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Early Winter Habitat Use by Mountain Caribou in the North Cariboo and Columbia Mountains, British Columbia.

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Abstract: Winter habitat use was compared between two mountain caribou (*Rangifer tarandus caribou)* populations in British Columbia. Regional differences were apparent during November and December. Radio-collared caribou inhabiting the gentle plateaus of the northern Cariboo Mountains, near Prince George, B.C. primarily used mid-elevation balsam-spruce stands on moderate slopes (<30%). In contrast, radio-collared caribou in the North Columbia Mountains, near Revelstoke, B.C. used low elevation hemlock-cedar stands and relatively steeper slopes (>30%). To adequately address habitat requirements of caribou, forest management plans should incorporate varying regional and seasonal habitat use patterns. Hypotheses on observed differences in habitat use are discussed.

Key words: *Rangifer,* winter habitat, forest management

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Introduction

Woodland caribou (*Rangifer tarandus caribou*) that feed on arboreal lichens in winter have been identified as an old-growth dependent species (Ministry of Environment B.C., 1989). Because arboreal lichens (*Bryoria* spp. and *Alectoria sarmentosa*) are used by caribou as winter forage and are most abundant on mature trees, clear-cut harvesting of mature high-elevation forests has been perceived as incompatible with maintaining winter habitat and caribou populations (Stevenson & Hatler, 1985). The early winter period (Nov-Dec) may be a particularly critical period because of low forage availability. During these months the majority of arboreal lichens accessible to caribou are found on windfallen trees and as litterfall (Simpson & Woods, 1987; Rominger & Oldemeyer, 1989). During early winter, caribou must search for these uncommon lichen sources plus understory vegetation that is not buried by snow. Clear-cut harvesting of mature low-elevation forests that grow on very productive sites may also be incompatible with maintaining winter habitat for caribou because these closed canopy stands provide reduced snow depths and accessible understory vegetation.

In response to forest harvesting conflicts in mountain caribou winter range, radio-telemetry studies have been undertaken to provide forest and wildlife managers with habitat information to help integrate the habitat requirements of caribou into forest management plans. Because forest management strategies should account for regional variation in caribou habitat use patterns, we present data to highlight differences between early winter habitat from two areas with similar biogeoclimatic sequences: (1) North Cariboo Mountains, near Prince George, British Columbia; (2) North Columbia Mountains, near Revelstoke, British Columbia.

Study Area

The Revelstoke core study area is located in the Columbia Mountains (51°N,118°W) and includes the northern portion of the Selkirk Mountains east of the Revelstoke Reservoir and the Monashee Mountains to the west (Fig. 1). Topography is typically rugged with steep sidehills and narrow valleys. Elevations range from 610 m (valley bottom) to 2700 m. Treeline is situated at approximately 1980 m. The lower slopes of the Columbia Mountains are in the wet-cool Interior-Cedar-Hemlock (ICHwk) biogeoclimatic subzone (Ketcheson *et al.*, 1991). These forests form a closed canopy and are dominated by western hemlock (*Tsuga heterophylla*)

and western red cedar (*Thuja placata*). Douglas fir (*Pseudotsuga menziesii*), western white pine (*Pinus monticola*), and white birch (*Betula papyrifera*) are present on drier sites. Dominant shrubs include falsebox (*Paxistima myrsinites*), black huckleberry (*Vaccinium membranaceum*) and western yew (*Taxus brevicola*). On wetter sites where the trees are larger and canopies more open, devil's club (*Oplopanax horridus*) is dominant with minor amounts of douglas maple (*Acer glabrum*), thimbleberry (*Rubus parviflorus*), and red-osier dogwood (*Cornus stolonifera*) (Ketcheson *et al.*, 1991). Mid slopes of the Columbia Mountains are in the very wet cold Engelmann Spruce-Subalpine Fir (ESSFvc) subzone where closed canopy forests are dominated by engelmann spruce (*Picea engelmanni* x *glauca*) and subalpine-fir (*Abies lasiocarpa*). Mountain hemlock (*Tsuga mertensiana*) can also be found in association with subalpine fir on some sites (Coupe *et al.*, 1991). At higher elevations subalpine fir grows in clumps forming an open canopy subalpine parkland.

