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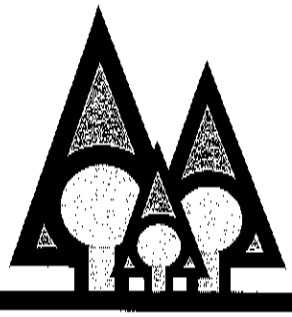


FOREST RESEARCH REPORT

No. 26 February, 1991

A RED SPRUCE UNIFORM-STRIP SHELTERWOOD TRIAL: 10 YEAR RESULTS

INTRODUCTION

Shelterwood treatments are designed to establish and promote natural regeneration under mature stands through one or more partial cuts. The overstory provides a seed source and protection from excess drying and heat during the seedling establishment period. When the regeneration stocking is adequate and the seedlings are established, the final-removal cut is made (Hannah, 1988).

A variety of shelterwood methods exist: two of the more common include the uniform and strip methods. In the uniform method, the overstory is partially and uniformly removed in one or more cuts to promote regeneration. Once the stand has successfully regenerated, the overstory is removed. In a progressive strip shelterwood, strips are clearcut progressively across a stand. As each clearcut strip regenerates, the adjoining strip is cut until the entire stand has been treated (Daniel et al., 1979, 447-448). The previously mentioned methods are more costly than conventional clearcut methods due to the need to make several entries into the stand or to perform partial cuts throughout the stand.

A combined uniform-strip shelterwood method could possibly reduce costs. This method involves clearcutting alternate strips and performing a uniform shelterwood cut within the leave strips during the first stand entry. After the stand has successfully regenerated, the remaining overstory in the leave strips can be removed. By using this method, only two entries into the stand are necessary and only one half the area requires a partial cut.

This preliminary report summarizes the results of a uniform-strip shelterwood trial, established in the winter of 1979 in a red spruce (Picea rubens Sarg.) stand near Sunnybrae (45°23'N, 62°28'W), Pictou County, Nova Scotia. The trial tested various clearcut strip widths, scarification, and partial cutting, on the establishment and growth of seedlings. A follow-up report will be written after the final-removal cut has been made.

Canada

Nova Scotia

SITE AND STAND DESCRIPTION

The stand is located on a level site with well drained, light brown, sandy loam soil derived from quartzite and slate (Halifax soil type, Cann and Wicklund, 1950). Eighty percent of the basal area was composed of red spruce and 20% was balsam fir (Abies balsamea (L.) Mill.) and hardwood species. The stand was 56 years old and had an average height of 14 m. The total basal area averaged 41.5 m^2/ha, the average diameter of merchantable stems was 16 cm, and the land capability was 4.0 m^3/ha/yr (NSDLF, 1988).

A 2.2 ha portion of the stand was divided into 23 strips of various widths 80 m long and oriented east-west. The strip widths and their orientation were chosen to provide the light and moisture conditions necessary for regeneration, and to prevent windfall in the leave strips (Smith, 1962, 447-448). In November 1979, strips 5, 9, and 14 m wide were clearcut with a mechanical tree length harvester leaving alternate uncut strips 5, 9, 14, 19, and 27 m wide (Figure 1). A uniform shelterwood cut was performed on the eastern end of all leave strips in February 1981, removing 30% of the basal area and resulting in a residual total basal area of 28.0 m^2/ha. The western portions of the leave strips were left as controls. In July 1981, six of the ten clearcut strips were scarified with a dozer and fixed-tooth root rake. Raking removed most of the advance-growth regeneration and stumps, together with the slash and humus, thereby exposing the bare mineral soil. This series of events resulted in the following four treatments:

1) untreated clearcut - clearcut in November 1979
2) clearcut and scarified - clearcut in November 1979 and scarified in July 1981
3) shelterwood strips - uniformly thinned in February 1981
4) untreated leave strips

METHODS

Permanent sample plots were established in August 1981 in all strips (this was 2 growing seasons following the clearcutting of the strips, 1 growing season following the shelterwood cut, and immediately after scarification). Regeneration data were collected after the 1981, 1982, 1983, 1984, 1986, and 1988 growing seasons. Circular plots were spaced evenly along sample lines in each treatment strip (Figure 1).

