New Hampshire Professional Loggers Program

Silvicultural Principles For New Hampshire Forest Types

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The ***New Hampshire Timber Harvesting Council*** was formed in 1993 to promote and protect the interests of the state's 1,400 loggers and truckers. The Council is jointly sponsored by the NH Timberland owners Association, the Forest Industries Training Center at the UNH Thompson School, and the UNH Cooperative Extension. The leadership is made up of independent contractors – large and small – from all corners of the state dedicated to ensuring that the harvesting of forest products remains a safe, environmentally responsible and commercially viable land use.

This booklet is the core text for the NH Professional Logger Program, Fundamentals of Forestry workshop. For more information on this program or others offered by the council please contact Sarah Smith, 862-2647 or New Hampshire Timberland Owners Association, 224-9699.

NH Timberland Owners Association

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Silvicultural Principles for NH Forest Types

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New Hampshire Forest Types

Forest types are distinctive associations of trees, shrubs and herbaceous plants. They are named for the predominant tree species.

There are other ways to group and describe forests. Natural communities and wildlife habitat are commonly used. Natural communities describe current and potential vegetation in the absence of disturbance. A comparison of these three methods is in the *New Hampshire Wildlife Action Plan* (Appendix C of the plan).

Forest types describe large expanses of land, or site-specific forest stands (grouping of trees similar in species, age and site). The common forest types in New Hampshire are white pine, northern hardwood, spruce-fir, red oak, hemlock, and aspen-birch.

Climate, elevation, soil conditions, and land use history all play a role in determining which forest type is growing in a particular area. Forest type, in turn, influences the variety of wildlife inhabiting an area and the silvicultural options available.

A forest type may be dominated by a single tree species or by several species growing together. White pine often occurs in a single-species stand. Northern hardwood, composed of sugar maple, beech, yellow birch and smaller amounts of other species, is a multiple-species type. Two types can blend together to form a mixed-wood type. Mixed-wood stands often occur in transition zones between major types. Two common mixed types are the pine-oak and spruce-fir-northern hardwood combinations.

White Pine

This type is most common in southern New Hampshire. White pine occurs in pure stands or mixed with red pine, hemlock, red oak or other hardwoods.

White pine often colonizes abandoned agricultural land. On fertile sites it is gradually replaced by hardwood or hemlock through succession. On less fertile, sandy soils the type is more persistent.

On sandy soils, acid-loving plants such as blueberries, starflowers, and pink lady's slippers are common. Associated wildlife includes red squirrel, deer mouse, pine warbler, and red-breasted nuthatch. Owls often use white pine for winter roosting.

Northern Hardwood

Most common in central and northern New Hampshire, northern hardwood is usually a mix of sugar maple, beech, yellow birch, red maple, and white ash. Sugar maple is typically the most abundant species on sites with fertile soils. Beech increases in abundance on drier sites and yellow birch becomes more prominent on moist sites.

Northern hardwood tends to be a relatively stable and permanent forest type. Stands typically grow on the slopes of hills and mountains, where the soils are fertile and well-drained. Sugar maple and beech are shade-tolerant trees that can reproduce and grow in the shade of a forest canopy. Yellow birch and white ash are less tolerant of shade and require more sunlight to reproduce and grow.

Common understory trees and shrubs include striped maple, witch hazel, and hobblebush. Associated wildlife includes gray fox, flying squirrel, red-eyed vireo, white-breasted nuthatch, and ovenbird.

Spruce-Fir

Most common in the north, red spruce and balsam fir dominate this type, which grows on poorly drained flats and the shallow, rocky soils of mountaintops.

Because of where they grow, these trees are susceptible to windthrow. The spruce budworm is a native insect which can impact vast areas during periodic outbreaks. Heart-rot fungi can affect overmature balsam fir.

Bunchberry, goldthread, and trilliums are common wildflowers and associated wildlife includes pine marten, snowshoe hare, spruce grouse, gray jay, black-backed woodpecker, and ruby-crowned kinglet. Deer often use spruce-fir stands for winter cover.

Red Oak

The red oak type occurs in close association with white pine in southern New Hampshire. Stands of nearly pure red oak are common on ridge tops. On abandoned agricultural land, red oak mixes with white pine to form the pine-oak type. Red maple and black birch are common associates. Maple-leaved viburnum, bracken fern, and whorled loosestrife are common understory species.

Deer, turkey, gray squirrel, and many other species eat acorns. Blue jays, tufted titmice, scarlet tanagers, and eastern towhees are some of the birds that commonly nest in red oak and pine-oak stands.

Hemlock

Hemlock occurs on wet flats, rocky ridge tops, and moist slopes in southern and central New Hampshire. Its ecological characteristics are similar to the spruce-fir type of the north.

Striped wintergreen and downy rattle-snake plantain sometimes grow under dense hemlock. Hobblebush and maple-leaved viburnum may grow in small canopy openings. Red-breasted nuthatches, solitary vireos, black-throated green warblers, and hermit thrushes are typical breeding birds. Deer often use hemlock stands for winter cover.

Aspen-Birch

Aspen-birch is a pioneer type relatively uncommon in the state. The type is composed primarily of quaking and big-toothed aspen and white birch and occurs on a wide variety of soils.

Aspen and white birch require full sunlight to grow. Disturbances such as fire, windstorms, or clearcutting create the conditions necessary for reproduction. In the absence of disturbance, natural succession leads to aspen-birch stands being replaced by other types.

Common associates in young stands are raspberries and blackberries. Aspen-birch provides valuable habitat for ruffed grouse, woodcock, Nashville warbler, mourning warbler, and beaver.

Silvicultural Principles
For New Hampshire Forest Types

Silviculture is the culture of forest-grown trees for the production of timber, improvement of wildlife habitat and other benefits. In practice, silviculture deals with the way foresters mark stands of trees for cutting.

There are four reasons why foresters mark trees the way they do:

1. To remove mature (or overmature) trees.
2. To improve vigor and value of the stand that will remain after the cutting.
3. To encourage regeneration (new seedlings) of the desired species, and
4. To meet certain requirements of the landowner or land manager for income (now or later?), for wildlife, or for scenic values; also, to improve the logging chance.

Usually, a timber sale involves more than one of these reasons for marking trees. Let's talk a little more about each reason.

1 Removing Mature Trees

Mature trees are those that have reached their maximum product value, or the point where vigor, health or growth are declining. Maturity doesn't relate very closely to tree diameter. For example, a diseased, rough or suppressed 12-inch oak may be mature while a healthy 20-inch oak that is still increasing rapidly in value and volume may not be mature. This is why simple rules such as "cut the big ones and leave the small ones" do not work well.

Biologically mature trees are an important wildlife habitat component and foresters may leave mature trees to benefit wildlife. Old forests with dead and dying trees provide habitat for pileated woodpeckers and other birds which carve out holes for feeding and nesting. In all, more than 40 species of New Hampshire's wildlife use the holes and hollows of dead and dying trees for feeding, nesting and denning. Species include flying squirrels, owls, bluebirds, kestrels, chickadees and raccoons.

Much of the value from a timber sale comes from cutting mature trees.

2 Improving Vigor and Value

In any partial cutting, one objective is to remove the diseased, slow growing, and mature trees and to leave those trees that are increasing rapidly in size and value. Volume and value of good stems increase at a faster and faster rate as tree diameter increases.

Crop tree release is a valuable tool for improving wildlife habitat as well. Foresters will often release apple trees, oaks and other food-producing (mast) species. Acorns are a staple for many of our forest wildlife (bear, deer, grouse, turkey, bluebirds, wood ducks, and squirrels). The reproductive success of some wildlife species rises and falls with years of good and bad acorn production.

Young trees (immature) grow much faster, sometimes twice as fast, when you remove the trees that crowd around them.

But if too many trees are removed, there aren't enough remaining trees to occupy the area and the growth per acre goes down. Also, open-grown trees may sprout along the stem, or retain their live limbs, so that tree quality declines. That's why foresters are careful to keep stand density above a certain minimum that varies with stand age and species composition.

3 Regeneration

It's important to create stand conditions where desired species will seed in and grow. There's some indication in New Hampshire that pine, oak and some other species are not regenerating very well, and this will eventually lead to a decline in these species.

The seedlings of some species, such as aspen and paper birch, need full sunlight to survive and grow. These are called intolerants (they won't tolerate shade). Tolerants can survive and grow in deep shade as well as in sunlight—beech, sugar maple, hemlock, red spruce, and balsam fir are examples. Intermediates, such as white pine and oak, can take partial shade.

There's a variety of regeneration cutting methods designed to encourage seedlings of tolerant, intermediate, or intolerant species. For example, clearcutting is used to favor regeneration of intolerants—paper birch, aspen, pin cherry— along with a mixture of other species.

Some species require special seed bed conditions for seed germination and early growth. For example, disturbed soil or exposed subsoil helps paper birch, yellow, birch and white pine; these conditions can be created by well-distributed logging activity or with special equipment. Other species do best when competing plants (shrubs, seedlings, and saplings) are removed.

In deciding which species should be regenerated, several factors are involved. We try to regenerate species that are suited to the site, since certain species grow better on one soil than another. We also try to grow species that will be valuable in that area for timber or wildlife. The current stand condition also has an influence: for example, we might not want to clearcut for paper birch if the stand only had a small proportion of mature trees.

4 Special Requirements

Trees can be marked for wildlife and scenic values (aesthetics). Here are a few thoughts on income needs of the landowner and logging.

Some landowners regard their woodlots as a bank account; you can repeatedly harvest the interest (growth) and not touch the principle. However, there are times when the income requirements are low and the landowner wants the growth to accumulate. In this case, the marking may be light, removing the low vigor trees. Leaving a woodlot untouched for long periods, however, will gradually lead to slower growth and too much low quality. On the other hand, there are times when the income needs of the landowner are high (college, sickness, etc.); then, the landowner may wish to have the woodlot marked a little heavier than usual (digging into the principle); this helps meet current income needs, but could delay the next stand entry.

Some trees are marked by foresters to facilitate the logging chance, e.g., to clear landings and roads/trails, to remove trees that will be damaged by felling/skidding other trees, to provide sufficient volume to making the logging worthwhile, etc. There's a good chance here for cooperation between loggers and foresters.

Silvicultural Systems

Based on these principles, foresters recognize several silvicultural systems— systems for regenerating, growing, and harvesting timber.

1 Clearcutting System

Clearcutting is best applied to stands where most of the trees are mature (or overmature) or defective and ready to go. It regenerates intolerant and intermediate species with some tolerants. As the new stand grows, it is thinned to improve species, quality and growth. The later thinnings remove products that can be sold. When the stand is mature (at the end of the rotation period), it may be clearcut again. Strip cutting is a form of clearcutting.

Clearcuts from 20 to 100+ acres create habitat for a great variety of wildlife not found in mature forests. Swallows, bluebirds and indigo buntings will quickly occupy a clearcut, particularly where snags or live trees with cavities and perches are left throughout. Raspberries, pin cherry, aspen and paper birch sprout soon after cutting, providing valuable sources of food (mast), browse and cover for many species of wildlife. Black bear will forage throughout the summer on the edges of these cuts.

2 Shelterwood System

This system is applied in stands of mostly mature trees. A harvest cut is applied, removing the smaller trees first and leaving an overstory of larger trees to provide seed and shade for the new seedlings. If many overstory trees are left, the shady conditions are good for tolerant species—red spruce, or hemlock, for example. Fewer overstory trees provide partial shade for oak or white pine. When an understory of desirable seedlings has developed, the overstory trees are cut. This has to be done carefully so that the regeneration is not damaged too badly. Then, the stand is thinned as needed over the rotation.

3 Single Tree Selection System

Under this system, mature and low-quality trees are removed at each harvest. The system is best applied in stands that have a range in tree size, and where the objective is to regenerate and grow tolerant species. After each cutting, new tolerant seedlings develop, and the stand always has the appearance of a well-stocked stand with a full range of tree sizes. As in any partial cutting, care is needed to avoid logging damage to the remaining trees and regeneration. Diameter limit cutting is a type of single tree selection, but it ignores the vigor and value potential of individual trees, regeneration needs, and growing conditions around the remaining trees. It is considered a poor practice unless accompanied by precautions such as varying the diameter limit by species, removing poor growing stock, releasing acceptable regeneration, and controlling residual basal area.

Single tree selection maintains a closed-canopy mature forest characterized by a diversity of vegetative layers—grasses, flowers and ferns on the forest floor, shrubs and small to medium sized trees, and mature trees. The more layers you have in a mature forest, the more places wildlife can live and forage for food. Snags and fallen logs add to the layering. Several species of birds require mature forests including scarlet tanager, ovenbird, wood thrush, red-eyed vireo and black-throated blue warbler.

4 Group Selection System

This is a variety of single tree selection in which groups of trees about ¼ to ½ acre or more are cut and single trees are removed between the groups. The system works best where the mature trees occur in clumps, and where some mixture of intolerant or intermediate species is desired in the regeneration.

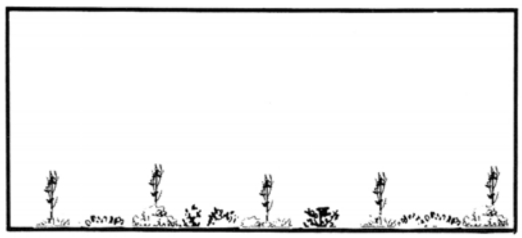
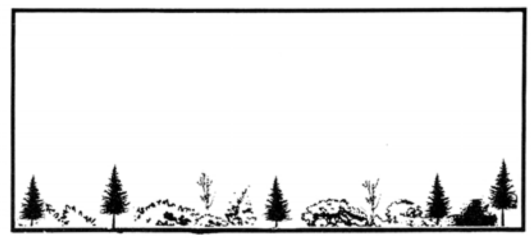
Group selection cuts maintain many of the bird species found in the mature forest. These cuts also create new habitat for some species that use clearings or regenerating stands (early successional). Although not found in the mature forest, chestnut-sided warblers, common yellow throats and white-throated sparrows will move into these small clearings, feeding on the abundance of insects. The buds, shoots, twigs, and leaves of new woody growth in these group cuts provide winter food for white-tailed deer, snowshoe hare, cottontails and beaver.

Summary

Not all timber sales fall neatly within these silvicultural systems. Sometimes a general improvement cut is made which upgrades the quality and species mix of a stand. However, all sales should involve one or more of the “reasons for marking” listed in this guide.

One of these systems of cutting is not necessarily better than the others for producing wildlife habitat. All systems maintain or create different habitat features that will benefit some species of wildlife while harming others. The best approach for wildlife will depend on current conditions, land use activities in the area, and overall management objectives.

Harvesting Methods

	Hardwoods	Softwoods
Clearcut		
Shelterwood		
Single Tree Selection		
Group Selection		

2.2 FOREST STRUCTURE

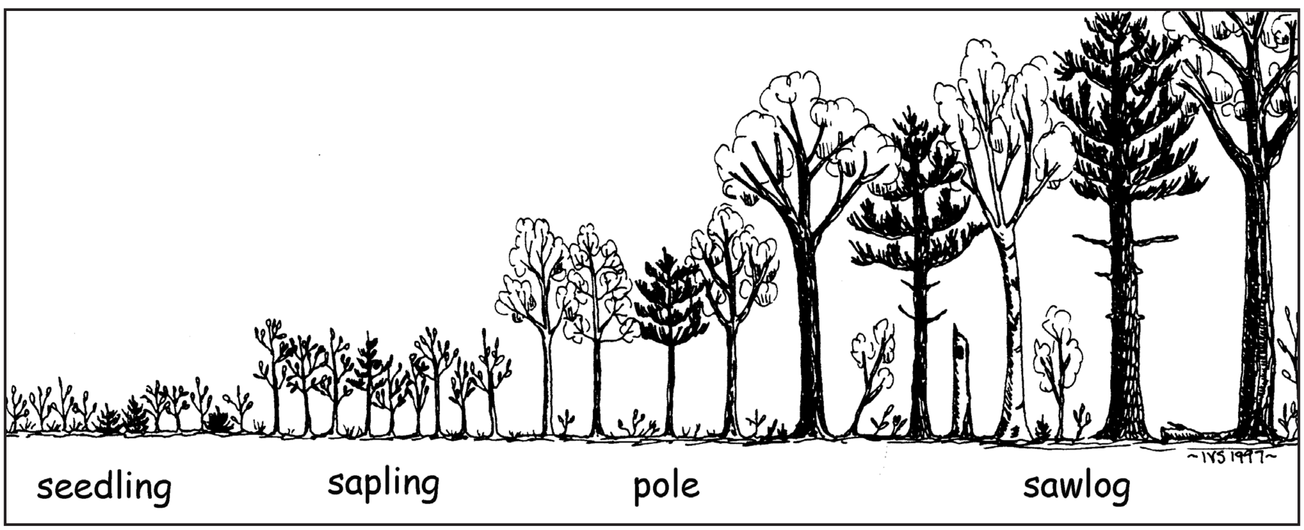
BACKGROUND

Managing forest structure can meet landowner objectives including a sustainable flow of forest products, wildlife habitat, aesthetics, clean water, and other benefits.