The core study area east of Prince George is situated at the very north end of the Cariboo Mountains (53°N,121°W) and is characterized by gende rolling plateaus. Elevations range between 750 m and 2000 m with treeline at about 1800 m.

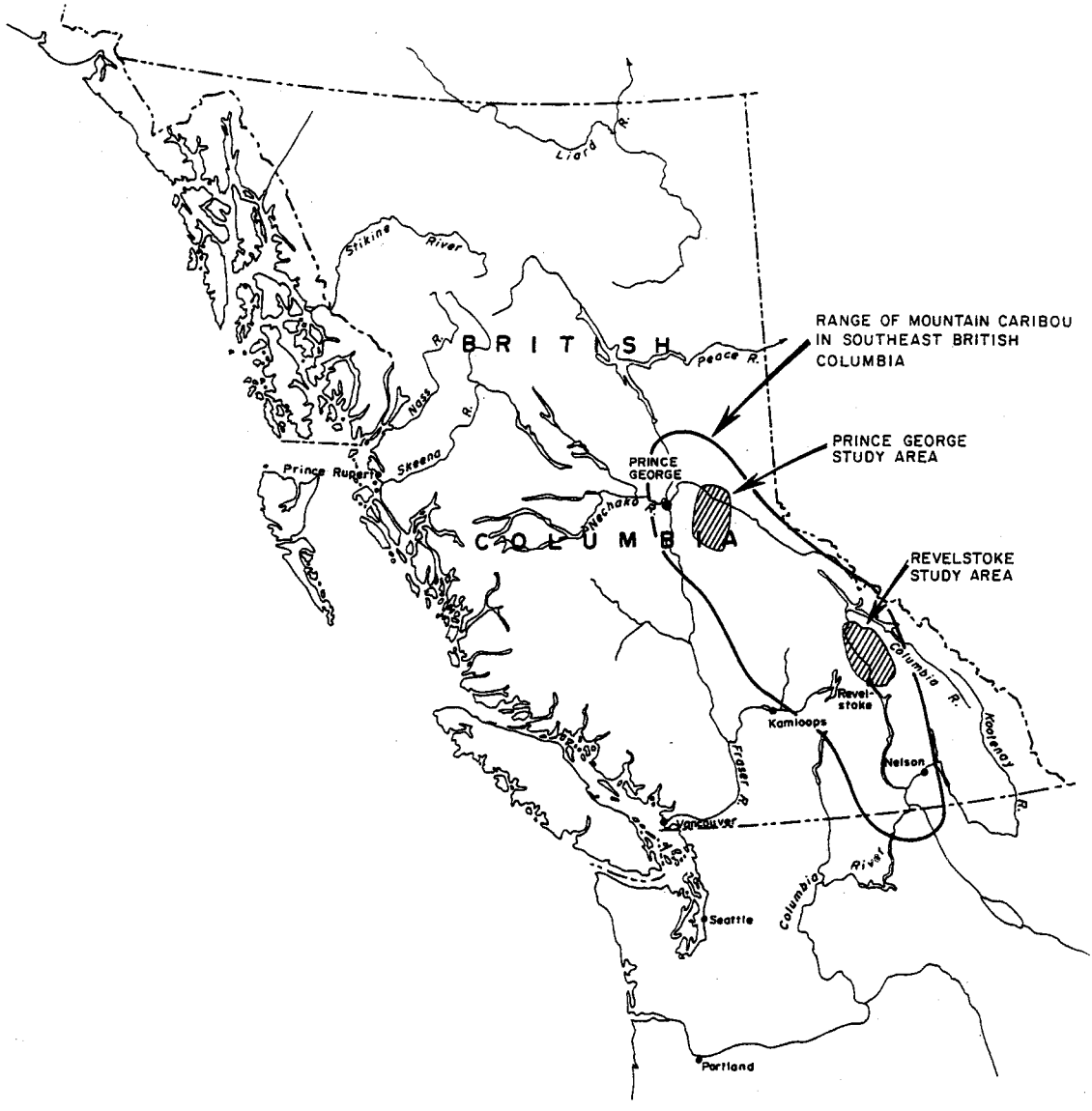


Fig. 1. Location of study areas: North Cariboo Mountains, Prince George; North Columbia Mountains, Revelstoke, British Columbia.

