

# Effects of Human Activities and Natural Processes on Wolverine Reproduction and Connectivity

*2019 Summary Report*

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Thank you to our partners and funders:



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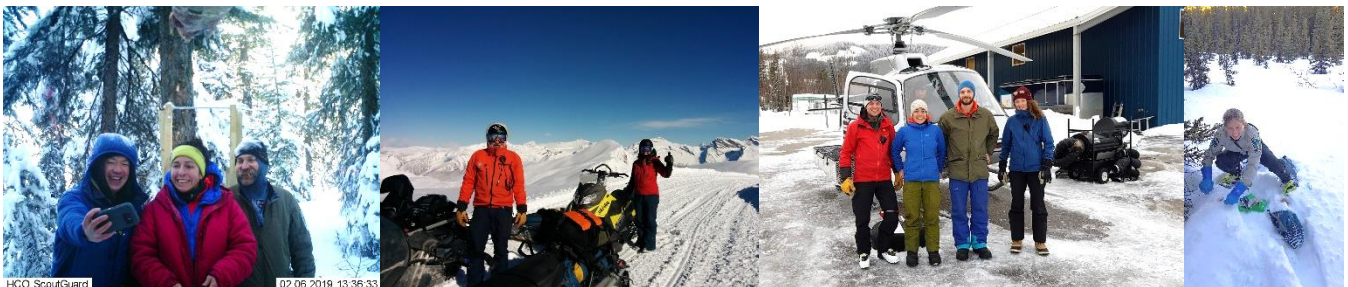
## ACKNOWLEDGEMENTS

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This project could not happen without the help and support of hundreds of people. It is a community effort.



## 1. BACKGROUND AND CONTEXT

Wolverine are listed as Special Concern in British Columbia and under the federal Canadian Species at Risk Act because a) populations are declining in the southern part of their range (British Columbia); b) wolverine habitat across Canada is increasingly fragmented by industrial activity and climate change especially in the southern part of their range; and c) wolverine have low reproductive rates, are sensitive to human disturbances, and require vast secure areas to maintain viable populations (COSEWIC 2014).

**Previous research** in the Columbia Mountains, the Central Canadian Rockies and Idaho indicates:

- a. Wolverine are susceptible to disturbance from high levels of human backcountry-use (Krebs et al. 2007; Stewart et al. 2016). Female wolverines experience indirect habitat loss in areas with intense motorized (snowmobile) and non-motorized (ski touring) winter recreation. Off-road snowmobiling elicited a stronger response than road-based snowmobiling (Heinemeyer et al. 2019).
- b. The Trans-Canada Highway is a barrier to female dispersal (Sawaya et al. 2019).
- c. Wolverine density across >100,000 km<sup>2</sup> in the southern Columbia and Canadian Rocky Mountains averaged 2 wolverines/1,000 km<sup>2</sup> and was positively related to spring snow cover and negatively related to forestry road density (Mowat et al. 2019).
- d. Current levels of trapping in the Kootenays may be unsustainable (Mowat et al. 2019).
- e. Within a 9000 km<sup>2</sup> study area in Banff, Yoho and Kootenay national parks, wolverine occurred at low densities of approximately 3 wolverines/1,000 km<sup>2</sup> in 2011-2013 (Barrueto et al. 2020).
- f. Within a 7000 km<sup>2</sup> study area in the Columbia Mountains (Big Bend Country of the Columbia River), wolverines occurred at densities of approximately 6 wolverines/1,000 km<sup>2</sup> in 1997 – 2004 (Lofroth and Krebs 2007).
- g. Protected areas may function as source populations for surrounding unprotected areas, with young individuals from protected areas dispersing to unprotected areas where fewer wolverines are born (Heim et al. 2017; Barrueto et al. 2020).

**In summary**, research conducted over more than 20 years in this region but mostly south of our study area (see Section 2), showed that the number of wolverines south of our study area is low; the Trans-Canada Highway is a barrier to female dispersal; harvest in the Kootenay Region (which includes the southern parts of our study area) may be unsustainable; and intense winter recreation, perhaps above current levels of recreation in our study area, may lead to indirect habitat loss for female wolverines.

Within our study area, no current information on the number of wolverines is available. The only prior survey ended in 2002; it was conducted in a small part of our study area, the Big Bend Country of the Columbia River (between Revelstoke and Golden, north of the Trans-Canada Highway). That study concluded that while wolverines were present and reproducing in the Big Bend area, human use (including winter recreation) and the presence of forestry roads reduced habitat values for female wolverines (Lofroth and Krebs 2007). The authors recommended precautionary steps including to 1) protect habitat and ungulate prey species, 2) collect quantitative map-based data on human use, and 3) conduct research to examine thresholds of human use intensities on wolverine behavioural and demographic responses.

