2007-2008 Jasper National Park Caribou Progress Report



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Executive Summary

Woodland caribou (*Rangifer tarandus caribou*) range throughout North America has retracted northward and many populations across Canada are in decline. The Committee on the Status of Endangered Wildlife in Canada has defined Canadian populations as *Endangered* (Atlantic-Gaspésie), *Threatened* (Southern Mountain and Boreal), *Special Concern* (Northern Mountain), and *Not at Risk* (Newfoundland) (Thomas and Gray 2002). Woodland caribou in Jasper National Park belong to the *Threatened* Southern Mountain Population.

Phase I of the Jasper Woodland Caribou Recovery Action Plan was implemented in 2005. Its larger goals were to increase awareness of woodland caribou and recommend a suite of actions to mitigate factors contributing to caribou decline. Implementation of recovery actions began in the 2005-2006 fiscal year, shortly after the Plan was signed by Parks Canada. In the fall of 2007 the Mountain Parks Caribou Coordinating Committee initiated development of a conservation strategy for caribou in the mountain national parks. The strategy is intended to contribute towards meeting Parks Canada's obligations under *Canada's National Parks Act* and the *Species at Risk Act*. Key direction for caribou recovery and sustainability, that is aligned with Parks Canada's mandate of ecological integrity, public education and visitor experience, will be formulated with the participation of the public and Aboriginal groups and incorporated into the respective management plans during the 2009 review.

Required knowledge for informed management relies on the caribou monitoring program, the results of which are reported herein. The program has grown in the past few years to incorporate several partnerships with university research. It has also expanded to include other species that are important to understanding the predator-prey dynamic in Jasper National Park and its effects on caribou persistence (e.g. Hebblewhite et al. 2007). We report on the results we've obtained in the past 2 years of our caribou monitoring program.

<u>Radio-collaring:</u>

- Aim to maintain 20 radio-collars (emphasis on VHF collars) on caribou in order to maximize precision in population parameter estimates and trend. Current collar distribution is 4 in the Brazeau (0 GPS; 4 VHF), 1 in the Maligne (0 GPS; 1 VHF), and 13 in the Tonquin (3 GPS; 10 VHF).
- Parks Canada has maintained GPS and VHF collars on wolves in the Signal, Sunwapta, and Brazeau packs.

<u>Population Estimates</u>:

- Fall 2008 population estimate: 127 caribou (90% C.I. 114-157). We observed 106 caribou and saw 15 of 18 radio-collars.
- Fall 2007 population estimate: 93 caribou (90% C.I. 82-117. We observed 74 caribou and 15 of 19 radio-collars. Although a precise estimate, the result may not be accurate, as it is lower than both the 2008 and 2006 estimates.
- Fall 2006 population estimate: 151 caribou (90% C.I. 126-207). We located 111 caribou and 11 of 15 radio-collared caribou. Waiting for good snow conditions contributed to a more successful survey.

- Fall 2005 estimate was 147 (90% C.I. 104-276). We located 82 caribou and 5 of 9 collars without the use of telemetry.
- 1988 minimum number: 153 (population guess: 175-200)

Calf recruitment

- March 2009: 39 calves per 100 cows (90% C.I. 23-54)
- March 2008: 21 calves per 100 cows (90% C.I. 13-30)

In the past four years, recruitment values have fluctuated high-low-high-low. Calf recruitment was higher in March 2007 compared to 2006: 13 calves per 100 cows (90% CL = 7-20) in 2006; 42 calves per 100 cows (90% CL = 31-53) in 2007.

Genetic diversity via fecal DNA collection

Preliminary results indicate that DNA-based mark-recapture modeling may be a valuable tool in estimating caribou population size. There are still some discrepancies between the visual survey estimates and DNA mark-recapture estimates, but year-to-year consistency in the DNA-based estimates, in addition to good precision, gives us confidence in the method. We report here only on preliminary findings, and expect that some findings may change.

Canadian Rockies Woodland Caribou Project Program

- Parks Canada, a partner in this regional research program, has collaborated on objectives related to predator/prey dynamics by relocating wolf kill-sites from four packs within Jasper National Park. Packs varied in their diet composition, location of kill-sites, and number of kills per unit time. Raw data were provided to Phd candidate Nick DeCesare for future analysis.

Primary-prey aerial surveys

- Twenty-three elk were collared in Jasper National Park, including 9 GPS collars. We used collars for mark-resight population estimates of elk (via aerial survey) in early winter 2008 and 2009. Survey units were stratified and methods followed guidelines set forth by Unsworth et al. (1994).
- Elk were estimated at 410 (90% C.I. 337-483) in 2008 at 435 (90% C.I. 368-502) in 2009 for Jasper National Park, not including the Brazeau drainage.

Gastrointestinal Nematodes in JNP

- In partnership with University of Calgary researcher Nathan deBruyn, Parks Canada collected and analyzed fecal samples from caribou in the A la Peche and Tonquin herds
- Samples from the A la Peche (collected in June) showed 100% prevalence for gastrointestinal nematodes in fecal pellets, while samples from the Tonquin (collected in August) showed 87% prevalence
- The A la Peche animals had noticeably higher egg counts than those sampled from the Tonquin, though this may have been a seasonal variation. Follow-up work will take place in summer 2009.

Communications

- Jasper National Park staff have delivered messages and presentations related to caribou to a wide audience in the form of field trips, lawn displays, television appearances, informal and formal talks, and participation in Parks Canada events

Acknowledgements

The South Jasper Woodland Caribou Research Program has been a success due largely to the help and commitment of many people. George Mercer initiated the project and raised awareness about caribou conservation issues in Jasper National Park. Alan Dibb, Jesse Whittington, and Rhonda Owchar coordinated caribou research in North Banff National Park. Jesse also made key contributions to the program as the Jasper National Park caribou biologist. Carolyn Duchoslav, Caroline Longtin, Duncan Bayne, Janet Breau, and Kim Weir were integral to production and development of excellent communications products. The Friends of Jasper National Park was a notable partner, particularly with respect to continued contributions to caribou awareness through public events. The wardens at the Sunwapta station over the years, Heidi Fengler, Kim Forster, Tracy McKay, and numerous volunteers also contributed to the caribou program in various capacities. Particularly we are grateful to Traudi Golla, Leanne Standing, Nathalie Chester, Doug Scatcherd, Mike D'Antonio, and Marcia Dewandel for their volunteer work with the wolf kill-site program. Clay Wilson and Bighorn Helicopters efficiently, professionally, and successfully radio-collared wolves and caribou in South Jasper. Pilots John Saunders and Steve Wotton of Peregrine Helicoptors, and Dale Brady and John Graham of Yellowhead Helicoptors Ltd. assisted with caribou surveys, scat collection, and collar retrieval. Mike Dupuis of Wildlife Observation Air assisted with aerial telemetry. Micheline Manseau and Peter Hettinga were important partners in initiating and analysing the caribou DNA from fecal samples.

1. Introduction

Southern Mountain woodland caribou are listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (Thomas and Gray 2002). In Jasper National Park (JNP), woodland caribou are a species of concern based on population trends since 1988 (Whittington et al. 2005a). Current management of the South Jasper caribou population has moved into Phase II, a regional conservation plan across the mountain parks. Phase I implementations of the South Jasper National Park Caribou Action Plan for Caribou Recovery are still in still in place, and may remain so into Phase II. Parks Canada has been involved in the West Central Caribou Landscape Planning Team, a part of the Alberta woodland caribou recovery process, which submitted its final report to the responsible Minister in July of 2008.

In this progress report, we address the status of woodland caribou populations based on population and demographic data and also report on the status of several recovery actions recommended in the 2005 South Jasper Action Plan. We present research findings and communications that have occurred since April 2007, but refer to findings from previous years where relevant or have not been reported elsewhere.

1.1 Study Area

The South Jasper Caribou project continues to focus on woodland caribou south of Highway 16 in Jasper National Park and in three core areas: the Brazeau, Maligne, and Tonquin (Figure 1). There has been limited exchange between these areas as measured by radiocollars and preliminary DNA samples.

The White Goat Wilderness Area (south of Jasper National Park) has not always been included in historical surveys. However, the mark-recapture based population estimates benefit from surveying this region as collared individuals regularly use the White Goat. We recommend its continued incorporation into future surveys and analyses.

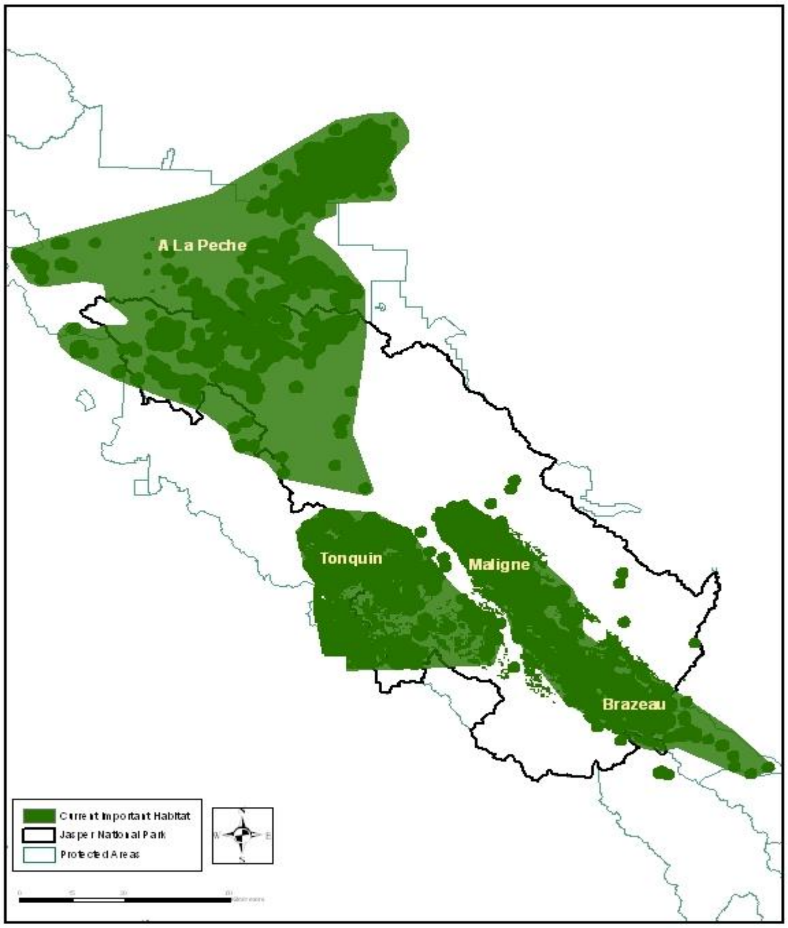


Figure 1. Overview of caribou ranges within the boundaries of Jasper National Park. South Jasper is comprised of the Tonquin, Maligne, and Brazeau sub-populations

2. Caribou, Wolf, and Elk Captures

Monitoring caribou and wolf populations via radio-telemetry in South Jasper has been an integral part of the Jasper caribou program. In late 2007 we also began collaring elk as part of a partnership with the Universities of Calgary and Montana, described in Section 6 of this report.

Details on study design and history of collared caribou and wolves are available in previous progress reports. The caribou monitoring program relies on radio-collars to identify trends, calculate population parameters, and examine habitat use. Since 2005, we have aimed to maintain a sample size of approximately 20 radio-collars on caribou and also maintain contact with wolf packs that hold territory in caribou habitat. From April 2007 to March 2009, 14 caribou were captured, including 8 recaptures. We deployed 4 new GPS, 9 new VHF collars, and released one caribou without a collar. Banff National Park had 2 caribou collared, but they have recently been killed in an avalanche (Dibb, pers. comm.).

We were successful in collaring wolves in all areas of interest and now have collared animals in three packs in south Jasper, the Signal, Sunwapta, and Brazeau. As part of the collaboration with the Canadian Rockies Caribou Project (Section 5), we have also collared the Glacier Pass pack in the northern portion of JNP.

2.1 Caribou

Since April 2007, eight radio collars have been recovered from dead animals, two malfunctioning collars were removed from the field, and one collar was removed from an older female. Thirteen caribou have been newly or re-collared, resulting in 18 collars currently within the Brazeau, Maligne, and Tonquin regions. In recent years we have emphasized using VHF collars, which last longer, weigh less, and require fewer captures of individuals over the long-term. VHF collars provide data for population demographics and trend, though they return limited information on habitat use. However, we continue to deploy 1-2 GPS collars per year in order to meet data requirements for collaborative research with the University of Montana. We aim to maintain approximately 20 radio-collars active by spring of each year in south Jasper National Park in order to gather more precise information on population estimates.

2.2 Caribou Mortality 2007-2009

Seven collared caribou died between April 2007 and March 2009. Caribou 59 and 60, of the Tonquin and Brazeau regions respectively, were located dead at the end of June 2007. It was estimated with good certainty that caribou 59 died 29 May 2007 and caribou 60 died 1 May 2007. Hair and bones at each site indicated the animals had been predated or at least scavenged. A calf jawbone was found with caribou 59's collar, located at the mortality site behind the Rampart Mountains. Bear scat was present and signs of bear digging and displacement of ground cover indicated that the carcass might have been buried and later recovered. Caribou 60's collar and remains were found in the Beauty Creek area, on the banks of a small tributary. Wolf scat was present at the site as was an adult jawbone; it is unknown whether caribou 60 was killed by wolves or was scavenged after a natural death. In fall 2007, caribou 1 was located dead between the upper Maligne River and Maligne Lake. It was estimated from the stage of decay that death occurred approximately 4 September 2007. The caribou was fully intact and little sign of struggle was present at the site. A necropsy was conducted which showed no sign of trauma, no bot larvae or lung parasites, substantial mesenteric fat, normal marrow in the femur, and healthy joints. It is suspected that caribou 1 died naturally from cardiac or pulmonary failure.

In March 2008 caribou 64 was located dead on the Astoria river/skidoo trail. Her death was estimated to have occurred 26 February 2008, as identified from hourly GPS locations. No remains were found at the site, which had been thoroughly cleaned by wolverines (identified by tracks). Information retrieved later from wolf 81 showed that caribou 64 and wolf 81 were in the same place on 26 February, and therefore it is very likely that wolves predated caribou 64. Caribou 51 was located 23 April 2008 in the White Goat Wilderness Area and estimated to have died 30 March 2008. Only hair and skin were left at the site and a wolverine was spotted nearby. It is unknown how caribou 51 died. Caribou 48's collar was heard on mortality 26 June 2008 near McGuire Valley, it was estimated that she died 18 June 2008. Caribou jaws, hair, marrow, and antlers were collected. There was no evidence of a calf having been present. Wolf scat and hair were found at the site and although it's likely that caribou 48 was predated it's unknown if she was in fact scavenged. Caribou 48's teeth were worn, but her marrow was healthy and it's assumed the animal was in good condition. In August 2008 we investigated caribou 36's mortality site on the west side of Tonquin Ridge. Date of mortality was estimated 12 July 2008 and only hair was left at the site. There was substantial evidence of struggle and running (disturbance to the moss). Wolf scat and bed sites were found at the site. The collar was found in heavy cover and thick undergrowth in an older pine forest. Caribou 46's collar was discovered in mortality mode in late December 2008. Data from the Sunwapta wolf pack shows a cluster of GPS points at the Cavell Meadows location on December 22nd, which is the estimated date of mortality for caribou 46. Although we were unable to access the site until February, we were able to investigate the site aerially during the elk survey (January 3rd) and confirm that the wolf cluster, the collar, and the kill-site were in the same location. We were unable to land at the site due to wind, but were able to see blood, hair, and a distinct kill-site. In February, we recovered the collar but did not find any bones under the snow. We believe wolves killed caribou 46.

