Management of a Red Spruce, Balsam Fir and Yellow Birch Stand — 1935 to 1959

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Introduction

An uneven-aged spruce-fir-yellow birch[2] stand of about 13 acres on the Valcartier Forest Experiment Station has been logged on four occasions beginning in 1935. In 1938 a two-acre sample plot was established in the middle of the stand, and all per acre values presented in this report are from plot measurements in 1938, 1950, 1954 and 1959.

The stand in 1935 contained an excess of mature and overmature balsam fir. The initial objectives are: 1) to harvest this fir and to permit a satisfactory development of advance growth and the establishment of new seedlings by increasing stand light; and 2) to accomplish this without heavy mortality from wind in the residual stand, and without an increase in the volume of less valuable trees such as white birch and red maple.

These objectives have been attained by an initial heavy cut, two moderately heavy cuttings, and more recently a light cutting. The stand structure is now suitable for the adoption of a selection system of cutting, with light logging at four or five year intervals. The effects of logging on growth and regeneration have been very favourable, particularly during the five-year period 1954—1959.

The Stand

The stand, at the base of the south slope of a 1,400-foot mountain, is on level ground bordering one side of a small lake. The soil is shallow, underlain by large boulders, and moderately well drained. The site type is similar to the Oxalis-Cornus type identified by Heimburger[3] at Lake Edward, P.Q.

Early records suggest that a fire burned through the area about 1890 but a lack of fire scars and absence of charcoal in the soil make it doubtful if the stand was, in fact, burned.

The area became part of the Valcartier Military Camp in 1914. Up to this date the private owners had cut very lightly; the total volume removed per acre, calculated from old stumps measured in 1938, amounting to about 460 cubic feet of spruce and fir. Between 1914 and 1935 there is no record of any logging.

In 1935 fir was the dominant species (70 per cent by volume), followed by yellow birch (20 per cent), red spruce (8 per cent), and red maple (2 per cent). When the sample plot was established in 1938, old stumps and those from the 1935 cut were measured. The volume represented by the 1935 stumps plus the 1938 tally of living and dead trees provided the estimate of the original 1935 stand included in Table 2.

A severe windstorm in the fall of 1950 completely demolished a 28-acre thinned fir stand lying immediately south but did little damage in the study area. By 1953 several large fir had been windthrown and many of the larger fir were overmature and susceptible to wind damage. The canopy had closed since 1935 and seedlings and saplings were being suppressed. Therefore the overmature fir was cut during the fall and winter of 1953 and 1954. In the late fall of 1958 the first in a proposed series of light selection cuts was made to remove mature fir.

Treatment

The logging in the winter of 1935—36 was a moderately heavy cut that removed 28 per cent of the basal area and 31 per cent of the volume. It is not known if the small trees removed were deliberately cut or if they were damaged by logging and subsequently salvaged.

The second and third cuts took place during the late falls of 1953 and 1954. For purpose of analysis, these two operations are considered as one. (No attempt was made to determine the number or the size of trees to be cut in order to regulate growing stock and diameter distribution). Only fir of the following classes were marked for cutting: 1) trees judged to be susceptible to butt rot and wind damage by reason of size or position; 2) trees with visible defects, i.e. broken tops, woodpecker holes, butt rot, frost cracks; 3) pole-sized trees with short, narrow crowns, selected from small clumps; and 4) all merchantable dead trees. A volume equal to 29 per cent of the 1950 total growing stock was cut (41 per cent of the 1950 fir growing stock).

The most recent cut, in 1958, was a result of the 1954 decision to remove mature trees at four or five year intervals. Logging was much lighter than in 1953 or 1954, and most trees cut were of the first class mentioned above. A volume equal to 15 per cent of the 1954 total growing stock was removed. The reduction in spruce-fir volume by diameter classes resulting from logging is shown in Fig. 1.

Results

The fluctuations in the growing stock, and the changes in species composition (per cent of total) are shown at each date of measurement in Fig. 2. Success in the attempt to increase the proportion of wind-resistant red

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[2]Common names of trees are those in "Native Trees of Canada," For. Br. Bull. 61.

[3]Heimburger, C.C. 1941. Forest site classification and soil investigation in the Lake Edward forest experiment area. Canada, Dept. Mines and Resources, Dom. For. Serv. Silv. Res. Note 66.

spruce is obvious. Only 31 cubic feet per acre of this species have been cut since 1935. The steady decline in the volume of yellow birch from a high of 30 per cent of the total after cutting in 1935 to a low of 8 per cent in 1959 is also obvious. The reduction from 1935 to 1954 is due to the death of a few large diameter trees. Axe-girdling of several large wolf trees in 1958 accounts for the reduction between 1954 and 1959. Cutting has not led to an upsurge of what in this stand would be considered weed species such as red maple and white birch.

