MOUNTAIN CARIBOU CALF PRODUCTION AND SURVIVAL, AND CALVING AND SUMMER HABITAT USE IN WEST-CENTRAL ALBERTA

Alberta
FORESTRY, LANDS AND WILDLIFE
Fish and Wildlife

Wildlife Management Branch
Wildlife Research Series
Number 4

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Wildlife Research Series Number 4

1991
Edmonton, Alberta

Pub. No. T/227
ISBN: 0-86499-746-9

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ACKNOWLEDGMENTS

Many permanent and seasonal employees of Alberta Fish and Wildlife assisted in collection of field data, primarily as observers on radio-telemetry aerial surveys. Bernie Goski, Alberta Environmental Centre, Vegreville, expertly handled the helicopter-borne net gun and captured the majority of the caribou. We appreciate the quality of flying provided by the Alberta Government helicopter pilots, in particular, A. Leiter and H. Bannister who helped capture the caribou. Our thanks to all these people.

The following people reviewed early drafts of the report and their constructive criticisms greatly improved its quality: K. Brown, TAEM Consulting, Calgary; E. Bruns, Alberta Fish and Wildlife, Rocky Mountain House; J.L. Davis, Alaska Department of Fish and Game, Fairbanks; D. Ealey, Editorial Services, Alberta Energy/Forestry, Lands and Wildlife, Edmonton; D. Hatler, Spatsizi Association for Biological Research, Smithers, B.C.; M. Pybus, Alberta Fish and Wildlife, Edmonton; J. Russell, Waterton Lakes; and D. C. Thomas, Canadian Wildlife Service, Edmonton.

L. Hodgson and W. Murphy typed innumerable drafts of the report; their patience is appreciated.

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ABSTRACT

A study of mountain caribou (*Rangifer tarandus caribou*) was conducted from 1987 through 1989 to obtain information on calf survival, calving and summer habitat, timing of spring migration and distances moved to calving areas. In addition, the effect of winter severity and snowfall on calf survival based on data collected since 1981 was assessed. Observations of a sample of radio-collared adult female caribou provided detailed data on calf production, timing of movement to calving sites, calving habitat, fidelity to calving sites and timing of mortality of calves. In years when winters were severe or snowfall was high through April and May, radio-collared females did not move as far from their winter range to calve and calved at lower elevations, than years when winters were of average or above average severity and springs were relatively snow free. Correspondingly, low percentage calves in fall/early winter composition counts were associated with a previous severe winter or late spring. Calving habitat was variable, though located primarily above 1600 m, and calving sites were widely dispersed. Dispersal to higher elevation calving sites was considered to be an antipredator strategy that was disrupted when snow cover on the winter range extended late into the spring. Over nine years of monitoring, the mean percentage calves in fall/early winter composition counts was 14 and four years of low calf survival negated five years of average or above average calf survival.

1.0 INTRODUCTION

The Alberta Fish and Wildlife Division conducted a study of woodland caribou (*Rangifer tarandus caribou*) in west-central Alberta from December 1979 to June 1984 (Edmonds and Bloomfield 1984). Conclusions of the study were as follows:

1. caribou herds in the area decreased rapidly during the late 1960s through the 1970s due to legal and illegal harvest by humans, wolf predation and extensive loss or alteration of winter habitat;

2. the primary factor limiting the growth of caribou herds during the study was predation (see also Edmonds 1988);

3. man-caused mortality continued despite closure of sport hunting in 1981, primarily from poaching and vehicle accidents; and

4. habitat loss and degradation due to extensive clear cut logging and other industrial development would accelerate rapidly over the next 20 years -- habitat changes will be a serious limiting factor in the long term.

Based on these conclusions and an assessment of the status of caribou and their habitat throughout the rest of the province, Alberta's woodland caribou were designated a "threatened" species (A Policy for the Management of Threatened Wildlife in Alberta. Draft Report of the Alberta Energy and Natural Resources, Fish and Wildlife Division, Edmonton). A Provincial Restoration Plan for Woodland Caribou (Edmonds 1986) identified data gaps and recommended management programs for the recovery of caribou herds in the Grande Cache area.

The Alberta Fish and Wildlife Division began, in the winter of 1986/87, to obtain data on:

1. recruitment;
2. the timing and causes of calf mortality;
3. a description of calving habitat;
4. timing of movements and distances moved to calving sites; and
5. a description of summer habitat and summer range size.

The study area and its seasonal use by caribou have been described previously (Edmonds 1988). In general, these caribou are migratory, moving in April or May from their winter ranges in the forested foothills to summer ranges in the mountains where they calve, summer and breed (Figure 1). This behaviour sets this population apart as mountain caribou.

2.0 METHODS

Adult female caribou were captured in winter using tangle nets (DesMeules et al. 1971) or a helicopter-borne net gun (Barrett et al. 1982). No drugs were used to subdue the caribou. Radio-collars and ear tags were attached, and body measurements and blood samples taken while the animals were tied and blindfolded.

In June, 1987, we relocated females at calving areas and attempted to capture their newborn calves with a helicopter-borne net gun. A descented, expanding radio-collar was placed on the calf. The calf was handled with sterile gloves, at arm's length and for just enough time to slip the collar over its head.

In 1987 and 1988, radio-collared females (RCF) and their calves were visually located with a Bell 206B helicopter once a week during June and once or twice a month during July through October. In 1989, the females and calves were located twice in June, once in August and finally during the rut. Location, group size and habitat description were recorded. Summer ranges were determined using the minimum convex polygon method (Mohr 1947), and their areas measured with a digital planimeter.

In October 1987, 1988 and 1989, surveys were conducted in known rutting areas to obtain total counts and age/sex composition. Based on studies of mountain caribou in Spatsizi Park in British Columbia, Hatler (1987) proposed that early winter (November) was a better time than the rut to survey for population data. Thus, additional surveys were conducted in November 1988 and 1989 to obtain total count and percent calves.

