# A Comparison of Mountain Caribou Winter Habitat Characteristics and Partial-Cut Blocks in the Southern Selkirk Mountains

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## 1.0 Introduction

This report compares winter habitat characteristics of mountain caribou foraging areas to characteristics of selectively logged cut-blocks (i.e., partial-cuts) located in the southern Selkirk Mountains. Habitat characteristics of caribou foraging areas are described using data from two caribou herds including the Revelstoke Herd in the north Columbia Mountains, and the Yellowhead Herd east of Prince George situated in the north Cariboo Mountains. Experimental partial-cut blocks near Salmo, B.C. were used to determine how well habitat attributes in selectively logged stands (managed stands) maintain winter habitat characteristics identified in these two study areas.

## 2.0 Study Areas

### Revelstoke

The core study area is located in the north 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. Topography is steep where elevations range from 610 m to 2700 m. The lower slopes are represented by the wet cool and very wet cool Interior-Cedar-Hemlock (ICHwk, ICHvk) biogeoclimatic subzones. Mid and upper slopes (1350-1800 m) are represented by the very wet cold Engelmann Spruce-Subalpine Fir (ESSFvc) subzone.

### Prince George

Within the Yellowhead population, the caribou trailing study area was confined to the Sugarbowl herd east of Prince George (53°N, 121°W). Moderate slopes and gentle plateaus characterize the topography. Elevations of caribou foraging areas were between 1372-1677 m and represent mid to upper slopes of the wet cool Engelmann Spruce-Subalpine Fir (ESSFwk1) biogeoclimatic subzone. Subalpine parkland habitats occur above 1677 m.

### Salmo Partial-Cuts

The experimental partial-cuts were located in the wet-cold Engelmann Spruce-Subalpine fir (ESSFwc) subzone in the southern Selkirk Mountains. Elevations of the partial-cut blocks ranged from 1525-1830 m.

## 3.0 Methods

Caribou data from Revelstoke was collected between November 1992 and February 1996. Although much of the caribou data collected in the Columbia Mountain study area has included caribou use in ICH forests, this analysis used only data collected in the Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zone. In Revelstoke, the majority of caribou sites ($n$ = 11) occurred in mid to upper ESSF forests, four caribou sites were sampled between 1380-1500 m elevation (lower ESSF), and four sites were visited at higher elevation subalpine parkland habitats (1950-2073 m ).

Seven partial-cut blocks near Salmo, B.C. were sampled (1525-1830 m) between 24-25 February 1998 . In Prince George, forty-seven caribou foraging areas were sampled primarily during the early winter (Nov-Jan) between 1990-93 at elevations ranging from 1372-1677 m.

Because the partial-cuts were situated in mid/upper ESSF sites, only data from mid to upper ESSF caribou use sites were used for comparison. However, tree density estimates were stratified into elevation classes and summarized for each study area location to represent lower ESSF forests, mid to upper ESSF forests and subalpine parkland habitats.

Six variables were used to compare habitat characteristics of caribou foraging areas and the partial-cuts including:

(i) tree species composition
(ii) DBH (cm)
(iii) tree class (i.e., live vs snags)
(iv) lichen abundance (number of 10 g clumps) within reach of caribou
(v) lichen genera composition (% *Bryoria* spp. /*Alectoria sarmentosa*)
(vi) tree density (stems/ha)

Total tree density was measured using 0.01 ha fixed area plots (5.64m radius). Three subsamples were completed at each caribou foraging area and three to nine fixed area plots in the partial-cuts (depending on size of block). For a more detailed description of the caribou trailing methodology, see McLellan and Flaa (1993) or Terry (1994).

To compare lichen abundance between partial-cut blocks and caribou foraging areas, we used only those caribou foraging areas that had somewhat similar snowdepths as the days when the partial cuts were sampled (~ 200 cm) near Salmo. In Revelstoke, 7 of 19 caribou foraging areas had snowdepths between 151-227 cm and were used for comparison. In Prince George, 16 caribou foraging areas had snow depths between 150-250 cm). Tree classes (1-9) were grouped into 4 classes for analysis including live stems (Class 1 and 2 trees); 'new snag' (class 3 tight-bark snags); 'old snag' (class 4-8; loose bark and no bark snags) and windthrow (class 9).

