Monitoring Wolverines in Northeast Oregon

January 2011 – December 2012

Final Report

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Photo by Jens Persson

TABLE OF CONTENTS

INTRODUCTION

Wolverine range in the contiguous United States had contracted substantially by the mid 1900s, probably because of high levels of human-caused mortality and very low immigration rates (Aubry et al. 2007). The species is currently listed as Threatened in Oregon by the Oregon Department of Fish and Wildlife. The Oregon Conservation Strategy lists the wolverine as a species for which status is unknown but habitat may be suitable to support the species in the Blue Mountains, East Cascades, and West Cascades Ecoregions of Oregon (Oregon Department of Fish and Wildlife 2006; pages 367−368). At the federal level, the U.S. Fish and Wildlife Service has recently proposed to list the wolverine as a threatened species in the contiguous U.S. under the federal Endangered Species Act (http://federalregister.gov/a/2013-01478).

In their historical review of wolverine distribution in the western states, Aubry et al. (2007) concluded that wolverines detected in Oregon in recent decades "probably represent extreme dispersal events that were not representative of self-sustaining populations" because "there is no evidence of wolverine occurrence in eastern Washington or Oregon currently." These authors used strict criteria for considering a wolverine record as "verifiable" (physical evidence) or "documented" (published or archived records of wolverines being killed or captured) [hereafter, collectively referred to as "verified" in this report]. Unverifiable accounts of wolverine sightings or tracks (anecdotal records) were not included in their database. Using records in their unpublished database (courtesy of Keith Aubry), we determined that there were 3 verified from Oregon in the 33-year period 1896−1928, none in the 36-year period 1929−1964, and 5 in the 28-year period 1965−1992. After the 1992 record, there were no verified records in the 18-year period 1993–2010 (the database ended in 2005, but we know of no additional verified wolverine records through 2010).

Resident wolverines could conceivably exist in montane habitats in Oregon but remain undetected because of low numbers, ineffective or inconclusive detection techniques, and lack of surveys in suitable habitat. A wolverine survey was conducted in the early 1990's in northeast Oregon using snow track intercept surveys and a small number of baited sites with cameras and hair snags (Schommer 1994). Few if any of the survey crew members were experienced in tracking wolverines and the areas surveyed largely fell outside the area with the best habitat for wolverines (sensu Copeland et al. 2010). During this survey, wolverine tracks were thought to have been detected in 2 different areas (Sled Springs near Tope Creek and the Unity Ranger District near Whitney/Patrick Creeks). Photographs and plaster casts of the tracks near Tope Creek were taken but no physical evidence of the Unity tracks was documented. Putative tracks would not be considered verified records using the criteria of Aubry et al. (2007) unless the photographs or plaster casts could be conclusively identified as wolverine by others familiar with wolverine tracks. In 2011, 2 of the authors of this report (Magoun and Valkenburg) examined the track photographs and 1 of the plaster casts from the Sled Springs area (courtesy of Jim Soares) but we could not verify that they were made by a wolverine.

All verified records of wolverines in Oregon (Aubry et al. 2007) resulted from opportunistic encounters, in that the animals were either shot opportunistically, unintentionally caught in traps set for other species, or killed while crossing roads (unpublished database provided by Keith Aubry). The success rate for documenting wolverine presence using such opportunistic methods would be quite low for Oregon where there is relatively little suitable habitat (i.e., within the area of persistent spring snow cover as delineated by Copeland et al. 2010) and this habitat is not easily accessed in winter. We anticipate that verified records of wolverines (sensu Aubry et al. 2007) will remain rare for the state unless surveys are targeted specifically to wolverines and are conducted in the most likely wolverine habitat in Oregon using techniques that provide irrefutable evidence of their presence.

The purpose of this project was to conduct camera trapping, hair snagging, and aerial snow track surveys in northeast Oregon to determine if wolverines are present, whether they are residents in the area, and whether females, if detected, show evidence of reproduction. Detection of lactation would verify that wolverines in Oregon constitute a breeding population and not just dispersing individuals or temporary residents. Even if a breeding population is not detected, verification of presence, even of transient individuals, can provide important information on the role Oregon plays in the dynamics of wolverine populations across the western states. We focused our surveys in and adjacent to the Eagle Cap Wilderness (ECW) in the Wallowa-Whitman National Forest (WWNF).

STUDY AREA

The Wallowa Mountain Range, located in northeast Oregon, is ~25 miles wide and 50 miles long. The study area is located in the Wallowa Mountains within and adjacent to the ECW

(Fig. 1). The 560-mi^2 ECW comprises montane forests at lower elevations and sub-alpine/alpine habitat with glacial cirques, perpetual snow/ice fields, and glaciers at higher elevations. Elevations range from ~4,000 to 10,000 feet. Snow in the ECW lasts well into summer and can occasionally form multi-year snow beds (Fig. 2). Some trails used for access at higher elevations are still snowbound until July. Avalanches in winter and early spring are common and widespread, particularly in March and April.

Most of the ECW and some portions of the Wallowa Mountains outside the ECW fall within the area of persistent spring snow (Fig. 3) that currently defines wolverine habitat in the western mountains (Copeland et al. 2010). Snow that lasts into May provides protection for young wolverines, which are typically born in snow dens in late February or early March (Inman et al. 2012*a*). Wolverines use snow dens until early May (Magoun and Copeland 1998). Areas with long-lasting snow also provide caching sites where wolverines can store food and protect it from other scavenging species (Inman et al. 2012*a*). Accumulated snow in the ECW is highest during the wolverine denning period. For example, the median snow water equivalent (SWE) at the Aneroid SNOTEL site in the ECW (elevation 7,400 feet) for the period 1981−2010 (measured on the first day of the month) was 14.4 inches in February, 20.2 in March, 24.1 in April, and 25.2 in May. In June the SWE decreased to 16.8 inches and then dropped to zero in July (Source: USDA Natural Resources Conservation Service).

Wolverines are primarily scavengers, especially in winter when they rely on carcasses of large mammals killed by predators, disease, malnutrition, accidents, and wounding loss from hunting. In the WWNF, large mammals most likely to be scavenged by wolverines are elk, mule deer, and mountain goats (Fig. 4). Large predators capable of providing ungulate carcasses for wolverines include black bears, mountain lions, and wolves. Occasionally, under the right conditions, wolverines may also kill ungulates. In summer, in addition to ungulates killed by predators, smaller species that could provide food for wolverines in the WWNF include snowshoe hares, ground squirrels, and other small mammals as well as ground-nesting birds and their eggs.

No motorized travel is allowed in the ECW and access to the periphery of the ECW is limited to a series of unimproved U. S. Forest Service (USFS), county, and state roads. In winter, most USFS roads are not plowed so access is by snowmachine or other over-snow transport. Non-motorized winter recreation in the ECW is light with most activity occurring near the eastern and southern wilderness boundary. In summer, hiking and horseback riding are the most common activities and occur throughout the wilderness, but certain areas of the ECW, such as the Lake Basin area, are used more heavily than others. Fall big game hunting occurs throughout the ECW.

METHODS

Integrated Motion-detection Cameras and Hair Snags

Winter

Our study plan called for deploying ~30 motion-detection cameras in forested habitat across the study area in or near the ECW where the spring snow cover map in Figure 3 indicates that habitat may be suitable for wolverines. Until a wolverine was detected in the study area, we simply hung baits in trees and attached motion-detection cameras to another tree facing the bait. Once a wolverine was detected in the study area, we used an integrated camera-trapping and hair-snagging method as described by Magoun et al. (2011*a,b*). Hair-snagging devices were added to the camera stations to collect hair for DNA. With this technique, motion-detection cameras are very effective in detecting wolverine presence, identifying individuals, determining the gender of the individuals, and determining if females are lactating if photographed from March–May. DNA from hairs collected with hair snags can provide the genotypes of wolverines visiting the camera stations. The pattern of light-colored fur on the ventral surface of wolverines (ventral pattern) provides a unique identifier for each individual, which can then be linked to the genotype of the wolverine in the photographs (Magoun et al. 2011*b*).

The cameras stations consisted of run poles attached horizontally to trees along which wolverines approached hanging baits, usually portions of road-killed deer, hung from 3/32-inch steel cable above the ends of the run poles (Fig. 5). Motion-detection cameras were set to photograph wolverines as they looked up at the bait to document the ventral pattern on the throat and chest. Baits positioned at least 18 inches above the run pole enticed wolverines to stand up to reach the bait, thereby producing photographs of the abdominal area, which can provide evidence of gender and lactation. Cameras used for this study included models from Trail Watcher© (Trail Watcher, Monticello, Georgia) and Reconyx© (Reconyx, Inc., Holmen, Wisconsin).

Summer

From late June through mid August, we established summer camera stations at high elevation sites where access in winter would have been difficult and dangerous. Most of these stations were deployed in boulder fields where remnant snowdrifts still lingered at the time the stations were established. Pieces of road-killed deer were placed under boulders or large logs, where they were protected from sunlight. The bait was secured by cables around boulders or trees, and scent lures (beaver castor, perfume, and wolverine urine from captive wolverines and anal gland secretions from wolverines harvested in Alaska) were distributed in the area. The intent of the summer camera-trapping effort was to document additional wolverines, in particular females, that might be occupying areas of the ECW that were inaccessible to us for camera trapping in winter. We retrieved these cameras from late September through mid October.

Snow Tracking from the Air

Some areas of the proposed study area, in particular high alpine habitat within the ECW, are difficult or dangerous to access in winter and yet may represent the best habitat for wolverines in the study area. Therefore, we used snow-track survey flights from a fixed-wing aircraft (PA-18 Supercub) to detect wolverine presence in open areas such as alpine habitats, ridges, meadows, and frozen lakes. The survey technique was developed and tested in Ontario by authors Magoun and Valkenburg (Magoun et al. 2007, Koen et al. 2008). Approximately 24−48 hours after fresh snowfalls and when winds were light, we flew all open areas of the ECW and adjacent areas of the WWNF and the Hell's Canyon National Recreation Area (HCNRA). The aircraft was based at the Enterprise Municipal Airport near the study area.

Wolverine tracks detected during these surveys would verify the presence of wolverines even if no wolverines were photographed at camera stations, and location of tracks detected during the flights would help to determine the best location for camera stations. All survey flight routes, wolverine tracks, and goat sightings and tracks were recorded on a GPS tracking device. Flight routes were variable depending on tracking conditions, elevation, and topographical features.

RESULTS

Winter 2010-2011

Camera Deployment

Due to unusually heavy, frequent snowstorms in the study area during the camera-trapping period, we were only able to set up 16 of the proposed 30 camera stations (Table 1). However, at 4 camera stations, we deployed 2 cameras to increase the probability of detecting wolverines when the camera stations could not be checked frequently (e.g., every 2–3 weeks). All cameras except WCAM6 were located either in or adjacent to the ECW (Fig. 6). We placed WCAM6 at a location outside of the WWNF boundary where an unverified sighting of a wolverine was reported in August 2010 (Marsha O'Dell, personal communication). The highest elevation where a camera was deployed was 6,398 feet and the lowest was 4,646 feet. We placed 3 camera stations at elevations <5,000 feet, 9 from 5,000 to 6,000 feet, and 4>6,000 feet.

Deployment of cameras was initiated on 30 January 2011 and the last camera station was set up on 21 April 2011 (Table 2). Camera stations were operated for a cumulative total of 1,453 camera-station days (range 36–137; mean=91). Photo history from the cameras indicated that the cameras were operable on at least 888 (61%) of the days (range 20−89; mean=55.5). Camera stations were checked from 1 to 6 times over the winter with an average of 3 checks per camera station. All camera stations were removed by 20 June 2011.

Until wolverines were detected in the study area, we simply hung portions of deer carcasses from a tree by a cable and set up the cameras to photograph animals feeding on the bait (Fig. 7). After we began detecting wolverines, we set up the integrated camera and hair snag protocol at all the stations to obtain ventral pattern photos and hair samples from wolverines (Fig. 5). The camera used at most stations was Trail Watcher, a camera that photographs in color both day and night and provides sharp, high-resolution photographs of the ventral patterns on the wolverines. We added a Reconyx camera at some stations because this camera had a much longer battery life (but lower resolution and only black & white photos at night). We used the Reconyx camera at 5 stations on the south side of the Wallowa Mountains where repeated access to the cameras in late winter was difficult or dangerous because of avalanches.

Wolverines Detected at Camera Stations

Wolverines were detected at 7 of the 16 camera stations (44%), either by photos, hair, or both (Table 2). For the stations with wolverine detections, the number of days before a wolverine was photographed ranged from 4−75 (mean=40.5). At WCAM1 we had only hair because the camera stopped functioning after 90 days, which was before the wolverine arrived. The identity of the wolverine that visited 2 stations was not determined, either because photos of the individual were not diagnostic of individual identity (WCAM2) or hair collected did not have sufficient DNA to identify the individual or its gender (WCAM1). At 1 of these stations and at the remaining 5 stations with detections, we identified 3 individual wolverines by photographs: Stormy (Figs. 8), Iceman (Fig. 9), and Zed (Fig. 10). Stormy left enough hair to determine his genotype and verify that he was a male. Zed was a subadult male, based on the small size of testicles in photographs of him, but we did not collect any hair from him. We could not verify the gender of Iceman and we did not collect hair from him. Photographs suggested that Iceman was also a male. Zed was identified at only 1 camera station, Iceman at 2 stations, and Stormy at 4 stations.

The earliest date that a wolverine was detected at a camera station was 14 March 2011 (8 days after the camera was deployed). At this station (WCAM10), Stormy was photographed on 8 days between 14 March and 9 April feeding on the bait (Table 3). He spent 50 minutes on his first visit and from 1 to 24 minutes on subsequent visits, with 1 to 5 separate visits on the days he was detected at this camera station. We defined a "visit" as the period that a wolverine was being photographed at a camera station with <30 minutes between photos of the individual. On 12 April this same male wolverine was detected at a different camera station (WCAM8) 16 miles north of WCAM10. He visited this station on 7 days during April and 3 days in May (Table 3). On 22 April he also began visiting a new camera station (WCAM16) located 5.2 miles from WCAM8 and was documented at that station on 3 days in April and again on 12 May. He moved back and forth between WCAM8 and WCAM16, in one case visiting both stations on the same day <3 hours apart (Table 3). He spent at least 178 minutes of total time at WCAM8 during 19 visits in April and May and at least 81 minutes at WCAM16 during 8 visits in April and May. Overall, Stormy made 37 visits on 21 days with an average length of 14.6 minutes per visit (range 1−65).

The wolverine Iceman was first detected at WCAM8 on 2 April 2011 and revisited the station just after midnight on 3 April and again at around 0600 hours on 3 April for a total of 37 minutes (Table 3). About 12 hours later he visited WCAM2, which was 7.7 miles from

WCAM8, fed on the bait for 26 minutes, and then left. He was not detected again during the study. The average length for all 4 visits was 18.8 minutes (range 1−33).

The third wolverine, subadult male Zed, was detected at only 1 camera station 62 days after the camera was first deployed and was the only wolverine photographed at that station (Table 3). He visited the station on 12 May for 23 minutes, returned 32 minutes later for <1 minute, and then returned 5 hours later on 13 May, visiting the station that day on 5 occasions for a total of 37 minutes. His visits averaged 8.7 minutes; n=7; range 1−23. He was not detected again at the camera station in the remaining days that it was deployed.

At 2 camera stations (WCAM7, WCAM8), a wolverine was detected but could not be identified because only a small part of the individual was photographed during visits that lasted ≤3 minutes and no hair was collected (Table 3). Both of these camera stations had been visited by 1 or more of the 3 individuals mentioned above. No females were detected at the camera stations, however, the gender of the unidentified wolverines and of Iceman could not be verified.

All photos of wolverines were taken at camera stations at or above 5,500 feet, however, at WCAM1, located around 5,000 feet elevation, we collected a single wolverine hair late in the field season >90 days after the camera was deployed (Table 2). The camera's memory card was full, mostly with photos of marten, before the wolverine visited the camera station.

<u>DNA Analysis of Hair</u>

Hair was collected at 2 camera stations (WCAM1 and WCAM8) and was analyzed by the Wildlife Genetics Laboratory at the Rocky Mountain Research Station in Missoula, Montana. Hair from WCAM1 could only be identified as "wolverine." Genotype and gender of the individual could not be determined because the DNA was degraded. Abundant hair was collected at WCAM8, which provided a genotype and verified the gender of the male Stormy. The DNA indicated that Stormy was genetically more closely related to wolverines in Idaho than to wolverines in Washington. The laboratory designation for this wolverine is "OR-Stormy-M-H" and DNA from this individual is archived at the Wildlife Genetics Laboratory (Rocky Mountain Research Station, USDA Forest Service, Missoula, Montana).

Snow Tracking from the Ground

Although ground-tracking wolverines in the study area was not one of the techniques we proposed to use in this study, we actually found the first evidence of wolverines in the study area by detecting wolverine tracks in the Hurricane Creek drainage during a trip to check a camera station. The wolverine had not visited the camera station, but its tracks were found within 0.5 miles of the camera (Fig. 11; photo on the left). We set up a camera station close to where the tracks were found and subsequently photographed Stormy at the site.

Snow Tracking from the Air

Despite generally poor conditions for aerial surveys in winter 2010-2011, we completed 27.8 hours of aerial surveys for wolverine tracks in and adjacent to the ECW, including relatively large areas to the east and north (Fig. 12). Flights were made on 8 days from 26 February through 1 May 2011 (Table 4). Two separate flights were made on both 12 and 23 April and on 1 May. Flights were made at altitudes ranging from 1,681 feet to over 10,000 feet, at 300−500 feet above ground level (conditions permitting), and at speeds averaging 82 mph. Flight time per route ranged from 1.4 hours to 4.3 hours. Seven sets of wolverine tracks were recorded during these flights (Fig. 13). Five sets of tracks were found on 23 April, with 11 miles being the greatest distance between sets of tracks that day. The other 2 sets of tracks were found on 1 May and the distance between these sets was 17 miles. The time flown between detections of tracks during the same flight was 45−75 minutes. Due to weather conditions, most survey flights over the ECW were on the north side of the Wallowa Mountains, but 4 flights were on the south side and 3 were in the HCNRA (Fig. 12). All but 1 set of wolverine tracks were detected between the Wallowa River and the Lostine River. The other set of tracks was located much further west on the North Fork of Catherine Creek. These tracks crossed the divide between Catherine Creek and the Minam River. During the aerial surveys, no wolverine tracks were located outside of the ECW, even though extensive surveys were flown over the HCNRA (Fig.12).