Weather data (mean monthly temperatures and total monthly snowfall) were obtained from the Alberta Forest Service Ranger Station at Grande Cache, which borders the eastern side of Willmore Wilderness Park at an elevation of 1310 m (Figure 1). An annual winter severity index was calculated by subtracting the total snowfall and mean monthly temperatures for November-May of each winter from the 1975-1989 mean for November-May. Each value was then divided by the 1975-1989 mean for November-May and then multiplied by 100 to give a percent value. The percent values for snowfall and temperature were added to form the annual winter severity index and expressed as a positive or negative deviation from the mean (see Burles et al. 1984).

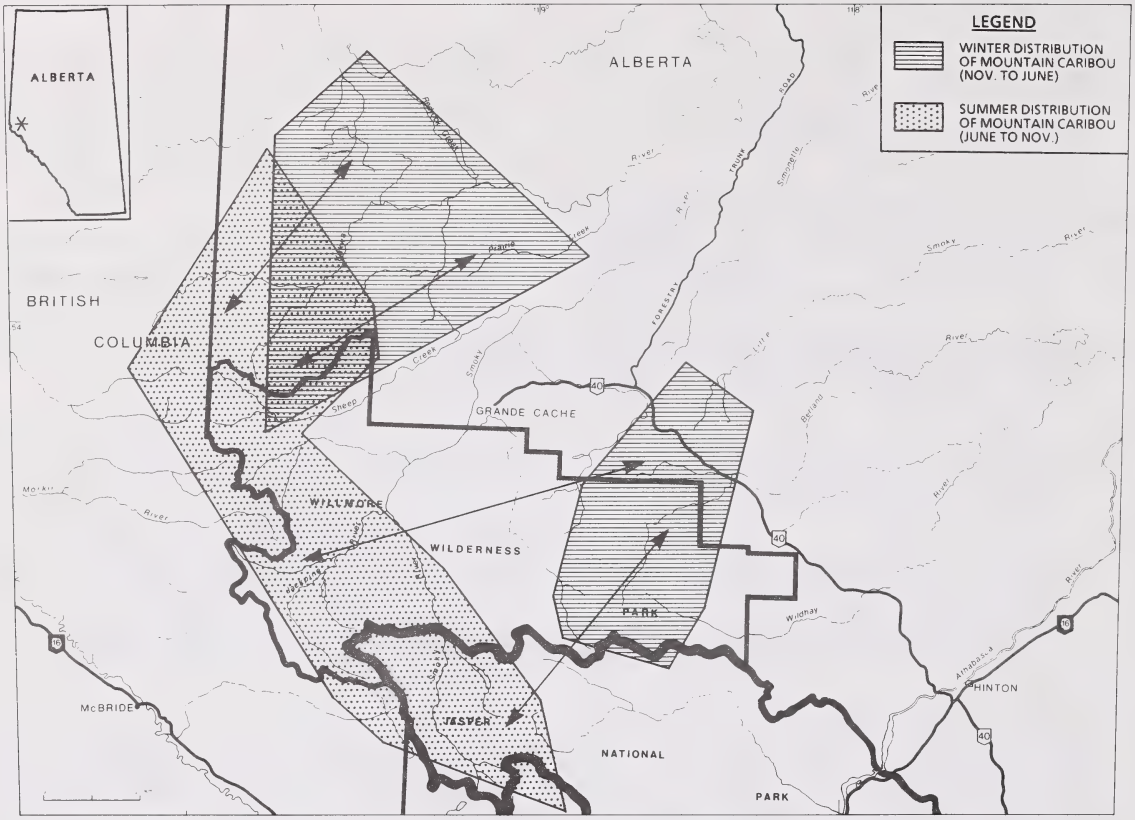


Figure 1. Study area and seasonal distribution of mountain caribou during the study based on radio-collared females.

Example:

Year A November-May total snowfall =100 cm

1975-1989 Mean November-May total snowfall = 200 cm

Year A November-May mean monthly temperature = -5°

1975-1989 Mean November-May mean monthly temperature = -2.5°

Snowfall Index: $\frac{200\text{ cm} - 100\text{ cm}}{200\text{ cm}} \times 100 = 50\%$

Temperature Index: $\frac{-2.5°C - -5°C}{-2.5°C} \times 100 = -100\%$

Winter Severity Index: + 50% + -100% = -50%

3.0 RESULTS

3.1 Calf Production and Survival

In February/March 1987, October 1987 and October 1988, five, seven and five adult female caribou, respectively, were captured and radio-collared. In June 1987, one calf was captured and radio-collared, but no capture attempts were made in 1988 or 1989. The collared calf was last observed with a RCF in May 1988, at which time the radio signal was failing.

In 1987, no newborn calves were seen on May 25 but four of five calves were born to RCF by June 2. In 1988, nine of 10 calves of RCF were seen on the 3 June flight and a 10th newborn calf was observed on 8 June. In 1989, three of nine RCF had newborn calves on 3 June and by 11 June, 11 RCF had newborn calves.

Over three years the mean calving rate of RCF was 90%, five of five (100%) in 1987, ten of 11 (90%) in 1988, and 11 of 13 (85%) in 1989. Table 1 presents survival rates of those calves from June through to the rut (October 1 - 15).

Table 1 Survival of calves of radio-collared female caribou, June 1 - October 15, 1987 - 1989.

	Number observed with female (calves/females)				
Year	June 1-8	June 30	July 31	August 31	September 30
1987	5/5	5/5	4/5	4/5	4/5
1988	10/11	9/11	5/8	6/10	5/11
1989	11/13	no data	3/10	no data	1/5[a]

[a] three radio-collared females died in August and September and the status of their calves is unknown.

Rut surveys conducted annually since 1981 provided numbers and age/sex ratios of caribou (Table 2). The mean percent calves in observed samples has been 14% and the mean calf:cow ratio was 27:100. On 8 and 9 November 1988, an additional population survey located all 16 RCF. A total of 272 mountain caribou observed at that time included 41 calves (15%). Poor weather and logistical problems resulted in a low count of caribou during the 1989 rut and early winter (November) surveys. Based on a combined total count of 122 caribou, the proportion of calves was calculated to be 11%.

