Detecting Female Wolverines: Pilot Fieldwork in the Columbia Mountains

2017 Field Season Report

Prepared for:

BC Ministry of Forests, Lands and

Natural Resource Operations

Prepared by:

Mirjam Barrueto, MSc
PhD Student (Start Date: September 2017)
Dept. of Biological Science
University of Calgary
P: (403) 679 8057
Email: mirjam.barrueto@gmail.com

August, 2017

Summary

Wolverines are a conservation priority in Canada. A recently completed wolverine inventory in southern Canada provided the first large-scale population data for the region. It suggested low population abundance and low connectivity between sub-populations in the surveyed areas. Based on these results we are proposing further research to better understand wolverine population structure, trends and connectivity in the northern Kootenay Region. The proposed research would be carried out from 2018 to 2020, in collaboration with the helicopter and cat ski industry. We will study the mechanisms by which different forms of human activity in wolverine habitat affect wolverine populations, with a particular focus on reproductive females. Between January and July 2017, we conducted a pilot project prior to the planned survey. The goals were to (1) test and refine the proposed field methods; (2) increase understanding of logistical challenges; (3) demonstrate the efficacy of photo based individual wolverine identification. With the help of one helicopter ski company, two snowcat ski companies, and a number of volunteers, we successfully installed ten camera stations with run poles throughout the study area, and checked and re-baited them twice. Eight of the ten camera stations were visited at least once by at least one wolverine. Thirteen individual wolverines were detected, easily distinguished by their unique chest pattern: Five females, four adult males and four individuals of unconfirmed sex. We successfully determined the lactation status of all of the females. Of the females, three did not lactate during session three, when they would have shown signs, while one was confirmed to be lactating. In addition to fulfilling the set goals, we had many opportunities to collect valuable feedback on the proposed research and discuss potential concerns with stakeholders.

Contents

Introduction

Wolverines (*Gulo gulo*) occur in mountain ranges, boreal forests and the arctic tundra across the northern hemisphere. Wolverines naturally occur in low numbers, have very large home ranges, and low reproductive rates. Females only breed every second year, and produce small litters (Persson 2005). These two attributes make them sensitive to increases in adult mortality, be it directly caused by humans through trapping, hunting and accidental vehicle collisions, or indirectly through increased natural predation following ecosystem changes (Banci and Proulx 1999; Krebs et al. 2004; Lofroth and Ott, 2007; Copeland et al. 2010). Even in the absence of increased mortality, habitat degradation and fragmentation can lead to lower population densities, potentially reducing reproductive rates (Krebs et al. 2007). In addition, climate change impacts spring snow cover. This affects breeding females in particular, as they select for areas with persistent spring snow cover for reproduction (Copeland et al. 2010; McKelvey et al. 2011). In conclusion, throughout Canada but particularly in the south, human alteration and usage of the landscape is placing increasing pressure on wolverines, making them a priority conservation species in Canada (BC CDC 2017; COSEWIC 2014).

Female wolverines occupy exclusive territories that they defend from other adult females. They have specific habitat requirements, as they need reliable food sources and protection from predators and from human disturbance when raising their young. This results in very low overall densities of breeding females on the landscape. While male offspring disperse, young females usually stay within or close to their mother's home range, and take over hers or neighbouring territories if they become vacant. Wolverine population distribution and colonization are thus primarily constrained by female dispersal (Vangen et al. 2001; Flagstad et al. 2004). From a management and conservation perspective, the number of breeding females in an area is thus of much greater importance and predictive power than the overall number of wolverines, as it strongly influences the reproductive potential of a population. This is especially true in shrinking and recovering wolverine populations, which may contain large areas without breeding females and thus do not produce young females to occupy suitable but empty habitat.

Recently completed non-invasive DNA based wolverine surveys in the southern Kootenay Region suggested low population abundance in most of the region and low connectivity between sub-populations (Clevenger et al. 2016; Kortello and Hausleitner 2016). Declining wolverine populations in southern Canada may significantly impact the long-term viability of the small contiguous US population, which depends on Canadian immigration from the Canadian Rockies and Columbia Mountains (Stewart et al. 2016). The data collected during the southern Kootenay surveys provided density estimates, sex ratios, and genetic data, but no population trend estimates. Also, no further demographic information, such as breeding status of females or age group of the detected individuals, was collected. To help fill this knowledge gap, we are planning further research to better understand wolverine population structure, trends and connectivity in southern Canada. A non-invasive camera and DNA based field study will take place in the northern Kootenay Region from 2018 to 2020, in collaboration with the helicopter and cat ski industry. For this area, virtually no data on wolverines is available, but it is considered a stronghold of wolverines, despite

increasing levels of human access and activities, and significant levels of wolverine harvest. In addition to collecting population data, the study will investigate the mechanisms by which different forms of human land use in wolverine habitat affect breeding female wolverine habitat selection and distribution. This will allow us to predict population impacts of future land use changes and management actions in this and other regions. The work will be conducted as part of a PhD program, which Mirjam Barrueto will begin at the University of Calgary in September 2017, under supervision of Prof. Marco Musiani.

