GROWTH OF YOUNG LODGEPOLE PINE AFTER MECHANICAL STRIP THINNING IN ALBERTA

by

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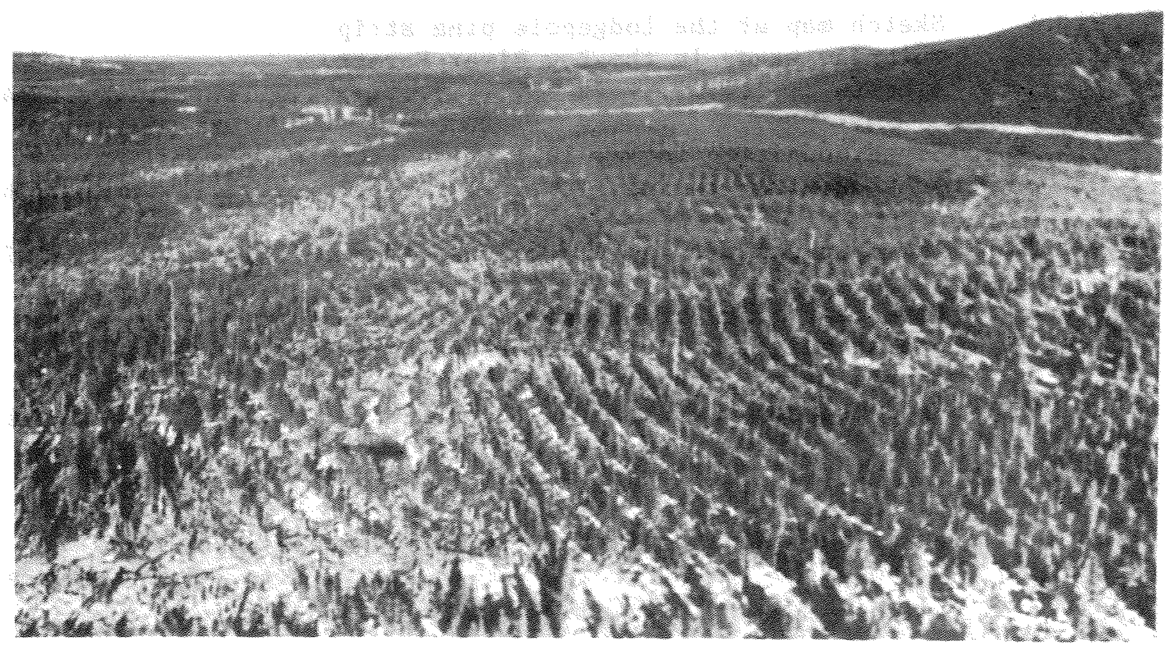

Oblique views of mechanically strip-thinned lodgepole pine in the foothills. (Photo by Alberta Forest Service)

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by

I. E. Bella*

ABSTRACT

In 25-year-old lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) stands in the foothills, strip thinning stimulated diameter increment, both at breast height and at ground level, of all trees in the dense portions of the stand within five years after treatment. Greatest absolute response in increment was among the larger trees while the small trees showed greater relative response. No significant thinning-response in increment could be established among trees growing under relatively open stand conditions. Because this species seems to respond well to release in dense stands even at age 25, the scheduling of treatment is quite flexible.

There was relatively small amounts of drum chopper damage to trees on strip borders and there is no evidence of increase in insect and disease activity. Slash from thinning is decomposing rapidly in the 'cut' strips. Black spruce advanced growth that escaped the chopper blades shows vigorous growth here and will likely form a second story in these stands.

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INTRODUCTION

As a result of numerous fires in the 1930's, young, dense lodgepole pine stands cover extensive areas in Alberta's foothills. At high densities, all available growing space is occupied by the time the stand is 10 to 15 years old. Then tree growth starts to decline and if natural thinning is too slow, the stand may stagnate. This danger of stagnation and associated loss of merchantable yield for harvest provides a strong case for thinning.

