Drones and Dens

Using unmanned aerial vehicles (UAVs) to search for wolverine (*Gulo gulo*) reproductive dens in the South Columbia Mountains 2019 Report

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Executive Summary

Wolverine (*Gulo gulo*) is a species of provincial and federal concern and a focal priority in the south Columbia Mountains. Current knowledge of denning characteristics in British Columbia is from a few sites and improved knowledge of reproductive habitat characteristics and specific information about denning areas is of highest priority for focused conservation. Thus, we used existing knowledge from a genetic mark-recapture study to create a predictive map of high value female wolverine habitat. We reached citizens through press releases, presentations, posters, direct contact and social media. Citizen science efforts resulted in 296 wolverine reports and 8 potential den sites. Through mapping and citizen science, we delineated 10 potential locations to search in the south Columbia Mountains using an Unmanned Aerial Vehicle (UAV). Of these, 3 sites were deemed probable den locations and one was confirmed as a den site.

Introduction

Wolverine (*Gulo gulo*) is a species of provincial and national conservation concern (BCCDC 2019, SARA 2018, COSEWIC 2014) and a focal priority in the region. Identified threats include disturbance, habitat loss, caribou (*Rangifer tarandus*) decline, mortality from trapping and climate change (COSEWIC 2014). Wolverine occur at low densities with low reproductive rates (Persson et al. 2006) and inventory in the Columbia Mountains (2012-2016) indicate that wolverine are at even lower densities than anticipated. To add to this conservation urgency, in our region, mortality from trapping is high and there may be poor connectivity amongst some populations (Mowat et al. in press, Kortello and Hausleitner 2016, Lofroth and Ott 2007).

Female wolverine avoid forestry roads in winter, which are used primarily for snow machine recreation and to a lesser extent forest harvest (Kortello et al. 2019). Other studies also suggest that female wolverine avoid areas used for winter recreation (Heinemeyer et al. 2019, Krebs et al. 2007). Female wolverine are particularly vulnerable to human disturbance at den sites (Magoun and Copeland 1998, Pulliainen 1968). While only a handful of den sites have been described in British Columbia, these were excavations in the snow in high elevation cirques near tree line (Krebs and Lewis 2000). There appears to be fidelity to preferred denning areas (May et al. 2012).

Some authors have suggested that protecting maternal denning habitat from human disturbance may be crucial for reproduction and species persistence (May et al. 2012, Magoun and Copeland 1998). Our objective was to expand scientific knowledge on reproductive habitat requirements and by describing specific sites, providing mangers with information on den site locations that will facilitate focused conservation or access management in areas with the greatest potential benefit. Specifically, our objectives were to:

a) Create a map to predict high value female wolverine habitat use is created and shared with resource managers
b) Identify a minimum of 5 wolverine dens and model wolverine denning habitat by spring 2019.
c) Use citizen science to collect a broader range of wolverine sightings.
d) Assess the effectiveness of UAVs as a tool to discover den sites.

Methods

We used female wolverine locations and habitat-based models from previous data collected (2012-2016; Kortello et al. 2019, Kortello and Hausleitner 2016) to map high value female habitat in the Selkirk and Monashee mountains and establish potential areas where female wolverine may be denning using GIS.

Additionally, we requested information on den observations in the southern Columbia Mountains from the outdoor community. We used radio, print and electronic media, social media and face-to-face contacts to ask people to submit observations to our website, Wolverinewatch.org (Table 1). Outreach also included Kootenay Conservation Program newsletters, facebook posts, email communication with ski guides, back country lodges, parks personnel, biologists, trappers, forestry and snowmobile user groups, posters at trailheads and public presentations in Nakusp (40 people), Kaslo (36 people), Castlegar (120 people), Nelson (100 people) and Creston (50 people). We used some of the reported observations to identify potential denning areas.

Table 1. Broad scale media outreach activities, January-March 2019.

