SUMMARY OF THE 1999 POST CALVING AND RUT SURVEYS AND THE 2000 LATE WINTER SURVEY FOR THE ITCHA, ILGACHUZ AND RAINBOW MOUNTAINS, CARIBOO REGION

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March 2001

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ABSTRACT

As part of ongoing monitoring, the Itcha-Ilgachuz and Rainbow Mountains caribou population was surveyed aerially three times in an effort to determine population trends, sex ratios, and calf recruitment. The post calving survey completed on July 13, 14 and 21, 1999 observed a total of 1850 caribou; 936 cows, 404 calves, 294 bulls, 19 yearling cows, 26 yearling bulls and 171 unsexed animals. The observed percent calves was 21.9 in the Itcha-Ilgachuz Herd and 19.8 in the Rainbow Herd. No significant differences in elevation use were found among adult cows, cows with calves or yearlings; however, adult bulls and unclassified adults were both significantly different from all the age/sex groups. The 1999 October rut survey on October 19 and 20 observed 1038 caribou; 658 cows, 193 calves, 94 mature bulls, 90 immature bulls and 3 unclassified. The observed calves/100 cows and bulls/100 cows in the Itcha-Ilgachuz Herd were 29/100 and 26/100, respectively. In the Rainbow Herd the observed calf/100 cow ratio was 29/100 and the bull/100 cow ratio was 43/100. The late winter survey on April 11 observed 452 caribou, all of which were in forest habitats. The Itcha-Ilgachuz Herd calf percentage was estimated at 15.8% and the Rainbow calf percentage was assumed to be 13.0%. The Itcha-Ilgachuz Herd appears to be stable to increasing, with adequate calf recruitment and an increasing bull to cow ratio: the estimated population is 1900-2000 caribou with a density of 0.19 caribou/km^2. The Rainbow Mountains Herd showed greater calf recruitment numbers and a relatively high bull to cow ratio compared to recent years: the estimated population was 125 animals at a density of 0.028 caribou/km^2. Further studies coupled with population modelling will be necessary to confidently produce a long-term caribou strategy as required by the Cariboo-Chilcotin Land Use Plan (CCLUP).

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INTRODUCTION

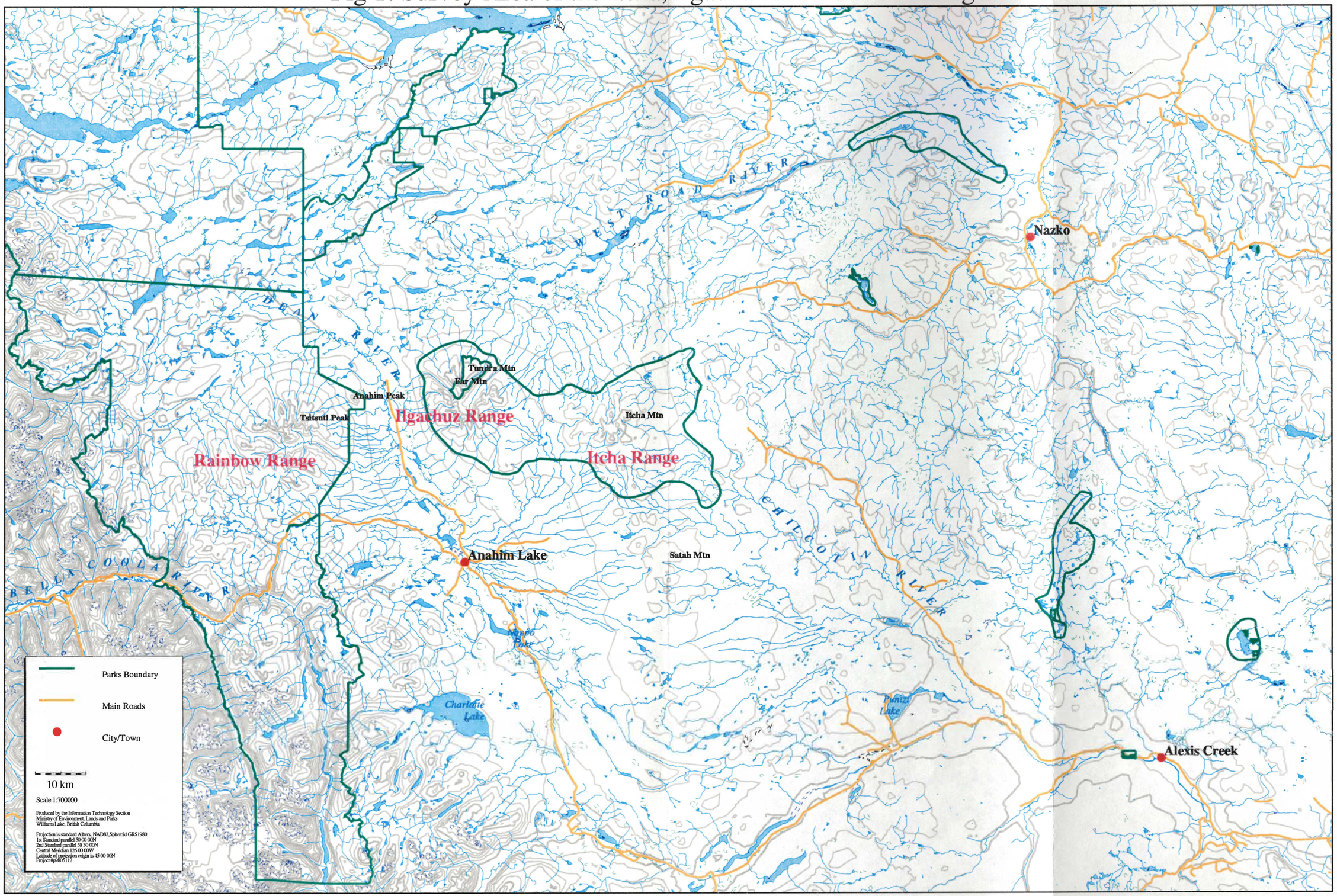
Caribou (*Rangifer tarandus caribou*) from the Itcha-Ilgachuz Mountains Herd and the Rainbow Mountains Herd in some years share a common winter range, thus for management purposes, they are considered two herds of the same population (Hatler, 1987). As such, aerial caribou population surveys were completed in July and October of 1999 and in April of 2000 throughout the Itcha, Ilgachuz, and Rainbow Mountains. These surveys contribute to developing a long-term caribou strategy as outlined in the Cariboo-Chilcotin Land Use Plan (CCLUP). Planned timber harvesting in the mature pine forests surrounding the Itcha-Ilgachuz Mountains will significantly decrease available terrestrial and arboreal lichens foraged upon by caribou in the winter months. Reduced winter habitat may impact the abundance and composition of the caribou population; therefore, population monitoring is required to provide a benchmark, as planned logging continues to expand throughout much of their range. The post calving survey attempted to measure the relative abundance of the breeding female component and early calf production. The rut survey estimated the sex composition and summer calf survival. The late winter survey compared the proportions of forest and alpine-dwelling cows with calves as well as the overall calf recruitment. Observations of radio-collared caribou provided a sightability index for the post calving survey and an additional measurement of calf production through the survey period. Future surveys of the same area and the previous results will provide quantifiable population trends to aid wildlife managers.

We wish to thank Pat Dielman, Lara Roorda, Stefan Himmer, Chris Schmid, and Ken Owens for serving as observers during the surveys. Michaela Waterhouse provided statistical advice and performed the Scheffe Multiple Range Test. Debbie Cichowski provided her unpublished population survey data from the mid-1980's. Project funding was provided by Forest Renewal British Columbia (FRBC).

SURVEY AREA

The Itcha, Ilgachuz and Rainbow Mountain Ranges are situated in a plateau region of mature lodgepole pine (*Pinus contorta*) forest interspersed with wetlands and meadows within Management Units 5-10, 5-11 and 5-12 of the Cariboo Region (Figure 1). Once active volcanoes, the mountains now contain gently rolling alpine areas chosen by caribou for calving and rutting. All alpine areas are protected; Tweedsmuir Provincial Park surrounds the Rainbow Mountain Range and the Itcha and Ilgachuz Mountain Ranges now lie within the newly protected Itcha-Ilgachuz Provincial Park. The survey area is within the Western Chilcotin Uplands Ecosection and is characterized by two biogeoclimatic zones at the higher elevations; the Alpine Tundra zone and the Engelmann Spruce Subalpine Fir, very dry, very cold sub-zone. The total area known to be inhabited by the Itcha-Ilgachuz caribou herd and Rainbow Mountains caribou herd is 10,0042 km^2 and 4,409 km^2, respectively.