Thinning that requires the selection and cutting of individual trees in young stands is a costly operation that would rarely be economical in Alberta under present utilization practices. To lower the cost of thinning, various non-selective, multi-stem mechanical thinning techniques have been tried in the past. Crossley (1952) used an Athens disc to cut trees in young lodgepole pine stands; Tackle and Shearer (1959) felled trees in swaths by bulldozer blades in Montana. Both of these methods had some drawbacks. The drum chopper--a recently developed machine--chosen for the present operation is more suitable and more economical for strip thinning than either of the above implements.

In the mid-1960's, the Alberta Forest Service initiated a program of mechanical strip-thinning with drum choppers to release young, dense stands of lodgepole pine. The present study was conducted by the Canadian Forestry Service to determine the response of residual trees to release and how this growth response would be affected by initial density, tree size, and crown status. Results available up to now are presented in this report.

DESCRIPTION OF AREA AND THINNING PROCEDURES

The study plots were located in treated stands in the Bow River Forest on both sides of the Forestry Trunk Road, immediately south of Teepeepole Creek (Fig.1). Forests in this area are part of the Upper Foothills Section, B. 19c of the Boreal Forest Region (Rowe, 1959).

The stands studied were predominantly lodgepole pine with local patches of black spruce, (*Picea mariana* Mill.) and were established after a fire in 1941. At the time of thinning, viz. January to March 1966, (the following information was provided by the Alberta Forest Service) stand density ranged as high as 100,000 stems/acre; tree height averaged about 9 ft and d.b.h. 1 inch. Table 1 presents stand and tree summaries at plot establishment (May 1971). Fig. 2 illustrates stand conditions in May 1971.

Topography in the area varies from hilly to gently rolling; only stands in the latter were thinned.

A drum-chopper with a specially designed yolk attachment was used for thinning. The chopper was dragged by a D7 crawler type tractor (Fig.3). Thinning was done in parallel strips--10½ ft swaths alternating with residual strips of 4 to 6 ft width. The yolk attachment guided the trees into the path of the chopper and eliminated bent or hanging trees along strip edges. About 1,000 acres were thinned in this block at a cost

