ANNUAL REPORT

Enhancing Calf Survival to Help Avert Extirpation of the Klinse-Za Caribou Herd

R.S. MCNAY[1], M. ERICKSON[1], AND L. GIGUERE[1]

MARCH 27, 2020

Prepared by:
[1]Wildlife Infometrics Inc., PO Box 308, Mackenzie, BC, V0J 2C0, wild_info@wildlifeinfometrics.com
Under agreement with the Nickanese Wah Tzee Stewardship Society, Project PEA-F20-W-2937

Prepared with financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders.

CITATION: McNay, R.S., M. Erickson, and L. Giguere. 2020. Enhancing calf survival to help avert extirpation of the Klinse-Za caribou herd: Annual report. Wildlife Infometrics Inc. Report No. 710. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

EXECUTIVE SUMMARY

The Klinse-Za caribou herd in northern British Columbia, part of the endangered Central Mountain population of caribou (*Rangifer tarandus caribou*), declined from 198 animals in 1995 to 16 animals in 2013. Due to unsustainable levels of predation, the herd was predicted to be extirpated by 2015. Consequently, removal of wolves in the area began in 2013 and maternity penning was implemented in 2014; both actions are seen as emergency measures to avert extirpation of the herd. The pen project in combination with wolf removal has helped to arrest the steep population decline and to create a positive population trajectory over the 6-year period from 2013-14 to 2019-2020.

Currently, we estimate that the population size of the combined Klinse-Za and Scott East caribou herd (hereafter referred to as the Klinse-Za/ScottE) has increased from 36 individuals in 2013 to 85 in 2020 (average $\lambda = 1.13$). Ten months following the calving season in 2020, we observed 11 calves (from 16 penned cows) and three calves (from 14 free-ranging cows) still alive and presumed to soon become successful recruits into the juvenile stage of the population. Despite apparent successes in observed population growth and recruited juveniles over multiple years, the increase in the female reproductive population, about 8 cows, has been limited due to mortalities from avalanches in two winters (2017-18, 2018-19) and significant predation (2019-20).

We recommend continuation of the maternity pen project based on the following: 1) implementation of the penning operation has been relatively successful over multiple years with no catastrophic pen-related events, 2) penned cows in 2019 produced a higher ratio of recruited calves per cow compared to free-ranging cows (0.69 compared to 0.21) coupled with the fact that we are still able to capture and pen 40-60% of the reproductive cows, 3) after accounting for mortalities that occurred during the year, penned animals contributed a net gain of ten animals while there was a net loss of four animals from the free-ranging population, 4) there is no evidence that the maternity pen operation has negatively influenced the health or behavior of the herd, and 5) we have been effectively meeting extension and reporting expectations. Assuming population vital rates continue as they have for the past six years, forecasted population growth demonstrates the maternity pen is likely to remain as an effective recovery measure in this herd area for at least another 3-4 years before calf production in the free-ranging population surpasses that of the penned population.

The Klinse-Za maternity pen project aligns with the Fish and Wildlife Compensation Program's Species of Interest Action Plan in that it addresses the outlined Species-based Actions. Specifically, the Action addressed is 1b-3 'Implement projects identified through approved recovery strategies, action plans, and management plans developed for woodland caribou'. We address that action by enhancing the population size of Klinse-Za caribou herd, which is a priority noted in the "Implementation Plan for the Ongoing Management of South Peace Northern Caribou (*Rangifer tarandus caribou* pop. 15) in British Columbia", specifically the section therein - 3.5.3 "Species and Population Management to increase the population of South Peace Northern Caribou across the current range, it is essential that species and population management occur in certain herd areas…. Species and population management activities will include improving knowledge of South Peace Northern Caribou population estimates and trends, improving knowledge of adult and calf survival, increasing adult and calf survival, and augmenting herds (e.g., maternal penning, transplants)".

ACKNOWLEDGEMENTS

We would like to acknowledge the support provided by the ~25 individuals (helicopter pilots, veterinarians, government biologists, First Nations Lands Office biologists, First Nations guardians, contract biologists) during the capture and transport of adult cows that occurs each March, from 2014 to present. This “team” performs the delicate job of handling each caribou in the most professional and humane manner possible. The 2019 “keepers of the caribou” or guardians, Ryan Desjarlais, Rocky Desjarlais, Cheyenne Mercer, Julian Napoleon, Jordan Garbitt, and Starr Gauthier should be especially congratulated and genuinely thanked for their continued support to this project and to the caribou. More than anyone else, the guardians personally make a difference to the recovery of caribou each day that they spend monitoring the cows and calves while they are penned. Their dedication to the caribou, and to the contribution that caribou make to their way of life, is something they demonstrate and care about strongly. Especially, we thank Chiefs Roland Willson (WMFN) and Ken Cameron (SFN) for their continued, unwavering support for recovery of caribou in their traditional territories. In addition, we also acknowledge the remarkable efforts of the Lands staff, Tamara Dokkie (WMFN) and Teena Demeulemeester (SFN).

Finally, this project could, of course, never have happened without the financial and in-kind support from a long list of sponsors; we thank each sponsor for their support and willingness to work with us to make the maternity pen project a success: Teck Coal, West Fraser Mills, Treaty 8 Tribal Association, Canadian Forest Products, BC Min. of For., Lands, and Nat. Res. Operations, Spectra Energy (now Enbridge), Anglo American Coal, Walter Energy (now Communa Coal), BC Hydro, Yellowstone to Yukon, Habitat Conservation Trust Foundation (FCTF), Environment and Climate Change Canada, TransCanada, and Public and Private Workers of Canada. This Project is also funded in part by the Fish and Wildlife Compensation Program (FWCP). The FWCP is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations and public stakeholders formed to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams. We also acknowledge and send thanks for the funding assistance provided by the BC Oil and Gas Research and Innovation Society (BC OGRIS) and the BC Boreal Caribou Research Effectiveness Monitoring Board (REMB).



TABLE OF CONTENTS

EXECUTIVE SUMMARY i
ACKNOWLEDGEMENTS ii
LIST OF FIGURES iv
LIST OF TABLES iv
INTRODUCTION 1
GOALS AND OBJECTIVES 2
STUDY AREA 2
METHODS 4
Protection of caribou cows and calves 4
Planning 4
Preparation 4
Implementation 5
Effectiveness Monitoring 6
Implementation 6
Arresting population decline 6
Health and behavior indicators 8
Extension and Reporting 8
RESULTS 8
Implementation 8
Modelling herd contributions of maternal penning 9
Arresting population decline 10
Extension and Reporting 13
DISCUSSION 14
CONCLUDING THOUGHTS 15
RECOMMENDATIONS 16
LITERATURE CITED 17
APPENDIX A. COMMERCIAL CARIBOU PELLET INGREDIENTS 20
APPENDIX B. MATERNITY PEN DAILY MONITORING REPORT 21
APPENDIX D. DATES FOR INTERNAL EXTENSION ACTIVITIES 23
APPENDIX E. BROCHURE PROVIDED TO PUBLIC AT PEN 24

LIST OF FIGURES

Figure 1. Location of the Klinse-Za/ScottE caribou herd range and two maternity pens in northern British Columbia. 3

Figure 2. Observations of caribou groups in the Klinse-Za/ScottE caribou herd in northern British Columbia, March 2020. Yellow Caribou group sightings align with observations (Obs_no) presented in Table 2. 12

Figure 3. Population trends for Klinse-Za (orange), ScottE (blue), or combined (purple) caribou herds, British Columbia. Dotted lines depict no data (orange/blue) or estimates (purple; assuming $\lambda = 1.14$). 13

LIST OF TABLES

Table 1. Parameters used to evaluate effectiveness of a maternity pen to protect caribou cows and their calves from March to July, Klinse-Za caribou herd area, northern British Columbia, 2019-20. 11

Table 2. Observations of caribou, group numbers, and sex/age class in the Klinse-Za/ScottE caribou herd in northern British Columbia, March 2020. Observations (Obs) align with those in Figure 2. 11

INTRODUCTION

The Klinse-Za caribou (*Rangifer tarandus caribou*) in northern British Columbia (BC) are part of the Southern Mountain population of caribou, which is listed as Threatened under Schedule 1 of the federal *Species at Risk Act* (Environment Canada 2014). Prior to the recent implementation of population management measures within the herd area[1], the Klinse-Za herd had undergone a significant long-term population decline, was threatened by unsustainable levels of predation (Seip and Jones 2015) and was considered unlikely to persist without immediate population management. The population in 2013 consisted of 16 caribou (Seip and Jones 2015), down from 25 in 2012 (Seip and Jones 2012), 35 in 2011 (Seip and Jones 2011), and 191 in 1997 (TERA 1997); a 16-year lambda of 0.86. The number of calves available for recruitment to breeding age was ≥15% of the population in the early 2000's but was usually <10% after that time and was only 5.7% in 2011, indicating calf recruitment was insufficient to contribute to a stable or growing population (Seip and Jones 2015). Within historic times, caribou in the area were apparently much more plentiful. Spalding (2000) summarized a few recorded observations of caribou and of caribou killed in the Moberly area in the late 1800s and early 1900s and suggested that caribou were plentiful around Moberly Lake and in the area west of Moberly Lake. West Moberly First Nations Elders spoke of a "sea of caribou" and also referred to them as "bugs" on the landscape (WMFN 2009). No other recorded observations were available for the area until 1981 when the first population surveys by the provincial government were conducted (Cichowski et al. 2012).

