

**Revelstoke Caribou Maternity Pen Project
Annual Report, Year 2
April 1st 2015 to March 31st, 2016**

Revelstoke Caribou Rearing in the Wild Society
April 14th, 2016



Banner donated by local artist Cat Mathers for the City of Revelstoke Street Banner program.

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Background

Southern Mountain caribou are listed as endangered by the Province of BC and threatened by the Federal Species at Risk Act. 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 and climate change.

Revelstoke Caribou Rearing in the Wild Society (RCRW) is a community-led initiative that launched a 5 year maternal penning pilot project in March 2014. The aim is to determine if penning can improve the survival of calves and adults in the North Columbia Mountains of B.C. by protecting them in a secure enclosure until calves are larger and more capable of avoiding predation.

The goal of maternal penning is to increase calf survival by a factor of 2 to 3 (from a recent rate of 25%). 10-20 pregnant caribou are placed in a recently expanded 9.3-ha enclosure on provincial land, safe from predators, for 4 months (March –July) until calves are approximately 4 weeks old. The project will require 1-3 years to demonstrate feasibility and multiple years to increase the population. Adult caribou and calves are fitted with radio-collars to monitor movements, survival and cause of mortality after release.

Maternal penning addresses predation, which is listed as an “urgent” threat in the Southern Mountain Caribou Recovery Strategy (2014). This project is being conducted in concert with a Provincially-led reduction in the moose population that has reduced the number of wolves in the area (Serrouya 2013). The project will also provide information on caribou health, parturition rate and neonatal mortality.

RCRW (rcrw.ca) directly engages the public and all major stakeholders in collaborative conservation through volunteer opportunities (e.g. lichen picking, board engagement), environmental education for K-6 students as well as media coverage, events, and social media presence in the Columbia Mountains, and beyond.

Project progress to March 31st, 2015 is summarized in the first annual report (Serrouya et al. 2015, <http://rcrw.ca/media-2015/>) and in an accessible project update ‘RCRW Year One Monitoring Results; <http://rcrw.ca/media-2015/>).

In the first year of the project, 10 female adult caribou and two juveniles were captured in March 2014. Nine of ten adults were pregnant and birthed live calves. All caribou survived and were released from the pen July 24th, 2014. All 10 adults, and at least one of two juveniles survived to March 2015, but only 2 of 9 released calves were alive in March 2015 (similar to the estimated survival rate for wild calves).

This report updates progress of the second operational year of the project. Eighteen adult female caribou were captured in March/April 2015. Sixteen of 18 adults were pregnant, and 15 birthed calves. Four calves, and one adult died in the pen. Eleven calves, one juvenile and 17 adults were released from the pen on July 13th, 2015. Two calves, and two adults were killed by a cougar in fall 2016, and one other calf was a suspected mortality in early winter 2015 (cause unknown due to collar failure). Eight of the calves were alive to March 17th, 2016, which is approximately double the typical wild-calf survival rate for caribou in this region.

Project Update:

Capture

On March 27th and April 2nd, 2015, 18 female adults and one 10-month old calf from the Columbia North caribou subpopulation were captured in the subalpine and transported to the RCRW caribou enclosure at Ruddock Creek on Lake Revelstoke (100km North of Revelstoke). Caribou were captured from 4 different groups at Kirbyville Creek, and the Seymour River drainage in the Monashee Mountains. Caribou were captured using a net gun deployed from a 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 20 minutes. Caribou were carefully transferred to the pen in a toboggan pulled by snowmobile with their heads on the lap of an attendant.

The Provincial Wildlife Veterinarian supervised handling at the pen. 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, including assessing *Besnoitia* lesions in the eyes and palpating the lower limbs. A 20 mL blood sample was drawn (for serum progesterone to confirm pregnancy) and for future analysis (as indicated) of serum antibodies, serum chemistry, complete blood count, and analyses following Murray et al. (2006). Blood was allowed to clot and centrifuged for serum collection, and 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, frozen and submitted to the University of Calgary's parasitology lab for analysis. A standard protocol of prophylactic treatment was administered (an anti-inflammatory, larvicidal anthelmintic, vitamin E, selenium, and antibiotics (only if required)).