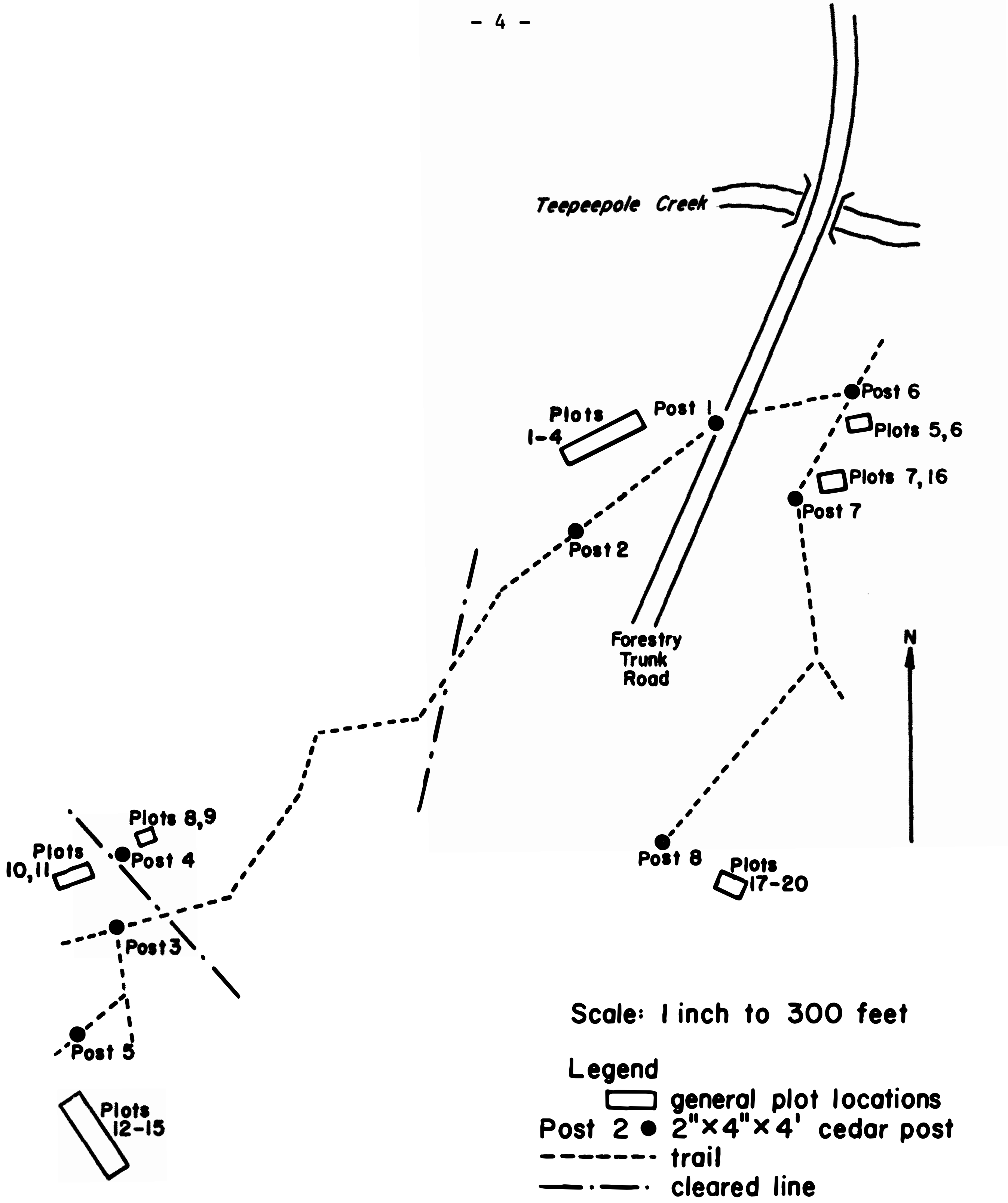

Figure 1. Sketch map of the lodgepole pine strip thinning study in the Bow River Forest, Alberta. Twp. 34; Rge. 8; W. of 5.

TABLE 1. SUMMARY STATISTICS FROM THE SAMPLE PLOTS AND FROM SAMPLE TREES

		STAND STATISTICS (per acre)						TREE STATISTICS (lodgepole pine only)						
Plot No.	Treatment	Number of trees: Under 4.5 ft height		Number of trees: Over 4.5 ft height		D.b.h. of trees greater than 0.5 inches		No. of sample trees	Height (ft)		Diameters (inches): Stump		Diameters (inches): Breast Height	
		lP[1]	bS	lP	bS	Ag.	Range		Av.	Range	Av.	Range	Av.	Range
1	Thinned	0	3,971	7,937	5,209	1.55	0.6-3.4	10[2]	13.0	8.4-20.5	2.2	1.2-3.8	1.7	0.9-2.7
2	Thinned	0	12,672	5,280	3,432	1.69	0.6-2.9							
3	Thinned	284	3,416	18,783	0	0.99	0.6-1.8	5	10.5	8.3-13.0	1.7	0.8-2.7	1.2	0.7-1.9
4	Thinned	0	1,556	23,336	259	1.05	0.6-2.1	5	11.2	7.4-14.1	1.8	0.8-2.4	1.3	0.5-1.8
8	Thinned	0	0	9,841	0	1.75	0.6-3.4	5	15.1	9.0-18.8	2.7	1.8-4.1	1.8	1.2-2.8
9	Thinned	0	0	4,598	0	2.22	1.1-4.1	5	17.5	9.0-22.3	2.7	1.2-4.7	1.9	1.0-3.2
