MANAGEMENT GUIDE FOR DEER WINTERING AREAS IN VERMONT

Vermont Department of Forests, Parks & Recreation
Vermont Department of Fish & Wildlife

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EQUAL OPPORTUNITY EMPLOYERS

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INTRODUCTION

The availability of quality wintering areas is the limiting factor for deer in most of Vermont. Since only about 6% of Vermont's land base is deer wintering area, the ability to recognize and manage these critical habitats is necessary to ensure the future well-being of the state's deer herd. Valuable yarding areas are lost each year to road construction, housing, and other forms of development. Additional threats are over-cutting of timber and pest outbreaks, such as spruce budworm. Each lost wintering area results in great pressure on the remaining areas of winter range.

Spruce-fir stands are the basic cover component of many wintering areas. However, some spruce-fir stands in Vermont cannot be managed for timber or deer cover by using existing silvicultural guidelines, because of Armillaria root rot. Some recommended cutting practices, such as shelterwood and single-tree selection, may actually accelerate tree decline and loss of cover under conditions favorable to the disease.

This guide is a supplement to existing silvicultural guides, for use in Vermont. It includes: 1) guidelines for managing deer wintering areas of all species, organized by timber type and 2) a prescription key for spruce-fir management, considering deer habitat, root rot, and timber production. Practices are recommended for perpetuating winter shelter and food for deer while assuring sustained production of wood products.

This management guide frequently cites silvicultural guides published by the USDA Forest Service. These guides and other forestry texts should be consulted for basic silvicultural and forest management principles.

Much is still unknown about Armillaria root rot. Some of the prescriptions in this guide are based on general observations and current understanding of the disease rather than research. Because of this, we have had to rely on the experience of many others in putting this guide together. We particularly wish to thank Robert M. Frank, Hewlette Crawford and Philip Wargo of the US Forest Service for their review and recommendations, and Cedric Alexander, James Horton, David Willard, Neil Monteith, and Gary Sabourin for their contributions based on experience in the spruce-fir region of northern Vermont. We would also like to thank Eric Goodenough of the Vermont Fish and Wildlife Department for his assistance with the design and printing of this booklet and Deborah Peloquin for her sketches of the spread of Armillaria root rot fungus.

DEER WINTERING AREAS

Deer in Vermont live near the northern limit of white-tailed deer range in eastern North America. This forces deer to use very specific winter habitat when severe climatic conditions become a threat to the animals' survival.

Areas which are used year after year by deer seeking winter shelter are called "wintering areas" or "deer yards." These areas consist of two basic habitat components. The "core range" is often characterized by concentrations of softwoods with high crown closure. This provides numerous thermal and microclimatic advantages to the deer such as reduced snow depths, less wind, increased daily mean temperatures, and increased relative humidity. South facing slopes are often preferred yarding areas because they receive more direct solar radiation. The second component consists of mixed hardwood and softwoods adjacent to or within the core range, which provide accessible browse.

Stand maturity, canopy closure, crown shape and height, species, slope, and aspect are all important factors that determine whether or not deer will overwinter in a particular area. For example, snow cover is often melted or blown off steep, south-facing slopes in southern Vermont, and deer may be found on these slopes even when very little softwood cover is available.

Identifying Wintering Areas

Physical evidence of use by deer is the best way to determine whether an area can be considered a wintering area. The most obvious indications of very recent deer use include tracks, trails and droppings. Other less obvious, though more reliable, indicators of deer wintering area are the more permanent signs of deer use on vegetation, such as browsing and bark scarring.

Heavily browsed seedlings and saplings have a deformed or broomy appearance. Photo: John Hall.

Physical evidence of deer wintering area use includes tracks, trails and droppings. Photo: John Hall.

Browsing on young, small diameter twigs and branches should be evident, even though the intensity of deer browsing may vary from site to site. Seedlings and saplings in heavily used areas have a deformed or "broomy" appearance. Bark scars from deer feeding can be visible to the trained eye for 20 years. Well-worn deer paths may also be evident.

Deer yard maps of currently known wintering areas are available from all town clerks, regional planning commissions, and at each Fish and Wildlife Department District Office.

In addition, upon request, a Wildlife Biologist can be available to meet with resource managers and interested private landowners for on-the-ground reconnaissance of suspect areas.

Wintering Area Management

The management goal for all wintering areas, regardless of species composition, is to prolong the useful life of the area by:

1) perpetuating shelter,

2) maintaining deer mobility and access throughout all non-regenerating segments of the wintering area,

3) providing preferred, accessible browse.

In the short term, any cutting of the softwood component reduces the winter shelter value and carrying capacity of the area. Any management plan for a deer wintering

area must be designed to provide a minimum of at least one-half (50%) of the entire wintering area to be in "functional shelter" at all times. Throughout this document, "functional shelter" is defined as softwood cover at least 35 feet tall, with at least 70% crown closure.

A deer's-eye view of a dense softwood canopy which intercepts snowfall and lessens cold winter wind chills. Photo: Cedric Alexander, Vermont Fish & Wildlife Department.

Area Regulation

To assure that at least 50 percent of the wintering area can provide functional shelter at all times, stands must be managed by area regulation. Area regulation is a highly disciplined management approach in which calculated acreages of regeneration and thinning occur on a fairly rigid timetable.

Area regulation produces a mosaic of stand conditions with a variety of winter shelter values. Stands or patches currently under treatment offer no shelter, while other recently-cut areas are supporting saplings which afford little shelter.

Whether the management is described as even-age or uneven-age, the area of regeneration in each stand treatment is calculated using the following formula:

$$\frac{\text{CUTTING INTERVAL}}{\text{ROTATION AGE}} = \text{amount of area to be regenerated}$$

Example: In a stand on an 80-year rotation, and treatment scheduled every 15 years, 15/80 (19%) of the stand should be regenerated during each treatment.

If the area actually regenerated exceeds the theoretical target, the wintering area will never reach maturity, the size of individual regeneration clearings may be so large that undesirable regeneration becomes established, and the area capable of affording functional winter shelter is reduced.

If the regenerated area falls short of the target, the acreage providing functional winter shelter is maintained; however, a portion of the stand will become overmature, and total acreage regenerated may be smaller than required to secure adequate regeneration for future shelter.

Regeneration, including sapling stands or patches adjacent to functional shelter should be incorporated into the overall wintering area as desirable age-class diversity, and managed to provide shelter in the future.

Preferably, no more than half of the wintering area should be treated at any one time, with the remainder treated half a cutting interval later. This option is very workable when access and stand operability permit frequent small sales, or when the wintering area is located so that portions can be treated along with scheduled entries in adjacent stands. Frequent entries with small treated acreages reduce the area of deer shelter that is disturbed, and create a more sustained supply of browse.

Travel Lanes

Travel lanes should be designed into each cutting plan to ensure uninterrupted deer mobility and access by deer throughout the wintering area. Generally, a lane of unbroken, dense softwood cover at least 200 feet wide is recommended. Travel lanes located along streams offer the greatest shelter, and serve a dual role as a water quality buffer against harvest operations. Depending on stand and site conditions and deer-use patterns, travel lanes can be permanently established or relocated as needed within a wintering area. Permanent travel lanes should be regarded as a separate stand, and managed very lightly so as to preserve maximum shelter value at all times.

MANAGEMENT GUIDELINES FOR THE CORE RANGE

Spruce-Fir

Spruce-fir wintering areas can be managed using either uneven- or even-age techniques, depending on the size of the area. Uneven-age cutting practices generally preserve the greatest amount of contiguous winter shelter, and are strongly recommended for all wintering areas. In small wintering areas, especially those under 200 acres, uneven-age management is the only viable option for maintaining the shelter. Even-age regeneration techniques (clearcutting or shelterwood) should be confined to large wintering areas where the untreated portion is large enough to provide the required acreage of functional shelter.

Primary spruce-fir site. Photo: Gary Salmon, Vermont Forests, Parks & Recreation Dept.

Secondary spruce-fir site. Photo: Gary Salmon.