3.2 Spring Migration, Calving Site Fidelity and Summer Range

The caribou migrated in May and were subsequently on their summer ranges by June in 1987 and 1988. However, in 1989, a late spring with continued snow accumulation in April and May, slowed movement to the mountain calving ranges for five of nine RCF whose previous calving behaviour was known. The migration delay resulted in a significantly (ANOVA, $F=3.75$, $P=0.04$) shorter mean distance moved between winter range and calving site in 1989 relative to 1987 and 1988 (Table 3).

Calving site fidelity was assessed on the basis of four RCF followed for three calving seasons (1987-89) and six followed for two calving seasons (1988-89). Under moderate weather conditions in spring, fidelity to calving sites was strong. In June 1988, four of five RCF were first observed with newborn calves within 100 m to 200 m of their 1987 calving site and the fifth cow was within 2.5 km of her 1987 calving site. In 1989, only four of nine RCF calved within 5 km of their 1988 calving site, and one RCF calved on the foothills winter range, 43 km straight-line distance from her 1987 and 1988 calving site in the mountains. In six years of monitoring radio-collared mountain caribou in the Grande Cache area, this was the first observation of a female not migrating from the foothills winter range to calve in the mountains. By August of 1989, all RCF had moved to the mountains and were within the summer ranges used in 1987 and 1988. Also, in 1989, RCF were not as widely dispersed during calving surveys as in 1987 and 1988. In early June 1989, three RCF were within one or two kilometers of each other in the same valley, while in 1987 and 1988 RCF were 10 kilometers or more from each other with valleys or mountain ridges separating them.

RCF restricted their movements during June to small areas (Table 4). Total summer range size varied among individuals and between years (Table 5). Data from 1989 were insufficient to estimate a range size. Most of the collared cows (81%) were within their summer range during the rut.

3.3 Calving and Summer Habitat Use

Cows with newborn calves were found in alpine, treeline and forest habitat in both 1987 and 1988 (Table 6). As June progressed, the mean elevation where cow/calf pairs were observed increased (Figure 2) and alpine and treeline habitats were more commonly used. Throughout June, cow/calf pairs were primarily found on moderate to steep slopes with primarily southeast through south to west aspects.

Again, data collected in 1989 were different from those of 1987 and 1988, particularly with the increased use of lower elevation habitat (primarily valley bottoms). This difference also was reflected in the increase of observations on flat terrain in 1989 (Table 6). An estimate of snow cover at calving sites indicated there was little difference between years (Table 7). No calving sites had 100% snow cover in any of the three study years.

Summer habitat used by RCF in 1987 and 1988 was primarily in alpine and treeline areas above 1600 m

Table 2 Age/sex composition of mountain caribou during fall/early winter surveys, 1981-1989.

Date	% bulls	% cows	% calves[a]	Number classified	Survey conditions
October 1981	37	63	14	88	fair
October 1982	ND	ND	11	79 [b]	fair
October 1983	33	67	18	119	good
October 1984	41	59	10	99	fair
October 1985	40	60	20	130	good to excellent
October 1986	25	75	11	84	fair
October 1987	36	64	18	100	fair to good
October 1988	41	59	16	134	good
November 1988	ND	ND	15	272 [b]	excellent
Oct./Nov. 1989 [c]	ND	ND	11	121	fair
Means	36.0	64.0	14.4		

[a] calculated as the percentage of total animals seen.

[b] classified to adult and calf only.

[c] data from October and November surveys were combined and classification was to adult or calf only.

Table 3 Mean distance moved by radio-collared females from the centre of their winter range and their location during calving surveys (June 1 - 15), 1987 - 1989.

Year	1987	1988	1989
Sample Size	5	10	9
Mean distance between winter range and calving area (km) (range)	70 (40-86)	67 (48-100)	46[a] (5-96)

[a] significantly different at $P \leq 0.05$

(Table 8). In 1989, during a single relocation flight in August, the RCF were found in habitats similar to those observed in the previous two summers.

Discussion

The mean pregnancy rate of RCF (90%) over three years was higher than the average pregnancy rate of 82% reported for mature females in eight North American caribou herds (Bergerud 1980). The sample of RCF were all adult caribou (>2 years) and cows with calves were chosen for capture whenever possible. Thus we did not capture any yearling or two year old cows and may have biased our sample towards the most reproductive animals. However, these data suggest that mountain caribou in our study area were not limited by low pregnancy rates.

Calf survival to five months (based on fall composition counts) in 1987 and 1988 was higher than the long term mean (Table 2). However, the 1989 calf survival was lower for both the radio-collared cow sample and the long term mean of fall/early winter surveys (Tables 1 and 2). Percentage calves in fall classification counts of caribou herds in south Jasper National Park (70 km south of the study area) showed an even greater difference between 1988 (23% calves in a total count of 159 caribou) and 1989 (11% calves in a total count of 107 caribou) (Brown 1988, 1989).

There were several differences between the winter and the calving period for 1989 and the winters and calving periods for 1987 and 1988:

- total winter snowfall and snowfall in April and May were higher in 1989 (Figure 3);
- mean distance moved from the winter range to calving site was significantly shorter in 1989 (Table 3);
- mean elevation and minimum elevation were significantly lower in 1989 (Table 6); and
- radio-collared cows were not as widely dispersed in early June.

These data suggested that the greater snowfall in April and May of 1989 caused some RCF to move a shorter distance, calve at lower elevations and reduce their dispersal. These factors in turn were associated with a lower than average calf survival to five months.

