GIRDLING HARDWOODS TO RELEASE CONIFERS.

By A. L. BEST

Forest Service, Department of the Interior

INTRODUCTION

IN 1925, the Forest Service, Department of the Interior, co-operating with the Laurentide Pulp and Paper Company, established a hardwood-girdling experiment at its Lake Edward experimental station, Quebec.

LOCATION

That portion of the St. Maurice valley in which this station is situated lies on the border between the tolerant hardwood and the mixed hardwood-softwood belts of Eastern Canada. (1) The preponderance of yellow birch, however, leads one to associate the area with the tolerant hardwood belt.

HISTORY

The original forest has been described as being dominated by white pine, with a mixed spruce-balsam-hardwood under-story. The pine was logged at intervals between forty-five and eighty-five years ago, while spruce has been cut two or three times during the past forty-five years (2).

COMPOSITION OF FOREST TYPES

In general, the cut-over stands are composed of mature or overmature hardwoods with an under-story of young spruce (*Picea rubra* and *P. canadensis*) and balsam fir (*Abies balsamea*). The overwood is made up of hard and soft maple (*Acer. saccharum* and *A. rubrum*), ash (*Fraxinus nigra*), and yellow birch (*Betula lutea*), the last species comprising about seventy-five per cent by volume of the mature hardwoods.

PURPOSE OF EXPERIMENT

The study was begun with a view to ascertaining to what extent the softwoods and younger hardwoods would benefit in increased growth by the removal of the hardwood canopy and the attending root competition. Logging of the hardwood stand in preference to a girdling treatment would have been impracticable owing to the defectiveness and overmaturity of the hardwoods.

The results obtained here are supplementary to those shown in a similar experiment and described in an article on the subject by W. M. Robertson in the Forestry Chronicle for June, 1930.

-
- (1) Dominion Forest Service Classifications
  - (2) Howe, C. D. Forest Regeneration on Certain Cut-over Pulpwood Lands in Quebec. Report of the Ninth Annual Meeting, Commission of Conservation, Canada, 1917.

PROCEDURE

An area of six and one-half acres was laid out, where the overmature and defective hardwoods were selected and girdled. The girdling was done with the usual felling axe, a four-inch band of bark being removed at approximately breast-height. Ten and one-half man-hours were required to complete the work, and ninety per cent of the hardwood volume was girdled. Of the fifty-two hardwood stems per acre selected, more than fifty per cent were above eleven inches in diameter and constituted 1990 of the 2130 cubic feet that were girdled—a fact which indicates the advanced state of maturity of the hardwood stand.

ESTABLISHMENT OF SAMPLE PLOTS

Two permanent sample plots, each one acre in area, were established, one in the centre of the girdled area, and the other (the control plot) outside and adjacent to the girdled stand. All trees over one-half inch in diameter at breast-height were tagged and mapped and their diameters recorded. A stand table was compiled for each plot by means of diameter-height curves and volume tables.

CONDITION OF STANDS BEFORE GIRDLING

A statement of the stands of the two plots prior to the girdling operation is given in Table I.

TABLE I.
STANDS PER ACRE BEFORE GIRDLING

	<i>Control Plot</i> (Ungirdled)		<i>Plot to be Girdled</i>	
	No. of Stems	Volume Cu. Ft.	No. of Stems	Volume Cu. Ft.
<i>Total Stand</i> (1 inch D.B.H. and up)				
Softwoods (1925)	284	448	343	385
Hardwoods (1926)	191	2604	190	2450
Totals	475	3052	533	2835
<i>Main Stand</i> (4 inch D.B.H. and up)				
Softwoods (1925)	95	412	73	348
Hardwoods (1926)	87	2575	88	2426
Totals	182	2987	161	2774

It will be noted that the softwoods were recorded in 1925, and the hardwoods a year later; this resulted in 1931, in a shorter recorded growing period for hardwoods than for conifers.

