TITLE STRIP THINNING OF JUVENILE LODGEPOLE PINE

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1.0 Introduction

Natural regeneration on lodgepole pine clearcuts and burned-over areas often exceeds 20,000 stems/hectare, and initial density control is necessary to avoid repression. Strip thinning has been chosen for implementing stand density reduction in the following two trials. The purpose of this project is to select and test the most suitable type of strip thinning equipment in order to find a cost-effective means of reducing density at an early stage in stand development, and ultimately, to confirm whether or not selective hand spacing costs can be significantly reduced by this earlier density control.

The type of equipment selected for testing had to satisfy two criteria: the maximum cut strip width allowed was two metres, and the machinery had to work effectively in clearcuts with rocks and stumps. The selection of drag scarification equipment arose from literature research, as well as from local experience and expertise. McKenzie and Miller (1978) provide extensive data on a variety of shredders, brush cutters, flails, and rotating blades for precommercial thinning and slash treatment. In addition, Pinette and Therrien Mills Ltd. of Williams Lake had pulled a delta V-bar and three sharkfin drums behind a JD 740 skidder in 1979 to similarly strip thin seven pine cutblocks near Big Creek. Mortality in the cut strips increased over several years. Consequently, due to the suitability, availability and apparent success of using this scarification equipment, the same concept using a narrower prime mover and set-up of sharkfins was selected for use in Trials #1 and #2.

2.0 Treatment Area

The three blocks on which the trials have been undertaken are located
in the Williams Lake Forest District within the SBS(a) - Chilcotin Pine subzone, at the junction of the Palmer Lake and 1400 Roads. The area is located in A05451 and was clearcut in 1973. At the time of treatment, the lodgepole pine regeneration ranged in height from germinant size to almost one metre. The only secondary tree species on the blocks was some aspen saplings at the east end of Block #2. Slopes in the blocks ranged from 0 to 5% and slash levels were low. Further stand characteristics are given in Table #1 and maps showing the block locations and boundaries are included in Appendix I.

Table 1. Pre-Treatment Data

<table>
<thead>
<tr>
<th>BLOCK</th>
<th>TYPE OF TREATMENT</th>
<th>SITE CLASS</th>
<th>AREA (ha)</th>
<th>DENSITY AVERAGE AND RANGE (stems/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strip</td>
<td>P</td>
<td>4.6</td>
<td>11,111 (3,500-21,500)</td>
</tr>
<tr>
<td>2</td>
<td>Strip</td>
<td>P</td>
<td>3.6</td>
<td>12,857 (3,500-28,000)</td>
</tr>
<tr>
<td>3</td>
<td>Diamond</td>
<td>P</td>
<td>3.1</td>
<td>14,583 (5,500-38,000)</td>
</tr>
</tbody>
</table>

3.0 Parallel Strip Thinning

3.1 Treatment Method

Parallel cut and leave strips measuring 2 metres and 4 metres in width, respectively, have been scarified in Trial #1. The prime mover used was a Caterpillar D3, and the drag scarification equipment best-suited in terms of efficiency and minimal weight for the relatively small D3 consisted of two sharkfin drums each attached to the ends of a small, triangular 1,320 mm boat (Figures 1 and 2). Short chains attached to the free ends of the sharkfins did not improve ballast and were removed. Equipment specifications are given in Appendix II.

A secondary type of trial was undertaken on approximately the last ten strips of Block #2. The operator felt that the straight blade on the D3
Figure 1. Drag scarification equipment used in Trials #1 and #2.

Figure 2. First pass of parallel strips on Block 3.
could be lowered as required to uproot the seedlings. The drag scarification equipment was detached from the prime mover and the blade was angled to reduce its width. One of the permanent plots has been installed in this part of Block #2.

3.2 Results

The available results from the Fall 1982 sampling are summarized in Table 2, and Figures 3 and 4 show the visual effects to the sites. Permanent plots have been installed in the cut strips to monitor treatment results 1, 2, 3, and 5 years after treatment.