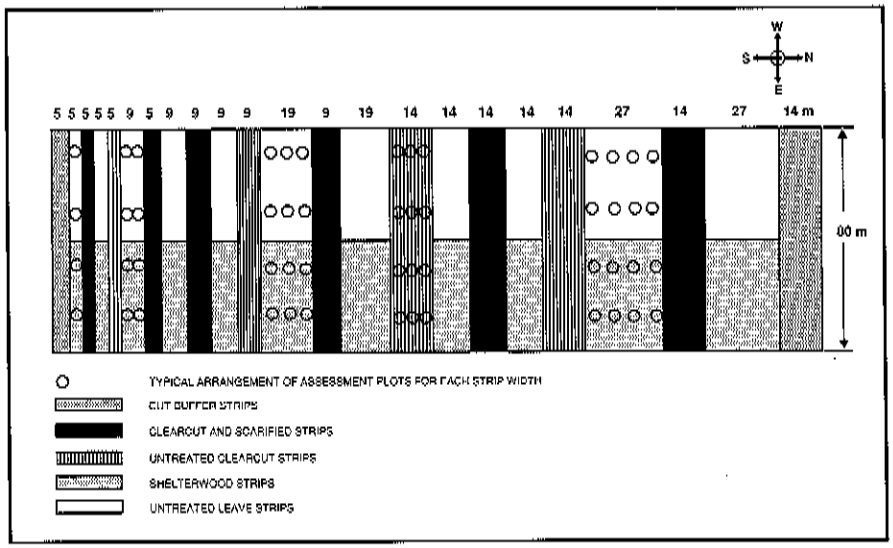


Figure 1. Schematic showing the design of the Sunnybrae uniform-strip shelterwood trial.

The number of lines was determined by strip width (Table 1). Each 2.25 m radius (1/629 ha) circular regeneration plot was divided into four quadrants in which the height and species of the two tallest tree seedlings were recorded. Stocking was determined as follows:

1) If the tallest seedling was softwood, the quadrant was considered stocked to softwood.
2) If the tallest seedling was hardwood and the next tallest seedling was softwood, the quadrant was considered stocked to softwood. This assessment procedure was based on the assumption that the regeneration would be cleaned in favour of softwood species.
3) If the two tallest seedlings were hard wood, the quadrant was considered stocked to hardwood.

Table 1. Number of Sample Lines Per Strip Width

Strip Width (cm)	Sample Lines (#)
5	1
9	2
14	3
19	3
27	4

4) If no seedlings of commercial species were present, the quadrant was considered unstocked (Appendix I).

Average dominant regeneration height was calculated based on the height of the seedlings used to determine stocking. In the fourth quadrant, all tree seedlings older than two years were counted and recorded by species.

RESULTS AND DISCUSSION

Seedling Establishment by Treatment

The 1988 remeasurement data for the four treatments show that stocking to hardwood plus softwood commercial species, dominant softwood seedling height, and softwood seedling density was greatest on the scarified strips (Table 2). By the 2nd growing season after treatment, the scarified strips averaged 90% stocking to softwood and hardwood species combined. By 1988, softwood stocking in the scarified strips was 94% compared to 75%, 88%, and 86%, respectively, in the clearcut, shelterwood, and leave strips (Figure 2). Red spruce made up 85% of the softwood stocking for all treatments except the leave strips where only 71% was red spruce. Stocking to hardwood was less than 5% for all treatments, and was greatest in the scarified strips (Table 2).

Dominant softwood seedlings in scarified strips were taller than in the other treatments by the 3rd growing season, and averaged 30 cm by the 7th year (Table 2, Figure 2). In comparison, dominant softwood in the unscarified clearcut strips did not reach 30 cm in height until the 9th growing season. In both the shelterwood and the leave strips, the softwood regeneration was less than 11 cm after 8 growing seasons.

According to Lands and Forests guidelines (NSDLF, 1988), a uniform shelterwood should be stocked with well-established regeneration approximately 30 cm tall before the final-removal cut is made. Yuill (1980) suggests that uniform shelterwood regeneration is adequately established when the seedlings are 12 - 25 cm tall. After 7 growing seasons, 63% of the dominant seedlings in the scarified strips were taller than 20 cm compared to only 22% in the