Technicians applied bilateral ear tags (blue), and a satellite-linked GPS radio collar with a UHF proximity detector (Vertex Plus, 670g, Vectronic Aerospace GmbH). Once processing was complete a Veterinarian administered a drug antagonist (Atipamezole) and caribou walked away from the processing site. Once released into the pen, caribou began eating lichen within 24-48 hours.

Adult Caribou weighed an average of 111kg (range 91.7-127.5kg) at capture, and 16 of 18 females had serum progesterone levels >2ng/ml indicating they were pregnant. Subjective body condition scores recorded at capture (based on the prominence of the spine) averaged 2.8 out of 5 (range 2-3) for adults. Two caribou, and one calf were recaptured from the first year of the project. The recaptured adult with a calf was not pregnant. These animals were originally captured (in 2014) in the Selkirk Mountains at French Creek.



Figure 1. Caribou released into pen after capture on March 27th, 2015

Penning, Calving and Release

The caribou enclosure (6.4ha) was constructed in fall 2013 and was expanded to 9.3 ha in fall 2015. The fence consists of a 12-foot high visual barrier of black landscape cloth, surrounded by a 14-strand high-tensile electric fence that is powered 24 hours per day during operations (for construction detail see Serrouya et al. 2015). The fence has performed well in the deep snows of the Columbia Mountains, but requires annual maintenance to fix broken welds and bent posts caused by heavy snow-load.

Staff (minimum of one, usually 2) live on-site approximately 200 m away from the pen at a pre-existing facility and they patrol the pen, make repairs, feed and observe caribou for 7-8 hours/day. Staff use dedicated footwear on site, handwash, and disinfectant boot washes when entering the pen. Dedicated clothing, as well as gloves are used when handling animals.

Five infrared motion triggered cameras are positioned at roads and trails around the pen to monitor predators and are checked every 2nd day. Between capture and release 2015, photographs of wolverine, wolves and grizzly and black bears were captured on remote-triggered cameras and recorded on track traps, but there was no evidence of predators attempting to access the pen.

After capture, caribou were fed arboreal lichen (collected by volunteers over approx. 300 hours during the winter 2014-15) and transitioned to a pelleted ration developed specifically for caribou (High-Pro feeds, Edmonton, Alberta) over a ten-day period.

Caribou were then fed ad libitum pellets in 6 troughs twice per day and after snowmelt, water was provided in 8 troughs and changed 2 -3 times per day. 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 in spite of several re-designs, and feed options provided.

During calving, 2-3 staff were on site to monitor progress, and assist with capture of calves. Calves were captured 12-24 hours after birth, sexed, weighed, and fitted with a small, expandable VHF/UHF transmitter collar (25cm diameter, with four 4-cm stitched folds and a rot-off (expanded size 41cm), weight 64g; Vectronic Aerospace, GmbH), 1-2 small ear tags (blue) 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.



Figure 2. Calves are collared and ear tagged 12-24 hours after birth with an expandable VHF/UHF tag collar. The cylindrical magnet on the collar is removed prior to deployment.

Fifteen of the 16 pregnant female adults were parturient (7 female and 8 male calves) between 25th of May and 22nd of June. One caribou was pregnant (based on progesterone results) but did not give birth, and she was the lightest (91.7 kg) adult caribou at capture. Calves weighed an average of 9.3kg (SD 0.9 kg) at approximately 12 hours old, compared to an average 8.4 kg (SD 1.1 kg) in 2014.

There were 5 mortalities in the pen in 2015. 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. A cow (#2015-19) and calf (female) pair died on May 27/28th, four days after parturition. The cause of mortality was unclear but concerns identified included suboptimal condition (in spite of ample feed and some browse available in the pen). A second calf (male,) died on May 29th two days after birth. Concerns identified included possible failure of passive transfer of immunity (FPT) (lack of first milk) and infection (possibly related to FPT, environmental contamination and/or neonatal stress). On July 2nd a calf (female, born June 20th) was stabilized and transported to the Calgary Zoo by a veterinarian after being identified with a severe limp. Her injuries were consistent with being stepped on by an adult, and in spite of best care, she died a day after arriving at the Zoo. During the same visit a cow (#2015-09) was treated by veterinarians at the pen for an infected wound on its withers. She immediately re-united with her calf after treatment and ultimately recovered, but the calf (male, born June 22nd) declined and was transported by a veterinarian to the Calgary Zoo on July 6th. In spite of treatment he did not recover.