Table 2. Summary of Fall 1982 Post-Treatment Sampling

<table>
<thead>
<tr>
<th></th>
<th>TRIAL #1</th>
<th>TRIAL #1 (bladed strip)</th>
<th>TRIAL #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave. cut strip width (m)</td>
<td>1.7</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Ave. leave strip width (m)</td>
<td>3.7</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Ave. no. stems/ha before treatment</td>
<td>11,875</td>
<td>11,875</td>
<td>14,583</td>
</tr>
<tr>
<td>Ave. no. uprooted stems/ha</td>
<td>2,119</td>
<td>2,691</td>
<td>***</td>
</tr>
<tr>
<td>No. of remaining stems/ha</td>
<td>9,756</td>
<td>9,184</td>
<td>***</td>
</tr>
<tr>
<td>% trees removed</td>
<td>18</td>
<td>23</td>
<td>***</td>
</tr>
<tr>
<td>Ave. stem position in plot*</td>
<td>1.98</td>
<td>.93</td>
<td>2.15</td>
</tr>
<tr>
<td>Ave. damage in plot**</td>
<td>1.22</td>
<td>.77</td>
<td>1.31</td>
</tr>
</tbody>
</table>

* Stem positions: 1 - edge of the cut strip
2 - sharkfin path
3 - middle of the cut strip

** Damage classes: 0 - nil
1 - light (only a small portion of the stem has been scraped)
2 - medium (stem and branches have been scraped)
3 - heavy (a large part of the stem and branches has been scraped and/or the tree's form has been altered)

*** Information available in 1983

The cut strip width of 1.7 metres for Block 1 is well under the maximum allowed. The track width of the D3 is 1.78 metres, and because the average strip width was less than this, the unballasted sharkfins have bounced around
Figure 3. Parallel cut and leave strips created by the drag scarification treatment.

Figure 4. Uprooted and damaged stems in a cut strip.
over slash and stumps so much that where edge trees were not damaged by the D3 tracks, the apparent strip was often narrower than the width of the prime mover. The average leave strip width of 3.7 metres falls slightly short of the prescribed width of 4 metres.

The difference between the number of initial and uprooted stems/hectare in Table 2 gives the estimated number of stems/hectare removed by the strip thinning treatment. The average value for Trial #1 was 18%, and the rather low average damage rating of 1.22 (between light and medium) suggests that mortality of the remaining stems will be low. The average position of the remaining stems in Trial #1 (1.98) is very near the sharkfin path.

The result of the blade treatment in Block #2 was a wider cut strip width, a much higher degree of exposed mineral soil, and a greater amount of broken tops and seedlings buried in soil. Few seedlings were actually uprooted; however, mortality from the treatment would probably improve as the operator gained experience in using the equipment in this manner. Initial assessment indicated that this method is equally as successful at producing cut strips as is the drag scarification technique, although the high degree of mineral soil exposure may affect the long-term treatment success if grasses and suckering species become a major competitive threat to the crop trees. The bladed plot had the highest value of 23% of stems removed, and the actual value may be higher due to the number of uprooted trees that are buried in soil by this method.

The success of this drag scarification treatment method has been summarized in Appendix III, "Factors affecting the success of using sharkfin drag scarification equipment for strip thinning juvenile lodgepole pine". The seven factors listed and discussed are:

- position of each stem relative to path of sharkfin
- slash
- ground cover
- slope
- power of prime mover
- soil moisture during treatment
- soil moisture after treatment

Rows 1 to 8 in Block 1 have been marked so that a visual assessment over time can also be made of the preliminary set-ups of drag scarification equipment tested. None of the equipment in Rows 1 to 6 appeared satisfactory at the time of treatment, although the results may improve with time. Appendix IV gives the equipment descriptions and immediate post-treatment results for reference, and Rows 7 and 8 appear the most satisfactory. The equipment set-up used was similar to that used in Rows 3 and 4 (the 1,320 mm boat pulling two sharkfins and two lengths of chain), but the major difference was that a second pass was made on each of Rows 7 and 8 in the same direction as the first pass. This has produced a marked increase in seedling uprooting. The first pass aligns the slash and rips out some of the seedlings and the second pass increases the uprooting without interference of the slash. The suitability of incorporating the second pass into the strip thinning method would depend on such factors as whether or not edge tree damage is increased, and on any gain in mortality for the additional cost of the second pass.

4.0 Diamond-Patterned Strip Thinning

4.1 Treatment Method

This strip thinning method is supplementary to Trial #1. Two sets of scarified strips have been produced, with the second series crossing the first at an angle of about 45°. This technique is a variation on strip
thinning two sets of passes perpendicularly to each other, by increasing
the number of edge trees with potential for release.

4.2 Results

The permanent plots for Trial #2 have been installed at the junctions
of cut strips in order to monitor the effectiveness of two passes over an
area. Plot areas will not be measured until 1983 and therefore, the number
of uprooted stems cannot be extrapolated to a per hectare basis at this
time.

