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SURVIVAL OF BLACK SPRUCE ADVANCE GROWTH FOLLOWING THREE HARVESTING METHODS

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CATEGORY: Regeneration
KEY WORDS: Black spruce, low-cost regeneration, advance growth, careful logging

INTRODUCTION

In northeastern Ontario, black spruce (*Picea mariana* [Mill] B.S.P.) advance growth is often abundant on a variety of moist to wet site types prior to harvesting (Groot 1984). This has prompted greater interest in the need for careful harvesting (Fig. 1).

Preserving advance growth is attractive for a number of reasons. Because a site can be assessed as being restocked immediately after harvest, with no further treatment required, costs related to artificial regeneration such as seed and seedling production, site preparation, and tree planting are avoided. Also, preservation of advance growth returns the locally adapted gene pool to the site. Recent research has shown that the height growth of black spruce advance growth following harvest compares favorably with that of planted trees (Doucet and Boily 1986). Since advance growth usually has an initial size advantage over planted or seeded trees, the stand rotation period is often shorter (Archibald and Arnup 1993).

Figure 1. Black spruce advance growth 10 years after harvesting near Smooth Rock Falls, Ontario.

Harvesting equipment and methods have been evolving as the forest industry has attempted to balance the need to control costs with the need to protect advance growth (Gingras 1991). Information is currently lacking on what proportion of advance growth survives the harvest when using different harvesting methods. This note summarizes a study that compared the survival of advance growth following harvesting of peatland black spruce stands by three methods that were in use in the early 1980s.[1]

APPROACH

The study was carried out in peatland stands dominated by black spruce, which contained abundant black spruce advance growth in the understorey. The basal area of these stands averaged 22 m²/ha. Forest Ecosystem Classification (Jones et al. 1983) Operational Groups (OGs) 11 and 12 (*Ledum* and *Alnus*/herb-poor) predominated in these stands, which were located within 80 km of Kapuskasing, Ontario.

Harvesting took place between 1982 and 1984. Operators were unaware that they were working in experimental blocks.

[1]Groot, A. Harvesting method affects survival of black spruce advanced growth. Northern J. Appl. For. (In press).

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Skidding distances varied from 75 to 200 m, and all merchantable trees were removed. Three harvesting methods were studied:

1. Winter harvesting: felling using a tracked feller-buncher (John Deere 693B), combined with full-tree skidding with a narrow-tired (60 cm) cable skidder (John Deere 540) in winter (3 blocks) (Fig. 2).

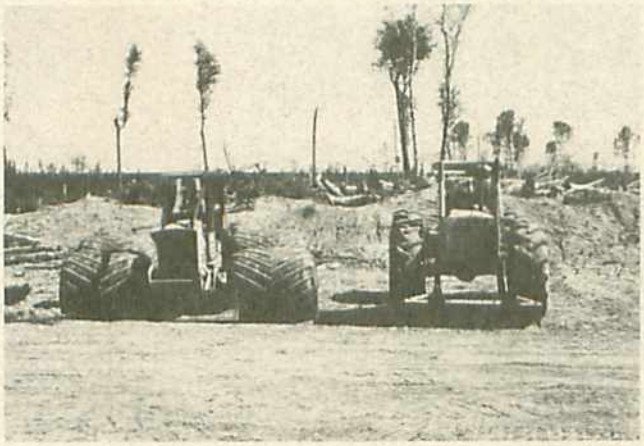

Figure 2. Wheeled skidders equipped with wide and narrow tires.

2. Summer, wide-tire: felling using a feller-buncher (John Deere 693B), combined with full-tree skidding with a wide-tired (127 cm) cable skidder (John Deere 540) in summer (5 blocks) (Fig. 2).

3. Summer, narrow-tire: felling manually using a chainsaw, combined with tree-length skidding using a narrow-tired (60 cm) cable skidder (John Deere 540) in summer (3 blocks).

Plots consisting of five parallel lines of 20 contiguous 2-m x 2-m quadrats, which were oriented perpendicular to the direction of planned harvesting machinery traffic, were established in the stands prior to harvesting (Groot 1987). Measurements were made on the quadrats before the harvest and repeated on the same quadrats one, three, and six growing seasons afterwards. The number of advance growth stems (i.e., stems less than 2.5 cm diameter at breast height) was tallied by species. Advance growth stems were classified three and six growing seasons after harvest as being of acceptable quality if they were upright and possessed a single leader with an annual height growth greater than 5 cm. The number of seedlings established after the harvest was also recorded in these latter two assessments.