Since then, human activities have continued to occur and possibly grow in our study area, but no quantitative human use or wolverine data has been collected; furthermore, caribou, a preferred food source for reproductive females, have declined. Progress has been made with regards to our knowledge of wolverines behavioural and demographic responses to winter recreation (Heinemeyer et al. 2019). Female wolverines are selective about habitat and if they don't disperse across major highways, the value of the North Columbia Region as source populations will be reduced.

To answer some of the open questions, Mirjam Barrueto started this PhD research project in September 2017 at the University of Calgary, to better understand the ecology of female wolverines in the North Columbia Region and Canadian Rocky Mountains.

**Research objectives** include:

1. To determine the regional density and distribution of wolverines;
2. To evaluate and compare top-down and bottom-up effects of human activities on wolverine density, distribution and potentially on physiological status, particularly that of breeding females, while accounting for variability in natural habitat characteristics;
3. To estimate regional population structure, connectivity and source-sink mechanisms;
4. To determine how infrastructure such as highways and hydro-reservoirs impact female dispersal and gene flow that can lead to fragmented populations;
5. To communicate among interested parties and decision-makers.

Similar to what is advised for other species of conservation concern, our data on female wolverine reproduction and abundance will be used to assess population viability and identify potential management factors and thresholds to achieve sustainable use of landscapes for people and wildlife. The project uses a combination of remote cameras and hair snagging to look at the effects of human activities and natural processes on breeding female wolverines. Fieldwork is planned from 2018 to 2020, and the PhD (including all data analysis and write-up) is slated to end late 2022.

**Partnership:** The research project is conducted through a partnership including the Department of Biological Sciences at the University of Calgary; Parks Canada Agency (Banff, Yoho, Kootenay, Glacier and Mt Revelstoke National Parks), Yellowstone to Yukon Conservation Initiative, several members of the helicopter and cat skiing industry in British Columbia (Mike Wiegele Helicopter Skiing, Selkirk Tangiers Heli Skiing, K3 Cat Ski, Mustang Powder). Strong partnerships are needed for this kind of landscape study, not only for financial reasons, but also to ensure effective sharing of knowledge and information that may otherwise not be available to researchers and other partners.

## 2. STUDY AREA AND METHODS

Our study area is focused on the Columbia Mountains and the Canadian Rocky Mountains (Figure 1 and 2). 2018 was the first year of the three-year sampling program. We surveyed wolverine occurrence using a clustered sampling design, consistent with previous wolverine research to enable data pooling and large-scale analyses. In

2019, the number of sampling stations was expanded. For 2020 we plan to put out the same number of sampling stations as in 2019. Some sampling stations will be moved to new areas to fill data gaps.

We use a non-invasive hair and camera trap to sample each site. Stations are baited and include wooden structures (“run poles”) attached to a tree, on which wolverines climb, exposing their chest and abdomen to the camera. Each station is equipped with two cameras. One aims at the run pole, taking photos of chest and abdomen. A second camera takes overview photos to document visits by wolverines that don’t result in climbing of the run pole, and visits by other species. Stations are equipped to collect hair for DNA analysis. Once sites are set, two or three visits are conducted approximately one month apart to collect hair samples, photographs, and rebait the station. Wolverine numbers and distribution will be determined by analyzing the photographs and hair samples. We will use spatial capture re-capture, population and landscape genetic models to answer the research questions. Genetic analyses of hair samples collected over the entire three-year period will begin in spring 2020 – all hair samples from 2018 and 2019 have been delivered to the lab (Wildlife Genetics International) in Nelson, BC.

### 3. RESULTS

#### 3.1. Year 1 (2018)

In 2018 we set up and made 3 repeat visits to 58 stations in the North Columbia Region (NCR) and 22 in Banff, Yoho and Kootenay national parks (BYK). We collected 186,000 photos from the remote cameras. We collected 350 hair samples, many from wolverines. Out of 78 sites, 63 sites (80.8%) were visited by wolverines at least once. Based on photos we detected 35 individual wolverines in the NCR and 11 individuals in BYK.

