Cutting Practices for Conifer Swamps and Upland Spruce-Balsam Fir in Northern Michigan
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CONTENTS

THIS BULLETIN deals with forest cutting practices for conifer swamps and upland spruce-balsam fir stands as found in the northern third of the Lower Peninsula and the Upper Peninsula of Michigan. It is written for the small forest owner who wants to manage his forest land primarily to produce timber. Harvest methods and cultural practices to improve the quality and increase the yield of woodlands are discussed. The first sections present definitions and explanations of certain forestry terms and cutting practices. The remainder discusses the application of forest practices to different kinds of forest stands.

Forestry Assistance

Proper application of many forest practices depends on a technical knowledge of forestry. For this reason, the individual woodland owner should seek the advice of a forester. Help is available from foresters of the Michigan State University Cooperative Extension Service, from Michigan Department of Conservation service foresters, and from industrial foresters and private consulting foresters. The Michigan Tree Farm program, sponsored by the forest industries, is another source of assistance. Cooperators with the local Soil Conservation District can obtain assistance through their district. Cost-sharing for forest improvement is available through the Agricultural Stabilization and Conservation Service and forestry loans through the Farmers Home Administration. County offices of the Cooperative Extension Service may be consulted for more information on sources of assistance.

ACKNOWLEDGEMENT

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SOME FORESTRY FUNDAMENTALS

KNOWLEDGE OF CERTAIN FORESTRY TERMS and concepts helps in understanding the use and limitation of various cutting practices. A discussion of some of the most important follows.

Forest Site

Site as used in forestry includes soil, climate, slope of land and all other factors that influence the growth of trees on any given location. A site is referred to as "good," "medium," or "poor," depending upon its capacity to produce crops of timber. Species of trees differ in their site requirements. A site that is good for the growing of pine might be poor for growing spruce.

Tolerance

Tolerance is the ability of a tree to grow and develop in shade and in competition with other trees. Trees that can stand much shading and competition are said to be "tolerant," whereas those that can stand little are called "intolerant." Table I gives a classification of trees based on their tolerance.

Forest Types

Different *forest types* (natural tree communities) result primarily from variation in soil, topography, and climate. The same type can be expected to occur where these conditions are similar, and in the absence of disturbances like fire. Several species may make up a type, with usually one or a very few predominating. Those made up almost entirely of one species, such as jack pine, are called "pure" types.

Northern Michigan has many different forest types, and these have been broadly grouped below:

Northern hardwood	White pine
Upland spruce-balsam fir	Red pine
Conifer swamp	Jack pine
Aspen	Hardwood swamp

Forest types can frequently be classified on the basis of *soil*. For example, the jack pine type commonly occurs on coarse dry sands, the northern hardwood on loamy soils, and the conifer swamp on low, wet organic soils.

Origin is another basis of classification. A *temporary type* results from a passing influence, such as fire. Aspen is a temporary type. It serves to cover the ground temporarily, but will ultimately give way to a type composed of more tolerant species. A *climax type*, on the other hand, evolves slowly over a long period of time through *plant succession*, whereby one stage of vegetation gives way to another until a final, or climax stage, is reached. Given stable site conditions and climate, no further successional change would be expected. The northern hardwood type, which includes such tolerant species as sugar maple, basswood, beech, and hemlock, is a climax type.

Even-aged and Uneven-aged Stands

Timber stands in which trees are all about the same age (within about 10 to 20 years of each other) are called *even-aged*, whereas trees in *uneven-aged* stands show greater age differences.

