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CLAREMONT - ARROWHEAD FOREST
FOREST MANAGEMENT PLAN

1 PLAN PURPOSE AND DESIGN

The purpose of this forest management plan is to provide the City of Claremont and the resource manager with a comprehensive description of the property and proposed management activities. It is meant to be a "User's Guide" that reflects Claremont's objectives and will remain flexible as changes in the property condition or objectives change through time.

Management planning on the Claremont ownership is a threefold system including a master plan, forest management plans, and pre-harvest planning. The master plan covers broad property descriptions, ownership objectives, and management strategies. Forest management plans, such as this one, are the second piece of this threefold system. They cover specific property descriptions and management activities intended to span a 10-year period. Forest management plans are stand alone documents. The third part of this system involves pre-harvest plans, detailing even more specific management concerns and objectives particular to individual harvests. As their name indicates, pre-harvest plans are prepared prior to a scheduled harvest.

2 PROPERTY LOCATION AND BRIEF DESCRIPTION

The Arrowhead forest is 188.6 acres[1] and is managed by Claremont's Department of Parks and Recreation. It includes the open ski slopes of the Arrowhead ski area, but is dominated by dense hemlock and pine forest types with scattered hardwood including primarily red oak, white birch and beech. The terrain is variable, including a mix of steep and moderate slopes with little level ground. The ground undulates as you travel east-west along the contour. The height of land is relatively dry and ledgy with red oak, white pine and low-bush blueberry in the understory.

The property is located amidst a residential neighborhood behind the Claremont Middle School, approximately 1/3 mile from downtown Claremont. It includes a popular trail network accessed by ATV's in the summer and snowmobiles in the winter. A down-hill mountain biking course has been set up in the forested islands between the ski slopes. The height of land above the ski trails, locally called 'Flat Rock' offers a panoramic view of the city and far-off Ascutney Mountain.

1 Mapped acres, 1/2008

Woodlot History

The land has a long agricultural history; the abundance of stone walls throughout the property suggests a fairly intense use. Claremont had a prosperous agricultural history, which peaked in the mid to late 1800's. This agricultural use of the land came to a halt early last century when many farmers in New England abandoned their agrarian lifestyles and once open-land has since become reforested. Given the topography and general rockiness of the soil likely Arrowhead was used primarily as pasturage with a lesser amount of hayland. Neighboring open fields on flatter terrain likely were the tilled portions of the farm.

The once fully operational Arrowhead ski area is now limited to a rope tow providing access for tubing and skiing on the main slope and occasional rides up the mountain by the groomers, but nonetheless provides a welcome, inexpensive recreational opportunity to the many families of Claremont. The forested trail network, primarily used by ATV's and snowmobiles, provides opportunity for motorized recreation but would benefit from additional trail maintenance and better signage.

The forest has seen no recent harvesting activity. It was last harvested in the 1980's. It is densely stocked and would benefit from improvement thinning, salvage, and general opening up to release the better growing and quality trees and provide opportunity to regenerate a new age-class of trees.

3 LANDOWNER MISSION, PRINCIPLES, AND OBJECTIVES

As stated in Claremont's master plan, the ownership-wide objectives of the City of Claremont are:

Mission Statement

The City of Claremont will actively manage Claremont's natural areas with a strong land ethic in order to achieve responsible land stewardship. These stewardship activities will help to promote Claremont as a healthy community with a quality of life that values the environmental quality of forest ecosystems and the benefits of commercial and recreational land uses.

Principles for Management

- Adopt a holistic view of natural systems which places human activity within rather than apart from the natural environment.
- Implement forest management that is ecologically, economically, and socially responsible.
- Resource extraction should not exceed the regenerative capacity of the ecosystem or reduce natural productivity or diversity.
- Whenever possible management shall incorporate the results of previous actions into future

decision-making efforts.

- Management practices shall support indigenous habitats and prevent fragmentation so that wildlife can migrate for seasonal food and reproductive needs.
- Manage for ecologically and socially sustainable recreational opportunities.

Management Objectives for Arrowhead

Overall:

- Be responsible *stewards* of the land and its resources
- Maintain the stability and integrity of the ecosystems within our control
- Maintain a healthy, productive and aesthetically pleasing forest
- Manage with respect to *Natural Community* type
- Maintain and improve natural *biological diversity*

Timber:

- Enhance the *quality* and *quantity* of our timber resource
- Manage for *Sustainable* harvest and growth
- Provide *periodic revenue* through the sale of forest products

Education and Recreation:

- Maintain ski slopes
- Provide opportunities for *education*
- Create educational infrastructure such as interpretive signs and kiosks
- Identify and conserve important *archaeological* and *cultural* sites
- Provide for both motorized and non-motorized sustainable *recreation* opportunities such as ATV and snowmobile trails, foot paths, and cross county skiing and snowshoe trails
- Create aesthetic *vistas* along recreational trails
- Create *wildlife viewing* areas

Wildlife:

- Provide and enhance the naturally diverse variety of wildlife habitat in forest, wetland, and openland settings

Water Quality:

- Protect our *water resource*
- Protect and improve the *water quality* of streams and wetlands

4 GEOLOGIC ATTRIBUTES

Topography and Aspect

The Arrowhead Forest ranges from 580 to about 1,080 feet in elevation. The terrain is somewhat variable, but mostly consists of moderate slope with a northwesterly aspect. The Arrowhead ski trail system occupies much steeper slopes, including some rocky, rough ground. The height of land falls on three summits with gentle terrain, the northernmost being Flatrock Hill.

Brooks, Ponds, and Wetlands

The property contains a number of seasonal streams that drain to the north and eventually into the Sugar River. The forest also hosts a small amount of shrub wetland, near the central height of land likely located on an area that is shallow to bedrock. This wetland is dominated by wintergreen shrubs and provides important habitat for many wildlife species, especially amphibians, but also including some of conservation concern such as spotted turtles, Canada warblers, New England cottontail, and American woodcock[2].

Recommended Actions to Improve and Manage the Wetland and Water Resource of Arrowhead Forest[3]:

Riparian and Stream Ecosystems:

- Establish riparian management zones along streams, rivers, ponds, and lakes. These are not intended as no-harvest zones. Forest management systems, such as single-tree or small-group selections cuts, that retain relatively continuous forest cover in riparian areas (65-70 percent canopy cover) can help maintain biodiversity by protecting water quality, providing shade, supplying downed woody material and litter, and maintaining riparian wildlife habitat conditions.
- No-cut zones of 16 to 100 feet are recommended by several management guides on river or pond shores containing wet seeps, shallow or poorly drained soils, or area with slopes greater than 8 percent. Limited single-tree cutting can occur on other sites within this zone, with cabling from outside the zone suggested.
- Consider management at the watershed-level as an approach to avoiding stream channel degradation from excessive runoff.
- Road construction, stream crossings, skid trails, log landings, and all phases of timber-harvesting operations should conform to Best Management Practices

Springs and seeps:

- Avoid leaving slash in woodland seeps, springs, or associate wildlife trails.
- To the extent feasible, avoid interruption groundwater flow above or below seeps and above springs. When seeps and springs can't be avoided, minimize flow interruption by strictly adhering to appropriate Best Management Practices for water crossings.
- Where feasible, use woodland seeps and springs as nuclei for uncut patches to retain snags, cavity trees, and other site-specific features.

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2 Habitat Stewardship Series, Marsh and Shrub Wetlands, New Hampshire Wildlife Action Plan, UNH Cooperative Extension

3 Riparian and Stream Ecosystem management recommendations from the publication Biodiversity in the Forests of Maine; Flatebro, Gro, Foss, Carol, and Pelletier, Steven, 1999, UMCE Bulletin #7147

Soils

The upland soils were derived from glacial till and are primarily moderately well drained stony silt loam soils. The major soil types present include Bernardston silt loam and stony silt loam, Cardigan-Kearsarge silt loam, Kearsarge-Cardigan rock outcrop complex, Monadnock-Lyman rock outcrop complex, and minor amounts of Pittstown silt loam, Stissing stony silt loam, and Ossipee mucky peat. The majority of the soils are well drained and generally productive, but have limitations due to rockiness and to a lesser degree slope. The small amount of highly productive soil on good ground is found at the base of the ski slopes in an area now occupied by the parking lot. The small wetland at the height of land lies in an area of Ossipee mucky peat.

Recommended actions to improve and manage the soil resource of Arrowhead Forest[4]:

Forest soils, forest floor and Site Productivity:

- Avoid whole-tree removal, particularly on low-fertility sites (i.e., shallow to bedrock soils, coarse sands, wetlands, and area with high water tables), unless replacement of nutrients and organic matter is considered
- Conduct harvest operations during the season of the year that is most appropriate for the site. Operating on snow or frozen ground, whenever possible, minimizes effects of the soils and forest floor.
- Choose harvest equipment to suit the site and minimize disturbance. For example, in dry conditions, and in some wet conditions, consider using tracked vehicles to reduce rutting.
- Minimize skid-trail width using techniques such as bumper trees when appropriate.
- Establish skid trails that follow land contours where possible rather than directed straight uphill.
- When possible, conduct whole-tree harvests of hardwoods during dormant leaf-off season to retain nutrients on site.
- Avoid or minimize practices that disturb the forest floor, remove the organic soil or cover it with mineral soils, except as necessary to accomplish silvicultural goals and to regenerate certain tree species.

5 NATURAL COMMUNITIES[5]

"Natural communities are recurring assemblages of plants and animals found in particular physical environments. New Hampshire has a fascinating and complex variety of natural communities, from tidal marshes to alpine meadows, river banks to mountain forests, and streams to lakes. Each type of natural community has a unique set of environmental conditions that support certain species adapted to those conditions."

"Just as individual organisms can be classified into species, plant assemblages can be classified into natural community types. Classifying natural communities is a useful way of viewing the landscape because it allows us to distill the broad range of complex interactions between species and their environments into a limited number of units that share certain key features."

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4 Soil management recommendations from the publication Biodiversity in the Forests of Maine; Flatebro, Gro, Foss, Carol, and Pelletier, Steven, 1999, UMCE Bulletin #7147

5 All information on Natural Communities referenced from the publication: Natural Communities of New Hampshire, Daniel Sperduto and William Nichols, New Hampshire Natural Heritage Bureau and The Nature

"Natural community types are usually defined in terms of plants because they are easy to study, often compose the physical structure to which most other organisms respond, and are sensitive indicators of physical and biological factors that influence many types of organism."

"The need to classify natural communities is fundamentally pragmatic: People need a way to sort out, understand, and communicate about nature's complexity on order to be good stewards."

Determining natural community types can be a challenge because it is uncommon to find land that has not been influenced by human intervention. Past agricultural and silvicultural practices often change the plant communities that you would find on any given acre naturally. Identifying natural communities then becomes a process of understanding the past management activities, the physical conditions of the site, and the plant communities currently found there and determining to the best of our ability what community would occupy that site without human intervention. The natural community types found on Claremont forestland has been identified on a broad level to the best of our ability. A more comprehensive and detailed study by an ecologist would be required to determine natural community types on a more fine-grained and certain basis.

The dominant natural community type found on this forest is Hemlock-beech-oak-pine. This is a common, broadly defined community occupying glacial till and terrace soils of low to mid elevations in central and southern New Hampshire. On Arrowhead, this community grades into oak-pine forest on the more droughty soils found on the height of land. The height of land also hosts a small wetland, likely a Highbush blueberry-winterberry shrub thicket. This is a common and widespread community. See Appendix A for a map of the natural communities.

Rare Species and Unique Natural Communities

An in-depth flora and fauna survey was not within the scope of this plan. There were no endangered plants or animals knowingly encountered while collecting the data for this plan. The Natural Heritage Inventory, in Concord, New Hampshire, has been contacted and they have no records of any endangered plant communities in the vicinity. That does not mean there are not any, however.

Realizing the significant habitat conditions found on Arrowhead Forest demands *adaptive management*. All attempts will be made on the management level to identify unique areas, learn what makes them unique, how to best manage them and most importantly, refine the management of these areas as the knowledge base grows.

6 WILDLIFE HABITAT CONDITIONS

Arrowhead Forest provides a variety of habitats for wildlife, but is dominated by dense

forestland. There is a substantial amount of dense hemlock to provide shelter during winter months for white tailed deer and other small mammals. An abundance of antler rubbed trees have been seen adjacent to the hemlock. Red oak, also fairly abundant on the property provides a source of hard mast (acorns) that is eaten by a variety of animals from birds to many mammals including both turkeys and deer. The adjacent open agricultural land to the northwest and due east, and the open ski trails provide grassy, open habitat utilized characteristically by small rodents, which in turn attract predator species such as red fox, coyote, hawks and owls. Turkeys are also abundant on the property. The small wetland provides important habitat for amphibians such as the spotted salamander and red newts. Wetlands also provide an important source of food in early spring as they tend to be of the first places to "green up" providing a much needed early food source.

The forestland on Arrowhead is fairly dense, offering little in the form of browse, an integral part of the white tailed deer diet. In the absence of significant disturbance, as the forests found here mature less food in the form of browse will be available. Forest management objectives will integrate actions that improve wildlife habitat found here, including attempt to mimic natural disturbances that will help to create and maintain young tree and shrub growth for browse opportunity and release of individual trees possessing important habitat features such as hard mast from oaks, cavity and snag trees and trees with biological legacy value.

The New Hampshire Wildlife Action Plan includes mapping of significant wildlife habitats as they occur throughout the state and provides strategies for the management of wildlife that occur on these habitats, especially as they relate to threatened and endangered species, but also including information on common wildlife species. According to their delineation, one wildlife habitat type dominates the Arrowhead Forest- Hemlock-Hardwood-Pine. A summary of this habitat type and the wildlife species found there is in Appendix B of the Master Plan.

Recommended actions to improve and manage the wildlife habitat of Arrowhead Forest[6]:

Snags, cavity trees, and down logs:

- Avoid damaging existing downed woody material during harvesting, especially large (16"+) hollow logs and stumps.
- Leave downed woody material on site after harvest operations when possible.
- Leave several sound downed logs well distributed on the site, where possible. Especially important are logs >12 inches dbh and > 6 feet long. Hollow butt sections of felled trees are also good choices.
- Create additional snag trees by girdling large cull pine where possible. Attempt to retain or create a minimum of 4 secure cavity or snag trees per acre, with one exceeding 24" dbh and three exceeding 14" dbh. In areas lacking cavity trees, retain love trees of these diameters with defects likely to lead to cavity formation.
- Retain as many live trees with existing cavities and large unmerchantable trees as possible.
- When possible, avoid disturbing cavity trees, snags, and upturned trees roots from April to July

6 Wildlife habitat management recommendations from the publication Biodiversity in the Forests of Maine; Flatebro, Gro, Foss, Carol, and Pelletier, Steven, 1999, UMCE Bulletin #7147

to avoid disrupting nesting birds and denning mammals.

- Retain trees with cavities standing dead trees, downed logs, large trees, and large super canopy trees in the riparian management zone to the greatest extent possible.

Habitat Connectivity:

- Avoid harvests that isolate streams, ponds, vernal pools, deer wintering areas, or other sensitive habitats
- Maintain the matrix of the landscape in relatively mature, well-stocked stands. Where even-aged management is practiced, consider the cumulative effects of multiple cuts and include wider habitat connectors as necessary.
- Consider opportunities for coordinating habitat connectivity with other, on-going land-management efforts that maintain linear forested ecosystems, such as hiking trial corridors and natural buffer strips retained to protect water quality. This may require expanding the physical size of the connector habitat and increasing structural values to fulfill multiple management goals. Also consider the potential for effects that may arise because of incompatible uses (e.g., heavily-used ATV or snowmobile routes around and through deer yards).

Deer Wintering Areas:

- Identify dense stands of mature softwood as potential DWAs, particularly in riparian ecosystems.
- Whenever possible, schedule harvests in DWAs are during December through April.
- Protect advance conifer regeneration during timber-harvesting operations.
- When conducting harvests in coniferous forest adjacent to watercourses, maintain an unbroken conifer canopy along shorelines to protect riparian travel corridors.
- When planning harvests within any DWA, (strive to) maintain a closed-canopy coniferous overstory over at least 50 percent of the area at any given time. Avoid constructing major haul roads within DWAs.

