rank	B-



MANAGEMENT RECOMMENDATIONS

The purpose of NH Natural Heritage's study of the ski lease area was to provide information to facilitate informed land use decisions for the ski area. Our mission is to facilitate conservation of New Hampshire's biodiversity and the ecological processes that maintain it. Our recommendations below reflect this mission, and are based on the best available information and ecological considerations. We have not considered the timber management and recreation objectives and needs for the ski lease area; these considerations will need to be blended with our recommendations to identify appropriate activities within the ski lease area.

Based on our findings, we have four primary recommendations for protection activities within the ski lease area:

1. **Protect the forest mosaic within the ski lease area.**

The forest within the ski lease area is characterized by a mosaic of forest types and conditions which include old growth, but which is fragmented by ski runs. Some of the polygons within the old growth site have relatively high concentrations of old growth patches, others have small patches with elements of old growth condition surrounded by high-quality forest, and many are high-quality forest with little if any direct evidence of human disturbance.

Davis (1996) estimated that 99.6% of forested areas in the Northeast are *not* old growth, meaning that only a tiny fragment of these important forest ecosystems remain. Because so little old growth is left, all sites in New Hampshire are ecologically significant, in addition to providing excellent opportunities for education and study.

APPROACH 1 - The best conservation approach would be to protect in perpetuity the entire mosaic of forest types, including old growth, to protect the assemblage of forest conditions and elevate the significance and viability of the site through time ("Approach 1" on Figure 3). The upper slopes of the ski lease area represent a mosaic of forest conditions that are ecologically significant and add to the ecological, conservation, and educational value of the old growth site.

APPROACH 2 - A less conservative approach would be to focus on the smaller polygon group that contains a less extensive forest mosaic but includes the densest concentration of old growth ("Approach 2" on Figure 3). The more forested area that is protected around this core area, the lower the potential for additional fragmentation in the future.

No cutting of timber or other soil disturbance should be allowed in protected areas. One of the essential elements of old growth is the absence of any discernible human influence. This does not mean that cutting has never taken place at a specific old growth location, only that there is no longer any evidence of such disturbance. In the case of old growth, "management" necessarily means no human influence. Cutting of timber or soil disturbance could alter ecological processes in ways that could influence natural forest dynamics.

The effects of the January 1998 ice storm do not preclude damaged stands from maintaining the status of old growth. The persistence of natural ecological processes is one



element of old growth, and impacts from periodic storm events is clearly an example. In fact, evidence of crown damage from previous storms was a common characteristic in the oldest stands within the lease area. Northern forests have evolved to withstand periodic disturbances of this type. In addition, forests remain viable as long as the forest patch is large enough to withstand such periodic and patchy disturbances. There is evidence to suggest that storm cycles on the order of hundreds of years may have determined the age limit of northeastern trees and forest processes over evolutionary time periods (C. Cogbill, pers. comm.).

2. Conduct a complete forest and natural features inventory at Mount Sunapee State Park.

The old growth forests at the ski lease area may be only a portion of the overall old growth forest at Mount Sunapee State Park. A full study of the area should be undertaken to improve our understanding of the State Park's forest history and ecological processes. This study would include more intensive assessments of the old growth stands in the ski lease area and identification and assessment of old growth areas elsewhere in the State Park. The additional research would allow NH Natural Heritage to map forest communities and old growth areas, establish long-term study areas for monitoring forest dynamics over time, and develop a clearer picture of old growth distribution and processes on Mount Sunapee.

Forest and natural community inventory work at Mount Sunapee (as well as regionally!) is not sufficient to completely understand old growth ecology, what constitutes sufficient buffer forests, and how old growth contributes to biological diversity within New Hampshire and the Northeast. New discoveries and study of old growth throughout New England, and especially near or on ski resorts (e.g. Wachusett Mountain in Massachusetts) add to our understanding of these ecosystems. Management, research, and protection decision-making would benefit from dialogue with, and perspectives of scientists and land managers familiar with, such comparable sites. Mount Sunapee should be a part of the expanding research and protection efforts in the region.

3. Attempt to limit cutting of unprotected forest polygons to their edges.

There will undoubtedly be instances where management of ski slopes is necessary. Managers should limit alterations to forest edges, and clearing, equipment and road maintenance, etc. should be done in a way that minimally impacts interior forest conditions. Some forest stands between ski runs may be so narrow that edge effects from one side effectively overlap with edge effects from the other side.

4. Protect the bog twayblade population.

This state-threatened orchid is protected by the NH Native Plant Protection Act of 1987 (NH RSA 217-A). Since the population grows on the cleared area at the base of the Duckling Slope, its persistence is dependent on the timing of clearing or mowing activities to keep the trail open. Bog twayblade generally flowers in mid-summer and will produce and drop seeds by mid- to late August. It currently appears to be maintaining a stable population, in part because of the seepy soils and open aspect of the ski trail. Mowing in late August or early September should help to maintain the population at current levels. Censusing the population annually or every few years will help NH Natural Heritage track its condition.



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Appendix 1. Relevant notes on forested polygons at Mount Sunapee Lease Area. "Date" = date visited by NHHHI Ecologists; "NC" = natural community type (Sperduto 1996); NHF - Sugar maple-beech-yellow birch forest; NHSF - Northern hardwood-spruce-fir forest; SRMF - Semi-rich mesic sugar maple-beech forest (Semi-Rich Mesic Forest); MSF - High elevation mountain spruce-fir forest; "Ice" = relative ice damage (based on percent of canopy loss); "Notes" = ecological parameters important within the polygon; JA,KD refers to notes taken by Division of Forests and Lands foresters John Accardi and Ken Desmarais (Appendix 6).

