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STRIP CUTTING: CAN IT CURB THE SHIFT FROM BLACK SPRUCE TO MIXEDWOOD STANDS?

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INTRODUCTION

The 1992 report on the status of forest regeneration in Ontario (Hearnden et al. 1992) documented that major species compositional shifts have occurred following harvesting. Virgin coniferous stands, especially black spruce (*Picea mariana* [Mill.] B.S.P.), have frequently regenerated to deciduous species. This shift in composition seems to be a result of current forestry practices rather than a natural phenomenon. Regeneration during the horse-logging era was often comprised of unmerchantable-sized residuals or, in the case of overmature stands, well-established advance growth that was not destroyed by harvesting.

From the mid-1970s to the mid-1980s, a cooperative study was carried out by the Canadian Forest Service–Ontario, the Ontario Ministry of Natural Resources, and Domtar Inc. on the company license to determine whether strip cutting (Fig. 1) was a biologically and economically acceptable harvesting system to naturally regenerate black spruce on shallow soil sites. This technical note describes changes in species composition within the first 5 years after harvesting. The results are compared with regeneration survey data from clearcuts on the former limit area of James River–Marathon Corp. (formerly American Can Canada Inc.) north of Marathon, Ontario.

STUDY AREAS

At Nipigon, the preharvest forest was dominated by black spruce (Table 1). The approximately 115-year-old fire-origin stand was overmature, blowdown was a frequent occurrence, and regeneration was abundant on the throw-mound scars. Most advance growth was balsam fir (*Abies balsamea* [L.] Mill.) and black spruce, but white birch (*Betula papyrifera* Marsh.) seedlings were also abundant.

APPROACH

The study examined a number of factors that could have an important influence on regeneration. These included strip width, leave time, scarification, topographic position, seedbed conditions, and vegetative regrowth (Jeglum 1980). Strip widths were 20 m, 40 m, and 80 m. Leave periods for the residual strips were 2 and 4 years. The study was replicated in three areas, each of which had 1,400 permanent quadrats sampled before the cut. Half this number (the first-cut strips) were sampled 1, 3, and 5 years following the cut.

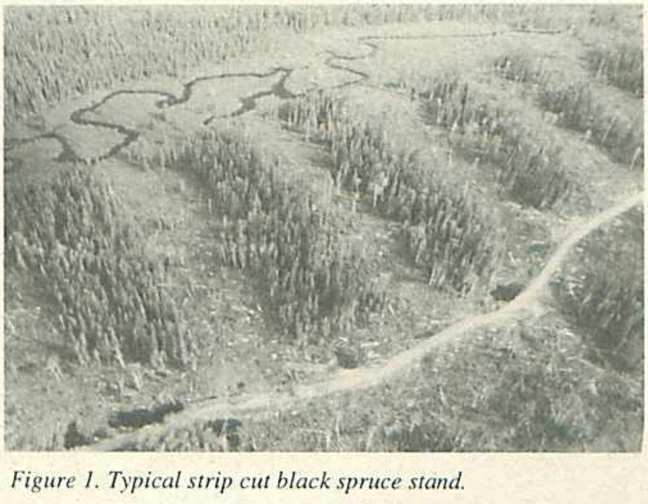

Figure 1. Typical strip cut black spruce stand.

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Table 1. Percent stocking in the preharvest forest: Nipigon strip cut experiment, Study Area 1.

	Percent stocking (4 m² basis)		
	Trees	Saplings	Seedlings
Black spruce	19	2	54
Balsam fir	4	7	70
Jack pine	5	0.1	0.4
Trembling aspen	2	0.1	9
White birch	1	0.1	32
All species	28	10	86

In July 1975, soon after harvesting, the first-cut strips were scarified using rubber-tired skidders pulling flanged barrels. Unscarified 40-m strips served as controls.

Regeneration assessments were based on 2-m x 2-m single examination plots. Natural regeneration data in the black spruce cover type recorded 5 years after the harvest were analyzed in terms of Moisture Regime (MR) and topographic relief category.

RESULTS

Nipigon Strip Cuts

The relative stocking percentages of the main species in the original forest and the postharvest regeneration are compared in Table 2. The original forest was dominated by conifers (89%), but the postharvest regeneration is a mixture of approximately equal quantities of conifers and hardwoods. The relative proportions of black spruce and jack pine *(Pinus banksiana* Lamb.) decreased, while those of trembling aspen *(Populus tremuloides* Michx.) and white birch increased.