Media	Estimated Reach (x 1000 people)
CBC BC digital story https://www.cbc.ca/news/canada/british-columbia/wolverine-study-bc-interior-alberta-1.5028641	3.7
CBC Daybreak South radio show	10
e-KNOW digital news https://www.e-know.ca/regions/east-kootenay/backcountry-users-asked-to-help-in-wolverine-research/	13
Vancouver StarMetro daily and online https://www.thestar.com/vancouver/2019/02/13/elusive-wolverines-cant-escape-climate-change.html	30
Yellowstone to Yukon Action Alerts	4.8

Wolverine may be misidentified, consequently an attempt was made to classify observations according to quality. All observations started out as credible. Observations with clear photos or thorough descriptions that left little doubt as to the animals' identity were upgraded to convincing. Descriptions that did not quite match with typical wolverine appearance or behavior, especially outside of normal range, were classed as questionable and photographs of species that were not wolverine or descriptions that were obviously of a different animal were classified as false. Attempts were made to contact the reporting individual to clarify questionable observations or observations that were outside of the normal range.

We used our habitat map and previous non-invasive DNA results (Kortello et al. 2019) in combination with citizen science observations, and published descriptions of reproductive dens to identify 10 potential denning areas in the West Kootenays. We searched these potential areas for concentrations of tracks from late February to late April. We considered a concentration of tracks during this time period to be indicative of denning activity as the female must travel back and forth to the den in order to forage (May et al. 2012). Concentrations of tracks may also occur where wolverine are caching large prey, however, this localized activity is limited to days, not weeks or months and food remains or scat may be visible on the snow surface. We approached potential denning areas via skis several days following a snowfall. On two occasions we used either a helicopter or a snowmachine to access areas of interest to within ~1 km and skied from there to a suitable launch or observation site.

For areas of interest, the upper elevation valley or bowl was flown at 100 m above the ground with the assistance of the Selkirk Geomatics Research Centre (SGRC) using an unmanned aerial vehicle (UAV; DJI Mavic 2 Pro). The UAV was programmed to fly according to the topography using Maps Made Easy - Map Pilot (Business Edition) software in order to maintain a relatively constant elevation above the ground. Adjacent photographs had at least 30% overlap. We batch processed photographs to enhance contrast and two observers scanned through photographic images for tracks on a large 72" screen. If a probable den site was located, we set up a wildlife camera (Reconyx Hyperfire Infrared Digital Game Camera Hc600) along a nearby wildlife travel route to confirm the presence of wolverine and kits. This camera was left up to monitor activity. Wolverine den sites were further distinguished from other wolverine excavations by multiple entrances and chambers, including a latrine chamber (Myrberget 1968, Magoun 1985). These can be visible after snowmelt as a concentration of scat in a limited area and we considered these to be indicative of a wolverine reproductive den. The Thompson Rivers University Animal Care Committee (#102023) approved our sampling protocol.