Despite the population management measures described here, the current population size in March 2020 is still below the minimum viable size of 120 (NCTAC 2004), below population objectives recommended in an implementation plan for the ongoing management of caribou in the area (Aitkens 2013), and below the population goal established as part of a Recovery Action Plan for the Klinse-Za herd (McNay et al. 2013). An unsustainable level of predation in the area, primarily by wolves (*Canis lupus*) (Seip and Jones 2015), is presumably an outcome of extensive habitat conversion to early seral plant communities that support a higher biomass of the primary prey species of wolves and hence, more wolves. Additionally, the road infrastructure associated with industrial activities can apparently lead to increased encounter rates between predators and caribou (Mumma et al. 2017) by allowing wolves to travel (and presumably, hunt) farther and faster than they would otherwise (Dickie et al. 2016). Although the proximate cause of population decline for southern mountain caribou populations is now widely accepted to be by predation, Johnson et al. (2015) demonstrated that it is industrial disturbance to caribou habitat that has, ultimately, led to unsustainable population demographics in these populations.

The additive population growth from maternity penning is consistent with a precautionary approach to caribou population recovery in which the simultaneous use of multiple recovery actions is more likely to be successful than using any single action (Serrouya et al. 2019). Achieving higher rates of growth than otherwise aligns well with the First Nations goal to re-engage in a meaningful harvest of caribou as soon in the future as it is feasible to do so.

The project is conducted under a BC Wildlife Act permit granting authority to the Nikanese Wah tzee Stewardship Society to capture and hold caribou in a maternity pen and to protect penned caribou against predators (Permit FJ18-421458; valid 2019-2024), and conduct effectiveness monitoring surveys (Permit FJ19-568256; valid 2019-2024). A Lands Act, Special Use Permit

[1] Removal of wolves began in 2013 and maternity penning began in 2014.

(SUP S26316) was granted to Wildlife Infometrics Inc., in 2017, for construction of the maternity pen protection facility on public land.

GOALS AND OBJECTIVES

Most primary objectives in 2019-20 were the same as previous years of operating the maternity pen; which were to: 1) reduce mortality of pregnant cows and their new born calves through the calving period with the intended outcome of reversing the historical decline in the size of the herd (McNay and Sittler 2013), 2) conduct effectiveness monitoring, and 3) provide extension and reporting about the project. In addition, in the winter of 2017-18, we selected a new site and constructed a second maternity pen on Mt. Rochfort, allowing the original Bickford pen site to go dormant and proactively avoid pathogens or disease that may have potentially built up after four years using the original pen site. The size of the second pen was purposefully increased to allow for the potential protection of a greater number of animals (~20) and thus offset the expected diminishing returns from the pen as the population size increases (see *Implementation* below). Finally, the location of the second pen was chosen, in part at least, to test the notion that maternity pens can support reintroduction of caribou to currently unoccupied portions of their historic range (see *Results* below).

A condition of funding was that we use whatever means to address a question about when the operational use of a maternity pen in the Klinse-Za herd would become inefficient or ineffective. The condition was raised because, in theory at least, a maternity pen is operationally constrained in terms of what proportion of the herd's cows (and their calves) can be protected. As the herd grows in size, the effect of the maternity pen in returning healthy calves to the population is expected to decline because the free-ranging population will produce more calves than the pen.

STUDY AREA

The original maternity pen, in operation 2014-2017, was situated on Mt. Bickford, about 11 km north of Highway 97, along a resource road, 50 km west of Chetwynd, in northern BC (Figure 1). The pen was located at ~1200 m asl in a natural subalpine meadow that was historically used by caribou during the calving period (Jones et al. 2004). This maternity pen was removed in the spring of 2018 and efforts to completely restore damaged vegetation from intensive herbivory are ongoing.

The currently active maternity pen site is located on Mt. Rochfort at ~1580 m asl in a natural sub-alpine forest/meadow complex that was also historically used by caribou (Dubman et al. 2018). This site is 60 km west of Hudson's Hope, and ~71 km up the Johnson resource road (Figure 1). After the first year of maternity penning, when we captured and penned five cows from each of the Klinse-Za and Scott East herd areas, animals' use of the two herd areas has become less distinct than prior to the maternity pen project. We therefore now consider the project to address recovery of caribou in both herd areas, so henceforth we refer to caribou in the Klinse-Za/ScottE herd. The Klinze-Za/ScottE herd area is approximately 3291 km^2 and is located in the Rocky Mountains of northern BC. The herd area is bounded in the north by the Peace Arm of the Williston Reservoir, in the south by Highway 97, to the east by lowland agricultural areas around Moberly Lake, and to the west by the Williston Reservoir (Figure 1).

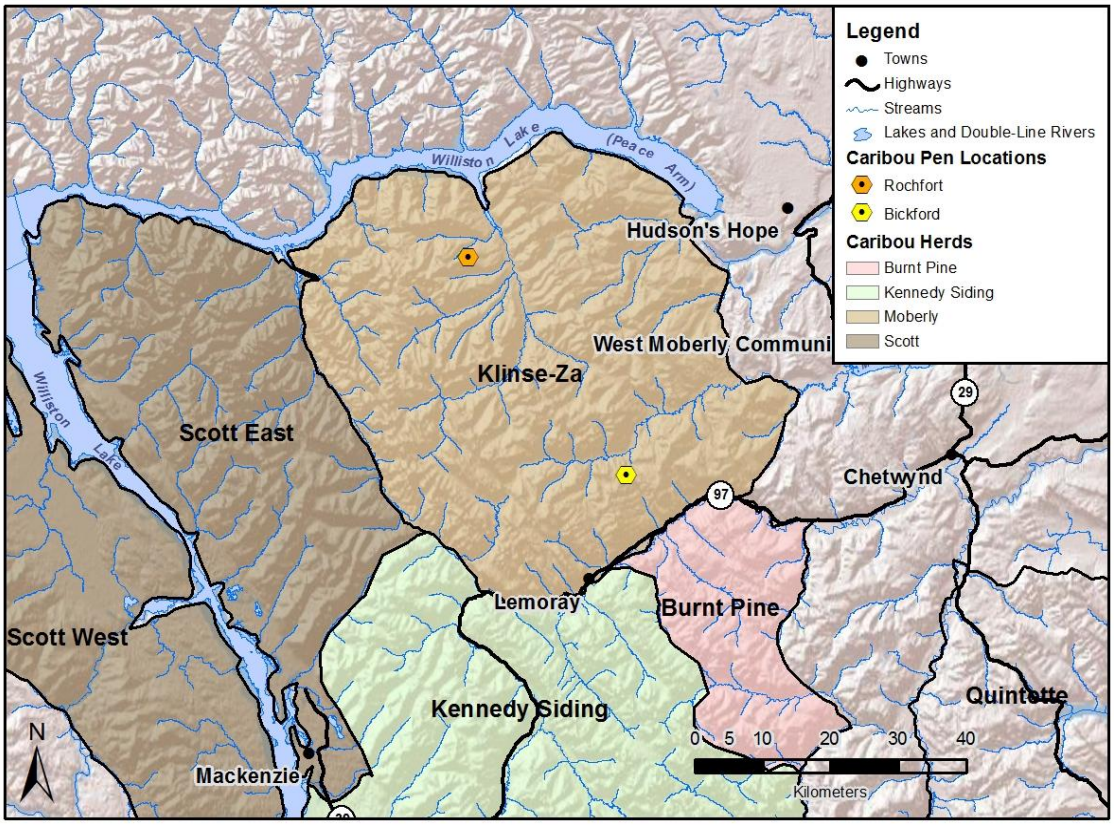

Figure 1. Location of the Klinse-Za/ScottE caribou herd range and two maternity pens in northern British Columbia.

The herd area is characterized by mountains and rolling hills, forest cover of lodgepole pine (*Pinus contorta*) and hybrid white-spruce (*Picea glauca x engelmannii*) at lower elevations, and

subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) forest at higher elevations. Alpine summits occur from 1400 m to 2090 m. Four biogeoclimatic zones (Meidinger and Pojar 1991) occur within the herd area: Sub-Boreal Spruce (SBS), Boreal White and Black Spruce (BWBS), Engelmann Spruce-Subalpine Fir (ESSF), and Alpine Tundra (AT). Predators of caribou in the area include gray wolf, black bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), wolverine (*Gulo gulo*) and potentially lynx (*Lynx canadensis*) and cougar (*Puma concolor*), although cougar occur in the study area and may prey on caribou, only rarely. Moose (*Alces alces*), elk (*Cervus canadensis*), mountain goat (*Oreamnos americanus*), and deer (*Odocoileus spp*.) also occur in the area, particularly in the eastern portions of the historic range of caribou where the landscape tends to be less mountainous and more altered by sources of anthropogenic disturbance. The percentages of industrial-based disturbance in caribou range in the region is relatively high, affecting 89% and 34% of low-elevation range and the entire herd area, respectively[2]. Conversion of habitat within the Klinse-Za/ScottE caribou range is caused by forestry, wind power generation, mining, hydro-electric power generation, oil and gas pipelines, roads, and other infrastructure/facilities.

[2] Disturbance was calculated as the area covered by a 250-m buffer around the footprint of all anthropogenic features (WMFN 2014).

