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Using Alternative Silvicultural Systems to Integrate Mountain Caribou and Timber Management in British Columbia

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Abstract: Even-aged forest management using the clearcutting silvicultural system as it is currently applied threatens mountain caribou habitat in British Columbia. Since neither complete preservation nor maximum development of timber resources are socially acceptable alternatives, forest managers are anxious to find integrated management options. We describe alternative silvicultural systems currently being tested, including single-tree and group selection. All the treatments have the goal of periodically extracting viable timber volumes while perpetually retaining stand characteristics necessary for caribou. The effects of these logging prescriptions on lichen biomass and growth rates are being tested. Alternative silvicultural systems may become part of a larger strategy to maintain caribou habitat in managed forests.

Key words: *Rangifer*, logging, forest management, arboreal lichens

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Introduction

Why do we need to consider alternative silvicultural systems to integrate mountain caribou (*Rangifer tarandas caribou*) and timber management? What is wrong with the status quo? A brief review of mountain caribou habitat requirements in British Columbia will help explain why the current application of the clearcutting silvicultural system is threatening mountain caribou habitat, and why alternatives are necessary.

Mountain caribou occur at low densities and range over large areas of east-central and southeastern British Columbia. Throughout the winter caribou use old forests and avoid immature stands (Simpson *et al.,* 1985; Seip, 1992). In early winter, as snow is accumulating to depths of 3 metres or more in the upper Engelmann spruce-subalpine fir zone (ESSF), caribou use the lower parts of the ESSF and the interior cedar-hemlock (ICH) zone, where the snow is not as deep. Most stands used by caribou in early winter are commercially valuable. Shrubs supplement hchen forage until snow burial makes them unavailable. As snow densities increase to levels that will support caribou, the animals move up in elevation and feed almost exclusively on arboreal lichens for the rest of the winter. In the late winter there is less conflict with forest management since more of the stands used by caribou at that time are non-merchantable.

Several types of silvicultural systems, or cycles of activities by which a stand is harvested, regenerated, and tended over time, are used in British Columbia. Nearly all ESSF and ICH forests are currently managed with only the clearcutting silvicultural system. Logging with that system removes the entire arboreal lichen food source, which is problematic because lichens are slow to disperse and slow to grow, even when a suitable substrate and microclimate exist. To attain a biomass useful to caribou, lichens take much longer than the 100 to 120 year rotation length normally used with the clearcutting system. Entire drainages could be virtually devoid of useful lichen bearing habitat after a number of logging passes and with normal rotation lengths.

Although space is thought to be the single most important habitat variable affecting caribou (Bergerud, 1980; Bergerud *et al.,* 1984), that space must contain suitable habitat providing the attributes specifically necessary in each season. In winter, that means having forests with available arboreal lichen forage. While caribou will travel across recent clearcuts, an area devoid of arboreal lichen food resources is not suitable winter habitat. Fragmentation of suitable habitat (space) by timber

Table 1. Mountain caribou partial cutting trials in the ESSF (adapted from Stevenson *et al.* 1994).

Study area	Stand age	Subzone	Forest District	Prescription	Planned volume removal	Actual volume removal[1]	Study components[2]	Year and season of treatment	Cooperators[3]; contact persons
George Cr. CP 32	200-300 yr	ESSFwk1	Prince George	overstory removal: - 35 cm diameter limit - feller-buncher - WCB variance to retain safe snags	45%	52%	AP,LA,W	winter 1989/90	WHC, SSWG,PGW, PGFD (S. Stevenson)
George Cr. CP 37	200-300 yr	ESSFwk1	Prince George	overstory removal: - 35 cm diameter limit - feller-buncher - WCB variance to retain safe snags	not available	52%	AP,W	winter 1990/91	WHC,SSWG, Rustad, PGFD (S. Stevenson)
Pinkerton	140-250 yr	ESSFwk1	Prince George	single tree selection: - Q=1.3 overstory removal: - 55 cm diameter limit partly feller-buncher, partly hand-felled	32%	AP,LA,LG,R,W		fall 1991 (to be completed summer 1994)	HCF, SSWG, Northwood, PGFD (S. Stevenson)
Lucille	200-300 yr	ESSFmm	Robson Valley	several prescriptions, all hand-felled: - single tree selection (STS) - irregular shelterwood - group selection sanitation cut	 50% 50% 50%	 44% 49% 69%	AP,LA,LG, CM,R	winter 1991/92	WHC, SSWG, RVFD, Mica (S. Stevenson, M. Jull)
Research Cr. CP 113-1	180-300 yr	ESSFwk1	Horsefly	group selection - 10 m diameter openings - 20 m diameter openings (.03 ha) - feller buncher - safe snags retained	30%	28%	LA,LG,CM,R	winter Dec-Jan 1990/91	CFR, HFD, SSWG, WELD (H. Armleder)

