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REPRODUCTION AND GROWTH IN CUT-OVER BLACK SPRUCE SWAMPS AT THE PETAWAWA FOREST EXPERIMENT STATION

by
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Reproduction and Growth in Cut-Over Black Spruce Swamps at the Petawawa Forest Experiment Station

by

A. B. Berry[1] and J. L. Farrar[2]

In 1936 a black spruce[3] cutting experiment was initiated at the Petawawa Forest Experiment Station located in Forest Section L.4 (2). The object of this experiment was to test the effect on the reproduction and residual stand of two methods of slash disposal in conjunction with clear and partial cutting.

Black spruce stands in this area are mostly located in small swamps. Those selected for this experiment were relatively pure and even-aged. The ages of these stands varied from 60 to 100 years. The site indices of the individual plots varied from 43 feet to 52 feet at 50 years of age. The site index for each plot was found by using the average height and average age of its dominant black spruce trees along with a site index chart for spruce and balsam (5). A representative stand 95 years of age, having a merchantable volume of 22 cords per acre, is illustrated in Figure 2.

The two slash disposal methods used in this experiment were scattering, and burning in piles. Where the slash was burned, the cone-bearing branches were set aside and later scattered over the cut-over areas. A third method of slash disposal, burning the scattered slash, was tried but owing to difficulty in securing a satisfactory burn this method of disposal was discontinued.

On the clear-cut areas, all merchantable trees (four inches d.b.h. and larger) were removed. On the partially cut areas some trees of each size class were left; the cuts amounted to 60 to 75 per cent of the volume.

During the years 1936 to 1938, 21 permanent sample plots were established, 14 before cutting and the remainder after cutting. Eleven of these plots were partially cut and the other 10 plots were clear cut. The plots varied in size from 0·3 to 0·5 acre; the individual swamps which were cut varied from 2 to 10 acres. The appearance of an area immediately after clear cutting is shown in Figure 3. The spindly trees which were left were already beginning to blow down, and piles of slash were prominent.

A tally of the reproduction was made on transects of 20 $\frac{1}{4}$-milacre quadrats, at establishment, in 1947, and again in 1953. The results of the 1947 reproduction tally have been omitted from this report, as they are materially the same as those from the 1953 tally. The reproduction tally at establishment was by the total count method, all stems on each quadrat being counted. The 1953

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tally was by the stocked quadrat method, that is, a quadrat was considered stocked to a given species if there was at least one stem of that species on the quadrat. To obtain an estimate of the number of stems in 1953, for comparison with the number at establishment, a total count was made on every fifth quadrat. Additional data taken in 1953 included the total height and the height growth during the past five growing seasons of the tallest stem of black spruce reproduction on each quadrat.

The reproduction data, collected at establishment and in 1953, were compiled to show the stocking, to spruce and to all species combined, for each sampling method. The per cent stocking figures for the $\frac{1}{4}$-milacre quadrats were converted, by formula (1), to the equivalent figures for milacre quadrats. The milacre stocking and the number of stems per acre, by cutting method and type of slash disposal, are shown in Table 1. The stocking to black spruce, for individual plots, varied from 68 to 100 per cent, and to all species combined from 95 to 100 per cent. Since the experiment was established the number of black spruce stems has remained relatively constant for three of the treatments. The fourth treatment was associated with a large increase in numbers of black spruce; both partial cutting and burning the slash in piles seem to have favoured the germination and survival of new seedlings.

At the time of the cut, the black spruce advance growth on all the areas was generally less than one foot in height. In 1953, 15 to 17 years later, the average height of the more vigorous specimens was 4·5 feet with a range up to 12 feet. In the clear-cut areas, 67 per cent of the stocked quadrats had black spruce reproduction that was more than 3 feet high, while 48 per cent of the stocked quadrats in the partially cut areas had black spruce reproduction that was taller than 3 feet (see Table 2). In general the black spruce reproduction on both the clear-cut and partially cut areas had grown almost half its height during the preceding five years.

An example of the reproduction 16 years after clear cutting is shown in Figure 4; the same sample plot, immediately after cutting, is shown in Figure 3.

The satisfactory results of the black spruce cutting experiment at the Petawawa Forest Experiment Station are in agreement with results of studies in Minnesota described by Watson (6) and LeBarron (4). Watson stated that on some 80 different sample plots examined, four-fifths of the plots supported a reasonably good second growth regardless of how the stands were cut. LeBarron noted that slash fires in clear-cut black spruce swamps resulted in regeneration failures, as the seed in the slash and on the ground was destroyed. In the Petawawa experiment regeneration was assured because there was adequate advance growth present and also because loss of seed was reduced by spreading the cone-bearing slash over the area after the burn was completed.