Table 1. A classification of trees based on tolerance

TOLERANT	INTERMEDIATE	INTOLERANT
Balsam fir	American and rock elm	Aspen (popple)
Basswood	Black spruce	Black cherry
Beech	Black and white ash	Jack pine
Eastern hemlock	Red maple	Red (Norway) pine
Ironwood	Red oak	Tamarack
Northern white-cedar	White pine	White birch
Sugar maple	Yellow birch	
White spruce		

An understanding of whether different species tend to grow naturally in even-aged or uneven-aged stands is very helpful in forest management. Intolerant species like aspen, tamarack, and jack pine typically grow in even-aged stands. In these stands all trees become established, reach maturity, and are ready for harvest about the same time. Tolerant hardwoods such as beech, sugar maple, and basswood typically develop into uneven-aged stands. The same is true of such tolerant conifers as northern white cedar and balsam fir. In uneven-aged stands trees become established and reach maturity at different times.

Tree Size-Classes

Individual trees and timber stands are commonly classified on the basis of tree diameter at breast height (4½ feet above ground) as follows:

Seedlings	less than 1"
Sapling	1" - 4"
Pole	5" - 9"
Small sawlog	10" - 14"
Medium sawlog	15" - 19"
Large sawlog	20" and over

TIMBER HARVEST AND REPRODUCTION

When trees are mature they should be harvested. The orderly process by which this is done, and a new forest established, is called a *reproduction method*. There are four such methods of harvesting and re-establishment for trees that reproduce from seed — (1) *clearcutting*, (2) *seed-tree*, (3) *shelterwood*, and (4) *selection*.

Clearcutting

Clearcutting removes all trees from an area in one cutting. Sometimes stands are clearcut in strips or patches to better insure reproduction. A new stand starts from seedlings and seed present at the time of harvest, and seed from adjacent stands. Reproduction also starts from root suckers and stump sprouts, if species that sprout are present. Planting may also be done to start a new forest. The stand that results is even-aged.

Seed-Tree

The seed-tree method leaves a scattering of seed-trees over the area, usually not more than ten per acre. These provide seed for a new stand. It results in an even-aged stand.

Shelterwood

The shelterwood method leaves more trees than the seed-tree method as a seed source and as "shelter" for establishing reproduction. Intensive application may involve several cuttings over a short period of time to open the stand gradually and create the best possible condition for reproduction. It is important that the trees left are wind-firm and good seed bearers. These will usually be the largest and best developed trees. After seedlings are established, all seed-trees and sheltering trees are removed. The shelterwood method produces an even-aged stand.

Selection

Under the selection method, light repeated cuttings of mature trees are made at relatively short intervals, usually every 10 to 20 years. Trees are cut as scattered individuals or in small groups. Continuous reproduction takes place in the openings created. An uneven-aged forest is maintained.

Each of the four reproduction methods has advantages and disadvantages. In general, the clearcutting and seed-tree methods are easy to apply and the logging is concentrated. However, reproduction may be uncertain (at least in some types), there is high danger of brush invasion, and there are long waiting periods between harvest cuttings. Maximum sprout reproduction also results, which as a rule is less desirable than seedlings.

Compared to the clearcutting and seed-tree methods, the shelterwood method lessens the likelihood of serious sprouting and brush invasion on upland sites, but it requires greater skill to apply. It provides partial shade during the reproduction period, which favors the establishment of more tolerant species. Compared to the selection method, waiting periods between major harvest cuttings are long.

The selection method provides opportunity for annual sustained yield from relatively small woodlands of about 40 acres or more in size, a feature that should appeal to anyone who wants to obtain a regular income from his woodland. Reproduction is obtained relatively easily, at least with tolerant species. Brush invasion and sprouting is kept to a minimum on upland sites. Intensive application of the selection method does, however, require the most skill. It also tends to increase logging costs.

TIMBER STAND IMPROVEMENT

Cutting to improve the composition, quality, and growth of a developing stand (called *timber stand improvement*) may begin when the stand is still quite young. Usually, however, it is delayed until trees reach a size salable for such products as posts and pulpwood.