Management to prevent losses from Armillaria root rot must be considered, especially where trees are growing slowly on secondary spruce-fir sites. Primary and secondary sites are defined as follows:

	PRIMARY	SECONDARY
Terrain:	Flat to gently sloping	Gentle slopes, rolling, to side hill
Topography:	Valley bottom, toe of slope, high plateau	Upper slopes, ridges, foothills
Soils:	Silts, loams, high in organic matter, shallow to hardpan, stone-free	Sands, gravels, tillable, shallow to bedrock, stoney to very rocky
Drainage:	Poorly drained	Moderately well-drained or better
Previous Uses:	Always forested, not used for agriculture w/motorized equipment	Upland forests, abandoned agricultural lands
Tree Species:	Fir, spruce, tamarack, occasional red maple, yellow birch	Spruce, fir, red maple, yellow birch, white birch, other hardwoods

Armillaria on Spruce-Fir

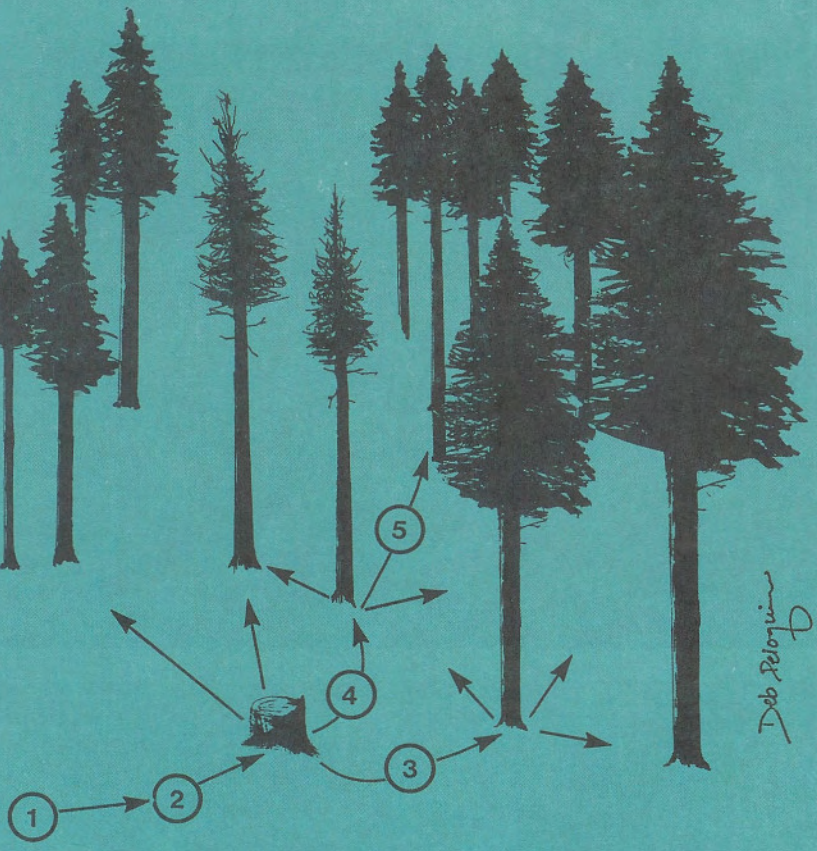
The Armillaria root rot fungus (probably *Armillaria ostoyae* on conifers) infects woody roots of stressed trees and decays recently dead wood. The result of infection depends on the tree's species and ability to compartmentalize the fungus (see table 1).

Table 1. Tree Response to Armillaria

Tree Condition	Armillaria in the soil will:	Tree will:	Probable Result:
Healthy ↓	Not successfully invade roots	Resist infection	Tree remains healthy
	Infect some roots	Compartmentalize infections	No symptoms. Fungus has a toehold in the root system if tree is stressed again.
	Infect many roots	Compartmentalize infections	Root blockage by fungus and host response leads to dieback.
Very Weak	Infect many roots	Not successfully compartmentalize infections	Fungus colonizes major roots and root collar. Tree dies.

Crown of spruce tree infected with Armillaria. Photo: Gary Salmon.

Figure 1 How Disease Centers Develop



(1) Armillaria is generally present on decaying woody material and in the soil.

(2) Armillaria colonizes fresh stumps or dead trees and builds up on these food bases.

(3) Rhizomorphs spread from food bases and infect roots of nearby trees.

(4) If they are stressed or stagnant, infected trees will decline.

(5) Dying trees become food bases and means for spread to additional trees.

Armillaria disease center. Photo: Barbara Burns, Vermont Forests, Parks & Recreation Dept.

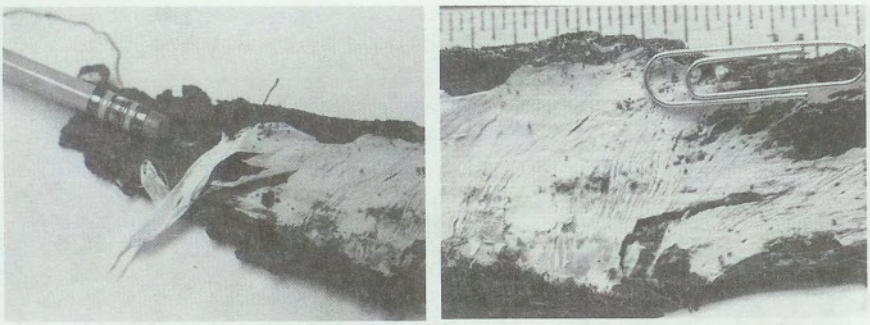
Trees affected by Armillaria first show symptoms in the upper crown. The leader and outside lateral shoots die first. If the tree is not able to recover, branches will die from the top down and from the outside in. Sometimes the root-collar area will become resin soaked. The leathery white "mycelial fans" of the fungus may be found under the bark of roots or at the root collar, especially on recently killed trees. Because Armillaria is a root and butt rotter, some infected trees may snap before symptoms appear. Dieback and mortality are most common on infected red spruce; root and butt rot are more common on balsam fir.

Armillaria is widely distributed in hardwood and softwood forests. It builds up in recently dead root systems. From these "food bases", dark shoestring-like structures, called "rhizomorphs," grow through the soil to susceptible roots of nearby trees. Rhizomorphs are long black, sometimes brittle, strands, which are white on the inside. Trees within 15 feet of food bases are most likely to be infected. Pockets of infected trees, or "disease centers," can develop as Armillaria spreads radially from tree to tree via root contact and rhizomorph growth. (Figure 1.)

Identifying Armillaria To determine whether Armillaria is present in a pole- or sawtimber-sized stand, examine recently dead trees for the white mycelial fans under the bark at the root collar and the black shoestring-like rhizomorphs on the surface of the root. The most reliable indicators are trees which have been dead 1-2 years. At least five trees should be examined.

Not all white fungi under the bark are Armillaria. Look for the distinct fan shape, (like a gingko leaf) which may leave an imprint in the inner bark after the fungus is no longer visible. Armillaria is never cottony, and does not show up as flecks. It can be peeled off in a thin, leathery sheet.

In recently regenerated stands, Armillaria is a concern if the disease was a problem in the previous stand. Otherwise, examine stumps and surrounding soil for the presence of rhizomorphs. They may be round or flat in cross section. Examine at least five stumps to determine whether Armillaria is a problem.



Mycelial fans. Note the leathery texture and fan-shaped pattern of venation. Photo: Gary Salmon.

Management to Reduce Mortality The likelihood of an Armillaria problem is highest when stands are overstocked. These trees are stagnant and resist infection poorly. Their intertwined root systems facilitate disease spread. Armillaria can be held in check if dense areas are thinned frequently and stocking is controlled, beginning early in the rotation.

Disease hazard is higher in stands with recently dead trees or fresh stumps. Hardwood stumps and stumps of dormant trees are good food bases because they have higher carbohydrate levels. Hardwood stumps are also more decay resistant and act as food bases for longer periods of time. Reducing the hardwood component early in stand development helps reduce the build-up of Armillaria.

Planting in recently cut stands may cause additional Armillaria problems. Planted trees often have distorted root systems which are vulnerable to infection. When many fresh stumps are present the chances for infection are increased. Armillaria should be allowed to "run its course" on the stumps by waiting 5 to 10 years after cutting before planting in an area where the disease was present. Natural regeneration is generally resistant to infection.

Armillaria spread can probably be reduced by creating a root-free barrier zone around root-rot centers. This method has been tested in western conifers, but not in northeastern spruce-fir. Trees are pushed over, or stumps are uprooted after cutting. The treatment should be most effective in uniform stands, with light or shallow soils, and where disease centers are well defined. To create a barrier zone, clear two codominants between the outermost infected tree and the reserve stand, or establish a root-free zone 15-20 feet wide around a disease center.