The volume of spruce-fir increased by 203 cubic feet per acre between 1954 and 1959 even though a cut removed 235 cubic feet in 1958 (Table 1).

The large spruce have grown rapidly but an increase in the number of saplings has not yet occurred (Table 2). The main concern about fir for selection management is the small number of 5- to 7-inch trees in 1959. This situation may result in one or two reduced future cuts but it should be remembered, however, that these trees are the best of their size, being residuals from three cuttings. Future mortality among them will probably be very low.

Following the initial period of loss from wind after the first heavy cutting, the net annual production of spruce and fir, 1938 to 1954, was about 55 cubic feet per acre (Table 3). Taking 100 cubic feet, *total* volume, as equalling one cord, this rate is equivalent to one-half cord of merchantable wood per acre per year. For the five years 1954—1959, the annual growth rate increased to 88 cubic feet or about nine-tenths of a cord per acre. Negative rates for yellow birch are a result of large trees dying out, plus girdling in 1958.

The 1935 cutting resulted in many fir and yellow birch seedlings becoming established but apparently there was no influx of spruce. In 1938 there were over 30,000 fir seedlings per acre, almost 4,000 yellow birch, but only 20 spruce. These values dropped by 1950 to 19,000, 500, and nil respectively. Evidently the canopy closed rapidly after the cut and during the later years up to 1950 there was insufficient light to permit satisfactory seedling development. This occurred despite the stand being only moderately dense in terms of basal area per acre (88 square feet in 1938, increasing to only 105 square feet in 1950).

The 1953—54 cuttings resulted in a second heavy influx of seedlings, this time including spruce. A stocked quadrat survey in 1954 disclosed a

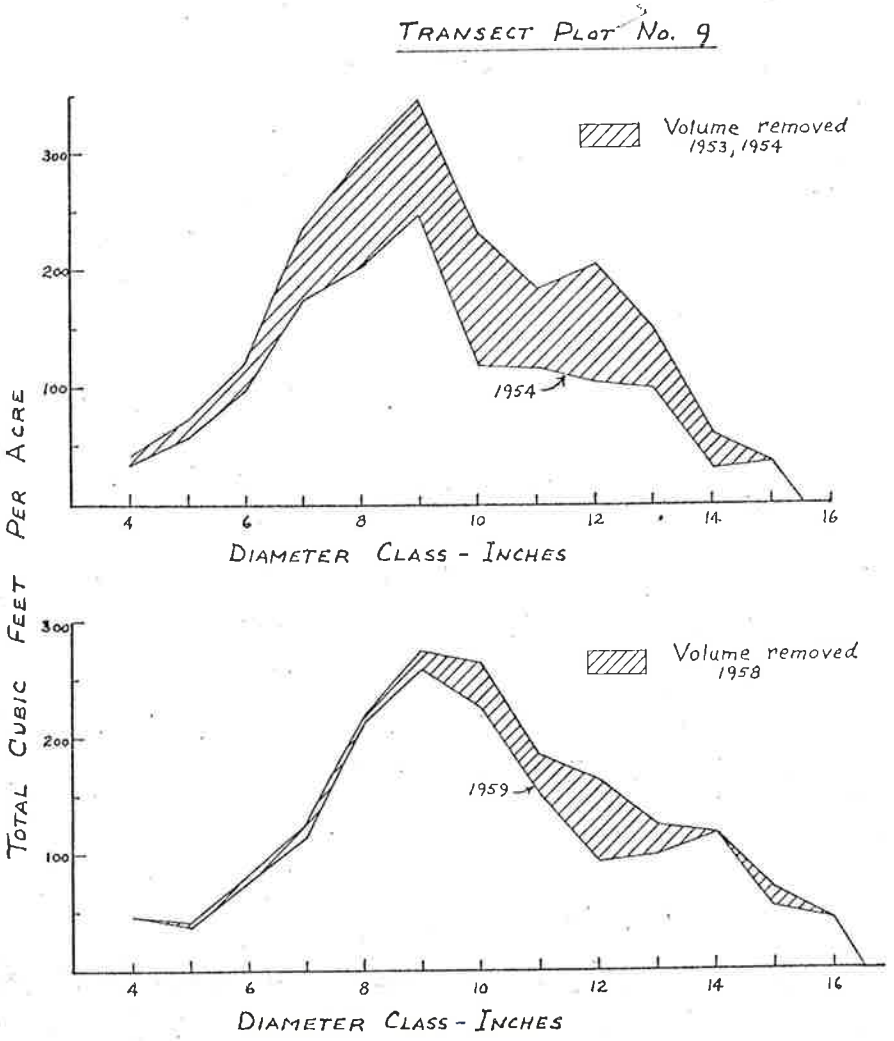


Fig. 1. Stock profiles — spruce and fir.