2.3 Wolves

Wolves are monitored in Jasper National Park as they've been identified as an important predator of caribou (Brown et al. 1994). Maintaining contact with wolf packs through radio-collars is challenging. Wolves are difficult to find and capture, cause damage and malfunction radio-collars, have relatively high mortality, and occasionally disperse from the study area. The last collar from the Signal pack was removed in August 2007 and we were unable to locate this pack during capture events in winter 2007/2008. Similarly, we had no collars in the Brazeau pack and were unable to locate the pack at the times when the capture crew was present. In February 2009, the capture crew was fortunately able to locate both the Signal and the Brazeau packs; both packs are once again being monitored.

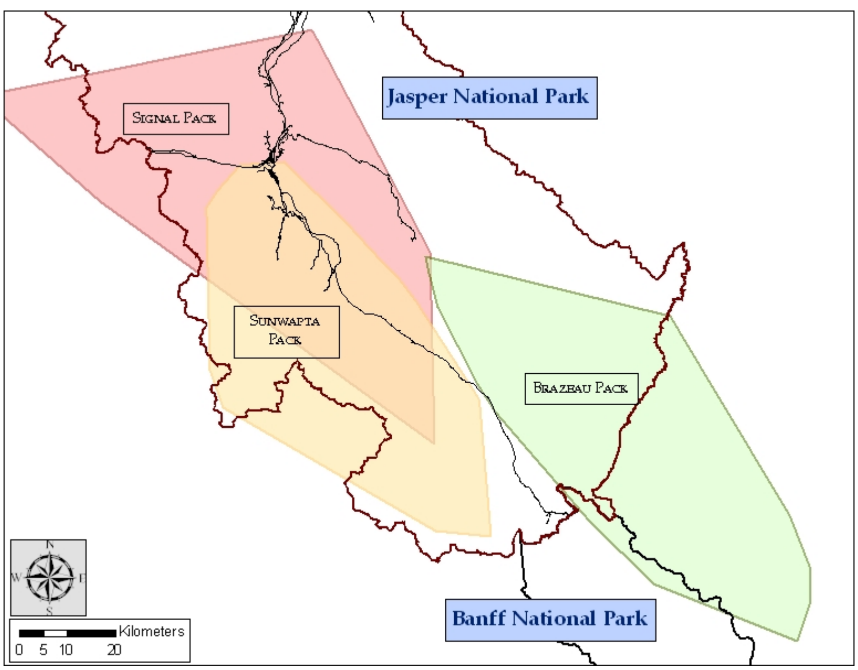


Figure 2. Wolf pack boundaries identified from animals collared 2006-2008 in South Jasper.

Wolf mortalities have contributed to losing monitored packs in the past. Wolf 44 was captured in January 2007, but dispersed from the park via the Moosehorn river. The wolf was legally trapped outside the park boundary in early winter 2007. Wolf 19 was humanely destroyed after becoming increasingly weak and habituated to unnatural food sources. Collars from wolf 57 (Signal) and 47 (Brazeau) stopped beaconing and were not recovered. Wolf 62, captured in the Signal pack in January 2007, died naturally from an infected puncture wound in May 2007. Wolf 63, captured in the Sunwapta pack in January 2007, died naturally from malnutrition in September 2007. Wolf 73, captured in December 2007 in the Sunwapta pack, appears to have dispersed from Jasper National Park and has not been located. Wolf 81, collared in the Sunwapta pack in January 2008, had a malfunctioning collar that was recovered in March 2009 when the wolf was trapped near Bridge Lake, British Columbia. Wolf 68, collared at Maligne Lake in March 2007, moved to the Rocky River and was collared for just 1 month before the collar hardware broke and the collar was recovered. Wolf 68 did not return to the Maligne area during the time that he was collared. Wolf 56, originally captured in the Sunwapta pack in January 2006, was recaptured by foothold trap in August 2008. Her weakly-functioning VHF collar was replaced with a GPS collar.

There are 8 collars in three packs in Jasper National Park as of March 2009. Many of the GPS collars currently deployed are in support of predator-prey research as described in section 5. Two wolf GPS collars were recovered from the field in early 2009. In addition to the recovery of wolf 81's collar, Wolf 40, originally collared in 2005, had a malfunctioning collar that was observed by the capture crew and recovered through recapture. The collar was badly water damaged and data were not recoverable. Wolf 40 has been recollared in the Sunwapta pack. Two additional wolves were collared in the Sunwapta pack, including one with a temporary 3-month collar that will be used to collect summer kill-site information. Four of nine wolves are collared in the Sunwapta pack at present. The Brazeau pack consists of two wolves, a male and female, both of which have been collared. The Signal pack is comprised of four grey wolves and two females have been collared.

In partnership with the Universities of Montana and Calgary, a fourth wolf pack within the range of the A la Peche caribou was collared in Glacier Pass. Three wolves are collared in this pack of approximately 4 individuals, though one collar is temporary.

Table 1: Current collar distribution – April 2009

Caribou Region	**GPS**	**VHF**	**Total**
Brazeau	0	4	4
Maligne	0	1	1
Tonquin	3	10	13
Wolf Pack	**GPS/UHF**	**VHF**	**Total**
Signal	1	1	2
Sunwapta	3*	1	4
Brazeau	1	1	2
Glacier Pass	2*	1	3

*One collar is temporary and will be removed in summer 2009

3. Caribou Surveys

Regular caribou population surveys are essential to the detection of trends over a meaningful timeframe for caribou. Aerial censuses have been the preferred method to assess caribou minimum count in the fall (Brown et al. 1994). Late autumn is the ideal time to survey mountain caribou as the animals are rutting, above treeline, and in larger groups. A covering of snow increases the probability of observing an individual because fresh tracks are visible and the animals are contrasted against the snow.

Aerial surveys in the fall took place intermittently from 1988 to 2001, and annually from 2003 to the present. Since 2003 the surveys have included mark-recapture estimates in addition to minimum counts. In the period 1961-1973, the caribou population in south Jasper was approximated at 425 – 711 caribou (Stelfox 1974) based on ground and aerial observational counts. In 1974, 200-500 caribou were thought to be present throughout Jasper National Park, based on the largest unduplicated count of 192 and accounting for only the portion of the A la Peche herd that used the park (Stelfox 1974). In 1988 the population was approximated at 175 to 200 based on aerial survey work (Brown et al. 1994). The range of population sizes reported for both 1973 and 1988 are conjecture based on ground-based observations and aerial minimum counts; they are not population estimates with confidence limits. Since 2003, population estimates are given with associated precision based on mark-recapture techniques (see comments on counts in Section 3.6).

From 2005 to 2009, we have conducted annual spring calf surveys and fall population surveys. The results of previous calf and population surveys are discussed in previous Progress Reports (Whittington et al. 2005a, Neufeld and Bradley 2007).

3.1 Survey Methods

We conducted aerial surveys of alpine and subalpine caribou regions in South Jasper using a Bell 206 helicopter. Survey altitude was dependent on local sightability, but in general was between 200m to 400m above ground. Survey speed was also variable, generally 80 kph in heavily treed sections, and approximately 100 kph in open areas.

We started the population survey in the fall, once conditions were suitable (light snow covering). During the survey, when a caribou group was sighted, we landed nearby and classified caribou into 3 sex/age categories: bull, cow, or calf. The presence or absence of a vulva patch or penis was used to discriminate between young bulls and cows. We identified adult bulls by large antlers, large body size, and the presence of a penis. Small size, small antlers, short snout length, and square body shape identified calves.

At the time of the 2007 and 2008 population survey there were 19 and 18 radio collars on female caribou, respectively, that were used as marks for a mark-recapture population estimate. Each caribou region (Tonquin, Maligne, and Brazeau) required at least one day to survey. Without the assistance of a radio receiver, we searched each area and recorded the number of caribou we observed and noted whether they were collared. After the survey, we returned to the area to locate any missed collars and ensure those animals were present and still alive. In both years we also stopped to collect fecal matter for caribou DNA population estimate research explained in Section 4 of this report.

In March of each year we also conducted a calf recruitment survey using similar methods. Radio-collared females were located, and upon visually observing the group we distinguished cows, bulls, and calves. When possible, we landed nearby and used a spotting scope. We also used photos for further confirmation of group demographics, which worked very well for most groups. In the spring, caribou were more often in the trees and occasionally it was difficult to differentiate cows from young bulls. For this reason, we calculated a calf to adult ratio as well as calf to cow ratio. However, because bulls are not often in groups of females and calves in the spring this ratio is similar to the calf to cow ratio.

3.2 Data Analysis

We used program NOREMARK's joint hypergeometric maximum likelihood estimator (JHE) to estimate population abundance by means of mark-resighting data (White 1996). The JHE estimator assumes that the population is demographically closed (i.e. no births or deaths), geographically closed (no emigration or immigration), and the marks are distributed evenly among groups. Since our 'marks' and 'recaptures' are on the same day, chances of death or movements are minimized. The JHE can accommodate emigration or immigration, but not with only one recapture occasion. We calculated 90% confidence intervals, which increase power to detect trends at the expense of Type II error (i.e. the chance of declaring a change, when in fact there was no change). Calf per 100 cow ratios were calculated from our classification of caribou during the survey. Confidence intervals for the calf per 100 cow ratios were calculated as per Czaplewski (1983).

3.3 Survey Coverage and Location of Groups

The 2007 survey was flown on October 4,5, and 9. The helicopter was airborne for approximately 19 hours (Table 2) during the survey, which is within the range of effort exerted in previous years.

In 2008, we flew the survey October 18-21. Survey time was greater in 2007 because we flew at an overall slower speed in some regions during surveying. Nevertheless, we covered similar distances as in the past, approximately 2100 km and 2000 km, respectively.

Table 2: Number of hours flown in each of the three areas.

	Total		Ferry		Survey	
	2007	2008	2007	2008	2007	2008
Tonquin	7.13	5.62	0.5	0.78	6.63	5.62
Maligne	3.63	4.62	0.28	0.88	3.35	3.73
Brazeau	8.85	6.65	1.87	1.53	6.98	5.12
Total	19.62	16.88	2.65	3.82	16.97	13.68

In 2007, conditions for spotting caribou were generally good with about 85% snow cover. As might be expected across such a large range, there was variability in snow cover. The Brazeau and Maligne regions were snow covered and tracks were obvious. In the Tonquin snow was patchy, but conditions were still good.

In 2008, snow in the alpine was late to arrive, and it was necessary to wait until late October for the survey in order to have better sighting conditions. Our timing for the survey was similar to 2006 and in both years caribou were still in alpine regions (presumably because of low snow cover). This provides added incentive to conduct surveys shortly after the first major snowfall of the year.

We surveyed approximately the same areas in 2007 and 2008 (Figure 3). Survey coverage included part of the White Goat Wilderness area in Alberta, and part of Mount Robson Provincial Park in BC. In 2008 we did not cover the Geraldine Lakes area on the same day as the visual survey (Figure 3), but did cover this area the next day during the scat collection. In 2008 we included the Southesk lake area in our Maligne survey due to reports of caribou observations in this region during the previous summer.

Caribou were located throughout the survey region in both years, but there were some notable differences. We failed to locate any caribou in the White Goat Wilderness and did not have a radio-collar there to see if we'd missed a group or if they'd moved out of the White Goat. The majority of the Brazeau caribou in 2008 were west of highway 93, with only 2 small groups observed east of the highway (Figure 4). In the Maligne, three small groups were observed throughout the range as opposed to one large group. Total number observed was similar but we failed to find more than 2 adult females in 2008 . In the Tonquin, caribou groups were more dispersed in 2008 than 2007, but the number of animals seen was similar (Figure 4).

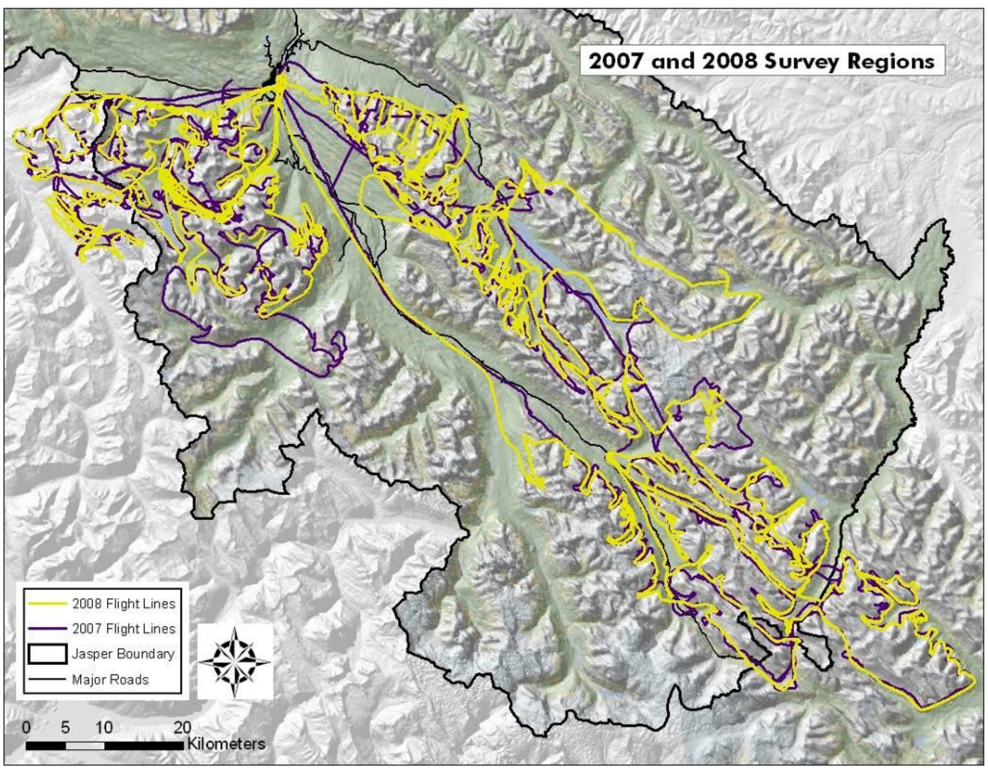


Figure 3. Flights lines during the 2007 and 2008 caribou surveys

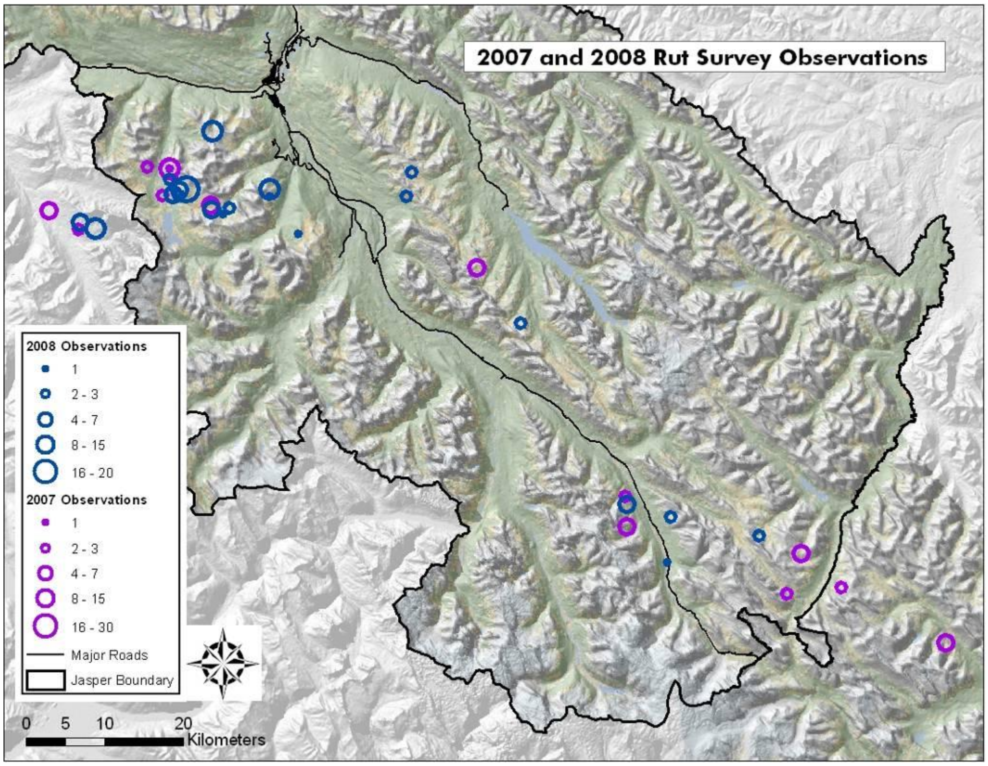


Figure 4. Location and group size of woodland caribou in South Jasper during the 2007 and 2008 rut surveys

3.4 Population Estimate Results: 2007 and 2008

In the 2007 annual visual survey, we observed 74 and 88 caribou without and with the assistance of telemetry, respectively. We observed 15 of 19 collars during the survey and calculated sightability at 79%. The JHE population estimate was 93 with 90% confidence limits of 82 to 117 (Figure 5). However, we know that a minimum of 88 animals were alive and consider this estimate to be lower than the actual number of caribou. In gregarious species like caribou, missing a single group without a collar can change the minimum number and the estimate - the larger the group, the larger the effect. In 2007, we saw most of the collars, but not a large number of animals. The result was a low estimate with small confidence intervals. This underscores the importance of long-term studies for caribou; taken out of context an estimate of 93 may result in erroneous conclusions about the caribou population trend. In 2008 we observed 106 and 113 animals without and with the use of telemetry, including 15 of 18 collars. Sightability was higher at 83% and the JHE population estimate was 127 with 90% confidence limits of 114 to 157 (Figure 5).

