CHAPTER 34

FIR-SPRUCE TYPE

TYPE DESCRIPTION

A. Stand Composition

More than 50 percent **balsam fir** (*Abies balsamea*) or **white spruce** (*Picea glauca*) or both.

B. Associated Species

Paper birch (*Betula papyrifera*), **trembling aspen** (*Populus tremuloides*), **red maple** (*Acer rubrum*), **white cedar** (*Thuja occidentalis*), **black spruce** (*Picea mariana*), **hemlock** (*Tsuga canadensis*), **red pine** (*Pinus resinosa*), **white pine** (*P. strobus*), **jack pine** (*P. banksiana*), and other species found among **northern hardwoods** (Chapter 40) and **swamp hardwoods** (Chapter 46).

C. Soil Preferences

Loamy soils are preferred but the type also does well on sand-based soils.

Balsam fir grows on a wide variety of soils but generally does best on loams. It grows on gravelly sands and in peat swamps.

White spruce grows on a variety of soils of glacial, lacustrine, marine, or alluvial origin. Over its geographic range, soils vary from heavy clays to sandy podzols. White spruce is exacting in its nutrient requirements and tends to show symptoms of potassium deficiency on poor soils.

D. Range of Habitat Types

In northern Wisconsin this type is common on TMC, ArC, AArS, and AASM. It is a minor cover type on AQT, QAE, AQV, PMV, ATM, AC, and AAr (Kotar et al., 1988).

SILVICAL CHARACTERISTICS*

Species	Balsam fir	White spruce
Pollination	Strobili open the last of May through the beginning of June.	Strobili open by the end of May and stay open only 3 to 5 days.
Cones Mature	Erect cones, 2 to 4 inches long, maturing in autumn.	Pendulous cones ripening in August or September and opening in September.
Seed Dispersal	Begins in autumn and continues through spring. Cones open as they mature and seed is carried short distances by wind. Most seeds fall near base of parent tree.	Seed is quickly shed with 80 percent dispersal within five weeks of opening. Usually seed is blown about 330 feet but dispersal in excess of 1000 feet is possible from mature trees.
Good Seed Years	Every 2 to 4 years with light crops intervening. Seed production begins at 15 years of age, but best production is after 30 years. Seed numbers average 59,800 per pound.	Every 2 to 6 years with light crops in intervening years. Seed production begins at 30 years of age with optimum production when trees are 60 years old or older. White spruce cones average 140 seeds each. These seeds are extremely lightweight with about 240,000 seeds per pound.

Germination	Generally occurs from late May to early July on almost any seed bed including mineral soil, rotten wood, and shallow duff. Best under a forest cover with low light intensity (15 to 20 percent of full sunlight at midday). Summer mortality is due to high soil surface temperatures and drought. Winter mortality results from frost heaving, or from being crushed or smothered under fallen hardwood leaves, ice or snow.	Usually in June and July. Dry stored seed exhibits dormancy and requires stratification to induce germination. Moisture condition of seed bed is the most important factor in seedling survival as first year seedlings are small with root penetration of only three inches. In undisturbed forest settings, the majority of seedlings are found on decayed wood which offers more moisture, less chance of being smothered by fallen leaves, and better temperature and light conditions. However, overall survival and growth is better on mineral soils.
Seed Viability	Depends on age of parent tree. Increases through mid-life and declines as tree completes life span. Highest observed germination rate was 68 percent from a 41-year-old tree.	Germinative capacity was 70 percent in germination tests with no stratification and eight hours of daily light for 21 days (Safford, 1974).
Seedling Development	Will grow well in dense shade during first 6 to 8 years but needs nearly full light for best development.	Although tolerant, white spruce is unable to compete with dense ground cover or understory growth because of its small size during the first year. Consequently, white spruce is difficult to maintain when grown in mixture with hardwoods.
Growth	Vigorous trees with room to grow will reach 10 inches in diameter and 50 to 60 feet in height in about 50 years. At maturity, reaches 12 to 18 inches in DBH and 40 to 60 feet in height. Maximum reported height is 75 feet with a diameter of 34 inches. Maximum age is 200 years.	Grows rapidly in early years under good conditions and full sunlight. In Wisconsin a 13-year-old plantation on sandy clay loam contained dominants that were between 18.2 and 21.4 feet in height and 2.8 and 4.2 inches in diameter. White spruce, 110 feet tall and 21 inches in diameter, are not uncommon.
Shade Tolerance	Classified as very tolerant; relative tolerance varies with soil fertility and climate. Responds quickly to release.	Classified as tolerant along with black spruce. Will survive 40 to 50 years of suppression and respond to release. In mixed hardwood stands, white spruce will remain an understory tree until it is released. In mixed conifer stands, will reach dominance with balsam fir and black spruce and eventually outgrow them.
Major Pests	**Spruce budworm** (*Choristoneura fumiferana*), several heart rots (including **red heart rot**), and over 30 butt rots (including **brown cubical butt rot** and **white stringy butt rot**) affect both species. Spruce budworm outbreaks occur in open growth and in overstocked stands, causing defoliation, growth loss, and mortality. Rots generally enter the tree bole through injury to the root and root collar zone. A history of budworm attack usually indicates a higher potential for developing butt rot and heart rot within a stand. Generally the drier the site, the higher the incidence of heart rot and butt rot in fir-spruce. Balsam fir should not be grown on dry upland sites beyond 60 years of age. White spruce grown on a sawlog rotation should be monitored for signs of rot; overstocked and stagnant conditions should be avoided. Fir-Spruce Pest Management Guidelines are included at the end of this chapter.	