Figure 3 shows total snowfall, April/May snowfall and percentage calves present in population counts in the following October, for 1979 through 1989. Three of four years of lowest fall calf percentages coincided with snowfall above 40 cm in the previous April and May (Figure 3). After the severe, deep snow winter of 1982, the fall percentage of calves was also low (Figure 3). RCF left the winter range two to three weeks later in the spring of 1982 than in the springs of 1981 and 1983 (Edmonds 1988). In 1989, when snowfall was greater than average and with continued snowfall through April and May in the mountains and on the winter ranges (higher elevations than the Grande Cache weather station), some of the RCF caribou did not leave the winter range or did not travel as far to calve. They calved at lower elevations in valley habitat where predators and alternate prey were probably more abundant, and vulnerability of calves to predators would be higher. In addition, the hard winter and late spring may have resulted in poor condition of cows or newborn calves, and a corresponding poor calf survival due to failure to thrive or increased vulnerability to predation. In years with these kinds of environmental conditions (1982, 1984, 1986 and 1989), low calf survival was reflected in the following fall composition counts.

Determination of causes of calf mortality, an objective of this study, was not obtained from direct evidence but required inference from data described in calf mortality studies conducted elsewhere. The calf capture program was unsuccessful, so timing of disappearance of calves became the primary means of inferring cause of death. Appendix 1 describes the problems associated with calf capture and relocation of cow/calf pairs to determine timing of calf mortality.

Weekly checks through June allowed an assessment of calf mortality based on timing of the disappearance of a calf (presumed dead), and observation of calves with a RCF during rut composition surveys provided an index of survival to five months for the collared subsample. Calves disappearing in the first few days after birth may have died due to failure to thrive (poor condition of calf or cow), abandonment, accident, severe weather at time of birth (exposure) or predation. In general, caribou calves are followers, not hiders, and can follow their mothers within an hour of birth (Bergerud 1978). Within a week or two, a calf should be sturdy and growing, and the mortality factors associated with condition at birth would be less. In 1987 and 1988, calves disappeared primarily after June 30, suggesting that cause of death was either accident or predation.

Several studies have been conducted to assess causes of mortality of newborn calves. In Denali National Park, Alaska, 224 caribou calves were captured and radio-collared within one to five days of birth during May 1984-87. Predation was the primary cause or mortality of 88 calves: grizzly bear (*Ursus arctos*) predation accounted for 49% of the mortality, wolves (*Canis lupus*) 28%, golden eagles (*Aquila chrysaetos*) 5%, wolverines (*Gulo gulo*) 1%, unknown predators 16% and drowning 1%. Mortality of calves (33%) was similar for three of four years but significantly higher in the fourth year (56%), following a winter of deep snow cover which persisted through the calving period (Adams et al. 1988).

Table 4 Area used by radio-collared females in June, 1987 and 1988.

Animal number	Range Size in June (km^2)	
	1987	1988
F-1	<1	1
F-2	<1	1
F-3	<1	12
F-4	2	1
F-5	2	5
F-6	no data	15
F-7	no data	4
F-8	no data	2
F-9	no data	<1
F-10	no data	1
F-12	no data	12
Mean	1	5

Table 5 Range sizes (June 1 - October 15) of radio-collared female caribou, 1987 - 1988.

	Summer/Fall Range			
	1987		1988	
Animal number	size (km^2)	# of relocations	size (km^2)	# of relocations
F-1	7	11	10	8
F-2	35	10	48	8
F-3	95	11	57	8
F-4	10	9	15	7
F-5	117	10	51	9
F-6	ND [a]	ND	21	7
F-7	ND	ND	57	8
F-8	ND	ND	42	7
F-9	ND	ND	8	7
F-10	ND	ND	6	7
F-12	ND	ND	35	7
Mean	53	10	32	7.5

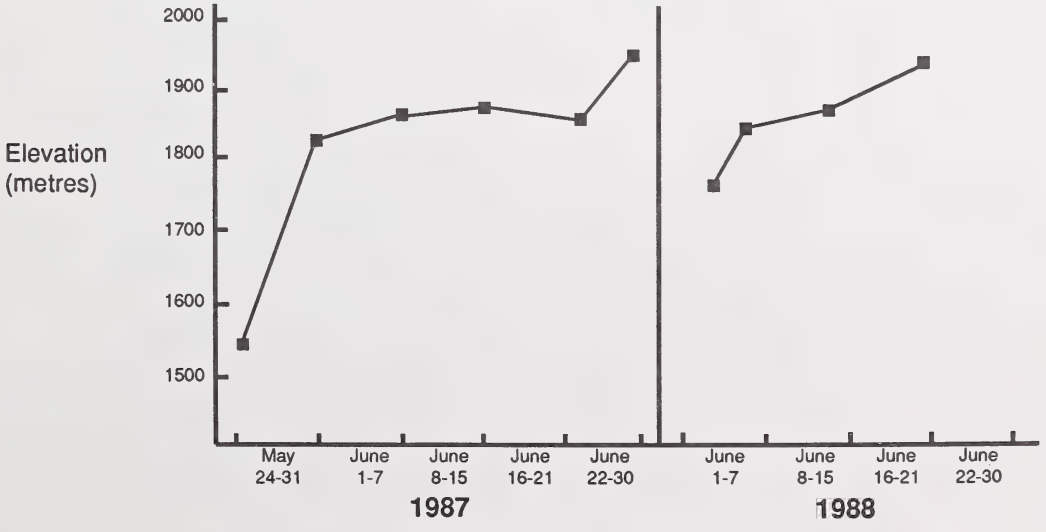
[a] no data

Table 6 Habitat used by radio-collared females during calving period surveys (June 1-15), 1987-1989.