Fig 1: Survey Area of the Itcha, Ilgachuz and Rainbow Ranges



METHODS

Aerial surveys were completed in a Bell 206 Jet Ranger utilising the total count technique (Resource Inventory Committee 1997). The surveys were restricted to high strata habitats, where under the proper conditions, animal sightability is high. This included the Itcha Flats wetland complex, alpine and adjacent parkland habitat and the larger wetlands between the Itcha and Ilgachuz Mountains. Mountain complexes were flown in a counter clockwise manner to allow observers on the left side of the aircraft to scan the open habitat for caribou. The observer in the back right-hand seat provided additional coverage when necessary, particularly in the flatter terrain. Several of the wider ridges required more than one pass (see flight maps for details). Radio-collared caribou not observed during the systematic survey were subsequently searched out and recorded separately. In this way, caribou numbers visually observed each year could be compared directly, and data collected from all radio-collared caribou could still be gathered and used for separate purposes.

The post calving survey flights on July 13 and 14 (Itcha and Ilgachuz Mountains) and July 21, 1999 (Rainbow Mountains) included pilot Tom Arduini, Pat Dielman (navigator), Lara Roorda (observer/navigator), Stefan Himmer, and Ken Owens. The survey was delayed until mid-July as a result of poor weather conditions. Flight time totalled 18.6 hours in mostly clear conditions with some high overcast; however, due to deteriorating weather conditions on July 14, the Rainbow Mountain portion of the survey was further delayed. Caribou were classified into the following categories; cow, calf, yearling cow, yearling bull, or bull. UTM co-ordinates were recorded for each group of animals to digitally produce flight maps and elevation groupings.

The rut survey flights on October 19 and 20, 1999 included pilot Tom Arduini, Lara Roorda (navigator), Stephen Himmer, and Chris Schmid. Flight time totalled 13.6 hours in good visibility conditions. Caribou were classified as mature bulls, immature bulls, cows and calves. Due to the difficulty of classifying large groups of caribou, both male and female yearlings were included in the cow classification.

The late winter survey flights on April 11, 2000 included pilot Tom Arduini, Nicola Freeman (navigator), Pat Dielman, and John Youds. This survey, normally undertaken in March, was delayed due to poor weather conditions. Flight time totalled 7.3 hours in moderate conditions of high-overcast clouds. Alpine and forest areas were searched using radio-telemetry to locate groups containing radio-collared females. Animals were classified as either adults or calves.

Caribou not delegated to a specific category due to large group size or visibility difficulties encountered during the surveys were counted as unclassified caribou; however, when possible, yearlings and adults were distinguished from each other and counted separately as unsexed adults and unsexed yearlings. Unclassified animals were removed from the sample for calculations of percent calves and percent bulls.

Estimates of cow caribou abundance were derived using the Joint Hypergeometric Estimator (JHE) and the NOREMARK computer statistical package by Gary White (1996). The JHE is an extension of the Peterson Method (White & Garrot 1990) used in previous population reports and is now the Resource Inventory Committee (RIC) standard method for mark recapture estimates in closed populations with only one sighting occasion. A sighting occasion is an attempt to view animals in a population, keeping track of the number of marked and unmarked animals observed. This model assumes that individual marked animals have the same probability of sighting as every other individual within the population on a given occasion.

The joint maximum likelihood estimator of mark-resight is the value of N that maximizes the likelihood:

$$£(N \mid M, n_i, m_i) = \prod_{i=2}^{k+1} \frac{(M/m_i) \times [(N-M)/(n_i-m_i)]}{(N/n_i)}$$

Where n_i and m_i are the total number of animals observed and the number of marked animals observed, respectively, on sighting occasion i, i=2, . . ., k+1. The number of available marked animals located within the survey area at the time of the i^{th} sighting, are defined as M. Computerised optimization is required to find N, the estimated population size. The 95% confidence interval is constructed directly from the likelihood. As such, estimates of the lower and upper confidence bounds are the values of N that produce values of the log likelihood which are 2 units less than the value of the log likelihood at the maximum (White & Garrot 1990). With this type of confidence interval the lower confidence bound is never estimated at a value less than the minimum number of animals known to exist.

The following attributes, adapted from Simpson et al. (1993), were used to classify individual animals:

Class III Bulls:	large, heavy beamed antlers
(Mature Bull)	antlers often have many points and palmated brow tine
	body size
	testicles or penis sheath
	lack of vulva patch
Class II Bulls:	antlers larger than females and smaller than Class III
(Medium Bull)	body size
	testicles or penis sheath
	lack of vulva patch

Cows:	small antlers black vulva patch presence of calf or yearling short face for yearlings
Calf:	body size dark bodies lack of antler development proximity to adults

RESULTS

Post Calving Survey

A total of 1850 caribou were observed on the July 13, 14 and 21 flights; 936 cows, 404 calves, 19 yearling cows, 26 yearling bulls, 99 unsexed yearlings, 72 unclassified adults, and 294 bulls (Table 1 and Appendix 1). The observed calf to 100 cow ratio in the Itcha-Ilgachuz Herd was 43.6/100 and the bull to 100 cow ratio was 31.5/100. Both the observed calf/100 cow ratio and the bull/100 cow ratio were lower in the Rainbow Herd at 35.2/100 and 29.6/100, respectively. In the Itcha-Ilgachuz area, there were 11.1 yearlings/100 adult caribou; this ratio was lower at only 10.0 in the Rainbow Mountains area.

Table 1. Caribou Observed July 13, 14 and 21, 1999 within the Itcha, Ilgachuz and Rainbow Mountains.

Mountain Range	Total Caribou	Cows (>1yrs)	Calves	Bulls (>1yrs)	Yrlg.-Cows	Yrlg.-Bulls	Unsexed Yrlgs.	Unsexed Adults
Itcha	1017	513	205	207	10	9	73	0
Ilgachuz	737	369	180	71	3	16	26	72
Rainbow	96	54	19	16	6	1	0	0
Itcha-Ilgachuz	1754	882	385	278	13	25	99	72
Itcha-Ilgachuz-Rainbow	1850	936	404	294	19	26	99	72

Average elevations of each age/sex group during the post calving surveys ranged from 1730m to 1834m (Figure 2). Each group was appointed one elevation regardless of group size, which ranged from 1 to 409 caribou. Overall mean group size was 34 caribou (N=55); when herds greater than 100 (N=5) caribou were omitted, mean group size was

13 animals. Hence, the data may be weighted by the occurrence of large groups, resulting in non-normality, and small groups at different elevations may be under-weighted due to the presence of large bands of caribou. To account for this, elevation data was ranked and the distributions of the variates were compared with Scheffe's test, a conservative non-parametric analysis of variance (one way ANOVA) using the program SAS. Since the majority of the yearlings were unclassified, resulting in small sample sizes of yearling bulls (26) and yearling cows (19), all yearlings were lumped into one category (Figure 2). Scheffe's test found elevation use among the adult bulls and the unclassified adults significantly different from each other and the rest of the sex/age groups; both were observed at lower elevations than the other categories, with the unclassified adult group being the lowest. No significant differences were observed between the adult cow, adult cow with calf, or the yearling sex/age categories (Appendix 2).

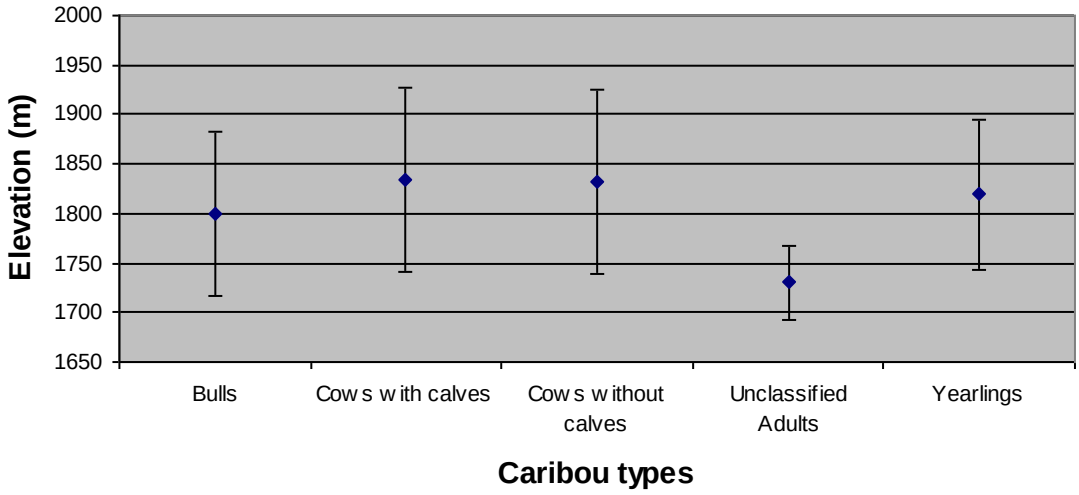


Figure 2. Average elevation of caribou population segments with 95% confidence intervals in July 1999.