METHODS

Protection of caribou cows and calves

Planning

In situ penning to protect caribou from predators had not occurred in BC prior to this project. Another maternity pen established near Revelstoke, BC was first implemented about the same time (Serrouya et al. 2015). Two other trials of a similar nature were implemented elsewhere; in the Chisana caribou herd in Yukon (Farnell 2009, Adams et al. 2019) and in the Little Smokey herd in Alberta (Smith and Pittaway 2011). Our planning for the Klinse-Za maternity pen drew extensively on those two projects and on the experience of the biologists who implemented them. Although our team has extensive experience in handling caribou, we acknowledged a lack of experience or knowledge about holding animals captive in a pen for long periods of time. For this reason we assembled a team of experienced professionals to help guide the project. This team was composed of members of other pen trials, local and provincial-level veterinarians, nutrition specialists, a member each from the two First Nations communities, and selected staff of the BC provincial government. Our experience from four years of operation at the Bickford maternity pen led to a more efficient and higher quality pen being constructed at the new Rochford site (Erickson and McNay 2018).

Preparation

Two collections of terrestrial forage lichens (*Cladina* sp., *Cladonia* sp., *Stereocaulon* sp., *Cetraria* sp.) are made each year, usually occurring in June and September. Two collections allow for fresher lichen to be available after the ground thaws, thus reducing the chance of quality deterioration. In the Chisana and Little Smokey trials, lichens were collected and fed to penned caribou on a schedule that allowed for a slow change in diet away from natural forage to a commercial pelleted ration (see Appendix A for pellet composition). The amount of terrestrial forage lichens was then increased back to 100% of the penned caribou diet prior to releasing the animals from the pen. Details of the collection and storage techniques undertaken for the first year of collections were provided by Robin et al. (2013). The lichen collection task is now primarily collected by West Moberly and Saulteau First Nations schools using the same or similar methods as described by Robin et al. (2013).

Selection of each penning site, our second step in preparation, was crucial because we expected caribou to become semi-habituated to the pen and/or the pelleted ration they received while penned (Smith and Pittaway 2011). If animals were to return to the maternity pen site after release, they could place themselves at a higher risk of predation, depending on the pen location. We selected the Mt. Rochfort site primarily because (Dubman et al. 2018): 1) it occurs within the natural, historically used calving range of the Klinse-Za herd (Jones et al. 2004, Jones et al. 2007); 2) it is within a 10 min helicopter flight from the currently used calving range; 3) it is reasonably accessible for project staff/members (i.e. 8 km by snowmobile along an unplowed road, 81km along resource use road); 4) there is an abundance of fresh water on site, and 4) the site's proximity to alpine habitat (~200m) made it logistically easier to conduct a soft release of caribou calf-cow pairs in spring (Seip 1992).

At both pens, we followed a design and construction method similar to that used at the Little Smokey project (Smith and Pittaway 2011). At the Rochfort pen, we also drew upon experience

gained through the construction, operation, and disassembly of the Bickford pen. The 15 ha pen at Mt. Rochfort consists of a fence made of geotextile fabric, attached to three (or more) strands of wire rope; a top wire hung at 2-3 m above the snowpack and tightened around trees, a middle supporting wire, and a third wire positioned as close to the ground as possible. The geotextile fence is fortified by a 2-m high, 8-strand electric fence placed approximately 0.5m away and along the exterior perimeter of the geotextile. A second electric fence 2-m high, 8 strands is placed ~3-m away from the other fence to establish multiple electric barriers to predators. More specific details on construction of the Rochfort pen site are presented in Erickson and McNay (2018).

Implementation

We used a stage-based population demographic model (Sutherland et al. 2015) to explore the potential population growth outcomes based on interactions between initial population size and the number of pregnant cows penned. The model results demonstrated maternity pens with <20 cows would be unlikely to make a material difference in demographics of caribou herds with >120 animals; the ratio of surviving penned calves to surviving free-ranging calves would be small (i.e., probably <0.5). Alternatively, penning at least half the cows in relatively small herds (e.g., <50) is more likely to substantially augment the overall calf recruitment (Sutherland et al. 2015). Based on our initial population size of only 16 Klinse-Za animals in 2013, we set a goal to capture 10 cows for the 2014 maternity pen but half the captures were to come from the adjacent Scott East herd area. We intended at the time to increase this goal annually up to a maximum of 15-20 animals once the herd was larger. The active maternity pen was built to accommodate 20 animals annually and that was our goal in 2019-20.

To address the question about the efficiency or effectiveness of maternity penning, we used the same population model (Sutherland et al. 2016) with population pools for penned versus free-ranging animals. The model was parameterized with average vital rates observed during the past six years of penning (e.g., adult survival, calf recruitment, etc.). We held the number of penned calves constant at 15 and assumed wolf removal would reduce wolves to <3/1000 km^2. We then ran the model for a hypothetical 13-year period with three initial population sizes: n = 35 (the number of animals in the combined herds when we first began penning), n = 85 (the size of the herd now), and n = 135 and measured average Lambda across the three scenarios as an indicator of population viability.

We conduct cow captures, collaring, and transport to the pen each year in mid-March using experienced crews and Resource Information Standards Committee (RISC) protocols. The operation is under veterinarian supervision and monitoring is conducted by First Nations. Details on capture and translocation methods and other operational protocols are provided in Sittler et al. (2019). We collar cows with a GPS-enabled Iridium Satellite transmitter also capable of emitting a Very High Frequency (VHF) signal (model Survey-2D Iridium Collar; Vectronic aerospace GmbH, Germany). In 2019-2020, we also deployed six other GPS-enabled collars which also have video capability (Lotek LiteTrack with small Insight camera attachment). We capture calves about 2-3 days after birth and fit them with an expandable, rot-away collar (model M4200, Advanced Telemetry Systems, Isanti, MN) equipped with a VHF transmitter. Collars used for adults and calves meet animal care guidelines for weight restrictions. The average lifetime of GPS collars used on caribou cows is four years, with a fix rate of four per day, and a transmission frequency of once per day. Calf collars have an average lifetime of two years; after this time the neck has generally grown sufficiently to break all of the expandable threads. Battery life is around 4-5 years for these small VHF collars.

Guardians monitor penned caribou 24 hrs/day, seven days a week (alternating crews, eight days on and six days off, with a day of crew overlap), from the time of initial capture (i.e., mid-March) to release of cows and calves (mid- to late-July). The two Guardian crews are composed of two First Nations each. The Guardians are supported by professional biologists and veterinarians that are on call to address any issues that may arise with the pen itself or the penned caribou. Guardian responsibilities during monitoring are to: 1) feed caribou twice daily, 2) visually assess the penned caribou for signs of nutritional or behavioral distress, 3) identify when cows start calving, 4) look for structural compromises to the pen, 5) search for signs of predators, 6) take any corrective actions that may be necessary regarding any observations made, and 7) log all observations and/or corrective actions daily (Appendix B). As part of the monitoring protocol, the pen crews record the amount of feed (lichen and commercial pellets) provided to caribou, and note the quantity of feed left over after each feeding. If no food is left, the ration provided is increased.

We release penned cows and calves from the pen each year with a 'soft' release. In the days leading up to the release, Guardians adjust the cows' feed to include more lichen and less commercial feed every day. The Guardians gradually move one of the feeding troughs towards the section of the pen wall chosen as the release point. On the date of release (which in 2019 occurred on July 30th), the pen crew opens a 20-m section of the geotextile fabric at the release point and the cows and calves are left to leave the pen on their own.

Effectiveness Monitoring

We use effectiveness monitoring to measure success of: project implementation, the operation as a population recovery measure, and our extension efforts.

Implementation

We assess implementation effectiveness based on the following measures and targets:

- sufficient amounts of forage lichen are in storage to initiate feeding immediately after capture;
- cow mortality as a direct result of capture, transport, or operation of the pen is minimized and all mortalities are discussed with the provincial veterinarian to ensure the highest level of animal care;
- percent of the adult cow population protected by the pen is >30%;
- no major breach in the integrity of the maternity pen structure while in operation;
- no predators gain access to the inside of the maternity pen in operation;
- successful removal of predators that threaten to compromise the integrity of the pen;
- release of penned caribou is conducted without incident; and
- recording of daily observations at the pen is consistently completed by the Guardians (Appendix B).

Arresting population decline

Each year we collar additional free-ranging animals in December/January, with our goal of ensuring there is at least one collared cow in each group of caribou; however, due to the increasing size of the Klinse-Za/Scott E herd, we are progressively less confident we'll be able to collar all free-ranging groups in the future, which is necessary for conducting a total count to

obtain minimum population size – the most basic parameter for assessing our ability to arrest population decline. We therefore tested a different survey approach in March 2020 to estimate the population size (N) using a standard mark-resight model based on the Lincoln-Peterson estimator as follows (McClintock and White 2009):

$$N = m_1 n_2 / m_2 ,$$

where m_1 is the number of collared caribou in the surveyed population, n_2 is the total number of caribou seen including those collared, and m_2 is the number of collared caribou seen without the aid of telemetry. Prior to flying the mark-resight survey, the navigator was responsible for ensuring that >90% of collared animals in the search area were using high-elevation habitat, as sightability would differ greatly between high and low elevation habitat. However, most (75%) of the collared animals in the eastern portion of the range, west of the Clearwater valley, were using habitat below the alpine; therefore, we decided to located those animals with telemetry and did not attempt a mark-resight survey in that portion of the range. Total herd size was the sum of the minimum count (western portion) and the mark-resight estimate (east of the Clearwater valley). By estimating the population using the mark-resight method, and comparing that estimate to our minimum count, we also hoped to determine the collaring effort necessary to ensure precise population estimates in the future.