Maintaining Shelter in Diseased Stands Mortality leaves breaks in the canopy which reduce the area of functional shelter. To ensure that half the wintering area remains functional, the acreage to be regenerated during a stand entry must include the area lost to mortality. If a calculated allowable cut is added to mortality, the cumulative effect is the same as over-cutting.

If a deer wintering area has mortality, and stand deterioration is expected, the first priority must be to maintain adequate functional shelter. Prolonging available shelter for as long as possible may lead to a "no-cut" prescription in the short term, or a prescription limited to salvaging in disease centers.

If area-regulation calculations allow cutting, it should be focused on the disease centers. The calculated allowable cut must be reduced in anticipation of further losses to Armillaria. In group selection cuts this could mean reducing the number of

groups, or reducing maximum group size. Where large-acreage cuts are allowable, and regeneration is present, it may be possible to liquidate diseased stands.

Sometimes mortality has progressed so far that functional shelter cannot be perpetuated. The land manager is encouraged, at this point, to shift the focus of management talents and energies to the new stand, rather than actively preserving the decadent stand at hand.

Integrated Management of Other Pests

In addition to root rot, significant pests of spruce-fir include spruce budworm, balsam woolly adelgid, decay, and bark beetles. In deer wintering areas, mortality from these pests leads to loss of cover and conversion to hardwoods. These losses can be reduced through treatments which maintain stand vigor such as early spacing, regular thinning and eliminating hardwood competition.

The risk of spruce budworm or balsam woolly adelgid damage can also be reduced by discriminating against balsam fir, if this can be done without disrupting current cover or reducing stocking so much that future cover is inadequate. Less susceptible species, such as spruce, hemlock, and cedar, are also longer-lived than fir, prolonging the life of the wintering area. Where over half the basal area is in fir, short rotations and breaks in stand continuity (groups, patches or strips consistent with area regulation) also reduce losses from these insects. If insect outbreaks occur, bacterial or chemical insecticides may prevent tree mortality.

Uneven-age Management

Uneven-age management by area regulation is the best method of wintering area management. Group selection is preferred over single-tree selection. Single-tree selection may reduce shelter value because more of the canopy may be interrupted. It may also leave more residual stand damage and Armillaria food bases throughout the operated area. Group selection, however, may leave more of the area undisturbed. Maturity ages should range from 60 years (for predominantly fir stands) to 80-100 years (for predominately spruce stands).

Uneven-age spruce-fir stand. Photo: Gary Salmon.

Group Selection No more than half of a wintering area should be scheduled for treatment at one time, unless the area is so small that it cannot be subdivided. Group selection openings should be 20 to 40 feet in diameter and uniformly distributed. These small patches will be heavily shaded, favoring spruce-fir regeneration.

Enter the stand every 10 to 20 years and distribute openings evenly. Harvesting should favor spruces, cedar, and hemlock, if present. These species are longer-lived, more windfirm, and more resistant to spruce budworm injury than fir. Whenever possible, summer logging is preferred, because scarification favors spruce regeneration. Winter logging should only occur on sites and terrain that will not support bare ground disturbance.

Those segments of the stand not slated for group selection removal should be evaluated for thinning or release (see page 14). Thinnings in patches of larger poles or sawtimber should not occur, for these groups are the basis for winter shelter. Spacing in patches of regeneration and pre-commercial thinnings in patches of saplings or small poles is especially valuable. These treatments promote crown development on young trees leading to earlier development of functional shelter as well as rapid stem growth.

Observations suggest that Armillaria damage should be suspected in stands on secondary sites. These stands usually include a hardwood component. If a site is undisturbed, Armillaria will slowly spread radially from a food base or disease center. However, when patches are made, Armillaria may build up more rapidly in the new hardwood stumps, and invade additional trees on the perimeter.

If Armillaria disease centers are present, the cut patches should be focused on them. However, this may accelerate the spread of the disease. A long narrow patch has less perimeter than several small circular patches of the same area. A pattern of long patches oriented east-west should reduce the potential loss from spread. The narrow configuration would favor softwood regeneration. As noted previously, extensive Armillaria mortality may point to a no-cut prescription in the short-term followed by intensive management in the next stand.

Even-age Management

Even-age management is acceptable in wintering areas larger than 200 acres due to ease of timber sale layout and economics of harvest. An area regulation plan should be established with rotations and cutting intervals specified. Shelterwood systems are preferred, except in stagnant stands on secondary sites, because they are a reliable regeneration method. Clearcutting is acceptable only as a means of quickly regenerating a mature and nearly pure stand of balsam fir or on secondary sites where Armillaria is a problem. Clearcutting is offered as the least-preferred alternative in a wintering area, but one which may be necessary.

Shelterwood System Regenerate spruce-fir using a two- or three- stage shelterwood system.

Shelterwood treatments on secondary sites present a unique challenge. The partial shade favors spruce-fir regeneration. However, the spacing of stumps after a shelterwood treatment may be conducive to the spread of Armillaria into residual trees. This suggests that a stand on a secondary site may not hold together long enough for a three-stage treatment.

Under the two-stage shelterwood system, the first entry should result in the removal of 30-35 percent of the basal area. This includes submerchantable hardwood down to l-inch dbh. Favor longer-lived species such as spruce, cedar, and hemlock. Cut from below to remove low shade. Leave the larger and more vigorous trees to

Spruce shelterwood. Photo: Gary Salmon.

provide seed and shade. Late summer logging is preferred to prepare a seedbed for spruce regeneration and to reduce residual stand damage during this bark-tight period. The second or final removal should occur after adequate regeneration is established and usually no sooner than five years after the first entry. Winter logging is recommended for the final removal in order to protect regeneration.

On primary sites, if the risk of windthrow is high or the acreage of functional shelter is extremely limited, a three-stage shelterwood system may be used. Remove 20 percent of basal area during the first entry and another 20 percent during the second entry 5 to 10 years later. In this way, protective cover is maintained through the first stage. Remove the overstory when adequate regeneration is established. Winter logging may be required for the final removal operation especially if regeneration is marginal.

Caution! Aspen coppice growth is severe competition for spruce and fir regeneration. Because shade is necessary to retard sprouting, it follows that aspen removals should occur in the first cut. However, the retained overstory may not be dense enough to retard fairly vigorous sprouting. If aspen removal is postponed until the final entry, the coppice growth is assured to be very vigorous, and may overtop the spruce and fir regeneration in the first year of sprouting. Complete abstention from aspen removal may be the best way to minimize its presence in future stands.

Strip Shelterwood In stands over 60-years old with at least 70% balsam fir, or where the uniform shelterwood system is inappropriate, strip shelterwood can be used to quickly regenerate the allowable acreage. Once regenerated, the stand can be managed by uneven-age group selection, or even-age shelterwood.

Between 25 and 40 percent of the area to be regenerated should be removed in the first cut. The remainder should be removed when adequate regeneration is 1-2 feet tall in the residual strips. Cut strips should be 20 to 40 feet wide, and leave strips 40 feet to 80 feet wide. Orientation should be east-west to northeast-southwest, depending on windthrow hazard.

Bare-ground logging is preferred in the initial cut to prepare a seedbed for spruce regeneration. Winter logging is recommended for the removal of residual strips where snow will protect regeneration. This treatment is essentially a two-strip shelterwood cut.

Clearcutting Clearcutting is an acceptable practice only when well-established regeneration is present. The clearcut acreage must meet area regulation calculations. Log in winter when snow offers protection to the established seedlings.

Thinning The rule of thumb is to thin early, or don't thin at all.

Even-age stands or patches of spruce and fir regeneration in uneven-age stands should be thinned before they reach 15 feet high, or a 2-inch mean stand diameter (MSD). This increases the softwood component, prolongs the life of the stand, and prevents growth losses and mortality from stand stagnation.

Because a closed canopy is needed for winter shelter, repeated thinnings in a particular patch, group, or stand are discouraged. Thinnings should not be so restrained, however, that stagnation occurs. Thinnings should occur early in the rotation when tree and crown sizes are insufficient for winter shelter. These early thinnings should be heavy or at least frequent enough so that a thinning will not be essential in the last half of the rotation.

For example, in a management program featuring a 15-20 year operating interval, and long rotation (80+ years), the stand would be spaced to 700-800 stems per acre at age 15 or 20 and thinned to 400 stems per acre at age 30-35. This stand would then be left alone for the remainder of the rotation.