10	Thinned	293	0	14,365	0	1.05	0.6-1.7	5	10.3	7.7-14.1	1.8	1.0-2.8	1.3	0.7-2.0
11	Thinned	2,112	1,056	20,328	0	1.05	0.6-2.1	5	9.1	7.4-11.6	1.5	0.9-2.2	1.1	0.6-1.6
12	Thinned	1,815	0	14,883	0	0.94	0.6-1.8	5	8.6	6.2-10.6	1.4	0.8-2.2	1.0	0.6-1.4
14	Thinned	2,151	0	15,411	0	1.00	0.6-1.8	5	8.8	7.6-10.5	1.4	0.9-2.2	1.0	0.6-1.8
13	Check	0	0	9,576	0	1.37	0.7-2.2	5	10.7	7.8-13.9	1.7	1.2-3.0	1.2	0.8-2.0
15	Check	435	0	19,162	0	0.89	0.6-1.4	5	12.0	5.7-19.2	2.0	1.0-3.7	1.4	0.6-2.6
5	Thinned	0	12,906	14,512	3,547	1.29	0.6-2.5	5	12.1	9.0-14.8	2.1	0.9-3.5	1.6	0.7-2.5
6	Thinned	315	9,153	9,461	4,732	1.36	0.7-2.8	4	10.6	7.5-15.0	1.5	0.8-2.0	1.1	0.6-1.6
7	Thinned	0	13,631	13,920	3,258	1.08	0.6-1.9	5	10.8	8.9-14.5	1.6	1.0-2.9	1.2	0.8-2.2
16	Thinned	0	9,679	11,502	4,709	1.10	0.6-2.2	5	10.7	8.7-12.9	1.7	1.1-2.3	1.2	0.8-1.7
17	Check	0	193	10,067	193	1.66	0.6-3.9	5	14.9	9.0-18.7	2.2	0.9-3.6	1.7	0.6-2.8
20	Check	0	1,161	14,894	0	1.36	0.6-3.0							
18	Check	0	1,161	20,318	0	1.30	0.6-3.5	6	14.6	9.0-17.8	2.2	1.8-2.8	1.7	1.2-2.2
19	Check	0	2,613	19,450	0	1.10	0.6-2.1							