Improvement work includes the removal of undesirable trees (crooked, poorly formed, decayed, sharply forked, low-valued, etc.) and thinning to increase the growth rate and total yield of timber. It may also involve cutting larger trees to allow more valuable trees beneath them to grow. Limbs are sometimes pruned from tree trunks to produce knot-free wood. It is not necessary to actually remove trees by felling. They can be eliminated by girdling or use of chemicals (see MSU Extension Folder F-182, "How to Control Undesirable Trees and Shrubs with Chemicals.")

CONIFER SWAMPS

Conifer swamp stands occupy wet lowlands and drainage ways throughout northern Michigan. They grow on both organic (peat or muck) and mineral soils. Conifer swamps are an important source of posts, poles, pulpwood, and numerous other timber products, and provide food and cover for many species of wild animals.

The principal species composing the conifer swamp type (page 3) are northern white-cedar, black spruce, balsam fir, and tamarack. These species commonly grow in mixture, but stands predominantly cedar, or pure black spruce, do occur. Other conifers present in some swamps are white spruce, white pine, and eastern hemlock.

Through natural plant succession (page 3), there is a strong tendency for hardwoods to invade conifer swamps, especially following cutting. Hardwoods that commonly grow in association with swamp conifers are red maple, aspen (popple), black ash, white birch, yellow birch, Balm-of-Gilead, mountain maple, and elm. *Keeping hardwood invasion in check is one of the most important and difficult problems involved in the management of conifer swamps.*

Description of Species

Conifer swamp species differ considerably in tolerance (page 3), reproductive habits, growth rate, soil preference, and maturity age. A knowledge of these and other differences is very helpful in the management of conifer swamps.

Northern White-Cedar. Cedar is a slow-growing, tolerant, shallow-rooted, medium-sized tree, around 40 to 60 feet in height at maturity. It is long-lived, with some trees reaching 400 years of age. It prefers nearly neutral or slightly acid, well-decomposed, woody peat or muck soils, and swamps in which there is good soil water movement. Seedling reproduction is usually present in dense stands, but will not survive in heavy shade. Cedar is also preferred food for deer, and deer browsing may prevent reproduction from developing. In openings resulting from cutting, wind throw, and natural mortality, cedar reproduction must usually compete with the more tolerant balsam fir and hardwoods to survive and grow.

Balsam Fir. This is a medium-sized tree that reaches a height of about 40 to 75 feet at maturity. Balsam fir is shallow-rooted and grows on a wide range of from moist to wet sites. It makes its best growth in swamp border areas and poor growth in poorly drained swamps. Under favorable conditions it grows rapidly, but seldom lives beyond 100 years of age. Balsam fir is highly susceptible to butt rot. On dry upland sites it often develops serious rot as early as 40 years of age, and on other sites by the time trees are 60 to 70 years old. Balsam fir is very tolerant, and when small openings are created in mature stands, balsam fir seedling reproduction usually becomes readily established, and is likely to increase along with the hardwoods.

Black Spruce. This is a medium-sized tree, commonly about 60 feet tall at maturity. It is longer-lived than balsam fir. It is more tolerant than tamarack, but many foresters consider it less tolerant than either balsam fir or cedar. It commonly grows in poorly drained swamps. It also grows in swamps with better water drainage, but here cedar, balsam fir, and white spruce tend to crowd out black spruce. When black spruce occurs in the upland spruce-balsam fir type it makes good growth, but is shorter-lived than white spruce.

White Spruce. In northern Michigan this tree is found primarily on upland sites and only to a limited extent in swamps. Mature trees in swamps commonly measure 12 to 14 inches in diameter. White spruce makes its best development on well-drained, loamy soils, where some trees may reach 24 inches in diameter. White spruce grows to somewhat older age than balsam fir and is similar to black spruce in tolerance.

