EXPERIMENTAL HARVESTING OF DRY-BELT DOUGLAS-FIR
ON A MULE DEER WINTER RANGE AT KNIFE CREEK

Working Plan
and
Progress Report

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ABSTRACT

The objective of this study is 1) to design a timber harvesting system for dry-belt Douglas-fir located on critical mule deer winter range; and 2) to test the system’s compatibility with maintaining the carrying capacity of the range for deer. In 1983 a small area of the Knife Creek winter range was selectively harvested, resulting in the removal of only 13% of the merchantable Douglas-fir volume. Although initial responses to the results of this experiment were positive, the operation was not economically viable. Refinements were made in 1984 including a shift from the mark-to-cut approach to the more efficient fallers selection method of determining which trees to harvest. During the spring of 1984 this revised system was applied on a larger area within the winter range. An assessment is in progress.
TABLE OF CONTENTS

Abstract................................................................. ii

1 Introduction.......................................................... 1

2 Objective.............................................................. 1

3 Winter Habitat Requirements of Mule Deer......................... 2

4 Study Area............................................................ 3

5 Phase I................................................................. 3
  5.1 Harvesting Criteria............................................... 3
  5.2 Monitoring........................................................ 8
  5.3 Results........................................................... 12
    5.3.1 Mule Deer Response......................................... 12
    5.3.2 Harvesting.................................................... 15
    5.3.3 Silviculture................................................ 16
    5.3.4 Protection................................................... 16

6 Phase II............................................................... 18
  6.1 Harvesting Criteria............................................. 18
  6.2 Monitoring....................................................... 19

7 Appendix.............................................................. 20
LIST OF TABLES

1. Percentage of tracks by micro-habitat on the experimental and control areas during the winter of 1983/84.......................... 14

2. Diameter distribution of the 1983 experimental block before and after harvesting as determined by timber cruise........................ 17
LIST OF FIGURES

1 Location of the Knife Creek study area................................. 4

2 The experimental and control blocks on the Knife Creek study area..... 5

3 Diameter distribution of Douglas-fir on the experimental
   and control blocks...................................................... 6

4 Forest cover map of the Knife Creek study area........................ 7

5 Diagrammatic representation of the application
   of the marking criteria.................................................. 9

6 Layout of track transects and positions of
   radio-telemetry receiving towers...................................... 11
1 INTRODUCTION

Throughout the Cariboo Region are patches and tracts of mature Douglas-fir forest which are key winter ranges for mule deer. Those same stands are also sources of high-value, low-cost raw material for the region's forest industry. Over a decade ago the Fish and Wildlife Branch cautioned the Ministry of Forests about the consequences of harvesting mule deer winter ranges. Severe deer population declines were forecast if harvesting trends were permitted to continue unchecked. As a result, the Ministry of Forests agreed to temporarily reduce harvesting pressures on such key areas as Knife Creek and Meldrum Creek in addition to using the normal harvesting plan referral process in an attempt to prevent further erosion of wildlife habitat.

The Fish and Wildlife Branch staff recognized that this was only a temporary solution to the problem and in 1980, after consultation with a small contract logging company, proposed a Douglas-fir logging experiment for mule deer winter ranges. The objective of the experiment was to determine if low volumes of timber could be removed from a winter range without reducing the value of the habitat for deer. The Ministry of Forests accepted the idea and a joint committee was appointed to develop a mutually acceptable plan. At that time Ministry of Forests research staff emphasized that a scientific approach was required if the objective of the study was to be met. Therefore, in January 1982 the logging study was incorporated with the Ministry of Forests funded research work "Habitat Relationships of Mule Deer in the Interior Douglas-Fir Zone of Central B.C." (E.P. 903). The joint Ministry of Forests/Ministry of Environment Committee set up to guide that work agreed to supply similar guidance for the logging study described in this working plan.