October Rut Survey

A total of 1038 caribou were observed during the October 19 and 20, 1999 rut survey flights; 658 cows, 193 calves, 94 mature bulls, 90 immature bulls, and 3 unclassified adults (Table 2 and Appendix 3). Yearling caribou were included within the cow classification. The observed calf/100 cow ratio in the Itcha-Ilgachuz Herd was 29.4/100 and in the Rainbow Herd the ratio was 28.6/100. There were 328.6 mature bulls/100 immature bulls and 42.9 bulls/100 cows in the Rainbow Herd compared to 85.5 mature bulls/100 immature bulls and 26.2 bulls/100 cows in the Itcha-Ilgachuz Herd.

Table 2. Caribou observed on October 19th and 20th, 1999 within the Itcha, Ilgachuz and Rainbow Mountains.

Mountain Range	Total Seen	Cows	Calves	Mature Bulls	Immature Bulls	Unsexed Adults
Itcha	753	478	142	57	75	1
Ilgachuz	165	110	31	14	8	2
Rainbow	120	70	20	23	7	0
Itcha-Ilgachuz	918	588	173	71	83	3
Itcha-Ilgachuz-Rainbow	1038	658	193	94	90	3

Late Winter Survey

A total of 452 caribou were observed during the late winter survey on April 11, 2000 (Table 3 and Appendix 4). From previous population surveys and radio-telemetry information, the caribou in the alpine on the north side of the Ilgachuz Mountains and in the Anahim Lake area were assumed to have calved in the Rainbow Mountains. The caribou on the north side and in the forests to the north, south and east of the Itcha Mountains were assumed to have calved in either the Itcha or Ilgachuz Mountains. The Itcha-Ilgachuz Herd calf percentage was observed at 15.8% and the Rainbow Herd calf percentage was observed at 13.0%. The overall calf percentage was 15.3%. Although searched, no caribou were observed in the alpine in the Itcha Mountains or on the north side of the Rainbow or Ilgachuz Mountains.

Table 3. Caribou observed April 11, 2000 in the Itcha, Ilgachuz and Rainbow Mountains and surrounding areas.

Caribou Herd	Mountain Range	Habitat Type	Total Classified	Adults	Calves
Itcha-Ilgachuz	Itcha	Alpine	0	0	0
	Itcha-Ilgachuz	Forest	360	285	57
		Total	360	285	57
Rainbow	Rainbow	Alpine	0	0	0
	Ilgachuz	Alpine	0	0	0
	Rainbow-Ilgachuz	Forest	92	78	12
		Total	92	78	12
Itcha-Ilgachuz-Rainbow	Combined	Alpine	0	0	0
	Combined	Forest	452	363	69
		Total	452	363	69

Annual Calf Survival Trend

The calf percentage in the Itcha-Ilgachuz Herd dropped from 21.9% in July to 18.9% in October. By April, the calf percentage decreased to 15.8%. The calf percentage for the Rainbow Herd started in July at 19.8%, dropping to an observed 16.7% in October, and then 13.0% in April (Figure 3). A similar trend is evident in the calf/100 cow ratio of the relocated radio-collared animals. In the July survey, 2 of the 6 radio-collared cows in the Rainbow Herd had calves. None of the 6 cows were observed with calves in the October or April survey, the latter having only 5 radio-collared cows remaining in the sample. In the Itcha-Ilgachuz Herd, 10 of 22 had calves in the July survey, 7 of 20 had calves in October, and 6 of 20 had calves in April (Figure 4).

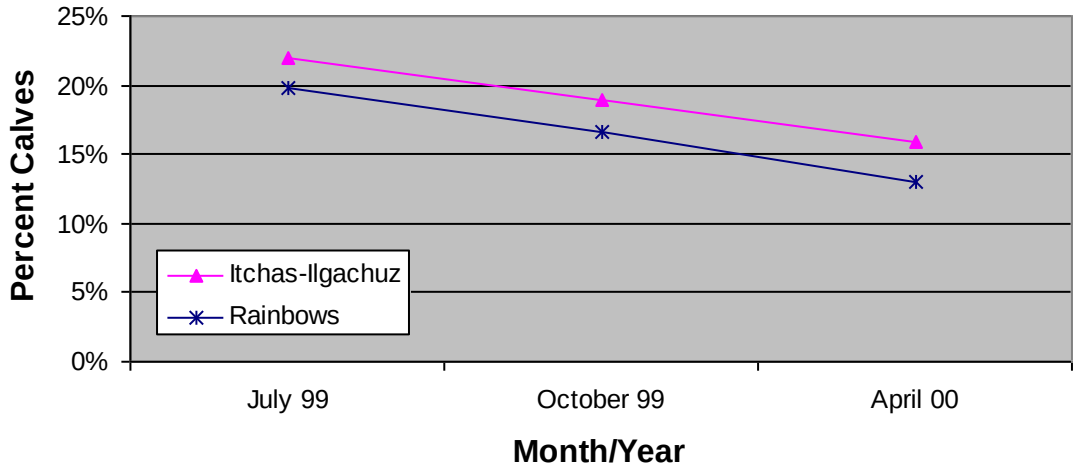


Figure 3. Calf percentage observed in the post calving, rut and late winter population surveys of the Itcha-Ilgachuz and Rainbow Mountains Herds.

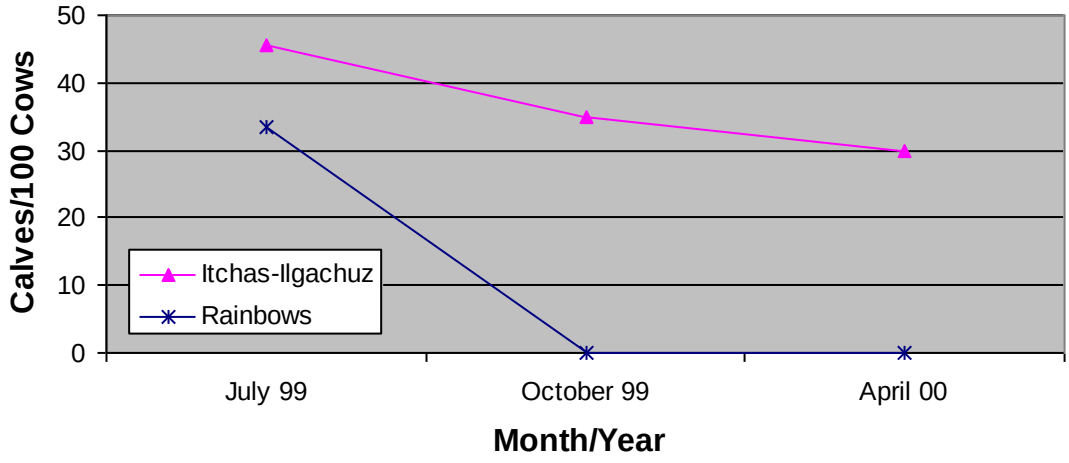


Figure 4. Calves/100 cows observed in the post calving, rut and late winter population surveys of radio-collared caribou in the Itcha-Ilgachuz and Rainbow Mountains Herds.

Survey Costs

Helicopter rental costs totalled $25,257.86 (or 39.5 helicopter hours) for all surveys. Wildlife staff committed 25 person days for pre-planning, surveys and report completion.

DISCUSSION

Fewer caribou were observed in this year's post calving survey (1850) than in the previous year, however numbers appear to be increasing (1466 in 1995 and 2219 in 1998; Loveridge and Young, 1997 and Young et al., 1998). The Itcha-Ilgachuz 1999 July calf/100 cow ratio of 44/100 was lower than the 1997 and 1998 Itcha-Ilgachuz calf/100 cow ratio (56calves/100cows and 55calves/100 cows). The 1999 post calving Rainbow Herd ratio of 35 calves/100cows, also observed in 1997, was lower than last year's ratio of 44calves/100cows. Post-calving surveys indicate that the Itcha-Ilgachuz Herd remained relatively stable during the late 1980's and early 1990's (Figure 5). There appears to have been an increase in caribou numbers over the past five years, likely due to actual increases and better overall sightability.