Forest structure is the horizontal and vertical distribution of layers in a forest including the trees, shrubs, and ground cover (which includes vegetation and dead and down woody material). Structure looks at the proportion of small, medium, and large trees and is usually reported as trees per acre by diameter class. These age- or size-class groupings are further defined as seedling, sapling, pole, and sawlog.

Size Class Groupings

	Diameter in Breast Height (DBH) in inches
Seedling	up to 1
Saplings	1-4
Pole	5-11
Sawlog	12 and larger



Forests can have a simple structure or they can be very complex. Based on the range of ages among the different levels of structure, forest stands are defined as even-aged, two-aged or uneven-aged.

Even-aged structure means a stand has one distinct age and size class. (An age class is comprised of trees within 20 years of age). They are often less diverse and composed of fewer species than other structures. Most of the tree diameters come close to the average stand diameter. A plantation provides an extreme example of an even-aged structure.

Two-aged stands are often, but not always, a result of human intervention and may be a temporary condition as management works towards developing an even-aged or uneven-aged stand. Structure within these stands will often have patchy or partial overstory canopies with a well-defined second story, or layer, of either poletimber or seedlings and saplings.

Uneven-aged structure means a stand has three or more age classes. This type of structure is a result of increasing species, age- and size-class diversity within a stand. Different species grow at different rates, and a distinct overstory canopy may no longer be recognizable. Each species or age class exhibits an average stand diameter of its own, and smaller diameter classes may contain more trees per acre than the next larger one. Uneven-aged stands are considered balanced when they have three or more age classes occupying approximately equal areas. When this is achieved, the stand can be considered self-sustaining.

Wildlife biologists and foresters are often interested in structure because of its relationship to timber flow, biological diversity and wildlife habitat. Other chapters in this publication address habitat issues. The focus of this chapter is on the role of structure in maintaining a flow of timber products over time.

OBJECTIVE

Maintain a sustainable flow of quality timber through control of stand and forest structure.

CONSIDERATIONS

- A forest inventory is useful for analyzing and understanding structure.
- Controlling stand structure requires appreciable effort, especially in uneven-aged stands, and will require professional assistance with stand inventory and timber marking practices.
- Maintaining a balanced stand structure is more practical on larger ownerships.
- Attempts to sustain production of quality timber by simple rules such as keeping harvest equal to growth is only possible after the stand structure becomes balanced at an optimum level. Keeping harvest equal to growth may not allow for other practices in this publication.
- A true uneven-aged condition takes time to establish and can be difficult to implement when harvesting.
- While in theory uneven-aged management requires maintaining size-class balance at the stand level, in practice it may be more feasible to maintain this balance across larger management units, with individual stands managed for a muti-aged (though not perfectly balanced) structure.
- Stand and forest structure and density guidelines vary by species. See the Recommended Practices for general guidelines to cover the likely range in conditions.
- Uneven-aged stands often provide a variety of vertical structure (i.e. multiple canopy layers, for example; overstory, midstory and shrub layers). Even-aged stands can provide some vertical structure, particularly when routinely thinned.
- Even-aged stands can provide horizontal diversity (i.e. a variety of forest types and age classes across the landscape). Uneven-aged stands can provide some horizontal structure, especially when group selection is used.
- Site factors such as soil type can influence stand structure.
- Stand growth and harvest yields will differ depending on any stand's existing structure and the intention of management.
- Rotation age will be fixed or nearly so for even-aged stands, whereas uneven-aged stands have a continuum of harvests and regeneration and theoretically have no end of rotation date.
- Shade tolerance, a species' ability to thrive and prosper depending on the amount of available light and competition from others, will often dictate what species will regenerate (2.3 Regeneration Methods).

- Advance regeneration are those young trees established naturally without the influence of harvesting. When present, they can simplify the silviculture needed to sustain the future forest.
- Forest structure within the understory also includes down woody material, shrubs, forbs, grasses, and other herbaceous plants. These dead and living plant materials comprise an important part of the forest ecosystem, vital to habitat, forest soils and biodiversity.
- The prevalence of mechanized harvesting systems and the growing demand for biomass fuel make it efficient and profitable to manage even-aged stands.
- The selection system, both group and individual, establishes an uneven-aged structure. Small group cuts are most often used and preferred over individual tree selection, which can lead to high grading.

RECOMMENDED PRACTICES

✓ Have a clear understanding of the goals and objectives for a stand and how the existing structure can or can't be manipulated to achieve the stated goals.

✓ Inventory the stand to gather data on the species composition, trees per acre, average diameter, basal area, and stem quality.

Even-aged Management

✓ Provide an array of even-aged stands over time using clearcut or shelterwood harvest practices (2.3 Regeneration Methods).

✓ Use even-aged harvest techniques to regenerate shade-intolerant or moderately tolerant species.

✓ Strive for the following percentages of acres in seedling/sapling, pole, and sawlog stands:

Tree Size	Percent of Acres
Seedling/Sapling	20-30
Pole	25-35
Sawlog	35-55

These targets are based on rotation ages of about 80 to 120 years (shorter if there is a predominance of short-lived species such as aspen, white birch or balsam fir). They are most applicable at the landscape scale or on large properties (several thousand acres or larger).

✓ Change the percentages suggested in the above table in seedling/sapling stands and the percentages in sawlog and mature stands when biodiversity, wildlife or aesthetic goals extend or shorten rotation ages. For example, lower the percentage of seedling/saplings and increase the percentage of sawlogs when rotation age is extended.

✓ Identify, maintain, and regenerate wildlife habitat inclusions (e.g. aspen, soft mast, hemlock, or oak raptor-nesting trees).

Uneven-aged Management

✓ Develop stands with a range in tree sizes using some form of partial cutting such as individual tree selection or group selection.

✓ Use uneven-aged management to favor shade-tolerant species (e.g., northern hardwoods).

✓ Harvest trees to adjust stand conditions to within the recommended ranges below. Sustained yield is ensured by the ever-increasing number of younger trees available in the stand.

Tree Diameter	Percent Basal Area (of Sq. Ft./ Acre)	Percent Nos. (of Trees/ Acre)
6-10	30-50	60-80
12-14	20-30	15-20
16-22+	25-50	5-20

Examples (using the mid-range in above categories):

(1) If a stand contained a basal area of 100 square feet per acre, 40 square feet per acre may represent trees 6-10 inches in diameter at breast height (DBH), 25 square feet may represent trees 12 to 14 inches DBH and 35 square feet may represent trees 16 inches DBH or greater.

(2) If the stand contained 100 trees per acre, those same classes may contain 70, 17.5 and 12.5 trees per acre respectively.

✓ Identify, maintain, and regenerate wildlife habitat inclusions (aspen, soft mast, hemlock, oak raptor nesting trees).

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material; 6.4 Overstory Inclusions; 6.6 Temporary Openings Created by Forest Management; 6.7 Aspen Management; 7.5 Old-Growth Forests.

ADDITIONAL INFORMATION

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2.3 REGENERATION METHODS

BACKGROUND

Carefully designed regeneration practices help perpetuate desired tree species.

Regeneration refers to the seedlings and saplings that develop beneath a forest stand, in openings within a stand, or following the removal of a stand (grouping of trees similar in species, age and site). In younger stands with potentially valuable trees, the immediate goal may be to manage the existing trees for timber as described in 2.4 Managing for High-Quality Trees. If the stand is older or contains an abundance of poor-quality trees, the emphasis can shift to a regeneration harvest using the techniques described in this section.

Silviculture is the art and science of establishing and tending trees and forests. Controlling the composition, health, structure, and growth of forest stands to help meet the landowner's objectives lies at its foundation. Landowner objectives may include timber products, wildlife, aesthetics, recreation, or overall health and stability. Some owners may wish to develop a forest that appears completely natural or untouched. Landowner objectives play a predominant role when choosing a silvicultural approach.

Successful regeneration involves analyzing the condition of the existing trees, advanced regeneration and seed source, and the site capability, then choosing a harvest practice that will regenerate the species best meeting your objectives. Regeneration is one of the most important factors affecting the long-term value and productivity of a forest property.

Financial and Biological Maturity

The need for income, promoting wildlife habitat or creating special aesthetics are but a few reasons to regenerate a stand. Financial maturity is one indication of whether or not to harvest. A tree is financially mature when its rate of return becomes less than what other financial investments (such as stock or bonds) can yield. Trees growing on better sites become financially mature at larger diameters than the same species growing on average or poor sites, since they grow faster and are able to deliver a higher rate of return for a longer period. Likewise, poor-quality trees mature financially at much smaller sizes than high-quality ones. Approximate diameters for financially mature, high-quality trees are given below. Maturity varies depending on tree condition, site quality, and markets.

Except for short-lived species such as paper birch and balsam fir, financial maturity isn't highly correlated with biological maturity. Most tree species can live for decades or centuries past their financial maturity. Biological maturity occurs when a tree begins to decline. Biological maturity may trigger a regeneration harvest, but these older trees provide benefits described in other chapters. Approximate ages are listed below.

Financial Maturity by DBH and Biological Maturity by Age

Species	Financial Maturity (DBH) inches	Biological Maturity years
Sugar maple, white ash, yellow birch, red oak	18-24	150-200
Red maple, beech	14-18	120-150
Paper birch, aspen	12-14	80-100
White pine	18-24	150-200
Red spruce	12-16	200-300
Balsam fir	10-14	60-80
Hemlock	16-18	200-300

Site Capability

Analysis of site capability gives insight into which species are best adapted to grow on a particular site. Some general guidelines are:

Species	Preferred Site and Soil Conditions
White ash, sugar maple	Moderately well-drained and enriched fine-textured soils, especially with low acidity (higher pH soils)
Beech	Sandy tills, but common on a wide variety of soils
Red oak *	Sandy tills and outwash (where red oak may be poorly formed and defective)
White pine*	Outwash and, to a lesser extent, sandy tills
Yellow birch	Moderately well-drained, fine-textured soils; also on somewhat poorly drained pan soils in mixture with softwood
Red spruce, hemlock, balsam fir	Shallow pan soils and lakebed sediments often somewhat poorly drained; outwash; or shallow-to-bedrock
Paper birch, aspen, red maple	Adapted to a variety of soils, but often on sites that supported shade-tolerant softwoods.

** Currently found growing on a variety of soils due to agricultural history and generally difficult to regenerate on the better soils.*

New Hampshire soils are complex and highly variable, primarily due to their glacial origins. The Natural Resources Conservation Service (NRCS) categorizes site capability to correlate with county soil survey maps. Referred to as Important Forest Soil Groups, these categories can be used to evaluate the relative productivity of soils and better understand patterns of plant succession and the ways soil and site interactions influence management decisions. All soils are grouped into one of six categories. For a more complete treatment see the appendix. NRCS field offices can provide more information.

Site index is another way to categorize site quality. It is expressed as the height of a species at a given age, usually at age 50. The higher the site index, the taller the tree will grow in the given amount of time, and the better the site is for that species. A poor site for one species may be adequate for another. In New England, a site index of 45 or lower is poor, 55 to 65 is average, and 80 is excellent.

Tolerance

Shade tolerance, a species' ability to thrive and prosper depending on the amount of available light and competition from others, influences what will regenerate.

Sugar maple, American beech, red spruce, hemlock, and balsam fir are shade-tolerant. They can survive under heavy shade, including shade from the species itself, although growth is usually more rapid in the open.

White ash, red oak, white pine, and yellow birch are intermediate and can survive under partial shade or in small openings. Red maple is intermediate to tolerant.

Paper birch and aspen are shade-intolerant and survive best with full sunlight. They are called pioneer or early successional species, because often they are the first to inhabit openings after a disturbance.

In the absence of advanced regeneration, tree tolerance provides guidance as to which species may regenerate from a given harvest technique.

2.3: Regeneration Methods

Advanced Regeneration

Seedlings or saplings established naturally without the influence of harvesting under a forest canopy are called advanced regeneration. Often it will determine what species will regenerate.

Some hardwoods such as beech and red maple are aggressive as advanced regeneration on certain sites. When crushed during timber harvesting, they sprout profusely. Other hardwoods aren't as aggressive and may sprout from small stumps but their survival and future in the stand is less certain.

Other species including most softwoods, may be persistent as advanced regeneration but may be eliminated from a stand from crushing if harvesting practices don't protect them. Most softwoods don't sprout. If advanced regeneration is destroyed during a timber harvest, new stems must start over from seed. Many softwood species are slow starters, giving hardwoods a head start.

Lack of advanced regeneration may provide opportunities to establish desired species suitable to the site. Measures may be taken to establish the desired species as advanced regeneration, or harvest practices may encourage regeneration at the time of harvest.

Seed Source

During all phases of management, it's important to maintain or increase a source of seed for the several species of most interest. The best seed producers are sawlog-sized trees with well-developed crowns. However, there is great variation among individual trees and seed crops vary greatly from year to year. If the desired species aren't present as advanced regeneration, harvest during the fall or winter of a good seed year. Most seeds fall within a couple hundred feet of the seed tree, but some seeds, notably red and white oak, may be moved (and eaten) by birds and small mammals such as squirrels. Both red and white oak are heavily consumed by wildlife.

Seeding Characteristics of Selected Trees

Species	Seeding Interval (good years)	Other Seeding Characteristics
Birches	1-2	wide dispersal on snow
Sugar maple	3-7	
Red maple	1-2	
Beech	2-5	occasional animal dispersal
White ash	2-5	most germination second year after dispersal
Red oak	3-5	two years to mature; look closely for small one-year acorns
White oak	3-5	one year to develop
White pine	3-10	two years to mature; look for one-year cones
Red spruce	3-8	
Eastern hemlock	2-4	

Regeneration Harvest Methods

Knowing landowner objectives, site capability, advanced regeneration and seed sources helps to choose an optimum regeneration harvest method. Regeneration practices are applied in even-aged stands at the end of the rotation when the stand is mature and ready for final harvest. In uneven-aged stands, regeneration takes place after every harvest cut. The methods described below cover a wide range of disturbance levels, some approximating natural disturbances:

Single tree selection

- Removes about ¼ to ⅓ of the trees singly or in small groups, leaving a range of tree sizes—roughly one-third to half the basal area in sawlog and the remainder in poletimber.
- Encourages tolerant species such as beech, sugar maple (on good sites), red maple, red spruce, balsam fir, and hemlock.
- Produces or perpetuates an uneven-aged stand (three or more age classes). If the tolerant understory that develops is undesirable (e.g. beech), choose a different system such as groups, patches or clearcuts.

Group selection

- Creates openings of ¼ to 2 acres centered on clumps of mature or defective trees.
- Regenerates intermediate shade-tolerant species such as white ash, yellow birch, red oak, and white pine.
- Harvested in larger groups (> ⅔ acre), it promotes aspen and paper birch.
- Produces a patchy, uneven-aged stand.
- Produces consistent timber flow when harvested in groups the equivalent of about 1 percent of the stand for each year between harvests. For example, for a 10-year entry period, about 10 percent of the stand is harvested in groups, as well as some trees between groups.
- Works well for stands with patches of large trees intermixed with patches of immature trees.

Shelterwood

- A flexible system ranging from high-density shelterwoods (removing about ⅓ of the basal area) to encourage tolerant regeneration to low-density shelterwoods (removing about ⅔ of the basal area) to encourage intermediate and some intolerant-species regeneration.
- A standard shelterwood harvest is followed by a removal harvest of the remaining overstory trees in 5 to10 years, producing an even-aged stand.
- In a deferred shelterwood, the overstory is left in place for perhaps several decades, resulting in a two-aged stand.

Clearcut

- Removes all trees (above 2 inches DBH). If necessary, unmerchantable stems may be removed by a followup noncommercial operation.
- Commonly about 5 acres or larger. Smaller openings (2 to 5 acres) are often called patch cuts.
- Results in early successional (intolerant) regeneration including paper birch, aspen, pin cherry, and *Rubus* species together with intermediate and tolerant species.
- Useful in mature, overmature, and defective stands and stands subject to windthrow, or to produce early successional wildlife habitat.
- Not generally effective for softwood regeneration unless advanced regeneration is present (sometimes called a natural shelterwood or overstory removal).
- The retention of uncut groups of trees can improve the appearance and provide diversity.