The data presented below was collected between January and July 2017, during the pilot field season prior to the full survey. The goals of the fieldwork were to (1) test and refine the proposed field methods; (2) to increase understanding of logistical challenges; (3) demonstrate the efficacy of photo based individual wolverine identification.

Methods

Baited camera stations [*sites*] were installed at 10 sites across the study area (Figure 1; Table 1). The intention was not to conduct a representative survey, but to sample various regions and mountain subranges of the proposed study area. Site locations were chosen based on three criteria: First, support by the local helicopter ski or snowcat ski company. Second, places that had a high probability of being frequented by adult female wolverines, based on information from either the local company or other credible sources. Third, locations that were relatively easy to access. Sites were accessed mostly by snowmobile (sled), but two sites were accessed by helicopter (Table 1). We set two sites in each of the five general areas selected; the two "sister" sites were all within 6 to 25 kilometers of each other (Figure 1).

Camera stations were created following instruction of Magoun et al. (2011), and included run poles with a support structure to allow for individual identification, sex determination and lactation status (Figure 2). A wire was strung between two trees above the run pole, and the bait was hung from it: a frozen beaver for the first two sessions, and leg bones of road-kill elk for the third session. The wire had a long tail to lower it to the ground for re-baiting (Figures 2 to 4). Camera stations were re-visited and re-baited two times with approximately 30-day sampling intervals, for a total of three sampling *sessions*.

We tested two new and inexpensive camera models (*HCO* Scoutguard white flash camera; *Spypoint* Force-10 infrared camera), against a reliable brand we have used in the past (*Reconyx* HC 550 white flash and HC 600 infrared models). The white flash cameras faced the run pole, taking photos of chest and abdomen of visiting wolverines. The infrared cameras took overview photos of the site, to document visits by wolverines that did not climb the run pole, and other animals. At some sites we introduced barbwire and/or alligator clips to the run pole and tree bole, upon visitation by wolverines, following Magoun et al. (2011).

All sites were located within active trap lines, but with one exception, our sites were located away from actual trap locations. We informed all trap line holders of our activities by means of a letter, and included Mirjam Barrueto's contact information to enable them to ask further questions.

Results

Data collection - cameras

We tested two new and inexpensive camera models (*HCO* Scoutguard white flash camera; *Spypoint* Force-10 Infra-red camera), against a reliable brand we have used in the past (*Reconyx* HC 550 Whiteflash and HC 600 Infrared). The main reason for considering inexpensive cameras is the considerable upfront cost associated with purchasing the large number of cameras necessary for this project. We were very pleased with the performance of the *HCO* Scoutguard cameras. While one individual camera appeared to malfunction (it is not yet determined why), the images taken by *HCO* Scoutguard cameras rivaled those taken by *Reconyx* HC 550s, and in some instances surpassed them. The main concern was the distance between run pole and camera. During the summer we will finish testing and refining the exact distances necessary to achieve sharp, focused images. The *Spypoint* cameras performed satisfactorily. They are in place to take overview photos of the sites and do not need to produce high quality images. Their video capability was very useful.

Data collection - individuals identified

We identified a total of thirteen individuals by their chest patterns (Table 2, 3). For all of these individuals, we collected defining photos of their chest patterns, which will allow future photo-based identification. In addition, for nine of these individuals we were able to conclusively determine sex (Table 2, 3). We collected hair samples of three individuals, and a few additional samples where the individual was not certain (Table 4). We collected scat of one photo-identified individual, and scat samples from two additional individuals (one of which we also have hair samples for) (Table 4). We currently have no DNA analysis planned for these samples until 2018, but they are available to interested parties for earlier analysis.

Only two sites had no wolverine visits: The site on Bugaboo Creek FSR (*CMHBU1*), and the site in Goat Range Provincial Park in McKian Creek (*SelkWCat1*). Most individuals only visited one site each, but visited the site multiple times. This was intended, as we had attempted to set only one site within each potential female's territory (Table 3). The exceptions were the male and female in K3's cat ski tenure in the Monashee Mountains (Anstey Range), which both visited both K3 sites repeatedly (Table 3). These sites were 7.1 km apart, and apparently were part of both individuals' territories. The female was not lactating, which might explain her large movements throughout winter.

Of the five females captured on camera, one was lactating, and the other four were not (Table 2). Females usually breed every second year only, and generally stay close to their dens in winters when they do breed, but begin to increase their movement radius in spring (Myhr 2015). The lactating female (*Dore1-F2 Freyja*) visited one site (*Dore 1*) in late April, after the bait had already disappeared. Another female (*Dore1-F1 Sara*) had visited that same site repeatedly in March and April, feeding on the offered bait.

