YOUNG LODGEPOLE PINE RESPONDS TO

STRIP THINNING, BUT ....

BY

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ABSTRACT

Operational strip thinning in a 25-year-old pine *(Pinus contorta* Dougl. var. *latifolia* Engelm.) stand in south west Alberta resulted in an increase in basal-area growth of over 60% among the largest leave trees (potential crop) by the tenth year after treatment. Relative response to thinning was greatest where the trees were small, that is, on plots with initially high densities. Tree mortality, which was greater with higher stand densities, was unaffected by treatment in the same period.

Recommendations are given about similar thinning operations.

RESUME

Une éclaircie par bandes étroites dans un peuplement de 25 ans de Pin tordu latifolié *(Pinus contorta* Dougl. var. *latifolia* Engelm.) dans le centre-ouest de l'Alberta a donné lieu à un accroissement de la surface terrière de plus de 60% chez les plus grands arbres marqués en réserve au cours de la seconde période de 5 ans après traitement. La réponse relative à l'éclaircie fut la meilleure lorsque les arbres étaient petits, c'est-à-dire dans les parcelles à densité initiale plus forte. Au cours de cette période, la mortalité ne fut pas modifiée par le traitement mais elle augmenta généralement avec la densité du peuplement.

Les auteurs font certaines recommendations utile à ceux qui planifient des éclaircies du même genre.

CONTENTS

INTRODUCTION

In the mid 1960's, the Alberta Forest Service started an operational program of strip thinning with drum choppers in young dense stands of pine as a low-cost release treatment. The Canadian Forestry Service was asked to evaluate this treatment in terms of tree growth response. This study was initiated in 1971 in the Bow-Crow Forest (close to the junction of Forestry Trunk Road and Teepee-pole Creek) in a predominantly lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) stand that had been thinned 5 years earlier when the stand was 25 years old. Thinning was done in parallel strips, with 3.2-m (10.5-ft) swaths alternating with residual strips 1.2-1.8 m (4-6 ft) wide. (See Bella 1972 for additional details.)

The first 5-year results after thinning showed that the treatment stimulated tree diameter increment only in the dense portions of the stand, where the greatest absolute response was among the larger trees (Bella 1972). This report presents results to 10 years and includes recommendations about similar thinning operations.

METHODS

In mid-May 1971, 20 permanent sample plots were established: 14 thinned, 6 control. Plots in the thinned stand were 9.14 m (30 ft) long and their width was the same as that of the residual strip (1.4-2 m or 4.5-6.5 ft). Control plots in unthinned stands were 3.05 x 3.05 m (10 x 10 ft) and 3.05 x 4.57 m (10 x 15 ft) or 4.57 x 4.57 m (15 x 15 ft) under more open conditions. Trees within the plots were tallied by species, and dbh was measured to the nearest 2.5 mm (0.1 in.) on trees exceeding breast height (1.37 m or 4.5 ft) and 1.2 cm (0.5 in.) dbh. Smaller trees were put into two classes: 1) trees that exceeded breast height but were under 1.2 cm (0.5 in.) dbh, and 2) those below breast height. The first 5 years' growth was based on stem-disk data from ground level and from breast height of five sample trees adjacent to each plot.

After the 1975 growing season, the plots were remeasured following the same procedure used at plot establishment. In addition, 5-10 lodgepole pine sample trees per plot, encompassing the range of tree sizes, were tagged, and their heights and diameters recorded. These tagged trees will provide individual tree growth information at future remeasurements. Stand statistics in 1971 and 1976 and tagged tree summaries for 1976 are presented in Table 1.

Growth data for this report were obtained as a difference between mean dbh values of the 10 largest trees per plot in 1976 and those in 1971, although the two sets of trees may not have been identical. This procedure was followed because:

1. No measurement data were available for individual trees. (Trees were not tagged in 1971.)
2. Most of the 10 largest trees in 1971 and 1976 would be the same.
3. When the adjacent cut strip is included in the plot area, the 10 largest trees per plot represent between 1900 and 2500 trees/ha (800-1000/acre), depending on plot size, and roughly correspond to the expected number of crop trees at harvest.

Regression and covariance techniques were used in the analysis. The latter provided a means to account for inherent differences in tree growth, which may have resulted from differences in site or density conditions. This was particularly important because of the difficulty in establishing truly similar control plots in the area.

