Wolverine Persistence in an Idaho Core Population Area

IDAHO DEPARTMENT OF FISH AND GAME

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February 2022

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INTRODUCTION

The Salmon River Mountains loosely describes a collection of peaks extending across central Idaho south of the Main Salmon River, north of Highways 21 and 75, between the towns of McCall and Salmon. This area encompasses portions of 3 national forests, the Frank Church River of No Return Wilderness Area, and much of the modeled wolverine (*Gulo gulo*) habitat in the state. It also is near the southernmost extent of resident wolverine occurrence in North America, which currently includes the Rocky Mountains of Idaho, Montana, and Wyoming, and the north Cascade Range of Washington (Idaho Department of Fish and Game 2014). Prior to 2003, incidental reports of wolverine in the western portion of the Salmon River Mountains (north and east of McCall) were relatively scant (Idaho Department of Fish and Game 2021), although this may reflect access and inclination to report sightings rather than actual wolverine occurrence. Notable during the mid 1990s were multiple records from a single wolverine, a collared animal from the first wolverine ecology study in Idaho (Copeland 1996). This individual dispersed from the Sawtooth Mountains and was tracked west to Bruin Mountain north of McCall, where it spent the winter. Beginning in 2003, activities to investigate wolverine presence in the Salmon River Mountains around McCall increased. Idaho Department of Fish and Game (IDFG) conducted 3 consecutive winters of snow track surveys (Paton 2006), followed by 3 winters of baited camera stations (IDFG unpublished data). Detections from these efforts influenced the wolverine–winter recreation study (Heinemeyer et al. 2019), which established the first of its 5 study areas around McCall in 2010. Collectively these efforts amassed many more sightings of wolverine. More importantly, these efforts established that wolverines were present consistently in the western portion of the Salmon River Mountains and confirmed a resident, breeding subpopulation there.

No systematic, fine-scale information on wolverine activity has been collected in the western Salmon River Mountains on the Payette National Forest (PNF) and northern portion of the Boise National Forest (BNF) since the completion of the wolverine–winter recreation study in 2015 (Heinemeyer et al. 2017, Heinemeyer et al. 2019). At the conclusion of that study, the researchers noted that the number of wolverines in the western Salmon River Mountains appeared to have declined from when the project was initiated, with an incremental loss of resident animals. This observation was based on similar monitoring effort each year and relatively predictable appearance of resident study animals at baited live traps.

More recently, the Western States Wolverine Conservation Project (WSWCP) implemented a camera survey across 4 states, including Idaho, in the winter of 2016–17 (Lukacs et al. 2020). The survey documented wolverine occurrence in the western Salmon River Mountains, including individuals known from previous studies (Evans Mack 2018). The survey is being repeated in winter 2021–22 for the first comparison to baseline conditions. However, the western states survey was designed to provide broad-scale trends across continental-scale landscapes. It was not designed for fine-scale information.

Our objective with this project was to return to a more localized scale, specifically the McCall portion of the wolverine–winter recreation study (Heinemeyer et al. 2019), to assess wolverine

activity in this core population area of Central Idaho. By sampling at a similar density and using the same station locations as previous work in this area, the aim was to obtain contemporary data on wolverine distribution on the PNF and northern BNF and assess wolverine occurrence and distribution 5 years after the conclusion of the winter recreation study (Heinemeyer et. al. 2017).

METHODS

During the winter of 2020–21, IDFG and PNF deployed 14 non-intrusive remote camera stations, primarily at locations that had supported baited camera stations and/or wolverine live traps in the past decade (Figure 1). Ten stations (all 8 on the PNF plus 189-CC and 190-WLS on the BNF) had been used during the wolverine–winter recreation study and still had inactive log box traps on site. An 11th location (214-BL1) was a sampling location on the BNF from the WSWCP camera survey (Lukacs et al. 2020) that fell within our geographic area of interest. We added 3 additional stations to increase coverage across our study area. 190-BL2 and 190-JC increased sampling effort north of Landmark in the Burntlog drainage and Johnson Creek Road corridor, an area that had previous detections of wolverine (IDFG unpublished data; Midas Gold 2013, 2014). Camera station XXX-GF in the Gold Fork drainage filled a gap between the PNF and the BNF stations. It was a different location than the live-trap site used the first year of the winter recreation study, but was near wolverine detections from camera work conducted on the BNF (J. Foust, BNF, personal communication).

