Frontline

Forestry Research Applications

Canadian Forest Service–Sault Ste. Marie

Technical Note No. 29

INTERMEDIATE CROWN CLASS BLACK SPRUCE CONES HAVE MORE SEEDS

G.T. Atkinson and V.F. Haavisto

CATEGORY: Cone and seed
KEY WORDS: Black spruce, seed yield, crown class, peatland, lowland

INTRODUCTION

Because black spruce (*Picea mariana* [Mill.] B.S.P.) produce some cones every year, and heavy cone production occurs about once every 4 years, a considerable store of seeds can build up in tree crowns. Results of an investigation conducted in northeastern Ontario showed that trees from different crown classes had cone crops of different sizes. Trees in the dominant crown class produced the most cones and those in the intermediate crown class yielded the least (Haavisto 1975). This work suggested also that cones from trees in different crown classes yield different quantities of seeds per cone, and that per-cone seed yields decreased markedly by the time the cones were 5 years old.

A tree crown that projects significantly above the average crown level of a stand, and receives light from all sides as well as from above (Fig. 1), is defined as being in the dominant crown class. A codominant crown class tree is one in which the live crown is located in the general level of the forest canopy, but receives some light from the side and much from above. An intermediate crown class tree is one in which the crown is located within the general crown structure of the stand, but receives light only from above.

For effective seed procurement, good quality seeds must be gathered. Little difference was found in the viability of seeds from semiserotinous cones in an overmature stand (140+ years) during the first 3–4 years, but viability decreased markedly after this time. Some viable seeds were obtained from 20-year-old cones (Haavisto 1982). Even though study results from an exceptional 65-year-old black spruce stand showed a dramatic decrease in seed yield by the third year, seed viability remained fairly constant with 63.1 percent, 70.6 percent, and 69.5 percent for 1974, 1975, and 1976 seed years, respectively (Haavisto 1982).

This technical note reevaluates the data to ascertain differences in per-cone seed yields among the three crown classes, and to confirm whether seed retention and viability are different. Results of this analysis should be useful to forest managers interested in the specific cone and seed production characteristics of this important pulpwood species.

APPROACH

The investigation was initiated in 1964 in the Kennedy Black Spruce Area, 18 km northeast of Cochrane, Ontario. The

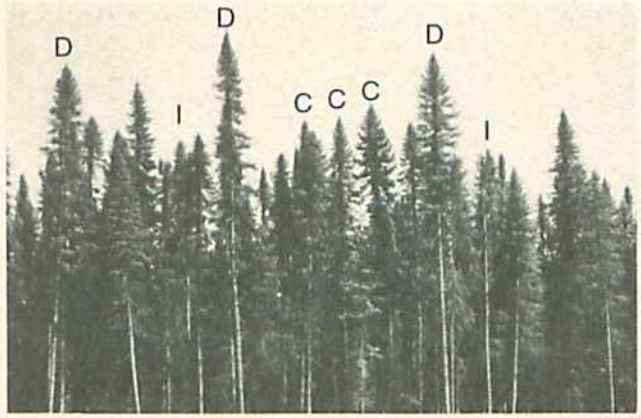

Figure 1. A view of a typical black spruce stand showing D) dominant, C) codominant, and I) intermediate crown class trees.

Natural Resources Canada | Ressources naturelles Canada

Canada

purpose of the study was to determine the duration of seed retention in semiserotinous black spruce cones in typical Clay Belt stands. Five black spruce trees from dominant, codominant, and intermediate crown classes were carefully felled each year for 4 consecutive years. All cones were harvested and aged according to year of origin. The seeds were extracted and the proportion of full and empty seeds was determined (Haavisto 1975). A sample of the full seeds was tested for viability. Due to incomplete extraction, the numbers of viable, nonviable full, and empty seeds were amended using a correction factor developed from Haavisto et al. (1988).

RESULTS

Mature cones are lost from cone bearing tree tops for a variety of reasons. Lacking tangible evidence, the authors assume that the rate of cone loss, or conversely, cone retention, is proportional for all black spruce crown classes. When comparing cone retention for any specific year, the number of cones per tree is usually considerably higher in dominant crown class trees than in either codominant or intermediate trees (Fig. 2). In almost all cases, intermediate crown class trees have the lowest number of cones. It should be noted that after about 8 years of age the number of cones is similar among the crown classes. The rate of cone loss from intermediate crown class black spruce trees is somewhat less than from codominant crown classes. The relative peaks and hollows in cone numbers reflect good and poor cone years.