2 OBJECTIVE

The objective of this study is 1) to design a timber harvesting system for dry-belt Douglas-fir located on critical mule deer winter range; and 2) to test the system's compatibility with maintaining short- and long-term carrying capacity of the range for deer. The approach has been to divide
the harvesting into two phases. In the initial phase a small block of timber was harvested in a very controlled manner using a mark-to-cut system. This was to determine whether it was possible to selectively harvest a low volume of timber while leaving the stand structure intact. During the first winter following the harvest, an examination of the response of deer to the stand manipulation was made. The initial responses from this small area were positive and hence the second phase will be carried out. This will be done in spring of 1984 on an operational scale, incorporating refinements suggested from the first phase experience. A detailed assessment of both the mule deer response and the implications to timber management will be made the following winter 1984-1985.

3 WINTER HABITAT REQUIREMENTS OF MULE DEER

To provide background for the following sections, a brief review of mule deer winter habitat requirements is presented.

To survive the winter period, deer must find habitats where energy demands are less than what can be obtained from available forage and fat reserves. As snow depths increase, so do the energy costs of locomotion. Since energy resources during the winter cannot meet the demands of travel through deep snow, mule deer seek habitats with less snow. Habitat variables that influence snow depth include slope, aspect, tree species, canopy closure, and crown structure. Habitats that have acceptable snow depths must also provide a supply of forage of adequate quality. Winter forage is composed largely of shrubs available above the snow, as well as litterfall (lichen and foliage) from Douglas-fir.

These requirements for shelter and food combine to make areas having old-growth Douglas-fir canopy cover and slopes with south aspects the preferred forage areas during winter. However, within any winter range there are variations in canopy cover, understory vegetation, and topography, which produce a mosaic of micro-habitats of differential value to deer. The harvesting criteria designed for this study recognizes these and seeks to maintain what are regarded as the important micro-habitats for deer.
4 STUDY AREA

The study will be conducted on an area of old growth Douglas-fir approximately 15 km southeast of Williams Lake that constitutes part of the Knife Creek mule deer winter range (Fig. 1). A natural gas and oil pipeline right-of-way divides the area into east and west sections with the most important part of the winter range lying to the west of the pipelines. The study area (760-870 m A.S.L.) has a general southwest aspect with slopes ranging from 2-140°. Figure 2 shows the locations of the four paired experimental and control blocks within the study area. A timber cruise was conducted over the entire area. Figure 3 presents the diameter distribution data for each of the experimental and control blocks, and Figure 4, the forest cover.

5 PHASE I

In the spring of 1983 a 25 ha cutblock was designated for harvest on the winter range (Fig. 2). To meet the study objective, a low-volume selective cut directed largely at micro-habitats least important to deer was planned.

5.1 Harvesting Criteria

Before the harvesting started, research personnel marked trees to be cut, according to the following set of criteria:

1) Because dry-belt fir grows naturally in stands with trees of all ages, where groups of mature trees are frequently surrounded by clumps of dense regeneration and pole-sized stems, groups of merchantable trees were marked for harvest while other entire groups were left intact. This made logging more efficient than if single trees were removed, and it also preserved the integrity of the remaining groups by not diminishing their cover value.

2) Trees large enough to supply cover from snow are less useful to deer if in isolation and hence, trees apart from groups of cover trees were marked for harvest. The number of trees involved in this individual selection, however, was small.
FIGURE 1. Location of the Knife Creek study area.
Figure 2. The experimental and control blocks on the Knife Creek study area.
FIGURE 4. Forest cover map of the Knife Creek study area.
3) No trees were marked for harvest within 20 m of the pipeline right-of-way. This prevented deer from becoming more visible from the road.

4) Slopes with southwest, south, or southeast aspects and ridges receive the heaviest deer use of any habitats on the winter range and are also the poorest tree-growing sites. Therefore, little harvesting was designated for these habitats.

5) Conversely, slopes with northwest, north, or northeast aspects and gully bottoms receive much less deer use, and tend to be the best tree-growing sites. These habitats, therefore, were heavily marked for harvest.

