Frontline
Forestry Research Applications
Canadian Forest Service–Ontario
Technical Note No. 54

BLACK SPRUCE ADVANCE GROWTH: AN IMPORTANT BASIS FOR STAND RENEWAL

R.A. Sims and S.A. Walsh

CATEGORY: Regeneration
KEY WORDS: Black spruce, forest ecosystem classification, advance growth, V-type

INTRODUCTION

Advance growth (Fig. 1) is defined as natural regeneration that exists in a stand prior to harvesting. On selected sites, it is increasingly viewed as a potential source of quality black spruce. If advance growth survives the harvesting of surrounding mature timber, it can supplement subsequent artificial regeneration efforts, such as planting or direct seeding, or it may be the sole method required to sustain productivity on difficult sites (e.g., organic or shallow soils). In Ontario, the inclusion of advance growth in regeneration strategies has become accepted. Widespread application of this strategy, however, is hampered by the fact that stand and site conditions associated with abundant advance growth are poorly defined, and advance growth is often damaged or destroyed by current harvesting techniques. This note summarizes the results of a study that attempted to better define some of the stand and site conditions in north central Ontario in which black spruce advance growth occurs.

APPROACH

The Northwestern Ontario Forest Ecosystem Classification (NWOFEC) (Sims et al. 1989) was used to define stand and site conditions; NWOFEC vegetation types (V-types) and soil types (S-types) provided the basis for stand selection and data summaries. Sampling locations were chosen to provide adequate sampling across the range of V-types and S-types that were known to have an understorey component of black spruce.

Black spruce advance growth was tallied in twenty 2-m x 2-m quadrats around the perimeter of more than 200 previously established 10-m x 10-m NWOFEC plots. Each stem was recorded in one of four height classes (<10 cm; 10–49.9 cm; 50–199.9 cm; and 2 m and <2.5 cm diameter at breast height). As well, each was assessed as being either of seedling or layer origin. Seedlings are created by sexual reproduction; layers are reproduced vegetatively from living tree branches that become rooted in the ground surface organic material, especially in mosses.

Stocking and density of black spruce advance growth were summarized by V-type and S-type. Four stocking classes were also defined using provincial criteria for black spruce

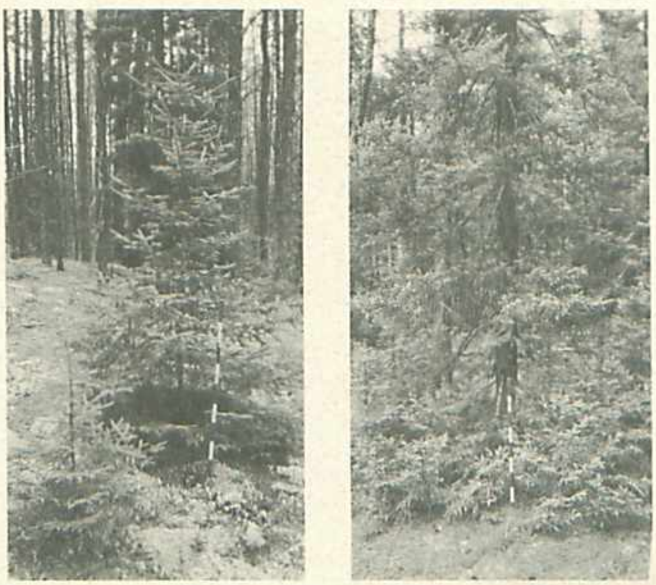

Figure 1. Black spruce advance growth. (A) seedling and (B) layer.

stocking levels: (1) 0–40%, (2) 41–60%, (3) 61–80%, and (4) >80%.

RESULTS AND DISCUSSION

Black spruce advance growth occurs in most V-types and on a wide range of soil and site conditions across north central Ontario. However, its abundance in any particular V-type or S-type is extremely variable. In total, 29 of the 38 NWOFEC V-types and 20 of the 21 S-types were sampled. Layered stems accounted for 96% of the total number inventoried; the remaining 4% were of seedling origin.