	Calving Period Observations in Survey Year		
	1987	1988	1989
# of caribou observations	17	32	20
% observed in:			
alpine	30	44	25
treeline zone	24	15	15
subalpine forest	46	34	45
treed and open muskeg (valley)	0	3	15
valley meadow	0	3	0
mean elevation (m)	1869	1828	1635 [a]
range	(1675-2135)	(1500-2250)	(1200-2160)
% observed on:			
flat terrain (≤2°)[b]	18	13	35
gentle slopes (3-8°)[b]	6	15	30
moderate slopes (9-25°)[b]	64	28	30
steep slopes (>25°)[b]	12	44	5
% observed on aspects:			
northwest through east	21	30	15
southeast through west	79	70	85

[a] significantly different (ANOVA, F=5.42, P=0.007)
[b] estimated

Figure 2 Elevation changes of cow/calf pair observations during June, 1987 and 1988.



A study of early survival of radio-collared caribou calves and calves of radio-collared females in the Porcupine caribou herd in Alaska and Yukon was conducted from 1983 to 1985 (Whitten et al. in prep.). Predation, primarily caused by golden eagles, followed by grizzly bears and wolves was involved with the death (13 of 19 deaths) of older calves (>48 hours old). However, most mortality (59% - 74%) of the calves born to collared cows occurred within 48 hours of birth. Many of these early deaths were attributed to stillbirths, congenital defects or very low birth weights, not to predation (Whitten et al. in prep.). It was concluded that calf mortality could be underestimated using radio-collared calf data only since many calves die within 48 hours due to perinatal mortality (i.e., before they can be collared). Two studies of the mortality of newborn

Table 7 Percent snow cover where cows with newborn calves were first observed in June.

Year	Snow Cover (%) [a]				
	0	<25	25-50	51-75	>75
1987 (5)[b]	0	1	1	0	3
1988 (10)	3	3	3	0	1
1989 (10)	2	2	3	1	2

[a] estimated
[b] number of observations

Figure 3 Relationships of winter severity index and snow data to percentage calves in fall composition counts, 1980 to 1989.

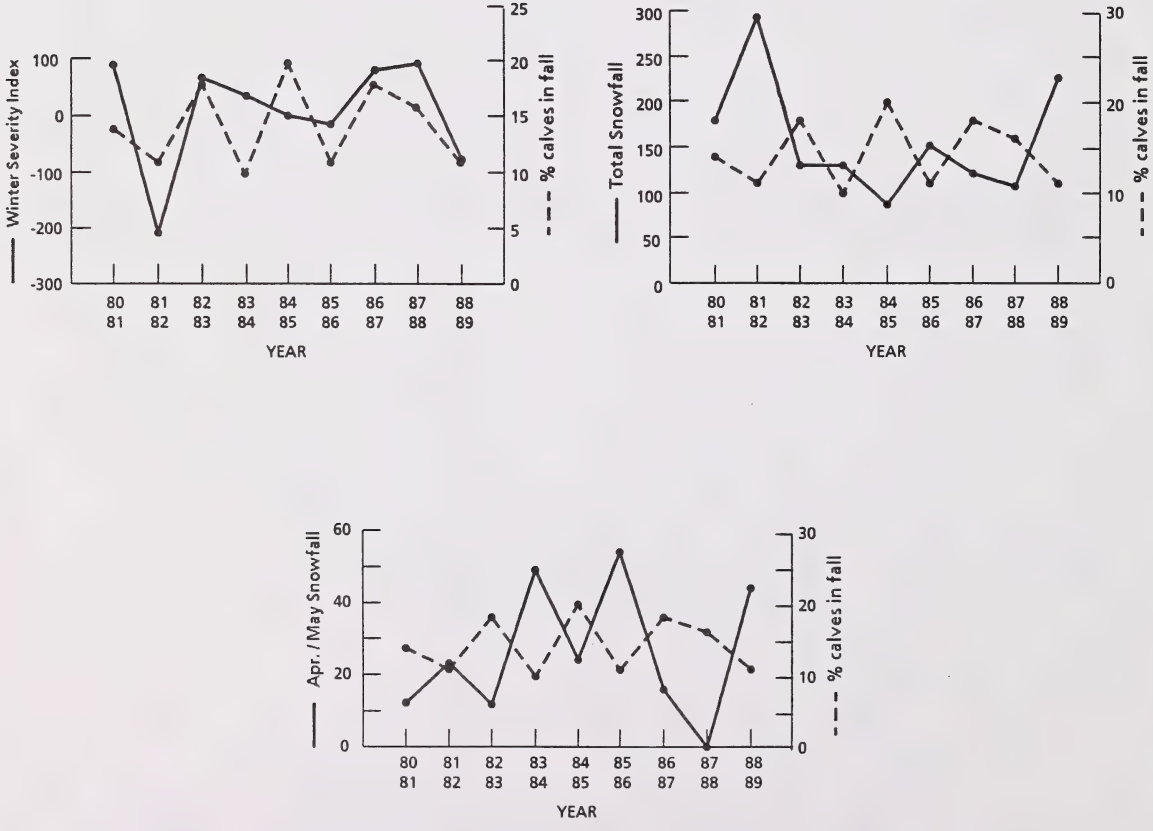


Table 8 Frequency of occurrence of summer caribou observations (June 15 - October 15) by habitat and elevation, 1987 - 1988.

	% Occurence	
	1987 (N = 93)[a]	1988 (N = 109)[a]
Elevation (m)		
900 - 1050	0	0
1051 - 1200	2	0
1201 - 1350	0	0
1351 - 1500	6	7
1501 - 1800	37	30
1801 - 2000	40	46
2001 - 2200	12	13
2201 - 2400	3	4
>2400	0	0
Habitat		
Pine forest	1	1
Pine/spruce forest	4	0
Spruce forest	0	0
Mixed coniferous forest	0	0
Treed muskeg	2	5
Regenerating pine	3	1
Shrub meadow	3	4
Open muskeg	4	5
Subalpine forest	10	17
Alpine	41	42
Treeline	24	19
Snowbed	4	3
Other	4	3
Man-made clearing	0	0
Highway or road	0	0
Cutline	0	0
Right-of-way	0	0

[a] numbers in parenthesis are number of caribou observations

barren-ground calves by Miller and Broughton (1974) and Miller et al. (1985, 1988), based on investigations of caribou calf carcasses in N.W.T., found that predation was the primary cause of death, with non-predation causes (abandonment, stillbirths, physiological or pathological disorders, pneumonia, malnutrition and injuries) cumulatively being less of a factor.