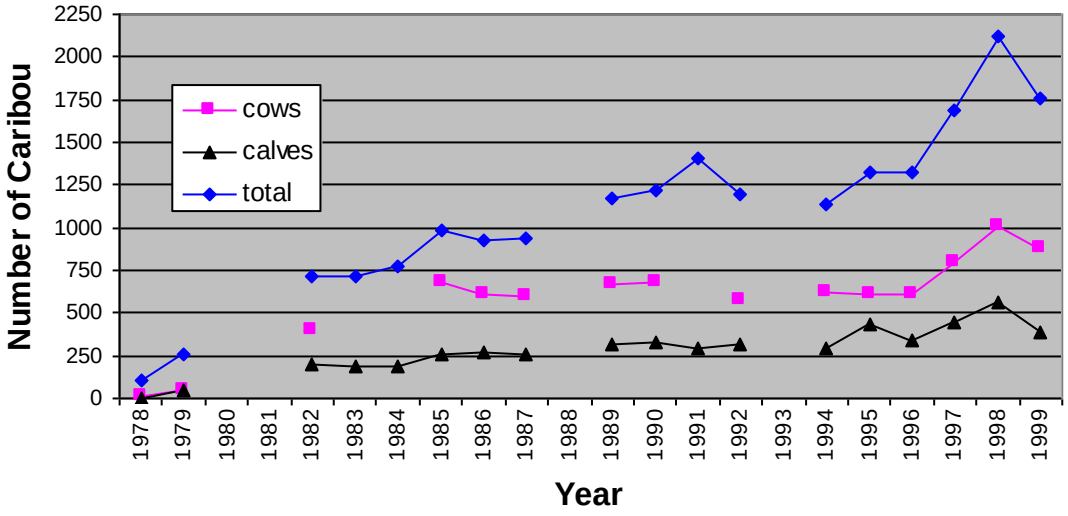


Figure 5. Summary of caribou post calving surveys for the Itcha-Ilgachuz Mountains Herd.

Bergerud (1978) counted 310 caribou in the Itcha and Ilgachuz Mountains in 1973, and suggested there was a maximum of 400 animals in the herd during the mid 1970's. During the late 1970's and early 1980's, surveys undertaken by regional wildlife staff observed a dramatic increase in caribou numbers (Smith and Hebert 1986). The Itcha-Ilgachuz Herd is currently estimated at 1900-2000 animals (post hunting season) with a density of 0.19 caribou/km^2; surveys have observed healthy calf production, a stable breeding female component and a relatively stable bull/100 cow ratio. Over the past five years post calving surveys have observed bull/cow ratios of approximately 35 bulls/100 cows, which is the provincial target for post season estimates (Figure 6). There may be

an unaccounted-for sightability bias during rut surveys, resulting in lower bull/cow ratios being observed at that time (Figure 7).

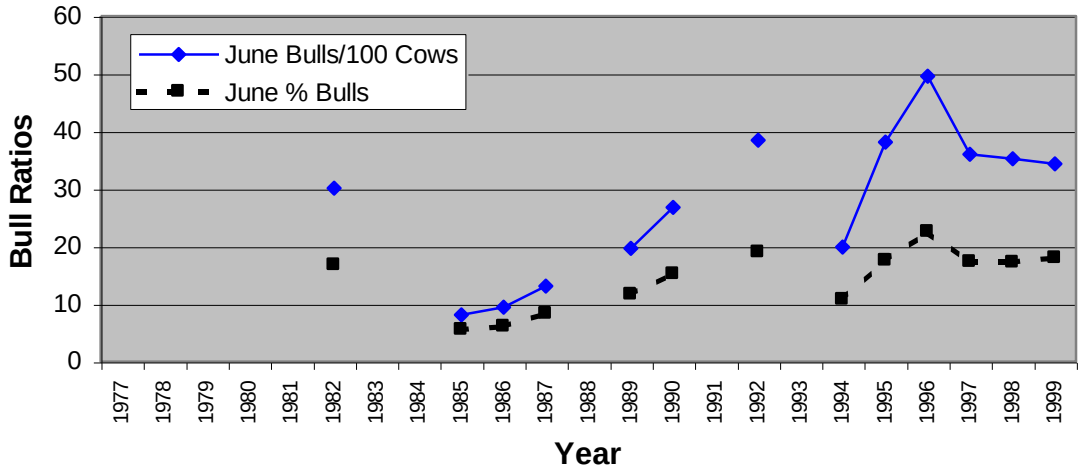


Figure 6. Summary of post-calving bull ratios for the Itcha-Ilgachuz Mountains Herd for all years (1991 omitted due to small sample size).

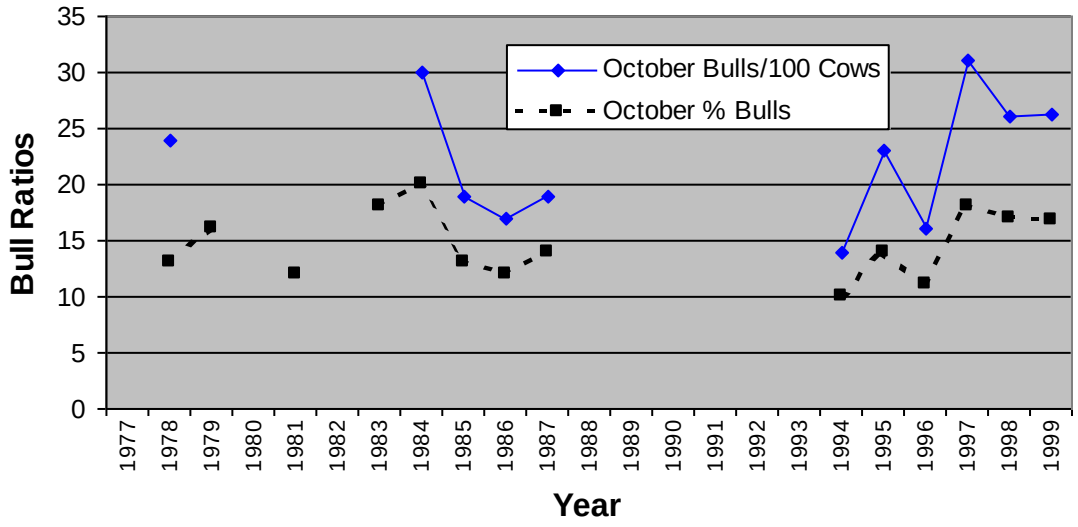


Figure 7. Summary of caribou rut surveys for the Itcha-Ilgachuz Mountains Herd detailing observed bull ratios for all years (1979, 1981 and 1983 estimates are minimums as there were numerous unclassified caribou, which may have included immature bulls, for these surveys).

Ritcey (1956) estimated 100-150 caribou in the Rainbow Mountains in 1956 after seeing 68 while walking during the summer. Bergerud (1978) estimated the Rainbow Herd likely peaked in the late 1960's at 200-300 animals after he observed only 41 caribou during a survey in 1977. There have been few complete surveys in the Rainbow Mountains, but the Rainbow Herd is now estimated at about 125 animals with a density of 0.028 caribou/km^2 and has appeared to remain stable since the mid 1980's with a relatively high mature bull to immature bull ratio (Figure 8).

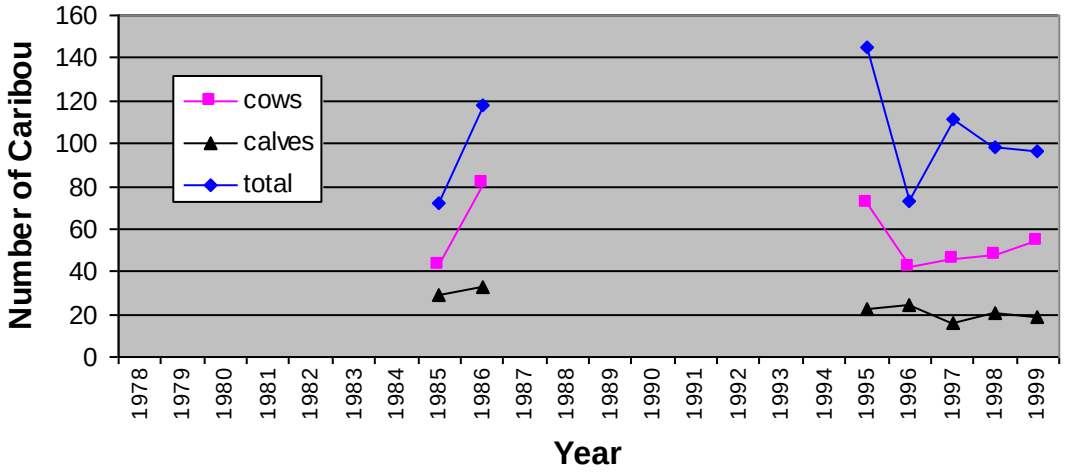


Figure 8. Summary of caribou post calving surveys for the Rainbow Mountains Herd.

