2009-2013 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 2007, as a follow-up to the Action Plan, 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, which is aligned with Parks Canada's mandate of ecological integrity, public education, and visitor experience, is being formulated with the incorporation of the results from the public and Aboriginal consultations recently completed into the management plan.

Required knowledge for informed management relies on the caribou monitoring program, the results of which are reported herein. The caribou program has continued to grow to incorporate additional partnerships with universities. 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 (Hebblewhite et al. 2007). We report here on the results obtained in the past 3 years of our caribou monitoring and research program.

<u>Radio-collaring</u>

- In the past, we aimed to maintain 20 VHF radio-collars on caribou to maximize precision in population parameter estimates and trend; however, having used scat DNA collection in parallel with collar surveys since 2006, we are increasingly confident that we can rely on scat DNA non-invasive population estimation, and as a result stopped capturing and collaring caribou in 2011. There remain 8 active VHF collars on the air as of August 2013.
- The current caribou collar distribution is 1 VHF collar in the Brazeau, 2 in the Maligne, and 5 in the Tonquin.
- We have maintained collars on wolves in the Signal, Sunwapta, and Brazeau packs for much of the past few years and in addition have collared the Pyramid and Robson packs. At the time of publication, we suspect we've lost contact with the Brazeau and Sunwapta packs, and are unsure of the Pyramid pack's home range territory
- In collaboration with the University of Calgary we have collared 21 deer in the early winters of 2012 and 2013 to initiate a study of deer population trends. This is an important element in understanding the predator-prey dynamic in Jasper National Park and work will continue in 2014.
- We have captured 2 new elk and recaptured 7 elk to replace expiring GPS collars with VHF collars, which were used to conduct an elk population survey in 2013. Additionally, 7 townsite elk were captured to support a University of Alberta aversive conditioning study.

Caribou population Estimates

- Fall 2012 population estimate was not possible to calculate as we were unable to conduct the Tonquin survey; we are awaiting DNA population results
- Fall 2011 population estimate: 71 caribou (90% C.I. 64 - 92). We observed 64 caribou and saw 9 of 12 radio collars in the Tonquin.
- Fall 2010 population estimate: 73 caribou (90% C.I. 72 - 102) plus 6 in the Maligne giving an estimate of79 (90% C.I. 78 - 108). We observed 61 caribou in the Tonquin/Brazeau, and a minimum of 72 including the Maligne and missing animals found with telemetry. We observed 10 of 12 radio collars.
- Fall 2009 population estimate: 87 caribou (90% C.I. 87 – 96). We observed 87 caribou and saw all available radio collars (12 in the Tonquin/Brazeau).

This shows a marked decline from the previous years' estimates (2008: 127 caribou (90% C.I. 114-157), 2007: 93 caribou (90% C.I. 82-117), 2006: 151 caribou (90% C.I. 126-207) and 2005: 147 caribou (90% C.I. 104-176). These were in turn well below the 1988 minimum number of 153 caribou (population guess: 175-200).

Calf recruitment

- March 2013: 53 calves per 100 cows (90% C.I. 37-74)
- March 2012: 41 calves per 100 cows (90% C.I. 32-50)
- March 2011: 20 calves per 100 cows (90% C.I. 17-23)
- March 2010: 19 calves per 100 cows (90% C.I. 10-28)

In the four years preceding this report, recruitment values fluctuated high-low-high-low. Calf recruitment was higher in March 2009 (39 calves per 100 cows (90% C.I. 23-54) than in 2008 (21 calves per 100 cows (90% C.I. 13-30)); higher again in 2007 (42 calves per 100 cows (90% CL = 31-53)) and lower in 2006 (13 calves per 100 cows (90% CL = 7-20)). Decreasing sample size in recent years has led to greater uncertainty, but the trend in the last 2 years has been positive and there is a statistically significant difference between 2010 and 2013. Given low numbers of collars and difficulty locating caribou in March, we are unlikely to continue calf surveys in the future.

Fecal DNA research

In 2006 we partnered with the University of Manitoba to initiate a population monitoring research program using fecal DNA. Visual and scat population estimation techniques have produced similar results, though the fecal DNA estimate produces higher precision. The method has produced reliable results and we intend to use this less invasive technique for future population monitoring.

Fecal morphometrics and hormone content have been shown to be useful in identifying demographics (age-class) of caribou in Jasper. Non-invasive fecal sampling for use in cohort

analysis and in combination with mark-recapture methods may provide valuable insight on the age-structure of woodland caribou populations.

From 2006-2012 1,646 samples were amplified at 10 microsatellite loci and unique individuals were further amplified at an additional 8 loci. Parentage assignment was determined and a consequent pedigree was constructed. Parent-offspring and sibling relationships were found between individuals belonging to different herds indicating that some movement of caribou has occurred between herds. Fecal DNA has the potential to assess the reproductive fitness of animals in a population, the social structure of caribou, and for monitoring caribou movements within and between populations.

Wolf movement and kill-rates: the Cavell Road winter closure

Access of winter caribou habitat by wolves can be artificially enhanced by the maintenance of packed snow trails and roads. Improved travel rates by wolves on packed snow trails has been demonstrated by telemetry studies throughout Canadian caribou range, as well as within Jasper National Park itself. Since 2009, there has been a Superintendant's closure of the Astoria trail/Cavell Meadows area from first snowfall until February 15th. Preliminary results of travel and kill rate analyses indicate that wolves selected packed or cleared trails/roads for travel, travelled faster on packed or cleared trails/roads, and were more likely to use the Cavell Valley when the road was packed compared to when it was not. Further analysis is ongoing.

Canadian Rockies Woodland Caribou Project

Parks Canada collaborated in this regional research program exploring 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 analysis, the results of which can be seen in a series of publications over the past several years. These analyses contribute both to our understanding of the predator / prey dynamics in the park as well as to conservation applications, such as the role of caribou translocations in augmenting small herds.

Jasper data were also shared with post-doctoral fellow Dr. Hugh Robinson who modeled relationships between fire, caribou, wolves, elk and moose to aid prescribed fire and caribou recovery goals.

Primary Prey Research – Elk and FireSmart

Through the FireSmart program forest modification has occurred throughout the Three Valley Confluence area of Jasper National Park. An ongoing study with colleagues at the University of Calgary will aim to determine how elk are affected by forest modification, examine the recourses that are critical to elk in Jasper National Park, and identify factors and variables that might influence the species' decline.

Consultations

Following the release of the *Conservation Strategy for Southern Mountain Caribou in Canada's National Parks*, an on-line comment form was available on the Parks Canada website. The public was invited to submit their feedback over a two month period. The Conservation Strategy and background information were also sent to Aboriginal partners of the mountain national parks and consultations were held with the First Nations through the spring and summer of 2012.

Generally, all showed strong support for caribou recovery, and First Nations groups expressed a desire to be more actively engaged in the process. Feedback from both the public and Aboriginal engagement activities will help inform management decisions for caribou conservation and guide revisions to the strategy.

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. They have also published caribou project research in several peer-reviewed scientific journals.

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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. Jesse Whittington made key contributions to the program as the Jasper National Park caribou biologist prior to 2006. Shelley Bird has taken caribou communications and outreach to places it would have never gone without her dedication and ongoing involvement. We are grateful to volunteers Traudi Golla, Adam Zier-Vogel, Melissa Carroll, Jerry Duhamel, Ed Logan, and Lynn D'Ambrico for their dedicated work with the wolf kill-site and the deer trapping programs. Clay Wilson and Bighorn Helicopters efficiently, professionally, and successfully radio-collared wolves, caribou, and elk in South Jasper and we are grateful to have them as project partners. Pilot Steve Wotton of Peregrine Helicoptors safely and professionally assisted with caribou surveys, scat collection, telemetry relocation, and collar retrieval. Sean Biesbroek of Wildlife Air assisted with aerial telemetry. Micheline Manseau, Peter Hettinga, and Amy Flasko were important partners in initiating and continuing the caribou DNA from fecal samples. Colleen Arnison's tireless and cheerful work with both the deer and elk studies has made for a very enjoyable collaboration, we are grateful for her many volunteer hours. We are fortunate to work with many delightful and experienced professionals and it makes our work infinitely more enjoyable and easier.

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 is guided by a regional conservation plan across the mountain parks (Committee 2011). Many actions that were implemented as part of the South Jasper National Park Caribou Action Plan for Caribou Recovery are still in still in place.

In this progress report, we update the status of woodland caribou in Jasper National Park based on population and demographic data and also report on progress as a result of the new conservation plan. We also present research findings and communications that have occurred since April 2009, but refer to information 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 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 have been known to use the White Goat in recent years. We recommend its continued incorporation into future surveys and analyses.

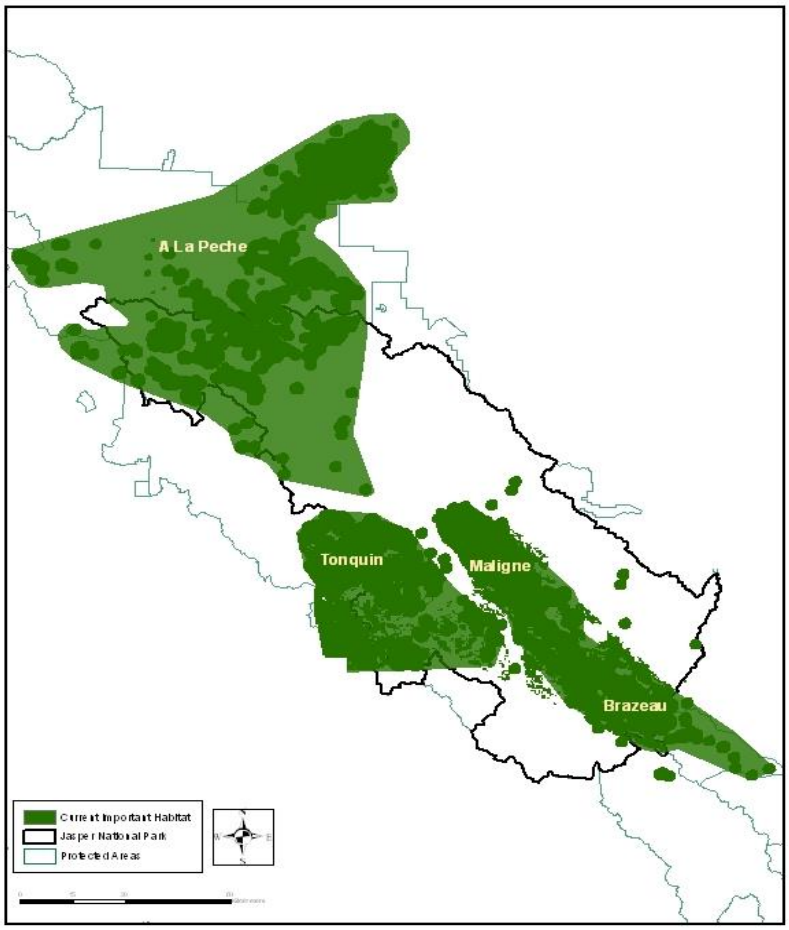

Figure 1. Overview of caribou ranges within the boundaries of Jasper National Park. South Jasper is comprised of the Tonquin, Maligne, and Brazeau sub-populations

2. Caribou, Wolf, Elk and Deer Capture Summary

Monitoring caribou and wolf populations via radio-telemetry in South Jasper has been an integral part of the Jasper caribou program since 2001. Recently (2007) have incorporated elk and deer research to help further our knowledge of the predator-prey dynamic in Jasper National Park.

Details on study design and history of collared caribou and wolves prior to 2009 are available in previous progress reports. The caribou monitoring program has relied on radio-collars to identify trends, calculate population parameters and examine habitat use. From 2005 to 2010 we aimed to maintain a sample size of approximately 20 radio-collars on caribou and also maintain contact with wolf packs that hold territory in, or adjacent to, caribou habitat; we stopped collaring caribou in spring 2011, when we felt that non-invasive DNA surveys from faecal collection could provide enough information on population trend and size. As of 2013, remnant collars are monitored on caribou in each of the 3 subpopulations. From April 2009 to our last caribou capture in February 2011, 18 caribou were captured, including 4 recaptures (one of which was unintentional). There are 9 functioning VHF-collared caribou on the air as of March 2013 (1 in Brazeau, 2 in Maligne, and 6 in the Tonquin).

During this time we also collared 21 wolves and have been largely successful in maintaining collared animals in the Signal, Sunwapta, and Brazeau. Changes to Brazeau pack size (mainly due to trapping) and territory has resulted in recent loss of contact with this pack, but we intend to outfit the pack with a satellite collar in the future (winter 2013/14). We were unable to locate the Brazeau pack in December 2012. The Cavell pack, formed as a result of a split from the Sunwapta pack in 2009 (including a collared wolf), was monitored until it dissolved in the spring of 2010. We have been successful in capturing the Pyramid pack, though currently don't know the pack's whereabouts and suspect that the entire pack may have shifted territory. A newly discovered pack in west Jasper, the Robson pack, was also collared in December 2012.

2.1 Caribou

From April 2009 - August 2013, 22 radio collars have been recovered from dead caribou, one collar was removed from an older female, and 2 GPS collars were recovered from the field. VHF collars, although they last longer, weigh less, require fewer captures of individuals over the long-term, and provide data for population demographics and trend, return limited information on habitat use; we have also been using scat DNA collection in parallel with collar surveys since 2006, and have moved exclusively to this non-invasive population estimating technique, thereby eliminating a source of stress and potential injury to caribou.

2.2 Caribou Mortality 2009-2013

Twenty-two collared caribou died between April 2009 and August 2013. Five were clearly cases of wolf predation and another 3 were probably wolf predation. Seven of the mortalities were of unknown causes, generally because the site visit date was not close enough to the mortality event to find clear signs, and 7 mortalities were from other causes (3 probable bear predation, 1 likely capture myopathy, 2 avalanche, and 1 unknown but likely not predation).

Caribou 70 was killed by the Brazeau wolf pack on April 24, 2009, west of Jonas Creek. Not much was left but some skin, bone shards, rumen and the lower mandible; GPS data from wolf 107's collar confirmed wolf predation.

Caribou 66 was likely killed by wolves on May 13, 2009, at Moat Creek; all that was found was the rumen, hair pile and teeth from the foetus, as well as lots of wolf scat and tracks, although it was too melted to read the signs clearly.

In mid-June to early July 2009, caribou 67 was also likely killed by wolves at Tonquin pass at the west end of Moat Lake; her collar was found chewed by wolves, along with bone shards, white wolf hair and caribou hair and hide, although the collar must have been carried away from the actual kill-site as the carcass was not found.

Caribou 34 was located dead by aerial telemetry flight in early September 2009 in the Fraser Valley, having died probably a week earlier. The collar, hide, and long bones were buried deep in the moss. There was part of a skull and the spine/ribs were nearby. Skin remained on the bones and there had been no chewing of bones or the collar. There was bear scat nearby, but we could not determine whether caribou 34 had been killed or scavenged by the bear.

Caribou 101was located dead near Moat Lake during our aerial survey in September 2009, having died at least 2 weeks earlier according to her GPS data (this was our last-deployed GPS

collar). Due to a new covering of snow, we found very little evidence of a predator species or bones. We concluded this mortality was of unknown cause.

Caribou 55's collar was heard on mortality during field work in the Tonquin Valley, she had died near Majestic Pass/Meadow Creek. We observed wolf tracks travelling from Maccarib Pass and through Majestic Pass on the same day that the signal changed from normal to mortality (October 1, 2009). Radiocollar, spinal column, and scapula were found and the site was scavenged by wolverine and marten. We noted this as a certain wolf predation event.

In late May of 2010, caribou 117 died west of the Fraser River. Only hair, bone shards and a calf femur head were found, which still had soft tissue. Bear and wolf scat were both present at the site, but the remains were too old to determine the cause of death.

Caribou 114 also died near the Fraser of unknown causes sometime in early summer 2010 (we were unable to locate 114's signal from June-September, when it was eventually heard in mortality); her pelvis was found with part of a femur (marrow was not red or runny) and several wolf scats containing caribou hair, but the rumen and killsite were never found and her actual cause of death remains uncertain.

Caribou 43 was located dead in Cavell Meadows in August 2010. There was a small wolf scat near the collar and just one broken bone shard. There was a small hair pile, but no rumen present and we were unable to find the actual kill location. We concluded that scavengers had distributed the carcass widely, including the collar. There was no wolf GPS data from the area.

Caribou 21, an old female, died in December 2010 at Muhigan Peak; only one ear, some rumen and the collar were found, as well as a lot of wolverine tracks; her cause of death is unknown.