Examining the influence of topographic position and scarification on changes in species composition reveals differences in response to treatment, as shown in Table 3.

Hardwood competition increased relative to conifers in all topographic site positions, although somewhat less so in the drainage ways. In drainage ways, black spruce had higher stocking in the nonscarified strips, whereas on the upper slopes and crests it was higher in the scarified areas. For balsam fir, stocking was usually higher in the nonscarified strips. For jack pine and white birch, scarification led to higher stocking on lower slope, upper slope, and crest sites. Similar values were obtained for trembling aspen on all site types, independent of scarification.

Industry Clear-cuts

To compare results between strip cut and clear-cut areas, for which site types are classified differently, it was necessary to interrelate the two classification systems. Dry and Fresh Moisture Regimes, and medium relief types were interpreted as predominantly shallow-soil uplands; Moist and Wet MRs, and gentle and flat relief types, were classified as wetlands. This included the moist upland sites that are transitional to wetlands.

Fifth year regeneration survey results showed that Dry and Fresh MRs and medium relief sites had comparable stocking levels, 31–36% and 30–36%, for black spruce and trembling aspen, respectively (Table 4).

Comparing the results of strip cuts (Table 3) to clear-cuts, it appears that aspen has uniformly increased in relative stocking in both clear-cut and strip cut areas and, to a certain extent, so has balsam fir. White birch has much lower stocking in the clear-cuts. In the clear-cut areas, the absolute stocking to aspen and spruce is 22 and 23%, respectively. This is considerably less than in the strip cuts. Black spruce and balsam fir tended to have higher relative stocking in the Moist to Wet MRs and gentle to flat sites (Table 4). Aspen and birch were relatively unimportant stand components.

Table 2. Composition of the original forest, and of the postharvest regeneration on strips with 2 and 4 years of natural seeding, Nipigon strip cut experiment, Study Area 1, scarified strips (relative percent stocking)[a].

Species	Preharvest (mature trees)[b]	Regeneration 2 years[c]	Regeneration 4 years[d]
Black spruce	61	27	31
Balsam fir	13	15	15
Jack pine	16	8	9
Trembling aspen	6	21	18
White birch	3	29	26
Conifers	89	48	53
Hardwoods	11	52	47

[a] A quadrat could contain all five species or any combination thereof. Breakdown by species or class will alter proportions.
[b] 1,400 quadrats.
[c] 300 quadrats.
[d] 265 quadrats.

Table 3. Composition of natural regeneration (% stocking) 5 years after harvesting in scarified (S) and nonscarified (N) first-cut strips in four topographic site types (all widths and leave times combined), Nipigon strip cut experiment, Study Area 1.

	Topographic site types									
	Drainage way		Lower slope		Upper slope		Crest		All	
	S	N	S	N	S	N	S	N	S	N
Black spruce	39	73	57	61	62	41	62	54	58	59
Balsam fir	20	35	22	35	41	41	32	23	30	35
Jack pine	3	0	19	4	20	4	13	5	17	3
Trembling aspen	30	37	37	41	43	47	43	46	39	42
White birch	45	45	50	47	60	41	59	41	55	44
Conifers	47	83	68	70	80	69	70	72	71	73
Hardwood	61	60	67	65	74	69	73	62	70	64
All species	72	92	86	85	91	78	87	85	86	85

Though no data were gathered on stem density, it was observed that density values were higher in the strip cuts. The low stocking levels for most species in the clear-cut areas were comparable to levels in the Nipigon strip cuts. Until the mid-1960s this was largely attributable to winter logging, in which bundles of logs were forwarded by high lead cable yarding. This resulted in minimal surface disturbance and hence little creation of receptive seedbeds. Clear-cutting of the black spruce stand component removed most of the seed source and the lack of seedbeds inhibited regeneration of white birch. Most black spruce regeneration resulted from advance growth; most aspen regeneration resulted from suckering.

DISCUSSION

Clemmer and Atkins (1980)[1], in assessing cutover conditions on the same Nipigon limits as the strip cuts, noted that during the horse-logging era balsam fir comprised most of the regeneration on upland sites, black spruce regeneration dominated the wetter lowlands, and jack pine was almost completely prevented from regenerating. With the advent of mechanized logging and mechanical site preparation in the late 1960s, spruce and jack pine now comprise 39% of the working groups; previously they comprised 65%. Also, balsam fir, mixedwood, and hardwood groups have increased from 35 to 61% following harvest.