6) Cover along major deer trails is essential to allow the deer mobility within the winter range. However, occasional breaks were allowed along trails if the distance between adequate cover was not great (less than 10-15 m).

7) Although not marked, all merchantable lodgepole pine could be harvested at the contractor's discretion. Pine does not provide the cover and food value that Douglas-fir supplies.

Figure 5 diagrammatically represents how trees were selected for harvest.

In addition to the harvesting, a small area within the experimental block was juvenile spaced by research personnel for demonstration purposes.

5.2 Monitoring

The effect of the harvesting on mule deer habitat use was examined at two levels of detail: To determine if the use of the entire experimental block changed as a result of the harvesting, comparisons were made with the adjacent control area and with the experimental area prior to manipulation. This was done using systematically located track transects (Fig. 6). Fifteen transects, each 100 m in length, were examined on both the experimental and control areas to record track
Before Logging

After Logging

North | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | South

(LEGEND - over)

FIGURE 5. Diagrammatic representation of the application of the marking criteria.
Note: This two-dimensional representation of a forest is presented to illustrate the harvesting criteria. It is not meant to reflect the proportion of trees harvested.
FIGURE 5. (continued)

LEGEND

1. These trees are marginally merchantable and would contribute little volume to the first harvest; hence, they are to be left for the next pass.

2. This slope with a south aspect provides food, cover, and direct solar radiation, making it invaluable to deer. These areas are the poorest tree growing sites. No harvesting is prescribed.

3. Most of the merchantable trees are to be harvested in this gully bottom and north aspect slope. In this area these sites seem to have limited value to deer but are the most productive growing sites. Harvesting these trees will increase insolation on the south slope, giving thermal benefits to deer.

4. Cover is maintained along ridges because they are used as travel corridors and feeding sites.

5. Overstocked thickets should be spaced to promote improved growth of replacements for future harvests and deer use.

6. Isolated trees are probably of limited use to deer in times of deep snow and therefore may be harvested. The greater the distance from clumps of cover, the less value these trees probably have.

7. This young patch of dense regeneration should be spaced to a different level than old thickets to allow for natural mortality.

8. Some larger clumps of cover trees can be reduced in size by harvesting perimeter trees, especially when these trees are suppressing regeneration.

9. Even slight south aspects receive heavy deer use. Mature canopy cover will be maintained on these areas.

10. This slight north aspect is less important to deer and will be harvested.

11. On a heavily used winter range such as Knife Creek, deer make use of flat areas having Douglas-fir cover. The majority of these areas must be protected if the carrying capacity of the winter range is to be maintained.

12. All merchantable pine may be harvested. Pine does not provide the cover and food that Douglas-fir can supply.
FIGURE 6. Layout of track transects and positions of radio-telemetry receiving towers.
data. The track surveys were conducted as described in the working plan for the comprehensive mule deer habitat study¹.

On a more detailed level, the use of specific micro-habitats was examined. These included both the habitats created by the harvesting and the untreated control. Such an examination helped the researchers assess the validity of the marking criteria by visually observing deer and evidence of their presence such as track transects and pellet-groups). Additionally, the harvesting was examined from the standpoint of timber, silviculture, and protection by the Cariboo Region of the Ministry of Forests.

5.3 Results

5.3.1 Mule Deer Response

The response of mule deer to the habitat changes resulting from logging must be examined within the framework of weather conditions on the winter range.

The 1983/84 winter was relatively mild, with less-than-average snowfall. The coldest temperatures were received in December with a mean of -15.4°C (7.8°C lower than the 20-year average). All other months were much warmer than the 20-year average. From November through January the snowfall was slightly less than average, while February and March received snowfalls that were far below average.

The 1982/83 winter was much milder than the 20-year average. Temperatures were much warmer except in November and snowfall was far below average during all of the winter months. One track survey was conducted during this winter prior to the harvest and it indicated no significant difference in deer use between the experimental and control blocks.

