AUGUST 30th, 1989

IRON MOUNTAIN ELECTRIC FENCE PROJECT
FINAL REPORT SK NUMBER 87/105K OPENING FILE 921-007-32

OBJECTIVES:

1) To determine the effectiveness of electric fencing for keeping cattle out of forestry plantations.

2) To determine what effect cattle exclusion has on plantation survival and the resulting stocking level.

3) To compare the costs versus the benefits of electric fencing.

LOCATION

The study area is located approximately 10 km southeast of Merritt as shown on the attached map (Appendix 3). This particular opening was chosen because:

i) planting was completed in 1983 just prior to the implementation of the trial;

ii) cattle would use the area for the duration of the trial;

iii) the site is close to Merritt.

SITE DESCRIPTION AND HISTORY

The trial area is classified as IDF dkl 4 and is generally subalpine or mesic with a moderate amount of soil nutrients. Pdi and Pli are the dominant species over most of the site, with S6 being a major component in the wetter draws.

The site was diameter-limit logged in 1969; all stems less than 13 inches at stump height (11 inches dbh for P1) were left to provide shade for natural regeneration. Mechanical site preparation (trenching) was done in 1982 to break up pine grass and expose mineral soil prior to planting. Pdi 2-0 BBR stock was planted in 1983.

TRIAL DESIGN

Approximately 1250 m of electric fence was erected in 1983 after planting. The electric fence initially consisted of 4 wires (2 hot, 2 ground) that joined to an existing standard fence to enclose a total area of approximately 6 hectares. One hot wire and one ground wire were removed in 1984 and the remaining two-wire fence was maintained until the end of the 1988 growing season. The remainder of the opening (approximately 15 ha) was left unfenced as a control. The opening was surveyed both inside and outside the fenced enclosure in 1984, 1986 and 1989.
PRELIMINARY AND INTERMEDIATE RESULTS

The 1984 survival and stocking survey (R. Neighbor) showed survival to be significantly higher inside the fenced enclosure (80.8%) than outside (37.3%). Poor survival outside the fence was attributed to cattle trampling.

The 1986 stocking survey (B. Nash and B. Pryce) stratified the site into 3 areas as follows:

AREA 1  Inside fence
- little slash overall
- high grass competition
- no cattle damage

AREA 2  Just outside fence
- little slash
- no grass competition
- very heavy cattle grazing
- heavy browsing and scarring of the trees by cattle (on 25% of the planted trees)
- no shade protecting the trees
- soil highly compacted

AREA 3  Outside and away from fence
- moderate slash (protects the seedlings from cattle damage and provides some shading)
- moderate grass competition
- moderate cattle grazing

The data collected during the 1986 survey is summarized below:

<table>
<thead>
<tr>
<th>Planted Trees Only</th>
<th>Planted &amp; Natural Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total/Ha</td>
</tr>
<tr>
<td>Area 1 (inside fence)</td>
<td>659</td>
</tr>
<tr>
<td>Area 2 (immediately outside fence)</td>
<td>367</td>
</tr>
<tr>
<td>Area 3 (outside &amp; away from fence)</td>
<td>367</td>
</tr>
</tbody>
</table>

* W.S./Ha = well-spaced acceptable trees per hectare.

The number of well-spaced planted trees per ha and well-spaced total trees per ha were found to be greater inside the fenced enclosure. The number of well-spaced trees per ha in areas 2 and 3 were found to be comparable.

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<table>
<thead>
<tr>
<th>Strata 1 (inside fenced enclosure)</th>
<th>Survey Year</th>
<th>W.S./Ha</th>
<th>Minor Cattle Damage on W.S./Ha</th>
<th>Major &amp; Cattle Damage on all planted stems/Ha</th>
<th>Total Cattle Damage to all planted stems/Ha</th>
<th>PLANTED &amp; NATURAL TREES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>147</td>
<td>40</td>
<td>67</td>
<td>120</td>
<td></td>
<td>493</td>
</tr>
<tr>
<td>1986</td>
<td>524</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>659</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strata 2 (outside fenced enclosure)</th>
<th>Survey Year</th>
<th>W.S./Ha</th>
<th>Minor Cattle Damage on W.S./Ha</th>
<th>Major &amp; Cattle Damage on all planted stems/Ha</th>
<th>Total Cattle Damage to all planted stems/Ha</th>
<th>PLANTED &amp; NATURAL TREES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>106</td>
<td>13</td>
<td>27</td>
<td>40</td>
<td></td>
<td>333</td>
</tr>
<tr>
<td>1986</td>
<td>216³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>350³</td>
</tr>
</tbody>
</table>

1 W.S./Ha = well-spaced acceptable trees per hectare
2 "Major" and "Minor" cattle damage as defined in Appendix 2
3 Average of Area 2 (immediately outside fence) and Area 3 (outside & away from fence) values
### APPENDIX 4 - COSTS OF TRIAL FENCING OPERATIONS (1984 dollars)