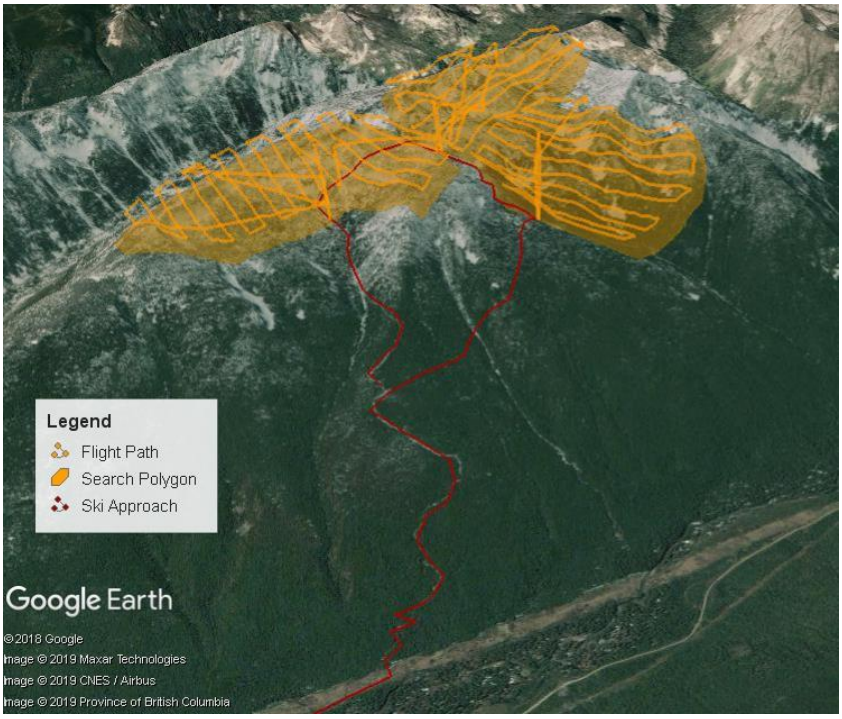

Figure 1. Example of UAV den search showing approach, flight path and search area.

We compiled information from citizen science, UAV searches and wildlife cameras to identify potential, probable and confirmed den sites. Potential den sites included credible public observations that were not ground truthed, probable den sites included concentrations of tracks found during UAV searches of potential sites and repeated observations of track concentrations. Confirmed den sites further included observations of kits or kit tracks from UAV's or wildlife cameras, or evidence of a latrine associated with the excavation.

The research products; a female wolverine habitat map, specific den locations, and den site characteristics will be provided to managers in a final report, along with access management recommendations. Our previous work on wolverines has directly provided critical information to provincial management plans and has informed harvest policies. Non-specific research summaries will be made available to participants and the general public through media releases, Y2Y's newsletter and public presentations. We have intentionally avoided reference to detailed den locations in this document because this information is considered sensitive.

Results

Habitat Modeling

We mapped female wolverine habitat using forest service road density and marmot habitat (Kortello et al. 2019; Figure 1). The largest and most contiguous high probability areas for female wolverine lay within provincial parks and protected areas, in particular areas within and around the Purcell Wilderness Conservancy (Figure 2).