[*] Mainly from Fowells (1965) except where indicated.

MANAGEMENT ALTERNATIVES

The management objective should be identified within an ecosystem framework, giving consideration to a variety of objectives within the local and regional landscape. The habitat type is the preferred indicator of site potential. Possible alternatives include managing to produce the maximum quantity and quality of balsam fir pulpwood and white spruce sawtimber where it is consistent with site potential.

SILVICULTURAL SYSTEM

Even-age management can be applied with periodic thinnings based on site capabilities. Fir-spruce can also be managed on an all-age basis. Development of compositional and structural diversity (within and across landscape) is encouraged.

MANAGEMENT RECOMMENDATIONS

Swamp edge or lower ridge areas are considered primary sites for fir-spruce. Upland locations tend to convert to hardwoods and are considered secondary sites for fir-spruce. On some sites aspen and fir may dominate every other rotation on a cyclical basis. The Lake Superior lowlands (glacio/acustrine clay plain) were historically associated with this type.

Balsam fir has a better developed juvenile taproot than white spruce but both are subject to windthrow if more than 50 percent of a stand is removed at one time. Cutting on a minimum tree limit of 2 or 3 pulp sticks, is usually too heavy, and results in some windthrow of remaining trees, removal of seed trees, and overexposure and excessive drying of organic matter and small seedlings. Row thinning of either every other row or every fourth row, removing the center row of the remaining three in the next thinning, provides access and encourages development in spruce plantations.

A. Seedling/Sapling Stands (0-5" DBH)

Most pole size fir-spruce stands have 1 to 3 inch seedlings present which can be encouraged to develop by partial removal of the overstory.

By the time seedlings are one foot or greater in height, their root systems are established in mineral soil and they can withstand full release.

B. Pole and Small Sawtimber Stands (5-9" and 9-15" DBH, respectively)

1. Mixed or pure stands with white spruce management potential (at least 200 dominant and co-dominant white spruce per acre):

   Manage for white spruce. Reduce basal area stocking to B-level whenever stand becomes operable (see stocking chart in Figure 34.1). Remove fir as it reaches maturity but do not harvest more than 50 percent of the total stand volume at any one thinning.

   Rotate stand in accordance with site index rotation age (see Figures 34.2 and 34.3). Opportunities for extended rotation management may occur. Regenerate by stripcutting stand, leaving 50 feet wide uncut strips or patches at no more than 150 feet intervals as a seed source. Bunch or windrow slash and disc cutover area to provide a mineral soil seed bed.