RESULTS

Thinning increased basal area growth rate of the 10 largest trees per plot (Fig. 1). The mean increment in the period 1971-76, adjusted for initial tree size at the beginning of the growth period by covariance procedures, was 11.2 cm^2 (1.74 $in.^2$) on thinned and 6.8 cm^2 (1.06 in^2) on control plots, a difference of 65%. This mean increment and related average dbh of crop trees are taken to represent medium stand-density conditions in this study. Two additional stand-density classes, dense and open, are represented by average crop tree

TABLE 1. Stand statistics for sample plots (1971 and 1976) and summaries for trees tagged in 1976

Treat-ment	Plot. No.	Stand Statistics (per ha)[2] Number of trees (all sizes 1971 1P[1]	1971 bS	1976 1P	1976 bS	Dbh (cm) of trees > 1.4 cm 1971 Avg	1971 Range	1976 Avg	1976 Range	Tagged Tree Statistics (1976) Number Tagged	Height (m) Avg	Height (m) Range	Dbh (cm) Avg	Dbh (cm) Range
Thinned	1	19 613	22 684	19 013	23 306	3.9	1.5- 8.6	4.5	1.5- 9.6	7	6.0	5.4-7.4	6.8	4.8- 8.6
	2	13 047	39 793	12 395	32 618	4.3	1.5- 7.4	5.0	1.5- 8.9	7	6.1	4.3-8.0	6.6	3.6- 7.9
	3	47 116	8 441	38 694	5 628	2.5	1.5- 4.6	3.1	1.5- 6.4	7	3.8	3.1-4.9	4.5	3.0- 6.4
	4	57 664	4 485	41 649	5 767	2.7	1.5- 5.3	3.2	1.5- 5.6	8	4.0	3.0-4.8	4.2	2.5- 5.6
	5	35 860	40 656	32 690	0	3.3	1.5- 6.4	4.1	1.5- 8.6	9	5.2	3.9-5.9	5.8	4.3- 8.6
	6	24 157	34 310	23 399	41 338	3.4	1.8- 7.1	4.1	1.5-10.2	9	5.1	3.8-6.2	6.2	3.6-10.2
	7	34 397	41 734	32 950	50 524	2.7	1.5- 4.8	3.4	1.5- 6.4	9	4.7	3.6-5.3	5.0	2.8- 6.4
	8	24 318	0	23 088	0	4.4	1.5- 8.6	5.1	1.5- 9.4	9	5.0	3.4-6.5	5.3	2.8- 8.7
	9	11 362	0	9 568	0	5.6	2.8-10.4	6.8	2.8-12.2	7	6.4	4.7-8.5	8.1	5.6-12.2
	10	36 221	0	32 618	0	2.7	1.5- 4.3	3.4	1.5- 5.8	9	3.7	2.4-4.6	4.1	2.0- 5.8
	11	55 450	2 609	39 794	0	2.7	1.5- 5.3	3.2	1.5- 6.1	9	4.1	2.5-5.5	4.6	2.0- 7.4
	12	41 262	0	18 837	0	2.4	1.5- 4.6	3.9	1.8- 6.4	9	3.9	2.4-5.3	4.1	2.0- 6.4
	14	43 397	0	36 322	0	2.5	1.5- 4.6	3.4	1.5- 6.6	9	3.5	2.3-4.5	4.0	2.5- 6.6
	16	28 422	35 554	28 445	34 910	2.8	1.5- 5.6	3.5	1.5- 7.9	9	4.6	2.4-5.7	5.4	2.8- 7.6
Thinned Avg		33 735	16 448	27 819	13 864	3.3		4.0			4.7		5.3	
Control	13	23 663	0	43 055	0	3.5	1.8- 5.6	3.0	1.5- 5.6	10	3.0	2.2-4.1	3.5	2.3- 5.6
	15	48 425	0	44 132	0	2.3	1.5- 3.6	2.6	1.5- 4.6	9	3.3	2.4-4.6	3.0	1.5- 4.6
	17	24 876	954	16 265	478	4.2	1.5- 9.9	5.4	1.8-11.4	6	7.2	5.8-8.9	7.6	4.1-11.4
	18	50 207	2 869	36 598	0	3.3	1.5- 8.9	3.9	1.5-11.4	5	7.0	5.4-8.5	7.3	3.3-11.4
	19	48 062	6 457	31 574	0	2.8	1.5- 5.3	3.6	1.5- 6.6	5	6.1	5.6-6.8	5.1	4.1- 6.4
	20	36 804	2 869	27 268	0	3.4	1.5- 7.6	4.2	1.5- 8.6	5	7.0	6.0-7.6	6.9	5.1- 8.6
Control Avg		38 673	2 192	33 149	80	3.2		3.8			5.6		5.6	

[1] 1P lodgepole pine bS black spruce

[2] In the thinned stand, these statistics describe conditions in the residual strips, as only those were sampled.

