

# Population Characteristics of the Lake Revelstoke Caribou

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## ABSTRACT

The Lake Revelstoke caribou (LRC) are the southernmost contiguous mountain caribou population in British Columbia. Population characteristics of the LRC were examined during 1981–85, with 13 radio-collared caribou, and 1992–98, with 47 radio-collared caribou. During several late-winter censuses, sightability of marked animals was 92% and the proportion seen was a function of the height of snow (HS). Our best estimate of the population size was 375 animals (95% CI 337–413). Cause of death of 31 radio-collared animals included accidents (42%), predation (29%), and poor condition (10%). Deaths due to avalanches (accidents) were the single leading cause at 23%. Survival of radio-collared caribou averaged 84% since 1992. Progesterone levels in 29 female caribou indicated that 83% were pregnant. There was an average of 28 calves/100 adults during 1981–84, and 18 calves/100 adults during 1994–97. Survival rates of adult caribou and the ratio of calves per 100 adults indicate that the population was stable.

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**Key words:** caribou, census, mortality, pregnancy rate, *Rangifer tarandus caribou*, recruitment, survival rate.

Woodland caribou (*Rangifer tarandus caribou*) are listed as Vulnerable by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and those in southern British Columbia are Blue-listed (vulnerable) by the British Columbia Conservation Data Centre. Woodland caribou in southern British Columbia are a unique ecotype characterized by their use of deep snow as a platform to access arboreal lichens in subalpine forests during winter (Stevenson and Hatler 1985). The Lake Revelstoke caribou (LRC) are the southernmost contiguous mountain caribou population in British Columbia. Population characteristics of the LRC were examined during 1981–85 (Simpson et al. 1987), and during 1992–98 (McLellan and Flaa 1993, McLellan et al. 1994a,b). This paper summarizes the population characteristics of the LRC during these studies.

## STUDY AREA

The study area was located north of Revelstoke, B.C. (51°N, 118°W) and included the Selkirk Mountains to the east of the Revelstoke Reservoir, and the Monashee Mountains to the west of the reservoir. Elevations range from 550 to 3,050 m, with tree line at approximately 1,980 m. Lower slopes are in the wet-cool Interior Cedar–Hemlock (ICHwk) biogeoclimatic subzone. Mid-slopes are in the very wet cold Engleman Spruce–Subalpine Fir (ESSFvc) subzone. Alpine, rock, and

glaciers of the Alpine Tundra (AT) zone occur above the ESSF. The area of transition between the ESSF and the AT is characterized by clumps of subalpine fir forming open subalpine parkland (Pojar et al. 1987). Timber harvesting and hydroelectric development are major industrial uses of the area and have changed the landscape and forest cover of the study area.

## METHODS

Between 1981 and 1985, 13 caribou were captured by darting with Anectine (succinylcholine chloride) from the ground, and in 1992–98, 47 caribou were captured by net-gunning from a helicopter in subalpine habitat. All caribou were fitted with mortality/motion-sensitive radio-collars. Aerial relocation schedules for both study periods were bi-weekly, with increased coverage in early winter. Blood samples were collected from 29 female caribou during the 1992–98 study and analyzed for progesterone concentration to determine pregnancy.

When mortality signals were detected during monitoring flights, the site was investigated as soon as possible. Caribou were necropsied, with carcass position, evidence of bleeding, predator sign, and bone marrow fat content used to aid in determining contributing factors and primary cause of death. Survival rates were determined using BOOTER (Hovey and McLellan 1996), while MICROMORT (Heisy and Fuller 1985) was used to determine seasonal differences in mortality rate.

Caribou were censused during late winter, when they were

in open subalpine parkland (Simpson et al. 1987, Seip 1992b, McLellan et al. 1995). Censuses in 1994, 1996, and 1997 were conducted shortly after new snowfalls in 3 discrete census units from a Bell 206 helicopter with 3 observers plus the pilot. A contour near timberline (1,800–2,130 m) was flown, including all suitable habitat within the study area, and tracks were followed until animals were sighted, unless the tracks descended into mature timber and were lost from view. Collars were used as marks and not to locate animals. Classification was limited to adults or calves in mixed groups and males in segregated all-male groups.