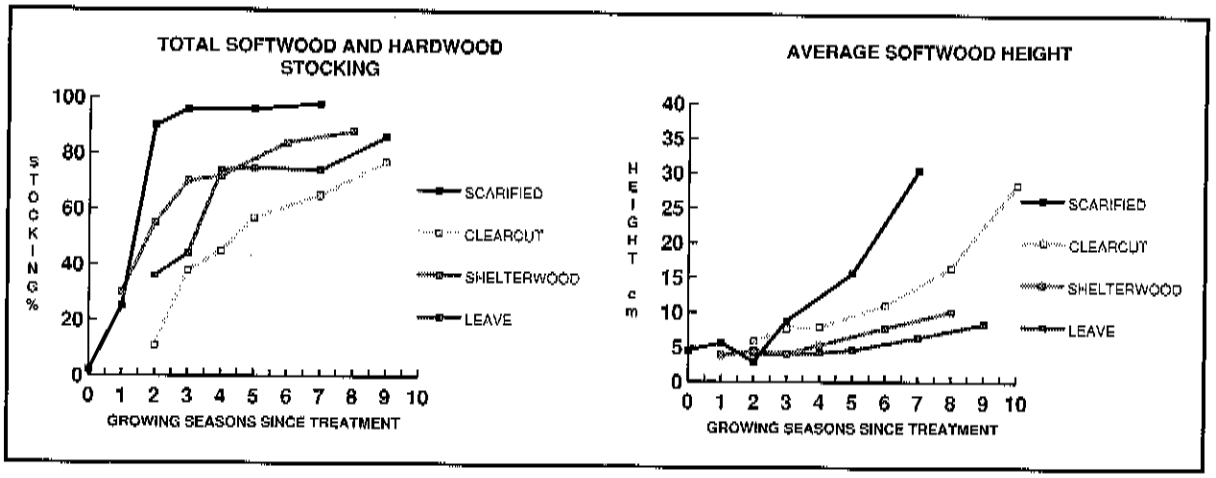


Figure 2. Total hardwood plus softwood stocking and average softwood height by treatment.

clearcut strips. In the shelterwood and leave strips, softwood stocking in 1988 to trees greater than 20 cm was only 8% and 5%, respectively (Figure 3).

Scarification greatly increased seedling density. In fact, there were 68,000 softwood stems/ha in 1988 in the scarified strips. This was 6 times more stems/ha than on the clearcut strips, 4 times more than the shelterwood strips, and 3 times more than the leave strips (Figure 4, Table 2).

Table 2. Summary of regeneration data by year, treatment, stocking, average height and density.

Treatment	Year of Assessment	Years After Treatment	Number of Quadrants	Stocking (%)				Height(cm)				Density (stems/ha)			
				Spruce	Fir	Softwood	Hardwood	Spruce	Fir	Softwood	Hardwood	Spruce	Fir	Softwood	Hardwood
Scarified	1981	0	192	1	0	1	1	4.5	0	4.5	16.0	0	0	0	0
	1982	1	192	5	2	7	18	4.7	7.8	5.6	4.5	100	0	100	500
	1983	2	192	75	13	88	2	2.7	3.8	2.9	14.0	14 400	1 700	16 100	1 700
	1984	3	192	90	5	95	1	8.8	8.7	8.8	19.0	26 700	4 800	31 500	3 400
	1986	5	192	73	20	93	3	15.7	15.3	15.6	35.3	31 600	6 600	38 200	3 900
	1988	7	192	80	14	94	5	30.4	30.7	30.4	77.5	41 000	27 400	68 400	3 600
Clear Cut	1981	2	144	8	0	8	3	5.8	0	5.8	7.0	400	100	500	20
	1982	3	144	24	4	28	10	7.5	9.3	7.7	7.2	1 200	300	1 500	300
	1983	4	144	30	9	39	6	8.0	7.6	7.9	12.6	1 500	400	1 900	100
	1984	5	144	44	8	52	6	10.2	15.9	11.0	12.0	5 100	400	5 500	800
	1986	7	144	51	10	61	3	15.5	21.5	16.5	50.6	5 200	800	6 000	400
	1988	9	144	65	10	75	2	28.3	29.0	28.4	238.7	8 000	3 000	11 000	600
Uniform Shelter-wood	1981	1	224	17	8	25	5	3.8	3.8	3.8	18.5	700	300	1 000	100
	1982	2	224	41	12	53	2	4.6	4.2	4.5	15.0	6 100	1 300	7 400	0
	1983	3	224	56	12	68	1	4.1	4.0	4.1	3.5	7 700	1 500	9 200	40
	1984	4	224	60	11	71	1	5.3	5.1	5.3	4.0	4 900	1 300	6 200	300
	1986	6	224	65	18	83	1	8.2	6.5	7.8	4.0	7 100	1800	8 900	200
	1988	8	224	74	14	88	0	10.5	8.6	10.2	85.0	9 800	6 900	16 700	100
Leave	1981	0	224	29	3	32	4	4.0	5.8	4.1	5.1	1 300	500	1 800	40
	1982	1	224	35	8	43	1	3.9	5.1	4.1	4.3	5 600	2 100	7 700	50
	1983	2	224	56	17	73	1	4.2	4.3	4.2	14.5	7 600	2 900	10 500	100
	1984	3	224	66	10	76	0	4.7	3.8	4.6	3.0	6 900	2 400	9 300	200
	1986	5	224	48	26	74	0	6.2	6.9	6.4	7.0	6 100	4 800	10 900	300
	1988	7	221	61	25	86	0	8.2	8.8	8.4	0.0	9 200	12 900	22 100	0