Vernal Pools:

- Identify and mark vernal pool edges in spring when they are filled with water to prevent damage during harvests conducted when pools are difficult to detect
- Avoid any physical disturbance of the vernal pool depression.
- Keep the depression free of slash, tree tops, and sediment form forestry operations.
- Maintain a shaded forest floor, without ruts, bare soil, or sources of sediment, that also provides deep litter and woody debris around the pool. Avoid disturbing the organic layer or drainage patterns within the pool watershed.
- Whenever possible, conduct harvests when the ground is frozen or snow covered.

7 RECREATIONAL and EDUCATIONAL OPPORTUNITIES

Recreation

Arrowhead Forest provides ample recreational and educational opportunities. As discussed above, the Arrowhead ski area, though limited, provides skiing and tubing through the winter. The open ski slopes also provide foot-access to ‘Flat Rock’ at the height of land, affording panoramic views of the city of Claremont and far-off Ascutney Mountain.

The extensive trail network through the forest provides opportunity for motorized recreation including snowmobiles in winter and ATV’s in summer months. This trail system is maintained in cooperation by the Sullivan County ATV Club, Shuga Valley Snow Riders Club, New Hampshire Trail Bureau, Claremont Parks and Recreation Department, and the Arrowhead Recreation Club. The trail system is part of a larger network extending throughout and beyond Sullivan County, New Hampshire.

The trails on Arrowhead are in need of additional maintenance, especially regarding prevention of soil erosion and "trail braiding" around wet spots. *Best Management Practices* provide trail construction and maintenance guidelines that will help prevent soil erosion. Additional signage outlining proper trail use and respect of the land would also benefit the condition of the trails and surrounding forest, as well as provide educational opportunities. Regular upkeep of signs and trail maintenance is important as it demonstrates integrity of the leadership and clubs involved.

Recommended Actions to Improve and Manage the Recreational Resource of Arrowhead Forest:

- **Improve existing signage**.
  - Post a Welcome sign to the land that identifies the owner and what is allowed or encouraged on the land. This is not the best place to detail what is not allowed.
  - Post signs at all property corners and a intervals along the boundary identifying the landowner.
  - Improve informational signage about use of trails, explaining what is allowed and what is not allowed. For example:
    - Stay on the trail
    - Carry in and Carry out
    - Avoid trails if conditions are muddy
- **Clearly identify what trails are open to non-motorized and motorized use.**
  - Post a map of the trails and allowed uses.
- **Maintain trails to prevent erosion** as outlined in Best Management For Erosion Control During Trail Maintenance and Construction by New Hampshire Department of Resources and Economic Development, Division of Parks and Recreation, Bureau of Trails
- **Maintain ski trails**

Education

Educational opportunities are limitless on Arrowhead. Its close proximity to local school systems would make it an ideal destination for outdoor classroom activities. Forest management operations will also provide educational opportunities in the form of public workshops to see timber harvesting in action or school field trips focused on management of renewable natural resources or to learn more about what land ownership and management can be about. Interpretive signs put in place during forest management operations can be a helpful educational resource that aid in public relations and understanding of land management. The Sullivan County forester is an excellent resource for public education needs and is usually willing to participate in workshops or provide educational resources. There are many creative ways to educate; opportunities are not limited to those listed here.

Suggested opportunities to utilize the public education potential of Arrowhead Forest:

- **Encourage local schools/clubs/etc. to utilize this valuable resource**
- Prior to any forest management activities, **promote and present workshops** inviting the public to come learn about management activities in Arrowhead Forest
- **Create educational kiosk and signage** about Arrowhead Forest and management philosophy and activities

8 FOREST CONDITIONS

Forest Types

The following forest type designations are used in the forest type map:

COVER TYPES
H ≥ 50% dominant & co-dominant trees are hardwood
S ≥ 50% dominant & co-dominant trees are softwood
HS = Mixed species but dominated by hardwood
SH = Mixed species but dominated by softwood
(in some instances a dominant species, such as WP or HE may be included in the cover type)
SIZE CLASS
1 = Seedlings or regeneration - 90% of stems < 3" DBH
2 = Saplings or small poles 3" - 8" DBH
3 = Large poles and or small sawtimber 9" - 12" DBH
4 = Sawtimber 13" and larger
CROWN CLOSURE/DENSITY
A = 75-100% crown closure of co-dominant or dominant trees
B = 50-74% crown closure of co-dominant or dominant trees
C = 0-49% crown closure of co-dominant or dominant trees

An inventory was conducted in December, 2007 consisting of 48 sample points. Data was collected as outlined in the Claremont master plan.

Age and Age Class Distribution

As with most forests in New England, Arrowhead Forest is largely even-aged, with the bulk of the trees getting their start after the abandonment of agriculture here early last century. That said, different species and individuals within the same species grow faster and mature at different rates than others. White pine, a fast growing tree can get to quite a large size, compared to a hemlock of the same age. White birch, another fast growing tree, doesn't get as large as white pine and in addition, matures at an earlier age. So, variability exists within an evenage forest, providing opportunity to manage for multiple age classes and diversify the forest structure, providing better wildlife habitat, continuous forest cover, and relatively less intensive silvicultural management. In general, Arrowhead Forest is dominated by 60-70 year old white pine, hemlock and red oak in the overstory. Likely older, and definitely larger, white pine and hemlock can be found in the islands between the ski slopes. Younger trees, often clusters of pole-sized hardwood species, can be found in pockets where past harvesting or natural disturbances, such as blow down, created openings.

Growth Rates

An in-depth study of tree growth is beyond the scope of this plan. While not statistically sound, some growth observations can be made by counting tree rings on old stumps and taking increment cores of some trees. Although volume growth is very difficult to accurately calculate using this method, some rules-of-thumb do apply. A tree's growth is directly related to the substrate on which it is located. Wet, ledgy, and dry areas do not promote rapid growth of trees. Lower elevation and cool moist but well drained areas support better tree growth as the soils are deeper and more fertile. The average managed woodlot in New Hampshire grows at a rate of 2 to 4 percent per year. This corresponds to volume increases of approximately 0.5 cords or 250 board feet per acre per year. Given the site conditions and the current density of the forest, it is likely that tree growth of the Arrowhead Forest falls at the low extent of this range.

Tree Quality and Tree Health

Overall tree quality on the Arrowhead Forest is generally fair. A large percentage of the stocking includes maturing and over mature white pine. The quality of the pine varies, from some little to no value "wolf pine" that are crooked, multi-stemmed, and branchy to some fairly decent quality, straight stemmed individuals. Given the age and average diameter of the pine, red rot (a common decay fungus in white pine, typically affecting the main stem) is likely widespread. Hemlock, only second to pine in volume, is of average quality. Red oak, ranking third out of the three dominant tree species, is of fair quality, similar to the pine ranging from little to no value to decent quality. The remainder of the volume is a mix of species, with some maturing but fair quality white birch and average quality red maple.

The most pressing health concern involves the red rot in the white pine. This is common on pine of this age and initiation, and its presence typically indicates a timber harvest is overdue. Other commonly occurring tree diseases and damage were noted on the forest; including weevil damage in pine, beech bark disease, sugar maple borer, and sterile conk of birch. These diseases and insect damage alone do not signal the need for treatment, but should one occur high priority should be given to improving stand quality and health by removing trees with signs of the above mentioned diseases and damage.

Forest Management Approach

Management on the Arrowhead forest will utilize a combination of silvicultural techniques that typically are separated into two general categories, even-age and unevenaged management. Evenaged management methods include clearcut, seed tree, overstory removal and patch cut applications and may be used to regenerate a new stand when deemed necessary. Unevenaged

management methods generally include single tree and group selection used to regenerate small areas resulting in uneven age classes in a given stand. Often though, applied techniques fall somewhere in between these two text-book defined categories. One may define a large group opening (unevenage management) as a small clear-cut (evenage management). Improvement thinnings often fall somewhere in between as well, depending on the intended results and the actual results. A thinning may result in improved growth of the overstory trees, an even-aged treatment. A thinning may also provide similar conditions as single tree selection, an unevenaged technique, and result in regeneration of shade-tolerant species. Crop tree release, a practice where designated "crop trees" are released from shade of competing trees on typically 2 to 3 sides, falls somewhere in between as well. Given the variability of site quality and stocking, even within a defined stand, unless evenaged management is specifically called for, management typically will fall in the unevenage category.

Further discussion of unevenage management is required. Traditionally, the intent of unevenage management is to attain forest stocking conditions that mimic a specific diameter/age distribution. But, practicably speaking, unevenage management is often carried out as a simpler form of multiple-age management resulting in the introduction of a new age-class on a portion of a stand each harvest entry. Given the even-aged condition of the majority of land in New England, encouraging multiple age classes is a more attainable, practicable goal and in effect, desirable goal. To clarify discussion of management technique on Claremont lands, the term multiple-age management will replace traditional uneven-aged management, but will utilize the same techniques including single tree and group selection.

Applied Silviculture

Below are the generalized silvicultural systems and methods that will be broadly applied to the natural forest communities found on Arrowhead Forest and the forest stands within. The methods and their corresponding cutting cycles, rotation ages and target diameters are described and will serve as management guidelines for application in the field.

Hemlock/Hardwood Silviculture

The hemlock and hardwood community on Arrowhead forest will be largely managed using a multiple-age system. Methods of multiple-age management will involve a combination of singletree and group selection silviculture and will mimic singletree and canopy gap disturbances. These silvicultural methods are used to create and/or maintain a multi-aged stand of largely mid-tolerant and shade tolerant species. Residual stand basal area densities following cuts will range between 60-90 square ft/acre for the hardwood and 110-200 square ft/acre for areas dominated by hemlock. Where mixed types exist, basal area densities will average between the two types. Depending on a number

of considerations, the cutting cycles using this multiple-age system will be between 15 and 20 years. Target diameters of the hemlock and hardwood components are listed below. However because of the variability of sites both diameters and age goals may or may not be reached. Target diameters are as follows:

White Pine	18-24	Beech	14-18
Hemlock	16-20	Aspen	12-14
White Ash	16-22	Sugar Maple	16-22
Black Cherry	14-18	Red Oak	16-24
White Birch	12-16	Red Maple	14-18
Yellow Birch	16-22		

White Pine Silviculture

White pine, mostly a component of the hemlock hardwood community is found throughout Arrowhead Forest. White pine trees generally produce a seed crop every 7 to 10 years during a period commonly known as a “cone year”. The 100-200 seeds produced by each cone are delicately small and remain viable for a short period after dispersal, approximately a year. Because the pine seed is so small, it does not have the stored energy necessary to grow through the forest duff layer, particularly under shady conditions. This means exposed mineral soil, ideally in deep well-drained sandy loams, and heat are required for successful seed germination. Keeping this in mind, these conditions need to be present during the seeds year of viability. To create these requirements, the silvicultural method most appropriate for pine, or most softwood regeneration for that matter, is evenage. Silvicultural techniques that are best applied where opportunity exists are patch, shelterwood and seed tree cuts. These techniques provide the stand dynamics required for pine regeneration that include space, heat, light, uniform canopy level, tight geotropic structure, hence an evenage structure. Timing of treatments is most effective during the snow-less season, where maximum soil scarification is attained. Another variable in obtaining sufficient pine regeneration is the overall ability of the soil to grow hardwood trees. A soil with a high site index for hardwoods is best suited to grow hardwood. In these soils there is a high level of available nutrients that will undoubtedly permit a layer of hardwood regeneration so thick that whatever pine is established will be overgrown readily. This hardwood competition is often seen on the nutrient poor sites as well, but these soils that are better suited for pine. On these sites precommercial weeding of the hardwoods is required for the pine continuance. This hardwood competition is due to the fact that once the seed germinates it has a slow growth rate for approximately 5 years before more rapid growth begins. Site wise, sandy soils, well-drained and low cation exchange, provide excellent pine sites. Timing, silvicultural technique and

soil type is critical to promote the continuity of the pine resource.

Red Oak Silviculture

The art and science of growing red oak is equally as tricky as the pine, due to regeneration challenges. Good seed years for oak are more frequent than that of pine, being 3-5 years. However, two major obstacles affect the germination success of the acorn. As a highly coveted food resource by most wildlife, the acorn is heavily used and if the wildlife does not find the acorn, insects like the acorn grub do. According to USFS studies, up to 500 acorns are required to produce one seedling, but generally 1% of acorns become available for regenerating northern red oak successfully. Thus, the availability of viable acorns is naturally scarce.

To successfully germinate, the acorn prefers exposed mineral soil, ideally in well-drained, deep loams. Scarifying the duff layer during logging operations in the snowless seasons best does this. Oak's overall survival is most importantly related to light intensity levels. For the seedlings/saplings to photosynthesis optimally it requires 30% light intensity in the open, where under a closed forest canopy light intensities are less ten 10%. Therefore, heat and space is critical. Once the seed germinates rapid and vigorous taproot development occurs. This root growth contributes to another challenge of oak management, where it causes very slow initial shoot development and competition for light from other species is very common. Thus, achieving lasting regeneration success of oak, weeding of interfering species is often a requirement. The success of regenerating oak is highly dependent on the combination of the availability of viable seed, soil scarification, adequate light levels, implementation of weeding applications and seed distribution by wildlife.

Overall, the oak silvicultural system will be multiple-age. Methods of this system to best achieve the requirements of oak will involve mainly singletree and group selection silviculture. These methods will be used for both regeneration and thinning applications. Cutting cycles of oak dominant types will be between 15-25 years with crop tree diameters of 16-22 inches. During thinning and release applications it is important to maintain minimal direct light exposure to oak boles. Maturing and mature oak stems have large reserves of sensitive hidden buds that respond easily to increased light levels, resulting in epicormic branching and severe quality lose. During these cutting entries, releasing crop trees on eastern and northern sides, while maintaining heavier shade conditions on the south and west sides will ensure less opportunity for epicormic branching.

Access

The forest can be accessed via the ski trails. Historically the western half of the forest has been accessed through adjacent open lands. An old landing site exists just in from this point of access. All truck roads, landings and skid trails should be created and maintained according to Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire. Another helpful road building manual is a USDA publication #NA-TP-06-98: A Landowner's Guide to

Building Forest Access Roads by Richard L. Wiest.

Operability

The terrain and ground conditions on this tract in general do not limit operability. The ski slopes occupy the steepest slopes, elsewhere slope is moderate to gently and does not inhibit operability. The general rockiness of the soil in places creates obstacles that much be worked around, but again in general does not limit operability. The small wetland areas generally are not productive timber growing sites and should be avoided during all operations. Winter harvesting on frozen ground with good snow cover will provide the best protection for the soils found here. But, given the unreliability of winter conditions, operations may occur during the summer in dry periods as long as wet areas are avoided or tracked with equipment that minimizes impacts such as a cut-to length system that creates a mat of slash to drive over, therefore protecting wet ground from rutting and mitigating negative impacts.

Boundary Delineation

The Arrowhead forest boundary is in variable condition and includes 3.3 miles of maintainable boundary line. A combination of stonewalls, corner monumentation and painted blazes make up the boundary. The entire boundary should be blazed and painted where needed as soon as possible. It is recommended that all boundary corners be monumented with City of Claremont signs.

FOREST DATA

Stand 1 White Pine/Hemlock 4-5A 24.5 acres

Stand Structure

Forest Canopy

Forest Floor

GENERAL ATTRIBUTES

Natural Community Type:	Hemlock - beech - oak - pine forest (S5)
Past Management History:	No recent management
Approximate Age of Dominant Trees:	71-90 years
Stand Health:	Fair
Insects/Damage/Disease:	Red rot in pine

SITE CONDITIONS

Site class:	2A
Determined by:	Field observation; soils
Tree vigor:	Medium vigor
Soils:	Pittstown silt loam, Bernardston silt loam, Kearsarge-Cardigan rock outcrop complex, Cardigan-Kearsarge silt loam
Parent material:	Glacial till
Soil texture:	Silt loam
Drainage:	Well drained
Terrain:	Moderate to steep slope
Aspect:	Northeast
Elevation:	580-1060'

Snags Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"			7.8	7.8
12-18"				
>18"	0.8			0.8
Grand Total	**0.8**		**7.8**	**8.6**

Table 1.1: Standing dead trees per acre by size and decay class.