A snow depth sampling network was established over the 1983 experimental and control blocks at Knife Creek to determine the effect of canopy on snow accumulation. The habitat types sampled included open (no canopy), mature fir, and dense immature. One hundred sample stakes were randomly located in both the mature fir and open types. In the dense immature, 90 stakes were placed. In each case the stakes were randomly located in groups of 10 in 10 representative sites for each type (nine sites for the dense immature). The survey was conducted only once, in January 1984, as there was only one snowfall substantial enough to warrant measurement.

An analysis of variance conducted on the data indicated a very significant difference in snow depths among the three types ($P < 0.0005$). The mean snow depth in the dense regeneration ($\bar{x} = 14.7$ cm) was twice that of the mature fir ($\bar{x} = 6.9$ cm), while snow in the open areas was considerably deeper than in either of these ($\bar{x} = 33.5$ cm).

During the 1983/84 winter, the track transects could only be monitored twice, once in December and once in January. In December a greater number of tracks were found in the control block (2.7 versus 1.9 tracks per 100 metres per day since snowfall), while in January the logged experimental block received double the use of the control (5.4 versus 2.8 tracks per 100 m of fall). Clearly more data are needed before the response of deer to the habitat manipulation is understood.

Besides counting numbers of tracks during the survey, the researchers made a record of the micro-habitats in which the tracks were found. These types included mature fir, dense immature, openings, and skid trails. In December, although most tracks were found under mature cover in both the experimental and control blocks, skid trails received considerable use (20% of the tracks in the experimental area). The deer clearly were using the skid trails as travel corridors. Mean snow depth at that time in the open was 17.4 cm. In January when snow depths were twice as deep ($\bar{x} = 33.5$ cm), use shifted to micro-habitats offering shallower snow (Table 1).
TABLE 1. Percentage of tracks by micro-habitat on the experimental and control areas during the winter of 1983/84

<table>
<thead>
<tr>
<th>Micro-habitat</th>
<th>December</th>
<th>January</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mature</td>
<td>48</td>
<td>55</td>
</tr>
<tr>
<td>Dense immature</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Open</td>
<td>26</td>
<td>16</td>
</tr>
<tr>
<td>Skid Trail</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>CONTROL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mature</td>
<td>59</td>
<td>78</td>
</tr>
<tr>
<td>Dense immature</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>Open</td>
<td>16</td>
<td>2</td>
</tr>
</tbody>
</table>
The small area that was juvenile spaced to 1100 stems/ha (3 X 3 m) received no deer use in areas where dense immature patches were treated. The slash load, often 75 cm deep, no doubt produced an undesirable barrier to deer. Any future spacing on winter range should require lopping and bucking of spacing slash to a maximum depth of approximately 25 cm.

While the data that was collected to measure effects on habitat use were limited, they suggest that given the type of winter experience in 1983/84, the logging caused the deer no adverse effects. However, it must be stressed that a more conclusive assessment requires examination of deer habitat use during a winter with more snow for longer duration.

5.3.2 Harvesting

A timber cruise of the experimental block revealed that 13% (27 m³/ha) of the merchantable volume of fir was marked for harvest. The small volume of lodgepole pine (7 m³/ha) on the block that the contractor (Single Tree Holdings Ltd.) could take or leave at his discretion, together with the marked fir, amounted to a total harvest of 27 standard logging truck loads from the 25-ha outblock.

Logging costs were much greater than in conventional operations. The figure submitted by the contractor was 18% greater than the Ministry of Forests appraisal of the permit, and 105% greater than an appraisal of a theoretical cut at a typical diameter limit of 37.5 cm for fir.

Skidding and loading were the largest contributors to higher logging costs. A John Deere 440 rubber-tired skidder was used for most skidding, however, an International Harvester 175 crawler was used for some of the larger timber. Skidding was done at a slower pace than in conventional operations to minimize damage to residual stems. Since the tree marking was done prior to the layout of skid trails, considerable time and effort were often involved in getting marked trees to a skid trail without causing substantial damage to standing timber. Additionally, skid trails were long (500 m) because
the existing right-of-way was used as the landing (Fig. 2). With the low skidding production, the Caterpillar 966 loader was operating far below capacity, resulting in high unit production costs.