Study area	Stand age	Subzone	Forest District	Prescription	Planned volume removal	Actual volume removal[1]	Study components[2]	Year and season of treatment	Cooperators[3]; contact persons
Blackbear Cr TSL A43738	150-250 yr	ESSFwk1	Horsefly	group selection - .03,.13,1.0 ha openings - feller buncher - safe snags retained	30%	30%	LA,LG, DSS,R	summer Aug 1992	CFR, HFD,SSWG, WELD (H. Armleder)
Blackbear Cr. TSL A43738	150-250 yr	ESSFwk1	Horsefly - feller buncher	group selection - .03,.13,1.0 ha openings - feller buncher - safe snags retained	30%	30% DSS	LA,LG,R, V,CM, 1992	winter Nov-Dec WELD	CFR, HFD,SSWG, (H. Armleder)
Grain Cr. TSL A43737 BLK 1	180-300 yr	ESSFwk1	Horsefly	group selection - .03,.13,1.0 ha openings - feller buncher - safe snags retained	30%	30%	LA,LG ,R,V	winter Nov-Dec 1992	CFR, HFD,SSWG, WELD (H. Armleder)
Grain Cr. TSL A43737 BLK 1	180-300 yr	ESSFwk1	Horsefly	group selection - .03,.13,1.0 ha openings - feller buncher - safe snags retained	30%	30%	LA,LG,R, V,DSS	winter Dec-Jan 1992-93	CFR, HFD,SSWG, WELD (H. Armleder)

[1] Although volume removal >30% occurred in some management trials, this is not recommended for caribou habitat management.

[2] AP = air photo dot grid; LA = lichen abundance; LG = lichen growth rates; CM = canopy microclimate; V = detailed vegetation monitoring; R = regeneration; W = winter habitat measures/trailing; DSS = detailed snow survey (tentative).

[3] CFR = Cariboo Forest Region; HCF = Habitat Conservation Fund; HFD = Horsefly Forest District; Mica = Mica Wildlife Compensation Program; Northwood = Northwood Pulp & Timber Ltd.; PGFD = Prince George Forest District; PGW = Prince George Wood Preserving Ltd.; Rustad = Rustad Bros. & Co. Ltd.; RVFD = Robson Valley Forest District; SSWG = Silvicultural Systems Working Group; WELD = Weldwood of Canada Ltd.; WHC = Wildlife Habitat Canada.

harvesting may lead to higher levels of predation by introducing conditions that favour predators and by concentrating caribou into smaller areas.

The most promising stand level option that permits harvesting while potentially maintaining caribou habitat is the selection silvicultural system. The objective in using that system for caribou management is to retain, in perpetuity, a managed stand in a condition suitable for continued caribou use.

In this paper we review several major research initiatives that are exploring those alternative silvicultural systems and we describe how they might fit into a management strategy for caribou. Although research on alternative silvicultural systems in caribou habitat is ongoing in both the ESSF and ICH zones, we restrict our discussion to the ESSF zone.