Studies to date suggest that after both clear-cutting and strip cutting there is an increase in the hardwood component in the black spruce cover type. For example, Frisque et al. (1978) documented a compositional shift on black spruce uplands from a ratio of 88:12, softwood/hardwood before logging, to 51:49 after logging. This is comparable to the results of this study, where a shift from 89:11 to 53:47 was observed in the strips after 4 years of natural seeding.

Even though there are shifts toward hardwoods, the levels of black spruce are acceptable or desirable for a pure spruce stand. It is probable that the hardwood component will disappear due to natural mortality over time, and that the stand will move closer to the original high proportion of conifer:hardwood.

Seedbeds created by harvesting or site preparation are often invaded by hardwoods that regenerate from seeds supplied by residual standing trees. The original, predominantly coniferous stands regenerate to mixedwood stands dominated by various proportions of black spruce, white birch, and trembling aspen.

In the horse-logging era, when harvesting was usually conducted in winter, little destruction of advance growth or ground surface disturbance occurred. Hence, balsam fir advance growth was preserved on the upland sites (Maclean 1960, Hughes 1967). Without site disturbance, species requiring exposure of the lower humus layers and mineral soil for seed germination, such as black spruce, jack pine, and white birch, are not favored.

Several authors have noted that site preparation, although effective in increasing spruce and pine regeneration, also favors hardwood species, which grow faster and offer vigorous competition to conifers (Hughes 1967, Ellis and Mattice 1974). Scarification also effectively destroys balsam fir advance growth, which does not subsequently regenerate by seeding or suckering.

Table 4. Absolute and relative stocking of natural regeneration 5 years after logging in clear-cut black spruce cover types on James River–Marathon Corp. license areas.

	Moisture Regime			Terrain type		
Species	Dry and Fresh	Moist	Wet	Medium	Gentle	Flat
Absolute stocking ($4\ m^2$ basis)						
Black spruce	23	14	21	23	21	18
Balsam fir	21	20	17	13	17	19
Jack pine	--	--	--	--	--	--
Trembling aspen	22	20	9	23	13	9
White birch	8	3	3	5	4	3
All species	74	57	50	64	55	49
Relative stocking ($4\ m^2$ basis)						
Black spruce	31	25	42	36	38	37
Balsam fir	28	35	34	20	31	39
Jack pine	--	--	--	--	--	--
Trembling aspen	30	35	18	36	24	18
White birch	11	5	6	8	7	6
All species	100	100	100	100	100	100

(Source: Unpublished data provided by James River–Marathon Corp.)

MANAGEMENT CONSIDERATIONS

Compositional changes after harvesting vary according to precut stand conditions, understory vegetation, site types, the season and method of cutting, the distribution of residual trees, and the distance to the nearest seed source. Postharvest treatments, such as scarification, prescribed fire, and chemical weed control, also play a role, as does the degree of suckering and the occurrence of stress-induced cone crops. Because of the influence of these factors on species composition, they should be assessed prior to harvest and be considered when developing a treatment prescription. Evidence is presented that drainage ways and lower slope locations are moist enough to regenerate adequately to black spruce dominated softwood cover types without scarification. Scarification can in fact lead to the "mucking up" of these lowland sites, as well as to the proliferation of undesirable graminoid competition.

[1] Clemmer, E.; Atkins, T. 1980. St. Lawrence licence cutover assessment final report. Ont. Min. Nat. Resour., Nipigon District, Nipigon, ON. Unpubl. Rep. Mimeo. 46 p.

Shallow soil upland sites actually encompass a wide variety of conditions: rock crests or plateaux with very shallow soils or bedrock, cliffs, boulder outwash, and patterned areas consisting of rock ridges and peaty drainage ways. These sites or portions of them can be considered as either nonplantable or plantable. Nonplantable sites should be excluded from harvest, or harvested in narrow strips to avoid compositional changes and stand deterioration. On plantable sites, consideration should be given to the removal of white birch during the harvest, girdling of aspen prior to harvest, or only a partial harvest to discourage suckering. This should be followed by stand tending to minimize compositional changes. The recent growth in markets for hardwood species is an encouraging development that should assist in this effort.

Strip cutting black spruce stands can help curb the shift to mixedwood stands, but to accomplish this several management measures must be considered. Implementation of strip cutting must also reflect the local site characteristics if it is to meet desired objectives.

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