

# Revelstoke Caribou Maternity Pen Project

Annual Report, Year 4

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## Executive Summary

In March 2017, 12 adult cows and 1 bull were transported to the maternity pen. Eleven of the cows were pregnant (92%), 11 calves were born but one was stillborn and another died shortly after birth. Nine calves plus 13 adults were released from the pen in July 2017. By March 2018, 4 of 11 calves were alive (0.364), and one cow died in an avalanche. This level of calf survival amounts to a net contribution of 0.72 penned calves over the wild calf population.

Wild calf survival was estimated by accounting for pregnancy rate, bull:cow ratios, and the proportion of the population that were calves during late-winter census. From 2014 to 2018, wild calf survival was 0.20, 0.24, 0.31, 0.27, with higher values in recent years that would dampen the benefit of maternal penning.

After 4 complete annual cycles of penning, average calf survival was 0.413 (19/46), compared to the wild survival of 0.264. This is an increase of  $1.5 \times$  over the wild population and means that approximately 6.0 calves were added to the population over 4 years.

During this 4-yr time frame, the RCRW project has not met the proximate objective of increasing calf survival by 2 to 3-fold, and consequently it has not met the ultimate objective of increasing population growth for the Columbia North subpopulation. A 2 to 3-fold increase (i.e.,  $2.5 \times$ ) would mean pen survival would have to be 0.66, compared to the current mean of 0.41. The final pilot year (2018 March penning) is underway. Twenty cows were transported to the pen, with 17 (85%) of these being pregnant. Careful monitoring will continue until at least March 2019, when final contributions of the pen can be estimated.



## Introduction

Southern Mountain caribou (SMC) are listed as endangered by the Province of BC and threatened by the Federal Species at Risk Act (Environment Canada 2014). Several caribou subpopulations are declining at a rate that will likely result in extirpation in the near future (Wittmer et al. 2010), largely because of excessive predation (Wittmer et al. 2005b) due to altered predator-prey dynamics resulting from habitat loss. Predation is listed as an “urgent” threat in the Federal Southern Mountain Caribou Recovery Strategy (2014).

Southern mountain caribou declined across the province between 1997 and 2000, and most herds continue to decline (Environment Canada 2014). The Columbia North herd (located north of Revelstoke in the Selkirk, Rocky and Monashee Mountains) declined by roughly 25% between 1997 and 2002 and has not recovered (Serrouya, Furk and Legebokow, 2014) but has been approximately stable for 14 years, since 2003 at approximately 150 animals (Serrouya et al. in prep). In the Columbia north herd, calf recruitment has been low since the late 90s (8.9 -14.3%) and below the (19-20+%) recorded in the early 80s and mid 90s (Simpson and Woods, 1987; McLellan, Serrouya and Flaa, 2006; Serrouya, Furk and Legebokow, 2016).

It is increasingly clear that addressing several limiting factors simultaneously will be needed to recover caribou (Environment Canada, 2014; Boutin and Merrill, 2016). In the Columbia North area, wolf numbers have been reduced by about 70% because of an experimental moose reduction (Robert Serrouya *et al.*, 2015). Bears and wolverine are also common predators of mountain caribou (Wittmer et al. 2005a), and are likely an important source of calf predation, particularly within the first month of life (Adams, Singer and Dale, 1995; Gustine *et al.*, 2006).

Our goal is to use maternal penning in the Revelstoke area to increase calf survival and contribute to population recovery. Maternal penning addresses the threat of predation by protecting caribou cows and their young calves in an enclosure between March and July, when calves are particularly vulnerable. Adults may also benefit from penning during a time of year when mortality is high (Wittmer et al. 2005a). Maternal penning has increased calf survival in the Yukon of 5-month-old calves to 0.74, much greater than that of wild calves (0.15) (Chisana Caribou Recovery Team, 2010), though this increase had no influence on the population trend because too few females were penned (Layne Adams, US Fish & Wildlife Service, in prep.). Survival rates of calves while in the pen were 0.95 (n = 96 calves). However, results were less clear in another pilot area in Alberta (Smith and Pittaway, 2011).