With a shorter rotation, such as 60 years, two early thinnings may not be practical. A single pre-commercial thinning to 400 trees per acre would create a stand that probably would not stagnate before rotation age.

In an area regulation program, the amount of acreage which provides functional shelter and the length of time a particular stand/group/ patch affords functional shelter are interdependent. If at least half of the acreage is to provide functional shelter, thinnings must be conducted so that crown closure (70%) is recovered before one half of the rotation age has been reached.

Thinning a young stand to 400 stems/acre is preferred over thinning it to B-level stocking. At 400 stems/acre a stand will be at B-level when MSD is 6 inches, and will not become overstocked until 11 inches MSD. This stand approaches functional shelter (35 feet high, 70% crown closure) at 30 years of age, and will afford shelter for the rest of the rotation without becoming stagnant. It will be scheduled for regeneration at about the time stagnation becomes a concern.

Stands that are stagnant and of low vigor may deteriorate rapidly if thinned. Stands should be considered stagnant if: live-crown ratio is less than 30%; growth is slower than 15 rings per inch; symptoms of Armillaria, red rot (indicated by pitchy nodes) or brown cubical rot are widespread. Within the parameters of an area regulation plan, stagnant stands should be scheduled for regeneration. Stagnant stands should not be thinned.

Hardwood Competition

Hardwood removal in spruce-fir has multiple benefits. By increasing the softwood component, future cover is improved. Repeated hardwood cuttings may also assure a supply of browse. Hardwoods in the main canopy are beyond the reach of deer. Their removal stimulates regeneration, including stump sprouts, which is available for browse.

Hardwood removal in regeneration also has the dual benefit of preventing the development of Armillaria by eliminating potential food bases, as well as enhancing softwood vigor. In a vigorous stand, several hardwood removals will reduce the number of large hardwood stumps which could pose an Armillaria threat in the future.

If the initial entry into a wintering area is in a low-vigor stand with a pole-sawtimber sized hardwood component, the prescription must recognize the high risk for losses to Armillaria.

Guiding Principles of Spruce-Fir Wintering Area Management

- Use area regulation to schedule regeneration, allowing for mortality, to ensure a sustained supply of functional cover.
- Anywhere trees aren't stagnant, eliminate hardwoods to improve cover, produce browse, and maintain tree health.
- Outside of the 50% functional cover acreage, thin vigorous stands early and often to enhance cover longevity. Maintain stocking that will allow 70% crown closure by one half the rotation age.

Silvicultural Prescriptions for Spruce-Fir in Vermont

This section includes a key for spruce-fir wintering area management and for spruce-fir timber management outside of wintering areas where Armillaria may be a concern. The prescriptions are based on and should be used as a supplement to *A Silvicultural Guide for Spruce-Fir in the Northeast.*

Silvicultural prescriptions can be made only after evaluating a stand and determining management objectives. When using this key, the manager must assess site quality, stand structure, size, and vigor. Guidelines for identifying deer wintering areas (page 1), for determining whether or not Armillaria is present (page 9), for distinguishing between primary and secondary sites (page 6), and for identifying stagnant stands are described elsewhere. Other criteria used in the key are based on the silvicultural guide.

Based on the silvicultural guide, adequate stocking of stands, patches or groups is defined according to tree size. For stands 4.5 inches MSD, use the stocking guide (Figure 2). Regeneration under mature stands is adequate if at least 50% of milacre sample plots have at least one spruce or fir stem. Sapling-sized stands (0.5-4.5 inches MSD) are considered to be adequately stocked if at least 50% of milacre plots have at least two spruce-fir trees 0.5-1.5 inches in diameter, or at least one spruce-fir tree 1.5-4.5 inches in diameter. In reproduction stands (0.5 inches MSD), a stocked plot must have at least two spruce or fir trees.

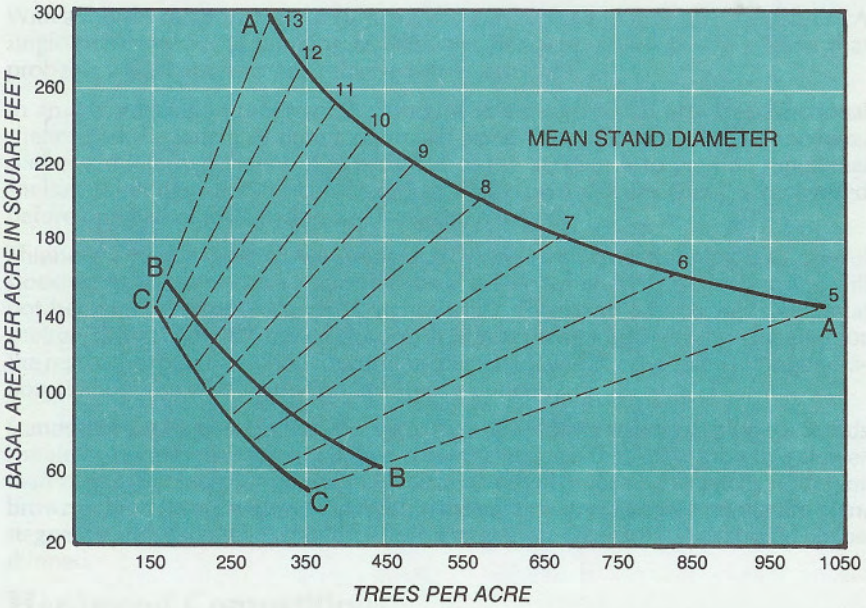
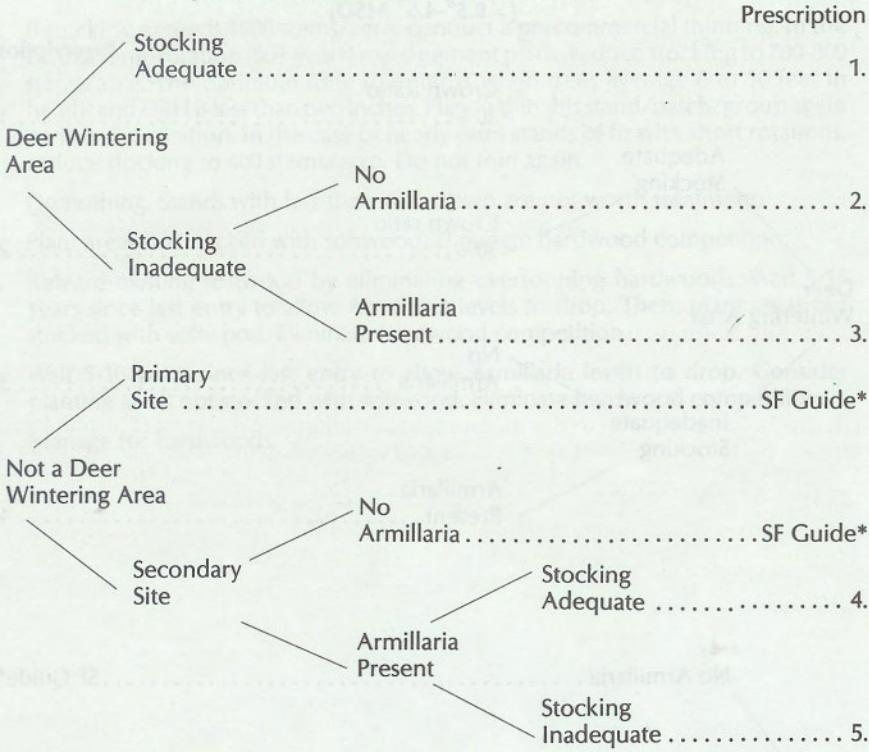


Figure 2—Growing-stock guide for even-aged spruce-fir, based on the number of trees in the main canopy, average diameter, and basal area per acre. The area above the A-level represents overstocked stand conditions. Stands between the A-and B-levels are adequately stocked. Stands between the B- and C-levels should be adequately stocked within 10 years or less. Stands below the C-level are understocked. Source: USDA Forest Service.