Caribou 134 also died near Muhigan Peak near caribou 21's location, most likely from capture myopathy (the first for caribou in Jasper). She had been net-gunned on December 6, and her largely intact and frozen carcass was found in January with the head severed and wolverine tracks everywhere.

Caribou 113 died at the start of May, 2011, near the Fraser river. Her collar was untouched and all that was left was one bone shard and some hair; the source of her mortality is unknown. We located one small bone shard and caribou hair throughout the area (hair was on top of shrubby vegetation indicating a mortality when snow was still present).

Caribou 126 was also killed in May on the Fraser, north of Tonquin creek, presumably by wolves; her collar was chewed, her hair was spread out in piles and there were at least 10 wolf scats at the site. It is likely that wolves killed or scavenged caribou 126.

Caribou 136 died in Oldhorn Basin in mid-June, 2011; although we don't know the cause of death, it was probably not predation. Her head and hindquarters were missing but the rest of the carcass was intact and the organs from the intestines forward were still present and not too autolysed. Marrow from the humerus was solid and pink, and an autopsy did not reveal any obvious cause of death. No wolf or bear scat was at the site.

Caribou 100 was killed by the Sunwapta wolf pack on February 3, 2012, at Chrome Lake as documented by GPS data from wolf 112's collar. Snow tracking conditions were excellent and the trail of the struggle and bleeding were clear; so were wolf tracks and beds, wolverine and marten tracks, and the rumen, hair pile and bone shards. The wolves seemed to be marking territory heavily around the area. Wolf 112 GPS data also showed that caribou 115 was killed by the Sunwapta pack on the Astoria river on May 10; a lot of wolf scat was found at the site, as

well as clumps of caribou hair in tree branches suggesting she was cornered against a tree. The same pack killed caribou 65 one week later on Lectern mountain; wolf tracks and sign supported the GPS data and wolverine had scavenged the site. Finally, caribou 127 was probably killed by a grizzly in June or July, 2012, near Vista pass in the Tonquin. The carcass had been buried and bear scat with bones was found at the site, although it is unknown whether the bear actually killed her; there was no sign of wolves at all. Caribou 52's collar was heard on mortality in the 2012 fall survey, but we were not able to visit the site until summer 2013. At the site there was significant evidence of grizzly bear predation (large burial pile, scat, damaged vegetation), though it is unknown whether a grizzly predated or scavenged caribou 52.

In spring 2013, three caribou mortalities were attributed to avalanche. Caribou 124 was found on a north-facing slope west of Meadow Creek during the calf survey in March 2013. Field observation confirmed that avalanche was very likely the cause of the mortality, and it's possible that 2 animals were killed at the site. Wolverines had cleaned up all caribou remains except for hair. We roughly estimated that the avalanche occurred mid-February 2013. Caribou 138 was also very likely killed in an avalanche on a NE-facing slope of Mt. Morden Long, likely sometime in late March (collar was found beaconing at the bottom of an avalanche run-out). Conditions to land and examine the site were not safe until summer 2013, at which time it was clear that at least one adult and one calf had died, and possibly 2 adults. We have sent hair samples for DNA testing to confirm this. Bear tracks (in the snow at the time of discovery) and scat at the site suggested scavenging. It is unknown whether caribou 45 was also caught in this avalanche – her signal was not on mortality at the time we located 138's, but she was in the area. We did not get a visual relocation or a detailed UTM. Later, we were able to pick up 45's collar (not in mortality) three times from the road before it was located on mortality (June 2013). The collar was found 500m from the avalanche site but without any hair pile, indicating it had been carried from the wherever the mortality occurred. We hope to have clarity on this when DNA from the collected hair samples are analyzed.

2.3 Wolf Capture and Mortality

We continue to monitor wolves in Jasper National Park as they've been identified as an important predator of caribou (Brown et al. 1994). However, keeping wolves 'on the air' is challenging – they are difficult to find, cause damage and malfunction to radio-collars, have relatively high mortality, and occasionally disperse from the study area (Table 1).

The main wolf packs that overlap with caribou ranges in south Jasper are the Sunwapta pack (Tonquin herd), the Brazeau pack (Brazeau herd) and the Signal pack (Maligne herd), and these packs have been the focus of our collaring efforts. Shifts in pack dynamics recently suggest that collaring animals in the Pyramid pack may also provide information on wolf use of caribou habitat, since the Signal and Sunwapta packs have reduced in size and the Pyramid wolves are taking up territory in the main valley.

Signal Pack

The Signal pack was once a primary pack in the area, but its numbers have declined in recent years. Wolf 110, a female, is collared with a VHF collar (replaced GPS collar in March 2010). Wolf 135, the large, older alpha male, was briefly collared in Februay 2011 before his collar released prematurely 2 months later. He was still with wolf 110 as of June 2012, but was seen with a broken jaw and hanging teeth, has lost weight and has not been observed since January 2013. A younger wolf collared in December 2010 (wolf 121) was killed by a car in June 2012, in

emaciated condition and with a stomach full of coyote. Another collared female from the Signal pack, wolf 111, was collared in February 2009 but disappeared from the area in late 2010; she was killed by a trapper on the Peace River in March of 2012. Although the pack has not been observed for several months, the pack consisted of 5 members (including wolf 110, 135 and likely 170 (a young of year collared in December 2012), although it appears that 170 may have dispersed.

Sunwapta Pack

In the Sunwapta pack we collared wolf 112 with a GPS collar in December 2009, and again in December 2010 and December 2011 (GPS collars last only 1 year), but switched this collar out for a VHF collar in December 2012. Wolf 40's collar (collared in February 2009) appears to have malfunctioned and is not beaconing, but we believe we recaptured this wolf in December 2012, and the previous collar had come off. We have not confirmed this with DNA. Wolf 122 was collared in March 2010 with a VHF collar, recollared in December 2010 with a new VHF collar as the previous one had a very weak beacon. Wolf 137 was collared with a VHF in February 2011, but was killed on the highway in July 2011. Wolf 140 was captured in December 2011 and a VHF collar was deployed. Both wolf 122 and 140 were killed on the highway in March 2012, leaving 112 as the only functioning collar until wolf 40 was collared in December 2012. In August 2013, wolf 40's collar fell off due to screws that worked loose at the dropoff attachment site. At this point, we are considering the Sunwapta pack unlikely to be marked.

Brazeau Pack

In December 2009, we deployed a GPS collar on wolf 119 in the Brazeau pack, in addition to an already collared 107 (GPS) and 108 (VHF) from February 2009. By mid-2010, both 107 and 108's collars had stopped beaconing. In December 2010, the capture crew was able to recapture wolf 107 and 108 and replace their collars. Wolf 119 was also recaptured and his collar was removed. Both wolf 107 (GPS store-on-board) and 108 (VHF) were collared through 2010-11, though 107's GPS collar stopped functioning and although she was observed several times along highways, we were unable to get her collar back. A wolf that appeared to be very similar to wolf 107 was killed on the highway in Banff (near Rampart Creek) in January 2013. No collar was on the wolf, but there was a recent collar wear mark. Wolf 108 has not been heard or observed since May 2012 by airplane and July 2012 by remote camera at the Glacier SkyWalk site. However, during captures in December 2012 we were unable to locate 108.

Wolf 47, collared in November 2005, was trapped just outside of Jasper National Park's south boundary in early winter 2011, and her collar was returned and data recovered. Wolf 47's collar had stopped beaconing in 2007, and we were unable to locate her or the pack she was with when we recollared the Brazeau wolves in February 2009. It appears that a new pack developed in the Brazeau region (wolves 107/108) while wolf 47's pack had shifted south-east (confusingly, these packs are both called Brazeau by our program). The trapper in this region removed 6 wolves (of an estimated 7) from wolf 47's pack. However, there is some evidence that wolves from 107/108's pack were also trapped (e.g. a distinct orange/yellow wolf that had been observed with 107/108 appeared to have been trapped).

Cavell Pack

We were able to identify a new pack in the Cavell area in approximately mid-2009 after wolf 109 was collared with the Sunwapta pack in February 2009. Shortly after wolf 109 was collared, photographers spotted a white/light grey wolf trailing the Sunwapta pack. The distance between the female and the 6 others in the Sunwapta pack implied the white/grey was new to the pack

and had not been fully accepted. By early summer 2009, we noted that wolf 109 seemed to be consistently using areas different from the other collared Sunwapta wolves, more on the north end of the Sunwapta territory. In fall 2009 we had the capture crew put a collar on any wolf that was with 109, and the white female who had been trailing the pack the previous winter became wolf 120. Wolf 109, 120, and a third grey wolf formed the Cavell Pack, and ranged from town to the Whirlpool river.

The northern and western limit of their territory was on the west highway (16), as far as Meadow Creek, east to the Athabasca River just south of Jasper townsite, and south to the Whirlpool River. They used the Astoria valley, Maccarib Pass and Portal Creek, Marmot Pass, Meadow Creek, and also spent some time in Whistlers Creek, on Whistlers Mountain and into Indian and Whistlers Pass. The majority of this pack's time was spent lower down in the Athabasca valley, near the Cavell and Marmot roads.

Wolf 109 died on March 20th 2010. He was found on the Astoria trail, 20 feet from Verdant Creek by a local skier. We necropsied 109 in summer 2010 and it was clear that he had been killed by other wolves. We don't know which pack killed him, but the Signal pack was in the area around the same time.

Sometime in March 2010, we lost track of 120 and couldn't pick up the signal in her usual territory. In late August 2010, we recovered a card from a remote camera on the Miette Lake trail and informed us that there was a collared white wolf in the photos. Indeed, there were three photos of w120 in this region, never with any other wolves. Wolf 120 was later discovered in Meadow Creek in fall 2010, having shifted her territory west. Her collar has since stopped functioning and was not recovered.

Pyramid Pack

The Pyramid pack, located primarily in the 3-valley confluence, has been expanding into Signal and Sunwapta territories since 2011; initial attempts to net-gun the pack in December 2011, and to live-trap them in February 2012, were unsuccessful. In December 2012 we were able to net-gun 2 females in the Pyramid pack, but the GPS collar has failed and has not been replaced. The Pyramid pack's signal has not been heard for several months, and the pack of 4 grey and 1 black was last seen in early May 2013 on the Jacques Lake remote camera.

Robson Pack

A new pack in west Jasper, the Robson pack, was also collared in December 2012. Details about this pack are mostly unknown, they have been seen on the Clairvaux Pit camera and at the time of capture had a pack 5. We have relocated the VHF collar some time ago near Yellowhead Lake.

Table 1: Current collar distribution – August 2013

Caribou Region	GPS	VHF	Total
Brazeau	0	1	1
Maligne	0	2	2
Tonquin	0	6	6
Wolf Pack	**GPS/UHF**	**VHF**	**Total**

Signal	1*	1	2
Sunwapta	0	1	1*
Brazeau	0	0	0
Pyramid	1*	1	2
Robson	0	1	1

*presumed dispersal or not-functioning

As of August 2013, 3 of the 4 packs (Signal, Sunwapta, Pyramid, and Brazeau) remain collared, but missing collars in the Sunwapta and unknown location of the Pyramid pack indicate that we may have lost contact with 2 of these 3 packs. We were unable to deploy new collars on the Brazeau pack in winter 2012/13.

2.4 Elk Capture

We continue to use radiocollars to monitor elk, but since April 2012 have removed all GPS collars and have no active capture program ongoing. As of August 2013, 17 elk were collared with VHF collars in locations throughout the park. We continue to investigate mortalities and use the collars for mark-resight population estimates (as described in Section 5).

2.6 Elk Mortality

Since spring 2009, fourteen elk mortalities have been located and investigated. Mortality causes have been identified as 2 highway, 1 railway, 4 predation/scavenged, 1 non-predation, and 6 unknown.

Elk 87 was located near the tracks at Devona in May 2009, but evidence left at the site indicated very little about cause of mortality; we found only hair and bones and the animal had been dead a long time before we were able to investigate. Wolf scat was present, but given its proximity to the railway tracks, E87 could have been hit by a train.

Elk 77 was located near the Snake Indian River in a mixed aspen, spruce, pine forest in April 2010. The carcass bones were largely intact (the spine and ribs were contiguous with the skull still attached, there were also 3 intact legs at the site). The elk's marrow was fatty and white with pink spots, indicating a healthy animal. There was no bear or wolf scat at the site and it is presumed that a cougar killed and/or scavenged this elk.

Elk 94 was hit on the highway near the Transfer Station in May 2010, and elk 96 was hit on the railway near Jasper in February 2011.

Elk 82 was found near Lake Annette in July 2010, there was no external trauma visible, but her pericardium and lungs were full of blood/fluid, and there was bruising of the thorax muscles. This amount of trauma indicated that the elk was likely struck by a vehicle and later died of associated injuries.

The mortality site found at elk 80's collar indicated very likely cougar predation in late February 2011. Cougar tracks, a latrine and bed site were found at the site and the elk's heart and lungs were eaten. The carcass was removed in the afternoon it was discovered and a cougar was sighted in the killsite area that evening.

Elk 86 was relocated on mortality during a 2012 flight near the confluence of the Athabasca and Snake Indian rivers. When we investigated on the ground, only the collar was found and there was no sign of the carcass. Originally, the pilot had estimated the collar location 1.6 km south of where it was found, so it was possibly moved by scavenger. The collar was chewed through and close to railway tracks; it's possible the elk was hit by a train.

Elk 105 was located on an island in the Athabasca River, the skull, spine and ribs were all intact, and the remains were partially buried in river mud. There were no signs of predation and the animal was presumed to have died in spring 2012.

Elk 89's mortality site was located in August 2012 (several months after the time of mortality), and only bones (long bones and mandibles), hair pile and rumen, and signs of burial and digging were found. The collar was buried and we assumed that the cause of mortality was likely wolf predation and then bear scavenged, but could have been the other way around. Both wolf and bear scat were present at the site.

Elk 139 was found at the confluence of the Snaring and Athabasca rivers in April 2012, with clear indication of having been killed by wolves only days earlier.

We located elk 76's collar under the ice near the Snake Indian Bridge – we attempted to recover it twice before melt-off, but were not able to extract it. The cause of mortality is unknown and we assume the collar was carried to this location by high water.

Elk 102's collar was located during the 2013 elk survey near the confluence of the Snake Indian and Athabasca Rivers. The skeleton was mostly intact but divided into two. Long bones were not broken open and the ribs were not broken off. Our best guess is that the elk was injured by a train and then scavenged.

Elk 79's collar was recovered near Kerkeslin in spring 2013, but it is presumed that she was killed during the winter. No predator scat was apparent and only the jawbones, pelvis, and hair were left at the site.

Elk 104 was relocated on mortality as part of a flight by ESRD in the Snake Indian/Willow Creek region. The collar was found in a grassy meadow along the Snake Indian River, and her bones were in two groups with hair located far away. There were no reports of predator scat at the site.

2.4 Mule and White-Tailed Deer Capture and Mortality

We initiated a deer study in partnership with colleagues at the University of Calgary in 2011. We aimed to collar deer in the Three-Valley confluence area to identify population trends, distribution, and estimate population sizes for both white-tailed deer and mule deer, with an emphasis on the FireSmart areas. This ties in with on-going research into prey abundance and change as it relates to wolf and caribou in Jasper.

Trap Summary 2012

During the 2012 trapping season traps were open from January 20 to March 31, 2012. We used 9 Clover traps and placed them in 17 different locations south, east and west of the town of Jasper. Seven locations were within FireSmart areas, while the other ten were located in non-FireSmart areas. Traps were moved to different locations when a collared female deer was

recaptured or if the trap appeared to be unsuccessful. At each location, the trap was open for 35 days on average.

Trap success in each location varied. Seven of the locations produced no captures, 4 locations caught one deer each and 6 locations had more than one capture. Our most successful location, at the junction of Jasper Park Lodge road and Maligne Lake road, caught 6 deer (3 were recaptures). The first month of the season was the most successful, with 11 deer that captured and collared. The last 18 days of the season, no deer were caught at all, possibly due to low snow accumulation and warmer temperatures. It is recommended that in subsequent years, the trapping commence earlier.

Throughout the 2012 trapping season we also caught and released 7 recaptures (5 individual deer) and 7 young of the year. As well, we had two captured deer escape through the trap before our capture crew could arrive.

Traps were baited with alfalfa hay, oats and chopped apples. This did not only attract deer, but also wolves, coyotes, elk, a cougar, martens, foxes and numerous rabbits. All traps were checked twice a day: visually and mechanically every morning and using a VHF radio signal, which signalled the trap was dropped, in the afternoon.

Near the end of the trapping season, two mule deer within the town of Jasper were immobilized and collared in order to deploy all the GPS collars and to monitor deer that frequent the town site.