<table>
<thead>
<tr>
<th>1. Materials</th>
<th>Our Costs (1280 m)</th>
<th>Estimated Operational Cost/km on 2 km enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Posts 2 1/2-3&quot; X 6' pressure treated 156 @ $2.17</td>
<td>$338.98</td>
<td>$270.00 or less</td>
</tr>
<tr>
<td>1.2 Wire 12 1/2 gauge high tensile high tensile smooth 5 1/2 rolls @ $54.62</td>
<td>$300.41</td>
<td>$150.00 or less</td>
</tr>
<tr>
<td>1.3 Insulators - Gallagher Type W 310 @ 0.22 Statite Corner 6 @ 0.20</td>
<td>$ 68.20</td>
<td>$ 56.00</td>
</tr>
<tr>
<td>1.4 Tighteners - Ezy Way 14 @ $3.55</td>
<td>$ 49.70</td>
<td>$ 40.00</td>
</tr>
<tr>
<td>1.5 Energizer Gallagher E 12 1 @ $179.05</td>
<td>$179.05</td>
<td>$ 90.00</td>
</tr>
<tr>
<td>1.6 Batteries - 12 Volt 2 @ $66.00</td>
<td>$132.00</td>
<td>$ 33.00</td>
</tr>
<tr>
<td>1.7 Charger 1 @ $30.00</td>
<td>$ 30.00</td>
<td></td>
</tr>
<tr>
<td>1.8 Ground Rods with Clamps 3 @ $7.00</td>
<td>$ 21.00</td>
<td>$ 10.00</td>
</tr>
<tr>
<td>1.9 Staples 325</td>
<td>$ 5.00</td>
<td></td>
</tr>
<tr>
<td>1.10 Freight Line Clamps 20 @ $0.63</td>
<td>$ 12.60</td>
<td>$ 10.00</td>
</tr>
<tr>
<td>1.11 Vandal Box</td>
<td>$100.00</td>
<td>$ 50.00</td>
</tr>
<tr>
<td>1.12 Total</td>
<td>$1268.09</td>
<td>$709.00 or less</td>
</tr>
</tbody>
</table>

| 2. Labor | 9 man days @ 10.70 hr. (laborer) (7 hr. day incl. travel time) | $674.10 | $270.00 |

| 3. Machinery | Right of way | $1000.00 | $ 20.00 |

| 4. Grand Total | $2942.19 | $899.00 or less |
The figures show stocking to be somewhat better inside the enclosure, but the difference is not significant at the 95% confidence level. The results contradict the figures from the 1984 and the 1986 surveys which show stocking levels to be higher inside the enclosure. Also, stocking levels were found to be much lower overall in 1989. The discrepancy in results is probably attributable to differences in survey method; the 1989 survey located plots according to a systematic grid layout whereas the 1986 survey biased plot location in order to reduce inter-plot variability. The trial area is highly variable in terms of: i) density of residual trees left after logging, ii) topographic features (i.e. rock outcrops, wet drainages, etc.) and iii) quantity of slash. The 1989 plots were situated in a wide range of conditions, while the 1986 plots were concentrated in more open patches where planting intensity was higher.

The results of the 1989 survey do not support the popular belief that reduced cattle grazing will automatically improve plantation survival in high risk areas. The following factors probably contributed to the results:

i) The effect of cattle grazing on stocking was probably insignificant compared to losses from uncontrollable variables such as moisture stress. Pdi dkl openings are typically difficult to regenerate with Pdi stock, regardless of grazing intensity;

ii) Much of Strata 2 has poor accessibility for cattle because of slash and topography. Grazing intensity over parts of the Strata 2 is consequently very low and similar in appearance to Strata 1 (see photos 1 and 4). Areas of very heavy cattle use are limited to within ± 75 meters of roadways and trails (photo 5).

iii) Cattle grazed in Strata 1 after the electric fence was removed at the end of 1988. A few plantation trees in Strata 1 were cattle-damaged in 1989 to the point of being classified as non-acceptable crop trees.

iv) Intense grass competition within the enclosure has probably reduced survival.

Cattle damage to plantation trees was noted and classified as either "major" or "minor" according to the Range/Silviculture Interaction Report damage rating system (Appendix 3). Trees with "major" cattle damage are not expected to grow to be crop trees. Surprisingly, the amount of cattle damage found on plantation trees inside and outside the enclosure was not significantly different at a 95% confidence level. The cattle damage figures should be viewed with skepticism because:

i) Cattle damage surveys probably underestimate the amount of cattle impact when conducted several years after planting (six years in this case). Seedlings that died from trampling soon after planting would not be taken into account as the survey measures only damage to surviving trees.
Some plantation trees within the enclosure have been recently scarred from cattle grazing in 1989. Ideally, the survey should have been completed prior to the removal of the fence.

Evidence of moderate deer and moose browsing within the enclosure was found. Wildlife has presumably damaged some plantation trees both within and outside the fence.

**ELECTRIC FENCING FOR RESTRICTING CATTLE ACCESS**

Periodic field checks showed that the two-strand electric fence accomplished its primary objective of keeping stock outside the enclosure. An occasional cow was spotted within the fenced enclosure only on rare occasions. Cattle tended to congregate near the fenceline once encountering the barrier, especially where access was good.

