Archives

Frontline

Forestry Research Applications

Canadian Forest Service
Great Lakes Forestry Centre

Technical Note No. 89

DECREASED STRIP WIDTH AND INCREASED SEEDING PERIOD RESULT IN INCREASED BLACK SPRUCE STOCKING AND DENSITY IN 18-YEAR-OLD STRIP CLEAR-CUTS

M.D. Tenhagen, J.K. Jeglum

CATEGORY: Silviculture
KEY WORDS: Strip cutting, stocking, density, prediction

INTRODUCTION

In 1973, an assessment to compare natural regeneration in clear-cuts with regeneration in alternate strip clear-cuts was made in the Central Plateau and Northern Clay sections of Ontario (Fraser et al. 1976). This survey revealed that strip cutting yielded better regeneration of black spruce (*Picea mariana* [Mill.] B.S.P.). It was not clear, however, what factors were important to regeneration. Consequently, a long-term study was initiated near Nipigon, in north central Ontario, to study the effects of strip width, seeding period, and receptive seedbed on natural regeneration in both first- and second-cut strips (Jeglum 1980).

This technical note details a reassessment of the regeneration 12 to 18 years after initial harvesting (1974). Black spruce was the main target species in this study. However, regeneration data were also collected for jack pine (*Pinus banksiana* Lamb.), balsam fir (*Abies balsamea* [L.] Mill.), trembling aspen (*Populus tremuloides* [Michx.]), and white birch (*Betula papyrifera* [Marsh.]). One of the objectives of the study was to determine the importance of the following factors on natural regeneration: strip width, seeding (leave) period, and receptive seedbed.

METHODS

A strip-cut experiment, established in 1973 (Jeglum 1980) and replicated in two nearby areas in 1974 and 1975, was positioned 20–40 km southeast of Beardmore and east of Lake Nipigon, in the Central Plateau Section of the Boreal Forest Region (Rowe 1972).

Each of the study areas contained strips of three different widths (20 m, 40 m, and 80 m). Assessment quadrats measuring 2 m by 2 m were systematically located in each strip, for a total of 1 400 quadrats in each of the three areas.

The first-cut strips in Area 1 were scarified with barrels and chains; in Areas 2 and 3 a nonpowered TTS disc trencher was used. This intervention was designed to expose mineral soil and seedbed conditions presumed to be favorable to seedling regeneration. The areas were initially assessed 1 year prior to cutting. A partial regeneration survey of Area 1 (first-cut strips) was conducted in 1989 (15 years postharvest). In 1992 the remainder of the strips in Area 1, and all the strips in Areas 2 and 3, were surveyed. In each quadrat, the presence and number of seedlings of each tree species were recorded according to their height or diameter class.

RESULTS

Strip Width

Stocking for different strip widths is presented in Table 1. Differences in stocking between first-cut 20-, 40-, and 80-m strips were still apparent 16–18 years after harvest. For black spruce, stocking levels increased as strip width decreased. A stocking of 71.6 percent was achieved in the 20-m strips, 59.4 percent was noted in the 40-m strips, and 53 percent was recorded in the 80-m strips. White birch, all conifers, all hardwoods, and all species showed the same trend to increased stocking in the narrower strips. Stocking of jack pine, balsam fir, and trembling aspen were least affected by strip width

Natural Resources Canada — Ressources naturelles Canada

Canada

Table 1. Levels of stocking (S) and density (D) in first-cut strips of five species for three strip widths, measured 16 years and 18 years postharvest.

	Strip width					
	20 m		40 m		80 m	
Species	S	D	S	D	S	D
Black spruce	71.6	4.4	59.4	3.5	53.0	2.4
Jack pine	6.6	0.1	9.7	0.2	8.4	0.2
Balsam fir	20.9	0.4	16.3	0.4	18.6	0.5
All conifers	78.7	5.3	70.9	4.28	66.7	3.1
Trembling aspen	12.8	0.2	15.4	0.3	12.1	0.3
White birch	41.5	1.4	31.4	1.1	25.5	0.9
All hardwoods	50.0	1.6	42.6	1.64	33.8	1.2
All species	85.9	6.9	78.6	6.4	74.4	4.3

and did not show the same trend (levels were below 21 percent in the three strip widths).