Trap Summary 2013

The trapping program continued in 2013, but due to reduced availability of staff time, was not started until later in the year (February start). We used the same protocol as for 2012, though we did add pieces of salt to the site mid-way through trapping. Traps were pre-baited by the 8th of February. Five traps were opened on 17th, and 2 more were opened on the 25th of February after the Junction trap was permanently closed (February 24th). The first deer capture was on the night of the 23-24th of February at Junction trap, but a cougar entered the trap and killed the deer. We removed all remnants of the deer and monitored with remote camera for several days. We closed other traps in the vicinity (Soggy Dog) and monitored those with remote camera as well, in case the cougar had associated the traps with prey. After several days of no cougar activity at either site, we reopened the Soggy Dog trap and immediately caught the second deer of the winter: a white-tailed buck. Within the next 7 days we captured another white-tailed buck, and recaptured the first one. All bucks were released without collars. We did not catch deer at any of the other locations. The Palisades trap was open for 39 days and remote camera photos showed deer walking by and even going into the trap, but no deer were captured at this location. Buffalo Prairie trap was open for 39 days and deer were in the area but none were lured into the trap. Teahouse trap was open for 39 days, deer were frequently in the vicinity and at one point triggered the trap (probably from the outside), but we failed to capture any individuals at this location. Soggy Dog trap was open for 36 days and caught 3 male deer (including one recapture). Valley of the Five Lakes trap was open for 31 days and there was very little deer activity at this site, we captured photos of one white-tailed deer investigating the trap but it did not go inside. The Range trap was open for 31 days, there was minimal deer activity at this site, but there were deer tracks in the general area. JPL junction was open for 7 days before being permanently closed. A warm spring, low snow, and fewer traps, and late trapping contributed to low success in capturing deer in 2012.

We recommend starting the trapping in December, pre-baiting with salt, and experimenting with other trap bait. In 2013/14 we will dedicate a full-time technician to the deer-trapping program.

Collared Deer

In 2012 we had 19 deer collared in Jasper National Park, including 10 female and 2 male mule deer and 3 female and 4 male white-tailed deer. Nine GPS, 5 VHF and 6 rot-off collars were deployed (Table 2).

Most GPS collars that were deployed in 2012 dropped-off and were recovered from the field in spring 2013. Two collars remain missing – deer 141 and deer 160; we assume the beacons failed and it's probable that the drop-offs fired and the collars are now lost.

Table 2: Collar distribution on mule and white-tailed deer in Jasper National Park, 2013.

	Collar Type			Sex		
	GPS	**VHF**	**Rot-off**	**Female**	**Male**	**Total**
Mule Deer	2	3	2	5	2	7
White-tailed Deer	1	0	4	1	4	5

We have made attempts to relocate deer at least monthly, though often it is longer between relocations because most of our work has to be done on the ground. In the summer, especially, deer move great distances to locations that are inaccessible by road (e.g. Coronet Creek, or headwaters of the Whirlpool River).

Since 2012, we have detected 4 mortalities. Deer 150 was relocated near Maligne Canyon but the cause of death was unclear. We were able to locate the collar and only one site with a small amount of deer hair scattered around. There were no predator scats and no rumen/blood pile. The collar had a large bite-mark in it and blood on the rotoff, so the animal is presumed to have been predated.

Deer 162 died sometime in winter 2013 of unknown causes and her collar was turned in by a member of the public. There was no carcass observed and the collar belting was sliced partway, but there was no blood.

Deer 165 was hit on the highway near the east entrance of Jasper in December 2012 and the collar was recovered immediately.

Deer 155 is presumed to have been killed by predators, even though no kill evidence was located. We relocated this collar after it went into recovery and was assumed to have dropped-off. The collar was found in two pieces and had been heavily chewed. Because the collar was severed, the GPS mechanism was probably working after that point, and it is therefore not known where the collar was prior to having been found in its location.

From the 7 recovered GPS collars, we gained nearly 25000 location points, giving Jasper National Park its first insight into deer movement and distribution (Figure 2). From this, we see that

seasonal ranges are apparent, but strikingly, many mule deer that winter around town migrate during the spring and fall (to Maligne area or Whirlpool valley; Figure 2).

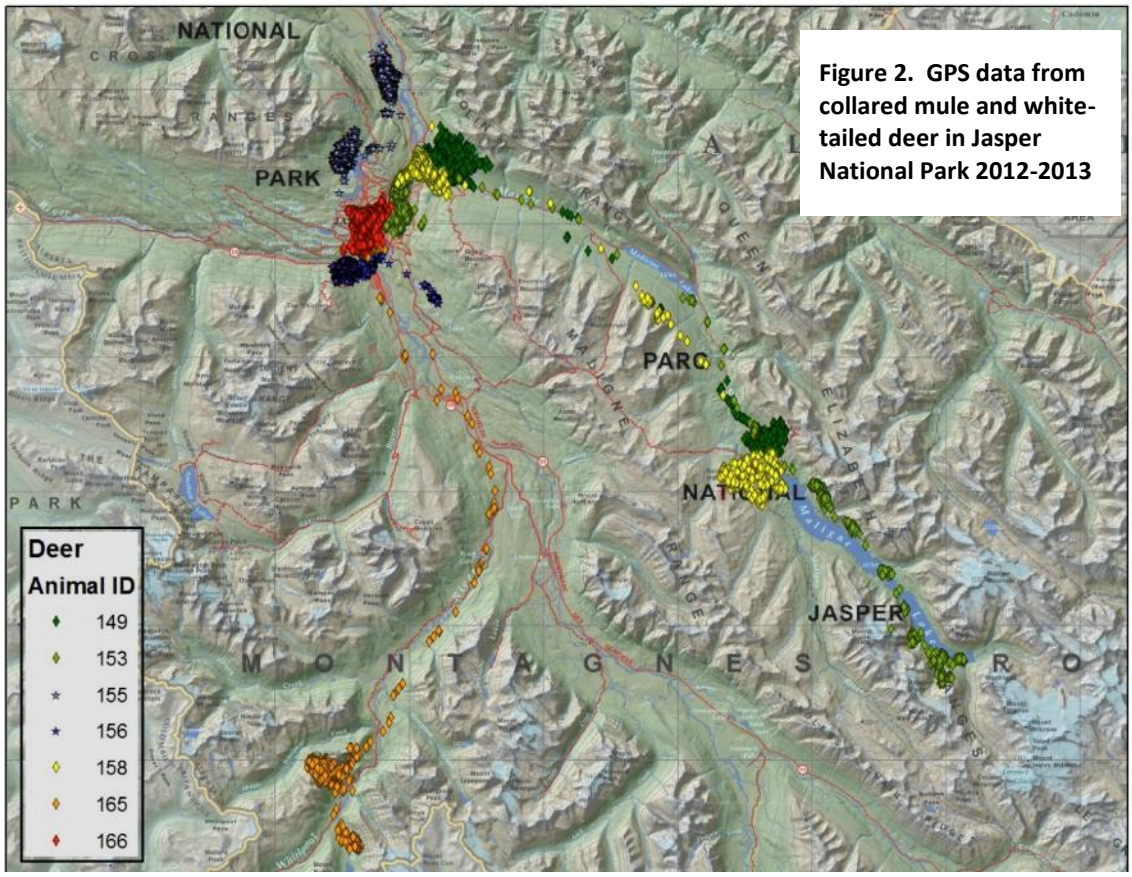

Figure 2. GPS data from collared mule and white-tailed deer in Jasper National Park 2012-2013

3. Caribou Surveys

Regular caribou population surveys are essential to detecting caribou population trends. 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 woodland caribou as the animals are rutting, above treeline, and in larger groups. A covering of snow increases the probability of observing individuals 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 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 present, 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), (Neufeld and Bradley 2009).

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.

Population surveys commenced in the fall, once conditions were suitable (snow covered the ground). 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.

The number of collars available for mark-resight population estimate was 12 for 2009, 2010 and 2011. Each caribou region (Tonquin, Maligne, and Brazeau) required at least one day to survey. However, in 2012 flying conditions were so consistently poor that we were unable to complete the Tonquin survey before the rut ended and caribou descended to the trees. We will rely on DNA results for population estimates for 2012. 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 pellets for caribou DNA population estimate (Section 4).

In March of each year we also conducted a calf recruitment survey using radio-collars to locate females. 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. 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 et al. (1983)

3.3 Survey Coverage and Location of Groups

We surveyed approximately the same areas over the 2009-2012 surveys (Figure 3). Survey coverage included part of the White Goat Wilderness area in Alberta, and part of Mount Robson Provincial Park in BC. In 2011 we did not cover the Geraldine Lakes area on the same day as the visual survey (Figures 3 and 4), but did cover this area the next day during the scat collection. We did not cover this area in 2010.

Table 3: Number of hours flown in each of the three areas.

	2009	2010	2011	2012
Tonquin	7.4	9.4	6.3	n/a
Maligne	6	5.9	6.0	4
Brazeau	5.3	5.7	6.6	5.6
Total	18.7	21	18.9	9.6

The 2009 survey was flown over 4 days from 9-16 October. The helicopter was airborne for approximately 18.7 hours (Table 3), which is similar to survey effort exerted in previous years. Snow and observation conditions were good, with 100% snow cover and tracks easily observed in the alpine. The Maligne had less snow cover, but observation conditions were still good. We covered approximately 1705 km during the survey, including a reconnaissance trip to Southesk after an observation of caribou from that region in summer 2008. We also surveyed the Geraldine Lakes area.

In 2010 we flew the survey over 5 days from 15 October to 3 November. Survey time was greater than in 2009 because we had to abandon the first Tonquin survey part-way due to weather; we continued the next day but had to resurvey many areas. Late snowfall pushed our survey later into October than preferred, and conditions were fairly good, but higher cloud cover and less than 100% snow cover compromised our observation conditions a little. There were large regional differences in snow cover across ranges as well (e.g. very little at south end of the Brazeau). We flew approximately 1543 km during the survey, including a reconnaissance of slopes south of the Fraser headwaters to Hugh Allan creek. We did not cover Geraldine lakes in this survey.

In 2011 we flew the survey over 3 days from the 22 October to 1 November, not including a 2.4 hour first attempt at surveying the Tonquin (aborted due to weather). Total survey time was just under 19 hours. In general, survey conditions were poor. Less than 100 % snow cover and persistent cloud cover compromised sightability of caribou. We flew 1840 km of caribou habitat in this survey, and surveyed the Fryatt, Geraldine, and Southesk areas.

In 2012 consistent low cloud, high wind, and snow throughout October caused great difficulty in completing the survey. We were able to complete the Maligne and Brazeau sections on October 4th and 24th, respectively and made two attempts at the Tonquin but could not complete this part of the survey. Approximately 3 hours of flight time were related to abortive attempts in the Tonquin. There was a large early snowfall for the Maligne survey and conditions were very good. Conditions were also good in the Brazeau with 100% snow cover. We flew approximately

877 km of caribou habitat in the Maligne and Brazeau, though the GPS signal was lost several times in the flight and this number is a low estimate.

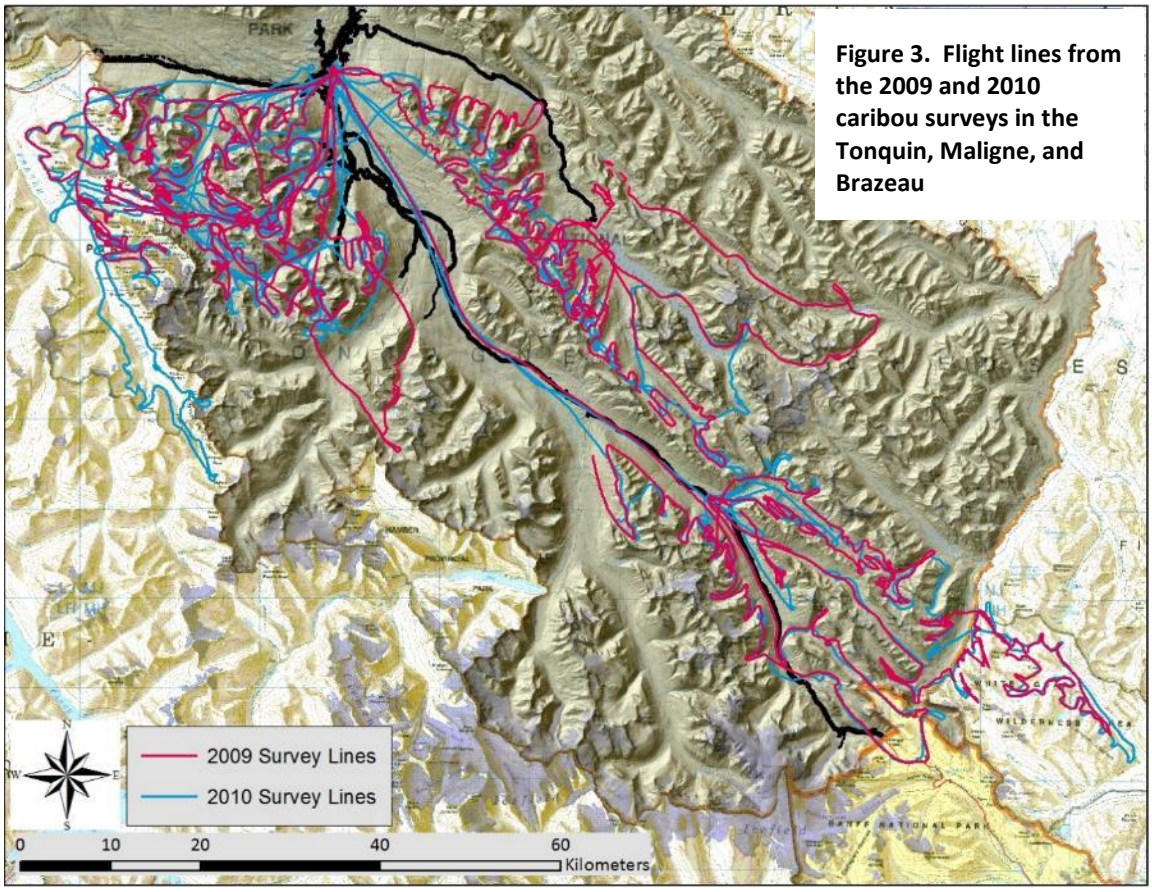

Figure 3. Flight lines from the 2009 and 2010 caribou surveys in the Tonquin, Maligne, and Brazeau

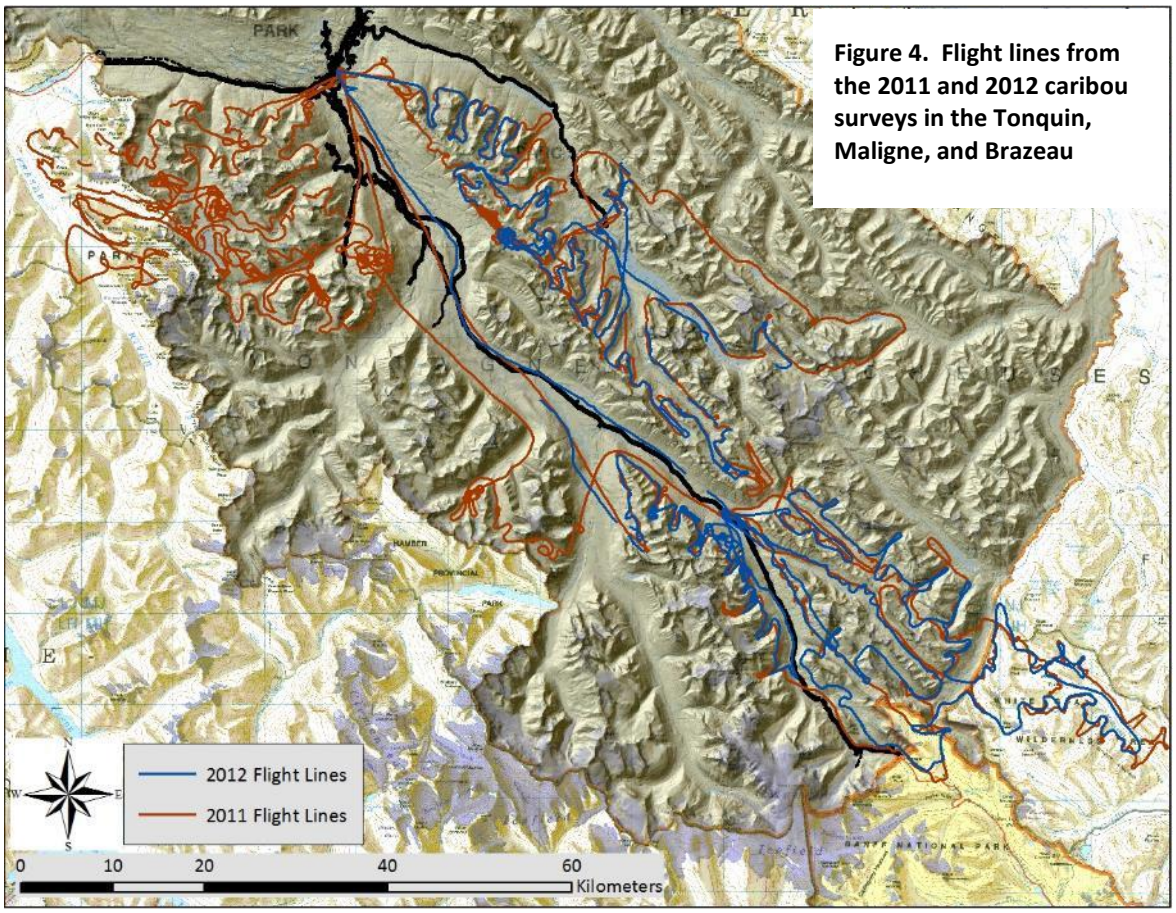

Figure 4. Flight lines from the 2011 and 2012 caribou surveys in the Tonquin, Maligne, and Brazeau

Caribou were located throughout the survey region in all years. However, similar to 2008, we failed to locate caribou in the White Goat Wilderness and did not have a radio-collar there to see if we'd missed a group or if there were indeed no caribou present. All Brazeau caribou were located west of Highway 93 in both 2009, 2010, 2011, and 2012 (Figures 5 and 6). In the Maligne, caribou were located from Hardisty Pass through to Trapper and Evelyn creek in 2009 and 2010, and primarily in the vicinity of Hardisty Pass and the Bald Hills in 2011 and 2012. In the Tonquin, caribou groups were in similar locations as in the past, but the number of animals seen was smaller than previous years (Figures 5 and 6).

