Thinning young lodgepole pine is faster with a brush saw

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Young lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) stands that originate after fires are frequently very dense. It is not uncommon to find stands with 40,000 or more trees per acre (100,000/ha) at 10 years of age. Tree growth is reduced at such high densities and if natural thinning is slow there is a danger of stagnation and considerable or even complete loss of merchantable yield. Thus, thinning such stands may be economically justified.

Selective thinning with hand tools is an expensive operation. Recently, various non-selective multi-stem mechanical thinning techniques have been tried which are much cheaper. A drumchopper dragged by a crawler-type tractor was found to be most effective for mechanical strip thinning of pine stands in Alberta and in Manitoba (Bella and De Franceschi 1971, Bella 1972). But this technique is unsuitable for thinning if numerous large, dead trees are standing in the young stands — as after fire — or if large size slash and/or boulders are present on the ground. Under these conditions, light portable machines are more suitable. Newly developed portable circular power saws, 'brush saws' or 'clearing saws', seemed to be potentially useful. In a pilot scale thinning operation in Ontario Riley (1973) reported that one man with a brush saw could thin an acre of 9-year-old jack pine (*Pinus banksiana* Lamb.) from 5,300 stems/acre down to 1,600 in about 4 hours (Riley 1973). The equivalent time to thin 1 hectare from 13,100 stems/ha down to 3,950 stems/ha would be 10 h.

My objectives were to evaluate labour input required to thin young lodgepole pine stands of various densities with one of the better, currently available brush saws in 1/ undisturbed conditions and 2/ stands that had previously received mechanical strip thinning.

The brush saw

A new Husqvarna 165R brush saw was used (Fig. 1). It has a special 10-inch (25-cm) 'brush blade', an overall length of 69 inches (176.5 cm), a dry weight of 22.7 lb (10.3 kg) and came equipped with an adjustable leather harness. Its two-cycle engine delivers 3.8 hp at 8,000 rpm. The manufacturer claims an expected working life of 2,000 h for the machine.

The stands and methods

Area 1. Undisturbed stands were selected about 15 miles (24 km) south of Hinton, Alberta, in the foothills of the Rocky Mountains. Topography is hilly and the soils are silty sand. The stands orig-

inated after an extensive fire in 1956 and were 16 years old at the time of study. The former stand included mature lodgepole pine with a varying mixture of spruces (*Picea mariana* (Mill.) BSP. and *P. glauca* (Moench) Voss). A small fraction of the burned-over area had been salvage-logged but even there considerable slash was left on the ground. Much of the new stand was now too dense. It contained up to 40,000 trees per acre (100,000 trees/ha) — estimates based on 1/40 acre (approx. 0.01 ha) sample plots. Figures 1 to 3 show stand conditions. A vigorous black spruce understorey was present where stand density was under 10,000 trees/acre (25,000 trees/ha).

Eighteen, approximately 1/40 acre (0.01 ha) rectangular sample plots were established in the area which was salvage-logged after the burn. The nearly pure lodgepole pine stands varied from open to dense.

Area 2. For the strip-thinned stands, a 33-year-old lodgepole pine stand, with local patches of black spruce understorey, was chosen in the Bow River Forest of Alberta. It had started after a fire in 1941. The burned-over stand was salvage-logged, and there was now only a moderate amount of slash on the ground. Between January and March of 1966 a level and gently rolling portion of the stand was mechanically strip-thinned; 10-foot-wide (3 m) swaths alternating with 4- to 6-foot-wide (1.2 - 1.8 m) residual strips. In 1971 stand density within the residual strips and untreated areas averaged 19,000 stems/acre (47,000 stems/ha).

Ten, 80 - 100 ft (24 - 30 m) continuous sections of leave strips were selected for sample plots. Average strip width was 5.9 ft (1.8 m) and ranged from 5.0 to 6.7 ft (1.5 to 2.0 m). These 'sample strips' were selected to represent the range of leave strip densities present in the area. In addition, a 33 x 33 ft (10 x 10m) control plot was established in a part of the stand not previously thinned.