Contingency tables (log-likelihood $G$-test) were used to compare habitat characteristics between caribou foraging areas and the partial-cuts. The number of trees used in each contingency table was about 200 for Revelstoke and the partial cuts and 450 trees in Prince George. Fixed area plots (subsamples) were combined to provide one independent observation for each foraging area and each partial-cut and then compared using two-sample (independent) $t$-tests. Tree density was log transformed to stabilize the variance prior to analysis. All statistical tests were considered significant at $P < 0.05$ and completed using SYSTAT 6.0 Windows (SPSS Inc.1996).

## 4.0 Results

### Total Tree Density (stems/ha)

Total mean tree density of the partial-cut blocks was significantly less than caribou foraging areas found at mid to upper ESSF forests in Revelstoke ($P = 0.02$) and Prince George ($P = < 0.001$) (Table 1). The average tree density of the partial-cuts (292 sph) was about 50% less than caribou foraging areas in Revelstoke and 60% less than caribou foraging areas near Prince George (Table 1). An examination of the 95% confidence intervals around tree densities of caribou foraging areas further indicated partial cut block tree densities fell outside those that typically occur at mid/upper slope caribou foraging areas in Revelstoke and Prince George. However, the average partial-cut block tree density did fall within the variation found at late winter caribou foraging areas that typically occur in higher elevation parkland habitats. The high variance associated with the parkland tree density estimates reflect the mosaic of open areas and clumping of subalpine fir trees and suggests a larger plot may be more appropriate in these habitat types.

**Table 1. Average tree densities (stems per ha) at mountain caribou foraging areas (ESSF) and experimental partial-cut blocks in Salmo, B.C.**

| Location | ESSF Slope Position | Elevation Range (m) | Live (sph) | Snag (sph) | Total (sph) |
|---|---|---|---|---|---|
| Partial-Cuts ($n$ =7) | Mid/Upper | 1525-1830 | 252 ± 115 | 57 ± 64 | 292 ± 116 (185-399) |
| Revelstoke ($n$ = 11) | Mid/Upper | 1500-1950 | 483 ± 204 | 102 ± 112 | 585 * ± 291 (389-740) |
| Prince George ($n$ = 47) | Mid/Upper | 1372-1667 | 504 ± 224 | 202 ± 124 | 713 * ± 271 (633-792) |
| Revelstoke ($n$ = 4) | Parkland | 1950 -2070 | 442 ± 461 | 58 ± 32 | 500 * ± 492 (0-1283) |
| Prince George ($n$ =5) | Parkland | >1667 | 339 ± 281 | 66 ± 45 | 407 ± 308 (24-789) |
| Revelstoke ($n$ = 4) | Lower ESSF | (1350-1499) | 508 ± 137 | 58 ± 68 | 566 * ± 159 (314-820) |
| Prince George ($n$ =3) | Lower ESSF | (1220-1372) | 520 ± 193 | 240 ± 150 | 760 * ± 104 (501-1018) |

Tree density estimates are means ± 1SD; numbers in brackets are lower and upper 95% confidence intervals. * significantly ($\alpha$ 0.05) different from partial-cuts

### Tree Species Composition

Residual tree species composition of the partial-cut blocks differed significantly from caribou foraging areas in Revelstoke ($G = 88.4$ df =2, $P < 0.001$) as well as Prince George ( $G = 61.5$, df = 1 , $P < 0.001$) (Fig. 1). Caribou foraging areas in Revelstoke had significantly more 'other' tree species (e.g., mountain hemlock) and less spruce (19%) than the partial-cuts (40%). In Prince George, caribou foraging areas were strongly

dominated by balsam (85%) and had less significantly spruce (15%) compared to the partial-cut blocks at Salmo (Fig 1).