There has been little change in the population estimates since 2003 (Figure 5). The estimates did vary between 2003 and 2008, but the width of the confidence intervals precludes the detection of trends during this short time period.

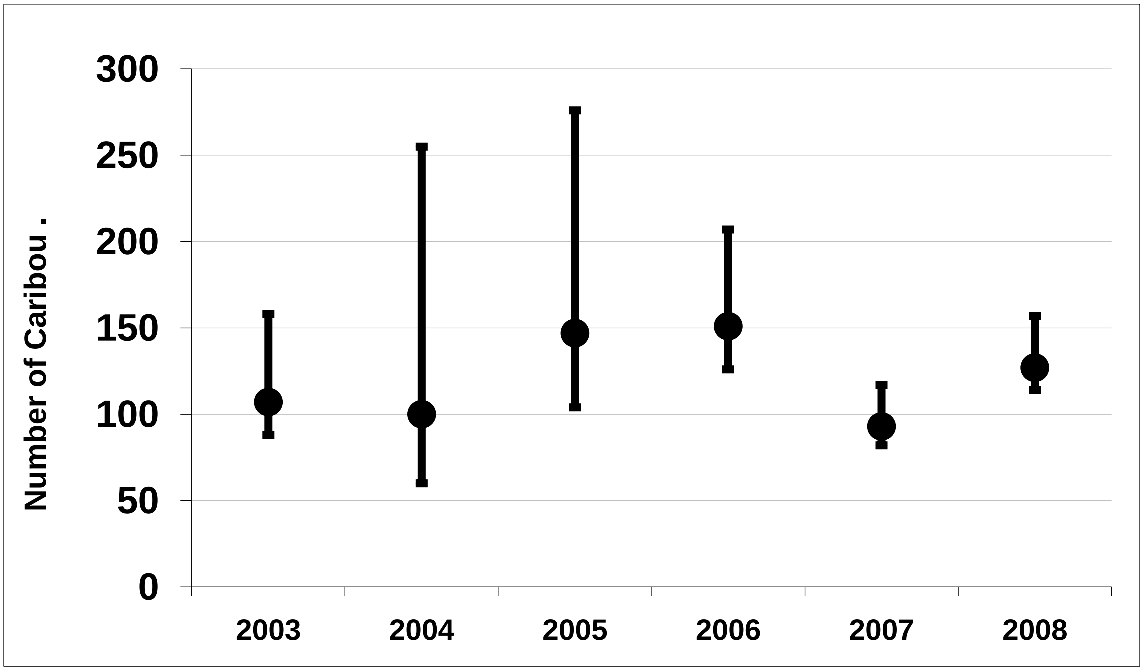


Figure 5. South Jasper caribou population estimates. Error bars are 90% confidence limits.

Detection of trends in a timely manner is essential for management of threatened species. Combining annual estimates into groups has the effect of increasing precision (with the assumption that there was no change within the years combined). We used three, two-year periods: 2003/2004, 2005/2006, and 2007/2008. A combined population estimate from 2005 and 2006 estimated 150 caribou with 90% confidence limits of 127 to 196, and the 2007/2008 estimate was 119 with 90% confidence intervals of 112 to 136. Confidence intervals around the estimates were smaller in 2007 and 2008 compared to previous years because of the larger number of collars available for calculating mark-resight population estimates in later years. While there appeared to be a low/high/low trend, precision was still inadequate for detecting significant differences among the time periods (Figure 6).

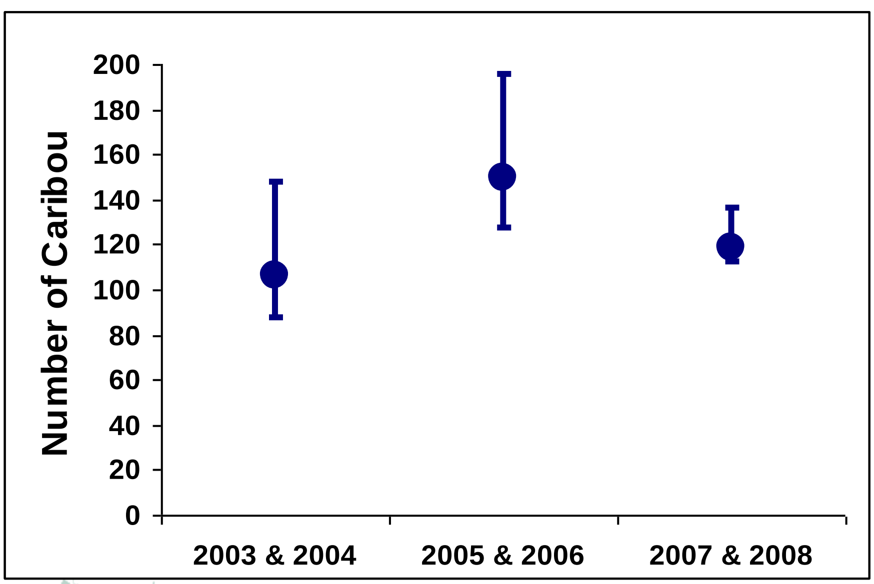


Figure 6. Combined population estimates for woodland caribou in South Jasper for the years 2003-2004 and 2005-2006. Error bars are 90% confidence limits.

Precision of annual estimates can be improved by increasing sample size, sightability, or both. In our case, both sample size and sightability have improved, so our chances of detecting short-term trends should be better in the future (Figure 7).

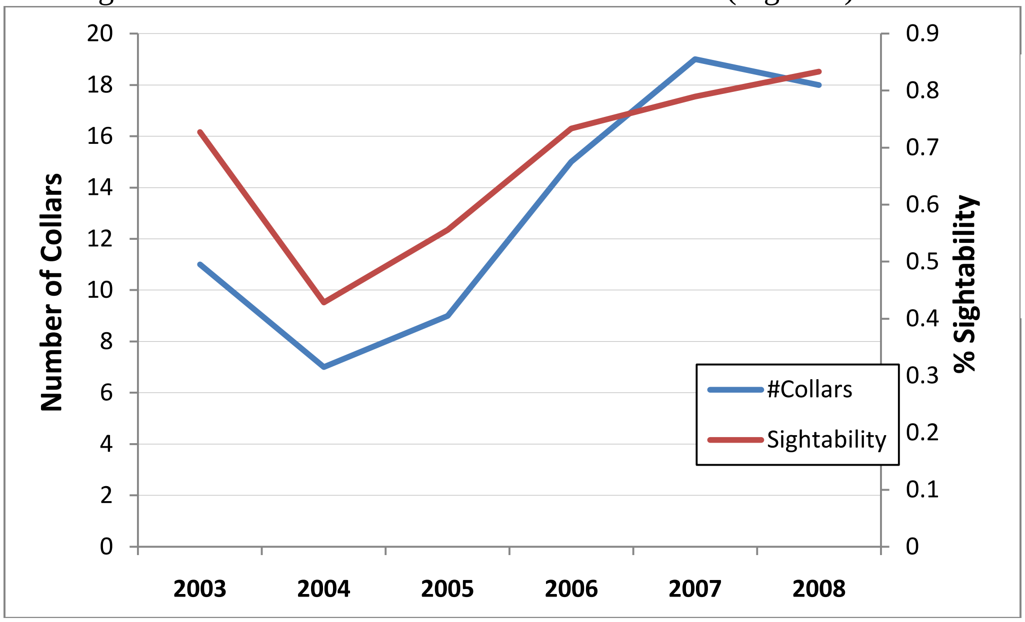


Figure 7. Sample size and sightability for South JNP Caribou population estimates.

3.6 Counts: Historic and Current

Counts (i.e. the number of caribou seen during a survey without correcting for sightability bias) are a low quality source of information. Trends in count data reflect changes in caribou numbers *and* changes in sightability of caribou, and counts could also be affected by caribou leaving or entering the study area. Raw counts always underestimate the actual number of animals, but the amount of underestimation is never known when only counts are used. Without information about how inaccurate estimates are, comparing counts long-term could likely lead to erroneous conclusions. Nevertheless, counts are the only data available for comparing recent and historic population sizes and count data should be examined with the above limitations in mind.

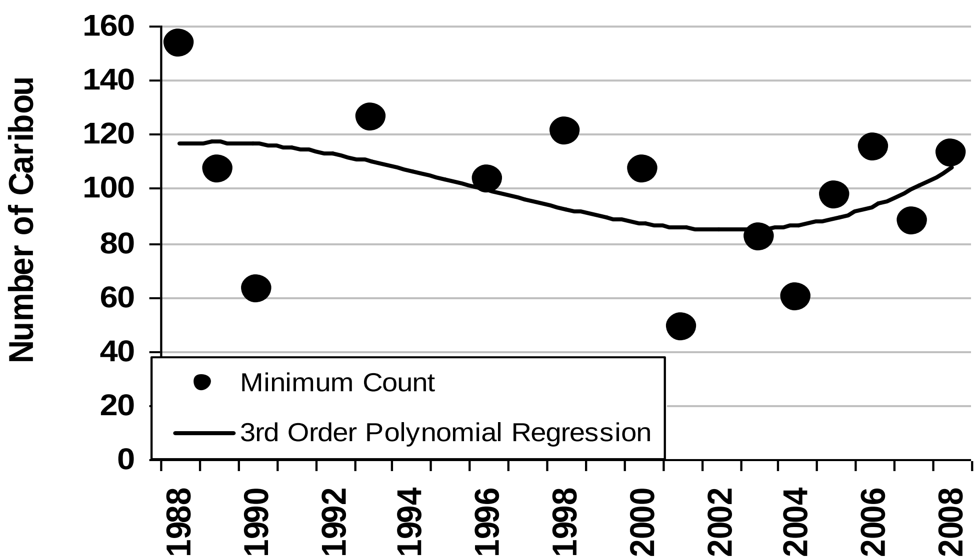


Figure 8. Historic trend in minimum numbers of caribou seen during south Jasper caribou surveys.

The time series of aerial counts for south Jasper starts at a high of 153 in 1988, reached a low of 42 in 2001, and then increased to 115 by 2008 (Figure 8). These data are highly variable – one of the lowest counts was recorded in 1990, two years after the highest count. Low counts that are followed by considerably higher counts can be safely ignored as reflecting poor sightability rather than low caribou numbers. If we remove these presumed poor sightability surveys, then we get a less variable time series (Figure 9). This smoothed time series is still imperfect; we cannot account for the degree of potential underestimation due to differences in sightability. If we assume that the higher data points (especially 1988) reflect caribou abundance rather than sightability, then the time series indicates that the south Jasper caribou population has declined by about 26% in the last 30 years (153 to 113 caribou). Over half of this decline occurred in the first 5 years (between 1988 and 1993, Figure 3). A rapid decline in the late 1980s is consistent with the poor adult survival recorded by Brown et al. (1993).

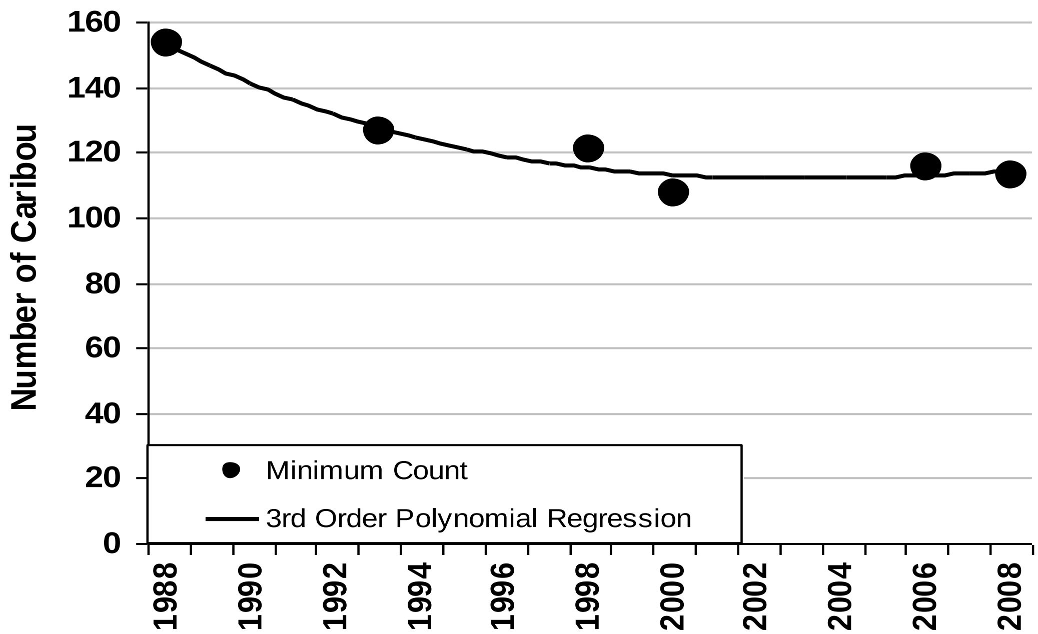


Figure 9. Historic trend in counts of caribou seen during JNP caribou surveys - with 'low' counts eliminated.

Assessing historical caribou numbers is even more difficult because population estimates prior to 1988 are subjective estimates based on caribou seen during ground-based patrols, plus some limited aerial surveying. As described in Section 3, Stelfox et al. (1974) estimated that there were 425 to 711 caribou during 1960-1973, which was based on a maximum single day ground-based count of 149, plus an unknown number seen during aerial surveys.

3.7 Minimum Counts: Regional

To compare the three regions in South Jasper (Tonquin, Maligne, and Brazeau) we must also rely on counts (rather than more reliable estimates) because the numbers of caribou in the Maligne and Brazeau are too small to generate meaningful population estimates.

Counts in the Maligne area were between 40 and 68 from 1988 to 2000. In 2001 the count dropped to 12, and has not been above 12 since 2004 – we observed 5 and 6 animals in 2007 and 2008 (Figure 10). Counts in the Brazeau area were 45 in 1984, 39 in 1988, 32 in 1993, then dropped to 8 in 1996. The values have fluctuated between 13 and 24 since then – we observed 20 and 13 caribou in 2007 and 2008 (Figure 10). The count in the Tonquin area was 74 in 1988 and a low of 22 was recorded in 2001. In 2007, 63 caribou were seen in the Tonquin, and in 2008 the minimum number observed was 94 – larger than had been previously recorded (Figure 10). It is critical to acknowledge the limitations of counts when interpreting Figure 10: counts always underestimate and changes in the data could reflect sightability, emigration, or immigration, as well as changes in actual caribou abundance.