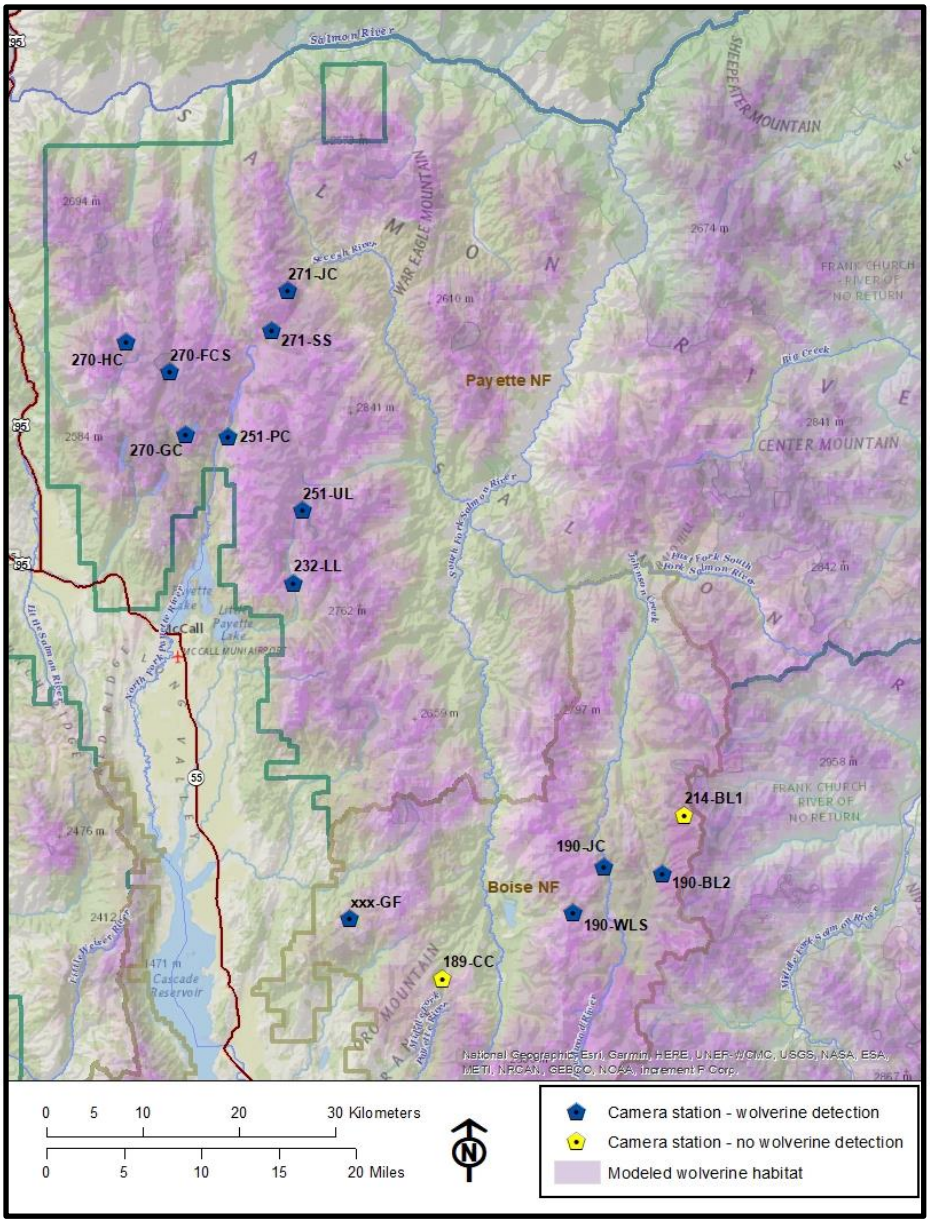
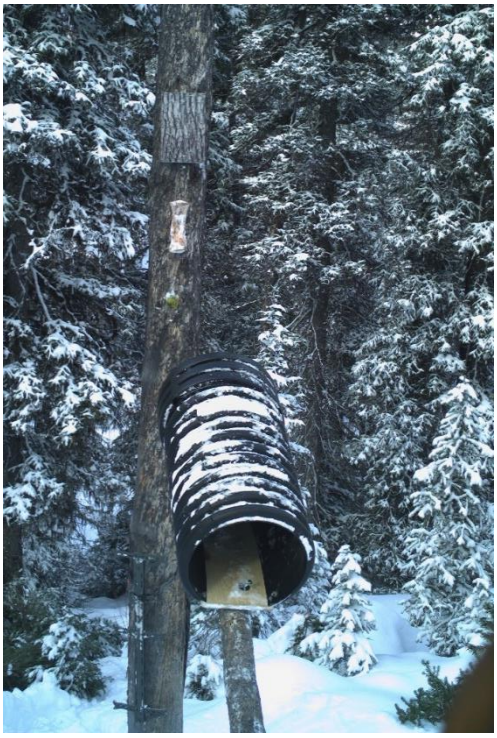


Figure 1. Distribution and results of camera stations in the western Salmon River Mountains core wolverine population area, Idaho, winter 2020–21.

Our baited camera station protocol has reliably detected wolverines over many years, and typically documents resident animals multiple times per winter. The protocol was similar to that used during the WSWCP camera survey (Western States Wolverine Working Group 2018), which yielded a high probability (92%) of detecting a wolverine at least once if it was present during the survey period (Lukacs et al. 2020).

Most (8 of 14) cameras deployed were Reconyx™ PC800 HyperFire™. The remaining 6 cameras were Reconyx™ HyperFire™ 2. Cameras were programmed for infrared and motion detection and the PC800s had a daily time-lapse image at 11 AM as a check that systems were operating as expected.