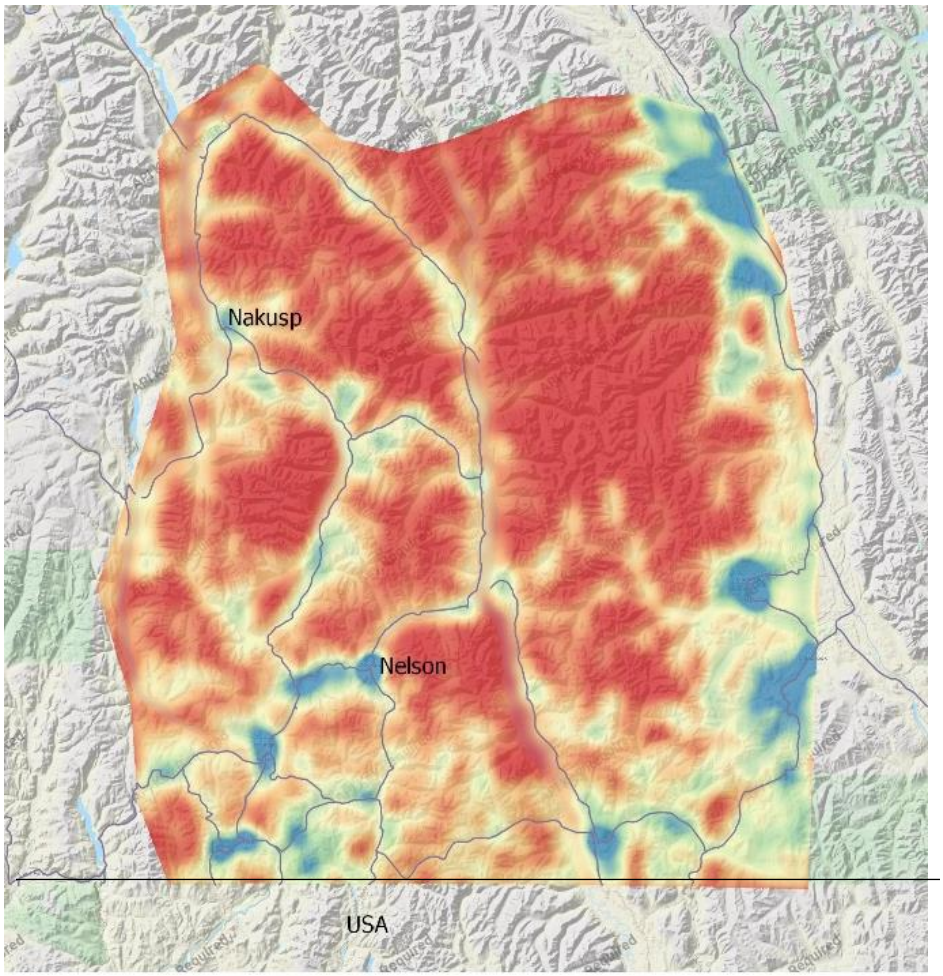

Figure 2. Female wolverine habitat map, warm values represent high probabilities of occurrence, cool values represent low probabilities.

Citizen Science

The involvement of Yellowstone to Yukon (Y2Y) in media outreach enabledthousands of people to find out about our wolverine research and wolverinewatch.org. As a result, the total number of observations on the Wolverinewatch.org website increased by ~400% over a 7 month period. We obtained 296 observations between 1 January 2019 and 31 July 31 2019. These included 215 sightings; 77 tracks and 3 of both sightings and tracks and 1 unknown. Of all observations, 65 were convincing, 205 credible, 20 questionable, and 6 observations classified as false (Figure 3).

Citizen science observations occurred at the intersection of human activity and animal habitat. These observations were concentrated in the mountains of southwestern Alberta and southern British Columbia, reflecting high human use densities in areas of potential wolverine habitat and where our outreach was concentrated. However, a handful of interesting observations were reported from southern Saskatchewan and Manitoba and areas where wolverine populations are thought to be extirpated such as Vancouver Island, Quebec and New York State (Figure 3).