Polygon #	Date	NC	Ice	Notes
2	7/1	NHF *	low	Pockets of white birch (<i>Betula papyrifera</i>); weak enriched conditions along steeply entrenched drainage; beech (<i>Fagus grandifolia</i>) dominant in some areas; early successional species on east side of polygon; medium crown damage; occasional canopy red oak; occasional very large hardwood trunk (>30" DBH). Second growth; very good site (JA,KD)
3	6/30 7/1	NHSF, MSF *	low	Areas of wet soil with red maple (<i>Acer rubrum</i>); red spruce (<i>Picea rubens</i>) and balsam fir (<i>Abies balsamea</i>) on flats at lower elevation; northern hardwood species upslope; abundant rocky moss cover; low crown damage; dense shrub layer downslope; grades into northern hardwoods to west. 180 year old red spruce; pockets of "forest primeval" (JA,KD)
5	6/30	NHSF, MSF	low	Spruce-fir at highest elevations near the summit; transitional forest at middle elevation; dead wood throughout; some previous crown damage.
10	7/1	NHSF	low	Thick shrub layer. 95 year old sugar maple (<i>Acer saccharum</i>); possibly enriched (JA,KD).
11	6/30	NHSF	low	Thick subcanopy; DBH increases upslope; transitional to spruce-fir upslope; occasional large yellow birch.
14	6/30	NHF	low, med	White and yellow birches common in canopy; sugar maple dominance increases downslope; medium crown damage; blowdown gaps occasional; ice damage increases downslope; 165 red spruce; upper portion older (JA,KD).
15	6/30	NHSF	low, med	Transitional to spruce-fir upslope; evidence of glade ski run, intermediate wood fern (<i>Dryopteris intermedia</i>) cover high on the forest floor; stand fairly disturbed overall
16	6/25	NHSF	med , high	40" yellow birch snag along northern edge of polygon.



17	6/25	NHSF	high	Eastern edge more disturbed; fairly thick subcanopy and shrub layer; occasional canopy red spruce; evidence of previous crown damage.
18	6/30	NHF *	med	Fairly thick subcanopy and shrub layer; previous crown damage; high amount of standing and fallen dead wood, including stumps. Possible old growth; multiple age classes, dead wood abundant, early damage (JA,KD)
19	6/30	NHSF, SRMF	med ,high	Weakly enriched, heart-leaved white birch (<i>Betula cordifolia</i>) appears with increase elevation; evidence of previous crown damage.
20	6/30	NHSF **	high	Previous crown damage evident; standing dead snags common; occasional large mature (>35") hardwoods (primarily sugar maple and beech). 160 red spruce, although small, lower stand is younger (JA,KD).
21	6/30	NHF, SRMF *	med	Weakly enriched pockets; semi-rich forest species common along drainage. Second growth, high quality timber (JA,KD).
22	6/25	SRMF	med	Weakly enriched conditions and indicator species throughout polygon. Second growth, high quality timber (JA,KD).
23	6/25	SRMF **	med ,high	High quality stand / old growth along steep mid-slopes, with pocket of old trees; scattered enriched indicator herbs; white ash (<i>Fraxinus americana</i>) and sugar maple dominant; evidence of previous crown damage; abundant standing and down dead wood; pit and mound microtopography; northwest side less enriched; several hardwoods >30" DBH.
24	7/1	NHF	low	Red maple (<i>Acer rubrum</i>) and hemlock (<i>Tsuga canadensis</i>) in wetter areas; yellow birch common upslope, with hemlock in the understory; DBHs range between 18"-24" for red oak (<i>Quercus rubra</i>), and big-toothed aspen (<i>Populus grandidentatum</i>) midslope; pockets of white birch; evidence of slight enrichment downslope; occasional red oak in canopy; glade signs tacked on several trees throughout polygon. Primarily second growth (JA,KD).
25	7/1	SRMF, NHF	low	Evidence of enrichment on lower slopes; clear edge effect along slopes; some wet red maple sections.



26	7/1	NHF	low	White ash and red oak scattered throughout polygon; hemlock and hardwood species common upslope. Upper slope may be older/large trees (JA,KD).
28	7/1	NHF	low	Several large (20" DBH) canopy red spruce; large dead standing snags (25-35" DBH) throughout polygon. A few old spruce (180) within younger hardwoods (JA,KD).
30,32	7/1	NHSF *	low	Lower slopes weakly enriched; lowest slopes contain early successional species; old chairlift contains a swaths of regenerating subcanopy hardwoods; occasional thick patches of subcanopy hardwoods; tree DBHs increase upslope; occasional canopy and subcanopy hemlocks; patches of older/old growth forest, with big trees with large canopies. Dead and down material; upper and middle regions may be older growth, with swath of young stand centrally (JA,KD).
Summit	6/30	NHSF, MSF	low	Rock outcrops scattered; spruce and fir stunted and flagged from harsh wind and temperature; lower summit transitional to puresubalpine spruce-fir at summit.

* indicates patches of locally significant, high quality forests within the polygon

** indicates exemplary, old growth forest condition within polygon

+ indicates polygon number assigned by NHNHI Ecologists



Appendix 2. Location of forested natural communities at Mount Sunapee Lease Area. State Ranks are given (S1 is most rare to S5, most common). Several polygons have more than one forest natural community type. See Sperduto (1996) for a more complete description of natural communities listed here.