Reproduction Stands (< 0.5" Mean Stand Diameter)



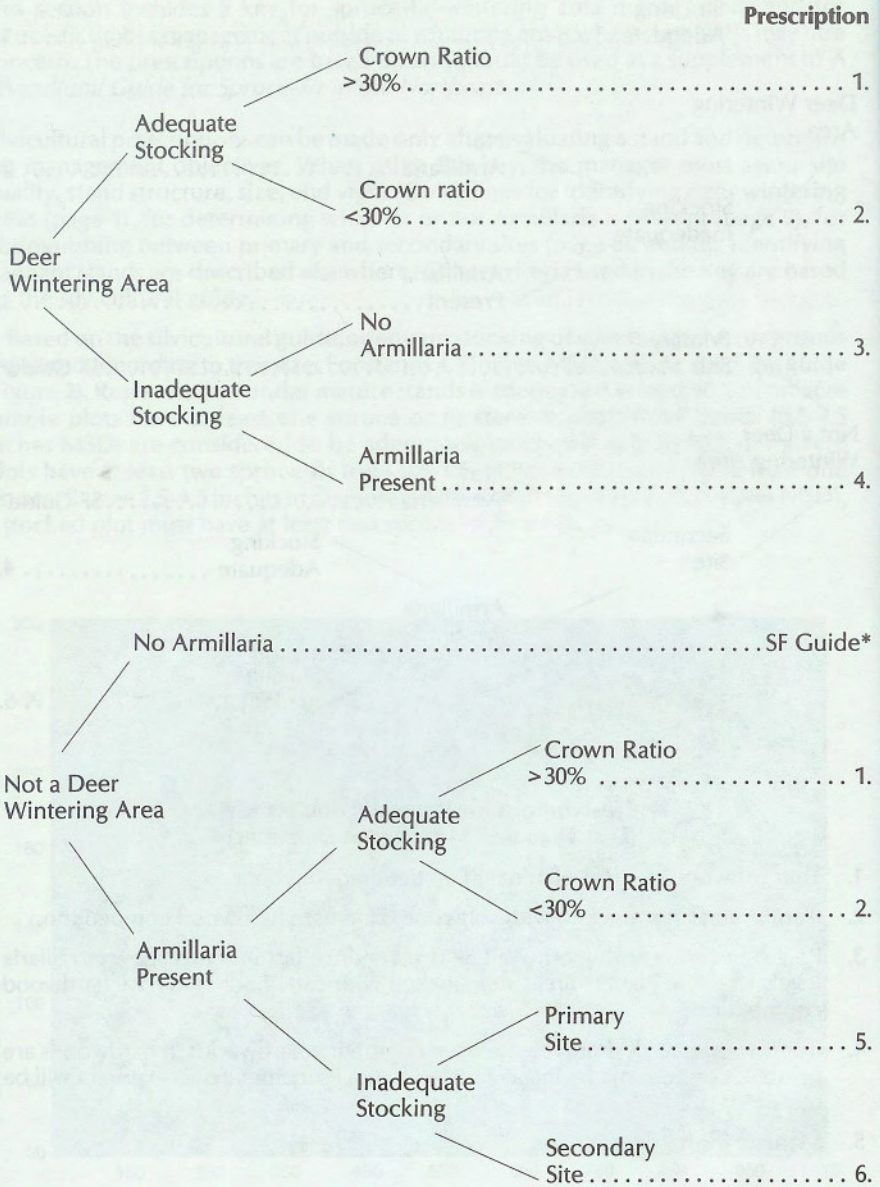
Prescriptions for Reproduction Stands (Less Than 0.5" Mean Stand Diameter)

1. Thin softwoods and/or eliminate competing hardwoods.
2. Plant** areas not stocked with softwood. Eliminate hardwood competition.
3. Release existing softwood. Wait 5-10 years since last entry to allow Armillaria levels to drop. Plant** areas not stocked with softwood. Eliminate hardwood competition.
4. If softwoods are desired, release from competing hardwoods. If hardwoods are present, consider managing as a mixed stand. Precommercial treatment will be required.
5. Manage for hardwood.

* SF Guide - refer to *A Silvicultural Guide for Spruce-Fir in the Northeast* by Robert M. Frank and John C. Bjorkbom, USDA Forest Service General Technical Report NE-6, 1973.

** Planting stock should be white, red, or black spruce due to budworm resistance. Genetically improved stock is recommended. Do not plant fir. Spacing of 8' x 8' is 680 trees per acre.

Sapling Stands
(> 0.5"-4.5" MSD)

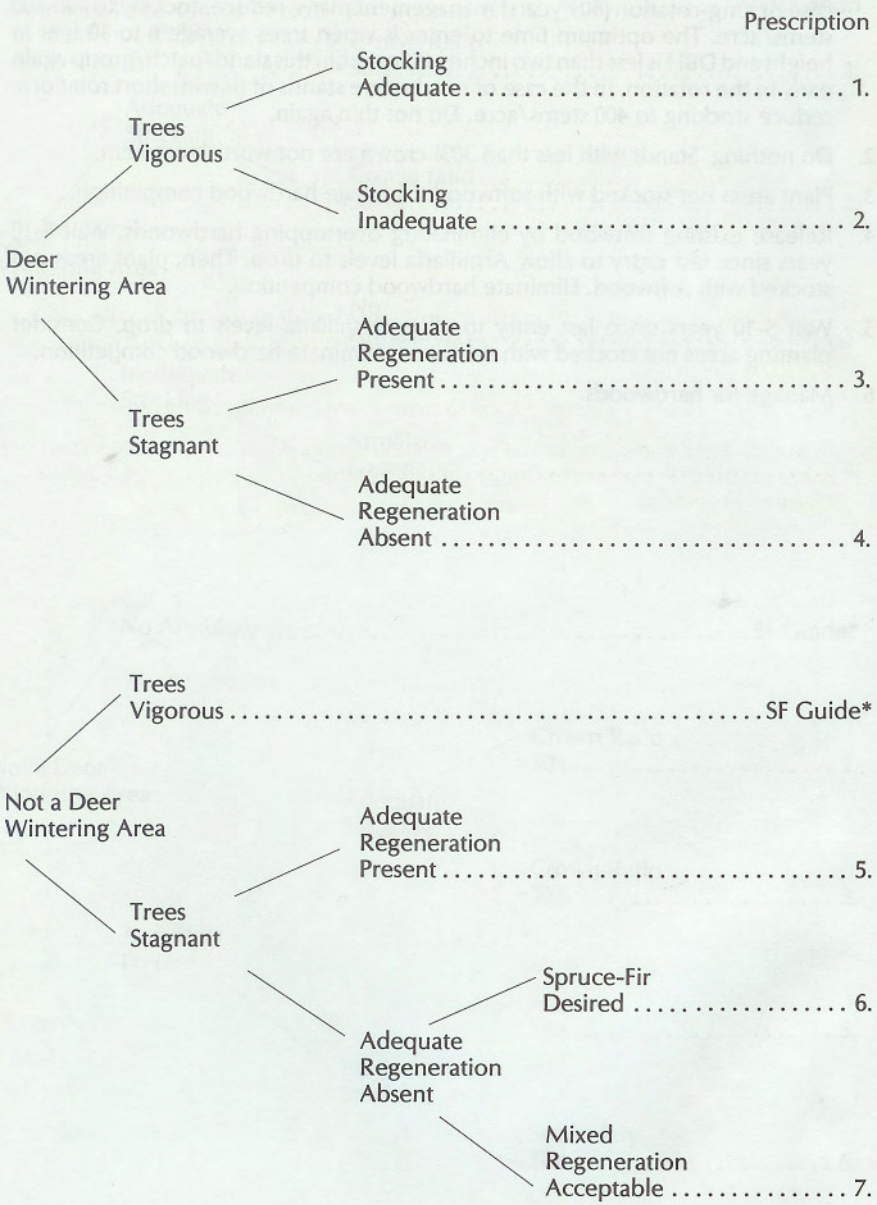


* SF Guide - refer to *A Silvicultural Guide for Spruce-Fir in the Northeast* by Robert M. Frank and John C. Bjorkbom, USDA Forest Servic General Technical Report NE-6, 1973.

Prescriptions for Sapling Stands (0.5"-4.5" Mean Stand Diameter)

1. If stocking exceeds 1000 stems/acre, conduct a precommercial thinning. In the case of long-rotation (80+ years) management plans, reduce stocking to 700-800 stems/acre. The optimum time to enter is when trees average 6 to 10 feet in height and DBH is less than two inches. Plan to thin this stand/patch/group again early in the rotation. In the case of nearly pure stands of fir with short rotations, reduce stocking to 400 stems/acre. Do not thin again.
2. Do nothing. Stands with less than 30% crown are not worth treatment.
3. Plant areas not stocked with softwood. Eliminate hardwood competition.
4. Release existing softwood by eliminating overtopping hardwoods. Wait 5-10 years since last entry to allow Armillaria levels to drop. Then, plant areas not stocked with softwood. Eliminate hardwood competition.
5. Wait 5-10 years since last entry to allow Armillaria levels to drop. Consider planting areas not stocked with softwood. Eliminate hardwood competition.
6. Manage for hardwoods.