Selection Silvicultural Systems

Selection systems designed to maintain mountain caribou habitat are being field tested in various study areas in British Columbia (Table 1). Both the single-tree and the group selection systems are being tested to explore the widest range of options for forest managers (Fig. 1). The single-tree selection system involves the removal of individual trees from the stand, and offers the flexibility of leaving trees with high lichen loads. The group selection system involves the removal of groups of trees, allowing more efficient logging and leaving much of the stand untouched until the next cutting cycle. Each system has its advantages (Table 2).

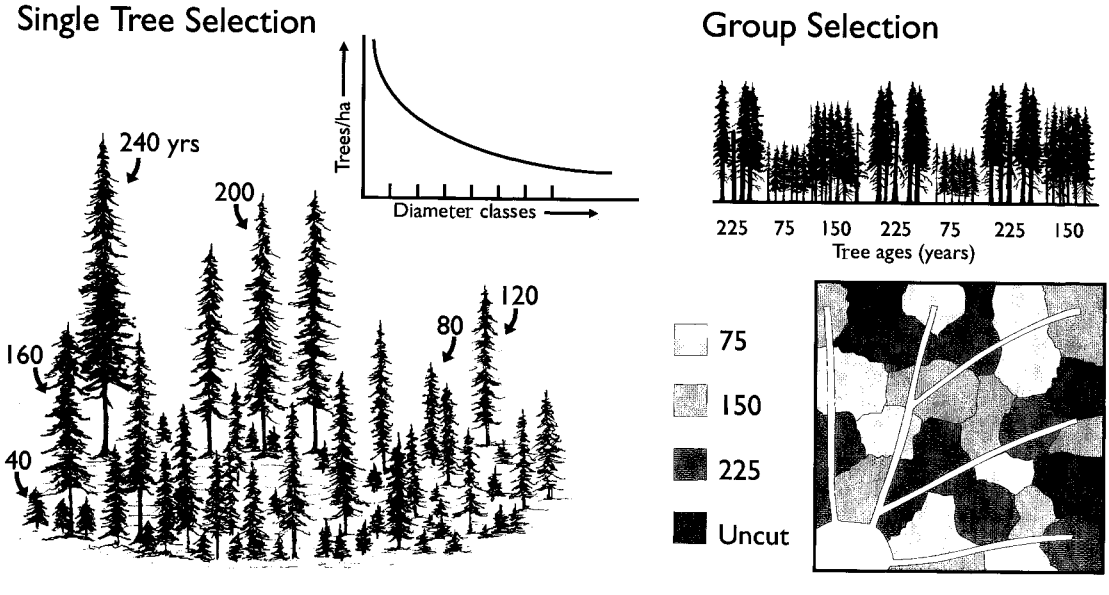
The selection systems being tested are intended to address the caribou habitat concern. For example, the timber volume removed is typically light so a significant proportion of trees remain for caribou and to ensure that the stand remains windfirm. Prescriptions are designed so that lichen-bearing trees are left in the stand.

The distribution of arboreal lichen biomass within a stand is highly variable. For example, surveys done on the trials in the Horsefly Forest District (Table 1) revealed that within species, larger trees (>30 cm dbh= diameter at breast height i.e. 1.3 m) have significantly (α=0.05) more arboreal lichen than smaller trees (10-30 cm dbh). Thus, harvesting just the largest trees is clearly not the best strategy for maintaining caribou habitat, and our prescriptions emphasize maintaining the tree size profile while harvesting timber.

Standing dead trees are common in these high elevation forests and often comprise 20% or more of the stems. Our surveys indicate that dead trees account for 12 to 35% of stand lichen biomass. In normal logging operations all dead trees must be felled concurrently with harvesting to protect worker safety. On some of our trials we obtained a variance from the Workers' Compensation Board of British Columbia (WCB) to retain safe dead trees by using fellerbunchers and grapple skidders, which enclose and protect the operators.