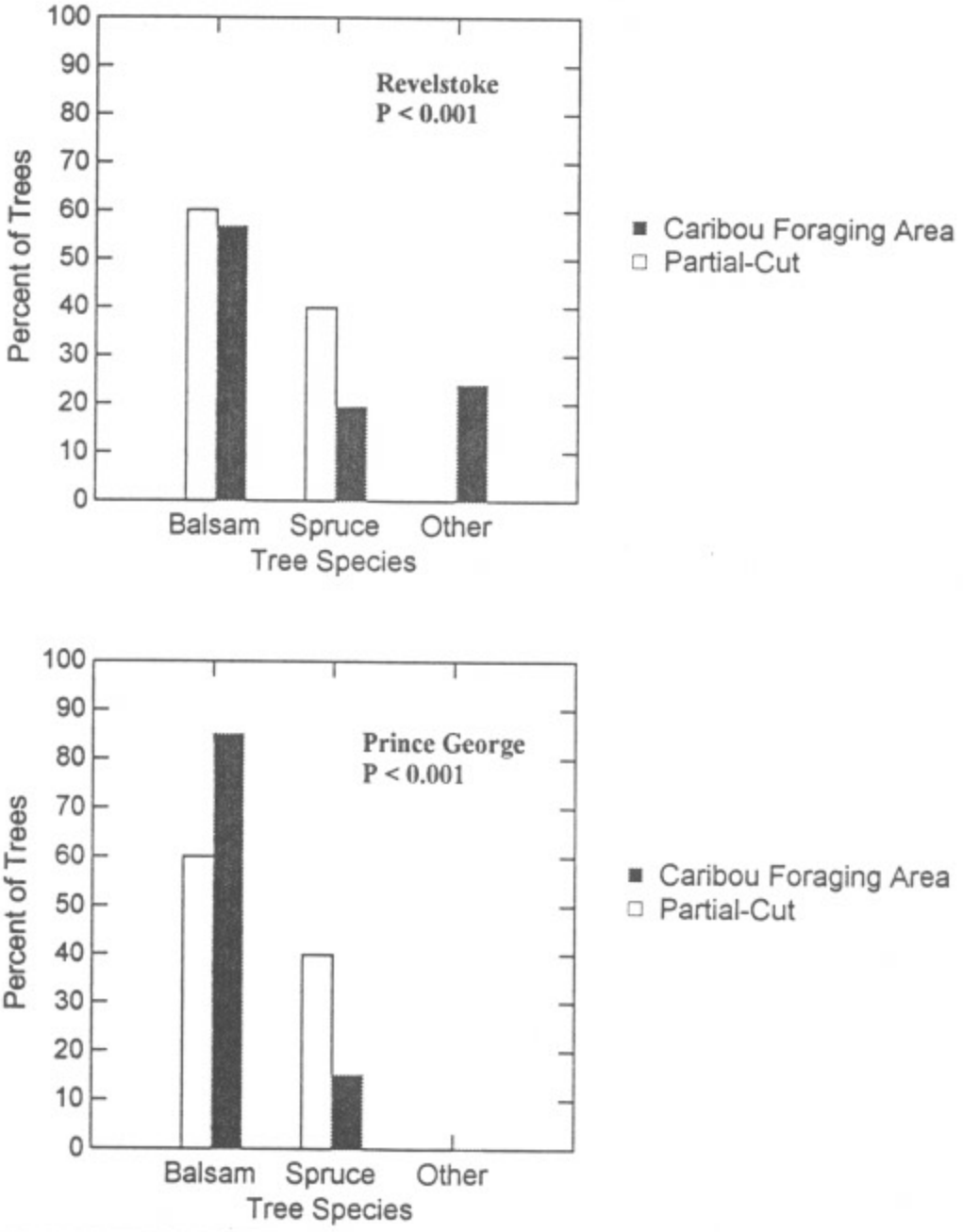


**Fig. 1 Tree species composition at two caribou study areas (Revelstoke and Prince George and experimental partial-cuts (Salmo, B.C.)**

### Tree Diameter (DBH cm)

Although caribou foraging areas in Revelstoke had slightly more trees between 10-30 cm and fewer large diameter (> 50 cm) trees than the partial-cut blocks, the distribution of tree diameter sizes was not significantly different between caribou foraging areas and the partial-cuts ($G = 9.7$ , df = 5, $P = 0.085$) (Fig. 2). In contrast, caribou foraging areas near Prince George had significantly more stems between 10-20 cm DBH as well as fewer large (> 50 cm) and very small (7-9 cm) diameter trees compared to the partial-cuts at Salmo ($G = 88.3$, df = 5 , $P < 0.001$) (Fig. 2).

### Tree Class (Live trees, snags and windthrow)

The proportion of live trees and snags was very similar between caribou foraging areas in Revelstoke and the partial-cuts ($G = 2.35$, df = 3, $P = 0.504$). The majority of trees at both study areas were dominated by live stems (> 80%) with 15-20% of the stems occurring as snags (Fig. 3). In addition, very little windthrow was present at caribou foraging areas in Revelstoke and none encountered at the partial-cuts in Salmo.

In contrast, the frequency distribution of tree classes at caribou foraging areas near Prince George was significantly different than the partial-cut blocks ($G = 34.8$, df = 3, $P < 0.001$). Although caribou foraging areas had similar amounts of live trees and tight-barked snags as the partial-cuts, caribou foraging areas had more older snags (e.g., loose-bark snags) and windthrow compared to the partial-cuts (Fig. 3).