Agreement was unanimous among government and licensee foresters that an exceptional job was done of logging. Skid trails, for example, were as narrow as 2.4 m (8 ft) compared to 3.7 m (12 ft) or more, typical of dry-belt Douglas-fir logging. An International Harvester 175 equipped with loading forks was used to push skid trails. The forks prevented stems from falling sideways and creating a wider trail. Falling in two passes also contributed to minimizing stand damage. This allowed the faller to put second pass trees into the holes created by the first pass of falling and skidding. The techniques used by the contractor were not new or innovative; however, by working carefully and understanding the objective, the crew achieved excellent results.

5.3.3 Silviculture

In selective logging a prime silvicultural objective is to provide more growing space while not damaging the residual trees. In this study, although stand damage was minimal, the improvement in growing space was less than ideal. Table 2 presents a breakdown of the stand structure before and after logging. Silviculturally, the whole cutblock should have been juvenile spaced and thinned to promote growth. However, doing so would probably have compromised the value of the winter range by increasing sight distances, wind velocity, and snow accumulation while reducing thermal cover.

5.3.4 Protection

Douglas-fir bark beetle is a major source of mortality in dry-belt fir stands. Logging encourages the spread of the beetle if damaged trees and large debris are left on the site or on landings. Because minimum damage was caused to residual trees, and all debris on the landing was burned, the harvesting is not expected to make the
TABLE 2. Diameter distribution of the 1983 experimental block before and after harvesting as determined by timber cruise

<table>
<thead>
<tr>
<th>Diameter breast height (cm)</th>
<th>Before harvesting</th>
<th>Removed</th>
<th>After harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>67</td>
<td>-</td>
<td>67</td>
</tr>
<tr>
<td>25</td>
<td>65</td>
<td>-</td>
<td>65</td>
</tr>
<tr>
<td>30</td>
<td>59</td>
<td>6</td>
<td>53</td>
</tr>
<tr>
<td>35</td>
<td>51</td>
<td>5</td>
<td>47</td>
</tr>
<tr>
<td>40</td>
<td>27</td>
<td>-</td>
<td>27</td>
</tr>
<tr>
<td>45</td>
<td>22</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>50</td>
<td>16</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>55</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>60</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>65</td>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>70</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>75</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>80</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>85</td>
<td>0.5</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>90</td>
<td>0.5</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>95</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>100</td>
<td>0.2</td>
<td>0.2</td>
<td>-</td>
</tr>
</tbody>
</table>
area more susceptible to Douglas-fir bark beetle attack. However, old-growth Douglas-fir stands are always susceptible to beetle attack even if no disturbance takes place. If a problem develops in the future, action may be required such as a trap tree program.

6 PHASE II

A larger area had to be treated in the second phase of the study to examine the harvesting system on an operational scale and conclusively investigate the response of deer. Three cutblocks measuring 35, 27.6, and 14.2 ha were laid out for harvest in the spring of 1984. A control area having comparable forest cover and topography was designated for each of the cutblocks (Fig. 2).

6.1 Harvesting Criteria

Changes incorporated into the second phase of the study deal with improving the economic viability of the actual logging while maintaining the basic system established in the initial phase. Two major changes were made. Because of the inefficiency of the mark-to-out approach it was decided to allow the faller to apply the harvesting criteria and select trees for removal. This approach, known as "fallers' selection", requires that the fallers be fully aware of the desired result and be trained to achieve it. A five-page package complete with figures describing the system was given to each faller (Appendix, Section 7), and the study was discussed with them.

The other change was to allow 20% of the total merchantable volume of Douglas-fir to be removed, including the volume harvested on landings, access roads, and skid trails. This is up from the 13% harvest level of Phase I.
6.2 Monitoring

In addition to the methods described for the initial phase of the study, radio telemetry will be used to evaluate the response of deer to the harvesting. Four telemetry receiving towers plus a mobile unit will be used to gather data on 10 deer equipped with radio telemetry collars.