We acknowledge that population demographics (i.e., population size, population growth rate, adult survival rates, and calf recruitment) estimated from monitoring data is confounded by other simultaneous recovery efforts, such as predator removal. For that reason, we take precaution to stratify demographic observations between radio-collared animals that are taken to the pen, and ones that are not (i.e., free-ranging). We infer demographic parameters for penned caribou from the daily monitoring records taken during the penning period. We also complete five aerial surveys in May, June, and July to assess reproductive status of free-ranging animals. After penned animals are released, we monitor both the previously penned and free-ranging caribou with two aerial surveys conducted in November[3] and the population survey in late February or early March.

We posed the following expectations (or predictions) on which to assess effectiveness of arresting population decline:

- Pregnancy and parturition rates– penned cows should have pregnancy and parturition rates that are not lower than the rates observed for the free-ranging population. Pregnancy was assumed if blood progesterone levels ≥ 1.5 ng/ml. Blood samples were taken as part of the regular health sampling during capture (Sittler et al. 2017). Parturition was assessed daily in the pen during calving. Estimates of parturition rates from free-ranging caribou were assumed to be similar to the rates observed during a study of three reference populations west of the Klinse-Za herd in the Omineca Region of BC (McNay and Giguere 2007).
- Cow and calf survival– Penned cows and their calves should survive better than cows and calves in the free-ranging population. This was measured as number of radio-collared cows (free-ranging and penned) surviving annually and calves/100 cows surviving at three milestone dates: the first of July, end of October or first of November, and in mid-March (i.e. still in their first year).
- Population growth– lambda (i.e., instantaneous population growth rate; $\lambda = (N_{2019\text{-}20}/N_{2013\text{-}14})^{(1/6_{years})}$) should be positive and the number of cows assumed to be reproductive (i.e., ≥34 months old in the March survey) should be increasing. Because

[3] In November, weather conditions and animal locations do not always allow for an accurate survey to be conducted.

we are unable to distinguish 2.8-year-old cows from juvenile cows (i.e., 1.8 year olds) in March, we assumed all non-calf females to be of reproductive status.

Health and behavior indicators

We considered that it is possible that maternity penning could effectively arrest population decline but, at the same time, still put the herd at greater risk of catastrophic failure. Examples of how failure could occur are: i) catastrophic events inside the pen (e.g., a single but large-scale predation event, build up and/or transmission of disease), ii) a modification of behavior that leads to excessive mortality either inside the pen or after release, and/or iii) reduced nutritional status of penned animals due to feeding methods that may lead to more chronic, rather than acute, causes of mortality. As a result of these considerations, we implemented a deeper study of the potential for maternity penning to have subtle but significant, effects on: 1) the health, and 2) behavior of the Klinse-Za caribou. Effects of maternity penning on health and behavior of the penned animals will be reported in association with independent and separate funding programs for those study components.

Extension and Reporting

We pursued a variety of extension and reporting outlets to make sure that a broad audience was well informed about the maternity pen project, including the following: regular internal and external meetings and presentations, digital and other media updates (web pages, Facebook, newspaper articles), engagement with schools, technical and annual reports, information for FWCP extension, and informal periodic newsletters. For specifics, see 'Extension and Reporting' in Results, below. We tracked all costs for the project, assigned each cost to a project phase, reconciled cost against revenue, and reported results in a separate financial report. We assessed effectiveness of extension by:

- Opposition to the maternity pen– opposition was measured by the number of negative media events recorded from national, regional, or local sources (e.g., newspapers, periodical publications, television, and social media such as web pages, Facebook, twitter, or personal blogs).
- Opportunities to present maternity pen results– opportunities were counted as the number of outputs used to relay results of the pen to all audiences.

RESULTS

Implementation

Terrestrial forage lichens were collected in the fall of 2018 (n = 150 bags) for storage in advance of the 2019-20 pen operation, again in the spring of 2018 (n = 300 bags) to supplement feeding prior to release of the penned animals, and again in September 2019 (n = 300 bags) for storage in advance of the 2020-21 pen operation.

We did not reach our desired goal for the number of penned cows (n = 20) but still managed to pen 48% of the adult cow population (n = 16 cows, 1 yearling), the highest number in project history. We successfully conducted the captures during one event in March with no mortalities and no apparent adverse effects on the health of captured animals. Twelve of the 16 cows had previous pen experience (four being calves born in the pen, first time as adults in the pen); three

of which have been penned in three previous years, three of which have been penned in two previous years, and two that have been in the pen only once before. We were unsuccessful at capturing more cows because some collared groups were using forested habitats and could not be safely moved to more open areas for capture.

No predators gained access to the pen and the pen structure itself was not compromised in any way during the pen operation in 2019. Throughout the penning season, Guardians observed predators and/or predator sign around the pen, and on the access road up to the pen, by both remote cameras and visual sightings. The main predator species consistently observed around the maternity pen were grizzly bears: several different individuals were observed throughout the year. In total, there were three black bears, and one grizzly bear shot. This was the first year there was a feeding related issue; one of the cows (a former calf, born inside the pen) died of a choking accident eight days after capture. In order to reduce any chance of this occurring in the future, we have added blocks of wood in the feed troughs and added additional feedings of reduced quantity, to reduce the rate of feed intake. Since that incident, there have been no more choking related issues. As far as we could tell, there were no other significant observations of feeding-related issues inside the pen (e.g., aggression at the feeding troughs) or other types of negative behavioral incidents.

On July 30th, 2019, we released all thirteen calves that were born in the pen as well as the one juvenile and the 16 cows. At release, one calf was 11 weeks old, seven calves were 10 weeks old, 2 calves were 9 weeks old, and one calf was eight weeks old

All daily observation sheets for the penning period (n = 142 days) were properly completed and filed, with the exception of a few days in late June. An example of a completed sheet is presented in Appendix B. There were occasional unplanned visits made by members of the public to the Mt. Rochfort site during penning, but all visitors were informed of the need for minimal disturbance to the penned caribou, and most of them congenially agreed to leave the site. Informational brochures were available for the shepherds to provide to any unplanned visitors (see Appendix E). Considerably fewer visitors were seen at the Mt. Rochfort site, compared to the Mt. Bickford site; largely due to the more difficult access to the pen.

Modelling herd contributions of maternal penning

Results of the population model were less helpful than we anticipated. Lambda when the initial population was 35 was ~ 1.13, the same rate of population growth as we have measured over the past six years. Lambda declined to 1.05 when the initial population size was 135 which demonstrates the gradual swamping of the pen effect by the conditions of poor calf recruitment existing in the free-ranging population. We considered a simpler hypothetical scenario (than the scenarios used in the stage-based population model) with the current demographic parameters as follows: 30 adult cows of which 15 are penned each year with the free-ranging cows producing 0.3 calves/cow and penned cows producing 0.8 calves/cow. In this scenario, we would need to double the cow population before there would be the same number of calves produced by free-ranging cows (13) as there would be produced by penned cows (12). Unless, demographic conditions change, it would take six years before reaching 60 cows at a lambda of 1.13. Our conclusion is simply that the maternity pen is a useful recovery action in this particular herd area and should be continued for the foreseeable future unless demographics in the free-ranging population can be improved. Again, one of our recommendations from this is that we need to conduct further investigations behind the mechanisms of poor calf production in the free-ranging cohort in order to identify possible corrective management.

Arresting population decline

In March 2020, we observed 29 adult cows, 40 adult males, 2 unknown adults/juveniles, and 14 calves for an overall minimum count of 85 caribou (Table 1, Table 2, Figure 2). The population estimate using the mark-resight approach was 83 calculated as follows:

1) For the portion of the range east of the Clearwater valley:
    a. We observed 13 groups, 61 caribou, and nine of ten functioning radio collars (90%) without the use of telemetry (Table 2).
    b. We found one group (group observation number 8) and nine caribou, including the one missed collared caribou, using telemetry (Table 2).
    c. Correcting for sightability resulted in a population estimate of 68 (61/0.9) caribou in the Klinse-Za
2) For the portion of the range west of the Clearwater valley:
    a. We observed seven groups (four collared groups using telemetry, one group with no collars was located as an incidental) for a total of 15 animals (Table 2).
3) The estimated population size was therefore 83 (68 + 15).

Blood PSPB levels indicated that 14 of the 17 penned cows were pregnant (range: 0.06-0.94 ng/ml); pregnancy assumed when PSPB levels >0.21ng/mL. Blood was also available from four re-collared cows that were left outside the pen and they were all pregnant. While pregnancy rates differed considerably between penned (82%) and free-ranging (100%) animals, we believe herd level rates are similar, and the 100% pregnancy rate in the free-ranging portion was an artifact of a small sample size. From these observations, although a small sample, we infer similar pregnancy rates between penned (82%) and free-ranging (100%) females. One cow died soon after arriving in the pen because she consumed the pelleted ration too quickly resulting in digestive complications that became fatal. Thirteen calves (7♂ and 6♀), from 16 cows, were born between May 14th and June 6th, 2019. Successful parturition of penned cows was therefore 81%, one percent lower than pregnancy (accounting for the one pregnant cow dying).

Observed post-partum calf survival in the pen to the end of July was 100% so the ratio of calves/cow remained at 0.81 at the time of release. We observed four calves with 11 free-ranging, collared cows in July for a ratio of 0.36 calves/cow. Throughout the year, we did not observe any additional calves despite observations of the remaining uncollared cows on several occasions; and so we are relatively confident that there were only four calves alive in the free-ranging population, following the neonatal period. In the survey results from March 2020, we observed all the free-ranging animals within the one survey, including cows without collars for an overall ratio of 0.48 calves/cow (n = 29 cows total; 24 collared cows, 16 from the pen and 8 free-ranging, and 5 uncollared). The penned calves/cow ratio in March 2020 was 0.69 (11/16) representing a loss of two penned calves since release, while the free-ranging calves/cow ratio was 0.23 (3/13).

