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COSTS OF ALTERNATE STRIP CUTTING AND CLEAR-CUTTING IN UPLAND BLACK SPRUCE

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INTRODUCTION

The most widely used method of harvesting upland black spruce (*Picea mariana* [Mill.] B.S.P.) is clear-cutting. However, this exposes harvested sites to wind and high temperatures, results in dry surface conditions, and may render areas susceptible to erosion. Often compounding the problem is an inadequate supply of viable seed for natural regeneration following harvest operations. In turn, this limits the manager's options for regenerating the area. These problems are accentuated on shallow-soil sites over bedrock, where there is little mineral soil for conventional planting. In strip cutting (Fig. 1), residual strips provide seed for the regeneration of harvested areas and protect natural growth from excessive drying (Jeglum and Kennington 1993).

To investigate harvest alternatives that could mitigate this regeneration problem, a cooperative research project involving the Canadian Forest Service – Ontario, the Ontario Ministry of Natural Resources, and Domtar Inc. was initiated in 1973. Emphasis focused upon an examination of the effectiveness of alternate strip cutting on shallow-soil upland sites.

Alternate strip cutting results in higher harvesting costs than those associated with conventional clear-cutting. Ketcheson (1979) provides an analysis of these additional costs. However, depending on the harvesting method used, savings can be realized when regenerating the next stand. Therefore, costs should be considered in the broader context of integrated harvesting and renewal (Johnson and Smyth 1987). To be conservative, the highest planning, layout, and supervision costs encountered in five Forest Management Agreement's were used for this project.

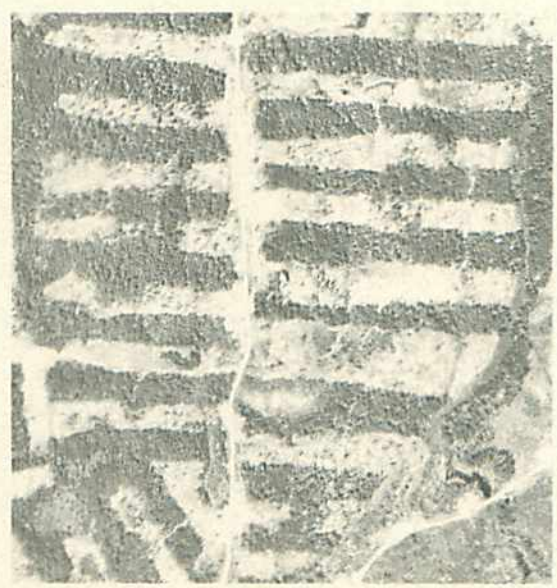

Figure 1. Aerial view of a strip cut area in north central Ontario.

ADDITIONAL STRIP CUTTING HARVEST COSTS

Additional harvesting costs, as well as the renewal savings associated with alternate strip cutting, were estimated for strips 60 m wide and both 183 m and 366 m long. Leave periods between the initial and final harvests were 3, 5, and 10 years. Figure 2 illustrates, by leave periods, the items that contribute to extra strip cutting costs for strips 183 m in length. Table 1 presents the costs and assumptions used.

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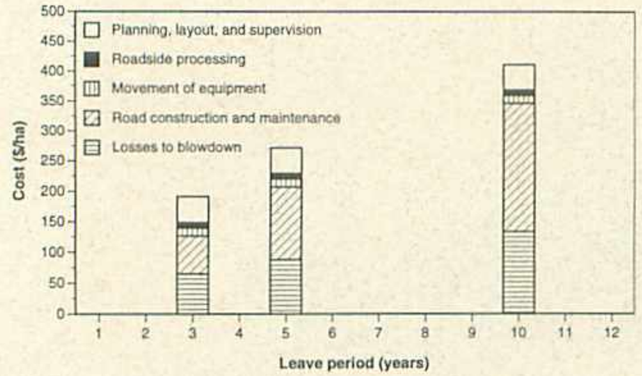

Figure 2. Additional costs of alternate strip cutting over those of clear-cutting for three leave periods in areas harvested using strips 183 m in length.