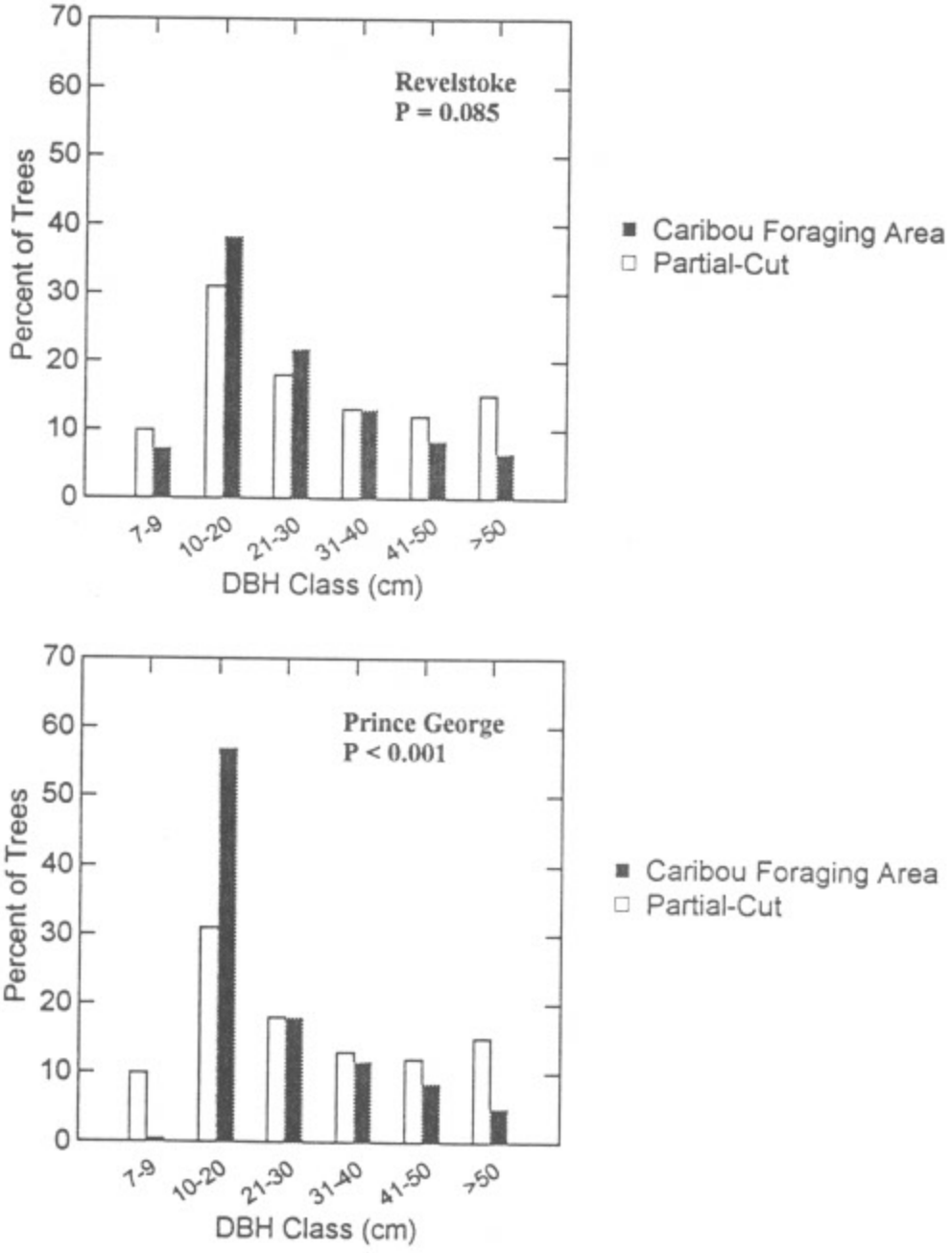


**Fig. 2 Frequency distribution of tree diameter (DBH) classes at two caribou study areas (Revelstoke and Prince George) and experimental partial-cuts at Salmo, B.C.**