All trees on the plots were tallied. Crop trees were marked with coloured ribbons prior to thinning so the operator would not hesitate to select them. The objective was to leave about 1,000 of the largest dominants per acre (2,500/ha), about 6 to 7 ft apart (1.8 - 2.1 m) in untreated stands and about 4 ft (1.2 m) apart in leave strips to allow for the lack of stocking in the cut strips.

With the exception of the 'sample strips' a 6-ft (1.8 m) surround was thinned around each plot prior to the time trials. This was to prevent bias from having to start thinning in a closed stand. (Normally, operational thinning would start from

Fig. 1. Thinning in a dense, 16-year-old stand with the Husqvarna 165R brush saw. Many stems are cut in each sweeping motion and stump height is usually above slash level.

Fig. 2. Thinning in a 16-year-old stand of medium density. An experienced worker can cut several trees with each sweeping motion.

Fig. 3. Thinning in an open 16-year-old stand. Trees are cut individually unless they are clumped.

an opening, a point adjacent to a road, a trail, or a cleared strip.) Including this work, the operator had about three days of intermittent practice to become familiar with the brush saw for thinning.

Trees in closed stands on level or gently sloping terrain were cut concentrically in 3- to 4-ft (0.9 to 1.2 m) swaths with a scything motion (Fig. 1 to 3) to fall the trees in the opening. On slopes, thinning was started on the low side of the plot and proceeded back and forth on parallel 4-ft (1.2 m) swaths for the entire plot. Stump height depended on the amount of slash on the ground, which in

some instances was more than a foot. The operator aimed to cut trees beneath the lowest living branch.

In strip-thinned stands, the operator proceeded along the leave strip, standing and walking in the cut swaths (Fig. 4). After he thinned one side of the strip, he crossed to the next swath and finished thinning from the other side.

Thinning rates

Results in Table 1 and Fig. 6 indicate that the labour input required to thin an acre of 16-year-old lodgepole pine (Area 1) increases with stand density. The average time required to thin an acre was 4.7 h (11.6 h/ha). The requirement for a medium density stand was 4.4 h (10.9 h/ha). It took about three times as long to thin a dense stand as an open one, even though average tree size was nearly double in the latter (Table 1). In a dense stand practically every square foot must be thinned whereas in medium and open stands only certain areas need to be thinned.

Results presented in Fig. 6 indicate a declining rate of increase in labour input at higher stand densities. That is, an increase of 1,000 stems/acre (2,471 stems/ha) requires greater additional labour input at low than at high densities. At around 40,000 stems/acre (100,000 stems/ha) there would be no further increases in labour required with greater numbers of trees. This is understandable: additional small trees would hardly affect performance if the area was completely worked over with the saw.

The average labour required to thin an acre of about 6-ft wide (1.8 m) residual strips was 8.3 man-hours, or 20.5 man-hours/ha (Area 2, Table 1). There was no relation between labour input and density within the strip, contrary to the results above for thinning 16-year-old lodgepole pine. In the strip-thinned stands, however, the range of stand density was much narrower, thus any trend may be obscured. Also, the highly variable stand density of the black spruce understory affected labour requirements. Thinning removed only those spruce trees that happened to be in the way.