Natural Community (Sperduto 1996)	Polygons
Sugar maple-beech-yellow birch forest; S5	2*, 14, 18*, 21*, 24, 25, 26, 28,
Northern hardwood-spruce-fir forest; S4	3*, 5, 10, 11, 15, 16, 17, 19, 20**, 30*, 32*, 41, 42, 43, 44
Semi-rich mesic sugar maple-beech forest; S3S4	19, 21*, 22, 23**, 25
High Elevation mountain spruce-fir forest; S4	3, 5, 51, 52, 53, 54, Summit

* locally significant, high quality forest within polygon

** exemplary, old growth conditions within polygon



Appendix 3. Tree cores taken at Mount Sunapee Lease Area and old growth areas on Mount Sunapee State Park. "Date" = date tree cores taken; "Spp" = tree species; "Polygon" = forested area depicted on Figure 1; "#Rings" = tree rings on core; "GD" = estimated germination date for tree; "Est. Rings" = estimated number of rings based on number of rings missing from tree core (from the center of the tree and/or estimated based on growth rate and length of readable portion of core); "Source" = who took core (DRED = Forests and Lands foresters John Accardi and Ken Desmarais; NHHNI = NHHNI Ecologists; KANE = Ecologist Chris Kane); "Notes" = relevant notes on core, including an estimate of the additional number of years--Rings to center--missed by core. Bolded core ages exceed 200 years old.

Date	Spp	Polygon	DBH	#Rings	GD	Est. Rings	Est. GD	Source	Notes
4/98	Pinus strobus	A		90	1908			DRED	
4/98	Picea rubens	B		90	1908			DRED	
4/98	Pinus strobus	1		90	1908			DRED	
4/98	Fraxinus americana	2		85	1913			DRED	
4/98	Acer saccharum	3		150	1848			DRED	
4/98	Fraxinus americana	3		75	1923			DRED	
4/98	Picea rubens	3		180	1818			DRED	
6/30/98	Picea rubens	3	18.5	84	1914	94	1904	NHHNI	Rings to center (5); release at 60 years ago
6/30/98	Picea rubens	5	14.5	102	1896	111	1887	NHHNI	Rings to center (4-5); tightest growth 50-90 years ago
6/30/98	Picea rubens	5	12	54	1944	63	1935	NHHNI	Rings to center (4-5); even growth
6/30/98	Picea rubens	5	17.5	108	1890	115	1883	NHHNI	Rings to center (2-3); very tight 20-70 years ago; release >70 years ago
4/98	Acer saccharum	6		75	1923			DRED	
4/98	Fagus grandifolia	7		75	1923			DRED	
4/98	Acer saccharum	10		95	1903			DRED	
4/98	Acer saccharum	11		90	1908			DRED	
6/25/98	Acer saccharum	13	25	204	1794	214	1784	NHHNI	Rings to center (5-10); Tightest 60-90, 150-170
4/98	Picea rubens	14		165	1833			DRED	
4/98	Picea rubens	15		102	1896			DRED	
4/98	Fagus grandifolia	16		128	1870			DRED	
4/98	Picea rubens	18		130	1868			DRED	
6/30/98	Picea rubens	18	27.7	101	1897	107	1891	NHHNI	Rings to center (1-2); steady, fast growth
6/30/98	Acer saccharum	19	26.5	105	1893	118	1880	NHHNI	Rotten center; 4" missing from core; even growth



6/30/98	Acer saccharum	19	21	128	1860	135	1853	NHNHI	Rings to center (2-3); 50-70 y.a. tightest growth
4/98	Acer saccharum	20		85	1913			DRED	
1997	Betula allegheniensis	20	30	228	1770			KANE	East Bowl area
1997	Betula allegheniensis	20	18.5	153	1845			KANE	East Bowl area
4/98	Picea rubens	20		160	1838			DRED	
1997	Picea rubens	20	29	249	1749			KANE	East Bowl area
1997	Picea rubens	20	15.6	206	1792			KANE	
6/30/98	Picea rubens	20	13	74	1924	84	1914	NHNHI	Rings to center (5-10); very tight 60-74 years ago
4/98	Fraxinus americana	21		83	1915			DRED	
6/30/98	Fraxinus americana	21	32	92	1906	126	1872	NHNHI	not to center; 5" missing from core; even growth
4/98	Picea rubens	22		125	1873			DRED	
1997	Acer saccharum	23	28	153	1845			KANE	North Peak area
6/25/98	Acer saccharum	23	31	238	1733	269	1669	NHNHI	not to center, 3.5" missing; tight growth at center
6/25/98	Acer saccharum	23	29	102	1896	108	1890	NHNHI	Rings to center (1-2); fat rings, even growth
4/98	Acer saccharum	23		90	1908			DRED	
6/25/98	Acer saccharum	23	23	170	1828	178	1820	NHNHI	Rings to center (3-4); hard to read; maybe off by 10 years(?)
4/98	Fraxinus americana	23		90	1908			DRED	
4/98	Hardwoods	23		150- 165	1833- 1848			DRED	
1997	Picea rubens	23	17	103	1895			KANE	
4/98	Fraxinus americana	24		90	1908			DRED	
4/98	Picea rubens	24		120	1878			DRED	
4/98	Picea rubens	24		120- 154	1844- 1878			DRED	
4/98	Quercus rubra	24		90	1908			DRED	
4/98	Betula allegheniensis	26		90	1908			DRED	
4/98	Picea rubens	28		180	1818			DRED	
4/98	Acer saccharum	30		150	1848			DRED	
4/98	Picea ribens	30		110	1888			DRED	



4/98	Picea rubens	30		180	1818			DRED	
4/98	Quercus rubra	31		90	1908			DRED	
7/1/98	Acer saccharum	32	29.5	98	1885	164	1815	NHNHI	Core is only 5.5"; rotten center; tightest growth at bark end
4/98	Picea rubens	34		125	1873			DRED	
4/98	Picea rubens	35		116	1882			DRED	
4/98	Quercus rubra	41		70	1928			DRED	



Appendix 4. Species recorded at Lease Area, Mount Sunapee State Park, 1998.