As expected, most individuals readily climbed the run poles to reach the offered bait, but some visited the sites a number of times until finally climbing the run poles. It is possible that there were additional individuals visiting the sites that we were not able to identify, if

they never climbed the run pole. The number of individuals identified is not necessarily indicative of population status, as this was not a representative survey. Yet, the results reflect that wolverines were present on the landscape around the camera sites, especially at the more remote northern sites in the Cariboo and Monashee Mountains, and were attracted to the bait stations. In line with all previous wolverine studies using white-flash cameras, wolverines and all other visiting species appeared unfazed by the bright flash during nighttime visits.

Data collection - Other species detected

Marten were recorded at all sites and during all sessions but one (Table 5), and usually consumed most of the bait before wolverines arrived. Red squirrels were detected at most sites, but might not have triggered the cameras at all sites. Similarly, flying squirrels were only documented at one site, but might not have triggered the camera at others. Lynx were only detected at one site (*CMHBB1*). Black bears were detected at four sites, during the last session. One grizzly bear was photographed, also during the last session. Wolves were only detected at one site, after takedown of the site, when all of the snow had disappeared. An overview infrared camera that had inadvertently been left at the site recorded the wolves. In addition to the wolves, this camera yielded interesting photos of the resident male wolverine, which repeatedly visited even after all bait and structures had been removed. The visits of wolves and black bears after takedown suggested that the lingering smell still attracted carnivores well after all of the bait was consumed. We detected four different moose but only at one of the sites, during the last session after the snow had melted. Ungulates often visited the hair sites during our Canadian Rockies' surveys. A summary of all species detected is provided in Table 3.

Interactions with stakeholders

From the ten trappers contacted by mail, three contacted Mirjam Barrueto by phone, to discuss the project and contribute their own knowledge of wolverines in the area. During our monthly visits at the three snowcat and heli ski companies, we discussed the upcoming survey with owners, managers and staff, and collected input as to the feasibility of different fieldwork management strategies. In addition, we gave a small presentation to the guests at one lodge, and Mike Wiegele Heli Skiing put together a short film with video footage of wolverines at the two sites in their tenure for their own guests. Most interactions with BC government representatives were made over the phone, and included permitting related questions, but also other, more general topics with regards to the upcoming research. We were very fortunate to have had one BC Parks Ranger volunteer to help set up and re-check two of the sites.

Discussion

Goal 1: Test and refine the proposed field methods

This pilot study confirmed that cameras aimed at baited run poles could successfully document lactation in females. While the sampling was not a population survey, eight of the cameras were located in places that have never been surveyed for wolverines before. Compared to non-invasive methods relying on DNA analysis, which have been used in previous wolverine studies that we have been involved with, identification by chest patterns has multiple advantages:

1) Individual visitation data is immediately available upon collection of the memory card.
2) Breeding status for males and females can be determined.
3) Visitation data is continuous.
4) Multiple people can analyze photographs and minimize the risk of false recapture events.
5) Data is robust and a high level of data quality is easily achievable. High levels of data quality are more difficult to achieve with DNA based recapture data due to a high degree of reliance on lab analysis.
6) Upfront costs for the white-flash cameras are offset by much lower costs for DNA analysis, especially during a multi-year study, although cameras may have long term resale value.

During this pilot study, we did not spend very much effort collecting hair samples from visiting individuals, but still collected hair and scat samples from at least four individuals. Obtaining one high quality DNA sample of each individual will be one of the goals of the full survey. Utilizing cameras to identify individuals allows assignment of hair samples collected during a session. This can make DNA extraction of the often relatively low quality hair samples much more successful, as samples can be pooled if only one individual visited during a session.

One big challenge of the study area is that snow levels vary dramatically during winter. Despite the input of people with extensive local knowledge, anticipating peak snow depth at each site was difficult, but necessary to ensure that run poles do not get buried. Installing a run pole too high is not a problem as wolverines will still climb, but it significantly increases the time needed to install the site and to collect hair samples, which in turn increases the cost of the fieldwork. One solution to increase site-setup and re-baiting efficiency is to change the way the run pole is attached to the tree, to facilitate moving the run pole higher or lower as winter progresses. The wire attachment setup we devised worked capably and effectively, allowing us to quickly lower and raise the wire on which the bait was hung, without having to climb during re-baiting (Figures 2, 3, and 4).

The tested cameras performed very well. While *Reconyx* cameras are still the best option with regards to robustness, reliability, versatility and cold tolerance, the other brands are priced much more competitively. Given the large disparity in price, we will consider using the two brands we tested for the large-scale survey.

Due to concerns about grizzly bears by government biologists, and in keeping with our research permit requirements, we used elk legs (from road killed animals) for the last round of baiting. Skinned frozen beavers are a preferred bait type for carnivore research purposes because of the absence of hair and their attractiveness to most carnivores. However, large elk, deer and moose bones are also successful at attracting wolverines, and last longer in warm spring temperatures.

Goal 2: Increase understanding of logistical challenges
We trialed a number of "site management options". We specifically attempted to include many people with different levels of wolverine and winter-specific fieldwork experience.