Winter 2011-2012

Camera Deployment

In the second winter season, we increased the number of camera stations from 16 to 26 (Table 1) and used run poles and hair-snagging devices at all camera stations as described in

Magoun et al. (2011*a*). At least two cameras were set at each station to provide a back-up camera and lengthen the period the station was active before our next visit. Deployment of cameras was initiated on 26 September 2011 and the last camera station was set up on 4 February 2012 (Table 5). All cameras were located in the ECW or within 1 mile of the boundary. Camera stations were deployed for a cumulative total of 5,515 camera-station days (range 100–319; mean=212). Photo history from the cameras indicated that the stations were operable on at least 4,747 (86%) of those days (range 68−262; mean=183). The camera stations were checked an average of 3.5 times (range 1–14) during the deployment period. The highest elevation where a camera was deployed was 7,373 feet and the lowest was 4,993 feet. We placed 2 camera stations at elevations <5,000 feet, 9 from 5,000 to 6,000 feet, and 15 >6,000 feet. All but 3 of the 26 camera stations were deactivated by the end of June, 2 by the end of July, and 1 by 10 August. See Table 1 for information on individual camera stations and Figure 6 for a map of camera station locations. We again used both Trail Watcher and Reconyx camera models.

<u>Wolverines Detected at Camera Stations</u>

The male wolverine Stormy (also detected in the previous season) was photographed at 10 of the 26 (38%) camera stations deployed in winter 2011-2012, with the first detection occurring on 27 January. No other wolverines were detected including the 2 other wolverines detected in the first season. Stormy visited all but 1 of the 4 stations he had visited in winter 2010−2011 (Table 1). The camera station that did not detect Stormy (WCAM10) was in the West Eagle Creek drainage ~1 mile south of a new camera station (WCAM25) that did detect Stormy in 2011-2012, therefore, we know he used the southern part of the ECW in both years. Only 1 camera station in the previous season was visited by a wolverine but not visited by Stormy (WCAM12). This station was reestablished in winter 2011-2012 but was not visited by any wolverine even though it was ~1 mile from an active station in the same drainage that was visited by Stormy (WCAM34).

The last date that Stormy was detected at a camera station in the 2011-2012 camera-trapping season was 17 June (Fig.14). This station (WCAM33) remained active until 26 July although we had not replenished the bait since 29 April. We left another station (WCAM16) operating until 10 August. Stormy had visited this station numerous times in both years of the study. The last detection of Stormy at this site was on 2 May when there was still some snow present. We visited this station on 5 additional occasions since that date, periodically adding bait and/or scent lure to the site, but Stormy was not photographed again at the station. An additional camera focused on the ground beneath the run pole also failed to detect wolverines at the site.

After the last winter camera station was deactivated on 26 July, we reviewed the detection history for Stormy at the camera stations. Even though 81% of the camera stations that were active during winter were deployed by the end of December 2011 (Table 5), including all but 1 of the stations that had wolverine detections the previous winter, the first photograph of Stormy in winter 2011-2012 was not taken until 27 January 2012. Stormy was known to be in the study area at least as early as 23 December 2011, when he was captured and released from a #3 foothold trap set for bobcats. For 3 months before he was trapped in the bobcat set, 2 camera stations that he had visited the previous season were active within 4 miles of the bobcat set but no photos of Stormy were taken during that period at those stations or any others.

Stormy was detected at camera stations in winter 2011-2012 on 39 days (Table 6). The longest interlude between visits to camera stations was 23 days. This long gap in detections at camera stations occurred in March after Stormy traveled 11 miles in about 40 hours from the north side of the Wallowa Mountains to the south side, where he was detected for the first time at a new camera station in West Eagle Creek (WCAM25). He visited this camera on 2 consecutive days, 12 and 13 February 2012. After a 19-day gap in detections, he was again photographed on the north side of the mountains at the first station he visited in 2012. He only made 1 other visit to WCAM 25, which occurred on 8 May, and none of the other 5 cameras on the south side of the mountains had wolverine detections.

For the 10 camera stations where he was detected in 2012, Stormy was photographed on an average of 5.5 days per station (range 3−8). Some visits per station were made on consecutive days and others after interludes of 1 to 83 days. Multiple visits (range 2−3) to a particular camera station on a single day occurred 23% of the time. Detectable visits to a camera station lasted an average of 9.9 minutes (range 1−51). Note, however, that not all visits to camera sites were necessarily detectable. Wolverines would only have been detected on a camera if they entered the detection zone of a functioning camera. Thus, the actual time spent at a camera station cannot be determined.

In addition to multiple visits to the same camera station on the same day, Stormy also visited multiple camera stations on the same day. He was detected at multiple camera stations on

31% of the 39 days on which he was detected in 2012 (2 stations per day on 8 days, 3 on 3 days, and 4 on 1 day). The average straight-line distance between 2 cameras visited on the same day was 3 miles (range 1.0−6.5).

In winter 2011−2012, the average number of days between initial deployment of camera stations and the first detection of Stormy at each of 10 stations where he was photographed was 111 days (range 35−185). For the stations that were visited in both winter seasons, the average days to detection was 137 (range 63−185), and for those stations visited only in the second season, the average days to detection were 94 (range 35−126).

Snow Tracking from the Ground

Wolverine tracks were discovered by skiers on the eastern boundary of the ECW on 2 occasions in winter 2011-2012. Photographs of the tracks were submitted to the authors by Ken Bronec and Holly Akenson for verification of track identity (Fig. 15). Good photos and detailed descriptions of the animal's behavior helped to identify the tracks as wolverine. We established a camera station in the area that eventually provided photos of the male wolverine Stormy. In addition, a set of wolverine tracks was found and photographed by Pat Matthews about 20 miles north of the ECW in December 2012 and the tracks were verified by the authors. These tracks were located outside the area of persistent spring snow cover (Fig. 16).

Snow Tracking from the Air

Despite poor flying weather again in winter 2011-2012, we were able to fly 26.7 hours in search of wolverine tracks in the ECW and adjacent areas in December and April (Table 4 and Fig. 12). Flight time per route ranged from 2.5 to 5.6 hours. Although the hours and distances flown were about the same as in 2010-2011, only 1 set of wolverine tracks was verified in 2011-2012 compared to 7 sets the previous winter. Several additional sets of tracks could have been wolverine tracks, but conditions were too poor for positive identification. We flew twice in December before we had obtained any wolverine photographs at our camera stations, many of which had been operating since October. When skiers photographed wolverine tracks in December 2011, we suspended aerial searches for tracks until after February when we expected wolverines to be moving more frequently (Magoun et al. 2007; Gardner et al. 2010) and possibly denning, if females were present. No concentrations of wolverine tracks were found during our flights in April, except near camera stations that Stormy was visiting.

Summer 2012

Camera Deployment

From late June through mid August, we established 10 summer camera stations (WCAM37–WCAM46; Table 1) at high elevation sites (range 7,200−8,500 feet). Most of these stations were deployed in boulder fields where remnant snowdrifts still lingered at the time the stations were established (Fig. 17). We retrieved these cameras from late September through mid October. For different reasons, 3 of the 10 summer cameras did not function properly (all Reconyx PC800s), although 1 of these was active for 30 days before it malfunctioned. The stations were deployed for a cumulative total of 747 days with 570 active camera days (76%) (Table 5). For cameras that operated for ≥30 days, the average length of the active period was 70.9 days.

Wolverines Detected at Summer Camera Stations

No wolverines were detected at the summer camera stations but photographs showed that at least 6 carnivore species visited the stations (Table 7*a*), suggesting that wolverines too might have visited the sites had they been in the vicinity. Baits were also fed on by smaller species such as Columbian ground squirrels (Fig. 18) and golden-mantled ground squirrels (Appendix A). At the end of the deployment period, all camera stations had pieces of bait still attached to the cable, although most of the meat was gone and the remaining meat dried out. Bones had been gnawed on at only 2 stations. Maggots had fed on all the baits. None of the baits had been pulled out from under boulders by scavengers, not even by bears that visited the stations, but bait under a large fallen tree was less secure and was removed from under the tree and the meat consumed, probably by a coyote that was photographed at the site.

Other Species Photographed at Camera Stations

In addition to wolverines, 30 other species were identified from photographs taken at camera stations of which 21 were mammals (Table 7*a*) and 9 were birds (Table 8*a*). Scientific and common names for mammal species are provided in Table 7*b* and for bird species in Table 8*b*. The number of mammals photographed at a camera station ranged from 1 to 9 (Table 7*a*) and the number of birds ranged from 1 to 3 (Table 8*a*). The camera station with the highest number of species was WCAM13, with 9 mammal and 2 bird species. Wolverines were not detected at this station. Appendix A and Tables 7*a* and 8*a* provide details on individual species identified at camera stations.

Marten and red squirrel were by far the most common mammal species photographed (each at 84% of 43 camera stations with functioning cameras; Table 7*a*). Four other mammals were commonly photographed: black bear (42%), coyote (33%), flying squirrel (33%), and deer mouse (30%). Wolverines were the seventh most commonly photographed mammal (28% of camera stations). The bird species most commonly photographed at camera stations were Steller's jay (40%), Clark's nutcracker (30%), and gray jay (30%) (Table 8*a*). Other bird species were rarely detected at camera stations, even though some known scavengers (chickadees and nuthatches) were often heard in the study area when the camera stations were active.

Whether or not an animal was photographed at a cameras station depended on the location, time of year, length of time the station was active, and position of cameras relative to the ground. We deployed most run poles at least 4 feet above the ground or snow to reduce the number of scavengers that might remove the bait before a wolverine found the camera station. Some of the species photographed at camera stations were not scavengers (i.e., did not feed on the bait) but were either passing by the camera stations or stopped to investigate the sites, apparently curious about the scent lures and bait. Animals ranging beneath run poles would generally not have been photographed unless they climbed onto the run pole or until snow accumulated to a height that placed an animal within the detection zone of the cameras. Therefore, only species attracted to the bait and able and willing to climb onto the run poles would be adequately surveyed using this technique.

Our camera stations were designed to detect wolverine but worked well with other species that were attracted to the bait and readily and consistently fed on bait hung above the run poles. These species were marten, bobcat, flying squirrel, and black bear (after they emerged from hibernation) as well as Steller's jay, Clark's nutcracker, and gray jay. Of these species, wolverine, marten, and bobcat have unique markings and provide enough photographs during visits to camera stations that individuals can be identified from photographs. For black bears, if photographs are taken over a relatively short period of time, at least a minimum number of bears visiting a particular camera station could be determined using differences in size, color (which ranges from cream to black in the study area), coat condition, and distinguishing marks of the bears. Some other relatively common carnivores in the study area (e.g., cougar and coyote) were photographed at camera stations occasionally, but stations would need to be modified to collect quantitative data for these species.

The camera stations occasionally provided photographs of uncommon species that are of particular interest to scientists, conservationists, and wildlife managers. Red foxes, which were photographed at 7 of our camera stations (Fig. 19), may be a subspecies of native fox referred to as the "montane fox" (Aubry et al. 2009; Statham et al. 2012). Photographs of foxes and locations of camera stations where they were photographed are archived by Keith Aubry (U. S. Forest Service, Pacific Northwest Research Station, Olympia, WA). We also obtained photographs of a lactating female wolf at camera station WCAM20 (Fig. 20). The presence of this wolf was not previously known to wolf biologists studying the expansion of wolf range in Oregon.

Photographs at camera stations also provided information on the presence of some species that are potential food for wolverines, including elk, mule deer, mountain goat, Columbian ground squirrel, golden-mantled ground squirrel, and snowshoe hare (Appendix A). Most of these species were not attracted to camera stations as a source of food, although ground squirrels did feed on baits that were placed on the ground at summer camera stations. Elk, mule deer, and mountain goats showed interest in the scent lure, most commonly a combination of beaver castor and perfume, and elk and mountain goats sometimes lingered at camera stations investigating the scent. Mountain goats were only photographed at 2 camera stations, both of which were deployed in summer in boulder scree at elevations over 8,000 feet.

Photographs taken at camera stations were examined to determine which species left hair in the snagging devices. Black bear hair and occasionally marten hair is not always distinguishable from wolverine hair in the field. If cameras were no longer active when we revisited the camera stations, we collected hair to determine if wolverines had visited the site after the cameras stopped working. In addition to collecting wolverine hair, we collected hair from marten at many of the camera stations, even though our placement of the hair-snagging structures was designed to reduce the chances that marten would trip the hair snags before the stations were visited by wolverines. Marten hair was submitted to the USFS as part of ongoing research on marten as a management indicator species (1990 Wallowa-Whitman Land and Resources Management Plan, U. S. Forest Service, Baker City, OR). DNA was extracted and archived at the Wildlife Genetics Laboratory at the Rocky Mountain Research Station in

Missoula, Montana (for additional information, contact Mark Penninger, U. S. Forest Service, Baker City, Oregon). Hair from black bears, bobcats, and other species was not archived.

Similarly to wolverines, photographs of marten at camera stations can be used to identify individuals, gender, and even lactation. Ventral patterns on marten showed individual differences that were distinguishable in high-resolution color photographs taken with Trail Watcher cameras (Fig. 21). At least 3 marten were identified at some camera stations.

DISCUSSION AND CONCLUSIONS

Deployment of Camera Stations

Winter

The best time to establish camera stations for winter camera trapping in the Wallowa Mountains is late October and early November before snow has accumulated to depths that make it difficult to transport camera station equipment and bait to high elevation sites. Hanging bait at camera stations earlier than late October may result in bait rotting before night temperatures fall below freezing. Deploying cameras in the fall has some drawbacks however. It is often difficult to judge how deep snow might accumulate at the station over winter, therefore, the run pole and camera must be mounted high enough to avoid being covered in snow. Choosing sites under large trees with closed canopies and in areas protected from wind will help with this problem but it may be necessary to use climbing equipment to construct the station at a height that will be above the snow surface throughout the winter. Moreover, wolverine movements increase in late winter and previous camera-trapping studies have shown that detectability of wolverines at camera stations is higher in late winter and spring (Royle et al. 2011). Therefore, camera stations established in the fall should be visited again, preferably by the end of January, to add bait and change memory cards and batteries to ensure that the station is functional during the critical late winter period. Ideally, camera stations should be checked monthly to be sure that no opportunity is lost to detect wolverines because of malfunctioning cameras or bait removed by other scavengers. As temperatures begin to warm in the spring months, it is necessary to visit camera stations more frequently when collecting hair for DNA because DNA quickly degrades in warm temperatures, especially when exposed to sun and moisture.

Although a wolverine was detected at 2 camera stations within 4 and 8 days, respectively, of station deployment (Table 2), the remaining camera stations with wolverine detections operated for a month or more, and 1 for as many as 185 days, before wolverines were detected at the stations. We recommend that camera stations should be deployed for at least 3 months, and preferably longer, to allow sufficient time for wolverines to find the stations. Camera stations deployed in the fall should be active over the entire winter, particularly February–April and including May if possible, to provide the best opportunity to detect wolverines.

<u>Summer</u>

We obtained useful information on scavengers using high elevation sites in summer, but we did not detect wolverines at summer camera stations even though some of the stations were ~1 mile from winter stations used by Stormy as late as the middle of June in 2012. Snow lingered so long in the spring and early summer in the ECW that we were not able to deploy cameras at high elevations until late July and early August in 2012, considerably shortening the period the summer camera stations were active before fall snowstorms necessitated removing the cameras. It would have been better to begin deployment in spring as soon as the danger of avalanches had subsided, but we had no prior knowledge of boulder scree fields that would provide the best sites for bait over the summer and most of the best sites at high elevations, including the sites we eventually used, were still covered with snow in May and June. To deploy summer camera stations earlier than July, specific locations for the stations would need to be chosen in the fall and marked so they can be relocated in the spring and the snow excavated down to a cavity in the boulders. Ideally, summer camera stations at high elevations should be run from May through October in the ECW. We recommend using only sites with boulder scree for summer camera stations because these were the only sites that prevented bears and coyotes from accessing the bait. Consideration must also be given to positioning cameras to take into account how the detection zones of cameras might change as the snow melts over summer.

Wolverine Detections at Camera Stations

Only 3 wolverines were detected in the study area in 2 years of camera trapping, despite the use of 43 functional camera stations and 6,205 active camera-station days over the 2 years, and only 1 wolverine (Stormy) was detected in the 2011-2012 season. We cannot conclude that there were no other wolverines residing in the ECW in 2011-2012, but the failure to detect additional animals suggests that there were very few wolverines, possibly only a single individual, in the second year. Certainly, within the small area in the central part of the ECW where the 3 wolverines were detected over the 2 years (Fig. 22), it is unlikely that any wolverine other than Stormy was present in 2011-2012 given Stormy's detection history. Stormy was detected at 10 of 20 active camera stations within the central ECW in 2011-2012 and 6 of the stations where he was not detected were summer camera stations. Considering only camera stations active in the central ECW in winter 2011-2012, Stormy failed to visit only 4 of 14 stations. Because wolverines often follow each other to sources of food, it is unlikely that other wolverines, had they been present in the central ECW in 2011-2012, would have failed to find at least 1 of the winter camera stations used by Stormy that winter, especially since 3 of the 4 stations not visited by Stormy in 2011-2012 were visited by wolverines in 2010-2011 (Stormy, Zed, and an unidentified wolverine). Winter camera stations were distributed north and south of the central ECW where Stormy was located in both years of the study, but no wolverines were detected in these areas (Fig. 6). Camera stations in the home ranges of wolverines are not always visited by the resident wolverines (Magoun, personal observations), including Stormy in this study, so it is possible that wolverines were present in these areas but went undetected at the camera stations.

Wolverines can reach densities of 25/1000 mi^2 (9.7/1000 km^2; Royle et al. 2011) not including young of the year, but estimates of wolverine density at the southern periphery of their distribution in North America are much lower. For example, a density of 9.3/1000 mi^2 (3.5/1000 km^2; Inman et al. 2012*b*) is probably more typical in the western United States, particularly where wolverine habitat is fragmented into relatively small mountain ranges separated by low elevation valleys. Using this lower estimated density, we assume that the ECW, an area of 560 mi^2, could support about 5 wolverines. Some suitable habitat lies outside the ECW to the south, and areas within the WWNF to the east of the ECW could contain portions of home ranges of wolverines occupying the ECW. Therefore, a reasonable estimate of the number of wolverines that could occupy the ECW and adjacent areas in the WWNF would be about 6 animals (not including young of the year). That we found only 1 resident wolverine in 2 years of camera surveys in and adjacent to the ECW suggests that either the habitat is insufficient to support a higher density or wolverines have not fully reoccupied the available habitat.