To test the reliability of the converted stocking figures, the 1953 data from the clear-cut and partially cut plots were selected. The $\frac{1}{4}$-milacre quadrats were combined in groups of four contiguous quadrats and the actual per cent stocking by milacres was determined. A comparison of the actual milacre figures with the converted figures is shown in Table 3. The converted figures are higher than the actual stocking figures, as suggested by Grant (1), but the agreement between the two stocking figures is sufficiently close to indicate that it is reasonable to convert results obtained with quarter milacres to a milacre basis.

TABLE 1.—SUMMARY OF REPRODUCTION

Cutting Method	Method of Slash Disposal	Number of Quadrats	Spruce				All Species			
			Quadrats Stocked		Number per Acre		Quadrats Stocked		Number per Acre	
			Establishment	1953	Establishment	1953	Establishment	1953	Establishment	1953
			(per cent)	(per cent)			(per cent)	(per cent)		
Partial	Scattered	500	88	98	5,600	7,100	100	100	22,600	19,300
	Piled and Burned	420	89	100	5,400	10,200	100	100	38,300	27,100
Clear	Scattered	120	90	95	6,000	6,200	99	100	16,200	15,700
	Piled and Burned	480	93	96	7,200	6,000	100	100	17,100	11,100
	Weighted Average	1,520	90	98	6,100	7,500	100	100	24,700	18,600

NOTE: 1. The per cent stocking figures shown are the ¼-milacre stocking figures converted to equivalent milacre stocking.
2. The numbers of stems per acre are based on a total count of the reproduction on 20 per cent of the quadrats.

TABLE 2.—SUMMARY OF THE TALLEST BLACK SPRUCE ON EACH OF THE STOCKED QUADRATS

Height Groups	—	Type of Cutting		
		Partial	Clear	Both
Group 1 (1 — 3 feet)	Number of stems (per cent of total)	52	33	45
	Average height (in feet)	2·5	2·4	2·5
	Height growth past five years (in feet)	1·0	0·8	1·0
Group 2 (4 — 6 feet)	Number of stems (per cent of total)	39	38	38
	Average height (in feet)	4·8	5·0	4·8
	Height growth past five years (in feet)	2·1	1·8	2·0
Group 3 (7 feet and up)	Number of stems (per cent of total)	9	29	17
	Average height (in feet)	8·2	8·5	8·4
	Height growth past five years (in feet)	3·9	3·7	3·8
All Groups	Number of stems (per cent of total)	100	100	100
	Average height (in feet)	3·9	5·2	4·4
	Height growth past five years (in feet)	1·7	2·1	1·8

TABLE 3.—COMPARISON OF ACTUAL AND DERIVED STOCKING FIGURES

—	Milacre Stocking to Spruce	
	Actual (per cent)	Derived (per cent)
Partial cut, slash piled and burned	99	100
Clear cut, slash piled and burned	88	96

All trees were tallied on eight plots in the partially cut areas in 1942 and 1947, so that the effects of partial cutting on the residual stand could be determined (Figure 1). In 1942 the volumes on all plots measured were less than they were immediately after the cut. The decreases in volume to that date varied from 10 to 40 per cent. They resulted from mortality caused by wind and exposure. In 1947 the volume on all the plots but one was less than it had been immediately after cutting.

Heavy mortality of residual trees in partially cut black spruce swamps was also noted by LeBarron (3) in Minnesota. He found that cuttings greater than 30 per cent resulted in sufficient mortality to bring about a reduction in net growth.

The results of this experiment showed that:

1. Adequate reproduction followed cutting of small swamps of mature black spruce regardless of the method of cutting or type of slash disposal. This was due mainly to the presence of a good stand of advance growth at the time of cut and also to the fact that the cone-bearing slash was scattered over the area.
2. Partial cutting, in which 60 per cent or more of the original volume was removed, resulted in considerable mortality among the trees of the residual stand.
3. Clear cutting was preferable to partial cutting because it eliminated losses of standing timber associated with partial cutting.