Strip cut

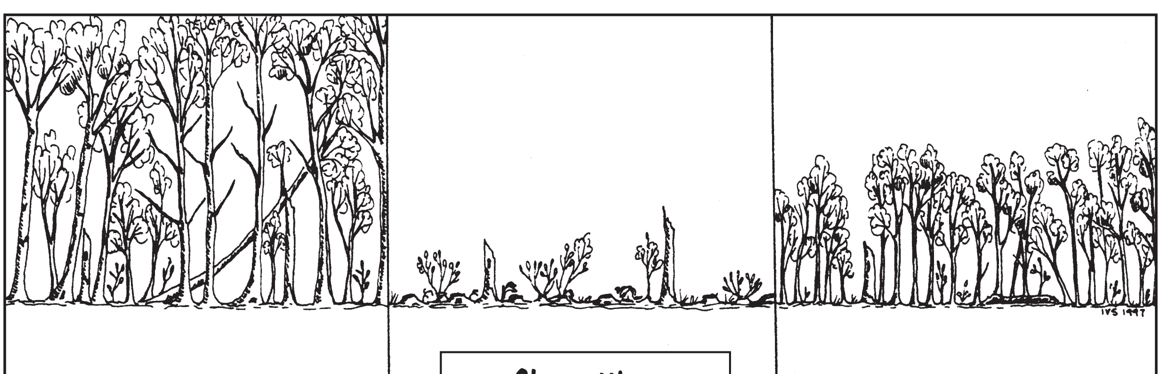
- All trees are removed in strips ranging from perhaps 25 to 100 feet wide.
- A progressive strip cutting leaves three to four uncut strips, which are harvested at intervals over a rotation.

Regeneration Harvest Methods

Single Tree Selection

Group Selection

Shelterwood



Clearcutting

- Strip cutting (especially without snow cover) provides maximum ground disturbance and is useful for removing unwanted advance regeneration or other undesirable vegetation.
- A strip shelterwood consists of a clearcut strip and an adjacent strip harvested by shelterwood methods. During the next entry the shelterwood strip is harvested by overstory removal and another adjacent strip is shelterwood-harvested, etc., until the cycle is complete and ready to be repeated.

Overstory removal

- Removal of the larger overstory trees to release advanced regeneration—removing overstory trees in the absence of advanced regeneration isn't truly an overstory removal.

Natural disturbance and natural process silviculture

- Natural disturbance silviculture approximates natural disturbances from windthrow, disease, and natural mortality. Trees are harvested, sometimes in small groups, when they approach biological maturity and begin to decline. The system resembles small group or individual tree selection and creates an abundance of large, old trees, dead woody material, and shade-tolerant regeneration.
- Natural process silviculture is concerned with maintaining ecological processes: natural succession, nutrient cycling, woody-material production, forest-floor maintenance and development, multiple-age and size-classes development, and minimal aesthetic impacts.

Practices Not Recommended

- Diameter limit removes all trees above a fixed diameter. It is considered a poor practice unless accompanied by precautions such as varying the diameter limit by species, removing poor growing stock, releasing acceptable regeneration, and controlling residual basal area.
- High grading removes the most valuable trees, usually the largest. It causes a progressive decline in stand value.
- Liquidation completely removes all merchantable trees, usually without measures to protect the site or provide for future harvests. It may be associated with a land-use change.

OBJECTIVE

Select a harvest practice that regenerates desired species rapidly and economically, consistent with landowner objectives and site capability.

CONSIDERATIONS

- Natural regeneration in New Hampshire is prolific due to favorable conditions of climate, soil, and native species. Natural regeneration is usually the best option, although seeding or planting may be useful to meet certain objectives.
- Predation and browsing may impact regeneration success or necessitate revision of the management objective or harvest method. Examples include predation on acorns and other seeds from small mammals, deer, turkeys, and insects; browsing from moose, deer, and rabbits; and defoliation of understory white pine by gypsy moth.
- The success of regeneration practices can be clearly evaluated only 5 to 10 years after the regeneration is well established. There are no hard-and-fast rules that will result in successful regeneration of the desired species every time.
- Some common trees and shrubs may out-compete more valuable commercial trees. Hobblebush, striped maple, ferns, and beech-sucker growth are common, competitive, noncommercial species.

RECOMMENDED PRACTICES

- ✓ Determine the species to regenerate, based on landowner objectives, site capability, the presence or absence of advanced regeneration, and biological and economic risks.
- ✓ Choose a regeneration method based on the general guidelines below:

Species	Harvest Method
Beech, sugar maple, red spruce*, balsam fir*, hemlock*	Single tree/small group selection (< ¼ acre) or narrow strips (< 50 feet wide)
White ash, yellow birch, red oak, white pine	Group selection (¼-2 acres) or medium strips (50-100 feet wide)
Aspen, paper birch	Group selection (> ⅔-2 acres) or medium strips (50-100 feet wide)
Red oak, white pine, red spruce, balsam fir, hemlock	Shelterwood (natural or planned)**
Aspen, paper birch, yellow birch	Clearcut or wide strips (> 100 feet)

** On wet and shallow soils, windthrow can be a problem if using single tree selection.*
***A natural shelterwood is a removal cut where advanced regeneration is present.*

- ✓ Plan for the following special features when regenerating the species listed below:

Species	Special Feature
Red oak, white pine, red spruce, hemlock, balsam fir, sugar maple	Advanced regeneration important
Red oak, white pine	Important to bury the seed through harvesting activity or site preparation
Aspen, beech	Sprout from roots of trees present in the stand
Red maple, red oak	Prolific sprouters from stumps of poletimber or small sawlog trees
Sugar maple, red oak, red maple, yellow birch	Browsed heavily by deer
Paper birch, aspen	Short-lived species that typify early succession with pin cherry and *Rubus* sp.

- ✓ Regenerate oak on better sites by encouraging small stump-sprouts by fall and winter harvesting or shelterwood cutting during the fall and winter of a good seed year (coupled with special treatment to bury the seed).
- ✓ Reduce unwanted shade-tolerant advanced regeneration through groups, clearcuts and heavy harvesting to convert the stand to earlier-successional species.
- ✓ Where there is an undesirable understory of beech or other species, harvest in snow-free seasons to reduce the understory and provide a scarified seedbed.
- ✓ Where there is a minimal undesirable understory with overstory beech, harvest in the winter to minimize beech-suckering, unless scarification is required for regeneration of desired species.
- ✓ Reserve clean beech trees that show resistance to beech bark disease. Lightly harvest nearby to encourage resistant root suckers.

- ✓ Regenerate hemlock by releasing patches of advanced regeneration in the winter. To encourage advanced regeneration, apply very light harvests coupled with ground disturbance during late fall of a good seed year.
- ✓ In areas subject to heavy deer browsing (over 10 to 15 deer per square mile), use larger patches or clearcuts or regenerate species such as black birch or softwoods, or spot-plant with spruce or white pine.
- ✓ Invasives (e.g. European buckthorn) may almost completely inhibit desired regeneration, especially in areas with intense deer browsing. Try patch or clearcuts, making sure there are adequate nearby seed sources, or obtain professional advice on chemical control.
- ✓ Evaluate advanced regeneration by recording the species of the dominant (tallest) seedlings and saplings in a series of small circular plots about 3.7 feet radius (1/1000 acre). Advanced regeneration is adequate if 50 percent of the plots are stocked. Percent of stocked plots by species approximates predicted species composition following harvest.
- ✓ Retain snags and patches of mature live trees for wildlife habitat.
- ✓ Consider the aesthetic impact of the proposed harvest using the visual quality protection techniques described in 3.2 Logging Aesthetics.
- ✓ When clearcutting, give consideration to the landscape in which the cut occurs as part of an overall forest management strategy to maintain a sustainable balance of forest structures, age classes, and habitats across the landscape. Separate clearcuts by a manageable stand of at least the width of the area being harvested. Avoid the following areas:
  - Slopes > 35%.
  - Thin organic soils on top of bedrock ("duff soils") and soils classified in NRCS soil surveys as having severe erosion hazard.
  - Riparian management zones—except for specific wildlife management purposes.
  - In or around seeps, or vernal pools.
  - In highly visible or aesthetically sensitive areas.

CROSS REFERENCES

2.2 Forest Structure; 2.4 Managing for High-Quality Trees; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 3.5 Soil Productivity; 4.1 Water Quality; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 5.4 Logging Damage; 6.1 Mast; 6.2 Cavity Trees, Dens and Snags; 6.3 Dead and Down Woody Material; 6.7 Aspen Management; 7.2 Seeps; 7.3 Vernal Pools; Appendix: Important Forest Soils Group.

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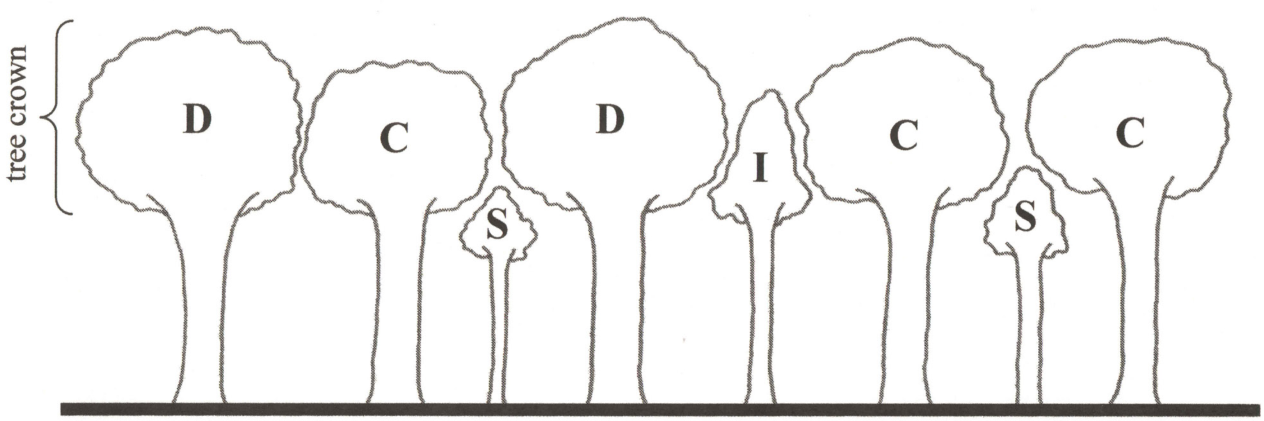
2.4 MANAGING FOR HIGH-VALUE TREES

BACKGROUND

Quality timber trees are important to the region's wood products industry.
Quality is determined by tree size and the amount of clear, knot-free lumber the tree produces. Both are heavily influenced by the density of the stand. Stand density also affects tree growth. When the density is too high, tree growth will slow. When density is too low, individual trees may grow quickly, but growth per acre diminishes because there are too few trees. There may be problems with excessive branching because low stand density interferes with natural pruning. Excessive branching results in reduced lumber quality. Pruning excess branches is expensive but can increase timber quality.



Tree crown position as it relates to dominance in a forest stand. D=Dominant, C=Codominant, I=Intermediate, S=Suppressed
(by M. Tarr adapted from Smith 1986)

Stand Development: Tree diameter isn't always correlated with age.
Many forest stands are even-aged because they developed following major disturbances such as agricultural abandonment or clearcutting. Although many stands contain trees of different diameters, most overstory trees are in fact the same age. Diameter isn't always correlated with age.

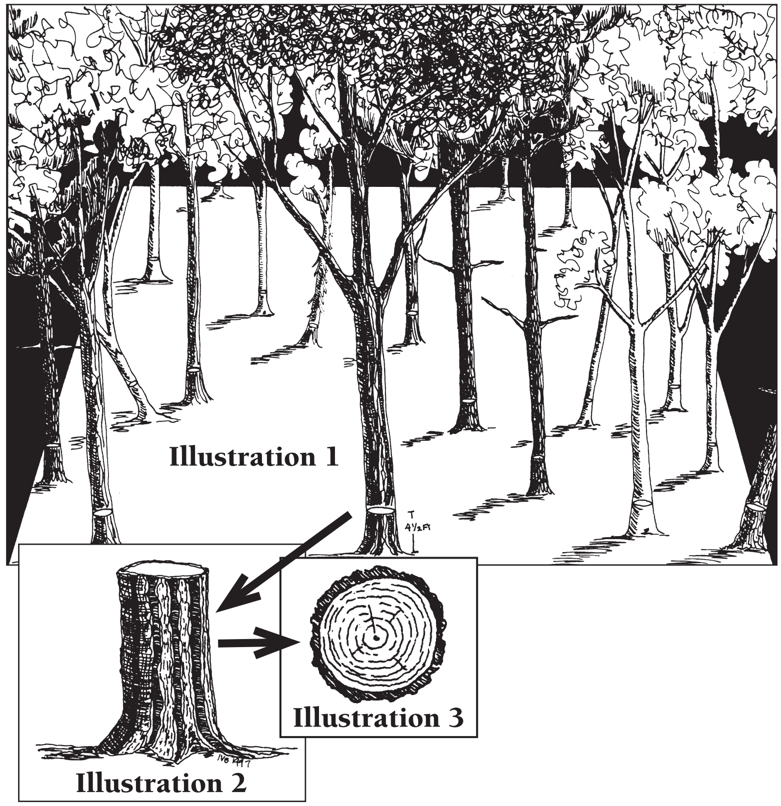
Trees are grouped into four crown classes: dominant, codominant, intermediate and suppressed. Dominant and codominant trees are the largest trees and form the main canopy of a stand. Dominant and codominant trees have larger crowns and grew faster than their neighbors. Intermediate and suppressed trees are the smallest trees and generally are overtopped by dominant and codominant trees. They have much smaller crowns than dominant and codominant trees.

Trees with the largest crowns are the fastest-growing and healthiest trees. In many stands, a 16-inch diameter tree and a 10-inch diameter tree of the same species are the same age. To improve the timber quality and growth of an even-aged stand, focus on removing the weak competitors (intermediate and suppressed trees) and leaving the well-formed strong competitors (codominant and dominant). In an even-aged stand don't remove the large trees to favor the small trees.

Stand Density

Stand density, or crowding, is based on tree size (diameter), the number of trees per acre, and how close together they are growing. Stand density is calculated in terms of basal area. Basal area is a measure of the area of the cross-section of tree diameter at breast height (DBH).

Basal area is usually expressed in square feet. To picture basal area, imagine that all the trees in a stand were cut off at 4.5 feet above the ground (illustration 1). The area of the top surface of the stump (illustration 2) is measured to determine the basal area of that tree (illustration 3). If the basal areas of all trees on an acre are added together, the result is square feet of basal area per acre. It takes several small trees to equal the basal area of a large tree. For example, the basal area of four 6-inch DBH trees equals the basal area of one 12-inch DBH tree.



Adjust a stand's density by cutting some trees and removing them for firewood (or some other use) or by girdling (cutting into the cambium in a complete ring around the tree) and letting them die in place. Different standards apply to even-aged and uneven-aged management. Thinning is the silvicultural tool most often applied to improve timber quality and growth. When done before the trees are ready to harvest, it is called precommercial.

Precommercial Treatments

Precommercial treatments, also known as timber stand improvement, refers to a variety of noncommercial practices that improve growth, value and regeneration of desired species. Focus timber stand improvement activities on the better growing sites—soils with a site index of 60 or higher for the desired species (see 2.3 Regeneration Methods for a discussion of site index). Stands with shallow-to-bedrock soils or excessively wet soils are less of a priority. The poorer growing conditions increase the probability of the trees being in poor form or declining health. Stands dominated by one species, such as oak or white pine, benefit more from precommercial thinning than mixed-species stands. For stands dominated by a single species, start releasing the crop trees when they reach 5 to 8 inches DBH. Releasing involves removing the less desirable trees whose crowns overtop or otherwise touch the crowns of the crop trees. The goal is to give more sun to the crop trees' crowns. The sooner released, the faster they will grow in diameter.

Weeding controls the species composition by cutting or girdling unwanted species and favoring desired ones. Weeding is usually most needed in mixed stands of conifers and hardwoods when conifers are the crop trees. Release conifers by weeding out overtopping hardwood in sapling stands (1 to 4 inches DBH and 10 to 20 feet tall). Bring the upper crowns of valuable stems into full sunlight. Stands remaining after treatment should be dense enough to assure self-pruning of lower limbs, straightness of stem, and protection against snow and ice damage.

Financial benefits of timber stand improvement are questionable especially if the costs per acre are too high. Often the increased growth provided by releasing a crop tree at a young age is offset by the cost that is carried (and compounded) for decades. Generally, releasing fewer crop trees per acre and having a commercial harvest as soon as possible helps maximize the return.

Crop Tree Management

Crop tree management is a thinning technique where high-quality trees with vigorous crowns are identified as crop trees and competing trees are cut to release their crown. It encourages the fastest growing, highest quality trees to have as large a crown as possible by allowing increased amount of sun on the crown. The larger the crown, the faster the tree will grow in diameter. Focus crop tree release on those trees that are most likely to increase in volume and value.

