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DEVELOPMENT OF YOUNG LODGEPOLE PINE AFTER THINNING

by

J.R.B. Holmes

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J.R.B. Holmes[1]

INTRODUCTION

Pure even-aged stands of lodgepole pine, (Pinus contorta Dougl. var. latifolia Engelm.), are widespread in the Boreal and Subalpine regions of Alberta. After fire this species may regenerate in stands as dense as one-half million stems per acre, and although many seedlings die, overstocking may persist for as long as one hundred years, resulting in totally unmerchantable stands. Overstocked conditions prevail in many existing stands, and must be anticipated in future stands created by wildfire.

It has been shown that the total basal area of mature fully stocked lodgepole pine stands is consistent with site quality, regardless of the number of stems per unit area (Smithers 1956). The net basal area increment and net cubic foot volume increment of fully stocked stands have been shown to vary inversely with number of stems per unit area (Smithers 1957). Therefore, if the timber volume potential of the site can be concentrated on fewer stems through thinning, a more valuable product is possible in a shorter rotation. Smithers (1957) has shown further that the most marked response occurs when stands are thinned early in life, and that heavy initial thinning may give the best results.

Wilson (1952), found that the diameter and volume increment of jack pine (Pinus banksiana Lamb), in Saskatchewan increased with thinning intensity, but height growth was not improved. Mortality, in terms of stems per acre, varied inversely with thinning intensity. This effect was expected to become more pronounced as the percentage of trees in the suppressed class increased on the high-density plots. Thinning had little effect on the net volume increment, and total volume is still greater on the high-density plots. The results however, indicated that a more valuable product at rotation age on the treated plots was likely.

The purpose of this project, initiated in 1954 (Smithers 1955), is to study the effects of single and multiple thinnings of varying intensity on the growth and development of dense young lodgepole pine stands in the Foothills section of the Boreal region of Alberta (Rowe 1959). Ultimately the results will provide information on maximum yields of small poles and other products which can be realized through intensive pre-commercial thinning.

[1] Research Officer, Forest Research Branch, Dept. of Forestry, Calgary, Alberta.

This report shows the growth trends five growing seasons after thinning. Thinnings are, as yet, single treatments as the project does not call for additional thinning until 1964.

METHODS

Description of the Area

The study area is located six miles south of Mackay, Alberta in Section 3, Township 53, Range 11, West of the 5th Meridian.

When the study was begun the forest consisted of a 22-year-old stand of lodgepole pine which originated from fire after logging. The regeneration varied from pure pine to mixed pine and aspen and occasionally pure aspen. The experimental thinnings were made only in pure pine where stocking was sufficiently low that stagnation was not apparent, but the probability of overcrowding in the near future was evident.

Topography and Site

The topography of the region consists of low undulating hills with coarse textured material predominating on the high ground and fine textured material in the wet low-lying areas. The general appearance of the area and the nature of the soils suggest post-glacial lacustrine deposition. The wet lowlands extend north and south of the study area and appear to have been part of a large lake of which Chip Lake, six miles to the north, is a relic.

The study area is located on the lower slopes of a wide shallow valley. The maximum difference in elevation over the treated portion is approximately 10 feet; land quality, however, is somewhat less uniform. Three soil-site types are present:

1. Silty clay over slowly permeable clay, water table perched at 20 inches in October. The gleization indicates sub-soil saturation as shallow as 14 inches for at least part of the growing season and continuous saturation at 20 inches during the remainder in years of normal rainfall.

2. Silty clay over slowly permeable clay, water table not perched in October, but gleization evident at 30 inches, indicating sub-soil saturation at this depth for at least part of the growing season.

