

**Mule Deer Response to Low-volume
Partial Cutting on Winter Ranges in
Central Interior British Columbia**

**H.M. Armleder, M.J. Waterhouse,
R.J. Dawson, and K.E. Iverson**

1998



Ministry of Forests
Research Program

Mule Deer Response to Low-volume Partial Cutting on Winter Ranges in Central Interior British Columbia

**H.M. Armleder, M.J. Waterhouse,
R.J. Dawson, and K.E. Iverson**



Ministry of Forests
Research Program

Canadian Cataloguing in Publication Data

Main entry under title:

Mule deer response to low-volume partial cutting on
winter ranges in central interior British Columbia

(Research report ; 16)

Includes bibliographical references: p.

ISBN 0-7726-3697-4

1. Mule deer - Effect of habitat modification on -
British Columbia - Cariboo Region 2. Forest management
- British Columbia - Cariboo Region. I. Armleder, H. M.
II. British Columbia. Ministry of Forests. Research Branch.
III. Series: Research report (British Columbia. Ministry of
Forests. Research Branch) ; 16.

QL737.U55M84 1998 639.9'79653'0971175 C98-960288-5

© 1998 Province of British Columbia

Prepared by

Harold M. Armleder
B.C. Ministry of Forests
Research Section
200 - 640 Borland Street
Williams Lake, BC
Canada V2G 4T1

Richard J. Dawson
B.C. Ministry of Forests
Research Section
200 - 640 Borland Street
Williams Lake, BC
Canada V2G 4T1

Michaela J. Waterhouse
B.C. Ministry of Forests
Research Section
200 - 640 Borland Street
Williams Lake, BC
Canada V2G 4T1

Kristi E. Iverson
Box 511
Lac La Hache, BC
Canada V0K 1T0

for

Research Branch
B.C. Ministry of Forests
712 Yates Street, 3rd floor
Victoria, BC V8W 3E7

Copies of this and other Ministry of Forests titles are available from
Crown Publications Inc.

521 Fort Street
Victoria, BC V8W 1E7

ABSTRACT

A specialized low-volume removal (20%) single-tree selection silvicultural system was designed to integrate timber harvesting with the needs of mule deer (*Odocoileus hemionus hemionus*) on interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) winter ranges in central interior British Columbia, Canada (Armleder et al. 1986). The impact of this harvesting was assessed on mule deer during winter by counting mule deer tracks 2—3 days after snowfalls of 6 cm or greater. The assessment was made during the winters of 1984 — 1991 in paired unlogged and partially cut blocks on two winter ranges. To test the effect of snow depth on mule deer use of partially cut logged stands, snow depth for each track assessment date was characterized as shallow (0–25 cm), moderate (26–40 cm), or deep (>40 cm) by measuring snow depth in the open. The mean number of tracks per 50 m per week did not differ significantly between control and logged blocks for either winter range. Increased snow depths did not significantly affect the number of tracks in either partially cut or unharvested areas. This single-tree selection silvicultural system can be used to harvest portions of Douglas-fir winter ranges in central interior British Columbia while maintaining winter habitat requirements of mule deer.

Acknowledgements

We appreciate the help of Stephen Walker, Phil Belliveau, and Rob Thomson for assisting in the collecting of field data. Wendy Bergerud kindly provided statistical advice. Research Branch and the Cariboo Forest Region of the B.C. Ministry of Forests provided financial support for Experimental Project No. 903.

CONTENTS

Abstract iii

Acknowledgements iv

Introduction 1

Study Area 2

Methods 3

Results 5

Discussion 5

References 9

Figures

1. Mean number of tracks, Big Lake 7
2. Mean number of tracks, Knife Creek 7

Introduction

During winter, mule deer use approximately 15%, or 250 000 ha, of the interior Douglas-fir forests within the Cariboo Forest Region of central interior British Columbia (Armleder and Dawson 1992). The area of winter range is several times larger when the entire interior of British Columbia is considered. The forest industry desires the high-value Douglas-fir trees from these ranges; however, common types of logging degrade winter range values. This issue necessitated the development of an economically viable form of low-volume partial cutting based on winter habitat requirements of mule deer to provide managers with another option.

The central interior of British Columbia is the northern range limit of continuous, high-density, mule deer populations (McTaggart-Cowan and Guiguet 1978). Compared to southern ranges, mule deer are stressed due to deep snow and low temperatures even at low elevations. Suitable winter range enables mule deer to minimize the negative energy balance that harsh winters induce (Swift et al. 1980; Torbit et al. 1985) by intercepting snow, providing adequate food (Dawson et al. 1990), and maintaining security cover and a favourable thermal environment (Jones 1975; Kirchhoff and Schoen 1987).