   If adequate spruce regeneration does not occur within 5 to 6 years, plant to white spruce. Do not leave undesirable seed trees such as aspen, birch, and soft maple in the reserve strip. If hardwoods are present in the fir-spruce stand, either tolerate them as a component in the future stand or remove them during the regeneration cut.

   Uneven aged management can be applied through individual tree or group selection. Development of structural diversity should be encouraged.

2. Pure or mixed balsam fir stands (with less than 200 dominant and co-dominant white spruce stems per acre):

   Manage for balsam fir. Reduce basal area stocking to B level whenever stand becomes operable if at least 10 years prior to rotation age. Rotate stand in accordance with site index rotation age.

To regenerate, reduce basal area stocking to 60 square feet of basal area by removing no more than 50 percent of the dominant and co-dominant trees in the residual stand to provide seed. Remove hardwoods with partial harvest. Harvest shelterwood residual when 60 percent millacre stocking of regeneration taller than one foot in height will remain after removal of overstory.

Slash accumulation should be controlled to prevent covering of advance regeneration by bunching slash during felling and limbing. Tree length skidding to landing may also be used if damage to regeneration is minimal.

3. Understocked stands below C stocking level:

   Scarify with disc or blade to expose mineral soil. Clearcut overstory when regeneration reaches one foot or greater in height and 60 percent millacre stocking will remain after harvest.

   OR

   Clearcut, prepare site and plant to white spruce.

4. White spruce plantations:

   Allow stocking level to reach 160 square feet of basal area, then reduce to 90 square feet. A combination of row thinning and selective marking from below will be needed. Never remove more than 50 percent of the stocking level at one time.

   Subsequent thinnings should be made from below, whenever the stand becomes operable, with a residual level of 90 square feet of basal area in poles and 120 square feet in sawtimber.

   Regenerate as previously described above in subsection B-1.

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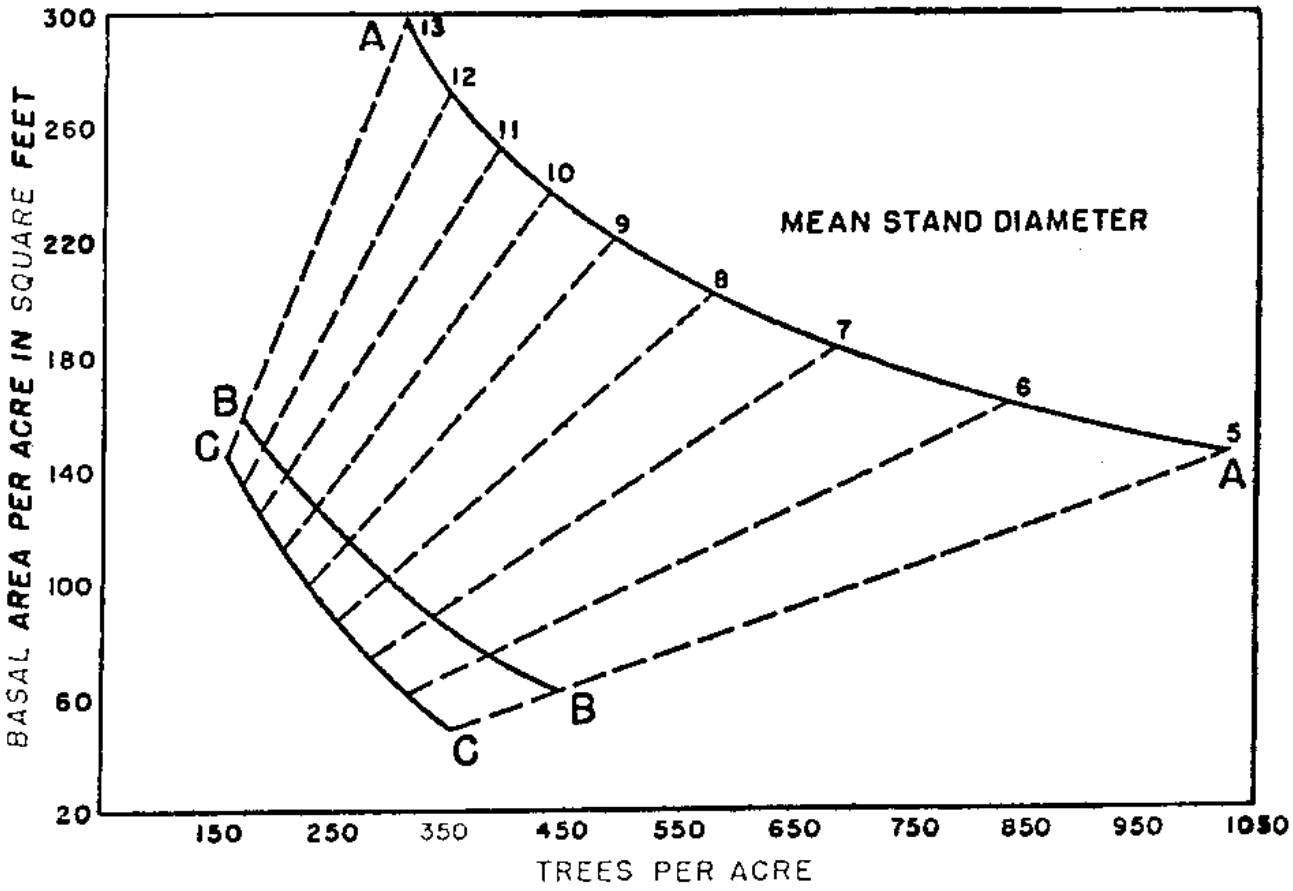
Figure 34.1 Growing stock guide for even-aged spruce-fir (Frank and Bjorkbom, 1973).