Trees

American beech (*Fagus grandifolia*)
balsam fir (*Abies balsamea*)
black cherry (*Prunus serotina*)
heartleaf birch (*Betula papyrifera*) var. *cordifolia*
ironwood (*Ostrya virginiana*)
paper birch (*Betula papyrifera*) var. *papyrifera*
red oak (*Quercus rubra*)
red spruce (*Picea rubens*)
red maple (*Acer rubrum*)
sugar maple (*Acer saccharum*)
white ash (*Fraxinus americana*)
yellow birch (*Betula alleghaniensis*)

Shrubs

alternate-leaved dogwood (*Cornus alternifolia*)
American mountain ash (*Sorbus americana*)
beaked hazel-nut (*Corylus cornuta*)
bush honeysuckle (*Diervilla lonicera*)
Canada yew (*Taxus canadensis*)
Canadian honeysuckle (*Lonicera canadensis*)
choke cherry (*Prunus virginiana*)
common elderberry (*Sambucus canadensis*)
hobblebush (*Viburnum alnifolium*)
mountain maple (*Acer spicatum*)
pin cherry (*Prunus pennsylvanica*)
purple-flowering raspberry (*Rubus odoratus*)
skunk currant (*Ribes glandulosum*)
spiny swamp currant (*Ribes lacustre*)
strigose red raspberry (*Rubus idaeus*) ssp. *melanolasius* var. *strigosus*
striped maple (*Acer pennsylvanicum*)
western black raspberry (*Rubus occidentalis*)

Herbs

beech-drops (*Epifagus virginiana*)
blue marsh violet (*Viola cucullata*)
blue-bead lily (*Clintonia borealis*)
bunchberry (*Cornus canadensis*)
Canada mayflower (*Maianthemum canadense*)
Clayton's sweet-cicely (*Osmorhiza claytoni*)
clustered hawkweed (*Hieracium kalmii*) var. *fasciculatum*
common shinleaf (*Pyrola elliptica*)
common Jack-in-the-pulpit (*Arisaema triphyllum*) var. *triphyllum*
downy goldenrod (*Solidago puberula*)
downy yellow violet (*Viola pubescens*)
false Solomon's seal (*Smilacina racemosa*)
false hellebore (*Veratrum viride*)
foamflower (*Tiarella cordifolia*)



drooping sedge (*Carex crinita*)
field sedge (*Carex conoidea*)
Lindheimer's panic-grass (*Panicum lanuginosum*) var. *lindheimerii*
poverty oat-grass (*Danthonia spicata*) **D**
red fescue (*Festuca rubra*) var. *rubra* **D**
redtop (*Agrostis gigantea*)
Rhode Island bent-grass (*Agrostis capillaris*)
sensitive fern (*Onoclea sensibilis*)
slender spike-rush (*Eleocharis tenuis*) var. *tenuis*
stellate sedge (*Carex radiata*)
tangled panic grass (*Panicum lanuginosum*) var. *implicatum*

D = dominant species associated with bog twayblade (*Liparis loeselii*)



Appendix 5. Selected photographs on Mount Sunapee Lease Area, June 1998.



View from Wingding ski run to East Bowl. Note red spruce growing above hardwood canopy.



Looking East toward East Bowl. Large red spruce growing through the hardwood canopy.





Typical old growth hardwood stand at ski lease area. Note various hardwood canopy species, and a diverse canopy structure.



Typical seepy area at base of Duckling Slope. This type of habitat supports the rare bog twayblade (*Liparis loeselii*).



Appendix 6. Mount Sunapee Ski Area Stand Descriptions from field work conducted by John Accardi and Ken Desmarais in April, 1998.



Mount Sunapee Ski Area Stand Descriptions

* Denotes areas that should be studied more closely

Polygon #1- Stand Description: Scattered white pine size class 5 over hemlock, & mixed hardwood size class 3-4. Age 90 years for white pine. Some old blowdown, no stumps evident. Reproduction consists of striped maple, hemlock, red spruce, and beech.

Area A - Stand Description: Scattered decadent white pine, size class 5 over red maple, size class 3-4. Age 90 years for white pine. Some WP stumps near ski trail, and some blowdown from the recent ice storm. Understory species consists of white ash, striped maple, beech, and red maple. Regeneration species consists of striped maple, red oak, white pine, and red spruce. The white pine component of this stand is breaking up and is going to red maple.

Polygon # 2- Stand Description: This is a mixed hardwood stand consisting mainly of red oak, paper birch, beech, sugar maple, and white ash, size class 3-4. Age 85 years for white ash. No stumps are evident here. Understory consists of hemlock, sugar maple, beech, and yellow birch. Regeneration consists of striped maple, and sugar maple. This is an obvious second growth stand growing on a very good site.

Polygon # 3- Stand Description: The lower 1/5 of the polygon is primarily paper birch. Sugar maple, yellow birch, white ash, size class 4-5 dominate the remainder of the polygon. Ages range from 75 years for white ash, 150 years for sugar maple, and 180 years for red spruce. Understory consists of beech, and yellow birch. Regeneration consists primarily of beech. There is a small pocket, less than 2 acres, of particular interest approximately 1/4 of the way up slope in this polygon (see map). It appears to be old growth red spruce. This is the spot where the 180 year old red spruce was cored. Nearby was a much larger spruce Approx. 30" DBH (too large to core). This area contained much dead and down material, a multi layered stand structure, red spruce regeneration, and an overall look of old growth spruce. It appears to be a small pocket of "forest primeval" and is definitely worth another look. The upper reaches of the polygon have ages around 110 years.