Forest cover plays a major role in decreasing snow depth on the forest floor by intercepting snow (Jones 1975; Kirchhoff and Schoen 1987). Snow interception is maximized in stands with a multi-layered structure and trees with deep spreading crowns, thus reducing the energy that deer expend by moving through snow (Parker et al. 1984). These stands also effectively reduce air movement, minimize radiation to the open sky, and provide visual cover.

Armleder et al. (1986) designed a single-tree selection silvicultural system based on low-volume removal (20%) with long cutting cycles (approximately 40 years) and a recognition of micro-habitat values. Partial cutting of small groups of two to six trees through a range of merchantable diameter classes, with an emphasis on leaving more of the larger, older Douglas-fir trees, is recommended. This system was designed to meet the winter habitat requirements of mule deer by maintaining stands with a multi-aged structure that still retain areas of moderate to high crown closure. Volume removal is lighter

on micro-habitats most important to deer (i.e., warm aspects and ridges). The remaining areas of moderate to high crown closure within the stand should effectively maintain enough area with shallower snow and provide litterfall food from the breakage caused by crown contact (Waterhouse et al. 1991). A review of the system and how it contrasts with typical harvesting of interior Douglas-fir is presented in Armleder and Dawson (1992).

Our objective was to test the hypothesis that deer use is unchanged due to this low-volume partial-cutting system under shallow, moderate, and deep snow conditions.

Study Area

The experiment was conducted on two winter ranges, Knife Creek and Big Lake, in the Cariboo Forest Region of central interior British Columbia. Knife Creek, 15 km southeast of Williams Lake (52° 03' N, 122° 49' W), has predominantly south to west aspects. The variable topography features gently rolling hills interspersed with a few deep gullies, steep slopes, and short ridges. Elevation ranges from 750 to 900 m. Big Lake lies 10 km west-northwest of 100 Mile House (51° 39' N, 121° 28' W) at higher elevations than Knife Creek (975 — 1194 m). Most of the site lies on a gentle northeast slope with little topographical relief; the other part of the site is a steeper, more topographically variable southwest slope.

Both winter ranges are located in the east Fraser Plateau variant of the Interior Douglas-fir biogeoclimatic zone (IDFdk3) (Steen and Coupé 1997). Uneven-aged stands of Douglas-fir are the climax forest type. At both sites, Douglas-fir dominates all canopy layers, while some scattered lodgepole pine (*Pinus contorta*) is also present. The understory of this variant is dominated by pinegrass (*Calamagrostis rubescens*) and mosses, particularly red-stemmed feathermoss (*Pleurozium schreberi*). Twinflower (*Linnaea borealis*) and kinnikinnick (*Arctostaphylos uva-ursi*) are common, while shrubs such as prickly rose (*Rosa acicularis*), soopolallie (*Shepherdia canadensis*), and snowberry (*Symphoricarpos albus*) are scattered.

The climate is relatively dry (annual precipitation is 41 cm), with warm summers and cold winters. The snowpack averages

15 cm at the beginning of December, builds to 27 cm at the end of December, peaks at 39 cm at the end of January, and then declines to 32 cm by the beginning of March. During January, mean minimum temperatures ranges from -14.5 to -18.5°C, as recorded at the Williams Lake Airport. During the study period, winters ranged from milder to colder than average with very shallow to deep snowpacks.

Logging prior to the study was negligible at the Knife Creek blocks, while at Big Lake about 50% of the volume was removed between 1952 and 1965 on the research blocks. Prior to harvest of the study blocks, crown closure was between 55 and 75% at Knife Creek and between 35 and 45% at Big Lake.

Methods

Seven cutblocks were logged using the low-volume selection harvesting system developed for mule deer winter range (Armleder et al. 1986). The three cutblocks at Knife Creek averaged 25.0 ha, while the four cutblocks at Big Lake averaged 16.3 ha. An equal-sized control area with similar topography, aspect, slope, and stand characteristics was left beside each cutblock.

At Knife Creek, the pre-harvest volume was 210 m³/ha, comprised of 207 m³/ha Douglas-fir and 3 m³/ha lodgepole pine. In the spring of 1984, 15% of the Douglas-fir was removed and 90% of the lodgepole pine was removed in each of the three cutblocks, for a total of 16% removal by volume. Post-harvest volume was 176 m³/ha. At Big Lake, pre-harvest volumes for the four cutblocks averaged 94 m³/ha. In the fall of 1985, 20% of the volume was removed, resulting in a mean post-harvest volume of 75 m³/ha.