Table 1. Parameters used to evaluate effectiveness of a maternity pen to protect caribou cows and their calves from March to July, Klinse-Za caribou herd area, northern British Columbia, 2019-20.

	Data stratum	Pen	Free-ranging
(A) Natal and Survival Rate	Number of radio-collared cows	17	11
	Number of collared cow mortalities	1	3
	Collared adult survival	0.94	0.75
	Collared adult mortality	14.0%	
	Number of other mortalities[a]		4
	Pregnancy	0.83	1.00
	Parturition	1.00	0.81[b]
	Calf/cow in Jul	1.00	0.29[c]
	Calf/cow next Mar	0.69	0.23
	Number added to population[d]	10	-4
(B) Population survey	Number of cows		29
	Number of males		40
	Number of unknown/juveniles		2
	Number of calves		14
	Total (observed)		85
	Total (estimated from mark-resight)		83
	Total (calculated from known births and deaths)		87
	Known immigration		0
	Calves (% of population)		16
	Bulls:Cow		1.33

a – Calculated by the total adult population size at year start (n = 81-11 calves = 70 adults) multiplied by the collared mortality rate (3/28 = 0.11) and subtracting the known number of mortalities (n = 4).
b – Observed as an average from other herd areas in the region (McNay and Voller 2007).
c – 100% of the collared individuals observed.
d – Calculated as the number calves in $March_{2018}$ – number of adult $deaths_{2018/19}$

Table 2. Observations of caribou, group numbers, and sex/age class in the Klinse-Za/ScottE caribou herd in northern British Columbia, March 2020. Observations (Obs) align with those in Figure 2.

Obs	Type	Adult Male	Adult Female	Juvenile	Penned Calf	Free-ranging Calf	Total
1	Telemetry	0	1	0	1	0	2
2	Telemetry	1	1	0	0	0	2
3	Telemetry	0	1	0	0	0	1
4	Telemetry	1	1	0	0	1	3
5	Visual	2	0	0	0	0	2
6	Visual	0	1	0	0	0	1
7	Visual	0	1	0	1	0	2
8	Telemetry	3	4	1	1	0	9
9	Telemetry	1	0	0	0	0	1
10	Telemetry	2	0	0	0	0	2
11	Incidental	2	1	0	0	1	4
12	Visual	6	1	0	0	0	7
13	Visual	4	0	0	0	0	4
14	Visual	4	0	0	0	0	4
15	Visual	1	4	0	3	0	9
16	Visual	0	0	0	1	0	1
17	Visual	1	0	0	0	0	1
18	Visual	6	3	1	1	1	11
19	Visual	4	9	0	3	0	16
20	Visual	2	0	0	0	0	2
21	Visual	0	1	0	0	0	1
Total		40	29	2	11	3	85

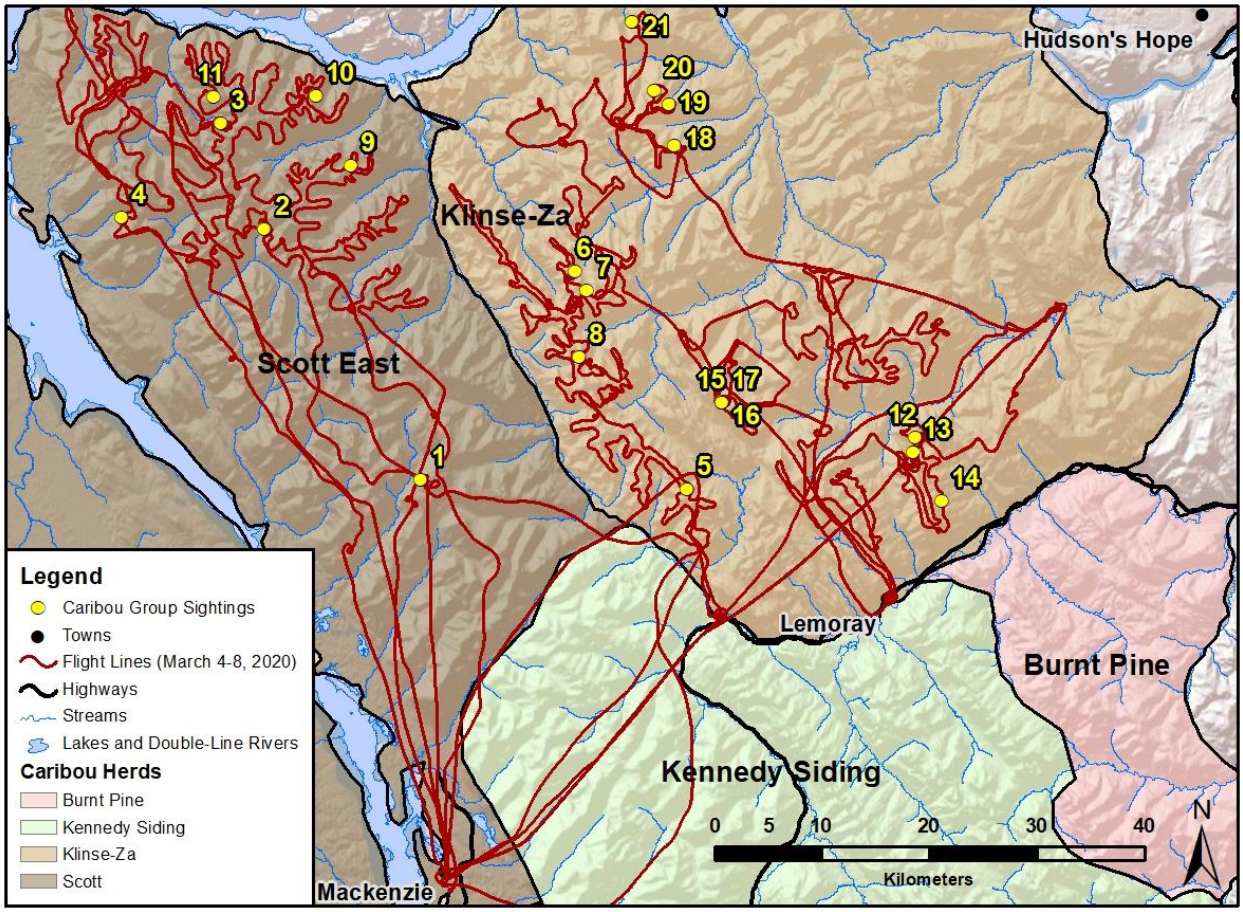

Figure 2. Observations of caribou groups in the Klinse-Za/ScottE caribou herd in northern British Columbia, March 2020. Yellow Caribou group sightings align with observations (Obs_no) presented in Table 2.

One of the penned calves died from wolf predation and the cause of another calf death has still not been determined. Calves overall were 16% of the total population of 85 (Table 1B).

Three collared, non- penned cows, from the 2019 penning cycle died in the past year. Two cows died from wolf predation; one cow in August 2019, and another in December 2019. Another non-penned cow died of an accident, falling off a cliff in early January. Overall, adult mortality based on radio-collared animals was therefore 14.0% (i.e., from Table 1A (2/21)). This mortality rate from predation, limited the increase in overall population rate (only 4 animals).

Our observations of 81 animals in March 2019 (McNay et al. 2019), plus the 14 new calves, minus the four known mortalities, and minus another four estimated adult deaths (Table 2) would result in a total population of 87. Due to the mortality this past year, there was only a population increase of four (possibly six) animals, or about 5%, in 2020 (Figure 3); a difference which is obvious when contrasted to a hypothetical rate of increase of 14% (Figure 3). Without the additive effect of the pen, we estimate there would have been an overall population decline of at least four caribou. We estimate that the number of reproductive cows in the population has increased from 23 in 2014 to 30 in 2020.