Monitoring intensity will vary from weekly to hourly locations. At least one session of 24 hours intensive monitoring will be conducted each winter month. These sessions will consist of three- to six-hour monitoring periods within which the animals being followed will be located every hour. The entire 24-hour period will be covered over several consecutive days. This monitoring schedule will provide a thorough assessment of habitat use through the full range of winter weather conditions.
APPENDIX 7. Instructions to fellers to aid in the selection of trees for harvest.

HARVESTING ON THE KNIFE CREEK MULE DEER WINTER RANGE
1984 EXPERIMENT

OBJECTIVE

The objective of the experiment is 1) to design an economically viable forest management system (including timber harvesting) for dry-belt fir located on a critical mule deer winter range; and 2) to test the system's compatibility with maintaining the short- and long-term carrying capacity of the area for deer.

HARVESTING CRITERIA (see Figs. 1 and 2)

1. A maximum of 20% of the merchantable volume of fir may be harvested in each outblock.

2. Trees marked with red paint are to be left (only a small percentage of the trees to be left will be marked for demonstration purposes).

3. All merchantable lodgepole pine may be harvested.

4. Do not harvest trees on ridges or near the edge of slopes.

5. Harvest very lightly on southeast, south, and southwest aspect slopes.

6. Harvest more heavily on north aspect slopes and gully bottoms.

7. Select groups of trees (typically 3-6 trees) for harvesting while leaving other groups intact.

8. Harvest all merchantable size classes in proportion to their occurrence in the stand.

9. Some individual trees isolated from groups of cover trees may be harvested.

10. Maintain tree cover along obvious deer trails.

11. Design skid trails and access roads to minimize visibility into the stand.

12. Skid trails should be as narrow as possible.

13. No logging should occur within 20 m of any road or pipeline right-of-way unless the visibility into the stand from the road or right-of-way is not affected.

14. Damage to residual merchantable stems and regeneration should be minimized.

15. Trees that are badly damaged or show signs of dying should be harvested.
FIGURE 1. Diagrammatic representation of the application of the logging criteria.

Note: This two dimensional representation of a forest is presented to illustrate the application of the marking criteria in various situations. It is not meant to reflect the proportion of trees to be harvested.
LEGEND

1. Some trees in all merchantable diameter classes should be harvested.

2. This slope with a south aspect provides food, cover, and direct solar radiation making it invaluable to deer. These areas are the poorest tree growing sites. No harvesting is prescribed.

3. Most of the merchantable trees will be harvested in this gully bottom and north aspect slope. In this area these sites seem to have limited value to deer but are the most productive growing sites. Harvesting these trees will increase insolation on the south slope giving thermal benefits to deer.

4. Cover is maintained along ridges since they are used as travel corridors and feeding sites.

5. Isolated trees are probably of limited use to deer in times of deep snow and therefore may be harvested. The greater the distance from clumps of cover the less value these trees probably have.

6. Even slight south aspects receive heavy deer use. Mature canopy cover will be maintained on these areas.

7. Harvest groups of trees while leaving other groups untouched.

8. All merchantable pine may be harvested. Pine does not provide the cover and food that Douglas-fir can supply.
After Logging

West

1  2  3  4  5  6

East

FIGURE 2. Diagrammatic representation of the application of the logging criteria on rough terrain.

LEGEND

1. Groups of trees may be harvested on this moderate west aspect slope.

2. Cover is maintained on ridges.

3. & 5. Gully bottoms and depressions may be heavily logged; however, some trees should remain.

4. This ridge is quite wide, and therefore some logging may take place away from the edges of the ridge.

5. This steep rocky slope is reserved from harvesting.
FIGURE 3. Pattern of harvesting.

This figure illustrates the basic approach of harvesting small groups of trees. Although groups of trees can be selected that would make falling and skidding more efficient, the goal is not to produce a strip cut along skid trails.

All sizes of merchantable trees should be cut to reach the harvest level of 20% of the volume.