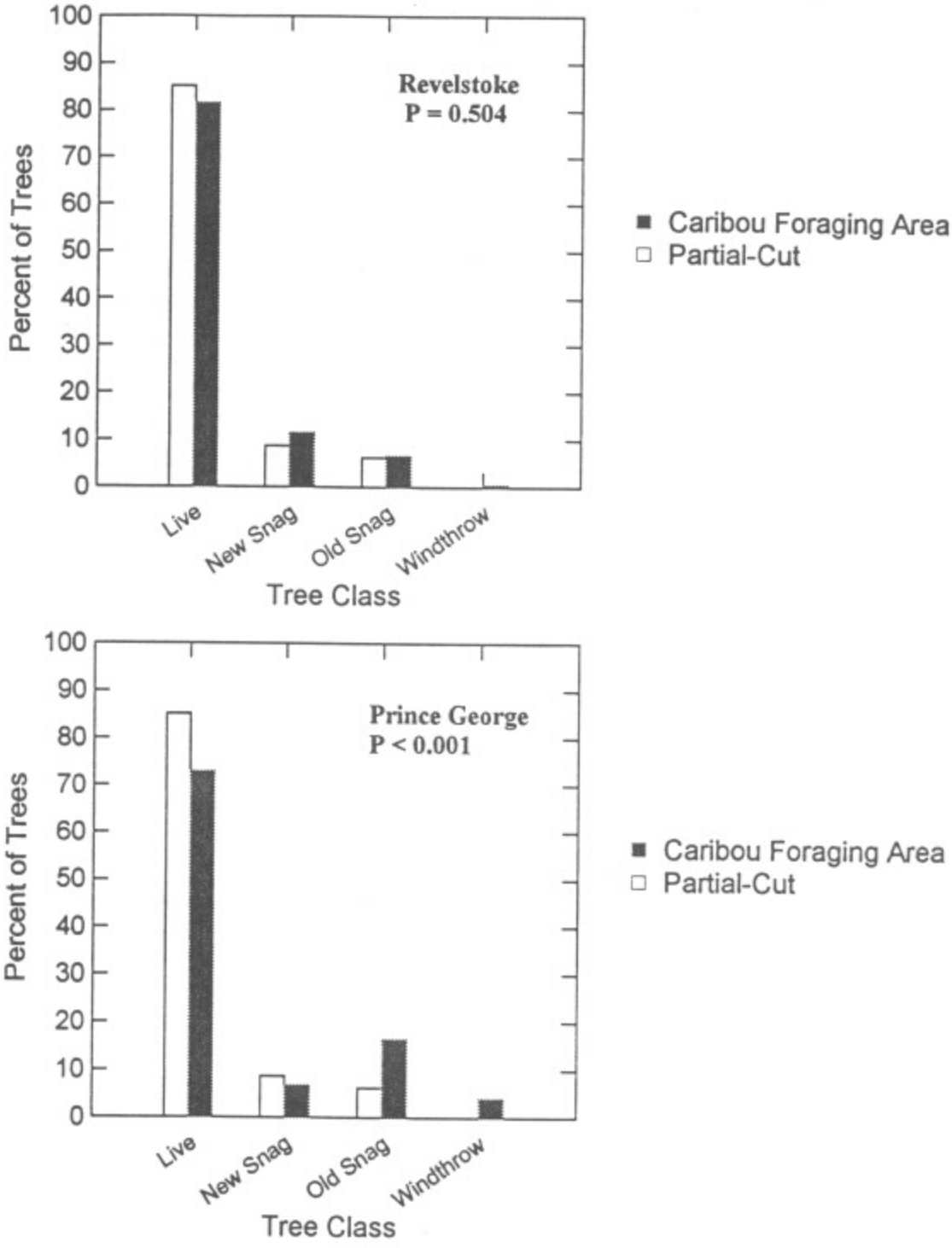


**Fig. 3 Frequency distribution of tree classes at two caribou study areas (Revelstoke and Prince George) and experimental partial-cuts at Salmo, B.C.**

## Lichen Abundance

The proportion of trees supporting various amounts (nil to > 3 clumps) of arboreal lichen was significantly different between the partial-cuts and caribou foraging areas in both Revelstoke ($G = 41.6$, df =3, $P < 0.001$) and Prince George ($G = 42.3$, df =3, $P < 0.001$). In Revelstoke, caribou foraging areas had significantly more trees that supported only small amounts (less than 1 clump) of lichen and fewer trees with heavier lichen loads (> 3 clumps) compared to the partial-cuts (Fig. 4). Similarly, caribou foraging areas near Prince George had significantly more trees that supported less than 1 clump and fewer trees with more than 3 clumps compared to the partial-cut blocks (Fig. 4).