Seedling Height and Strip Widths

The wider scarified and clearcut strips resulted in taller softwood seedlings. Strip widths had little or no effect on seedling height in the shelterwood and leave strips (Figure 5). Softwood seedling height after seven growing seasons averaged 38, 24, and 19 cm respectively for the 14, 9, and 5 m scarified strips. Stocking to trees taller than 20 cm was 82% for the 14 m scarified strip, compared to only 44% for the 9 and 5 m scarified strips. In the clearcut strips, softwood seedling height averaged 32, 29, and

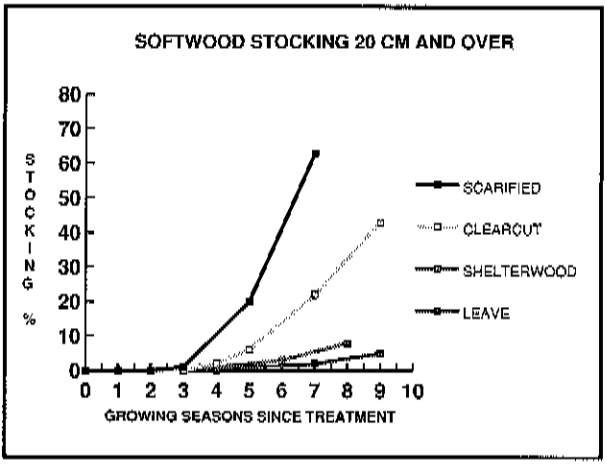


Figure 3. Softwood stocking to seedlings taller than 20cm by treatment.

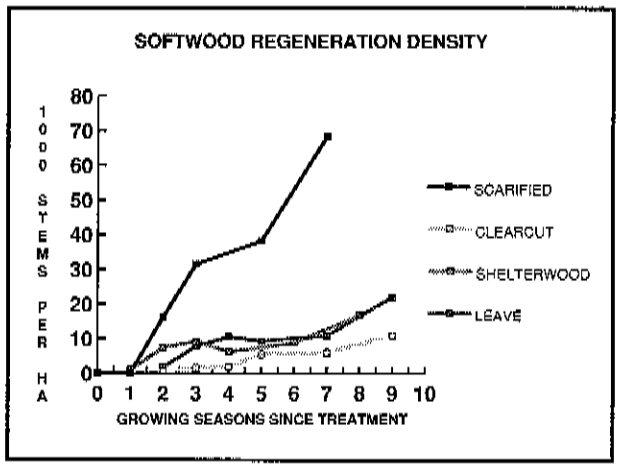


Figure 4. Softwood regeneration density by treatment.

20 cm for the 14, 9 and 5 m widths respectively. Stocking to softwood trees taller than 20 cm was 50, 47, and 6% respectively for the 14, 9 and 5 m clearcut strips.

Stocking and Strip Width

Stocking was inversely related to strip width in the clearcut strips. For example, after 9 years, the 5 m clearcut strip was 100% stocked to softwood, while the 9 and 14 m clearcut strips were only 72% stocked to softwood. On the other hand, in the scarified strips, the average softwood stocking was 90% after 4 years for all widths (Figure 5).

Stocking and Height Growth of Seedlings by Location Within Treatment Strips

Conditions for the germination and initial establishment of both red spruce and balsam fir is optimal under forest cover with a minimum light intensity of 15-20% of noonday sun, but once established, growth is best in full sunlight (Fowells, 1965).

Figure 6 shows the stocking and height growth of the seedlings in relation to their location within the 14 m strips. The greatest softwood stocking occurred where the seedling received the most shade, that is, along the north edge of the leave and shelterwood strips, and along the south edge of the clearcut and scarified strips. The greatest height growth, however, occurred on the sunniest area of the strips. For the leave and shelterwood strips, this was on both edges. In the clearcut and scarified strips, height growth was greatest in the centre of the strips, and least along the southern edge.