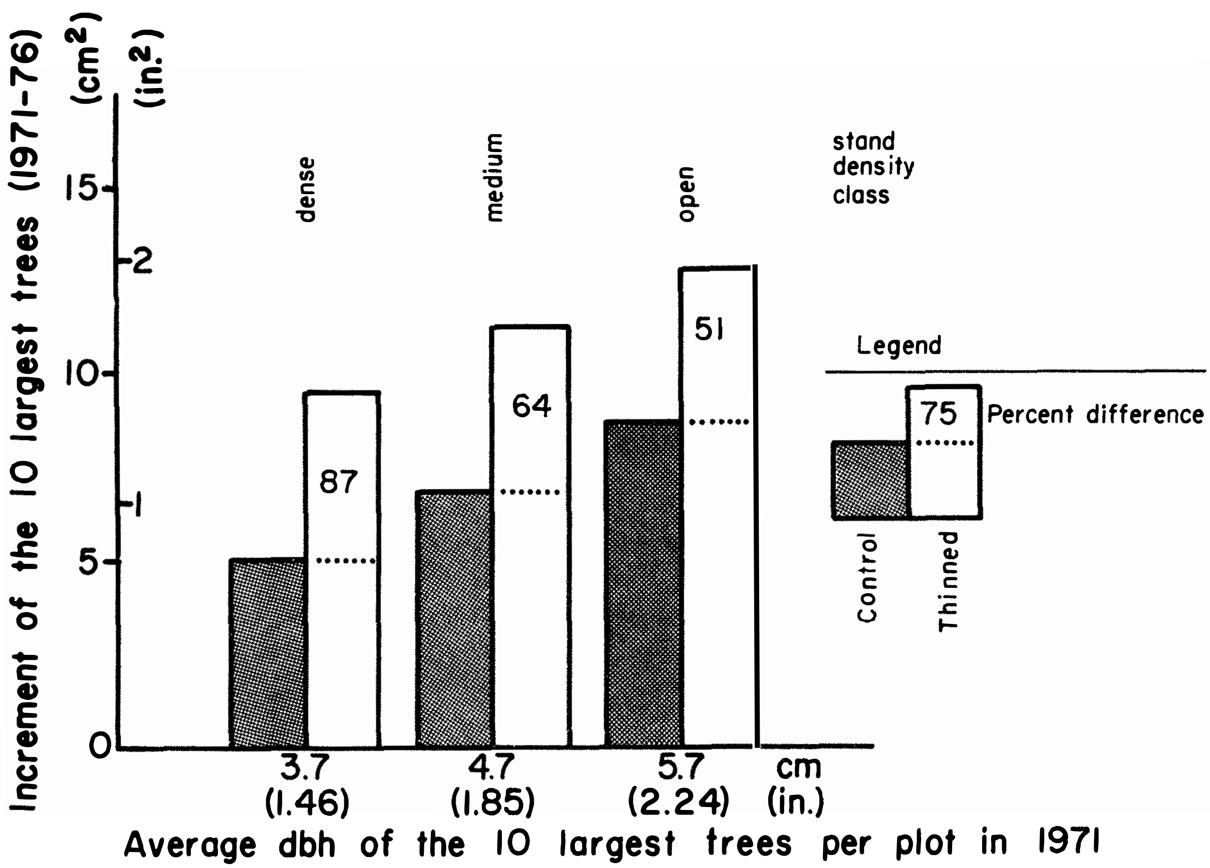

Figure 1. Basal area increment of the 10 largest trees per plot from 1971 to 1976 by average dbh, representing dense, medium, and open density classes.

dbh of 3.7 cm and 5.7 cm respectively (1.5 and 2.2 in.).

Figure 1 also shows that the absolute difference in increment between thinned and control was about the same for all three classes: regressions of increment on dbh were parallel. This, however, means that the relative response to thinning was greatest where the trees were small; that is, on plots with initially higher densities (see also Fig. 2).