Density levels for different strip widths are also presented in Table 1. Levels for all species, all conifers, and black spruce clearly show the trend of decreasing values with increasing strip width. White birch and all hardwoods showed slightly lower densities in the 80-m strips. Densities of jack pine, trembling aspen, and balsam fir were relatively unchanged in relation to strip width, and averaged fewer than 0.5 stems/quadrat. The effect of strip width on density was also significant ($P \leq 0.05$) even after 16 to 18 years.

Seeding Period

The original experimental design allowed for 2- and 4-year leave periods. Due to harvesting oversights some strips were left uncut, thereby providing adjacent strips with a seed source for a longer period of time. These were classified as having 8+ years of natural seeding.

The effects of leave period on stocking and density in the first-cut strips were still evident in the 1989 and 1992 regeneration assessments (Table 2). Stocking and density were higher in strips with longer leave periods. When combined with different strip widths, there was a clear trend toward higher stocking and density of black spruce as strip width decreased and leave period increased (Fig. 1). Leave period (2 years and 4 years) had a significant effect on stocking ($P \leq 0.001$). The interaction of strip width and leave period was not significant on either stocking or density.

Receptive Seedbed

Receptive seedbed, assessed 1+ years postharvest (Jeglum 1984), was incorporated with the 1989 (Area 1) and 1992 (Areas 2 and 3) data to determine if the present density of black spruce was affected by the amount of receptive seedbed created by site preparation. The amount of receptive seedbed in each quadrat was calculated by summing individual categories of percentage receptive seedbed (Jeglum 1984).

Current mean density of black spruce ranged from 2.1 stems/quadrat in quadrats with 0 percent receptive seedbed (1+ years postharvest) to 4.7 stems/quadrat in quadrats with 20–100 percent receptive seedbed. In a one-way analysis of variance performed on density for five levels of receptive seedbed, the amount of receptive seedbed had a significant effect on density even after 16–18 years ($P \leq 0.001$).

Predictor Equations for Stocking and Density

Linear and nonlinear model procedures were developed (SAS 1990), with good predictive capability (all with

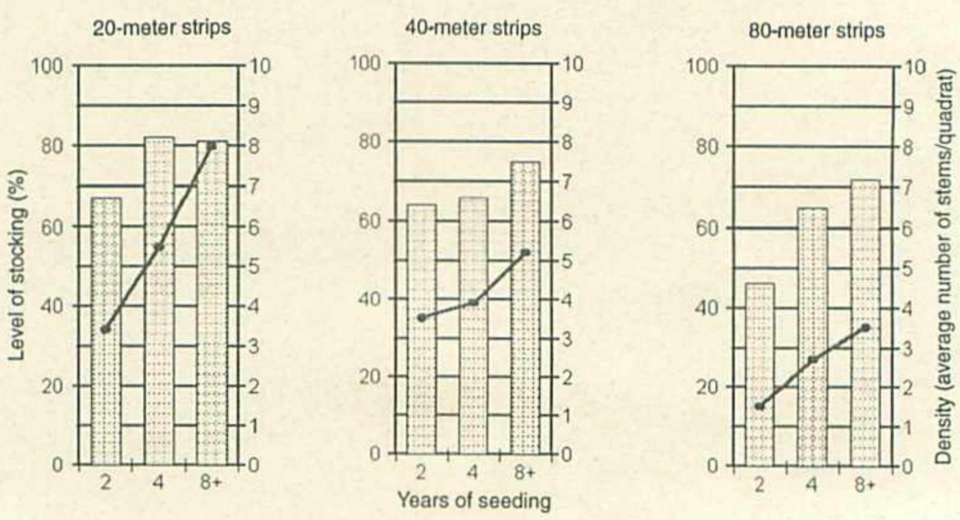

Figure 1. Levels of stocking and density of black spruce, for cut quadrats only, in the first-cut 20-m, 40-m, and 80-m strips with 2, 4, and 8+ years of natural seeding (stocking = bar, density = line).