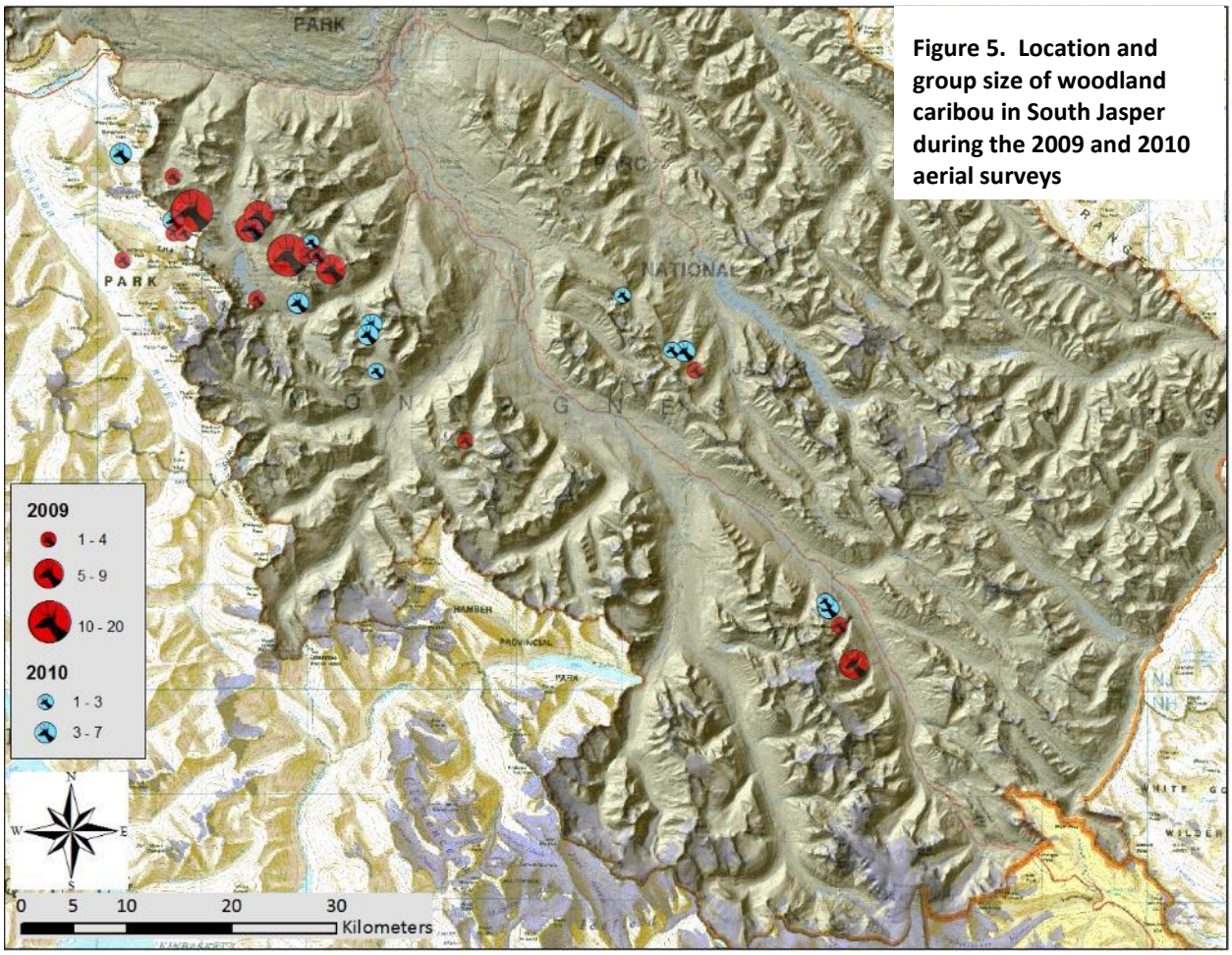

Figure 5. Location and group size of woodland caribou in South Jasper during the 2009 and 2010 aerial surveys

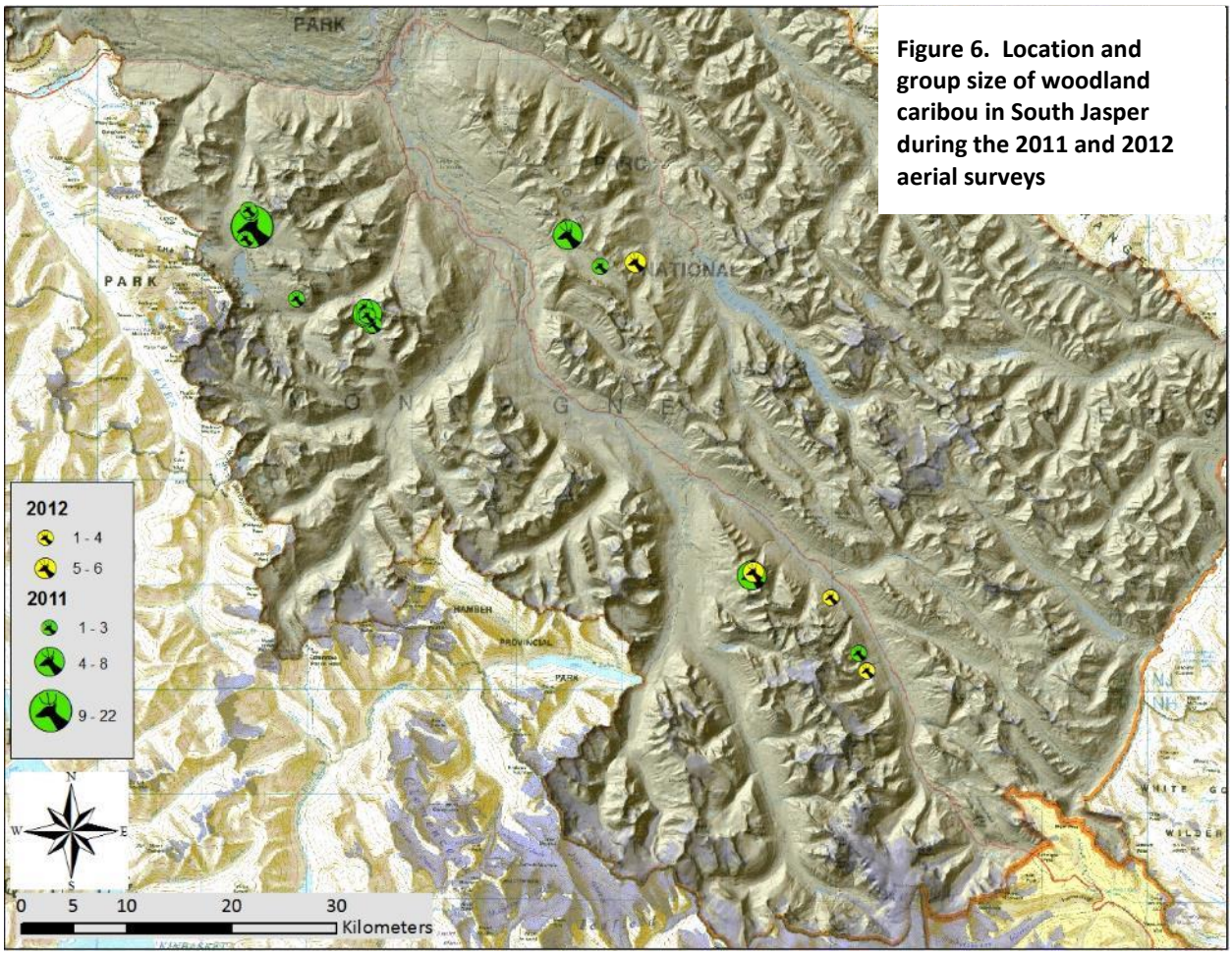

Figure 6. Location and group size of woodland caribou in South Jasper during the 2011 and 2012 aerial surveys

3.4 Population Estimate Results: 2009-2012

In 2009, we adapted our analysis methods slightly and excluded the Maligne herd from the JHE population estimate because the population was very small, unchanging, and usually in one group. In the 2009 annual visual survey, we observed 87 caribou in the three herds, including all available radiocollars (12). Eighty-seven, then, represents the estimate, since sightability was 100%, but also the minimum count. We calculated a 90% confidence interval of 87 to 96 (Figure 7). However, since we know that a minimum of 87 animals were alive, we consider the estimate to be lower than the true number of caribou and indeed the lower bound of the confidence interval reflects this.

We observed 61 caribou in the Tonquin/Brazeau survey, but missed 2 collars (observed 10 of 12 collars) and with telemetry found another 5 caribou plus 6 in the Maligne, resulting in a minimum count of 72 in 2010. There may have been another 2 bull caribou observed in Verdant during the scat collection the next day, but we can't be sure and therefore left this out. Based on our survey observations, the JHE population estimate was 73, with 90% confidence limits of 72 to 102 (Figure 7). Adding in the 6 Maligne animals (not included in the JHE calculation), we estimated there were approximately 79 caribou in 2010. Again, the lower confidence bound is equivalent to the minimum number observed (excluding Maligne), and we consider the true number of caribou to be higher than this minimum count.

In 2011, we used the same technique of excluding the Maligne, but also excluded the Brazeau herd from the JHE for the same reasons as cited above. We observed 9 of 12 collars (in the Tonquin) as part of the 41 animals seen without telemetry. We observed an additional 6 animals with telemetry, giving a minimum count of 47 in the Tonquin region, and and a JHE estimate of 54 with a 90% confidence interval of 46 to 75. Adding in the 11 animals observed in the Brazeau (including 4/4 collars) and the 6 in the Maligne (2/2 collars) we estimate the south Jasper caribou population to be 71, with 90% confidence intervals of 64 to 92. The lower bound represents the minimum number of caribou known to be alive at the time of the survey in 2011. As described earlier, we were unable to count the Tonquin population in 2012, and observed a minimum of 6 and 12 in the Maligne and Brazeau. Sightability in 2010 and 2011 was 83% and 75%, respectively.

Woodland caribou population trend in south Jasper since the 2006 era shows a clear decline to 2011 (Figure 7). Although earlier estimates had larger confidence intervals, a consistently lower estimate and recent higher precision in estimates indicates that we are confident at the 90% level that the population has declined significantly in the 2011 era, driven mainly by changes in the Tonquin. We have not received the 2012 DNA survey results, but based on survival and recruitment values (Section 3.10), we expect that the Tonquin population continued to decline in 2012.

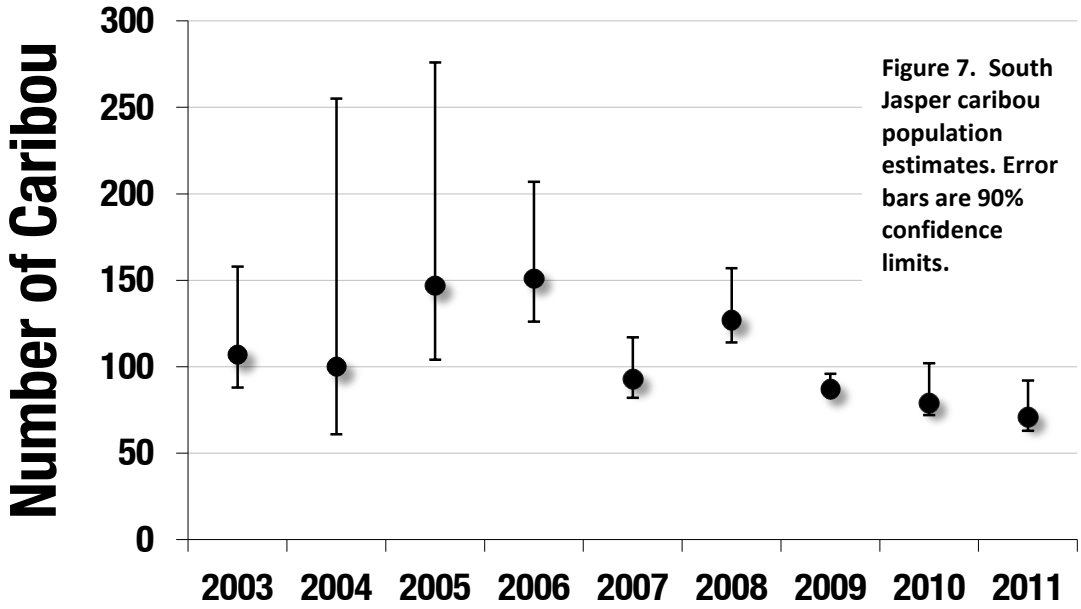

Figure 7. South Jasper caribou population estimates. Error bars are 90% confidence limits.

3.7 Minimum Counts: Regional

To compare the three regions in South Jasper (Tonquin, Maligne, and Brazeau) we must 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. We discussed drawbacks of relying on minimum counts for data interpretation in the previous progress report (Neufeld and Bradley 2009). Generally, it is critical to recognize the limitations of counts when interpreting Figure 8: counts always underestimate and changes in the data could reflect sightability, emigration, or immigration, as well as changes in actual caribou abundance.

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 4 caribou in 2009 and 6 in each of 2010-2012 (Figure 8). 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 9, 8, 11, and 12 caribou in 2009-2012, respectively (Figure 8). The count in the Tonquin area was 74 in 1988 and a low of 22 was recorded in 2001. We counted 74, 58, and 54 caribou in the Tonquin from 2009-2011 (Figure 8).

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 into these populations means that caribou will not be self-sustaining without augmentation.