Mountain Caribou are identified as a *Recovery Species* under the Species of Interest Action Plan in the FWCP Columbia Basin Plan. Improving recruitment using maternal penning is identified as a specific *species based* action (priority 2) under the Species of Interest Action plan. This project also monitors survival and habitat use of caribou from the maternal pen which is identified as a *research and information acquisition* action (priority 1) under the Species of Interest Action plan. The RCRW project participates in spring inventories of the North Columbia subpopulation (a *monitoring and evaluation* action (priority 1) under the Species of Interest Action Plan), including recruitment surveys in years when no full population survey is conducted.

Maternal penning is recommended by the Federal SMC Recovery strategy and the BC Provincial Government as one option to recover caribou. We acknowledge that additional conservation actions will be required to increase the Columbia North subpopulation move towards a self-sustaining population.

## Goals and Objectives

The project is collaborative, and engages a diverse group of stakeholders, including recreationalists, environmentalists, First Nations, industry and biologists to work together to deliver the project. Benefits of this model are long lasting and include relationship building, increased awareness and cross- sector communication. RCRW also aims to engage the public to increase awareness and engagement in caribou conservation through volunteer opportunities, school education programs, presentations and media engagement.

There are two main operational objectives, these are:

**Objective 1** is to determine if maternal penning can improve the survival of captive-reared calves, relative to unpenned calves, in the Columbia Mountains Ecosystem. Our measure of success will be 90% survival of adults and calves in captivity, and an increase in survival relative to unpenned calves, by a factor of 2 – 3 in March. The multi-year target is 45% survival of calves to ten months of age. Associated biological questions will also be addressed:

1. Are parturition rates as high as pregnancy rates in the CME? Caribou pregnancy rates in BC are 92% (Wittmer et al. 2005a), but it remains unknown whether pregnant cows give birth to viable calves.
2. Will the survival rate of penned calves be higher than recent survival rates of wild calves for this area?
3. Will cows and calves released from the pen mix with the rest of the population? It

will be important to determine if animals transported to the pen resume normal habitat use and elevation migrations that occur in this area (sensu (Apps *et al.*, 2001)).

**Objective 2** (population-level, future years) is to increase recruitment, and to stabilize and then increase the Columbia North caribou subpopulation. If the first objective is successful, meeting this objective will require penning approximately 20 caribou (1/3 of the female adult population).

## Study Area

The project focuses on the Columbia North Caribou subpopulation, located North of Revelstoke, BC. This subpopulation lives in the Columbia River watershed, in the North Selkirk and North Monashee Mountains, and a small portion of the Rocky Mountains near the Wood River. The maternal pen is located approximately 100-km north of Revelstoke, BC, near Ruddock Creek, beside the Columbia River (Lake Revelstoke Reservoir) in the Interior Cedar Biogeoclimatic Zone at 580m ASL. The pen was expanded from 6.4 to 9.3 ha in 2015 and includes portions of a regenerating clearcut and old growth cedar hemlock forest. Caribou in this region use low elevation old growth forests in late fall and for a short part of spring. They calve at tree line or above, and spend summer and winter in upper elevation and subalpine Engelmann spruce and subalpine fir forests (Apps *et al.*, 2001).

## Methods

A summary of methods is provided here. For details, please refer to the operational protocols for capture, husbandry, calving, release and monitoring that are outlined in a living document titled *Protocols and Guidelines for the Revelstoke Caribou Rearing Caribou in the Wild Maternity Penning Project February 2017, Version 2.1*.

## Capture

Avalanche and weather conditions were monitored for suitable conditions, and possible capture locations were evaluated for suitable caribou and terrain with minimal avalanche hazard prior to capture. The RCRW avalanche safe work procedure was followed for staff working in avalanche terrain and included a short rescue training session, a team leader with avalanche safety training and avalanche safety equipment. All capture crew attended a capture meeting and avalanche orientation prior to the operation to review protocols in detail.