The two plots were almost fully stocked, with about 500 stems or 29 cords to the acre. Consequently, it is reasonable to suppose that under existing conditions increment would soon be offset by mortality.

Although there were nearly $1\frac{1}{2}$ coniferous stems to every hardwood stem, 21 of the 29 cords were composed of overmature and defective hardwoods, with little or no commercial value. Even if these hardwoods were utilized for fuel-wood, the excessive costs of cutting and marketing would make logging costs unprofitable in this locality.

That the selection of the control plot, as such, was justified, can be seen from Table 1. In the control plot, the number of stems (475) differs by 11 per cent from the 533 stems in the plot to be girdled, while its volume of 3,052 cubic feet is 8 per cent more than the 2,835 cubic feet. The hardwoods of the two plots are practically identical in number of stems and differ by only 6 per cent in volume. Notwithstanding the 17 per cent. difference between the two plots in numbers of coniferous stems (284 and 343), and 14 per cent difference in coniferous volume (449 and 385 cubic feet), the average coniferous stem for each plot falls into the same diameter-class, that for the control plot averaging 3.35 inches D.B.H., and for the plot to be girdled 2.54 inches D.B.H.

STAND REMAINING AFTER GIRDLING

A perusal of Table 2, shows that the remaining stand in the girdled plot contains 481 stems or 702 cubic feet per acre, of which 343 stems are softwood, aggregating 386 cubic feet, or almost 4 cords to the acre. The young and thrifty hardwood stand contains 138 stems or 316 cubic feet (3 cords) per acre.

REMEASUREMENT OF PLOTS

In 1931, these plots were remeasured. In addition to the trees measured in 1925-26, all new trees coming into the one-inch diameter-class were tagged, mapped, and measured. A sufficient number of heights was taken to allow of the construction of curves which were used with volume tables to compile a new stand table for each plot.

RESULTS OF GIRDLING

A comparison of the stand tables for the two plots (Table 2) reveals a remarkable increase in coniferous growth on the girdled plot, as compared to that on the control plot. Contrary to expectations at the time of establishment, the young and thrifty hardwoods did not benefit as much as the coniferous understory, but showed a relative decrease in growth.

DIAMETER AND HEIGHT GROWTH

Diameters were measured with a diameter tape to hundredths of an inch. Heights were taken with the Abney hand-level and recorded to the nearest

TABLE NO. 2
STAND TABLES (Per Acre)

CONTROL PLOT						GIRDLED PLOT					
	1931 No.	1925-26 No.	Net Annual Increment		1931 No.	1925-26 No.	Net Annual Increment		1931 No.	1925-26 No.	Gross Annual Increment Per cent.
			No.	Per cent.			No.	Per cent.			
Total Stand		Number of Stems									
Softwoods	369	284	12.2	4.3	497	343	25.7	7.5	25.7	7.5	28.4
Hardwoods	217	191	5.2	2.7	137	138	-0.2	-0.1	-0.2	-0.1	1.0
Totals	586	475	17.4	—	634	481	25.5	—	25.5	—	29.4
Main Stand											
Softwoods	111	95	2.7	2.7	106	73	5.5	7.5	5.5	7.5	6.0
Hardwoods	90	87	0.6	0.7	46	39	1.4	3.6	1.4	3.6	2.0
Total	201	182	3.3	—	152	112	6.9	—	6.9	—	8.0
Volume in Cubic Feet.											
Total Stand											
Softwoods	668	448	36.7	6.6	669	386	52.3	9.6	52.3	9.6	56.2
Hardwoods	2663	2604	11.7	0.5	279	316	-7.5	-2.5	-7.5	-2.5	12.9
Total	3331	3052	48.4	—	978	702	44.8	—	44.8	—	69.1
Main Stand											
Softwoods	623	412	35.2	6.8	635	348	47.8	9.7	47.8	9.7	51.2
Hardwoods	2627	2575	10.4	0.4	249	294	-9.1	-3.3	-9.1	-3.3	11.1
Total	3250	2987	45.6	—	884	642	38.7	—	38.7	—	62.3

foot. For the purposes of comparing the growth of conifers, all diameters and height measurements taken in 1931 were averaged, and the 1925 measurements of the same trees averaged also, the differences representing the average diameter and height increments for the six-year period. The results are given in the following table.