Down Logs Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	18.5	3.1		21.5
12-18"	3.9	1.8		5.7
>18"	1.6			1.6
Grand Total	**24.0**	**4.9**		**28.9**

Table 1.2: Standing down logs per acre by size and decay class.

WILDLIFE HABITAT

Forest type:	Hemlock/White pine/Hardwood
Vertical diversity:	High
Vegetative diversity:	High
Hard mast:	Oak, pine
Soft mast:	--
Special habitat features:	Large pine and hemlock legacy trees; Large cavity trees; Some rocky/exposed ledge habitat
Snag trees:	Few
Down logs:	Good
Special wildlife practices:	Create snag trees

RECREATION

Recreational features:	Part of trail system for motorized and non-motorized recreation; Downhill mountain bike race course (currently not maintained)
Recreational infrastructure:	Parking lot at base of ski trails
Aesthetic resources:	Large, old white pine and hemlock; Rock outcrops; Vista of the City of Claremont and Ascutney from Flatrock hill
Public access:	Trail system open to public; Bike course currently not maintained

SILVICULTURE

Structural and Silvicultural Attributes

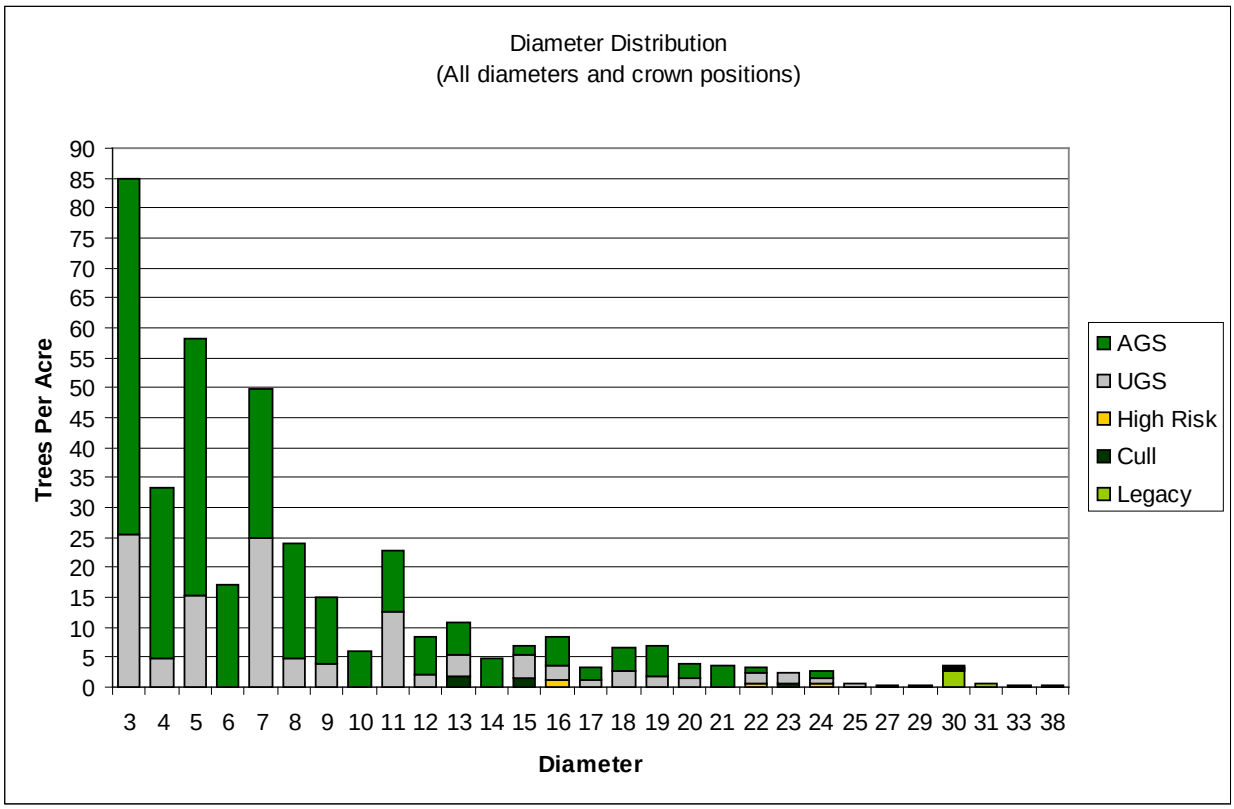
Broad Forest Type:	S4-5A
Size Class:	Large sawtimber
Stand Structure:	Evenage
Crown Closure:	90%
Total Basal Area Per Acre:	207
Total Merchantable Basal Area Per Acre:	200
Total Acceptable Basal Area Per Acre:	105
Trees Per Acre:	388
Quadratic Mean Stand Diameter:	9.9
Percent AGS Sawtimber:	72.4%
Basal Area of AGS Sawlogs:	68
Timber Quality:	Mature and Overmature Timber

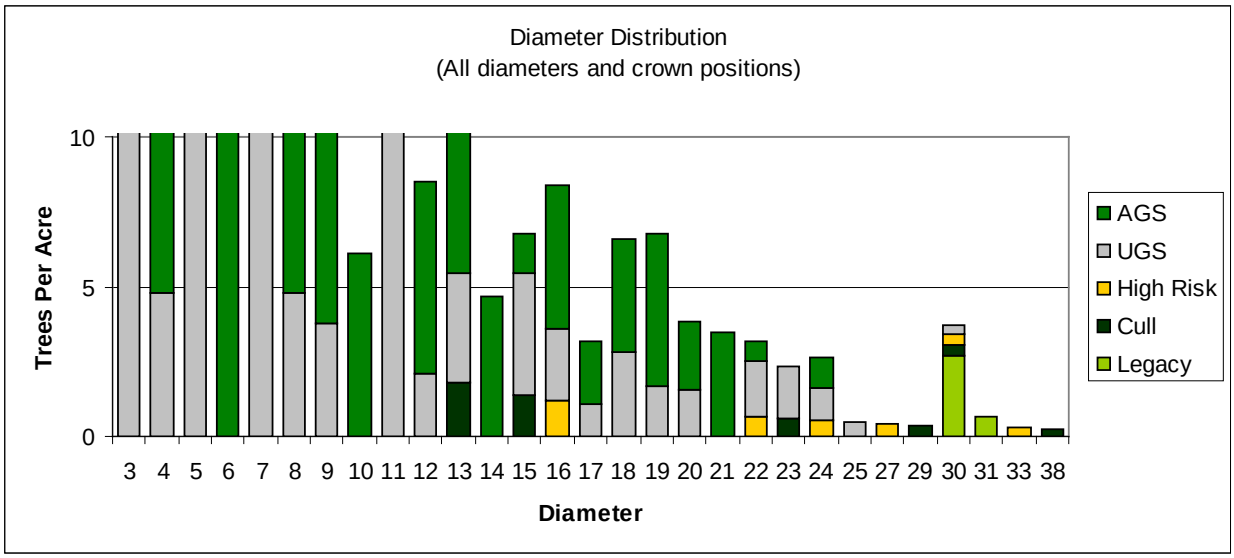
Forest Composition and volume

Species	% TPA	Veneer (bf)	Sawlog (bf)	Pallet/Tie (bf)	Pulp (cd)	Growing Stock (cd)	Total Cords	High Risk	AGS Saw	% AGS Saw
American Beech	2.3%	0	0	0	0.2	0.0	0.2	0	0	0%
Black Birch	4.1%	0	0	0	0.1	0.2	0.3	0	0	0%
Red Maple	14.7%	0	246	502	3.3	0.5	5.3	0	425	57%
Red Oak	8.3%	0	182	0	1.5	0.5	2.5	121	0	0%
Sugar Maple	3.6%	0	173	154	1.1	0.1	1.8	0	224	69%
White Birch	2.4%	0	192	0	0.4	0.0	0.7	192	0	0%
Total Hardwood Per Acre:	*35.4%*	*0*	*793*	*656*	*6.6*	*1.3*	*10.9*	*314*	*649*	45%
Hemlock	46.9%	0	1,909	0	11.4	1.2	15.9	0	1,909	100%
Red Pine	3.0%	0	134	0	0.7	0.0	1.0	0	134	100%
White Pine	14.7%	0	5,943	2,653	8.8	0.0	23.6	794	6,064	71%
Total Softwood Per Acre:	*64.6%*	*0*	*7,985*	*2,653*	*20.9*	*1.2*	*40.5*	*794*	*8,107*	57%
Total Volume Per Acre:	100.0%	0	8,778	3,309	27	3	51	1,107	8,756	72%
Stand Volume:		0	215,070	81,063	672	61	1,259	27,126	214,512	

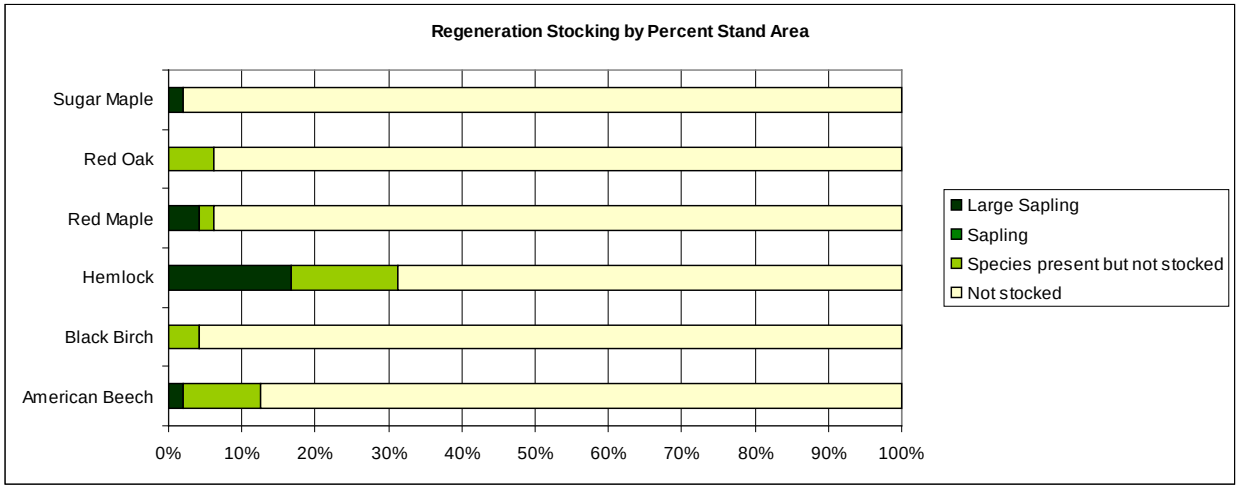
Table 1.3: Stand volume by species and product per acre values.

Graph 1.1a and 1.1b: Diameter distribution showing trees per acre on the Y axis, diameter class on the X axis and tree condition. Includes trees in all canopy positions down to 2 inches in diameter. 1.1b provides a close-up of the breakdown in the larger diameter classes.

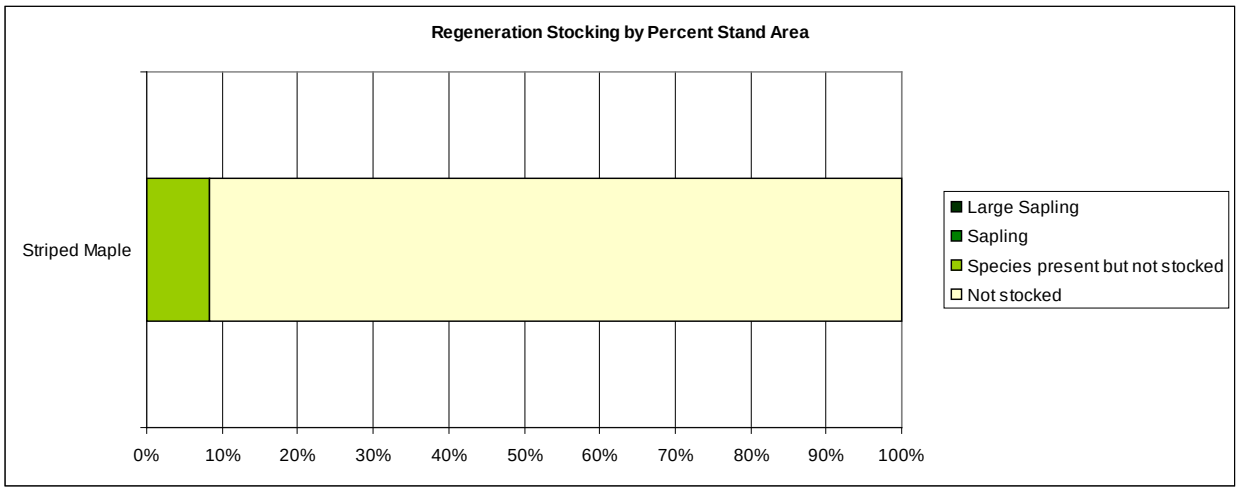




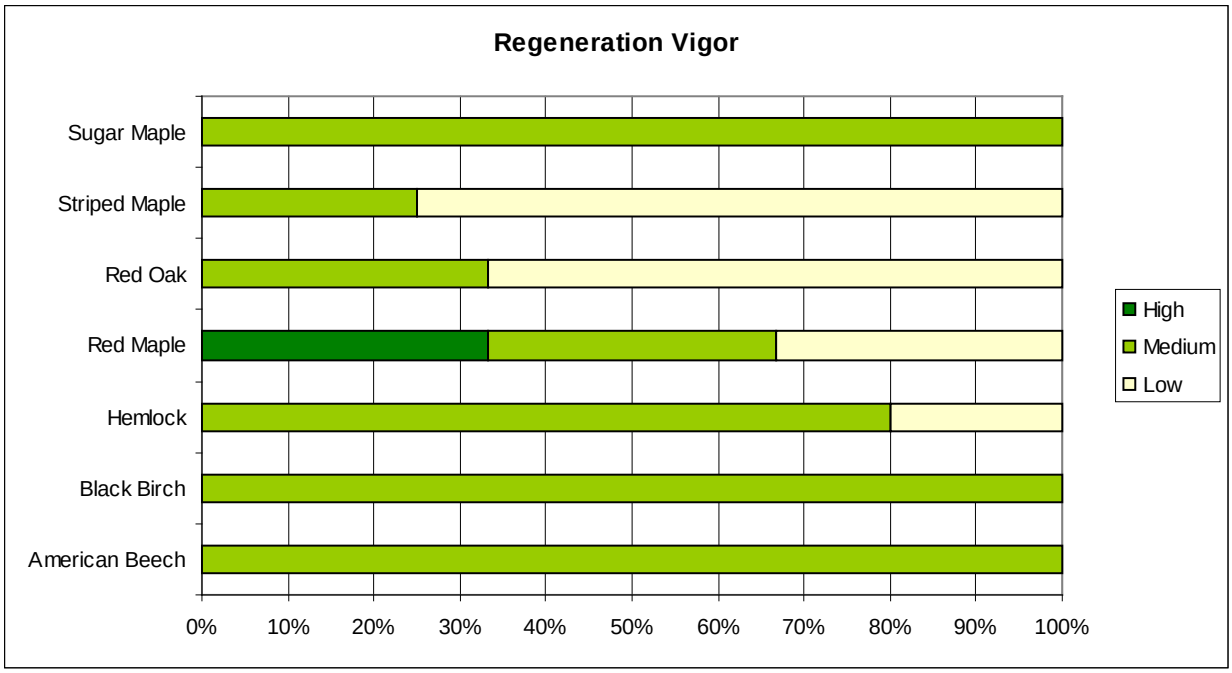
Graph 1.2: Regeneration stocking by percent of stand, species and stocking class. The species is considered "stocked" if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