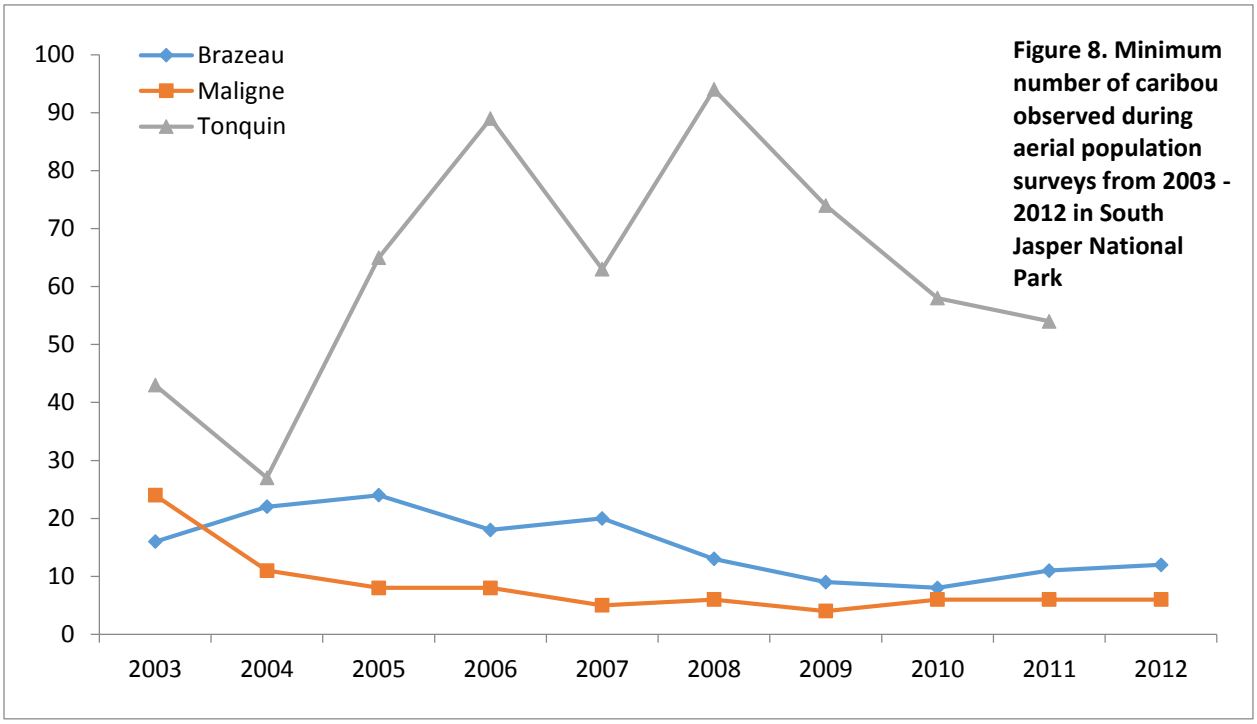

Figure 8. Minimum number of caribou observed during aerial population surveys from 2003 - 2012 in South Jasper National Park

3.8 Calf Surveys

Calf surveys (aerial counts of the adult females and their calves) allow estimation of recruitment rate (the number of the previous year's calves that survive to adulthood). Recruitment rate is expressed as a ratio, standardized as the number of calves per 100 adult females. The recruitment rate can be combined with the survival rate of adult females (estimated from our collared animals) to produce an estimate of the change in population size, also known as *lambda* (Hatter and Bergerud 1991). We conducted calf surveys in March, when the previous year's calves were approximately 10 months of age, and snow on the ground helped with finding caribou. Ideally, recruitment rate would be calculated when calves are 12 months of age (i.e. adult age), but caribou are difficult to find in June when they are calving, so March surveys are a compromise – we assumed that at 10 months of age, calves have the same survival rate as

adults, hence the recruitment rate should not change between March and June. Locations of detected caribou are shown in Figure 9.

Recruitment rates for all three populations (Brazeau, Maligne, and Tonquin) combined are shown in Figure 10. Recruitment rates are typically the most variable of the vital rates for ungulates (Gaillard et al. 1998), and the last several years for South Jasper caribou are no exception – 2010 and 2011 recruitment rates were low, relative to most years, but 2012 and 2013 were relatively high. The long-term trend of the estimates is, if anything, positive.

The long-term average for calf:cow ratio for all caribou populations in Alberta is 0.15 (Alberta Sustainable Resource Development and Alberta Conservation Association 2010), while the average for South Jasper is 0.28, or almost twice the Alberta average. A high recruitment rate is the result of adequate birth rates and first year survival rates, both of which indicate that nutrition is adequate on a population level (i.e. enough fat reserves to bring fetuses to term, as well as to provide adequate milk for the calves).

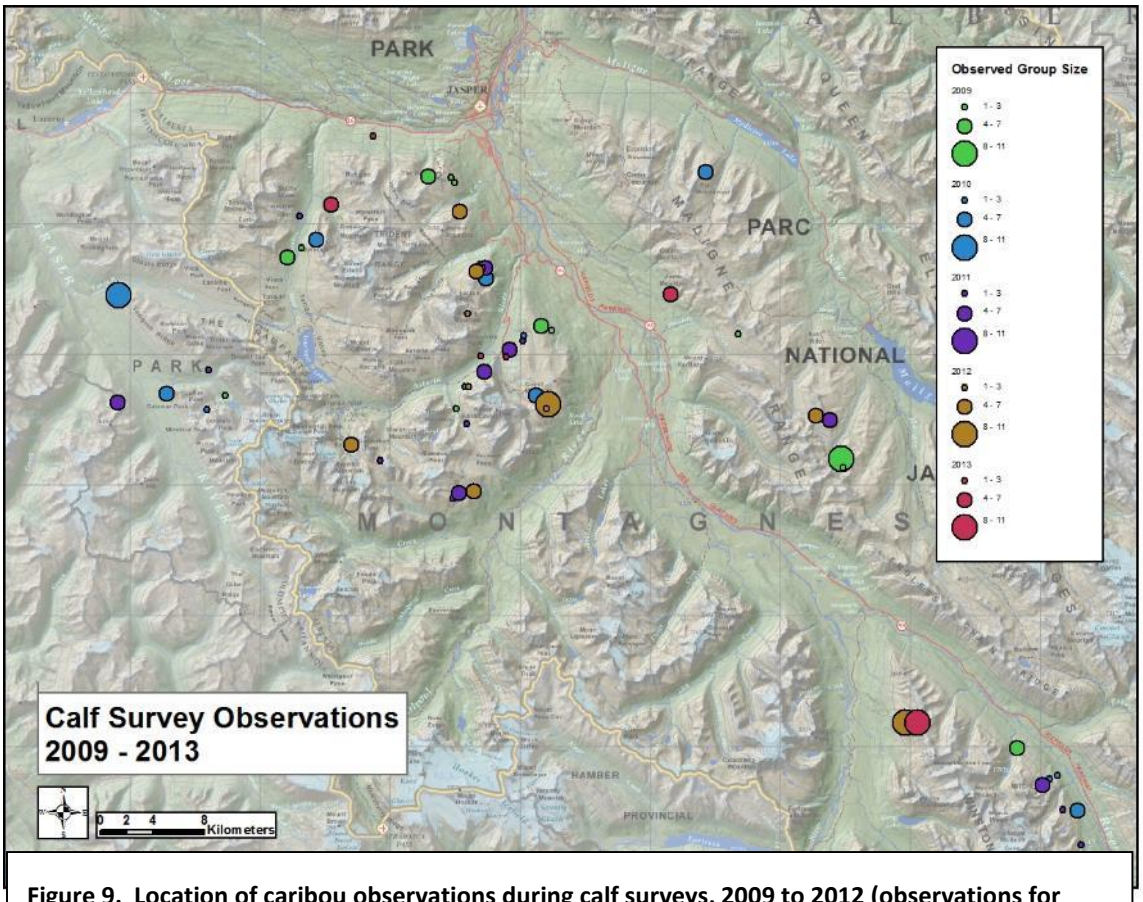

Figure 9. Location of caribou observations during calf surveys, 2009 to 2012 (observations for previous years are in Neufeld and Bradley (2009)).

The large confidence intervals associated with the 2013 recruitment rate are a result of the diminishing sample size of collared adult females (we stopped collaring adult females in 2010, and we rely on radio-telemetry to find caribou for the calf surveys). Estimates with such large confidence intervals are not particularly useful, and because sample sizes will continue to decline as the collared animals die, we will likely stop surveying calves in the future. We will rely on our scat DNA techniques (Section 4) to provide lambda and recruitment rates in the future. Also, we will re-examine this on the scat DNA recruitment rates from the fall rut survey data. Recruitment rates calculated from fall data are less reliable, however, because calves are only 5 months old.

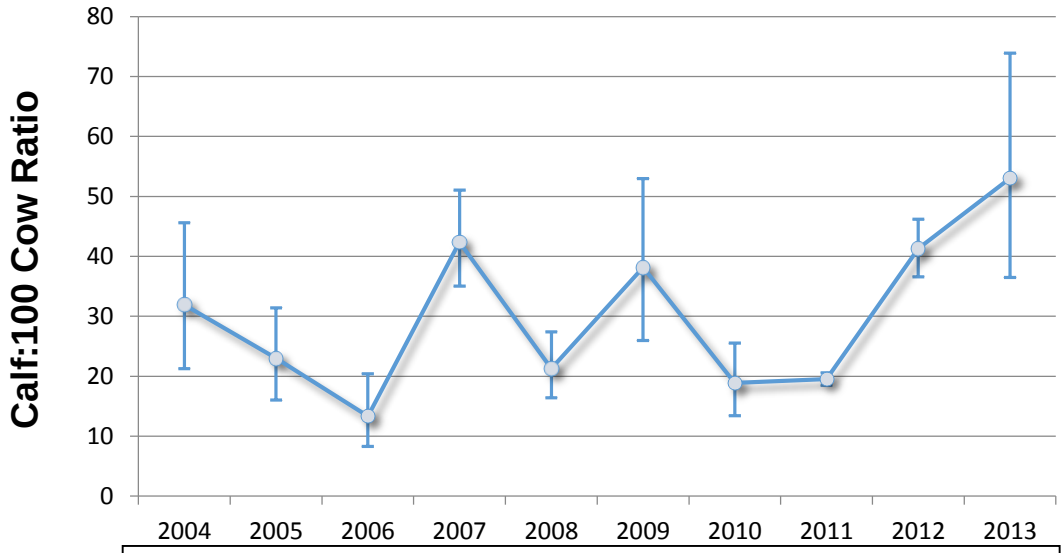

Figure 10. Calf to 100 cow ratios for spring of consecutive years, 2004-2013. Error bars are 90% confidence limits.

3.9 Adult Female Survival Rate

Adult female survival in ungulates is an important contributing factor for population growth rate (Gaillard and Yoccoz 2003), but usually shows little annual variation (Gaillard et al. 2000). We estimated annual survival in South Jasper caribou by monitoring radio-collared adult females. We checked each collar for survival status at approximately one month intervals and calculated survival rate using the Kaplan-Meir staggered entry estimator. A caribou-year begins on June 1, the approximate annual date of birth.

Survival rate has been declining since 2003, and the 2012 survival rate was the lowest on record (Figure 11). The geometric mean of survival rates from 2003 to 2012 is 0.78. For comparison, the geometric mean for the rest of the caribou populations in Alberta was 0.85 (2002 to 2008). Both the low mean survival rate and the declining trend are a major concern for South Jasper caribou.

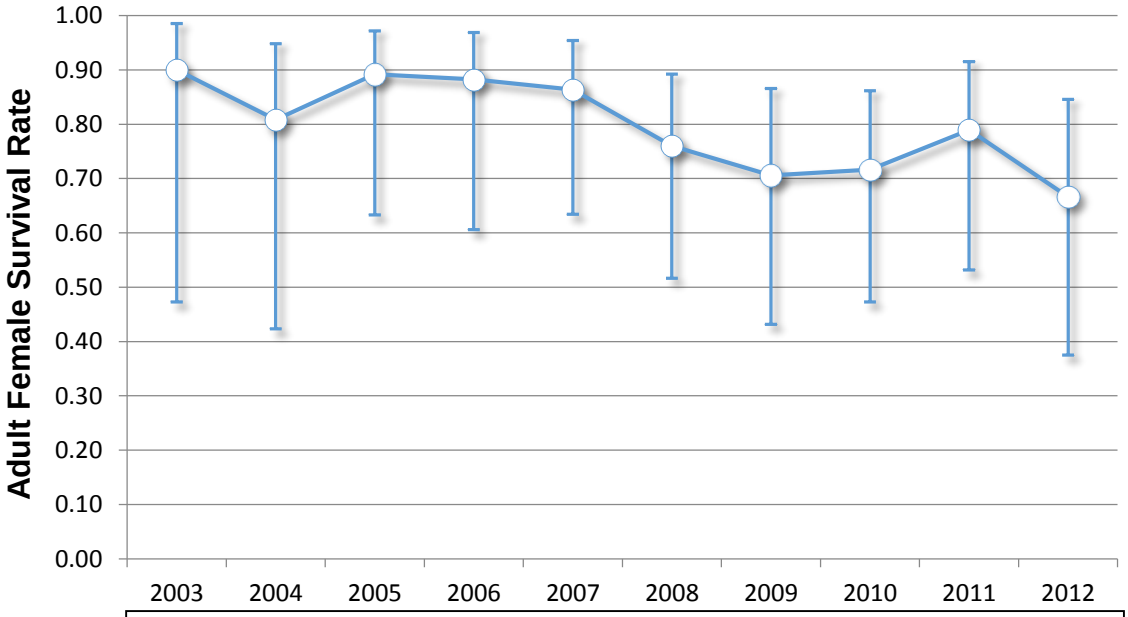

Figure 11. Adult female survival rate for the South Jasper caribou population (includes Maligne, Brazeau and Tonquin herds), 2003 to 2012.

3.10 Population Growth Rate (lambda)

Data from the previous two sections, recruitment (section 3.8) and survival (section 3.9), can be combined to provide an estimate of the population growth rate, or lambda (λ). We use Hatter and Bergerud (1991)'s formula for calculating lambda: $\lambda = (1-M)/(1-R)$, where M is adult female mortality and R is female recruitment. $R= (CCR/2)/(1+CCR/2)$. Confidence intervals were calculated using Monte Carlo simulations using the variances from the recruitment and survival rate estimates.

Lambda for the South Jasper caribou population is low (Figure 12a). Relative to other Alberta caribou populations, recruitment rates in Jasper are high and either stable or increasing (Figure 10). Survival rates, however, are low relative to other Alberta populations, and declining (Figure 11). The declining population in South Jasper is most likely due to poor adult female survival, in spite of good recruitment. This is an important conclusion, as it allows us to focus management attention on factors that could lead to adult female mortality, as opposed to factors that could lead to increased recruitment.

Another way to illustrate lambda is to simulate population change by starting at a hypothetical number of caribou (in our case, 100) and successively applying the annual population growth rates. Figure 12b illustrates this simulation: based on estimated lambdas, if we started with 100 caribou in 2002, we would have approximately 40 caribou in 2012.

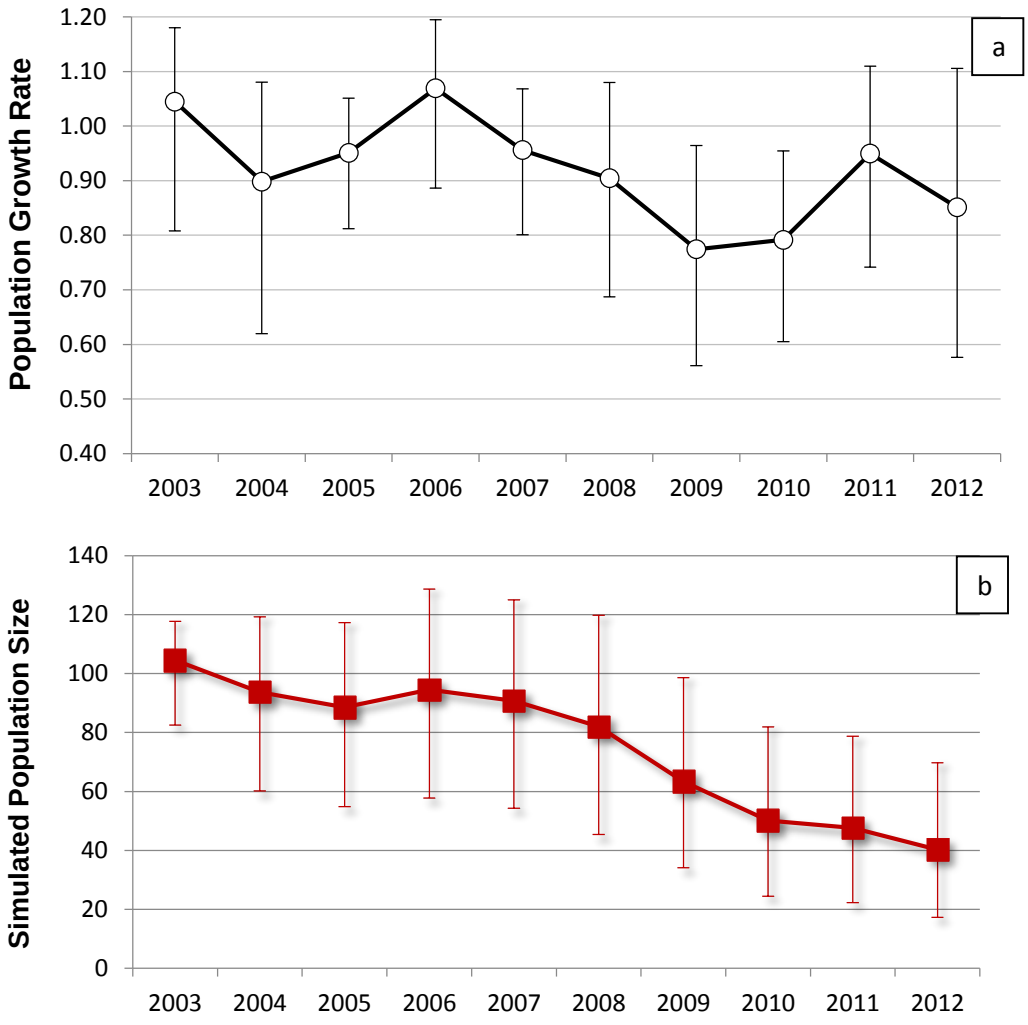

Figure 12. a) Estimate of population growth rate (lambda (λ)) for Jasper National Park calculated as per Hatter and Bergerud (1991); b) JNP caribou population growth simulation based on estimated lambdas

In sections 3.8 to 3.10 (recruitment, survival, lambda), we have treated all three herds (Maligne, Brazeau, and Tonquin) as one, for brevity. In reality, caribou movement among the three herds is rare, so it would be useful to consider them separately; however the sizes of the Maligne and Brazeau herds are so small that it becomes impractical to calculate vital rates. Much of the adult female mortality from 2009 to 2011 occurred within the Tonquin herd, but in 2011-2012, most mortalities occurred within the Brazeau herd. We therefore have reason to be optimistic about the largest herd in South Jasper (Tonquin): the 2012 lambda for the Tonquin herd was very close to 1.0, or stability.