RESULTS AND DISCUSSION

Advance Growth Survival by Logging Method

Stocking and density of black spruce advance growth one growing season after harvest were greatest following winter harvesting; intermediate following summer, wide-tire harvesting; and least following summer, narrow-tire harvesting. Almost all of the decreases in black spruce advance growth stocking and density occurred within the first year after harvest for all logging methods (Figures 3 and 4, respectively).

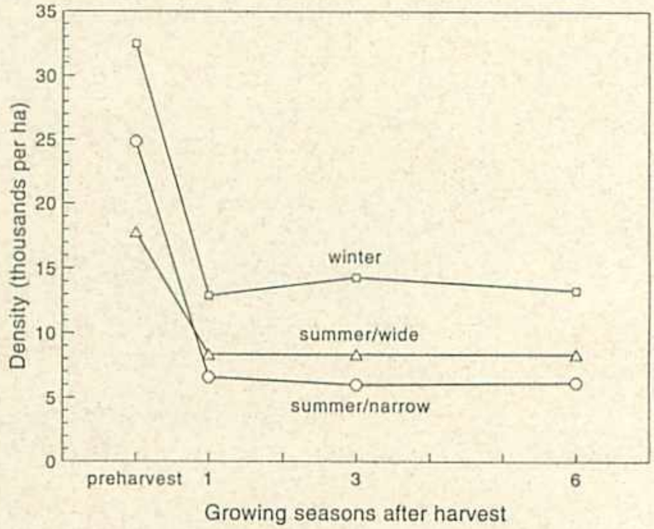

Figure 3. Stocking of black spruce advance growth before and after harvesting using three methods.

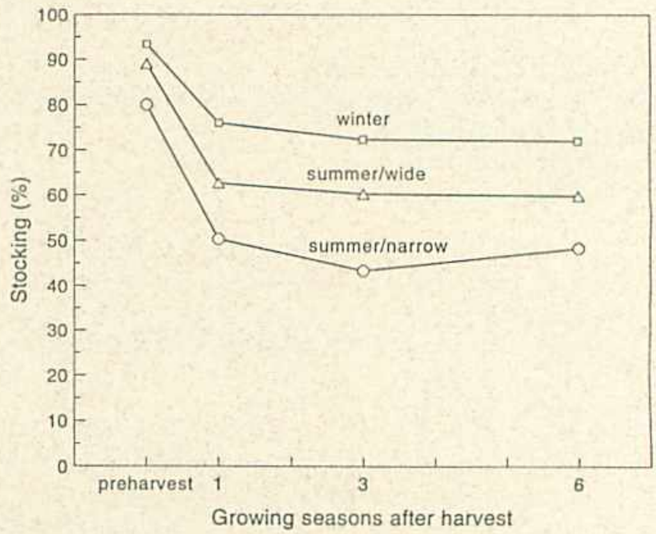

Figure 4. Density of black spruce advance growth before and after harvesting using three methods.

Depending on the harvest method, from 18 to 38% of the preharvest black spruce advance growth stocking, and from 59 to 74% of the preharvest advance growth density, were either destroyed by the logging operation or died within one growing season. The proportion of preharvest advance growth stocking that remained on the plots (i.e., the proportion that survived = postharvest stocking/preharvest stocking) 1 year after harvesting ranged from 62 to 82%, and differed significantly among harvesting methods. The greatest survival occurred with winter harvesting and the most mortality occurred with summer, narrow-tire harvesting. The proportion of preharvest advance growth density that was present 1 year later ranged from 26 to 41%, but did not differ significantly among the three methods.

Mortality of black spruce advance growth occurred mainly during the logging operation and the first growing season thereafter. Causes of mortality included complete destruction of advance growth, mechanical injury to the trees sustained during harvesting, and exposure following removal of the tree canopy. Although causes of mortality were not assessed in this study, the timing suggests that much of it was caused by complete destruction and mechanical injury. Other research has shown that black spruce mortality during the first growing season after harvesting is related to the degree of stem injury (Ruel et al. 1991).