We used 3 types of station set-up. Traditional bait stations (n=7) were deployed mid–late December 2020 and used road-kill deer or elk pieces and a long-call lure as attractants. These stations were revisited 3 times during the winter (at approximately 4-week intervals) to refresh bait and scent, collect DNA samples, and move everything higher up the tree as snow accumulated. These accessible stations ran through mid-April 2021. Inaccessible stations (n=2) were too remote to revisit in winter; these were deployed in late October 2020 and collected in July 2021. We substituted a scent dispenser and cow femur for road-killed bait (Woodland Park Zoo 2015, Western States Wolverine Working Group 2018), and the station components were intentionally deployed higher in the tree in anticipation of snow. Both of these types of stations included a 4-gun brush array secured to the tree with a corrugated plastic collar below the bait or scent pump/bone to snag hair as animals climbed to investigate (P. Figura, California Department of Fish and Game, personal communication).



The third station type (n=5) was a hybrid — a scent pump station with an added component (a culvert "runway") with a set of 9 gun brushes and a second cow femur inside. It was designed to encourage a wolverine to enter the culvert to reach the cow bone that was cabled to the back, passing through the gun brushes on the way (C. Mosby, IDFG, personal communication). The aim was to assess whether DNA from hair snagged on the brushes, if protected from sun and moisture, would yield quality DNA after 6 or more months, the typical time that an inaccessible scent pump station is run. Thus, while these stations were revisited periodically, the gun brushes were not collected until the station was pulled at the end of the survey.

Figure 2. Experimental camera station component to shelter hair snagged on gun brushes to preserve DNA quality.

We submitted hair samples associated with camera detections of wolverine and additional species of interest, primarily fisher (*Pekania pennanti)* and marten (*Martes caurina*) to the USFS Rocky Mountain Research Station National Genomics Center for Wildlife and Fish Conservation (Missoula, MT). The Genomics Center analyzed samples for species identification using mitochondrial DNA. All wolverine-positive samples were further analyzed for haplotype (based on mitochondrial DNA), gender (using an SRX/SRY analysis for mustelids), and individual genotype (using 19 microsatellite loci used in previous mustelid studies; Pilgrim and Schwartz 2021). Individual genotypes from this study were compared to all individual wolverines in the genomics database to determine if each individual was unique (new to the database) or a recapture (a known animal from previous studies).

Camera images were uploaded and organized with CPW Photo Warehouse (Newkirk 2016). Each image was viewed and classified to species by at least 2 independent observers. A third observer reviewed and reclassified images with conflicting species assignments. Because quality DNA was not obtained for each wolverine detected on camera, we examined all wolverine images for distinguishing physical characteristics that could identify a unique individual. We looked for white on the legs or paws and different throat and upper chest markings. We mapped wolverine visits to camera stations by date and time as an additional means of distinguishing individuals.

We compared trapping effort and success from the wolverine–winter recreation study (Heinemeyer and Squires 2012, 2014) to our camera trapping effort as an indicator of change in wolverine occurrence within the McCall study area. We felt this was a reasonable comparison because our cameras were located at former live-trap sites, bait and lure were used as attractants at both cameras and live traps (when they were active during the winter recreation study), and trapping success from the winter recreation data included multiple captures of individuals, much like our cameras captured multiple visits made by the same individuals. In addition to trap effort and success (calculated per 100 trap nights), we also compared the number of unique individual wolverines identified each year, based on unpublished data from the winter recreation study shared with IDFG.

RESULTS

Camera Detections

Accessible stations that were revisited throughout winter (bait stations and scent pump/experimental DNA boxes) were deployed during a 17-day period from 14–30 December 2020. These stations were active an average of 120 days (range 82–126 days) and pulled 19 April through 9 June 2021 (Appendix Table A-1). The 2 inaccessible stations were deployed on 16 and 28 October 2020. They were active an average of 260 days (range 254–266 days) and pulled on 9 July 2021.

We detected wolverines with photographs at 12 of the 14 camera stations (86%; Figure 1, Table 1). We documented at least 51 separate wolverine visits to these stations collectively (Appendix Table A-2) and logged 1,552 images of wolverines. The earliest wolverine detection was on 4 January at

Hard Creek (station 270-HC), 18 days after the camera was deployed (Table A-2). This was also the quickest detection (fewest days between deployment and detection). Wolverines were detected at 5 of 7 scent pump stations and 7 of 7 bait stations. On average, we obtained twice as many photos of wolverines at bait stations than scent pump stations, and a 30% greater number of wolverine visits to bait stations.

Wolverines showed little interest in entering the experimental DNA shelter except at Hard Creek. The Hard Creek station alone accounted for almost 40% of the visits to all stations with scent pumps instead of bait. Across the 5 scent pump/DNA culvert stations, little to no hair was found on the 9 gun brushes within each culvert. The culvert also appeared to divert attention away from the scent pump and marrow bone hanging above on the tree. There were only 2 occasions, at 1 station, when a wolverine was photographed investigating the scent pump and bone. From photographs, it appeared that wolverines were not able to reach the bone anchored to the back of the culvert, possibly due to the angle and smoothness of the plywood runway. Thus, little hair was snagged in the gun brushes arrayed close to the bone. The exception was at Hard Creek, where the gun brushes were inadvertently installed closer to the entrance of the culvert rather than toward the rear near the bone. This may have allowed wolverines to stand on and use the brushes for leverage, as the brushes were bent and held decent amounts of hair.

It also was difficult to identify distinguishing marks on wolverines at the culverts to aid in recognizing individuals. Our cameras were positioned head on to include, in 1 image, both the culvert and the scent pump tree. Wolverine activity at the culvert entrance was viewed from straight above and animals tended to back out rather than turn around, so most pictures were of the back of the animal and not the more characteristic throat and chest.