4. Fecal DNA Project

4.1 Fecal DNA Population Estimates: Tonquin herd

In 2006, we began investigating the efficacy of using DNA collected from caribou scat to identify individuals (genotyping). Genotypes are used as a *mark* to calculate mark/recapture population estimates. In this work, we collaborate with Dr. Manseau and Dr. Arnason (University of Manitoba). We use Program Mark's implementation of (Pollock 1982)'s robust design to estimate population size. The results described in this section are for the Tonquin herd only, because there have not been enough caribou to produce estimates for either the Maligne or Brazeau herds.

Overall, the visual and scat population estimation techniques have produced similar results (Figure 13). A linear regression of the two methods yielded an r^2 value of 0.87 ($F = 26.0$, $P < 0.01$), indicating a high degree of consistency between our estimation techniques. Agreement between the two methods also seems to be improving with time. An advantage of the scat DNA estimates is higher precision (Figure 13), perhaps because the number of 'marks' with scat is so much higher than with collars (on the other hand, the resight with collars is often close to 100%, but is much lower with scat 'resights'). Using scat DNA for population estimates has proven to be a useful technique, and we intend to use it solely for future population monitoring, both for the increased precision and to avoid the stress and intrusiveness that radio-telemetry inflicts on caribou.

Population estimation using mark-recapture techniques for gregarious mammals like caribou may produce results that are precise but not necessarily accurate. For example, results from 2007 and 2008 visual and scat based population estimates indicated a decline between 2006 and 2007, and then an increase between 2007 and 2008. This decrease followed by an increase is extremely unlikely – if true, lambda for 2007 would have been almost 1.6, a value that is virtually impossible for a wild caribou population. Additionally, the collar based lambda for 2006 was above 1.0, indicating an increase from 2006 to 2007, not a decrease, so both techniques were likely flawed in 2007. Perhaps a most likely explanation for the low value in 2007 is that some caribou were not available for sampling during both the visual survey and scat collections. However, there was nothing unusual about the rut survey and scat collections in 2007 and we cannot explain why this would have been the case. In his M.Sc. thesis, (Hettinga 2010) shows that fewer bulls were sampled in 2007 and this probably contributed significantly to the overall low population count in 2007.

There are other discrepancies between the techniques that are not easily explained – in the 2008 rut survey we observed a minimum of 92 caribou, which is more than the number estimated by the scat technique (suggesting that the visual survey was more accurate). It is therefore necessary to explore reasons for these discrepancies and determine if improvements in sampling design can alleviate problems. The failure of the scat technique to estimate even the minimum number seen during the 2008 rut survey is also inexplicable and we continue to collaborate with our academic partners on this issue.

Regardless of random bias in any particular year that may contribute to an inaccurate population estimate, an examination of the entire time series should result in an accurate assessment of population size and trend. Coupled with 95% confidence intervals, therefore, we expect 1 estimate in 20 to be outside the error bars. Further, the recent near-perfect correlation between the two techniques gives us some degree of confidence in relying on the scat technique in the future.

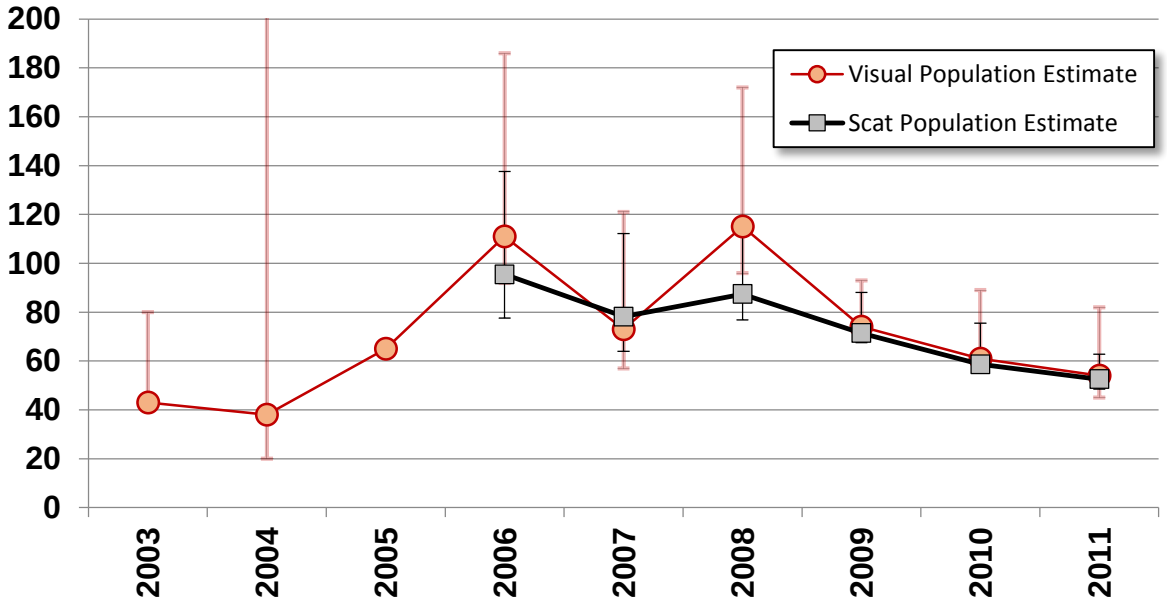

Figure 13. Population estimates of caribou in Jasper National Park based on aerial surveys and scat DNA mark-recapture analysis; 95% confidence intervals.

4.2 Fecal hormones analysis as a non-invasive tool to estimate age-class of woodland caribou

Flasko, A., M. Manseau, G. Mastromonaco, M. Bradley, L. Neufeld, and P. Wilson

Fecal pellet morphometrics and hormone content were measured to differentiate calf from adult woodland caribou within the South Jasper and North Interlake herds. Fecal pellet collections occurred during the fall of 2006 to 2011 for South Jasper and during the winter of 2004 to 2010 for North Interlake. All samples were amplified at 10 microsatellite loci and unique individuals in each population identified. A developed capture history was used to identify samples from adults, observed in at least three previous capture years; and calves, individuals first observed in later years. Fecal pellets were measured for length, width, and depth, dry weighted, and analyzed for levels of progesterone, estrogen, and testosterone content. Results showed a significant difference in pellet size, testosterone, and progesterone levels between fall sampled female calves and adults, while winter sampled female calves differed significantly from adults in pellet size and progesterone only. Furthermore, fecal pellet size and all three hormones significantly differed between calf and adult male caribou for both fall and winter sampling periods. This study shows the potential of non-invasive fecal sampling for use in cohort

analysis and in combination with CMR methods may provide valuable insight on the age-structure of woodland caribou populations.

4.2 Sociogenetics: Exploring fine-scale social structure of woodland caribou

Flasko, A., M. Manseau, P. Wilson, M. Bradley, and L. Neufeld

The social structure of woodland caribou was investigated in the Tonquin, Brazeau and Maligne herds of Jasper National Park's central mountain caribou through pedigree analysis. Non-invasive genetic sampling of caribou fecal pellets occurred over six consecutive years, from 2006 to 2012. A total of 1,646 samples were amplified at 10 microsatellite loci and unique individuals were further amplified at an additional 8 loci. Parentage assignment was determined via the maximum likelihood method implemented in COLONY 2.0 and a consequent pedigree was constructed. Results showed that fewer males produced more offspring (21% of males reproduced, with a maximum of 13 offspring by a single male), while more females produced fewer offspring (38% of females reproduced, with a strong median of 3), thus representing a polygynous mating system. In addition, parent-offspring and sibling relationships were found between individuals belonging to different herds indicating that some movement of caribou has occurred between herds. This study demonstrates the potential of non-invasive genetic sampling as a method to assess the reproductive fitness of animals in a population, the social structure of caribou and its innovative potential for monitoring caribou movements within and between populations.

5. Primary Prey Research

5.1 Elk Survey 2013

The predominant theory for explaining woodland caribou decline is apparent competition - the negative effect of predation on a rare prey species caused by the hyper-abundance of a more common species, mediated by a shared predator. In Jasper, elk are the abundant species, caribou the rare species, and wolves the shared predator (other predator-prey species also contribute to this complex dynamic, but the elk/wolf/caribou dynamic is an important driver of the Jasper ecosystem (Bradley and Neufeld 2012)). Therefore, because elk are important for caribou conservation we monitor elk population size and trend with aerial surveys – previous surveys were flown in 2008 and 2009 (Neufeld and Bradley 2007, Robinson et al. 2008, Robinson 2009).

Aerial elk surveys in Jasper National Park were designed as per (Unsworth et al. 1999) and are described in detail in (Robinson 2009). The surveys involve sampling a proportion of randomly chosen survey units and producing estimates of population size, sightability variance, and sampling variance. Survey units are stratified by assigning relative presumed densities to the survey units prior to flying, as a means of increasing survey precision (see (Unsworth et al. 1999) for a more complete explanation). The stratification of survey units changes prior to each survey based on insights gained in the previous survey. For the 2013 survey, we also discarded 11 survey units that had been included in the 2008 and 2009 survey areas because we could find no evidence of elk within them in the 2008 and 2009 surveys – 19 survey units remained (Figure 14). Many of the discarded survey units had been designed for surveying moose, but we did not

attempt to survey moose in 2013. Also, some survey units were redrawn to simplify flying, and to improve the precision of stratification (Figure 14). Another change from the 2008 and 2009 surveys is the addition of seven survey units in the Brazeau River drainage at the southeast corner of Jasper National Park (Figure 14). We believe the Brazeau elk to be separate from elk in the rest of the park because of telemetry data.

We surveyed 5 of the 7 survey units in the Brazeau area, but observed only 8 elk. Furthermore, elk tracks were seen east of the study area. Survey units in the Brazeau sampled only a small proportion of the actual elk distribution, most of which was outside the park in the winter. Given sightings information and data from remote cameras, It is very likely that elk in the Brazeau region use the park most often in the summer. We therefore did not attempt to calculate a population estimate for the Brazeau elk, and excluded these survey units from further consideration.

We surveyed 15 of the 19 survey units in the main valley and Snake Indian valleys, and observed 270 elk. We estimated that there are 317 elk in the study area (90% confidence intervals are 278 to 356; Figure 15). The 2013 estimate is statistically lower than 2009 estimate (alpha = 0.1; 90% confidence intervals do not overlap). A decreasing elk population, should, in the long-term, be beneficial for caribou populations, assuming that the decreasing trend in elk is not mirrored by an increasing trend in another prey species of wolves.

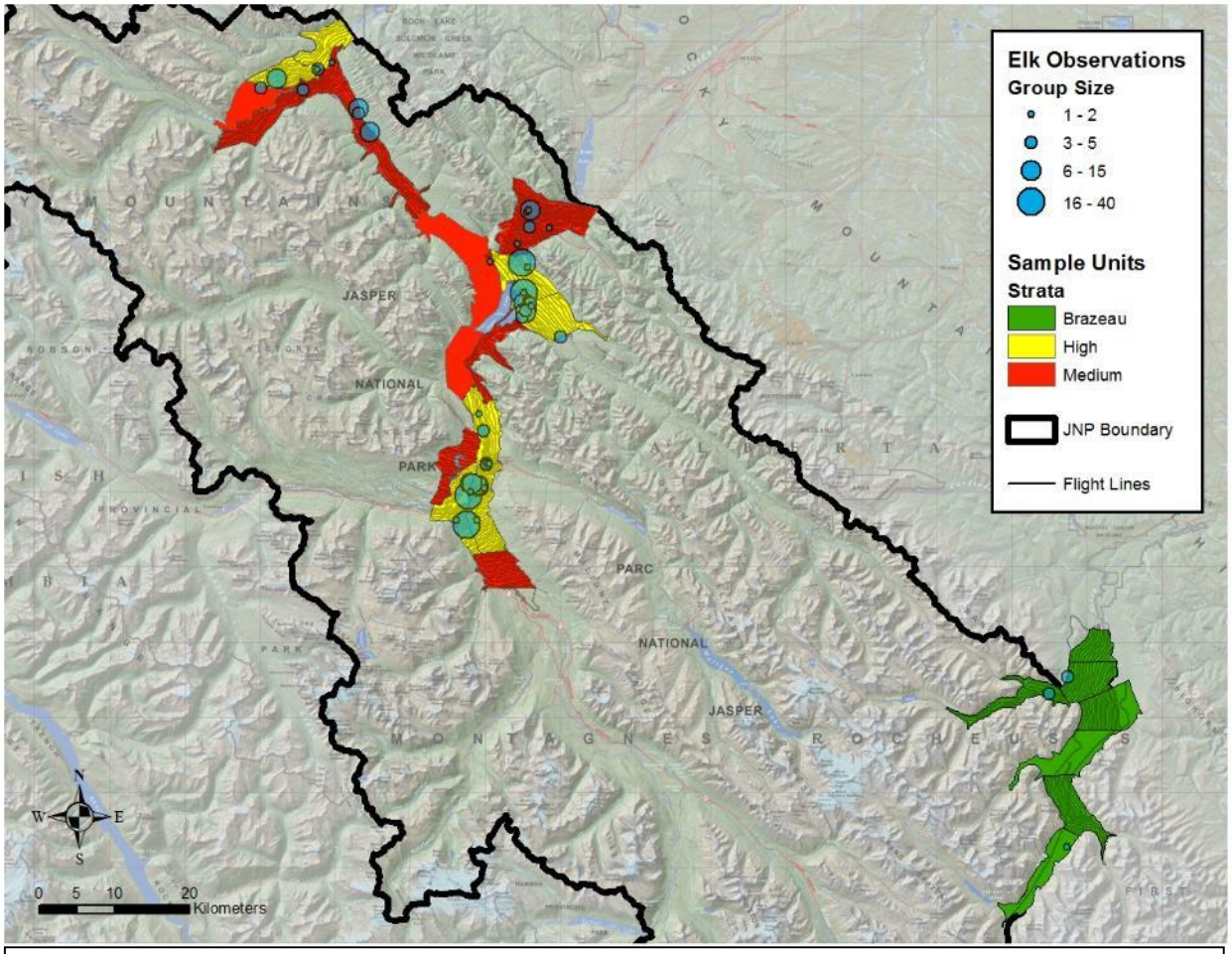

Figure 14. Elk observations and location of survey units flown in 2013 elk survey in Jasper National Park

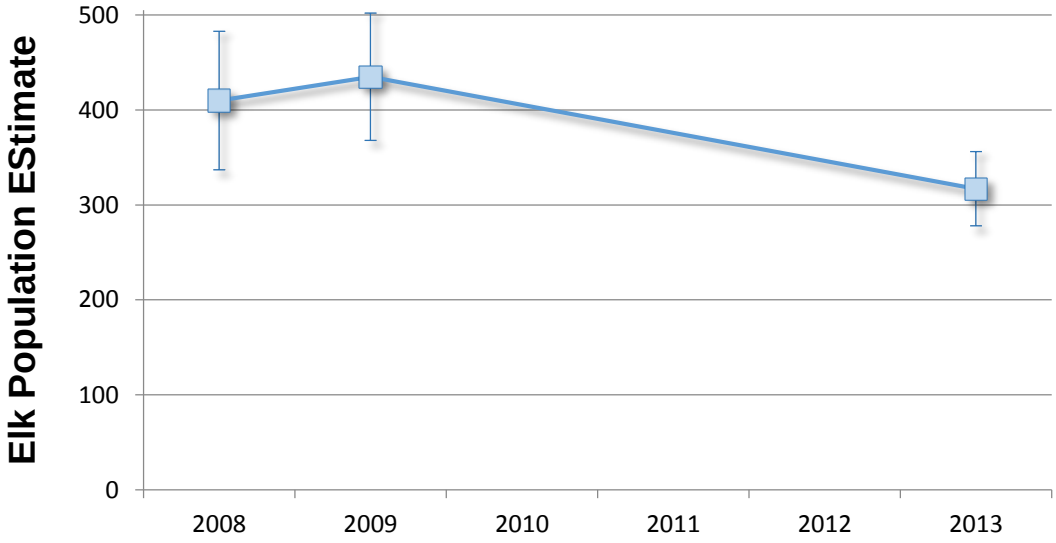

Figure 15. Elk population estimates in Jasper National Park derived from aerial surveys flown in 2008, 2009, and 2013.