Table 2. Effects of strip width and leave period on the stocking (S) and density (D) of five species, in the first-cut strips, measured 16 years and 18 years postharvest.

		Strip width								
Species		20 m			40 m			80 m		
		Years of seeding			Years of seeding			Years of seeding		
		2	4	8+	2	4	8+	2	4	8+
Black spruce	S	67	82	81	64	66	75	51	65	72
	D	3.4	5.5	8.0	3.5	3.9	5.2	1.7	2.7	3.5
Jack pine	S	4.4	13	0	7.3	18	8	14	13	1.8
	D	0.1	0.3	0.0	0.2	0.4	0.2	0.4	0.2	0.0
Balsam fir	S	17	26	24	15	30	8	20	7.4	25
	D	0.3	0.5	0.5	0.4	0.8	0.1	0.5	0.1	0.7
All conifers	S	73	90	87	71	85	79	62	69	78
	D	3.8	6.3	.6	4.0	5.2	5.5	2.5	3.0	4.2
Trembling aspen	S	15	10	16	20	15	11	13	9.8	13
	D	0.2	0.1	0.3	0.4	0.3	0.3	0.3	0.2	0.4
White birch	S	27	57	56	28	37	46	12	26	44
	D	0.9	1.8	2.2	1.1	1.0	1.5	0.5	0.6	1.7
All hardwoods	S	39	64	62	44	47	51	23	32	52
	D	1.1	2.0	2.5	1.5	1.3	1.8	0.8	0.8	2.1
All species	S	83	95	96	82	90	86	70	75	87
	D	4.9	8.2	11.0	5.5	6.6	7.3	3.2	3.9	6.4
Number of strips		11	9	4	12	7	5	10	5	9

P<0.0001), to predict levels of stocking and density from percent receptive seedbed in various combinations of strip width and seeding period (leave time of second-cut strips). Predicted levels of stocking and density are shown in Figure 2.

DISCUSSION AND CONCLUSIONS

The effects of strip width, period of natural seeding, and receptive seedbed on black spruce regeneration were significant in both first- and second-cut strips even after the intervening 12 to 18 years. Generally, it can be stated that as strip width decreased and seeding period increased, both stocking and density increased. Site preparation was helpful to produce receptive seedbed.

Seeding period was slightly more significant than strip width. This suggests that leave strips should be retained as long as possible. However, windthrow may become a problem, and seedbeds mature and become less receptive with age. This suggests that the leave strips be removed as soon as acceptable or desirable levels of regeneration are achieved. Usually this will happen in 3 to 5 years.