During the post calving survey, mature females (two years and older) were included in the cow component during classification. As most two-year old caribou do not bear young and many three-year olds are not parous the results overestimate the number of reproducing females (Bergerud 1983).

When the yearling/100 adult ratios from June 1996-1999 surveys were compared to the March 1996-1999 calf/100 adults ratios, there was generally good correlation (Table 4). The exception being a substantial drop in the estimates from March 98 to June 98 in the Rainbow Herd. In 1999 the Itcha-Ilgachuz and Rainbow ratios decreased from March to June in a similar magnitude. These findings suggest that the results from the June surveys may be adequate to estimate the previous year's recruitment if seasoned observers are utilised that are able to differentiate yearlings from adults.

Table 4. Caribou calves and yearlings/100 adults for March and June in the Itcha-Ilgachuz and Rainbow Mountains Herds.

	Itcha-Ilgachuz Herd		Rainbow Herd	
Year	March calves/100 adults	June yrlg./100 adults	March calves/100 adults	June yrlg./100 adults
1996	27.1	22.9	12.5	11.4
1997	19.8	20.4	2.9	3.3
1998	15.5	13.0	7.3	2.7
1999	20.8	11.1	14.0	9.6

Sightability corrections were made to the survey information from 1985-87 and 1996-99 to estimate total cow numbers in June within the Itcha-Ilgachuz Herd (Figure 9). Data from the 1980's included yearlings with the cow count and therefore overestimated the female breeding population. The 1996-99 estimates included only two year and older cows and excluded bulls, yearlings, and calves. Although these differences make it

difficult to directly compare the data between the late 1980's and the 1990's, it indicates the same generally stable to increasing population trend as found in Figure 5.

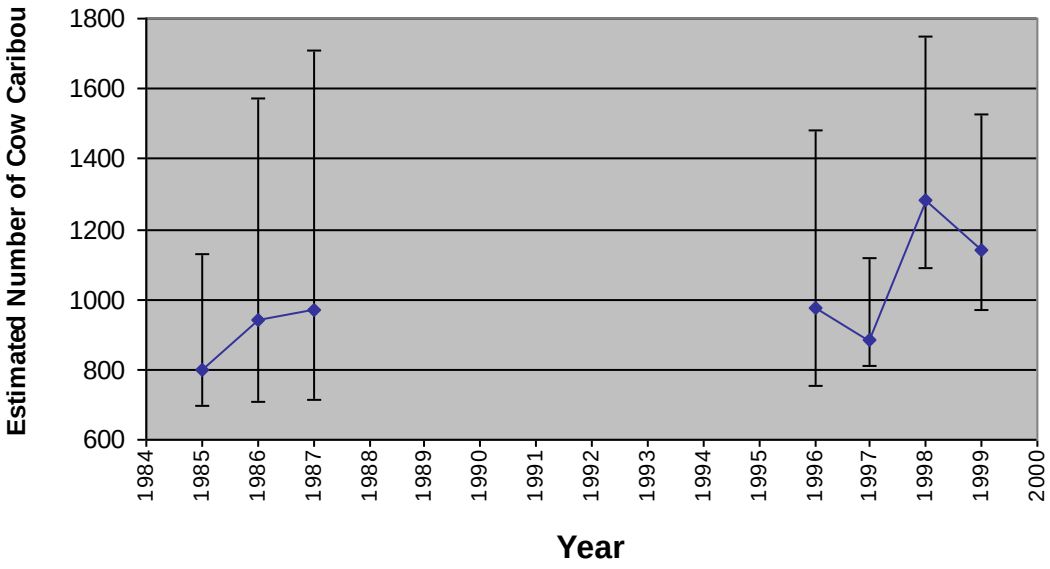


Figure 9: Estimated number of cow caribou in the Itcha-Ilgachuz Herd, post calving, and 95% confidence limits using collared animals to correct for sightability. Estimates in the 1980's included cows and yearlings, while 1996-99 data included only cows (1985-87 estimates; Cichowski unpubl. data).

Aggregation of caribou in late Spring and early Summer may introduce bias into the population estimate derived from the post-calving survey results. When sighting probability is a function of group size, such that larger groups of caribou have a greater probability of being sighted than smaller groups, bias of the estimate may occur as a result of violating the assumption of independent observations (Neal et al. 1993, Samuel et al. 1987). The potential for overestimation increases with aggregation; however, Neal showed that relative confidence interval length did not change regardless of whether animals grouped or whether increasing group size increased the probability of being observed.

The annual migration to the alpine spring calving grounds is thought to be an anti-predator strategy by caribou to distance themselves from predators. By distancing themselves from other prey types, predator search time is increased making it less energetically favourable to subsist on a diet of caribou. Cows and calves are the most vulnerable segments of the population during calving and therefore tend to seek out the highest elevations. Bulls are often the last to migrate, choosing instead to feed on higher quality forage found at lower elevations. Elevation use of adult bulls was significantly different from the adult cow, adult cow with calf, and the yearling sex/age categories during the July survey. The average elevation of caribou locations in the July 1999 survey was 1812m, substantially lower than previous years (1947m and 1917m in 1998

and 1997, respectively). Data from the Environment Canada weather stations at Lunch Lake (approximately 90m SE of Anahim Lake) and Kleena Kleene (65km SE of Anahim Lake) showed temperatures 2.5°C and 1.6°C below normal for the month of May 1999 (Table 5).

Table 5. Average monthly temperatures at Lunch Lake and Kleena Kleene weather stations for April and May 1996-1999 (normal temperatures calculated from 1980-1992).

Year	Location	April Avg Temp. (°C)	April Normal Temp. (°C)	May Avg Temp. (°C)	May Normal Temp. (°C)
1996	Lunch Lake	4.4	3.4	5.7	7.7
1996	Kleena Kleene	4.5	3.6	5.9	7.8
1997	Lunch Lake	3.5	3.4	8.3	7.7
1997	Kleena Kleene	3.9	3.6	8.8	7.8
1998	Lunch Lake	3.3	3.4	11.3	7.7
1998	Kleena Kleene	3.9	3.6	11.7	7.8
1999	Lunch Lake	incomplete	3.4	5.2	7.7
1999	Kleena Kleene	3.0	3.6	6.2	7.8

In 1996, bull numbers in the Itcha-Ilgachuz Herd appeared to be decreasing (16 bulls/100 cows in the October rut survey) based on post season rut surveys (Figure 7); however, the following year noted an increase in bull numbers to 31.1 bulls/100 cows. In 1998 and 1999 ratios were fairly consistent at 26.4 and 26.2 bulls/100 cows respectively (Table 6).

Table 6. Rut survey bulls/100 cows ratios and mature bulls/100 immature bulls, 1995-1999.

Year	Itcha-Ilgachuz Herd			Rainbow Herd		
	Bulls/100Cows	Mat. Bulls/100 Imm. Bulls	% Calves	Bulls/100Cows	Mat. Bulls/100 Imm. Bulls	% Calves
1995	23/100	89/100	24.6%	36/100	291/100	9.0%
1996	16/100	55/100	18.2%	24/100	92/100	7.1%
1997	31/100	115/100	13.5%	27/100	175/100	2.8%
1998	26/100	91/100	17.1%	27/100	300/100	12.1%
1999	26/100	86/100	18.8%	43/100	329/100	16.7%

There is no hunting season of caribou in the Rainbow Herd and the male component of the Itcha-Ilgachuz Herd is harvested under a mature bull regulation. We have limited information on the effects of sustenance hunting on this population, and there is some speculation that compulsory reporting, required in 1995-1996, was not as effective as compulsory inspection in obtaining accurate harvest values. Thus, compulsory inspections became required once again in 1997 and more accurate accounts of hunting activity have since been recorded. Between 1985 (the year the mature bull season was implemented) and 1994 (when compulsory inspection was required) the average annual harvest was 27 bulls (Appendix 5). Estimates from reported harvest values for 1995 and 1996 were 11 and 26 respectively. The 1997 and 1998 harvests were 26 and 40 bulls. In 1999, annual harvest was 29 bulls representing approximately 1.5% of the entire population.