The lower slopes of the Northern Cariboo Mountains are also in the wet-cool variant of the ICHwk subzone. As in the Columbia Mountains, the ICHwk near Prince George is dominated by western hemlock, western red cedar and spruce. Understory shrubs include black huckleberry and devil's club. Mid slopes of the Cariboo Mountains contain closed canopy wet cool Engelmann Spruce-Subalpine Fir (ESSFwk) forests with *Rhododendron albiflorum* and *Vaccinium* spp. common in the shrub layer. Upper slopes are dominated by a wet cold (ESSFwc) subzone where shrubs are less abundant but support a rich herbaceous layer. At higher elevations subalpine fir also grows in clumps forming an open parkland. High elevation snowpack depths average 1 m during Nov-Dec and reach 2-3 meters by late winter (Mar-Apr) in both study areas.

Methods

Cariboo Mountains, Prince George, B.C.

This analysis was confined to portions of the Yellowhead population(s); specifically, Sugarbowl Mountain, Bearpaw ridge, and a section of the North Haggen winter ranges because these had ICH habitats available to caribou. Twenty radio-collared caribou were located approximately once a month from March 1988 to Feb. 1992 using a fixed wing aircraft. In March 1992, 5 additional adult female caribou were collared in the core study area (Sugarbowl-Raven Lake) and located once a week during the early winter period 1992-93. Variables recorded at each radio location included elevation, aspect, slope, and forest cover type using leading tree species.

North Columbia Mountains, Revelstoke, B.C.

Twenty-two collared caribou were located once a week from March 1992 to February 1993 using a fixed wing aircraft. An additional 14 caribou were collared in March 1993 which provided a total of 36 caribou that were monitored weekly for at least one year. Variables recorded at each radio location were similar in both study areas.

Caribou sinking depth (CSD) and a ski pole penetration (PP) (22 kg force) in the snow were measured in both areas. The following regression equation [CSD=5.3 + .76(PP); r^2=.84; $S_{y.x}$=3.4; n=76] was used to predict mean caribou sinking depths in Revelstoke.

Results and discussion

Use of Elevation bands

Caribou were located in significantly different elevation bands in the two study areas (X^2=213.8; df=8; P<.001). During November and December 52% of 403 telemetry locations in the Columbia Mountains

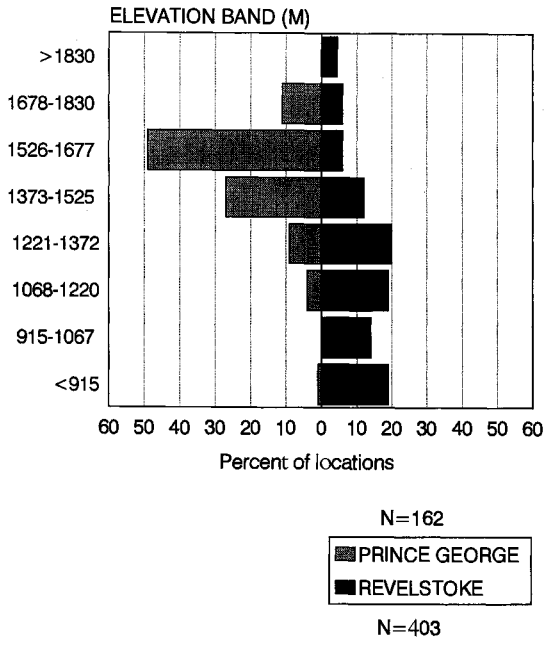


Fig. 2. Percent of caribou locations in each elevation-band during the early winter (Nov-Dec) nearPrince George, and Revelstoke, B.C. Samplesize (N) is number of locations.