Differences in tree diameter growth resulting from treatment should eventually show up as related differences in average dbh values. Naturally, variation in stand density within the leave strips and between plots tends to obscure treatment effects. Therefore, we plotted the average dbh of the 10 largest trees per plot over the number of trees per unit area to account for density effects (Fig. 2). Nevertheless, these dbh values showed no distinct separation by treatment (no higher values for thinned than for unthinned plots at similar densities), and appropriate covariance tests indicated a common relationship for thinned and control plots both in 1971 and 1976.

Tree mortality was unaffected by treatment in the second 5-year growth period after treatment (Fig. 3), as indicated by covariance tests that showed a common mortality-density relationship for both thinned and control plots. On both thinned and control plots, however, tree mortality rapidly increased with increasing stand density.

DISCUSSION AND CONCLUSIONS

Merchantable volume is the best criterion for evaluating the effectiveness and economics of thinning; however, at this early stand age it is possible only to provide an indication of future yield on the basis of tree diameter growth information.

These results indicate a substantial thinning response--an average of over 60% increase in cross-sectional area--among the crop trees in the second 5-year period after treatment. The greatest relative response, close to 90%, was in the dense portion of the stand. This is most advantageous, because dense stands are the ones where release is needed most and where the greatest danger of stagnation exists. While