Black Spruce Advance Growth Within Vegetation Types

Seedling and layer stem densities (stems/ha) for sampled V-types are shown in Table 1. Seedling densities are low for most V-types, reflecting the limited importance of seedlings as a form of advance growth in north central Ontario. Only in V38, a lowland type that supports unmerchantable black spruce, does advance growth of seedling origin achieve a degree of significance. In contrast, the density of layers is significant on a range of V-types and tends to have increasing abundance in conjunction with the black spruce component of the overstory.

All sampled V-types were stocked to some degree with black spruce advance growth, but stocking levels were generally low and exhibited extreme within-type variability. Mean stocking levels exceeded 60% only in V38 (typically an unmerchantable type). Only three other V-types (V20, V34, and V37) had a mean stocking of >40%, though stocking values on individual plots ranged from 0 to 90%. These four V-types are spruce dominated and tend to occur on moister sites with thick feathermoss and/or *Sphagnum* surface organic layers.

To better define the occurrence, distribution, and related stocking levels of advance growth for management needs, four stocking classes were used to summarize the advance growth occurrence data. The majority of sampled stands occurred in Stocking Class 1, with <40% stocking to black spruce advance growth. In Ontario, a minimum of 60% stocking is the desired level for black spruce; less than 40% stocking is considered a failure (Robinson 1974). Stocking levels ranging from 41–60% are considered marginal but usually acceptable. Four V-types (V20, V34, V37, and V38) have mean stocking levels within the acceptable (41–60%) range. V38 is the only V-type to exceed the standard, with 86% stocking to black spruce advance growth.

Black Spruce Advance Growth Within Soil Types

Although all sampled S-types were stocked to black spruce advance growth to some degree, only three types, SS2, SS3, and S12S attained a stocking level of 40%. SS2, a shallow soil condition with <5 cm mineral soil and 5–20 cm of organic matter, had the highest mean stocking (60%). Variability within the S-types is considerable, usually ranging from 0 to 80 or 90% stocking. These large ranges reflect the inherent variation associated with each S-type.

Other S-types, such as S11, S12F, S1, S2, S3, and S10 exhibited relatively high stem densities, although stocking levels were low. On these S-types, advance growth potential is significant (high densities), although some form of subsequent stand management such as thinning and fill-in planting may be required to improve tree distribution.

Table 1. Comparison of seedling and layer densities in NWOFEC V-types.

		Density (stems/ha)	
V-type group	V-type	Seedlings	Layers
Aspen hardwood and mixedwood	4	0	3,860
	5	10	210
	7	0	0
	8	0	100
	9	50	830
	10	0	690
	11	80	1,130
Balsam fir–white spruce, conifer and mixedwood	15	100	0
	16	30	30
	21	0	0
	24	0	0
	25	0	0
Jack pine / shrub-rich	17	40	1,100
	28	0	300
Jack pine / feathermoss	18	70	3,550
	29	10	4,730
	32	90	3,550
Jack pine–black spruce / lichen	30	60	5,660
Black spruce–jack pine / feathermoss	19	140	1,790
	20	70	6,550
	31	40	960
	33	60	2,450
Black spruce / wet organic	22	140	1,440
	23	10	840
	34	60	3,060
	35	490	2,290
	36	70	3,050
	37	190	4,340
Black spruce / leatherleaf / *Sphagnum*	38	1,250	8,680

The highest stocking levels of black spruce advance growth are associated with wet and nutrient-impoverished sites. Stand types with the greatest potential for black spruce advance growth are wet organic lowlands and nutrient-poor uplands.

Black Spruce Advance Growth in Relation to NWOFEC V-types and S-types

The ordination diagram (Fig. 2) shows relationships among V-types with respect to soil moisture (y-axis) and soil nutrient (x-axis) gradients and was derived from the NWOFEC vegetation data set (Sims et al. 1989). Shadings on the diagram indicate the frequency of occurrence of sites within particular stocking classes for each V-type sampled in this study.