Seed retention on trees is a function of the rate of cone loss. Even though the number of cones differs considerably among the crown classes, the number of seeds per tree based on the age of the cones is not directly proportional. This suggests that considerable differences exist in the number of seeds per cone. For example, with current-year cones, dominant crown class trees had an average of 44 seeds per cone; intermediate and codominant crown class trees had 73 and 35 seeds per cone, respectively.

The average number of seeds per cone in the three crown classes differs significantly ($p = 0.05$) among the current-year, 1-year-old, and 2-year-old cones (Fig. 3). For 3- to 7-year-old cones, the number of seeds per cone is more or less similar regardless of crown class. Even though intermediate crown class trees initially have more than twice as many seeds per cone than do the other two classes, a very rapid loss of seeds occurs during the first 2 years.

The trend of seed retention among different ages of cones in the three crown classes, dominant (Fig. 4), codominant (Fig. 5), and intermediate (Fig. 6), is fairly similar. The intermediate trees (Fig. 6) show the highest number of viable seeds per cone for the first 4 years. For the dominant (Fig. 4) and codominant (Fig. 5) crown class trees, the numbers are quite similar. Beyond the fifth year, the number of seeds per cone is not significantly different ($p = 0.05$) regardless of crown class. It should be noted that the number of nonviable

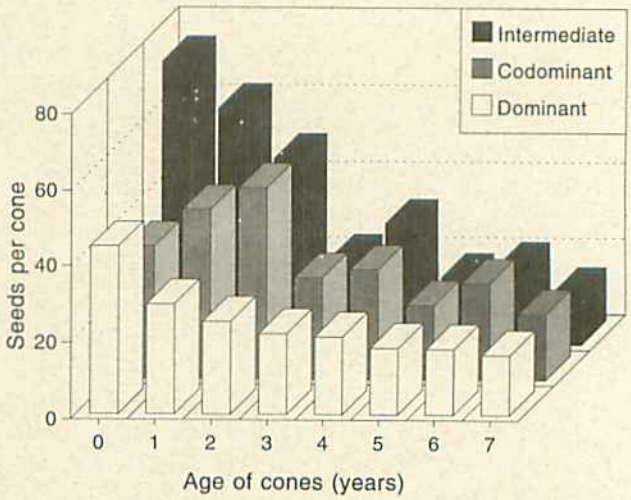

Figure 3. Average number of seeds per cone (current to 7 years old) in three black spruce crown classes.

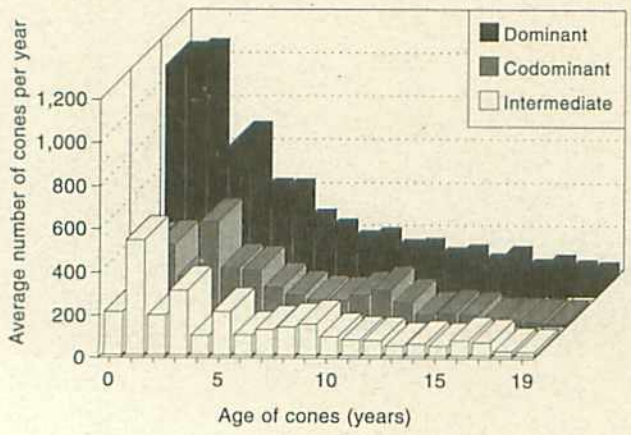

Figure 2. Average number of cones per tree, by year of origin, for three black spruce crown classes.

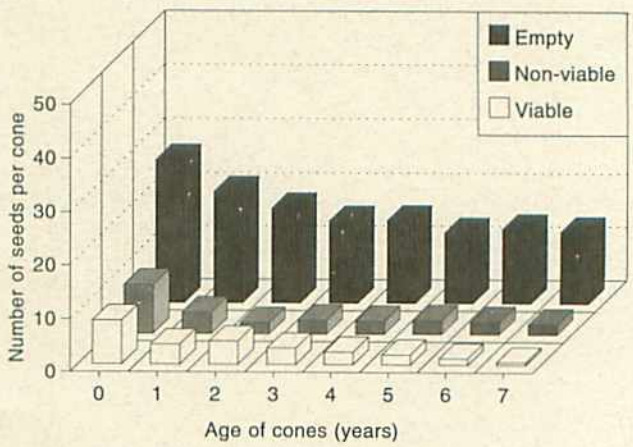

Figure 4. Average number of viable, nonviable full, and empty seeds per cone in dominant crown class black spruce from current to 7-year-old cones.

full seeds in the intermediate crown class is twice that of the viable seeds. The proportion of nonviable to viable seeds is similar for the dominant and codominant crown class trees. As such, even though not significant, there is a suggestion that a higher degree of seed set occurs in codominant and intermediate crown class cones than occurs in dominant trees.