Pole/Immature Stands
(4.5"-8.5" MSD)

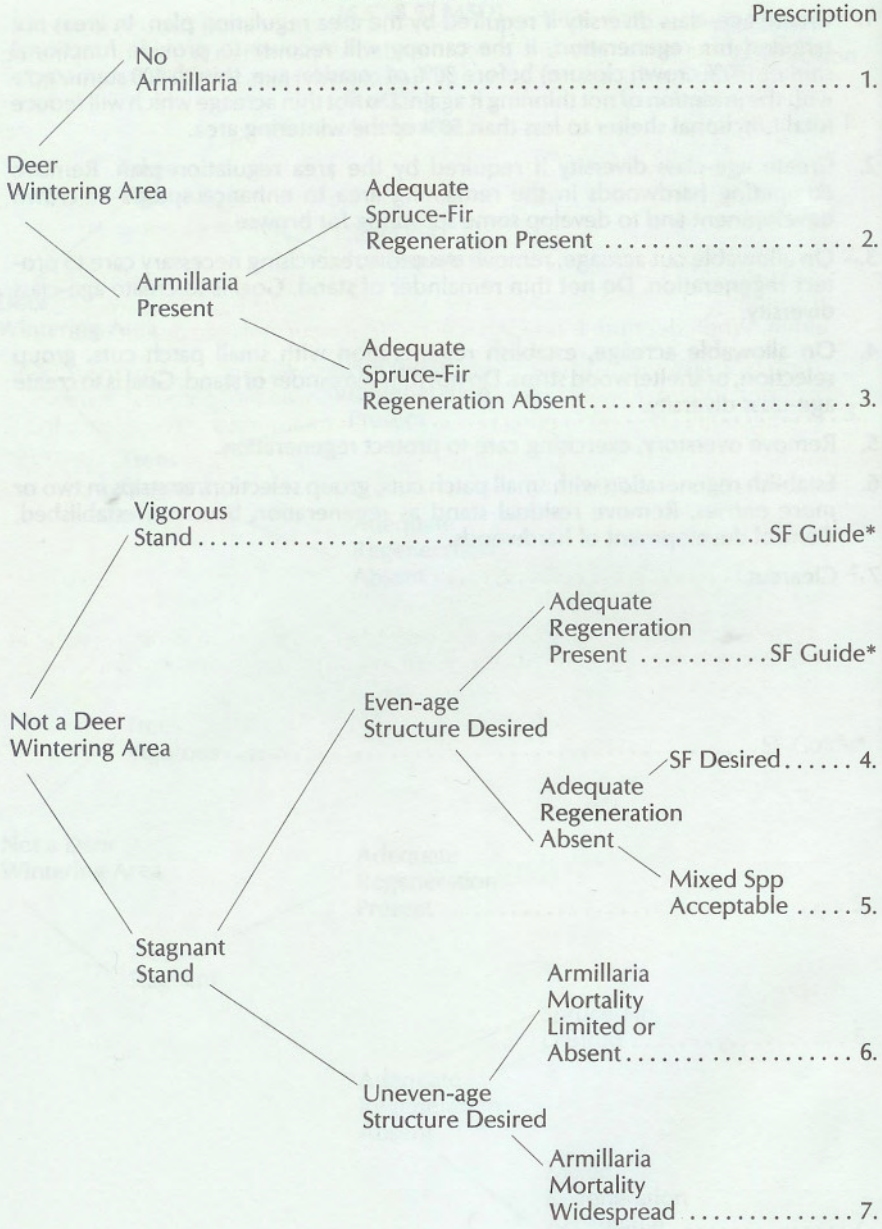


* SF Guide - refer to *A Silvicultural Guide For Spruce-Fir in the Northeast* by Robert M. Frank and John C. Bjorkbom, USDA Forest Service General Technical Report NE-6, 1973.

Prescriptions for Pole/Immature Stands

1. Create age-class diversity if required by the area regulation plan. In areas not targeted for regeneration, if the canopy will recover to provide functional shelter (70% crown closure) before 50% of rotation age, thin to 400 stems/acre with the intention of not thinning it again. Do not thin acreage which will reduce total functional shelter to less than 50% of the wintering area.
2. Create age-class diversity if required by the area regulation plan. Remove competing hardwoods in the remaining area to enhance spruce-fir crown development and to develop some sprouting for browse.
3. On allowable cut acreage, remove overstory, exercising necessary care to protect regeneration. Do not thin remainder of stand. Goal is to create age-class diversity.
4. On allowable acreage, establish regeneration with small patch cuts, group selection, or shelterwood strips. Do not thin remainder of stand. Goal is to create age-class diversity.
5. Remove overstory, exercising care to protect regeneration.
6. Establish regeneration with small patch cuts, group selection, or strips in two or more entries. Remove residual stand as regeneration becomes established. Control development of hardwoods.
7. Clearcut.

Mature/Sawlog Stands (> 8.5" MSD)



* SF Guide - refer to *A Silvicultural Guide For Spruce-Fir in the Northeast* by Robert M. Frank and John C. Bjorkbom, USDA Forest Service General Technical Report NE-6, 1973.

Prescriptions for Sawlog/Mature Stands

1. Create age-class diversity within area regulation guidelines. Group selection or shelterwood treatments are recommended depending on size of wintering area. Scarify if regeneration is absent. Release advance softwood regeneration. Eliminate hardwoods.
2. If area regulation permits cutting, perform group selection with groups focused on disease centers. Allowable-cut calculations must include areas currently affected by Armillaria mortality. Reduce actual acreage treated in anticipation of additional mortality. In the case of even-age management in a large wintering area, locate clearcuts or strip cuts to include the disease centers. Harvest on deep snow to protect advance regeneration. If area regulation indicates that cutting this stand will reduce winter shelter below 50% of the wintering area, leave it alone. When deer use is no longer evident, conduct salvage operations.
3. Same as 2, however, site scarification must be included in the harvest operation. Size and orientation of operations must acknowledge potential hardwood regeneration. Summer logging or post-harvest treatment are recommended.
4. Regenerate using strips or small patches covering 30-50% of the area. When regeneration is established under the residual stand remove the overstory.
5. Clearcut.
6. Group selection focused on disease centers if present. Protect advance regeneration or scarify if regeneration is absent.
7. Uneven-age structure cannot be established in this stand. Regenerate stand as effectively as possible and create uneven-age structure in the next stand.

Hemlock

Hemlock stand. Photo: Russell Reay, Vermont Forests, Parks & Recreation Department.

Hemlock provides superior cover and is the basic component of many wintering areas in central and southern Vermont. It is highly preferred browse and can be difficult to regenerate. Hemlock should be managed under an area-regulation

system using rotations no shorter than 100 years, and 10-20 year operating intervals. Longer rotations are preferred because they provide superior cover for long periods. Long rotations reduce the area being regenerated at any one time, and they lower the risk of unsuccessful regeneration.

Hemlock is extremely long-lived (up to 600 years) indicating that, under some conditions, a no-cut decision is appropriate for a hemlock wintering area. Examples include very small wintering areas where tree removal will destroy the shelter value of the canopy, stands with a high percentage of very large or poor quality stems where a commercial operation will lead to stand degradation, or where conditions suggest that hemlock regeneration will be unsuccessful. In such cases, the landowner, forester, and a wildlife biologist should evaluate the wintering area and surrounding acreage to determine how timber can be removed without undue impact on the cover.

Uneven-age Management

Pure hemlock stands of more than a few acres are rare. Most hemlock stands are irregular in structure, size, and composition. This makes even- or uneven-age guidelines difficult to apply uniformly. In wintering areas, however, this irregularity is a distinct asset.

The silvicultural needs and winter shelter opportunities of the various patches or pockets within a stand are easily recognized by foresters and biologists. Without losing track of the overriding objectives (dense crown closure, travel lanes, and maximum area of shelter), the management of an irregular stand includes releasing regeneration and overtopped understory, thinning poles and small sawtimber, and harvesting large sawtimber to stimulate regeneration. When these distinctly even-age practices are applied to many small, homogeneous patches by area regulation, uneven-age structure results.