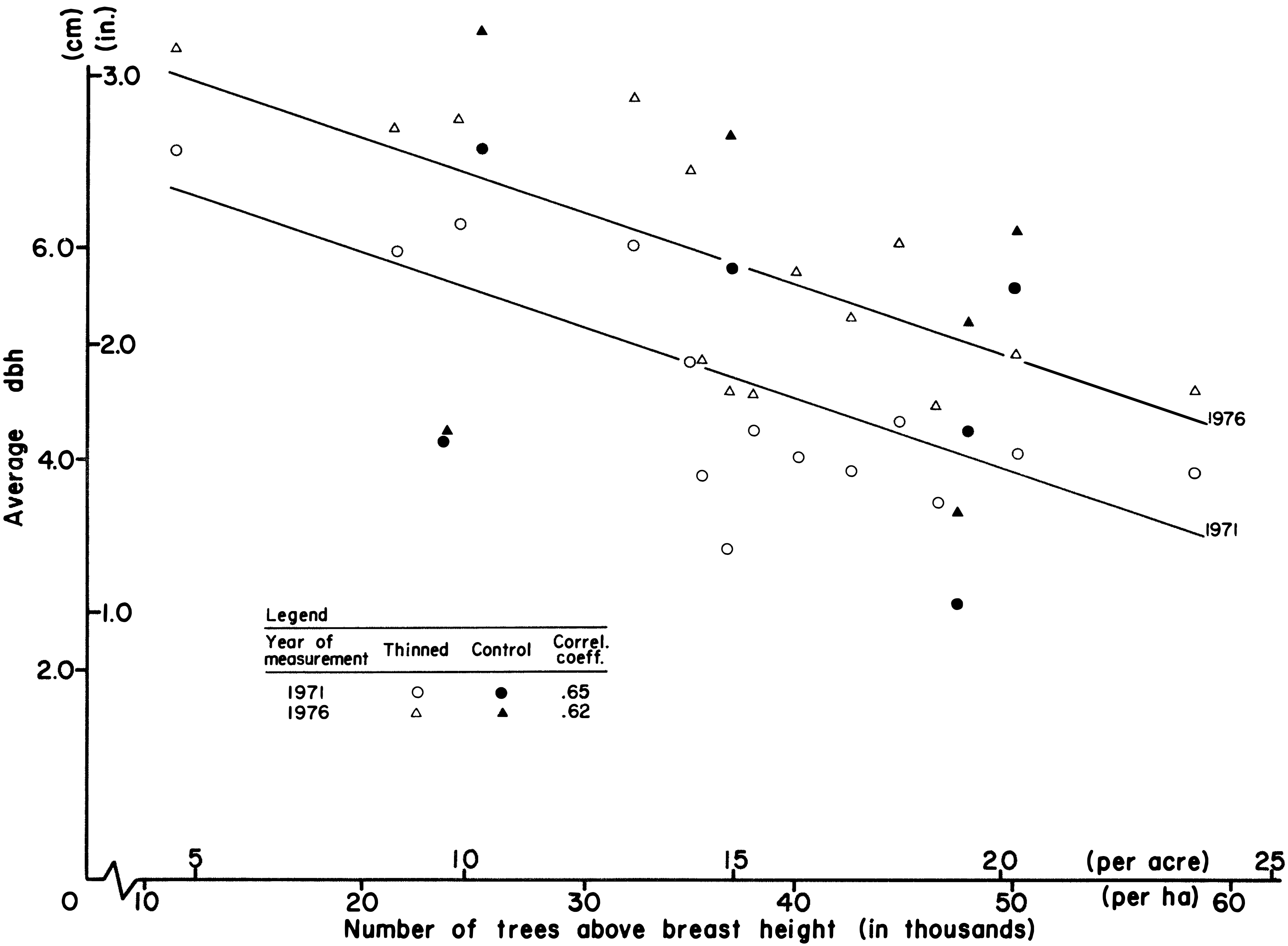

Figure 2. Average dbh of the 10 largest trees per plot in relation to stand density, which in the thinned area was based on leave strip density. Test showed a common regression for thinned and control plots both in 1971 and 1976.