## Lichen Genera Composition

The percent of trees supporting various proportions of *Alectoria sarmentosa* and *Bryoria* spp. lichens also differed between the partial-cut blocks and caribou foraging areas in Revelstoke ($G = 30.0$, df = 4, $P < 0.001$) and Prince George ($G = 116.3$, df = 4, $P < 0.001$). Although trees sampled at caribou foraging areas in Revelstoke and the partial-cuts were largely dominated by *Bryoria* spp. lichens ( < 35% *Alectoria*), caribou foraging areas also had more trees dominated by *Alectoria* than the partial-cuts (Fig. 5).

Lichen genus composition of partial cuts and caribou foraging areas near Prince George, were even more significantly different than Revelstoke. In Prince George, caribou foraging areas supported significantly more trees dominated by *Alectoria* and fewer trees dominated by *Bryoria* spp. compared to the partial-cut blocks at Salmo. (Fig. 5)

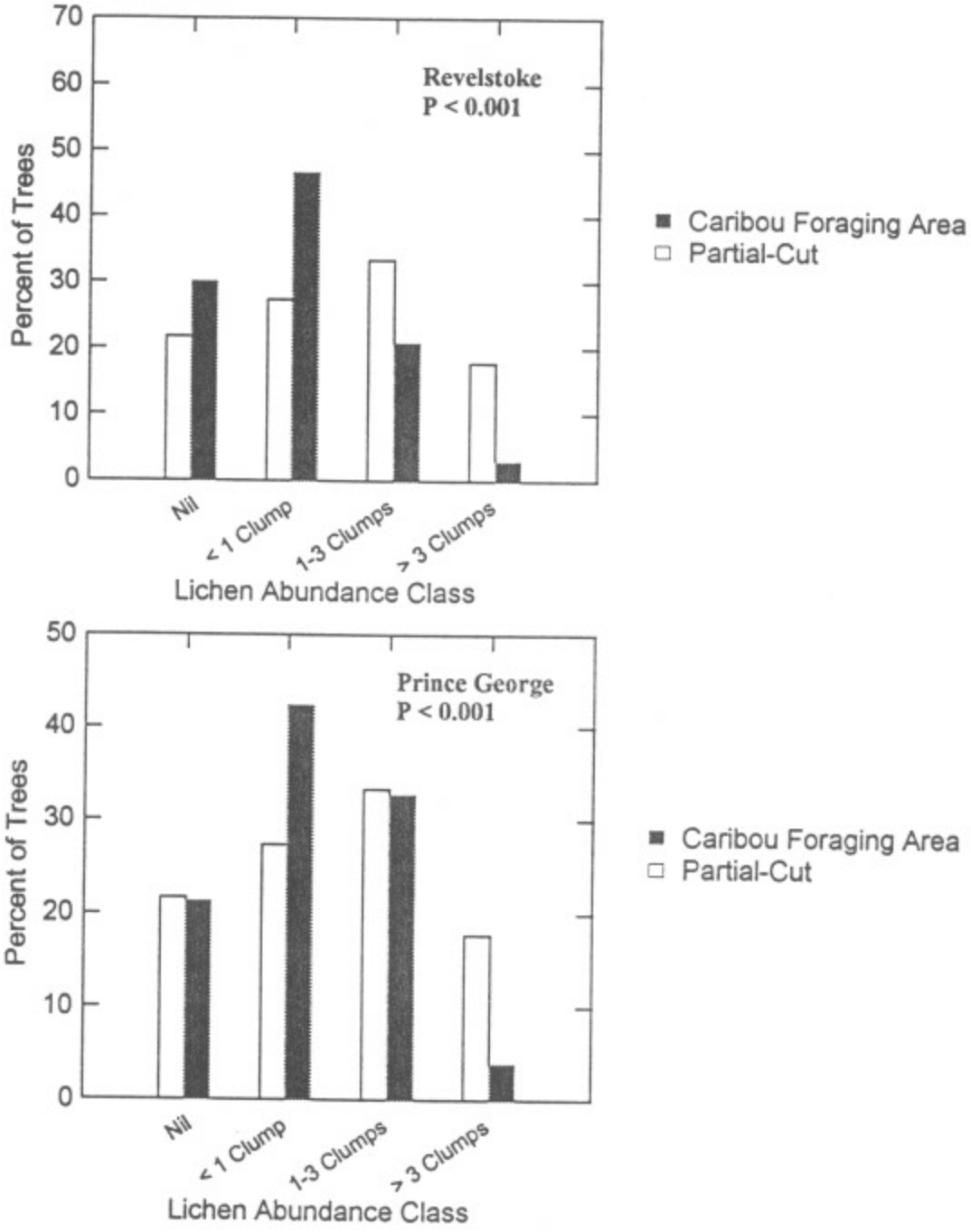


**Fig. 4 Frequency distribution of arboreal lichen abundance classes at two mountain caribou study areas (Revelstoke and Prince George) and experimental partial-cuts at Salmo, B.C.**