Treatment should occur every 10-20 years based on site quality and accessibility. At each entry understory hemlock should be released and thinned so that it will afford shelter when mature cover trees are harvested (see thinning recommendations below). Mature patches which are scheduled for regeneration should be cut in small groups. Total area of these groups should meet area regulation calculations. Openings in the canopy should be no larger than one-half the height of dominant trees. Residual basal areas of retained cover should be no lower than B-level, as shown on the stocking guide in figure 3.

Hemlock seedlings are particularly vulnerable to moisture stress. Scarification allows the seedling roots to reach mineral soil quickly without penetrating a thick duff layer. High basal area and heavy shade also prevent seedling dessication.

Single tree selection is not recommended for hemlock wintering areas. The residual basal area needed to maintain effective winter shelter is too high to maintain vigor in the lower crown classes. Further, the small openings from selection cuts do not stimulate enough regeneration to withstand even light browsing pressure.

Even-age Management

Even-age management is appropriate in large hemlock stands lacking the diversity described above, or where browsing pressure is so heavy that dense regeneration is needed to assure that some seedlings will survive.

The acreage to be treated should meet area regulation calculations. Operating intervals should be 10-20 years.

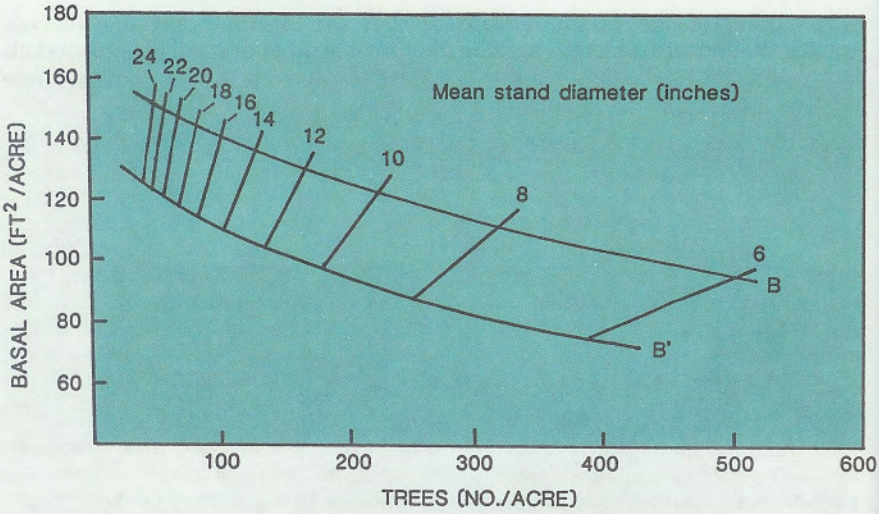


Figure 3. Residual stocking levels (B and B' levels) for even-aged hemlock stands based on number of trees, mean stand diameter, and basal area per acre. B level represents minimum residual stocking of stands with 30% or more hemlock initially. B' level applied to stands with 15 to 29% hemlock. (In mixed stands, the percentage of hemlock is based on a comparison of hardwood stems in the main crown canopy and *the hemlock 6 inches DBH and larger in the overstory and understory positions.)*
Source: USDA Forest Service.

***Authors' note:* In deer wintering areas use only the B-line as a guide to residual stocking. The B'-line is for stands with less than 30% hemlock which would not provide functional shelter.**

Weber (1986) and Lancaster (1985) both describe two- or three-stage shelterwoods as the best means of establishing hemlock regeneration when none exists. During the first stage, remove trees from the lower crown classes. Discriminate against hardwoods, especially maples. Up to 30% of the residual basal area can be retained in mast producers (oak, hickory, beech). The residual stand should be fully stocked with dominants and co-dominants (B-level stocking, 70% crown closure). Scarification is absolutely necessary.

The second stage should occur after 8-12 years or when regeneration is 3-4 feet tall. Adequate hemlock regeneration is 5000 seedlings/acre or 1000 saplings/acre. Reduce crown cover to 50%. The thin canopy will help to reduce winds in nearby functional shelter. This cut should occur on deep snow to protect regeneration and should remove any hardwood regeneration. If no hemlock regeneration is present after the first cut, re-scarify. *Do not make the second cut until adequate regeneration is in place.*

When regeneration is well-established (5-10 feet tall), the third and final stage should remove the remaining overstory. Again, log in deep snow.

Thinning

Thinnings improve timber production, crown development, and increase the likelihood of successful regeneration. Acreage to be thinned should be determined through area regulation calculations:

50% of wintering area	−	acreage to be regenerated	=	acreage to be thinned.

Primary emphasis should be on spacing regeneration and pre-commercial thinning of saplings and small poles. Functional shelter (70% crown closure) must be recovered before the other half of the wintering area is sheduled for treatment. Reduce stocking to no less than B-level with at least 70% in hemlock.

Because hemlock is so shade-tolerant, it is not absolutely necessary to eliminate all crown competition. Up to 30% of the main canopy may be in mast producers, especially oak, or valuable timber species such as pine and ash. The high-value timber component will help to offset the low value of hemlock.

Crown closure in white pine stand grown for timber. Photo: Gary Salmon.

White Pine

White pine is a common and extremely valuable timber species. It is most productive, from a timber management point of view, in stands which are thinned repeatedly. Conversely, the best deer shelter is usually found in denser stands. White pine deer wintering areas should be managed under an even-age area-regulation system with a rotation length not less than 80 years and operating interval of 10-15 years.

Regeneration

Regeneration should be accomplished under a two-stage shelterwood system. The first cut is made during the summer to achieve adequate scarification and to eliminate advance hardwood regeneration. Remove 40-60 percent of the overstory during the first entry. The second entry is made 5-10 years after the first or when regeneration is three feet tall. This cut should remove the entire overstory. If adequate regeneration does not occur after the first operation, the area should be rescarified.

Operational units should be no larger than 10 acres. The uncut portions of the wintering area should be large enough, and so situated, that they continue to afford adequate winter shelter and travel cover to deer. Every reasonable effort should be made to eliminate advance hardwood regeneration on areas to be regenerated to pine. Harvests should be made during a good pine seed year.

Regeneration of white pine on sites with a hardwood site index of 65 or greater will be very difficult. Hardwood competition will be hard to overcome. In managed stands many seedlings, including pine, will become established long before stand regeneration is required. Pine seedlings and saplings should be protected and released during every stand entry on good sites.

Crown closure of white pine in a wintering area. Photo: Gary Salmon.

Thinning

Acreage to be thinned should be determined through area regulation calculations:

50% of wintering area	−	area to be regenerated	=	area to be thinned.

Thinning interval should be 10-15 years. Thinnings should begin at about age 40, or when the stand reaches 6 inches M.S.D. Reduce stocking to no less than B-level as shown on the stocking guide (Figure 4). In general, all hardwoods competing with the pine canopy should be removed. In oak-pine stands an oak component of 10% is acceptable. The oaks should be in clumps rather than scattered uniformly throughout the pine.