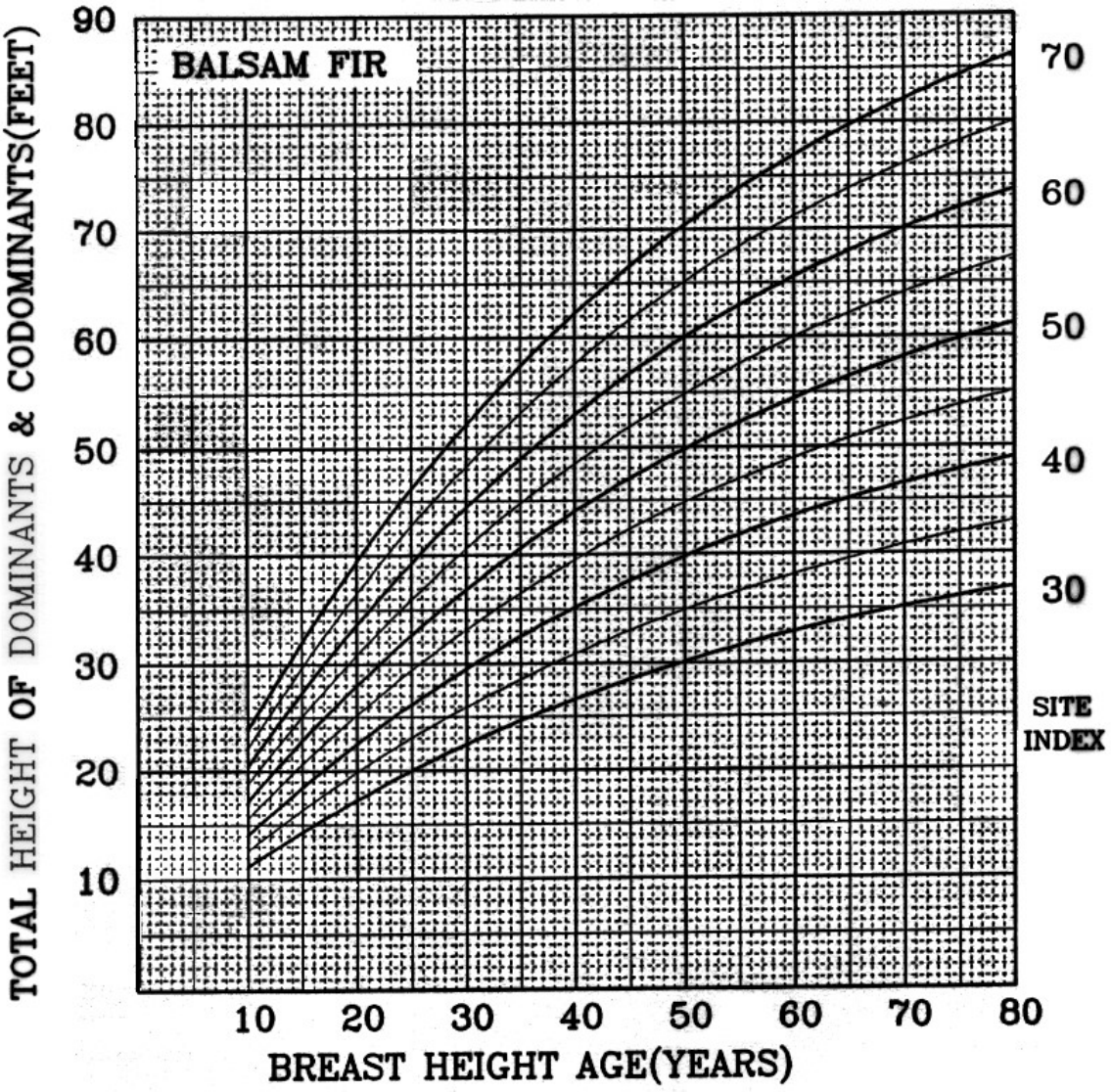


Based on the number of trees in the main canopy, average diameter, and basal area per acre. The area above the A-level represents overstocked stand conditions. Stands between the A- and B-levels are adequately stocked. Stands between the B- and C-levels should be adequately stocked