DNA Results

We submitted 74 hair samples to the Genomics Center. Of these, 54 samples were associated with positive camera detections of wolverine, 13 samples were associated with other species of interest (fisher, marten), and 7 were submitted due to camera malfunction during a sampling period. Collectively these samples yielded 17 positive wolverine samples (Pilgrim and Schwartz 2021; K. Pilgrim, Genomics Center, personal communication). Only 3 of these were from an experimental DNA shelter (culvert), all collected at 1 location (Hard Creek). While the overall return on DNA appears low, there were a number of occasions when we detected wolverines in photographs, but the animals did not contact gun brushes to leave a DNA sample. Thus, there was no opportunity to obtain species or genotype.

All of the DNA samples confirmed as wolverine belonged to haplotype Wilson-A. This was consistent with results from the WSWCP camera survey in 2016–17, which found that all wolverine samples from Idaho, Montana, and Wyoming were Wilson-A (Lukacs et al. 2020). Haplotype Wilson-A is the most common and widely distributed wolverine haplotype in North America (McKelvey et al. 2014).

Individual Wolverines

Of the 17 wolverine-positive DNA samples, 13 were of sufficient quality to yield gender and individual profile (Pilgrim and Schwartz 2021; K. Pilgrim, Genomics Center, personal communication). These results confirmed 3 females previously known from this study area, and 1 male new to the genomics database (Table 1). From photographs alone we identified another 3–4 individuals. Thus, using a combination of DNA analyses and photographs, we detected 7 individual wolverines across the 14 camera stations (detailed below), and likely at least 8. Although we had no photographs of multiple animals together, we did have photographic evidence at 2 stations of multiple individuals appearing at different times. Wolverine visits to cameras are detailed in Appendix A, Table A-2.

Individual Wolverines - PNF

F10-Olive---This female was first identified in spring 2013, captured as a subadult in the White Cloud Mountains between Stanley and Ketchum, Idaho, during the wolverine–winter recreation study (Heinemeyer and Squires 2014). She dispersed to the PNF shortly after capture and settled in the apparently vacant home range of a female consistently detected there years prior up until 2013. During the present study, F10-Olive was confirmed by DNA at Hard Creek and Granite Creek, both of which are locations known to be within this established territory. Photographs suggest she also could have been the individual detected at Fisher Creek Saddle, 5.3 km east of Hard Creek. There were 17 wolverine visits to Granite Creek and Hard Creek combined, and while not all photos were diagnostic, we didn't see any images that suggested another individual other than F10-Olive during these visits. This female was 9 years old in spring 2021.

IDFG20_Secesh_F---This female was first identified in spring 2020, a year prior to the current study, from an IDFG camera station at Secesh Summit. During the present study she again was detected at Secesh Summit and also at Josephine Creek, 4 km to the north. A decade ago, a female from the winter recreation study also was detected at these 2 locations, suggesting that the 2 sites typically fall within 1 female territory (Heinemeyer and Squires, unpublished data).

IDFG21_ULC_M1---This male, a new individual, was confirmed at Upper Lick Creek. From radio-collared animals followed during the winter recreation study, males that visited Upper Lick Creek also visited Lower Lick Creek and Pearl Creek, but this male did not appear to be the wolverine in photographs at Pearl Creek in 2021 (see below). Lower Lick Creek had only 1 brief wolverine visit and no wolverine-positive DNA, so we could not confirm whether it was IDFG21_ULC_M1.

Pearl Creek wolverine---No wolverine-positive DNA was collected at this site, but based on photographs, this individual appeared to be different from IDFG21_ULC_M1. This location typically has been outside the female territory that encompassed Granite Creek and Hard Creek, so we thought it unlikely to be F10-Olive.

Table 1. Camera survey stations in the western Salmon River Mountains core wolverine population area, Idaho, winter 2020–21, with results for wolverine detection and DNA analysis of wolverine-positive samples to gender and individual.

Site Code[a]	Location	Station Type[b]	Wolverine Detection by Photo	Positive Wolverine DNA	Wolverine Gender	Wolverine ID	New to Wolverine Genomics Database?
270-HC	Hard Creek	SP/DNA box	Yes	Yes	F	F10-Olive	No
270-FCS	Fisher Creek Saddle	SP/DNA box	Yes	No			
270-GC	Granite Creek	B	Yes	Yes	F	F10-Olive	No
271-JC	Josephine Creek	B	Yes	Yes	F	20_Secesh_F	No
271-SS	Secesh Summit	B	Yes	Yes	F	20_Secesh_F	No
251-PC	Pearl Creek- New	SP/DNA box	Yes	No			
251-UL	Upper Lick Creek	B	Yes	Yes	M	21_ULC_M1	Yes
232-LL	Lower Lick Creek	SP/DNA box	Yes	No			
189-CC	Curtis Creek	SP/DNA box	No				
190-WLS	Warm Lake Summit	B	Yes (2)[c]	Yes	Unknown[d]	Unknown[d]	Unknown[d]
190-JC	Johnson Creek	B	Yes (2)[c]	Yes	F	MS-Gulo-F13	No
xxx-GF	Gold Fork	B	Yes	No			
214-BL1	Burntlog #1	SP	No				
190-BL2	Burntlog #2	SP	Yes	No			

[a] See Figure 1 for station location. Numeric prefix refers to grid cell ID from Western States Wolverine Conservation Project (WSWCP) camera survey grid; alpha code is abbreviation of location. xxx-GF fell outside of the WSWCP camera survey grid. Bolded entries correspond to live-trap sites from the wolverine–winter recreation study 2010–2015 (Heinemeyer et al. 2019).

