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A PRACTITIONER'S GUIDE TO STRIP CLEAR-CUTTING IN BLACK SPRUCE

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CATEGORY: Stand management
KEY WORDS: Black spruce, strip cut, natural regeneration, careful logging, natural seeding

INTRODUCTION

Sites that support black spruce (*Picea mariana* [Mill.] B.S.P.) stands vary widely, but approximately half can be broadly classed as upland and half as lowland or peatland. Both site types present regeneration problems when harvesting is carried out by conventional clear-cutting. Furthermore, the same conditions that create difficulties for regeneration (i.e., thin soil over bedrock on upland sites and excess moisture on peatland sites) also mean that many of these sites are in the mid to low end of the productivity range.

As both funding and planting stock are limited, it is imperative that forest managers apply their resources judiciously. This can be accomplished by confining intensive (and expensive) regeneration systems primarily to the more productive sites, and employing extensive systems on poorer and/or less accessible sites. Alternate strip clear-cutting represents one low to moderate cost option for harvesting and naturally regenerating black spruce stands.

Research into strip clear-cutting in Ontario has indicated that black spruce can be regenerated successfully using the right combinations of strip width, leave time, and receptive seedbed.

The Canadian Forest Service–Ontario has been involved for many years in researching and developing this technique in cooperation with the Ontario Ministry of Natural Resources (OMNR) and the forest industry. *Strip clearcutting in black spruce: A guide for the practicing forester* (Jeglum and Kennington 1993) (Fig. 1) is a synthesis of knowledge and experience gained to date in this field. The aim of this technical note is to give the reader an overview of strip clear-cutting based on this guide.

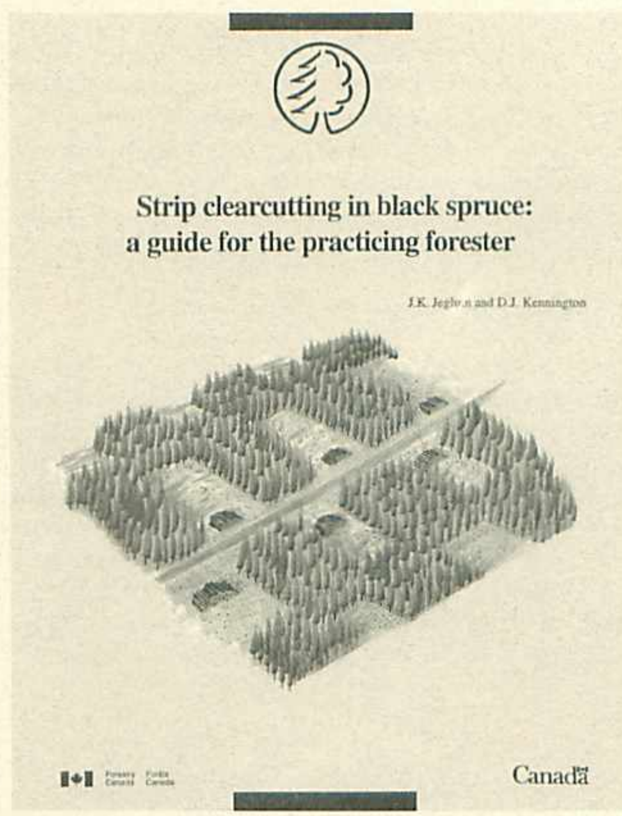

Figure 1. Strip clearcutting in black spruce: A guide for the practicing forester *was recently published by the Canadian Forest Service–Ontario.*

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BACKGROUND

The term "strip cutting" was first used in Ontario in the early 1900s to describe a method of clear-cutting that combined manual felling with horse skidding. Parallel strips about 20 m wide were cut and the logs were skidded down a central trail. Much of the advance growth was saved as a result of the minimal disturbance; however, at the time not much thought was put into regenerating the next stand — it occurred as a result of the logging technique itself.

In the mid to late 1940s the technique was carried out in demonstration trials and experiments, and later as an operational system. It was usually applied as a two-cut system, although sometimes three cuts were used. As a small-area clear-cutting method, the objectives were not only to regenerate stands inexpensively, but also to provide other advantages such as fire breaks, aesthetics, recreation, wildlife habitat, gene pool maintenance, and landscape diversity (Robinson 1987, Jeglum and Leblanc 1988, Nicolson 1988, Jeglum 1990a, Jeglum and Kennington 1993).