3. Sandy loam over sandy clay over sand, drainage rapid, moisture-holding capacity of sub-soil low.

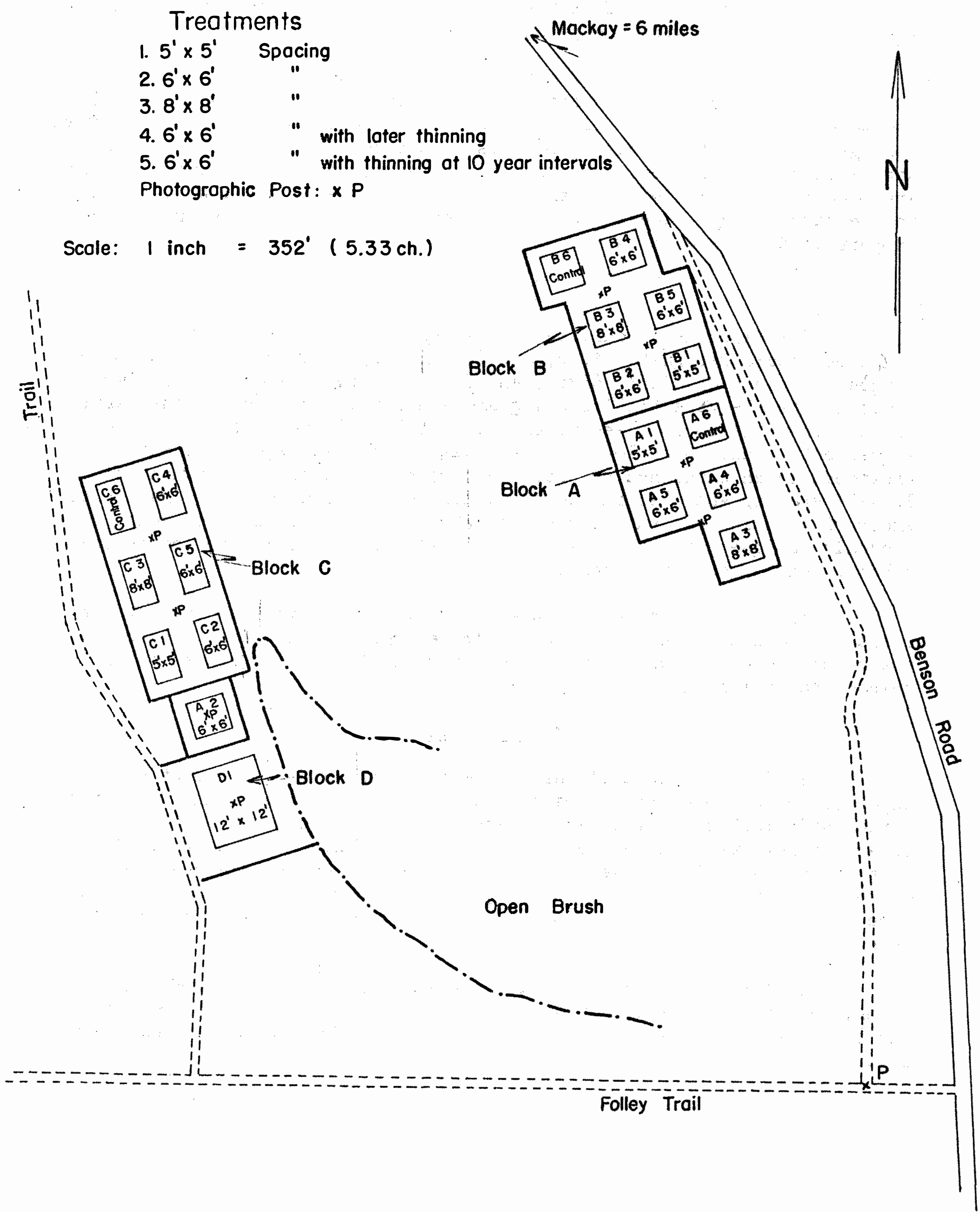
Although soil types 1 and 2 offer similar growing conditions now, they are separated in anticipation of growth differences in the future. The perched water table may eventually restrict root development resulting in reduced growth rates later in the life of the stand.

The soils of the western portion of block A and the western and northern portions of block B (Fig. 1) are type 1. The perched water table does not appear in the central and eastern portions of block A and the eastern portion of block B, although the same impermeable subsoil is present, and some gleization is evident, e.g.: type 2.

Project—A.34

Mackay Experimental Block

Thinning in young Lodgepole Pine



South West 1/4 Sect.3 Tp. 53 R. 11 West 5th. Merd.