[1] lP Lodgepole pine; bS Black spruce.

[2] Bracket indicates that these 10 sample trees represent both plot 1 and 2.

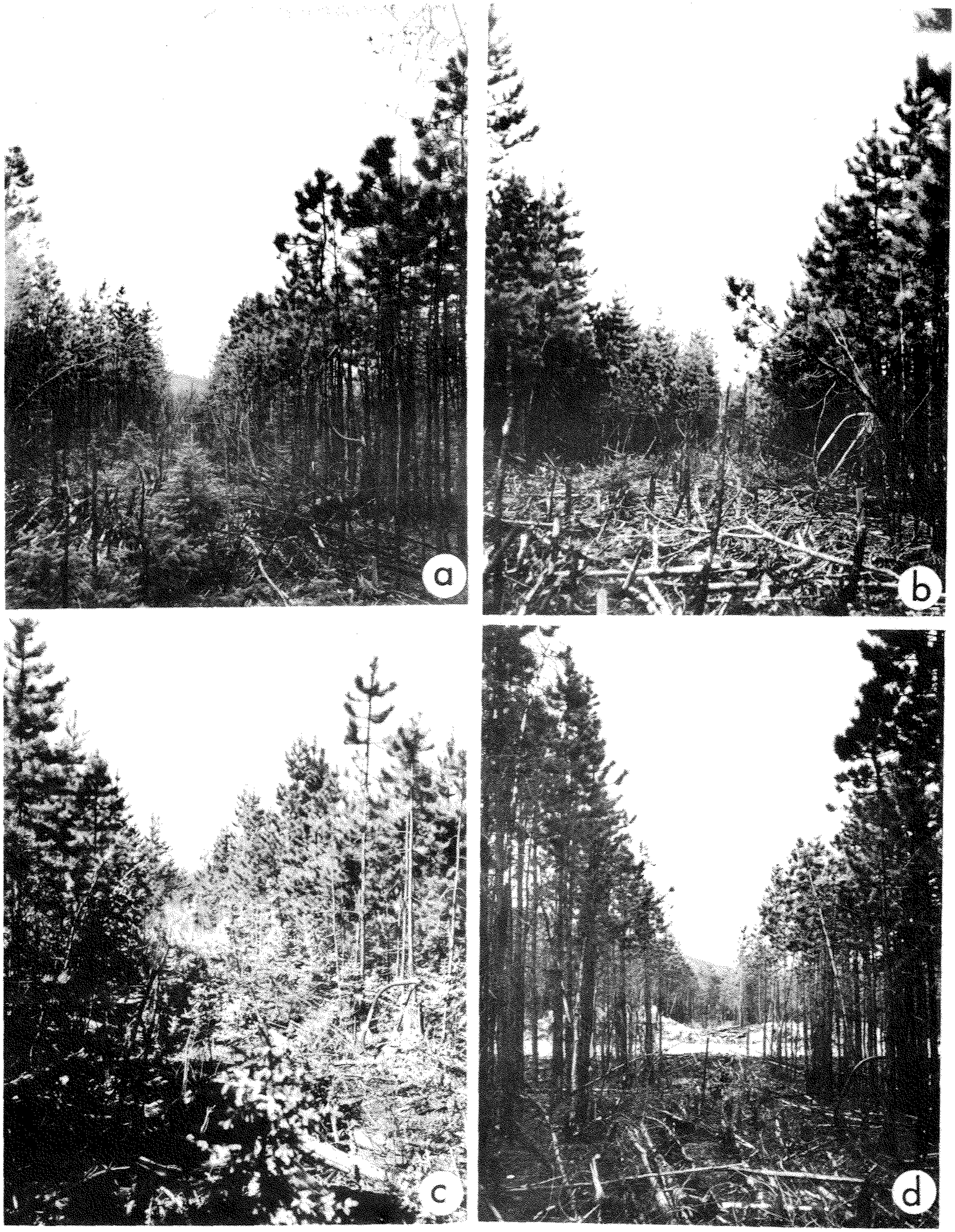

Figure 2. Stand conditions in May 1971, five growing seasons after thinning: (a) and (b) shows stands with high original density - note small tree sizes and the poorly developed crowns; (c) and (d) shows more open stands with bigger trees and better developed crowns.
Note debris conditions and black spruce advanced growth in cut strips.