TABLE 3A.
DIAMETER INCREMENT OF CONIFERS

	Control Plot		Girdled Plot	
	Spruce (72 trees)	Balsam Fir (196 trees)	Spruce (88 trees)	Balsam Fir (244 trees)
	Inches	Inches	Inches	Inches
1931	3.99	3.90	3.51	3.61
1925	3.34	3.21	2.71	2.51
Total Increment	0.65	0.69	0.80	1.10
Average Annual Increment	0.11	0.11	0.13	0.18

TABLE 3B
HEIGHT INCREMENT OF CONIFERS

	Control Plot		Girdled Plot	
	Spruce (17 trees)	Balsam Fir (28 trees)	Spruce (18 trees)	Balsam Fir (59 trees)
	Feet	Feet	Feet	Feet
1931	28.4	23.0	29.6	24.3
1925	23.4	18.9	22.7	17.6
Total Increment	5.0	4.1	6.9	6.7
Average Annual Increment	0.83	0.68	1.15	1.12

The above results in diameter increment show for spruce an annual gain due to girdling of 0.02 of an inch, or 18 per cent, and for balsam fir a gain of 0.07 of an inch, or 63 per cent.

In height increment, the acceleration for spruce as a result of girdling is 0.32 of a foot, or 38 per cent, and that for balsam fir is 0.44 of a foot or 65 per cent.

On separating the saplings from the main stand, in Table 3b, it was found that in the lower diameter-classes, for both species, the girdled plot showed considerably more height growth than the control plot (1.02 feet and 0.38 foot each for spruce and balsam fir). In the upper diameter-classes, this increase in height growth of the girdled over the control plot is not nearly so evident (1.37 feet and 1.15 feet for spruce, and 1.48 feet and 1.32

feet for balsam fir). However, the diameter growth for these trees is more than twice as great on the girdled as on the control plot.

DENSITY OF STOCKING

That the girdled plot benefited by the treatment in an increased stand per acre is illustrated by Figure I.

FIG. I - STEMS PER ACRE

The shaded columns represent the girdled plot; the unshaded columns, the control plot; and the hatched areas, the number of stems actually girdled. In the softwood stand, the growth on the girdled plot is seen at a glance to exceed that on the control plot, while the reverse condition is true of the hardwood stand. This increase is shown as an annual increment in the first part of Table 2. In the control plot, the softwoods have a net annual increment of 12.2 stems per acre, or 4.3 per cent, and in the girdled plot the net annual increment for softwoods is 25.7 stems per acre, or 7.5 per cent. For the hardwood stands in the two plots, the net annual increments are 5.2 stems per acre, or 2.7 per cent, and -0.2 stem per acre, or -0.1 per cent respectively. Presumably owing to girdling, the hardwoods have lost in density of stocking, whereas the coniferous stand has gained.

Referring again to Table 2, the gross annual increment for the total stand

represents the average number of saplings which came into the stand annually during the period. For softwoods, this is 14.9 stems in the control plot, and 28.4 stems in the girdled plot, a difference of 3.1 per cent between the two plots. In 1931, the sapling stand in the girdled plot contains 391 conifers, while in the control plot there are 258 coniferous saplings per acre. In the

FIG 2 - VOLUME PER ACRE

absence of definite information on reproduction, this may be considered as an indication that adequate stocking of coniferous young growth was present before, and has taken advantage of the release.

VOLUME GROWTH

In the second section of Table 2, the volumes for the two plots in 1925-6 and 1931 are given, also the net and gross annual increments in cubic feet per acre and in growth per cent.