A crown thinning releases one to four sides of the crop tree from trees that touch its crown. A crown thinning should provide 5 to 10 feet of free growing space for the crown of the crop tree by removing competing trees. When two crop trees grow in close proximity, treat them as one tree and remove all trees whose crowns touch those of the two crop trees.

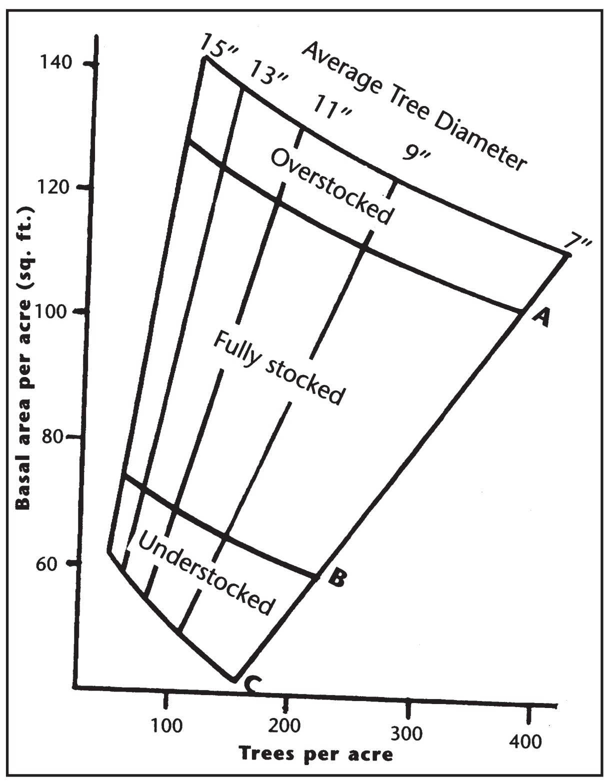
Timber crop trees have the following characteristics:

- Dominant and codominant trees at least 25 feet tall.
- Healthy, vigorous crown.
- High-quality butt-log potential.
- No epicormic branches (sprouts).
- No high-risk trees such as splitting forks or leaners.
- High-value commercial species (red oak, sugar maple, yellow birch, black birch, black cherry, white pine, red maple, white ash and red spruce).
- Expected longevity of at least 20 years.
- Species well-adapted to the site (see table in 2.3 Regeneration Methods for site requirements by tree species).

Fully releasing the crown of a crop tree increases the possibility for epicormic branching, which lowers its timber quality. Practicing crop tree management only on the best growing sites limits epicormic branching. Black cherry and red oak have strong epicormic branching tendencies; red maple has moderate tendencies; white ash and yellow birch low; and sugar maple has low tendencies on good sites.

Even-aged Management

When a forest stand is managed for one distinct age class, it is termed even-aged management. These stands are regenerated by clearcut, shelterwood, or seed tree cutting methods. Two-aged stands result when larger trees are left temporarily to aid regeneration or for goals other than regeneration (e.g., for wildlife). Two-aged methods regenerate and maintain stands with two age classes for a longer time period, even after regeneration is established. Two-aged management is included as an even-aged technique in this and other references.



The best density for even-aged stands is reflected in stocking guides (also called stocking charts). These guides help the timber manager determine if the forest is stocked too heavily with trees (overstocked), too lightly (understocked), or adequately (fully stocked).

Stocking guides provide at least two reference lines, an A-line and a B-line. In general, the A-line shows the upper density limit of a naturally developing uncut forest stand, although some stands do become more dense. The B-line estimates the best density for sawtimber growth in the stand. If the stand's density is higher than the B-line, the stand is too crowded and diameter growth will be slow. If density is lower than the B-line the stand is understocked, resulting in lower timber growth per acre and potentially excessive branchiness, resulting in knots in the timber.

When density has increased to halfway between the A-line and the B-line, foresters generally reduce the stand's density to the B-line level. This typically permits a commercial harvest and increases diameter growth. The trees removed are often the poorest quality, so the growth is concentrated on the best quality trees (crop trees). Crop trees may be chosen on the basis of commercial value, aesthetic quality, or their contribution to desired wildlife habitat. Since crop trees are the most capable of achieving the desired goals, use extra consideration when deciding the spacing around these trees and how much light they receive.

Uneven-aged Management

In uneven-aged management, forest stands are managed for three or more age classes. This technique simultaneously provides for regeneration, thinning competing trees, and harvesting mature timber.

All diameter classes are in the stand. Since the relative proportions of the diameter classes to each other are the same, there is generally one best density range after the harvest. Foresters mark the trees to be cut in the stand to achieve a desired distribution of diameter classes. Diameter classes are used because age is difficult to determine in standing trees. Harvests can be considered when the basal area is at least 30 square feet above the desired distribution (See Recommended Practices for specifics).

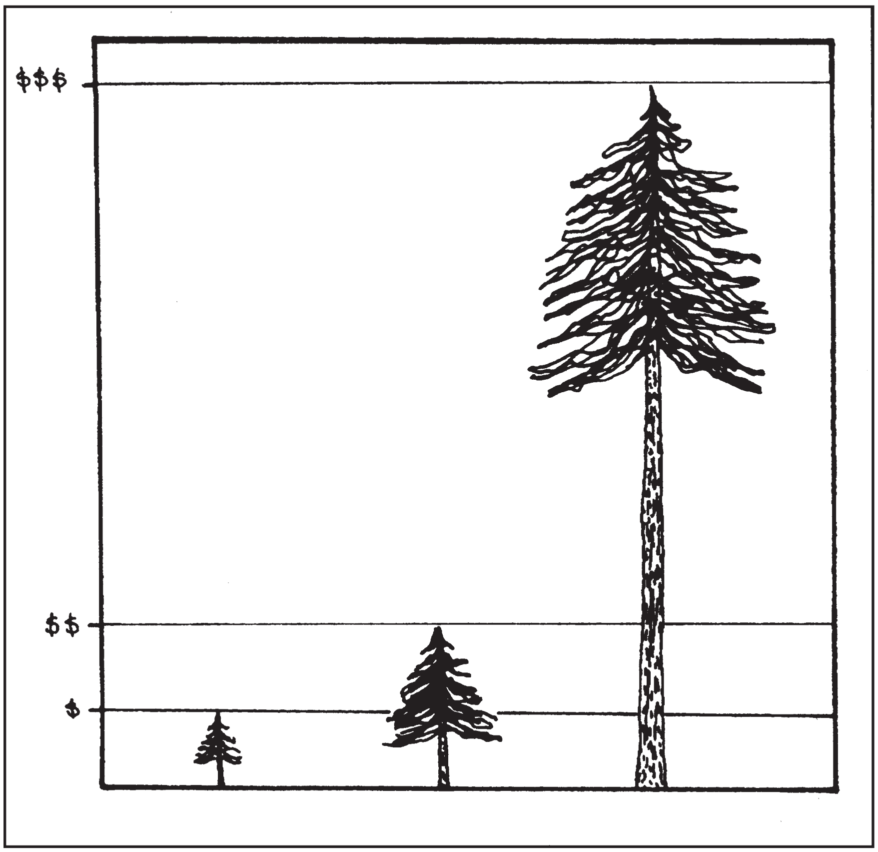
OBJECTIVE

Control the growth and quality of forest stands through maintenance of optimum stand densities.

CONSIDERATIONS

- Providing a sustainable flow of timber depends on maintaining density and stand structure, and providing for regeneration.
- Thinning is the silvicultural tool most often applied to improve timber quality and growth of a stand.
- Young stands, where most of the trees to be removed won't produce commercial products, may require noncommercial treatments. These stands may qualify for federal financial assistance. Pruning also may qualify.
- Markets for timber are variable, especially over the span of a couple of decades. What is a low-value species today could become a high-value species in 20 years. Maintaining a diversity of tree species with good form and vigorous crowns will help lessen the impacts of our limitations in predicting future timber markets.
- The following conditions affect the optimum residual basal areas in uneven-aged stands:
  - The time between harvests (the cutting cycle, which ranges from 10 to 25 years). When the cutting cycle is short, the density of the remaining forest stand should be on the high end of the suggested density range because of the shorter growing period until the next harvest. When the cutting cycle is long, the density of the remaining forest stand after cutting should be on the low end of the suggested range. This accommodates the longer period of growth available and prevents overcrowding within the stand toward the end of the cutting cycle.

- ○ Occasionally the stand density must be decreased to the lower ranges of the suggested density to accommodate harvesting trees that would otherwise die or deteriorate. There are many causes for this such as insect attack, diseases, ice damage, drought stress, or an uneven distribution of age classes.
- A dramatic jump in value usually occurs as a tree grows into the sawlog class (greater than 8 to10 inches DBH for softwood and greater than 10 to 12 inches DBH for hardwoods). An even greater jump in value may occur as a tree grows past the 10 to 18 inch DBH classes. The difference in value between a 12-inch DBH sawlog-grade tree and an 18-inch veneer-grade tree can be 400 percent to 500 percent.



- The overall quality of a stand being considered for uneven-aged management may be so low (less than 40 square feet per acre of high-quality trees in hardwoods and 60 square feet per acre of high-quality trees in softwoods and mixed-woods), that even-aged management may be a better option.
- Growing high-quality trees can't be accomplished through high grading (removal of the best trees) or liquidation (removal of all merchantable trees). Diameter-limit cuts also aren't preferred. If used, they should be based on an inventory and use different diameter limits by species to qualify as a quality-sustaining practice.

- Stand density varies by the species mix:

Stocking Table for Hardwood, Mixed-Wood and Softwood

	Hardwood		Mixed-Wood		Softwood	
Mean DBH (inches)	**A-line** sq. ft./acre	**B-line**	**A-line** sq. ft./acre	**B-line**	**A-line** sq. ft./acre	**B-line**
4	90	54	100	81	114	100
8	117	61	155	101	199	125
12	122	63	173	106	230	137
16	125	64	180	108	240	141

Hardwood = less than 25% softwood.
Mixed-wood = 25% to 65% softwood.
Softwood = greater than 65% softwood.

Stocking Tables for White Pine and Spruce/Fir/Hemlock

	White Pine		Spruce / Fir / Hemlock	
Mean DBH (inches)	**A-line** square feet / acre	**B-line**	**A-line**	**B-line**
8	240	90	205	110
12	255	100	270	150
16	285	150		

- Another approach to managing for high-value, fast-growing pine is called low-density white pine management. Low-density management grows fewer crop trees per acre than traditional stocking guides suggest. The goal of this technique is to grow a high-quality butt log free of knots in the shortest time possible. To achieve this goal white pine crop trees (100 or fewer per acre) are heavily released and pruned to a height of 1½ logs (a log is 16 feet long). Recommended residual stocking densities are well below the C-line on traditional white pine stocking guides.

RECOMMENDED PRACTICES

Even-aged Management

✓ Measure the basal area and average stand diameter of the overstory trees only. Leave out the trees that are in the understory and are completely overtopped by other tree crowns.

✓ Follow the density guidelines in the stocking table. Thin when the density is halfway between A and B, or higher.

Example: A mixed-wood stand is determined to have an average stand diameter of 8 inches and a basal area of 135 square feet per acre. Locate the average diameter in the first column and follow that row across to the mixed-wood category. Half the distance between the A-line and the B-line would be:

(155 + 101) ÷ 2 = 128 square feet per acre.

The basal area of the stand presently (135 square feet per acre) is greater than half the distance between the A-line and the B-line.

Uneven-aged Management

- ✓ Measure the basal area of all trees down to 4.5 to 5.0 inches in DBH. (Since uneven-aged stands have a range of tree size, average stand diameter isn't used as a guide.)
- ✓ Use the following optimum ranges. Schedule a harvest when the basal area exceeds the desired residual basal area by about 30 square feet.

Stand Type	Residual Basal Area (sq.ft./acre)
Hardwood	70-80
Mixed-wood	70*-100
Softwood	70*-120

** The lower end of the range is based on spruce-fir and applies to longer cutting cycles. The suggested minimum residual basal area is higher for white pine. The higher end of the range will maximize growth.*

Precommercial Treatments

- ✓ Protect crop trees susceptible to epicormic sprouting (most hardwoods) from receiving too much light on their trunks. For those trees not prone to epicormic sprouting and growing on good sites, release on at least three sides of its crown to increase diameter growth. Check with your UNH Cooperative Extension county forester to see if financial assistance is available.
- ✓ Follow the following guidelines when pruning:
  - Prune pole-sized crop trees (4 to 6 inches in DBH and never larger than 10 inches).
  - Limit the number of crop trees pruned per acre to those that can be carried to full maturity and add enough growth of clear, knot-free wood to justify the pruning investment. Prune no more than 100 softwood and no more than 50 to 75 hardwood crop trees per acre.
  - Pruning should follow, rather than precede, thinning. Keep damage to crop trees at an absolute minimum during harvests.
  - Document when and where pruning occurred.

CROSS REFERENCES

2.2 Forest Structure; 2.3 Regeneration Methods; 5.4 Logging Damage.

ADDITIONAL INFORMATION

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5.4 LOGGING DAMAGE

BACKGROUND

Excessive damage to residual trees during a timber harvest can negate the intended benefits of forest improvement operations.

Activities associated with felling, winching, and skidding can damage 20 to 40 percent of the residual trees (trees left behind).

Young trees may be bent or broken during felling or crushed by harvesting equipment. Branches and tops of residual trees may be broken during felling, reducing crown area and eventually tree vigor. Valuable lower trunks of larger trees may be wounded, allowing entry of fungi or insects that cause wood discoloration and decay. Injuries resulting in exposed sapwood wounds of 100 square inches or greater are likely to develop decay. Approximately 80 percent of skidding injuries are from bark scraped from the butt log of residual trees.

Skidding can cause root damage, allowing entry of rot-causing microorganisms. Repeated passes of heavy equipment over certain types of soils, especially during wet conditions, can compact soil air spaces, impeding root growth. Most healthy forest soils maintain about 50 percent solids, 25 percent air space and 25 percent water by volume. When these ratios change through compaction, roots are damaged and their growth restricted, erosion and run-off increase due to decreased permeability, and changes in soil temperature and microbial action disrupt soil nutrient cycling.

Logging may also combine with other stress factors to make individual trees (and eventually entire stands) more susceptible to dieback. Poor vigor invites attacks by insect pests and diseases. Also, though a stand may not be physically damaged, removing trees may reduce the stand's ability to withstand wind.

OBJECTIVE

Control and minimize logging damage to residual trees, and reduce the total area of soil compacted during harvest operations.

CONSIDERATIONS

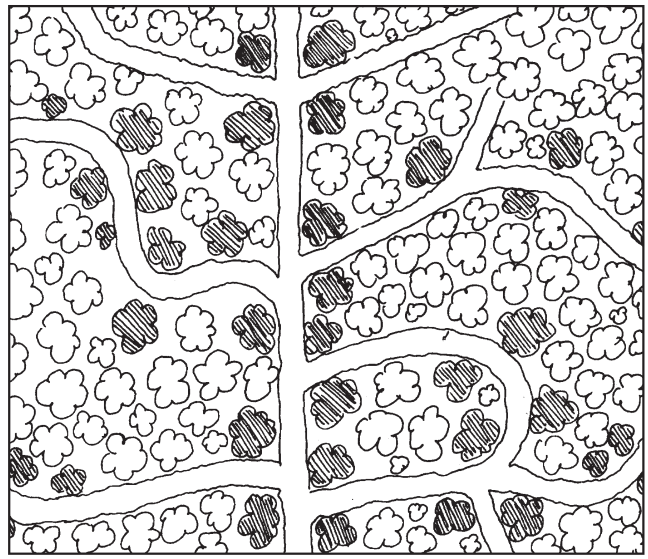
- Research indicates experienced operators can limit damage to the residual stand to 10 percent or less.
- Minimizing damage depends equally on supervision, skid trail locations, and care in felling and skidding.
- More damage occurs when bark is loose during spring and early summer; take extra caution if you can't avoid harvesting during these times.
- Certain species (e.g. paper birch and balsam fir) are more susceptible to damage than others.
- Trees growing on very dry, wet, or windy sites, as well as those that have a history of insect or disease attacks are less likely to survive logging damage.
- Elements contributing to compaction include site conditions such as soil texture (particle size), soil moisture, unevenness of the ground, and slope. The number of passes and equipment characteristics also contribute. These include total weight of the equipment, vibration, speed, pressure on the soil (pounds per square inch or psi), tire- or track-tread design, and operator

experience. Logger training, experience, attitude, and motivation are more important than equipment size in minimizing logging damage.