An earlier census in 1985 by Simpson et al. (1987) was conducted using a similar methodology.

Chapman's (1951) formula was used to estimate the population size:

$$N = [(M + 1)(C + 1)/(R + 1)] - 1$$

where  $N$  = population size,  $M$  = the total number of caribou marked,  $C$  = the total number of caribou seen during census, and  $R$  = the number of these marked. Confidence intervals were determined by Poisson distribution (Krebs 1989). Growth rate ( $\lambda$ ) was determined by:

$$\lambda = (1 - M)/(1 - R)$$

where  $M$  = adult mortality rate and  $R$  = calf recruitment rate (Bergerud and Elliot 1986).

## RESULTS

Plasma progesterone levels indicated that 24 of 29 female caribou (83%) were pregnant. Progesterone levels for pregnant caribou varied from 8.0 to 25.0 nmol/l, and were <2 nmol/l for nonpregnant caribou (Ringberg and Aakvaag 1982, Seip 1990, Seip 1992b; Fig. 1).

Deaths of 31 adult radio-collared caribou were recorded. Body-condition-related deaths, and accidents accounted for 52% of the mortality. Predation accounted for 29% of the deaths, and 19% died from unknown causes (Table 1).

There was no difference in mortality among seasons when adjusted by season length. Seasonal survival rates were between 0.93 and 0.97, with all 95% CI overlapping (Table 2).

Based on 26 mortalities from 1992 to 1998, with 177 caribou-monitoring years, adult annual survivorship varied between 71% and 92% over individual years. Cumulative annual survivorship was 84% (95% CI 78–89%). The 1981–85 survival rate was 81%, with 5 mortalities in 21 caribou-monitoring years (Simpson et al. 1987).

Estimates of the number of caribou in the LRC area are shown in Figure 2. Due to variable census methods, survey intensities, and winter conditions, any suggested trend should be viewed with caution.