The ability to detect changes and potential movement among the three areas has implications for caribou management. We have seen consistent low numbers in the Maligne and Brazeau and infer that lack of movement between regions could mean caribou persistence in these areas is dubious. Although counts are inadequate for detecting movements, there are three other sources of information to consider: DNA from blood samples, DNA from scat samples, and telemetry data.

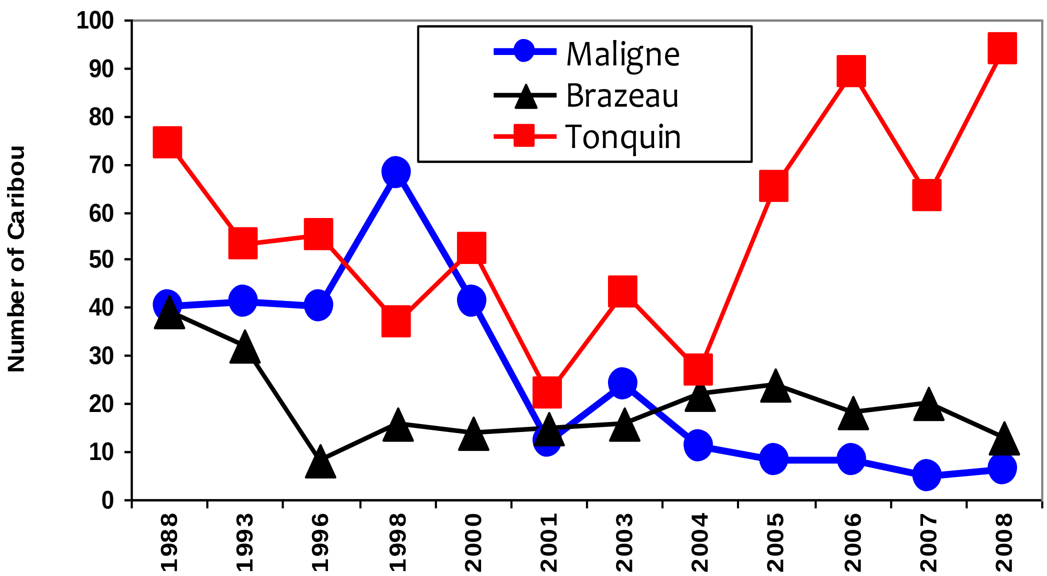


Figure 10. Minimum number of caribou observed during aerial population surveys from 1988 - 2008 in South Jasper National Park

Counts within each region have fluctuated dramatically since 1998 (Figure 10), but the total count has changed little (120 to 113, Figure 8). Movement of caribou between ranges would easily explain the regional fluctuations, but telemetry data and blood DNA data indicate that movement between the Tonquin and the other two areas was very unlikely, and that only rare movement between the Maligne and the Brazeau areas has occurred. Use of the scat DNA is still too preliminary to inform this question. A promising area of investigation will be the movement rates of male caribou, which is not captured in the telemetry and blood DNA information (only females are collared) but will be part of the scat DNA analysis.

Caribou are a slow-reproducing species, which means populations can decline rapidly but population growth is slow. For caribou populations in the Tonquin to have grown as is shown from 2000-2006 without immigration (Figure 10), survival and recruitment would have had to be consistently higher than average. Our calculated values of adult female survival in the Tonquin during this time *were* substantially higher than average, but sample sizes were small, reducing confidence in the survival estimates. Additionally, while we only have data for recruitment for 2004-2006, the calculated values were below average (again estimates are limited by small sample sizes). However, with adult female survival >95% and recruitment below average (but within the confidence limits of our calculated values), moderate population growth in the Tonquin would have occurred. Tonquin caribou have been known to use the Whirlpool valley and other parts of British Columbia outside of our survey area. A combination of very good adult female survival and small amounts of immigration, even in light of poor recruitment, is probably adequate to have increased caribou populations by the amount we've observed in the Tonquin. Therefore, the increase in the Tonquin is likely partly natural, but also due to either changes in sightability, or immigration, or both – we cannot determine which is most influential from our data. Similarly, declines in the Maligne coincided with very poor rates of adult survival and unknown calf recruitment from 1998-2004. Although we do not know the roles that predation, accidental deaths, immigration, and/or emigration could have played in the Tonquin increase or Maligne decrease, we cannot rule out that these were contributing factors. We continue to collaborate in research to help identify the relative role of each factor in caribou population dynamics.

3.8 Calf Survey

In March of 2007-2009, we relocated collared caribou to calculate calf recruitment, the number of calves surviving to approximately 1 year. The spring values are examined in relation to fall calf:100 cow ratios to estimate over-winter survival and recruitment into the population.

Calf recruitment in 2007 was excellent at 42 calves per 100 cows (90% CL: 31-53) compared to 13 calves per 100 cows in 2006 (90% CL: 7-20). In March 2008 the calf ratio was calculated as 21 calves per 100 cows (90% CL: 13-30) and in March 2009 the value was high again at 39 calves per 100 cows (90% CL: 23-54) (Figure 11).

Over-winter calf survival is variable among years: in fall 2007 we counted 22 calves per 100 calves (90% CL: 15-29), and in 2008 the value was 54 calves per 100 cows (90% CL: 43-66), compared to 40 calves per 100 cows in 2006 (90% CL: 30-50). Sample size, and therefore precision, is low during these surveys; no statistical differences are apparent between seasons (Figure 11). Although some years are statistically different (2005 and 2006; 2005 and 2008), this likely represents normal annual variation.

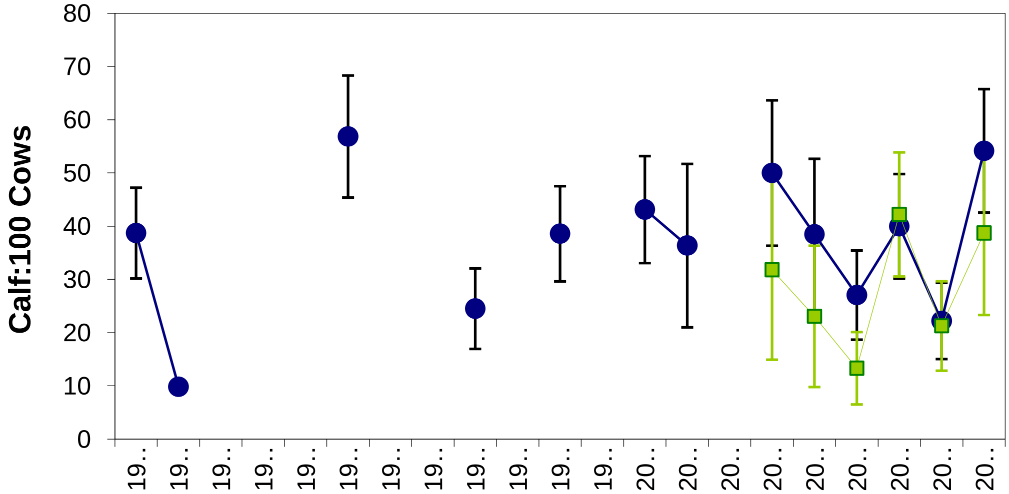


Figure 11. Calf to 100 cow ratios for fall (circles) and spring (squares) of consecutive years, 2003-2008. Error bars are 90% confidence limits.

4. Fecal DNA Project

4.1 Faecal DNA Background

In 2006, Jasper National Park embarked on a collaborative project with the University of Manitoba's Natural Resource Institute in a project titled "Use of genetic and hormonal information extracted from woodland caribou feces to monitor population demography." Dr. Micheline Manseau is the principal investigator on the broad-scale project, which has taken place in other parks across Canada, such as Prince Albert National Park, Quttinirpaaq National Park in Nunavut, and Manitoba Lowlands Proposed National Park. Peter Hettinga, an MSc student, has been working with the Jasper National Park data.

4.2 Faecal DNA Data Collection

In acquiring genetic information on the Tonquin, Brazeau and Maligne ranges each area was sampled twice during 2006-2007 and 2007-2008, with the exception of the Tonquin range which was sampled three times over 2007-2008. At least one initial collection and one follow-up collection are required to do mark-recapture analysis. Over each sampling period set flight paths were flown to avoid biasing collection sites. Each sampling site was reached by helicopter and was indicated by the presence of tracks, cratering, and/or live animals. Initial collections usually take place in conjunction with the annual visual survey in fall. After locating and counting caribou during the survey, we landed at a nearby foraging site and collected fresh faecal samples. Where possible, we documented whether the sample may have come from an adult or calf (based on tracks or group demographics) and we noted the group composition.

In collecting pellets a number of protocols were used to ensure the viability of collected genotype information. Faecal samples were collected in winter months when snow was present (preserved the pellet samples); samples were placed in a sterile plastic bag and kept on ice until they were frozen at the end of the day. We sought samples that were <48 hours old, as DNA extraction is more difficult from older samples. Pellets that were frozen together as pucks or patties were preferred over pellets distributed over an area as this ensured that each sample collected was from a single animal. Special caution was also taken to use wooden tongue depressors while collecting samples to avoid possible cross-contamination between samples. We collected approximately 1.4 times the number of faecal samples as there were estimated animals at the site. As the sample collection was in conjunction with the survey, the number of animals at each foraging sites was well estimated. Approximately 1 month after the survey, we returned to each region in south Jasper to search for tracks and collect another set of samples as part of the recapture.

In 2007 we collected 137 samples in the initial capture, and 117 in the recapture for the South Jasper populations. In the Tonquin valley we did a trial 3rd capture (2nd recapture) of scat to test if precision in a DNA-based population estimate would improve with an additional capture, we collected 44 samples to address this. We also collected scat from the northern A la Peche population in 2007: 102 samples in the first collection and 88 in the second. In addition to fall collections, we collected samples during the calf surveys: 76 in south Jasper in March 2007 and 51 in March 2008. In 2008 we collected another 174 samples during the annual visual survey, and collected 132 about one month later. We continued with the A la Peche collections, collecting 144 and 45 samples in two sample periods. After being sent for laboratory analysis at the Natural Resources Profiling and Forensic Centre at Trent University, each sample had DNA extracted by swabbing sloughed mucousal cells that surrounds each fecal pellet (Ball et al 2007). Typically five pellets are used per sample to acquire sufficient DNA for amplification in this way. 11 areas of the genetic code (loci) were amplified for use in genetic testing. 1 additional locus was amplified and used in determining the gender of each sampled animal also.

Scoring of alleles present at amplified loci provided each usable sample with a genetic fingerprint. This was important in allowing the identification of individual animals in performing mark-recapture analysis. A summary of the number of individual animals identified through genetic testing can be seen in Tables 3 and 4.

Table 3: Sampling information from 2006-2007 sampling sessions in Jasper National Park.

2006-2007 Sampling period	# sites sampled	# animals observed	# samples collected	#scored samples	#unique genotypes				#scored samples / unique genotype
					all	male	female	no sex data	
Maligne Oct 2006	2	7	12	3	2	1	1	0	1.50
Maligne Dec 2006	3		38	33	11	5	6	0	3.00
Brazeau Oct 2006	4	17	31	25	11	8	3	2	2.27
Brazeau Dec 2006	3		24	23	13	5	8	2	1.77
Tonquin Oct 2006	9	87	132	125	58	20	34	4	2.16
Tonquin Nov 2006	**5**		36	34	15	4	11	0	2.27

Table 4: Sampling information from 2007-2008 sampling sessions in Jasper National Park.

2007-2008 Sampling period	# sites sampled	# animals observed	# samples collected	#scored samples	#unique genotypes				#scored samples / unique genotype
					all	male	female	unidentified	
Maligne Oct 2007	2	5	9	7	4	0	4	0	1.75
Maligne Nov 2007	1	6	12	11	7	2	5	0	1.57
Brazeau Oct 2007	8	13-15	45	27	16	8	8	0	1.80
Brazeau Nov 2007	4	4	41	33	15	8	7	0	2.20
Tonquin Oct 2007	5	0	82	68	39	8	29	2	1.74
Tonquin Nov2007	6	7	64	60	27	6	20	1	2.22
Tonquin Jan 2008	4	5	44	40	17	10	6	1	2.35

4.3 Faecal DNA Preliminary Mark-Recapture Analysis and Results*

*final results are awaiting verification through additional laboratory analysis of available genetic material

The use of noninvasively collected genotype information in mark-recapture calculations has been well documented and studied. By sampling a population at close intervals and identifying individuals seen at each time, a proportion of seen to unseen animals can be identified and (ideally) used to estimate population size.

Done with only two sampling intervals, this process follows a Lincoln-Peterson model where population size, N, can be calculated provided sampling information on the number of animals sampled at sampling time 1, (n1), at sampling time 2, (n2), and the number of animals seen at time 1 also seen at time 2, (m2). There are also a number of assumptions Lincoln-Peterson models follow, notably that the study occurs in a closed geographic range where little to no migration has occurred from the sampling area and that the amount of time between the sampling events has not been enough to allow for natural changes to the population (births, deaths, etc.).

Following these protocols each a priori defined caribou range in south Jasper National Park was visited twice for estimates of population size to be calculated. Use of simple formulas were used in calculating Lincoln-Peterson estimates of population size for each sampled range and could be successfully broken down by gender through available genetic information (Tables 5 and 6). A population estimate for the 2007-2008 sampling period in Tonquin using Lincoln-Peterson models was unavailable because there were three sampling periods instead of only two.

Through use of more complicated numerical models other estimates of population size can be attained by use of maximum-likelihood statistics where population data is fitted to various models. This allows for variability in capture probability information from sampled individuals to be modeled and for the calculation of asymmetric confidence intervals (which are more representative of sampled data and secures the lower confidence interval not falling below the minimum number of animals seen).

Results acquired through maximum likelihood models in program MARK can be found in Tables 5 and 6. Because in the 2007-2008 sampling period all Maligne animals sampled in the first sampling period (Oct 2007) were also sampled in the second sampling event (Nov 2007), no estimate of population size was available using either Lincoln-Peterson or Maximum-Likelihood models. Comparisons of the number of genotypes recaptured over time in the Tonquin, Brazeau, and Maligne ranges can be found as Figures 12, 13, and 14.