The differences in black spruce advance growth survival among the three harvesting methods are consistent with expectations. However, the results provide a more detailed description of this survival than has previously been available. The data suggest the following rules of thumb for the proportion of preharvest advance growth stocking that will persist after harvesting on peatlands: 80% of the original stocking for winter harvesting, 70% for summer harvesting with wide tires, and 60% for summer harvesting with narrow tires. Similar results for careful summer harvesting were observed by Gingras et al. (1991); the portion of the preharvest stocking that persisted 2 months after harvesting ranged from 56 to 78% and averaged 70%.

Effects of Soil Disturbance

Reductions in stocking resulted mainly from the destruction of advance growth by skidding. The fraction of stocking that persists after harvesting is similar to the fraction of ground area that is undisturbed (Groot 1987; Gingras et al. 1991). The use of skidders equipped with wide tires for summer harvesting allows for the repeated use of the same skid trails. Consequently, less disturbance to the ground surface and less advance growth destruction occurs than with the use of narrow-tired skidders in summer.

In summer harvesting with narrow-tired skidders, proportional stocking reductions significantly increased with speckled alder cover. Site types that contain abundant speckled alder are very susceptible to rutting in the frost-free period. In the summer, narrow-tired skidders cannot reuse skid trails as often on these site types, but must travel over a greater portion of the cutover area. Rutting is less pronounced when wide-tired skidders are used or when harvesting is carried out in the winter, since machinery travel can be restricted to fewer skid trails, which in turn are used more often.

Advance Growth Quality

The stocking and density of stems classified as acceptable in this study increased dramatically between 3 and 6 years after harvesting because of increasing height growth (Table 1). Harvest treatment differences were significant only for stocking 6 years after harvesting and winter harvest showed greater stocking of acceptable stems than did the other methods. For all harvest methods, approximately one-half of the advance growth stems that survived logging were determined to be of acceptable quality after 6 years.

The height growth of understorey black spruce in peatland stands is slow, and averages only 2 to 3 cm per year (Groot 1984). Following harvest, the height growth of surviving advance growth stems improves gradually, but a maximum is not attained until 20 to 30 years after release (Paquin and Doucet 1992; Boily and Doucet 1993). Hence, further increases in the abundance of acceptable advance growth stems can be anticipated.

Table 1. Stocking (based on 4-m^2 quadrats) and density of advance growth stems of acceptable quality 3 and 6 years after harvesting using three harvesting methods.

	Stocking (%)		Density (stems/ha)	
	Years after harvest			
Harvest method	3	6	3	6
Winter	33	62	1,535	5,850
Summer, wide-tire	31	44	2,149	4,041
Summer, narrow-tire	31	42	2,533	4,225

Natural Seeding

In addition to advance growth, naturally seeded black spruce will contribute to the future stand. Between 3 and 6 years after harvesting, a considerable influx of natural black spruce seedlings was observed on all sites. The stocking of postharvest, naturally seeded black spruce averaged 27% three growing seasons after harvest, and 48% after six growing seasons. Corresponding densities were 1,386 and 3,021 stems/ha, respectively.

Advance growth has a height advantage over seedlings established after harvesting. Where possible, it is preferable to obtain regeneration using established, taller advance growth rather than relying entirely on postharvest seedlings.

MANAGEMENT IMPLICATIONS

Initial advance growth stocking is high in many overmature peatland black spruce stands (OG Types 11 and 12) in northeastern Ontario. Careful harvesting methods that preserve advance growth and minimize soil disturbance can result in the undelayed regeneration of logged sites. In peatland black spruce stands, managers should expect about 60% of the preharvest black spruce advance growth stocking to persist after summer harvesting with chainsaws and narrow-tired skidders. Approximately 70% of the preharvest advance growth stocking will still be present after summer harvesting with feller-bunchers and wide-tired skidders, and about 80% after winter harvesting with feller-bunchers and narrow-tired skidders.

Most of the advance growth mortality will occur within one growing season after harvest; therefore, assessments made after this time will provide a good forecast of future regeneration levels. Additional natural regeneration of black spruce from seed can be expected, although these seedlings will be at a height disadvantage.

Forest managers can achieve increased preservation of advance growth and reductions in soil disturbance by implementing a variety of careful harvesting methods. These techniques include matching harvesting equipment and season to site conditions, harvesting on frozen ground in winter, using high-flotation equipment during the frost-free period, minimizing travel on the site by organizing the harvesting and forwarding traffic pattern, and educating feller-buncher and skidder operators about the importance of protecting advance growth stems and following the traffic plan. Good planning and cooperative equipment operators are essential elements in all careful harvesting operations (Archibald and Arnup 1993).

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