Results from other camera-trapping studies suggest that detectability of wolverines using cameras in our study area is considerably lower than for wolverine populations with reproductive females. In southeast Alaska, in an area of 965 mi^2 where density was estimated at 25/1000 mi^2 (9.7/1000 km^2; Royle et al. 2011), 21 different wolverines were identified using 37 camera stations over a 165-day period during January–May, yielding an average detection rate of 0.57 individual wolverines per camera station. In western Montana, where density was estimated at 9.3/1000 mi^2 (3.5/1000 km^2; Inman et al. 2012*b*), a camera-trapping study identified 9 wolverines using 37 camera stations over a 61-day period (March−April), yielding an average detection rate of 0.24 wolverines per station (Robert Inman, personal communication). In our study in the first season, we detected an average of 0.19 wolverines per station (3 wolverines detected using 16 camera stations) but this dropped to 0.04 in the second year of the study, even though we had more camera stations (26) and a longer camera-trapping season (October−June). Even if the additional 2 wolverines (Iceman and Zed) had been detected on cameras in the second year, the average number of wolverines per station would only have been 0.12.

Understanding Reasons for the Low Density of Wolverines in the Study Area

In this section we consider potential reasons why we detected so few wolverines in the study area over the 2 years that we ran the camera stations. Failure to detect more wolverines, especially resident animals present during both years, was probably not due to an ineffective detection method. In addition to the studies mentioned above, which had camera-station detection rates of 0.24–0.57, other studies using this camera-trapping technique are reporting higher detection rates than we had in our study area, including a study in Alberta that detected an average of 0.93 individual wolverines per station (13 individuals identified using 14 stations; Michael Jokinen, personal communication). Therefore, we assume there is some reason other than detection technique for the low number of wolverines detected in our study area.

Habitat Quality

We chose the study area in the Wallowa Mountains to conduct camera trapping for wolverines in Oregon because it appeared to have the requisite habitat for supporting wolverines and was adjacent to Idaho where breeding populations occur. The study area largely falls within the area of persistent spring snow cover that Copeland et al. (2010) designated as potential wolverine habitat in the western states (Fig. 23). The study area is also included in the areas within the western states that Inman et al. (2013*a*) considered primary wolverine habitat, including maternal habitat (Fig. 24). There is little quantitative information on food requirements for the wolverine, but food resources critical to wolverines in other areas (Inman et al. 2012*a*) are present in the study area, although we cannot determine at this time if the biomass of food species or carrion is adequate to support a breeding population of wolverines in the study area. Elk and mule deer range throughout the study area from spring through fall and are hunted in the fall. As in other mountain habitat in the western states, elk and mule deer move to lower elevations for the winter. Wolverines may scavenge on remains of elk and deer killed by hunters, including those dying from wounding loss. At higher elevations, mountain goats are present all year round in the study area and may be an important source of winter food. The 2012 estimates of goat numbers in and adjacent to the ECW indicate that there were a minimum of 147 mountain goats on the north side of the Wallowa Mountains and 70 goats on the south side (ODFW, unpublished data). Goats on the north side were counted in the areas of Goat Mountain (47), Hurricane Divide (15), Hurwal Divide (47), and Cusick Mountain (38). On the south side, goats were distributed from China Cap and Granite Butte to Cornucopia Peak including Echo Lake and Traverse Lake basins and Granite Mountain and Red Mountain north of Cornucopia Peak. Areas used by the wolverine Stormy in winter included areas with mountain goats on both the north and south sides of the mountains. Snowshoe hares occur even at high elevations in winter in the ECW and can be a source of food for wolverines. Other summer foods that are available in the study area include Columbian ground squirrels and golden-mantled ground squirrels. However, marmots (important in other parts of the wolverine's range in the Rocky Mountains; Inman et al. 2013*a*) do not occur in the Wallowa Mountains. Wolverines in the Wallowa Mountains would not be limited by lack of denning sites, given the amount of boulder scree, avalanche debris, and fallen timber that is snow-covered all winter and even into June, which comprise denning sites for wolverines in the western mountains (Copeland 1996; Inman et al. 2007*a*).

<u>Size and Connectivity with Adjacent Wolverine Populations</u>

Although the size of our study area is small relative to mountainous areas in other western states that support wolverine populations, our study area should be large enough to support a small resident population of wolverines including some reproductive females. For example, in the Payette National Forest in Idaho in 2010, at least 6 resident wolverines including reproductive females occupied an area similar in size to our study area (Heinemeyer and Squires 2012) (Fig. 23). Moreover, denning female wolverines have been found in the Gravelly Range in Montana (Inman et al. 2007*a*), which is smaller than our study area and relatively isolated from other wolverine habitat by low valleys outside the area of persistent spring snow cover (Fig. 23). Therefore, the size of the study area does not appear to explain the apparent low number of wolverines detected in our study area. However, the study area is separated from Idaho wolverine populations by the Snake River and Hells Canyon. Edelmann and Copeland (1999) suggested the Hells Canyon and Salmon River Canyon may form geographic barriers that restrict movement of wolverines between Idaho and Oregon. Wolverines are capable of swimming rivers and moving long distances across non-typical habitat (Inman et al. 2009), but dispersal from Idaho may be inadequate, over the long-term, to sustain small populations of wolverines that might become established in eastern Oregon.

In their analysis of the distribution of wolverines in the contiguous United States, Aubry et al. (2007) concluded that records of wolverine in Oregon (and eastern Washington) "probably represent extreme dispersal events that were not representative of self-sustaining populations." Given the relatively small amount of habitat in Oregon that would be categorized as reproductive or maternal habitat (Copeland et al. 2010; Inman 2013*a*) for the western states (Fig. 23 and Fig. 24), we agree it is unlikely that Oregon could support a breeding population of wolverines over the long term without periodic immigration from adjacent populations. In fact, Inman et al. (2012*b*, 2013*a*) argue that wolverine populations in the western states should be considered a metapopulation, with local populations interdependent on one another for long-term viability. Moreover, because at least some of the records for Oregon in Aubry et al. (2007) were from outside the area of persistent spring snow cover (Copeland et al. 2010), it is certainly reasonable to conclude these records represent "extreme dispersal events" or at least "dispersal events." However, there is no way to determine if the records of wolverines from regions with persistent spring snow cover, such as the Cascades in Oregon, involved dispersing individuals or resident animals. At this time, it is only possible to conclude that, compared to some other western states where wolverines occur, the amount of habitat for wolverines in Oregon is quite limited and connectivity to other wolverine populations is perhaps compromised by geographic and anthropogenic features such as roads, housing developments and dams that could restrict immigration (Edelmann and Copeland 1999; Inman 2013*b*). However, we cannot make the assumption that breeding individuals have not, do not, or could not occur in Oregon, even if only tenuously over time. At this time, our camera-trapping survey suggests that a breeding population of wolverines does not currently exist in the study area.

Time Needed for Population Recovery

Aubry et al. (2007) argued convincingly that a widespread reduction in wolverine range across the western states occurred during the early 1900s but that after this period, populations began to recover and expand in the northwestern states of Washington, Idaho, Montana, and Wyoming. These authors did not believe that this recovery extended to Oregon because of the lack of verified records in the most recent period that they examined (1995−2005). They concluded that wolverine records in Oregon since 1961 represent dispersal from adjacent populations rather than a recovering population in Oregon and that the low number of verified historic records is evidence that Oregon will not support a sustainable population. However, Wyoming, which has a breeding population of wolverines, also had a low number of verified records from 1961−1997 (in fact, only 1 in Wyoming compared to 5 in Oregon during that period). Only when radiotelemetry studies began in 1998 did verified records increase appreciably in Wyoming; 9 of 12 verified sightings in the period 1998−2005 in Wyoming were live captures for radiotelemetry studies and another was DNA from a wolverine collected during a lynx survey. We argue that, unless systematic surveys for wolverines using effective detection techniques in suitable habitat types are conducted over time in Oregon, it is not reasonable to conclude that Oregon cannot support at least a small breeding population. We base this argument on recent evidence from Sweden showing that wolverines are slow to recover from historic lows but, given time and adequate protection, populations build and expand to adjacent suitable habitats and even occupy "non-typical" habitats, such as lowland forests adjacent to montane habitats (Aronsson and Persson 2012). Moreover, lactating females have been found outside the area of persistent spring snow cover in Alberta (Shevenell Webb, personal communication) and Ontario (Dawson et al. 2010), suggesting that not all female wolverines den in areas with snow cover that lasts into mid May as described by Copeland et al. (2010), at least in Canada at higher latitudes. Although the area covered by persistent spring snow in Oregon is small, large areas of national forest lands that surround these areas could be used, at least in part, by resident wolverines. The buffer provided by these national forest lands that surround high elevation habitat is larger in Oregon than in Montana (Fig. 23) where breeding populations of wolverines occupy small isolated mountain ranges like the Gravelly Range (Inman et al. 2012*b*).

We believe it is without question that wolverines in our study area were extirpated during the early 1900s, and possibly earlier, given the history of predator control (Bailey 1930) and livestock grazing (particularly domestic sheep) that occurred in the region during that time (Smith 1928; Williams and Melville 2005). Wild ungulate populations were also decimated in the study area in the early 1900s and mountain goats were probably extirpated from the Wallowa Mountains even earlier (Coggins and Matthews 2002). With adjacent source populations of wolverines also depleted in Idaho during that period (Aubry et al. 2007) and given the geographic features that could slow immigration to Oregon from Idaho (Edelmann and Copeland 1999), recovery of wolverines in Oregon may be lagging behind those states with greater connectivity to core breeding populations. The 3 wolverines we detected in 2010-2011 and the apparent residency status of 1 of these wolverines in 2011-2012 suggest the possibility that wolverines may be reoccupying Oregon, at least on a limited basis. Only long-term monitoring of wolverines in the Wallowa Mountains can determine if breeding individuals become established there.

Trapping seasons for wolverines are now closed in all the western states. Trapping closures for wolverines in Montana or other western states may not be permanent, but the wolverine harvest has been very low in recent years (Inman et al. 2007*b*) and is likely to remain so. Trapping closures and restricted trapping seasons increase the overall survival rate of resident and dispersing wolverines (Krebs et al. 2004), which could provide a source of immigrants to reoccupy habitats in Oregon. Breeding populations of wolverines in Idaho are within easy dispersal distance to the ECW (Heinemeyer and Squires 2012) and recent long-distance movements of wolverines to Colorado (Inman et al. 2009) and California (Moriarity et al. 2009) from the northern Rocky Mountains indicate that some features thought to be barriers to wolverine dispersal are not absolute. However, female wolverines may take longer to become established in Oregon than males because of the tendency of female offspring to remain near their natal home range (Aronsson 2009). In fully-occupied wolverine habitat, females do disperse from natal denning areas (Vangen et al. 2001). These gender-linked dispersal patterns (Inman et al. 2013*b*) suggest that resident male wolverines could be documented in Oregon long before females become established.

As discussed above, there is no reason to think that food availability is a limiting factor any longer for wolverines in northeast Oregon. Elimination of domestic livestock grazing in the high mountains, elimination of predator control programs (including use of poison), and the recovery of deer, elk, and mountain goats are likely important factors that will contribute to increased use of the ECW by wolverines. Mountain goats were reintroduced to the Wallowa Mountains in the 1950s, remained low and static through the 1980s, and then increased dramatically (Coggins and Matthews 2002). There are even now small populations of mountain goats reestablished in the Elkhorn Mountains southwest of our study area (Coggins and Matthews 2002) and in the northern portion of the Cascade Mountains in western Oregon where another camera-trapping survey for wolverines is underway (Tim Hiller, personal communication). Mule deer and elk are now relatively common in the Wallowa Mountains and are taken by hunters in the fall, contributing a source of food from gut piles and bones left in the field by hunters and from animals wounded during the hunting season that are not retrieved. The reoccupation of northeast Oregon by wolves may also affect reoccupation by wolverines because wolf-killed ungulates can supply a source of carrion for wolverines. However, it is not clear that wolves have a net positive effect on wolverine populations because wolves also compete for carcasses as scavengers, reduce overall ungulate numbers, especially vulnerable prey that could provide food for wolverines, and are also predators of wolverines (White et al. 2002).

LONG-TERM MONITORING OF WOLVERINES IN NORTHEAST OREGON

Determining if a breeding population of wolverines becomes established in Oregon will require a long-term monitoring program that detects lactating females over an extended period of time. The most cost-effective way to monitor lactating females is with camera stations that operate through April (and into May if possible). Because a resident male wolverine in the ECW was verified during this study, we recommend that the ECW and adjacent areas be monitored for at least 10 years to determine if female wolverines eventually become established in the area. We recommend 6–8 camera stations be established in and adjacent to the ECW, with at least 2 stations placed in the central ECW on the north side of the mountains where wolverines in this study were detected (see the detection zone in Fig. 22). The remainder of the stations should be distributed north and south of this recent detection zone at elevations >6,000 feet and as close as possible to areas used by mountain goats. One of these stations should include the West Eagle

Creek site where Stormy was detected in winter 2011-2012.

In addition to monitoring the ECW and adjacent areas, we recommend that additional camera stations be established east and north of the ECW in the WWNF and HCNRA where wolverines can be expected to occur if they disperse from Idaho into Oregon (Inman et al. 2013*b*). Anecdotal records of wolverines and a verified record of wolverine tracks in 2012 (Fig. 16) suggest some possible locations for camera stations in this region. One is the Hat Point area just west of the Seven Devils Mountains and another is the Sled Springs wildlife management area where wolverine tracks were detected (Fig. 16). We also recommend camera stations in the Wenaha-Tucannon Wilderness Area in the Umatilla National Forest and in the Elkhorn Mountains. If evidence of wolverines is verified for other areas in northeast Oregon, cameras stations should be deployed in those areas as well. The number of cameras in a long-term monitoring program will depend on the personnel and resources available to maintain the stations, which is arduous and time-consuming work requiring good physical condition, especially when deploying and checking camera stations in wilderness areas in winter where no motorized transport is permitted.

If female wolverines are detected during the monitoring program, high-resolution cameras with white flash (e.g., Trail Watcher cameras) should be used at the camera stations to obtain clear, detailed photos of the abdominal area of the females from March–May, if possible, to document lactation. See Magoun et al. (2011*a*) for details on photographing female wolverines.

LITERATURE CITED

Aronsson, M. 2009. Territorial dynamics of female wolverines. Unpublished thesis. Grimsö Wildlife Research Station, Swedish University of Agricultural Sciences, SE-73091 Riddarhyttan, Sweden.

Aronsson, M. and J. Persson. 2012. Järv i skogslandet. Report till WWF. Grimsö Forskningsstation. SE-73091 Riddarhyttan, Sweden. [http://www.wwf.se/source.php/1465945/J%E4rv%20i%20skoglandet.pdf]

Aubry, K. B., K. S. McKelvey, and J. P. Copeland. 2007. Distribution and broadscale habitat relations of the wolverine in the contiguous United States. Journal of Wildlife Management 71:2147–2158.

Aubry, K. B., M. J. Statham, B. N. Sacks, J. D. Perrine, and S. M. Wisely. 2009. Phylogeography of the North American red fox: vicariance in Pleistocene forest refugia. Molecular Ecology 18:2668–2686.

Bailey, V. 1930. Predatory animal control in Oregon. Record Unit 7176, United States Fish and Wildlife Service Field Reports, 1860–1961, Smithsonian Institution Archives. Washington, D.C.

Coggins, V. L. and P. E. Mathews. 2002. Status of Oregon Rocky Mountain goats. Proceedings of the Thirteenth Biennial Symposium. Northern Wild Sheep and Goat Council. Rapid City, SD.

Copeland, J. P. 1996. Biology of the wolverine in central Idaho. MS thesis, University of Idaho, Moscow, Idaho.

Copeland, J. P., K. S. McKelvey, K. B. Aubry, A. Landa, J. Persson, R. M. Inman, J. Krebs, E. Lofroth, H. Golden, J. R. Squires, A. Magoun, M. K. Schwartz, J. Wilmot, C. L. Copeland, R. E. Yates, I. Kojola, and R. May. 2010. The bioclimatic envelope of the wolverine (Gulo gulo): do climatic constraints limit its geographic distribution? Canadian Journal of Zoology 88: 233–246.

Dawson, F. N., A. J. Magoun, J. Bowman, and J. C. Ray. 2010. Wolverine, Gulo gulo, home range size and denning habitat in lowland boreal forest in Ontario. Canadian Field-Naturalist 124:139–144.

Edelmann, F. and J. Copeland. 1999. Wolverine survey in the Seven Devils Mountains of Hells Canyon. Technical Report. Northwest Scientific Association. 10 pp. (Originally published in Northwest Science 73, Number 4, pp. 295–300).

Gardner, C. L., J. P. Lawler, J. M. Ver Hoef, A. J. Magoun, and K. A. Kellie. 2010. Coarse-scale distribution surveys and occurrence probability modeling for wolverine in interior Alaska. Journal of Wildlife Management 74:1894–1903.

Heinemeyer, K. and J. Squires. 2012. Idaho wolverine – winter recreation research project: investigating the interactions between wolverines and winter recreation. 2011-2012 Progress Report. USFS Rocky Mountain Research Station, Missoula, Montana.

Inman, R., B. Brock, K. Inman, S. Sartorius, B. Aber, B. Giddings, S. Cain, M. Orme, J. Fredrick, B. Oakleaf, K. Alt, E. Odell, and G. Chapron. 2013*a*. Developing a spatial framework and conservation priorities for a wolverine metapopulation. Paper III *in* R. M. Inman. Wolverine Ecology and Conservation in the Western United States. PhD Dissertation, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Inman, R. B., S. Bergen, and J. P. Beckmann. 2013*b*. Endangered status, connectivity, and critical habitat of the wolverine. Paper IV *in* R. M. Inman. Wolverine Ecology and Conservation in the Western United States. PhD Dissertation, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Inman, R. M., K. H. Inman, M. L. Packila, and A. J. McCue. 2007*a*. Wolverine reproductive rates and maternal habitat in Greater Yellowstone. Chapter 4, Pages 65–84 *in* Greater Yellowstone Wolverine Study, Cumulative Report, May 2007. Wildlife Conservation Society, North America Program, General Technical Report, Bozeman, Montana.

Inman, R. M., K. H. Inman, A. J. McCue, and M. L. Packila. 2007*b*. Wolverine harvest in Montana: survival rates and spatial considerations for harvest management. Chapter 5, Pages 85–97 *in* Greater Yellowstone Wolverine Program Cumulative Report, May 2007. Wildlife Conservation Society, North American Program, General Technical Report, Bozeman, Montana.