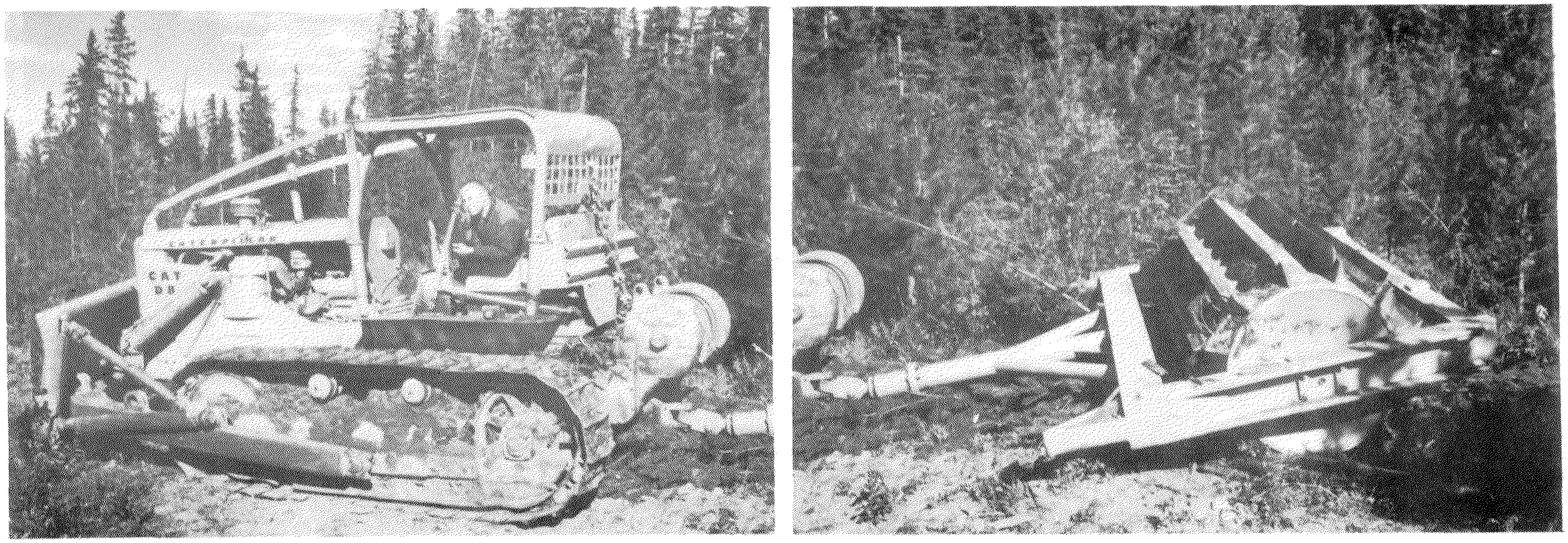

Figure 3. The drum-chopper and tractor used for thinning. (Photos by the Alberta Forest Service.)

of between \$5.00 and \$6.00 per acre, excluding the capital cost of the chopper (from Alberta Forest Service files). The treatment was done in freezing weather and the trees snapped off best when the temperature was well below 0°F.

METHODS

In mid-May, 1971 (before the start of the growing season), 20 permanent sample plots were established; 14 in the thinned and 6 in the unthinned portion of the stand. Plots in the thinned stand were 30 ft long and their width was the same as that of the residual strip (from 4.5 to 6.5 ft). Check plots in unthinned stands were 10 by 10 ft, and 10 by 15 or 15 by 15 ft under more open stand conditions. Trees within the plots were tallied by species and d.b.h. measured to the nearest 1/10 inch; while trees with d.b.h. less than ½ inch, or under 4.5 ft in height, were put in respective classes. The plots provided stand density information. Their future remeasurements will yield information on stand development.

A group of five sample trees were selected adjacent to these plots to represent similar stand conditions and felled for partial stem-analysis (Table 1). These were healthy trees, with no apparent defect or damage from thinning or browsing. The trees selected in thinned stands were growing on the edges of the residual strips--where the greatest release in growth would likely occur--while trees in check stands were adjacent to plot boundaries. The measurements included: stem diameter outside bark just above ground and at breast height (to nearest 1/10 inch); total height (to 1/10 ft), also crown class was described. Each group of sample trees was selected to cover the range of sizes present. A disc was cut from each stem just above ground level and at breast height.

In the laboratory, stem radii in four perpendicular directions were measured on the discs. Inside bark radii, corresponding to early spring of 1971 and 1966, and outside bark for 1971 were measured. Each set of four perpendicular radial measurements were averaged and used to calculate outside-bark diameters from appropriate ratios. Diameter increments for the 5-year period after thinning were obtained by subtraction.

Sample plots were separated into two density classes, open and dense. Measure of density used was number of trees per acre (excluding black spruce under 4.5 ft height). Density averaged 11,133 trees per acre in the open class (range from 4,598 to 14,658) and 19,107 (range from 16,211 to 23,595) in the dense class. Regression and correlation techniques were used to determine response to thinning in diameter growth for the range of tree size classes at time of thinning. Covariance analysis was used to test for significant differences between growth of trees in thinned and check stands. Separate analysis were conducted for open and dense stands using growth data from breast height and stump height.

RESULTS

Thinning increased diameter growth rate (expressed in cross-sectional area) at breast height of trees in all size classes in the denser stands within the first five years after treatment. There was even greater response at stump level. No significant response to thinning was found at this time under relatively "open" stand conditions.

Fig.4 shows diameter increment at breast height and stump, in square inches, in the first five-year period after thinning. Increment values were derived from regressions significant at the 0.01 level. A summary of regression statistics is present in Table 2. Results from thinned and check portions are compared for both stump and breast height for the dense stand condition. Greatest absolute response to thinning was among the large trees, although the smaller ones had a higher relative increase. Increase in cross-sectional area of the largest trees at breast height (2-inch class) was 54%, for the small trees (0.5-inch class) it was just over 100%. Increase in cross-sectional area at stump level for the largest and the smallest size classes was 75% and 806% respectively.