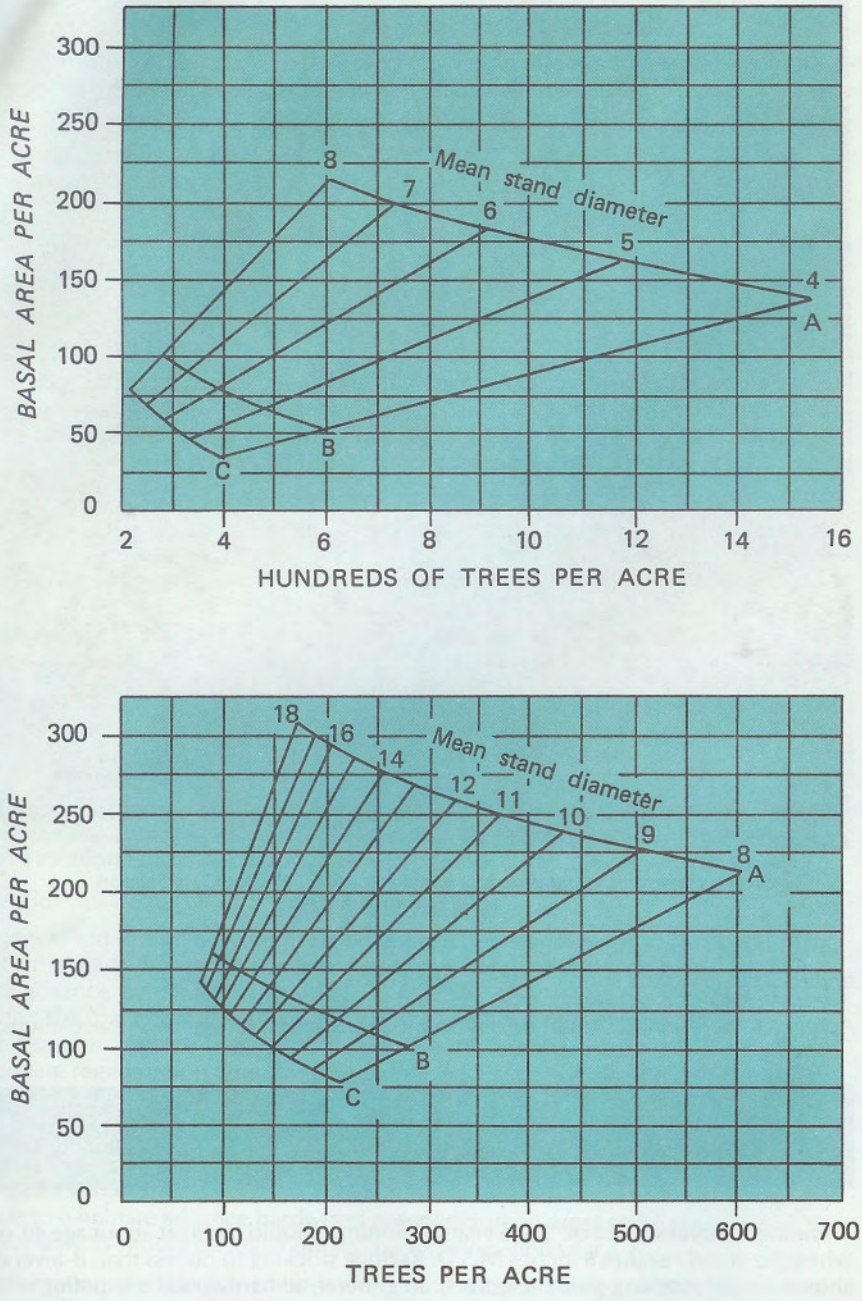


Figure 4—Stocking chart for nearly pure even-aged white pine stands (Philbrook et al. 1973). Source: USDA Forest Service.

Northern White Cedar

Northern white cedar is a locally important cover species, particularly in northern Vermont. Cedar can be extremely hard to regenerate, especially in deer wintering areas, because it is slow growing and is also a preferred browse species.

Regeneration should be accomplished using even-age techniques under an area-regulation system. Harvest units should be a series of clearcut strips alternating with two-stage shelterwood strips. Therefore, one harvest unit would likely include several clearcut strips and several shelterwood strips. Rotation length is about 120 years, and the operation interval is variable depending on the size of the area. Each harvest unit should be between 10 acres and 20 acres. Severe browsing pressure would occur on small units. Strips should be 1-2 chains wide oriented northeast-southwest.

The first entry both should establish clearcut strips and reduce the basal area of dominant and codominant trees in shelterwood strips to 60-80 square feet per acre. The second entry should be made approximately 10 years after the first or when regeneration is 2-3 feet high. All operations should occur during winter.

Mixed Softwood

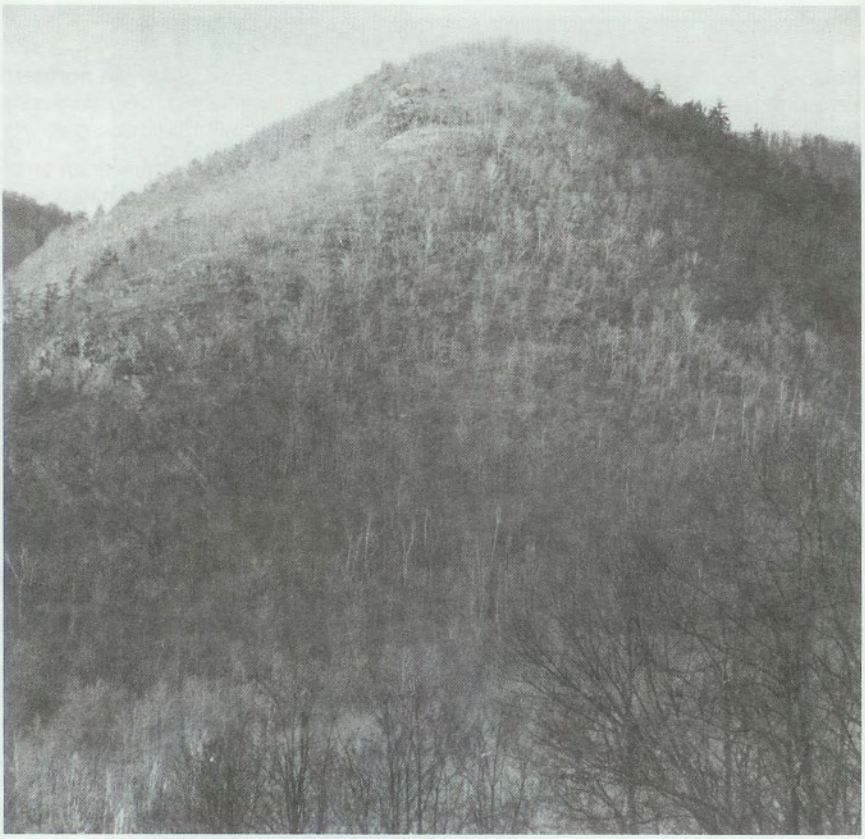
Mixed softwood stands should be managed to favor and enhance the species most suited to the site. Softwoods vary in their ability to provide good winter shelter in the following order: hemlock, cedar, spruce, fir, pine. However, promoting a superior cover species in off-site situations is counter-productive. In particular, cedar should not be favored where it will not respond and develop into a good stand.

Mixed Hardwood-Softwood Stands

Many deer wintering areas in Vermont occur in mixed hardwood/ softwood stands. These sites occur in many different soil types and elevational regimes. They tend to have marginal cover characteristics due to poor softwood crown closure.

Mixed-wood deer wintering areas should be targeted for conversion to softwood. Removing hardwoods through thinning(s) will improve softwood crown closure and increase browse supplies. Retention of up to 30% of the canopy in mast producers is beneficial. Hardwoods should not be removed by single-tree selection where the softwood component is stagnant spruce-fir (see Management to Reduce Mortality, p. 10).

Regeneration of these wintering areas, under an appropriate area regulation system, should follow the appropriate species guidelines.



Steep south-facing hardwood wintering area. Photo: Gary Salmon.

Hardwood

Most hardwood wintering areas are found in southern Vermont. They are characterized by steep, south-facing slopes where solar radiation reduces snow depths. The areas are generally in the lee of high ridges or mountains. The forest type commonly includes mast producers, especially oaks. Hardwood wintering areas should be actively managed using the even-age, area regulation system. Any responsible forest management objective is acceptable provided it includes frequent thinnings and regeneration treatments. High quality sawlog production is particularly appropriate for these areas. The main canopy should contain at least 10% mast producers of an age and vigor capable of yielding frequent mast crops.

MANAGEMENT GUIDELINES FOR HARDWOOD BUFFER STRIPS

A 200-foot buffer strip surrounding the deer wintering area should be managed as a browse production area. A constant supply of high quality browse, very close to the winter shelter, can usually be produced in the course of other scheduled treatments.

All commercial forest land within 200 feet of a deer wintering area should be managed on a maximum rotation of 100 years with a maximum operating interval of 10 years. Regenerate using patch clearcuts from ½ to 2 acres in size. At least 10% of the area should be regenerated every 10 years. Optimum browse production is achieved through a 40-year rotation, with 25% of the area regenerated every 10 years.

Frequent thinnings in the buffer strip increase the amount and frequency of available browse even though the primary intent of thinning is to improve the value and growth rate of the existing stand. Winter logging provides increased browse in the form of tops and slash and stimulates stump sprouts. Apple and hawthorn trees in or near this strip should be retained and periodically released from competition.

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