In response to these events a review of husbandry operations, and a visual assessment of animal health was conducted by a qualified wildlife veterinarian (Bryan Macbeth, DVM/PhD) on June 10th and July 8th/9th. Several short-term measures were implemented to mitigate risk after the first visit (including; fencing off a water filled depression, dedicated footwear for work in the pen, increased water changes from two to three per day, leaving calves for longer prior to handling and increased efficiency during handling, further restricting visitation and monitoring animal behaviour closely). Due to high air temperatures and related increasing interactions between animals, Dr. Macbeth recommended caribou be released earlier than the first year of the project (July 24th was the release date in 2014).

Caribou were released on July 13th, 2015 (a cool and cloudy day) when calves were at least 3 weeks old (the last calf was born June 20th, the first on May 24th). All caribou (17 adults, 1 juvenile and 11 calves) were released by moving feed/water troughs (and some lichen) out of the pen, opening the gate with 2 people quietly observing from a blind. Caribou moved out of the pen slowly, were headed up-hill within 2 hours of the gate opening and were in summer range within 24 hours. Two calves were temporarily separated from their cows, with one of them returning to the pen within a half hour to reunite, and the other reunited within 24 hours or less after release (based on proximity data from the collars).



Figure 1. Caribou leaving the pen on July 13th, 2015. Release went smoothly with all caribou making it into summer range within 24 hours.

Monitoring

Both calf and adult collars worked reasonably well (most transmitted a message at least weekly), and all animals were monitored daily for mortality and calf separation messages until adult collars were scheduled to drop off (via pre-set release mechanism) on April 10, 2016. In the case of a delay in satellite reception a fixed wing aircraft or helicopter was used to locate caribou at least once a month to track survival.

A new calf collar design was used in 2015 (Figure 2), and has resolved the (2014-15) issue with collars expanding and falling off prematurely. Calf collars are designed with expandable folds that open with exposure to the elements and cotton inserts designed to rot-off in approximately 10-12 months. The first calf collar successfully released on March 1st 2016, and another on March 17th (due to the cotton insert rotting off as intended) and we expect the remainder to rot-off in the next few months. Both of these calves were confirmed alive during a flight on March 17th.

On receiving a mortality signal, or indication of calf separation, wildlife technicians follow a protocol for investigating suspect mortalities to maximize the probability of determining cause of death, and to obtain samples required for animal health and condition monitoring. Where possible, mortality sites are recorded on video, and carcasses are slung out and necropsied by veterinarians.

As of March 17th, 2016, 8 of 11 calves released from the pen (of 15 born) were still alive. 17/18 adult caribou released from the pen in July 2015 had functioning satellite-linked collars, and one adult collar failed in December 2015 (#2015-08 - fate of animal unknown). The calf of #2015-08 was killed in early October 2015 (at Ruddock Creek); likely by a cougar. A cougar killed a collared adult caribou (#2015-07) in early November 2015 at Ruddock Creek, and one week later a collared cow/calf pair (#2015-12) was also killed by a cougar 5 km away at Hoskins Creek. Hair was collected from each of these sites and was analyzed by Wildlife Genetics International. DNA analysis indicated the same individual cougar (male) was present at all 3 mortality sites (1 calf, 1 adult, and one cow/calf pair) in October and November. The Province of BC removed this cougar. One calf was orphaned as a result of these predation events, but is still alive as of March 17th, 2016. In addition, one calf collar failed in December, and is a suspected mortality (however, the related female adult is still alive).