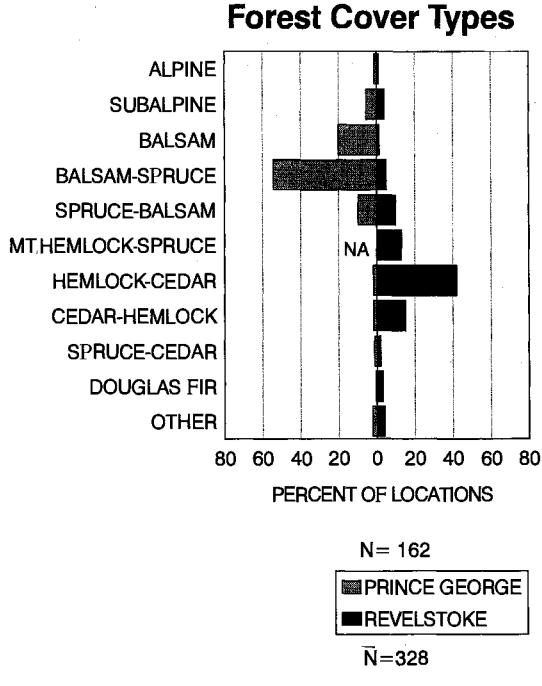


Fig. 3. Percent of caribou locations in each forest cover type during early winter (Nov-Dec) near Prince George, Revelstoke, B.C. (na = not available).

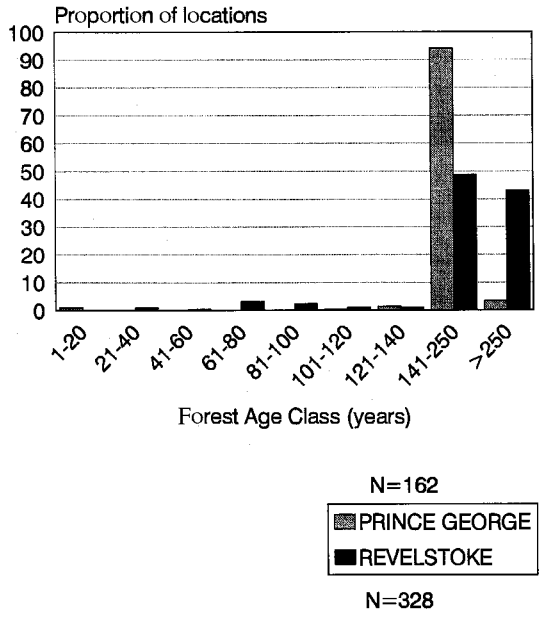


Fig. 4. Percent of caribou locations in each forest age class during the early winter (Nov-Dec) near Prince George, Revelstoke, B.C.

were located below 1220 m. Approximately one-third (32%) between 1221 and 1525 m, and the remaining 15% above 1525 m. In contrast, the majority (49% of 162) of radio-collared caribou in the Cariboo Mountains were located between 1526-1677 m (Fig. 2).

Forest Cover Types

Caribou in the Columbia Mountains used forests with significantly different species composition than those in the Cariboo Mountains (X^2=228.2; *df*=10; *P*<.001). In the Columbia Mountains 67% of the caribou locations were in forests dominated by western hemlock and western red cedar whereas less than 5% of radio-collared caribou in the Cariboo Mountains were in the ICH. Over half (54 % of 162) of the radio-collared caribou near Prince George were located in balsam-spruce stands and another 21% in balsam stands (Fig. 3).

Regional variation in the use of forest cover types partially reflected differences in elevation bands used. Caribou use of forest cover types in the northern Cariboo Mountains were similar to habitat use patterns reported by Seip (1992) in the Quesnel Highlands which has similar topographic and winter conditions. Caribou use of ICH stands near Revelstoke is consistent with more rugged areas of the province where caribou have also been reported to use low elevation ICH habitats extensively (Simpson & Woods, 1987; Servheen & Lyon, 1989; Rominger & Oldemeyer, 1989).

Forest Age

Caribou used forest age classes 8 (140-250 yr) and 9 (>250 yr) almost exclusively in both study areas (Fig. 4). Over 90% of the radio locations in the Cariboo Mountains were in 141-250 year old forests. In the Columbia Mountains 47% of the locations occurred in forests between 141 and 250 yrs and 42% in forest older than 250 years. Caribou used forests younger than 140 years old infrequently in both study areas.

Aspect

Caribou use of aspects varied between years in both study areas (Cariboo Mountains, X^2=15.1, *df*=4, *P*=.004; Columbia Mountains, X^2=11.2, *df*=1, *P*=.001). In the Cariboo Mountains warmer aspects were used to a greater extent in 1990 (79% of locations) and 1992 (62% locations); in the Columbia Mountains 65% of the locations were on warm aspects in 1992 and 45% in 1993 (Fig. 5.1). Caribou also used aspects significantly different (*P*<.001) between early and late winter periods (Fig. 5.2). Although all aspects were used, there was greater use of warmer aspects (S, SW, W, SE) during the early winter (50-79%) compared to late winter where caribou shifted to cooler (N, NE, E, NW) aspects.