Inman, R. M., M. L. Packila, K. H. Inman, B. C. Aber, R. Spence, and D. McCauley. 2009. Greater Yellowstone Wolverine Program, Progress Report, December 2009. Wildlife Conservation Society, North America Program, General Technical Report, Bozeman, Montana.

Inman, R. M., A. J. Magoun, J. Persson, and J. Mattisson. 2012*a*. The wolverine's niche: linking reproductive chronology, caching, competition, and climate. Journal of Mammalogy 93:634–644.

Inman, R. M., M. L. Packila, K. H. Inman, A. J. McCue, G. C. White, J. Persson, B. C. Aber, M. L. Orme, K. L. Alt, S. L. Cain, J. A. Fredrick, B. J. Oakleaf, and S. S. Sartorius. 2012*b*. Spatial ecology of wolverines at the southern periphery of distribution. Journal of Wildlife Management 76:778–792.

Koen, E. L., J. C. Ray, J. Bowman, F. N. Dawson, and A. J. Magoun. 2008. Surveying and monitoring wolverines in Ontario and other lowland, boreal forest habitats: recommendations and protocols. Ontario Ministry of Natural Resources, Northwest Science and Information. Thunder Bay, Ontario, Canada.

Krebs, J., E. Lofroth, J. Copeland, V. Banci, D. Cooley, H. Golden, A. Magoun, R. Mulders, and B. Shults. 2004. Synthesis of survival rates and causes of mortality in North American wolverines. Journal of Wildlife Management 68:493–502

Magoun, A. J. and J. P. Copeland. 1998. Characteristics of wolverine reproductive den sites. Journal of Wildlife Management 62:1313–1320.

Magoun, A. J., J. C. Ray, D. S. Johnson, P. Valkenburg, F. N. Dawson, and J. Bowman. 2007. Modeling wolverine occurrence using aerial surveys of tracks in snow. Journal of Wildlife Management 71:2221–2229.

Magoun, A. J., P. Valkenburg, D. N. Pedersen, C. D. Long, and R. E. Lowell. 2011*a*. Wolverine images–using motion detection cameras for photographing, identifying, and monitoring wolverines. Blurb http://www.blurb.com/bookstore

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

Moriarity, K. M., W. J. Zielinski, A. G. Gonzales, T. E. Dawson, K. M. Boatner, C. A. Wilson, F. V. Schlexer, K. L. Pilgrim, J. P. Copeland, and M. K. Schwartz. 2009. Wolverine confirmation in California after nearly a century: native or long-distance immigrant? Northwest Science 83:154–162.

Royle, J. A., A. J. Magoun, B. Gardner, P. Valkenburg, and R. E. Lowell. 2011. Density estimation in a wolverine population using spatial capture–recapture models. Journal of Wildlife Management 75:604–611.

Schommer, T. 1994. Wolverine and lynx winter snow track report. 1993-1994. Wallowa-Whitman National Forest. Unpublished report. USDA Forest Service, Baker City, Oregon.

Smith, W. D. 1928. Physical and economic geography of Oregon. The Commonwealth Review of the University of Oregon. Vol. X, No. 4. University of Oregon, Eugene, Oregon.

Statham, M. J., B. N. Sacks, K. B. Aubry, J. D. Perrine, and S. M. Wisely. 2012. The origin of recently established red fox populations in the United States: translocations or natural range expansions? Journal of Mammalogy 93:52–65.

Oregon Department of Fish and Wildlife. 2006. Oregon Conservation Strategy. Oregon Department of Fish and Wildlife, Salem, Oregon

Vangen, K. M., J. Persson, A. Landa, R. Andersen, and P. Segerström. 2001. Characteristics of dispersal in wolverines. Canadian Journal of Zoology 79:1641–1649.

White, K. S., H. N. Golden, and K. J. Hundertmark. 2002. Predation by wolves, Canis lupus, on wolverines, Gulo gulo, and on American marten, Martes americana, in Alaska. Canadian Field-Naturalist 116:132–134.

Williams, J. and E. Melville. 2005. The history of grazing in Wallowa County. Unpublished report. Oregon State University, Corvallis, Oregon. [http://extension.oregonstate.edu/wallowa/sites/default/files/_in_Wallowa_County_Compilation_edited_4_2009.pdf]

TABLES

Table 1. Locations of camera stations and wolverine detections in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon for years 2011 and 2012 (also, see Figure 6). Locations are specified by nearest minor drainage or mile within a major drainage. Cameras from WCAM23 were moved a short distance to station WCAM24 when human footprints were detected near the original location; data from these stations were combined, so WCAM 24 is not listed below. Wolverines: U=unknown; I=Iceman; S=Stormy; Z=Zed; X=no wolverine detected. "Active Camera Days"=number of days cameras were functioning during the period the cameras were deployed. The unknown wolverine at WCAM1 was detected using DNA; the DNA was degraded, preventing identification of this individual.

Camera Station	Drainage		Elevation (feet)	Wolverine Detections		Active Camera Days		
	Major	Minor		2010-11	2011-12	2010-11	2011-12	Total
WCAM1	Lostine River	Wood Lake outlet	4993	U	X	26	100	126
WCAM2	Lostine River	Maxwell Lake outlet	5484	I,S	S	89	218	307
WCAM3	Big Sheep Creek	Improvement Canal	6061	X		24		24
WCAM4	Big Sheep Creek	South Fork	6216	X		33		33
WCAM5	Hurricane Creek	Slick Rock Creek	5469	X		76		76
WCAM6	Indian Creek	Little Indian Creek	4646	X		63		63
WCAM7	Lostine River	Catched Two Creek	5890	U	S	45	215	260
WCAM8	W Fk Wallowa River	Adam Creek	5643	I,S	S	75	123	198
WCAM9	Catherine Creek	Middle Fork	5340	X		76		76
WCAM10	W Fk Eagle Creek	Fake Creek	5700	S	X	40	131	171
WCAM11	Little Minam River	Horseshoe Creek	5659	X		75		75
WCAM12	Lostine River	1 mile East Fork	6398	Z	X	79	145	224
WCAM13	Hurricane Creek	Falls Creek	6764		X		183	183
WCAM14	E Fk Eagle Creek	Little Kettle Creek	4762	X		60		60
WCAM15	Pine Creek	Elk Creek	5459	X		49		49
WCAM16	Hurricane Creek	Deadman Creek	5692	S	S	58	262	320
WCAM17	Hurricane Creek	Granite Creek	6016	X		20		20
WCAM18	Deer Creek	Standley Springs	7235		X		244	244
WCAM19	Deer Creek	Headwaters	7246		X		211	211
WCAM20	Bear Creek	Doc Creek	7147		X		162	162
WCAM21	Dobbin Creek	Headwaters	5598		X		251	251
WCAM22	Bear Creek	Blowout Basin Creek	5326		X		249	249
WCAM23	Bear Creek	below Dobbin Creek	4784		X		68	68
WCAM25	W Fk Eagle Creek	Olive Lake outlet	6014		S		235	235
WCAM26	Main Fk Eagle Creek	Culver Lake outlet	6190		X		233	233
WCAM27	Catherine Creek	Buck Creek	6556		X		230	230
WCAM28	Hurricane Creek	Thorp Creek	6720		X		177	177
WCAM29	Pine Creek	Boulder Creek	7373		X		183	183
WCAM30	Big Sheep Creek	Cabin Creek	7060		S		148	148

(cont.) Camera Station	Drainage		Elevation (feet)	Wolverine Detections		Active Camera Days		
	Major	Minor		2010-11	2011-12	2010-11	2011-12	Total
WCAM31	W Fk Wallowa River	Lake Creek	5820		S		203	203
WCAM32	Lostine River	Copper Creek	6468		S		186	186
WCAM33	Copper Creek	Elkhorn Creek	7196		S		205	205
WCAM34	Lostine River	2 mile East Fork	7053		X		162	162
WCAM35	McCully Creek	McCully Basin	7166		X		99	99
WCAM36	Pine Creek	West Fork	5149		X		124	124
WCAM37	Catherine Creek	Boulder Creek	7370		X		3	3
WCAM38	Catherine Creek	N Fk headwaters	7241		X		90	90
WCAM39	Minam River	Pot Creek	7232		X		90	90
WCAM40	Minam River	Last Chance Creek	8092		X		73	73
WCAM41	W Fk Wallowa River	Copper Creek	8458		X		73	73
WCAM42	North Minam River	Elk Creek	8204		X		73	73
WCAM43	W Fk Wallowa River	Headwaters	7529		X		70	70
WCAM44	W Fk Wallowa River	Headwaters	8275		X		68	68
WCAM45	Lake Creek	Headwaters	8267		X		0	0
WCAM46	N Fk Imnaha River	Headwaters	8364		X		30	30
Total						888	5317	6205

Table 2. Periods when camera stations were deployed, percentage of days that cameras were active, number of times stations were checked, date of first wolverine detection, and number of days before a wolverine was first detected at camera stations in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in winter 2010-2011. Wolverines: U=Unknown; I=Iceman; S=Stormy; Z=Zed.

Camera Station	Date Deployed	Date Retrieved	Days Deployed	Days Active	Percent of Time Active	Checks	Detected	Date of First Detection	Days before Detection
WCAM1	30-Jan-11	13-May-11	103	26	0.25	6	U	>30-Apr	>90
WCAM2	30-Jan-11	13-Jun-11	134	89	0.66	6	I, S	3-Apr	63
WCAM3	4-Feb-11	11-May-11	96	24	0.25	2			
WCAM4	9-Feb-11	12-Jun-11	123	33	0.27	2			
WCAM5	13-Feb-11	18-May-11	94	76	0.81	3			
WCAM6	15-Feb-11	7-May-11	81	63	0.78	2			
WCAM7	27-Feb-11	13-Jun-11	106	45	0.42	4	U	13-May	75
WCAM8	2-Mar-11	29-May-11	88	75	0.85	6	I, S	2-Apr	31
WCAM9	5-Mar-11	20-May-11	76	76	1.00	1			
WCAM10	6-Mar-11	19-Jun-11	105	40	0.38	1	S	14-Mar	8
WCAM11	7-Mar-11	19-Jun-11	104	75	0.72	1			
WCAM12	11-Mar-11	16-Jun-11	97	79	0.81	3	Z	12-May	62
WCAM14	22-Mar-11	21-May-11	60	60	1.00	1			
WCAM15	23-Mar-11	20-Jun-11	89	49	0.55	1			
WCAM16	18-Apr-12	15-Jun-11	58	58	1.00	3	S	22-Apr	4
WCAM17	21-Apr-12	27-May-11	36	20	0.56	1			
Total			1453	888	0.61				

Table 3. Detection histories for 3 wolverines photographed with motion-detection cameras in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in winter 2010-2011. “Interlude” is the number of days between detections at any camera station for that individual wolverine.

Camera Station	Date of Visit	Start Time	End Time	Duration of Visit (minutes)	Interlude (days)	Stations Visited per Day	Distance to Next Camera Visited (km)
Iceman							
WCAM8	2-Apr	2014	2051	33		1	0.0
WCAM8	3-Apr	0616	0617	1	0	2	0.0
WCAM8	3-Apr	1221	1236	15			12.0
WCAM2	3-Apr	1946	2012	26			
Average				18.8	0	1.5	4.0
Stormy							
WCAM10	14-Mar	1953	2043	50		1	0.0
WCAM10	15-Mar	0247	0253	6	0	1	0.0
WCAM10	15-Mar	0412	0445	33			0.0
WCAM10	17-Mar	0004	0022	18	1	1	0.0
WCAM10	17-Mar	0601	0612	11			0.0
WCAM10	17-Mar	1354	1413	19			0.0
WCAM10	17-Mar	2123	2127	4			0.0
WCAM10	18-Mar	0438	0455	17	0	1	0.0
WCAM10	18-Mar	1819	1839	20			0.0
WCAM10	25-Mar	2150	2202	12	6	1	0.0
WCAM10	27-Mar	2132	2156	24	1	1	0.0
WCAM10	3-Apr	0443	0443	1	6	1	0.0
WCAM10	9-Apr	1607	1622	15	5	1	25.5
WCAM8	12-Apr	2256	2311	15	2	1	0.0
WCAM8	13-Apr	0457	0506	9	0	1	8.0
WCAM16	22-Apr	0813	0918	65	8	1	0.0
WCAM16	23-Apr	2051	2051	1	0	1	0.0
WCAM16	24-Apr	0509	0515	6	0	1	0.0
WCAM16	25-Apr	0623	0623	1	0	2	8.0
WCAM8	25-Apr	0826	0836	10			0.0
WCAM8	25-Apr	0917	0918	1			0.0
WCAM8	25-Apr	1144	1155	11			0.0
WCAM8	25-Apr	1819	1838	19			0.0
WCAM8	27-Apr	0022	0036	14	1	1	0.0
WCAM8	27-Apr	1736	1752	16			0.0
WCAM8	27-Apr	1902	1908	6			0.0

(cont.) Camera Station	Date of Visit	Start Time	End Time	Duration of Visit (minutes)	Interlude (days)	Stations Visited per Day	Distance to Next Camera Visited (km)
WCAM8	28-Apr	0336	0341	5	0	1	0.0
WCAM8	28-Apr	1154	1205	11			0.0
WCAM8	29-Apr	0427	0430	3	0	1	0.0
WCAM8	8-May	0547	0608	21	8	1	0.0
WCAM8	8-May	1842	1905	23			0.0
WCAM8	8-May	1955	2008	13			0.0
WCAM8	9-May	0510	0516	6	0	1	8.0
WCAM16	12-May	1024	1031	7	2	1	0.0
WCAM16	12-May	1536	1550	14			0.0
WCAM16	12-May	2027	2042	15			8.0
WCAM8	22-May	0718	0721	3	9	1	
Average				14.6	2.5	1.0	1.6
Zed							
WCAM12	12-May	1837	1900	23		1	0.0
WCAM12	12-May	1932	1932	1			0.0
WCAM12	13-May	0026	0027	1	0	1	0.0
WCAM12	13-May	0420	0420	1			0.0
WCAM12	13-May	0528	0528	1			0.0
WCAM12	13-May	1121	1143	22			0.0
WCAM12	13-May	1709	1721	12			
Average				8.7	0	1	0
Unknown							
WCAM8	18-Apr	0821	0821	1			
WCAM8	27-Apr	0531	0532	1			
WCAM7	13-May	2048	2051	3			

Table 4. Aerial tracking flights in search of wolverine tracks in the Wallowa-Whitman National Forest and Hells Canyon National Recreation Area in northeast Oregon in winters 2010-2011 and 2011-2012. See Figure 12 for maps of color-coded survey routes.

Flight	Route Color on Survey Map – See Figure 12	Date	Miles Flown	Hours Flown
2010-2011				
1	Green	26-Feb	295	3.6
2	Dark blue	3-Mar	221	2.7
3	Magenta	17-Mar	139	1.7
4	Dark cyan	9-Apr	123	1.5
5	Cyan	12-Apr	283	3.3
6	Yellow	12-Apr	147	1.7
7	Dark gray	23-Apr	349	4.3
8	Blue	23-Apr	267	3.2
9	Dark yellow	24-Apr	116	1.4
10	Red	1-May	217	2.7
11	Dark green	1-May	135	1.7
Total			2292	27.8
2011-2012				
1	Green	19-Dec	232	2.8
2	Black	22-Dec	297	3.6
3	Dark yellow	19-Apr	344	4.2
4	Red	21-Apr	460	5.6
5	Cyan	22-Apr	333	4.0
6	Blue	23-Apr	324	3.9
7	Magenta	24-Apr	210	2.5
Total			2200	26.7
GRAND TOTAL			4492	54.5

Table 5. Periods when camera stations were deployed, percentage of days that cameras were active, number of times stations were checked, date of first detection, and the number of days before Stormy was first detected at camera stations in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in winter 2011-2012 and summer 2012.

Camera Station	Date Deployed	Date Retrieved	Days Deployed	Days Active	Percent of Time Active	Checks	Detected	Date of First Detection	Days before Detection
Winter Camera Stations 2011-2012									
WCAM1	14-Dec	23-Mar	100	100	1.00	4			
WCAM2	28-Sep	17-May	232	218	0.94	7	Stormy	11-Feb	136
WCAM7	28-Sep	20-May	235	215	0.91	7	Stormy	31-Mar	185
WCAM8	25-Nov	9-May	166	123	0.74	5	Stormy	27-Jan	63
WCAM10	31-Jan	10-Jun	131	131	1.00	1			
WCAM12	28-Sep	26-May	241	145	0.60	6			
WCAM13	2-Oct	15-Jul	287	183	0.64	5			
WCAM16	26-Sep	10-Aug	319	262	0.82	14	Stormy	8-Mar	164
WCAM18	6-Oct	21-Jun	259	244	0.94	2			
WCAM19	7-Oct	21-Jun	258	211	0.82	2			
WCAM20	8-Oct	21-Jun	257	162	0.63	2			
WCAM21	14-Oct	21-Jun	251	251	1.00	2			
WCAM22	15-Oct	20-Jun	249	249	1.00	2			
WCAM23	16-Oct	21-Jun	249	68	0.27	2			
WCAM25	19-Oct	10-Jun	235	235	1.00	2	Stormy	12-Feb	116
WCAM26	20-Oct	9-Jun	233	233	1.00	2			
WCAM27	25-Oct	11-Jun	230	230	1.00	2			
WCAM28	5-Dec	30-May	177	177	1.00	2			
WCAM29	8-Dec	8-Jun	183	183	1.00	2			
WCAM30	16-Dec	24-Jun	191	148	0.77	4	Stormy	20-Apr	126
WCAM31	25-Dec	17-Jul	205	203	0.99	4	Stormy	29-Jan	35
WCAM32	31-Dec	4-Jul	186	186	1.00	3	Stormy	1-Apr	92
WCAM33	3-Jan	26-Jul	205	205	1.00	2	Stormy	1-Apr	89
WCAM34	4-Jan	14-Jun	162	162	0.99	2	Stormy	21-Apr	108
WCAM35	23-Jan	1-Jun	130	99	0.76	3			
WCAM36	4-Feb	7-Jun	124	124	1.00	1			
Total for Winter			5496	4747	0.86				

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Camera Station	Date Deployed	Date Retrieved	Days Deployed	Days Active	Percent of Time Active	Checks	Detected	Date of First Detection	Days before Detection
Summer Camera Stations 2012									
WCAM37	29-Jun	29-Sep	92	3	0.03	1			
WCAM38	30-Jun	28-Sep	90	90	1.00	1			
WCAM39	1-Jul	29-Sep	90	90	1.00	1			
WCAM40	25-Jul	6-Oct	73	73	1.00	1			
WCAM41	25-Jul	6-Oct	73	73	1.00	1			
WCAM42	25-Jul	7-Oct	74	73	0.99	1			
WCAM43	3-Aug	12-Oct	70	70	1.00	1			
WCAM44	4-Aug	11-Oct	68	68	1.00	1			
WCAM45	5-Aug	2-Oct	58	0	0.00	1			
WCAM46	13-Aug	19-Oct	67	30	0.45	1			
Total for Summer			747	570	0.76				
Grand Total			6243	5317	0.85				

Table 6. Detection history for the male wolverine Stormy at camera stations in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in winter 2011-2012. No other wolverines were detected. "Interlude" is the number of days between detections at any camera station for that individual wolverine.