within ten years or less. Stands below the C-level are understocked.

Figure 34.2 **Site index curves for balsam fir in the Lake States (Carmean et al., 1989).**
Rotation age -- swamp sites -- 50 years.

Upland sites

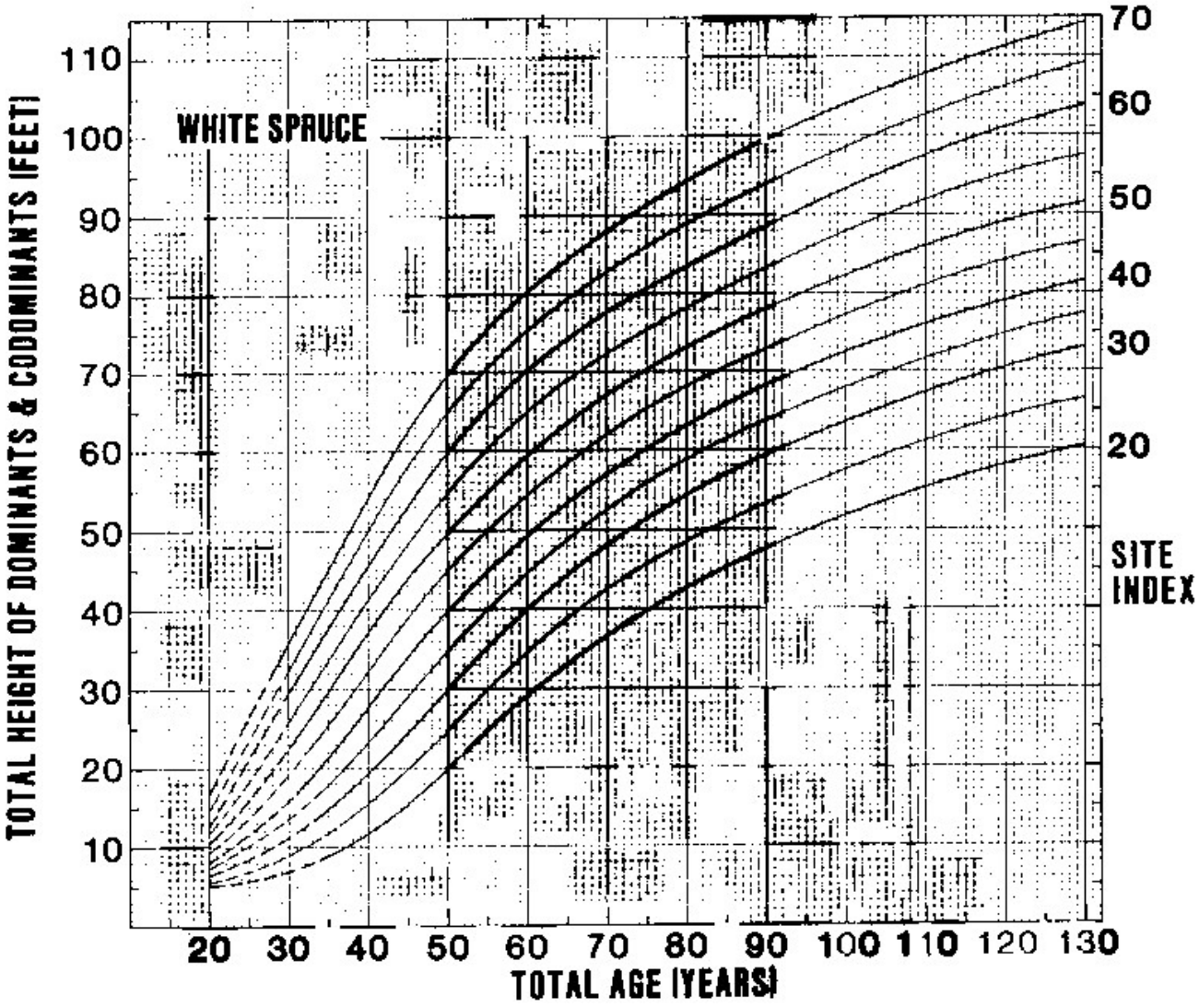
Site index	70	60	50	40	30
Rotation age (years)	60	50	50	40	40