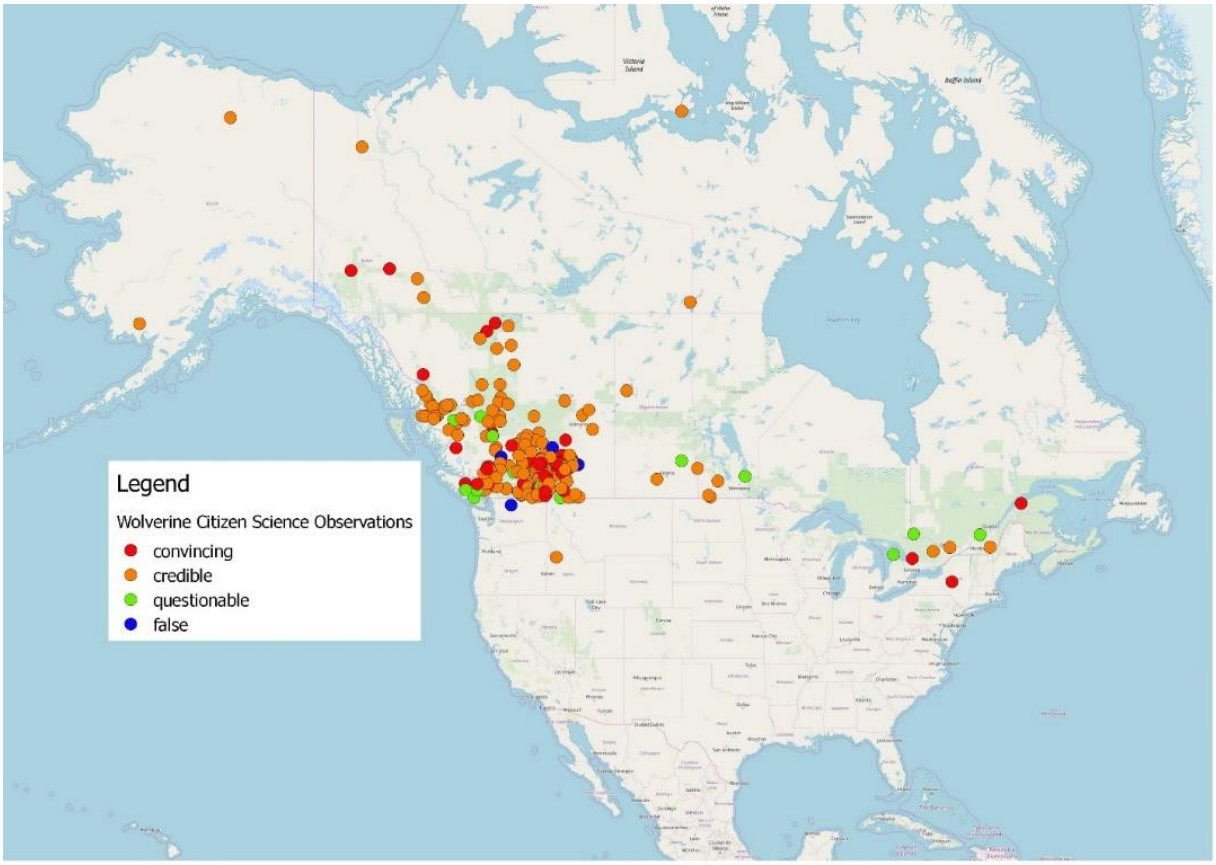

Figure 3. Distribution of wolverine observations reported from January-July 2019 at Wolverinewatch.org.

Most observations occurred while backcountry skiing (22%), followed by hiking (21%) and driving (16 %). Observations included 83 road crossings. The primary objective of this effort was to use citizen science to identify wolverine reproductive denning areas. Twenty-three excavations were reported, including 8 potential den sites (timing and appearance consistent with reproductive use), 3 food caches (associated with food remains and scat on top of snow), 8 indeterminate excavations and 3 summer observations (Figure 4).