5.2 Understanding and managing elk population decline in the Rockies National Parks

Colleen Arnison

In the Canadian Rocky Mountains, elk (*Cervus elaphus*) are an ubiquitous mega fauna esteemed for recreation, such as sport hunting and wildlife viewing opportunities, as well as for their conservation value. Since the introduction of elk in Jasper National Park, Alberta in 1920 populations have fluctuated over time due to predation, food availability and extreme climate events, as indicated by past studies. However, since the mid-1990s Parks Canada has observed a steady decrease in elk population numbers in Jasper without any explanation. This study examines the potential mechanisms explaining this steady decline and is applicable to managing and conserving elk in other areas where similar factors and variables might influence the species.

This study will determine how elk are affected by forest modification; determine the recourses that are critical to elk in Jasper National Park; and identify factors and variables that might influence the species' decline.

Jasper National Park implemented a FireSmart program to thin and prescribe burn forested areas adjacent to the town of Jasper to reduce the risk of wildfire losses to the town, restore ecological conditions, and enhance wildlife habitat. Vegetation monitoring plots were surveyed prior, immediately following and after forest modification treatments in both treatment and control sites in three stand types. This was used to study various ecological parameters, including stand density and structure, vegetation composition, and grass and forb biomass production, to understand the function of ecological processes inherent in these ecosystems. In the summer of 2012, 69 vegetation plots, 276 biomass plots and 69 transects were surveyed by a Master's student with the help of 2 volunteers and 12 Park's Canada summer students. Linear

regression models will be used to determine the vegetation response to FireSmart treatment and implications for ungulate forage and usage of the treatment areas.

Additionally, an elk summer and winter resource selection model (RSF) will be developed to understand the resources that are critical to elk. This will be done by incorporating elk telemetry data with existing biophysical data and using Akaike Information Criteria to construct generalized linear models. Spatial patterns of resource selection by elk have been shown to depend upon wolf predation risk, human activity, as well as other habitat characteristics. This approach allows for the disentanglement of top-down (predator and human driven) and bottom-up (food or resource-limited) processes and how elk distribution and resource selection are altered by the FireSmart program treatment areas.

The results of this project can be directly applied to manage and conserve elk populations in Jasper National Park and beyond its borders by unraveling the relative roles of different ecological forces in determining population change. If factors are identified that can be manipulated, such as with forest management programs like FireSmart, managers will have the ability for long term planning of desired population numbers such as causing a decline or growth in numbers overtime or concentrating the species in space.

This project has been presented at various conferences, including the 2013 Joint meeting of the Alberta Chapter and Canadian Section of The Wildlife Society (Canmore, Alberta), 2013 ConforWest conference (Kananaskis, Alberta) and the 2013 Western States and Provinces Deer and Elk Workshop (Missoula, Montana).

6. Delayed Winter Access to the Astoria Valley

Long-term caribou persistence depends on maintenance of low predation rates, and achieving adequately low rates necessitates that caribou live in relatively predator-free locations. In the winter, caribou are able to occupy areas of deeper snow than wolves because of their long legs and large feet, and by doing so reduce the likelihood of encountering predators. As winter progresses, freeze-thaw events and warming temperatures may provide stronger snow layers and wolves can travel more freely and are less restricted to low elevation regions. However, early-season wolf access to winter caribou habitat can be facilitated by the maintenance of packed snow trails and roads, particularly in cases where trails reach from valley-bottom to subalpine or alpine regions. Selection of trails and improved travel rates by wolves on packed snow trails has been demonstrated in studies throughout Canadian caribou range, including within Jasper National Park (Musiani et al. 2010). Once wolves have reached higher elevation areas they may intersect and travel on caribou tracks, or find improved wind- or sun-affected snow conditions that allow further incursion into caribou habitat.

Predation is the most common cause of death for Jasper caribou, and wolves are the significant predator. Recent declines of the Tonquin herd can be attributed to wolf predation. And while the Maligne and Brazeau herds haven't been affected by predation in recent years, this is only because their herd numbers are very small. Small herds can more easily avoid detection by predators, but if discovered, a large proportion could be killed. It is therefore important to reduce artificial wolf access to caribou habitat in all Jasper caribou populations, and by eliminating facilitated access through delays on human use of caribou habitat, unnatural wolf access is reduced. It is important to note that

although closing the road does not dissuade natural movements of wolves into alpine regions, it provides a more natural platform for predator-prey dynamics to unfold. We recognize that depending on snow conditions, some years will be better for wolves, while others better for caribou.

In 2009 we implemented delayed recreational access to the Astoria trailhead via Cavell Road, effectively eliminating human facilitated valley-bottom to alpine access to caribou habitat within the traditional range of the Sunwapta wolf pack. We were interested in learning how delaying human access on the road would change wolf use in the region. We established 2 study periods, one during delayed access (road closed) and one after the road was opened for human use. We monitored wolves' response to the closure via remote cameras and GPS collars. GPS collars allowed us to determine how fast wolves were travelling, and what types of relative habitats they selected. In 2009-2011 we also used GPS data to determine details (location, species, and habitat characteristics) of kill-sites within the Sunwapta and Cavell packs' ranges.

6.1 Wolf use of the Astoria Valley – Overview

Use of the Astoria valley by Sunwapta wolves, who've been monitored since 2006, has historically occurred throughout the winter (December to March). In March 2006, we deployed a GPS-collar on wolf 58, but although she was with 4 other wolves in the Sunwapta pack's territory, in Fall 2006 she left the pack and became a lone wolf. Wolf 58 made one trip up into the Astoria valley (to Cavell Lake) on January 22 2007. Also in January 2007, the Sunwapta Pack was re-located and 2 new wolves were collared (wolves 63 and 73). Wolf 63 made one trip into the Astoria in January 20-21 2007 (independent of 58). Wolf 81 was then GPS-collared in January 2008, and we ground-trapped and deployed a GPS collar on wolf 56 in August 2008. We had no Sunwapta wolves collared from September 2007-January 2008. Wolf 81 made a trip up the Astoria and out via the Eremite to Simon Creek in February (28th) 2008. Wolf 56 made several trips into the valley – November 2008, December 2008, January 2009, and March 2009. This was the last winter before delayed access was implemented. In 2009, there were 2 wolf packs in the Astoria region, but the Cavell pack was the main user of the Astoria valley. The Cavell pack was transient (see section 2.3) and as a result seemed to use marginal (i.e. alpine) areas more frequently than when the Sunwapta pack held this territory.

2009/10 Remote Camera Data Summary

One uncollared grey wolf was observed running by the camera and onto the road on the 9th of February 2009, but otherwise, we did not capture photos of any animals on the road prior to track-setting. There was a fair snowfall in early 2009, with about 30cm on the road by the end of December. After the Cavell road was track-set, we observed the Cavell pack passing in front of the camera 3 times: March 5th, March 7th, and March 16th 2010, after which they weren't photographed on the road again into April (the camera was removed 14 April). When photographed, they were always moving uphill along the road. We put up a camera on the Astoria River during the same time period, but it was lower elevation and probably not an important travel route to wolves – no wolves were seen using the river.

2009/10 GPS and Killsite Data Summary

GPS data showed the Cavell pack made two trips up the valley during the closure (i.e. road was not tracked). It is difficult to know if they used the road for part of their first trip (24th December), because the data aren't of good enough resolution, and the camera was not yet placed. On the 24th of December they appeared to move up the river, having crossed or walked on the road. Around the uppermost switchback they travelled on the road for several kilometres before moving down to the Astoria River where Cavell creek drains; here they killed a caribou. In January, the pack moved up-river to the Verdant creek junction, then turned around and descended the valley. They killed a deer on their way back to the main valley (at above the lower switchbacks and across the river).

Once the closure was lifted and tracks connected the Portal Creek and Astoria valleys, the wolves travelled farther afield. This may have also been a function of changing snow conditions at the time. The Cavell pack used the Portal trail on Feb 14th to access the Tonquin area beyond Maccarib Pass at which point they cut across to Meadow creek and travelled overland to Whistlers creek; here they killed a bull caribou. They didn't appear to make any ungulate kills while in the Tonquin valley. On March 1st, they came in via Portal crossed to the Astoria via Astoria Pass and then went out via Cavell meadows (some GPS data missing, so exact route is unknown). They made another foray into the Tonquin on March 5-6, again without killing an ungulate. They returned to the valley on the 16th, 22, 23, 26, 27, 29, and 30th of March, to the best of our knowledge without killing any additional caribou (though our formal study ended March 15). Regardless of success in killing caribou, this amount of wolf access represents a significant predation risk for Tonquin caribou.

2010/11 Remote Camera Data Summary

Wolves appear to be accustomed to using the Cavell road for early-season forays, and after the dissolution of the Cavell pack (who were still around in December 2010, but did not appear to use the road), the Sunwapta pack (4 wolves) recouped this territory. In December (19th) they used the road to travel up-valley and also return down-valley (31st). Once snow began to accumulate, we did not observe wolves again on camera until after the closure was lifted. On February 23, after recently returning to the north part of the range from the Chaba River, 5 wolves walked past the camera and into the Tonquin valley, they were observed again on the camera the 24th and 28th.

2010/11 GPS and Killsite Data Summary

In December (1-4th) 2010, wolf 120 travelled up the Astoria to past Verdant (via the river) and then over to Portal by passing over Lectern shoulder. They moved up toward Maccarib pass but turned around at approximately tree-line and descended to Marmot Basin ski hill. They then moved up the Whistlers creek trail and appear to have travelled over to Crescent creek via the Whistlers drainage. This is where our GPS collar in the pack (at this point a pack of 1) was recollared – she was eating a young caribou at the time of collaring – but the next collar failed to collect data. We know that wolf 120 left the Tonquin valley region after this, and was seen at Miette Lakes and Twintree.

In January, the Sunwapta wolves did not travel higher than the top of the lower switchbacks on the Cavell road. By February 23rd, when the wolves were first seen on the camera, they appeared to walk only partway up the valley (below Cavell lake, where they bedded for the night) before heading back down the road looping back across the river,

on the opposite slope and then back to the river trail (by 10pm on the 24th). From here and took a direct route along the trail to Verdant pass region, where they killed a caribou. They were at the kill-site within 2 hours of being at the Cavell creek/Astoria junction. They left the valley on the 28th via the trail. They did not return to the valley in March, until March 31/April 1, via the road and river trail, up to Cavell creek/Astoria.

2011/12 Remote Camera Data Summary

Wolves again used the road early-season to access the Cavell Meadows region; they were observed on the road November 1 2011 in only a few centimeters of snow.

2011/12 GPS and Killsite Data Summary

In late November 2011 the Sunwapta Pack used the road as part of 2 explorations into the Cavell Meadows region. The Sunwapta pack did not access the Astoria valley in December.

In January the Sunwapta pack moved uphill from the Whirlpool drainage (at Moab Lake, having travelled up the track-set road to get to Moab), through the Moab Lake burn and into the alpine of Cavell Meadows. They made a caribou kill in the lower Meadows, then descended to the Astoria river via the "switchback" creek, walked up-valley to Verdant, and then descended the valley via the river and the road (January 11th) - the used the river until the large switchback at which point they travelled down the road (cutting off to the SE before getting to the camera). The closure was violated in winter 2011/12, but it appears not beyond the location of the camera.

The Sunwapta moved back into the valley on 27 January, along the Astoria river (and likely along the road), and killed a caribou below Cavell Lake on the Astoria River (28 January 2012). The wolves continued up-valley, following the river/trail all the way to Chrome and Arrowhead lakes (2nd February), they killed another caribou (c101) between Amethyst and Chrome lakes on 2nd February 2012. They moved back to the Whirlpool drainage via the Eremite valley and Simon creek. This was an unusual amount of wolf-use of the Astoria valley compared to what had been observed previously. Three caribou kills occurred in winter 2011/12 and it is believed wolves followed caribou trails to access areas farther into the Tonquin valley. Once the delayed access was lifted, the Sunwapta pack did not travel back into the Astoria valley. There was a lot of snow in March 2012, possibly providing more protection to caribou that were not on the trail, and perhaps not offering wind-swept ridges for wolves to move along once they gained elevation into higher valleys. The Sunwapta pack spent the late winter at lower elevations and in the Chaba and Whirlpool drainages instead of in the Astoria.

2012/13 Remote Camera Data

In November 2012, 2 wolves of the Sunwapta Pack were observed travelling up the road following in a person's ski tracks (after the road closure was violated). The closure was once again violated in December and within days all 3 of the Sunwapta pack were observed travelling up the road, directly in human-made ski tracks.

2012/13 GPS Data

The Sunwapta wolves did not use the Cavell road to access the Astoria valley during the winter of 2012/13. They did, however, ascend the road a few kilometres on 4 December, and again on the 18 December up to Cavell Meadows, crossing through the Meadows and

down to the Whirlpool valley where they travelled back down the roads to the Athabasca valley. As noted above, the closure was violated 2 times in early winter 2012/13, once in November and again in December (18th), after which wolves were observed following the tracks both times.

6.2 Wolf use and selection of trails and roads: 2010 preliminary results

Wolves have been shown to travel more efficiently on packed trails than on unpacked trails (James 1999). When wolves are more efficient, they can cover more ground (travel more quickly) during hunting forays and have more opportunities to encounter prey. Additional studies have determined that, in addition to being more efficient, wolves choose to travel on packed trails over other alternatives during the winter (Whittington et al. 2005b). To understand more specifically how packed trails and roads affect wolf mobility in Jasper National Park relative to closure of the Cavell road, we examined two key questions: *1) Do wolves travel faster on packed roads/trails than other travel routes?; 2) Do wolves select to travel on packed roads/trails over other routes.* Analyses for the project up to 2013 are ongoing, but we report here on preliminary methods and results from 2010.

To address question 1, we used inter-fix distances to calculate wolf travel rates for each trip into 6 mountain valleys (Portal, Astoria, Whirlpool, Fryatt, Chaba, Athabasca). We contrasted travel rates on packed trails with travel rates on unpacked trails for the Cavell (winter 2009/10 only) and Sunwapta packs. We used generalized linear mixed models to identify the significance of packed trails/roads to explaining variation in wolf travel rates. We predicted that, consistent with previous work, wolves travel faster on packed trails, and that for the Cavell pack, travel into the Tonquin valley will be faster on the packed road (after the closure) than on the unpacked road (during the closure). Our results showed that 80% of the top travel rates (8 of the top 10) occurred when wolves were travelling on packed trails or ploughed roads. Wolves travelled significantly faster on packed trails/roads than unpacked alternatives ($p < 0.005$), but did not travel significantly faster on rivers or at lower elevations ($p > 0.05$).

To address question 2, we used wolf travel GPS data and generalized linear mixed models (logistic) to identify the influence of packed trails on wolf habitat selection by examining the relative influence of the packed trails/roads coefficient in habitat selection models. We used covariates from Robinson et al. (2010)'s wolf RSF model as the base of our habitat selection model. We predicted that wolves would select to travel on packed trails throughout the winter. In a second related analysis, we compared habitat selection covariates across the two seasons, and predicted that the coefficient for selection of the Cavell road would be larger after the road was packed (i.e a stronger selection coefficient for the Cavell road will be observed once the road became packed). Our results showed that wolves selected packed roads/trails significantly more than they were available ($p = 0.026$), and that wolves in the Cavell Pack were 1.6 times more likely to select the Cavell road for a travel route once it was packed compared to when it was unpacked.

In Jasper National Park, wolves select to travel on packed trails and roads, and while travelling on these features, they travel significantly faster (i.e. more efficient). Increasing wolf efficiency has the effect of providing wolves with easy access to caribou regions, and therefore increasing encounter rates. While wolf travel into caribou habitat does not necessarily directly result in mortality of caribou, artificially increasing the predation rate through increased encounters will likely have serious long-term consequences to caribou.

Whittington et al. (2011) concluded that wolf incursion into caribou habitat via anthropogenic linear features could be as important a factor as wolf density in its effects on caribou populations. These results led to recommendation that further expansion of delayed access to caribou habitat throughout caribou range in Jasper National Park. We recognize and regret that delaying recreational access will result in some loss of visitor experience but are encouraged by a recent survey of visitor opinion that demonstrated willingness to forgo some recreational opportunities in support of caribou conservation. Therefore, as of winter 2013/14, Parks Canada has implemented delayed recreational access to caribou habitat in the Tonquin, A la Peche, and Brazeau regions until February 14 (Tonquin) or February 28 (Brazeau and A la Peche). We are optimistic that this sacrifice by outdoor users will results in better conditions for caribou and support future recovery efforts.