From Table 2, the average damage value of 1.31 is only slightly more
than in Trial #1 and mortality of the remaining stems within the plots is
not expected to be high. Mortality in the cut strips that had been scarified
once was, as expected, comparable to that in Trial #1, since the equipment,
site, and method were similar. The pre-treatment sampling results show
that the three blocks had average densities of 11,000 to 15,000 stems/hectare.
Observation of the treated areas shows that this is minimally acceptable
for parallel strip thinning, but insufficient to justify the additional
costs of the diamond-patterned treatment. Block #3 had the most patchy
stocking and in some places, voids and understocked areas have been
increased in size by this method.

5.0 Production Data

The timing data, collected by I. Hedin of FERIC, is summarized in
Appendix V and the production summary is shown in Table 3. Production time
consists of the time spent moving forward within the blocks and turning
between strips. The productive time percentages from Block 1 (parallel strip
thinning) and the second pass of the diamond-patterned method are 74 and 63,
respectively. The first pass of Block 3 had a low value of 41% because of
an unavoidable major breakdown in the prime mover that accounted for 36% of
the total time. In addition, Block 3 required more turning than did the
longer, narrower Block 1. The two-pass system required five times as much
total time and 3.1 times as much productive time as the one-pass method to
treat a hectare, because of turn-around time, moving around outside the block,
and the major machine breakdown.

Table 3. Production Summary

<table>
<thead>
<tr>
<th></th>
<th>TOTAL TIME</th>
<th>PRODUCTIVE TIME</th>
<th>COST(Prod. TIME)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1 (parallel strips)</td>
<td>1.3 ha/hr</td>
<td>1.8 ha/hr</td>
<td>$23.97/ha.</td>
</tr>
<tr>
<td>Block 3 (diamond-patterned)</td>
<td>.26 ha/hr</td>
<td>.58 ha/hr</td>
<td>$72.84/ha.</td>
</tr>
</tbody>
</table>

6.0 Conclusion and Recommendations

No final conclusion can be made at this time regarding the suitability
of the drag scarification treatment method, but long-term monitoring of the
permanent plots will yield more information. The machinery used in future
trials requires the modifications described below; however, the concept of
using sharkfin drag scarification equipment for strip thinning juvenile
lodgepole pine does have potential for operational use.

The following recommendations should be considered to incorporate into
plans for further strip thinning using drag scarification equipment:

1. A third sharkfin should be mounted on the 1,320 mm boat between and
   behind the outer sharkfins, in order to increase mortality in the middle
   of the cut strips.

2. Each sharkfin should be ballasted to prevent it from nosing down at the
   front and falling downhill when travelling across a slope. Ballast can
   be produced by adding water to the rear compartments of the sharkfins
   and/or by attaching a trackpad to the back of each sharkfin.

3. Successive trials require a more powerful prime mover, providing that
   its width does not exceed the maximum cut strip width allowed. A higher
   amount of uprooted seedlings could be expected if the equipment was
   able to travel at a higher speed.

4. Diamond-patterned strip thinning should only be used in evenly-stocked
   stands of at least 30,000 stems/hectare.
5. Subsequent hand spacing of the outside one-metre wide edges of the
leave strips should be undertaken in Fall 1984 on at least one hectare
of Trial #1. Unacceptable stems remaining in the cut strips can also
be removed at that time. This two-step concept of strip thinning and
selective hand spacing is presented in Bella and DeFranceschi (1977).

6. Further equipment for strip thinning, such as flails, ripper teeth
mechanisms and modified drum choppers, should undergo similar trials,
in order to learn if another system can improve on the sharkfin method.

7.0 References

Bella, I.E., and J.P. DeFranceschi, 1977. Young lodgepole pine responds
to strip thinning, but ... . Info. Rpt. NOR-X-192, Nor. For.
Res. Cen., Edmonton, Alta.


Lotan, J.E., 1967. Eleven-year results of strip-thinning by bulldozer in
thirty-year-old lodgepole pine. USDA Forest Service Res. Note
INT-69, Intermountain For. & Range Exp. Stn., Ogden, Utah.

Thinning and Slash Treatment. USDA For. Ser. Dev. Cen.,
San Dimas, CA.
APPENDIX II

Equipment Specifications
(From Caterpillar technical data and Glen, 1979)

D3

1420 mm
1780 mm
2410 mm
2770 mm
3680 mm

1 2700 BOAT DETAIL

3 SHARK FIN DETAIL

NOTE: ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.