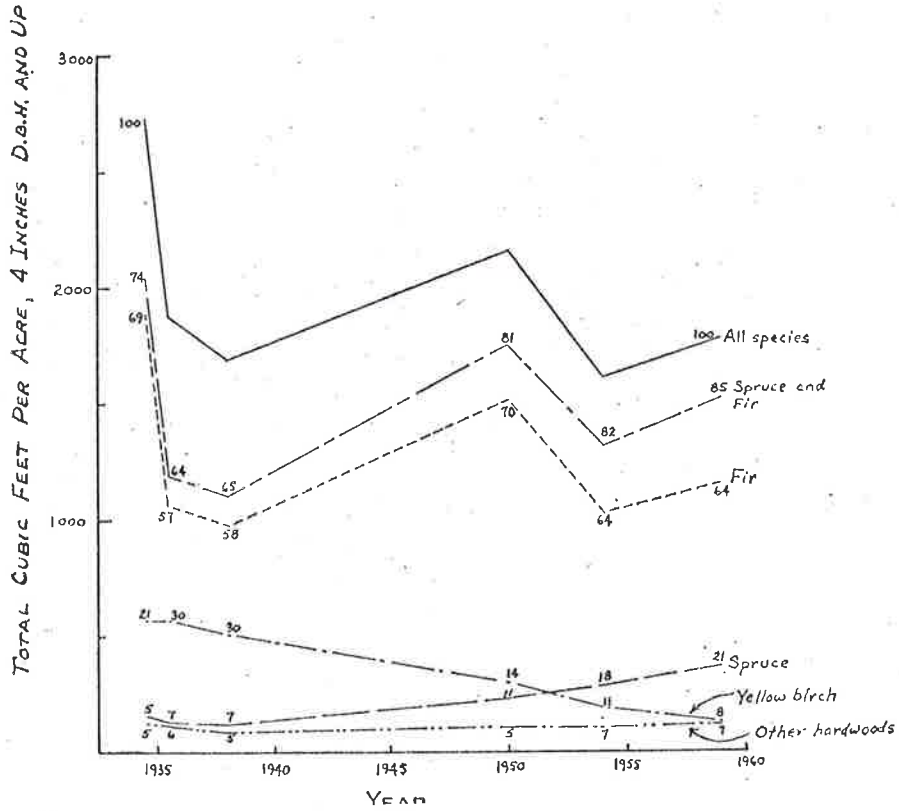


Fig. 2. Growing stock and species composition, 1935-1959. (Numerals indicate percentages of total).

96 per cent stocking of fir, 22 per cent of spruce, 82 per cent of yellow birch and 71 per cent of red maple. These cuttings took place before the snow and thus provided some ground scarification which was not the case in 1935 when logging took place during the winter.

The openings in the crown canopy caused by the 1954 cutting diminished in size rather rapidly, largely because of an extension of the hardwood crowns, and at the time of the 1958 light selection cutting, 3 or 4 malformed or wolf hardwoods per acre were axe-girdled to favour coniferous saplings.

The stand in 1959 had a more balanced uneven-aged structure than in 1935, the mature and overmature fir having been removed. The visual impression is of a moderately open stand of sound, vigorous trees with yellow birch and fir samplings taking advantage of light from canopy openings (Figs. 3 and 4).

TABLE 1

TOTAL CUBIC FEET REMOVED, [1] 4 INCHES D.B.H. AND OVER, PER ACRE

Year of Cut	Species			Total
	Spruce	Fir	Hardwoods	
1935	21	825	5	851
1953, 1954	0	655	0	655
1958	10	225	0	235
Total	31	1,705	5	1,741

[1]Includes a small volume from merchantable dead trees.