A variety of post-harvest silvicultural treatments are being tested to ensure that future trees will

Fig. 1. Examples of silvicultural systems suited to maintaining the stand characteristics required by caribou (Stevenson *et al.*, 1994).



replace those removed through harvesting and those lost to natural mortality. Both natural and artificial regeneration using various planting stocks, tree species, and site preparation options are being tested.

Methods of Testing Alternative Silvicultural Systems for Caribou

It is important to quantify the impact of timber extraction on lichen abundance. For the studies reported here, the photo reference manual of Armleder *et al.,* (1992) is used to estimate the abundance of arboreal lichen before and after logging. Growth rates of arboreal lichens are also being measured, since growth could be affected by changes to the stand microclimate caused by timber harvesting. To measure growth, lichen samples are placed in enclosures that allow ambient levels of temperature, humidity, and light while preventing contamination of the samples by wind-borne debris or losses through fragmentation. At intervals, the samples are brought into a laboratory and weighed in a humidity-controlled environment (Walker, 1996; Stevenson, 1993).

Direct use of the partially cut stands by caribou is difficult to quantify, because these animals live at low densities in remote areas. On some study areas, radio-collared caribou are available to provide some habitat use data, although probably not enough to allow quantitative assessments of treatment effects. Snow measurements are being taken on some of the trials to assess the hydrological impact of the timber harvesting prescriptions, and to gain insights on the possible impact of timber harvesting on the energy costs of locomotion for caribou through these habitats. Perhaps the most promising assessments of whether logged stands are still suitable caribou habitat will develop from trailing of caribou in managed and unmanaged stands, as in the studies described by Terry *et al.*, (1994).

Results

Although studies of selection harvesting in caribou habitat are still in progress, some useful insights have already been gained. The major factors contributing to loss of lichens due to harvesting are the removal of merchantable trees, the removal of snags, and loss of lichens from residual trees. In the group selection block at Research Creek (CP113), the proportion of lichens lost on felled trees was equal to the 30% of the area that was harvested. At George Creek (CP32), the proportion of lichens on felled trees (55%) was roughly equal to the 52% of the timber volume that was harvested. In both of those study areas, safe snags were retained during harvest. At Lucille Mountain, 43% of the lichens originally present was on living trees that were harvested, and an additional 27% was on snags that were felled during harvesting. That loss of lichens greatly exceeded the average of 45% of the timber volume harvested in the treatment units studied.

Some lichens are also lost from the trees that remain after selection harvesting, either from damage during logging or from increased exposure after logging. Those losses are greater in single tree selection cuts than in group selection cuts, and are greater on exposed sites than on sheltered sites.

Table 2. Comparison of advantages of single tree and group selection systems for mountain caribou habitat (Stevenson *et al.,* 1994).

Potential Advantages of Single Tree Selection	Potential Advantages of Group Selection
- more flexibility in selecting trees to harvest, therefore high lichen-bearing trees can be retained. - more flexibility in developing multi-layered stand structure on a micro level rather than producing series of even-aged clumps as with group selection - impact of logging homogeneously distributed throughout the stand - dispersed regeneration less likely to deter caribou use than even-aged clumps of regeneration - entire stand is structurally suitable for caribou use at any one time	- less damage to residual stems and less associated loss of lichens - snag retention a possibility with use of feller-buncher - logging costs lower than single tree selection - more options for post-harvesting silviculture available - influence of residual stand on regeneration can be varied through opening size selection - leaves much of the stand with no disturbance since logging only occurs in openings - typically smaller percent of cutblock in skid trails - risk of windthrow may be lower - better snow interception areas within stand

Residual trees assessed the summer after logging supported 26% less lichen than before logging at George Creek (CP 32), 8% less at Lucille Mountain, and about the same amount as before logging at Research Creek. Lichen abundance at George Creek has not been reassessed since 1990, but appears to be much lower than before harvesting.