The net annual coniferous increment in the control plot is 36.7 cubic feet, while that in the girdled plot is 52.3 cubic feet per acre. This represents an increase in annual volume growth on the girdled plot over that on the control plot, of 15.6 cubic feet per acre.

In the hardwood stand, the net annual increment on the control plot is

11.7 cubic feet. The girdled plot, however, reveals a decrement of 7.5 cubic feet, or a loss of 19.2 cubic feet.

The relative volumes for softwood and hardwood stands of the two plots in 1925-6 and 1931, are shown diagrammatically in Figure 2.

As in Figure 1, the shaded columns represent the girdled plot, the unshaded columns the control plot, and the hatched sections the volume actually girdled. In the softwood stand, the girdled plot indicates a remarkable increase in volume between 1925 and 1931, in contrast to the control plot. In the hardwood stand, the girdled plot shows a decrease in growth as compared to an increase in the control plot.

By the use of Pressler's formula, the net volume increment in Table 2 is expressed as a periodic average annual growth per cent. The growth of 6.6 per cent for the control plot and 9.6 per cent for the girdled plot gives an increase of 3.0 per cent on the softwood stand. This increase is considered to be due to the girdling of the overmature hardwoods, and as such shows the great advantage to be gained by this treatment. At the same time, the growth in the hardwood stand on the control plot is 0.5 per cent, and on the girdled plot is -2.5 per cent, or a loss in growth on the girdled plot of 3.0 per cent. This decrease may also be attributed to girdling; thus emphasizing the benefits of a girdling treatment in retarding the growth of hardwoods to promote that of conifers.

The increase in annual coniferous volume growth, as stated above, and presumably due to girdling, is 15.6 cubic feet, or 0.16 of a cord per acre. It may be argued that this result is not correct, in that the capital stock of the two plots, 386 cubic feet and 448 cubic feet respectively, was not the same. On reducing the increment of the control plot (36.7 cubic feet) to the same capital basis as that of the girdled plot (52.3 cubic feet) its value will become 31.6 cubic feet. Then the increased annual growth which may be attributed to girdling is actually 52.3—31.6, or 20.7 cubic feet, (0.21 of a cord) per acre.

COSTS OF GIRDLING

Using this latter figure of 20.7 cubic feet, the increase in volume due to girdling becomes 124.2 cubic feet per acre for the six-year growing period. At \$2.00 a cord, this gain represents a stumpage value in 1931 of \$2.50, with a cost for girdling in 1925 of \$1.70 per acre. Then the theoretical interest realized on the investment for the six-year period is 6.7 per cent, compounded annually. If a maximum rate of interest of five per cent can be assumed, a growing period of approximately five years is required to pay for girdling costs.

CONCLUSIONS

The point of interest to the operator is that the stand of 3.8 cords in 1925 has become 7.0 cords in 1931, an increase of 3.2 cords in six years. Of this increase 1.3 cords, or 41 per cent, is attributable to the girdling treatment.

It is admitted that the above conclusions, based as they are on the first short period after girdling, do not represent what might be expected over a longer growing period. Average results show the ultimate advantages of girdling hardwoods, as a release measure to benefit conifers, will be brought out in subsequent remeasurements of the plots at regular intervals.

SUMMARY

In the tolerant hardwood belt of eastern Canada, and more particularly in the lower St. Maurice valley, Quebec, the girdling of overmature hardwoods to benefit conifers in mixed stands is a practical silvicultural treatment.

Both the diameter and height growth for coniferous species showed a decided increase generally, owing to girdling, although trees of the larger diameter-classes increased to a greater extent in diameter than in height.

Softwoods gained in density of stocking as a result of the girdling operation, while young hardwoods under the same conditions revealed an appreciable loss.

In volume growth also, the softwood stand benefited to a marked degree by the girdling when hardwood volume growth was reduced.

On applying an arbitrary value to the growing stock, a period of five years was found to be necessary to pay for the girdling costs and the accumulated interest charges.