While more hands were always better, the site setup was complicated, and required training, especially compared to the fieldwork of previous surveys. The time needed to complete a site visit was significantly lower when only people familiar with the mechanics of it were present. The two helicopter accessed sites we managed differently: Following training and joint setting of the first site (*Wiegele 1 White River*), Mike Wiegele Helicopter Skiing ski guides independently and very successfully set up a second site in their tenure (*Wiegele 2 Maple Leaf)*. They then checked and re-baited both sites twice independently. Despite the busy operational schedule, they capably complied with an approximately one month sampling interval.

Another logistical challenge encountered was that in late spring, some of the snowmobile-accessed sites became very difficult to reach. Ideally, all sites are left up into mid to late May, as lactation in females is most evident in late April and early May. Access difficulties were particularly pronounced for sites at high elevations within cat ski tenures, which are accessed on snowcat roads. These sites can become inaccessible as soon as operations stop for the season and the cat roads are no longer maintained. For example, a heavy spring snowpack in the Selkirks this year meant that one of the sites (*SelkWCat 1* in McKian Creek) became inaccessible after operations stopped in early April, too early for take down. It remained inaccessible until early July, and necessitated walking 12 kilometers as three feet of lingering snow prevented ATV access. For a small study, this kind of effort to check and remove sites is acceptable, but it is not scalable. In the proposed, larger study, helicopters may be required for all but the most accessible high elevation sites. Low elevation sites that were accessed by snowmobile during winter, were less problematic, as the roads generally melted out enough to allow the use of 4x4 trucks for the final check and site removal.

In conclusion, the most efficient way to set up and manage a large number of sites will be to train a small, dedicated crew and mostly utilize helicopters for access. Local crews, such as helicopter or cat ski company staff, or interested trappers, can then check the smaller number of easily accessible sites.

Goal 3: Demonstrate the efficacy of photo based individual wolverine identification
Identifying individuals based on photos was very straightforward in most cases. Only two wolverine visits could not be assigned to a specific individual, as the photographs of them did not reveal sufficient detail of their fur patterns (Table 3). Neither of these individuals climbed the run pole. Most animals spent enough time on the run pole to produce hundreds of defining chest photos from various angles. In addition, most animals we were able to identify sex of, despite of the fact that most individuals were only detected at one station. During a population survey, camera stations are placed such that most individuals will be detected at multiple stations. This highly increases the chances that an individuals' sex and breeding status can be determined. Similarly, lactation status was very obvious in photos taken in late spring (Figure 5).

In addition to the practice gained in individual identification, the photos collected during the pilot season will help in designing a spatially indexed database that will simplify analysis of a large number of photographs arising during the full, upcoming survey.

Other species

As in previous wolverine studies involving baited camera stations, other carnivores were attracted to the stations and detected by the site overview cameras. Occurrence data on other carnivore species is very valuable, and will allow us to test hypotheses with regards to ecosystem condition impacts on wolverine distribution.

Acknowledgments

A number of people and businesses have generously supported this pilot field study and have put up with frozen beavers and smelly lure. Most importantly, K3 Cat Ski covered all of the material and fuel costs with a very generous donation, in addition to providing in-kind support in the form of staff time and accommodation. Mike Wiegele Helicopter Skiing generously supported the fieldwork with in-kind donations of helicopter and staff time, as well as assisting with lodging. Selkirk Snowcat Skiing also supported us with donations of staff time and accommodation. A big thank you is owed to Tony Clevenger for his help with fieldwork, logistics and equipment. We also wish to thank Garth Mowat from the Ministry of Forests, Lands and Natural Resource Operations, and Chris Price from the Ministry of Environment, for help with permits, and equipment. The following volunteers kindly helped with field work: Jonathan Effa, Dave Heagy, Reg Bunyan, Shauna Morey, Dan Cooper, Magdalena Kosior, Maria Cavedon, Verena Barrueto, and Asuncion Barrueto.

References

Banci, V. & Proulx, G. (1999). Resiliency of furbearers to trapping in Canada. Mammal trapping. *Alpha Wildlife Publications, Sherwood Park, Alberta, Canada,* 175-203.

[BC CDC] B.C. Conservation Data Centre. 2017. Conservation Status Report: *Gulo gulo luscus*. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Jul 20, 2017).

Clevenger, A.P., Mowat, G., Barrueto, M & Fisher, J. (2016). Understanding landscape and human effects on wolverine abundance, distribution and connectivity in the Canadian Crown of the Continent (CCoC) ecosystem. Technical report, http://www.wolverinewatch.org/wp-content/uploads/2015/05/2016-WolverineAnnualReport.pdf. 34 pages

Copeland, J. P., McKelvey, K. S., Aubry, K. B., Landa, A., Persson, J., Inman, R. M., ... & Magoun, A. (2010). The bioclimatic envelope of the wolverine (Gulo gulo): do climatic constraints limit its geographic distribution? *Canadian Journal of Zoology*, 88(3), 233-246.