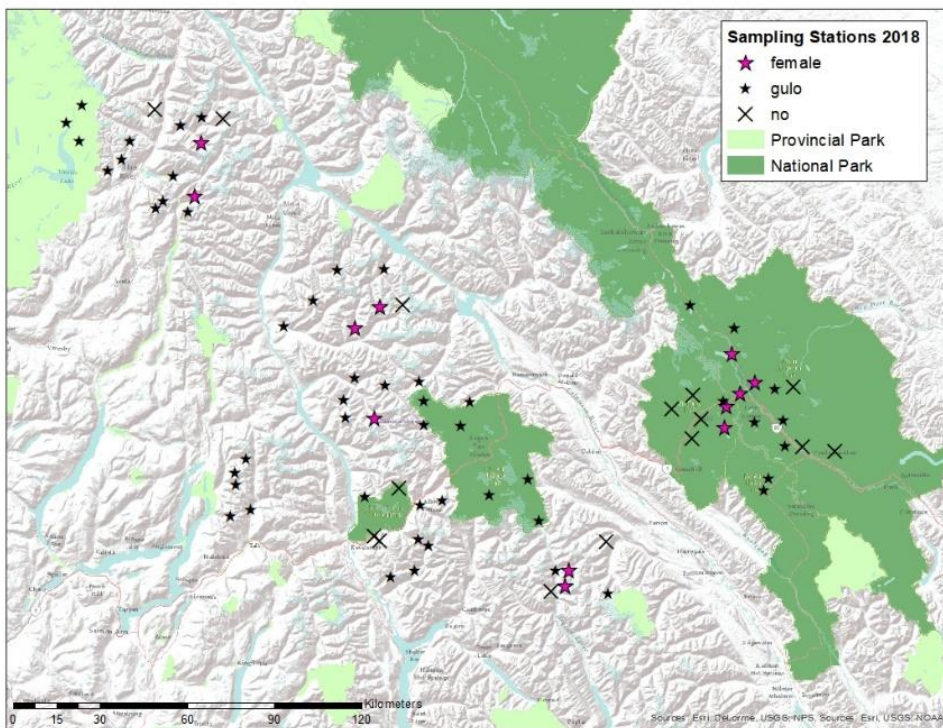


Figure 1 Sampling stations and preliminary results 2018

In 2018 in NCR, we made 177 site visits during 37 field days. In BYK, 62 site visits were conducted on 48 work days. In most cases, one of four project staff were leading site visits, usually assisted by two or more helpers: helicopter and cat ski guides and staff, Parks Canada staff, helicopter pilots, and volunteers. For both NCR and BYK combined, the field work was conducted in approximately 675 people work days, involving over 46 individuals.

### 3.2. Year 2 (2019)

We spent summer and fall 2018 evaluating lessons learned in Year 1 to ensure that Year 2 would build on successes and learn from challenges. This included starting the sampling season earlier (Jan-13 instead of Feb-01), hiring one full-time technician for January-April and one for February, in addition to full-time work by M. Barrueto (the PhD student) and hundreds of hours of volunteer time through our partners.

In 2019 we monitored 152 stations: 30 in BYK and 122 in NCR. We collected >99'700 photos in BYK, and >631'600 photos in NCR. We collected 226 (BYK) and 964 (NCR) hair samples, many from wolverines. Out of 152 sites, 134 sites (88.2%) were visited by wolverines in at least one of the two years. Other species detected on cameras include pine marten, red and flying squirrels, bird species, coyote, wolf, red fox, Canada lynx, mountain caribou, mountain goat, black and grizzly bears.

In 2019 in NCR, we made 481 site visits during 92 field days. In BYK, 100 site visits were conducted on 86 work days. As in 2018, many people were involved in the field work. In most cases, one of four project staff were leading site visits, usually assisted by two or more helpers: helicopter and cat ski guides and staff, Parks Canada staff, helicopter pilots, and volunteers. Over 45 people helped with fieldwork in NCR, at least 16 people helped in BYK with setup, and more during re-visits.

As analysis of the photographic and genetic data is ongoing, no formal abundance estimates have been carried out yet. Naïve occupancy, which is simply the proportion of sites where wolverines were detected at, in our combined study area (BYK and NCR) was approx. 0.88 (Figure 2). This is high compared to an occupancy probability of 0.50 (SE = 0.09) in the southern Columbia Mountains and of 0.32 (SE = 0.04) in the southern Canadian Rockies (Clevenger et al. 2017; Kortello et al. 2019).