Three of the above four studies found that predation was the primary cause of death of newborn calves. The majority of the calves in our study in 1987 and 1988 survived their first week of life; any subsequent disappearance (death) was most likely due to predation. Predation may be a greater factor in the survival of newborn calves in years when pregnant females do not disperse to high elevations, some distance from their winter range. In 1987 and 1988 and in a previous study of this mountain caribou population (Edmonds 1988), when snow cover dissipated through April and May, cow caribou left the winter range and dispersed widely over their mountainous summer range to calve alone at elevations above 1600 m in a variety of habitats. Similar calving behaviour has been reported for mountain caribou populations in south Jasper National Park (Brown 1989) and in Spatsizi Wilderness Park in British Columbia (Hatler 1986; Bergerud et al 1984). Bergerud et al. (1984) described this dispersal to high elevation calving sites as an anti-predator strategy, in which caribou move away from valley bottoms where presumably moose and predator densities are higher. Predators, like wolves and bears, are forced to search widely for calves and thus face reduced success.

The effect of late snow melt on calf survival is considered critical in studies conducted in northern British Columbia (Bergerud and Page 1987). As found in this study, calf survival is higher after springs of relatively limited snow cover. Bergerud and Page (1987) concluded that late springs (extensive snow cover) prevent wide dispersal of caribou cows away from the abundance of alternate prey and predators at low elevations, and thus result in a higher vulnerability of their calves to predation (i.e., less search area for predators).

In contrast Gauthier (1985) and Hatler (1986) monitoring differences in calf survival from birth to five months over several years in southwest Yukon and Spatsizi Wilderness Park, respectively found no such relationship between late snow melt in spring and poor survival of calves. Both studies suggested that inclement weather during calving and post-calving is the most likely cause of yearly variations in calf survival (Gauthier 1985; Hatler 1986). Table 9 presents rainfall data for June at Grande Cache. In some years there was a relationship between rainfall in early to mid June and calf percentages the following October; e.g. 1984 and 1986 when above average rainfall and lower than average calf survival occurred, and 1985 and 1987 when lower than average rainfall corresponded with above average calf survival. However, in other years when such a relationship would be expected, like 1981 or 1983, this did not occur. It may be that the additional stress of inclement weather during calving further aggravates poor calf survival but our data does not show a clear relationship. Our study suggests that late springs with continuous snow cover through April and May inhibited the movement of pregnant cows to high elevation calving areas and this factor had a greater influence on calf survival than did inclement weather at time of calving. Appendix 2 presents data from 1990 that continues to show this trend.

RCF chose a variety of forested and alpine habitats for calving. This behaviour may also be an anti-predator strategy as it reduces the predictability of a predator finding cow/calf pairs. However, most calving sites, particularly in 1987 and 1988, were above 1600 m and in early June showed only the bare beginnings of "green up". As well, many of the alpine sites chosen for calving had low vegetation cover. Vegetation in valley bottoms and lower elevation winter ranges was more abundant and further advanced in spring growth, so it would appear that dispersal to higher elevation habitat for calving was a predator avoidance tactic that was carried out at the expense of the cow's nutritional needs. Such a trade-off of nutritional needs for predator avoidance is described by Bergerud et al. (1984) for mountain caribou in British Columbia and Festa-Bianchet (1988) for bighorn sheep in Alberta. However, the selection of southeast through west slopes (Table 5) where snow cover left quickly and plants correspondingly leafed and flowered, could have allowed a lactating cow access to nutritious forage within a few days of calving.

Cow/calf pairs localized their movements in early June (1-15) and did not substantially increase their ranges until after July (Tables 4 and 5). Bergerud and Page (1987) documented similar behaviour for cow/calf pairs in the mountains in northern British Columbia, and described this as a tactic to reduce detection by predators, particularly if the calving spot chosen is in a location that minimizes encounters with predators.

Seventy-six percent of the cow/calf pairs located at calving in 1987, 1988 and 1989 were found on bare patches of ground. Those sites were often on southerly facing slopes, having generally patchy snow cover. Cow/calf pairs in the alpine were difficult to see, even with the radio-signal for guidance, because their colouring provided an effective camouflage against the mosaic of brown bare ground and snow. Eastland et al. (1989) described the preference for patchy snow-covered ground for calving by the Porcupine caribou herd in Yukon and Alaska. The authors of that study supported the ideas put forward by Bergerud and Page

Table 9 Precipitation in June at Grande Cache and percentage calves in composition counts in October, 1981 - 1989.

Year	Precipitation (rain - mm)			
	June 1-5	June 6-15	June total	% calves in October
1981	5.8	36.9	44.9	14
1982	8.4	5.2	32.4	11
1983	13.8	10.1	93.0	18
1984	4.0	33.5	66.3	10
1985	2.2	9.8	51.4	20
1986	5.0	28.6	41.6	11
1987	0	5.8	26.9	18
1988	16.8	23.8	82.5	16
1989	0	25.6	79.2	11
Mean	6.2	19.9	57.6	14

(1987), that the use of bare patches within snow covered terrain by cow/calf pairs minimizes detection and success of capture by predators.

Fidelity to a calving site was found to be strong in our study during 1987 and 1988 and a similar degree of fidelity was reported by Hatler (1986) for RCF in the mountains of Spatsizi Wilderness Park, British Columbia. Brown and Theberge (1985) found that about two-thirds of their RCF woodland caribou showed fidelity to calving sites in central Labrador over two years of monitoring. Both Brown and Theberge (1985) and Hatler (1986) described this as a homing behaviour. Hatler (1986) observed that this homing behaviour for calving sites was much stronger than any other seasonal distribution and this appeared to be the situation in our study. However, when severe environmental conditions occurred as were experienced in the spring of 1989 this fidelity was disrupted presumably due to a reluctance of cows to leave lowland winter ranges while snow continued to accumulate. Valkenburg et al. (1988) warn of making management decisions to protect calving sites or calving areas based on short term monitoring (<5 years) of calving distribution. As our study found, calving distribution and fidelity to calving sites was a relative situation, and thus it is important to ensure that caribou have access to a larger area for calving than was previously recognized.