Strip cutting creates an opening intermediate to that of clear-cuts and strip shelterwood cuts. Normally strip cuts are less than 100 m wide, although 200-m strips on peatlands have achieved acceptable stocking levels when combined with good site preparation (e.g., shearblading). Strips as narrow as 10 m have been tried.

Until recently, strip cutting has not been commonly used, owing to the perception that it is more expensive due to the extra costs of harvesting and planning. On average it represents less than 1% of the annual provincial harvest of black spruce. However, when the combined costs of harvesting and regeneration are considered, the system is less expensive than the conventional clear-cut and plant approach.

IMPLEMENTING STRIP CLEAR-CUTTING

Strip cutting is an alternative to unrestricted clear-cutting. The guide proposes that strips be oriented to fit natural landscape patterns. Boundaries are determined by streams, wetlands, ridges, and other landform features. This practice also provides an opportunity to adjust the first and second cuts so that the harvest can be conducted initially on either the poorer or the richer segments of the landscape and later on the remaining segments. A variant of this would be to leave poor or fragile sites (e.g., steep hills with rock outcrops) unharvested while harvesting the mid slopes (Fig. 2, Fig. 3).

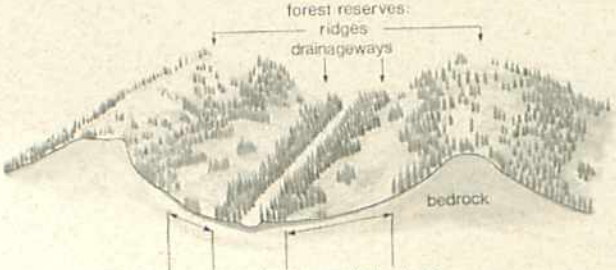

Figure 2. Implementation of strip cutting on hilly terrain.

The guide also discusses other aspects of implementing strip cutting such as site preparation, leave time between the first and subsequent cuts, regenerating the last strips cut, strip width considerations, and tending.

The amount of detailed information required for planning is illustrated in the guide with examples from operational trials, and from what has been found to work from formal research and the experience of practitioners. It is also emphasized that a wide range of values must be considered during the planning phase. Adaptations of strip layout related to such factors as terrain and landscape or to aesthetics should be taken into account.

Where advance growth is not abundant, or is irregular and patchy, strip cutting is an effective natural regeneration technique. Most often this method is applied on shallow soils over bedrock and on peatlands. The technique is also appropriate for remote areas where planting costs would be prohibitive. Strip widths should be chosen according to the potential moisture limitation of the site (e.g.,10–30 m on extremely shallow and dry sites, 40–60 m on moderately shallow soils or deeper mineral soil uplands, and 70–100 m on moist mineral and wet organic soils). On uplands, a light to moderate site preparation treatment such as disc trenching or patch scarifying is generally used to remove duff and expose the LH horizon. On stone-free, moist mineral and organic soils, shearblading is used to remove living layers of *Sphagnum* and feathermosses and to clear away slash. However, if advance growth is abundant it may be better not to shearblade.

Usually, leave strips are harvested after 3–5 years. Shorter leave periods are advisable to minimize the cost of road maintenance and losses to windfall (Fleming and Crossfield 1983, Whitney and Fleming 1994).

However, leave periods of 10 years or more may be appropriate for watershed protection, development of wildlife habitat, and landscape diversity. A consideration for regenerating the second (final) cut is to leave 10–15 m diameter groups of seed trees, spaced 70–90 m apart (Jeglum and Leblanc 1988; Jeglum 1990a, c; Jeglum and Kennington 1993).

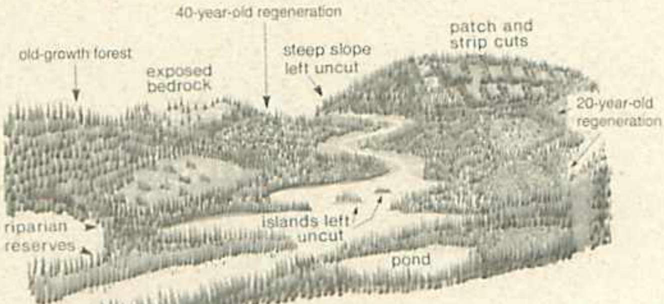

Figure 3. Implementation of strip cutting on rocky terrain and on poorly drained sites.

