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ESTABLISHMENT REPORT

EFFECTS OF UNIFORM, GROUP, AND STRIP SHELTERWOOD CUTTINGS ON AMOUNT, DISTRIBUTION, AND GROWTH OF BALSAM FIR REGENERATION IN THE EPAULE RIVER WATERSHED, QUEBEC

(Project Q-83)

by

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Quebec District
February 1964

Oxf.: 221.223

64-Q-12

EFFECTS OF UNIFORM, GROUP, AND STRIP SHELTERWOOD CUTTINGS ON AMOUNT, DISTRIBUTION, AND GROWTH OF BALSAM FIR REGENERATION IN THE EPAULE RIVER WATERSHED, QUEBEC[1]

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INTRODUCTION

The future productivity of any forest stand depends to a large extent upon the establishment and development of the natural reproduction that follows cutting. If a stand is to produce merchantable timber continually, it must contain enough of the right kind of well developed young trees to assure adequate stocking for the future.

For a number of years the question of choice of the cutting method most appropriate to promote full stocking has been a matter of interest and discussion in Quebec. It is generally believed that balsam fir regeneration after conventional clear cutting is satisfactory from a quantitative point of view. Because of the climate and site, characterized by high rainfall, good drainage, rapid decomposition of organic matter and and high nutrient content of the humus, balsam fir seedlings establish themselves profusely under mature stands (Hatcher 1959).

It is known that under 70-year-old balsam fir stands of the Dryopteris-Oxalis site-type (Linteau 1955) 80 per cent of the regeneration is advanced growth largely originating in the fifteen years previous to cutting, i.e. at stand age 55 to 70 (Hatcher 1959). It can also be shown that 50- and 70-year-old balsam fir stands of that site-type may have almost the same pulpwood volume. Thus if we can successfully regenerate 50-year-old stands after cutting, clear cut or otherwise, then we will shorten the rotation by 20 years and in 150 years produce three crops instead of two.

1/ See project plan on Q-83, by P.E. Vézina and R.J. Hatcher. 1960.

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If we clear cut 50-year-old stands, a smaller proportion of the seedlings may have established before the cut, so that we think it may be necessary to give the new reproduction protection against adverse influences of the milieu through a partial shade. Balsam fir is a very tolerant species and, consequently, one can normally think that during its first years of growth it will show a better behaviour under such conditions. As the environmental factors, and especially the climatic factors, are very different in small openings compared to large clearcut areas, it was intended to create artificially and experimentally a range of environmental conditions through the application of the shelterwood system in order to study, from a silvicultural point of view, the total effect of environment upon balsam fir regeneration.

PURPOSE

Quantitative and, especially, qualitative data on balsam fir reproduction in Quebec are scarce. No data are available for Quebec on the amount and distribution of advanced reproduction and new reproduction following clear or partial cutting in young-mature, that is, 45- to 60-year-old balsam fir stands.

The purpose of this experiment is threefold; it consists of:

(1) studying the natural reproduction following the cutting of young-mature balsam fir stands;

(2) creating a range of environmental conditions through the shelterwood system in order to study the relationships between environment as a whole and a) frequency, that is, presence or absence; b) distribution; and c) growth of balsam fir regeneration;

(3) and, finally, comparing the reproduction obtained under the shelterwood system with that following clear cutting.

The study was limited to the young-mature stands of the Dryopteris-Oxalis site-type found in the Epaule River watershed, some 40 miles north of Quebec City. According to Linteau (1955), the site is among the best to be found in the Northeastern Coniferous Section (B.1) of the Boreal Forest Region (Rowe 1959). Balsam fir stands grow rapidly and reach high volume in less than 60 years.

DESCRIPTION OF THE AREA

The study area is in the Laurentide Park, about 2 miles north of the Stoneham Gate along highway 54 between Quebec City and Chicoutimi. It is on a 3- to 5- percent middle slope facing west, and the soil is a sandy loam iron humus podzol. The bedrock is made up of Laurentian granite covered with glacial till.

The climate is characterized by a short frost-free period of about 60 days and an annual precipitation as high as 56 inches, usually well distributed throughout the year. The annual snowfall averages 174 inches.

The stand originated very likely from a diameter-limit cutting some 40 years ago, and dominant trees averaged 49 years at the time of plot establishment. It occupies an area of approximately 60 chains long by a maximum width of 30 chains (Figure 1). About 85 per cent of the trees were balsam fir (Abies balsamea (L.) Mill.), the remainder were white spruce (Picea glauca (Moench) Voss), white birch (Betula papyrifera Marsh.) and a few other associate species.

EXPERIMENTAL DESIGN

The study area is composed of 4 replication blocks. Three treatment plots and one control plot were laid out within each replication block. Treatment plots are three chains square (9/10 acre), and control plots are 12 chains square (14.4 acres). Treatments were assigned at random to plots within blocks. The area under treatment was 61 acres (Figure 1).