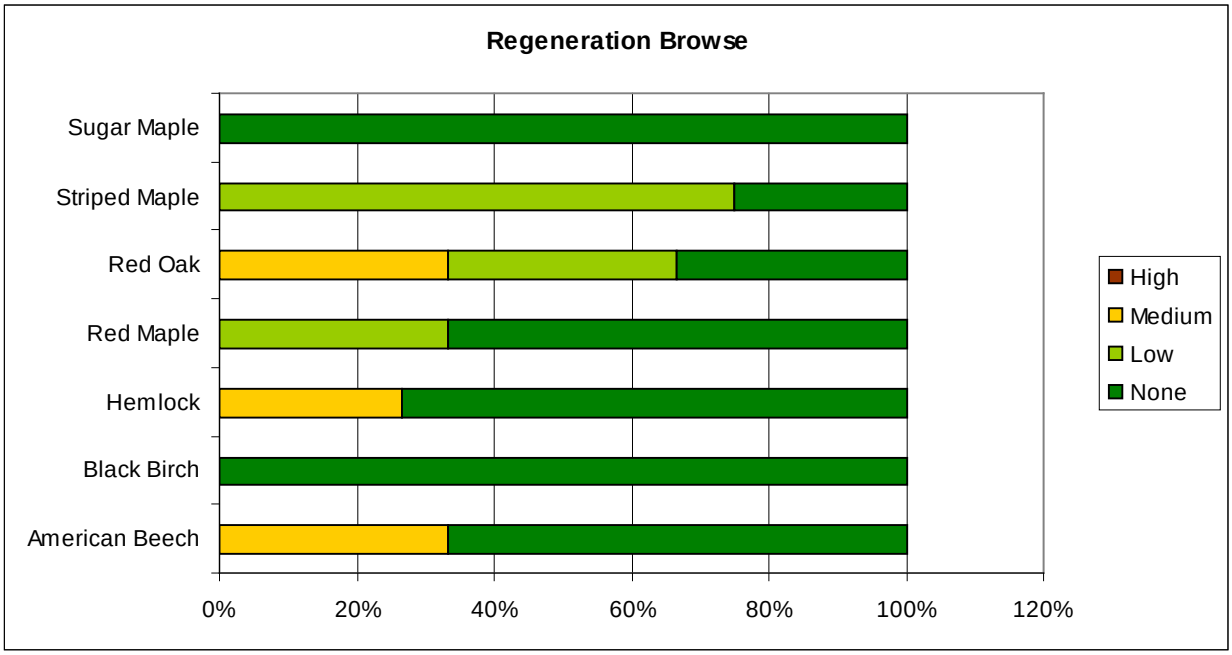
Graph 1.3: Shrub and competing species regeneration stocking by percent of stand, species and stocking class. The species is considered "stocked" if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



Graph 1.4: Vigor of all regeneration and shrub species.



Graph 1.5: Browse level of all regeneration and shrub species.



Silvicultural Objectives

Management system:	Multiple-age	
Harvest Entry:	20 year cutting cycle	
Products:	High quality sawlogs and pulpwood	
Desired Composition:	Maintain current natural species composition	
Crop tree target diameter:	White Pine 28"	Hemlock 24"

Operational Considerations

Operability:	Marginally operable

Seasonal limitations:	Exclude spring and fall mud season
Terrain:	Steep slope
Access and landing area:	Access via open ski trails
Access distance:	1/3 mile at most
General maintenance:	Roads in good shape
Brook-wetland crossings:	Small drainage crossing between trail system and western portion of Stand 1

STAND 1 SUMMARY AND 10 YEAR MANAGEMENT SCHEDULE

Stand 1 occupies several areas of non-contiguous, steep, rocky, forested terrain adjacent to the ski trails. Extremely large white pine and hemlock can be found throughout this stand. It has high aesthetic value and is closely integrated with the ski slopes, downhill mountain biking course, and hiking trails.

The long-term goal of management in this stand is to continually develop multiple age classes of quality sawtimber forest trees of species well suited to the site, improve wildlife habitat, and provide for recreational opportunity. The multiple age classes will exist primarily as pockets of similarly aged trees mixed throughout the stand. This multiple-age composition will provide a diversity of forest structure beneficial to wildlife and will provide opportunity for a mix of silvicultural operations. Timber production likely will be a benefit of management, but will not be the primary goal of silviculture.

Silviculture: The focus of management here is to improve the growth on the best stems, release important biological legacy trees, and create openings for regeneration to become established. This will be accomplished by a mix group selection and crop tree release.

Priority: Low

2016: Reduce overall basal area to approximately 100 square feet through:

- **Group selection:** Group selection up to ½ acre trees to remove pockets of poor quality stems and create conditions for successful regeneration.
- **Crop tree release** on the best quality and vigor stems, and on biological legacy trees.

Stand 2 Hemlock 3A 16.2 acres

Stand Structure

Forest Canopy

Forest Floor

GENERAL ATTRIBUTES

Natural Community Type:	Hemlock - beech - oak - pine forest (S5)
Past Management History:	Harvest in 1980's
Approximate Age of Dominant Trees:	71-90 years
Stand Health:	Fair
Insects/Damage/Disease:	White birch in decline; sapsucker damage in hemlock

SITE CONDITIONS

Site class:	2A
Determined by:	Field observation; soils
Tree vigor:	Medium vigor
Soils:	Kearsarge-Cardigan rock outcrop complex
Parent material:	Glacial till
Soil texture:	Silt loam
Drainage:	Well drained
Terrain:	Moderate to steep slope
Aspect:	Northeast
Elevation:	780-1020'

Snags Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	35.3		29.4	64.8
12-18"				
>18"				
Grand Total	**35.3**		**29.4**	**64.8**

Table 2.1: Standing dead trees per acre by size and decay class.

Down Logs Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	15.0	11.5		26.4
12-18"		3.3		3.3
>18"		1.4		1.4
Grand Total	**15.0**	**16.1**		**31.1**

Table 2.2: Standing down logs per acre by size and decay class.

WILDLIFE HABITAT

Forest type:	Hemlock
Vertical diversity:	Low
Vegetative diversity:	Low
Hard mast:	Oak
Soft mast:	--
Special habitat features:	Dense hemlock for winter shelter
Snag trees:	Few
Down logs:	Good
Special wildlife practices:	Improve shelter and browse resource

RECREATION

Recreational features:	Trail system
Recreational infrastructure:	Parking lot at base of ski trails
Aesthetic resources:	Dense hemlock forest
Public access:	Open to motorized and non-motorized access on designated trails and foot traffic elsewhere.

SILVICULTURE

Structural and Silvicultural Attributes

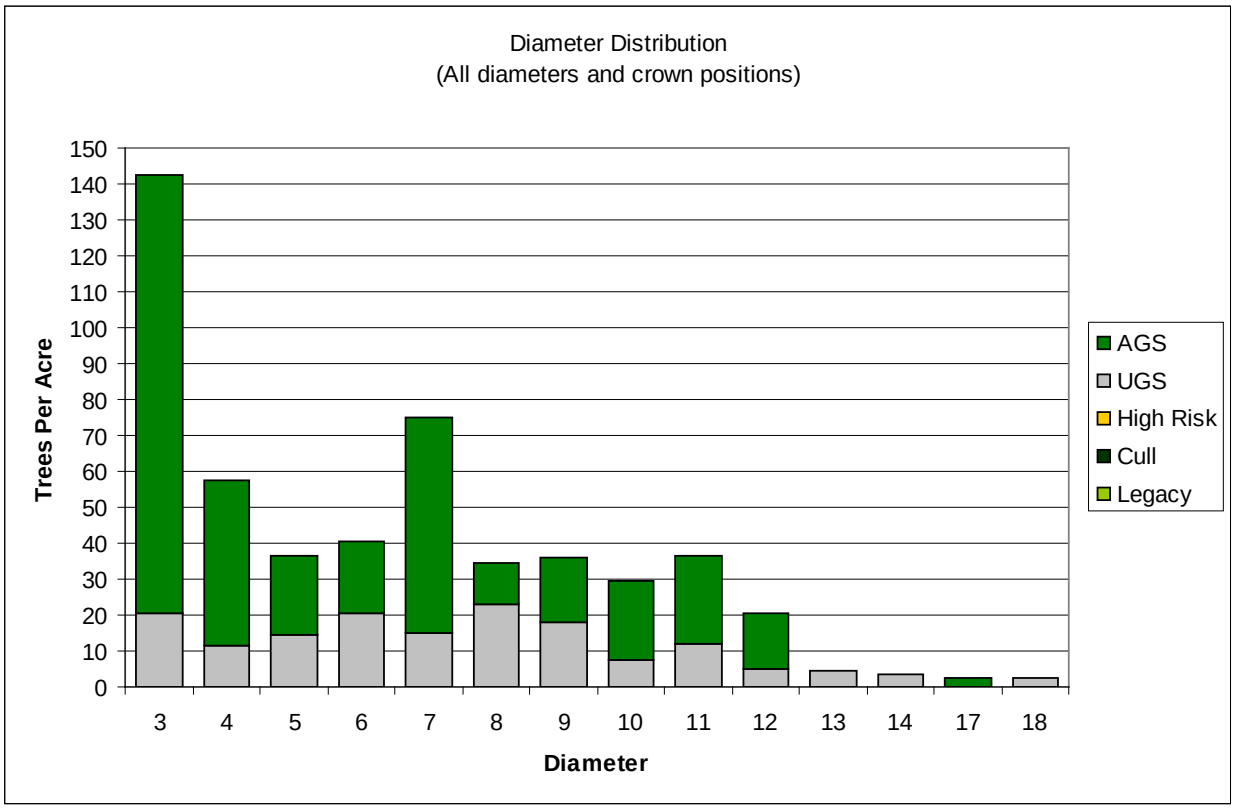
Broad Forest Type:	S3A
Size Class:	Small sawtimber
Stand Structure:	Evenage
Crown Closure:	95%
Total Basal Area Per Acre:	145
Total Merchantable Basal Area Per Acre:	133
Total Acceptable Basal Area Per Acre:	89
Trees Per Acre:	522
Quadratic Mean Stand Diameter:	7.1
Percent AGS Sawtimber:	100.0%
Basal Area of AGS Sawlogs:	32
Timber Quality:	Fair

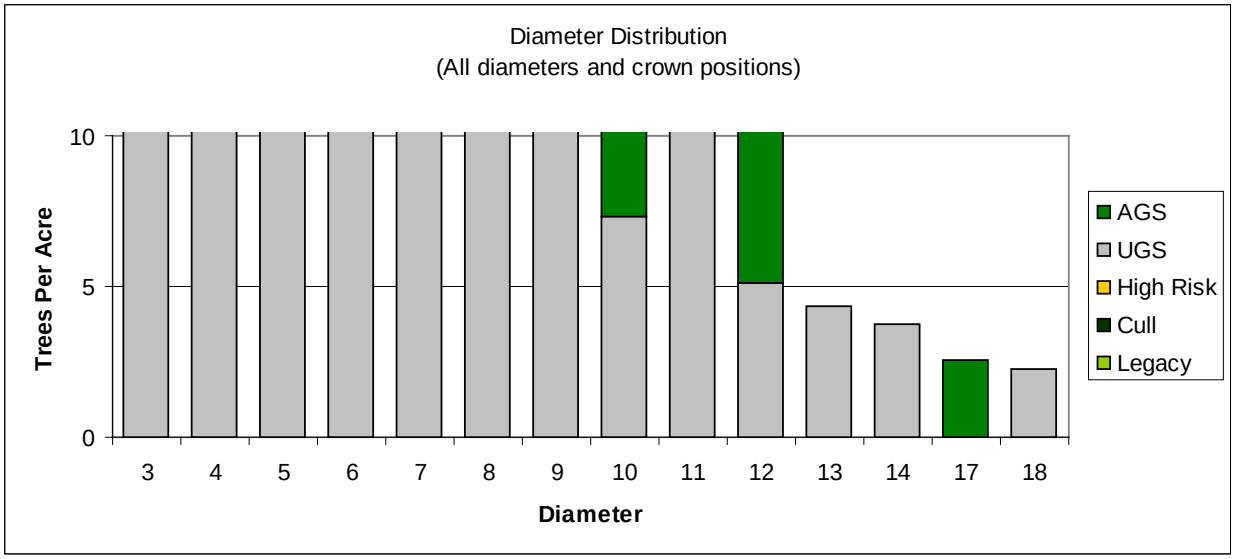
Forest Composition and volume

Species	% TPA	Veneer (bf)	Sawlog (bf)	Pallet/Tie (bf)	Pulp (cd)	Growing Stock (cd)	Total Cords	High Risk	AGS Saw	% AGS Saw
Black Birch	4.5%	0	0	0	1.8	0.0	1.8	0.0	0	0%
Red Maple	16.1%	0	309	0	2.7	0.6	3.9	0.0	309	100%
Red Oak	16.3%	0	175	134	2.4	3.2	6.2	0.0	309	100%
White Birch	2.1%	0	0	0	0.9	0.0	0.9	0.0	0	0%
Total Hardwood Per Acre:	*39.0%*	*0*	*484*	*134*	*7.8*	*3.8*	*12.8*	*0.0*	*618*	100%
Hemlock	58.9%	0	1,373	0	12.1	1.2	15.9	0.0	1,373	100%
White Pine	2.1%	0	298	0	0.6	0.0	1.2	0.0	298	100%
Total Softwood Per Acre:	*61.0%*	*0*	*1,671*	*0*	*12.7*	*1.2*	*17.2*	*0.0*	*1,671*	100%
Total Volume Per Acre:	100.0%	0	2,155	134	20.5	5.0	29.9	0.0	2,289	100%
Stand Volume:		0	34,909	2,175	332	81	485	0	37,084	

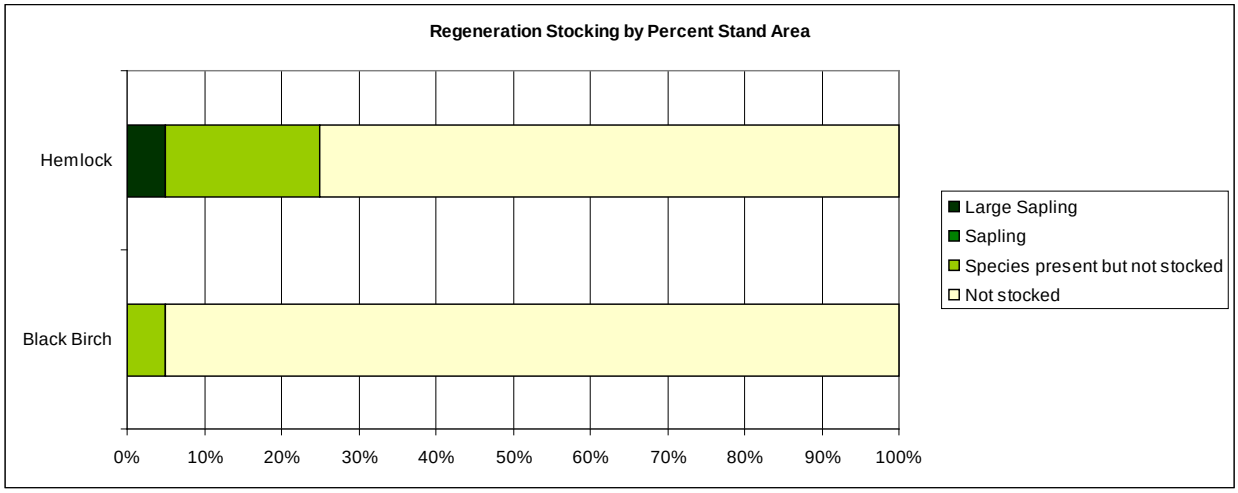
Table 2.3: Stand volume by species and product per acre values.

Graph 2.1a and 2.1b: Diameter distribution showing trees per acre on the Y axis, diameter class on the X axis and tree condition. Includes trees in all canopy positions down to 2 inches in diameter. 2.1b provides a close-up of the breakdown in the larger diameter classes.