Tamarack. This is a moderately long-lived, very intolerant, and relatively fast-growing tree. Because of its intolerance it will not become established and grow underneath other trees. Trees that receive sunlight and grow will attain a height of 60 to 80 feet, and 14 to 20 inches in diameter. Large numbers of tamarack were attacked and killed by a serious outbreak of the larch sawfly from 1890 to 1910, and as a result tamarack is less abundant now than it was at one time. Outbreaks of sawfly have also occurred in recent years, resulting in some tamarack mortality.

Stand Conditions

Most conifer swamps have been logged at least once, and some two or three times. Many have also been disturbed by fire, wind, insects, disease, and animals. As a result of these disturbances stand conditions in most swamps are highly varied. Some are even-aged and others uneven-aged (page 3). Many are made up of irregularly-sized patches of seedlings, saplings and mature trees; others are uniformly stocked with trees of one size-class (page 4). Tree stocking is also variable, ranging from dense to sparse. Remnants of the original stand, usually composed of highly defective and cull cedar, are scattered throughout many stands. Competing hardwoods, often poor in quality, are present in most cutover stands.

Fig. 1 Poor-quality red maple and birch overtopping conifers in this stand were killed by airplane spraying with a chemical.

Fig. 2 Strip clearcutting in a conifer swamp. All trees in the strip were cut to favor conifer reproduction and to prevent poor trees from becoming a part of the new stand.

Fig. 3 Conifer reproduction in a clearcut patch 8 years after it was cut.

APPLICATION OF CUTTING PRACTICES

In discussing the application of management practices to conifer swamps, it is convenient to consider them from the standpoint of whether they are composed of mixed conifer swamp species, pure black spruce, or predominantly cedar. These variations of the conifer swamp type result from differences in soil and ground water drainage conditions and each needs somewhat different cutting treatment for best management results. *Woodland owners who plan to do cutting in conifer swamps should consult a forester. He can best advise them on the proper application of improvement, thinning, and harvest practices.*

Mixed Conifer Swamps

Mixed conifer swamp stands are composed of various mixtures of mainly cedar, black spruce, and balsam fir. The most important management need of immature stands is timber stand improvement (page 5). Stand improvement work in particular should remove undesirable hardwoods and cull trees. When harvesting timber, use harvest methods (page 4) that will best insure the reproduction of a new conifer stand.

Improving Immature Stands

It is desirable to do improvement work in young, thrifty, mixed conifer swamp stands to improve the composition and quality of the growing stock. Whether or not improvement work is economically possible will usually depend upon how much salable timber can be removed in the cutting operation. Some stands will yield enough salable products from the removal of over-topping merchantable aspen, scattered mature and over-mature cedar, spruce, and balsam fir, not

Fig. 4 A pure black spruce swamp.

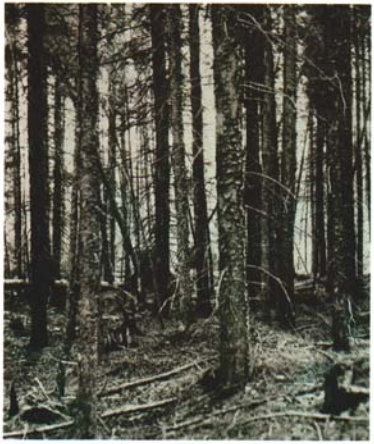

Fig. 5 The east edge (foreground) of this black spruce swamp was harvested for pulpwood by clearcutting. The "edge" or band of trees removed is about 150 feet wide. Natural reproduction is well established in the clearcut area. The next band of trees may now be clearcut along the east side of the stand in the background.

only to pay for the logging of these products, but also to eliminate seriously defective hardwoods and culls by felling, girdling, or the use of chemicals. On large tracts, several forties in size, undesirable hardwoods can be killed by airplane spraying with a chemical (Fig. 1). Airplane spraying of small tracts is likely to be too costly per acre to be practical.