The proportions of viable, nonviable full, and empty seeds in the cones from the three black spruce crown classes show some interesting differences. The proportion of empty seeds in the current-year cones, ranging from 53 percent to 60 percent, is quite close regardless of crown class. One-year-old cones had 73 percent empty seeds, suggesting that a greater proportion of filled seeds than empty seeds was released. The proportion of empty seeds increases to about 83–92 percent by Year 7. The significant loss in the number of nonviable full seeds from the current-year cones (21–29 percent) to 1-year-old cones (7–14 percent) suggests that these are also released quickly.

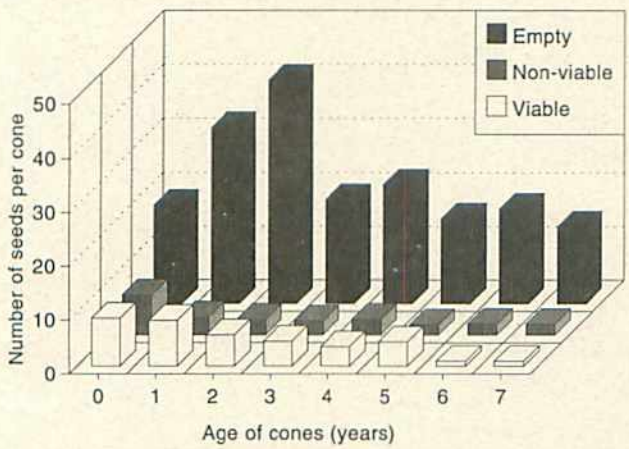

Figure 5. Average number of viable, nonviable full, and empty seeds per cone in codominant crown class black spruce from current to 7-year-old cones.

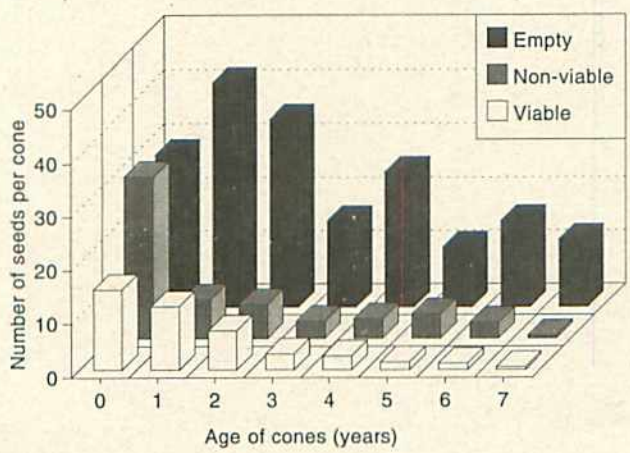

Figure 6. Average number of viable, nonviable full, and empty seeds per cone in intermediate crown class black spruce from current to 7-year-old cones.

DISCUSSION

Due to their semiserotinous habit, black spruce cones with some viable seeds are retained on the trees for more than 20 years. According to Haavisto (1975), dominant crown class trees had an average of 13 784 cones of all ages per tree; codominants had 4 695 cones and intermediates had 3 943 cones. This investigation also showed that considerable differences occurred in the number of cones that originated in any given year (Fig. 2). The slower rate of cone loss from intermediate trees may be due to greater protection from the elements. It should be noted that crown class in peatland black spruce does not necessarily reflect genetic variation. Often the dominant crown class trees are older than those occurring lower in the crown.

In the current year, cones harvested from the intermediate crown class had almost twice as many seeds per cone as those from dominants. Furthermore, more seeds per cone were retained in the intermediates for the first 3 years. This crown class also retained the highest number of viable seeds per cone for the first 4 years. The number of full seeds per cone in the intermediate crown class trees far exceeds that of either the codominant or the dominant crown class trees. However, the proportion of nonviable seeds is very high. If dormancy or other factors that restrain germination were broken, then 61 percent of the seeds of the intermediate crown class trees could potentially produce seedlings, compared to 47 percent and 39 percent in codominant and dominant trees, respectively.