7. Canadian Rockies Woodland Caribou Project

Previous collaboration with colleagues at the University of Montana on caribou work has resulted in a number of scientific publications. We direct readers to the following journal articles:

Bradley, M. and Neufeld, L. 2012. Climate and management interact to explain the decline of woodland caribou (*Rangifer tarandus caribou*) in Jasper National Park. Rangifer Special Issue 20: 183 - 192.

DeCesare, N. J., Hebblewhite, M., Bradley, M., Hervieux D., and Musiani, M. 2013. Linking habitat selection and predation risk to spatial variation in fitness. Journal of Animal Ecology Online early (open access).

DeCesare, N., Whittington, J., Hebblewhite, M., Robinson, H., Bradley, M., Neufeld, L., and Musiani, M. 2010. The role of translocation in recovery of woodland caribou populations. Conservation Biology **25**(2): 365-373.

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8. Consultations

7.1 Consultations

Conservation Strategy

Following the release of the *Conservation Strategy for Southern Mountain Caribou in Canada's National Parks*, an on-line comment form was available on the Parks Canada website. The public was invited to submit their feedback over a two month period.

Public

During the on-line public process, responses were received from approximately 150 individuals and organizations across Canada. The majority of respondents were supportive of caribou conservation and the proposed actions. The most prominent concern voiced centered on the potential use of predator control with many respondents being against any form of predator control. Parks Canada was urged to take action immediately to help caribou recover. A summary of the results is available at www.pc.gc.ca/caribou.

Aboriginal

The conservation strategy and background information were also sent to Aboriginal partners of the mountain national parks and consultations were held with the First Nations throughout 2012:

Aboriginal Engagement - Conservation Strategy for Southern Mountain Caribou in Canada's National Parks				
Aboriginal Group	Park Lead	Community Meeting Date/location	PCA Participants	Other participants (EC - Environment Canada)
Alexis Nakota Sioux Nation	JNP	18-Jul-12, Glenevis, AB	John Wilmshurst, Sherrill Meropoulis, Ken Walker	EC: Lucy Reiss
Aseniwuche Winewak Nation	JNP	Apr. 4, 2012 - Grande Cache	John Wilmshurst, Sherrill Meropoulis, Ken Walker	EC: Greg Wilson, Linnea Mowat, Lucy

				Reiss (by phone)
Bighorn Chiniki First Nation	BNP	04-Jun-12, Nordegg, AB	John Wilmshurst, Sherrill Meropoulis, Tracey Leblanc, Jenny Klafki	EC: Greg Wilson, Linnea Mowat
Confederacy of Treaty Six Nations	JNP	Apr. 23, 2012 - Edmonton, AB	John Wilmshurst, Sherrill Meropoulis, Ken Walker	EC: Greg Wilson, Linnea Mowat, Lucy Reiss (by phone)
Foothills Ojibway Society	JNP			
Kelly Lake Cree Nation	JNP	Apr. 27, 2012 - Kelly Lake, BC	John Wilmshurst, Sherrill Meropoulis, Ken Walker, Shelley Bird	EC: Greg Wilson, Linnea Mowat, Lucie Reiss
Ktunaxa Nation				
Métis Nation of Alberta				
Métis Nation of BC	MRG	04-Jul-13, conference call	Ian Brown, Sarah Boyle	
Nakcowinewak Nation	JNP	23-May-12, Hinton, AB	John Wilmshurst, Ken Walker, Sherrill Meropoulis	EC: Lucy Reiss
O'Chiese First Nation	JNP	26-Jul-12, Rocky Mountain House, AB	John Wilmshurst, Ken Walker	EC: Greg Wilson, Linnea Mowat
Okanagan Nation Alliance	MRG	06-Nov-12, West Kelowna, BC	Ian Brown, Tania Peters, Sarah Boyle	
Siksika Nation				

Sushwap Nation Tribal Council - Splatsin	MRG	14-Sep-12, Enderby, BC	Ian Brown, Tania Peters, Sarah Boyle, Kelsey Furk	EC: Lucy Reiss
Sucker Creek First Nation	JNP	May 8, 2012 - Enilda, AB	John Wilmshurst, Ken Walker, Mark Bradley	EC: Greg Wilson, Linnea Mowat
Sunchild First Nation				
Treaty 7 First Nations				
Treaty 8 First Nations of AB	JNP	Apr. 23, 2012 - Edmonton, AB	John Wilmshurst, Sherrill Meropoulis, Ken Walker	EC: Greg Wilson, Linnea Mowat, Lucy Reiss (by phone)

Generally what we heard:

There were varied responses from Aboriginal groups, reflecting the diversity of communities, their opinions, and their relationships with caribou. Common overarching themes were:

- The desire to do more than solely provide input; groups want to be directly involved, e.g. direct involvement in translocation of caribou and captive breeding initiatives, further involvement in the development of recovery documents.
- Many groups talking about how youth/Elders can be more involved, youth with getting jobs/experience, Elders with passing on their knowledge and seeing things first-hand. They want to know what's going on, maybe have some people (young and old) come to the park to see what's happening.
- Many groups were concerned about the level of human development taking place within their traditional territories, and felt that wildlife were being negatively affected. Some groups said they are struggling even within their own communities to find the balance – the Elders say to save the animals and don't worry about the money, but there are also pressures to find people jobs and not just live off the land.
- Most groups talked about the importance of protecting all wildlife saying things like 'we've told you all this before – just protect animals and the land, what are you waiting for?' 'Stop talking – do something!'
- A number of groups talked about all caribou being the same (big brothers and little brothers). It is scientists who like to divide things.
- Many groups expressed mistrust of government representatives and/or government itself. Some felt they were not being sincerely listened to. That we were there simply to

follow through with our commitment to talk, but not necessarily to listen and incorporate their suggestions into our plans.

- Some felt that we had already made up our minds about what to do. That we really had no intention of acting on any of their suggestions.
- The government needs to be sensitive to Aboriginal traditions and approaches to conservation; they want Aboriginal approaches be considered and combined with western/scientific modes of thought.
- Most groups felt they needed more time to think about the information and would get back to us with more specifics.

Specific comments on Parks Canada's proposed actions were:

- Regarding captive breeding: those who commented had mixed feelings. Some thought it was a good idea (it is a last resort, but do anything necessary to save the caribou), and others thought it was too unnatural, intrusive. Some felt it should be done closer to the home of the caribou. Others were tentatively supportive and could see the need for predator control once the young animals are released.
- Regarding maternity penning: those that specifically commented were supportive of the idea.
- Regarding predator management (in the future, if absolutely necessary): most that commented on this topic were supportive, but with some concerns around specifics.

Specific comments on Environment Canada/Canadian Wildlife Service's proposed process to develop a recovery strategy:

- All groups agreed that seeking to involve people early in the process is a good approach. There was mixed reaction to the idea of regional meetings. Some thought that might work; others would rather be involved on a community by community basis.
- Many groups specifically said they would like to see a plan that results in a harvestable surplus of caribou, so that Aboriginal and Treaty rights to hunt can be upheld.

Delayed Access Proposals for Important Winter Caribou Habitat in JNP

To meet key actions identified in the *Conservation Strategy for Southern Mountain Caribou in Canada's National Parks*, Parks Canada proposed adjustments to winter recreational access in areas of important caribou habitat in Jasper National Park (JNP). The proposals recommended delaying access to key caribou habitat in the A La Peche, Brazeau and Tonquin caribou ranges until after February 28th annually. The goal is to reduce the threat of *facilitated predator access*, one of five threats to caribou, recognizing that our success in reducing or eliminating all five threats will be essential for caribou recovery. While these proposals represent significant conservation gains for caribou, they would impact winter backcountry recreational use.

Parks Canada actively engaged the backcountry user community in two workshops held in Edmonton and Jasper in February 2013, to inventory winter recreational use in the park and identify potential areas for enhanced winter recreational opportunities. Input from these workshops and the subsequent public review period were used to draft options that modify the original proposals and consider new opportunities for winter recreation use. A summary of what was heard in these workshops is available at www.pc.gc.ca/caribou.

As part of on-going public engagement in this decision making process, representatives from Parks Canada (including the Park Superintendent) met with a group of stakeholders in a collaborative working session to reviewing the recommended options for both caribou conservation and enhanced winter recreational opportunities. The group was comprised of representatives from business, municipal government, the tourism industry (provincial and local), environment interest groups and outdoor recreational user groups.

Parks Canada assessed the proposals based on public input, conservation values and visitor experience attributes to determine actions to be implemented for winter 2013 - 14. The final decision for implementation combined with the review of potential alternate areas represents a balance between achieving caribou conservation gains and maintaining a variety of quality winter visitor experience opportunities.

9. Communications

Communication remains an important part of caribou conservation in Jasper National Park. Increased awareness and understanding of caribou conservation issues and actions helps build support for the program both regionally and nationally. Active engagement and opportunities for direct involvement also help foster lasting connections to the park. Over the last 5 years, there have been a wide variety of communications activities and products used to support Jasper National Park's Caribou Conservation Program. Communication strategies have been developed and implemented for a number of initiatives including an overall Mountain National Parks Public Engagement strategy and a strategy for the proposals to delay winter access into important caribou habitat in Jasper. Following the MOU with the Calgary Zoo and the Province of British Columbia, a draft communications strategy was also developed for the captive breeding program with input from all three partners.

Following is a summary of some of the key initiatives that have been implemented:

Public Outreach and Education Activities

Schools

Caribou awareness programs and activities have been offered to a variety of grades both in local schools and as part of Palisades Stewardship Education Centre programming. An interactive Powerpoint presentation was developed for use on SMART Boards, and has been presented annually for the Jasper Elementary School grade 3s along with outdoor games and hands on resources for their "Field School". *Species at Risk* and Woodland caribou in Jasper activities have been included in the Grade 10 Stewardship and Grade 7 Science programs at the Palisades. High school students were engaged in hands on learning for wolf kill site monitoring and caribou surveying in Jasper. Caribou presentations have also been included in the Jasper Youth Summit, and for other grades from local and regional schools as requested.

The Calgary Zoo added caribou as a case study for an on-site high school program. Jasper contributed content to the program as well as reviewing/editing the program.

Caribou content has also been included in presentations offered through the Marmot Learning Centre and through the Palisades Stewardship Education Centre's video conference programming.

Volunteers

In 2012, a Caribou Ambassador volunteer program was piloted and was successfully implemented in 2013. Volunteers participated in training sessions on Woodland caribou general biology and characteristics as well as conservation issues and actions in Jasper National Park. The volunteers then did outreach at key caribou habitat locations in the park including the Bald Hills and Cavell Meadows trailheads and the upper terminal of the Jasper Tramway, and helped with caribou outreach at special events.

Volunteers have also participated in some of the research projects associated with caribou conservation including the wolf and deer monitoring projects.

Urban Outreach

Since 2011, students have been hired to work as Parks Canada interpreters at the Calgary Zoo. Every year, Woodland caribou has been a priority topic for this urban outreach program. Jasper has participated directly by providing messaging and resources, developing, editing and evaluating caribou programs and presentations, providing staff training, and on-site visits for support, planning and evaluation. In 2013, the Calgary Zoo Urban Outreach initiative was awarded a CEO Award of Excellence.

Based on the Calgary Zoo model, urban outreach initiatives were started in Vancouver for the summer of 2013. Jasper provided caribou messaging and resources for outreach at the Vancouver Science Centre, and also reviewed and edited caribou program content for the program.

In 2012, an External Relations team from Jasper set up for a day of urban outreach at West Edmonton Mall. One of three topics, caribou awareness information and activities were presented to general mall visitors. The day was an excellent opportunity to connect with many young urban families.

Web and Social Media

Jasper National Park's caribou web content was updated, and new developments are posted on the site's *What's New* page. Two new pages were also created, a general Woodland caribou description page for the *Species at Risk* section of the Parks Canada website, and a page for the *Conservation Strategy for Southern Mountain Caribou in Canada's National Parks* highlighting public engagement processes, current research updates and conservation actions in the Mountain National Parks.

A 6 min video on caribou research in Jasper and the threats to Woodland caribou in the Mountain Parks was produced and posted on YouTube, as well as being featured on the Parks Canada caribou web page.

The Jasper National Park Facebook page and Twitter account were both launched on July 1st, 2012. Since then caribou content has been posted regularly including updates on survey results, remote camera images, and seasonal posts like rut, calving and Christmas (Jasper's reindeer).

Media

Caribou content is regularly featured in the local weekly paper, the Fitzhugh, and more recently a biweekly publication, the Jasper Local. Content has included Caribou population updates, wolf and deer research, information on public engagement activities and conservation action decisions.

Regional media has covered specific issues such as the release of the Conservation Strategy and signing of the MOU with the Calgary Zoo and Province of British Columbia, and the proposals to delay winter recreational access in areas of important winter caribou habitat. Proactive stories that included media trips into caribou habitat included a feature article in the Edmonton Journal, a story with CBC radio-Canada out of Edmonton in French that ran both locally and nationally, participation in the Nature of Things documentary "Billion dollar caribou", and a story with Global TV News out of Calgary.

Information Updates and Fact Sheets

Caribou spring and fall updates from the Mountain Parks are sent out to stakeholders and posted online. A number of additional updates and fact sheets have been produced to support announcements such as the release of the Caribou Conservation Strategy, signing of the woodland caribou conservation MOU with the Calgary Zoo and BC, and the decision to implement delayed access in areas of Jasper to support caribou conservation.

A *Species at Risk* brochure on woodland caribou was also produced and is used for presentations and events.

Stakeholder Engagement

Presentations are done annually for Parks Canada staff training sessions including the Information Centre staff, the Palisades Stewardship Education Centre staff and the Interpretation staff.

Caribou conservation presentations have also been delivered to the Interpretive Guides Association, the Friends of Jasper, the Aboriginal Forum, at the JNP Annual Planning Forum and as part of the "Wild Jasper" speaker series – a series aimed at keeping local residents informed of current research and actions in the park.

Visitor Experience Activities

Interpretive programs, activities and events

Two caribou events were hosted in Jasper with a focus on combining science, art and music to build awareness for caribou conservation. ("Caribou got the Blues" and "Caribou Fusion")

Caribou information and activities are included in special events throughout the year including the Jasper Wildlife Festival, the Enviro Fair, Jasper in January, and Parks Day.

Caribou information and activities have also been presented at Family Day events at Jasper Park Lodge, at the Community BBQ, and at regional hockey tournaments hosted in Jasper.

In cooperation with the Fire Communications Officer in Jasper, a life-size board game on caribou and fire in the mountain parks was created for use at events. Copies of the game have been made and used at the Calgary Zoo and in Banff National Park.

An interpretive theatre program was developed for use at the theatre in Whistlers Campground. In 2012, it was presented weekly along with a caribou themed Xplorers program earlier in the evening.

In park signs and information

New caribou interpretive signs were developed in 2009 and installed at Medicine Lake. Interpretive signs were also posted at trailheads into caribou habitat outlining the "no dogs" restriction.

A series of three pop up panels was created for use at presentations or events, one on key caribou characteristics, one on threats to woodland caribou, and one specific to Jasper. Another was also created for the Conservation Strategy and is often used as a backdrop in the Visitor Information Centre.

Caribou conservation information has also been incorporated into the Mountain guide and the trail guides for Jasper National Park.

11. Future Directions and Caribou Coordinating Committee

Southern Mountain caribou are an integral component of the fauna of the southern mountain national parks in which they presently occur, and the condition and trend of their populations are measures for the health of Jasper National Park's Native Biodiversity Indicator. 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, and likewise the fladry implementation has been discontinued because of results showing it was not effective.

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, was formulated with the participation of the public and Aboriginal groups and incorporated into the respective management plans during the 2009 review.

The committee consulted 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.

In November 2011 a Memorandum of Understanding was signed between the Calgary Zoo, Parks Canada, and the Province of British Columbia (with the Province of Alberta as a witness) to work together to develop a captive breeding program that would provide source animals for caribou translocations. Discussions are ongoing and partners remain committed to the concept, but long-term funding has not been secured. In the meantime we are working on a Conservation Agreement that will outlines details on the project's objectives, outcomes, governance, communications, and duration. Captive breeding of caribou for translocation requires 4 steps be planned and implemented: source animal capture; captive herd maintenance and husbandry; captive animal translocation to the wild; public and aboriginal engagement and communications. For each of these activities, a detailed protocol will be prepared by the team.

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