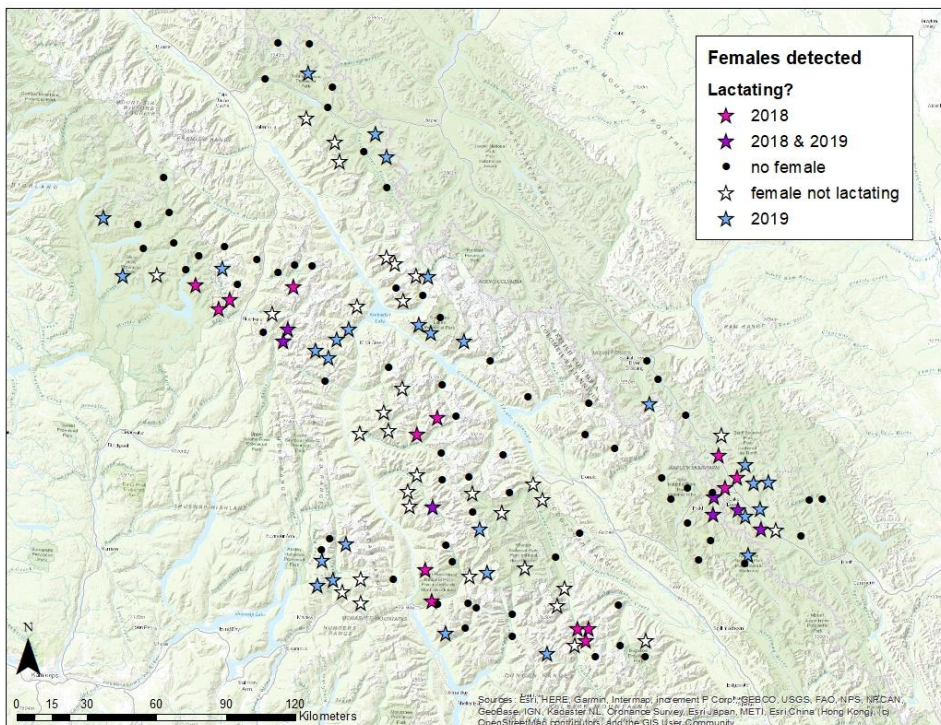


Figure 2 Female detections and lactation status, based on photographs.

Note: Our preliminary naïve occupancy estimate above may be artificially high and the comparison is not final until appropriate habitat quality adjustments are made (see below). To explain further: the two previous studies in the southern Columbias (Kortello et al. 2019) and southern Canadian Rockies (Clevenger et al. 2017; Mowat et al. 2019), sampled all wolverine habitat, including marginal habitat. On the other hand, our current sampling design

focuses on detecting breeding females across the region and less sampling may have been occurring in marginal habitat. To ensure precise results when comparing occupancy and later density of the three areas (our study area, southern Columbias, southern Canadian Rockies), and to reduce the potential for sampling bias from inadvertent focus on high quality habitat, we will have to consider underlying natural habitat factors.

The following numbers and breeding statuses are based on photographs. As the genetic analysis is not completed yet, they have not yet been cross-referenced with genetic results and should thus be treated as preliminary. A few of the “unknown sex” individuals may turn out to be already known as a female or male. In addition, the sex of an individual can be determined by either clear photographs of the reproductive parts, or by genetic analysis. Breeding females and adult males can usually be sexed with high confidence based on photos alone, but the sex of subadult wolverines generally requires confirmation from genetic analysis.

### 3.3. Preliminary numbers: Banff, Yoho, Kootenay National Parks (BYK)

Based on photographs, in 2018 and 2019 we detected 17 individuals: 6 Males, 7 Females (in 6 females lactating was evident), and at least 4 individuals of undetermined sex. 6 individuals were detected in both years. All but 5 individuals were found at more than one sampling station.

### 3.4. Preliminary numbers: North Columbia Region (NCR)

Based on photographs, in 2018 and 2019 we detected 111 individuals: 29 males, 43 females, and 39 of undetermined sex. 21 females appeared to be breeding (lactation evident). All numbers and breeding status are preliminary. We divided the NCR sites into 7 areas, partly based on geography, partly on the underlying helicopter ski tenures or protected area boundaries. So far, we have not yet detected any individual in more than one area. The breakdown of wolverines by area (Figure 3) is as follows:

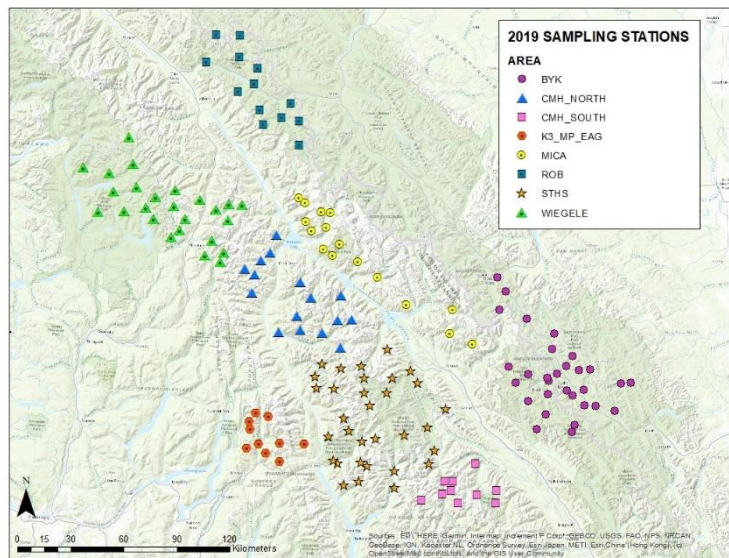


Figure 3 Sampling stations 2019 by area

1. **Mount Robson (ROB):** 3 males, 4 females (2 lactating), 4 of unidentified sex.
2. **Mica Heliskiing & Blackwater Range (MICA):** 2 males, 5 females (3 lactating), 3 of unidentified sex
3. **Selkirk Tangiers Heli Skiing & Glacier & Mt Revelstoke National Parks (STHS):** 9 males, 14 females (5 lactating), 9 of unidentified sex.
4. **Mike Wiegele Helicopter Skiing & Wells Gray Provincial Park (WIEGELE):** 7 males, 7 females (3 lactating), 9 of unidentified sex.
5. **K3 Cat Ski & Mustang Powder Cat Skiing & Eagle Pass/Boulder Mtn (K3 & MP & EAG):** 2 males, 4 females (3 lactating), 2 of unidentified sex.



6. **CMH North:** 4 males, 6 females (4 lactating), 11 of unidentified sex.
7. **CMH South:** 2 males, 3 females (1 lactating), 1 of unidentified sex.

### 3.5. Stress hormone pilot project: postponed

Stress hormones in hair have been successfully used as indicators of physiological condition of other mammals and might also be indicative of individual breeding status (Cattet et al. 2014, 2017). The planned pilot validation study to determine if hair collected during our sampling can be used to assess glucocorticoid (stress hormone) levels in individuals, had to be put on hold due to a lack of capacity at the collaborating university. We currently have no timeline for re-uptake of this project.

### 3.6. PhD candidacy examination

As planned, the PhD student (Mirjam Barrueto) spent summer 2019 preparing for her PhD candidacy examination, which she successfully completed in October 2019. The candidacy exam is a major milestone for PhD students that test a student's comprehension of their field of research, associated areas of study and their capacity to undertake independent research. Passing the candidacy exam means that the student has completed all required internal/university hurdles to the satisfaction of the advisory committee and university regulations, e.g., classes, proposal, candidacy exam. The student can now focus completely on carrying out the research project which will result in a thesis which includes all results, analyses and a discussion of it all. At the end of the PhD, once the thesis is written, a "thesis defense" in the form of an oral examination will mark the end of the program.

### 3.7. Letters to trapline holders

In British Columbia, wolverine can be legally trapped by trapline holders (a trapline is an area that gives its holder exclusive trapping rights) in all regions but the Okanagan, Lower Mainland and Vancouver Island. ("2018-2020 Hunting & Trapping Regulations Synopsis" 2018). Wolverines can also be hunted in some regions, but it is believed that few animals get harvested this way. Because of their low population densities, large home ranges, and slow reproduction, wolverine are vulnerable to overharvest (Lofroth and Ott 2007; Dalerum et al. 2008), and trapping has been considered a conservation concern for wolverines across the country by provincial and federal agencies responsible for wildlife management (COSEWIC 2014; BCCDC BC Conservation Data Centre 2017). Our recent analysis on trapping rates in the Kootenay Management Region (i.e. parts of our study area, the southern Columbias, and the southern Canadian Rockies), showed that current harvest rates are not sustainable, and we recommended a reduction in trapping rates (Mowat et al. 2019).

Our November 2019 film tour (see Section 5.1.) was well attended, including by many trappers. It provided valuable opportunities to discuss our past and current research and our common interest in ensuring thriving wolverine populations. Generally, our research has been well received and there is widespread support among trappers for the BC government's proposal to end wolverine trapping in the Kootenay Region, which is a direct result of our research (Mowat et al. 2019). Our study area contains 95 trap lines, but most trappers do not target wolverines. To inform them of our ongoing research we sent out letters to all trapline holders in our study area in fall 2019.

## 4. FUNDING

Since September 2017 we have raised > \$685,000 from the following sources: non-profit organizations and conservation foundations (e.g. Y2Y, HCTF, FESBC) (25%), public donations (22%), Parks Canada & BC Parks (21%), helicopter & cat ski companies (15%), scholarship granting agencies (10%), and the University of Calgary (7%). Funding (>\$1000) in 2019 came from the University of Calgary, Yellowstone to Yukon Conservation Initiative, Parks Canada, NSERC, Edmonton Community Foundation, Habitat Conservation Trust Foundation, Forest Enhancement Society of British Columbia, Mike Wiegele Helicopter Skiing, Selkirk Tangiers Heli Skiing, K3 Cat Ski, BC Parks, Helicat Canada, Earth Rangers, Mustang Powder, Mica Heli Skiing, Eagle Pass Heliski, Bow Valley Naturalists, Coyote Industries, Purcell Heli-Skiing and several private donors.