Studies have shown that electric fences often work better than standard fences because stock do not push or touch the electric fence and exploit weak spots as readily. Fences will only be effective, however, if they are properly constructed and maintained. Details on correct fencing procedures can be found in the Electric Fencing Manual 1.

During the trial the fence was rendered powerless by vandalism (stolen battery) and equipment failures (faulty energizer). The replacement battery was subsequently protected with the installation of vandal-resistant housing. Such problems must be anticipated and quickly remedied through routine maintenance, as stock soon lose their fear of the wire if they are not shocked when they periodically brush against it.

Manufacturer's literature claims that electric fences can be made even more effective by training stock to the fence prior to turning them out in the field. Prior training will reduce the amount of stress on an operational fence by reducing the frequency of contact as the stock is already familiarized. Stock can be easily trained to an electric fence by enclosing them in a small area where there is room to move around but where contact with the fence is possible.

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COST ANALYSIS

The fence was constructed in 1984 for a total cost of $3,000 or $2,400 per kilometer (Appendix 4). Cost savings of up to 60% or more would have been possible by:

i) using an experienced fencing crew;
ii) using less expensive wire that is easier to handle;
iii) using pounded posts at corners or on long spans only (metal rods are less expensive and easier to install);
iv) using proper tools such as a spinning jenny for rolling wire and;
v) clearing the right-of-way in conjunction with post treatment site preparation. Specific costs are listed in Appendix 4.

The following discussion was extracted from the 1984 report by G. Heyes:

"An average cutblock is approximately 25 ha in size and would require approximately 2 km of perimeter fencing. If we estimate the life span of a fence to be 24 years and we require 4 years protection on each plantation, the same fencing materials could be used on 6 separate blocks. The cost of moving the fence 6 times would be about $3,000.00. This means the cost to protect 150 ha of tree plantations (25 ha/blk. x 6 blk.) would be approximately 4,800 ((2 km of fence X $900/km) + 3,000 to move the fence 6 times). Additional maintenance costs are unknown but if we suggest $100/year, the total cost would reach $7,200 ($4,800 +($100/yr. X 24 yrs.)).

Replanting a cutblock costs approximately $600/ha. Therefore if the grazing use could be meticulously controlled on 150 ha of high risk plantations, there is a potential $90,000 saving (150 ha X $600/ha). The benefit cost ratio of 12.5:1 ($90,000 - $7,200) appears very favorable."

The potential savings and cost-benefit ratios are optimistic figures which assume that electric fencing will successfully eliminate the need to replant in all high risk areas. The trial presents a more pessimistic view; the one-off fencing operation has resulted in a loss of $3,000.00 (assuming no benefits have accrued from the fence based on the 1989 survey results). Obviously, the true potential benefits lies somewhere between these two extremes. If fencing eliminates the need to replant on just one plantation out of twelve, the venture would still break even (based on the benefit/cost ratio of 12.5:1).

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CONCLUSIONS

Properly constructed and maintained electric fences can control the movement of cattle at relatively low cost and therefore have potential for resolving forestry/grazing land use conflicts. Fencing plantations does not, however, guarantee higher plantation survival and stocking levels. Plantation mortality incurred from cattle damage can be inconsequential relative to losses from poor planting quality, poor stock quality, moisture stress and other factors.

Stocking was not measurably better inside the enclosure of the study area; the entire site is NSR and should be replanted. Although the survey showed that fencing did not improve survival or reduce plantation damage in this particular instance, the reader should not conclude that electric fencing has no potential as a silviculture tool in general. If the trial were repeated in an area where stand conditions are uniform (i.e. evenly distributed residual trees, slash and topography resulting in consistent cattle access throughout) and where other stress factors such as planting quality, drought, etc. have a lesser impact, the real effect of restricting cattle grazing on plantation survival would be easier to measure. Figures show that even a low success rate will make operational electric fencing financially sound on average.

Cattle grazing poses a threat to plantations from trampling and browsing but also helps to control pine grass. Electric fencing could be used to restrict the amount of cattle grazing, rather than eliminating it entirely.

A visual inspection of the trial area and the survey data indicates that cattle damage to plantations is reduced wherever slash restricts cattle movement. This suggests that the planting of seedlings near obstacles might be a suitable alternative to electric fencing.

The cattle damage assessment method as described in the Merritt T.S.A. Range/Silviculture Interaction Report is most effective when used soon after planting (say at the end of the first growing season). The survey becomes less certain if applied in later years because the survey can only assess the damage on surviving trees.

The results of the trial are inconclusive and further research is required to:

i) Test grazing impact on plantation survival in uniform stands.

ii) Determine appropriate grazing intensities and timing (i.e. time of season, length of time, forage utilization, stocking rate) on different sites (i.e. varying species and biogeoclimatic zones) to optimize the pine grass control/cattle damage trade off.

iii) Test electric fencing in areas of extremely high cattle pressure (multiple hot wires or physical barriers might be needed).

iv) Test the technology for special challenges presented by roads and creeks.

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