Observations in the field revealed relatively small amounts of chopper damage (wounding, bending or breaking) to trees on thinning borders. Trees with stems that were bent and/or broken, usually died within one to two years after treatment. There seemed to be no evidence of increase in the activity of insect and disease organisms in the residual strips that could be attributed to treatment; nor was there any increase in physical damage to residual trees from other causes (e.g. hail, snow, browsing) but there was evidence of greater snow accumulation in cut strips.

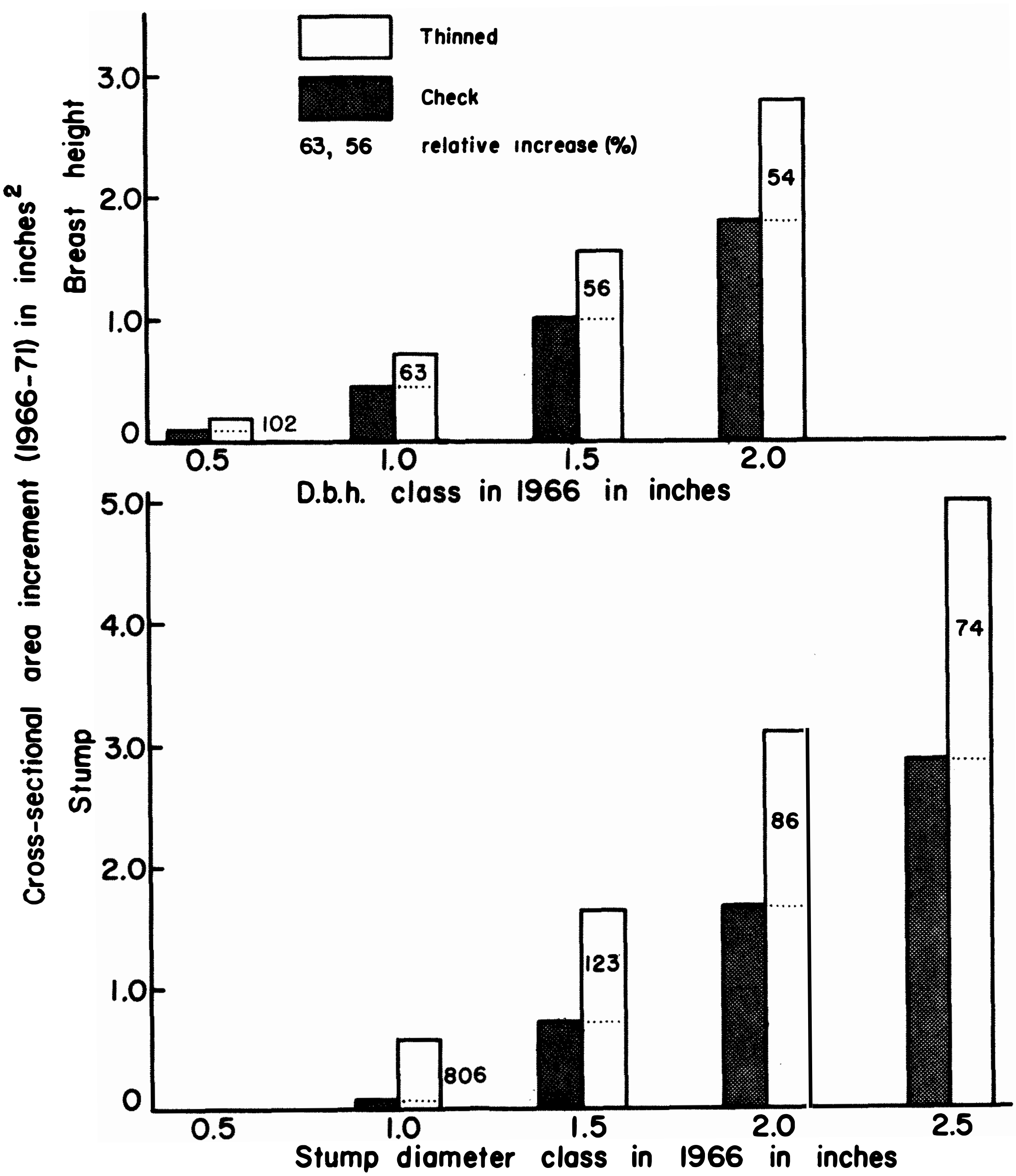

Figure 4. Five-year cross-sectional area increment at breast height and at stump after thinning; sample trees from thinned and check plots in dense stands.