Effects on Residual Stand

In 1985, the uncut strips and the uniform shelterwood strips had an average merchantable basal area of 40.6 m^2/ha and 32.5 m^2/ha respectively. Over the first 5 year period, the uniform shelterwood strips increased in basal area by an average of 16%, while in the leave strips, basal area increased by only 11%. In the leave strips, there were no trees blown down, and only one tree was blown down in the uniform shelterwood strips (observations September 1990).

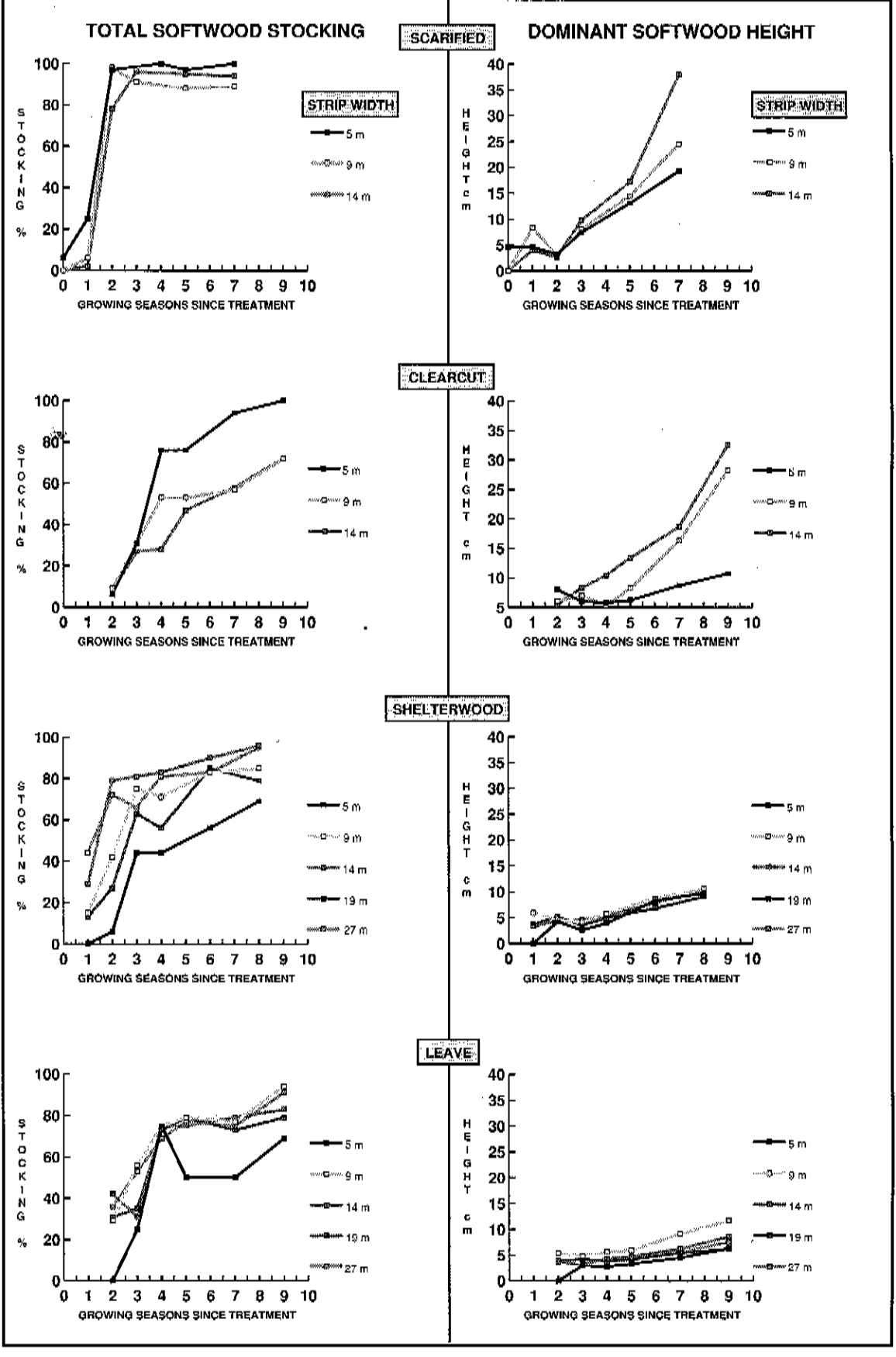
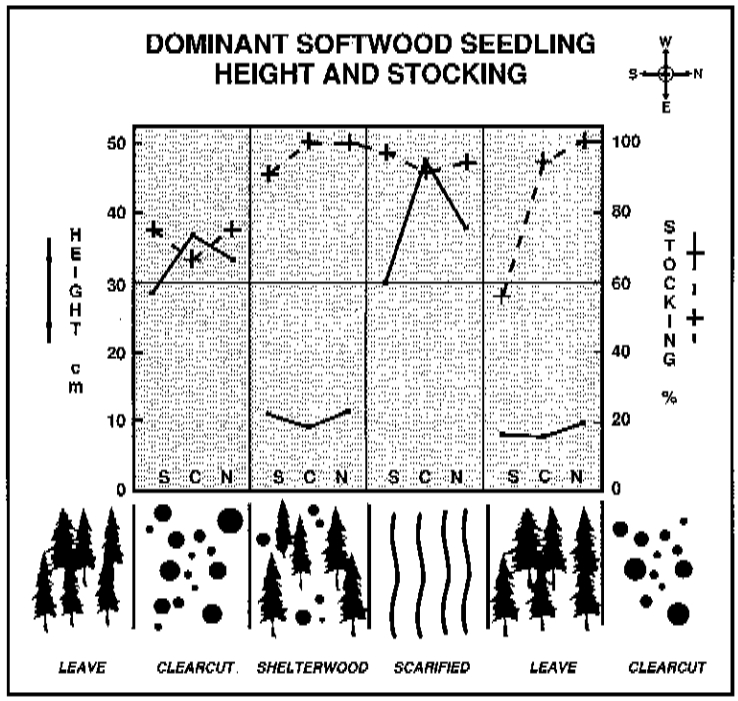