The dominant crown class maintains the greatest potential for cone production, because the longer crown results in a much higher proportion of potential cone-bearing loci. However, being located above the general crown level where most of the male strobili occur and from where pollen is distributed, there may be a reduced potential for complete pollination of all gametophyte chambers. There is also an enhanced risk of selfing. A codominant tree would not have as many potential cone-bearing sites because of its shorter live crown. However, it would have a better chance of more complete pollination of the female strobili due to the pollen rain from the dominant trees. Intermediate trees, with their crowns located in the general crown layer, have the highest potential for complete pollination of the female strobili; thus they have a higher possibility for developing a greater number of seeds per cone.

Considering the seed-retention habit of black spruce, it is suggested that cones up to 3 years of age can justifiably be picked for seed procurement (Haavisto 1975, 1982). As there are significantly more seeds per cone on intermediate crown class trees than on those that are either codominant or dominant, perhaps cone picking from dominant trees should not be emphasized. Collecting cones from intermediate crown class trees would also provide a better economic return, since fewer cones would need to be handled during transportation and seed extraction.

SILVICULTURAL IMPLICATIONS

For any regeneration program the ready availability of good quality seed is essential. Seed quality is dependent on many factors including climate, tree age and vigor, and cone quality. Because cone collecting is an expensive and labor-intensive operation, costs can be minimized by collecting cones that have a high degree of seed set. Methods for maximizing the degree of seed set remains to be ascertained.

If cone collecting is to be done strictly on the basis of the number of cones per tree, disregarding the seed complement, and assuming that a minimum of 100 cones per tree is worth collecting, then even 10-year-old cones can be taken. However, the seed complement in cones older than 3–5 years does not warrant collection.

Because of their perceived genetic superiority, dominant trees have historically been preferred for cone collection. However, cones from intermediate crown class trees have been shown to have significantly more seeds per cone than do dominant trees. Haavisto et al. (1988) also found that smaller cones have fewer seeds, and so the time taken to pick a small cone being essentially the same as for a large cone, it would be best to select only large cones, unless the collection is done mechanically. Choosing cones from intermediate crown class trees would therefore be most cost-effective.

REFERENCES AND FURTHER READING

Haavisto, V.F. 1975. Peatland black spruce production and seed dispersal in northeastern Ontario. p. 250–264 *in* J.W. Fraser and F.C. Robinson, eds. Black Spruce Symposium. 23–25 September 1975, Thunder Bay, Ontario. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Symp. Proc. O-P-4. 289 p. + appendices.

Haavisto, V.F. 1982. The retention of seed viability in semi-serotinous black spruce cones. p. 91–95 *in* B.S.P. Wang and J.A. Pitel, eds. Proc. IUFRO Int. Symp. Forest Tree Seed Storage. 23–27 September 1980, Petawawa National Forestry Institute, Chalk River, Ontario. Dep. Environ., Canadian Forestry Service, Chalk River, ON. 243 p.

Haavisto, V.F.; Fleming, R.L.; Skeates, D.A. 1988. Potential and actual yields of seed from black spruce cones. For. Chron. 64(1):32–34.

Skeates, D.A.; Haavisto, V.F. 1987. Black spruce cone and seed production: Yields from Ontario collections. Ont. Min. Nat. Resour., Sault Ste. Marie, ON. For. Res. Rep. 119. 24 p.

Vincent, A.B. 1966. Improving black spruce seed collection. Can. Dep. For., Maple, ON. Inf. Rep. O-X-32. 8 p.

G.T. Atkinson

V.F. Haavisto

Graydy Atkinson, who worked as a silviculture technician with the Canadian Forest Service–Sault Ste. Marie before his retirement in 1993, was involved in the study of techniques for the management of black spruce, especially the procurement of cones and seeds.

Fred Haavisto is a senior research applications and liaison officer with the Canadian Forest Service–Sault Ste. Marie. His specific interest is boreal forest management, in which he assists with the promotion and application of research results.

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

Catalogue No. Fo 29-29/29E
ISBN 0-662-23697-1
ISSN 1183-2762

This technical note is printed on paper containing recycled material.