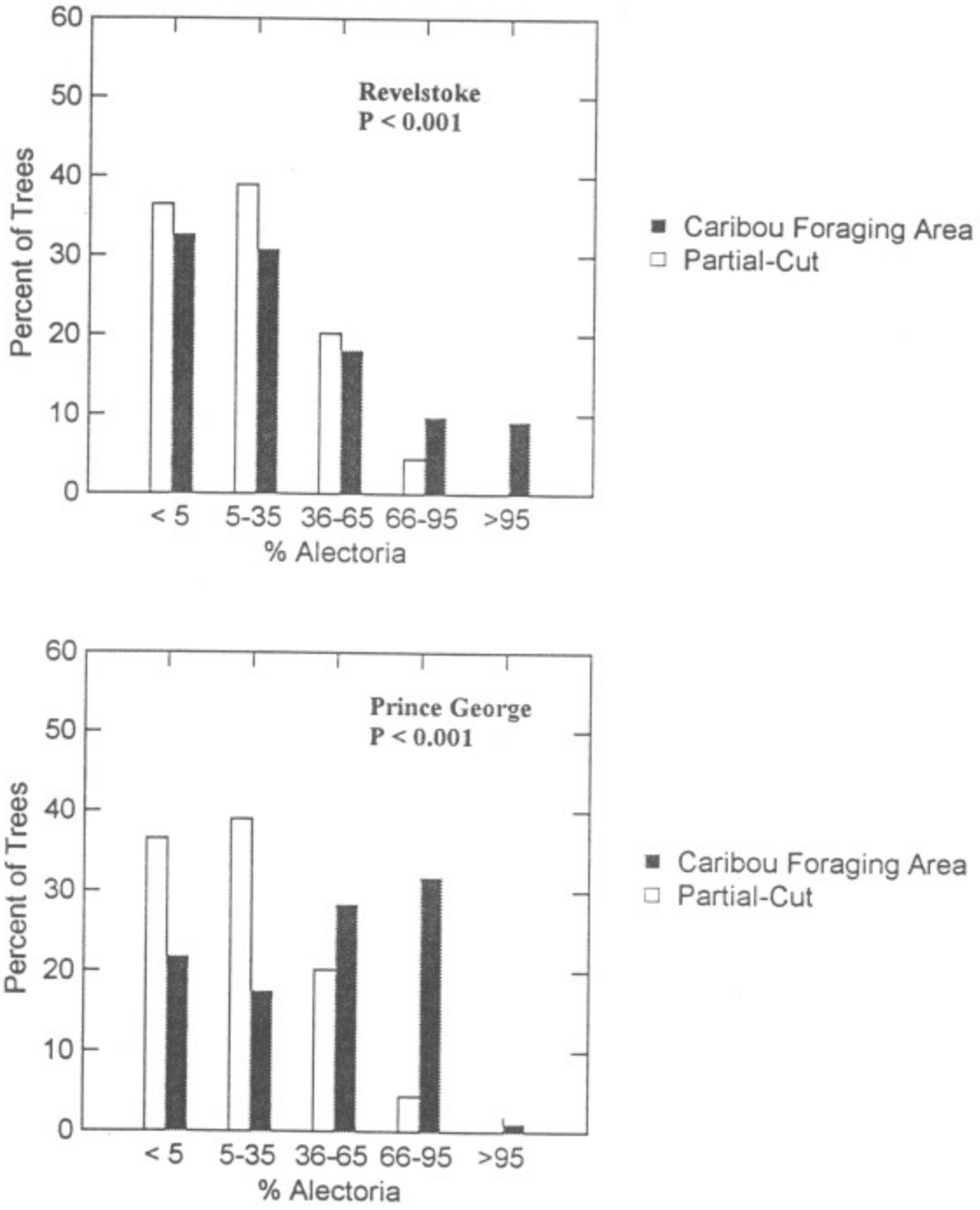


**Fig. 5 Frequency distribution of lichen genera composition at two caribou study areas (Revelstoke and Prince George) and experimental partial-cuts at Salmo, B.C.**