Caribou were captured by a professional crew (Canadian Wildlife Capture Ltd.) using a net gun

deployed from the capture helicopter when temperatures were cool (to reduce the chance of hyperthermia), and the snow deep (to prevent injuries). Capture attendants immediately attended to the captured animal, detangled the net, hobbled, blindfolded, and administered an intranasal sedative (medetomidine; under the direction of a wildlife veterinarian).

Each caribou was placed in a capture bag and transported via helicopter (2 at a time; with an attendant) to a location 200-m away from the enclosure (to avoid disturbing caribou already in the pen). Transport times were a maximum of 25 minutes. Caribou were carefully transferred to the pen in a toboggan pulled by snowmobile with their heads on the lap of an attendant.

Two Wildlife Veterinarians (Helen Schwantje (DVM) and Bryan Macbeth (DVM, PhD)) supervised animal handling and care of the animals. Once in the enclosure caribou were weighed on a platform scale and assessed at two processing stations by veterinarians for depth of sedation, age estimate, physical condition, injury, presence of external parasites. A blood sample was drawn (for serum progesterone to confirm pregnancy) and for future analysis of serum antibodies, serum chemistry, complete blood count, and analyses following Murray et al. (2006). Progesterone levels were determined by Prairie Diagnostic Services lab using standard assays. Hair and tissue samples (ear plugs) were collected and dried in paper envelopes for DNA archiving and feces were collected and frozen. A standard protocol of prophylactic treatment was administered (an anti-inflammatory, larvicidal anthelmintic, vitamin E, selenium, and antibiotics (only if required)).

A biologist specializing in assessment of body condition (Rachel Cook) estimated Ingesta Free Body Fat by collecting body conditions scores, and ultrasound of fat (results in prep.). Technicians applied bilateral ear tags, and a satellite-linked GPS radio (Vertex Lite-2D, Vectronic Aerospace GmbH). Once processing was complete a Veterinarian administered a drug antagonist (Atipamezole) and caribou walked away from the processing site.

## Husbandry

During the penning period staff (minimum of one, usually 2) live on-site approximately 200-m away from the pen at a pre-existing facility. Staff patrol the pen, make repairs, feed and observe caribou for 7-8 hours/day. When work in the pen is required, staff use dedicated footwear, as well as hand sanitizer, and disinfectant boot washes. Dedicated clothing, as well as gloves were used when handling animals. Visits to the pen were minimized, and visitors were restricted to the main blind. Visitation was pre-approved and is limited to funders, media (rarely), and scientists.



Staff received training at the beginning of the season with two wildlife Veterinarians that included a review of protocols, animal health records, how to evaluate condition, identify abnormal behaviour, and information on the need for biosecurity measures. Observation protocols required that all animals were visually confirmed within the pen at least twice a day and observed feeding and drinking. Each caribou was closely observed daily with a scope from “tip to tail” and a body condition score is assigned every few days. Photos were taken frequently to track condition and veterinarians are regularly updated.

After capture, caribou were fed arboreal lichen and transitioned to a pelleted ration developed specifically for caribou. Caribou were then fed ad libitum pellets in 5 troughs twice per day. Following snowmelt, water was provided in 5 troughs (total) at two stations in the south of the pen from a solar powered pump. During this period, lake water flowed through the troughs from 8am-5pm, and was available through the evenings. Troughs were cleaned every 3-4 days. A platform scale was placed at one of the troughs with a motion-triggered camera to record weights, however few caribou could be enticed to step on the platform despite several re-designs, and feed options provided.

Five infrared motion triggered cameras were positioned at roads and trails around the pen to monitor predators and are checked every 2nd day. Staff patrol the pen perimeter 1-2 times per day to ensure the fence is functioning, and to detect sign of predators.

During calving, two staff and one Veterinarian (from May 15<sup>th</sup>-June 30<sup>th</sup>) monitored calving progress and assisted with capture of calves. Calves were captured 12-24 hours after birth, sexed, weighed, and fitted with a small, expandable VHF transmitter collar (25cm diameter, with four 4-cm stitched folds and a rot-off (expanded size 41cm), weight 64g; Vectronic Aerospace, GmbH), one small ear tag (All-Flex Sheep Tag, white, applied in right ear) and a hair sample was taken for DNA archiving. The pair was left alone to reunite and was observed at a distance to ensure this occurred. To test whether handling stress was contributing to in-pen mortalities of calves, only half of the calves were caught, and fitted with collars.