[b] B=Bait, SP=Scent Pump, SP/DNA box=scent pump and baited box protecting gun brushes.

[c] Two different individuals in photographs, with DNA only from one.

[d] DNA was poor quality; it returned species but could not yield gender and individual.

Individual Wolverines - BNF

MS-Gulo-F13---This female was first identified in 2016–17 from DNA collected from station 214 in the Burntlog drainage during the WSWCP camera survey. During the present study, she did not appear at 214-BL1 (Burntlog #1) but instead was detected at Johnson Creek, 10 km to the southwest. The DNA samples that confirmed this female were collected during the last sampling interval, and unfortunately the camera failed to take photographs during that time. Thus, we have no direct temporal correlation of the DNA with photographs. However, we compared photographs from earlier intervals at Johnson Creek with those from 2017 and are confident that F13 was at Johnson Creek earlier in the winter. Based on that photo crosswalk, she also appears to have visited Warm Lake Summit. Based on home range sizes of collared females in the McCall study area of the winter recreation study (Heinemeyer and Squires, unpublished data), Warm Lake Summit, Johnson Creek, and Burntlog #1 could easily fall within 1 female's home range. This female definitely was not the wolverine with white paws described below that was detected at 190-BL2 (Burntlog #2).

BNF Individual 2, "white paws"---This individual had distinctive white markings on both front feet, enabling us to track its appearance at several camera stations from photographs. Based on our photo interpretation, it visited 3 stations (Warm Lake Summit, Johnson Creek, and Burntlog #2) that ranged from 5.7 km to 10.2 km apart. Unfortunately we obtained no wolverine-positive DNA from Warm Lake Summit or Burnt Log #2, and the genetic data from Johnson Creek was limited to MS-Gulo-F13, described above.

BNF Individual 3---This wolverine could actually be MS-Gulo-F13 described above. It also visited Warm Lake Summit and lacked white paws, but it appeared to have different throat markings than F13. Because photographs are limited, the identity of this animal remains uncertain.

BNF Individual 4---A wolverine was detected at the Gold Fork station on 4 occasions. Not all photographs offered the best vantage points, but they appeared to represent a single individual that was not similar to other wolverines detected at the Warm Lake Summit-Johnson Creek-Burntlog complex, nor did it appear similar to the animal at Upper Lick Creek on the PNF.

<u>Comparison of Wolverine Occurrence 2010–2014 to 2021</u>

Based on results from the 10 locations common to both time periods, we logged 42 wolverine visits over 1,189 "trap" nights. Our detection success with cameras was 3.5 visits per 100 nights, lower than live-trapping success during the wolverine–winter recreation study (range 3.8 to 8.9 captures per 100 trap nights, mean 5.6; Heinemeyer and Squires 2012, 2014). We detected 40% fewer individual wolverines with cameras in 2021 than the peak of 11 wolverines live-trapped and monitored during 2011. However, the number of individual wolverines detected with cameras in 2021 (6–7) was slightly higher than the winter recreation project's last 2 years (5 individuals).

Camera stations at Hard Creek, Granite Creek, and Fisher Creek Saddle formed a complex on the west side of Warren Wagon Road north of McCall (Figure 1). These 3 sites consistently were encompassed within a single female territory and an overlapping single male territory during the wolverine–winter recreation study, based on radio collared animal locations (Heinemeyer and Squires 2012; Heinemeyer and Squires, unpublished data). Granite Creek and Hard Creek were productive trap sites, with resident animals live-trapped numerous times each season. We

confirmed 1 female visiting these stations during the current project, a female that established residency during the winter recreation project. Because photographs often are not conclusive as to individual, we can't be certain that this female was the only wolverine represented in images at these 3 cameras, but we did not identify a different animal.

Secesh Summit and Josephine Creek were located at the northern end of the study area ~4.5 km apart. These 2 locations have, in the past, been encompassed within a single female territory and our results were consistent. The female we detected was a different individual than the one known from the winter recreation study, but our detections suggest she had acquired the same, or similar, territory.

Pearl Creek was located on the east side of Warren Wagon Road north of McCall. While it is closest geographically to Granite Creek (4.5 km), it was encompassed within home ranges separate from Granite Creek during the winter recreation study. Warren Wagon Road appeared to be a boundary. Over the course of the winter recreation study, an adult female, a subadult offspring of that female, and 2 adult males were live-trapped at this location (Heinemeyer and Squires, unpublished data). During this project we documented only 2 wolverine visits, both late in the season (Appendix A, Table A-2). We couldn't be certain it was the same individual both times due to a limited number of photographs.