Table 5: Preliminary results of population estimates calculated from DNA extracted from caribou pellet samples in south Jasper National Park, 2006-2007. Continued testing of genetic information is required and values seen here may change slightly

		Lincoln-Peterson Model			Maximum-Likelihood Models			
Region and Year	#unique genotypes	Population Estimate	Standard Error	95% CI	Population Estimate	Standard Error	95% CI	model
Maligne 2006-2007	12	15	5.5	(7,28)	16	8.5	(13,64)	M(t)
females[1]	6	6	-	-	6	-	-	-
males[2]	6	11	5.5	(1,22)	6	-	-	-
Brazeau 2006-2007[3]	20[3]	33	8.4	(17,49)	33	10.8	(22,74)	M(0)
females	10	11	2.8	(6, 17)	16	5.2	(12,37)	M(t)
males	10	15	4.5	(7,24)	16	5.2	(12,37)	M(t)
Tonquin 2006-2007[4]	66	117	26.0	(67,168)	67	1.3	(66,74)	M(b)
females	40	81	20.2	(42, 121)	70	17.6	(50,127)	M(t)
males	22	34	10.2	(14, 55)	38	(10.3)	(27,73)	M(t)

1 – all females recaptured
2 – no males recaptured
3- no sex data available for one genotype
4 – no sex data available for four genotypes

Table 6: Preliminary results of population estimates calculated from DNA extracted from caribou pellet samples in south Jasper National Park, 2007-2008. Continued testing of genetic information is required and values seen here may change slightly

		Lincoln-Peterson Model			Maximum-Likelihood Models			
Region and Year	#unique genotypes	Population Estimate	Standard Error	95% CI	Population Estimate	Standard Error	95% CI	Model
Maligne 2007-2008	7[1]	7	-	-	7	-	-	-
females	5[2]	5	-	-	5	-	-	-
males	2[3]	2	-	-	2	-	-	-
Brazeau 2007-2008	18	20	1.2	(18,23)	18	0.8	(18,21)	M(0)
females	8	10	0.6	(8,11)	8	0.4	(8,9)	M(0)
males	10	11	0.9	(9,13)	10	0.8	(10,13)	M(0)
Tonquin 2007-2008*	50[4]	65	7.4	(51,80)	53	3.1	(51,67)	M(b)
females	36	44	4.9	(35,54)	45	5.5	(38,62)	M(0)
males	11	15	3.4	(8, 22)	15	4.1	(11,38)	M(0)
Tonquin 2007-2008	56[4]	-	-	-	71	6.6	(62,90)	M(t)
females	37	-	-	-	44	4.2	(39,58)	M(tg)
males	16	-	-	-	20	3.3	(17,33)	M(tg)

1 – all animals recaptured
2 – all females recaptured
3 – no males captured in first sampling period
4 – no sex data for two genotypes in first sampling period and one in second
* Calculations done using first two sampling periods only

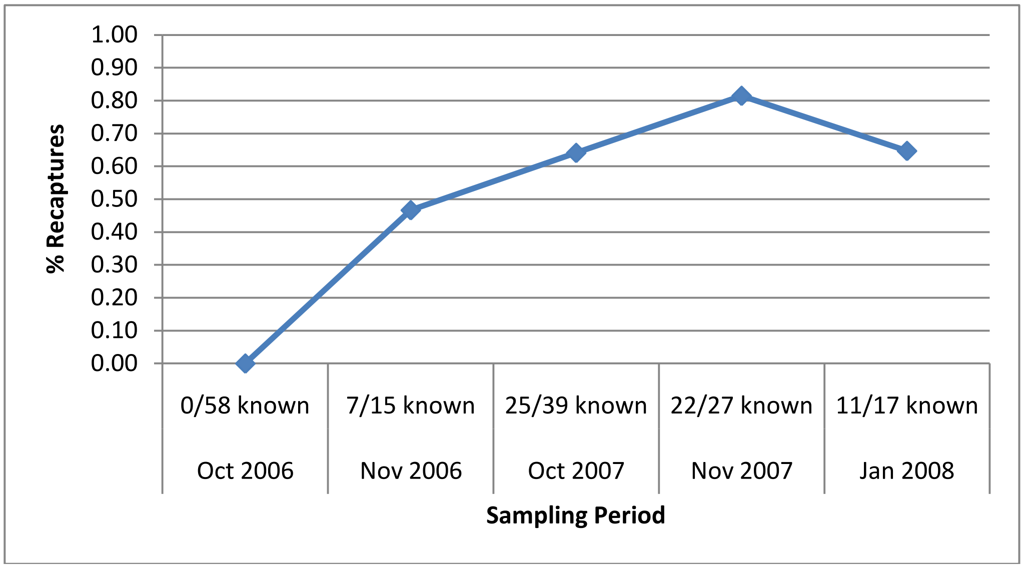


Figure 12: Porportion of genotypes previously sampled from the Tonquin Range in Jasper National Park with each sampling period

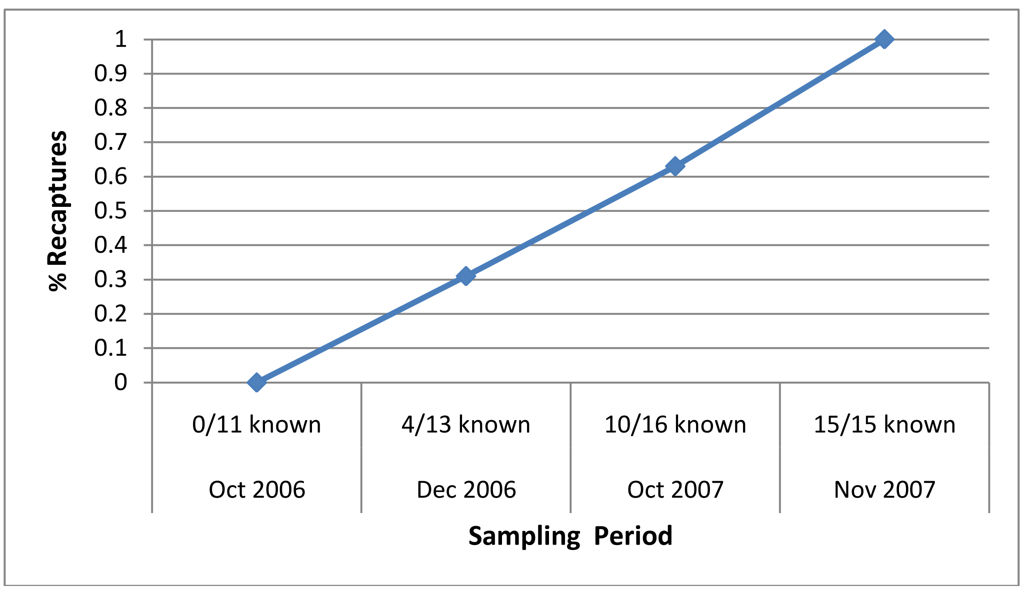


Figure 13: Porportion of genotypes previously sampled from the Brazeau Range in Jasper National Park with each sampling period

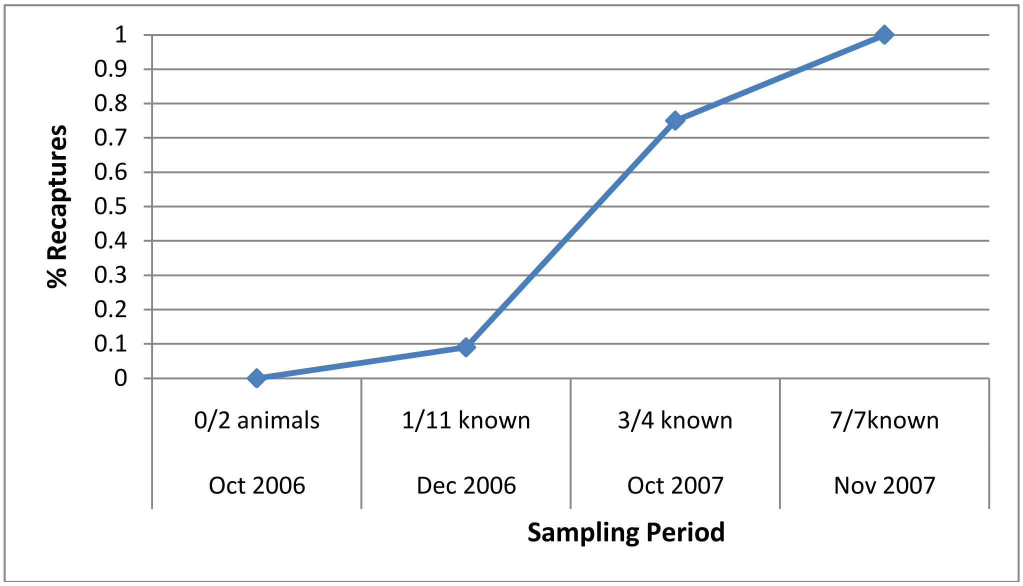


Figure 14: Porportion of genotypes previously sampled from the Maligne region in Jasper National Park with each sampling period

In 2006-2007, there were 12, 20, and 66 unique genotypes for the Maligne, Brazeau, and Tonquin identified overall (in both sample periods), and the population was estimated at 15, 33, and 117 caribou in each respective region (Table 5) via the Lincoln-Peterson model. The 2006-2007 estimate was lower (75) for the Tonquin when using the maximum likelihood method, but the estimate was more precise (Table 5). For the 2007-2008 samples, the population estimate was unavailable, 20, and 65 for the Maligne, Brazeau, and Tonquin. Confidence intervals are variable in relation to the estimate (8-65% of the estimate), but for some regions, the intervals are substantially <20% of the estimate, indicating very good precision.

When the annual survey and genotype estimates are contrasted minor discrepancies are evident, and it's unclear whether this is occurring at the collection or genotyping stage. For example, in 2006, we collected 12 samples from two sites where we observed 7 caribou; only 3 samples were of sufficient quality to score and 2 unique genotypes were identified (Table 3). Likewise in the Brazeau, we observed 17 individuals in 4 groups and collected 31 samples, for which 11 unique genotypes were observed. In the Tonquin, we observed 87 individuals during the survey, collected 132 samples at 9 sites, and identified 58 unique genotypes. Presumably, increasing the number of genotypes that are identified would increase the accuracy and precision of the population estimate. This may require increased sampling in the field (i.e. greater than 1.4x the number of individuals) or refined lab techniques (multiple scoring of samples).

While all results are preliminary it would seem that mark-recapture modeling may be a valuable tool in estimating population size. The use of a non-invasive alternative in acquiring demographic information allows managers to sample animals of interest without directly interfering in their day-to-day behaviours. While some inconsistencies do exist in the number of animals seen visually and sampled genetically, it is expected in the use of mark-recapture modeling that you are only seeing a proportion of animals present. The consistency of estimates across sampling times for the Brazeau and Tonquin ranges would indicate that a good degree of precision exists in how this sampling is occurring. An apparent decline of animals from the 2006-2007 to the 2007-2008 sampling period, for both the Brazeau and Tonquin ranges, is at this point not significant as the 95% confidence intervals for estimates of population size in each range intersect and are not statistically different.

Sample sizes have tended to decrease between the 1st and 2nd sampling session of each year because the 2nd session is after the rut when caribou have moved into treed regions. In future years, we hope to conduct two sampling sessions within the rut, or at least when caribou are in the alpine, to increase sample size. It is not always possible to complete two sessions within the rut, as clear calm weather, and adequate snow cover are required.

5. Canadian Rockies Woodland Caribou Project

5.1 Research Overview

In 2007, the Universities of Montana and Calgary, in partnership with Parks Canada, initiated a program to look at large scale patterns of genetics and predator-prey dynamics in caribou ranges across a gradient of human influence. The project's geographic reach includes seven caribou populations from Banff north to the Redwillow and Narraway in British Columbia; the research aims to determine how human activities affect caribou population ecology through modification of predator-prey relationships. The strength of the project is in comparing caribou dynamics across the mountain caribou range in Alberta and contrasting protected areas to developed landscapes in the province, where Jasper National Park represents a baseline region.

The research objectives are many:

- Population genetics: are present caribou herd delineations supported by genetics, and has human-caused fragmentation led to current herd structure?
- Landcover and human disturbance mapping: reliable and consistent landcover and spatial data are necessary to addressing all habitat-related research objectives.
- Critical habitat definition across spatial scales: to develop conservation strategies across caribou herds, boundaries, and scales, a definition of critical habitat is integral. A process for determining critical habitat will be developed and recommended to the SARA responsible agency, Environment Canada.
- Predator-prey relationships: how does predator efficiency change over a regional gradient of human development, and how do kill-rates differ across this gradient?
- Primary-prey relationships: how does human activity contribute to changes in primary prey productivity in wolf-caribou systems?
- Caribou-fire relationships: examine relationships between fire, mountain pine beetle, wolves, elk, and caribou to predict the effect of natural landscape change on caribou populations in the national parks
- Caribou migration: how do caribou migratory patterns and spatial separation from wolves change over regional gradients in human development

- Population viability and conservation strategies for threatened mountain caribou: project future scenarios with information from the identified objectives.

Jasper National Park has been supporting these initiatives with funds, equipment, data collection, data sharing, field support, and personnel support, although the Universities of Montana and Calgary administer the project in support of two PhD students and a post-doctoral fellow (Section 6). Much of Jasper's continued use of GPS collars on caribou has been in support of this collaborative research. We report here on two objectives with which Jasper personnel have been closely affiliated, and refer to progress reports from the Canadian Rockies Woodland Caribou Project for further detail about the larger project.

5.2 Predator-prey relationships

Predation is a key ecosystem process that shapes prey abundance and distribution. In Jasper's multi-prey system, of which caribou are a component, the relationship between primary prey (e.g. elk and deer in JNP) and wolves is important to identifying mechanisms of caribou decline, such as apparent competition. Apparent competition occurs when prey negatively affect each other indirectly by sustaining a shared predator population. In the context of Jasper, high numbers of elk and deer could be indirectly affecting caribou because more wolves are sustained due to abundant prey. We have collared wolves in Jasper National Park in support of predator-prey research that will help clarify the factors influencing kill-rate and caribou decline. Wolf GPS data enables detection of kill-sites and the sites' relationships to natural and anthropogenic features (e.g. trails, roads, seismic lines). Verifying species at kill-sites also informs prey-specific kill rates, which are used to assess the relative role of each ungulate species in regulating wolf density.

In winter 2008/2009, we helped visit kill-sites from four packs collared within the park's boundaries (Glacier Pass, Signal, Sunwapta, and Brazeau). Each pack has a remotely downloadable collar, which enables access to data from the collar on-demand. Data are downloaded approximately monthly and a space-time clustering algorithm is used to identify clusters of wolf GPS locations (methods similar to Webb et al. 2008). We visited cluster sites throughout the winter, and data collection is ongoing. We used both helicopter and snowshoes to visit sites depending on logistics or accessibility.

The Sunwapta pack has been collared for several years; in winter 2007/2008 the pack consisted of approximately 6 individuals and in 2008/2009 there were up to 9 wolves, but usually 8. In winter 2007-2008, we began preliminary examination of kill-sites during the protocol-building stages of the project. During this pilot winter season, we visited 28 sites, but did not consistently use the space-time permutation method to objectively identify sites; data were collected only to determine the efficacy of the program. Twelve kill-sites were found, including 7 elk, 1 caribou, and 4 deer (Table 7). Three double-kills were also discovered. Differentiating deer species is difficult without direct evidence (antlers), but samples were collected at each site for further identification in the lab. The pilot year confirmed our ability to identify and collect data on wolf predation events and even find caribou mortalities using wolf GPS data. The documented caribou kill was in fact that of Caribou 64, a GPS-collared female from the Tonquin herd. GPS data from the recovered collar indicated that she had died 2 weeks prior to our detection of the mortality event. When we visited the site, the only clear tracks were those of wolverine; no wolf sign was evident. However, when Sunwapta wolf 81's collar was subsequently downloaded, a distinct cluster of GPS points matched the date and location of 64's death. Had the wolf not been collared with a GPS collar, the caribou predation might have been mistakenly attributed to a wolverine, illustrating the impressive information-gathering power of GPS collars and the importance of collaring wolves in caribou ranges.

In December 2008, we began to collect wolf predation data using formal space-time permutation methods to identify potential kill-sites. We visited 23 clusters using November–December wolf data and located 10 kills: 4 deer, 2 elk, 2 caribou, 1 moose, and 1 mountain goat (Table 7). Three clusters were identified and visited prior to final development of the techniques to select clusters, but have been included in this summary. One of the elk kills was not made by wolves but was scavenged; Parks Canada's aggressive elk management program destroyed five problem elk in the winter of 2008-2009. Using January (3 January - 31 January) wolf data, we visited 15 cluster sites and located 1 elk, 1 moose, 1 caribou, and 2 deer. We also identified 10 bed-sites. The caribou was killed in Maccarib pass after wolves had travelled from Whistlers pass, through Marmot Pass, and up the Portal Creek trail. We visited an additional 19 sites using February (30 January - 3 March) wolf data; some of these sites necessitated helicopter access (Simon Creek, Athabasca Pass etc.). We documented 3 moose kills, 2 elk, 1 deer, and 13 bed sites. Both elk were scavenged (one killed on the highway and the other was an aggressive female destroyed by Parks Canada staff).