There is presently no method of determining the amount of mixing between the Itcha-Ilgachuz Herd and the Rainbow Herd, and therefore a small bias must be considered when interpreting sex ratios. In the past five years, the Itcha-Ilgachuz Herd ratio of mature bulls to immature bulls has been much lower than the Rainbow Herd (Table 6).

In the 1980's greater numbers of bulls were observed during rut surveys than post-calving surveys (Figures 6 and 7). Although bull numbers have been fairly consistent over the last five years, October results have shown both herds below the provincial target of 35 bulls/100 cows post season. In 1999 the Rainbow Herd was observed to exceed the target value at 43 bulls/100 cows. The fact that recent post calving bull/cow ratios were substantially higher and the harvest has been relatively low may indicate some sightability bias during the rut surveys. Post calving surveys observe more of the population and may better represent sex ratios.

Of the Rainbow Herd caribou observed in the late winter survey, 13.0% were calves. This does not fulfil the minimum calf percentage of 15-16% suggested by Bergerud (1992) needed to balance the natural mortality of adults and maintain population stability. In previous years recruitment was substantially lower indicating an hypothesised predatory influence (11.1% in 1996, 2.8% in 1997, 6.8% in 1998, 12.5% calves in 1999; Figure 10). In the last five years calf percentages were above the 15-16% mark in the Itcha-Ilgachuz Herd for both the rut and late winter surveys, with the 1997 exception of 14.9% and 13.4%, respectively (Figure 11). Similar trends were observed with radio-collared cows (Figures 12 and 13). The decrease in mortality rate following the summer is expected, as calves become less vulnerable to predation with increased size.

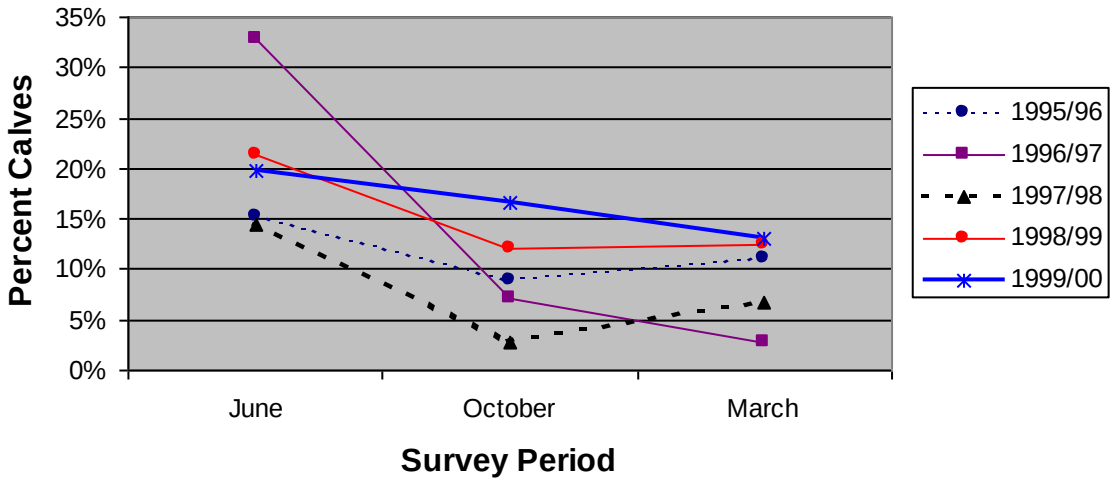


Figure 10. Summary of observed caribou calf survival for the Rainbow Mountains during the last five caribou years.

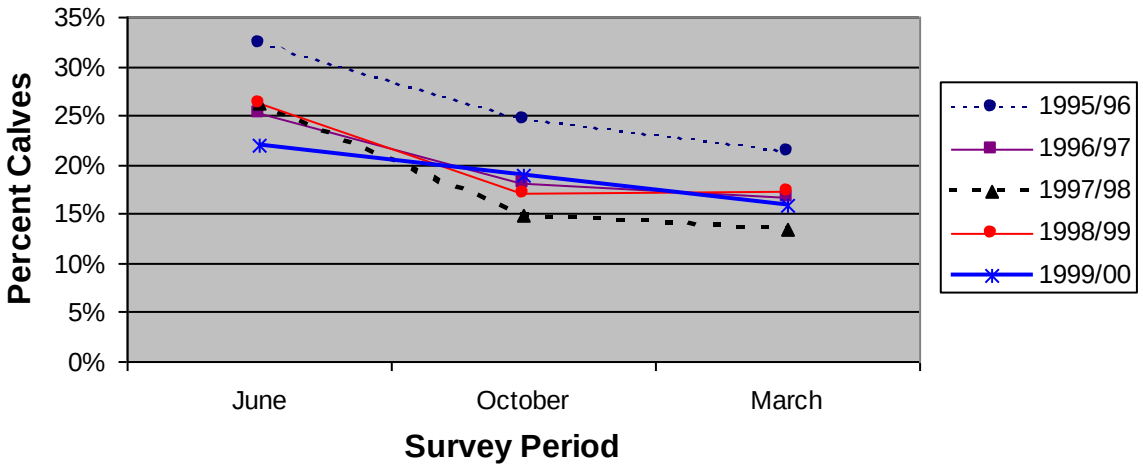


Figure 11. Summary of observed caribou calf survival for the Itcha-Ilgachuz Mountains during the last five caribou years.

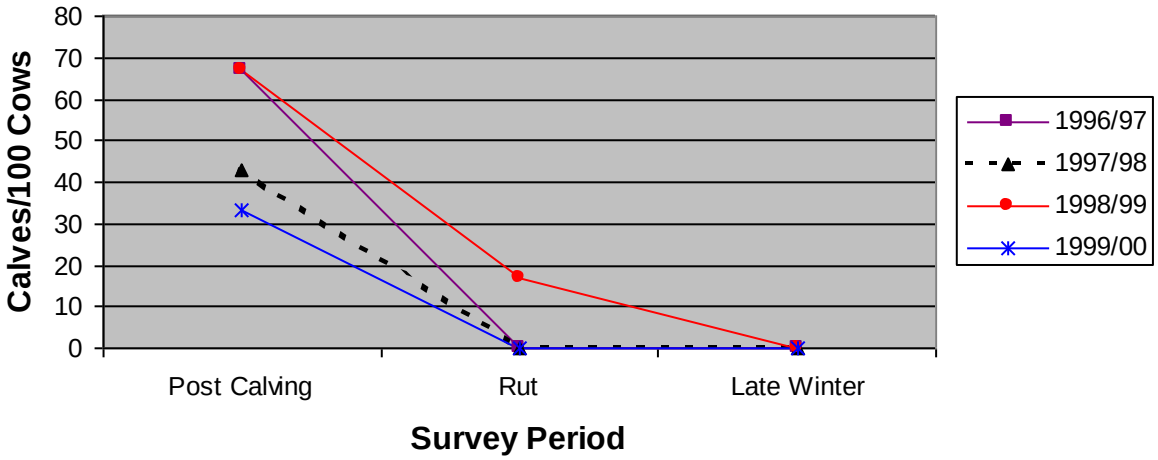


Figure 12. Calf survival ratios of radio-collared cows in the Rainbow Mountain Herd from post calving, rut and late winter surveys (1996-2000).