ECONOMICS OF STRIP CLEAR-CUTTING

The economics of strip clear-cutting have been considered in detail by Jeglum and Kennington (1993) and by Johnson et al. (1995). Depending on the combination of options, strip clear-cutting may range from high- to medium- to low-cost in relation to other methods available for black spruce regeneration (Jeglum 1990b). Compared to the clear-cut and plant approach, strip cutting can provide a net savings (harvesting and regeneration costs combined) of $25 to over $650 per hectare. A comparative analysis of costs for harvesting and renewal between strip cuts and clear-cuts for two leave periods and six renewal prescriptions (Table 1) shows that strip clear-cutting is cheaper than any method used to regenerate the second strips cut. Both spot seeding and group seed trees yield net savings of $400–700/ha. However, when a clear-cut is regenerated by seeding, this method is always cheaper than any strip cutting/regeneration option. Other advantages, such as environmental protection, aesthetics, wildlife habitat, and biodiversity, may still give strip clear-cutting additional value not accounted for in this analysis. A number of these values, such as the preservation of biodiversity and maintenance of the gene pool of black spruce on specific sites, are examined in the guide.

Table 1. Net combined harvesting and renewal savings (losses) by strip cutting instead of clear-cutting, by leave period and renewal prescription, for 183-m strips ($/ha) (*from* Johnson et al. 1995).

Prescription (clear-cut/strip cut)	Net saving or (loss) by leave period		
	3 yrs	5 yrs	10 yrs
A. Plant spruce/spot seed pine	676	596	457
B. Plant spruce/group seed trees	616	536	397
C. Plant spruce/plant spruce	246	165	26
D. Group seed trees/group seed trees	(125)	(206)	(344)
E. Spot seed pine/spot seed pine	(185)	(266)	(405)
F. Aerial seed pine/plant pine	(587)	(668)	(806)

MANAGEMENT IMPLICATIONS

Strip clear-cutting has both advantages and disadvantages that should be carefully weighed when this system is being considered as a harvesting option. The environmental impacts of forest harvesting are reduced when strip clear-cutting is adopted, because leave strips, buffers, and reserves help to prevent site degradation. The technique is regarded as intermediate between intensive and extensive forestry in terms of regeneration effectiveness, risk of failure, and cost.

Other kinds of small-area clear-cutting, such as patch, block, and irregularly shaped, terrain-adapted clear-cuts, can also be used to obtain natural regeneration from seed. In some cases, on both lowlands and uplands, small patches of unmerchantable black spruce (e.g., tops of bedrock knobs and mesas in shallow-soil terrain; centers of basin swamps) may be left for purposes such as wildlife habitat, diversity, and watershed protection.

Black spruce is generally not suited to the single seed tree regeneration method because of its lack of windfirmness (Robinson 1974). In one instance, however, unmerchantable (at time of harvest) black spruce residuals have been successfully used as seed trees in conjunction with prescribed burning on a peatland site (Chrosciewicz 1976). It is usually more prudent to leave groups of seed trees because these are likely to remain standing for a longer period of time.

The silvical characteristics of black spruce make it particularly suitable for strip and small area clear-cutting systems, in great part because of the generally abundant seed supply held in the semiserotinous cones. Such harvesting techniques lessen the negative visual and environmental impacts of clear-cutting, while adequately regenerating a site. They can also be practised successfully by a forest industry that is becoming increasingly responsible for the total management of the forest landbase. This reflects today's renewed commitment to sustainable forestry.

The strip cutting guide is available from the Canadian Forest Service–Ontario by contacting the address at the end of this technical note.

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Technical Note No. 67

DISEASE AFFECTS WINDFALL IN UPLAND BLACK SPRUCE STRIP CUTS

R.D. Whitney and R.L. Fleming

CATEGORY: Stand management
KEYWORDS: Black spruce, windthrow, windfall, blowdown, strip cuts, root rot

INTRODUCTION

Clear-cutting in alternate strips is well suited as a harvesting technique in the widespread black spruce (*Picea mariana* [Mill.] B.S.P.) stands of the boreal forest. These stands often occur on fragile, shallow, or peatland soils where regeneration by planting is difficult and expensive. This technique is applied by harvesting the stand in two stages. First, alternate strips are cut. Then, after these areas are naturally regenerated, the leave strips are removed.