The Brazeau pack (observed with a maximum of two animals) was collared in mid-February 2009. We have fewer site visits to this pack due to remote access and fewer available data. In March 2009, we used a helicopter to access 17 of 31 identified cluster sites that were collected during 17 February to 23 March. We located three kills: two bighorn sheep and one deer (Table 7). One of the sheep was a ram, but we did not find evidence of sex at the other two sites. The remaining 14 sites were bed sites, often on large overlooks high in the mountains. Cluster sites do not necessarily allow identification of smaller prey items (hares, voles, squirrels etc.), which may account for an unsampled portion of this atypically small pack's diet. Kills were made near Mount Aztec, Sawtooth Mountain, and above the Southesk river near the park boundary (deer). The pack ranges from Southesk lake to the eastern park boundary to Longview Mountain in the Whitegoat Wilderness Area. We will work with backcountry staff to continue kill-site investigation at a reduced level through the summer of 2008.

The Signal pack, also collared in February 2009, consisted of 4 grey wolves during winter 2008-2009, with 2 known females and 1 known male. They ranged from Morro Peak to Wabasso Lakes, primarily east of the Athabasca River. We were able to extensively sample kill-sites from this pack due to its proximity to town and ease of ground-access. We visited 30 of 33 identified clusters using February and March wolf data and located kills of 1 elk, 6 deer, and 1 bighorn sheep (ram) (Table 7). Several deer kills were identified only by visiting all GPS points that constituted a cluster, because of distinct feeding (kill-site) and bedding locations within a single cluster. Kills were located throughout the pack's territory and in a variety of habitats. We were unable to differentiate species or age at many of the deer kills because few remains were left, but hair samples were collected in order to identify species at a later date.

The Glacier Pass pack was collared in December 2008. They occupied habitat from Daybreak Peak and Blue Creek in Jasper National Park to Hardscrabble Creek and the Muskeg and Berland rivers in the Willmore Wilderness Area. The pack consisted of 4 animals in winter 2008/2009, two of which were collared. Much of their territory was very challenging to access in the winter and required the use of a helicopter. We visited 37 cluster sites that were made from December 2008 to March 2009. We located 4 mountain goat, 6 bighorn sheep, 1 elk, 1 moose, and 1 deer kill (Table 7). This wolf pack used many high alpine areas, exhibiting both kill-sites and bed-sites in high quality sheep and goat habitat, while rarely killing or bedding in the valley bottoms. This is a previously undocumented pattern for wolves in Jasper National Park, but may be typical of interior mountain packs.

During summer 2009, the University of Montana, University of Calgary, and Parks Canada will continue to collect predation data as a component of the joint research project. Collection of summer data will require different methods (i.e. visiting many more wolf cluster points) in response to seasonal changes to wolf behaviour and prey age structure.

Table 7: Kill-site visits and species killed by four wolf packs in Jasper National Park. Data were collected in winter 2007-2008 for the pilot study and 2008-2009 for the main component. Data collection will continue into summer 2009. Data from the pilot year were not sampled randomly.

	Total site visits	Elk	Moose	Deer	Caribou	Sheep	Goat
Sunwapta							
• Pilot	28	7		4	1		
• 2008/09	57	5*	5	7	3		1
Brazeau	17			1		2	
Signal	30	1		6		1	
Glacier Pass	37	1	1	1		6	4

* three elk were scavenged

6. Primary-prey aerial surveys (adapted from Robinson et al. 2008; Robinson et al. 2009)

In association with the Canadian Rockies Woodland Caribou Project described in section 5, a specific analysis of prey abundance was undertaken by a post-doctoral fellow (Dr. Hugh Robinson). The effect of primary prey and shared predators on caribou mortality could be critical to understanding one mechanism of caribou decline. However, without telemetry or population data on primary prey (moose, elk, and deer), aerial surveys may provide the only viable data source regarding alternate prey. Jasper National Park and the Canadian Rockies Woodland Caribou Project conducted one aerial survey in Jasper National Park in each of 2008 and 2009 in order to: 1) provide relative density of primary prey within and adjacent to caribou areas; 2) provide point locations to develop predictable habitat maps of prey species and to validate telemetry-based habitat maps; and 3) be comparable to past surveys conducted by Parks Canada and other jurisdictions.

6.1 Elk Collaring

Jasper National Park collared elk during the winters of 2007 and 2008 in support of survey and habitat selection research work. Fourteen elk were ground darted and immobilised using a telazol/xylazine combination. Habituated elk were readily approached on the ground and darted with little apparent stress to the animal. Ground-based chemical immobilization was carried out by experienced capture personnel that had completed the Canadian Association of Zoo and Wildlife Veterinarian Chemical Immobilization Course. An additional 15 elk were collared via helicopter net-gun.

We deployed VHF collars in the first winter and supplemented with GPS collars in winter 2008/2009. Collars were distributed in relation to the estimated number of elk in each area. Around town (high density of elk, approximately 150) we distributed 11 radiocollars (9 VHF, 2 GPS) between Jasper Park Lodge and Whistlers campground. In the Snake Indian valley (variable number of elk moving into/out of the Park) we deployed 2 VHF and 2 GPS collars. In the Rocky River/Devona region (approximately 100 elk) we deployed 4 VHF collars and 2 GPS collars. In the Palisades/Airport region (approximately 75 elk), we deployed one GPS and two VHF collars. In the Tekarra Marsh region (approximately 30 elk) we deployed two GPS and four VHF collars. And in the Wabasso region (small number of elk, maybe not independent from Tekarra group), we deployed one VHF collar.

Seven collared elk mortalities have occurred since collaring began in November 2007. Three of the elk were from the Tekarra group (74, 78, 98): elk 74's collar was located on the ice of the Athabasca river January 2, 2008. It is unknown whether the elk died naturally or was killed on the ice. Similarly, elk 78's collar was located on mortality on Christmas Day 2007, also on the Athabasca river ice. The cause of elk 78's death is unknown and capture myopathy cannot be ruled out as the elk died 6-8 days post-capture. However, the location of the collar and carcass on the ice suggests that predators may have caused the elk to move onto the river. Elk 98's collar was found on the Miette River on 4 January 2009. The carcass or kill-site was not located under fresh snow, but a wolf cluster from the Sunwapta pack was in the exact area and wolves had clearly chewed the collar. Elk 83 (townsite elk) was a confirmed highway mortality, hit in the wildlife zone near town in June 2008. Elk 88 (Rocky River), located in July 2008, was a suspected highway mortality. Elk 93 (Palisades/Airport) could have also been hit on the highway in April 2008, but also could have been killed by the Signal pack (at the time uncollared). Elk 90 was found intact near Jasper Park Lodge in September 2008. There was fluid in the lungs and pericardium region, which may have caused decreased function and may have been the primary cause of death. Finally, Elk 87 (Rocky River) died sometime between 17 September 2008 and 15 May 2009 in the Devona area. E87's mortality signal was heard on May 15, 2009, and the carcass discovered on 27 May 2009. Only the collar and a few bones remained – cause of death is unknown, though the carcass had either been killed, or scavenged, by wolves.

6.2 Survey Methods

Aerial surveys followed guidelines set forth by Unsworth et al. (1994). The Montane region of Jasper National Park was divided into 30 elk winter range subunits ranging from 23 km² to 39 km² ($\bar{x}$ = 29.9 km²) (Figure 15). Each subunit was classified into a high, medium, or low stratum for both elk and moose prior to the survey. Subunit classification was based on ground observations, a priori knowledge, and results from previous aerial surveys. In 2009, elk and moose strata were adjusted one level up or down depending on 2008 raw counts. Moose strata was adjusted from 2008 so that areas where more than one group of moose were observed were set to high (i.e. units 19, and 21), areas where single groups were observed were set to medium (i.e. units 11, 51, 54, and 39), and areas where no moose were observed were adjusted down one strata level. A comparison of 2008 and 2009 stratification levels is provided in Table 8.

Twenty of the 30 subunits were selected at random, representing a mix of all three strata for both moose and elk. All units flown were included in the survey for both species. For instance, a unit that was flown as high for elk was considered low or medium stratum for moose. In addition to elk and moose, observations of deer, wolves, and bighorn sheep were recorded during the survey although population estimates were not generated for these species.

Subunits were flown in transects approximately 300 m apart at a speed of 60 to 80 km/hr as dictated by terrain and animal density (Unsworth et al. 1994). When animals were sighted, the location and total number of animals observed in the group were recorded. Groups were classified as bull, cow, calf, or unclassified. The activity of the first animal observed (bedded, standing, moving), as well as vegetation class (grassland, sagebrush, juniper, aspen/deciduous brush, conifer), percent snow cover (10% increments in immediate area surrounding the sighted animal), and percent canopy cover (10% increments above sighted area) were recorded at each observation (Unsworth et al. 1994). In subunits where no animals were sighted, zeroes were entered in all fields for analysis. Sightability of elk was corrected using the Elk Hiller 12-E Idaho model, and for moose using the Moose Hiller-Siloy Wyoming model. The moose model contains a covariate for terrain ruggedness which was considered important in early iterations of the aerial survey program (Unsworth et al 1994), but which has since been removed (Anderson and Lindzey 1996). Although it has no effect on the population estimate, the input still requires that this field contain some value therefore it was set to 0 for all observations.

During the 2009 survey, in some instances when large groups of elk were encountered, a digital photo was taken in order to compare our count from the air with what was assumed to be a more accurate count using the digital record. Raw counts, one using the original totals and one using the corrected counts from digital photos, were analyzed in the Aerial Survey software separately in order obtain separate total population estimates.

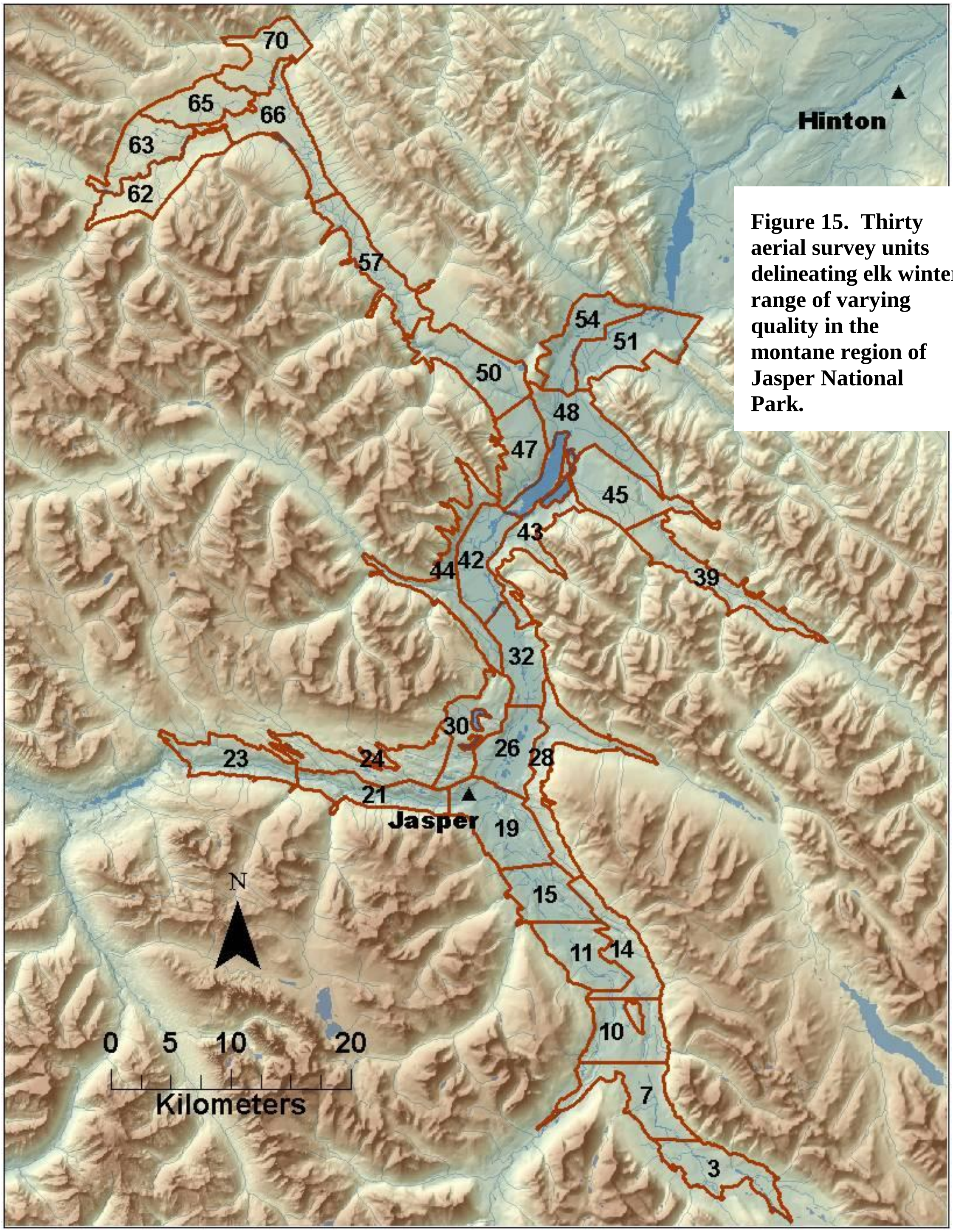


Figure 15. Thirty aerial survey units delineating elk winter range of varying quality in the montane region of Jasper National Park.

Table 8: Survey unit stratifications for elk and moose in the montane region of Jasper National Park, 2008 and 2009 (counts left blank when a unit was not surveyed in a particular year).

Unit	Elk 2008		Elk 2009		Moose 2008		Moose 2009	
	Strata	Count	Strata	Counts	Strata	Count	Strata	Count
3	Low	0	Low		High	0	Medium	
7	Low		Low	0	Low		Low	1
10	Low		Low		Low		Low	
11	Medium	0	Low	0	Medium	2	Medium	0
14	Low	0	Low	0	Low	0	Low	0
15	Medium		Medium		Medium		Medium	
19	High	55	High	76	Low	2	High	1
21	Medium	0	Low	0	High	3	High	0
23	Low	0	Low	3	High	6	High	8
24	Low		Low		Medium		Medium	
26	High	13	High	61	Low	0	Low	0
28	Low		Low	0	Low		Low	0
30	Medium		Medium	2	Medium		Medium	5
32	High	52	High	66	Low	1	Medium	0
39	Low	5	Medium		Low	1	Medium	
42	High	0	Medium	3	Medium	0	Low	0
43	Medium	9	Medium		Low	0	Low	
44	Low		Low		Low		Low	
45	High	42	High	31	Medium	1	Medium	2
47	Medium		Medium	1	Medium		Medium	0
48	High	85	High	68	High	0	Medium	2
50	Low		Low		Low		Low	
51	Low	0	Low	0	High	1	Medium	4
54	Medium	6	Medium		Medium	2	Medium	
57	Low		Low	25	High		High	2
62	Low	0	Low		Medium	1	Medium	
63	Medium		Medium	1	Medium		Medium	4
65	Medium	19	Medium	0	Medium	2	Medium	5
66	Low	5	Medium	3	High	10	High	9
70	Medium		Medium	8	Medium		Medium	9

6.3 Results

The 2008 survey was conducted over 4 consecutive days from February 25 to February 28. Due to time and budgetary constraints, 18 of the original randomly selected 20 subunits were flown (2 low strata units were omitted). A total of 491 animals were observed (Table 9) including 5 of 7 species of ungulate present in the park (neither caribou nor mountain goats were observed in the Montane survey units). The 2009 survey was conducted over 5 consecutive days from January 6th to January 10th. Twenty units were flown including 13 units that had been flown in 2008 and 7 units that were flown for the first time in 2009. A total of 848 animals were observed (Table 9) including 5 of 7 species of ungulate present in the park (neither caribou nor mountain goats were observed in the Montane survey units). The largest concentrations of elk were observed in and around the townsite, near the airstrip, and at the base of the Rocky River burn (Figure 16). Most moose observed were near the Dominion Meadows, and the Snake Indian River (Figure 16).

Table 9. Aerial survey results summary, Jasper National Park 2008 and 2009 (strata, and sightability corrections provided for moose and elk only).