METHODS

Stand Treatments

The effects of different patterns of timber harvesting on regeneration were the subject of this study. For each treatment the harvesting was intended to leave approximately the same percent of the original basal area, but the pattern differed from treatment to treatment. Three modifications of the shelterwood method were tried, namely the uniform method, the group shelterwood, and the strip shelterwood, and compared with the commercial clear cut in so far as the development of the advanced reproduction and the new reproduction are concerned. The treatments were as follows:

(1) check: commercial clear cut in young-mature, 45-year-old balsam fir stands. Those stands are not normally the ones clearcut in commercial operations. However, there exists generally on a compartment small areas of younger stands in mixture with mature stands, and which are cut in the same commercial operation. A survey was made in those stands where the cutting operations were contemplated for the following year, and 4 young-mature balsam fir stands were located.

(2) uniform shelterwood: involved a thinning aimed at leaving trees of good growth and quality, well distributed over the forest area and inducing regeneration. The trees left were mainly dominants and co-dominants so spaced to provide an even crown cover with spaces not more than 3 to 5 feet in width between the edges of the crowns. The basal area density of the original stand, which was about normal, was reduced by one third in the operation.

(3) group shelterwood: involved arbitrarily creating circular holes 2/3 of a chain in diameter, and with a spacing of one chain from center to center.

(4) strip shelterwood: involved 3 cut strips, 1/3 of a chain in width, with intervening uncut strips 2/3 of a chain wide and 3 chains long. The strips were oriented northeast-southwest.

In the group and the strip shelterwood methods the "clear-cutting" was the same as on the commercial clear cut. No slash disposal was done.

Stand and Cut Data

Prior to cutting, the following measurements were taken on 0.1-acre study plots located at or close to the center of each treatment plot. All tree species 0.6 inch d.b.h. and over were tallied by one-inch diameter classes. Fifteen height and age measurements were taken on each study plot in order to establish the age structure of the stand and construct height diameter curves. In addition, a record was kept of the basal area removed in each study plot. The clearcut plots were remeasured after cutting to determine the extent of the residual stand. A short silvicultural description of stand and site conditions were taken for each study plot.

Individual Tree Data

In the uniform shelterwood 10 to 21 dominant and co-dominant balsam fir were selected as crop trees in each of the study plots. Data recorded for each tree were as follows:

(1) Crown class: dominant or co-dominant.

(2) D.b.h. to the nearest 0.1 inch.

(3) Total height to the nearest foot.

(4) Height to live crown to the nearest foot.

(5) Age at breast height to the nearest full year.

(6) Tree index read from Linteau's (1955) curves.

(7) Basal area density of surrounding stand by relascope with factor of 10.

(8) Overstory density: by the "moosehorn", making 4 measurements, north, east, south, west of each selected tree, and just far enough away from the bole so that the crown of the measured tree was not included.

Logging and Skidding

A technician was assigned to assist the contractor. During the cutting operations the technician, aided by 7 to 10 students, stayed on the area with the loggers to ensure that the proper trees were cut. The cutting operation extended from June 17 to July 30, 1963, and a total of 1,100 cords of pulpwood was removed. On this gently sloping area, with a maximum hauling distance of 50 chains, hauling with horse and sleigh was considered to be the most economical and would cause the least damage to the residual stand.

STAND DATA BEFORE AND AFTER FELLING

About 1,300 cubic feet per acre was marked in each of the plots to be cut from a total growing stock of about 3,400 cubic feet.

Marked trees not cut during the commercial operation were subsequently felled. Permanent corner posts and boundaries were established. Representative soil profile descriptions were made and ground vegetation was described. Stand data before and after felling are presented in Tables 1, 2, and 3.

Basal Area.

In 1963 at stand age 50, number of trees with d.b.h. 0.6 inch and up averaged 1,400 with a basal area of 177 square feet per acre. Eighty-nine per cent of the trees were softwoods, mainly balsam fir. The treatments, except the clearcut, removed about 40 per cent of the original basal area and left from 755 to 945 trees per acre (Table 1). The proportion of softwoods after the cut was 87 per cent in terms of number of trees; this is about the same as before cutting.

Height

Total height of dominant trees on all the plots ranged from 41 to 44 feet (Table 2). Height and age data from each plot were combined to determine the site index of the stand as an indirect measure of its productivity. The site index averaged 45 feet at 50 years, which is a low site for the area.

Diameter

Average stand d.b.h. was calculated for each plot in 1963, both before and immediately after cut. It is observed (Table 3) that the average plot d.b.h. after cutting is slightly lower than before the cut due to the removal of large-size trees.