All mortalities were necropsied by a wildlife veterinarian and/or a certified Veterinary Pathologist from the BC Ministry of Agriculture Animal Health Centre, or veterinarians at the Calgary Zoo.

Once calves were 4-6 weeks old, and no recent predator activity was observed, all caribou were released from the pen by opening the NW gate and placing lichen and water outside the gate. Staff observed the gate from the blind to ensure all caribou have left, and a final sweep of the

pen is conducted for any remaining caribou.

## Monitoring

All collared adults were monitored daily for position and mortality messages by satellite transmission. Adult collars deployed in 2017 are scheduled to drop off using a timed release mechanism on 10.04.2020. Calf collars are expandable and have a cotton rot-off designed to fall off after 1 year. The VHF pulse rate changes if there has been no movement (mortality signal) for 12 hours (adults) and 3 hours (calves). When a mortality signal was received from an adult collar or collars were off-air, monitoring flights using a fixed wing aircraft or small helicopter were used to locate animals and check for status.

We aimed to investigate mortalities as soon as possible and within 48 hours of detection. Signs of struggle, predator sign (hair, tracks, feces), the position and state of the carcass, are all noted and photographed/videotaped to determine cause of mortality. If possible, the carcass is removed for necropsy, or a thorough inspection of the carcass (for bruising, deformity, punctures, condition etc.) is conducted and samples (where present) are collected using a list developed by Bryan Macbeth (DVM, PhD) for the Foothills Institute.

At adult caribou mortality sites, a femur was collected for marrow fat analysis along with an incisor to estimate age per. (McLellan et al., 2012). Very low marrow fat indicates starvation. We followed the methods of (Neiland, 1970) to determine marrow fat content and no correction was made for mineral residue (Davis, Valkenburg and Reed, 1987).

The Province of BC conducted a full census of the Columbia North herd including an estimate of calf recruitment. Uncollared calves released from the pen were located in March, 2018 during this census, and 10-month survival of penned calves was determined. Census methods are outlined in a separate report.

## Outreach

Outreach and engagement activities are outlined in a communications plan updated annually. Activities include once annual press release (after capture) and at least twice annual “factsheet” updates posted to the website. RCRW maintains a website, and presence on Facebook. RCRW communicates with the Klinse-Za Maternal Pen to share information. The Province of BC is regularly updated with progress, and the group maintains links to academics, biologists and resource managers in BC in order to share progress and advice.

## Results

### Capture, Husbandry and Monitoring

On April 4<sup>th</sup>, 2017, twelve adult female and one bull caribou were captured from the North Monashee Mountains. Caribou cows weighed an average of 121kg (range 92.2-142.8). Four of twelve caribou were recaptures, with one animal having been captured twice previous to this year, in years 2014 and 2015.

Of the cows captured, 11 were pregnant and birthed 10 live calves (2 male, 8 female) between May 22<sup>th</sup> and June 24<sup>th</sup>. One cow birthed a very small, non-viable calf, which was likely stillborn. The dead calf was found shortly after birth and weighed 1 kg. In addition to this stillborn calf, one other calf died in the pen. The death of the second calf was investigated, with several factors seemingly contributing to its demise. Bacterial infection, probably compounded by high ambient temperature during the early postpartum period were noted in the report. A detailed pathology report is available.

On July 4<sup>th</sup>, 2017, 13 adults and 9 calves (5 collared) were released from the pen. Of the unmarked calves, none died in the pen, but none of these animals were confirmed on census in March 2018.

Few predators were recorded in 2017. Only one grizzly sow with two 3-year-old cubs was detected on the trail cameras on June 13<sup>th</sup>. These animals did not linger in the area and were not detected again.