The moister conditions resulting from the perched water table were evident when the study was established. Before treatment the stand in block A was reasonably uniform; however, there was an increase in stand density toward the north end of the block, and this same area had a greater number of small spruce in the understorey. The increase in numbers of lodgepole pine and of spruce in the understorey continued into block B and was most marked in the northern and western portions. This again is associated with the perched water table.

The soils of blocks C and D are sandy loam over sandy clay over sand (type 3), and are quite different from those of blocks A and B. The low water-holding capacity of the coarse-textured subsoil provides relatively poor growing conditions during periods of drought. The subsoil in the northeast corner of block C has a higher clay content and conditions there are more mesic. This was evidenced by the presence of small white spruce in the understorey. The influence of these soil types on the trees they support is discussed below.

Treatment

The experiment consists of six thinning treatments replicated in three blocks designated A, B, and C, (Fig. 1). Three treatments were single thinnings of 5'x5', 6'x6', and 8'x8' spacing respectively. Two other treatments were 6'x6' spacing and are scheduled to be thinned again. For one there is to be a second thinning at age 50 years; for the other subsequent thinnings at 10-year intervals to rotation age. The sixth treatment is an unthinned control. A single unreplicated treatment of 12'x12' spacing was also included and has been designated D 1. Each block except A contains six subdivisions to which the individual treatments were randomly assigned; for block A it was considered necessary to locate one subdivision adjacent to block C.

Prescribed spacing and tree vigor governed the selection of the residual trees prior to thinning. Wherever possible the most vigorous trees were selected, with somewhat greater emphasis being placed on tree height and form rather than diameter.

Measurements

In 1954, immediately after the thinning, a 0.2-acre plot was established in the center of each treatment unit and plot boundaries were permanently marked. All trees on each plot were tagged and diameter at breast height was recorded for those over 0.6 inches. The heights of 30 trees on each plot, covering a full range of diameter classes, were measured to the nearest foot with a graduated height pole. Similar data were taken on a 0.74 - acre plot in the center of the 12'x12' treatment unit.

In 1960, the tree heights and diameters were remeasured and annual terminal leader growth was recorded for the period 1950 to 1960 for 15 of the height sample trees on each plot. The soils were examined in detail.

RESULTS AND DISCUSSION

For this presentation the results of treatments 4 and 5 in each block have been combined with the results of treatment 2, as they are all of 6'x6' spacing. The numbers of stems per acre in 1954 and 1960 are given in Table 1 by treatments within blocks.

Stocking:

TABLE 1. NUMBER OF STEMS PER ACRE IN 1954 BEFORE AND AFTER THINNING AND IN 1960.

Treatment		Number of Trees 1954		Number of Trees 1960	Mortality 1954-60
Block	Spacing	B.T.	A.T.		
A	5 ft.	4025	1460	1460	0
	6 ft.	2792	1027	1023	4
	8 ft.	2980	530	530	0
	Control	4310	4310	4225	85
B	5 ft.	4020	1575	1575	0
	6 ft.	4083	1102	1085	17
	8 ft.	4760	660	660	0
	Control	4750	4750	4675	75
C	5 ft.	4470	1405	1405	0
	6 ft.	4160	1068	1063	5
	8 ft.	4070	570	570	0
	Control	3905	3905	3820	85
D	12 ft.	2350	309	309	0

Mortality has been largely confined to the control plots and has been uniform between replications. In every instance the number of residual trees following thinning was less than the number required for the prescribed spacings. However, a proportional difference in terms of numbers of stems has been maintained between treatments.

Stand development:

TABLE 2. AVERAGE DIAMETER, BASAL AREA AND TOTAL VOLUME PER ACRE IN 1954 AND 1960.