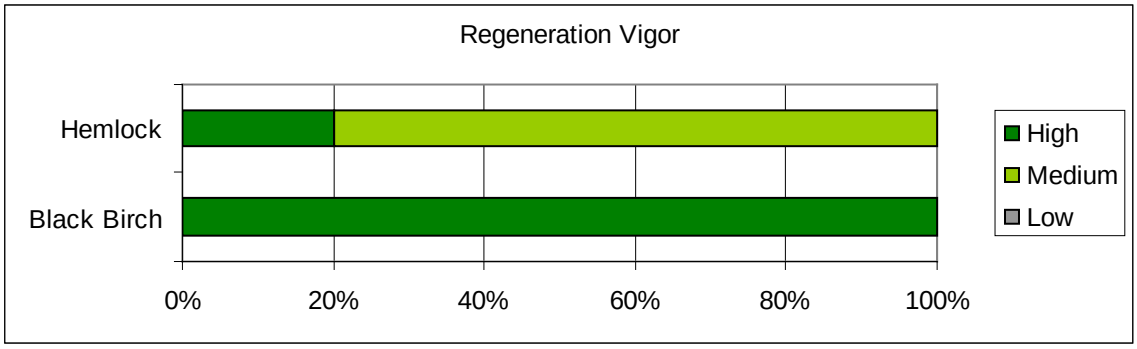




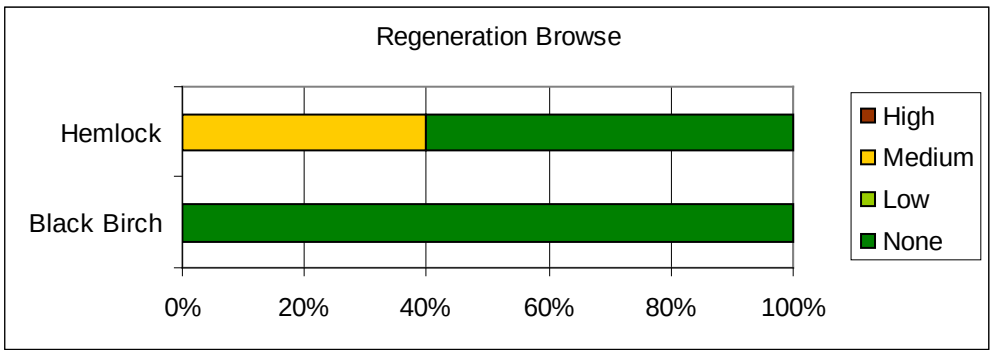
Graph 2.2: Regeneration stocking by percent of stand, species and stocking class. The species is considered "stocked" if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



Graph 2.4: Vigor of all regeneration and shrub species.



Graph 2.5: Browse level of all regeneration and shrub species.



Silvicultural Objectives

Management system:	Multiple-age
Harvest Entry:	20 year cutting cycle
Products:	High quality sawlogs and pulpwood
Desired Composition:	Maintain current natural species composition
Crop tree target diameter:	Hemlock 20"

Operational Considerations

Operability:	Operable
Seasonal limitations:	Exclude spring and fall mud season
Terrain:	Moderate slope
Access and landing area:	Access from the open ski trails via old woods roads, and from the west via old woods roads leading to historic landing site on neighboring land.
Access distance:	1/3 mile at most
General maintenance:	Woods roads in fair shape, heavy ATV use has caused erosion in places.
Brook-wetland crossings:	Small drainage crossing between trail system and western portion of Stand 1, second drainage in moderate gully running North between stand 2 and 3

STAND 2 SUMMARY AND 10 YEAR MANAGEMENT SCHEDULE

Stand 2 occupies the moderately steep slopes west of the open ski trails. It is a dense hemlock forest with little to no regeneration or understory species present, on shallow soil. Some hardwood is mixed in the overstory, including red maple, red oak and white birch. The timber quality is fair to poor in this stand, with just over 2,000 board feet per acre. The stand falls on moderately steep, northeast facing slopes. This forest provides important winter shelter deer. Old woods roads that provides access to this stand are used as part of the recreational trail system that circumnavigates Arrowhead Forest.

The long-term goal of management in this stand is to continually develop multiple age classes of quality sawtimber trees of species well suited to the site, improve wildlife habitat, and provide for recreational opportunity. The multiple age classes will exist primarily as pockets of similarly aged trees

mixed throughout the stand. This multiple-age composition will provide a diversity of forest structure beneficial to wildlife and will provide opportunity for a mix of silvicultural operations. The current species composition reflects the natural species mix, but over time likely the hardwood will make up a greater part of the composition.

Silviculture: The focus of management here is to improve the growth on the best stems and create openings for regeneration to become established. This will be accomplished by a mix of thinning out some area of higher quality stems, removing groups of low quality or diseased stems and by releasing individual crop trees. Attempt to release 15-20 crop trees per acre on at least two sides. All treatments should be accomplished by removing the poorest quality and diseased individuals. Successful treatment will release the best growing stock while improving the AGS to UGS ratio.

Priority: Medium

2014: Reduce overall basal area to approximately 100 square feet through:

- **Single tree and Group selection:** Single tree selection to capture value on mature or high risk trees. Group selection up to ½ acre trees to remove pockets of poor quality stems and create conditions for successful regeneration.
- **Crop tree release** on the best quality and vigor stems. Strive to release 15-20 crop trees on at least 2 sides per acre.

Stand 3 White Pine/Hemlock/Hardwood 3-4A 83.1 acres

Stand Structure

Forest Canopy

Forest Floor

GENERAL ATTRIBUTES

Natural Community Type:	Hemlock - beech - oak - pine forest (S5)
Past Management History:	Harvest in 1980's
Approximate Age of Dominant Trees:	71-90 years
Stand Health:	Good; invasive exotics present including buckthorn and barberry
Insects/Damage/Disease:	Red rot in pine

SITE CONDITIONS

Site class:	2A
Determined by:	Field observation; soils
Tree vigor:	Medium vigor
Soils:	Kearsarge-Cardigan rock outcrop complex, Bernardston stony silt loam, Monadnock-Lyman rock outcrop complex, Cardigan-Kearsarge silt loam, Stissing stony silt loam, Ossipee mucky peat
Parent material:	Glacial till
Soil texture:	Silt loam
Drainage:	Well drained
Terrain:	Moderate to steep slope
Aspect:	Northeast
Elevation:	840-1080'

Snags Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	6.5		2.0	8.5
12-18"		3.3	1.8	5.1
>18"		0.4	1.0	1.4
Grand Total	**6.5**	**3.7**	**4.8**	**15.0**

Table 3.1: Standing dead trees per acre by size and decay class.

Down Logs Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	6.4	6.8	10.4	23.6
12-18"	2.4	3.0	1.7	7.2
>18"	0.2			0.2
Grand Total	**9.0**	**9.8**	**12.1**	**30.9**

Table 3.2: Standing down logs per acre by size and decay class.

WILDLIFE HABITAT

Forest type:	Hemlock/Pine/Hardwood
Vertical diversity:	Medium
Vegetative diversity:	Medium
Hard mast:	Oak, pine
Soft mast:	--
Special habitat features:	Large old pine cavity trees
Snag trees:	Fair
Down logs:	Good
Special wildlife practices:	Create snag trees, increase vertical diversity

RECREATION

Recreational features:	Part of trail system for motorized and non-motorized recreation
Recreational infrastructure:	Parking lot at base of ski trails
Aesthetic resources:	Large scattered white pine; deep forest
Public access:	Open to motorized and non-motorized access on designated trails and foot traffic elsewhere.

SILVICULTURE

Structural and Silvicultural Attributes

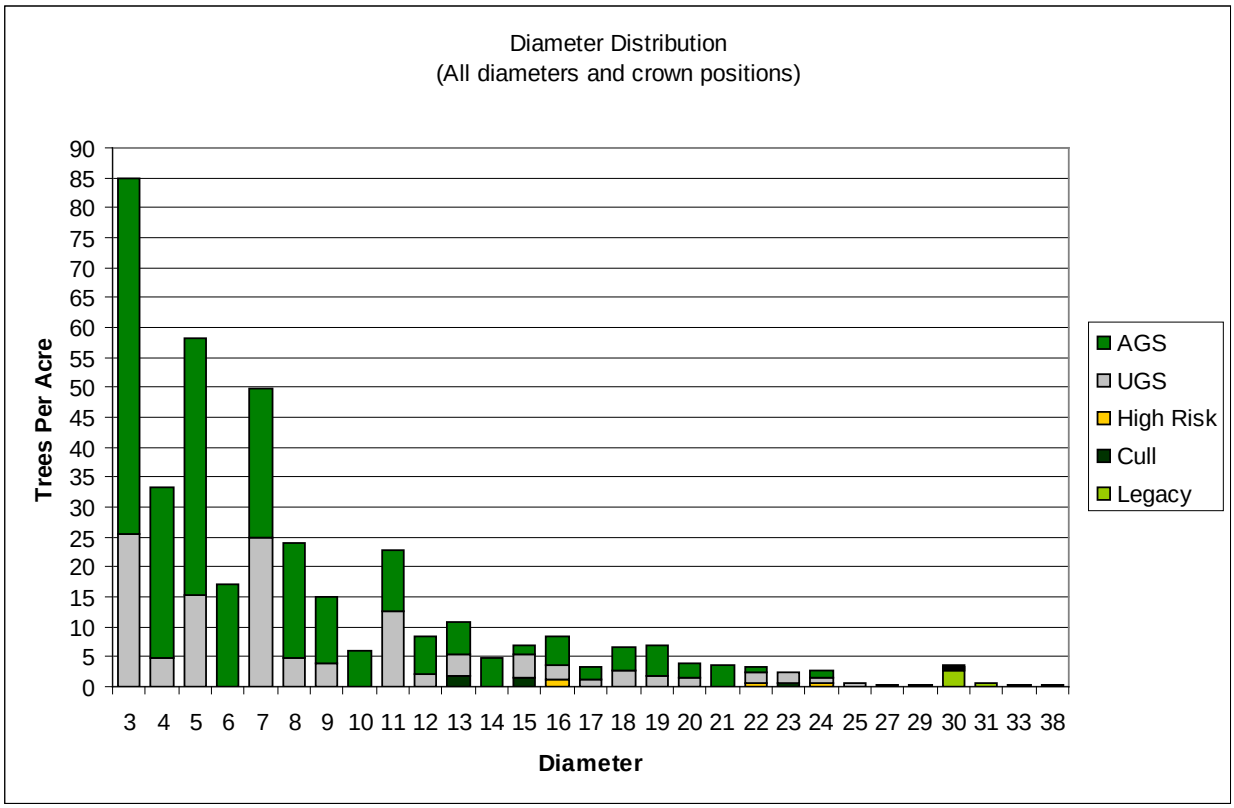
Broad Forest Type:	SH3-4A
Size Class:	Small to large sawtimber
Stand Structure:	Evenage
Crown Closure:	90%
Total Basal Area Per Acre:	164
Total Merchantable Basal Area Per Acre:	155
Total Acceptable Basal Area Per Acre:	74
Trees Per Acre:	343
Quadratic Mean Stand Diameter:	9.3
Percent AGS Sawtimber:	65.1%
Basal Area of AGS Sawlogs:	51
Timber Quality:	Fair

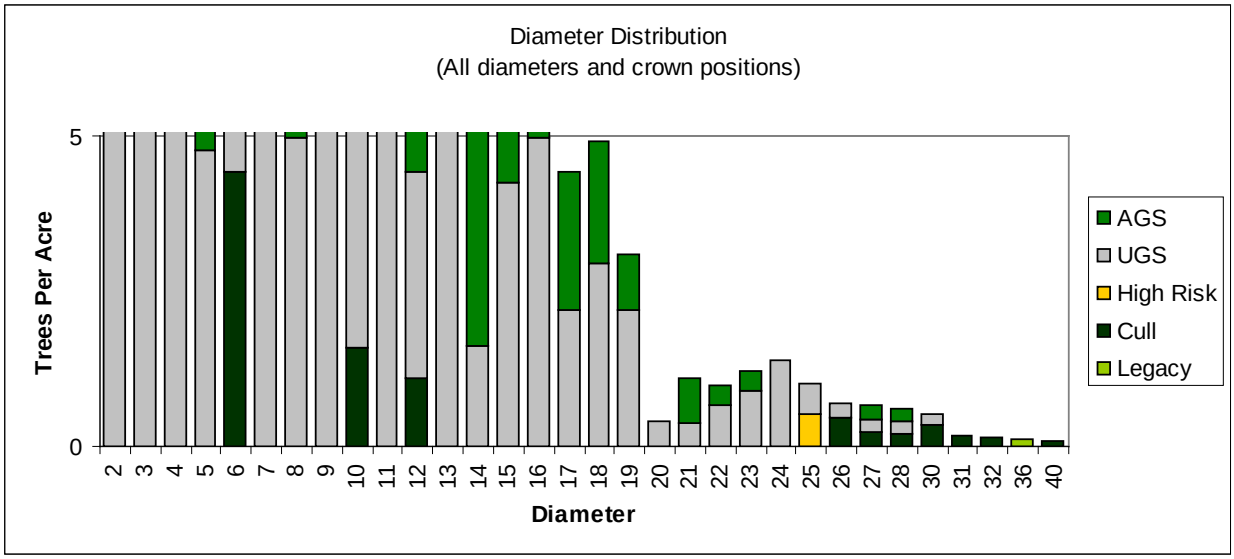
Forest Composition and volume

Species	% TPA	Veneer (bf)	Sawlog (bf)	Pallet/Tie (bf)	Pulp (cd)	Growing Stock (cd)	Total Cords	High Risk	AGS Saw	% AGS Saw
Black Cherry	0.8%	0	0	0	0.2	0.0	0.2	0.0	0	0%
Red Maple	22.6%	0	109	102	3.7	0.4	4.5	0.0	135	64%
Red Oak	2.6%	42	254	110	0.5	0.2	1.4	109.7	157	39%
White Ash	0.2%	0	108	41	0.0	0.0	0.3	0.0	0	0%
White Birch	4.6%	0	39	30	0.9	0.1	1.1	0.0	0	0%
Total Hardwood Per Acre:	*30.8%*	*42*	*510*	*283*	*5.4*	*0.7*	*7.5*	*109.7*	*292*	35%
Hemlock	31.0%	0	1,192	0	7.3	0.1	9.9	0.0	820	69%
White Pine	38.3%	0	5,641	2,199	10.4	0.2	25.0	80.5	5,313	68%
Total Softwood Per Acre:	*69.2%*	*0*	*6,833*	*2,199*	*17.8*	*0.2*	*34.9*	*80.5*	*6,132*	62%
Total Volume Per Acre:	100.0%	42	7,343	2,482	23	1	42	190	6,424	65%
Stand Volume:		3,531	610,217	206,264	1,923	75	3,524	15,807	533,863	

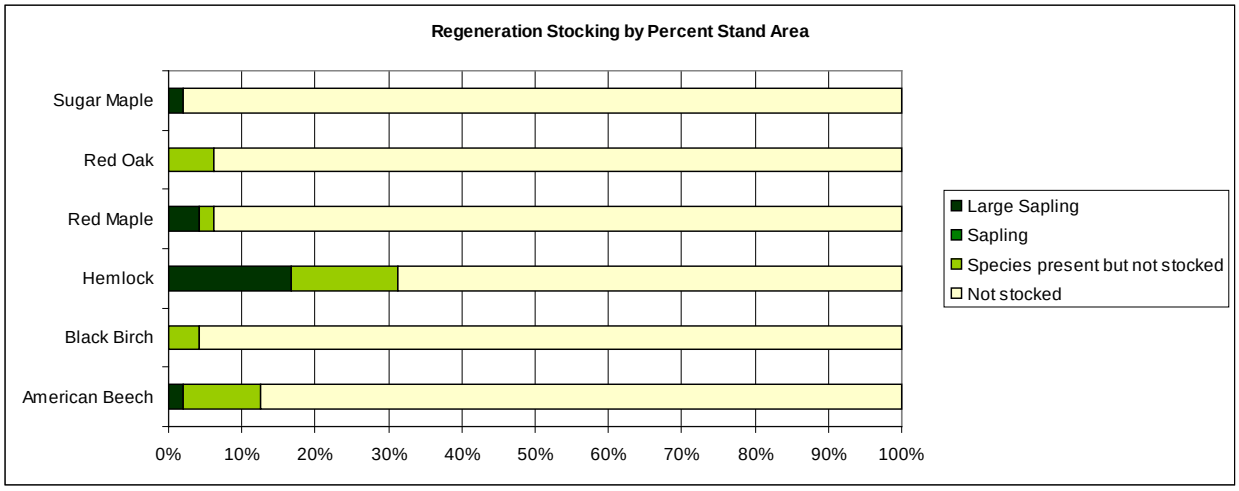
Table 3.3: Stand volume by species and product per acre values.