STAND RENEWAL COSTS

The three most important elements affecting the cost of stand renewal are site preparation, stock procurement, and planting/seeding costs. The four stand renewal options considered in the cost analysis by Johnson and Smyth (1987) were: planting black spruce or jack pine (*Pinus banksiana* Lamb.) container stock, spot seeding jack pine, and aerially seeding jack pine. Seeding black spruce was not considered to be an operational practice at that time.

The underlying assumption of alternate strip cutting is that the first strip cut will be adequately stocked with natural regeneration by the time the residual strip is harvested, up to 10 years later. In all, 12 renewal prescriptions were developed in the original study by pairing clear-cut/strip cut renewal options.

These options were applied to both types of cuts, with the exception of aerial seeding, which was not included in the field trials. Aerial seeding may be considered as a viable option to regenerate residual strips; however, because of operational considerations, both the residual and previously cut strips would be seeded. Therefore, the cost would be the same for both methods ($6.96/ha), as shown in Table 2.

OTHER REGENERATION OPTIONS

Other possible stand-renewal options include the use of group seed trees or planting with miniplugs[1]. The group seed tree method was developed to avoid having to artificially regenerate the final harvested strips (Wood and Raper 1987). Although this method is not used operationally on the thin soils of north central Ontario, if seedbed conditions permit it is employed to regenerate both strip cuts and clear-cuts on clay and organic soils in northeastern Ontario. Cost estimates are also presented for its use in clear-cuts. Table 2 provides a summary of the additional stand renewal costs associated with strip cutting. Figure 3 summarizes the net saving or loss associated with stand renewal for each of five options. Only one of these is more cost-effective for clear-cuts than for strip cuts.

The results of planting over 300,000 black spruce miniplugs since 1988 are promising in terms of survival and early growth (R. Booth, Domtar Inc., pers. comm.). However, further research into the use of miniplugs is currently being conducted.

RESULTS

Figure 4 illustrates the net savings that result from strip cutting for six harvest/renewal combinations, as compared to clear-cutting. The options shown reflect the range of costs for strips 183 m in length for 3- and 10-year leave periods. Costs were only marginally less for strips 366 m in length.

Not all of the strip cutting alternatives resulted in savings. Study results would indicate that if an area can be clear-cut and regenerated by scarification and seeding, the manager

Table 1. Estimated additional harvesting costs of strip cutting as compared with clear-cutting (*from* Johnson and Smyth 1987). All costs are converted to constant 1985 dollars based on the Gross National Expenditure Implicit Price Index.

Activity	Additional cost ($/ha)			Notes and assumptions
Planning, layout, and supervision	42.50			
Felling and forwarding	–			Similar for both strip lengths.
Slashing	9.01			Two sweeps of the road are required for strip cutting and more time is needed to move between wood piles.
Loading and hauling	–			Similar for both cutting systems.
Equipment overhead	13.31			Includes additional costs of servicing harvesting equipment and moving it to and from a site.
	Leave period (years)			
	3	5	10	
Construction and maintenance of secondary and tertiary roads	61.65	119.21	211.98	Deterioration increases with leave period; therefore, costs vary directly with it.
Blowdown losses in residual strips	65.00 5.4 m³	88.00 7.3 m³	134.00 11.2 m³	Value* of timber. Net mortality due to blowdown left on site is proportional to the length of leave period. Assume in-strip machine productivity is unaffected by blowdown.

*Value includes stumpage and overhead costs such as administration, planning, and garage costs.

[1]Miniplugs refer to container stock grown to a height of 4 cm in cavities that measured 1 cm in diameter by 4 cm in depth.

Table 2. Summary of stand renewal costs. All areas scarified using light equipment (e.g., Bräcke, disc trencher) are adequate for both systems with no significant differences in per unit area cost.

Activity	Costs[1] ($/ha)		Notes and assumptions
	Strip cuts	Clear-cuts	
Scarification	Ignored		
Container seedlings			
Black spruce	235.63	471.25	$188.50/1,000 seedlings, 2,500 seedlings/ha
Jack pine	225.63	451.25	$180.50/1,000 seedlings, 2,500 seedlings/ha
Seed			
Aerial	24.41	24.41	$140.87/kg, 288,500 viable seeds/kg, 50,000 seeds/ha (aerial)
Spot	6.11	12.21	25,000 seeds/ha
Planting	201.37	402.73	$161.09/1,000 seedlings
Seeding			
Aerial	6.96	6.96	
Spot	39.40	78.80	
Group seed trees			
Layout	40.96	81.92	Marking costs assumed equal to that of initial strip layout.
Volume lost	25.50	51.00	Stumpage value of wood.