Camera Station	Date of Visit	Start Time	End Time	Duration of Visit (minutes)	Interlude (days)	Stations Visited per Day	Distance to Next Camera Visited (km)
WCAM8	27-Jan	1118	1118	1		1	0.0
WCAM8	27-Jan	1207	1207	1			0.0
WCAM8	27-Jan	2126	2146	20			0.0
WCAM8	28-Jan	0101	0120	19	0	1	0.0
WCAM8	29-Jan	0117	0136	19	0	2	4.0
WCAM31	29-Jan	1043	1059	16			0.0
WCAM31	29-Jan	2204	2231	27			0.0
WCAM31	30-Jan	0030	0045	15	0	1	0.0
WCAM31	30-Jan	0715	0728	13			4.0
WCAM8	6-Feb	0208	0208	1	6	1	12.0
WCAM2	11-Feb	0230	0255	25	4	1	18.0
WCAM25	12-Feb	1843	1855	12	0	1	0.0
WCAM25	12-Feb	2349	2359	10			0.0
WCAM25	13-Feb	0241	0245	4	0	1	23.0
WCAM16	8-Mar	0509	0509	1	23	1	8.0
WCAM8	28-Mar	0715	0720	5	19	1	0.0
WCAM8	28-Mar	2012	2048	36			8.0
WCAM16	29-Mar	0048	0053	5	0	1	0.0
WCAM16	29-Mar	0645	0646	1			6.6
WCAM2	31-Mar	1407	1424	17	1	2	2.0
WCAM7	31-Mar	1458	1502	4			2.5
WCAM32	1-Apr	0630	0639	9	0	2	2.0
WCAM33	1-Apr	0724	0726	2			12.0
WCAM31	4-Apr	0239	0250	11	2	2	4.0
WCAM8	4-Apr	0645	0657	12			0.0
WCAM8	12-Apr	1022	1027	5	7	2	8.0
WCAM16	12-Apr	2140	2202	22			0.0
WCAM16	13-Apr	0444	0446	2	0	1	6.5
WCAM2	14-Apr	0946	0947	1	0	3	2.0
WCAM7	14-Apr	1019	1110	51			2.5
WCAM32	14-Apr	1148	1156	8			0.0
WCAM32	14-Apr	2055	2110	15			10.5

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Camera Station	Date of Visit	Start Time	End Time	Duration of Visit (minutes)	Interlude (days)	Stations Visited per Day	Distance to Next Camera Visited (km)
WCAM31	15-Apr	0704	0723	19	0	1	0.0
WCAM31	15-Apr	1355	1415	20			0.0
WCAM31	15-Apr	1949	1949	1			10.5
WCAM30	20-Apr	2047	2110	23	4	1	10.5
WCAM31	21-Apr	0805	0806	1	0	3	9.0
WCAM34	21-Apr	1329	1332	3			1.5
WCAM32	21-Apr	2051	2052	2			2.0
WCAM33	22-Apr	0515	0519	4	0	1	23.0
WCAM30	25-Apr	0657	0713	16	2	1	0.0
WCAM30	1-May	0723	0725	2	5	1	18.0
WCAM16	2-May	1013	1027	14	0	2	6.5
WCAM2	2-May	1425	1436	11			0.0
WCAM2	2-May	2203	2219	16			0.0
WCAM2	3-May	0949	0950	1	0	2	2.0
WCAM7	3-May	1037	1037	1			0.0
WCAM7	4-May	0504	0504	1	0	4	2.0
WCAM2	4-May	0621	0624	3			5.0
WCAM34	4-May	0758	0812	14			1.5
WCAM32	4-May	0935	0947	12			0.0
WCAM32	4-May	1805	1831	26			2.5
WCAM7	5-May	0521	0521	1	0	2	2.0
WCAM2	5-May	0553	0555	2			5.5
WCAM33	6-May	2317	2350	33	0	1	0.0
WCAM33	7-May	0730	0731	1	0	1	0.0
WCAM33	7-May	1227	1253	26			0.0
WCAM33	7-May	2328	2329	1			12.5
WCAM25	8-May	0854	0854	1	0	1	19.5
WCAM31	14-May	0812	0814	2	5	1	9.0
WCAM34	15-May	0827	0827	1	0	3	1.5
WCAM32	15-May	0847	0904	17			2.0
WCAM33	15-May	0939	0957	18			0.0
WCAM33	15-May	1759	1819	20			23.0
WCAM30	17-May	1018	1020	2	1	1	0.0
WCAM30	17-May	2054	2055	1			0.0
WCAM30	21-May	2052	2052	1	3	1	0.0
WCAM30	22-May	1142	1143	2	0	1	0.0

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Camera Station	Date of Visit	Start Time	End Time	Duration of Visit (minutes)	Interlude (days)	Stations Visited per Day	Distance to Next Camera Visited (km)
WCAM30	24-May	1021	1021	1	1	1	21.0
WCAM32	1-Jun	1018	1018	1	7	1	21.0
WCAM30	5-Jun	0948	0950	2	3	1	23.0
WCAM33	17-Jun	2055	2056	1	11	1	0.0
Average				9.9	2.7	1.4	8.8

Table 7*a*. Mammal species detected in the Wallowa-Whitman National Forest in northeast Oregon using motion-detection cameras and hair-snagging devices in January 2011−December 2012. Details on dates the cameras were deployed are presented in Table 2 and Table 5. Common and scientific names for the code designations are presented in Table 7*b*.

Camera Station	Code for Mammal Species Listed in Table 7b																						Number of Species
	GG	UA	Clu	Cla	PC	LR	VV	CE	OH	OA	LA	MA	TT	NC	TH	GS	SC	ME	OP	PM	TM	SL	
WCAM1						x						x			x	x							4
WCAM2	x					x						x			x	x							5
WCAM3												x											1
WCAM4		x		x			x					x											4
WCAM5															x	x		x		x			4
WCAM6		x						x							x								3
WCAM7	x					x						x			x	x							5
WCAM8	x											x			x					x			4
WCAM9				x								x											2
WCAM10	x											x			x	x							4
WCAM11		x		x		x		x							x					x			6
WCAM12	x				x	x	x					x			x								6
WCAM 13		x			x				x		x	x			x	x				x	x		9
WCAM14				x								x			x								3
WCAM15		x										x			x			x		x	x		6
WCAM16	x	x						x						x	x	x							6
WCAM17							x				x	x			x								4
WCAM 18		x					x				x	x			x								5
WCAM 19		x					x					x			x	x							5
WCAM 20			x									x			x	x					x		5
WCAM 21		x		x								x		x	x					x			6
WCAM 22		x				x		x							x					x			5
WCAM 23					x	x								x	x	x							5
WCAM 25	x	x					x		x			x			x					x			7

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WCAM 26		x		x				x				x			x	x							6
WCAM 27												x			x	x							3
WCAM28		x		x								x			x								4
WCAM29							x					x						x		x			4
WCAM30	x	x										x			x					x			5
WCAM31	x	x		x				x				x			x	x							7
WCAM32	x			x		x						x			x								5
WCAM33	x			x				x	x			x			x								6
WCAM34	x											x			x								3
WCAM35												x			x								2
WCAM36									x			x			x								3
WCAM37																					x		1
WCAM38		x		x		x		x	x			x		x	x							x	9
WCAM39				x							x	x			x	x							5
WCAM40		x								x		x			x				x			x	6
WCAM41				x				x				x	x	x	x		x					x	8
WCAM42		x		x						x		x									x	x	6
WCAM43												x									x	x	3
WCAM44												x			x			x		x	x	x	6
WCAM45																							
WCAM46																	x		x	x		x	4
	GG	UA	CLu	CLa	PC	LR	VV	CE	OH	OA	LA	MA	TT	NC	TH	GS	SC	ME	OP	PM	TM	SL	
Total	12	18	1	14	3	9	7	9	5	2	4	36	1	5	36	14	2	4	2	12	7	7	

Table 7*b*. Common and scientific names of mammals listed in Table 7*a* by code designation. Mammals were photographed at camera stations in the Wallowa-Whitman National Forest in northeast Oregon in January 2011−December 2012. The first column in the table is the number of camera stations at which each species was detected.

Mammal Species* in Descending Order of Occurrence at Camera Stations			
Number of Stations	Code	Common Name*	Scientific Name*
36	MA	American Marten	*Martes americana*
35	TH	Red Squirrel	*Tamiasciurus hudsonicus*
18	UA	Black Bear	*Ursus americanus*
14	Cla	Coyote	*Canis latrans*
14	GS	Northern Flying Squirrel	*Glaucomys sabrinus*
13	PM	Deer Mouse	*Peromyscus maniculatus*
12	GG	Wolverine	*Gulo gulo*
9	LR	Bobcat	*Lynx rufus*
9	CE	Elk	*Cervus elaphus*
8	TM	Least Chipmunk	*Tamias minimus*
7	VV	Red Fox	*Vulpes vulpes*
5	OH	Mule Deer	*Odocoileus hemionus*
5	NC	Bushy-tailed Woodrat	*Neotoma cinerea*
5	SL	Golden-mantled Ground Squirrel	*Spermophilus lateralis*
4	LA	Snowshoe Hare	*Lepus americanus*
4	ME	Ermine	*Mustela erminea*
3	PC	Mountain Lion	*Puma concolor*
2	OA	Mountain Goat	*Oreamnos americanus*
2	OP	American Pika	*Ochotona princeps*
2	SC	Columbian Ground Squirrel	*Spermophilus columbianus*
1	Clu	Gray Wolf	*Canis lupus*
1	TT	American Badger	*Taxidea taxus*

Source: Mammals of Oregon, American Society of Mammalogists
www.mammalsociety.org/mammals-oregon

Table 8*a*. Bird species detected in the Wallowa-Whitman National Forest in northeast Oregon using motion-detection cameras in January 2011−December 2012. Details on dates the cameras were deployed are presented in Table 2 and Table 5. Common and scientific names for the code designation are presented in Table 8*b*.

Camera Station	Code for Bird Species Listed in Table 8b									Number of Species
	CS	PC	NC	PG	SC	BV	ZL	SO	CB	
WCAM1	x	x								2
WCAM2	x	x	x							3
WCAM3										0
WCAM4	x					x				2
WCAM5										0
WCAM6	x									1
WCAM7	x	x	x							3
WCAM8	x									1
WCAM9	x									1
WCAM10	x									1
WCAM11	x									1
WCAM12	x	x	x							3
WCAM13	x		x							2
WCAM14	x									1
WCAM15	x									1
WCAM16		x	x							2
WCAM17	x	x	x							3
WCAM18	x	x	x							3
WCAM19										0
WCAM20		x	x							2
WCAM21										0
WCAM22										0
WCAM23		x								1
WCAM25										0
WCAM26										0
WCAM27			x							1
WCAM28		x								1
WCAM29				x	x					2
WCAM30		x		x						2
WCAM31	x		x							2
WCAM32	x									1
WCAM33			x							1
WCAM34			x							1

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WCAM35		x	x							2
WCAM36										0
WCAM37										0
WCAM38										0
WCAM39									x	1
WCAM40										0
WCAM41										0
WCAM42										0
WCAM43										0
WCAM44										0
WCAM45										0
WCAM46							x	x		2
	CS	PC	NC	PG	SC	BV	ZL	SO	CB	
Total	17	12	13	2	1	1	1	1	1	

Table 8*b*. Common and scientific names of birds listed in Table 8*a* by code designation. Birds were photographed at camera stations in the Wallowa-Whitman National Forest in northeast Oregon in January 2011−December 2012. The first column in the table is the number of camera stations at which each species was detected.

Bird Species* in Descending Order of Occurrence at Camera Stations			
Number of Stations	Code	Common Name	Scientific Name
17	CS	Steller's Jay	*Cyanocitta stelleri*
13	NC	Clark's Nutcracker	*Nucifraga columbiana*
12	PC	Gray Jay	*Perisoreus canadensis*
2	PG	Mountain Chickadee	*Poecile gambeli*
1	BV	Great Horned Owl	*Bubo virginianus*
1	CB	American Crow	*Corvus brachyrhynchos*
1	SC	Red-breasted Nuthatch	*Sitta canadensis*
1	ZL	White-crowned Sparrow	*Zonotrichia leucophrys*
1	SO	Rock Wren	*Salpinctes obsoletus*

*Source: The Sibley Field Guide to Birds of Western North America, published in 2003.

FIGURES

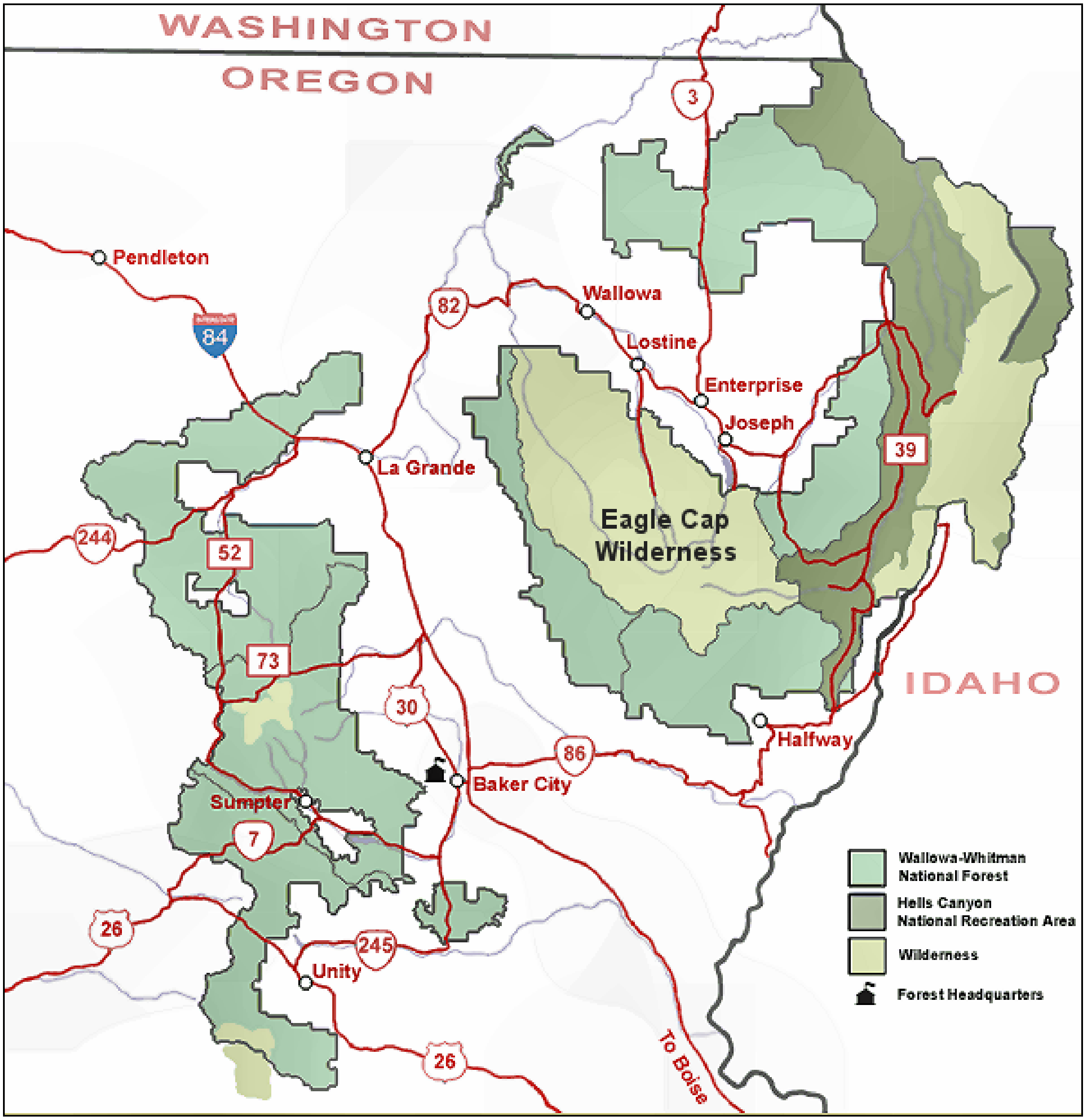


Figure 1. The study area includes the Eagle Cap Wilderness (ECW) and the Wallowa-Whitman National Forest (WWNF) immediately surrounding the ECW. Aerial surveys for wolverine tracks also extended to the Hells Canyon National Recreation Area and the WWNF north of Enterprise. No surveys were conducted in the WWNF west of Hwy 82.

Figure 2. Photographs taken on 25 July 2012 (above) and 4 August 2012 (below) in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon showing numerous snow beds that last all summer at high elevations (~8,000 feet) in the Wallowa Mountains (photos by Jens Persson and Norma Biggar, respectively).