Graph 3.1a and 3.1b: Diameter distribution showing trees per acre on the Y axis, diameter class on the X axis and tree condition. Includes trees in all canopy positions down to 2 inches in diameter. 3.1b provides a close-up of the breakdown in the larger diameter classes.

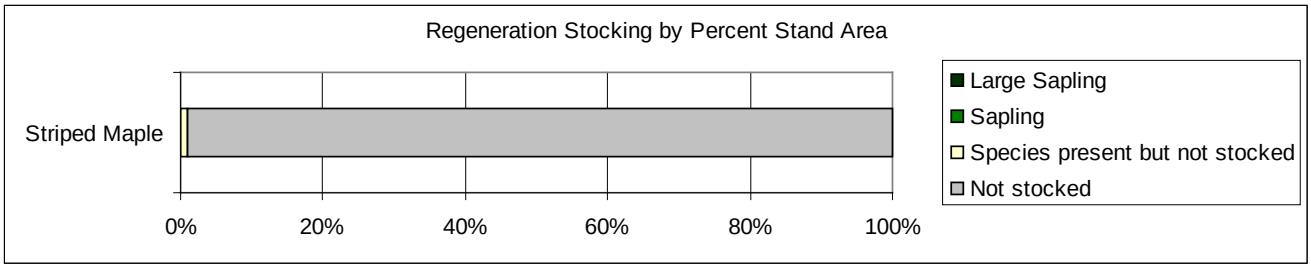




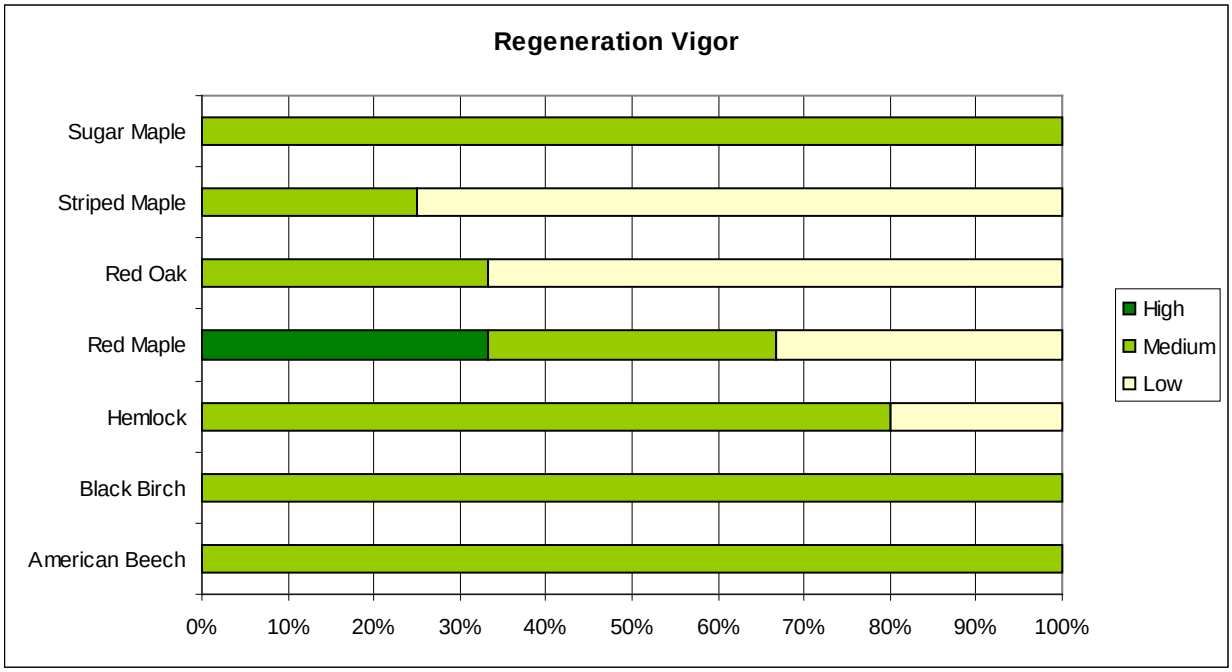
Graph 3.2: Regeneration stocking by percent of stand, species and stocking class. The species is considered "stocked" if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



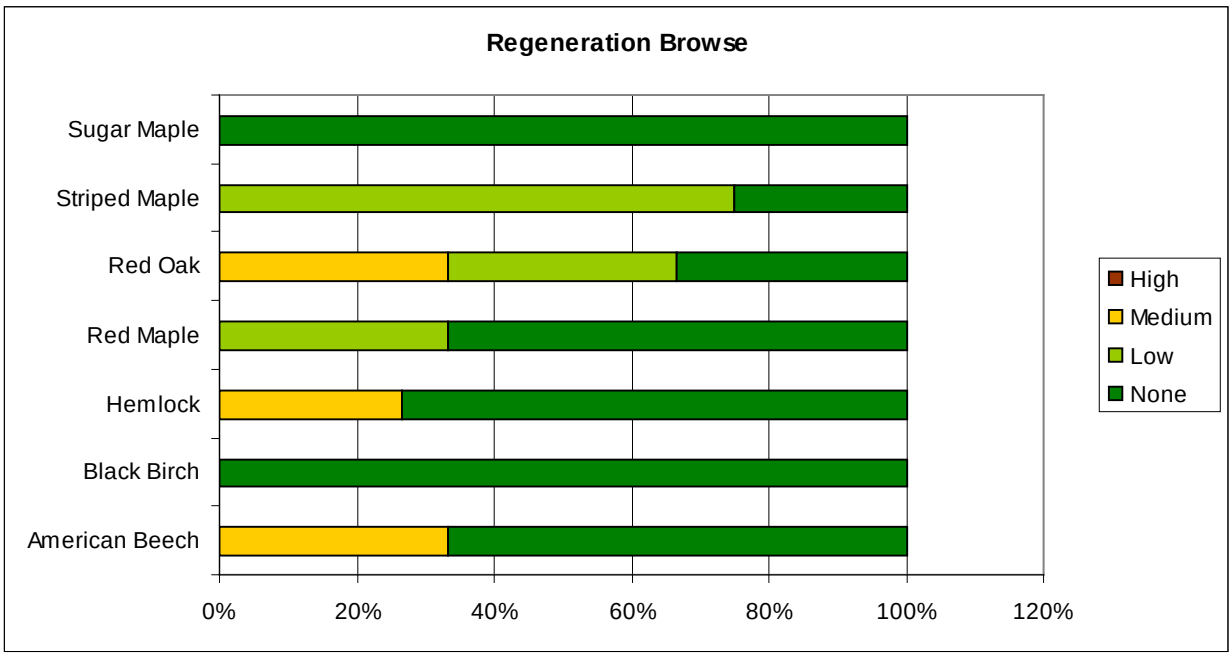
Graph 3.3: Shrub and competing species regeneration stocking by percent of stand, species and stocking class. The species is considered “stocked” if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



Graph 3.4: Vigor of all regeneration and shrub species.



Graph 3.5: Browse level of all regeneration and shrub species.



Silvicultural Objectives

Management system:	Multiple-age	
Harvest Entry:	20 year cutting cycle	
Products:	High quality sawlogs and pulpwood	
Desired Composition:	Maintain current natural species composition	
Crop tree target diameter:	Red Oak 22"	White Pine 22"
	Red Maple 18"	Hemlock 20"

Operational Considerations

Operability:	Operable
Seasonal limitations:	Exclude spring and fall mud season
Terrain:	Moderate slope
Access and landing area:	Access from the open ski trails via old woods roads, and from the west via old woods roads leading to historic landing site on neighboring land.
Access distance:	1/3 mile
General maintenance:	Woods roads in fair shape, heavy ATV use has caused erosion in places
Brook-wetland crossings:	Small drainage crossing between trail system and western portion of Stand 1, second drainage in moderate gully running North between stand 2 and 3

STAND 3 SUMMARY
AND
10-YEAR MANAGEMENT SCHEDULE

Stand 3 is the largest stand on the forest and occupies the southern extent of the tract. It is a mixed of hemlock and hardwoods but dominated by white pine. It extends from the top of the ski slopes, across the dense hemlock of Stand 2 to the western boundary and south to the height of land and the southern boundary. It includes the bulk of the area last harvested in the 1980's. The pine ranges greatly in size, age, and quality with a large amount of both cull and unacceptable growing stock. The inventory data reports close to 7,000 feet of pine per acre. The actual pine volume is difficult to determine though, as this pine is not easy to grade as a standing tree, sometimes a clean looking tree has red rot and other time what looks like a poor quality tree turns out to be sound and clean. There is a small area of younger pine located at the height of land, likely an area kept open for agricultural purposes later than the rest, which is of decent quality and would benefit from an intermediate thinning. Likely some amount of pine will remain in the community type, but existing regeneration and sapling-pole size trees that have grown in openings made by prior harvesting activities or natural disturbances are dominated by hardwoods, suggesting hardwoods will make up a greater proportion of the composition in the future. In addition, hemlock, an extremely shade tolerant species, has regenerated well in this stand comprising the bulk of the understory stems. This forest provides important a limited amount of browse for wildlife, and a minor amount of mast, mostly in the form of acorns and pine seeds. Large cull pine are abundant though, providing excellent habitat for cavity nesting birds, woodpeckers, and winged predators that prefer to hunt from a perch. In addition, this stand includes High bush blueberry-Winterberry Shrub wetland discussed earlier. This is an important factor contributing to the biodiversity of the forest and providing essential habitat for amphibians. As in Stand 2, old woods roads that provide access to this stand are used as part of the recreational trail system that circumnavigates Arrowhead Forest.

The long-term goal of management in this stand is to continually develop multiple age classes of quality sawtimber trees of species well suited to the site, improve wildlife habitat, and provide for recreational opportunity. The multiple age classes will exist primarily as pockets of similarly aged trees mixed throughout the stand. This multiple-age composition will provide a diversity of forest structure beneficial to wildlife and will provide opportunity for a mix of silvicultural operations. The current species composition reflects the natural species mix, but over time likely the hardwood will make up a greater part of the composition.

Silviculture: The focus of management here is to improve the growth on the best stems and create openings for regeneration to become established. This will be accomplished by a mix of thinning out some area of higher quality stems, removing groups of low quality or diseased stems and by releasing individual crop trees. Attempt to release 15-20 crop trees per acre on at least two sides. All treatments should be accomplished by removing the poorest quality and diseased individuals. Successful treatment will release the best growing stock while improving the AGS to UGS ratio.

Priority: Medium

2014: Reduce overall basal area to approximately 100 square feet through:

- **Single tree and Group selection:** Single tree selection to capture value on mature or high risk trees. Group selection up to ½ acre trees to remove pockets of poor quality stems and create conditions for successful regeneration.
- **Crop tree release** on the best quality and vigor stems. Strive to release 15-20 crop trees on at least 2 sides per acre.

Water Quality[7]:

- Maintain a 50' forested buffer around wetland with only limited harvesting that retains relatively continuous forest cover (65-70 percent canopy cover) to protect water quality.
- Avoid making either roads or landings within the 50' buffer.
- Avoid adding woody material to streams.

7 Water quality protection management recommendations from the publication Biodiversity in the Forests of Maine; Flatebro, Gro, Foss, Carol, and Pelletier, Steven, 1999, UMCE Bulletin #7147

Stand 4 White Pine 5B/Hardwood 3B 38.5 acres

Stand Structure

Stand Structure

Forest Canopy

GENERAL ATTRIBUTES

Natural Community Type:	Hemlock - beech - oak - pine forest (S5)
Past Management History:	Harvest in 1980's
Approximate Age of Dominant Trees:	71-90 years
Stand Health:	Good
Insects/Damage/Disease:	Red rot in pine

SITE CONDITIONS

Site class:	2A
Determined by:	Field observation; soils
Tree vigor:	Medium vigor
Soils:	Pittstown stony silt loam, Bernardston silt loam, Kearsarge-Cardigan rock outcrop complex, Cardigan-Kearsarge silt loam, Bernardston stony silt loam
Parent material:	Glacial till
Soil texture:	Silt loam
Drainage:	Well drained
Terrain:	Moderate to steep slope
Aspect:	Northeast
Elevation:	580-1060'

Snags Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	9.4			9.4
12-18"	3.6	2.7	2.7	9.0
>18"			1.8	1.8
Grand Total	**12.9**	**2.7**	**4.5**	**20.1**

Table 4.1: Standing dead trees per acre by size and decay class.

Down Logs Per Acre

DBH Class	Moderately punky	Punky throughout	Sound	Grand Total
<12"	18.8			18.8
12-18"	3.2		1.8	5.0
>18"		1.0		1.0
Grand Total	**22.0**	**1.0**	**1.8**	**24.8**

Table 4.2: Standing down logs per acre by size and decay class.

WILDLIFE HABITAT

Forest type:	Hemlock/Pine/Hardwood
Vertical diversity:	Medium
Vegetative diversity:	Medium
Hard mast:	Oak, pine
Soft mast:	--
Special habitat features:	Large old pine cavity trees
Snag trees:	Fair
Down logs:	Good
Special wildlife practices:	Create snag trees, increase vertical diversity

RECREATION

Recreational features:	Part of trail system for motorized and non-motorized recreation
Recreational infrastructure:	Parking lot at base of ski trails
Aesthetic resources:	Large scattered white pine
Public access:	Open to motorized and non-motorized access on designated trails and foot traffic elsewhere.