[1]Assumes that the initial strip cut will have been successfully regenerated, therefore costs are halved vs. those for clear-cuts.

should in all cases choose this option over strip cutting. This is because seeding, if successful, is the cheapest method of regenerating a site.

However, if planting is required after clear-cutting, strip cutting is less expensive in all cases, no matter which method is used to regenerate the residual strips.

Longer strips result in marginally higher net savings for each harvest/renewal alternative due to the lower density of tertiary roads required and reduced loss to blowdown.

Shorter leave periods result in higher savings because of the compounding effect of road construction capital costs, lower road reconstruction charges, and the direct relationship between leave period and blowdown (Fleming and Crossfield 1983).

MANAGEMENT IMPLICATIONS

The net cost of harvesting and regenerating a site should be examined, since decreased regeneration costs may offset increased harvesting costs. However, the decision to strip cut cannot always be based solely on cost. The choice of harvest and renewal systems may be determined by the site itself; for example, to either strip cut or designate the area as a protection forest may be the only options available on certain fragile sites.

An important assumption underlying this analysis is that strip cutting will not reduce harvesting productivity in the residual strip. An increase in extraction costs of $6/m^3$ would negate any savings, even for the best strip cut renewal option.

Higher harvesting costs are associated with strip cutting than with clear-cutting because twice as much area must be covered to extract the same volume. Therefore, managers who are unaware of the stand renewal savings offered by strip cutting will naturally discriminate against this system. The problem is compounded if different departments of an organization are responsible for harvesting and stand renewal, because the most efficient combination of silvicultural operations may not be chosen. Managers should employ the most cost-efficient harvesting/renewal combination available, but also keep in mind broader issues related to sustainable development.

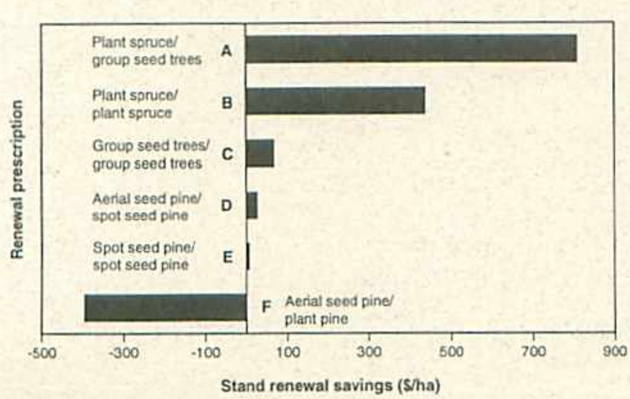

Figure 3. Savings realized by six renewal options in strips 183 m in length, comparing clear-cuts to strip cuts.

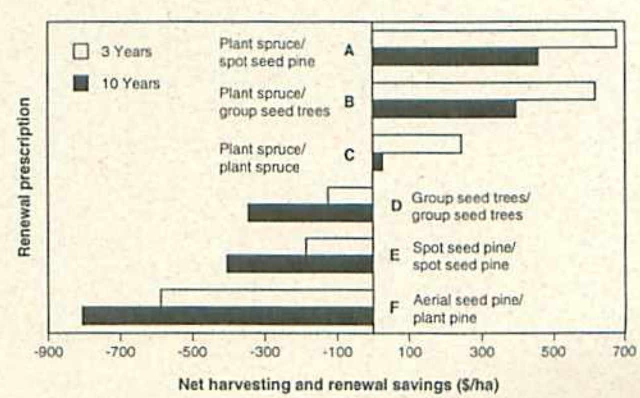

Figure 4. Net harvesting and renewal savings for two leave periods and six renewal prescriptions for strips 183 m in length, comparing clear-cuts to strip cuts.

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