Although reasons why this apparent shift occurs remains unclear, warmer aspects may be used to a greater extent in the early winter because they have relatively less snow and may provide accessible understory vegetation compared to northerly aspects. The shift to cooler aspects in the late winter may be related to greater snow depths that provide "lift" to facilitate arboreal lichen foraging.

Slope

Caribou use of slope classes was significantly different between the two study areas (X^2=114.5, *df*=4, *P*<.001). In the Cariboo Mountains, the majority of caribou were located on 16 to 30% slopes (59% of 162), 26% were located on 31-45% slopes, and the remaining 2% on slopes steeper than 45%. In the Columbia Mountains, caribou were more evenly distributed among the slope classes with 30% of the locations between 16 and 30%, 27% between 31 and 45%, and 38% on slopes greater than 45% (Fig. 6).

Caribou use of steeper slopes likely reflects the steeper terrain available in the Columbia Mountains. In the Cariboo Mountains, use-availability analyses indicated significant selection for moderate slopes (16 to 30%) slopes (Terry, 1993). Because slope often dictates operability and the feasibility of ground-based versus cable harvesting systems, ground-based partial cutting

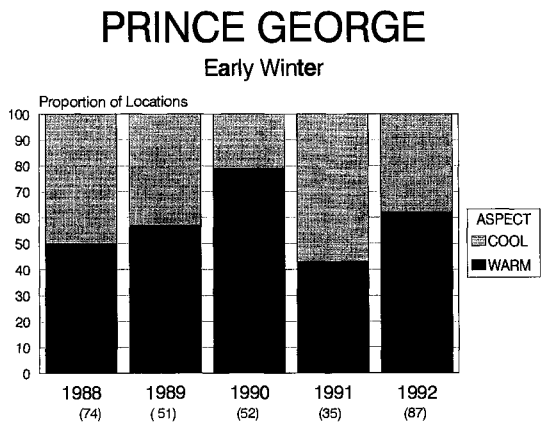
systems may not be an option over large portions of caribou winter range in the Columbia Mountains.

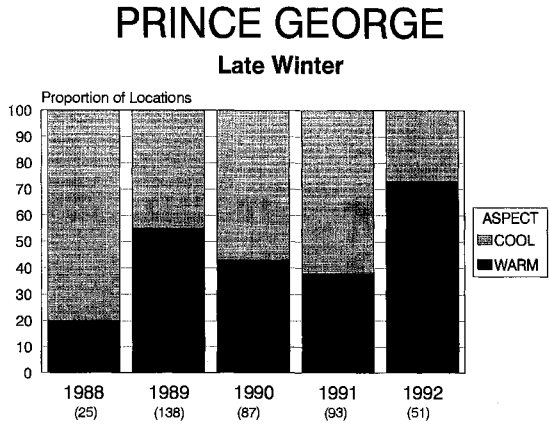
Use-Avoidance of Low Elevation Forests: Suggested Hypotheses

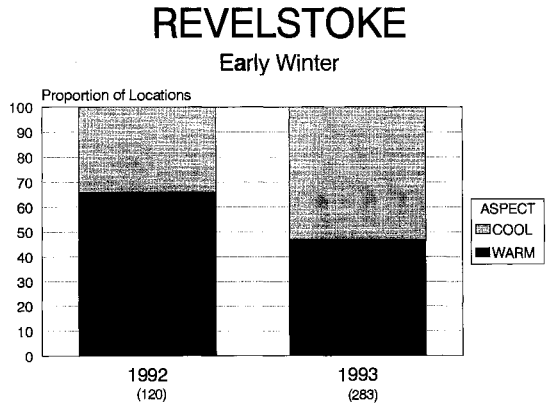
Although few data are available to address *why* caribou in the Columbia Mountains use low elevation forests and those in the Cariboo Mountains appear to avoid them, we suggest three factors that may be involved: (1) snow conditions; (2) food availability; and (3) predation. Because snow characteristics and forage availability are likely interrelated as are snow depth and predator abundance, these variables are not considered mutually exclusive.