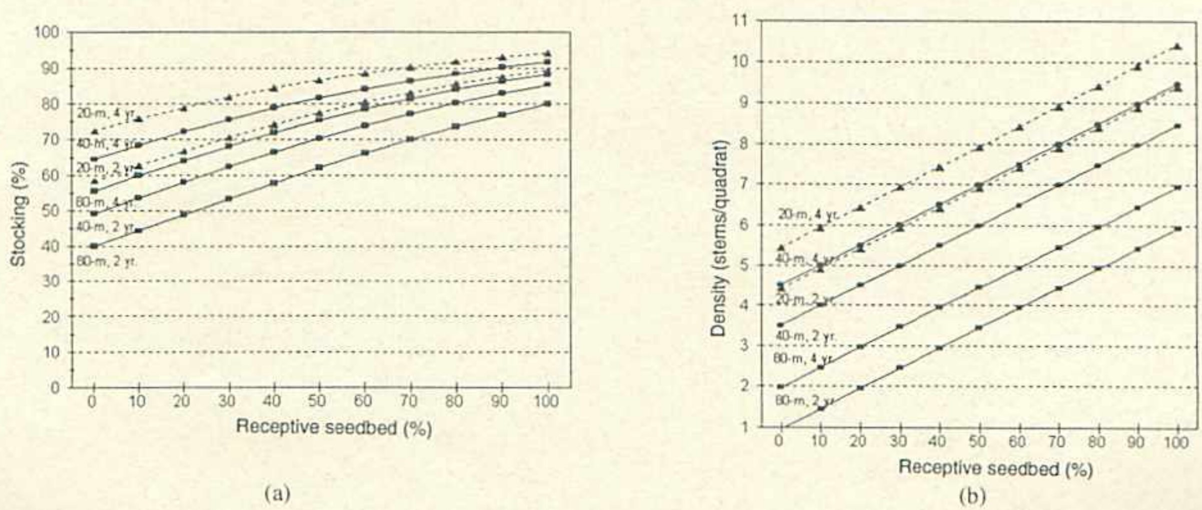

Figure 2. Predicted levels of stocking (a) and density (b) for a gradient of receptive seedbed. Points are predicted values calculated by best fit regression models.

Prediction of stocking and density can be achieved by relating percent receptive seedbed, strip width, and seeding period using the graphs in Figure 2. The amount of receptive seedbed can be assessed using methods outlined by Jeglum and Kennington (1993). In this way, strip-cut design and scarification levels can be prescribed for optimum levels of stocking and density. This is a useful tool for the black spruce silviculturist.

REFERENCES AND FURTHER READING

Fraser, J.W.; Haavisto, V.F.; Jeglum, J.K.; Dai, T.S.; Smith, D.W. 1976. Black spruce regeneration on strip-cuts and clear-cuts in the Nipigon and Cochrane areas in Ontario. Dep. of Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-246. 34 p.

Jeglum, J.K. 1980. Strip cutting in shallow-soil upland black spruce near Nipigon, Ontario. I. Study establishment and site conditions. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Report O-X-337. 24 p.

Jeglum, J.K. 1982. Strip cutting in shallow-soil upland black spruce near Nipigon, Ontario. II. Regeneration in the first study area. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Report O-X-315. 61 p.

Jeglum, J.K. 1983. Changes in tree species composition in naturally regenerating strip clearcuts in shallow-soil upland and black spruce. p. 180–193 *in* R.W. Wein, R.R. Riewe and I.R. Methven, eds. Resources and Dynamics of the Boreal Zone. Proc. Conf. August 1982, Thunder Bay, Ontario. Assoc. of Can. Univ. for North. Stud., Ottawa, ON.

Jeglum, J.K. 1984. Stripcutting in shallow-soil upland black spruce near Nipigon, Ontario. IV. Seedling-seedbed relationships. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-359. 26 p.

Jeglum, J.K. 1987. Alternate strip clearcutting in upland black spruce. II. Factors affecting regeneration in first-cut strips. For. Chron. 63(6):439–445.

Jeglum, J.K. 1990. Modified harvesting to promote natural regeneration of black spruce. p. 123–144 *in* B.D. Titus, M.B. Lavigne, P.F. Newton and W.J. Meades, eds. The Silvics and Ecology of Boreal Spruces. Proc. 11th IUFRO Northern Forest Silviculture and Management Working Party S1.05.12 Symposium. 12–17 August 1989, Gander and Grand Falls, Newfoundland. For. Can., St. John's, NF. Inf. Rep. N-X-271.

Jeglum, J.K.; Kennington, D.J. 1993. Strip clearcutting in black spruce: A guide for the practising forester. For. Can., Ontario Region, Sault Ste. Marie, ON.

Rowe, J.S. 1972. Forest regions of Canada. Dep. Environ. Can. For. Serv., Ottawa, ON. Publ. No. 1300. 172 p.

SAS Institute Inc. 1990. Base SAS®. Cary, NC.

Max Tenhagen

John Jeglum

Maxim D. Tenhagen, a forestry officer with the Canadian Forest Service, Great Lakes Forestry Centre, specializes in studying the effects of forestry practices on forest ecosystems and vegetation succession.

John K. Jeglum is a professor at the Swedish University of Agricultural Sciences, Uppsala, Sweden. Formerly a research scientist with the Canadian Forest Service, Great Lakes Forestry Centre, he concentrated on forest ecology studies and forested wetland ecosystem research.

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

Catalogue No. Fo 29-29/89E
ISBN 0-662-25397-3
ISSN 1183-2762

This technical note is printed on paper containing recycled material.