Thinning rate was 8.7 man-hours/acre (21.5 man-hours/ha) on the 'control' plot (Table 1). Although results from only one sample plot are not sufficient for generalization, it is noteworthy that required labour input and the stand density on this plot fall close to corresponding average values of the ten 'sample strips' (Table 1). This similarity of labour requirement for selective thinning of strips (average 8.3 man-hours/acre) and for selective thinning previously untreated stands (8.7 man-hours/acre) was unexpected. It seems that if thinning with this brush saw proceeds from an opening such as a former logging trail, cleared line, or an area already thinned, there is generally enough space for the cut trees to fall. Compared to the untreated part of the stand, the advantage of easier movement when working in the strip-thinned condition, where slash was flattened and no new stumps had to be avoided (compare conditions in Fig. 4 and 5), was at least partially offset by the

TABLE 1. Stand statistics and labour rates for thinning lodgepole pine

Condition		Number of trees per acre		Total	Dbh ^a Inches	Labour rate Man hours/acre
		Over 4.5 ft	Under 4.5 ft			
16-year-old stand						
Dense	Average	25,644	7,665	33,310	0.39	7.7
	Range	21,257 — 31,391	2,640 — 15,240	25,800 — 40,160	0 — 2.3	6.4 — 8.4
Medium ^b	Average	10,107	1,293	11,400	0.83	4.4
	Range	6,680 — 13,160	280 — 4,440	9,360 — 14,640	0 — 2.8	4.1 — 5.0
Open ^b	Average	3,840	1,746	5,587	0.75	2.1
	Range	1,880 — 5,240	440 — 2,480	2,320 — 7,720	0 — 3.3	1.2 — 3.3
33-year-old stand						
Treated ^b	Average	18,393	1,139	19,532	0.93	8.3
	Range	13,756 — 24,776	0 — 3,898	14,060 — 24,776	0 — 3.8	5.8 — 10.4
Control		18,400	0	18,400	1.05(.1-3.8)	8.7

^aArithmetic average based on all trees (dbh = 0.0 inch for trees under 4.5 ft).

^bIn this group, most trees under 4.5 ft were black spruce.

increase in walking time required by the operator to thin an equivalent area of residual strips.

When selective thinning follows strip thinning, only the area of the residual strips requires treatment. Thus labour production rate for selective thinning based on the total area of the stand (i.e. residual strip plus cut-strip) is considerably higher. In the present study, the residual strips were 6 ft (1.8 m) and the cut strips 10.5 ft wide (3.2 m). So, in terms of total area treated, when selective thinning followed strip thinning performance was nearly 3 times better than in previously untreated stands. If mechanical strip thinning costs \$15/acre (\$37/ha) and selective thinning with this brush saw costs \$40/acre (\$99/ha), a combination of the two methods as described here would mean a saving of about 25%, i.e. \$10/acre (\$25/ha) compared to the cost of selective thinning the entire stand with the brush saw. Combining the two treatments thus enhances the desirable characteristics of both; the economy of the mechanical strip thinning and the higher growth rate generally associated with selective thinning.

Using the brush saw

At high densities in the 16-year-old stand (Fig. 1), trees were generally less than 6 ft (1.8 m) tall and under 1 inch (2.5 cm) diameter near the base. In such conditions, the saw was used in continuous sweeping motions, like a scythe. Swaths were best done using a distal quartile of the saw blade (left or right depending on the direction of swing). Generally, using more of the blade caught the end of the shaft between the cut surfaces. When heights exceeded 5-6 ft (1.5-1.8 m) in dense stands, cut trees tended to become entangled with each other and with those still standing, creating extra work and slowing the operation.

In medium density conditions (Fig. 2), where the majority of the trees had a diameter near their base of about 1 inch (2.5 cm), work progressed better if the operator picked several trees that could be cut with the same motion; at high revolutions the machine can easily cut several trees in one

swing. This highly desirable and efficient technique comes with experience.

In more open conditions (Fig. 3), it usually took a separate motion to cut each tree unless several were clumped together. The largest trees were most efficiently cut with a steady, rather than a swinging motion. When the tree leaned away from

Fig. 4. Selective thinning with a brush saw in the residual strips. The slash on the ground from strip thinning 8 years earlier has largely decomposed.

Fig. 5. This is the 33-year-old control plot after selective thinning with a brush saw. Higher stumps increase cutting speed (stem diameter is smaller) and because the falling stem is much shorter, it is less likely to get hung up. The stand in the background received no thinning.