Figure 2 further illustrates that occurrences of black spruce advance growth stocking at levels greater than 40% are associated with V-types having poor stand nutrient conditions (left side of the ordination diagram) and soil moisture conditions ranging from wet to dry (bottom to top of the ordination diagram). Stands in these V-types are black spruce and/or jack pine dominated coniferous stands with a carpet of living feathermoss and/or *Sphagnum* moss.

In contrast, V-types having richer soil nutrient conditions (right side of the ordination diagram) have a component of black spruce advance growth that does not usually exceed

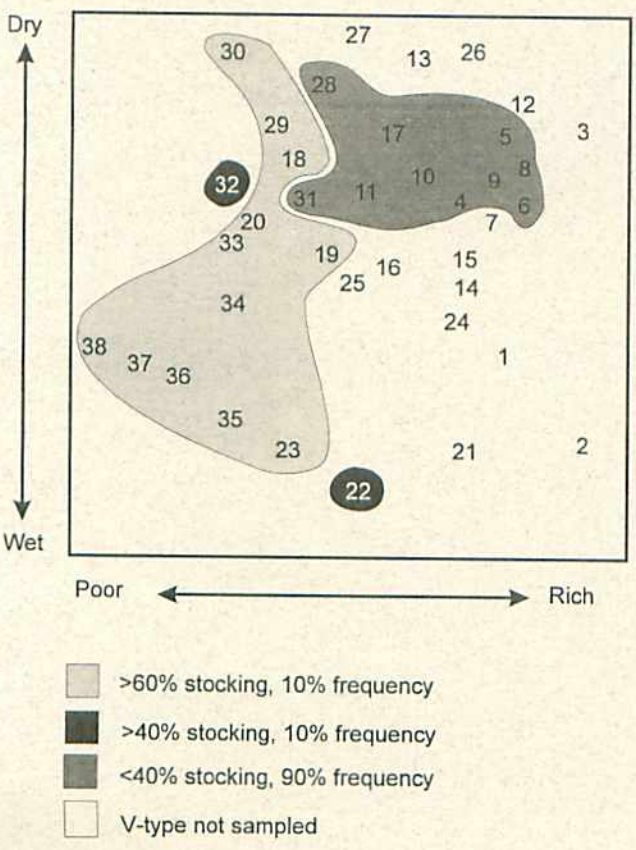

Figure 2. Frequency occurrence of sampled V-types in various black spruce advance growth stocking classes.

40% stocking. In fact, many of these V-types were not sampled in this study (*see* Figure 2) because they have little or no occurrence of black spruce in either the understorey or the tree canopy. V-types on the right side of the ordination diagram are characterized by mixed stands of hardwood and conifer, with shrub- and herb-rich understorey conditions.

BLACK SPRUCE ADVANCE GROWTH AND FOREST MANAGEMENT

Tree planting typically establishes 2,000–2,500 trees/ha at a spacing that is equivalent to one tree per 2-m x 2-m quadrat. Advance growth stem densities in most of the sampled V-types were above the recommended planting densities, but stocking levels were very low. This pattern indicates that although the number of stems of advance growth is suitable, their distribution is unsuitable because most stems occur in clumps that are widely scattered throughout the site. Naturally regenerating trees will seldom develop with systematic spacing, at least initially. In time, gaps between clumps of trees may eventually be filled by seedlings and layers, thereby resulting in a more evenly stocked, although uneven-aged, stand.

Ruel (1988) suggests that reductions in advance growth stocking of 20–35% can be expected after harvesting. Even if the loss of advance growth stocking is held to 20%, only V38 could be considered satisfactorily stocked after harvest; all other V-types would have stocking levels substantially below 40%. Additional measures would be required to boost stocking levels to an acceptable level. These results suggest that in many instances black spruce advance growth may best be viewed as a supplementary, rather than a primary, regeneration source.