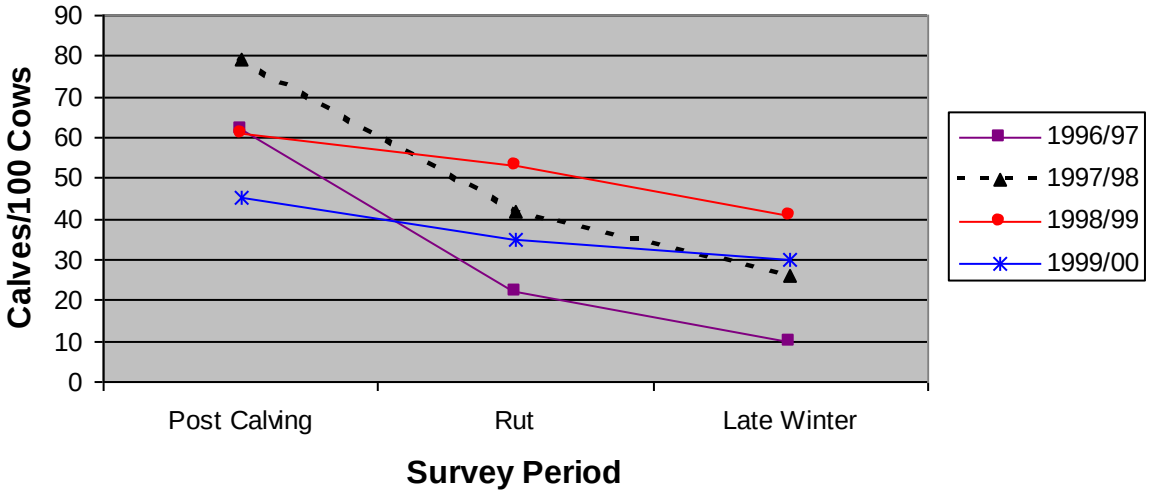


Figure 13. Calf survival ratios of radio-collared cows in the Itcha-Ilgachuz Mountains Herd from post calving, rut and late winter surveys (1996-2000).

The loss of winter habitat from clear-cut harvesting will reduce the amount of winter forage available to caribou. The indirect effects of timber harvesting, such as increased poaching and human disturbance from access development, and increased predation from changes to habitat, may negatively effect caribou populations. Population modelling will be undertaken to determine options for maintaining the population size and achieving a higher bull/cow ratio.

CONCLUSIONS

- During the 1999 post calving survey a total of 1850 caribou were observed which included 936 cows, 404 calves, 294 bulls, 19 yearling cows, 26 yearling bulls, 72 unsexed adults, and 99 unsexed yearlings. The observed calf/100 cow ratio was 43.7/100 in the Itcha-Ilgachuz Herd and 35.2/100 in the Rainbow Herd.

- During the 1999 October rut survey a total of 1038 caribou were observed which included 658 cows, 193 calves, 94 mature bulls, 90 immature bulls, and 3 unclassified. The observed calf/100 cow ratio was 29.4/100 in the Itcha-Ilgachuz Herd and 28.6/100 in the Rainbow Herd. The observed bull/100 cow ratio was 26.2/100 in the Itcha-Ilgachuz Herd and 42.9/100 in the Rainbow Herd.

- During the 2000 March late winter survey 452 caribou were observed, all of which were in forested habitats. The Itcha-Ilgachuz Herd calf percentage was estimated at 15.8% and the Rainbow Herd calf percentage was estimated at 13.0%.

- The Itcha-Ilgachuz caribou population appears to be stable to increasing while the Rainbow Mountain population appears to be stable to declining.

- The calf recruitment in the Itcha-Ilgachuz Herd has appeared to be sufficient to balance adult natural mortality in the past five years. The Rainbow Herd shows low calf recruitment rates from 1996-1999.

- The Itcha-Ilgachuz post season bull/100 cow ratio appears to be below the provincial target of 35 bulls/100 cows, while the Rainbow Herd's 1999 ratio is above the target.

RECOMMENDATIONS

- Future survey efforts should continue with both spring and autumn surveys conducted within the same year and a late winter survey the following year.

- Surveys should be undertaken every year to take advantage of radio-collared animals. This will allow for development of a sightability correction factor and monitoring of calf survival amongst collared females within the population.

- Population modelling should be undertaken to predict the consequences of maintaining the present harvest strategy on bull/cow ratios.

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APPENDICES

APPENDIX 1: POST CALVING SURVEY RESULTS

ITCHA MOUNTAINS CARIBOU SURVEY - JULY 13, 1999

Sighting	Easting	Northing	Total	Cows	Calves	Bulls	Yrlg. Cows	Yrlg. Bulls	Unclass. Adults	Unclass. Year.
2	3 74 339	58 35 075	409	272	84	3				50
3	3 73 753	58 34 823	161	2		136				23
4	3 79 947	58 34 492	2	1	1					
6	3 77 648	58 44 589	8			6		2		
7	3 76 862	58 45 455	16			15		1		
8	3 77 634	58 46 893	26			24		2		
10	3 78 309	58 46 604	19	1		17		1		
11	3 74 466	58 42 334	6	5	1					
12	3 73 912	58 46 877	3			1	1	1		
13	3 71 908	58 43 395	74	52	19		3			
14	3 68 073	58 40 506	231	144	86		1			
15	3 67 564	58 44 510	31	19	6	2	3	1		
16	3 65 386	58 44 128	28	16	8	1	2	1		
17	3 65 691	58 39 275	1	1						
18	3 56 846	58 31 285	2			2				
Total Caribou			**1017**	**513**	**205**	**207**	**10**	**9**	**0**	**73**

ILGATCHUZ MOUNTAINS CARIBOU SURVEY - JULY 14, 1999

Sighting	Easting	Northing	Total	Cows	Calves	Bulls	Yrlg. Cows	Yrlg. Bulls	Unclass. Adults	Unclass. Year.
22	3 47 726	58 51 355	2	1	1					
23	3 46 837	58 53 699	9	6	2		1			
25	3 45 565	58 57 032	85	54	15	9				7
26	3 45 365	58 56 393	42	7	7	12		2	11	3
28	3 44 879	58 56 998	15	4	4				5	2
29	3 45 154	58 55 848	4	1		2		1		
30	3 44 182	58 56 176	1	1						
31	3 44 076	58 56 599	23	1	1	12	2	7		
32	3 43 378	58 57 031	2						2	
33	3 42 875	58 57 092	279	141	70	12			51	5
34	3 41 799	58 55 147	132	78	48	5				1
38	3 48 018	58 40 609	3			1				2
39	3 50 251	58 41 406	8	6				1		1
40	3 52 913	58 41 020	3	1		1		1		
1	3 53 433	58 41 912	8			5		3		
2	3 51 772	58 43 396	8	2		1			3	2
3	3 53 566	58 47 285	2	1						1
4	3 52 236	58 48 271	31	20	11					
5	3 51 723	58 47 208	21	14	5					2
6	3 52 124	58 48 381	10	7	2	1				
7	3 49 742	58 49 789	10	5	5					
8	3 50 627	58 51 667	25	15	8	2				
9	3 50 283	58 51 890	9			8		1		
11	3 43 411	58 47 533	1	1						
2b	3 45 639	58 56 611	2	1	1					
3b	3 45 650	58 55 520	1	1						
4b	3 48 950	58 50 768	1	1						
Total Caribou			**737**	**369**	**180**	**71**	**3**	**16**	**72**	**26**

RAINBOW MOUNTAINS CARIBOU SURVEY - JULY 21, 1999

Sighting	Easting	Northing	Total	Cows	Calves	Bulls	Yrlg. Cows	Yrlg. Bulls	Unclass. Adults	Unclass. Year.
2	3 16 548	58 46 408	4			4				
7	3 04 951	58 46 774	2	1	1					
8	3 02 899	58 45 124	1	1						
9	3 01 432	58 45 224	26	16	7		3			
9b	3 02 624	58 43 637	11	8	3					
19	3 11 931	58 38 812	2	1	1					
26	2 89 389	58 32 014	13	1		11		1		
27	2 88 354	58 29 217	3	2			1			
28	2 87 856	58 30 418	3	1			2			
29	2 93 469	58 28 875	10	9		1				
30	2 95 252	58 29 433	3	3						
1	3 03 427	58 34 101	2	1	1					
2b	3 04 634	58 31 835	16	10	6					
Total Caribou			**96**	**54**	**19**	**16**	**6**	**1**	**0**	**0**

Total Caribou for the Itcha Mountains

1017	**513**	**205**	**207**	**10**	**9**	**0**	**73**

Total Caribou for the Ilgachuz Mountains

737	**369**	**180**	**71**	**3**	**16**	**72**	**26**

Total Caribou for the Rainbow Mountains

96	**54**	**19**	**16**	**6**	**1**	**0**	**0**

Total Caribou for the Itcha and Ilgachuz Mountains

1754	**882**	**385**	**278**	**13**	**25**	**72**	**99**

Total Caribou for the Itcha, Ilgachuz and Rainbow Mountains

1850	**936**	**404**	**294**	**19**	**26**	**72**	**99**

APPENDIX 2: RESULTS OF STATISTICAL TESTS ON GENDER/AGE AND ELEVATION

SCHEFFE'S TEST
Yearling bulls and cows lumped with unclassified yearlings

GROUP	**Cows with calves**	**Cows w/o calves**	**Bulls**	**Adult Unclassified**	**Yearlings**
MEAN ELEVATION	1834	1832	1800	1730	1819
N	404	532	294	72	144
SIGNIFICANT DIFFERENCE	A	A	B	C	A