Polygon # 4- Stand Description: This is a Sugar maple, beech, yellow birch, size class 4 stand. Average age is approximately 100 years. Understory and regeneration are entirely beech. Timber quality here is fair to poor with no stumps evident. The stand appears even-aged and is very unremarkable.

Polygon #5- Stand Description: Sugar maple, beech, yellow birch, size class 4 dominate here, with pockets of paper birch. Timber quality is poor. Understory is primarily

beech, and striped maple. Regeneration is beech, and hobblebush. Timber here is very similar to the upper portions of polygon # 3.

Summit Area- Stand Description: The summit area was not broken out by individual polygons due to their number and small size of them, and because they are all so similar.

*

Very shallow soils, and extreme weather exposure keep the trees here stunted.

Timber type is red spruce, paper birch, and balsam fir, size class 2-3.

Regeneration is primarily red spruce. All of the trees on the summit area are less than 30 feet tall. Age is variable from 40 to 100+ years. Extreme weather events are very common on the summit and prevent the timber from reaching merchantable size regardless of age. This area should be revisited.

Polygon #6- Stand Description: Sugar maple, beech, yellow birch, size class 3-4. Age is 75 years for sugar maple. Reproduction consists of yellow birch, and pin cherry. Regeneration consists of yellow birch, pin cherry, striped maple, and beech. This area appears to be second growth. It was hit very hard by the recent ice storm in January.

Polygon # 7- Stand Description: Beech, and sugar maple size class 3-4 are dominant here. Age is 75 years for beech. Understory and regeneration consists of beech, striped maple, and red maple. There are scattered pockets of paper birch size class 4 with red spruce throughout this polygon, a result of some kind of disturbance. This is obvious second growth timber which has been hard hit by the ice storm.

Polygon # 8- Stand Description: Similar to polygon # 7

Polygon # 9- Stand Description: Consists of sugar maple, beech, and yellow birch size class 4. Age is approximately 75 years. Understory and regeneration species are same as overstory. Timber quality is fair.

Polygon # 10- Stand Description: Consists of sugar maple, and yellow birch size class 4-5. Age is 95 years for sugar maple. Understory consists of sugar maple, beech, and yellow birch. Regeneration consists of striped maple, and beech. Timber quality is fair, showing good growth on a good site.

Polygon # 11- Stand Description: Consists of sugar maple, beech, yellow birch size class 4.

*

Age is 90 years for sugar maple. The lower portion of this polygon does not appear to be old growth, however the upper portion should be examined more closely. Aerial photos appear to show large trees in this area and was not seen during our initial field visit.

Polygon # 12- Stand Description: Consists of Paper birch size class 3. This is very poor quality stunted timber, with an average height of 35 feet. Understory consists of striped maple, and yellow birch. Regeneration consists of striped maple, beech, and mountain maple. This small polygon along with polygon # 13 do have a

few large decadent red spruce and paper birch, however they were too rotten to get an accurate age on.

Polygon # 13- Stand description: Similar to polygon #12.

Polygon # 14- Stand Description: Yellow birch, and beech, size class 3 make up the majority of this stand. Most of the trees are stunted with an average height of 40 feet. Timber quality is very poor. Understory consists of red spruce, and striped maple. Regeneration is mainly mountain maple, and beech. The upper portion of this polygon should be revisited. Here there are a few larger spruce with an age of 165 years. In general this stand is quite broken up and any old trees are very few and far between.

Polygon # 15- Stand Description: Yellow birch, beech, paper birch, size class 3 with red spruce size class 3-4 scattered about. Timber quality is poor. Age is 102 for red spruce. Understory species consist of yellow birch, red spruce, and beech. Regeneration consists of mountain maple and hobble bush. Average canopy height is 40 -50 feet.

Polygon # 16- Stand Description: Sugar maple, beech, yellow birch, size class 4. Age is 128 years for beech. This was a good quality stand prior to the ice storm. Understory consists of beech, and yellow birch. Regeneration consists of beech, and hobblebush. This stand appears to have been repeatedly damaged by ice storms.

Polygon # 17- Stand Description: Similar to polygon # 16.

Polygon # 18- Stand Description: Sugar maple, beech, yellow birch size class 4-5. Age 130 years for red spruce. Understory consists of beech, and yellow birch. Regeneration consists of beech. Timber quality is very poor. This area should be revisited. There are many large, very old yellow birch stumps from trees that have fallen over long ago. Many of the stumps are over 3 feet in diameter. Portions of the trees boles are also evident on the ground. We estimated that these trees were probably at least 150 years old when they died and fell over, and guessed that the stumps have been here for at least 80 - 100 years. We could not find any old red spruce stumps that appeared to have been cut or otherwise. There also appears to be multiple age classes of trees, further suggesting possible old growth.

Polygon # 19- Stand Description: Similar to polygon # 18, including the large old stumps and boles. However the upper portion is stunted paper birch, size class 3. There is also more red spruce regeneration, suggesting that red spruce may have been a component of the overstory at some point in the past.