Post-release, one cow (2017-13) was killed, likely by avalanche, during a period of poor stability in the northern Monashees on January 26<sup>th</sup>, 2018. This cow lost her calf (2017-24) just prior to August 10, 2017. Indications at the calf mortality site suggested wolf predation as the cause of death. Of the other known mortalities, only one had a known cause of death – 2017-22 (calf of 2017-11) was found dead on Highway 23N. Necropsy on this animal is pending but indications are that it was hit by a vehicle. The status of each caribou captured or born in the pen in 2017 is outlined in Table 2 and 3.

Year ID	RCRW Animal ID	RCRW Capture ID	Collar ID	Capture Weight (kg)	Pregnant (Y/N)	Estimated Age at Capture	Recapture	Mortality Date
2017-01	74	79	25309	-	Y	3	no	-
2017-02	7	80	25310	-	Y	young adult	2014-07	-
2017-03	75	81	25311	-	Y	5+	no	-
2017-04	76	82	25312	-	Y	4+	no	-
2017-05	3	83	25313	-	Y	5+	2014-03	-
2017-06	1	84	25314	121.60	Y	5+	2014-01, 2015-15	-
2017-07	77	85	25315	92.20	N	2	no	-
2017-08	78	86	25316	114.90	Y	3	no	-
2017-09	32	87	25317	129.60	Y	4+	2015-13	-
2017-10	45		-	88.60	MALE	2	2015-27	-
2017-11	79	89	25319	113.60	Y	4	no	-
2017-12	80	90	25320	142.80	Y	5+	no	-
2017-13	81	91	25321	130.60	Y	4+	no	2018-01-26

Table 1: Fate and pregnancy status of adult female caribou capture in 2017 for the maternal pen. The collar on cow 2017-05 blew off prematurely.

Year ID	RCRW Animal ID	RCRW Capture ID	Mother Year ID	Birth Date	Sex	Weight (kg)	10-month status
2017-14	82	93	2017-01	30-May-17	F	10.6	alive
2017-15	83	94	2017-02	25-May-17	M	-	dead
2017-16	84	95	2017-03	28-May-17	F	11.8	alive
2017-17	85	96	2017-04	05-Jun-17	F	10.0	alive
2017-18	86	97	2017-05	24-Jun-17	F	9.7	dead
2017-19	87	98	2017-06	02-Jun-17	F	10.7	alive
2017-20	88	99	2017-08	22-May-17	stillborn	-	dead
2017-21	89	100	2017-09	01-Jun-17	F	9.9	dead
2017-22	90	101	2017-11	23-May-17	M	-	dead
2017-23	91	102	2017-12	26-May-17	F	-	dead
2017-24	92	103	2017-13	02-Jun-17	F	-	dead

Table 2: Fate of caribou calves born in the maternal pen in 2017.

Monitoring flights were conducted on September 16<sup>th</sup>, October 27<sup>th</sup>, December 5<sup>th</sup> of 2017, and January 1<sup>st</sup>, and February 20<sup>th</sup> in 2018. During the flight on September 16<sup>th</sup>, 19 collars were detected, including the four remaining collared calves (animal id's: 2017-14, 2017-16, 2017-17, 2017-19). These calves were detected on all flights until December 5<sup>th</sup>, when a mortality signal was detected from calf 2017-06. This signal was investigated on December 18<sup>th</sup>, and the collar was recovered. Investigation of the site revealed little about the fate of the animal, particularly since 50cm of snow had fallen since the mortality signal was detected. A monitoring flight on February 20<sup>th</sup> indicated that cow 2017-04 had lost her uncollared calf in the previous month.

Penned calf survival rate is still well below the long-term target of 45%. In 2017, calf survival was 0.364, giving a net contribution of 0.26 calves to the population. Over the course of the project (with one year of penning left) average calf survival persists around 0.413, compared to the wild calf survival of 0.264, an increase of 1.5x over the wild calf survival. Wild calf survival has seen a general increasing trend over the course of the project, with 19.7% (2014), 23.2% (2015), 30.3% (2016) and 27.0% (2017) (Figure 1).