As of Dec 31, 2019, funds for budgeted 2020 expenses are not fully secured yet, and fundraising is currently ongoing. Grant applications to conservation foundations to cover the \$78k before April 1, 2020 (“Outstanding 1”) have not been successful; this is our main fundraising priority. Submitted grant proposals to conservation foundations to cover the \$52k (“Outstanding 2”) past April 1, are still under review – decisions are expected by early March. Budgeted expenses for 2020 are helicopter flights (64%; \$168k), Labour (Field Technicians) (13%; \$34k), PhD Scholarship (9%; \$24k), Ground Transportation and Accommodation (9%; \$24k), Materials (5%; \$13k). Most expenses will be incurred during the field season, Jan – May 2020.

Items	Dates	Amount
2017-19 - Expenses	Sep 2017 – Dec 2019	\$ 552,000
2020 - Budget	Jan – Dec 2020	\$ 263,000
2020 - Secured	Jan – Dec 2020	\$ 133,000
<b>2020 – Outstanding 1</b>	<b>Jan – March 2020</b>	<b>\$ 78,000</b>
<b>2020 – Outstanding 2</b>	<b>April – June 2020</b>	<b>\$ 52,000</b>



## 5. OUTREACH AND EDUCATION

Our target audience is broad, including furbearer conservation officers and other resource managers, heli and cat ski industry people, winter recreationalists (ski, sled), the trapping community, First Nations, and the general public that is interested in wolverine and conservation of mountain landscapes. Public interest in our research project is strong, as demonstrated by participation in our outreach activities and philanthropic donations to our project. We are spending approx. 0.3 of a fulltime position (i.e. personnel of our project) engaging with our partners and the public. We have an established online presence (details below) and we have regular interactions with individual trappers and other interested individuals. Overall, we fully understand that conservation is as much about the science as about communication, outreach, education and ultimately public participation in decision making.

## 5.1. Main outreach activities and events

**1. Documentary Film – Chasing a Trace.** In 2018, award-winning filmmaker Leanne Allison received a \$50,000 Storyhive Documentary Edition Award to create a short documentary about this project. ([www.storyhive.com/project/show/id/3976](http://www.storyhive.com/project/show/id/3976)). The 20-minute film portrays Mirjam Barrueto and this research project on female wolverines in the Columbia Mountains. It is now completed and was shown at the 2019 Banff Mountain Film Festival ([www.banffcentre.ca/node/13280](http://www.banffcentre.ca/node/13280)). The film credits include a mention of our 2018 research funders.



**2. Film tour:** In collaboration with Yellowstone to Yukon Conservation Initiative and Wildsight, we did a tour showing the film (“Chasing a Trace”) and giving a presentation on recent and on-going wolverine research. In Nov and Dec 2019, we showed the film in 13 Kootenay communities (Creston, Golden, Kimberley, Invermere, Cranbrook, and Fernie, Nelson, Kaslo, Castlegar, Nakusp, Rossland, Silverton, Revelstoke). Over 1200 people attended. (<https://wildsight.ca/events/chasing-a-trace-wolverine-film-tours-the-kootenays/>).

**3. Presentation:** As the Red Deer River Naturalists Speaker of the Month (Nov 22nd, 2018), we gave a presentation to interested public and students of the Red Deer College about wolverine research. (~50 people attended) <https://rdrn.ca/event/speaker-of-the-month-10/>

**4. Conference presentation:** BCPARF – BC Protected Area Research Forum in Prince George (Dec 4th, 2018). The presentation was part of an invited symposium about research to inform wildlife conservation and sound management in British Columbia and was attended by approximately 75 people. <https://www.unbc.ca/sites/default/files/sections/bc-protected-area-research-forum/bcparfagendaoctober30.pdf>