At adult caribou mortality sites, a femur is collected for marrow fat analysis. Fat deposits

decline in periods of food shortage, and the relationship between marrow fat and body fat is linear below about 9% body fat in adult caribou (Allaye Chan-McLeod et al. 1995, 1999). 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 et al. 1987). Marrow fat (MF) was analyzed for the two caribou cows killed by a cougar in November 2015 (81 % MF and 41 %MF) and the cow that died in the pen in late May 2015 (62%MF). McLellan et al. (2011) analyzed marrow fat values at mountain caribou mortality sites throughout BC (where predation was the known cause) and found it averaged 68.7 %, (n = 27, 95% CI 58–78). For the Columbia North subpopulation, the marrow fat at all types of mortality sites (accidents, predation events, unknown cause and malnutrition) averaged 65 % (95 % CI 49–71, n=17).

A portion of the Columbia North subpopulation with the highest density of caribou was surveyed on March 17th and 19th. Results from this survey will be updated in a revised report to be released by June, and will allow us to compare penned calf survival to an estimate of wild calf survival derived from a recruitment estimate (% calves in the population).

Lessons Learned

RCRW is committed to reviewing and improving operations to provide the best possible care for caribou and to attain our goal of increasing caribou populations in the North Columbia subpopulation. To this end, we commissioned a review of our in-pen operations by a highly qualified Veterinarian/Phd wildlife biologist (Bryan Macbeth). We then debriefed operations with all staff and scientific advisors (Helen Schwantje, DVM, Robert Serrouya, PhD, Bryan Macbeth DVM/PhD). Key recommendations from this process are summarized below. Wildlife veterinarians are confident that these improvements will significantly reduce the number of in-pen calf mortalities.

- Increase shade and decrease stocking density in order to decrease interaction between animals. *A three-hectare expansion into old growth forest (from 6.4-9.3ha) was completed in fall 2015. This will allow for additional shade and terrain complexity, to reduce interactions between animals. Fewer animals will be captured in March 2016 to ensure these measures reduce in-pen mortalities.*
- Add an additional flow-through water system. We currently have two watering stations with a total of 8 water troughs changed 2-3 times/day. This new system

would add additional troughs, and would provide running cool water throughout the day. *The solar powered water system will be in place by May 1st, 2016, prior to snow melt.*

- Have a veterinarian/vet technician conduct annual staff training sessions on animal husbandry, and protocols. Institute individual medical records for caribou. *A wildlife veterinarian is developing a custom course and it will be delivered in April 2016.*
- Increase capacity to recognize/respond to sick and injured animals through increased training, and additional capacity in the form of a veterinary technician on-staff or on-call in close vicinity (Revelstoke). *A wildlife veterinarian will be present during the first two weeks of calving, and will make site visits to observe animals throughout the penning period. A veterinarian or veterinary technician is on-call to respond to animal health concerns.*
- Pen maintenance: Fill any low spots in the pen to minimize mud/standing water (*complete*); Remove any remaining piles of brush to reduce chance of entrapment for small calves (*substantial improvements in Fall 2015*); Apply landscape cloth beneath electric fence to reduce need for weeding around pen (decreases disturbance) (*to complete in Spring 2016*).
- The pen has proven effective at deterring predators over two seasons with a combination of the fence and staff presence. There is a need to reduce human activity around the pen to minimize disturbing caribou. To achieve this, purchase additional CCTV cameras/ infrared-triggered cameras to allow for monitoring with fewer patrols. *Field capable options are sourced and will be purchased when funding is available.*

Updated Life-table analysis

Prior to initiating any broad-scale conservation effort, it is important to forecast outcomes to help minimize risk and to avoid costly mistakes. Such an approach will also help gauge the level of effort needed to achieve success. Without such tools, the chance of disappointing results is increased and the return on investment will be difficult to anticipate. The primary forecasting tool we used was a life-table analysis, when λ (lambda; the finite rate of population change) > 1 , the population is increasing, and declining when $\lambda < 1$. This analysis was conducted prior to initiating the project (see

Serrouya et al. 2015), and is updated here with data from the first 1.5 years of the maternity-penning project.

Parameters for our life table analyses were empirically derived from the CME, such as adult female survival = 0.88, pregnancy rate = 0.92, age at first parturition = 3, litter size = 1, and wild calf survival = 0.26. It is important to note that these parameters were derived prior to the implementation of the moose reduction experiment (Serrouya 2013) that has likely had a positive impact on female adult survival that is not accounted for here.