The Upper and Lower Lick Creek sites were located along the Lick Creek Road corridor northeast of McCall. Upper Lick Creek has a long history of wolverine activity, beginning with track surveys in 2004 and follow-up camera surveys (IDFG unpublished data). Based on wolverine captures during the winter recreation study, there didn't appear to be a clear demarcation between Upper and Lower Lick Creek, as 1 female and 2 males were captured at both places within 1 winter. Across all years of the study, 5 different individual wolverines were live-trapped at these 2 sites collectively. During our camera study, we had 3 visits to Upper Lick Creek late in the season, all of which appeared to be the same individual. DNA confirmed this as a male, new to the wolverine genomics database. A wolverine visited Lower Lick Creek only once, very briefly. It left no DNA and with limited photographs we can't be sure it was the same individual as Upper Lick Creek.

The Curtis Creek station was located off Warm Lake Road ~12.5 km southeast of Gold Fork and ~15 km southwest of Warm Lake Summit. We detected no wolverine activity at this camera station during the current study. During previous studies, numerous wolverines were detected here, either as part of wolverine territories that extended north on the PNF, or east on the BNF. In 2013, a female wolverine visited Curtis Creek and Gold Fork (Pilgrim and Schwartz 2013, 2014). In 2014, a male from the winter recreation study ranged from Curtis Creek north almost to the Main Salmon River, an unusually large home range that encompassed Lower Lick Creek, Upper Lick Creek, Secesh Summit, and Josephine Creek on the PNF (Heinemeyer and Squires 2014). Over multiple years, a different male from the winter recreation study visited Curtis Creek, Warm Lake Summit, and locations in the Johnson Creek and Burntlog drainages (Idaho Department of Fish and Game 2021).

The camera station at Warm Lake Summit, which was established during the winter recreation study and included in a comparison to that time, was part of a complex of wolverine activity near Landmark that extended beyond the winter recreation study area. Our photographs, combined with

DNA confirmation of 1 individual, connected Warm Lake Summit to both Johnson Creek and Burntlog #2. This was consistent with past years. A male live-trapped at Warm Lake Summit in 2011 during the winter recreation study (Heinemeyer and Squires 2012), subsequently was detected farther north in the Johnson Creek corridor (Idaho Department of Fish and Game 2021, Midas Gold 2014) and also at Burntlog #1 in 2017 (IDFG unpublished data). We detected at least 2 individual wolverines, and possibly 3, at Warm Lake Summit during the present study.

The Gold Fork camera station was located in the South Fork Gold Fork drainage on the BNF. This location was not part of the winter recreation study, and was not included in a comparison to that time period. Results from previous work by IDFG and BNF (remote cameras and fisher bait stations) linked wolverine activity in the Gold Fork drainage to Curtis Creek and to the Lick Creek Road Corridor on the PNF (described above).

In summary, we did not confirm with cameras the number of individual wolverines we expected on the PNF portion of our study area. During 2011, the peak year of the winter recreation study, 9 of the 11 wolverines captured were on the PNF. In 2014, 5 wolverines were captured there. In 2021, across the same locations, we could confirm only 4 animals. We did not confirm a male in the territory encompassing Hard Creek, Granite Creek, and Fisher Creek Saddle. We also didn't confirm a female on the east side of Warren Wagon Road in the Lick Creek or Pearl Creek drainages, where, in 2011, 3 females were live-trapped. We did confirm 1 male in the Lick Creek corridor, although in 2011 there were 2 resident males there. Our results seem to corroborate what Heinemeyer and Squires (2014) described as significant turnover, with known territories potentially vacant. In contrast, wolverine activity on the BNF portion of our study area appeared stable. As occurred during the winter recreation study, we confirmed 2 individuals at Warm Lake Summit, with possibly a third. The Gold Fork camera added an individual wolverine outside of the scope of the winter recreation study.

Other Species

We detected 17 other wildlife species at camera stations, including marten, fisher, fox, snowshoe hare (*Lepus americanus*), flying squirrel (*Glaucomys sabrinus*), elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), and 6 species of birds (Table 3). Red fox and marten were the most ubiquitous species, detected at 13 and 12 of the 14 camera stations, respectively. Two species of marten are now recognized in North America: American marten (*M. americana*) and Pacific marten (*M. caurina*; Pilgrim et al. 2017 and cites therein). All of the hair samples we collected that had sufficient DNA to test for species were *M. caurina*. This aligns with results from the WSWCP camera survey, which also found that all marten samples collected from Idaho were *M. caurina* except 1 station in the Panhandle where *M. americana* was detected and 2 stations in the Clearwater that yielded genetic signatures for both species. Hybridization is known to occur between these 2 marten species in the northern Rocky Mountains.

Table 2. A sample of other species detected at camera stations deployed in the western Salmon River Mountains, winter 2020–21.

Site Code	Fisher	Pacific Marten	Unid Marten[a]	Fox	Snowshoe Hare	Coyote	Red Squirrel	Wolf	Birds[b]	Black Bear	Flying Squirrel	Elk/Deer
270-HC			●	●			●		●			
270-FCS		●		●	●		●		●			
270-GC		●		●					●			
271-JC		●										
271-SS		●		●	●		●		●			
251-PC			●	●	●		●		●			
251-UL		●		●			●	●	●			
232-LL		●		●	●		●					
189-CC	●	●		●		●			●			
190-WLS		●		●	●	●			●		●	
190-JC	●	●		●	●		●				●	
xxx-GF				●					●			
190-BL2			●	●	●		●		●	●	●	●
214-BL1	●			●			●		●	●		●

[a] Appeared in photographs; DNA confirmation lacking but presumed to be Pacific Marten (*M. caurina*).
[b] Gray Jay, Stellar's Jay, Clark's Nutcracker, Pileated Woodpecker, Common Raven, and unid Owl.