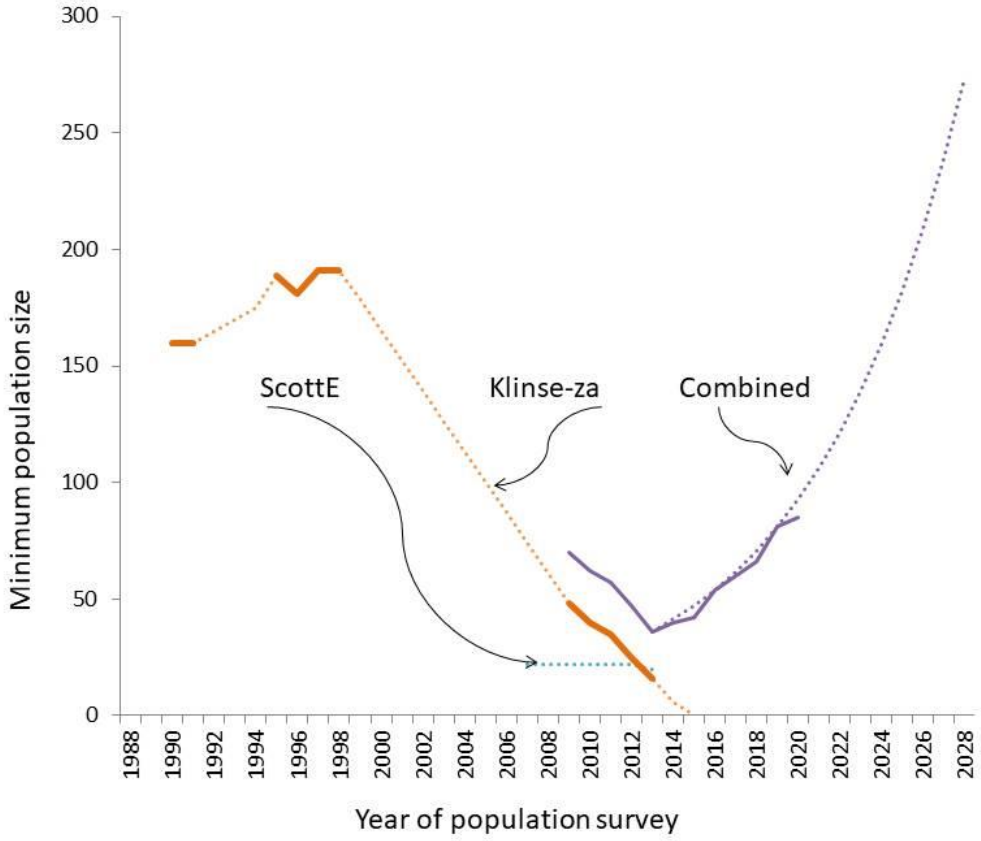

Figure 3. Population trends for Klinse-Za (orange), ScottE (blue), or combined (purple) caribou herds, British Columbia. Dotted lines depict no data (orange/blue) or estimates (purple; assuming $\lambda = 1.14$).

Extension and Reporting

The following is a listing of extension and reporting events, concerning the maternity pen project, which occurred during the 2019-20 fiscal year[4]:

- Internal meetings between project partners (West Moberly FN, Saulteau FN, and Wildlife Infometrics): in total, 8 meetings took place between May 2019 and March 2020 (dates are provided in Appendix D).
- External outreach and engagement:
    - Field trip with FWCP board members May 2019;
    - Open house for West Moberly and Saulteau community members April 2019;
    - Presentation to Treaty 8 Chiefs September 2019;
    - Webinar presentation to Northern Boreal Caribou Knowledge Consortium November 2019;
- Lichen collection trips were organized and implemented for community members, and elders of Saulteau First nation in 2019.
- Digital and other media:

[4] As confirmation of recognition for sponsorship, sponsor logos were included in each of these events on an acknowledgement page or were mentioned during interviews.

    - Seven internal/external extension memos issued between April 2019 and March 2020 (dates are provided in Appendix D).
    - Informational brochure provided to members of the public at the pen (see Appendix E)
    - updated project webpage published on the Wildlife Infometrics Inc. website: http://wildlifeinfometrics.com/project/klinse-za-caribou-maternity-pen/
- Technical materials:
    - Annual project report (this report) submitted to HCTF and FWCP by mid-April 2020.
    - Technical project article is in preparation for publication in 2020.
- Additionally, we have provided information for FWCP's website, which is another source of public communication about the project:
    - http://fwcp.ca/enhancing-caribou-survival-in-the-klinse-za-herd/,
    - http://fwcp.ca/supporting-risk-caribou-herds/,
    - http://fwcp.ca/update-on-fwcps-caribou-recovery-projects/.

In addition to these tracked references to the maternity pen, there has been many recent news articles and blogs written about the Section 11 agreement that also reference maternity penning in general and the Klinse-Za pen specifically.

DISCUSSION

The observed population decline of the Klinse-Za/ScottE caribou herd has been arrested through recovery actions (maternity penning and wolf removal) during the past six years. The population trajectory has been positive since implementation of the management measures and there has been an observed population growth of 49 animals, slightly more than double the population size of 2013. While there has been an overall increase of animals, we consider the stable/increasing population growth to be heavily dependent on recovery actions; the free-ranging calf recruitment this past year, in combination with the adult mortality rate, would have been insufficient to maintain an increasing population trend.

In general, population increase has occurred despite episodic mortality events; specifically, deaths from avalanches (2016-17, 2018-19), and localized predation events (2014-15, 2019-20. All of the wolf predation this past year (75% of investigated mortality) occurred likely by the same group of 1-2 wolves; this localized predation, limiting population growth, is indicative of the struggles of managing caribou herds with small populations.

Positive increase in the herd has averaged 13%, since 2014, however the increase has varied demographics within the herd. We have noticed a trend in the population towards a higher recruitment of males, when compared to females. The overall increase of adult females has been only seven, while the increase of adult males has apparently been 33 (accounting for two juveniles of unknow sex and 7 calves). Factors that have contributed to uneven population growth have been: 1) a higher mortality of relatively older adult females, compared to the influx of relatively young males, and 2) a sex bias in birth of penned calves (26 females, 33 males). The young males in the population may not have been exposed to the same mortality pressures that older, more mature bulls naturally undergo (e.g., accidents from fighting in the rut, energy drain during the rut leading to a higher susceptibility to predation , or subsequent exposure to other mortality factors, etc.) but we expect this may begin to occur which, if it does, could limit population growth in future years. Self-sustaining populations are generally discussed in reference to only the number of individuals (e.g., 120 (NCTAC 2004), however, the

demographics of small herds should be considered when implementing, changing, or ceasing recovery efforts.

Both free-ranging and penned caribou seem to have high pregnancy rates, and yet we have observed significant differences in recruitment rates between the two groups. Currently, we don't know if free-ranging calves are being aborted or reabsorbed between pregnancy and parturition or alternatively, perhaps parturition is similar to pen cows with subsequent, high rates of neonatal predation on free-ranging calves. In 2020, we intend to deploy video collars on free-ranging cows, with the hopes of understanding more about their parturition rates.

Although it is challenging to compare the relative benefits of maternity penning and wolf removals, Bridger (2019) downplayed maternity penning because population growth in adjacent caribou herds with wolf reduction alone, is comparable to growth of the Klinse-za population. Conversely though, Bridger (2019) also reiterated our observation from the Klinse-za penning, that survival of penned calves is more than double that of free-ranging calves. Reproductive status of cows could be a confounding factor in the ability to successfully deliver a calf the following year, however, at this point we are unable to determine whether this is the case. The relatively poor recruitment of free-ranging calves in the Klinse-za case, compared to penned calves, seems to support the notion that the maternity pen does have an additive positive contribution to population growth. Nevertheless, survival of free-ranging calves, in general, is still higher now than it was prior to removal of wolves (Seip and Jones 2016) and is potentially sufficient (assuming low rates of adult mortality) to maintain the population[5] but unlikely to be sufficient for population recovery (Bergerud 2007). A greater understanding of the factors influencing free-ranging calf recruitment is needed before we can begin to reduce recovery measures and predict the vital rates of a self-sustaining population

So, despite the contrast between growth rates among herds, we conclude that the maternity pen in the Klinse-za effectively contributes in an additive way to population recovery and will continue to do so as long as: 1) the apparent mortality of free-ranging calves remains high (calves/100cows < 30), 2) we can continue to pen a large portion of the adult cows (>30%), and 3) we continue to have a lack of evidence suggesting the pen is contributing detrimentally to other aspects of caribou recovery (e.g., health or behavior parameters), and 4) reduction of wolves (>90%) continues in the herd area.

CONCLUDING THOUGHTS

We think that intrusive management measures, such as the maternity penning implemented at Mt. Rochfort, is best used in only as an emergency measure to avert imminent extirpation such as the Klinse-Za case. Furthermore, penning should only be considered in conjunction with other recovery measures such as predator removal. While maternity penning has helped to avert extirpation of the herd, it is unlikely the return on investment could be defended in populations that are less at risk of extirpation.

Specific to penning operations, pen area should be large enough to accommodate a large number of caribou, as we would expect a steep diminishing return to a growing population,

[5] Applying the free-ranging survival rate (23 calves/100cows) to the penned cows would have led to a total of seven (rather than 11) surviving calves within a total population of 63 (rather than 67) animals– 11% calves in the population.

hence a declining rationale for maternity penning. That said, in such emergency situations as the Klinse-Za (i.e., steeply declining, small populations), sponsors appear willing to support maternity penning as a recovery measure whereas we speculate they might not be as willing to support other recovery measures to the same level. Given the current demographic statistics, there appears to be sufficient rationale to continue the mat pen operation in the Klinse-Za but we will need to address diminishing returns by penning more adult cows and by continuing to track the number of animals added to the population from the pen versus the number added by the free-ranging population.

RECOMMENDATIONS

Based on the demographic parameters presented here, we recommend the use of the Rochfort maternity pen in 2020 operations. We will be undertaking the following progressive actions during the 2020-21 operation:

- Use demographic and other collected data to identify thresholds or targets that can be used to guide and inform the scope under which maternity penning can justifiably be used as a population recovery measure.
- Continue efforts to monitor health of individual caribou with specific attention to how maternity penning may influence overall health of the population.
- Initiate a separate investigation using relocations from collared caribou to better understand post-release habitat use and possible effects of maternity penning.
- Initiate activities at the Bickford pen site to restore vegetation to pre-penning conditions.
- Initiate a separate investigation on parturition rates, and neonatal survival in the free-ranging population.
- Construct another maternity pen for use in 2021-2022, in order to reduce concentration of animals around Mt. Rochfort, and reduce any chance of parasite/contaminant buildup.

LITERATURE CITED

Adams, L., R. Farnell, M. Oakley, T. Jung, L. Laroque, G. Lortie, J. McLelland, M. Reid, G. Roffler, and D. Russell. 2019. Evaluation of maternal penning to improve calf survival in the Chisana caribou herd. Wildl. Monogr. 204:5-46.