Parameters under several scenarios are presented in Table 1 and predictions for population size over time in Figure 3. The scenarios are described here:

- Status quo is the scenario when no caribou are penned.
- The 'original' scenario assumed 30% of female adult population is penned (n=20) and parameters of calf survival in the pen = 0.90, calf survival the next 11 months after release = 0.6 (so $0.9 \times 0.6 = 0.54$ annual survival for penned calves). Also, given that some cows will be in the pen for 3 – 4 months, this should also increase adult female survival by a modest amount because they would not be subject to predation during spring, when the highest daily predation rates occur (Wittmer et al. 2005b). Therefore, we added 5% to the survival of penned adults.
- The 'Poor husbandry' scenario is the same as 'original' but reflects mortalities that occurred in the pen in summer 2015 resulting in reduced adult and calf in-pen survival, with calf survival in the next 11 months at 0.6 (same as original).
- The 'improved husbandry and AFS (adult female survival) boost' scenario assumes good adult and calf survival in the pen (calf survival = 0.90 and adult survival = 1), and improved adult survival post release over the 'original' scenario.
- The 'year 1 actual' scenario uses parameters from the first year maternal pen results (in pen calf and adult survival = 1, calf survival post release = .22, adult survival after release = 1) and the proportion of the female adult population penned is .12 (n=10).
- The 'AFS boost –poor calf' scenario assumes the same parameters of the 'year 1 actual' scenario, but with 30% of the female adult population penned, and a slightly lower (more realistic) adult survival.

Table 1. Scenario parameters.

Parameter	Original model	Status Quo	Scenario Name			
			Poor.husbandry	improved.husb.and.AFS.boost	yr 1.actual	AFS.boost.poor.calf
% of adult females penned **	30%	0%	30%	30%	12% (n=10)	30%
Penned Calves	Survival calves in pen	0.9	0.83	0.9	1	1
	Survival calves after pen	0.6	0.6	0.6	0.22	0.22
	Survival calves pen annual	0.54	0.5	0.54	0.22	0.22
Penned Adults	Survival Adults in pen	1	0.96	1	1	1
	Survival adults after pen	0.88	0.88	0.95	1	0.95
	Survival adults annual	0.88	0.85	0.95	1	0.95
Survival wild adults	0.88	0.88	0.88	0.88	0.88	0.88
Survival wild calves	0.26	0.26	0.26	0.26	0.26*	0.26
Pregnancy Rate	0.92	0.92	0.92	0.92	0.92	0.92

* was actually estimated at 19.6 % - but parameter was not altered because it is an estimate only.