COSEWIC (2014) COSEWIC assessment and status report on the wolverine *Gulo gulo* in Canada. *Committee on the Status of Endangered Wildlife in Canada, Ottawa.*

Flagstad, Ø., Hedmark, E. V. A., Landa, A., Brøseth, H., Persson, J., Andersen, R., ... & Ellegren, H. (2004). Colonization history and noninvasive monitoring of a reestablished wolverine population. *Conservation Biology*, *18*(3), 676-688.

Kortello, A. & Hausleitner, D. (2016). Abundance and distribution of wolverine in the Kootenay Region: 2016 Field Season Report: Central Purcell Mountains. Prepared for *Ministry of Forests, Lands and Natural Resource Operations, Nelson, BC.*

Krebs, J., Lofroth, E., Copeland, J., Banci, V., Cooley, D., Golden, H., ... & Shults, B. (2004). Synthesis of survival rates and causes of mortality in North American wolverines. *Journal of Wildlife Management,* 68(3), 493-502.

Krebs, J., Lofroth, E. C., & Parfitt, I. A. N. (2007). Multiscale habitat use by wolverines in British Columbia, Canada. *Journal of Wildlife Management*, *71*(7), 2180-2192.

Lofroth, E. C., & Ott, P. K. (2007). Assessment of the sustainability of wolverine harvest in British Columbia, Canada. *Journal of Wildlife Management*, 71(7), 2193-2200.

Magoun, A. J., Long, C. D., Schwartz, M. K., Pilgrim, K. L., Lowell, R. E., & Valkenburg, P. (2011). Integrating motion-detection cameras and hair snags for wolverine identification. *Journal of Wildlife Management*, *75*(3), 731-739.

McKelvey, K. S., Copeland, J. P., Schwartz, M. K., Littell, J. S., Aubry, K. B., Squires, J. R., ... & Mauger, G. S. (2011). Climate change predicted to shift wolverine distributions, connectivity, and dispersal corridors. *Ecological Applications*, 21(8), 2882-2897.

Myhr, T-M. (2015). Movement pattern of wolverine females around the den during the denning period. BSc. SLU (in Swedish). Translated to English by Ann Olsson.

Persson, J. (2005). Female wolverine (Gulo gulo) reproduction: reproductive costs and winter food availability. *Canadian Journal of Zoology*, 83(11), 1453-1459.

Stewart, F. E., Heim, N. A., Clevenger, A. P., Paczkowski, J., Volpe, J. P., & Fisher, J. T. (2016). Wolverine behavior varies spatially with anthropogenic footprint: implications for conservation and inferences about declines. *Ecology and evolution.*

Vangen, K. M., Persson, J., Landa, A., Andersen, R., & Segerström, P. (2001). Characteristics of dispersal in wolverines. *Canadian Journal of Zoology*, *79*(9), 1641-1649.

Figures

Figure 1. Yellow dots mark the ten camera stations deployed to detect wolverines during the pilot field season in winter 2017, in the Columbia Mountains, BC. All but two sites (*Wiegele 1* and *Wiegele 2*) were accessed by snowmobile, along established snowcat trails or logging roads. *Wiegele 1* and *Wiegele 2* were accessed by helicopter.