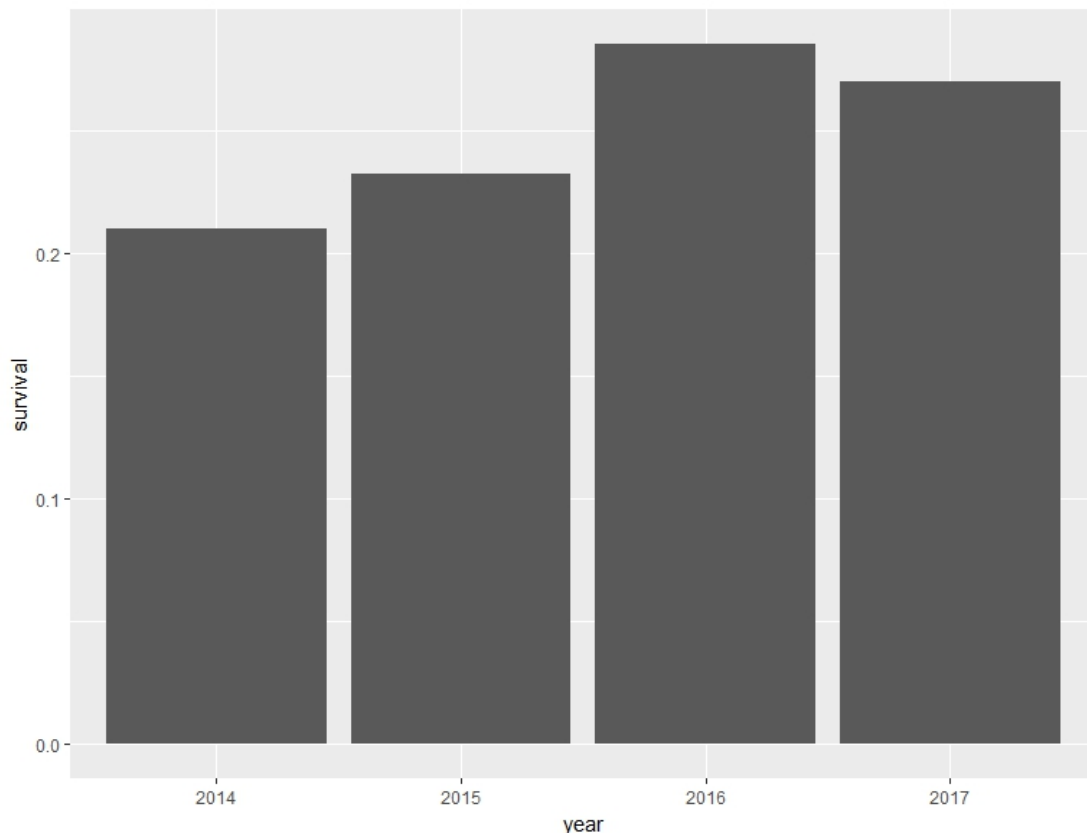


Figure 1: Proportion of wild calves surviving to 10 months, by year.



On March 24th the province of BC conducted a partial census, combined with a pre-capture flight. On this flight, calves 2017-14, 2017-16, 2017-17, 2017-19 were observed at the heel of their cow. Calf 2017-19, which lost its collar on December 10th, was seen at the heel of her cow, confirming her survival. None of the uncollared, unmarked calves released were detected at 10 months. Overall, four of 10 calves born in the pen survived to 10 months.

## Outreach

Over the course of 2017-2018 multiple avenues of public outreach occurred. An outdoor educator presented to three grade 6-7 classes, as well as two kindergarten classes in the Revelstoke school district. RCRW representatives coordinated lichen picking for high school students and community groups.

In 2018, the RCRW also updated the website, produced a factsheet for media release and commissioned a filmmaker to produce a five minute overview of the RCRW efforts over the past four years. This film, 'It Takes a Village', has been posted to the RCRW Facebook page, as well as YouTube, and has seen thousands of views, and hundreds of shares via Facebook. The reach of such a product cannot be underestimated.