Polygon # 20- Stand Description: Sugar maple, beech, yellow birch, size class 3-4. Age 80-90

* years for sugar maple. This area sustained heavy ice storm damage. Understory consists of beech, sugar maple, and yellow birch. Regeneration consists mainly of beech, hobble bush, and red spruce in pockets. Average canopy height is 50 feet. As in polygons 18 and 19, there are many large old stumps and boles. Trees cored here were not particularly old, however this polygon contains enough other attributes of old growth timber to warrant a closer examination. In addition, there are also pockets of fairly large red spruce, many of which are too rotten to core. However a couple of smaller spruce that were sound were approximately 160 years old. The extreme lower part of this polygon appears to be considerably younger and of better quality than the rest of the stand.

Polygon # 21- Stand Description: Sugar maple, white ash, size class 4-5. Age 83 years for white ash. Understory consists of sugar maple, and beech. Regeneration consists of striped maple, beech, and hobble bush. There are no stumps evident here, as well as very little dead and down material, with the exception of recent ice storm damage material. Timber quality here was very good prior to the ice storm. It is most likely that this is second growth timber.

Polygon # 22- Stand Description: Sugar maple, beech, yellow birch, size class 4, with age 125 years for red spruce. However this is not representative of the stand, as there are only a few overstory spruce in the polygon, all near the edge of a ski trail. Understory and regeneration consists of beech and striped maple. Timber quality was good prior to the ice storm, and appears to be second growth.

Polygon # 23- Stand Description: Sugar maple, beech, yellow birch, size class 4-5 with some scattered white ash size class 5. The upper portion of this polygon is even aged as a result of some sort of disturbance. Age is 90 years for sugar maple. Understory and regeneration is the same. Further down the slope where the ground is very steep, appears a band of very large, older norther hardwoods. Ages here are around 150-165 years. The stand is breaking up in places. In these pockets of older timber are the large white ash, age around 90 years. This area was hit hard by the recent ice storm, and appears to have been hit by many other storms in the past. This band of older timber on the steep slopes warrants another visit. Below this the topography levels out and the timber is of much better quality, and of the same timber type. The average age here is 90 years and appears to have been cut or cleared in the past.

Polygon # 24- Stand Description: This polygon is quite variable due to its long length and orientation up and down slope. The lower portion is primarily red oak, size class 5 with a few scattered red spruce, size class 4. Age is 90 years for the oak. The middle and upper portions of the polygon is primarily sugar maple, size class 4-5 with some larger white ash and yellow birch scattered about. Age is 90 for white ash. Understory and regeneration in all areas is primarily beech, sugar maple, yellow birch, and striped maple. Red spruce cored in this area ranged in age from 120 to 154 years, trees that were probably too small to cut

when the rest of the stand was. The stand as a whole is definitely second growth.

Polygon # 25- Stand Description: Similar to lower portions of polygon # 24.

Polygon # 26- Stand Description: The lower portions of this polygon is primarily Beech, and yellow birch, size class 4-5, with some scattered paper birch size class 4. Understory is sugar maple, and beech. Regeneration is beech and striped maple. Age is 90 years for yellow birch. The upper portions is made up of Sugar maple, beech, yellow birch, size class 5. Understory is hemlock, and beech. Regeneration is beech. The trees here were too large to core so no age can be established. However there are enough other attributes of old growth present in this area to warrant further study.

Polygon # 27- Stand description: This relatively young stand is made up primarily of sugar maple, size class 3-4, with some paperbirch and red spruce size class 3. This area was obviously cut in the past, probably when the ski area was established approximately 50 years ago.

Polygon # 28- Stand Description: This polygon is very variable for such a small area. For the most part sugar maple, yellow birch, and paperbirch, size class 3 dominate. However there are a significant number of older red spruce and yellow birch in this area. Age 180 years for red spruce. The stand is very broken and erratic with a fair amount of dead and down material. Timber quality is poor. Understory consists primarily of pin cherry, yellow birch, and beech. This area should be revisited.

Polygon # 29- Stand Description: Similar to polygon # 28.

Polygon # 30- Stand Description: This area is quite variable in nature. The lower portion of the polygon has an area made up of sugar maple, beech, yellow birch, size class 5. There are also some very large paper birch scattered here. Age is 150+ for sugar maple. Understory and regeneration consist of beech, and hemlock. There is quite a bit of dead and down material in this area and it should be revisited. The middle portions of this polygon is primarily paper birch, size class 4. This area has an approximately 2 acre pocket of red spruce in it that is 110 years old. This spruce was probably too small to cut when the rest of this area was. The upper portions of the polygon is made up of sugar maple, beech, and yellow birch, size class 3. This is a young stand. However in the upper left corner (southeast corner of polygon) is a pocket of older red spruce, and yellow birch. Age 180 years for red spruce. Regeneration here is primarily red spruce and yellow birch. This area is decadent and has lots of dead and down material. This upper corner of polygon should also be revisited.