Our study documented an upslope movement through June that continued through the summer and into the rut. This use of alpine and treeline habitat allowed a lactating cow and growing calf to take advantage of the elevation- and aspect-related phenological changes of plants in mountainous regions. As snow disappeared from higher elevations on north- and east-facing slopes, new plant growth, which is highly nutritious (Johnston et al. 1968) became available. In addition, persistent snow beds on north slopes and in the alpine habitat, as well as windswept ridge tops, were used by caribou for thermoregulation and insect avoidance.

In summary, our study found that pregnant caribou dispersed from their winter range in May to calve alone in a variety of habitats, primarily above 1600 m. This behaviour appeared to be an important anti-predator strategy for a cow to remove herself and her newborn calf from lowland habitat that may support more abundant and concentrated prey and predators. This behaviour appeared to be only partially successful over the years of this study, as the mean calf percentage in fall surveys (14%) suggested that these herds were not increasing (Bergerud 1978). In years like 1989, when snow conditions inhibited the dispersal of cows to high elevation calving sites, calf survival was lower than average and any gains in herd size made in "average" or "good" years may have been lost.

5.0 CONCLUSIONS

1. Pregnancy rates of RCF caribou in the study area were high (90%) and therefore primary calf production was not limiting the growth of herds in west-central Alberta.

2. Most of the calves were born between May 26 and June 8.

3. Calves made up 14% of the total caribou observed in rut and early winter composition counts obtained from 1981 to 1989.

4. Survival of the calves of radio-collared cows was lower in 1989 than in 1987 and 1988.

5. When spring snowmelt occurred at an average date or early, cows dispersed and travelled an average of 68 km from the winter ranges in May, to calve alone in a variety of alpine and subalpine habitats, with a mean elevation of 1840 m.

6. When snow cover continued through April to May, dispersal of radio-collared cows from the winter range was disrupted. Mean distance moved (46 km) from the winter range and mean elevation of calving sites (1635 m) were less than in years of average or early snow melt.

7. In years with severe winters or above average snowfall in April and May, calf survival was lower than in years with mild winters and early springs.

8. Movement by pregnant caribou away from lowland habitats with a higher prey and predator base was an anti-predator strategy and was carried out at the expense of the nutritional needs of a cow at calving.

9. In years when cow caribou were less dispersed and using lowland habitat for calving, newborn calves may have been more vulnerable to predation, which could account for survival rates to five months being lower than average.

10. Cow/calf pairs remained sedentary in June and expanded their summer ranges from July through to the rut.

11. Cow/calf pairs moved to higher elevations through June and primarily stayed at high elevations (>1700 m) throughout the summer, probably avoiding predators and following new plant growth as the snow line receded.

12. The dispersal of cows to high elevation, and solitary calving sites to avoid predators and ensure calf survival was only partially successful in the study area. The average calf component over a nine-year period was 14% (based on rut and early winter composition counts), indicating that these mountain caribou herds were not increasing.

6.0 LITERATURE CITED

Adams, L.G., B.W. Dale and F.J. Singer. 1988. Neonatal mortality in the Denali Caribou Herd. Pp. 33-34. In: Proceedings of the 3rd North American Caribou Workshop, Chena Hot Springs, Alaska 1987. Edited by R.D. Cameron, J.L. David and L.M. McManus. Alaska Dept. of Fish and Game, Wildl. Tech. Bull. No. 8.

Barrett, M.W., J.W. Noland and L.D. Roy. 1982. Evaluation of a hand-held net-gun to capture large mammals. Wildl. Soc. Bull. 10:108-114.

Bergerud, A.T. 1978. Caribou. Pp. 83-101. In: Schmidt, J.L. and D.L. Gilbert. Big Game of North America. Harrisburg, Penn. Stackpole Press.

——. 1980. A review of the population dynamics of caribou and wild reindeer in North America. Pp. 556-581. In: Proceedings of the 2nd International Reindeer/Caribou Symposia, Bros, Norway, 1979. Edited by E. Reimers, E. Gaare and S. Skjenneberg. Direcktoratet for vilt og ferskvannstisk, Tondheim, Norway.

——, H.E. Butler and D.R. Miller. 1984. Antipredator tactics of calving caribou: dispersion in mountains. Can. J. Zool. 62:1566-1575.

——, and R.E. Page. 1987. Displacement and dispersion of parturient caribou at calving as antipredator tactic. Can. J. Zool. 65: 1597-1606.

Brown, W.K. 1988. 1988 Fall classification and capture program. The Greater Jasper Ecosystem Caribou Research Project. Unpubl. Rept. pp.9.

——. 1989. Progress Report for the period May 1989 - October 1989. Greater Jasper Ecosystem Caribou Research Project. Unpubl. Rept. pp.32.

Brown, W.K. and J.B. Theberge. 1985. The calving distribution and calving-area fidelity of a woodland caribou herd in central Labrador. Pp. 57-67. In Proceedings of the 2nd North American Caribou Workshop, Val Morin, Quebec. 1984. Edited by T.C. Meredith and A.M. Martel. McGill Subarctic Research Paper No. 40. Centre for Northern Studies and Research McGill University, Montreal.

Burles, D., M. Hoefs and N. Barichello. 1984. The influence of winter severity on Dall sheep productivity in south western Yukon - a preliminary assessment. Bienn. Symp. North. Wild Sheep and Goat Counc. 4:67-84.

DesMeules, P., B.R. Simard and J.M. Brassard. 1971. A technique for the capture of caribou, *Rangifer tarandus*, in winter. Can. Field-Nat. 85:221-229.