Degrees of Freedom: 1441
Alpha: 0.05
Minimum Significant Difference: 129.95
F-Value: 2.37810

APPENDIX 3: OCTOBER RUT SURVEY RESULTS

ITCHA FLATS AND MOUNTAINS CARIBOU SURVEY- OCTOBER 20, 1999

Sighting#	Easting	Northing	Total	Cows	Calves	mat.bulls	imm.bulls	unclass
62	374887	5834402	47	29	10	5	3	
67	375818	5836275	5	3	1	1		
68	379460	5839246	1			1		
69	378871	5839470	4	2	1	1		
70	379031	5838913	14	10	1	1	2	
71	378156	5842718	5	3	1	1		
72	377884	5844544	48	32	11	2	3	
73	377446	5845710	15	8	6	1		
74	377993	5845839	4	3	1			
76	375344	5843132	28	19	3	2	3	1
77	375211	5846023	66	39	9	10	8	
78	375469	5847539	4	2	2			
79	374702	5847355	11	8	3			
80	374500	5846683	17	12	4	1		
81	374316	5846660	14	9	4	1		
82	373953	5846271	5	2	2		1	
83	373498	5844239	2	1	1			
84	372475	5844146	1				1	
85	372564	5844690	2	1	1			
86	371898	5842552	2	1	1			
87	371278	5843367	7	5	1	1		
88	368417	5843621	11	5	3	1	2	
89	366806	5844375	68	49	8	4	7	
90	367595	5844427	2	1	1			
91	366321	5843973	78	50	15	5	8	
92	365826	5843880	79	47	9	12	11	
93	366353	5844990	120	79	22	4	15	
100	366111	5839793	2	1	1			
101	367901	5840314	18	11	6	1		
102	368354	5839716	8	3	3		2	
103	370109	5841011	14	10	1	1	2	
104	369532	5841002	18	11	2	1	4	
105	369334	5842604	8	6	2			
106	370353	5840805	6	3	1		2	
107	370270	5840619	12	9	2		1	
108	371416	5839767	4	2	2			
109	370775	5838893	3	2	1			
TOTAL			**753**	**478**	**142**	**57**	**75**	**1**

ILGACHUZ MOUNTAINS CARIBOU SURVEY – OCTOBER 20, 1999

Sighting#	Easting	Northing	Total	Cows	Calves	mat.bulls	imm.bulls	unclass
1	351943	5840636	33	22	3	6	2	
2	350361	5842920	4	1	1	2		
46	346236	5853922	6	3	2		1	
47	342885	5855180	2	1	1			
48	341498	5854419	1	1				
49	340729	5853104	1			1		
54	339318	5850239	49	37	6	3	3	
56	339600	5848521	13	8	5			
57	339143	5847719	16	10	2	2	2	

ILGACHUZ MOUNTAINS CARIBOU SURVEY - OCT.20, 1999

58	338950	5846047	10	7	1			2
59	341611	5846155	30	20	10			
TOTAL			**165**	**110**	**31**	**14**	**8**	**2**

RAINBOW MOUNTAINS CARIBOU SURVEY – OCTOBER 19, 1999

Sighting#	Easting	Northing	Total	Cows	Calves	mat.bulls	imm.bulls	unclass
17	316994	5844336	26	15	7	4		
18	313927	5846981	3	1	1	1		
19	312378	5847385	1			1		
20	xxxxxx	xxxxxxx	2	1		1		
21	311031	5847883	1			1		
24	310812	5849362	1	1				
29	301260	5845306	5	3	2			
30	300387	5844104	9	4	3	2		
31	301667	5844037	72	45	7	13	7	
TOTAL			**120**	**70**	**20**	**23**	**7**	**0**

Total caribou for the Itcha Flats and the Itcha and Ilgachuz Mountains

	918	**588**	**173**	**71**	**83**	**3**

Total caribou for Itcha Flats, and the Itcha, Ilgachuz and Rainbow Mountains

	1038	**658**	**193**	**94**	**90**	**3**

APPENDIX 4: LATE WINTER SURVEY RESULTS

FOREST AND ITCHA-ILGACHUZ MOUNTAINS CARIBOU SURVEY - APRIL 11 , 2000

Sighting#	Easting	Northing	Total	Adults	Calves	Collared female	Caribou Home Range
1A	327875	5833415	5	4	1	150.500	Rainbow
2A	328963	5834559	10	6	4		Rainbow
3A	329886	5834761	14	13	1	150.701	Rainbow
4A	329833	5834009	3	3	0	150.602	Rainbow
5A	330591	5832836	3	3	0		Rainbow
6A	329707	5835103	8	8	0		Rainbow
7A	329473	5835597	14	14	0	150.441	Rainbow
8A	329530	5836167	3	2	1	150.522	Rainbow
9A	329830	5836167	23	19	2		Rainbow
10A	371244	5865045	9	6	3		Rainbow
1	394822	5823004	13	9	4	150.826	Itcha-Ilgachuz
2	391723	5816789	4	4	0	150.549	Itcha-Ilgachuz
3	393487	5815731	10	10	0	150.531	Itcha-Ilgachuz
4	401105	5814415	12	12	0	150.119	Itcha-Ilgachuz
5	401111	5814295	12	9	3		Itcha-Ilgachuz
6	401935	5815435	36	30	6	150.181/150.807	Itcha-Ilgachuz
7	403286	5815265	6	6	0		Itcha-Ilgachuz
8	403503	5815043	19	15	4		Itcha-Ilgachuz
9	402149	5816371	2	1	1	150.816	Itcha-Ilgachuz
10	403875	5814468	29	24	5		Itcha-Ilgachuz
11	404038	5814072	25	19	6		Itcha-Ilgachuz
12	404536	5814209	9	7	2		Itcha-Ilgachuz
13	406879	5813824	13	8	5		Itcha-Ilgachuz
14	405760	5815069	5	5	0		Itcha-Ilgachuz
15	405979	5814935	6	5	1	150.464	Itcha-Ilgachuz
16	405082	5807742	7	6	1	150.754	Itcha-Ilgachuz
17	406496	5807950	5	5	0		Itcha-Ilgachuz
18	406308	5806990	4	2	2		Itcha-Ilgachuz
19	405547	5808226	8	8	0		Itcha-Ilgachuz
20	396180	5815477	8	8	0		Itcha-Ilgachuz
21	397039	58153994	14	11	3	150.000	Itcha-Ilgachuz
22	396306	5814842	24	19	5		Itcha-Ilgachuz
23	391745	5808182	28	7	3	150.010	Itcha-Ilgachuz
24	392830	3807941	17	15	2	150.030	Itcha-Ilgachuz
25	393373	5808086	8	6	2		Itcha-Ilgachuz
26	413154	5806902	5	5	0	150.561	Itcha-Ilgachuz
27	387037	5809052	4	4	0	150.321	Itcha-Ilgachuz
28	364700	5782208	5	5	0	150.470	Itcha-Ilgachuz
29	367499	5789571	5	5	0	150.731	Itcha-Ilgachuz
30	365420	5799599	10	10	0	150.612	Itcha-Ilgachuz
31	359000	5802609	7	5	2	150.040/150.571	Itcha-Ilgachuz
TOTAL			**452**	**363**	**69**		

Total for the Rainbow Mountains Caribou

Forest	**92**	**78**	**12**
Alpine	**0**	**0**	**0**
Total	**92**	**78**	**12**

Total for the Itcha and Ilgachuz Caribou

Forest	**360**	**285**	**57**
Alpine	**0**	**0**	**0**
Total	**360**	**285**	**57**

APPENDIX 5: ANNUAL BULL HARVEST

Year	Number of Bulls Harvested
1984 (last year before mature bull season)	47
1985	17
1986	9
1987	30
1988	24
1989	29
1990	21
1991	49
1992	37
1993	31
1994	24
1995*	11
1996*	26
1997	25
1998	40
1999	29
Average	28
Standard Deviation	11

*Numbers estimated from reported harvest values