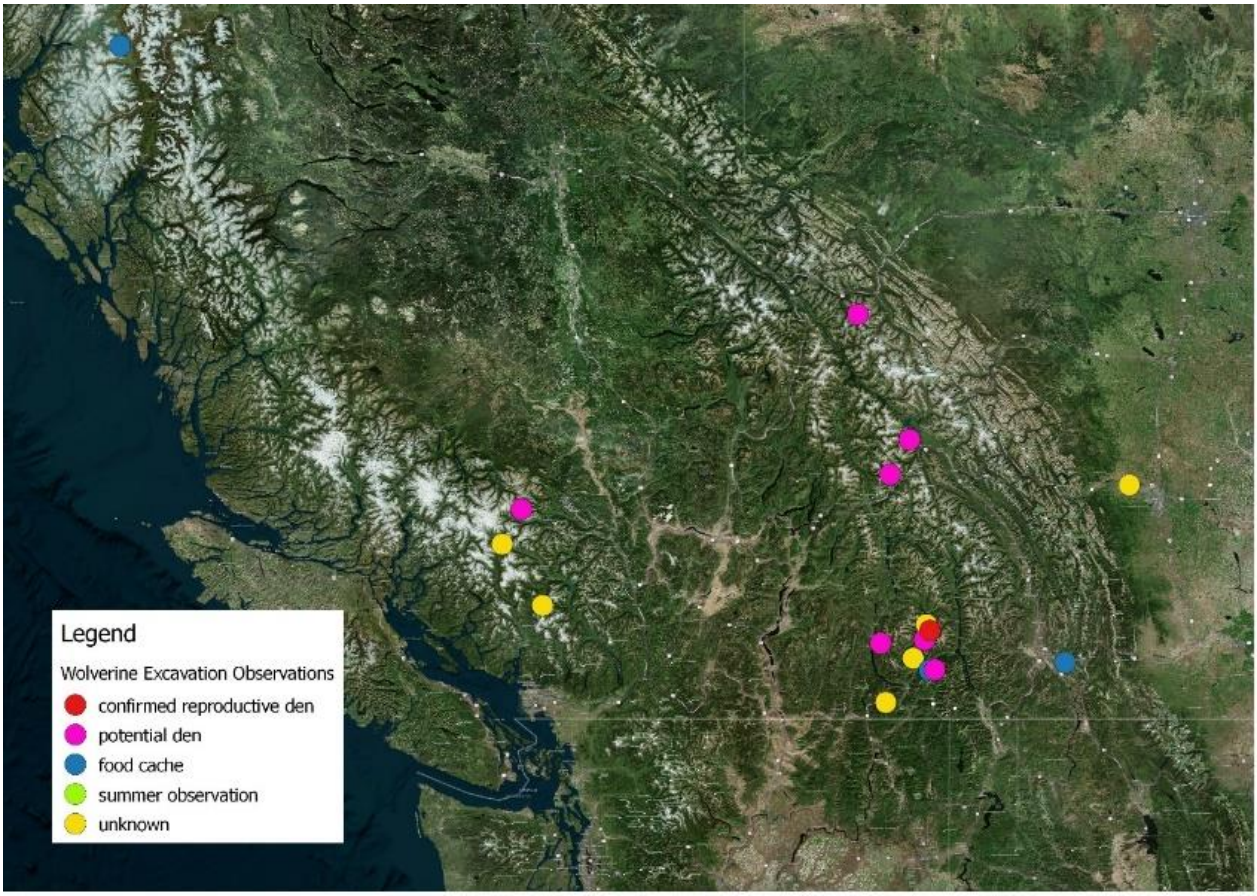

Figure 4. Wolverine excavations from citizen science data reported January-July 2019.

From our mapping, female location data and citizen science reports we selected 10 locations for further investigation. Over 100 km of linear transect were ground searched and an additional 1,256 ha area was searched by drone (Table 1). Eleven flight hours were logged using 33 batteries, averaging 4 batteries/day (Table 1). This resulted in 2331 photographs. From these, we identified pine marten, hare, lynx, squirrel, and wolverine tracks as well as snowmachine and ski tracks. We detected wolverine tracks at 60% of the locations searched, identified 4 probable den sites on basis of repeated observations of high track densities over the denning period and confirmed one of those as having a latrine associated with it.

Table 1. Potential den site investigation summary, 2019.

Site	Ground search distance (km)	Drone search area (ha)	Wolverine tracks detected	High track density in area	Repeated high track density observations over denning period	Wolverine detected on remote camera	Excavation found	Latrine found at excavation
MP1	5.5	unk	No	-	-	-	-	-
CD2	12	0	No	-	-	-	-	-
FN3	30	0	Yes	Yes	Yes	Yes	Yes	Not searched
QN4	10.5	334	Yes	Yes	Yes	Camera failure	Yes	Not searched
OG5	8	0	No	-	-	-	-	-
KC6	7.5	361	Yes	No	-	-	Yes	-
RF7	7	165	Yes	No	-	Yes	No	-
TL8	1	241	Yes	Yes	Yes	-	Yes	Yes
CF9	1	152	Yes	Yes	Yes	-	Yes	Not searched
VC10	8.5	0	No	-	-	-	-	-
Total	100.5	1256						