## 5.2. Other outreach

1. Interview for Rocky Mountain Outlook: <https://www.rmotoday.com/local-news/researchers-call-on-governments-to-reduce-wolverine-trapping-1899106> (Dec 2019) – Newspaper Article
2. K3 Cat Skiing Guides Training (Dec 2019) – Invited presentation
3. Great Canadian Heli Skiing Guides Training (Dec 2019) – Invited presentation
4. Mustang Powder Guides Training (Nov 2019) – Invited presentation
5. Eagle Pass Heli Skiing Guides Training (Dec 2019) – Invited presentation
6. Revelstoke Review (Mar 2019). [www.revelstokereview.com/news/video-the-secret-lives-of-wolverine](http://www.revelstokereview.com/news/video-the-secret-lives-of-wolverine). This article was distributed within the Black Press Media network of publications in British Columbia – Newspaper Article
7. Rocky Mountain Goat (Valemount newspaper) (Apr 2019). [www.therockymountangoat.com/2019/04/the-elusive-wolverine](http://www.therockymountangoat.com/2019/04/the-elusive-wolverine) – Newspaper Article
8. Alpine Club of Canada blog (Apr 2019). <https://blog.alpineclubofcanada.ca/blog/2019/4/15/wolverine-watch> – Blog Article

### 5.3. Social media

**Website** – We continued to use [www.wolverinewatch.org](http://www.wolverinewatch.org) as the project website. The main purposes of the website are to provide information on this and our previous wolverine research projects, collect detailed information on public wolverine sightings, provide information for people interested in supporting the project, and provide links to partner organizations.

**Facebook and Instagram** – We continue to use our linked Facebook and Instagram pages for WolverineWatch.org, to inform and raise awareness of wolverine conservation, management and research in the Canadian Rockies and now the Columbia Mountains. We document the research, show how data are collected, showcase the landscape surveyed for wolverines, our partners, and some of the highlights and frustrations of

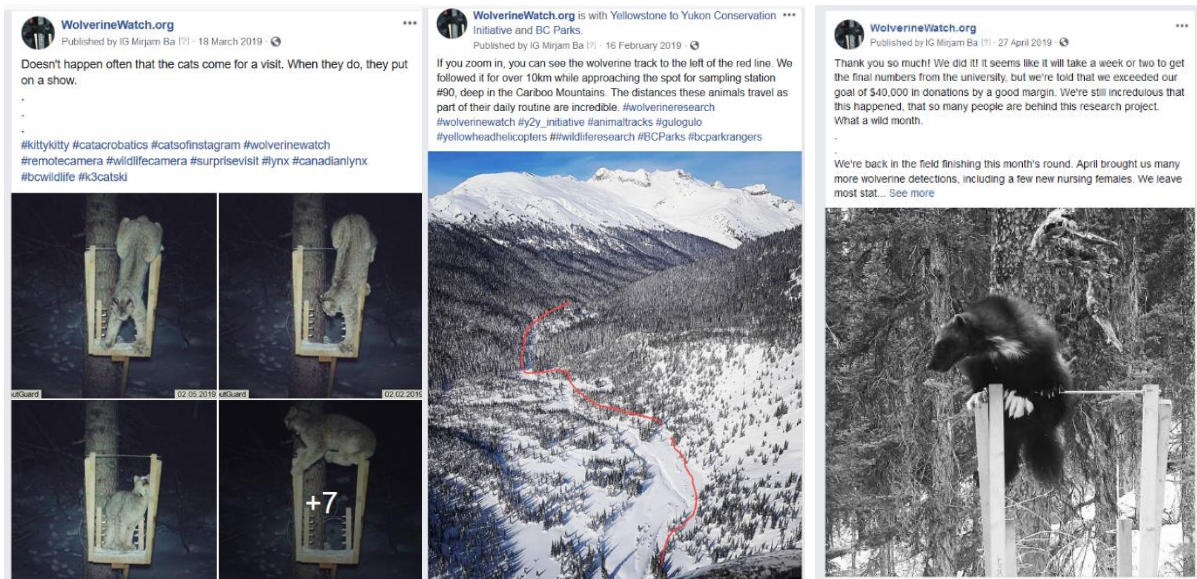


Figure 4 A sample of popular social media posts (Facebook and Instagram) from 2019

conservation research. The Facebook page ([www.facebook.com/wolverinewatch](http://www.facebook.com/wolverinewatch)) has ~4000 followers; Instagram ([www.instagram.com/wolverine\\_watch](http://www.instagram.com/wolverine_watch)) has ~1000 followers.

## 6. DISCUSSION

In the 2019 field season (the 2<sup>nd</sup> of 3 field seasons), we successfully monitored 152 sites across our study area and continued to collect data for the three-year sampling effort. The number of individuals visiting sites, and the detection of approx. 27 lactating females, is encouraging. About 50% of all detected females, whose sex was either confirmed by clear photographs or is (yet) to be confirmed with genetic analysis, showed signs of lactation. The third field season (2020) will be necessary to determine reproductive status of the other 50% of females, hopefully increasing the number of confirmed breeding females, and building on the number of detected breeding efforts.

Good weather in late January and February 2019 and a great, dedicated field crew enabled us to carry out a large sampling effort in 2019. Re-sampling already established sites is easier than first-time visits; weather will still play a large role in the success of the 2020 field season.