In each cutblock and control, transect lines were established 100 m apart perpendicular to the slope direction for an approximate total of 1.5 km per block. Each transect was broken into 50-m sampling segments. Two to three days after a snowfall of 6 cm or more, the number of tracks crossing the line was counted in each 50-m interval. If the animal followed the transect line within 1 m on either side, it was counted only once per 50- m segment. Using the number of hours since the snowfall, results were converted to number of tracks per 50-m per week and averaged for the harvested and control

portion of each block.

Snow depth is critical to the choice of habitat for mule deer. Generally, snow depths beyond 21–22 cm were found to initiate the movement of deer to other habitat (Kelsall and Prescott 1971). Parker et al. (1984) suggested that 60% of brisket height (about 40 cm) is a critical sinking depth based on energy expenditure. Snow deeper than 40 cm restricts deer movement and use within an area (Gilbert et al. 1970; Kelsall and Prescott 1971). We used these findings to develop three snow depth classes: shallow(0–25 cm), moderate (26–40 cm), and deep (>40 cm). To assess the effect of partial cutting on mule deer under different snow conditions we placed each track assessment date into a snow depth class based on snow depth measurements at a nearby open site.

At Knife Creek, blocks were assessed a total of 10 times between December and February from 1984 to 1991. Knife Creek was assessed twice at shallow snow levels, three times at moderate snow levels, and five times at deep snow levels. Big Lake blocks were assessed a total of 13 times between December and early March from 1985 to 1990. Seven assessments were made at shallow snow levels, four at moderate snow levels, and two at deep snow levels.

ANALYTICAL METHODS

The data for each site were examined using analyses of variance for a randomized complete-block design with a split-plot in time. The following factors were included in a mixed model: block and assessment were random factors, and treatment and snow depth class were fixed factors. Assessment was nested within snow depth class and treated as a split-plot in time. All other factors were crossed. This design required the use of several different error terms and the use of pseudo-*F*-tests (Hicks 1982) to test for the effects of treatment, snow depth class, and the interaction between them. Power analysis was used to test non-significant treatment effects. Assumptions of normality and homogeneity of variance were examined using plots of the residual errors.

Results

BIG LAKE

The low-volume harvesting did not significantly affect the number of mule deer tracks at Big Lake ($F_{19,9} = 0.29$; $p = 0.99$). However, our power to detect a 30% difference between treatment means at $\alpha = 0.05$ was only 0.20. Figure 1 shows the mean number of tracks per 50 m per week at Big Lake for each snow depth class and treatment. There was no significant ($\alpha = 0.05$) interaction of snow depth class and treatment ($F_{2,10} = 0.18$; $p = 0.84$), indicating that the logging treatments did not have significantly different effects at different snow levels. The mean number of tracks per 50 m per week did not differ significantly ($\alpha = 0.05$) ($F_{2,10} = 3.75$; $p = 0.06$) between snow depth classes, although fewest tracks tended to be found when snow depth was moderate.

KNIFE CREEK

Partial cutting also did not significantly affect the number of mule deer tracks at Knife Creek ($F_{9,4} = 0.98$; $p = 0.55$). However, our power to detect a 30% difference between treatment means at $\alpha = 0.05$ was only 0.07. The interaction between snow depth class and treatment was also non-significant ($\alpha = 0.05$) ($F_{2,7} = 1.37$; $p = 0.31$). Differences in number of tracks at different snow depth classes were highly non-significant ($F_{2,7} = 0.21$; $p = 0.81$) at Knife Creek. Figure 2 shows that the mean number of tracks per 50 m per week was similar in control and logged blocks for shallow and deep snow depth classes.

Discussion

This large, multi-year, replicated study surveyed all suitable snow events on seven cutblocks on two study areas. In spite of this, the patterns of deer use were variable enough to lead to the low power based on a 30% difference in treatment means. Although this result does not allow us to conclusively state that the low-volume harvesting had no impact on deer use, there is little evidence that a difference exists. Deer use did not differ significantly ($\alpha = 0.05$) between low-volume removal cutblocks

and unlogged controls. In contrast, areas harvested by diameter limit (>70% volume removal) were used significantly less than expected on the basis of availability, and the differences became greater as snow levels increased (Armleder et al. 1994). Therefore, while deer habitat use does change when the habitat alterations are great, it does not change with low-volume harvesting.