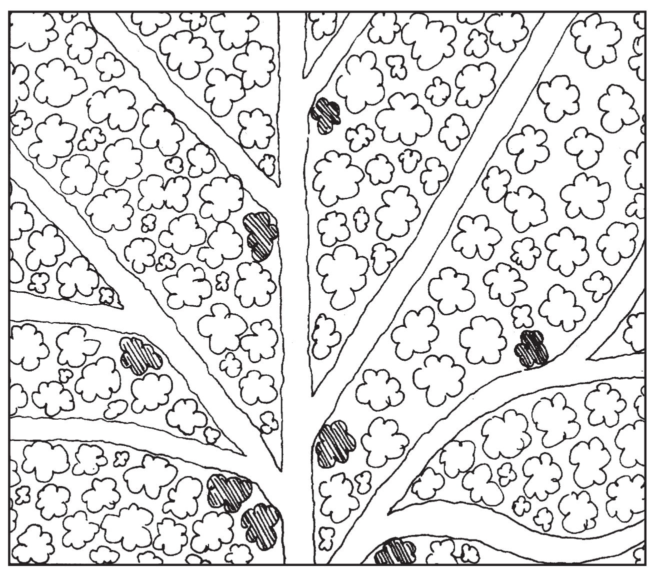
- Wet soils and fine-textured soils compact more readily than dry and or coarse soils.
- Soil compaction affects the type, productivity, and timing of natural regeneration.
- Forest floor scarification is often desired to promote regeneration.

RECOMMENDED PRACTICES

- ✓ Plan and mark skid trails and landings to accommodate the equipment, as well as skidding needs of future harvests. Reuse existing trails. For partial harvests keep the area dedicated to skid trails at or below 20 percent of the total harvest area.
- ✓ Use loggers skilled in proper directional felling, winching, and skidding procedures. Ask for references.
- ✓ Include contract provisions that provide incentives to minimize damage, and impose sanctions in the event of careless damage to the residual stand.
- ✓ Use equipment appropriate for the size and density of the trees, soil, and site conditions.
- ✓ Use branches (slash) in skid trails as a protective road bed.
- ✓ Use “bumper” trees along skid trails to protect residual trees.
- ✓ Harvest trees on sensitive or wet soils when the ground is during frozen or dry.
- ✓ Use group or patch cutting to reduce damage to the residual stand. Under this method trees can be felled toward newly created openings, rather than toward the residual stand.
- ✓ Work around pockets of advanced regeneration. Harvesting when a heavy snow cover is present will help protect small seedlings and saplings.
- ✓ Avoid harvesting heavily defoliated stands for two or three growing seasons to minimize stress on the trees.
- ✓ Avoid exposing adjacent uncut stands to prevailing winds.
- ✓ Monitor the harvest to make sure the operation is being properly conducted.



Too many bumper trees, poor road layout



Fewer bumper trees, better road layout

6.1 MAST

BACKGROUND

Mast is critical to wildlife survival.

Fruits, nuts, and seeds of woody plants are called *mast* when referring to their use by wildlife for food. *Hard mast* refers to nuts and seed and *soft mast* refers to fruits and berries. Seeds can regenerate the forest immediately following a natural disturbance or in conjunction with a harvest, but during most of the life of the forest, the majority of the seeds don't germinate and grow into seedlings—most of the time they are eaten by wildlife as mast, the focus of this chapter.

Masting cycles, insects and disease, plant species, plant age, tree diameter and dominance, weather, and genetics all affect mast production. "Masting" refers to the natural cycle in which trees and shrubs produce abundant seeds one year, followed by a year or more where mast production is moderate or low. Plant species, weather, and genetics are believed to control masting cycles. Genetics likely play the most important role in determining how much mast any individual tree or shrub is capable of producing. Some individual plants produce regular, abundant mast crops, while others consistently produce poor crops. Few physical features of plants allow managers to identify genetically superior mast-producing plants—even these plants don't produce superior crops every year. In general, mature plants exposed to full sunlight, with little competition from surrounding plants, will be most likely to produce abundant mast crops when all the other conditions affecting mast production are favorable. Insect damage can reduce tree vigor or damage young fruits, resulting in at least a temporary reduction in the amount of mast

Hard Mast

American beech, hickory, and red, white and black oak are important in the diets of white-tailed deer, black bear, wild turkey, ruffed grouse, wood duck, and more than a dozen other mammals and birds. Beechnuts are an important autumn food source for black bears in northern New England. Beech trees begin heavy nut production at about 50 years or 8 inches in diameter at breast height (DBH) and produce good crops at 2- to 8-year intervals.

Red oaks bear heavy acorn crops at 2- to 5-year intervals, reaching peak production at 19 to 22 inches DBH. White oaks bear heavy crops at 4- to 10-year intervals, and peak in production at 24 to 30 inches DBH. There is considerable variation among trees, but individual trees tend to produce consistently good or poor acorn crops. White oak acorns are more palatable than red and black oak acorns, because the former contain lower tannin levels. Ash, birches, maples, and conifers are also important sources of hard mast. Sources of hard mast have changed during the last century; most notably, when chestnut blight eliminated the American chestnut.

Soft Mast

Black cherry is the primary soft-mast producer and provides an important food source for bears, small mammals, and 28 bird species. While 10-year old saplings may produce fruit, peak production occurs between 30 and 100 years of age. Good crops occur at 1- to 5-year intervals, although black cherries usually produce some fruit every year.

Black cherry trees may vary widely in fruit production, making the production history of individual trees an important consideration when selecting trees for harvest or retention. Other important sources of soft mast include pin and choke cherries, wild apples, mountain ash, shadbush (also called serviceberry or juneberry), brambles (blackberries and raspberries), dogwoods, viburnums, blueberries, hackberries, elderberries, and grapes.

6.1: Mast

Sources of soft mast have changed with increases in non-native invasive shrubs such as autumn olive, barberry, buckthorn, honeysuckle, and multiflora rose. Some studies suggest berries produced by non-native plants may have a lower nutritional value than those from native plants, but this depends on the species being compared. Invasives raise many other concerns regarding their impact on wildlife habitat. Landowners and forest managers are encouraged to take appropriate measures to eliminate and control the spread of these plants.

OBJECTIVE

Manage mast-producing trees and shrubs for a continuous source of wildlife food and quality seed for regeneration.

CONSIDERATIONS

- The diversity and amount of mast lessens as you travel north.
- Individual oak, beech and black cherry trees may be poor timber quality but an invaluable source of mast. Such trees may have greater value left for wildlife than harvested for wood products.
- Beech bark disease may affect management decisions in infected stands.
- Understory or edge shrubs such as highbush blueberry, huckleberry, maple-leaved viburnum, hazelnut, silky dogwood, and northern wild-raisin (witherod) are an important source of mast and their mast production can often be improved simply by removing overtopping trees.
- It is illegal to plant non-native invasive such as multiflora rose, winged euonymus, non-native honeysuckle species, autumn olive, and other species per RSA 430:51-57.

RECOMMENDED PRACTICES

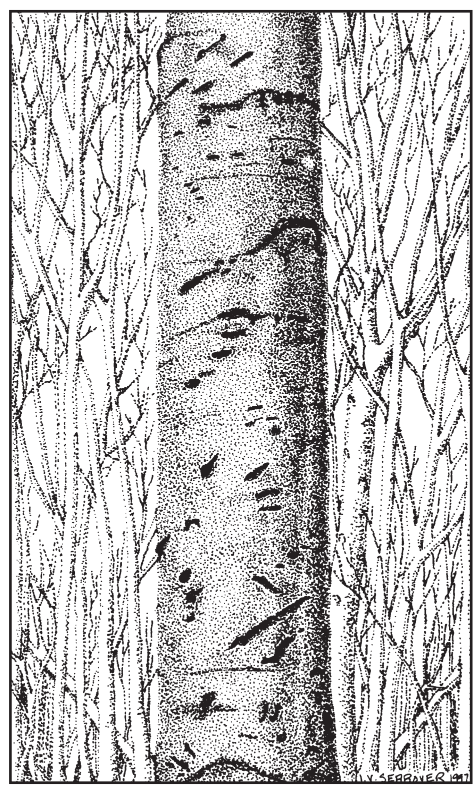
✓ When managing stands with multiple mast-producing species, maintain the diversity of mast sources.

✓ Manage oak and beech stands on long rotations (100 to 125 years), growing trees to greater than 18- to 20-inch diameters to maximize acorn production and timber value. Maintain oak in well-stocked stands by retaining vigorous trees with dominant crowns.

✓ Retain beech trees with bear claw marks on the trunk or clumps of broken branches in the crown. Retain beech older than 40 years in stands supporting wild turkeys.

✓ Improve mast production by leaving dominant and codominant trees with healthy crowns. Remove neighboring trees that have crowns touching the crowns of the trees you are saving. Remove competing trees from at least three sides to provide gaps into which the trees you retain can expand their crowns

✓ When harvesting stands with black cherry, retain some trees with high fruit production or any tree that shows evidence of use by bears (e.g., clumps of broken branches in the crown).



Beech tree with bear claw marks

- ✓ Retain wild apple trees and gradually release them from competition.
- ✓ Retain mountain ash when harvesting timber at high elevations.
- ✓ Whenever possible, avoid harvesting mast stands during spring (April through May) and fall (September through November), foraging periods favored by bears and other wildlife.
- ✓ Consider identifying high-quality hard-mast sites as "mast-producing areas" devoted specifically to long-term mast production for wildlife.
- ✓ Retain softwood "fingers" extending into mast stands and dense, brushy growth around them to provide wildlife with protective cover. This is important when managing near old apple orchards.
- ✓ Allow log landings to regenerate naturally to promote the growth of mast-producing shrubs such as brambles and strawberries. Encourage brambles by retaining down woody material in and around the landing.
- ✓ Favor the regeneration and maintenance of natives over non-natives. When planting mast-producing shrubs, select native species.

CROSS REFERENCES

2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 5.1 Insects and Diseases; 5.2 Invasive Plants; 6.4 Overstory Inclusions; 6.5 Permanent Openings; 6.9 Deer Wintering Areas; 6.10 Woodland Raptor Nest Sites.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. *A Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

RSA 430:51-57. *Invasive Species*. http://www.gencourt.state.nh.us/rsa/html/XL/430/430-mrg.htm Accessed May 26, 2010.

6.2 CAVITY TREES, DENS AND SNAGS

BACKGROUND

Retaining snags (dead or partially dead standing trees) and den trees (live trees with existing cavities) helps maintain populations of wildlife that require cavities.

Ten species of New Hampshire forest birds excavate cavities for nesting and roosting. Another 15 birds and 18 mammals use natural or excavated cavities in forests for nesting, roosting, or denning. In addition, the brown creeper nests under loose flaps of bark, attached at the top, on standing dead trees. Meeting the needs of these many different species requires a variety of cavity-tree sizes (Table 1). While cavity trees of any size have value for smaller-bodied wildlife such as the black-capped chickadee and tufted titmouse, trees larger than 18 inches in diameter at breast height (DBH) accommodate larger-bodied animals and are used by more species. Due to past agricultural and timber harvesting practices, cavity trees larger than 24 inches in diameter are uncommon.

OBJECTIVE

Maintain cavity and den trees, particularly trees with diameters exceeding 18 inches.

CONSIDERATIONS

- U.S. Occupational Safety and Health Administration (OSHA) regulations regarding the removal of dangerous trees may conflict with recommendations in this section. OSHA requires the removal of all snags (i.e., standing dead or dying trees) by mechanical or other means. If the tree is to be left standing, it must be marked, and no work can occur within two tree lengths of the tree, unless the employer demonstrates a shorter distance won't create a hazard for an employee.
- Cavity trees account for a very small percentage (less than 10 percent) of the standing tree in most forests.
- Broken large limbs in hardwood crowns provide smaller-diameter cavities over time. These cavities are often difficult to spot from the ground.
- Sawtimber and large-sawtimber snags remain standing longer than pole-size snags.
- Snags provide various substrates on which woodpeckers and other bark gleaners forage for insects. Snags also grow lichens, mosses, liverworts and fungi upon which many small mammals forage.
- Riparian zones, roadside buffers, scenic areas, and uncut patches contribute to snag-retention goals for an ownership.
- Snags and cavity trees are created in forest stands of all ages when natural disturbances such as wind and ice break tree branches or damage entire trees. Unmanaged forest stands or those managed on a rotation long enough to allow some trees to mature and die of natural causes often contain a greater proportion of snags and cavity trees than younger stands, and are more likely to contain large diameter (18+ inches) trees.
- Even distribution of snags may be desirable for some species, but there are many benefits to encouraging clumps of snags. Uniformity isn't always operationally practical or desirable.
- Landowners interested in retaining and recruiting snags and cavity trees greater than 24 inches in diameter may have to make an intentional effort to leave some trees uncut during a timber harvest. On smaller ownerships it may be necessary to manage snags on an acre-by-acre basis. On larger landholdings, it's usually more practical to take an approach that incorporates the broader surrounding landscape, emphasizing snag retention on some areas, while not on other areas.

RECOMMENDED PRACTICES

- ✓ In areas under uneven-aged management:
  - Retain a minimum of six live cavity trees and/or snag trees per acre, with one exceeding 18-inches DBH and three exceeding 12-inches DBH.
  - When lacking such cavity trees, retain live trees of these diameters with defects likely to lead to cavity formation.
- ✓ In areas under even-aged management:
  - Leave an uncut patch for every 10 acres harvested, with patches totaling 5 percent of the area. Patch size may vary from a minimum of one-quarter acre. Riparian zones and other buffers can help satisfy this goal.
  - Focus retention patches with the following trees as their nuclei:
    - Existing cavity trees exceeding 18-inches DBH or active den trees.
    - Broken-topped live trees exceeding 12-inches DBH.
    - Secure standing dead trees, especially those with top-attached bark flaps.
    - Living, large aspen and white pine, red spruce, eastern hemlock, sugar maple, beech, yellow birch, elm and oaks. Except for aspen, these trees will persist for long periods as standing dead trees.
  - ✓ Retain large-diameter snags.
  - ✓ Retain live trees with existing cavities.
  - ✓ Include the species, diameter and condition (e.g. living or dead) of snags and cavity trees as part of a forest inventory.

CROSS REFERENCES

2.2 Forest Structure; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.1 Mast; 6.3 Dead and Down Woody Material; 6.4 Overstory Inclusions.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. A *Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

USDL Occupational Safety and Health Administration. http://www.osha.gov/SLTC/etools/logging/userguide/safety_health/treeharvestingplan/treeharvestingplan.html Accessed February 22, 2010.

Table 1: Minimum Tree Diameters for Cavity-Using Species

6- 8"	Downy woodpecker*; Black-capped chickadee*; Boreal chickadee*; Tufted titmouse; House wren; Winter wren; Eastern bluebird
6-12"	Northern saw-whet owl; Hairy woodpecker*; Yellow-bellied sapsucker*; Red-breasted nuthatch*; White-breasted nuthatch; Brown creeper; Chimney swift; Southern flying squirrel; Northern flying squirrel; Ermine
12-18"	Eastern screech-owl; Three-toed woodpecker*; Black-backed woodpecker*; Northern flicker*; Great crested flycatcher; Northern long-eared bat; Indiana myotis
> 18"	Wood duck; Common goldeneye; Hooded merganser; Common merganser; Turkey vulture; Barred owl; Pileated woodpecker*; Silver-haired bat; Gray squirrel; Red squirrel; Porcupine; American marten (pine marten); Fisher; Long-tailed weasel
> 24"	Little brown bat; Big brown bat; Gray fox; Black bear; Raccoon

** = primary cavity excavators*

6.3 DEAD AND DOWN WOODY MATERIAL

BACKGROUND

Dead and down woody material (logs, stumps, limbs and upturned tree roots) in various stages of decay serves many critical functions.

Dead and down woody material, often referred to as coarse wood material (CWM) or coarse woody debris, is important for nutrient retention and cycling, as nurse logs for regenerating trees and understory plants, and as wildlife habitat. Large (18+ inches) hollow or rotten logs and stumps generally have the greatest value. Softwood stands usually contain more and longer-lasting down woody material than hardwood stands. Maintaining snags and cavity trees will also serve to maintain CWM, as these trees eventually fall over.

Coarse woody material is used by more than 30 percent of the region's mammals, 45 percent of the amphibians, and 50 percent of the reptiles. It's used as a feeding site by rodents, shrews, black bears, and woodpeckers and provides shelter for many small mammals. Seventeen mammal species, including black bear, otter, mink, fisher, weasels, and deer mouse either den or hunt in or under downed logs. CWM creates moist microhabitats used by amphibians. Downed logs create pools and riffles in streams that provide important fish habitat, as well as basking and nesting locations for turtles, waterfowl, mink, and otter. Several ground-nesting birds (including juncos and winter wrens) nest in upturned tree roots. Dead and down woody material provides habitat for many other organisms including insects and other invertebrates, mosses, fungi, and lichens.