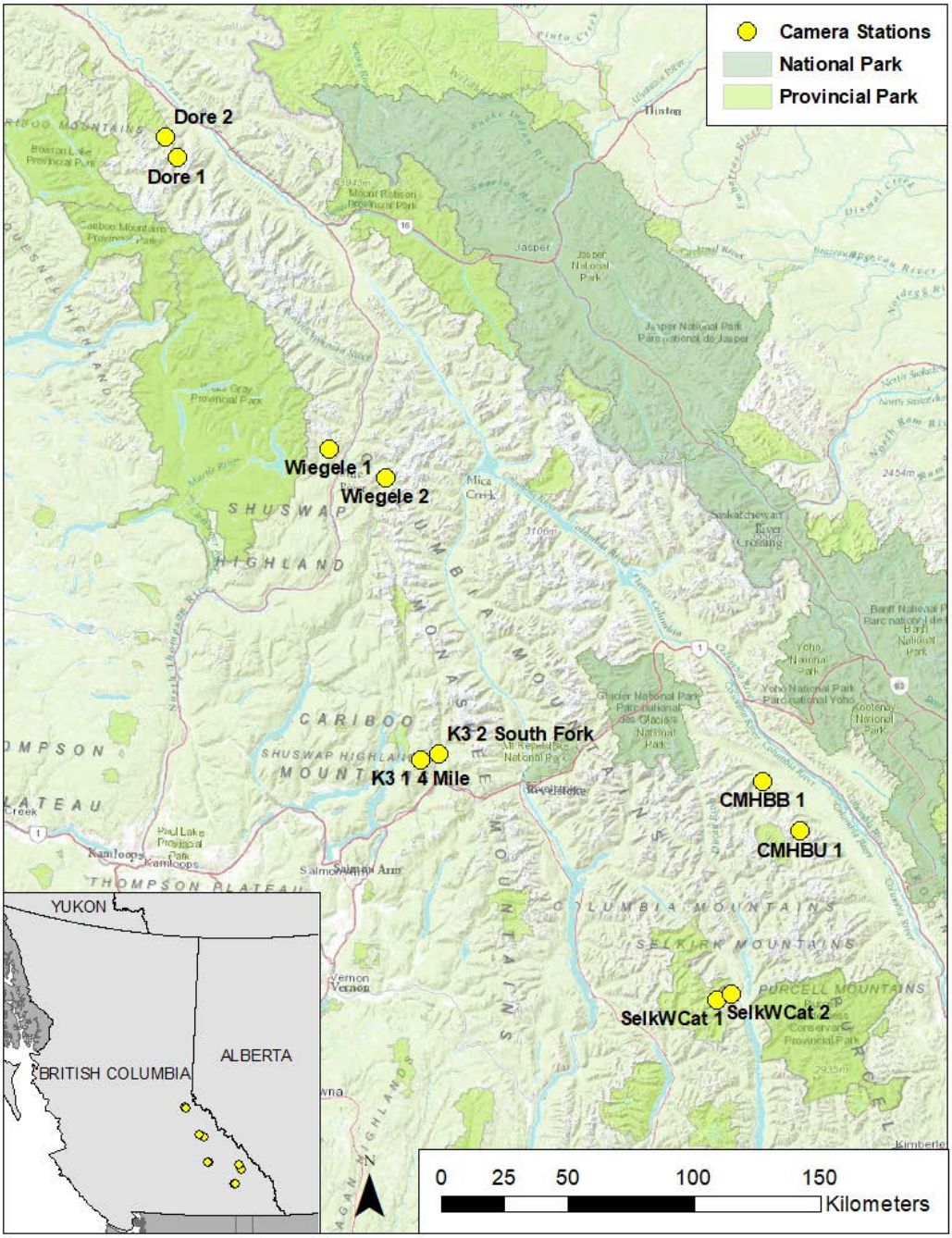

Figure 2 Overview of site set-up for the non-invasive camera stations. Ten camera stations were deployed as part of the pilot field season in winter 2017, in the Columbia Mountains, BC.