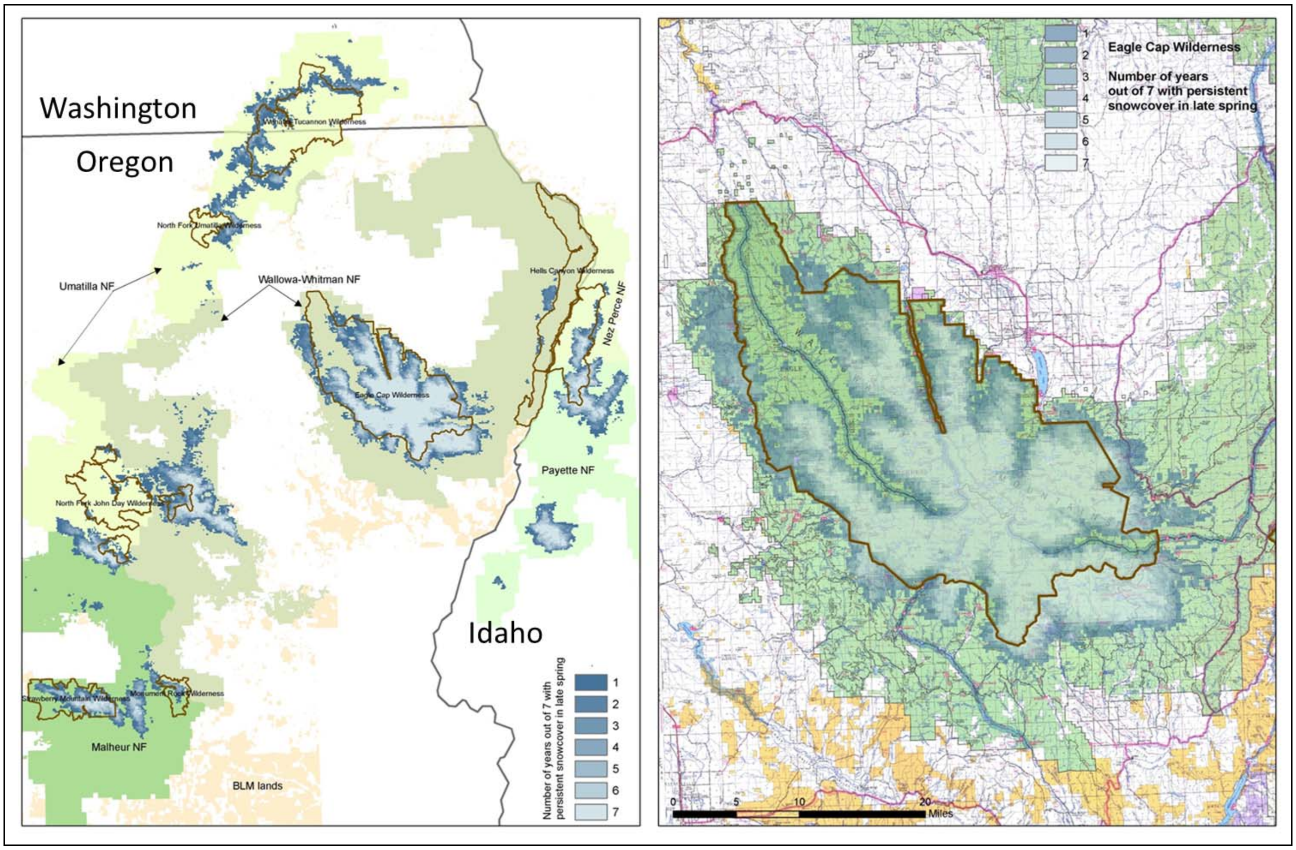


Figure 3. Spring snow cover in the Eagle Cap Wilderness (ECW) and surrounding U. S. Forest Service lands in northeast Oregon, southeast Washington, and western Idaho. The distribution of wolverine habitat in the western states is defined by the extent of persistent spring snow cover that lasts into mid May for at least 1 year out of 7 years (Aubry et al. 2007; Copeland et al. 2010). The map on the left shows persistent spring snow cover in the ECW in the Wallowa-Whitman National Forest relative to adjacent high-elevation habitat. The map on the right is an enlarged, detailed view of the ECW (bordered in brown) showing the extent of persistent spring snow cover (Copeland et al. 2010). Maps provided by Keith Aubry and Cathy Raley, Pacific Northwest Research Station, U. S. Forest Service, Olympia, Washington.

Figure 4. Remains of a mountain goat killed by a cougar (top photo) in the Eagle Cap Wilderness (ECW) in the Wallowa-Whitman National Forest (WWNF) in northeast Oregon and an elk fed on by wolves (bottom photo) near the location of wolverine tracks found in December 2012 about 20 miles north of the ECW and outside the boundaries of the WWNF (Figure 16).

Figure 5. In the photo on the top left, wolverine Stormy is shown at a camera station located in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in April 2011. On the top right is a side view of a similar structure showing position of snagging posts with alligator clips used to collect hair for DNA. The white arrows on the far right in this photo, from top to bottom, point to the crossbar, vertical upright, diagonal brace, and perpendicular crosspiece. This photo was taken of a captive wolverine at a facility where the structure was developed and tested. The structures were made with ultra high molecular weight (UHMW) plastic for durability and flexibility.

In the photo on the left, Stormy has climbed onto the UHMW structure to reach the bait, providing a view of the ventral pattern on his throat and chest and exposing the abdominal area, which provides evidence that he is a male. With this system, it is also possible to identify lactating females (Magoun et al. 2011*a*).

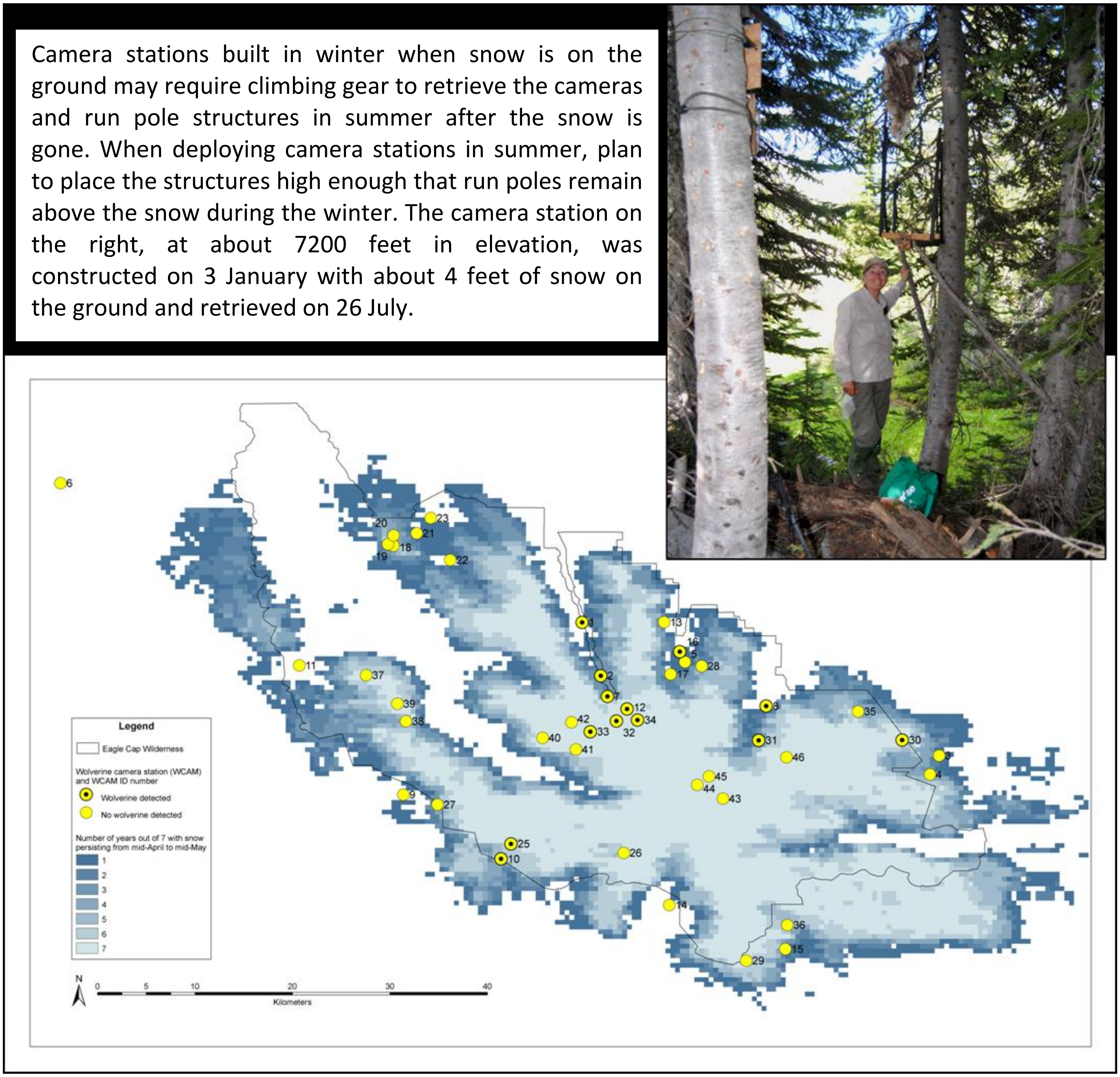


Figure 6. Locations of 45 camera stations in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest, northeast Oregon, January 2011–December 2012. A black dot in the center of a yellow dot indicates a camera station where a wolverine was detected (Table 1). Details on deployment dates and the number of days the cameras were active are presented in Table 2. The spring snow cover extent is from Copeland et al. (2010). Map provided by Keith Aubry and Cathy Raley, Pacific Northwest Research Station, U. S. Forest Service, Olympia, Washington.

Figure 7. Photograph of the first wolverine detected in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon using a motion-detection camera. This photo of "Iceman" was taken with a Trail Watcher© camera on 3 April 2011 before a run pole and hair-snagging structure were added to the station.

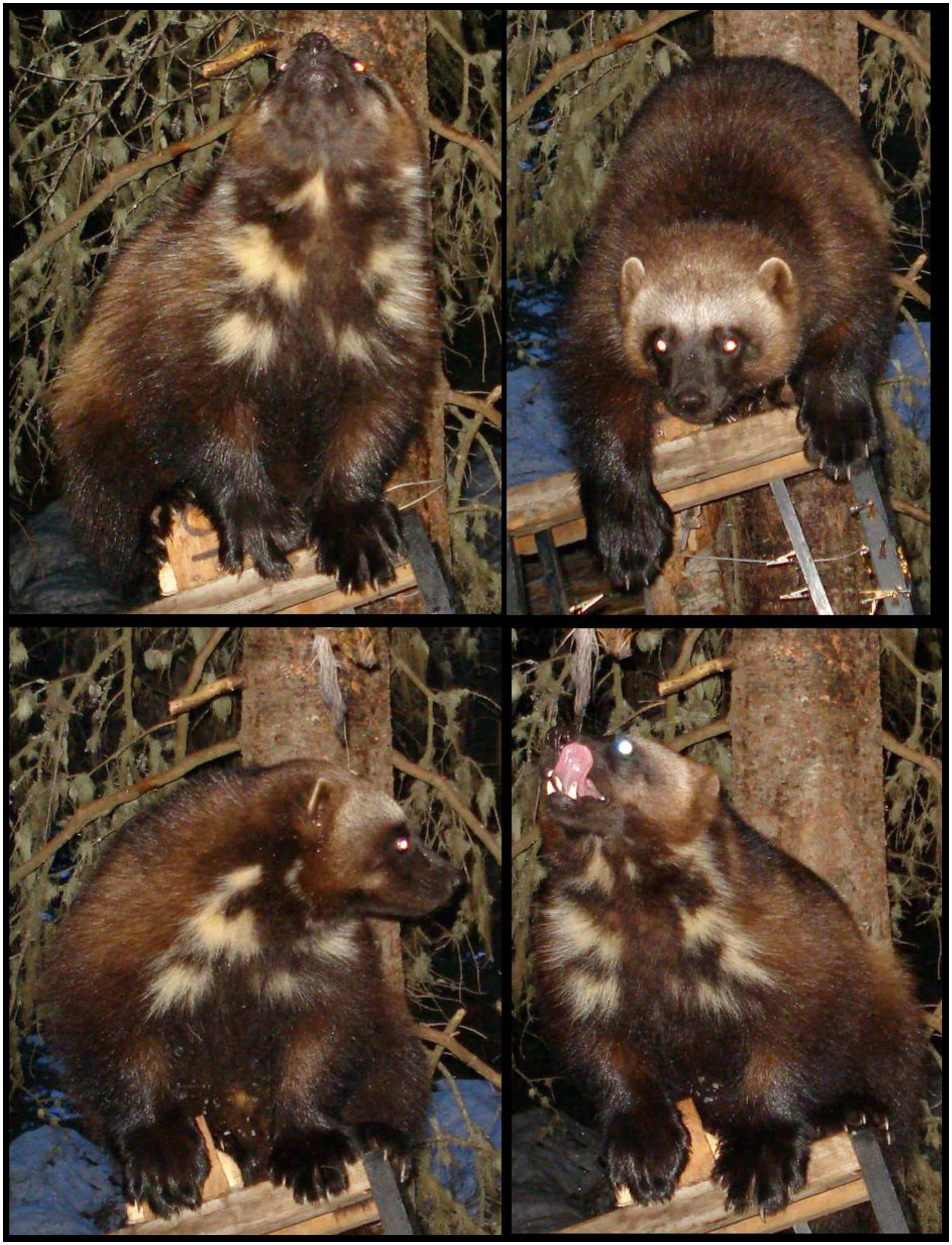


Figure 8. Photographs of male wolverine "Stormy" taken in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in late April 2011 showing views of the ventral pattern and head that can be used to identify this wolverine (Magoun et al. 2011*a*). Gender of this wolverine was verified by DNA analysis of his hair.

Figure 9. Photographs of wolverine “Iceman” taken in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in early April 2011. There are several good photos of the left side of the chest but few of the right side, making it more difficult to identify this individual in future visits to a camera station if no photos of the left side are available. However, the white toes on the right front foot will help to distinguish this wolverine from others with a similar ventral pattern. The white arrow in the photograph located in the bottom row, third photo from the left, points to the abdominal area indicating that this wolverine is probably a male, but more definitive photos or DNA are needed in order to verify the gender of this wolverine.

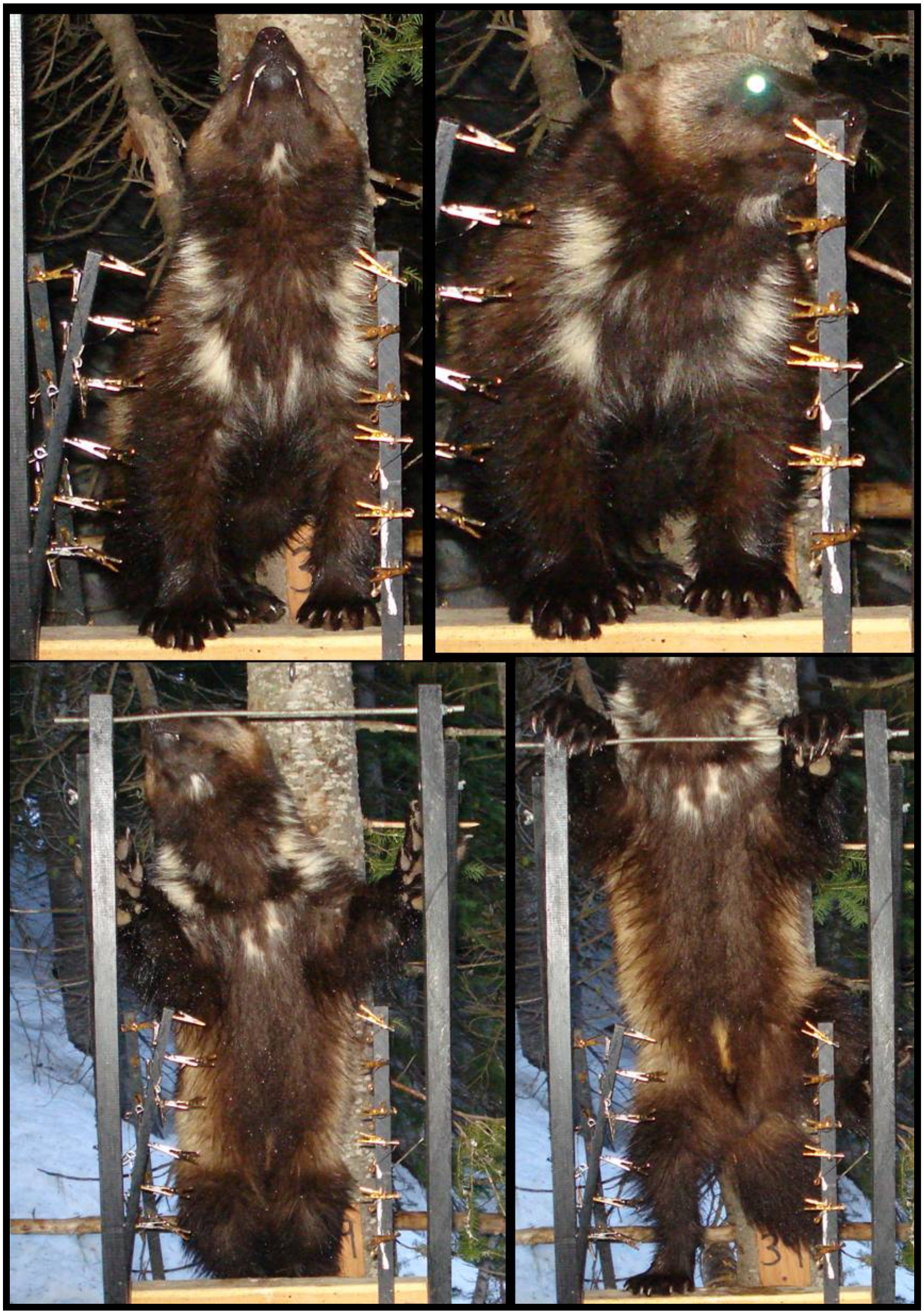


Figure 10. Photographs of male wolverine "Zed" taken in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in mid May 2011. The bottom right photo indicates that this wolverine is a subadult male, possibly around 14 months old. No hair was collected for this male at this camera station.

Figure 11. The photo on the left shows the 3X track of a wolverine detected in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest (WWNF) in April 2011 (photo by Audrey Magoun). A black glove on the left side of the track shows the relative size of the tracks. The arrow points the direction of travel and shows the position of each set of tracks relative to the next set. This 3X pattern is typical for wolverines and can also be seen in the photo on the right where a wolverine traveled on top of a snow-covered log in the WWNF in January 2012 (photo by Holly Akenson). A positive identification of a wolverine track may require following the tracks for some distance to detect the common 3X pattern and document the animal's behavior.