Figure 5. **Total softwood stocking and average dominant height by treatment, growing seasons and strip width.**



S - Southern edge of strips
C - Centre of the strips
N - Northern edge of strips

Figure 6. **Dominant softwood seedling height and stocking in 1988, by location within the 14 m strips: 9 growing seasons following clearcutting, 8 growing seasons following shelterwood treatment, and 7 growing seasons following scarification.**

SUMMARY AND CONCLUSIONS

Following are the major results from a variable width uniform-strip shelterwood trial established during 1979 in a red spruce stand located at Sunnybrae, Nova Scotia:

1) Red spruce can be regenerated on clearcut strips ranging in width from 1/2 to 1 times the height of the trees in the adjacent leave strips.

2) The wider clearcut strips resulted in taller softwood seedlings.

3) Scarification with a fixed-tooth root rake, exposing mineral soil, increased the stocking and height growth of softwood regeneration within the clearcut strips.

4) Height growth was slow. Even for the 14 m wide clearcut and scarified strips, the dominant softwood seedling height averaged only 38 cm after 7 years.

5) Seedlings in the centres of the 14 m clearcut strips were taller on average than seedlings on the north and south sides. The south side of the strips had the greatest percent stocking.

6) At least 85% of the softwood regeneration was red spruce in all treatment strips except the leave strips, where 71% was red spruce.

7) In the leave strips, a 30% basal area removal uniform shelterwood resulted in little increase in stocking and height growth.

8) Blowdown was not a problem in the leave or uniform shelterwood strips.

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APPENDIX I

COMMERCIAL SOFTWOOD AND HARDWOOD SPECIES.

Common Name	Latin Name
Eastern White Pine	*Pinus strobus* L.
Red Pine	*Pinus resinosa* Ait.
Jack Pine	*Pinus banksiana* Lamb
Eastern Larch	*Larix laricina* (DuRoi) K. Koch
Red Spruce	*Picea rubens* Sarg.
White Spruce	*Picea glauca* (Moench.) Voss
Black Spruce	*Picea mariana* (Mill.) B.S.P.
Eastern Hemlock	*Tsuga canadensis* (L.) Carr.
Balsam Fir	*Abies balsamea* (L.) Mill.
Trembling Aspen	*Populus tremuloides* Michx.
Large Tooth Aspen	*Populus grandidentata* Michx.
Yellow Birch	*Betula alleghaniensis* Britton
White Birch	*Betula papyrifera* Marsh.
American Beech	*Fagus grandifolia* Ehrh.
Red Oak	*Quercus rubra* L.
Sugar Maple	*Acer saccharum* Marsh.
Red Maple	*Acer rubrum* L.
White Ash	*Fraxinus americana* L.
Black Ash	*Fraxinus nigra* Marsh.

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