Eastland, W.F., R.T. Bowyer and S.G. Fancy. 1989. Effects of snow on selection of calving sites by caribou. J. Mamm. 70(4):824-828.

Edmonds, E.J. 1986. Woodland Caribou Provincial Restoration Plan. Alberta For., Lands and Wildl., Fish and Wildlife Div. Unpubl. Rept. pp.74.

——. 1988. Population status, distribution, and movements of woodland caribou in west-central Alberta. Can. J. Zool. 66:817-826.

—— and M.I. Bloomfield. 1984. A study of woodland caribou (*Rangifer tarandus caribou*) in west-central Alberta. 1979-1983. Unpubl. Rept. Alta. Ener. and Nat. Res., Fish and Wildlife Div. pp.203.

Festa-Bianchet, M. 1988. Seasonal range selection in bighorn sheep: conflicts between forage quality, forage quantity, and predator avoidance. Oecologia (Berlin) 75:580-586.

Gauthier, D.A. 1985. Population limitation in the Burwash caribou herd, South-west Yukon. Ph. D. Thesis, University of Waterloo. pp.247.

Hatler, D.F. 1986. Studies of radio-collared caribou in the Spatsizi Wilderness Park area, British Columbia, 1980-1984. Spatsizi Association for Biological Research. Report #3. pp.202.

——. 1987. Perspectives on inventory of caribou in British Columbia. B.C. Min. of Envirn. and Parks and Spatsizi Association for Biological Research. Rept. No. 4. pp.93.

Johnston, A., L.M. Bezeau and S. Smoliak. 1968. Chemical composition and invitro digestibility of alpine tundra plants. J. Wildl. Manage. 32(4):773-777.

Miller, F.L. and E. Broughton. 1974. Calf mortality on the calving ground of Kaminuriak caribou. Canadian Wildlife Service Report Series No. 26, pp.25.

——, A. Gunn and E. Broughton. 1985. Surplus killing as exemplified by wolf predation on newborn caribou. Can. J. Zool. 63:295-300.

——, E. Broughton and A. Gunn. 1988. Mortality of migratory barren-ground caribou on the calving grounds of the Beverly herd, Northwest Territories, 1981-1983. Occ. Paper No. 66, Canadian Wildlife Service. pp.24.

Mohr, G.O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37:223-249.

Valkenburg, P., J.L. Davis and D.J. Reed. 1988. Distribution of radio-collared caribou from the Delta and Yanert herds during calving. Pp. 14-25. In Proceedings of the 3rd North American Caribou Workshop, Chena Hot Springs, Alask 1987. Edited by: R.D. Cameron and J.L. Davis. Alaska Dept. of Fish and Game. Wildl. Tech. Bull. No. 8.

Whitten, K.R., G.W. Garner, F.J. Mauer and R.B. Harris. 1991. Productivity and early survival of the Porcupine Caribou herd in relation to potential petroleum development. (in prep.)

APPENDICES

Appendix 1. Problems associated with live-capture of calves and the assessment of the timing of calf mortality.

The calf capture program was not successful. Most cows chose steep alpine slopes or treed habitat for calving which prohibited the use of a net gun or landing a helicopter. Weekly checks through June allowed an assessment of calf mortality based on timing of the disappearance of a calf (presumed dead). Calves disappearing in the first few days after birth may have died due to failure to thrive (poor condition of calf or cow), abandonment, accident, severe weather at time of birth (exposure) or predation. In general, caribou calves are followers, not hiders, and can follow their mothers within an hour of birth (Bergerud 1978). Within a week or two a calf should be sturdy and growing, and the mortality factors associated with condition at birth would be less.

The method of assessing cause of death based on timing of disappearance assumes a strong cow/calf bond through the summer. This was found not to be the case after July. On four occasions a radio-collared cow was observed without a calf during a relocation flight but on subsequent flights was observed with a calf. Even in open alpine habitat with a clear view of an area (>400 m from cow) no calf was seen but the calf was observed in later flights. Thus, continual checks of cow/calf pairs through August and September were not reliable to assess timing of death. However, during the rut, cow/calf bonding appeared to strengthen again, as bulls attending a harem maintained a cohesive group and did not tolerate cows or caves straying far from the group. Care and time had to be taken though, to determine which cow in a group had a calf. Cow/calf ratios shown in Table 1 were adjusted on the basis of whether a radio-collared cow was accompanied by a calf during the rut (i.e., final confirmation of calf survival to five months).

Appendix 2. 1990 information on calf production and survival, calving habitat and weather conditions.

Further data on the location of RCF during calving were collected in 1990. A survey on June 17, 1990 located six RCF and they all had newborn calves. Mean distance moved from the centre of their winter range to their calving site was 50 km and the mean elevation of cow/calf observations was 1850 m. Again, a variety of habitat was used. A population survey conducted on October 20-23, 1990 located 233 caribou of which 21% were calves. Nine RCF were observed and five RCF had a calf at heel. We could not confirm that the remaining four RCF did or did not have a surviving calf.

We believe that the high percentage of calves in the 1990 composition count is in good part due to the previous winter and spring weather. The 1989-90 winter was mild: winter severity index was 56, total snowfall was 131 cm, and April/May snowfall was 17 cm. RCF were able to leave the winter range and disperse to high elevations for calving. As in 1987 and 1988, RCF were located ten kilometers or more from each other.

Inclement weather at calving time did not seem to be a factor in the 1990 calf survival. June had a greater than average rainfall (75.4 mm), the majority of which fell between June 6 and 15 (64.5 mm). In addition, a very heavy rainfall (23.5 mm) occurred on May 30, at the beginning of calving. The fall calf percentages did not reflect these cool, wet conditions around calving.

The distances moved to calving sites in 1990 were not as great as in 1987 and 1988, however, the dispersal to high elevation was consistent and all three years had average or above average calf survival to 5 months.