Discussion

Our female habitat models included such broad habitat parameters that much of the landscape is deemed suitable. This further justifies the need to identify den sites and distinguish characteristics at a finer scale. We identified 4 probable den sites of 10 search areas and confirmed the presence of a latrine at one of those sites. This effort is the first in North America to systematically attempt to identify wolverine denning areas by non-invasive means and was conducted using a small fraction of the cost of traditional radio telemetry efforts. As wolverine have fidelity to denning areas that extends beyond individual female selection, and females are particularly vulnerable to disturbance during denning (May et al. 2012, Maguon and Copeland 1998, Pulliainen 1968), identifying these areas will enable site-specific conservation and management efforts and contribute to population persistence.

While 6 of our searched areas did not show indications of reproductive activity, female wolverine average 1 litter of kits every 2 years so the absence of denning activity in a given year does not preclude subsequent use. For this reason, at least 2 consecutive years of searching would be more indicative of the areas importance.

Management of probable denning areas might include designating roadless areas and zoning human activities during the natal denning period (May et al. 2012). We suggest avoiding any additional industrial or recreational use in the upper elevation watershed around probable and confirmed dens sites, buffering the site by at least a 3 km radius (Magoun and Copeland 1998, Copeland 1996). Legislative protection of these areas on crown lands under the Forest Range and Practices Act, Identified Wildlife Management Species may be useful. Recent research has highlighted the importance of protected areas for wolverine presence and density (Barrueto et al. submitted 2019, Kortello et al. 2019, Mowat et al. submitted 2019). Although we were unable to confirm den locations at 3 sites, the heavy repeated use suggests denning activity and/or important habitat for this at risk species consequently a conservative approach may be warranted. On completion of this report, we intend to meet with land managers for each of the four probable denning areas to examine site-specific strategies for maintaining habitat suitability.

The 3 probable den sites and 1 confirmed den site all occurred on north facing aspects near treeline in areas of large talus. None of the sites showed evidence of motorized use; however evidence of non-motorized users were present within the search area for all locations.

The involvement of citizen science was critical to the success of this effort. All four probable den sites were first reported by the general public. Media outreach facilitated by Y2Y was incredibly effective and we are deeply grateful to the public who contributed their observations.

With the assistance of the Selkirk College Geospatial Research Center, we demonstrated the utility of UAV's for animal tracking, track identification and wolverine den detection. Distance and elevation constraints associated with the programmed flight paths combined with weather and travel distances, made accessing launch points challenging. At times, difficulty with

identifying wolverine tracks on the UAV screen in real time precluded effective deployment of the wildlife cameras.

As well, examining photographs proved much more time consuming than anticipated. However, the high resolution spatially referenced photography was invaluable to the success of the project, enabling large areas of landscape to be searched safely, with minimal noise and disturbance.

Additional Information

The citizen science database is a potential information source for modelling characteristics of wolverine road crossings, with a view to mitigating road effects and improving connectivity. This database also contains sightings outside the current understanding of wolverine range. These are likely dispersing subadults seeking suitable home ranges, however, in some areas (e.g. Vancouver Island, Quebec) these may represent a recolonizing population of interest to wildlife managers. For example, evidence suggests that wolverine range is expanding in Washington State (Williams 2018).

Next Steps

Future efforts will incorporate two additional data streams for predicting potential denning areas. These include:

1. The 2012-2016 harvest mortality database and provincial harvest records will be used to identify traplines where wolverine are harvested consistently, particularly mature females. The upper elevations of these traplines and adjacent areas are potential places to search.
2. A concurrent wolverine study based out of Revelstoke, BC is using bait stations, run poles and camera images to identify reproductive females. We will use these reproductive female locations to inform likely search areas. While reproductive females will range up to 20 km from den location (Copeland 1996) most movements are within 3 km. We will consider lactating females that appear at a bait site rapidly after the site has been rebaited to have a den close by.

Acknowledgements

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