We detected fisher in photographs at 3 stations on the east side of our study area: Curtis Creek, Johnson Creek, and Burnt Log #1. However, fisher DNA was confirmed only at Johnson Creek. The 4 fisher-positive samples from Johnson Creek were further analyzed for haplotype and individual. DNA confirmed this animal was a male and new to the fisher genomics database (Pilgrim and Schwartz 2021). All samples confirmed haplotype Drew-Hap4, consist with other fishers sampled in Idaho and Montana. Haplotype Drew-Hap4 also is common in British Columbia and is not reflective of fishers translocated from Minnesota and Wisconsin (Vinkey et al. 2006), suggesting this animal had a heritage from natural recolonization rather than translocation.

DISCUSSION

We conducted this project to determine if wolverine activity within a well-studied area north and east of McCall had changed over the past decade. Our metric of comparison ultimately was the number of individuals detected within this landscape. Ten years ago, that metric was generated from animals in the hand from capture and release. In the current study, the metric came from wolverine visits to camera stations. We assumed that activity at baited camera stations placed at inactive live traps would be comparable to baited live traps themselves. Both methods used olfactory cues to attract wolverines to a site, provided a food source to draw their attention, and relied on wolverines' propensity to revisit locations where they found food in the past. We also assumed that both methods adequately sampled wolverine occurrence within the study area. However, we recognized that results from our camera stations, specifically in identifying individuals, had a level of uncertainty compared to animals in the hand, and this could have influenced our count of wolverines.

On several occasions, we did not obtain high-quality DNA and/or diagnostic photographs to be positive of a wolverine's identity. Confounding this issue was the fact that not all of our baited camera stations were traditional bait stations, but rather were scent pump stations, which extend options for cameras in remote locations but also yield fewer wolverine visits overall, less time during visits, and thus fewer photographs from which to identify individuals (Evans Mack 2018, 2019). We collected wolverine photographs at all 7 of the traditional bait stations, and high quality DNA at 5 of the 7. In contrast, while we collected wolverine photographs at 5 of the 7 scent pump stations, we obtained diagnostic photos at only 3 of those 7, and high-quality DNA at only 1. Thus, our tally of individual wolverines has a level of uncertainty and could be high or low.

Our results suggested that wolverine activity on the BNF portion of the study area was similar to what had been documented over the past decade, with some differences in distribution. A wolverine was active in the Gold Fork area, although lack of DNA precluded us from knowing if that animal's territory extended north onto the PNF, as occurred in 2014, or east toward Warm Lake. The lack of wolverine visits to the Curtis Creek station was surprising, given its history. Similarly, activity in the Burntlog drainage was lower than expected. We detected no wolverines at Burntlog #1, a site that had 14 wolverine visits by 2 different individuals during the WSWCP camera survey 5 years earlier. One of those animals was still present during the current study, and its activity had moved farther south in the Johnson Creek corridor. By having cameras active simultaneously at Johnson Creek, the Burntlog drainage, and Warm Lake Summit, wolverine activity in this geographic area

was brought into focus and demonstrated how Warm Lake Summit was linked spatially to those other areas.

It was remarkable to detect a 9-year old female still occupying her 2013 territory north of McCall. Given that longevity, it was equally remarkable to not confirm a male within the overlapping territory, which had been occupied by a single male throughout the years of the winter recreation study (Heinemeyer and Squires 2014). Similarly, it was noteworthy that we did not confirm a female across the Upper Lick Creek–Lower Lick Creek–Pearl Creek complex, another area of consistent and predictable male and female wolverine occurrence in the past. Our results on the PNF portion of the study area affirmed a conclusion made by Heinemeyer and Squires (2014) that there had been an incremental loss of resident animals from 2010 and 2011 to 2014, and that previously-documented territories appeared to be vacant.

This suggests that what was considered to be a stable core subpopulation area could, in fact, be more tenuous. Given that there is no legal hunting or trapping season for wolverines in Idaho that could directly affect abundance, changes in wolverine distribution or decline in abundance could reflect changes to habitat quality, from direct or indirect influences. IDFG identified potential threats to wolverine in its management plan (Idaho Department of Fish and Game 2014), and will continue to collaborate in studies to understand the effects of environmental and human-related factors.

ACKNOWLEDGMENTS

This project was a collaboration among IDFG McCall Subregion, the PNF, and the BNF. June Galloway, PNF, provided equipment and helped deploy 2 scent stations. Jon Hunter, Isaac Fournier, Cameron Sena, Jordan Messner, Josh Poole, Mike Thomas, and Michael Young (IDFG); Rob Ryan and Brian Davis (PNF); and Curt Mack assisted with deploying or revisiting stations. Master Naturalists Nicki Humphries and Francis Russo and volunteer Ana Egnew reviewed thousands of photographs to assign species ID. This project was funded by the U.S. Fish and Wildlife Service through an Endangered Species Traditional Section 6 grant.