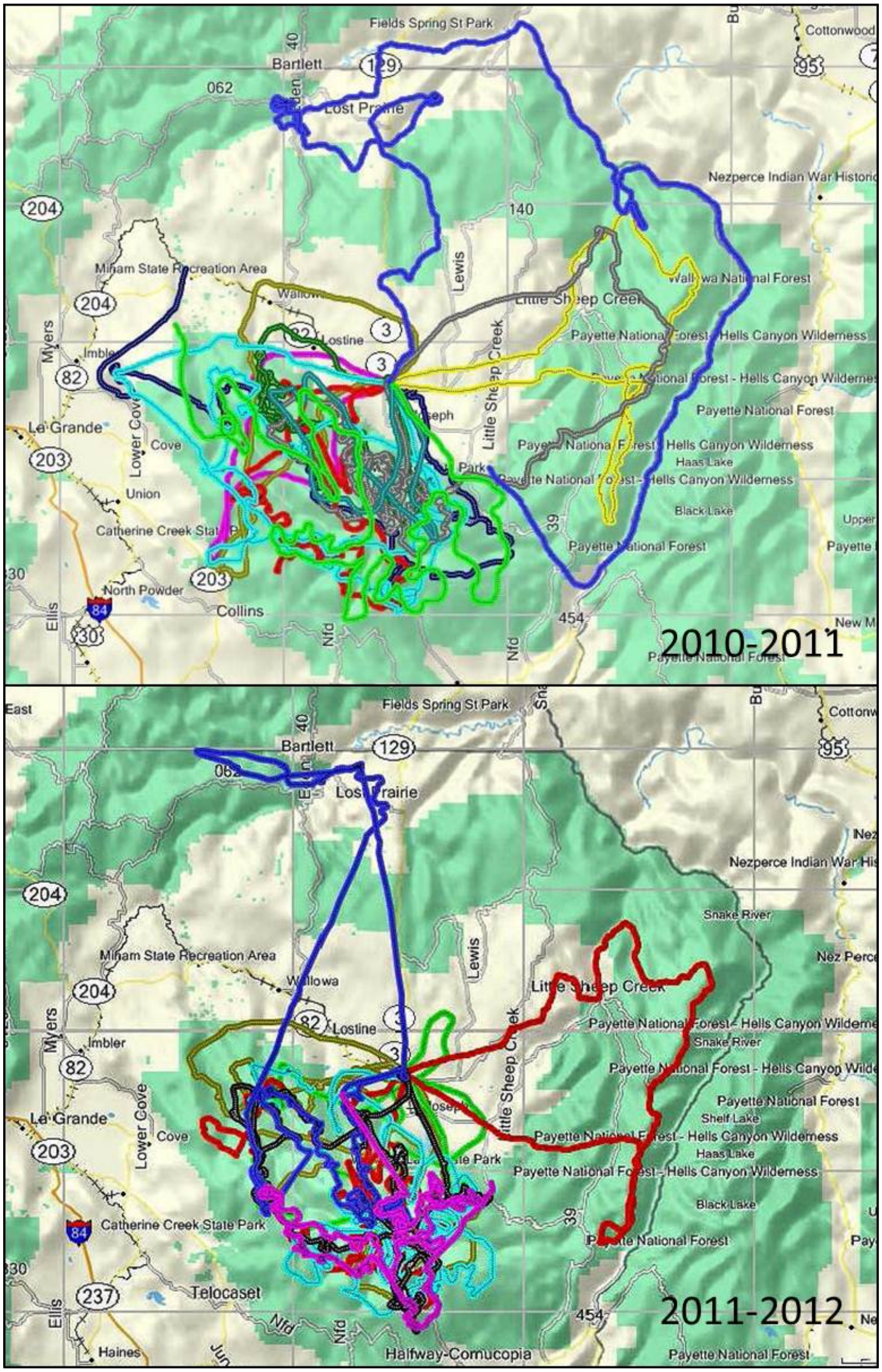


Figure 12. Aerial survey routes for detecting wolverine tracks flown in February 2011–May 2011 (top) and December 2011–April 2012 (bottom) over the Wallowa-Whitman National Forest and Hells Canyon National Recreation Area in northeast Oregon. See Table 4 for flight details.

Figure 13. Wolverine tracks photographed from the air during aerial surveys in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in April 2011. Note the change from a 3X gait on the left to a 2X gait on the right. Also, note that the tracks are close together and that the wolverine did not sink very far into the new snow.

Figure 14. The last photograph of male wolverine Stormy taken in 2012 in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon. The photograph was taken at camera station WCAM33 with a Reconyx© camera. Note that there is still snow on the ground when the photo was taken on 17 June at an elevation of 7,196 feet.

Figure 15. In the upper left photo, a perfect set of wolverine tracks (photo by Dale Pedersen) showing all 5 toes on both front and hind foot, the chevron-shaped interdigital pad (especially on the front foot), and the calcaneum pad on the front foot. Unlike for bears, the front foot track of a wolverine is longer than the hind foot track. In the lower left photo, the fifth toe on the right side of the print is barely discernible with only a partial print of the toenail (photo by Ken Bronec). The fifth toe is often not detectable on wolverine tracks. The photo on the right shows the 2X track pattern of a wolverine (photo by Holly Akenson). Individual track prints are often not well-defined under most tracking conditions so the track pattern and size of the track is often the best way to identify the species that made the track.

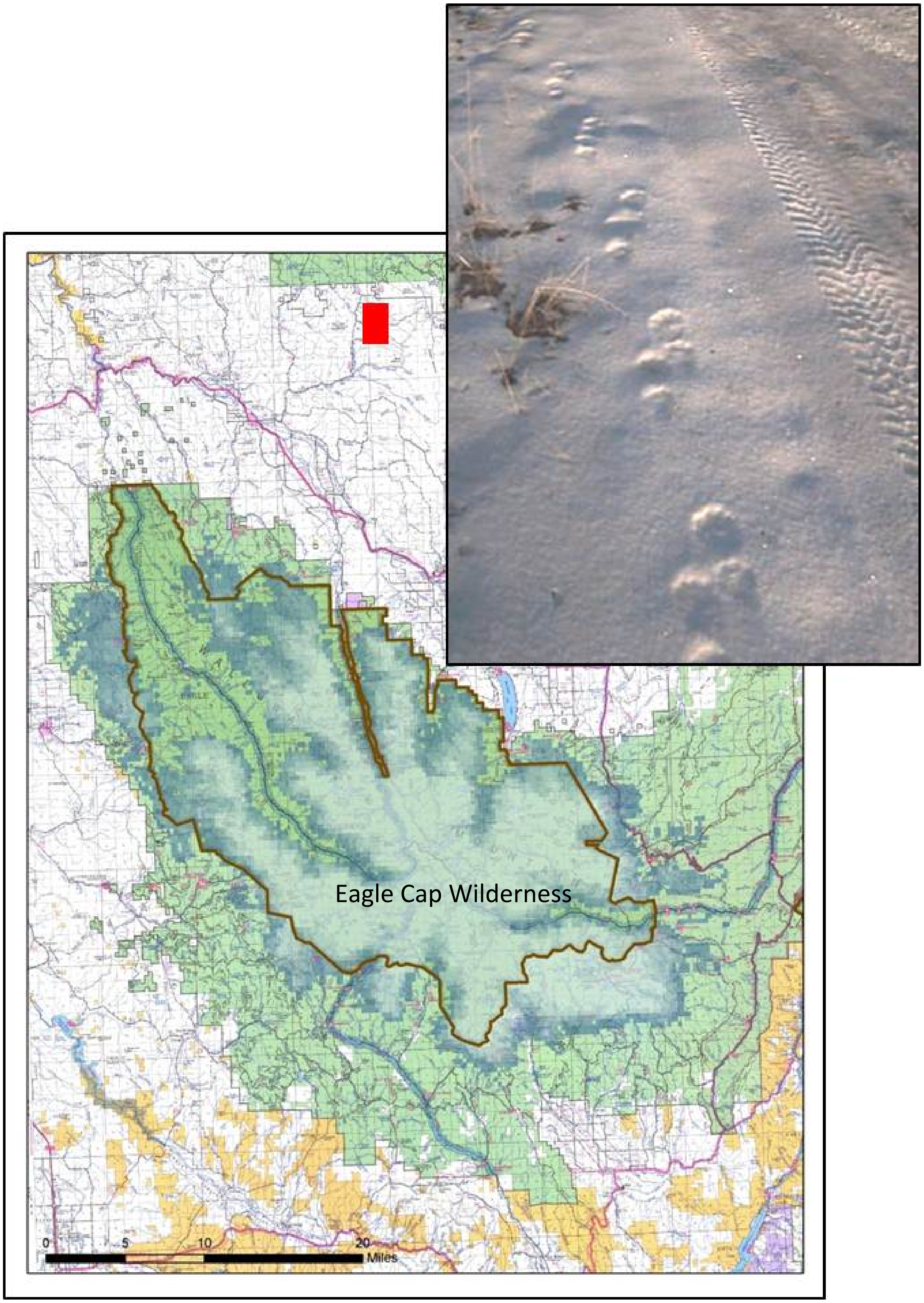


Figure 16. Location of wolverine tracks (red box) and photo of wolverine tracks found on 30 November 2012 north of the Eagle Cap Wilderness (outlined in brown on the map) by Pat Matthews (Oregon Department of Fish and Game). Map provided by Keith Aubry and Cathy Raley, Pacific Northwest Research Station, U. S. Forest Service, Olympia, Washington.

Figure 17. Location of a summer camera station in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest at an elevation of 8,092 feet. Note the lingering snowdrifts evident in the upper portion of the photo, which was taken on 24 July 2012 (photo by Jens Persson).

Figure 18. Columbian ground squirrels scavenged on bait at summer camera stations in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in 2012. The bait was secured by cable to rocks and ground squirrels did not remove the bait from under the rocks. At the station above, bones and dried hide from the bait (road-killed deer) remained beneath the rocks and was fed on by ground squirrels for 3 weeks before the camera at this station malfunctioned.

Photo by Norma Biggar

Figure 19. Four different red foxes photographed at different camera stations in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in winter 2010-2011 and 2011-2012. These foxes may be the native fox referred to as the "montane fox" (Aubry et al. 2009; Statham et al. 2012). Elevations where these camera stations were located ranged from 6,016 feet to 7,235 feet. Even though camera stations were not designed to photograph canid species, red foxes were photographed at 7 camera stations (Table 7*a*,*b*).

Figure 20. A lactating female wolf photographed at camera station WCAM20 in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon on 4 June 2012.

Figure 21. Two different martens photographed at camera station WCAM31 (top photo) in the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in 2012. The ventral patterns on martens photographed at camera stations can be used to identify individuals. Photographs will also show evidence of gender as seen in photographs of male martens below.

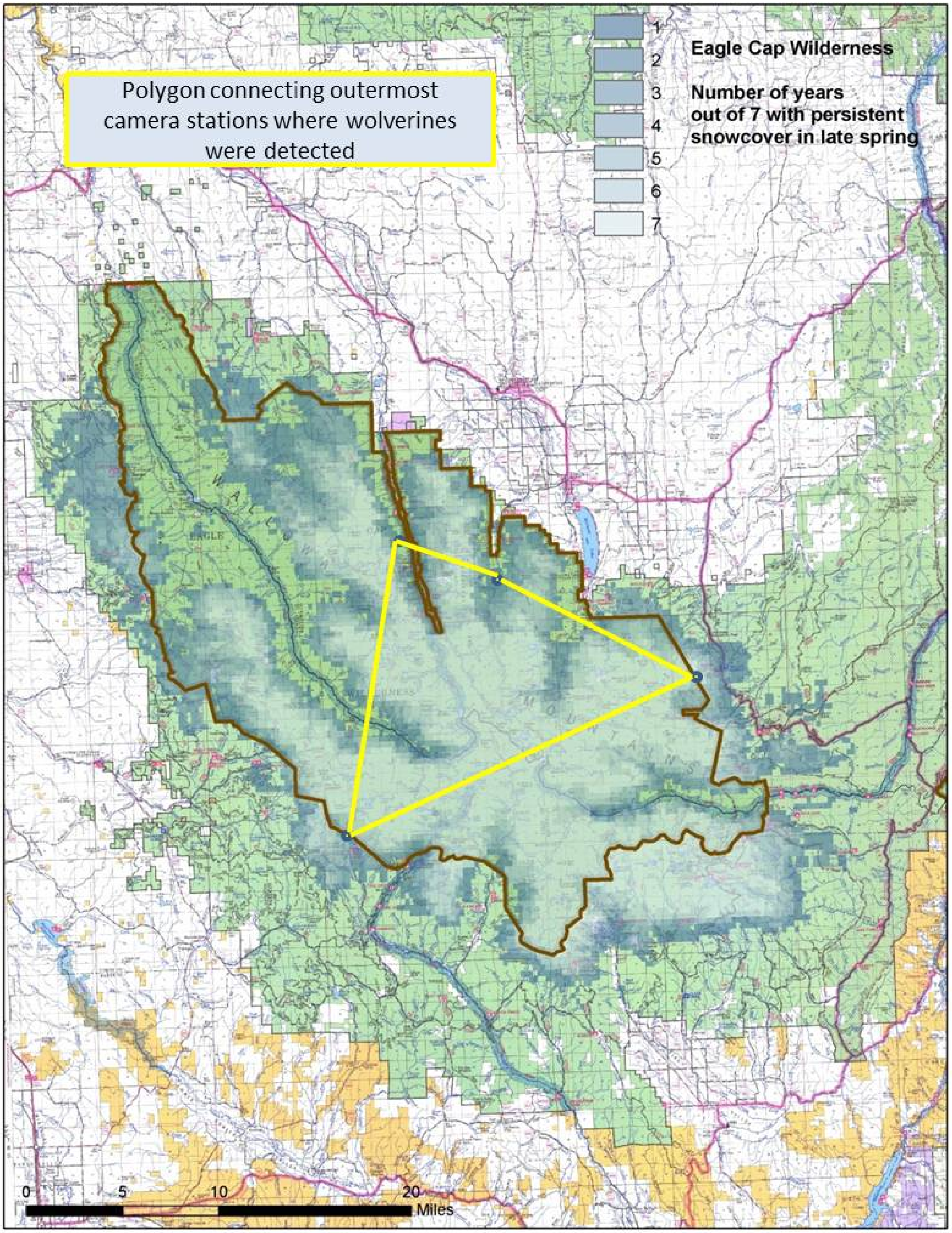


Figure 22. Polygon encompassing locations of camera stations where wolverines were detected in 2011 and 2012 in the Eagle Cap Wilderness (bordered in brown) in the Wallowa-Whitman National Forest in northeast Oregon. Map of persistent spring snow cover (Copeland et al. 2010) was provided by Keith Aubry and Cathy Raley, Pacific Northwest Research Station, U. S. Forest Service, Olympia, Washington.

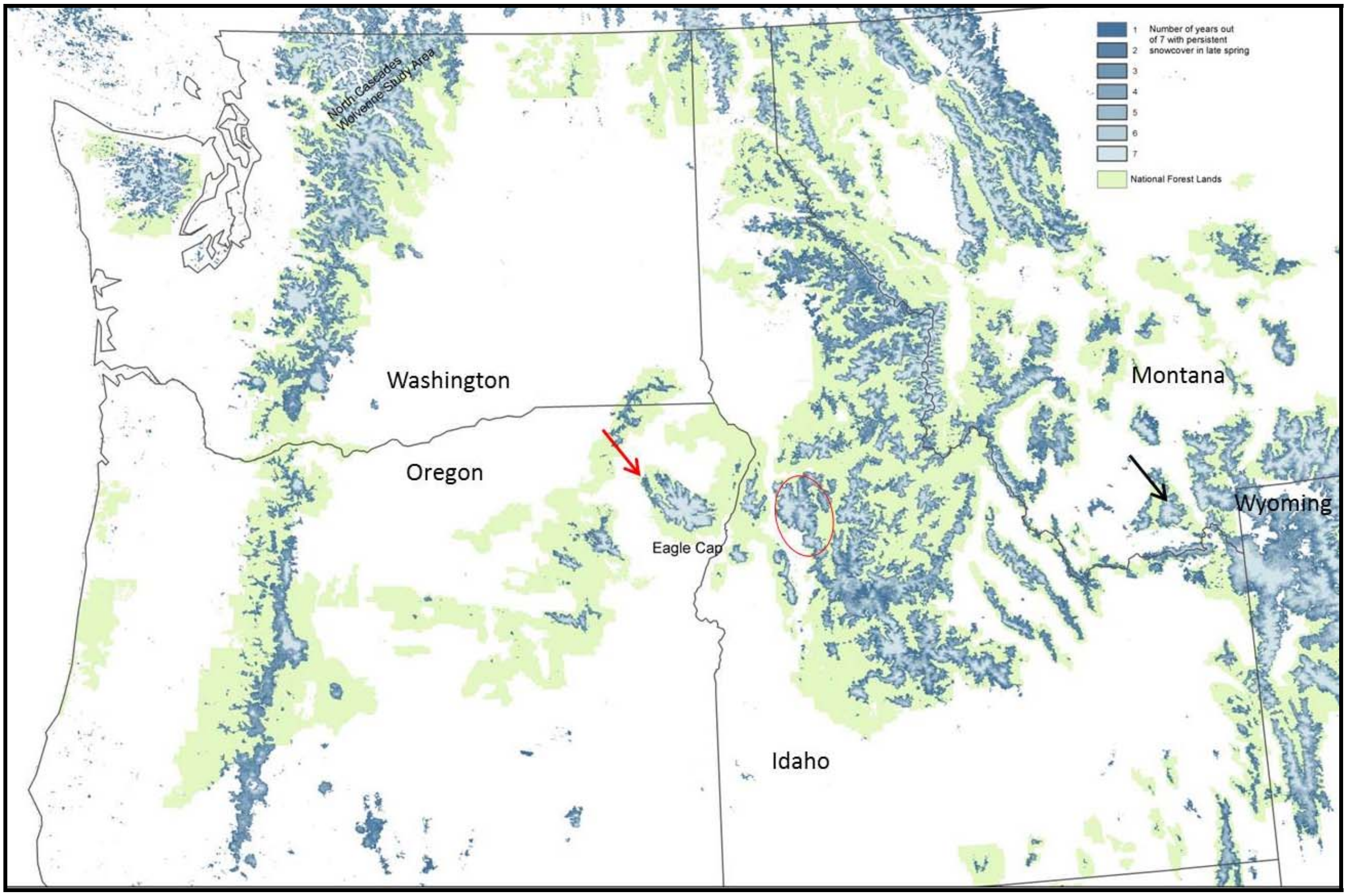


Figure 23. Relative location and size of the Eagle Cap Wilderness (red arrow) in the Wallowa-Whitman National Forest in northeast Oregon relative to other areas in Oregon, Washington, Idaho, Montana, and Wyoming with persistent spring snow cover (blue areas; Copeland et al. 2010). The red oval in Idaho delineates a portion of the Payette National Forest with at least 6 resident wolverines in 2010, including reproductive females (Heinemeyer and Squires 2012). The black arrow in Montana points to the Gravelly Range, a small isolated mountain area where wolverine dens have been located (Inman et al. 2007*a*). Light green shading shows the location of national forest lands. The snow cover map was provided by Keith Aubry and Cathy Raley, Pacific Northwest Research Station, U. S. Forest Service, Olympia, Washington.