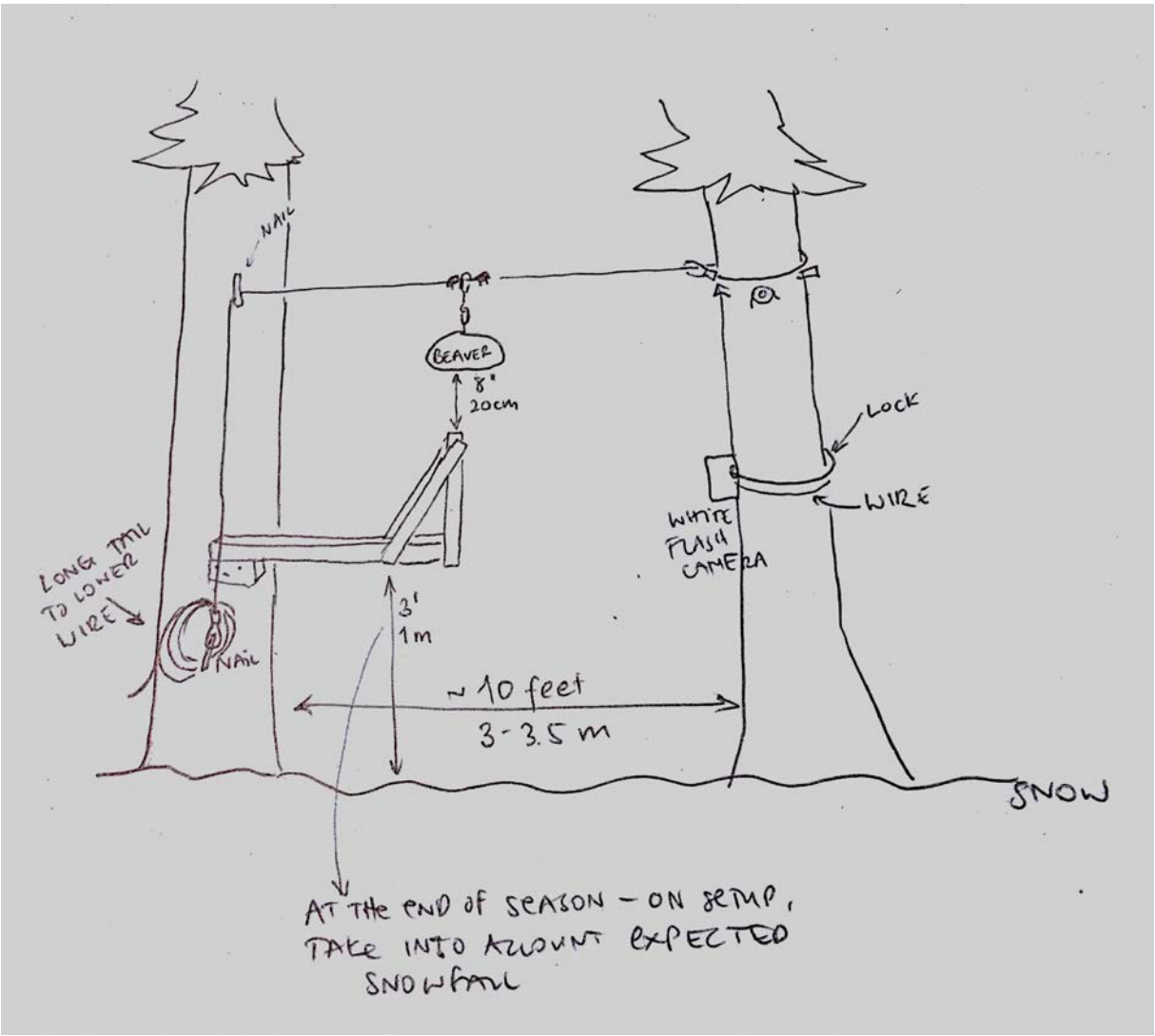

Figure 3 Lower attachment point for the wire spanned between trees. The tail is long enough to allow lowering of wire during re-baiting of the camera stations. Ten camera stations were deployed as part of the pilot field season in winter 2017, in the Columbia Mountains, BC.

Figure 4 Set-up to attach bait to the wire during setting and rebaiting of the camera stations. Ten camera stations were deployed as part of the pilot field season in winter 2017, in the Columbia Mountains, BC.

Figure 5 Abdomen of two females. The photo on the left clearly shows the enlarged teats of a lactating female, visible between the hind legs. Photo taken on April 12, 2017. The photo on the right shows the abdomen of a female that is not lactating. Photo taken on April 29, 2017. The photos were collected at two camera stations that were deployed as part of the pilot field season in winter 2017, in the Columbia Mountains, BC.

Tables

Table 1 Sampling sites location, access and management description. Ten non-invasive camera stations were deployed during the 2017 pilot field season, across the Columbia Mountains, BC.

Site	Mountain Range	Description	WMU	Land Status	Start Date	End Date	Zone (U)	UTM East	UTM North	Access	Elevation (m)
Wiegele 1 White River	Cariboo	White River	3-40	Crown land	14-Jan-17	18-Apr-17	11	338037	5783071	Heli	1358
Wiegele 2 Maple Leaf	Monashee	Adams River	3-42	Crown land	4-Feb-17	18-Apr-17	11	360756	5771492	Heli	1253
K3 1 4 Mile	Monashee	4 Mile Creek	3-36	Crown land	23-Jan-17	7-Jun-17	11	374521	5659851	Sled	1519
K3 2 South Fork	Monashee	Gorge South Fork FSR	3-35	Crown land	23-Jan-17	24-Apr-17	11	381472	5661988	Truck	617
CMHBB 1	Purcell	Vowell Creek FSR	4-34	Crown land	31-Jan-17	7-May-17	11	509611	5651138	Sled	1208
CMHBU 1	Purcell	Bugaboo Creek FSR	4-34	Crown land	31-Jan-17	6-May-17	11	524501	5631377	Sled	1358
SelkWCat 1	Selkirk	McKian Creek	4-30	Provincial Park	2-Feb-17	6-Jul-17	11	491423	5564591	Sled	2121
SelkWCat 2	Selkirk	Meadow Mountain	4-30	Crown land	2-Feb-17	6-Jul-17	11	497095	5566778	Sled	1533
Dore 1	Cariboo	South Dore FSR	7-5	Crown land	5-Feb-17	28-May-17	10	679301	5896732	Sled	1182
Dore 2	Cariboo	Dore River FSR	7-4	Crown land	5-Feb-17	28-May-17	10	673707	5904402	Sled	1264

Table 2 Individuals detected based on photographs. Thirteen individuals were detected during the pilot field season in winter 2017, in the Columbia Mountains, BC.

Sites	Sex	Lactating	Name 1	Name 2	Hair
CMHBB 1	Unconfirmed	-	BB1-unk1	-	-
CMHBB 1	Female	No	BB1-F1	Sophie	-
Dore 1	Female	No	Dore1-F1	Sara	X
Dore 1	Female	Yes	Dore1-F2	Freyja	(x)
Dore 1	Unconfirmed	-	Dore1-Unk1	-	(x)
Dore 2	Male	-	Dore2-M1	Mustafa	scat
SelkWCat 1	Unconfirmed	-	SelkWCat1-Unk1	-	x
Wiegele 1 White River	Male	-	Wiegele1-M1	Rolf	-
Wiegele 2 Maple Leaf	Female	No	Wiegele2-F1	Lilly	-
Wiegele 2 Maple Leaf	Male	-	Wiegele2-M1	Jordan	-
Wiegele 2 Maple Leaf	Unconfirmed	-	Wiegele2-Unk1	-	-
K3 1 and K3 2	Female	No	K3-F1	Willow	x
K3 1 and K3 2	Male	-	K3-M1	Goliath	(scat)

Table 3 Wolverine individuals detected by camera station (site) and session. Each session lasted approx. one month. Ten non-invasive camera stations were deployed during the 2017 pilot field season, across the Columbia Mountains, BC.