- Polygon # 31- Stand Description: Red oak, white ash, size class 4. Age is 90 years for red oak. Understory is sugar maple. Regeneration is striped maple, and red spruce. This is second growth timber.
- Polygon # 32- Stand Description: The lower 3/4 of this polygon is primarily sugar maple, red maple, and paper birch, size class 3-4. It is a relatively young stand that was cut in the past. Understory and regeneration consist of sugar maple, beech, and yellow birch. The upper 1/4 of the polygon appears to contain some areas of older timber. Beech, and yellow birch, size class 4-5 are dominant. The trees here were too rotten to core accurately. This upper area is very similar to the lower portion of polygon # 30.
- Polygon # 33- Stand Description: Paper birch, white ash, red maple, size class 4, with some scattered red oak size class 3-4. Understory is beech, hobble bush, and red oak. Regeneration is beech, and red spruce. This is second growth timber.
- Polygon # 34- Stand Description: The lower one half of this polygon is mostly white pine, size class 5, and paper birch, size class 4. This area was obviously cut in the past. The upper portion contains much red oak, size class 5, with scattered red maple and red spruce, size class 4. This area was also cut in the past. Age here is 125 years for red spruce. The scattered spruce here are probably older than the rest of the stand, trees that were too small to cut, when the rest of the stand was logged.
- Polygon # 35- Stand Description: Similar to polygon # 34 with a small pocket of red spruce at upper end. Age 116 years for red spruce. This area is also heavy to paper birch.
- Polygon # 36- Stand Description: Paper birch, red oak, size class 4. Age is approximately 80 years. Understory and regeneration is primarily sugar maple, and beech. This is second growth.
- Polygon # 37- Stand description: Similar to polygon # 36.
- Polygon # 38- Stand Description: Paper birch, white pine, red oak, red maple, size class 4. This is obviously former pasture land. There are many stone walls in the area.
- Polygon # 39- Stand Description: White pine, red oak, paper birch, size class 4. This is also former pasture land evident by the stone walls.
- Polygon # 40- Stand Description: Similar to polygon # 39.
- Polygon # 41- Stand Description: White pine, red oak, red maple, size class 4 with some scattered paper birch. Age is 70 for red oak. Stone walls indicate former pasture land.

Area B- Stand Description: The lower portion of this polygon (northern half) is similar to # 41. The upper half contains primarily white pine, red spruce, and paper birch, size class 4-5. Age is 90 years for red spruce. Stone walls indicate former pasture use. Along the eastern edge of the stand are the sewage disposal lagoons and a white pine stand that is used for surface disposal of waste water through a pipeline dispersal system.

Forest size class designations: referring to average stand diameter.

<u>Size Class</u>	<u>Size</u>
1	Reproduction
2	Saplings 2" - 4.9" DBH
3	Poles 5" - 9.9" DBH
4	Sawtimber 10" - 14.9" DBH
5	Large Sawtimber 15" + DBH

Note: DBH refers to diameter 4.5' above the ground.

Appendix 7. Summary of Ancient Forest Areas, Sunapee State Park, from a letter and results of field work conducted by Chris Kane, 1997.



Christopher Kane
6 Donovan St.
Concord, NH 03301
228-4755

December 1, 1997

Ken Desmarais
Fox Forest
PO Box 1175
Hillsborough, NH 03244

Dear Ken,

You may recall that as part of the old-growth inventory I prepared for Forests and Lands last spring I identified two areas in Mt. Sunapee park that appeared to hold potential as old-growth, or ancient forest. Two old hemlock stands had already been located in the park during the course of a masters project. Since the end of the inventory, I had the opportunity to visit these predicted sites and others several times, and to verify that they appear to be surviving examples of old-growth forest. A later trip to one of the stands with you, Frank Mitchell and Charlie Cogbill, as well as the recent discovery of specific references to some of these stands as "old-growth" or "primeval" in the 1915 Manual of Mount Sunapee strengthens my conviction that these are in fact rare, surviving examples of old-growth. I now believe that the Mt. Sunapee land mass, especially the area within the state park holds some one the most significant mosaics of ancient forest left intact in that part of New England.

The stands referred to are varied in character, but all exhibit the characteristics generally expected in old-growth forest stands: presence of old and often big trees. uneven age distribution, climax, or late successional species dominance in the canopy and presence in the understory, an abundance of snags and downed logs in all stages of decay, and lack of evidence of human or major natural disturbance. In addition, the relatively large size of some of the stands makes them all the more robust as surviving original forest remnants.

The timing of these discoveries is especially poignant, as the State Legislature awaits the return of bids for the private leasing of the Sunapee ski area. On Mt. Wachusett in Massachusetts the discovery of the now famous ancient forest there was made after the ski area was leased out, making forest preservation efforts difficult and contentious. It is critical that the Sunapee stands be undisturbed and that their special values be considered during the leasing process. Ideally there would be a moratorium on major construction in the park until further study has assessed the extent of ancient forest stands.

The general knowledge and awareness of old-growth forest in this part of the country is growing, and public interest in the Sunapee stands would likely be great. The park has traditionally provided multiple uses to the public and could continue to do so, as long as a balance between skiing and general recreation could be struck. After all, the original 1911 Reservation was purchased and formed explicitly to stop the logging of the surviving ancient forest, and to protect it for future generations to enjoy.

Sincerely,



Chris Kane

Sunapee State Park Summary of Ancient Forest Areas

Chris Kane
12/1/97

Background

In the spring of 1997 a partial inventory of reported ancient forest stands on DRED managed lands in the Southern New Hampshire was prepared by the author. As part of the inventory, several areas in Mt. Sunapee State Park which were predicted to potentially hold old forest were identified and mapped using a combination of landscape analysis with topographic maps and aerial photographs, and application of predictive guidelines developed by the author.

Subsequent field visits and a formal plot sample verified the existence of stands exhibiting old growth characteristics, including old and large trees, dominance in canopy and understory by "climax" tree species, uneven age structure, abundant coarse woody debris in all stages of decay, and lack of signs of human or catastrophic natural disturbance.

Research into the history of the park has since uncovered references to the pristine nature of the forest there, as well as to the logging on the north slopes which led to the 1911 purchase of a 656 acre reservation by the Society for the Protection of New Hampshire Forests. The 1915 "Manual of Mount Sunapee" edited by Philip W. Ayres describes "old-growth hardwoods" and "primeval spruce forest" in the text and on a map in areas coinciding with those identified in the field this year. The ancient forest on Sunapee would appear to be not so much a discovery as a re-discovery.