Table 1. Average stand data per acre by treatment before and after cutting in 1963. All trees 0.6 in.d.b.h. and over.

Treatment	Before cutting		After cutting	
	Trees	Basal Area	Trees	Basal Area
	Number	Sq.ft.	Number	Sq. ft.
Clearcut	1,415	186	0	0
Uniform	1,420	166	945	108
Group	1,218	179	755	101
Strip	1,542	177	792	89

Table 2. Average total heights of dominant and co-dominant balsam fir in 1963, by treatment.

Treatment	Average stand height (feet)
Clearcut	43
Uniform	43
Group	44
Strip	41

Table 3. Mean plot d.b.h., by treatment, before and after cutting in 1963.

Treatment	Average Stand d.b.h. Before cutting	After cutting
	Inches	Inches
Clearcut	4.9	0
Uniform	5.2	4.6
Group	5.3	5.0
Strip	4.6	4.5

Regeneration Study

The first regeneration survey was made on 10 plots in Sept. 1961, but logging was delayed till 1963. A complete regeneration survey was made in the spring of 1963, before treatment. Sufficient milacre quadrats (6.6' x 6.6') to give a ten per cent sample were established as follows:

1) in the check (clearcut) plots and in the uniform shelterwood plots, at random;
2) in the group shelterwood plots: two lines at random of alternate milacre quadrats to show the distribution of seedlings at various exposures and distances from the border;
3) in the strip shelterwood plots: two lines of milacre quadrats were run in each treatment plot in an east, west direction, at right angles to the clear cut strips, starting points were chosen at random.

The following data were recorded on each milacre quadrat:

1) The largest seedling of each species classified according to the following scale: (a) current years seedlings; (b) two years old to six inches in height; (c) over six inches to three feet in height; (d) over three feet in height to 0.6 inch d.b.h.
2) The largest tree of each species classified according to the following scale: (e) 0.6 inch d.b.h. to 3.5 inches d.b.h.; and (f) tree larger than 3.5 inches d.b.h.

The total number of seedlings of each species and their classification according to the scale in (1) above and tree according to (2) above, on two quadrats in each treatment plot, these quadrats were selected at random.

Germination of the 1962 fir seed had not begun at the time of the June 1963 survey. Except for trees over 3.6 inches d.b.h.,all classes showed a marked decrease in number of stems per acre since September 1961 (Table 4). Apparently large fluctuations in numbers of seedlings are possible from year to year. If a balsam fir seedling over six inches in height is considered as being established, there were in June 1963, before treatment 1800 balsam fir seedlings per acre plus 350 balsam fir saplings. Thus at the time of treatment in 1963 sufficient seedlings were present to ensure adequate stocking.

Of the four treatments, the uniform group cutting is the only one to have 100 per cent fir stocking (Table 5). The larger per cent stocking in uniform cutting for the six inches to three feet category might perhaps be due to the slightly lower basal area of this treatment which in turn might result in longer lived seedlings due to a more open stand.

FUTURE WORK

The original intention was to study regeneration in the spring following the cut. It is doubtful whether this will be possible in the spring of 1964 because of the very heavy slash cover. This study may then be delayed one year.

The next remeasurement of the plots and of the individul trees should be carried out in June 1968.

Table 4. Number of balsam fir per acre, 1961, compared to 1963, by size class

Date	SIZE CLASSES						
	1 yr. old	2 yrs to 6 in. tall	6 in. to 3ft. tall	3 ft. to 0.6 in. d.b.h.	0.6 in. d.b.h. to 3.5 in. d.b.h.	3.6in. d.b.h.+	Number of plots studied
Sept. 9, 1961	96,850	65,050	3,650	300	500	600	10
June 6, 1963	0	49,100	1,800	0	350	700	16

Table 5. Percent stocking and number of seedlings per acre, by species and treatment