Treatment		Basal Area (Sq. ft.)		Average Diameter (Inches)		Total Volume (Cubic ft.)	
Block	Spacing	1954	1960	1954	1960	1954	1960
A	5 ft.	32.4	45.1	1.9	2.2	272	578
	6 ft.	30.4	41.4	2.2	2.5	293	487
	8 ft.	15.3	27.1	2.2	3.0	132	296
	Control	58.3	77.5	1.5	1.7	493	830
B	5 ft.	39.8	58.6	2.1	2.5	408	699
	6 ft.	25.1	38.3	2.0	2.4	234	409
	8 ft.	20.1	31.9	2.3	2.9	190	356
	Control	39.8	61.6	1.2	1.4	408	571
C	5 ft.	21.7	31.7	1.6	2.0	180	292
	6 ft.	23.6	33.8	1.9	2.2	210	323
	8 ft.	14.1	20.1	2.1	2.5	132	209
	Control	53.6	66.9	1.5	1.7	465	841
D	12 ft.	10.2	16.4	2.4	3.0	109	196

Thinning has had a marked effect on the development of the residual stand, particularly in blocks A and B. The relatively dry soil is primarily responsible for the poor response by the residual stand in blocks C and D. Although growth, in terms of basal area and cubic foot volume, has been slower in blocks C and D than with similar treatments in blocks A and B, improvement with treatment is evident.

The general development of the stands is shown in Table 2 but the influence of thinning can best be demonstrated by considering each dependent variable in more detail.

Table 3. AVERAGE DIAMETER INCREMENT BY 1954 DIAMETER CLASSES

Treatment		Diameter increment by 1-inch classes			
Block	Spacing	1-inch	2-inch	3-inch	4-inch
A	5 ft.	0.24	0.33	0.47	0.78
	6 ft.	0.38	0.43	0.61	0.90
	8 ft.	0.91	0.85	1.06	1.14
	Control	0.19	0.25	0.35	0.97
B	5 ft.	0.22	0.55	0.65	0.60
	6 ft.	0.39	0.55	0.60	0.71
	8 ft.	0.38	0.58	0.73	0.60
	Control	0.17	0.32	0.55	- --
C	5 ft.	0.33	0.50	0.30	- --
	6 ft.	0.27	0.34	0.32	0.58
	8 ft.	0.26	0.41	0.50	- --
	Control	0.22	0.22	0.42	1.21
D	12 ft.	0.41	0.56	0.73	0.93

In Table 3 trees were grouped by the diameter classes to which they belonged in 1954. Average diameter increments are shown for each 1954 diameter class by treatment and block; three points are obvious from the data:

1. The influence of thinning on diameter growth of the residual stand is least marked among the largest trees, e.g.: the 4-inch diameter class.

2. Diameter release varies directly with thinning intensity except with the largest trees.

3. Diameter release is most pronounced on the moist sites, e.g. blocks A and B. Although the release trends in block C are similar to those in blocks A and B, the total release in all but the 1-inch class is considerably less. Even with the intensive thinning on block D, which is on the driest site, response is not superior to less intensive thinnings on blocks A and B.

TABLE 4. AVERAGE HEIGHT INCREMENT BY 1954 DIAMETER CLASSES IN FEET AND PERCENTAGE OF 1954 HEIGHT

Treatment		1-inch		2-inch		3-inch		4-inch	
Block	Spacing	Feet	Per Cent	Feet	Per Cent	Feet	Per Cent	Feet	Per Cent
A	5 ft.	2.3	22	2.7	16	5.4	28	6.1	27
	6 ft.	2.5	23	4.3	27	6.2	31	7.9	37
	8 ft.	3.4	33	5.4	35	5.1	29	6.5	36
	Control	1.9	17	5.3	35	5.8	28	- -	--
B	5 ft.	1.4	11	4.2	23	5.5	25	5.7	23
	6 ft.	2.1	18	3.9	24	5.0	25	5.5	25
	8 ft.	3.2	26	3.7	23	4.3	21	5.3	25
	Control	1.8	16	4.5	31	7.3	44	---	--
C	5 ft.	2.3	21	3.4	22	2.8	15	---	--
	6 ft.	1.9	16	2.8	17	4.7	25	---	--
	8 ft.	1.2	11	2.3	14	3.2	16	---	--
	Control	2.1	18	3.5	21	4.2	21	1.6	8
D	12 ft.	2.3	18	2.5	14	3.6	16	4.0	17

Thinning has had little influence on the height growth of the residual trees (Table 4). The trees of the 1-inch class in 1954 in blocks A and B have shown some height release, but this has not occurred on blocks C and D. Height increment of trees 2 inches and larger in 1954 has decreased slightly since thinning. In almost every instance the control plot shows a greater percentage height increase than the corresponding treatment plots for these diameter classes. This indicates that thinning was done before the stands had begun to stagnate owing to overstocking. The effects of overstocking have begun to appear in the 1-inch class, on the controls, and lightly thinned plots, and should be more apparent at the next remeasurement.