At the time improvement work is being done, thin stands, if possible, where trees are too dense. (Although the thinning of young dense sapling stands may be desirable to prevent trees from stagnating in growth, this usually is not economically feasible because sapling thinnings, as a rule, are not salable.) Thinning, generally, must be confined to stands old and large enough to yield salable amounts of posts, pulpwood or poles. In the thinning operation remove the poorer trees, which will usually be the smaller ones, and leave sound, thrifty trees to grow. Thinning of stands on shallow muck soils is not recommended, as serious wind throw is likely to result, owing to shallow tree root systems.

Improvement cutting is likely to leave some exposed hardwood stumps. To keep these from developing stump sprouts, which as a rule make poor timber trees, they may be sprayed with a chemical. Exposed stumps of red maple, in particular, sprout prolifically.

Conifer swamps should also be protected from grazing. Cattle trample small trees, bruise the roots of larger trees, and compact the soil, causing serious forest damage.

Harvest by Strip or Patch Clearcutting

Mixed conifer swamps in which most trees are of merchantable size and from 60 to 80 years of age may be harvested. Stands grown beyond this age are susceptible to serious decay. This is particularly true of balsam fir, a comparatively short-lived tree (page 6).

Present research shows that conifer swamps will reproduce themselves most satisfactorily when they are clearcut in strips (Fig. 2) or patches. Seedling reproduction of conifers usually becomes established (Fig. 3) within 5 to 10 years after clearcutting from seedlings present at the time of cutting, and from seed on the ground and blown in from adjacent stands.

Fig. 6 A cedar swamp stand thinned for fence posts. (Courtesy of U. S. Forest Service)

Fig. 7 A cedar swamp stand 12 years after it was thinned for fence posts. The stand in the background has not been thinned. (Courtesy of Dickinson County Soil Conservation District)

Compared to harvest methods that remove only a part of the stand, clearcutting in strips or patches results in the most conifer reproduction and less of the competing hardwoods. Hardwood brush growth (shrubs and young trees) that develops can be eliminated by cutting it out, or spraying it with chemicals, at an early age. This early treatment of the stand, 5 to 10 years after clearcutting and when the conifer reproduction is about 5 feet in height, will help much to reduce the amount of hardwoods in the next stand and improve growing conditions for young conifers.

Stands uniformly stocked with trees of one size-class are well adapted to clearcutting in regularly spaced strips of uniform width. A forester can best advise the forest owner on the width of strips to use, and the pattern of cutting to follow. In general, strips about 75 feet in width are suggested. Where northerly or north-westerly winds prevail, start cutting on the north side of the area and run strips in an east-west direction. Progress to the south, following a pattern of cutting one strip and leaving two uncut. This pattern of cutting results in harvesting one-third of the stand. After conifer reproduction has become established in the clearcut strips and has grown to a height of about 5 feet, which should be within 10 years, remove another third of the stand by cutting the next series of strips, leaving the ones to the north as a seed source. Ten years later clearcut the remaining strips and last third of the stand.

Stands composed of patches of trees of different age- and size-classes (irregular stands) are better suited for clearcutting in patches. Remove mature trees in clearcut patches from about a quarter of an acre to an acre in size. Patches need not be regular in shape nor follow any particular pattern. In general, scatter them as uniformly as possible throughout the stand. No one harvest cutting should remove more than a third of the total stand. After reproduction has become established in the clearcut patches, additional patches of mature timber may be clearcut.

Clearcutting in patches is not as orderly a way of harvesting timber as clearcutting in strips. For this reason one of the aims of management in irregular stands should be to change them into even-aged stands suitable for clearcutting in strips. This seems particularly desirable in stands 40 acres and larger in size.

Pure Black Spruce

In northern Michigan black spruce occurs primarily on organic soils. Although the total acreage of pure black spruce (Fig. 4) is not large, it nevertheless does have a high pulpwood value. On filled-in lake basin bogs the best black spruce sites are usually the swamp margins, with growing conditions becoming progressively poorer toward the center. At the center of some bogs, growth stagnates and spruce does not reach pulpwood size. Black spruce makes the fastest growth on good sites, but remains sound to an older age on poor sites. On good sites stands yield up to 50 cords of pulpwood per acre at maturity.