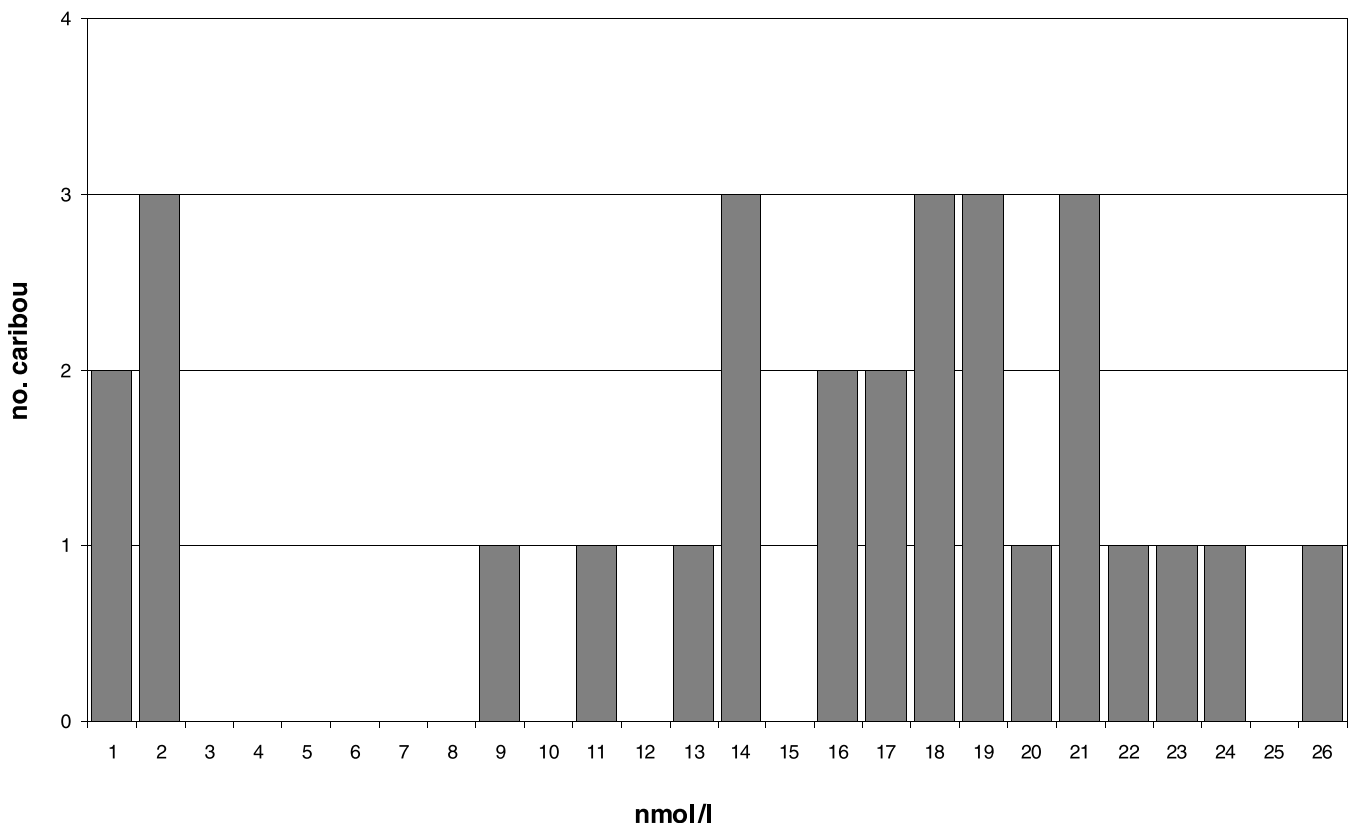


Figure 1. Progesterone concentration in 29 female caribou captured in March, 1992–1996.

**Table 1.** Mortality causes of radio-collared caribou in the Lake Revelstoke study area, 1981–85 and 1992–98. Percentages of total caribou mortalities are in parentheses.

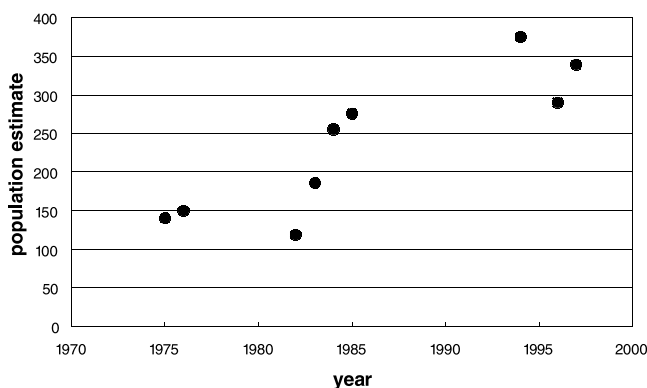
Cause of death	No. of caribou (% of total mortalities)
PREDATION	9 (29)
Bear	3 (10)
Cougar	4 (13)
Wolverine	2 (6)
NONPREDATION	16 (52)
Avalanche	7 (23)
Accidental	6 (19)
Condition	3 (10)
UNKNOWN	6 (19)

Since 1993, 3 censuses (1994, 1996, 1997) were completed and 1 census (1993) was aborted due to low sightability of marked animals. During the 1994, 1996, and 1997 censuses, 347, 268, and 308 caribou were observed respectively. Population estimates of caribou were 375, 290, and 339, with upper 95% CI of 590, 439, and 496 (Fig. 2).

During the censuses we saw 24 of 26 marked animals in 1994, 23 of 25 in 1996, and 26 of 28 in 1997, for an average sightability of 92%. There was a significant relationship between height of snow (HS) at 1,830 m elevation and the sightability of marked animals ( $r^2 = 0.93$ ,  $p = 0.002$ ; Fig. 3).