OBJECTIVE

Manage for coarse woody material by retaining material that currently exists and allowing its accumulation where it is missing.

CONSIDERATIONS

- The amount of CWM is low in many forests, because of past land use. As New Hampshire forests mature, the supply of this material is naturally increasing as older trees die and fall over. However, more use of entire trees through chipping (whole-tree or biomass harvesting) or other techniques such as firewood cutting that leave less CWM in the woods may reduce the supply of this material on certain woodlots.
- Dead and down woody material is a natural component in forests. It is created in forest stands of all ages when natural disturbances such as wind and ice break tree branches or damage entire trees. Forests that aren't managed, or those managed on a rotation long enough to allow some trees to mature and naturally die often have a greater proportion of CWM material than younger stands, and are more likely to contain large diameter (18+ inches) material.
- Recruiting and retaining this material requires a conscious effort, especially when harvesting.
- CWM may have minimal economic value as biomass.

- CWM can provide a favorable microclimate for regeneration. It can protect developing tree seedlings from deer and moose browsing when the trees are young and vulnerable to browsing damage.

RECOMMENDED PRACTICES

- ✓ Avoid damaging existing CWM, especially large (18+ inches), hollow or rotten logs and rotten stumps.
- ✓ Leave cull material from harvested trees, especially sound, hollow logs, in the woods. Leave some cull material in the woods during whole-tree or biomass harvests. Return large pieces of cull material bucked-out on the landing to the woods.
- ✓ Avoid disrupting downed logs in and adjacent to streams, ponds and wetlands.
- ✓ Avoid disrupting upturned tree roots from May through July to protect nesting birds.
- ✓ Maintain or create softwood inclusions in hardwood stands to provide a supply of longer-lasting down woody material.
- ✓ Collect information about the type and abundance of CWM as part of a forest inventory.

CROSS REFERENCES

2.2 Forest Structure; 3.1 Timber Harvesting Systems; 3.2 Logging Aesthetics; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 4.4 Stream Crossings and Habitat; 5.3 Ice and Wind Damage; 6.2 Cavity Trees, Dens and Snags; 6.4 Overstory Inclusions.

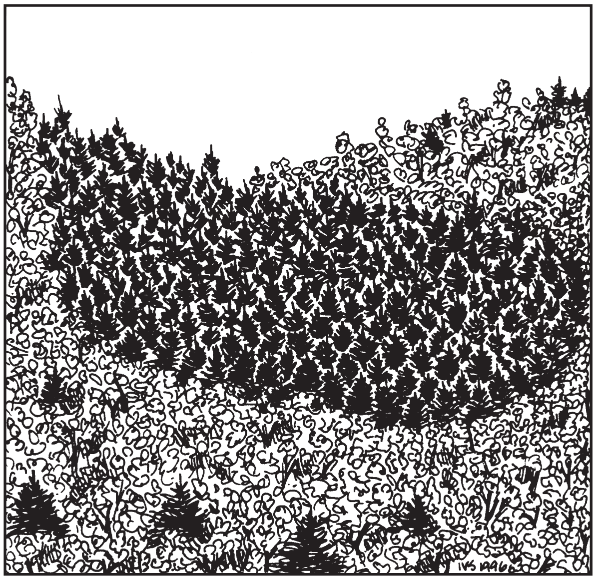
ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

6.4 OVERSTORY INCLUSIONS

BACKGROUND

Maintaining or creating inclusions of overstory that are distinct from the surrounding forest type can greatly increase the habitat diversity of otherwise uniform areas.



Overstory inclusions are small patches of forest distinct from the surrounding forest but too small to be mapped or treated separately. A patch of hemlock in a pure hardwood stand, or patches of oak in a pine stand would qualify as examples of overstory inclusions.

Inclusions provide feeding, nesting, and shelter that may not occur in continuous stands of a single forest type. More than 25 percent of New England's bird species and a lesser number of mammals use overstory inclusions in one way or another. Deer, moose and some furbearers are attracted to softwood inclusions within hardwood stands. Such inclusions may be important for facilitating movement of these animals during deep snow conditions.

Inclusions may range in size from just a few trees to more than an acre. The value of a minor inclusion increases in proportion to how different it is from the surrounding forest. Even a single softwood tree such as a hemlock, large-crowned spruce, or a large white pine within a pure hardwood stand, can greatly increase the variety of available habitats.

OBJECTIVE

Maintain and regenerate inclusions of softwood cover in predominantly hardwood stands and inclusions of hardwood cover in predominantly softwood stands.

CONSIDERATIONS

- Applying different treatments to small inclusions may be uneconomical if these treatments require different equipment or techniques.
- Small volumes of some species derived from harvesting inclusions may not be marketable.
- Removing surrounding cover may put inclusions at risk of to blowdown, sunscald, and other damage.
- Inclusions may result from either small-scale site differences or variations in the past disturbances of a stand. Natural succession may work against the maintenance of these areas, especially if advanced regeneration of the surrounding dominant vegetation is present. Maintenance and regeneration of inclusions will be more practical where inclusions result from relatively permanent site factors, rather than from variations in disturbance history across a uniform site.

RECOMMENDED PRACTICES

- ✓ Create inclusions in large uniform stands if site conditions allow.
- ✓ Where inclusions exist, develop prescriptions to maintain or regenerate them in their current type. Inclusions shouldn't necessarily receive the same prescription as the rest of the stand.
- ✓ Leave inclusions unharvested if the inclusion is:
    - Relatively unique to the area.
    - Small (one-quarter acre or less) and the volume of timber generated from its treatment will be limited.
    - From small-scale differences in site conditions that may be sensitive to disturbance (such as wet areas or shallow soils over ledge).
- ✓ Leave a buffer around softwood inclusions to provide wind protection. The buffer should be at least 2 to 3 tree-heights wide on the side exposed to prevailing winds. Don't remove more than 25 percent of the basal area within this buffer.
- ✓ Inclusions can often be incorporated with other desired habitat features such as a seep, vernal pool, or a large legacy tree.
- ✓ On larger ownerships, locate and map inclusions (e.g., with a GPS) for monitoring purposes.

CROSS REFERENCES

6.1 Mast; 6.7 Aspen Management; 6.9 Deer Wintering Areas; 7.2 Seeps; 7.3 Vernal Pools.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

Hunter, M.L., Jr.1990. *Wildlife, Forests and Forestry: Principles of Managing Forests for Biological Diversity*. Prentice-Hall, New York, N.Y. 370 p.

6.6 TEMPORARY OPENINGS CREATED BY FOREST MANAGEMENT

BACKGROUND

Shrubland wildlife species are rapidly declining in New England.

Many wildlife species such as black racer and milk snakes, woodcock, brown thrasher, whip-poor-will, chestnut-sided warbler, common yellowthroat, eastern towhee, indigo bunting, New England cottontail, meadow vole, and meadow jumping mouse require grass- and shrub-dominated early successional habitat for shelter and forage throughout the year. Early successional wildlife habitats (young trees and shrubs) have become very uncommon in much of the northeast, largely due to the maturation of the forests. These habitats are ephemeral and created through some type of human or natural disturbance (e.g., forest management clearcuts, periodic hurricanes, fire, beaver activity, and insects). Coastal and valley-bottom forests, historically exposed to disturbances from windthrow and fire are far less available as habitat today due to development and fire suppression. Today's forests are often shaped by public desire to view extensive, unbroken forests in all directions, making the presence of big patches and gaps of vibrant shrubby forest regeneration created through even-aged management far less likely on the landscape.

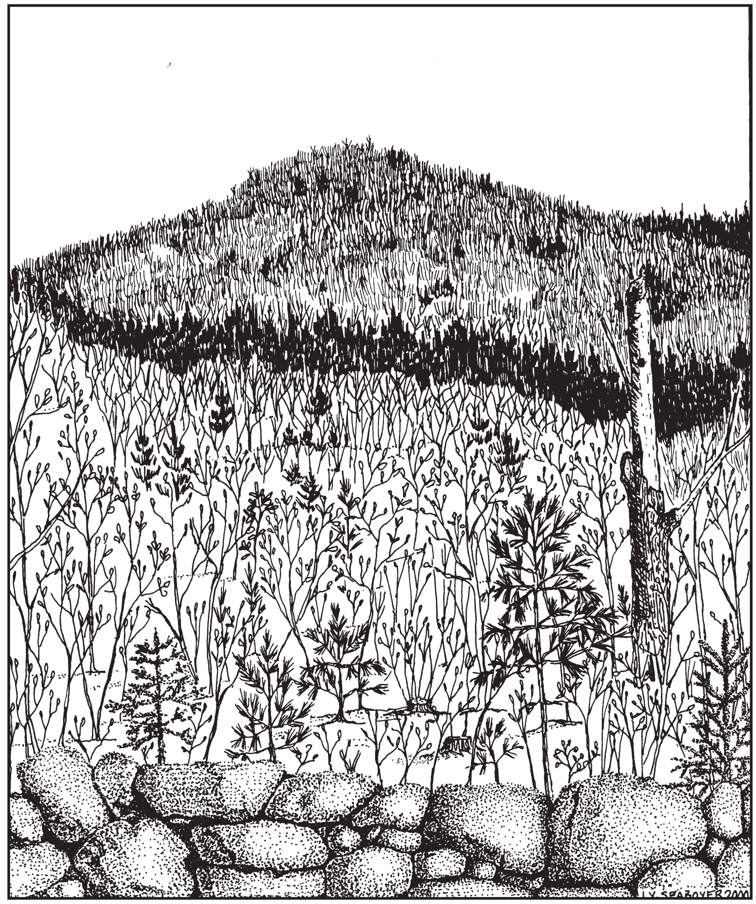
OBJECTIVE

Provide a sufficient range of early successional habitat through regenerating shade-intolerant forest types.

CONSIDERATIONS

- Integrated timber and wildlife habitat management can efficiently and cost-effectively create early successional habitat.
- Larger regenerating patches attract more species of early successional wildlife than smaller regenerating patches. To attract and support early successional birds, the minimum effective patch size probably exceeds 2½ acres and spans the gap between the maximum size of group selection cuts (2 acres) and small clearcuts (10 acres).
- Shade-intolerant tree species (aspens, pin cherry, and paper birch) are best regenerated by clearcut, patch, and large group selection practices during the snow-free season.
- Use of clearcuts by early successional birds peaks around 10 years post-cut, and generally disappear from clearcuts within 20 years. A more frequent re-entry schedule than every 20 years can help maintain the occurrence of such ephemeral habitat.
- Isolated patches of early successional habitat in extensively forested landscapes are likely to have lower rates of shrubland bird occupancy than forested landscapes with higher percentages of early successional habitat.
- Statewide estimates to optimize early successional habitat for the array of early successional wildlife suggest a goal of 5 to 20 percent of the landscape in an early successional condition. This goal includes regeneration (0-to-10-year age class) and permanent openings with all properties contributing.

RECOMMENDED PRACTICES



- ✓ Develop habitat-composition goals for a property that include young forest as well as mature and older forest for a broad diversity of wildlife over time.
- ✓ Increase the use of group selection, patch and clearcut methods to diversify a closed canopy, increasing the gap size whenever possible.
- ✓ Regenerate shade-intolerant and mid-tolerant trees using shorter rotations, larger cuts, and site scarification.
- ✓ To increase the effective area of available early successional habitat spatially and over time, locate new groups, patches and clearcuts adjacent to temporary and permanent openings (i.e. utility corridor rights-of-way, scrub-shrub wetlands, frost pockets, and brushy old-fields).

CROSS REFERENCES

2.3 Regeneration Methods; 6.5 Permanent Openings; 6.7 Aspen Management; 6.8 Beaver-Created Openings; 7.4 Pine Barrens.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

6.7 ASPEN MANAGEMENT

BACKGROUND

Aspen (also known as poplar or popple) stands are the preferred habitat for ruffed grouse, woodcock, Nashville warbler, beaver and other wildlife.

Although aspen is one of the most widely distributed forest types in North America, it is relatively uncommon in New Hampshire covering approximately 2 percent of the state's forest area. Aspen, including trembling aspen and big-toothed aspen, occurs chiefly as a "pioneer" forest type, often growing in close association with white birch. Pioneer types are the first to colonize disturbed areas such as burns and field edges. Big-toothed and trembling aspen are extremely intolerant of shade. They need full sunlight to grow. Disturbances such as fire or clearcutting are needed to regenerate shade-intolerant species such as aspen and white birch. In the absence of disturbance, aspen is replaced by more shade-tolerant trees, e.g., spruce, fir, white pine, or northern hardwoods.

OBJECTIVE

Maintain or expand the aspen type to enhance wildlife habitat diversity.

CONSIDERATIONS

- Aspen seed is extremely small and light. It can be blown long distances but requires exposed mineral soil for successful germination.
- Aspen typically regenerates by root-suckering. When an area containing aspen is clearcut, dormant buds on the roots sprout, often producing several thousand suckers per acre. Because they have an established root system, the suckers (collectively called a clone) may grow 4 feet or more the first year.
- All flowers on an individual tree are the same sex. Male aspens have larger buds and provide more valuable food for ruffed grouse.
- Trembling aspen stands reach maturity and begin to deteriorate at about 40 years old, though deterioration may begin at age 30 on poor sites or age 50+ on good sites. At maturity, aspen trees are generally 10 to 16 inches in diameter at breast height, depending on the quality of the site. Big-toothed aspen grows longer and larger than trembling aspen.
- Once aspen is gone, it is difficult to get it back, requiring cutting aspens to regenerate aspen from root suckers.
- A number of insects and diseases attack aspen. The only feasible method of dealing with them is to keep aspen stands vigorous by harvesting them at an appropriate rotation age.
- Aspen stands managed as feeding and nesting cover for woodcock or grouse are often 1 to 5 acres. Aspen openings as large as 10 to 20 acres are valuable for other early successional songbirds and mammals.
- Older and overmature aspen provide potential nest sites for pileated woodpeckers and other cavity nesters.

RECOMMENDED PRACTICES

- ✓ To regenerate aspen when a stand has at least 10 to 20 square feet of basal area per acre of aspen:
  - Harvest stands before the trees mature and begin to decline in vigor. Fast-growing, pole-sized trees sprout more vigorously than older, slower-growing trees.
  - Create openings with a diameter at least 1½ times as large as the height of surrounding trees to allow sunlight to reach the ground.
  - Clearcut nearly all of the stand; ideally, cut all stems 1-inch diameter and greater to ensure direct sunlight and to stimulate the best root-suckering response. The number of root-suckers is directly proportional to the number of aspen stems removed.
  - Cut aspen when dormant (late autumn through early spring), and avoid disturbance to aspen roots to maximize the density of root-suckers.
- ✓ To increase aspen where it occurs in very small groups or as individual trees mixed with other species such as growing along old woods roads, skid trails, and landings:
  - Locate openings following the above recommendations, so as to cut some, but not all of the aspens.
  - To maximize sunlight and heat exposure to roots and root-suckers, locate openings southwest of the aspens that are kept.
  - Expand these openings in subsequent harvests.
- ✓ Establishing aspen where none exists is more difficult and may require site preparation to enhance the germination and survival of seedlings.
- ✓ Where possible, retain downed logs at least 12 inches in diameter for ruffed grouse drumming.

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.3 Regeneration Methods; 5.1 Insects and Diseases; 6.4 Overstory Inclusions; 6.6 Temporary Openings Created by Forest Management; 6.8 Beaver-Created Openings.

ADDITIONAL INFORMATION

DeGraaf, R., M. Yamasaki, W. B. Leak, and A. M. Lester. 2006. *Technical Guide to Forest Wildlife Habitat Management in New England*. University of Vermont Press and University Press of New England, Burlington, Vt. 305 p.

Vermont Fish and Wildlife Dept. 1986. *Model habitat guidelines for deer, bear, hare, grouse, turkey, woodcock and non-game wildlife*. The Leahy Press, Montpelier, Vt. 64 p.

6.9 DEER WINTERING AREAS

BACKGROUND

White-tailed deer in New Hampshire live near the northern limit of their geographic range. Because of severe winters, deer require special habitats to survive.

The winter survival of white-tailed deer is related to their ability to occupy "wintering areas" when deep snow limits food availability and deer mobility. Special habitat characteristics of deer wintering areas allow deer to maximize their daily food intake and minimize the amount of energy they expend to move, keep warm, and avoid predators.

Deer wintering areas (DWAs) consist of two basic habitat components:

(1) The core shelter area—dense, mature softwood that provides cover, improving the deers' ability to move in the snow.

(2) Other habitats that provide accessible forage within or adjacent to the core area. These habitats might be hardwood stands, mixed hardwood-softwood stands, or nonforest habitats such as fields or wetlands.