Snowpack and Caribou Sinking Depths

It has been suggested that caribou move from high elevation habitats to lower elevations to avoid deep soft snow (Antifeau, 1987; Seip & Stevenson, 1987; Simpson & Woods, 1987). Early winter snowpacks at high elevations in the Cariboo Mountains, however, are quite similar to snowpacks in the Columbia Mountains (Table 1). Average caribou sinking depths in the Cariboo Mountains (43 $\pm$ 6 cm) are also similar to caribou sinking depths in the Columbia Mountains (40 $\pm$ 13 cm, unpubl. data) and suggests additional factors are needed to adequately explain early winter habitat use in these two regions. Although predicted caribou sinking depths were significantly less at 915 m than at 1525 m (Friedman Test, P <.05) during two winters near Revelstoke (Fig.7). and suggests caribou avoid deep snow, we have observed movement to lower elevations occurs before sinking depths at higher elevations become restrictive indicating that snow may not be the primary factor influencing caribou movement to lower elevations in the Columbia Mountains. The dynamic relationship between snow depth and forage availability (both understory vegetation as well as arboreal lichen accessibility) likely interact to produce the observed patterns.







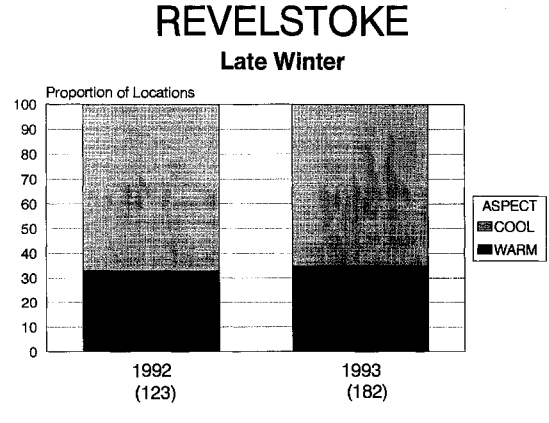


Fig. 5.1. Percent of caribou locations for each aspect class (warm vs cool) during early winter near Prince George, and Revelstoke, B.C. Sample sizes in brackets.

Fig. 5.2. Percent of caribou locations for each aspect class (warm vs cool) during late winter near Prince George, and Revelstoke, B.C. Sample sizes in brackets.

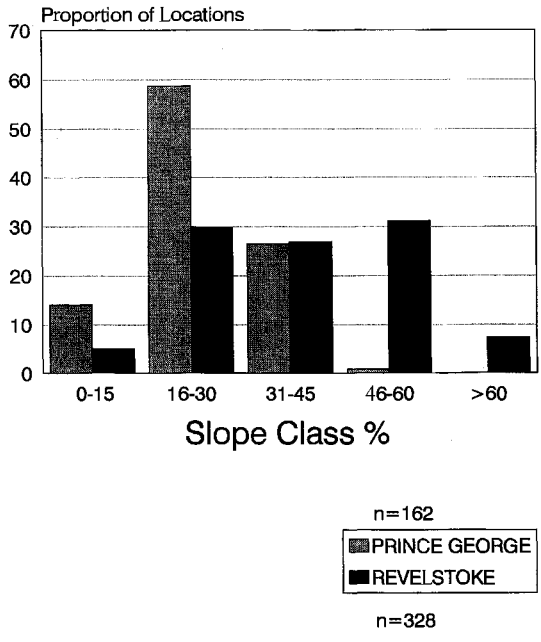


Fig. 6. Percent of caribou locations in each slope class near Prince George and Revelstoke, B.C.

Table 1. Comparison of average snowpack depths and density for Prince George and Revelstoke, British Columbia.

Location	December 30 Snowpack (cm)	Density (%)	March 30* Snowpack (cm)
Prince George	182 (153-240)	27 (19-34)	223 (136-317)
Revelstoke	175 (134-252)	30 (24-35)	307 (210-429)

numbers are averages with range in brackets.
snow course - Prince George: Bearpaw Longworth 1740 m (1989-1993).
snow course - Revelstoke: Mt. Revelstoke 1830 m (1978-1993).
* 30 year normals (1961-90).
Source: B.C. Snow Survey. Ministry of Environment Lands and Parks.