## Discussion

Wild calf 10-month survival<sup>3</sup> for the 2017 cohort was estimated at 27%, which follows a generally increasing trend of annual calf survival since 2014. This compares to known values for penned calf, 10-month survival, for the 2014 (22%, from n=9 pregnant cows), 2015 (56%<sup>4</sup>, n=16 pregnant), 2016 (40%<sup>5</sup>, n=11 pregnant), and 2017 (36%, n = 11 pregnant) cohorts. Overall the maternal pen project has added 6 additional calves to the population in four years of operation.

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<sup>3</sup> The wild calf 10-month survival estimates should be viewed with some caution since they are back-calculated using an estimate of bull:cow ratio and pregnancy rather than a sample of wild collared caribou. The bull:cow ratio (50:100) is what might be expected in a non-hunted population but it is not a local, empirically derived value. The pregnancy rate we used (92%) is empirically derived from local data over multiple years (mostly prior to 2005, (Wittmer *et al.*, 2005), and may not adequately reflect variability in any single year.

<sup>4</sup> There were 18 female adults captured in 2015, 16 were pregnant, 15 calves were born, and 9 survived to 10 months.

<sup>5</sup> There were 12 female adults captured in 2016, 11 were pregnant and parturient, 4 survived to 10 months and one was lost (fate unknown) but survived to at least Dec. 2016.

Pregnancy rates for all adult female caribou captured for the maternal pen reflect pregnancy rates of wild caribou (90% in 2014 (9/10), 89% in 2015 (16/18), 92% in 2016 (11/12), and 92% in 2017 (11/12). It is worth noting that we are targeting animals for capture without calves, so penned pregnancy rates may be higher than would naturally occur, if a calf at heel results in decreased chance of pregnancy. Over the lifetime of the project, 46 of 47 pregnant cows have given birth to live calves, and, with the exception of one cow, which likely died as a complication of calving, all cows have been successfully released from the pen.

In 2017 there were fewer in-pen calf mortalities than in the previous three years, with 18% of calves not surviving to release; only 2014 had a lower mortality rate (0). Of the two mortalities in 2017, neither could conclusively be linked to conditions in the pen, as one was a non-viable calf, and the other died shortly after birth, on June 24<sup>th</sup>, well after the other calves in the pen had been born (median birth date: 2017-05-30)<sup>1</sup>. It is possible that measures implemented in 2017 to reduce pathogens may have improved early post-partum survival of calves. These measures included thorough removal of fecal material from previous years, and increased access to water, through the addition of a water trough.

Shortly after release, two collared caribou made large movements independently. After losing her calf, cow 2017-13 moved 56 km in 12 days and continued these large movements, finally traveling 433 km before being caught in an avalanche in January. Cow 2017-03 made similar, large movements, but unlike 2017-13 she had her calf with her. This calf, despite these very large movements (264 km between August - April) is one of four penned animals surviving to 10 months.

Movement of the majority of penned animals followed patterns in previous years. Immediate dispersal into higher elevation habitats near the pen were the norm for most animals. However, a hot, dry and prolonged summer likely influenced habitat selection and dispersal to some degree. For much of August, a large group of animals remained above the pen near a persistent patch of snow. By September, this group had splintered with some animals making large movements, both south to Hoskins creek, and north to Scrip creek. The majority of this group moved to the headwaters of Ruddock creek, where they stayed until snow in November began pushing them downstream and into lower elevations.

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<sup>1</sup> Incidentally, the cow birthing this late calf has been caught again in 2018. She is confirmed pregnant, allowing us to compare calving dates among years.

Known predation events were unusually low in 2017-2018, with only one calf having been killed by wolves in August. No collared cows were killed by predators in 2017-2018 and this, combined with the increase in wild caribou recruitment, suggests management strategies in the region may be having a net positive effect on the North Columbia herd. Wild adult female survival ranged from .783 to .873 between 1993-2008 (Serrouya et al., 2017) and penned adult annual survival is higher than this value over the course of the project (0.87-1.0). Calf recruitment as a function of penning efforts has not met the long-term, 45% increase objective up to the current year and for this objective to be realized a penned calf recruitment rate would have to be 0.69, well above the highest annual recruitment rate of penned animals.