When the leave strips are logged, excessive windfall[1] is often encountered. This reduces stand volume and value, and restricts accessibility for the logging operation (Fleming and Crossfield 1983). The leave period between the first and second cuts varies from 2 to 5 years. During this period substantial windfall (relative to undisturbed stands) can occur along the newly exposed stand edges (Fig. 1). Following the initial cut, the previous mutual shelter provided by adjacent trees is reduced and wind speed and turbulence are increased. This environmental change is critical for tree species with shallow roots (e.g., black spruce).

LOSSES TO WINDFALL

Newly created stand edges not only expose previously protected trees to increased wind speed and turbulence, but the changed conditions often result in increased tree mortality[2] along the exposed edges. The majority of volume lost to windthrow and stem breakage in black spruce leave strips occurs near these edges; exposed corners sustain the most damage. In a study conducted in northern Ontario, the total volume losses resulting from windfall, standing dead trees, and wind breakage in operational leave strips (>55 m wide) exceeded that in the uncut forest by 6 to 10% of the merchantable volume over a period of 2 to 4 years (Fleming and Crossfield 1983). However, these losses can be reduced by some 60% by prorating them over the entire cut and uncut forest. Windfallen trees not recovered for industrial use cause an increase in harvesting costs in two ways: by reducing the volume of merchantable trees, and by affecting machinery performance (Jeglum and Kennington 1993).

Figure 1. Black spruce windfall along the edge of a leave strip in a mature stand near Nipigon, Ontario.

[1]The terms "windfall", "windthrow", and "blowdown" are used interchangeably in this report and refer to trees broken off at ground level or uprooted by winds, usually stronger than 80 km/hr. "Wind breakage" refers to trees broken off above ground level by such winds.

[2]The terms "standing dead" and "mortality" are used interchangeably in this report and refer to trees in the canopy that have died.

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FACTORS AFFECTING BLOWDOWN IN LEAVE STRIPS

At the new stand edges the modified physical and biological characteristics affect both stand dynamics and individual trees. In the northern Ontario study, Fleming and Crossfield (1983) found leave time, strip edge/area ratio, stand density, and site index to be the most important factors affecting windfall and mortality in black spruce strip cuts. Mean total black spruce volume losses varied from 4.4% in newly cut strips to 18.7% in residual strips adjacent to those cut 5 years earlier (Table 1). This compared with a mean total black spruce volume loss of 2.9% in uncut, undisturbed forest. Windfall losses decreased with increasing leave strip width but not with increasing strip length, and the greater the perimeter relative to the strip area, the greater the blowdown. Tree height, diameter, merchantable volume, and site index were all positively correlated with blowdown.

Table 1. Cumulative percent volume loss to windfall and mortality in uncut forest and in 0- to 5-year-old leave strips, black spruce only (*from* Fleming and Crossfield 1983).

	Strip leave time (years)						
Loss type	Uncut forest[a]	0[b]	1	2	3	4	5
New windthrow	1.8	1.9	5.4	9.8	12.2	11.2	12.4
New breakage	0.3	0.7	1.0	1.2	0.9	3.1	1.7
New standing dead	0.7	1.8	2.6	1.8	3.6	3.2	4.7
Total new mortality	2.9	4.4	9.0	12.7	16.7	17.5	18.7
Sample size (strips)		18	19	20	10	5	2

[a] Values obtained from internal plots (minimum 20 m from a cut face) in newly established strips.

[b] Newly established control strips.

In another Ontario study, Atkinson and Haavisto (1974)[3] found volume losses in 40- and 100-m wide leave strips to be 1.8 and 0.7 m^3 per ha, respectively.

Stand Type and Density

The degree of exposure of a tree influences its windfirmness. Trees that are open grown from the sapling stage are much more windfirm than are closely spaced trees. Because they have developed under exposed conditions, dominant trees are generally windfirm, even though their larger, taller crowns are more exposed to the wind. Trees in the lower crown classes require the protection afforded by larger adjacent trees, but frequent light thinnings during the life of a stand can increase the windfirmness of residual stems.

Trees in even-aged stands of uniform height rely on mutual protection for stability, and such stands may be quite windfirm as long as they remain intact. However, once opened by partial cutting or blowdown they become vulnerable to additional wind damage.