During winter, mule deer require habitats that provide them with snow interception, litterfall for forage, and thermal and security cover (Jones 1975; Kirchhoff and Schoen 1987). Snow depth is a key factor influencing the habitat selection of deer (Nyberg et al. 1986). If deer are forced to move through snow 50 cm deep, energy expenditure will increase five-fold relative to no snow (Parker et al. 1984). Because the amount of snow reaching the ground in forested areas is largely determined by the structure of the forest canopy and topography, any changes in stand structure resulting from removal of trees will affect snow depth. In central interior British Columbia, Armleder et al. (1994) found that mule deer favoured old Douglas-fir stands and stands with moderate (36–65%) to high (66–100%) crown closure during moderate to deep snow conditions. Low crown closure (0–35%) stands were not favoured (Armleder et al. 1994), probably because they tend to intercept snow poorly (Jones 1975; Kirchhoff and Schoen 1987). Although overall crown closure is reduced by low-volume selection logging, the specialized system designed for mule deer winter ranges involves the removal of small groups of trees, thus leaving interconnected areas of high crown closure on favoured micro-topography within stands (Armleder et al. 1986). This design means that snow levels are virtually unchanged over a substantial portion of the stand and in essential micro-habitats.

Mule deer are known to respond to deeper snow levels by moving out of an area (Gilbert et al. 1970; Kelsall and Prescott 1971). Studies have found that deer move onto southern aspects, steep slopes, windswept ridges, and lower elevations where snow is shallower (Gilbert et al. 1970; Willms et al. 1976; Telfer 1978; Wambolt and McNeal 1987; Armleder et al. 1994). We found that increased snow depths did not result in reduced use of harvested areas, indicating that sites logged with this selection system can provide mule deer habitat even during periods of deep snowpack.

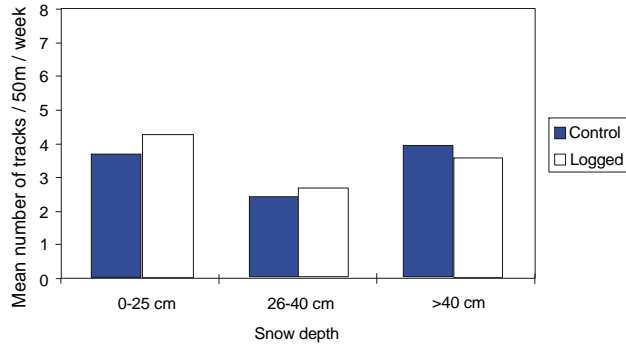


FIGURE 1. Mean number of tracks per 50 m per week on the Big Lake study area at shallow (0–25 cm), moderate (26–40 cm), and deep (>40 cm) snow depths in 1985–1990 (n=24 shallow, n=16 moderate, n=8 deep).

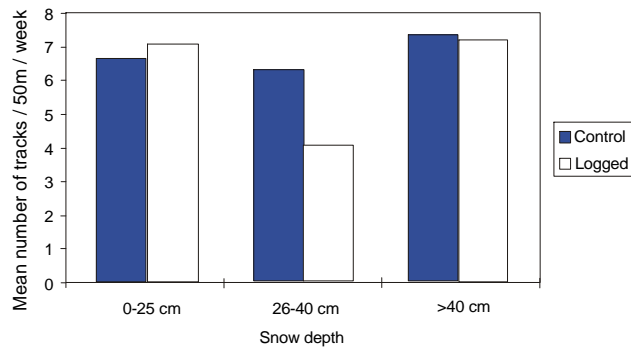


FIGURE 2. Mean number of tracks per 50 m per week on the Knife Creek study area at shallow (0–25 cm), moderate (26–40 cm), and deep (>40 cm) snow depths in 1984–1991 (n=5 shallow, n=8 moderate, n=15 deep).

Older Douglas-fir trees and stands also provide more forage from litterfall of conifer foliage and arboreal lichen (Stevenson 1978; Rochelle 1980; Waterhouse et al. 1991). During the winter in interior Douglas-fir forests of central interior British Columbia, most shrubs are buried by snow, and Douglas-fir foliage is a major source of food (Willms et al. 1976), providing 62–89% of the winter diet (Waterhouse et al. 1993). Mule deer greatly prefer the foliage from large, old Douglas-fir trees (>40 cm dbh) to that of smaller trees, and rapidly consume the arboreal lichen from such litterfall (Dawson et al. 1990). This harvesting system emphasizes the retention of old trees in high crown closure groups, which should provide litterfall and maximum snow interception from the remaining trees. The retention of the multi-layered characteristics of these stands also provides effective security cover and a favourable thermal environment.