Balsam fir (Gevorkiantz 1956b)
Lake States
Number of plots and number of dominant and codominant trees not given
Total height and breast height age, anamorphic, equation not given
Site index is total height of dominant and codominant trees at 50 years breast height age (BH = 4.5)

	b_1	b_2	b_3	b_4	b_5	R^2	SE	Maximum difference
H	1.0438	1.0708	-0.0222	1.5915	-0.1068	0.99	1.08	1.6
SI	0.4358	1.0650	-0.0179	-0.7497	0.0251	0.99	1.18	2.1

Figure 34.3 **Site index curves for white spruce (Carmean et al., 1989).**



White spruce (Carmean and Hahn 1981, revision of Gevorkiantz 1957g)
Minnesota
Number of plots and number of dominant and codominant trees not given
Total height and breast height age, anamorphic, Gevorkiantz (1957g) equation not given
Convert d.b.h. age to total age by adding years according to site index (BH = 0.0):

SI:	20	30	40	50	60	70
Years:	15	13	11	10	9	8

	b_1	b_2	b_3	b_4	b_5	R^2	SE	Maximum difference
H	11.3079	0.5419	-0.0345	34.1568	-0.6078	0.99	2.18	6.4
SI	0.0380	1.5142	-0.0124	-6.4840	-0.3550	0.99	2.29	6.4

Rotation age: All sites -- 80 to 100 years.