Prehminary results of growth rate studies suggest that where selection harvesting results in drier, more exposed conditions, the two principal genera of forage lichens respond differently. Over time those differences could result in a shift from *Alectoria sarmentosa* to *Bryoria* spp. on some sites. In view of the observations of Rominger & Robbins (1994) that caribou prefer *Bryoria* spp. to *Alectoria sarmentosa*, such a shift might be beneficial. The impact of selection harvesting on overall lichen abundance over time is not yet clear.

Caribou or signs of caribou use have been observed in most of the selection blocks since harvesting was completed. During trailing studies, Terry & McLellan (1991) noted limited use of the George Creek (CP 32) block. The caribou appeared to concentrate their foraging activities along the edges of the block where lichen was available on windthrown trees.

At one single tree selection block (George Creek CP 32) heavy blowdown has occurred, leaving a stand that is unacceptable in terms of both caribou habitat and timber management objectives. Very little blowdown has occurred at Lucille Mountain or at the group selection blocks in the Horsefly Forest District. Blowdown at the other George Creek block (CP 37) and at Pinkerton Mountain has not been assessed, although some has been noted along landing edges and roadsides.

Discussion

We anticipate that, within the next 5 to 10 years, significantly more information will be available on the short-term impact of selection harvesting on the abundance and growth rates of the two principal genera of forage lichens for mountain caribou. There will also be more information on various forestry-related measures, such as logging costs, windfirmness, and short-term regeneration success, and further understanding of the use of selection blocks by caribou is likely. However, a thorough study of use by caribou would require a much larger area managed under selection systems, and an intensive monitoring program.

Some key questions cannot be answered in the near future. The long-term changes in stand structure that follow selection harvesting are likely to affect the abundance and species composition of arboreal lichens, use by caribou, and timber values. Long-term monitoring is needed to assess the effectiveness of the various possible selection prescriptions in maintaining both caribou and timber values.

Short-term results have indicated that high removal of timber volume, especially on exposed sites, can result in blowdown and in heavy losses of lichens from the remaining trees. For those reasons, no more than 30% removal of timber volume (including that removed from skid trails) is recommended in blocks managed as caribou habitat (Stevenson *et al.*, 1994).

Selection silvicultural systems are more costly to plan and implement than is the clearcutting silvicultural system, especially while initial experience is being gained. However, increased use of alternative silvicultural systems in some forest types is necessary to meet the changing demands of the public for integrated resource management, and is required by the proposed Forest Practices Code for British Columbia (B.C. Ministry of Forests, 1993).

Ongoing research on selection silvicultural systems in caribou habitat primarily addresses management at the stand level. However, implications for management at the landscape level must also be considered. The effectiveness of selection silvicultural systems in maintaining caribou habitat is uncertain and will continue to be uncertain for some time in the future. Furthermore, the impacts of forestry activities on predator/prey relationships and the effects of increased access on caribou are incompletely understood. We believe that those uncertainties can best be addressed through zoning of the landscape.

Some core caribou ranges should be set aside as no-harvest, no-access zones, to function as refugia in the event that integrated management strategies are unsuccessful in meeting the needs of caribou. In some areas, that need can be met largely in high-elevation areas where timber values are relatively low, although some low-elevation ranges and movement corridors will also be required. Where caribou use low elevations more extensively, larger no-harvest zones at low elevations will be needed.

Other parts of caribou range should be designated as special management zones, in which experimentation with selection silvicultural systems can continue. In some cases, clearcutting may be used within the special management zone, where selection harvesting is not feasible or where lichen biomass is not great enough that partial cutting is warranted. However, clearcutting must not compromise overall landscape-level habitat objectives in the special management zone. Access management to protect caribou is important in the special management zone.

Marginal caribou ranges may be managed according to ordinary policies of integrated management. However, studies by Seip (1990, 1992) suggest that to minimize the risk of increasing predation on caribou, managers should avoid enhancing habitat for moose in areas adjacent to caribou habitat.

The effectiveness of alternative silvicultural systems in maintaining caribou habitat is incompletely understood. However, those systems have the potential of becoming part of an overall strategy for successfully managing mountain caribou in British Columbia.

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