Site Quality

On soils of a given depth, windfall losses are greater on richer sites than on poorer ones. This is due in part to the larger size of trees and to the greater incidence of root and butt rots on good sites (Whitney 1962). Also, trees growing on soils 30 cm or more deep are more windfirm than those on shallower soils. It has also been found that residual stands of black spruce suffered heavier losses on upland than on lowland sites (64% vs 30%, respectively, 6 to 7 years after cutting) (Bowman 1944).

Healthy, lowland stands are able to withstand storms (60–80 km/hr winds) quite well, even when stocking is moderately reduced as a result of partial cutting. However, stand faces exposed for long distances create blowdown hazards, especially if trees are overmature or occur on shallow peat overlying bedrock or boulder-till soils. Trees with plate-like roots, growing on soils where drainage is poor, are especially prone to windfall (Fig. 2). During high winds, tree roots on rock or boulder outcrops are often abraded by repeated rubbing against rock surfaces. This damage creates infection courts where root-rotting fungi can enter.

Figure 2. Flat, plate-like root systems of windfallen mature black spruce on thin soil near Nipigon, Ontario.

Stand Density

In the northern Ontario study, Fleming and Crossfield (1983) found that black spruce stand density was inversely correlated with the percentage of volume lost to windfall.

Tree Diseases

As a species, black spruce is relatively free from disease; however, it is among the most susceptible to root rotting fungi. In uncut, upland stands, trees commonly develop butt rot at 70 to 90 years of age. This makes them subject to windfall. Not only is the mechanical strength of the root weakened but, because of resulting root mortality, rot reduces and restricts the mass of soil held by the root. Wind breakage and uprooting of stems with butt rot are common causes of mortality in mature and overmature black spruce stands in

[3]Atkinson, G.T.; Haavisto, V.F. 1974. Blowdown in the Sangster stripcut area: A summary of results from a pilot study. Dep. Environ., Sault Ste. Marie, ON. File Report. 6 p.

northern Ontario (Whitney 1988). Root rot (Fig. 3) weakens the roots and lower bole of trees, thereby making them more susceptible to windfall. On peatland sites, deterioration from butt rots is much slower or even absent. Stands in such areas outlast those on the better drained uplands.

Over 68% of northern Ontario black spruce between 26 and 208 years of age have some degree of root decay; on average, 28% of the root and stump wood is decayed or stained. The average is higher in balsam fir (*Abies balsamea* [L.] Mill.) and slightly lower in white spruce (*P. glauca* [Moench] Voss) (Whitney 1988). Trees that blow over in the wind are those with the most root rot or combination of root rot and degree of exposure (Alexander 1967). A large portion (50 to 60%) of the roots may be decayed before aboveground symptoms appear. Studies have revealed an abundance of root decay in many windfall sites. These studies further show that tree resistance to windfall is much reduced when roots are rotted. Trees with 60% or more of the root wood decayed or stained are prone to windfall and may be killed outright if the decay reaches the sapwood, or if adjacent root bark is killed (Whitney 1962).

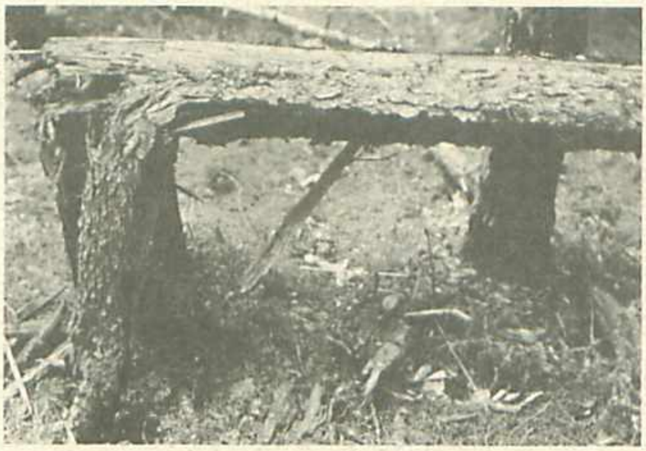

Figure 3. Ninety-year-old windfallen black spruce with heavy root and butt rot.