SILVICULTURE

Structural and Silvicultural Attributes

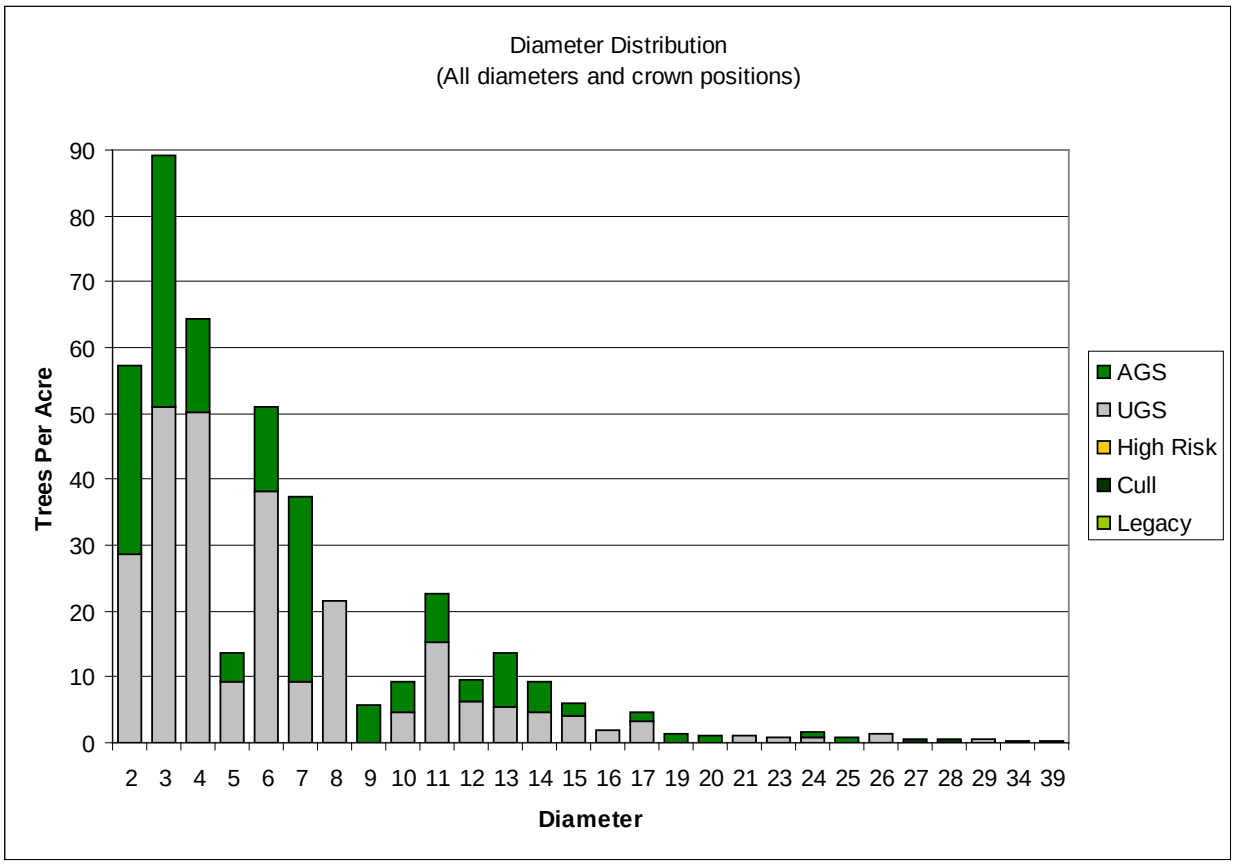
Broad Forest Type:	S5B/H3B
Size Class:	Large sawtimber
Stand Structure:	Evenage
Crown Closure:	95%
Total Basal Area Per Acre:	146
Total Merchantable Basal Area Per Acre:	134
Total Acceptable Basal Area Per Acre:	54
Trees Per Acre:	428
Quadratic Mean Stand Diameter:	7.9
Percent AGS Sawtimber:	55.5%
Basal Area of AGS Sawlogs:	35
Timber Quality:	Fair to Poor

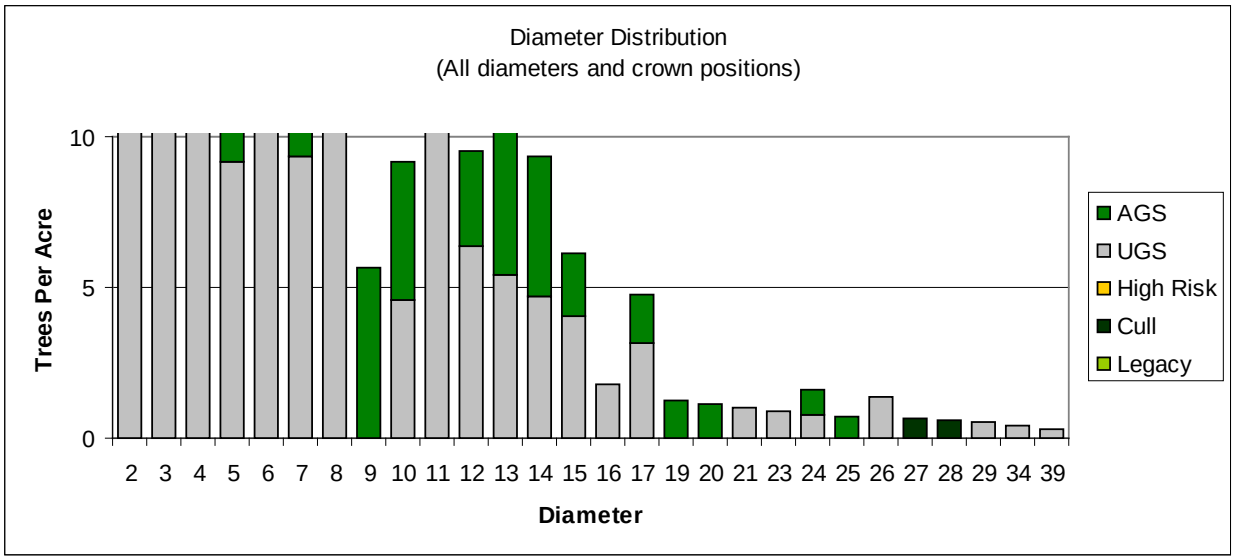
Forest Composition and volume

Species	% TPA	Veneer (bf)	Sawlog (bf)	Pallet/Tie (bf)	Pulp (cd)	Growing Stock (cd)	Legacy (cd)	Total Cords	High Risk	AGS Saw	% AGS Saw
American Beech	4.6%	0	0	0	0.3	0.0	0.0	0.3	0	0	0%
Red Maple	33.0%	0	0	0	4.0	0.0	0.0	4.0	0	0	0%
Red Oak	11.5%	0	372	48	0.3	0.3	0.0	1.4	0	421	100%
Sugar Maple	0.3%	0	0	0	0.0	0.0	0.0	0.0	0	0	0%
White Birch	12.9%	0	199	72	2.7	0.0	0.0	3.2	0	271	100%
Total Hardwood Per Acre:	*62.3%*	*0*	*571*	*120*	*7.2*	*0.3*	*0.0*	*8.8*	*0*	*691*	100%
Hemlock	1.2%	0	0	0	0.7	0.0	0.0	0.7	0	0	0%
Red Pine	2.2%	0	753	0	0.2	0.0	0.0	1.7	0	753	100%
White Pine	34.4%	0	3,535	2,790	11.3	0.6	0.0	23.6	0	2,869	45%
Total Softwood Per Acre:	*37.7%*	*0*	*4,288*	*2,790*	*12.2*	*0.6*	*0.0*	*25.9*	*0*	*3,622*	51%
Total Volume Per Acre:	100.0%	0	4,859	2,910	19	1	0	35	0	4,313	56%
Stand Volume:		0	187,067	112,032	748	35	0	1,339	0	166,069	56%

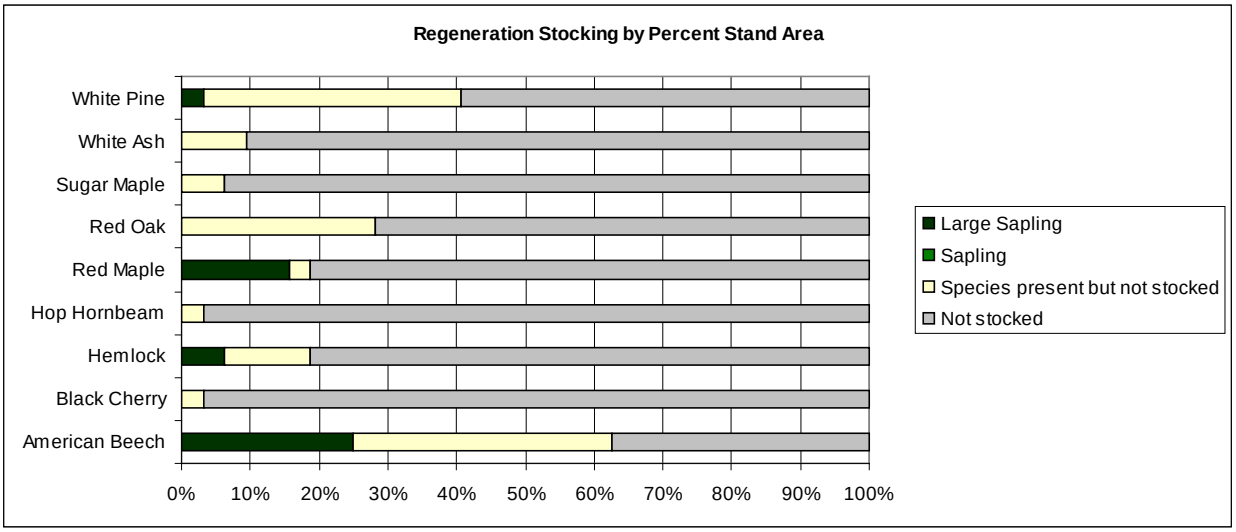
Table 4.3: Stand volume by species and product per acre values.

Graph 4.1a and 4.1b: Diameter distribution showing trees per acre on the Y axis, diameter class on the X axis and tree condition. Includes trees in all canopy positions down to 2 inches in diameter. 4.1b provides a close-up of the breakdown in the larger diameter classes.

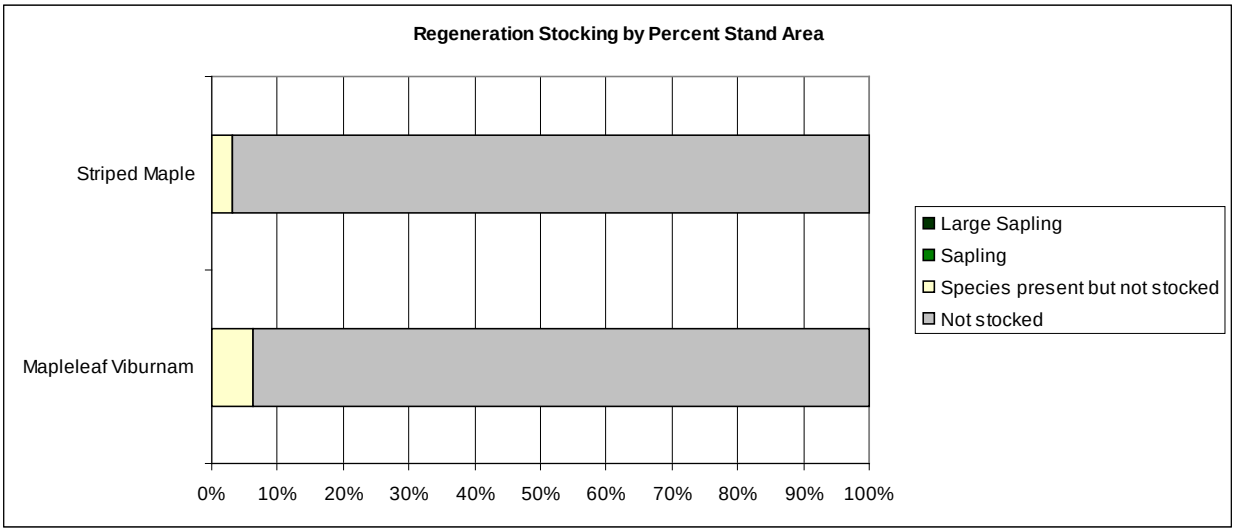




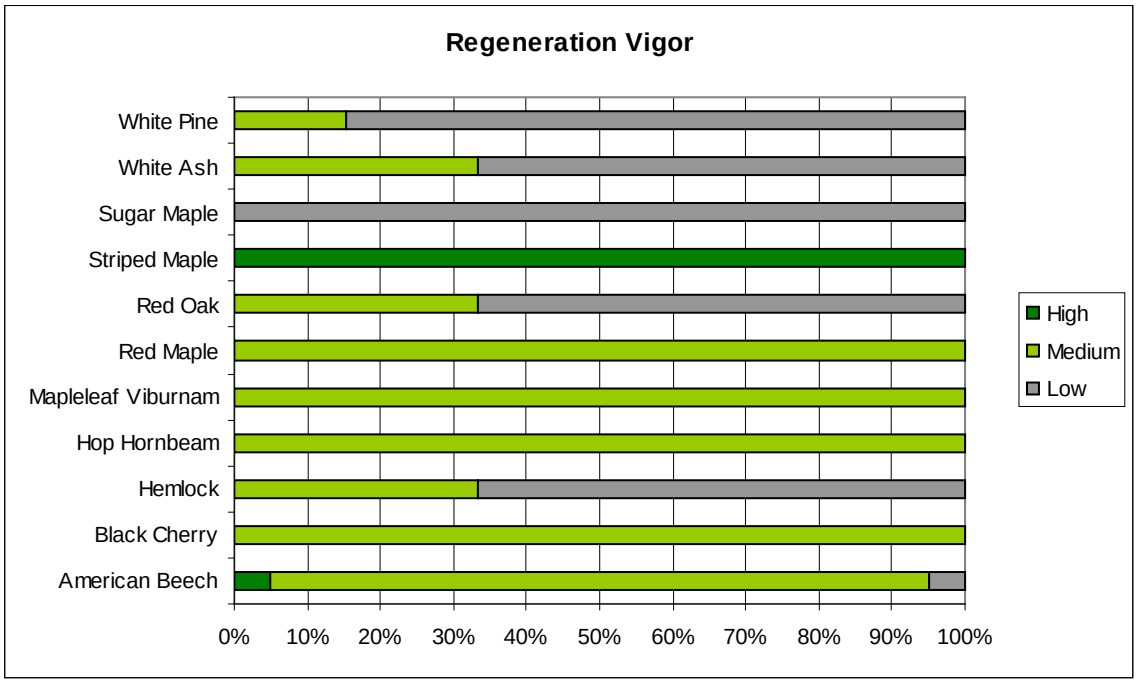
Graph 4.2: Regeneration stocking by percent of stand, species and stocking class. The species is considered "stocked" if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



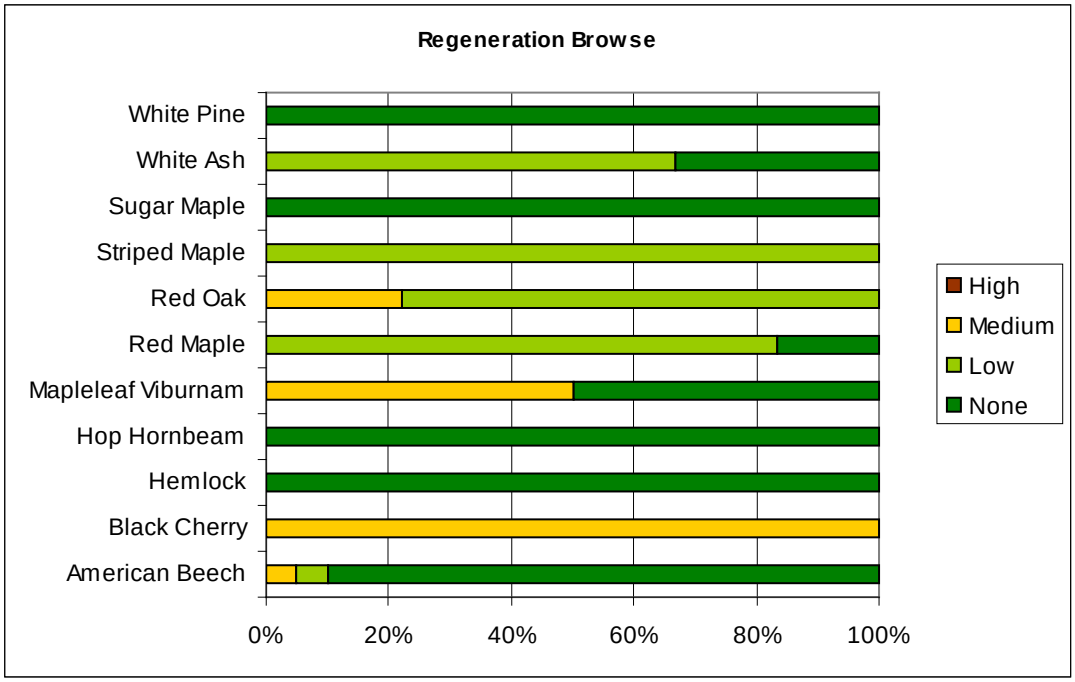
Graph 4.3: Shrub and competing species regeneration stocking by percent of stand, species and stocking class. The species is considered "stocked" if it meets at least one of three stocking levels including 2 stems between 0.5 and 1.5 inches diameter(Large Sapling), 5 stems between 3 and 5 feet tall (Sapling), or 25 seedlings less than 3 feet tall (Seedling). If a species is present but does not meet one of these conditions, it is recorded as present but not stocked.



Graph 4.4: Vigor of all regeneration and shrub species.



Graph 4.5: Browse level of all regeneration and shrub species.