Discussion

Several factors have probably contributed to the success of the treatments to date. Protection from the often strong northwest winds afford-

TABLE 2

SPRUCE AND BALSAM FIR STAND TABLES — (No. Trees per Acre)

			Spruce					Balsam Fir			
D. B. H.	1935	1938	1950	1954	1959	1935	1938	1950	1954	1959	D. B. H.°
1	2.5	2.5	5.0	4.0	5.5	264.5	186.5	188.5	153.0	258.5	1
2	3.0	3.0	1.5	3.0	1.5	192.0	123.5	110.5	102.5	120.0	2
3	3.5	3.0	1.5	3.0	2.5	133.0	103.0	69.5	53.0	62.0	3
4	7.0	7.0	5.5	2.5	3.5	82.5	74.0	54.0	26.5	37.0	4
5	1.5	1.5	1.5	1.5	0.5	74.0	67.0	48.0	26.0	18.0	5
6	3.5	3.5	1.5	2.0	2.0	68.0	57.5	47.0	26.5	20.5	6
7	3.0	2.5	1.5	1.5	1.5	60.5	43.0	39.5	31.5	20.0	7
8	4.0	3.0	4.5	4.0	1.0	32.0	16.5	16.0	23.0	27.0	8
9	2.5	2.5	1.0	3.0	3.0	14.0	6.0	24.0	21.5	22.5	9
10	1.5	1.0	1.0	0.5	4.0	19.0	7.0	11.5	8.5	13.0	10
11	1.0	0.5	2.0	2.5	1.5	8.0	1.5	10.0	4.5	8.0	11
12	1.0	1.0	2.5	2.0	2.0	11.0	0.5	4.0	3.0	2.5	12
13			1.0	2.0	2.0	2.0	0.5	2.0	2.0	2.0	13
14			1.5	1.0	2.0	1.0				2.0	14
15				1.0	1.5	0.5		0.5			15
16					1.0						16
TOTAL	34.0	31.0	31.5	33.5	35.0	962.0	686.5	645.0	481.5	613.0	

(Left) — Fig. 3. Condition of stand, winter 1959-60. (Right) — Fig. 4. Yellow birch saplings and balsam fir seedlings fill a small stand opening, 1959.

TABLE 3

NET ANNUAL PRODUCTION, TOTAL CUBIC FEET PER ACRE, 4 INCHES D. B. H. AND OVER

Period	Years	Species					
		Spruce	Fir	Spruce and Fir	Yellow Birch	Other Hardwoods	Total
1935-38.....	3	− 1	−29	−30	−19	−11	−60
1938-50.....	12	9	45	54	−17	2	39
1950-54.....	4	13	43	56	−28	0	28
1954-59.....	5	19	69	88	−10	5	83
1935-59.....	24	11	40	51	−18	1	34

ed by nearby Pinkney Mountain has probably been important, particularly after the heavy 1935 cut. However, in 1950 an adjacent even-aged fir stand was destroyed by a severe windstorm while the equally exposed study area stand was undamaged. Conceivably the presence of spruce, yellow birch and red maple as 30 per cent of the total volume gave the study stand greater wind resistance. Since 1935, special effort has been made to avoid leaving any large openings in the canopy when removing poor-risk trees.

Some of the mortality which followed the heavy 1935 cut might have been avoided had the stand been opened up more gradually. Had a second cut followed between 1940 and 1945 instead of in 1953, it would have prevented to some extent loss of regeneration which had occurred by 1950. It seems that scarification of the seedbed by fall logging is helpful in securing regeneration of spruce.

The results suggest that cutting should be frequent and light; future selection cuts will be at four or five year intervals. Barring a sudden reduction in growing stock, an annual growth rate of 70 to 80 cubic feet per acre of spruce and fir can probably be maintained indefinitely with a range in total growing stock from approximately 1,900 to 2,200 cubic feet per acre. Spruce will be grown to large dimensions, both to establish its maximum windfirm size and to produce high-value sawlogs. Another intention is to encourage an increase in yellow birch up to about 20 per cent of the total growing stock by liberating good-quality saplings, while gradually eliminating the large, malformed yellow birch by girdling.

Tree Farm Licence Helps Create Celgar Operation

Behind the development of Celgar Limited's bleached kraft pulp mill, and integrated sawmill now under construction in the Arrow Lakes Region of British Columbia, is the interesting story of forestry and forest tenure which made B. C.'s first interior pulp mill possible.

The Arrow Lakes region is part of the Columbia River system just north of the U. S. border and it is also part of the District known as the West Kootenays. Investigations into its timber resources led to the incorporation of Celgar Limited in 1951 with the ultimate investment of nearly $50 million in an integrated woods, sawmill and pulp mill operation.