Collars in 2017 were plagued by false mortality signals, beginning in early August 2017. By early January, 50 false mortality signals were sent by all 12 collars. Frequency of false mortality signals depended on the collar, but each collar sent more than one signal. The first two false mortality events were investigated by helicopter and ground crew. Prior to the first false mortality signal one collar blew off prematurely; this event was investigated, and the collar was retrieved (cow 2017-05). In early January Vectronic proposed a solution to the false mortality signals by switching the VHF transmission from 12 hours per day, to 24 hours per day. By March 2018, two of the first five collars to have this bug fix applied, stopped transmitting location data by satellite. As of March 31, 2018 collars on cows 2017-02, 2017-05, and 2017-06 had either failed, or were no longer checking in.

Given the current population size for Columbia North subpopulation, modeling indicates (updated in Furk and Serrouya 2016) that the number of female caribou penned must be approximately 20 to have a population-level effect. Both penned calf and adult survival will impact the effect size of maternal penning on population growth. Concerns in 2016 with calf mortality in the pen prompted discussions of reducing the number of caribou penned each year. However, discussions between the scientific advisory group, and provincial wildlife veterinarians concluded that the current site is large enough to support up to 20 penned adults and their calves. However, ambient temperature during penning is a concern, so in 2018 snow was stockpiled in an effort to moderate temperatures in shaded areas of the pen. A snowcat was barged to the pen in March, 2018 and spent a day piling snow in treed areas where snow was likely to persist.

The RCRW is entering its final year of maternal penning of caribou in the North Columbia. While this project has demonstrated that, through careful husbandry, caribou are capable of successful calving and release, challenges remain. The current site has been used continuously for four years, with 2018 being the last time this site will likely be used. Heavy browsing, mechanical disturbance,

and possible persistence of pathogens indicate, should a similar project continue, a new site should be used. Exploration of potential new sites was initiated in the winter of 2017-2018 with several candidate sites identified through the analysis. One of these sites, near Kirbyville creek, shows the highest potential as a penning location. Road access, high elevation, access to water, and structurally connected terrain to core summer and winter habitat are primary benefits to this site. Increased logistics with regards to access, and higher winter snowpack are essential challenges which must be considered if this site is selected. However, the concerns of the original pen at Ruddock creek (low elevation calving, high temperatures, proximity to predators during vulnerable life stages) should be addressed if penning is to proceed in the future. Whether these concerns are addressed through site management at Ruddock creek, or through moving to a new and higher pen location are issues to be investigated by any future penning project.

Maternal penning has had a net positive impact but to date the principle increase in lambda units (from 0.95 to 1.02) for this herd has been caused by the moose reduction treatment (Serrouya et al., in review; Serrouya, 2013; Robert Serrouya et al., 2015) along with predator reduction. Alternate prey (moose) have been reduced by >70% with hunting, with a concomitant reduction in wolves from 25-30 (in 2007) to 11-13 (2015) along Lake Revelstoke (Corey Bird et al., 2015). In contrast, deer populations have not been reduced. Forest harvesting continues in caribou habitat and it is unclear what the rate of loss is, in comparison to historic levels and habitat recovery (as mid- aged forests become caribou habitat).

## Recommendations

- If penning and wild rearing of caribou is to continue after the final year of the pilot project, the alternate site should be considered as a suitable pen location. Further assessment is required, but the Kirbyville site fulfills the criteria of a potential pen location.
- Transmitting collars deployed in 2016 and 2017 (and upon release in 2018) will continue to be monitored into 2019 to get additional information on wild adult female survival and calf recruitment. We will consider that the effect of the pen may last beyond one year after release, and that rearing a calf to 10- months may impact the ability to successfully recruit a calf the following year.
- Update an analysis to compare movements (rate of movement, elevation use, seasonal range comparison) of penned caribou to older data from wild cows with GPS collar data to determine if movements are unusual.

- A detailed analysis of survival data and multi-year report will be prepared in 2019.



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