** 30 % of the adult female population corresponds to roughly 20 adult females penned.

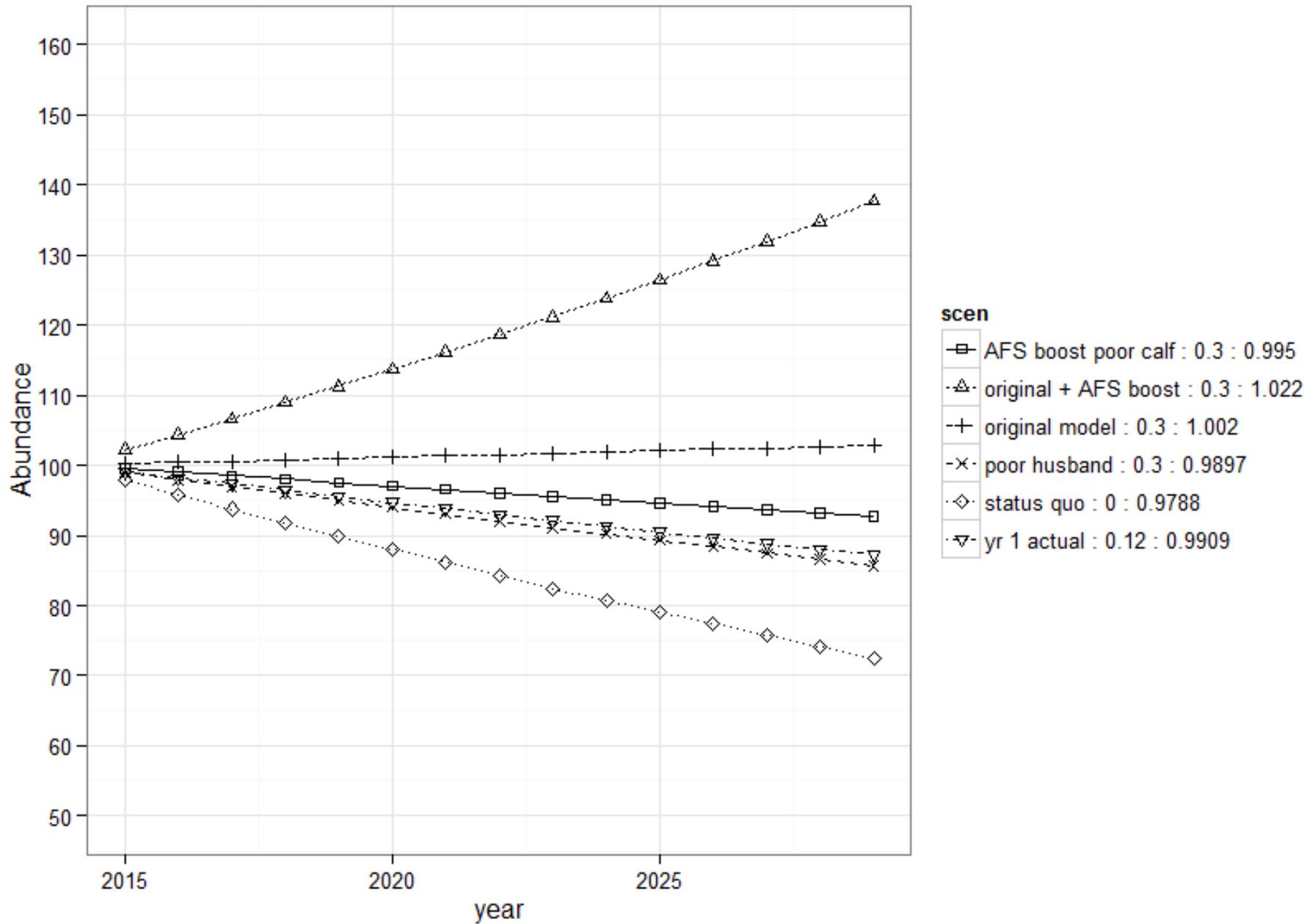


Figure 3 Population modeling for the Columbia North subpopulation under several scenarios (Table 1) . In the legend, the values on the right hand side are predicted lambda for each scenario.

Outreach and Media Engagement

Outreach activities conducted this year include a 5-day educational tour of West Kootenay Schools (Figure 4), a presentation to Rotary Revelstoke, the FWCP board, and the Selkirk College Integrated Environmental Planning Program. As well, RCRW participated in an external review of caribou conservation sponsored by the Columbia Mountains Institute and the Province of BC in December 2015. RCRW has provided advice on maternal penning to several organizations interested in similar projects in Alberta. Volunteers have contributed 253 hours to lichen harvesting and fence construction since March 2015. In addition, board members continue to contribute many hours to the project for public engagement, board and project management.

A press release was issued after capture in early April 2015, and at release in July 2015. Both press releases received coverage in local media and on the CBC. Local elementary school students raised money for the project “quarter for a caribou”, and garnered interest of local media in April 2015. An accessible-language project update was issued in October 2015 (rcrw.ca), and the RCRW Facebook site is regularly updated with project progress. A press release was issued on April 9th, 2016 updating 2nd year project results and the caribou capture that occurred in March 2016.



Figure 4. A certified teacher (Janette Vickers) was hired to conduct outreach for a week in October. In total, 229 students in Grades K-9, and 20 adults in Edgewood, Nakusp, New Denver and Kaslo, participated in an engaging presentation on caribou and wildlife ecology.

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