A cursory check of the experiment three years after treatment revealed a reduction in height growth. It was suggested that the cause might be insect damage to the terminal leaders; however, a detailed study of leader growth for the 10-year period 1950 to 1960 failed to show any serious insect attack. Numerous trees in the thinned plots were tapped by sap-suckers the summer following thinning and although two trees were killed, apparently by girdling, no general growth reduction could be attributed to the bird damage. Nor could the decreased growth rate be attributed to any effect of thinning since the slow-down occurred on the untreated as well as the treated plots. Probably poor growing weather was the controlling factor, but records are not available to check this.

TABLE 5. BASAL AREA INCREMENT IN PERCENTAGE OF 1954 BASAL AREA

Treatment Spacing	Block A	Block B	Block C	Block D
5 ft.	39	47	46	-
6 ft.	38	52	44	-
8 ft.	78	59	43	-
12 ft.	-	-	-	61
Control	33	49	25	-

Table 5 shows a favorable percentage increase in total basal area after thinning. In blocks A and B the response varies directly with thinning intensity, whereas in block C there is little difference between the three treatments. The response on block D is comparable to an 8'x8' treatment on the better sites.

The diameter, basal area, and volume increment of the 100 largest trees per acre in 1954 is presented in Table 6. These data demonstrate the effect of the various treatments on those trees which were dominants prior to treatment, and which will likely reach merchantable size first.

TABLE 6. AVERAGE DIAMETER, TOTAL BASAL AREA, AND TOTAL VOLUME INCREMENT OF THE 100 LARGEST TREES PER ACRE IN 1954.

Treatment Block	Treatment Spacing	Diameter Increment (Inches)	Basal Area Increment (Square feet)	Volume Increment (Cubic feet)
A	5 ft.	0.63	2.4	45
	6 ft.	0.75	3.3	76
	8 ft.	0.91	3.7	63
	Control	0.54	1.9	39
B	5 ft.	0.69	2.8	58
	6 ft.	0.68	2.5	48
	8 ft.	0.76	3.0	45
	Control	0.47	1.5	27
C	5 ft.	0.41	1.3	19
	6 ft.	0.46	1.6	31
	8 ft.	0.51	1.7	31
	Control	0.37	1.3	30
D	12 ft.	0.88	3.9	70

The favourable effect of thinning on the diameter and basal area growth of the 100 largest trees per acre is apparent in Table 6. Response varies directly with thinning intensity. Although all blocks show similar response the total response is greatest on the good sites, e.g. blocks A and B. The growth in the 12'x12' thinning on the drier site is only slightly better than the average of the 8'x8' thinnings on the moist sites.

Table 6 shows further that with the exception of block C the cubic foot volume increment of the 100 largest trees per acre in the thinned plots is superior to that in the control plots. In contrast with other aspects of stand development, volume increment does not vary with thinning intensity so soon after treatment; however, this trend may become apparent at the next remeasurement. The excellent volume growth of the largest trees in block D would indicate that a heavy thinning is required to induce volume increment response on the drier site.

SUMMARY AND CONCLUSIONS

In 1954 a study was begun of the immediate and long-range effects of single and multiple thinnings on the growth and development of a young lodgepole pine stand in the Foothills Section of the Boreal Forest Region of Alberta. From results five years after treatment a number of tentative conclusions can be drawn:

1. The effects of thinning dense young lodgepole pine stands are apparent five years after treatment.
2. Response to thinning is most pronounced on the moist sites.
3. Percentage basal area and diameter increment of the residual trees varies directly with thinning intensity on sites where moisture is not a limiting factor.
4. Response to thinning is most marked in the smaller diameter classes.
5. Thinning has little initial effect on height growth of the residual trees.
6. Thinning improves volume increment of the largest trees on moist sites. Only intensive thinning improves the volume growth of the largest trees on drier sites.
7. Basal area and diameter growth response of the largest trees vary directly with thinning intensity and are most marked on moist sites.

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