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APPENDIX
Camera Stations and Individual Wolverines

Table A-1. Locations and dates of camera stations in the west Salmon River Mountains core wolverine population area, Idaho, winter 2020–21.

Site Code	Location	National Forest	Station Type[a]	Deployed	Revist 1	Revisit 2	Revisit 3	Pull	Effort (days)
270-HC	Hard Creek	Payette	SP/DNA	12/16/2020	1/19/2021	2/17/2021	3/16/2021	4/21/2021	126
270-FCS	Fisher Creek Saddle	Payette	SP/DNA	12/29/2020	2/3/2021	2/26/2021	3/24/2021	4/21/2021	113
270-GC	Granite Creek	Payette	B	12/28/2020	2/3/2021	2/26/2021	3/24/2021	4/21/2021	114
271-JC	Josephine Creek	Payette	B	12/30/2020	1/26/2021	2/24/2021	3/18/2021	4/20/2021	111
271-SS	Secesh Summit	Payette	B	12/23/2020	1/20/2021	2/18/2021	3/18/2021	4/20/2021	118
251-PC	Pearl Creek	Payette	SP/DNA	12/18/2020	1/20/2021	2/18/2021	3/18/2021	4/20/2021	123
251-UL	Upper Lick Creek	Payette	B	12/17/2020	1/21/2021	2/19/2021	3/19/2021	4/19/2021	123
232-LL	Lower Lick Creek	Payette	SP/DNA	12/24/2020	1/21/2021	2/19/2021	3/19/2021	4/19/2021	116
189-CC	Curtis Creek	Boise	SP/DNA	12/21/2020	1/22/2021	2/22/2021	3/22/2021	4/22/2021	122
190-WLS	Warm Lake Summit	Boise	B	12/21/2020	2/1/2021	2/25/2021	3/23/2021	5/3/2021	123
190-JC	Johnson Creek	Boise	B	12/31/2020	2/1/2021	2/25/2021	3/23/2021	6/9/2021	82
xxx-GF	Gold Fork	Boise	B	12/14/2020	1/15/2021	2/23/2021	3/17/2021	6/3/2021	171
214-BL1	Burntlog #1	Boise	SP	10/16/2020				7/9/2021	266
190-BL2	Burntlog #2	Boise	SP	10/28/2020				7/9/2021	254

[a] B=bait, SP=scent pump, SP/DNA=scent pump and DNA box.

Table A-2. Dates and identities of wolverines visiting camera stations in the west Salmon River Mountains core wolverine population area, Idaho, winter 2020–21.

Site Code	Gulo?	Gulo Visit Dates	Individual	Comment
270-HC	Y	12/24/20 - 12/25/20		2 visits
		1/4/21		
		1/14/21		2 visits
		1/15/21		
		2/24/21		
		3/17/21	ID_2013_F10_Olive	DNA confirmation
		3/27/21		
		4/15/21		
270-FCS	Y	2/23/21		could be ID_2013_F10_Olive
		3/17/21		
		3/30/21		
		4/10/21		
270-GC	Y	2/22/21		
		2/23/21		
		3/6/21	ID_2013_F10_Olive	1st DNA confirmation
		3/13/21	ID_2013_F10_Olive	2nd DNA confirmation
		3/31/21		2 visits
		4/19/21		
271-JC	Y	1/26/21 - 1/29/21	IDFG20_Secesh_F	5 visits; 1st DNA confirmation
		3/6/21		
		3/26/21	IDFG20_Secesh_F	2nd DNA confirmation
		4/7/21		
271-SS	Y	4/9/21	IDFG20_Secesh_F	DNA confirmation
		4/18/21		
51-PC	Y	4/1/21	Pearl Creek 1	not same as IDFG21_ULC_M1
		4/18/21	same(?)	not positive is Pearl Creek 1
1-UL	Y	3/27/21	IDFG21_ULC_M1	DNA confirmation
		4/2/21	same	
		4/16/21	same	
32-LL	Y	1/19/21		unknown; only 3 images
189-CC	N			
190-WLS	Y	1/17/21	BNF Individual 2	"white paws"
		1/18/21	MS-Gulo-F13(?)	no white paws; could be MS-Gulo-F13
		3/18/21	BNF Individual 3?	no white paws; poss different from F13
		3/22/21	BNF Individual 2	"white paws"
		4/6/21	BNF Individual 2	"white paws"
190-JC	Y	3/3/21	MS-Gulo-F13(?)	no white paws
		3/15/21		
		3/18/21	BNF Individual 2	"white paws"
		3/23 thru 6/9 2021	MS-Gulo-F13	DNA confirmation
xxx-GF	Y	3/8/21	BNF Individual 4	
		3/10/21		
		3/25/21		2 visits
214-BL1	N			
190-BL2	Y	4/1/21	BNF Individual 2	"white paws"

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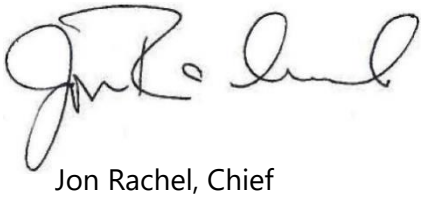

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