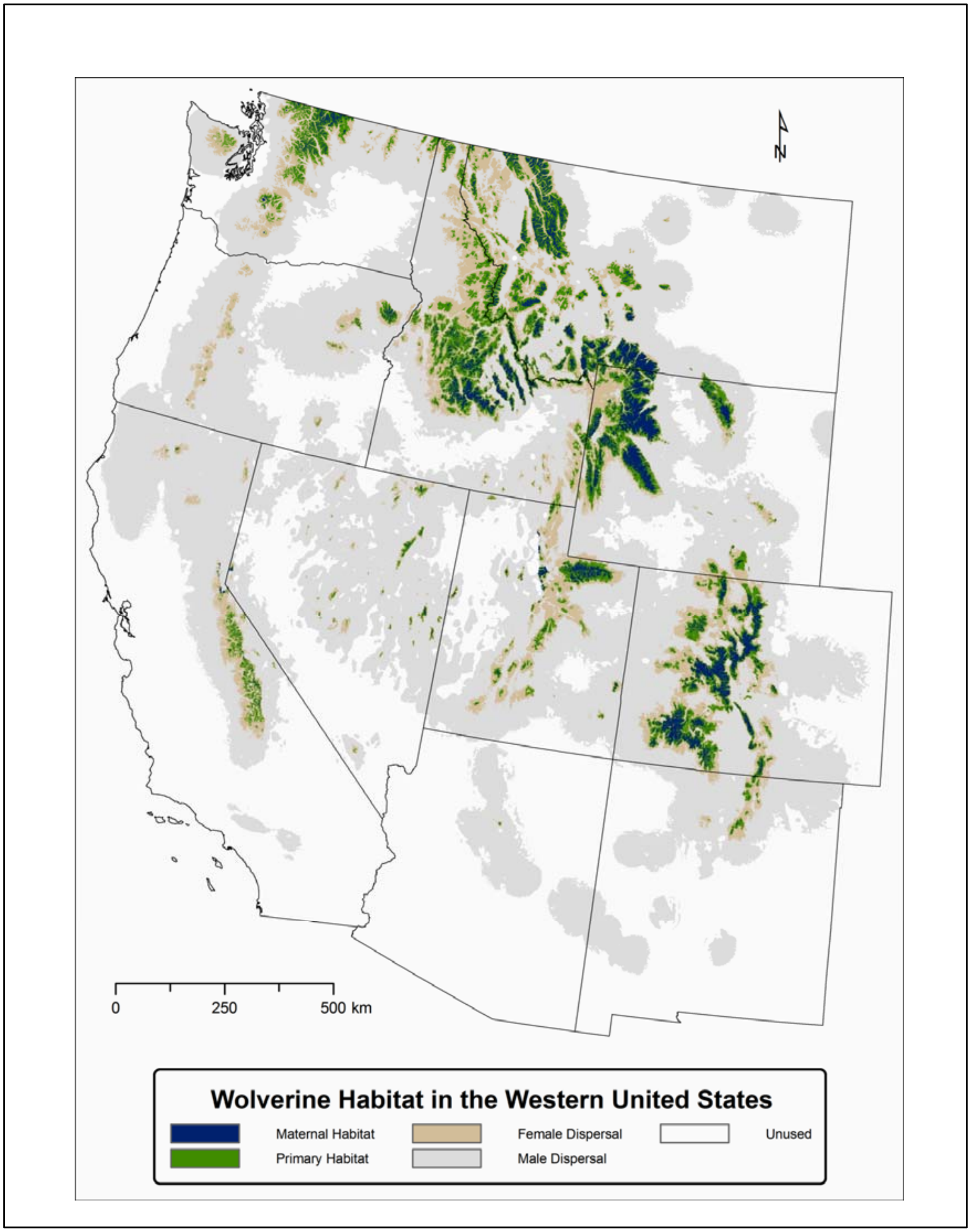


Figure 24. Distribution of wolverine habitat in the western United States from Inman et al. (2013*a*). In this model of wolverine habitat, the study area in the Wallowa Mountains in northeast Oregon contains both primary wolverine habitat (green) and maternal habitat (blue) for wolverines. Gray areas indicate dispersal habitat for male wolverines and make up a large portion of Oregon. Dispersal habitat for females is limited in this model but may be underrepresented because of the lack of information on habitat used by females during dispersal. Map provided by Bob Inman (Wildlife Conservation Society, North American Program).

Appendix A. Species other than wolverines photographed at camera stations in and adjacent to the Eagle Cap Wilderness in the Wallowa-Whitman National Forest in northeast Oregon in January 2011–December 2012. Also, see Tables 7*a*,*b* and 8*a*,*b*.

Note: the topmost hair-snag clips at camera stations should not be set in order to avoid catching birds that use the top clips as perches. The top clip where the Steller's jay is perched in this photo is not set, but the top clip on the snag post to the right is set and could snag a bird and therefore should be unset.

Canids

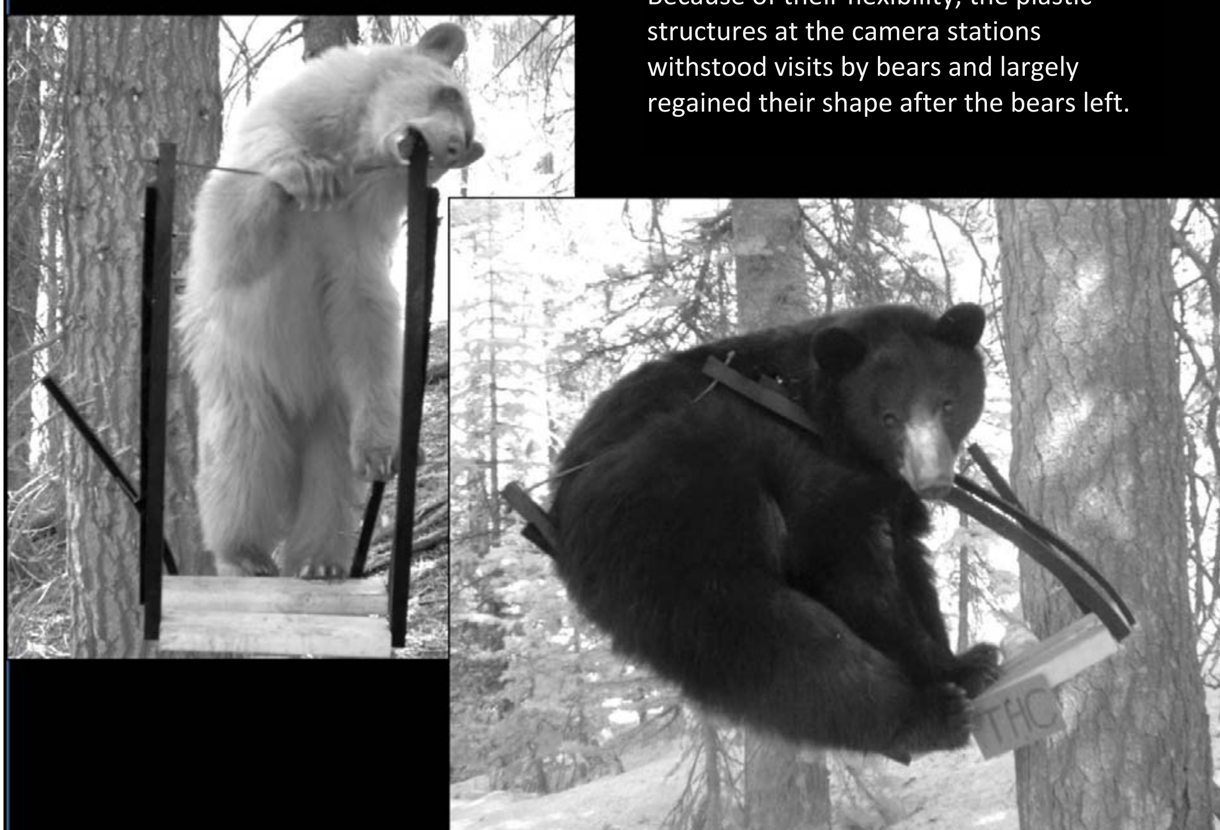
Coyotes were the most frequently photographed canid at camera stations, occurring at 33% of the stations in winter and summer (Table 7*a*). They were photographed at elevations from 4,762 feet to 7,196 feet in winter and at 8,458 feet in summer. Coyote tracks were common in the study area and were sometimes found near active camera stations even though no photographs were documented on the cameras. Coyotes were never photographed on the run poles. The only photos of coyotes feeding on bait were obtained at a camera station where we had placed bait near the ground before we set up a run pole. Photos of coyotes indicated they were aware of the cameras and were nervous around the camera stations. Red foxes were photographed at only 16% of camera stations, all in winter months with snow on the ground. Stations visited by foxes ranged in elevation from 6,016 feet to 7,373 feet. Tracks were sometimes seen near active camera stations where no photos of foxes were obtained. Foxes did not climb onto run poles to feed on bait, but 1 fox climbed up a tree to reach bait and another fed on bait in a tree by standing up against the tree (Fig. 19). Foxes may be wary of run poles and hair-snagging structures so placing bait near the ground might result in more photos of foxes. We obtained photographs of only 1 wolf, which were taken at camera station WCAM20 at 7,147 feet elevation (Fig. 20). We were able to determine that this wolf was a lactating female that was not known to be in the area before she visited this camera station. She was photographed on 4 June 2012 and again on 15 June 2012 as she passed by the camera station. On her second visit, she stared at the camera and moved around so that she could look up at the bait hanging above the run pole, but she was wary, staying less than a minute and not returning to the camera station again. In contrast, wolves are frequently photographed by Oregon Department of Fish and Wildlife along trails and roads. Use of baited camera stations with run poles and hair-snagging structures could discourage wolves from approaching close enough to be photographed. One of our camera stations had wolf tracks nearby but no photos of the wolf were obtained, although the camera may have been inoperable at the time the wolf visited the site. Use of additional cameras without a white flash, placed at camera stations at a distance from the run poles, could increase the opportunities to photograph wolves, coyotes, and foxes.

Felids

Two felids were photographed at the camera stations, bobcat and mountain lion. Bobcats (left and lower right) visited 9 camera stations at elevations ranging from 4,784 feet to 6,468 feet in winter and to 7,241 feet in summer. They fed extensively on bait, readily climbed onto run poles, and returned to camera stations repeatedly, over as much as 41 days at WCAM11. We could identify individuals by their markings, and hair was deposited in hair snags at some stations. Bobcats did not damage hair-snag structures. Mountains lions (lower left) were detected at only 3 camera stations, all where bobcats had also been detected (elevations of 4,784 feet to 6,398 feet). They fed on bait at only 1 station, making 2 visits to feed at this station on 6 May 2012 and returning the following day to feed once more. The lion below did not climb onto the run pole but stood on the ground and reached up for the bait, at times clinging to the bait with its forefeet and swinging off the ground. Its attempts to reach the bait eventually dislodged the hair-snag structure that had been attached to the run pole.

Ursids

Black bears were the third most common mammal at our camera stations, with 18 of 43 functional stations (40%) visited by bears over the 2 years of the study. Bears were detected over a wide range of elevations, from 4,600 feet to 8,200 feet. The earliest date that a bear arrived at a camera station was 11 April, but in most cases (80%), bears did not visit the winter camera stations until May or June. Elevation did not appear to be correlated with the dates of first detections at camera stations in the spring. Bears were not detected at camera stations in early winter after October. Despite their large size, bears did little damage to camera stations even though they readily climbed onto the run poles to reach the bait. They frequently left hair in the hair snags. If photos were taken over a short period of time, it was possible to identify individual bears, at least 3 at some stations, because of the wide range in size, color, coat condition, and individual markings.



Because of their flexibility, the plastic structures at the camera stations withstood visits by bears and largely regained their shape after the bears left.

Mustelids

Along with red squirrel, marten (left) was the most common mammal species photographed, being detected at 84% of camera stations over the range of elevations where cameras were deployed (Table 7*a,b*). Two or more were photographed at most of the camera stations. Marten were often the first species to arrive at camera stations, indicating that they were widespread and common in the Wallowa Mountains. Marten were even detected at summer camera stations where bait was placed under large boulders on open talus slopes at relatively high elevation sites. Martens made numerous, frequent visits to camera stations over winter to feed on bait, but usually there was still enough bait and bones remaining to lure wolverines onto run poles if they visited the sites. In addition to marten and wolverine, other mustelids photographed at camera stations included badger (lower left) and ermine (lower right) but visits by these species were uncommon (Table 7*a,b*). Ermine were detected at 4 stations between 5,459 feet and 7,373 feet elevation in winter and 8,275 feet in summer. Only 1 badger was detected, an individual that visited a summer camera station at over 8,000 feet elevation on 8 September 2012. Tracks and scats indicated an otter also visited a camera station (WCAM7) but apparently spent little if any time on the run pole. Photos of what appeared to be an otter at this station were inconclusive so otters were not included in Table 7.

Sciurids

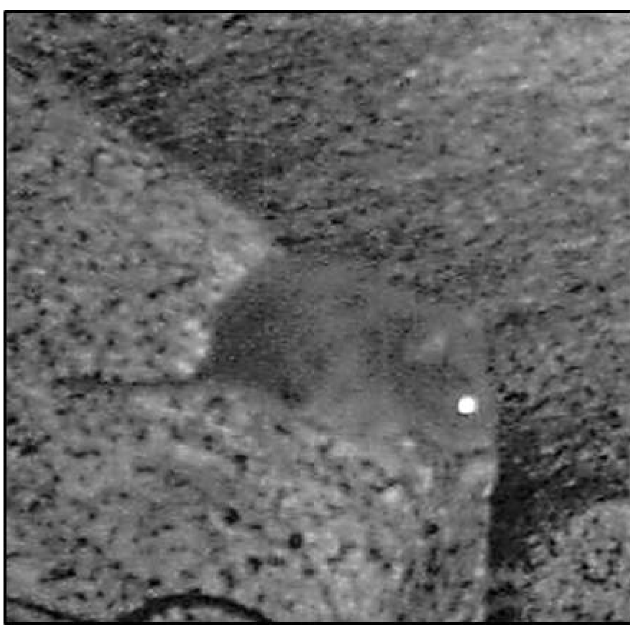
Five members of the squirrel family were detected at camera stations, only 2 of which (northern flying squirrel and red squirrel) were common winter visitors at the stations (Table 7). The northern flying squirrel (far left) was detected at 33% of the stations and occurred from 4,784 feet to 7,246 feet in elevation in forested habitats. Once flying squirrels discovered a baited camera station, they repeatedly visited the stations to feed both winter and summer. Their visits only occurred at night. Differences in the sizes of flying squirrels indicated that young squirrels foraged at the sites along with adults. Red squirrels visited 84% of the camera stations and, along with marten, were the most common species at the stations. They were distributed widely across the elevation range of camera stations up to 8,275 feet. They visited stations mainly during daylight hours and were photographed in all habitat types, even in the boulder scree at the summer camera stations. However, red squirrels were inconsistent in their visits to camera stations and were most active in the spring and summer months. The other 3 squirrel species, Columbian ground squirrel (Fig.18), golden-mantled ground squirrel (lower left), and least chipmunk (lower right), were detected primarily at summer camera stations and all 3 species scavenged on bait in the boulder scree where most summer cameras were deployed.

Lagomorphs

Pikas (left) and snowshoe hares (bottom) were locally common in the study area but were rarely photographed at camera stations. Pikas were only photographed at summer camera stations in boulder scree and were not consistently detected at the sites, indicating they probably did not feed on bait as the sciurids did. Hares were only photographed at camera stations in winter when passing by a camera station and when their movements were within the detection zone of cameras. They were photographed between 6,000 feet and 7,300 feet in elevation.

Miurids

The deer mouse and the bushy-tailed woodrat were the 2 miurid species that were identified at camera stations. The woodrat (left) was only detected at 5 camera stations and did not consistently visit the camera stations. At 1 camera station, visits by woodrats stopped after northern flying squirrels began visiting the station. The deer mouse (lower right) was detected at 30% of the camera stations and was a frequent visitor at one of the few stations that were not visited by martens. Other small miurids may have been photographed at camera stations, but it was sometimes difficult to identify miurids to species from photographs, especially with photographs taken with Reconyx© cameras. Any small miurid that resembled a deer mouse was considered a deer mouse in Table 7*a* because this was the most common miurid species identified at camera stations. However, the vole in the photo on the bottom left may be a long-tailed vole (*Microtus longicaudus*). It was photographed at camera station WCAM43 on 14 September 2012, which was located at an elevation of 7,529 feet in boulder scree near a small stream.



Cervids



Elk were photographed at 21% of the camera stations at elevations from 4,646 feet to 8,458 feet. Elk were most often detected at camera stations before November and after May but were also photographed on 3 March at 4,646 feet, 20 April at 5,659 feet, and 9 January at 5,236 feet. No elk were detected over 6,000 feet in elevation in winter. Elk were often interested in the camera stations and spent time investigating the bait (top left; note blood on his nose from sniffing the bait), scent lure (top center; smelling beaver castor and perfume), and camera (top right; cow elk sniffing the camera). On 8 July 2012, an elk (top center photograph) spent over 4 minutes at a camera station smelling the scent lure that we had deposited among boulders along a game trail a week earlier. Photos of an elk visit in September suggested the scent was still detectable. Mule deer (left and bottom) were detected at 12% of the camera stations between 5,149 feet and 7,241 feet in elevation. Mule deer were photographed incidentally as they passed by camera stations and usually did not spend time investigating the camera stations.


Ovids

Mountain goats were detected at 2 camera stations in summer 2012 that were deployed in boulder scree at elevations over 8,000 feet. The goats appeared to be attracted to the scent lure at the stations but also investigated the area where the bait had been deposited. In the photo on the left, a nanny spent 8 minutes investigating the camera station 3 weeks after the station was deployed. Previously, a billy had visited the station for less than a minute 4 days after deployment. The young billy in the photo below arrived at a different camera station 3 weeks after it was deployed and spent 2.5 minutes investigating the site. It was accompanied by at least 1 other goat that did not come within the full detection zone of the camera.

Avian Species

The 3 most common avian scavengers, the Steller's jay (top), the Clark's nutcracker (middle), and the gray jay (bottom left), were detected at camera stations at average elevations of 5,828 feet (mode 5,700), 6,494 feet (mode 6,556), and 6,215 feet (mode 6,207), respectively. Even though the mountain chickadee (bottom, top right) and the red-breasted nuthatch (bottom, bottom right) are winter scavengers and were frequently heard during winter in the vicinity of our camera stations, both species were rarely photographed

at the stations. The other 2 species below, the white-crowned sparrow (bottom, center top) and the rock wren (bottom, center bottom), were summer visitors at a camera station where they may have been feeding on flies attracted to the bait or maggots on rotting meat, which was accessible to these birds at the camera station.

Wallowa Mountains
22 May 2011