The term "deer wintering area" refers to the entire area deer occupy during winter, not just the dense-softwood cover—though the cover is critical and often the most difficult component to establish and maintain.

Most DWAs occur at elevations below 2,000 feet in lowland softwood stands such as spruce-fir and northern white cedar in the north, or eastern hemlock in the south. DWAs are often associated with watercourses and riparian areas, since these forest types grow there. Only about 3 percent of New Hampshire's land base meets the habitat requirements for deer wintering.

Deer use of wintering areas varies within and between winters, based mainly on differences in snow depth. Deer move into wintering areas when snow depth exceeds 10 to 12 inches, and they primarily use the core shelter area when snow depth exceeds 16 to 20 inches. During mild winters deer may range far from softwood shelter or not use a wintering area at all. Some wintering areas aren't used annually by deer, but these habitats are still critical when winter conditions are severe.

In northern New Hampshire, it isn't uncommon for some deer to travel more than 20 miles between the habitat they use in autumn and the DWA they use each year. Northern deer generally "yard" in large numbers and remain within or close to the cover provided by extensive softwood stands all winter long.

In southern New Hampshire, where winter conditions are less severe, deer often make short-distance movements during winter storms or periods of severe cold. They find refuge in small stands or patches of dense softwood cover near or within the habitat they use during autumn. They often don't yard in the same numbers or for the same length of time as deer in the north. As a result, DWAs in the north are often large, characterized by softwood stands exceeding 100 acres, while those in the south are often much smaller. Softwood stands covering less than a few acres provide temporary cover.

OBJECTIVE

Manage existing deer wintering areas to provide deer with functional shelter, softwood travel lanes to access food and escape predators, and a continuous supply of accessible browse.

CONSIDERATIONS

- Refer to the following comprehensive guides for in-depth coverage of DWA ecology and management options: Gill 1957, Boer 1978, Telfer 1978, Reay et al. 1990, Voigt et al. 1997, OMNR 2000, NBDNR 2002, Pekins and Tarr 2009, Pratte 2009. Full listings follow below in "Additional Information."
- N.H. Fish and Game (NHF&G) provides maps of known DWAs. Because locations of wintering areas change over time, a field evaluation of the current habitat conditions is recommended before conducting any work within a known or potential DWA.
- Maintaining DWAs on working forest land requires identifying sites where core shelter and forage can develop over time. The location of core shelter areas doesn't need to be static. Timber harvesting can be used to shift the location of these stands over time, to ensure they don't become overmature and lose their ability to provide functional shelter.
- Deer need to access adequate food throughout winter to offset their energy expenditure. This is best provided in DWAs with core shelter areas highly interspersed with forage areas and connected by corridors of mature softwoods. This allows deer to move among all habitats under a variety of snow conditions.
- It isn't clear how large a softwood stand needs to be to provide functional winter cover for deer. Experience and the existing research provide some considerations:
  - As you move from southern New Hampshire north, deer likely require larger core shelter areas due to differences in winter severity.
  - Wherever snow depth regularly exceeds 16 to 20 inches, individual core shelter areas should probably exceed 25 acres.
  - In the south, pockets of softwoods as small as 1 acre may provide functional cover, especially when crown closure in these stands approaches 100 percent.
  - Small-acreage softwood stands may effectively provide cover from cold temperatures or improve their access to forage. These stands may be ineffective in protecting deer from predators if the stands aren't large enough to enable deer to establish complex trail networks throughout the wintering area.
- Hemlock and northern white cedar provide the best winter cover for deer due to their superior ability to intercept snow. Spruce and balsam fir are important cover, but require denser stands to intercept the same amount of snow. Pines must grow in stands with considerably more than 70 percent crown closure to reduce snow depth.
- Hardwoods provide little to no cover for deer during winter. Hardwood stands on south- to west-facing slopes are important, though. During the day, deer often bed in these stands to be warmed by the sun's heat. Sun and wind often expose fallen acorns and beechnuts, which are among the highest-quality winter foods.
- After deer learn the location of their wintering area from their mothers, they generally return to it for life and are reluctant to abandon it for a new one. Focus on enhancing or expanding existing DWAs before attempting to create new ones.

- The aggregation of small DWAs on multiple ownerships provides a significant portion of the winter range of deer in New Hampshire.
- All forms of softwood silviculture can be compatible with DWA management, as long as mature softwood stands previously managed for cover are harvested only when regenerating stands have grown and are able to immediately replace the cover being removed.
- Maintaining stands within the DWA for a balanced age-class distribution provides habitat for a diversity of wildlife, reduces the susceptibility of softwood stands to common insect pests (e.g., spruce budworm), and allows for a continued yield of forest products.
- Landowners for whom DWA management is a priority may have to reduce or delay timber harvests on a portion of their land to develop the softwood age classes or establish harvest rotations required to create and maintain functional core shelter areas. Such accommodations may increase the administrative costs of harvesting and require landowners to defer income.
- Because of deer browsing, regenerating many hardwood trees and some softwoods (e.g., hemlock, cedar) can be difficult in stands located in and adjacent to DWAs. Options for reducing this impact include (1) focused hunting, (2) locating openings away from wintering areas, and (3) providing a number of browsing opportunities for deer each time you cut trees. Make a number of openings, rather than a single opening, so browsing isn't concentrated within a single area.
- The potential negative impacts of providing deer with supplemental food during winter outweigh the potential benefits.
    - Supplemental food concentrates deer in unnaturally high densities, leading to significant overbrowsing of natural foods around feeding sites. Even where supplemental food is provided, deer rely on natural browse for most of their daily food needs. Overbrowsing may reduce the overall ability of the wintering area to meet the needs of deer.
    - Supplemental feeding cause deer to alter their annual migration patterns. They concentrate their activity near residential areas and away from historic wintering areas that provide cover.
    - Supplemental feeding sites may increase the risk of deer contracting and spreading serious diseases such as chronic wasting disease and bovine tuberculosis.

RECOMMENDED PRACTICES

General recommendations for managing DWAs

✓ Contact NHF&G to find out whether known DWAs occur on your land and for assistance planning timber harvests in known or potential DWAs.

✓ Develop and maintain a balanced distribution of timber age classes across the DWA to maintain a constant supply of core shelter.

✓ Maintain "functional" core shelter on at least 50 percent of the DWA at all times. Functional shelter is provided by softwood stands at least 35 feet tall with softwood crown closure between 65 to 70 percent.

✓ Throughout the remainder of the DWA, maintain forage areas that provide a steady, abundant source of accessible browse by clearcutting 1- to 5-acre openings using a 40-year rotation and 10-year cutting cycle. Locate browse cuts within 100 feet of core shelter areas.

✓ Throughout the DWA, maintain strips of closed-canopy softwoods as travel corridors that connect core shelter areas with forage areas. Integrate these strips with riparian management zones. Create strips at least 100 to 300 feet wide and managed with uneven-aged silviculture to maintain softwood crown closure greater than 75 percent.

- ✓ Winter is generally the best season to harvest timber from DWAs since deer forage on fallen tree tops and tree lichens, and skid trails improve deer mobility. Summer logging is preferred when soil scarification is required to regenerate desired softwood species such as hemlock, spruce and fir.
- ✓ Protect advanced softwood regeneration. Lay out skid trails and incorporate harvesting technologies and techniques that have a lower impact to advanced regeneration (3.1 Timber Harvesting Systems).
- ✓ Avoid or limit disturbance to deer within the DWA during winter by routing all truck roads, skid trails, and recreational trails around, rather than through, core shelter areas. Locate new trails used during the winter (e.g., snowmobiling, skiing, snowshoeing) as far away as possible from core shelter areas—ideally so deer don't see trail users.

Forest-Type Specifics

- ✓ In spruce-fir stands, uneven-aged management using group selection is the preferred method for managing DWAs and is especially important in softwood stands smaller than 100 acres. Make group openings between 20 to 40 feet in diameter. Rotation age targets are 70 years for fir and 100 years for spruce.
- ✓ Suitable options for even-aged systems in spruce-fir stands depend upon advanced regeneration. If advanced regeneration is present, conduct an overstory removal. If regeneration is absent, use a two-cut shelterwood system or strip clearcutting to stimulate seedling growth.
- ✓ Favor spruce over fir because spruce is longer-lived, generally more root-firm, and less susceptible to common insect pests.
- ✓ Favor hemlock when possible since it provides the best cover of all the softwood species. Managing hemlock stands may be difficult. Seek professional advice. Refer to Tubbs (1978) and Reay (1985) for details on hemlock silviculture.
- ✓ Release advanced hemlock regeneration and establish browse by removing competing hardwoods around the core cover area.
- ✓ If DWA management is a priority, manage hemlock core shelter areas with at least a 150-year rotation. Hemlock is very long-lived. Older hemlock found growing in many DWAs tend to have poor timber quality.
- ✓ If advanced hemlock regeneration is present, conduct a single removal of the overstory trees in areas scheduled for regeneration. If there is inadequate regeneration, a two- or three-stage harvest is recommended.
- ✓ If harvesting in the summer, scarify the soil and remove advanced hardwood regeneration.
- ✓ In DWAs less than 10 acres, retain most or all of the hemlock to ensure the long-term production and maintenance of functional deer shelter.
- ✓ Northern white cedar can be extremely hard to regenerate because it grows slowly and is also a highly preferred browse species. If a cedar DWA is encountered, contact NHF&G for details on management options.

CROSS REFERENCES

2.1 New Hampshire Forest Types; 2.2 Forest Structure; 2.3 Regeneration Methods; 2.4 Managing for High-Value Trees; 3.1 Timber Harvesting Systems; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.4 Overstory Inclusions; 6.5 Permanent Openings; 6.6 Temporary Openings Created by Forest Management.

6.10 WOODLAND RAPTOR NEST SITES

BACKGROUND

Suitable nest sites are limited for woodland-nesting raptors. These birds can be sensitive to human disturbance and habitat changes in the vicinity of nests. Continued existence of these birds depends on an adequate supply of potential nest trees.

Accipiters (sharp-shinned and Cooper's hawks, and northern goshawk) build large stick nests on large branch fans of white pines next to the tree bole, and in multipronged "basket" forks (where three or more large branches meet) of mature hardwoods at different canopy heights. They often reuse the same nest in successive years, or build a new nest in another nearby tree. Goshawks build nests in the base of the canopy often in areas with prior goshawk nesting. Sharp-shinned and Cooper's hawks tend to build their nests higher in the canopy. Sharp-shinned hawks tend to nest in younger, dense forest stands; Cooper's hawks nest in more open forests. Goshawks nest in more mature forests in or near large white pines.

Buteos such as red-tailed, red-shouldered, and broad-winged hawks build large stick nests in "basket" forks of mature hardwoods and on large branch fans of white pines that are often near the edges of open, nonforest areas such as upland openings, marshes, beaver ponds and old woods roads. Red-shouldered hawks nest in mature woodlands near water or wetlands.

Ospreys nest on dead or dead-topped trees, most often in white pines but occasionally in other tall softwoods. Osprey often nest near large lakes, wetlands or stream riparian zones, but may occasionally nest in upland settings some distance from open water.

Bald eagles usually nest within half a mile of water along shorelines of large lakes and estuaries in large white pines or hardwoods. Both osprey and bald eagle nests are typically used for years or even decades, with pairs adding new nesting material each year.

Cavity-nesting owls (barred, long-eared, saw-whet, and screech) use a range of sizes of cavity trees in forested and riparian areas. Great horned owls commonly occupy large stick nests built by red-tailed hawks, crows, ravens, herons, and squirrels. Barred and long-eared owls may also use stick nests.

Excessive human activity near raptor nests in the early weeks of the breeding season may cause a pair to abandon the site; or if later in the nesting cycle, may cause an incubating or brooding female to flush from the nest, leaving eggs or nestlings vulnerable to fatal chilling or predation.

OBJECTIVE

Manage for suitable nest trees and potential replacement nest trees for woodland-nesting raptors and avoid disturbance of nesting pairs during the breeding season.

CONSIDERATIONS

- Cooper's hawk, northern goshawk and red-shouldered hawks are New Hampshire species of greatest conservation need.
- The number of nesting pairs of ospreys statewide has steadily increased to 68 in 2008 from the early 1980s, when 10 to 20 pairs nested in Coos County near the Androscoggin River. Though ospreys were removed from the state-threatened list in 2008, they remain a New Hampshire species of greatest conservation need.

- The number of bald eagle nesting pairs steadily increased to 15 in 2008 since bald eagles resumed nesting in New Hampshire in 1988. Bald eagles were removed from the federally threatened list in 2007 and remain on the state-threatened list and as a species of greatest conservation need.
- No regional surveys assess the status of owls.
- Identifying woodland raptor nests can be difficult without the birds' presence and activity. Active nests can be difficult to determine outside of the nesting season (mid-February through the end of July). Multiple raptor nests indicate areas where past raptor nesting has occurred. Active nest trees are often discovered during harvesting.
- Because of their poor form (from a timber-value perspective), potential raptor nest trees may be removed during timber stand improvement.
- While northern goshawks will aggressively defend their nest sites, some raptor species such as red-tailed and broad-winged hawks can tolerate nest disturbances better than other species.
- Nesting raptors may tolerate vehicular traffic on regularly used roads. However, all-terrain vehicle (ATV) traffic on otherwise unused roads and trails can be a disturbance factor.
- Great horned owls prey on both adult and nestling hawks and can discourage some hawk nesting attempts in landscapes with a significant open, nonforest component.

RECOMMENDED PRACTICES

- ✓ Look for stick nests in sawtimber-size white pine and hardwoods along woods roads and trails, near water and forest openings.
- ✓ Avoid recreational use of logging roads adjacent to active nests during the raptor nesting season (mid-February through the end of July). Trails may be temporarily rerouted around nesting areas.
- ✓ Retain trees containing large stick nests and some potential nest trees, especially those hardwoods with multipronged "basket" forks, and large cavity trees (6.2 Cavity Trees, Dens and Snags).
- ✓ In clearcuts, leave a group of several large trees for each 5 to 10 acres to ensure future availability of mature trees for nest sites. These clumps also can serve cavity-nesters' needs.
- ✓ Where raptor nests are found, leave a partially closed canopy using either single tree management or a small uncut buffer of at least a chain (66 feet) around the nest trees, leaving more than just the nest tree(s).

6.10: Woodland Raptor Nest Sites

✓ Minimize nesting-season disturbances around active nests.

- Temporarily limit forest management activities (tree cutting, road construction, etc.) within 10 chains (660 feet) of active raptor nests during mid-February through the end of July; with the understanding that tolerance levels are highly variable among raptor species and individuals of a given species and that each situation can be different.
- If nests are discovered during harvesting, continue working in another area, if possible, while the birds are nesting and until the young raptors have fledged.

✓ For bald eagles, avoid human activity within 5 chains (330 feet) of active nests from February 1 to August 31. Contact the Nongame and Endangered Wildlife Program at N.H. Fish and Game for assistance when planning a harvest within one-quarter mile of a nest. Refer to timber operations and forestry-practices guidelines in National Bald Eagle Management Guidelines.

✓ Though peregrine falcons aren't tree-nesters, minimize potential recreational and rock-climbing disturbance around cliff-nesting sites during the breeding season.

CROSS REFERENCES

2.2 Forest Structure; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 6.2 Cavity Trees, Dens and Snags; 6.13 Wildlife Species of Greatest Conservation Need.

ADDITIONAL INFORMATION

Elliott, C.A. 1988. *A Forester's Guide to Managing Wildlife Habitats in Maine*. University of Maine Cooperative Extension, Orono, Maine.

USDI Fish and Wildlife Service. 2007. *National bald eagle management guidelines*. http://www.fws.gov/pacific/eagle/NationalBaldEagleManagementGuidelines.pdf Accessed February 23, 2010.

7.1 NATURAL COMMUNITIES AND PROTECTED PLANTS

BACKGROUND

Protecting and conserving natural communities and threatened and endangered plants is essential to maintain native biodiversity.

Natural communities are recurring assemblages (groups) of species found in particular physical environments. Familiar examples include ***hemlock - beech - oak - pine forest***, and sugar maple dominated ***rich mesic forest***. The N.H. Natural Heritage Bureau (NHNHB) recognizes 193 natural communities, of which 42 are wooded uplands and 38 are wooded wetlands or floodplain forests.

NHNHB evaluates the ecological significance of natural communities and assigns a quality rank. Quality ranks are a measure of the ecological integrity of a community relative to other examples of that community. The rankings are based on community size, ecological condition, and landscape context (i.e., where the community is located). Exemplary communities include (1) all viable occurrences of rare natural community types, and (2) higher-quality examples of more common communities. Exemplary natural communities occupy only a small part of New Hampshire.