Species	Units Flown (high, med, low)	Total Units (high, med, low)	Raw Count	Sightability Corrected (90% CI)
2008				
Elk	18 (6, 5, 7)	30 (6, 10, 14)	291	410 (73)
Moose	18 (6, 6, 6)	30 (7, 12, 11)	32	180 (130)
Bighorn Sheep	18	30	105	
White-tailed Deer	18	30	29	
Mule Deer	18	30	26	
Wolves	18	30	8	
2009				
Elk	20 (5, 7, 8)	30 (5, 11, 14)	348	435 (67)
Elk (counts corrected using digital photos)	20 (5, 7, 8)	30 (5, 11, 14)	359	445 (67)
Moose	20 (5, 10, 5)	30 (5,16, 9)	52	296 (245)
Bighorn Sheep	20	30	260	
White-tailed Deer*	20	30	107	
Mule Deer*	20	30	52	
Wolves	20	30	6	

*An additional 23 deer were observed but species was not determined.

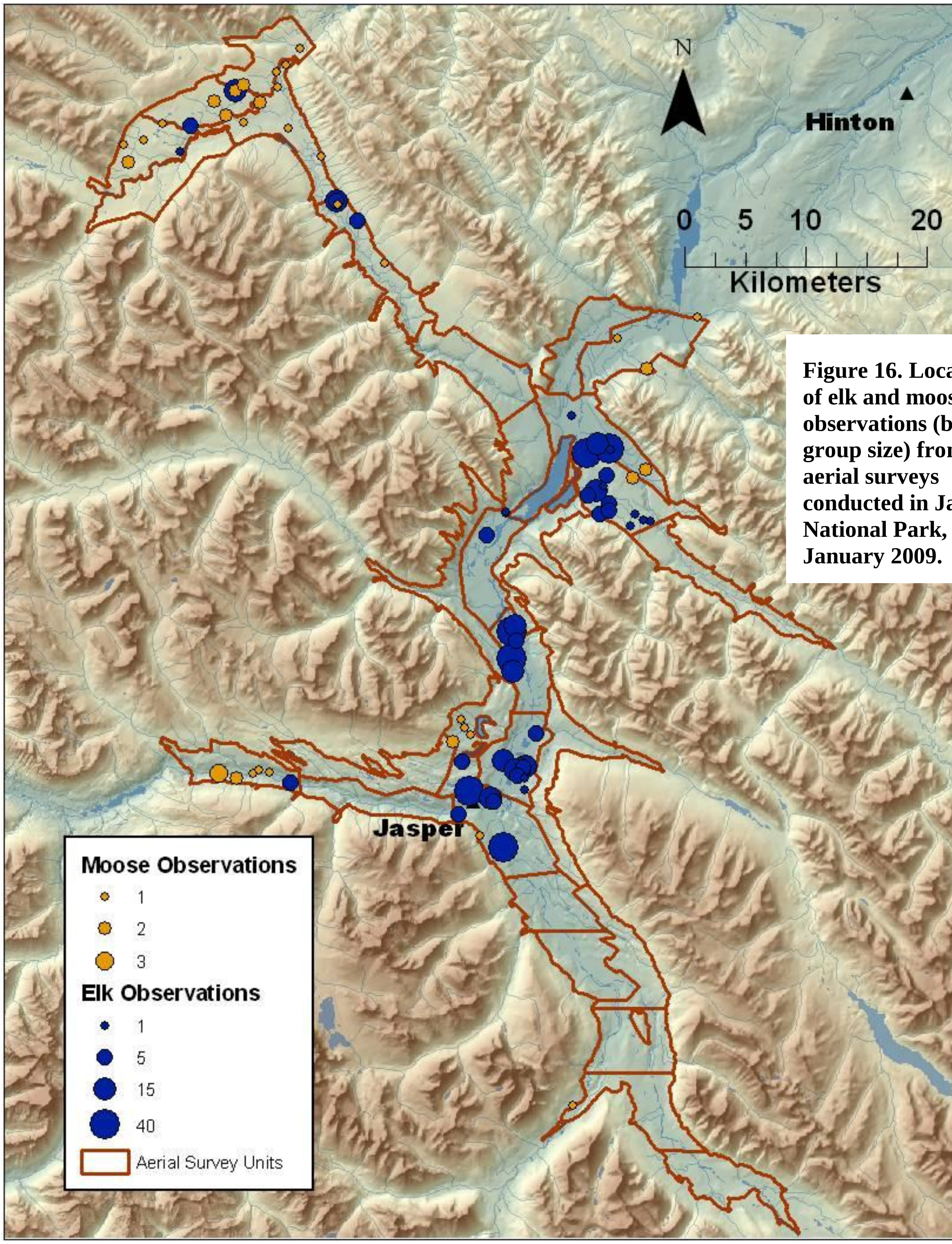


Figure 16. Locations of elk and moose observations (by group size) from aerial surveys conducted in Jasper National Park, January 2009.

6.4 Discussion

The aerial survey program corrects for missed animals using logistic regression models to quantify the probability that an animal or group of animals will be seen given a number of variables (i.e. group size, snow cover, vegetation cover, etc.). These corrected observations are then extrapolated to survey units not flown. This method introduces three sources of variance (sampling, sightability, and model). Sampling variance is reduced through accurate stratification of subunits and by increasing the percentage of units flown within each stratum. For instance, flying all subunits within a single stratum reduces sample variance for that stratum to 0, as does observing equal numbers of animals in each subunit within one stratum. The high degree of variance calculated in the moose population estimate comes primarily from observations in the medium strata. Despite re-stratification of the survey units in 2009, this high level of variance continues to disappoint. Both the sample and sightability variance are very high. While some of the sample variance may be explained by the fact that 10 of 16 medium strata units were flown (compared to high strata where all 5 units were surveyed resulting in 0 sample variance), the high sightability variance is not easily explained. The authors of the moose sightability model state "The sensitivity of the variance components of this model suggest that surveys should be applied during early winter when moose are most likely to occupy open habitat types and estimates are most precise" (Unsworth et al 1994:62). Several of the moose observations are in cover greater than 60% canopy, causing the variance attributed to sightability within the model to inflate. As a result, the moose population estimates should be viewed with a level of caution. There is not a significant difference in the moose population estimate between years due to the wide confidence intervals, and it is unlikely that the moose population within Jasper National Park increased from an estimated level of 180 (±130) in 2008 to 296 (±245) in 2009. It is possible that moose are in high levels of canopy cover during January and February when elk surveys are best conducted and this may reduce our sightability and limit the utility of this particular model.

In contrast to the moose model, the elk population estimates appear to be more consistent and reliable. The 2008 survey was conducted in late February with little snow cover and resulted in a population estimate of 410 (±73). The 2009 survey was conducted in early January when snow cover in most areas was 100% and resulted in a population estimate of 435 (±67). The high level of snow cover made detection of all species, including elk, easier as evidenced by the higher total count in 2009 (848 total observations) compared to 2008 (491 total observation). The model takes into account this higher detection probability however, resulting in comparable estimates between years despite disparate sightability.

The use of models developed in other regions may introduce a form of bias in our population estimates. Although this bias is constant and therefore can be discounted when making comparisons between survey years, a more accurate estimation of real populations will be possible through development of a local sightability model. Data collected during this survey regarding radio collared elk, both observed and unobserved, will be used to develop a sightability model peculiar to Jasper National Park.

7. Distribution and Diversity of Gastrointestinal Nematodes in JNP Caribou (adapted from deBruyn 2009)

Caribou *(Rangifer tarandus spp.)* face numerous anthropogenic stressors including habitat alteration and loss, and climate change. The cumulative effects of these stressors may limit their resilience and leave them vulnerable to further risk, such as infectious disease. In particular, anthropogenic breakdown of ecological barriers may lead to emergence of new pathogens and outbreaks of existing disease agents (Hoberg et al. 2002). For example, the presence of roads in remote regions of northern Alaska is correlated with trematode infections in snails, leading to potential health implications for moose and caribou (Urban 2006). Concomitantly, warming temperatures and increased precipitation, predicted for northern latitudes (Hassol 2004, Christensen et al. 2007) may increase development times, survival and transmission of parasites in caribou, similar to what has already been observed with lungworms in muskoxen (Kutz et al. 2005). These studies suggest climate and industrial-mediated parasitism may be widespread and pose a subtle, yet significant threat to free-ranging caribou.

Woodland caribou in Alberta may be especially vulnerable to emerging parasitism. These populations are typically found at low densities and are spatially isolated from other ungulates, limiting the possibility of parasite-host transfer. However, remote habitat accessed by industrial and agricultural activities may encourage establishment of non-resident ungulates in regions currently inhabited by woodland caribou. An influx of novel hosts (e.g. white-tailed deer) and their parasites will have both direct and indirect effects on caribou populations. Caribou may be impacted via direct competition for limited resources (forage) as well as indirectly through increased predation mediated by higher localized ungulate densities (Seip 1992). In addition, caribou are potentially vulnerable to apparent competition mediated by novel parasites. Parasites, which would otherwise be unable to persist in low-density caribou populations, may be sustained at high numbers on the landscape in reservoir hosts such as deer and elk. In other systems, parasite mediated competition has been shown to dramatically reduce survivorship or exclude species within competing guilds (e.g. Tompkins et al. 2002).

Gastrointestinal nematodes in the family Trichostrongylidae, are common and potentially harmful parasites shared by domestic and wild ruminants. Hosts inhabiting tropical and temperate climates harbour the majority of these parasites. For example white-tailed deer are competent hosts of over 20 species of GI nematodes, many of them pathogenic, while caribou are known to support eight species. Many species of trichostrongyle nematodes are of major importance to animal health. Adults reside exclusively in the abomasum or small intestine (Figure 17) where they feed on host blood or food particulate. Mixed species infections are common and may have compounding effects on host health. Severe infection in both domestic and free-ranging ungulates can lead to fluid and tissue loss, clinical secondary infection and death. Lower intensity, subclinical, infections are associated with reduced growth rate, poor appetite, decreased body fat, reduced overwinter survival, gastritis, incomplete digestion, and a decline in fertility (Stien et al. 2002). Ultimately, in conjunction with other stressors such as bacterial and viral disease, increased direct and indirect competition, habitat disruption and toxicity from environmental contaminants, novel nematode induced disease may contribute disproportionately to continued caribou decline.

Figure 17. **Typical direct life-cycle of trichostrongyle nematodes in ungulates, illustrating the free-living larval stages L1, L2, and L3. The infective L3 larvae are ingested and complete the life cycle within the host. In suboptimal conditions (freezing temperatures) larvae may revert to a semi-dormant hypobiotic state (L4h) in gut mucosa. Adult nematodes inhabit the abomasal or intestinal lumen, where they feed and deposit eggs that are ultimately shed in feces. (Photo: N. deBruyn)**

Currently, species diversity and geographic range of trichostrongylid parasites in Alberta's woodland caribou are virtually unknown. Published reports of trichostrongylid nematodes in free-ranging Albertan cervids are restricted to wapiti (Cervus elaphus) and moose (Alces alces) in the Cypress Hills (Samuel et al. 1976, Stock and Barrett 1983) and Waterton Lakes area (Kingscote et al. 1987). There is only one published account of trichostrongyle parasites in Canadian woodland caribou. The paucity of baseline knowledge for caribou host-parasite assemblages in Alberta is a limiting factor for management plans attempting to mitigate risk for threatened caribou populations. Therefore, the aim of this survey was: 1) to non-invasively determine the prevalence of GI nematodes in two caribou herds (A La Peche & Tonquin) inhabiting Jasper National Park; and 2) to identify the species of GI nematodes infecting these herds using fecal-based DNA. To our knowledge, this is the first complete survey of GI parasites in caribou inhabiting the Rocky Mountains. Results from this survey will feed into a much larger study investigating GI parasite diversity and distribution in Nearctic cervids.

7.1 Methods

Fecal Collection

Fresh (≤ 24 hrs old) fecal pellets from the A la Peche and Tonquin herds were collected opportunistically during the spring and summer of 2008 (see Figure 18 for sample locations). Approximately 40 g of feces were collected from the pellet group. Where possible pellets were collected from caribou bed-sites, in snow fields, in order to prevent repeat sampling of the same individual. Samples were frozen at -20 °C as soon as possible and sent to University of Calgary for parasitological analysis.

A total of 100 fecal samples were collected; 33 from the A La Peche herd during the spring and 30 and 37 from the Tonquin herd during the summer and fall, respectively. All samples collected were deemed to be from adult individuals based on size of the pellets. The distribution of nematode eggs among samples was highly skewed, therefore statistical comparisons within and between herds were performed using non-parametric techniques (Mann-Whitney U-test).

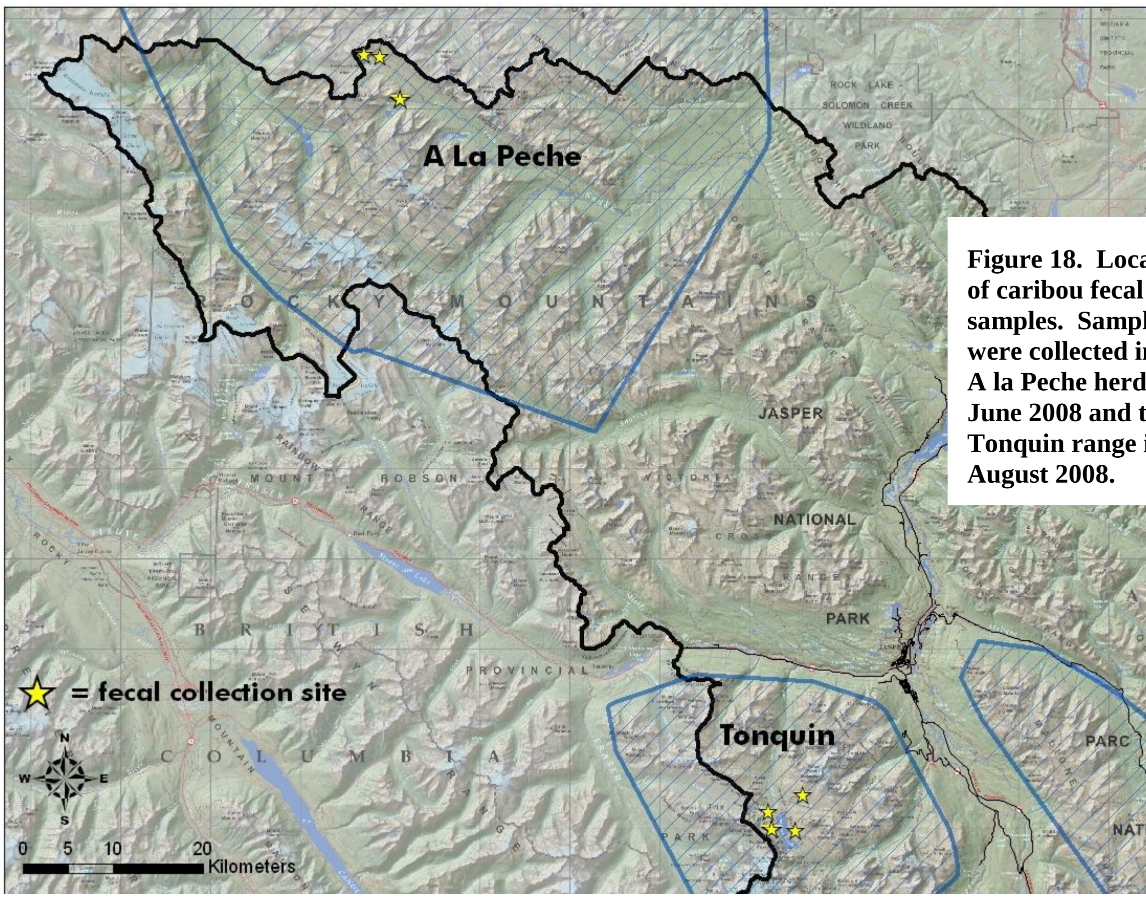


Figure 18. Locations of caribou fecal samples. Samples were collected in the A la Peche herd in June 2008 and the Tonquin range in August 2008.