12 1320 mm BOAT DET
APPENDIX III

FACTORS AFFECTING THE SUCCESS OF USING SHARKFIN DRAG SCARIFICATION EQUIPMENT FOR STRIP THINNING JUVENILE LODGEPOLE PINE:

1. Position of each stem relative to path of sharkfins.

The chances of a stem being completely uprooted were the greatest if a sharkfin rotated directly over it. Stems in the middle of the cut strip were often unharmed by the prime mover and at the most, may have suffered only some minor damage. Germinants and stems under 40 cm in height were rarely uprooted, regardless of their position in the cut strip.

2. Slash.

Slash caught up in the drag scarification equipment damaged trees in the leave strips and inhibited the beneficial rotating action of the sharkfins. Slash levels for this type of treatment must be low in order to achieve maximum potential mortality in the cut strips with minimal damage to the leave strips.

3. Ground-Cover.

The rotating action of the sharkfins was inhibited by medium to heavy ground cover (shrubs and hardwood saplings) and by rocks and stumps. Soil penetration by the sharkfin blades was consequently reduced, and seedling uprooting decreased as a result.

4. Slope.

Moving uphill reduced the speed of the prime mover, depending on the slope angle, terrain and the machine's power. Decreased speeds reduce the ability of the sharkfins to uproot seedlings. Traversing a slope causes sharkfins without a heavy length of chain behind them to slide downhill, which increases cut strip width and damage in the leave strips.

5. Power of prime mover.

The maximum cut strip width permitted in this trial was 2 m, and from the technical specifications the D3 appeared to be the best-suited prime mover. Unfortunately, despite the gentle slope and low number of obstructions (stumps, large rocks, and patches of heavy slash), the D3 is under-powered to pull the sharkfins and boat at a speed high enough to wrench most of the seedlings from the ground. The average speed of the machine with attachments in the trial was about 2.5 km/hr.
6. **Soil moisture during treatment.**

The sharkfins are able to penetrate the soil much more deeply when the soil is moist, as proven by comparing the areas treated in August and in September. A visual check showed that a higher proportion of stems was uprooted during the latter treatment, which occurred after a week of relatively high rainfall. Soil consistence and soil moisture together affect the amount of seedlings uprooted, due to the cohesion of soil particles and adhesion with seedling roots.

7. **Soil moisture after treatment.**

Post-treatment mortality of seedlings that are only partially uprooted or which suffered heavy damage (stem and branch scraping and/or loss of foliage) will probably depend considerably on soil moisture after treatment. Dry conditions are expected to act as a secondary stress following mechanical damage and, if severe enough, may increase mortality above the level obtained immediately after treatment. Individual tree monitoring within the permanent post-treatment plots will yield information on this factor.
Appendix IV - Equipment Used on Rows 1 to 8, Block 1

Rows 1 and 2 - 2700 mm boat used, with 1 sharkfin attached to each of the outside attachment points and an anchor chain connected to the middle point of the boat.

- cut strip is too wide (average of 2.8 m)
- drag scarification equipment is too heavy for the D3.

Rows 3 and 4 - 1320 mm boat with a sharkfin attached at each of the widest settings, and a length of scarification chains behind each sharkfin.

- acceptable cut strip width
- seedlings in middle of cut strip were unaffected.
Rows 5 and 6 – 3 parallel scarification chains attached to the 1320 mm boat.

- no uprooting action without the sharkfins.
- slash was accumulated and dragged perpendicularly to the direction of travel – damage to edge trees and the entire leave strip greatly increased.
- trees in the cut strips would more likely die from the stripping of bark and branches, rather than from uprooting. A lower or more gradual rate of mortality would be expected compared to the results of uprooting by the sharkfins.

Rows 7 and 8 – same equipment used as for Rows 3 and 4, with the sharkfins each set one hole closer to the middle of the boat in order to increase mortality in the middle of the cut strip. No scarification chains were used, and two passes in the same direction were made on each row.

- the first pass aligns the slash and uproots some seedlings; the second pass uproots more of the remaining seedlings.
this method has potential for operational use if the additional mortality offsets the increased treatment cost.
# APPENDIX V

## Summary of Timing Data by Percent of Total Time

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>BLOCK 1</th>
<th>BLOCK 3 1st Pass</th>
<th>BLOCK 3 2nd Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Productive time</td>
<td>74</td>
<td>41</td>
<td>63</td>
</tr>
<tr>
<td>2. Preparation, instructions, and moving to and from block.</td>
<td>16</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>3. Delays during operation (hang-ups in slash, loss of traction).</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4. Minor adjustments to equipment.</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5. Major mechanical problems with prime mover.</td>
<td>0</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>6. Lunch and coffee</td>
<td>9</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>