New Hampshire has about 1,500 species of native vascular plants, about 25 percent of which are protected by the New Hampshire Native Plant Protection Act (RSA 217-A). Another three plants are protected by the federal Endangered Species Act, only one of which—small whorled pogonia—occurs in forests.

Many threatened and endangered plants occur in nonforested habitats such as marshes, riverbanks, and alpine areas. Threatened and endangered forest plants are largely restricted to uncommon habitat types. Black maple, river birch, hackberry, and jack pine are four threatened or endangered tree species that may reach harvestable size. Black maple typically occurs with sugar maple on moist, rich soils of river bottoms in mixed hardwood forests in southern New Hampshire. River birch is restricted to streambanks and other moist places. Hackberry usually occurs on rich, moist sites along streambanks or on floodplains. Jack pine occurs on only a few acidic rocky summits at moderately high elevations in the White Mountains, and in lakeshore settings north of the mountains.

Rich Woods

Rich woods are a special subset of hardwood forest communities. These communities share a diverse assemblage of plants restricted to nutrient-rich conditions. Many of New Hampshire's rare plants occur in rich woods. Sugar maple, white ash, and a species-rich herbaceous layer are hallmarks of rich woods. Ferns, perennial forbs, and sedges are abundant, including many species that flower in early spring, but few shrubs grow in rich woods. In New Hampshire, rich woods typically occur in south-facing locations associated with bedrock types that weather to form enriched soils, a combination of conditions infrequent in the state.

The New Hampshire Native Plant Protection Act, RSA 217-A, protects and conserves plants for human needs and enjoyment, the interests of science, and the state's economy. The NHNHB administers the Act, including collecting and analyzing data on the status, location, and distribution of rare or declining native plants and exemplary natural communities, as well as developing and implementing measures for their protection, conservation, enhancement, and management.

Small Whorled Pogonia

Small whorled pogonia is a federally threatened orchid. It grows in ***hemlock - beech - oak - pine forests*** along with Indian cucumber root, New York fern, partridgeberry, downy rattlesnake plantain, and witch hazel. As of 2008, NHNHB identified 49 populations, although only six have good or excellent viability. The plant tolerates some disturbance and persists in stands managed for timber. Habitat management experiments (e.g., canopy thinning) may maintain population viability, but the long-term beneficial effects haven't been confirmed.

The NHNHB is not a regulatory agency, and its statute specifically gives private property owners the right to take protected plant species on their own lands. The statute directs state agencies to avoid jeopardizing the continued existence of any protected plant species. Prohibited acts include exporting or importing protected species into or out of New Hampshire, transporting protected species within the state, and taking, possessing, and selling any protected species from public property or property of another.

The Endangered Species Act applies to federally listed threatened and endangered species, three of which occur in New Hampshire as of 2009. Rights and prohibitions resemble the New Hampshire Native Plant Protection Act, though the right to take protected species on one's own property is less explicit.

OBJECTIVE

Maintain natural communities and threatened and endangered plants.

CONSIDERATIONS

- Most exemplary natural communities and threatened and endangered plants occur in distinct, small patches in the forest and conflicts with forestry operations are rare. Adoption of appropriate silvicultural and timber harvesting techniques can avoid or minimize impacts. Knowledge of the effect of various forestry practices is limited, but expanding.
- Protecting natural communities and plants may reduce harvest volume and increase planning costs, resulting in a reduced income.
- Some natural communities and plants depend on disturbance (e.g., fire or timber harvest) for their maintenance. Disturbance suppression, combined with succession, may alter or eliminate species or communities.
- Threatened and endangered and other uncommon plants may grow in nonexemplary communities.
- The N.H. Dept. of Environmental Services wetland permit applications require determining if the NHNHB has identified threatened and endangered plants or exemplary natural communities in the wetland. Applicants can use the DataCheck Tool on the NHNHB website to determine whether a plant or community is potentially impacted, or contact the NHNHB.
- Identifying certain threatened and endangered species and natural communities requires specialized training. The NHNHB website includes a list of threatened and endangered plants by habitat type and a photo index of natural communities.
- Working with NHNHB helps avoid or minimize impacts and eliminates or reduces permit effort, cost, and restrictions.

RECOMMENDED PRACTICES

- ✓ Look for threatened and endangered plants and exemplary natural communities during field visits or forest inventories; include your findings and recommendations for their protection and conservation in your management plan.
- ✓ Look for areas with distinct vegetation or extreme site conditions (e.g., very dry, wet, or nutrient-rich) when surveying or working in a harvest area. Contact NHNHB early in your planning for help to determine the presence or absence of protected species and communities in a harvest area.
- ✓ Avoid excessive changes in stand composition and structure, crown closure, forest floor characteristics, and other stand conditions if harvesting in areas with threatened and endangered species and exemplary natural communities. When possible, harvest during the nongrowing season. In general, focus management on communities rather than individual species.

CROSS REFERENCES

1.3 Forest Management Planning; 2.1 New Hampshire Forest Types; 4.2 Wetlands; 4.3 Forest Management in Riparian Areas; 7.2 Seeps; 7.3 Vernal Pools; 7.4 Pine Barrens; 7.5 Old-Growth Forests; 7.6 High-Elevation Forests.

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Maine Natural Areas Program Rare Plant Fact Sheets. http://www.maine.gov/doc/nrimc/mnap/features/plantlist.htm Accessed February 27, 2010.

N.H.Natural Heritage Bureau. http://www.nhdfl.org/about-forests-and-lands/bureaus/natural-heritage-bureau, Accessed February 27, 2010.

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Sperduto, D.D., and W.F. Nichols. 2004. *Natural Communities of New Hampshire*. N.H. Natural Heritage Bureau, Dept.of Resources and Economic Development, Concord, N.H. 229 p.

Glossary

Advance regeneration	Seedlings and saplings present in the understory before cutting
Annual ring	The ring of wood developed in one year on the outside of the tree stem.
Aspect	The direction a slope faces.
Basal area	Sum of the cross-sectional areas (at 4.5 ft. high) of all trees on an acre. A measure of stand density or crowding.
Biomass	The total weight of all harvestable vegetation from stands that is usually processed into chips.
Bole	Tree trunk or stem.
Board foot	1-foot by 1-foot by 1-inch piece of wood or the equivalent.
Buffer strip	A protective border of trees, brush, and/or herbaceous vegetation along streams and other sensitive sites.
Browse	Leaves, buds and woody stems used as food by woodland mammals like deer and moose.
Butt log	Lowest log in the tree bole.
Canopy	Overhead layer of branches and foliage formed by the trees in a stand.
Cavities	Hollows in living or dead trees that usually form following injury to the tree or excavation by woodpeckers. Cavities provide important nesting and resting cover for many birds and mammals.
Cleaning	Early (noncommercial) silvicultural operation in a young stand removing weed trees and poorly-formed trees. See weeding.
Clearcutting	Regeneration cut that removes all trees. A commercial clearcut removes all trees that can be sold.
Climax	An association of plants and animals that will prevail in the absence of disturbance. The culmination of a successional cycle.
Clones	A collection of stems that have propagated by vegetative means from the roots of a single parent.
Codominant	A tree whose crown receives full sun from above and some from sides.
Conversion	Generally means a drastic change in the species mix of a stand; e.g., from oak to pine, from northern hardwood to aspen, etc.
Corridors	Wide travel lanes that allow wildlife access from one site to another, as from a bedding site to a feeding site.
Cord	Stack of wood occupying 128 cubic feet of space.
Crop tree	Tree of good species and form that is released in a thinning operation.

Crown — Foliage and branches of a tree.

Crown class — Classification of trees according to position of the crown in relation to adjacent trees: dominant (exposed to full sun on top and sides), Codominant (full on top and some on sides), intermediate (receives little sun from above), and suppressed (no sun from above).

Crown closure — Percent of ground area under a stand that is shaded by foliage.

Cruising — Determining the volume in a stand, usually by measuring the trees on a series of sample plots.

Cubic foot — 1 x 1 x 1 foot piece of wood. Includes all of the sound wood in the bole of a standing tree, up to a minimum diameter.

Cull — Anything that reduces the volume scale. May be rotten cull or sound cull such as crook or sweep.

Cunit — 100 cubic feet of solid wood.

Cutting cycle — Years between cutting operations within a stand.

Deciduous — Trees that drop all leaves in the fall (usually hardwood).

Defect — Usually refers to factors that reduce grade (branches, overgrown knots, splits, etc.) and may also reduce scaled volume.

Density — Stand density refers to basal area per acre, or some other measure such as crown closure, that reflects tree crowding. Wood density is weight per unit volume at a specified moisture content.

Diameter class — Interval used to classify the diameters of trees in a stand, for example 1-inch classes, 2-inch classes, etc.

Diameter-limit — A cutting system where trees above a certain diameter are cut, and smaller ones are left. This system ignores the vigor and health of individual trees.

Diameter tape — A tape that reads directly in tree diameter when the tape is wrapped around the circumference of a tree. Assumes a perfect circle.

Dieback — Any condition where portions of a tree's crown dies due to conditions other than shading.

Dominant — A tree whose crown receives sun from the top and sides.

Dormant — A resting stage due to climatic or internal conditions when trees, buds, roots or seeds are not actively growing.

Early successional — Any association of plants and animals that are capable of surviving and reproducing under harsh environmental conditions. The first species to occupy an area after a major disturbance. Also known as "pioneers."

Even-aged — A stand of trees about the same age, within about 20 years. Also refers to silvicultural systems that create even-aged stands (e.g., the clearcutting system).

Forestry — The art and science of growing and managing forests and forest lands for the continuing use of their resources.

Forest type	A commonly associated group of species such as spruce-fir, white pine-hemlock, beech-birch-maple.
Form class	A measure of tree form or taper. For example, the Girard form class is the diameter inside bark at 17.3 feet above ground divided by the outside bark diameter at 4.5 feet.
Grade	Product value classification usually based on number and size of defects, and diameter and length of log.
Ground cover	The herbaceous and shrubby plants within 1 to 2 feet of the ground.
Group selection	Regeneration cutting system that removes trees in small groups about ¼ to ½ to 1 acre, and removes individual trees between groups. Perpetuates an uneven-aged stand.
Growing stock	The trees in a stand that have potential to produce salable products now or in the future. Excludes cull trees.
Growth	A general term referring to the increase in diameter, height, or volume of individual trees, or the increase in volume per acre of a stand.
Habitat	Any area that contains all resources essential to the survival of a wildlife population: food, water, cover, and space.
Hardpan or pan	Very firm subsoil that holds up water.
High grading	An exploitive logging practice that removes only the best, most accessible and marketable trees in the stand.
Improvement cutting	An intermediate treatment to improve the growth rate and vigor of residual trees.
Increment	The increase in diameter, basal area, height, volume, quality or value of trees in a stand.
Indicator plant	A plant, commonly herbaceous or shrubby, that indicates something about the site quality.
Intermediate cutting	Silvicultural cutting in an immature, even-aged stand. Examples are thinning and weeding.
Intolerant species	Plant species that are incapable of establishing in the shade of other trees.
Mast	The seed and fruit of a tree or shrub. Hard mast includes nuts, and soft mast includes catkins, berries and other fruits.
MBF	One thousand board feet.
Mean annual increment	Volume of an even-aged stand (plus any volumes harvested previously during the life of the stand) divided by stand age. The age at which mean annual increment is maximum is sometimes used as the best rotation age.
Mean stand diameter	The average diameter of a stand or the overstory trees in a stand. Sometimes used as a measure of stand development.

Merchantable	A standing tree that has a net value when processed and delivered to a mill or some other market, after all harvesting and transportation costs are considered.
Mid-successional	An association of plant and animal species that replace early successional species, but are eventually replace by climax species in the absence of disturbance.
Monoculture	Growing stands of trees of all the same species.
Mortality	Trees lost by death.
Old-growth	Maximum-aged, uncut stands of trees that show little or no evidence of human activity.
Overmature	A stand of trees that is older than normal rotation age for the type.
Parent material	Crushed up rock from the glacier or solid rock that the present day soils developed from.
Partial cutting	Any cutting that takes some and leaves some. It includes silvicultural operations more properly described as thinning, improvement cutting, single tree selection, etc.
Patch cutting	Small clearcuts. In the east, they may be ¼ to 1 acre or larger and not much different than group selection.
Pioneers	Shade-intolerant species, like aspen and paper birch, that are the first trees to invade freshly disturbed sites and abandoned fields.
Point sampling	Cruising with sample plots laid out with a device (prism, angle-gauge) that projects an angle from a center point. Trees larger than the sides of the angle are “in”, others are out.
Pole	Trees between about 5 to 10 inches diameter. Larger than a sapling; smaller than a sawtimber tree.
Precommercial thinning	An intermediate treatment in a young stand that does not yield any saleable products.
Prescription	A course of action to effect change in a forest stand.
Pruning	Removing the live or dead branches from the lower bole of a tree to improve quality.
Random	Taking a sample or locating a plot completely by chance.
Regeneration	New small trees that develop on an area after cutting. May come from seedlings already present on the area, newly germinating seeds, stump sprouts, or root sprouts.
Release	The freeing of well established cover trees, usually large seedlings or saplings, from closely surrounding growth.

Release cutting	Removal of competing trees, shrubs, or vines to (releasing) promote the growth of a desired plant species.
Residual	Trees that are left to grow in a stand following a silvicultural treatment.
Riparian zones	Floodplains, banks, and associated areas that border free-flowing or standing water.
Rotation	Years between regeneration of an even-aged stand and the final cut. Often as long as 80 to 120 years.
Salvage cutting	The removal of dead, dying, and damaged trees after a natural disaster to use the wood before it rots.
Sapling	Trees about 1 to 4 inches diameter.
Sapwood	Outer, lighter-colored, living and active portion of a tree bole.
Scarify	Mixing the humus and subsoil to encourage germination, establishment and early growth of a species.
Second growth	Loose term for younger stands that originated following complete or partial cutting. See old-growth.
Seedling	Small trees less than an inch in diameter.
Seed tree	The removal of most of the trees in one cut, leaving a few scattered trees of desired species to serve as a source of seed for the new even-aged stand.
Seed bed	The type of ground conditions existing for the germination and establishment of new regeneration.
Selection	Sometimes called single tree selection or (less acceptable) selective cutting. This is a silvicultural harvest in which mature and poor trees are cut, leaving a well-stocked stand of trees ranging in size and age.
Shade tolerance	The capacity of a tree to develop and grow in the shade of, and in competition with, other trees. An example of a highly shade-tolerant species is sugar maple.
Shelterwood	A silvicultural harvest cutting where a partial overstory of trees is left to shade the regeneration for awhile.
Silviculture	The art and science of growing forests for timber and other values.
Single tree selection	The removal of individual trees under uneven-aged regeneration methods.
Site	Soils and other factors that affect the growth, regeneration, and health of a species.
Site index	A method of evaluating site potential based on the height reached by a free-to-grow tree in 50 years.
Site preparation	An activity intended to make conditions favorable for planting or for the establishment of natural regeneration.

Snags Dead, standing trees. Snags are valuable to many wildlife species as sites for feeding and as sites in which to excavate or find cavities.

Slash Limbs and branches left after logging.

Snag Standing dead tree that has lost most of its branches.

Stand A group of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition as to be distinguishable from the forest or adjacent areas.

Stocking An indication of the number of trees in a stand as compared to the optimum number of trees to achieve some management objective, usually improved growth rates or timber values.

Strip cutting Cutting timber in strips that might range from 50 to 200 feet.

Stumpage The value of timber as it stands in the woods just before harvest (on the stump).

Succession The natural process by which early intolerant (see tolerance) species are replaced over time by more tolerant species.

Sustained yield An annual or periodic output of products from the forest without impairment of the productivity of the land.

Suppressed A tree that is overtopped by other trees.

Thinning In an immature even-aged stand not ready for final harvest, thinning is the removal of less valuable trees to make room for the valuable. It may be noncommercial (no products sold) or commercial (a regular sale).

Timber stand improvement (TSI) Activities conducted in young stands of timber to improve growth rate and form of the remaining trees.

Tolerance (shade tolerance) Classification of tree species according to their ability to survive in shade. Species are classed as tolerant, intermediate or intolerant.

Uneven-aged A stand of trees varying in age. Uneven-aged management refers to silvicultural approaches (e.g., selection cutting) that maintain uneven-aged stands.

Weeding Silvicultural operation in a young (sapling) stand to remove unwanted stems. The terms cleaning, weeding, release, precommercial thinning mean about the same thing although there are fine distinctions.

Yield table Tables showing how volumes, numbers of trees, and other stand characteristics change with age for a given forest type and site.

Sources:

Leak, B. 1993. Silvicultural Principles For New England Forest Types.

McEvoy, Thom J. 1993. Silviculture Handbook for Loggers. University of Vermont Extension System.

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