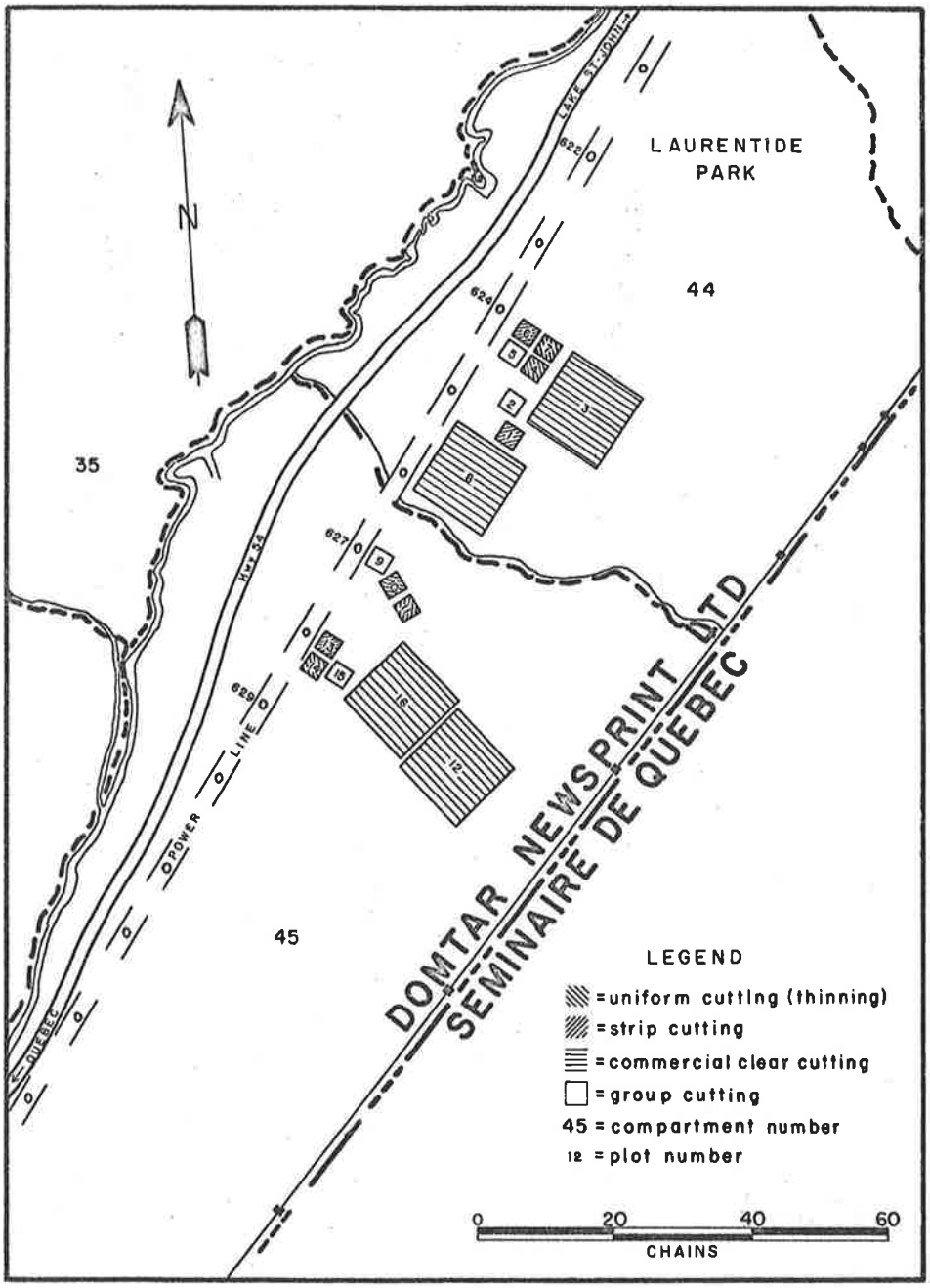
Species	Treatment	SIZE CLASSES						Total Stocking
		2 yrs old to 6 in. high		6 in. high to 3 feet		3 feet high to 0.6 in. d.b.h.		
		Percent	Number	Percent	Number	Percent	Number	Percent
Balsam Fir	Clear cut.	65.0	56,875	25.0	875	5.0	0	95.0
	Uniform	37.5	44,625	55.0	2,125	7.5	0	100.0
	Group	50.0	37,625	45.0	1,000	0	0	95.0
	Strip	55.0	57,000	25.0	1,750	17.5	0	97.5
White Birch	Clear cut.	22.5	1,375	5.0	750	0	0	27.5
	Uniform	10.0	500	7.5	0	0	0	17.5
	Group	5.0	125	2.5	125	0	125	7.5
	Strip	7.5	625	5.0	0	0	0	12.5
White Spruce	Clear cut.	2.5	125	0	0	0	0	2.5
	Uniform	7.5	125	2.5	0	0	0	10.0
	Group	12.5	125	5.0	0	2.5	0	20.0
	Strip	0	0	0	0	0	0	0

REFERENCES

Hatcher, R.J. 1959. Development of balsam fir following a clear cut in Quebec. Canada Dept. Northern Affairs and National Resources, Forestry Branch, Forest Research Division. Technical Note No. 87.

Linteau, A. 1955. Forest site classification of the Northeastern Coniferous Section, Boreal Forest Region, Quebec. Canada Dept. Northern Affairs and National Resources, Forestry Branch Bull. No. 118.

Rowe, J.S. 1959 . Forest Regions of Canada, Dept. Northern Affairs and National Resources, Forestry Branch Bull. No. 123.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DOMTAR NEWSPRINT LTD
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=strip cutting
=commercial clear cutting
=group cutting
45 = compartment number
12 = plot number
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CHAINS