Our results suggest that low-volume partial cutting maintains the stand characteristics that mule deer select during winter. However, deer use varies with stands of different age, crown closure, and other stand characteristics (Armleder et al. 1994). We found that deer use at Knife Creek was consistently higher than at Big Lake. This is not surprising, given the higher stand volumes at Knife Creek. Proper winter range management necessitates that any harvesting must be applied within the context of the habitat status of the entire winter range. The integrated management approach of Armleder et al. (1986) recommends specific proportions of high, moderate, and low crown closure habitat over the whole winter range. If low-volume harvesting is used within this context, then the forests on winter range can provide both timber and mule deer habitat.

References

- Armleder, H.M. and R.J. Dawson. 1992. Logging on mule deer winter range: an integrated management approach. *For. Chron.* 68:132–7.
- Armleder, H.M., R.J. Dawson, and R.N. Thomson. 1986. Handbook for timber and mule deer management co-ordination on winter ranges in the Cariboo Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 13.
- Armleder, H.M., M.J. Waterhouse, D.G. Keisker, and R.J. Dawson. 1994. Winter habitat use by mule deer in the central interior of British Columbia. *Can. J. Zool.* 72:1721–5.
- Dawson, R.J., H.M. Armleder, and M.J. Waterhouse. 1990. Preferences of mule deer for Douglas-fir foliage from different sized trees. *J. Wildl. Manage.* 54:378–82.
- Gilbert, P.F., O.C. Wallmo, and R.B. Gill. 1970. Effect of snow depth on mule deer in Middle Park, Colorado. *J. Wildl. Manage.* 34:15–23.
- Hicks, C.R. 1982. Fundamental concepts in the design of experiments. Holt, Rinehart and Winston, New York, N.Y.
- Jones, G.W. 1975. Aspects of the winter ecology of black-tailed deer (*Odocoileus hemionus columbianus* Richardson) on northern Vancouver Island. MSc thesis. Univ. B.C., Vancouver, B.C.
- Kelsall, J.P. and W. Prescott. 1971. Moose and deer behaviour in snow in Fundy National Park, New Brunswick. *Can. Wildl. Serv. Rep. Ser. No. 15.*
- Kirchhoff, M.D. and J.W. Schoen. 1987. Forest cover and snow: implications for deer habitat in south-east Alaska. *J. Wildl. Manage.* 51:28–33.
- McTaggart-Cowan, I. and C.J. Guiguet. 1978. The mammals of British Columbia. 7th printing. Prov. Museum, Victoria, B.C.

- Nyberg, J.B., F.L. Bunnell, D.W. Janz, and R.M. Ellis. 1986. Managing young forests as black-tailed deer winter ranges. B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 37.
- Parker, K.L., C.T. Robbins, and T.A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. *J. Wildl. Manage.* 48:474–88.
- Rochelle, J.A. 1980. Mature forests, litterfall, and patterns of forage quality as factors in the nutrition of black-tailed deer on Vancouver Island. PhD thesis. Univ. B.C., Vancouver, B.C.
- Steen, O.A. and R.A. Coupé. 1997. A field guide to forest site identification and interpretation for the Cariboo Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 39.
- Stevenson, S.K. 1978. Distribution and abundance of arboreal lichens and their use as forage by black-tailed deer. MSc thesis. Univ. B.C., Vancouver, B.C.
- Swift, D.M., J.E. Ellis, and N.T. Hobbs. 1980. Nitrogen and energy requirements of North American cervids in winter—a simulation study. *In Proc. 2nd Internat. Reindeer/Caribou Symp.*, 1979, Roros, Norway. E. Reimer, E. Gaare, and S. Skjenneberg (editors). Direktoratet for vilt og ferskanskfisk, Trondheim, Norway, pp. 244–51.
- Telfer, E.S. 1978. Cervid distribution, browse and snow cover in Alberta. *J. Wildl. Manage.* 42:352–61.
- Torbit, S.C., L.H. Carpenter, D.M. Swift, and A.W. Alldredge. 1985. Differential loss of fat and protein by mule deer during winter. *J. Wildl. Manage.* 49:80–5.
- Wambolt, C.L. and A.F. McNeal. 1987. Selection of winter foraging site by elk and mule deer. *J. Environ. Manage.* 25:285–91.

- Waterhouse, M.J., H.M. Armleder, and R.J. Dawson. 1991. Forage litterfall in Douglas-fir forests in the central interior of British Columbia. B.C. Min. For., Victoria, B.C. Res. Note No. 108.
- _____. 1993. Winter food habits of mule deer in the central interior of British Columbia. B.C. Min. For., Victoria, B.C. Res. Note No. 113.
- Willms, W., A. McLean, and R. Ritcey. 1976. Feeding habits of mule deer on fall, winter and spring ranges near Kamloops, British Columbia. *Can. J. Anim. Sci.* 56:531–42.