Thinning

On shallow organic soils black spruce is so susceptible to wind throw that thinning should not be attempted. On deeper organic soils where wind throw is less of a hazard, vigorous immature stands stocked with trees large enough to yield salable products may be thinned. Remove the poorer trees, especially those with a short weak crown (top), and leave the best ones to grow.

Fig. 8 Merchantable aspen overtopping a young, thrifty stand of spruce-balsam fir. Removal of aspen will improve growing conditions for the conifers.

Harvest

Black spruce on average to good sites probably should not be grown beyond 80 to 100 years of age if serious losses from butt rot are to be avoided. Clearcutting in strips or patches as described for mixed conifers (page 9) is recommended for stands growing on the deeper, organic soils where wind throw is less of a hazard. Harvesting stands on shallow, organic soils presents a problem because of the wind throw hazard. A system of "edge" clearcutting (Fig. 5) may work best in these stands. In applying this method, cutting starts along one edge (usually the south or east) of the swamp. Cutting progresses across the swamp in stages by removing trees in bands 100 to 200 feet wide about every 10 years, after reproduction becomes established in the previously clearcut area. If the swamp is large, a second "edge" may be started in the middle of the tract.

Black spruce reproduction usually becomes established within 10 years in the clearcut strips or patches from seedlings present at the time of cutting, and from seed blown in and already on the ground. Where there is an accumulation of logging slash (tree branches and tops) in piles or windrows, black spruce reproduction does not take place. Burning of this slash will permit seeding of burned areas and result in better distribution of seedlings. Before doing any burning, obtain a permit from a Michigan Department of Conservation official. *Burning of slash, however, is hazardous, since muck fires can result.* One way of burning slash is to fell tree tops into the center of the strip, allow them to dry through the following summer, and then burn them in the spring. The hazard of muck fire can be reduced by burning while snow is still on the ground.

Cedar Swamps

Cedar swamps properly managed will yield good crops of posts, poles, lumber, cabin timber, and other products. With some modifications, practices used to improve, thin, and harvest mixed conifer swamps (pages 8 to 10) also apply to cedar swamps.

Cedar swamps may be thinned on sites where wind throw is not a serious problem. When markets exist for small cedar products, such as fence pickets, thinning of cedar can begin at an early age. Thinnings in older stands can be made for posts and other products (Fig. 6 and 7). The size and age to which cedar should be grown before a final harvest is made de-

Fig. 9 This 55-year-old natural stand of upland spruce-balsam was first thinned when it was 30 years old and the second time when it was 45 years old. It is growing pulpwood at the rate of 1.0 cord per acre per year.

pends largely upon the market demand for products. On average sites unthinned cedar stands will yield 6-inch cedar posts in 60 to 80 years, and small poles at about twice this age. Faster growth can be expected in thinned stands.

Following harvest cutting of cedar, the amount of balsam fir and hardwoods in the new stand usually increases considerably and grows vigorously in competition with the cedar. Early weeding of new stands to remove undesirable hardwoods will favor the growth of conifer reproduction.

The durability of cedar posts and poles is associated with growth rate. Cedar in dense stands grows at a slow rate and develops a high proportion of heartwood, which is very durable. On the other hand, cedar growing in thinned stands and making rapid growth develops mostly sapwood, which is non-durable. For this reason fast-grown cedar posts often last only 8 to 10 years in the ground whereas slow-grown posts may remain serviceable for 20 years or more.

Upland Spruce-Balsam Fir

The upland spruce-balsam fir type occurs on mineral soils on upland sites. The principal species in this type are white spruce and balsam fir. Common associates of these two species are white pine and hemlock and, in some localities, black spruce. This type is found on a fairly wide range of soils, including clays, but makes its best growth on well-drained loamy soils. On good sites spruce-balsam fir stands, properly managed, will grow timber at the rate of 1.0 cord per acre per year.