A method of forest tenure known as the Tree Farm Licence system was established in British Columbia as a means of bringing the cut up to sustained yield forest management requirements, and at the same time to provide the incentive and security of tenure for the large capital investment necessary to establish the integrated forest operations so vital to the economical utilization of the range and grades of species found in B. C. forests.

Most Tree Farm Licence agreements in British Columbia involve a partnership in which public lands and the private holdings of the Licensee are combined and managed as a sustained yield unit.

In 1952 Celgar obtained a Reserve on certain Crown lands and at the same time purchased sawmill properties and private timber holdings in the area. Since that time the company has operated a sawmill at Nakusp and one at Castlegar.

After years of inventory work and forest planning, in 1955 Celgar received timber rights to about 860,000 acres of productive forest land under Tree Farm Licence No. 23 issued by the Provincial Government. Subject to compliance with the terms of the Licence, the Licence is perpetual. In return for this assurance of timber supply, Celgar agreed to adopt acceptable standards of forest management and to establish a pulp mill of at least a 300-tons per day capacity by March 1, 1961.

An important feature of the Tree Farm area is that the majority of the timber lies within a 15-mile distance of the Columbia River, which runs through the length of the area, providing water transportation to the mill for the logs.

Why Castlegar Was Chosen for Mill Site

Construction plans call for an integrated sawmill and a 500-ton per day bleached kraft pulp mill for completion early in 1961.

The 545-acre mill site is located 2½ miles up river from Castlegar which in turn is about 38 miles north of the U. S. border near a point where the Kootenay River joins the Columbia. It is centred on a group of well-established communities with a total population of some 50,000 people within a thirty-mile radius. Spokane is about 160 miles to the south.

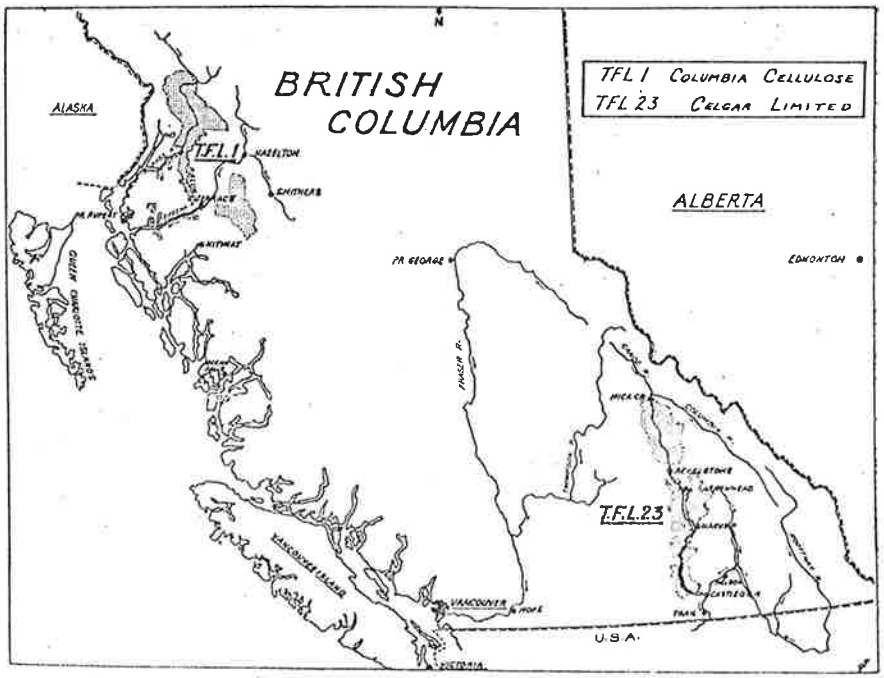
Transportation, natural gas, hydro-electric and community facilities are well developed, and the area is popular for its scenery, fishing, skiing and vacation accommodation.

These features, plus the proximity of the U. S. market, and the bountiful water and timber resources, added up to an ideal situation for a forest industry based on lumber and pulp manufacture initially, with the possibility of fibreboard, flakeboard or other forest products later as conditions warrant.

The Timber Resources

Because wood is a major cost component in a forest industry, wood cost and continuity of supply are fundamental to the establishment of such an industry.

The Arrow Lakes area extends from Mica Creek in the north to Castlegar



The above map shows Columbia Cellulose Company, Limited's Tree Farm Licence No. 1 and Tree Farm Licence No. 23 held by its subsidiary, Celgar Limited. Combined acreage of the two areas is over 1.6 million productive acres of forest land.