Causal Fungi

Tomentosus root rot, a white pocket rot caused by *Inonotus tomentosus* (Fr.) Teng, was commonly found in the windfallen and dead standing trees in the northern Ontario study. This fungus not only contributes to windfall by weakening the structure of the tree, but kills spruce trees outright when it spreads to the sapwood and bark of the large roots and stump area (Fig. 4).

Another major fungus consistently isolated from windfallen trees in northern Ontario is *Coniophora puteana* (Schum. ex FR.) Karst., the cause of a brown cubical decay (Fig. 5). This fungus invades via wounds at or near ground level, travels through the stump, and spreads as much as 3–4 m upward in the stem of large trees. Some 20 other decay fungi, including *Armillaria ostoyae* (Romagn.) Herink, attack the roots of black spruce in northern Ontario (Whitney 1988). This latter fungus, isolated from the roots of 41% of the living black spruce sampled in that region, is known to be capable of killing black spruce trees of all ages.

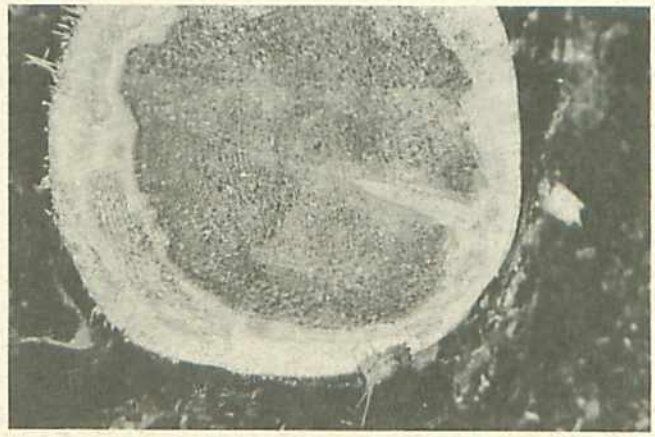

Figure 4. Tomentosus root rot at ground level in a 79-year-old black spruce stand near Geraldton, Ontario.

Figure 5. Brown cubical decay in the lower stem and roots of windfallen 100-year-old black spruce near Nipigon, Ontario.

On soils of high Soil Moisture Regimes, such as those found in peatland or swampy areas, root rot is of little consequence on black spruce. (One exception is the unnamed, yellow stringy decay fungus known as Unknown F.) Shallow, plate-like root systems make trees subject to windthrow on such sites (Fig. 2). Root rots are more prevalent in black spruce at a given age on coarse-textured, well-drained upland sites of low to moderate Moisture Regime. Trees in residual strips on these sites are therefore vulnerable to windthrow, especially if growing in exposed locations such as upper slopes or ridge summits.

The stem rotting fungus *Phellinus pini* (Brot.: Fr.) A. Ames, along with several of the root rotting fungi that extend 2 or 3 m up the stem, weakens the wood and results in increased likelihood of stem breakage when trees are exposed to wind.

SUMMARY AND MANAGEMENT IMPLICATIONS

In northern Ontario, windfall and mortality are greater in leave strips than in uncut forest stands. Leave time was the most important factor affecting volume loss. In strips equal to or greater than 55 m in width, losses additional to those in uncut stands averaged 6.0, 7.8, and 10.0% of merchantable volume in 2-, 3-, and 4-year-old leave strips, respectively. Prorated over the entire area, these losses were 2.4, 3.1, and 4.0%, respectively.

Wide strips with only one end exposed sustained the least windfall and mortality per unit area. Lower stand density and higher site indexes contributed to greater windfall and mortality in leave strips. Overmature trees, those with unstable root systems, and those with butt or stem rot are especially susceptible to damage.

Management recommendations to reduce losses to windfall in strip cuts:

1. In relatively dense stands growing on poor to moderately productive sites, establish long, wide (>40 m) residual strips with only one open end (unless the stand has been open-grown from the sapling stage).
2. Minimize the leave period by cutting leave strips as soon as harvested areas have regenerated.
3. Do not position cut boundaries on poorly drained or shallow soils (shallow root systems).
4. Position boundaries in healthy stands with sound trees. Trees with decayed or machinery-damaged roots are poor risks.
5. If possible, position cut boundaries in young, immature stands.
6. Avoid positioning cut boundaries on ridges, upper slopes, or in areas exhibiting prelogging windthrow damage.

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