Session	Site	Individual 1	Individual 2	Individual 3
1	CMHBB 1			
2	CMHBB 1			
3	CMHBB 1	CMHBB1-unk1	CMHBB1-F1 Sophie	
1	CMHBU 1			
2	CMHBU 1			
3	CMHBU 1			
1	Dore 1	Unknown (Hair sample)		
2	Dore 1	Dore1-F1 Sara		
3	Dore 1	Dore1-F1 Sara	Dore1-F2 Freyja	Dore1-Unk1
1	Dore 2	Dore2-M1 Mustafa		
2	Dore 2	Dore2-M1 Mustafa		
3	Dore 2	Dore2-M1 Mustafa		
1	K3 1 4Mile	K3-M1 Goliath	K3-F1 Willow	
2	K3 1 4Mile		K3-F1 Willow	
3	K3 1 4Mile	K3-M1 Goliath	K3-F1 Willow	
1	K3 2 South Fork	K3-M1 Goliath	K3-F1 Willow	
2	K3 2 South Fork		K3-F1 Willow	
3	K3 2 South Fork	K3-M1 Goliath		
1	SelkWCat 1			
2	SelkWCat 1			
3	SelkWCat 1			
1	SelkWCat 2			
2	SelkWCat 2			
3	SelkWCat 2	SelkWCat2-Unk1		
1	Wiegele 1			
2	Wiegele 1	Unknown (Wiegele1-M1?)		
3	Wiegele 1			
4	Wiegele 1	Wiegele1-M1 Rolf		
1	Wiegele 2	Wiegele2-F1 Lilly		
2	Wiegele 2	Wiegele2-M1 Jordan	Wiegele2-Unk1	
3	Wiegele 2	Wiegele2-F1 Lilly		

Table 4 Hair and scat samples collected during the pilot field season in winter 2017, in the Columbia Mountains, BC.

Session	Site	Source	# Samples	Species	Individuals present
1	Dore 1	Hair	1	Gulo	Unknown individual (likely Dore1-F1 Sara)
2	Dore 1	Hair	6	Gulo	Dore1-F1 Sara
3	Dore 1	Hair	3	Gulo	Dore1-F1 Sara; Dore1-F2 Freyja; Dore1-Unk1
1,2,3	Dore 2	Scat	many	Gulo?	Dore2-M1 Mustafa.
2	K3 1 4Mile	Hair	2	Gulo	K3-F1 Willow
1,2,3	K3 1 4Mile	Scat	many	Gulo?	K3-F1 Willow; K3-M1 Goliath.
2	K3 2 South Fork	Hair	4	Gulo	K3-F1 Willow
1	SelkWCat 1	Hair	1	Marten	na
2	SelkWCat 2	Hair	2	Marten	na
3	SelkWCat 2	Hair	3	Gulo	SelkWCat2-Unk1

Table 5 Species and individuals detected during each session at the ten non-invasive camera stations that were deployed during the 2017 pilot field season, across the Columbia Mountains, BC.

Session	Site	Wolverine	Marten	Lynx	Black bear	Flying squirrel	Red squirrel	Moose	Grizzly	Wolf
1	CMHBB 1		x			x				
2	CMHBB 1		x	x		x	x			
3	CMHBB 1	x	x			x	x			
1	CMHBU 1		x							
2	CMHBU 1		x							
3	CMHBU 1		x				x			
1	Dore 1	x	x							
2	Dore 1	x	x							
3	Dore 1	x	x		x			x		
1	Dore 2	x	x							
2	Dore 2	x	x				x			
3	Dore 2	x	x		x		x		x	
1	K3 1 4Mile	x	x							
2	K3 1 4Mile	x	x							
3	K3 1 4Mile	x	x				x			
1	K3 2	x	x				x			
2	K3 2	x	x				x			
3	K3 2	x	x		x		x			x
1	SelkWCat 1		x							
2	SelkWCat 1		x							
3	SelkWCat 1		x		x					
1	SelkWCat 2		x							
2	SelkWCat 2		x							
3	SelkWCat 2	x	x				x			
1	Wiegele 1		x				x			
2	Wiegele 1	x	x				x			
3	Wiegele 1		x				x			
4	Wiegele 1	x	x				x			
1	Wiegele 2	x								
2	Wiegele 2	x	x							
3	Wiegele 2	x	x				x			