During 1981–84, an average of 22% of the population in March was calves. The average for 1994, 1996, and 1997 was 15% calves, with a range 12–17%.

Population growth rate was estimated to be 1.01 for 1981–85, and 0.98 for 1994–97.



**Figure 2.** Population estimates of the Lake Revelstoke caribou, 1975–1997.

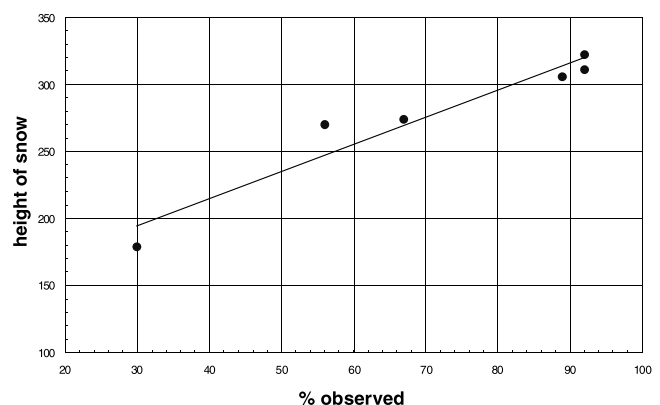
**Table 2.** Estimated seasonal survivorship of Lake Revelstoke caribou, 1981–85 and 1992–98.

Season	Survival rate	Upper 95% CI	Lower 95% CI
Early winter	0.973	0.999	0.948
Late winter	0.958	0.991	0.926
Spring	0.966	0.996	0.937
Summer	0.933	0.972	0.896
Annual	0.841	0.898	0.787

## DISCUSSION

The pregnancy rate found in the LRC is similar to the 76–100% recorded for woodland caribou in other areas (Seip 1992a, Crete et al. 1996, Seip and Cichowski 1996). There was a high loss of calves from the population in the first year of life. During March we found an average of 18 calves/100 adults, which indicates a loss of 23 calves/100 adults if we assume adult males and females were in equal proportions in the population, which is unlikely true, and thus even more calves were lost. This high loss of calves is similar to that reported for other populations of woodland caribou in British Columbia (Bergerud and Elliot 1986; Seip 1992a,b; Seip and Cichowski 1996).

Death of adult caribou due to accidents was common in this study but was not reported for other woodland caribou populations. This high accident rate was attributable to the rugged topography and extreme snow accumulation. Wolves, which occur but are not abundant in the study area (Allison 1998), did not kill radio-collared caribou. Bear predation occurred during summer, and wolverines preyed on weak or injured caribou in the winter. The incidence of cougar predation appears to have increased during the study, with 3



**Figure 3.** Percentage of radio-collared caribou observed during censuses relative to height of snow (HS) at 1,830 m on Mount Revelstoke.

of the 4 incidents occurring since 1996 and none reported by Simpson et al. (1987).

Unlike other studies in British Columbia, where the major period of mortality occurred between May and October (Seip and Cichowski 1996), mortality in our study showed no significant difference among seasons. This balance of seasonal mortality was due to the increased winter-related accidental mortality of the LRC, compared to other studies where predation during summer and fall was a major cause of death (Bergerud and Elliot 1986; Seip 1992a,b; Rettie et al. 1998).

Census results indicate that there were 350–400 caribou in 1997. Simpson et al. (1987) estimated the population to be 275–300 in 1985; however, that estimate may be low, as their coverage of the study area was not as extensive as in 1994, 1996, and 1997.

Major limiting factors include high calf mortality and accidental adult mortality due to the rugged terrain and extreme winter snowfalls. Increased cougar predation appears to have become a more significant factor and may require management action. Loss of habitat is not thought to be a major limiting factor at present; however, it will likely become more significant as the forest profile changes from older stands and young plantations to a forest fragmented by younger stands.

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