Upland spruce-balsam fir stand conditions vary considerably as a result of logging, fire, and other disturbances. Stocking ranges from poor to good, and both even-aged and uneven-aged stands occur. There is a strong tendency for hardwoods to invade this type, especially following cutting. As a result varying amounts of red maple, aspen, white birch, elm, yellow birch, and sugar maple are present in many stands. The hardwoods are generally poor in quality. There is a need to improve the quality and composition of the growing stock in most stands.

Stand Improvement Practices

A number of practices can be used to improve the quality and growth of young, thrifty spruce-balsam fir stands. The economic feasibility of doing improvement work will usually depend on how much salable timber can be removed in the operation.

Fig. 10 The selection method was used to harvest mature pulpwood from this spruce-balsam fir stand. Trees were removed in small groups and singly.

When markets permit, remove merchantable aspen overtopping immature stands (Fig. 8). At the same time eliminate any seriously defective hardwoods and cull trees that may be present. This may be done by girdling, felling, or the use of chemicals. If the spruce and balsam fir is large enough to yield salable products, also do thinning where trees are too dense. In the thinning operation leave the best trees to grow and remove the poorest ones. Stands may be thinned two or three times as they develop to maintain a good rate of growth (Fig. 9). A suggested guide for thinning is to thin so that the average spacing between trees does not exceed $\frac{1}{5}$ of the average height of the tallest trees. If the stand is made up mostly of balsam fir, a tolerant species, the spacing may be somewhat less.

Some stands are overtopped and crowded by sprout red maple and other hardwoods of such poor quality that they are unlikely to ever yield any appreciable amount of merchantable timber. Large tracts of these stands may be airplane sprayed with chemicals to kill the hardwoods (Fig. 1).

Spruce-balsam fir stands on good soils, such as a loam, often contain considerable good-quality aspen, white birch, maple, and other hardwoods of unmerchantable size. When doing improvement work in these stands, leave the good quality hardwoods to grow, as they are likely to yield considerable pulpwood, boltwood, and sawlogs when they reach merchantable size.

Following improvement cutting, exposed hardwood stumps, especially red maple, may be sprayed with chemicals to control the development of stump sprouts. It is recommended that aspen stumps not be sprayed. Root suckers of this species will make good growth in openings and produce pulpwood and other products.

Harvest

The selection method may be used to harvest mature trees from uneven-aged spruce-balsam fir stands (Fig. 10). Balsam fir is highly susceptible to butt rot. To avoid serious losses from rot balsam fir probably should not be grown beyond 45 to 50 years of age on average sites, and 55 to 60 years on good sites. White spruce will stay sound to a somewhat older age than balsam fir and may be grown to 70 or even 80 years of age. In the cutting operation remove the oldest and largest trees, singly or in small groups, and leave a good stocking of thrifty trees to grow, favoring the white spruce where there is a choice.

Also thin where trees are too dense, and remove undesirable hardwoods of all sizes and culls to improve the quality of the stand and favor the growth of spruce and balsam fir reproduction.

Clearcutting is also used to harvest mature spruce-balsam fir stands. This method applies best to overmature stands where advanced reproduction is present. The shelterwood method (page 4) is being tried experimentally to determine its applicability to this type. Use of these methods, as well as the selection method, frequently results in considerable invasion of hardwood brush. Elimination of this brush when conifer reproduction is about 5 feet in height, will help much to establish a new stand of spruce and balsam fir and keep hardwoods in check.

Harvest cutting in the upland spruce-balsam fir type does not always result in satisfactory reproduction of white spruce and balsam fir. Stocking is sometimes poor and the proportion of white spruce to balsam fir decreases. Planting of white spruce in openings will help much to improve stocking and maintain this valuable species in the stand.

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