Aitkens, F. 2013. Implementation plan for the ongoing management of South Peace northern caribou (*Rangifer tarandus caribou* pop.15) in British Columbia. Draft Rep., British Columbia Min. of Environ., Victoria, BC. 16pp.

Bridger, M. 2019 South peace caribou recovery following five years of experimental wolf reduction. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Bergerud, A. T. 2007. The need for the management of wolves an open letter. Rangifer, Special Issue 17:39-50.

Cichowski, D., R.S. McNay, and B. Muir. 2009. A plan for sustaining Wah tzee (Caribou) in the Moberly area of British Columbia. Wildlife Infometrics Report 274, Wildlife Infometrics Inc., Mackenzie, British Columbia. 166pp.

Cichowski, D., D. Culling, and S. McNay. 2012. Performance measures for resource review areas for woodland caribou in British Columbia. Prep. for Ministry of Forests, Lands and Natural Resource Operations, Prince George, BC. 60p.

Dickie, M., R. Serrouya, R. S. McNay, and S. Boutin. 2016. Faster and farther: Wolf movement on linear features and implications for hunting behaviour. J. Appl. Ecol. 54:253-263.

Dubman, E, R. S. McNay, L. Giguere, and B. Pate. 2018. New maternal pen site selection for Klinse-Za caribou herd. Report No. 587. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

Environment Canada. 2014. Recovery Strategy for the Woodland Caribou, Southern Mountain population (*Rangifer tarandus caribou*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. viii + 103pp.

Erickson M., and R.S. McNay. 2018. Rochfort maternity pen construction and maintenance: Supplemental Report. Wildlife Infometrics Inc. Report No. 631. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

Farnell, R. 2009. Three decades of caribou recovery programs in Yukon: A paradigm shift in wildlife management. Dept. of Environment, Whitehorse, YK.

Johnson, C. J., L. P. W. Ehlers, and D. R. Seip. 2015. Witnessing extinction - Cumulative impacts across landscapes and the future loss of an evolutionarily significant unit of woodland caribou in Canada. Biological Conservation 186:176–186.

Jones, E.S., D.R. Seip, M.P. Gillingham. 2004. Ecological relationships between threatened caribou herds and their habitat in the Central Rocky Mountains Ecoregion. Forestry Innovation Investment, Forest Science Program Project Y051035, British Columbia Min. of For., Victoria, BC.

Jones, E.S., M.P. Gillingham, D.R. Seip, and D.C. Heard. 2007. Comparison of seasonal habitat selection between threatened woodland caribou ecotypes in central British Columbia. Rangifer 17: 111-128.

McClintock, B.T. and G.C. White, G.C. 2009. A less field-intensive robust design for estimating demographic parameters with mark-resight data. Ecology, 90, 313-320.

McNay, R.S. and K.L. Sittler. 2013. Enhancing calf survival to help avert extirpation of the Klinse-Za caribou herd. Wildlife Infometrics Inc. Report No. 453. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

McNay, R.S. and L. Giguere. 2007. Timing and synchronicity of calving in woodland caribou herds of north-central British Columbia. Wildlife Infometrics Report 230. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

McNay, R.S., D. Cichowski, and B.R. Muir. 2013. Action Plan for the Klinse-Za herd of woodland caribou (*Rangifer tarandus caribou*) in Canada [Draft]. *Species at Risk Act* Action Plan Series. West Moberly First Nations, Moberly Lake, British Columbia. 28 pp.

McNay, R.S., M. Erickson, and L. Giguere. 2019. Enhancing calf survival to help avert extirpation of the Klinse-Za caribou herd: Annual report. Wildlife Infometrics Inc. Report No. 620. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

Meidinger and Pojar 1991. The ecosystems of British Columbia. Special Report Series No. 6. British Columbia Ministry of Forests. Victoria, BC, Canada. 330pp.

Mumma, M.A., M.P. Gillingham, C.J. Johnson, and K.L. Parker. 2017. Understanding predation risk and individual variation to risk avoidance for threatened boreal caribou. Ecol. Evol. http://dx.doi.org/10.1002/ece3.3563

NCTAC (Northern Caribou Technical Advisory Committee). 2004. A Strategy for the Recovery of Northern Caribou in the Southern Mountains National Ecological Area in British Columbia. Version 1.0. Ministry of Water, Land and Air Protection, Victoria, B.C. 108p.

Robin, J., K. McNay, and R.S. McNay. 2013. Lichen collection trial for caribou penning project: plan and implementation. Wildlife Infometrics Inc. Report No. 451. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada

Seip, D. R. 1992. Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia. Canadian Journal of Zoology 70:1494–1503.

Seip, D., and E. Jones. 2016. Population status of caribou herds in the Central Mountain Designatable Unit within British Columbia, 2016. Unpub. Rep., British Columbia Min of Forests, Lands, and Natural Resource Operations, Prince George, BC.

Seip, D., and E. Jones. 2015. Population status of caribou herds in the Central Mountain Designatable Unit within British Columbia, 2015. Unpub. Rep., British Columbia Min of Forests, Lands, and Natural Resource Operations, Prince George, BC.

Seip, D., and E. Jones. 2012. Population status of threatened caribou herds in the Central Rockies Ecoregion of British Columbia, 2012. Unpub. Rep., British Columbia Min of Forests, Lands, and Natural Resource Operations, Prince George, BC.

Seip, D., and E. Jones. 2011. Population status of threatened caribou herds in the Central Rockies Ecoregion of British Columbia, 2011. Unpub. Rep., British Columbia Min of Forests, Lands, and Natural Resource Operations, Prince George, BC.

Serrouya, R., K. Bollefer, K. Furk, and C. Legebokow. 2015. Maternal penning in the Northern Columbia Mountains: Revelstoke Caribou Rearing in the Wild's first-year pilot and results of the 2015 calf census. Version 2.0.

Sittler, K.L., R.S. McNay, L. Giguere, E. Beckie, C. Marshall, and N. Owens. 2017. Protocols for maternity penning to enhance the survival of caribou calves within the Moberly caribou herd area. Wildlife Infometrics Inc. Report No. 461. Wildlife Infometrics Inc., Mackenzie, British Columbia, Canada.

Smith, K.G. and L. Pittaway. 2011. Little Smoky woodland caribou calf survival enhancement project. Rangifer Special Issue No. 19:97-102

Spalding, D. J. 2000. The early history of woodland caribou (Rangifer tarandus caribou) in British Columbia. B.C. Ministry Environ., Lands and Parks, Wildl. Branch, Victoria, B.C. Wildl. Bull. No. B-100. 61 pp.

Sutherland, G., R.S. McNay, and R. Serrouya. 2015. Projecting outcomes of management options for boreal caribou populations in north-eastern BC: Modelling assumptions and scenario design. Wildlife Infometrics Inc. Report No. 514. Wildlife Infometrics Inc., Mackenzie, British Columbia.

TERA 1997. Large mammal surveys of the upper Pine River/Carbon Creek watersheds, British Columbia, February and March 1991. TERA Environmental Consultants Ltd., Calgary, Alberta

WMFN (West Moberly First Nations). 2014. Population and distribution objectives and identification of critical habitat for seven herds of woodland caribou in the South Peace area of British Columbia. West Moberly First Nations, Moberly Lake, British Columbia.

WMFN (West Moberly First Nations). 2009. "I Want to Eat Caribou Before I Die." Unpublished report, West Moberly First Nations Land Use Department, Moberly Lake, BC.

APPENDIX A. COMMERCIAL CARIBOU PELLET INGREDIENTS

15% CARIBOU PELLETS
(For Caribou)

INGREDIENTS:

Barley, Wheat, Corn
Faba beans, Soybean meal
Molasses
Canola oil
Limestone, Salt, Dical
HP Mineral Mix(Wheat, Millrun, Canola oil, Copper Sulfate, Zinc Oxide, Calcium Carbonate, Iodine, Manganeous Oxide, Selenium, Cobalt)
HP Fortifier(Wheat, Millrun, Canola oil, Copper Sulfate, Zinc Oxide, Calcium Carbonate, Iodine, Manganeous Oxide, Iron Sulfate, Calcium Pentothenate, Selenium, Santoquin, Biotin, B-Traxim, Niacin, Folic Acid, Vitamin A, Vitamin B1, Vitamin B2, Vitamin B6, Vitamin B12, Vitamin D, Vitamin E, Vitamin K3)
Vitamin A, D, E, Vitamin E
Choline chloride
MAG OX, Dyna-Mate

INGREDIENTS: A list of ingredients used in this feed may be obtained by the manufacturer or registrant.

This feed contains added selenium at 0.4 mg/kg.

GUARANTEED ANALYSIS: Crude Protein (min) 15.0%; Crude Fat (min) 2.0%; Crude Fibre (max) 6.0%; Calcium (act) 1.00%; Phosphorus (act) 0.90%; Sodium (act) 0.25%; Potassium (act) 0.83%; Magnesium (act) 0.20%; Sulfur (act) 0.20%; Iron (act) 400 mg/kg; Iodine (act) 1.3 mg/kg; Copper (act) 25 mg/kg; Manganese (act) 100 mg/kg; Zinc (act) 191 mg/kg; Cobalt (act) 0.40 mg/kg; Vitamin A (min) 15,000 I.U./kg; Vitamin D (min) 2,000 I.U./kg; Vitamin E (min) 100 I.U./kg; Thiamin (min) 5.3 mg/kg; Riboflavin (min) 8.2 mg/kg; Niacin (min) 72 mg/kg; Vitamin B_6 (min) 14 mg/kg; Biotin (min) 0.28 mg/kg; Pantothenate (min) 28 mg/kg; Choline (min) 1,500 mg/kg; Folate (min) 4 mg/kg; Vitamin B_{12} (min) 0.02 mg/kg.