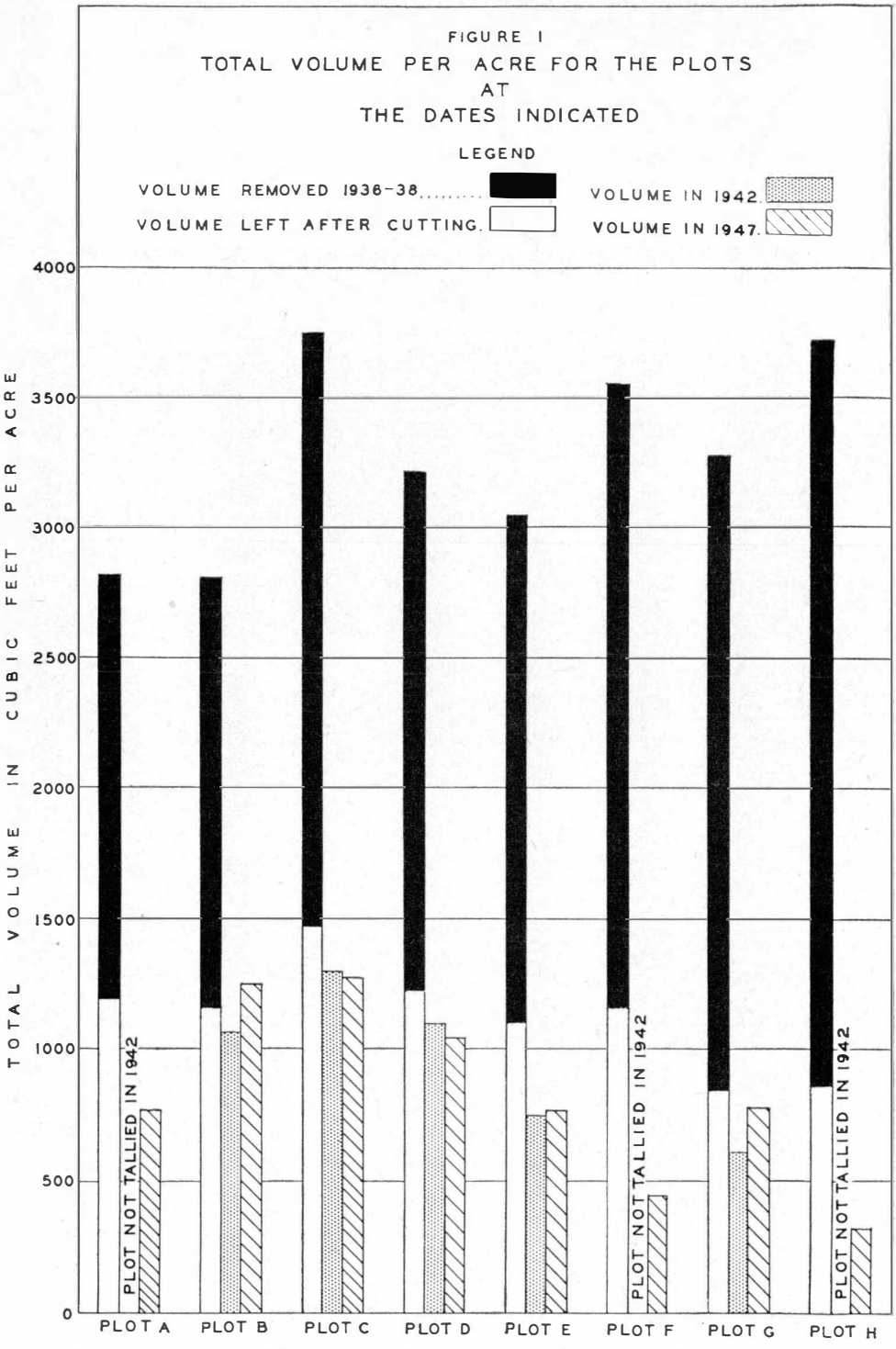
FIGURE I
TOTAL VOLUME PER ACRE FOR THE PLOTS
AT
THE DATES INDICATED
LEGEND
VOLUME REMOVED 1936-38.
VOLUME LEFT AFTER CUTTING.
VOLUME IN 1942.
VOLUME IN 1947.
TOTAL VOLUME IN CUBIC FEET PER ACRE
4000
3500
3000
2500
2000
1500
1000
500
0
PLOT NOT TALLIED IN 1942
PLOT NOT TALLIED IN 1942
PLOT NOT TALLIED IN 1942
PLOT A
PLOT B
PLOT C
PLOT D
PLOT E
PLOT F
PLOT G
PLOT H

FIGURE 2.—A 95-year-old black spruce stand. This stand had approximately 22 cords per acre when it was cut.

FIGURE 3.—A typical black spruce cut-over, showing slash piles and wind damage to spindly residuals.

FIGURE 4.—Black spruce reproduction 16 years after clear cutting. Almost all the residuals have blown over or died since the cut in 1937.

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