Brief Stand Summaries (see accompanying map)

"East Bowl": ≈150 acres

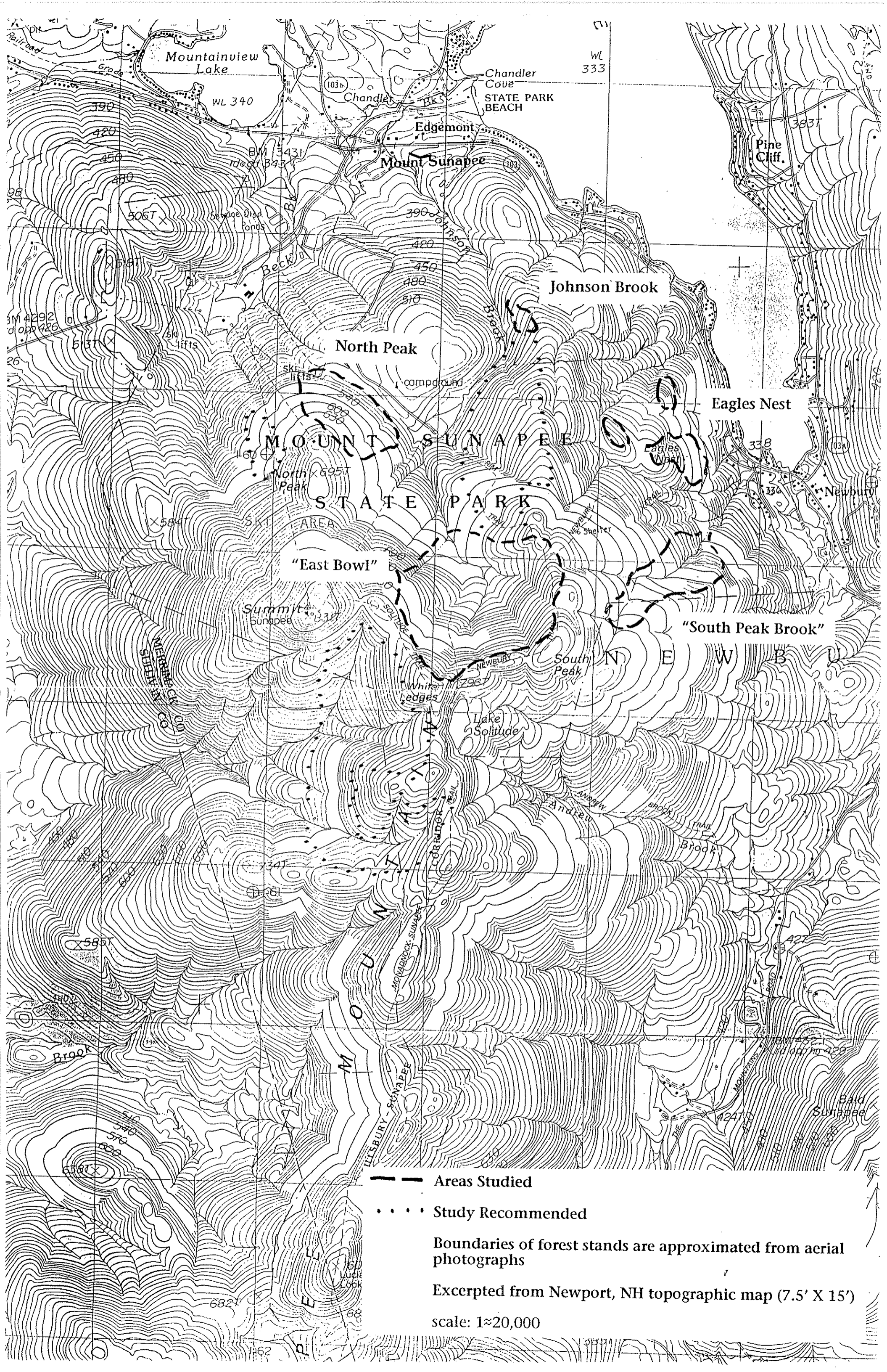
A yellow birch/red spruce/sugar maple/beechn stand with white ash lower and balsam fir higher on the slope. Largest dominant canopy trees are yellow birch ($\leq 41''$) and sugar maple with numerous large red spruce ($\leq 29''$) as super canopy emergents. Selected ages: 29" red spruce, 249; 15.6" red spruce, 206; 30" yellow birch, 228 (8" core); 18.5" yellow birch, 153.

North Peak: ≈55 acres

A sugar maple/beechn/yellow birch/white ash stand with some red oak and black cherry near top of slope, and red spruce in two pockets toward the south. Largest dominant canopy trees are sugar maple ($\leq 36''$), yellow birch ($\leq 30''$) and white ash ($\leq 34''$). Selected ages: 28" sugar maple, 153; 17" red spruce, 103.

"South Peak Brook": ≈40 acres

A yellow birch/red spruce/beechn stand. Lower areas also contain red maple and white ash, with hemlock and red oak in places. Largest canopy species are yellow birch ($\leq 41''$), red spruce ($\leq 28''$), beech ($\leq 26''$) and white ash ($\leq 30''$). Selected ages: 28" yellow birch, 138 (5" core); 17" red spruce, 170.



— — — — Areas Studied

..... Study Recommended

Boundaries of forest stands are approximated from aerial photographs

Excerpted from Newport, NH topographic map (7.5' X 15')
scale: 1:20,000