To maximize the potential contribution of advance growth to forest renewal, some effort is required to reduce the damage to, and mortality of, advance growth during harvesting operations. The impacts of timber harvesting on advance growth and recommendations for modified harvesting techniques to protect such growth have been reported by several authors (Vincent and Haavisto 1967; Groot 1987; Ruel 1988; Archibald and Arnup 1993; Groot and Arnup 1994). The season of harvest, type of equipment, method of harvest, and operator awareness are all important considerations.

In summary, the unmerchantable stands of V38 have the greatest occurrence of black spruce advance growth. However, 14 additional V-types (V11, V18, V19, V20, V22, V23, and V29 to V37) have potential for black spruce advance growth to a stocking level greater than 40%, but the frequency of such occurrences is low. Often, it is not distributed evenly across a site, but still has tremendous potential as a source of naturally occurring regeneration that could supplement artificially regenerated trees in forest renewal programs. Therefore, harvesting methods that minimize damage to advance growth should be employed.

REFERENCES AND FURTHER READING

Archibald, D.J.; Arnup, R.W. 1993. The management of black spruce advance growth in northeastern Ontario. Ont. Min. Nat. Resour., Timmins, ON. NEST Tech. Rep. TR-008. VMAP Rep. No. 93-05. 32 p.

Groot, A. 1987. Silvicultural consequences of forest harvesting on peatlands: Site damage and slash conditions. Gov't of Can., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O–X–384. 20 p.

Groot, A.; Arnup, R.W. 1995. Survival of black spruce advance growth following three harvesting methods. Nat. Resour. Can., Canadian Forest Service, Sault Ste. Marie, ON. Frontline Technical Note 53. 4 p.

Robinson, F.C. 1974. A silvicultural guide to the black spruce working group. Ont. Min. Nat. Resour., Toronto, ON. 44 p.

Ruel, J.-C. 1988. The impact of harvesting on advance regeneration in Quebec. Can. For. Ind. 108(7):63–66.

Sims, R.A.; Towill, W.D.; Baldwin, K.A.; Wickware, G.M. 1989. Field guide to forest ecosystem classification for northwestern Ontario. Ont. Min. Nat. Resour., Toronto, ON. 120 p.

Vincent, A.B.; Haavisto, V.F. 1967. Logging damage to black spruce and balsam fir reproduction. Woodlands Rev., Pulp and Paper Mag. of Can. June. p. 283, 286, 293.

Walsh, S.A.; Wickware, G.M. 1991. Stand and site conditions associated with the occurrence and distribution of black spruce advance growth in north central Ontario. For. Can., Ont. Reg., Sault Ste. Marie, ON. COFRDA Rep. 3309. 37 p.

Richard Sims

Sheila Walsh

Dr. Richard Sims is a research scientist with the Canadian Forest Service–Ontario and former project leader of the now completed Black Spruce Ecosystem Silviculture Project. His research focuses on forest site classification and ecology, and on geographic information systems.

Sheila Walsh is a forest ecologist with extensive experience in the development, testing, and application of forest ecosystem classification. She has coordinated research studies in advance growth, forest stand dynamics, and ecosystem mapping, and wrote this technical note under contract.

NODA • EDNO CANADA ONTARIO Forestry • Foresterie

Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts
Ministry of Natural Resources / Ministère des Richesses naturelles
Ontario

The preparation of this note was funded under the Northern Ontario Development Agreement's Northern Forestry Program.

Additional copies of this publication are available from:

Natural Resources Canada
Canadian Forest Service – Ontario
Great Lakes Forestry Centre
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7
(705) 949-9461
(705) 759-5700 (FAX)

Catalogue No. Fo 29–29/54E
ISBN 0–662–22761–1
ISSN 1183–2762

This technical note is printed on paper containing recycled material.