While rigorous wolverine population assessments remain few and far between in Canada, since 2011 we are working on building a current, comprehensive dataset in the region (Heim et al. 2017; Kortello et al. 2019; Mowat et al. 2019; Sawaya et al. 2019; Barreto et al. 2020). The last 15 years of North America-wide wolverine research, often telemetry-based, paint a picture of an elusive and relatively rare species that tends to avoid encounters with humans and their activities and infrastructure within their home-range or territory and whose populations are sensitive to human-caused mortality. What is missing is knowledge of whether these human factors, which influence how wolverines use their habitat within their home-range, also impact where (female) wolverines choose to locate their home-ranges on the landscape, thus driving density. This is the overarching question motivating this project.

Preliminary data from 2018 and 2019 indicate that wolverines in the North Columbia Region may be more numerous than the struggling populations in the southern Columbias and the southern Canadian Rockies. Naïve occupancy, which is a measure of the proportion of available habitat that is occupied by a species, in our combined study area (BYK and NCR) was 0.88. This is high compared to an occupancy probability of 0.50 (SE = 0.09) in the southern Columbia Mountains and of 0.32 (SE = 0.04) in the southern Canadian Rockies (Kortello et al. 2019). However, see “Note” at the bottom of Section 3.2. with regards to preliminary results.

The Chasing a Trace - film tour where we showed a short documentary film on the project and gave a presentation about wolverine conservation and about our research (See Section 5.1.) was a highlight of the year, as it allowed us to engage with local communities and explain our research and findings. Communicating previous research results was a priority during the tour, especially explaining the low numbers of wolverines detected and our findings that wolverines are overharvested in the southern Columbias and Canadian Rockies (Mowat et al. 2019). Many audience questions were answered, discussions were spurred and the public and the trappers appeared to welcome our research efforts. We will continue to prioritise such community outreach opportunities to ensure an on-going dialogue with interested audiences.

The biggest challenge in 2019 was a funding short-fall in late March 2019. A group of local artists and wildlife photographers, and the University of Calgary were crucial in helping us raise the funds needed to complete the 2019 field season. This project is funded by a myriad of financial and in-kind contributions by government agencies, conservation grants, non-profit organizations, several helicopter and cat ski companies, and private donors. This set-up has advantages, e.g. it leads to strong outreach efforts reaching many people, and it allows our partners and interested parties to be a crucial part of the project. However, there is also uncertainty involved in funding from year-to-year, and it takes considerable time and effort to fundraise. Granting cycles and fiscal year-ends of government agencies also are set to begin and end in the middle of our field seasons (March 31<sup>st</sup>/April 1<sup>st</sup>), which adds an additional layer of budgeting and fundraising. As of the time of writing, for 2020 we have secured 50% of required financial and in-kind contributions. A final push is currently underway to bring in new partners and ensure that this last field season will be feasible.

## 7. FUTURE

### **2020:**

In January 2020, pending fundraising outcomes, we will resume monitoring the 152 established sites for wolverine use. We will re-bait the sites approximately once per month and collect hair and photos for analysis.

Genetic analysis of 2018 and 2019 hair samples is scheduled for late spring 2020 at Wildlife Genetics International (WGI), Nelson, BC. Photo analysis is ongoing. Where possible, we will begin assembling large-scale spatial data of human use and natural factors to be used in final analyses.

We are planning to partner with a post-doctoral researcher at the University of Northern British Columbia, under whose leadership we will assemble a large-scale map of winter recreation intensity (e.g. ski touring, snowmobiling, potentially heli & cat skiing) for the study area. We are currently determining feasibility of different approaches and data sources (e.g., survey-flights in key areas of the Columbia headwaters, trail counter data, expert opinion). Our preliminary evaluation indicates that such human use datasets will become available to some degree, which will complement the datasets on other habitat features.

### **2021:**

Targeted field work is planned for some areas for 2021 and 2022, e.g. to monitor specific individuals, survey for winter recreation and tourism, or disassemble sampling stations. We anticipate continuation of the work to quantify winter recreation intensity and will continue to assemble other spatial data sets and finalize photo analysis. We expect first density and genetic connectivity results in mid to late 2021.

### **2022:**

Analysis and writing up of results will continue throughout 2022. The PhD thesis is anticipated to be completed and defended by the end of 2022, for a total project duration of 5 years.

## 8. ADDITIONAL INFORMATION

Further photos, higher resolution maps and location data are available on request. More detailed expense statements for 2018 and 2019 are also available on request.

## 9. REFERENCES

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\*\* *Paper available from author or by request at website provided*

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