Forage Availability

At lower elevations in the Columbia Mountains, falsebox provides caribou with an accessible food source in addition to the arboreal lichen available as litterfall and on windfallen trees (Simpson & Woods, 1987; McLellan & Flaa, 1992). In the southern Selkirk Mountains, microhistological analysis of feces also revealed falsebox to be a significant forage source during the early winter (Rominger & Oldemeyer, 1990). Because arboreal lichen is low in crude protein (Antifeau, 1987; Robbins, 1987) falsebox may provide caribou with a protein supplement to offset a low protein lichen diet. In contrast, this alternative forage source is not available in the ICH forests in the Cariboo Mountains and may be a factor related to their infrequent use. Although other shrubs such as willows (*Salix* spp.) and *Vaccinium* spp. are available they are sparsely distributed and forage intake in these habitats may be seriously constrained.

Predators

Predator avoidance may influence habitat use patterns and seasonal movements of caribou (Bergerud, 1983; Simpson & Woods, 1987; Seip, 1992). Wolves (*Canis lupus*) are the primary predator of caribou in most areas of B.C. and have been reported as a significant limiting factor for northern caribou (Bergerud & Elliot, 1986; Bergerud & Page, 1987) and some mountain caribou populations (Seip, 1992). Historically, wolves have been rare in the Columbia Mountains reflecting relatively low prey populations of other ungulates including moose (*Alces alces*), deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) and perhaps difficult hunting conditions due to deep snow. If wolf populations have been and continue to be relatively sparse, caribou may be able to use valley bottoms in the Columbia Mountains without a significant risk of becoming prey.

Population status of wolves in the northern Cariboo Mountains is poorly documented, however, pack activity is known to exist (Watts, pers. comm). Although wolf predation in the southern Cariboo Mountains (with similar terrain) has been implicated as a significant limiting factor (Seip, 1992), adult mortality rates of caribou in the northern Caribou Mountains has been relatively low (5-8%). Historic and possibly current wolf predation in the northern Cariboo Mountains may have either ehminated the use of low elevation forests in early winter as a viable strategy or presently represent a high predation risk.

Summary

Estimates of habitat availability will be required to assess habitat selection. The preliminary information presented, however, demonstrates that caribou use different forests and foraging strategies in different parts of British Columbia. Forest management planning and habitat protection guidelines should reflect the importance of low elevation hemlock-cedar stands in the Columbia Mountains whereas mid-elevation balsam-spruce stands should be targeted for protection or special management in the

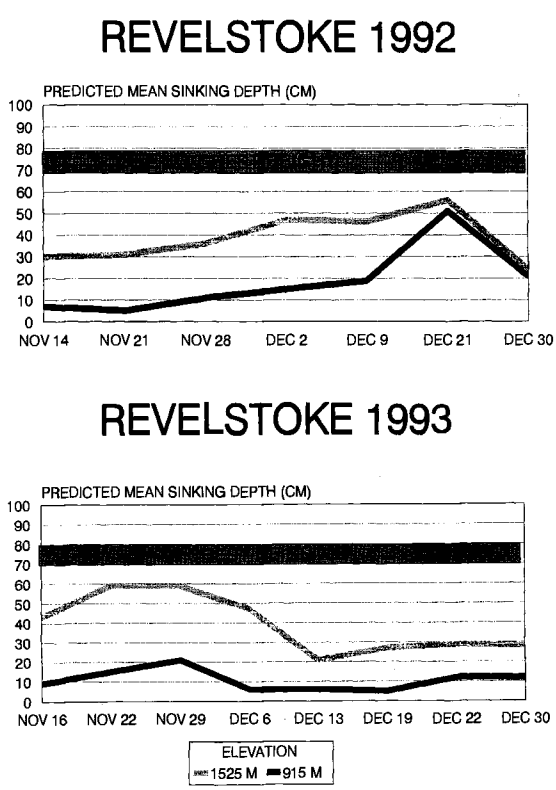


Fig. 7. Predicted mean caribou sinking depth (cm) for each week during the early winter period (Nov-Dec) in Revelstoke, B.C. 1992-93.

Cariboo Mountains. Landscape level planning should include movement corridors linking high and low elevation habitats in both areas.

The extent to which silvicultural systems such as partial cutting can be used to manage for both timber and caribou will also differ between regions. The steeper slopes of the Columbia Mountains may reduce the amount of area suitable for partial cutting. Managing for snow interception and understory production of shrubs such as falsebox will be relatively more important in the Columbia than Cariboo Mountains.

Acknowledgements

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