FEEDING INSTRUCTIONS: Feed Caribou Pellets to Caribou when they are on tundra. Provide Hi-Pro Mineral and salt free choice and provide fresh water.

CAUTION:
1. Directions for use must be carefully followed.
2. Do not feed in association with another feed containing supplemental selenium.

Individual results from the use of this product may vary due to management, environment, genetics, health and sanitation differences. Therefore, Hi-Pro Feeds does not warrant or guarantee individual results.

Net Weight 20 KG

APPENDIX B. MATERNITY PEN DAILY MONITORING REPORT

Klinse-Za Caribou Maternal Pen Project – 2018

Crew Name (Full Names): Ryan/Steven Desrochers Date: March 29/18

Visitors (Full Names):

CARIBOU

ID#	Freq. #	Collar #	Ear tag Left	Ear tag Right	Observation* (V, H, NS, NH) AM	Observation* (V, H, NS, NH) PM	Health issues? (yes/no) (If 'yes', leave comment in last column) Limping	discharge	skinny	wound	head low	alone	Calf ID	Calf Freq	Calf Ear Tag Left	Calf Ear Tag Right	Comments
C319K	148.805	29173	2	NA	V	V											
C372K	149.653	NA	15	NA	V	V											
C349S	148.925	29594	22	NA	V	V											
C347K	149.135	29595	12	20	V	V											
C317S	149.365	29596	7	1	V	V											
C332K	149.525	29597	NA	799	V	V											
C364K	149.545	29598	6	10	V	V											
C312K	149.565	29599	4	3	V	V											
C336K	149.750	31174	6	7	V	V											
C376K	None	None	NA	NA	V	V											
C335K	149.780	31175	2	NA	V	V											
C313K	149.795	31176	796	1	V	V											
C337S	149.024	34839	8	NA	V	V											

*Codes for Observation: V = Visual, H = Heard (with telemetry), NS = Not Seen, NH = Not Heard

Comments: All animals looked to be in good health.
Calf 13 were in feeding meeting.

SCALES

Time	Reading (kg) before re-set	Reading after re-set?	Comments: *(scale not working properly - needs fixing, caribou refusing to use the scale, problems like aggressive behavior, etc)*
AM :			
PM :			

	Time	Amount (bags)	% Remaining <5%, 5-10%, 20-50%, 50-100%	Trough Condition comments: *(e.g. lots of moss, only dirt left, etc.)*
LICHEN	AM 8:30	2	0	All lichen was gone.
	PM 7:	2	0	
	Time	**Amount (kg)**	**% Remaining <5%, 5-10%, 20-50%, 50-100%**	**Trough Condition comments:** *(e.g. foggy, birds feeding in trough, etc.)*
PELLETS	AM 8:30	20	>5	Only 1 trough had little pellets left.
	PM 7:	20	0	All gone.

Wildlife Infometrics Inc. Updated March 17, 2018

DISTURBANCE

Time	Event *	Location **	Comments: *(any actions taken?)*
2:00	People	Pen	Drove into meadow to drop of pellets
:			
:			
:			

*Codes for Event: Aircraft – Visitors (expected) – Public (unexpected) – Trucks – Sleds – Quads – Big wind storm – Rainstorm – Tree falling, etc...
**Codes for Location: Camp – Pen – Road (which km?) – Alpine – etc...

PEN PERIMETER WALK-AROUND

Section #	Time	Snow * Inside	Snow * Outside	Electric *	Voltage (min 6v)	Geo *	Veg *	Comments: *Describe the problem(s) and indicate if it is "Fixed" or not and if not when it will be fixed* (hole, wire short, broken wire, vegetation touching the wire tree on the fence, etc.)
All	8:30	✓	✓	X	X	✓	✓	No Concerns at all
	:							
7pm	:							
all	7:00pm							Need shovelling tomorrow
	:							
	:							
	:							
	:							
	:							
	:							
	:							
	:							

*Codes: ✓ = Checked & in good standard; X = Need attention; F = Fixed

PREDATOR CONTROL

Time	Species	Sign (Tracks, Scat, Visual)	Location (Pen, Camp, Road, Alpine)	Actions = what did you do? Note: If no predators or predator sign seen, WRITE DOWN "No predator sign observed, and no action needs to be taken"
8:30				Nothing seen or tracked
:				
7:00pm				No Concern
:				
:				
:				
:				

WEATHER

Time	Max Temp (°C)	Min Temp (°C)	Wind *	Precipitation (Snow, Rain, Fog, Dry, Windy)	Comments:
:					

*Codes for Wind: 0 = calm, 1 = light air, 2 = light breeze, 3 = gentle breeze, 4 = moderate breeze, 5 = fresh breeze, 6 = strong breeze

GENERAL COMMENTS and OTHER NOTES:

Walked through camp side of the inside pen No Caribou sign on this side at all.

Wildlife Infometrics Inc. Updated March 17, 2018

APPENDIX D. DATES FOR INTERNAL EXTENSION ACTIVITIES

Communication medium	Date
Meeting – NWS Society	2019-05-09
Meeting – NWS Society	2019-06-28
Meeting – NWS Society	2019-08-19
Meeting – NWS Society	2019-08-26
Meeting – NWS Society	2019-10-16
Meeting – NWS Society	2019-12-05
Meeting – NWS Society	2020-02-03
Meeting – NWS Society	2020-03-31
Newsletter	2019-04-01
Newsletter	2019-04-18
Newsletter	2019-06-21
Newsletter	2019-07-03
Newsletter	2019-08-02
Newsletter	2020-01-23
Newsletter	2019-03-26

APPENDIX E. BROCHURE PROVIDED TO PUBLIC AT PEN

Maternal Penning

Mt. Bickford is the site of a protective maternal pen for caribou. The maternal penning project is an important initiative, now in its 4th year, which is helping the Klinse-Za herd avoid extinction.



Spring is calving time for the caribou. During these months, the pregnant and nursing cows are very attentive and protective of their vulnerable calves. Both cows and calves are easily stressed at this time, so it is crucial that we minimize disturbance and keep their stress low.

Legal Regulations

Please note that under the BC Wildlife Act (1996), there are **no motor vehicles allowed above 1,400 m in this area** (MU 7-31). Snowmobiles weighing > 450 kg are not allowed above 1,400m year-round, while snowmobiles < 450kg are allowed above 1,400 m ONLY from Nov 1—April 30.

Partners & Sponsors

Many thanks to our dedicated partners and generous supporters. Without their contributions the penning project would not have been possible.

West Moberly First Nations
Saulteau First Nations
Spectra Energy
British Columbia — Ministry of Forests, Lands & Natural Resource Operations
Wildlife Infometrics
Habitat Conservation Trust Foundation
FWCP Fish & Wildlife Compensation Program
Teck
TransCanada — In business to deliver
Environment Canada
BC Hydro
West Fraser Mills
Anglo American
Canfor
Walter Energy

Klinse-Za caribou maternal pen



***** Please *** respect the calving season**

There are 9 caribou cows with their calves currently living in a maternal pen on Mt Bickford. Please refrain from driving and quadding in the alpine (i.e. above 1,400m) to avoid disturbing the animals during this sensitive time.



Woodland Caribou

Woodland caribou are considered a species of Special Concern in BC and across Canada. In BC, caribou are classified into three ecotypes - Mountain, Northern and Boreal – based primarily on behavior and how they use their habitat.

The Klinse-Za herd is the Northern ecotype because they migrate long distances between seasonal habitats, eat terrestrial lichens, and over-winter at both low- and high-elevations, depending on snow conditions.

Caribou are an iconic northern species. Both male and female caribou have antlers. Caribou used to be abundant in this region, and are culturally important to indigenous communities.

Caribou Food





Klinse-Za Herd

The Klinse-Za herd belongs to the Pine group of caribou, which is composed of 4 herds that inhabit the region between the Peace Arm and the Parsnip Reach of Williston Lake: Klinse-Za, Kennedy Siding, Scott East, and Burnt Pine.

This herd has been declining since 1997, from ~190, reaching a record low of 16 individuals in 2013. This population crisis brought together concerned First Nations communities (West Moberly and Saulteau) and other partners to implement emergency management measures intended to avoid the extinction of the herd.

The immediate cause of caribou population decline is believed to be excessive predation. As such, a multi-pronged approach that includes maternal penning, local predator control, and habitat restoration has been developed and is being implemented.



The essential purpose of a maternal pen is to protect calves from predators during the vulnerable neonatal (i.e. infant) stage. By keeping the cows and calves in a pen guarded 24/7, from late March to mid-July, we are giving those calves a much better chance of surviving to adulthood and continuing to perpetuate the herd.



While in the pen, the caribou are closely monitored for health and behavior. First Nations Caribou Keepers from West Moberly and Saulteau First Nations guard the pen from predators, feed the caribou (see 'Caribou Food') and work to minimize the disturbance from the surrounding area.

These measures have stopped the previous decline in the population and the herd has grown in size to 61 individuals.

Thank you for respecting the caribou

For more information, please contact Wildlife Infometrics at 250-997-5700 or WILD_INFO@wildlifeinfometrics.com