Isolation and Identification of Parasite Eggs

Nematode eggs were counted using a modified Wisconsin sugar floatation technique (Egwang and Slocombe 1982). Eggs and oocysts from other GI parasites were also recorded, however they were not identified beyond the generic level. Individual nematode eggs used for molecular identification were separated from fecal pellets using salt floatation. Eggs were stored in nanopure water at -20°C in preparation for molecular identification. Parasitological analyses were conducted at the University of Calgary Faculty of Veterinary Medicine.

Trichostrongyle eggs are morphologically indistinguishable (Hoberg et al. 2001) and, therefore used a molecular diagnostic tool, PCR-based Single-Stranded Conformation Polymorphism (SSCP), to facilitate species-specific identification of individual eggs. Molecular work was carried out at the University of Saskatoon with the assistance of Dr. Neil Chilton.

7.2 Results & Discussion

Trichostrongyle eggs were recovered from 70 % of the fecal samples collected (Table 10). Spring and summer infection prevalence was near 100 % for both herds, suggesting that the majority of animals within these herds are infected with GI nematodes during the spring and summer (Table 10). The A La Peche animals had noticeably higher egg counts than those sampled from the Tonquin herd [median (IQR): 21 (12 - 42) vs. 7 (3.6 - 11.4), respectively, p = 0.00], perhaps indicating a difference in intensity of infection between herds. This difference may also reflect seasonal variation in egg production by adult worms. Pooled 2007-2008 fall egg counts for the Tonquin herd, were 20 times lower than spring/summer values [0 (0) vs. 7.3 (4.0 - 11.5), respectively, p = 0.00] most likely because adult worms were inhibited and not producing eggs in preparation for winter. This is consistent with extremely low fall egg counts found in nearby caribou herds (Maligne, Narraway, Redrock Creek, Brazeau – data not shown). A drop in egg production is typical for most species of gastrointestinal nematodes at northern latitudes during late fall and winter.

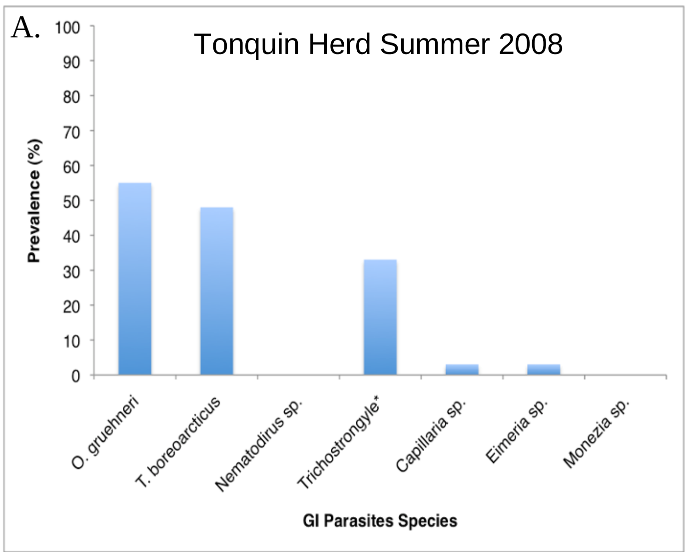
Table 10: Seasonal prevalence of GI nematode parasites in *Rangifer tarandus* fecal pellets.

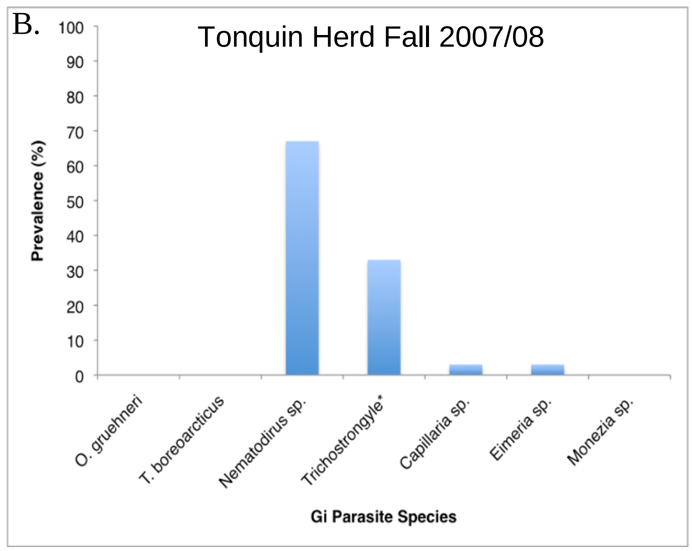
Caribou Herd	Sample Location	No. of samples collected	No. of samples infected	Prevalence [a] (%)	Median EPG [b] (Range)	Collection Period
A la Peche	Hardscrabble Pass & Caribou Lakes	33	33	100	21 (2-195)	June 17-18, 2008
Tonquin	Amethyst Lake area	30	26	87	7 (1-19)	Aug 10-21, 2008
Tonquin	Amethyst Lake area	26	11	42	0 (1-5)	Fall 2008
Tonquin	Amethyst Lake area	11	0	0	0 (0)	Fall 2007
Total		**100**	**70**	**70**		

[a] number of fecal samples infected with one or more nematode egg(s) divided by the total number of samples examined
[b] EPG = Eggs Per Gram of feces

Two taxa of trichostrongyle nematodes were identified to species using molecular analyses. Ostertagia gruehneri and Teladorsagia boreoarcticus were found in both herds during the spring and summer (Figure 19). These species are common at northern latitudes (Fruetel and Lankester 1989, Hoberg et al. 1999, Hoberg et al. 2001), in barren-ground caribou (O.gruehneri is dominant) and muskoxen (T. boreoarcticus is dominant), however this is the first record for both species in free-ranging caribou south of 60 degrees latitude. The difference in prevalence for these two species between the A La Peche and Tonquin herds (Figure 19) may be attributable to seasonal variation in egg production for each species. We intend to resample in June 2009 to address the seasonal variation problem.

Unlike most trichostrongyle nematodes, *Nematodirus spp*. produce eggs during winter and, in fact, require prolonged exposure to cold temperatures before they hatch (e.g. Thomas 1959, Rickard et al. 1987,), this may explain the high prevalence of Nematodirine eggs in the fall Tonquin samples (Figure 19). We were unable to successfully identify these eggs to the species-level. Other GI parasites, including, *Eimeria* (protozoan) and Capillaria (nematode) were found at low prevalence in the Tonquin herd, while *Moniezia*, a ruminant tapeworm, was seen exclusively in the A La Peche herd. All of three organisms are non-pathogenic at low intensities.





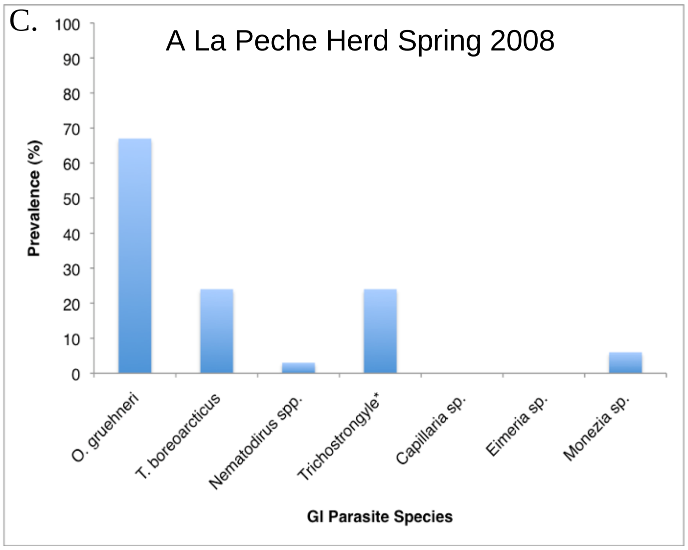


Figure 16. Prevalence of GI parasite species in infected animals in the Tonquin herd during the a) summer (n = 26, b) fall (n = 9) and in the A La Peche herd during the c) spring (n = 33). Nematodes were identified to species using PCR-SSCP. ***GI nematode eggs we were unable to identify to species (i.e. no DNA isolated).**

Anthropogenic stressors such as habitat loss, introduction/translocation of invasive species and climate change can significantly alter regional parasite communities and, subsequently the health of their hosts. Baseline parasitological surveys such as this provide platforms from which to monitor animal health and generate proactive management policy. We hope to continue our partnership with N. deBruyn through increased animal health monitoring in the form of non-invasive surveys for GI parasites and new disease, such as Johne's Disease and West Nile Virus.

8. Communications

The Jasper caribou program biologists continue to be involved in communicating the findings and messages of Jasper National Park's caribou monitoring and research program. Since May 2007, we have done the following:

6.1 Formal Science Presentations

- Presentation on scat DNA project to Parks for Tomorrow conference
- Wilmshurst, J.F., Neufeld, L., and Bradley, M. 2009. Managing trophic interactions in Jasper National Park for the protection of caribou populations. Presented at Alberta Chapter of the Wildlife Society Conference and Annual Meeting, February 2009.

6.2 Community Outreach presentations

- Jasper Caribou Recovery Action Group - Update recovery group with research results and next stages of consultation

- Biologists participated in large park learning events with a project display and fieldtrips to caribou habitat during Parks Day in July 07 and July 08 and the Wildlife Festival in October 07 and Oct 08. Attendance at these events was high given the average visitation at that time of year, (about 2000 at Parks Day and 500 people at Wildlife Festival)
- Jasper in January street party – biologists and interpreters presented caribou information to park visitors (2008/2009) – (700 visitors over the 2-day event)
- EnviroFair (May 2008/2009) – street festival with caribou display and question/answer for residents and visitors
- Biologists gave presentations to wildlife guides and the Mountain Parks Guides' Association about the status of caribou and wolves
- Quality Visitor Services training – information and Q and A session for park staff (2009)
- Information Centre staff training session by biologist – spring 2008, 2009
- Interpreters information session by biologists

6.3 Special Education Events

- During the summer of 2007 and 2008, one interpretive program per week was presented at Whistlers Campground:
    - 2007 - 9 x 45min "Puzzled about Caribou" Whistler Outdoor theatre program. 1665 visitor contacts.
    - 2007/2008 - 2 x 45min "Horns and Antlers" Whistler Outdoor theatre living with wildlife program with a 5 min caribou section. 303 visitor contacts.
    - 2008 - 10 x 45min "Survivor Jasper" Whistler Outdoor theatre SAR program with caribou messages. 1906 visitor contacts
    - 2007 & 2008 - 201 x 45min "Behind the Scenery" research update programs featuring 5min section on caribou. 3941 visitor contacts
    - 2007-2008 – Horns and Antlers and SAR Interpretive roves; interpreters contact thousands of people every summer
    - 2009 - FRI Open House May 20, 2009: 1200-1700hrs, 175 visitor contacts
- Wildlife Festival – telemetry demonstrations, maps, props, information, field-trips, and presentations by wildlife biologists and researchers on caribou biology and recovery actions Fall 2007/2008. Caribou presentation/demonstrations on-site at Whistlers Mountain 2007 and 2008.
- Parks Day - telemetry demonstrations, maps, props, information and presentations by wildlife biologists and researchers on caribou biology and recovery actions. Fall 2007 – 2008
- Jasper in January – animal adaptations to winter presentations, including special emphasis on caribou (January 2008/2009)

6.4 Education/Awareness

- Recovery Fact Sheet – updated version under development
- E-mail, special events, recreational outlets and stores, etc.
- Caribou in your Backyard Week at Jasper Elementary and High School, with school field trips for grade 5 and 11 students (including students from Ecole Desrochers) – spring 2007/2008.

- Minimum twelve caribou-based articles were published in local newspapers relying on interviews and updates from park staff. Four articles outside of Jasper referencing Jasper's caribou status
- Video-conference species at risk caribou session for students in Alberta, Saskatchewan, and the Northwest Territories (2008/2009), integrated into PSEC curriculum linked programs
- Palisades Stewardship Centre - Species at Risk/habitat assessment/GPS/GIS workshops for Grade 10 students
- On-site interpretive exhibit on caribou in the Maligne Valley, designed and installed 2007, expected expansion of the exhibit to other caribou regions in the park
- Biodiversity Kit - developed by Sue Wolff and Alberta Science Foundation, one of the six units is about caribou recovery and recovery actions. Education kit developed for use in Grade 9 science and distributed to regional schools
- Caribou recovery messages included in park publications – Summer Trails, Winter Trails, Backcountry Visitor Guide, Mountain Guide 2005-07
- Caribou recovery and Species at Risk info updated on JNP website 2007-2009
- Drivers for Wildlife road signs at reduced speed zones on Icefields Parkway and speed reminder signs along Maligne Road – winter 2007-2009

6.5 Stakeholder Relations and Issues Management

- Presentation to management team about project direction - 2007
- Poster at Park Management Plan Review Forum for stakeholder and public review and consultation - 2009
- On-going updates to community members and businesses through Enews
- On-going email updates to park staff through staff newsletter (Beaver Fever)

9. Future Directions and Caribou Coordinating Committee

Southern Mountain caribou are officially designated by COSEWIC as threatened, are an integral component of the fauna of the southern mountain national parks where they presently occur, and their condition and trend are ecological integrity monitoring measures for Jasper National Park's State of the Park reporting. Moving forward with plans to conserve caribou within our mountain national parks will require a collaborative, broad-based planning initiative, as identified following Phase I of Jasper's local planning process.

Phase I brought together a group of local people and parks staff to generate ideas for helping caribou (Van Tighem et al 2005). Because the cause of Jasper's caribou decline was not known with any certainty, the Phase I group generated a number of management actions that should help caribou if implemented as a group (i.e. no one idea was identified as the 'cause' of caribou decline). We continue to implement aspects of Phase I as part of the larger caribou program. The lithium chloride experimentation has been discontinued, however, due to lack of resources to effectively monitor or implement the program.

In the fall of 2007 the Mountain Parks Caribou Coordinating Committee initiated development of a conservation strategy for caribou in the mountain national parks. The conservation strategy is intended to contribute towards meeting Parks Canada's obligations under Canada's National Parks Act and the Species at Risk Act. Key direction for caribou recovery and sustainability, that is aligned with Parks Canada’s mandate of ecological integrity, public education and visitor experience, will be formulated with the participation of the public and Aboriginal groups and incorporated into the respective management plans during the 2009 review.

The committee intends to consult the public on 5 general threat categories:

Altered Predator/Prey Dynamic: Caribou are not the main prey of wolves, but as the wolves’ primary prey (elk, deer, moose) increase in abundance, wolves will also increase, cover more territory, and encounter caribou more often. The likely result is that caribou will decline. In Jasper National Park, an altered predator/prey dynamic could be facilitated by the townsite, which becomes a refuge for prey from predators. We are collaborating with the Universities of Calgary and Montana to research this question.

Predator Access: During the winter caribou have adapted to inhabit areas with deeper snow than wolves. Packed snow on roads and trails however, can enable wolves to access caribou that would normally be unavailable. This could increase predation risk in caribou ranges.

Direct Disturbance: Humans influence caribou through human/caribou interactions. Caribou can be: killed by vehicles; prevented from accessing otherwise suitable habitat; or their energy balance may be impacted by excessive interactions with humans.

Habitat Loss: Any permanent or long-term loss to caribou habitat, either through industrial and human developments, altered fire regimes, insect population growth, or climate change.

Small Population Effects: Caribou populations that decline below a certain threshold become very difficult to recover for stochastic and genetic reasons. This category recognizes that small population effects exacerbate the other 4 categories.

In the context of woodland caribou throughout Canada there is an emerging consensus that the Altered Predator/Prey Dynamic has been the most important factor in caribou decline, however we are have not demonstrated this scenario for caribou within Parks Canada – we believe that the Altered Predator/Prey Dynamic is a large contributory factor, but other factors may be important as well. Because of this uncertainty, we intend to work with Canadians to agree on reasonable efforts that can be made for all 5 of our threat categories.

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