TABLE 2. REGRESSION STATISTICS OF CROSS-SECTIONAL AREA INCREMENT (1966-1971) OVER DIAMETER (1966): SAMPLE TREES FROM THINNED AND CHECK PLOTS IN DENSE STANDS

Treatment	Number of sample trees	Independent variables at the time of thinning							
		X_1 = stump diameter, $X_2 = X_1^2$				X_1 = d.b.h., $X_2 = X_1^2$			
		Regression and correlation coefficients							
		a	b_1	b_2	R	a	b_1	b_2	R
Thinned	40	-.33	NS[1]	1.07	.85	.025	NS	.88	.85
Check	11	-.60	NS	.68	.93	-.024	NS	.58	.92

[1] NS Non-significant term dropped and new regressions calculated.

Photographs in Fig.2 illustrate stand conditions five years after thinning. Slash from thinning has been decomposing rapidly in the cut strips, resulting in diminished fire hazard. Stumps that had some living branches after treatment have mostly succumbed. There was some black spruce advance growth present, especially in the more moist part of these stands. These, being of small size with flexible stems, generally escaped the chopper blades in the cut strips and now show strong response to release. With relatively little competition from neighboring trees, these black spruce can maintain vigorous growth and will likely form a second story in these stands.

DISCUSSION AND CONCLUSIONS

These results showed substantial response in diameter increment in all trees--both at breast height and at stump level--in dense stands within five years after thinning. The greatest response to thinning was among dominant trees. These trees are most likely to survive through the whole rotation and will constitute the final harvest. Thus final merchantable yield will largely depend on maintained vigorous growth of these dominants. It is most advantageous that greatest growth response occurred in dense stands because these are the stands where release is really needed and where the greatest danger of stagnation exists. Strip thinning relatively open stands resulted only in a minor improvement in growth. In comparison, 10- to 15-year-old jack pine in Manitoba showed best response to strip thinning if it was growing in relatively open stands (Bella and DeFranceschi, 1971). The very intolerant jack pine when growing in dense stands loses its ability to respond to release at a relatively young age. This applies particularly to jack pine stands on poor sites, where tree growth is generally slow. This means that thinning stands of this species is best done at very young age (usually under 10 years) while there is much more flexibility in the timing of thinnings in lodgepole pine, at least up to age 20 or 25 years.

Early thinning of lodgepole pine stands, 10 years old or younger, may also be advantageous. The cost of thinning operation would be lower at such ages, because smaller tree sizes would permit lighter equipment and faster operation. The percentage of residual stems damaged would be lower and fewer bent or hanging trees would result. Because of the smaller tree sizes and lesser amount of biomass present at younger ages, there would be less organic debris and it would be of smaller size (diameter). The rate of decomposition of this material would be faster, with a consequent rapid reduction of fire hazard.

Earlier thinning would also contribute to better crown development and continued vigorous stem growth. This would likely result in generally larger tree sizes and greater merchantable yield at final harvest.

Strip direction may affect thinning response on steep southern slopes, which are inherently warm and dry. Here, opening the stands to the hot mid-day sun by running the strips north-south would likely accelerate the drying of soil. Maintaining the desired strip direction on steep slopes is difficult because of extensive side-slippage of the chopper. However, chopper attachments that are being developed by the Alberta Forest Service to prevent side-slippage of the chopper (personal communications with Karl Altschwager) should result in much greater flexibility of operations on sloping terrain.

Although the main purpose of this thinning is increased merchantable volume production, it also has other beneficial side effects. It results in much improved accessibility in the thinned stand for recreational purposes; fire suppression; and eventually it could provide skid trails for logging.

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