HAZARD	LOSS OR DAMAGE	PREVENTION, MINIMIZING LOSSES AND CONTROL ALTERNATIVES	REFERENCES
Spruce Budworm	Periodic outbreaks of spring defoliation cause growth loss and mortality of balsam fir and, to a lesser extent, white spruce.		Spruce-Fir Silviculture and Spruce Budworm in the Lake States. 1983. J.L. Flexner, et al. CANUSA Handbook 83-2.
	OUTBREAKS: 1. One severe defoliation (more than 75% new needles destroyed) causes growth loss and up to 50% top kill and some tree mortality	MINIMIZE LOSSES BY: 1. Harvest defoliated stands within two years.	
	2. Two severe defoliations cause up to 50% tree mortality on good sites and up to 90% on poor sites.	2. Harvest defoliated stands within one year on all sites.	
	HAZARDOUS STAND CONDITIONS: 1. Even aged and overmature balsam fir to 95%.	PREVENTIVE PRESCRIPTION: 1. PRIORITY 1: Clearcut as soon as feasible.	Spruce Budworm Handbook: Managing the Spruce Budworm in Eastern North America. 1984. D.M. Schmitt, et al. Agr. Handbook No. 620. USDA Forest Service.
	2. Even aged, mature to overmature balsam fir and white spruce: Balsam fir to 70%, white spruce to 10% and swam hardwoods to 20%.	2. PRIORITY 1: Clearcut as soon as feasible. Do not leave white spruce to carry budworm population to next generation.	
	3. Balsam fir and swamp conifers with mature balsam fir to 30% and cedar, black spruce, tamarack to 70%.	3. PRIORITY 2: Cut balsam fir within 5 years and remove older cedar and white spruce favoring younger cedar, black spruce and tamarack to rotation age.	
	4. Balsam fir and aspen in mature stands. Balsam fir to 50% and aspen to 50%.	4. PRIORITY 2: Clearcut balsam fir and aspen within 5 years of initial infestation.	

	5. Balsam fir and northern hardwoods with mature balsam fir in fringe area to 10% and northern hard-woods to 90%.	5. PRIORITY 3: Selective cut hardwoods and harvest mature balsam fir as part of the overall cutting operation.	
STEM AND ROOT DECAY			
Red Heart Rot of Balsam Fir (Haemato-stereum sanguino-lentum)	STEM DECAY OF BALSAM FIR: 1. Incipient Stage: Wood is water-soaked and reddish but firm. 2. Advanced Stage: Wood is cull; half or more of diameter is defective.	1. Limit rotation age to 50 years. Harvest. 2. Harvest.	Balsam Fir Decay and Cull on Different Sites, with Rotation Age Recommendations. Don Prielipp. 1956. Kimberly-Clark Corp.
Brown Cubical Butt Rot of Balsam Fir (Phaeolus schweinitzii)	Heartwood decay in roots and lower 4 feet of stem.	Limit rotation age to 50 years.	Balsam Fir Decay and Cull on Different Sites, with Rotation Age Recommendations. Don Prielipp. 1956. Kimberly-Clark Corp.
White Stringy Butt Rot (Armillaria mellea) of Balsam Fir and White Spruce	Growth loss, tree mortality, decay of lower stem wood.	Limit rotation age to 50 years.	Armillaria Root Disease. R. Williams, et al. 1986. USDA Forest Service. Forest Insect and Disease Leaflet 7p.
White Pocket Root Rot of White Spruce (Inonotus tomentosus)	Decay of heartwood of roots and lower stem. Growth loss, decline, mortality of individual trees or groups.	On sites with very acid (pH 4-5) soils, low nutrient availability, and water-holding capacity, very shallow or compacted soil: 1. Discriminate against white spruce. 2. Clearcut entire stand when infected.	Polyporus Tomentosus Root Rot of Conifers. R.D. Whitney. 1977. Canadian Forestry Service GLFRC Tech. Report 18.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
NOTICE OF FINAL GUIDANCE & CERTIFICATION

Pursuant to ch. 227, Wis. Stats., the Wisconsin Department of Natural Resources has finalized and hereby certifies the following guidance document.

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FA-20-0001

DOCUMENT TITLE

Silviculture Handbook

PROGRAM/BUREAU

Forest Economics and Ecology, Applied Forestry Bureau

STATUTORY AUTHORITY OR LEGAL CITATION

S. 823.075, Wis. Stats. & NR 1.25, Wis. Admin. Code

DATE SENT TO LEGISLATIVE REFERENCE BUREAU (FOR PUBLIC COMMENTS)

2/10/2020

DATE FINALIZED

4/6/2020

DNR CERTIFICATION

I have reviewed this guidance document or proposed guidance document and I certify that it complies with sections 227.10 and 227.11 of the Wisconsin Statutes. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is not explicitly required or explicitly permitted by a statute or a rule that has been lawfully promulgated. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is more restrictive than a standard, requirement, or threshold contained in the Wisconsin Statutes.

Carmen Hardin — March 27, 2020

Signature — Date