Silvicultural Objectives

Management system:	Multiple-age	
Harvest Entry:	20 year cutting cycle	
Products:	High quality sawlogs and pulpwood	
Desired Composition:	Maintain current natural species composition	
Crop tree target diameter:	Red Oak 22"	White Pine 22"
	Red Maple 18"	Hemlock 20"

Operational Considerations

Operability:	Operable
Seasonal limitations:	Exclude spring and fall mud season
Terrain:	Moderate slope
Access and landing area:	Access from the open ski trails via old woods roads
Access distance:	1/3 mile
General maintenance:	Woods roads in fair shape, heavy ATV use has caused erosion in places
Brook-wetland crossings:	None required

STAND 4 SUMMARY AND 10-YEAR MANAGEMENT SCHEDULE

Stand 4 occupies the area of Arrowhead Forest east and south of the ski slopes. It is similar to stand 3 but with less of the hemlock component in the overstory. It is a mix of hardwoods, primarily red oak, red maple and white birch, and white pine. The pine are throughout the forest and make up a “super canopy” that extend above the hardwood treetops. As with stand 3, the inventory reports a relatively large amount of pine volume, over 4,000 feet of pine per acre. The actual pine volume is difficult to determine though, as this pine is not easy to grade as a standing tree, sometimes a clean looking tree has red rot and other time what looks like a poor quality tree turns out to be sound and clean. Regeneration is fairly abundant, but is dominated by American beech. There is also a good amount of white pine, red maple, and hemlock regeneration. This forest, like stand 3, provides important a limited amount of browse for wildlife, and a minor amount of mast, mostly in the form of acorns and pine seeds. Large cull pine are abundant, providing excellent habitat for cavity nesting birds, woodpeckers, and winged predators that prefer to hunt from a perch. As in Stand 2, old woods roads that provide access to this stand are used as part of the recreational trail system that circumnavigates Arrowhead Forest and provides access to the vista on Flatrock Hill.

The long-term goal of management in this stand is to continually develop multiple age classes of quality sawtimber trees of species well suited to the site, improve wildlife habitat, and provide for recreational opportunity. The multiple age classes will exist primarily as pockets of similarly aged trees mixed throughout the stand. This multiple-age composition will provide a diversity of forest structure beneficial to wildlife and will provide opportunity for a mix of silvicultural operations. The current species composition reflects the natural species mix, but over time likely the hardwood will make up a greater part of the composition.

Silviculture: The focus of management here is to improve the growth on the best stems and create openings for regeneration to become established. This will be accomplished by a mix of thinning out

some area of higher quality stems, removing groups of low quality or diseased stems and by releasing individual crop trees. Attempt to release 15-20 crop trees per acre on at least two sides. All treatments should be accomplished by removing the poorest quality and diseased individuals. Successful treatment will release the best growing stock while improving the AGS to UGS ratio.

Priority: Medium

2016: Reduce overall basal area to approximately 100 square feet through:

- **Single tree and Group selection:** Single tree selection to capture value on mature or high risk trees. Group selection up to ½ acre trees to remove pockets of poor quality stems and create conditions for successful regeneration.
- **Crop tree release** on the best quality and vigor stems. Strive to release 15-20 crop trees on at least 2 sides per acre.

ARROWHEAD FOREST
TOTAL FOREST TIMBER AND PULP VOLUME
December, 2007
162.2 Forested Acres

Species	Veneer (bf)	Sawlog (bf)	Tie (bf)	Total BF	Pulp (cds)	Growing Stock (cds)	Cull (cds)	Total Volume in Cords	% Cords
Hardwood									
American Beech	0	0	0	*0*	18	0	0	*18*	*0.3%*
Black Birch	0	0	0	*0*	31	5	0	*36*	*0.5%*
Black Cherry	0	0	0	*0*	20	0	0	*20*	*0.3%*
Red Maple	0	20,073	20,735	*40,808*	585	53	49	*716*	*10.8%*
Red Oak	3,531	42,756	13,180	*59,467*	125	94	10	*332*	*5.0%*
Sugar Maple	0	4,231	3,774	*8,005*	26	3	44	*45*	*0.7%*
White Ash	0	8,970	3,421	*12,391*	3	0	0	*24*	*0.4%*
White Birch	0	15,610	5,257	*20,867*	205	6	11	*250*	*3.8%*
Total Hardwood:	3,531	91,640	46,367	141,538	1,013	161	114	*1,441*	
Softwood									
Hemlock	0	168,059	0	*168,059*	1,109	54	44	*1,496*	*22.6%*
Red Pine	0	32,261	0	*32,261*	24	0	0	*88*	*1.3%*
White Pine	0	755,304	355,166	*1,110,470*	1,529	37	362	*3,583*	*54.2%*
Total Softwood:	0	955,624	355,166	1,310,790	2,662	91	406	*5,167*	
Total Volume:	3,531	1,047,264	401,533	1,452,328	3,675	252	520	*6,608*	

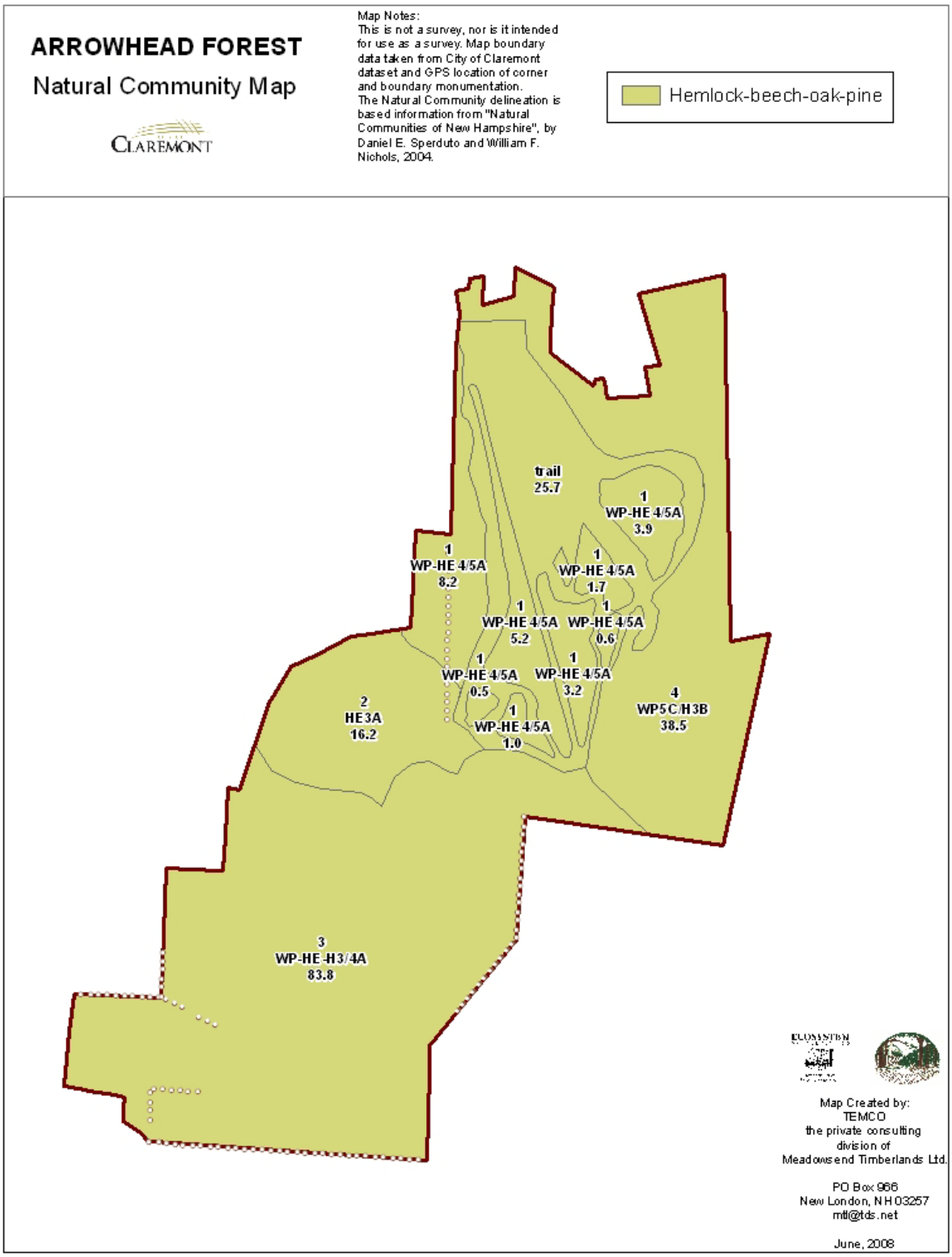
ARROWHEAD FOREST

10-YEAR TREATMENT SCHEDULE

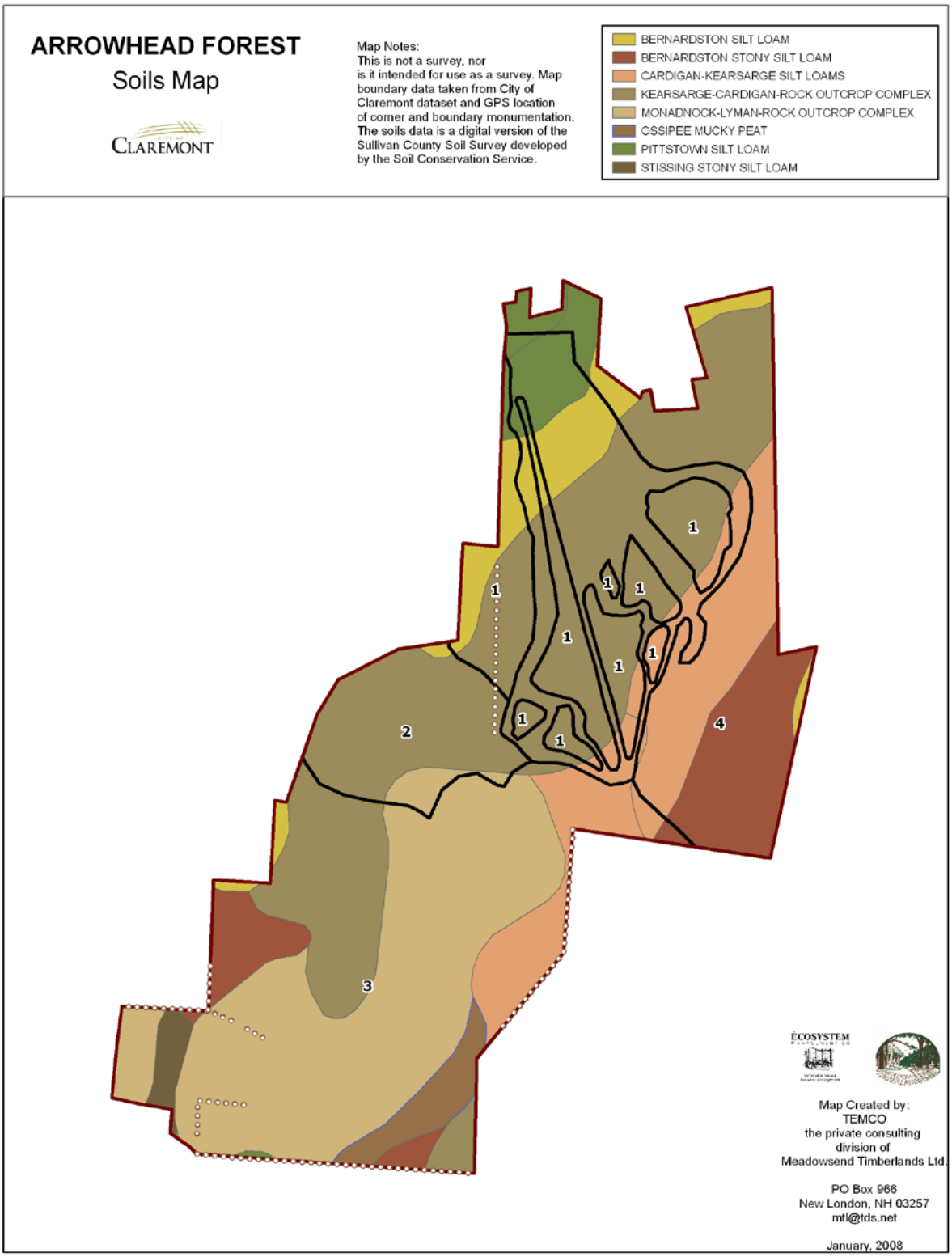
The dates given in this treatment schedule are meant to help prioritize work on the entire Claremont ownership. It is meant to be flexible and may change due to weather and market conditions or to unforeseen opportunities and access issues. The treatment activities may change due to the same reasons if silviculturally justifiable and agree with landowner mission, principles and management objectives.

Stand #	Type	Acres	Treatment	Year
2	**S3A**	**16.2**	Single tree; Group Selection; Crop Tree Release	**2014**
3	**SH3-4A**	**83.1**	Single tree; Group Selection; Crop Tree Release	**2014**
1	**S4-5A**	**24.5**	Group Selection; Crop Tree Release	**2016**
4	**S5C H3B**	**38.5**	Single tree; Group Selection; Crop Tree Release	**2016**
all			Blaze and paint property boundary lines	**ASAP**
all			Reevaluate and update management plan	**2018**

APPENDIX A: NATURAL COMMUNITY MAP


ARROWHEAD FOREST
Natural Community Map
CLAREMONT
Map Notes:
This is not a survey, nor is it intended for use as a survey. Map boundary data taken from City of Claremont dataset and GPS location of corner and boundary monumentation.
The Natural Community delineation is based information from "Natural Communities of New Hampshire", by Daniel E. Sperduto and William F. Nichols, 2004.
Hemlock-beech-oak-pine
trail
25.7
1
WP-HE 4/5A
3.9
1
WP-HE 4/5A
8.2
1
WP-HE 4/5A
1.7
1
WP-HE 4/5A
5.2
1
WP-HE 4/5A
0.6
1
WP-HE 4/5A
0.5
1
WP-HE 4/5A
3.2
2
HE3A
16.2
1
WP-HE 4/5A
1.0
4
WP5C/H3B
38.5
3
WP-HE-H3/4A
83.8
Map Created by:
TEMCO
the private consulting division of
Meadowsend Timberlands Ltd.
PO Box 966
New London, NH 03257
mtl@tds.net
June, 2008

APPENDIX B: SOILS MAP


ARROWHEAD FOREST
Soils Map
CLAREMONT
Map Notes:
This is not a survey, nor is it intended for use as a survey. Map boundary data taken from City of Claremont dataset and GPS location of corner and boundary monumentation. The soils data is a digital version of the Sullivan County Soil Survey developed by the Soil Conservation Service.
BERNARDSTON SILT LOAM
BERNARDSTON STONY SILT LOAM
CARDIGAN-KEARSARGE SILT LOAMS
KEARSARGE-CARDIGAN-ROCK OUTCROP COMPLEX
MONADNOCK-LYMAN-ROCK OUTCROP COMPLEX
OSSIPEE MUCKY PEAT
PITTSTOWN SILT LOAM
STISSING STONY SILT LOAM
1
2
3
4
ECOSYSTEM
Map Created by:
TEMCO
the private consulting division of
Meadowsend Timberlands Ltd.
PO Box 966
New London, NH 03257
mtl@tds.net
January, 2008

APPENDIX C: NEW HAMPSHIRE IMPORTANT FOREST SOIL CLASSIFICATION

Productivity of New Hampshire Forest Soils*

1A: Deeper, loamy soils, moderately to well-drained; prime northern hardwood sites.

1B: Sandy or loamy soils, moderately to well-drained; oak and beech depending on sites.

1C: Outwash sands and gravels; white pine sites.

2A: 1A and 1B soils with limitations, for example, very steep, shallow, or rocky; northern hardwood sites.

2B: Poorly drained soils; spruce/fir sites in northern New Hampshire.

Not considered because they generally rank low in timber productivity, despite often being very high in wildlife ecological value: Muck and peat, rock outcrop, gravel pits, marsh, etc.

**New Hampshire Forest Land Base Study, 2000*