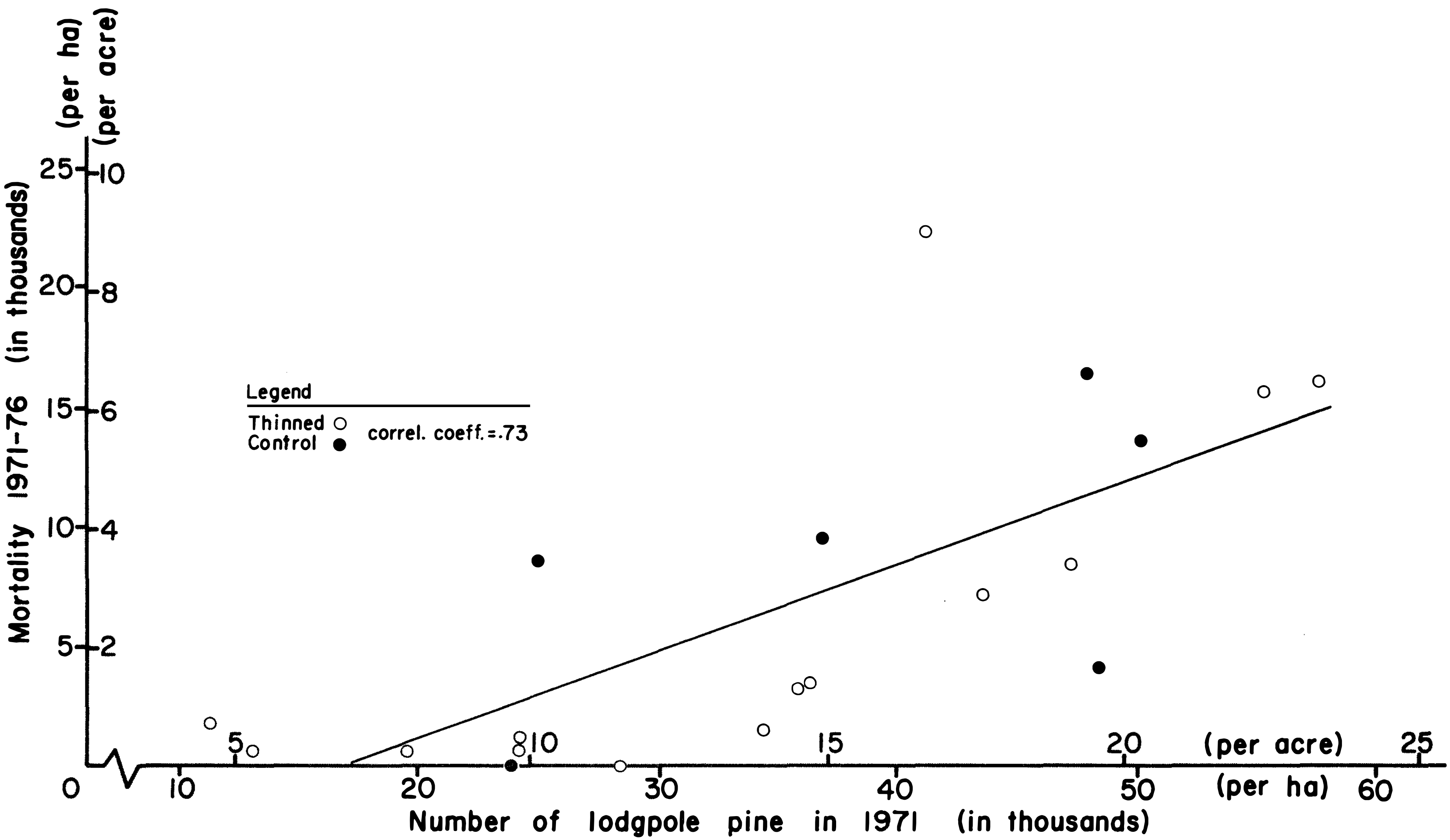

Figure 3. Mortality in relation to stand density by treatment (in the thinned area, stand density was based on leave strip density). Test showed a common regression for thinned and control plots.

this response is in accord with the first 5-year results after treatment (Bella 1972), it is in contrast with thinning results in Manitoba jack pine (*Pinus banksiana* Lamb.), where best response to strip thinning occurred in relatively open stands (Bella 1974a). However, lodgepole pine is a somewhat more tolerant and more responsive species than jack pine, which would partly explain this difference in response.

There is now a general agreement that strip thinning in pine should be done at a very young age, preferably before the stand is 10 years old. These results indicate, however, that there is more latitude for the timing of such treatment in lodgepole than in jack pine.

Although these results indicate a significant increment response to thinning, the cumulative effect of response, as manifested by the average size of crop trees, has been very limited so far. It seems that it takes longer than 10 years for this effect of treatment to show up.

There has been no evidence of treatment effect on mortality, which is usually reduced by thinning because of the increase in available living space and lesser competition by the remaining trees. However, the same effect may not occur after strip thinning, which creates unstocked openings (cut strips) while leaving stand density essentially unchanged within the residual strips. This may apply particularly under dense stand conditions, where trees may appear to be in a deadlock because of the lack of differentiation into distinct dominance or crown classes from which they can break out only through accelerated mortality of the smaller trees and vigorous growth of the larger ones, and then reoccupy the cut swaths. Otherwise, the overall effect of thinning will be simply a reduction of stocking, stand volume increment, and possibly final yield in proportion to the intensity of treatment. Granted, there has been significant growth response to strip thinning among larger trees, especially under dense conditions, and the effect of treatment may eventually manifest itself in tree mortality. However, further remeasurements are needed to provide conclusive answers.

Strip thinning these stands at age 25 was much later than ideal. Response would likely have been better at a younger age, as suggested by thinning results in jack pine (Bella 1974a). Also, the relatively narrow leave strips (1.5 m or 5 ft) compared to the cut strips (3.2 m or 10.5 ft) may have resulted in too great a reduction in the number of potential crop trees where the stands had lower initial density. The ultimate result could be a reduction of final merchantable yield. On the other hand, under dense conditions, even the largest trees may have insufficient vigor to respond quickly and substantially to release, especially when this release is from one side only. This in part explains why the maximum potential diameter growth response after strip thinning is considerably less, possibly only about half, than after a heavier selective thinning.

It seems advantageous, then, to combine strip and selective thinning in future treatments. First, strip thin the stand while very young, with cut strips 3 m (10 ft) or narrower to alternate with 3.5-m (12-ft) leave strips. This would be a relatively low-cost operation. About 5 years later, selectively thin the two edges of the leave strips perhaps up to 1-m (3-ft) widths, leaving the best dominants and codominants. The center band of the original leave strip would be left undisturbed, where a good number of the trees may eventually be crowded out by faster-growing trees on the selectively thinned edge bands. This combination treatment requires selective thinning in only a fraction of the area--in this example about one-quarter--and it would be facilitated by having the cleared strip to work from. The use of brush saws like the one made by Husqvarna may also considerably improve the efficiency of the selective thinning operation (Bella 1974b).

To summarize, we recommend the following steps for thinning similar lodgepole pine stands:

1. Strip thin only overdense pine stands with uniform stocking.
2. Strip thin as soon as the young trees can be effectively killed with the choppers (i.e., cut below the first living whorl). This occurs when the trees reach heights of 1.8 m (6 ft), between 5 and 10 years of age.

3. Selective thin within 5 years favoring the largest, most vigorous individuals along the edge of the leave strips.

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