## 5.0 Discussion

The results reported here suggest the partial-cuts at Salmo maintained some but not all of the attributes found at caribou foraging areas in Revelstoke and Prince George. However, many of the apparent differences can be explained by differences in study area location and not necessarily the harvesting prescription (i.e., treatment). For example, both caribou study areas had significantly different tree species composition than the partial-cuts; however, the difference in Revelstoke was largely due to the presence of mountain hemlock and other tree species that did not occur in the Salmo partial-cuts or control sites. Considering tree species common to all locations revealed the partial-cuts , however, still had more residual spruce (40%) than caribou foraging areas in Revelstoke (19%) and Prince George (15%). Although there needs to be a better understanding of how various tree species are correlated with lichen abundance and lichen genera composition, it appears ESSF forests that contain a relatively high proportion of spruce do not make up a significant component of caribou winter range in Prince George or Revelstoke (Terry 1994, this study). This suggests that partial cutting in areas that contain a significant component of spruce and have explicit objectives of maintaining caribou habitat may be unwarranted and needs further consideration. Or perhaps, more spruce could be harvested from partial-cuts with little negative impact on caribou, if more balsam is maintained. Nonetheless, other management objectives (timber and/or wildlife) usually require that pre-harvest tree species composition be maintained.

The partial-cut blocks appeared to maintain a similar distribution of diameter classes as caribou foraging areas in Revelstoke. However, tree diameters at caribou foraging areas near Prince George were skewed to small diameter stems (10-20 cm ) which differed from the partial-cuts that maintained a broader range of tree sizes. However, this difference is largely due to geographic location, as caribou do not show selection for small diameter trees (Terry 1994).

The proportions of live trees and snag classes were similar between the partial-cuts and Revelstoke, however, caribou foraging areas near Prince George, had more old snags (class 4 to 8) and windthrow compared to the partial-cuts. Although windthrow has been identified as an important source of arboreal lichen during the early winter (Simpson *et al.* 1987, Rominger and Oldemeyer 1989, Terry 1994), the fact that the partial-cuts have experienced minimal windthrow thus far, is a positive attribute if arboreal lichen is to be maintained over the long term.

Overall, it should be emphasized that the significance of maintaining tree species composition, snags or a specific diameter class distribution must ultimately be related to lichen abundance and lichen genera composition. Preliminary work in the Cariboo Region has shown within tree species, larger trees (>30 cm DBH) have significantly more lichen than smaller trees (Armleder and Stevenson 1996). However, more work needs to be done to clarify the relationships between tree attributes and lichen abundance, especially for those trees that provide apparent critical energetic thresholds (Class 3 lichen trees) and the preferred arboreal lichen of caribou – *Bryoria* spp. (Rominger *et al* .1996).

Interestingly, the partial-cuts did appear to support not only more trees with greater lichen loads, but also more trees that were dominated by *Bryoria* spp. lichens compared to both caribou study areas. This result is in contrast to early experimental partial-cutting trials near Prince George which were not able to maintain arboreal lichen biomass even in the short term (Terry 1994). However, recent studies using group and low volume (<30%) single tree selection methods have shown more promising results (Armleder and Stevenson 1996) including a possible shift in lichen composition towards *Bryoria* spp. (Stevenson 1995). Because lichen abundance and lichen genus composition likely play an important role in determining whether a caribou perceives a partial-cut block as suitable habitat and uses it to feed, these partial cuts appear to provide at least suitable forage *trees*. However, to maintain suitable *habitat*, there must be enough trees to meet daily energy requirements and they must be spatially distributed in such a way that caribou would use them. Therefore, perhaps the most significant result and implication for caribou habitat are the residual tree densities found at the partial-cuts. Because selection harvesting can alter the spatial and temporal availability of arboreal lichens, reducing tree densities may influence foraging energetics by affecting both energy intake and costs.

Clearly, any kind of selection harvesting will reduce total tree density below those found at early winter caribou foraging areas (500-800 stems per ha). However, the average residual tree density found at the partial-cuts in this study (292 sph) is quite low even relative to typical late winter or parkland densities (300-500 sph) (Terry 1994, Rominger *et al.* 1996). Although Rominger *et al.* (1996) found caribou intake rates were not affected by a 50% decrease in tree density from 790 sph to 410 sph, it not clear how caribou would respond to tree densities below 400 sph. Whether the greater lichen loads could compensate for the lower tree densities in the partial-cuts remains unclear. Caribou use of managed stands should be monitored and foraging trials initiated in selectively logged areas (similar to Rominger *et al.* 1996) to determine caribou foraging behaviour patterns in managed stands.

## 6.0 Literature Cited


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