

Distribution and Ecology of Wolverines in the North Cascades

Pilot Project – Year 2

Year-End Status Report

Interagency Special Status/Sensitive Species Program



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Abstract

During the winter of 2006/07, we operated 4 log cabin-style livetraps for wolverines in the northwestern portion of the Methow Valley Ranger District in the Cascade Range of north-central Washington. We opened traps for varying time periods from January 9 to March 30, for a total of 180 trap-nights. We captured 3 different wolverines on 5 occasions, 2 of them twice and 1 once. We trapped one a third time, but he escaped. We fitted all 3 wolverines with radio-collars containing both satellite (Argos) and VHF transmitters. A young female (Xena) used an area about 760 mi², based on 120 high-quality satellite locations (Argos location classes 1–3). A young male (Chewbacca) used an area of about 730 mi², based on 80 high-quality locations. Xena and Chewbacca's activity areas overlapped by about 90%. We recaptured Melanie this year, a young female we originally captured in February 2006. As of last year, she had not bred, but she was pregnant this year. Based on 130 high-quality locations, she used an area of approximately 560 mi². Due to logistical constraints and problems encountered during aerial telemetry, we were unable to locate her natal den, or even verify that she had successfully reproduced. A preliminary analysis of elevational use by our 3 study animals indicated that elevations $\leq 4,400$ ft were used less than expected, elevations 5,901–7,000 ft more than expected, and other elevation zones (4,401–5,900 ft and $>7,400$) at levels comparable to availability, suggesting a preference for relatively high-elevation habitats near treeline. In April 2007, we obtained a remote-camera photograph of Thor, a young male we originally captured in April 2006, near the Hart's Pass trap. We suspect these 4 animals represent 2 mated pairs, because there was almost complete overlap of Chewbacca and Xena's activity areas and, although location data on Thor were limited, Melanie's activity area this winter completely encompassed Thor's activity area from last winter. Future research will involve the continuation of trapping and telemetry efforts, including the construction of 2 additional live-traps along the southern boundary of the Pasayten Wilderness, and field trials using GPS radio-collars in an effort to improve our ability to locate the natal and maternal dens of reproductive females.

Introduction

The wolverine (*Gulo gulo*) is one of the rarest mammals in North America, and the least known of the large carnivores (Banci 1994). It is considered a sensitive species in the Pacific Northwest Region by the U.S. Forest Service, and a candidate species for listing as threatened or endangered by the state of Washington. The northern Cascade Range in Washington represents the southernmost extent of the current range of wolverines along the Pacific coast of North America (Aubry et al. 2007). Wolverines have never been studied in the field in this region, due partly to their low densities and extremely limited access during all periods of the year into the unroaded wilderness areas where they occur. Recent research on wolverines in the Rocky Mountains of British Columbia (Krebs et al. 2007) and the United States (Copeland 1996, Copeland et al. 2007, Squires et al. 2007) indicates that wolverines are wide-ranging, inhabit remote areas near timberline, and are sensitive to human disturbance at natal and maternal den sites. Winter recreation activities are widespread in the North Cascades and often occur in suitable wolverine denning habitat. Such activities may adversely affect wolverine populations or their preferred habitats.

Snowtracking and remote-camera surveys conducted during the last 10 yr, coupled with a review of historical occurrence records from Forest Service files, resulted in a number of highly credible wolverine observations (many verifiable) from areas near the Cascade Crest on the Methow Valley Ranger District of the Okanogan-Wenatchee National Forest. Consequently, we chose this area for a pilot study that was designed to evaluate the feasibility of trapping wolverines during winter in the North Cascades, and using satellite-based telemetry to monitor their movements, estimate home ranges, and investigate patterns of habitat use. This report is for the

second year of a planned 5-yr study of wolverine distribution and ecology in the North Cascades of Washington.

Study Area

Our study area is located in the northeastern Cascade Range, primarily on the Methow Valley Ranger District of the Okanogan-Wenatchee National Forest (Figure 1). The Methow Valley Ranger District is bounded on the north by British Columbia, Canada, on the west by North Cascades National Park, and extends south to near the Columbia River and east to the divide between the Methow and Okanogan River watersheds. It encompasses portions of the Pasayten and Lake Chelan-Sawtooth wildernesses and extends approximately 50 mi along the Cascade Crest. Vegetation cover types include bitterbrush/bluebunch wheatgrass at lower elevations, mixed-conifer forests at mid- to high elevations, and alpine meadows, rocky ridges, peaks, and small glaciers at the highest elevations.

Methods

We constructed 3 wolverine livetraps during the fall of 2005 (Hart's Pass, Twisp River, and Cutthroat), and a 4th trap (Baldy Pass) during the fall of 2006. Traps were built *in situ* in areas where wolverine occurrences had been documented recently, and were located within about 500 ft of roads that were regularly used by snowmobiles. Traps were constructed of native logs using the design recommended by Copeland et al. (1995) that is currently being used for wolverine studies in the northern Rocky Mountains and elsewhere in North America (Figure 2). Trap locations were near the Cascade Crest and/or adjacent to the Pasayten and Lake Chelan/Sawtooth Wildernesses. The Hart's Pass trap was located near the Cascade Crest at an elevation of 6,200

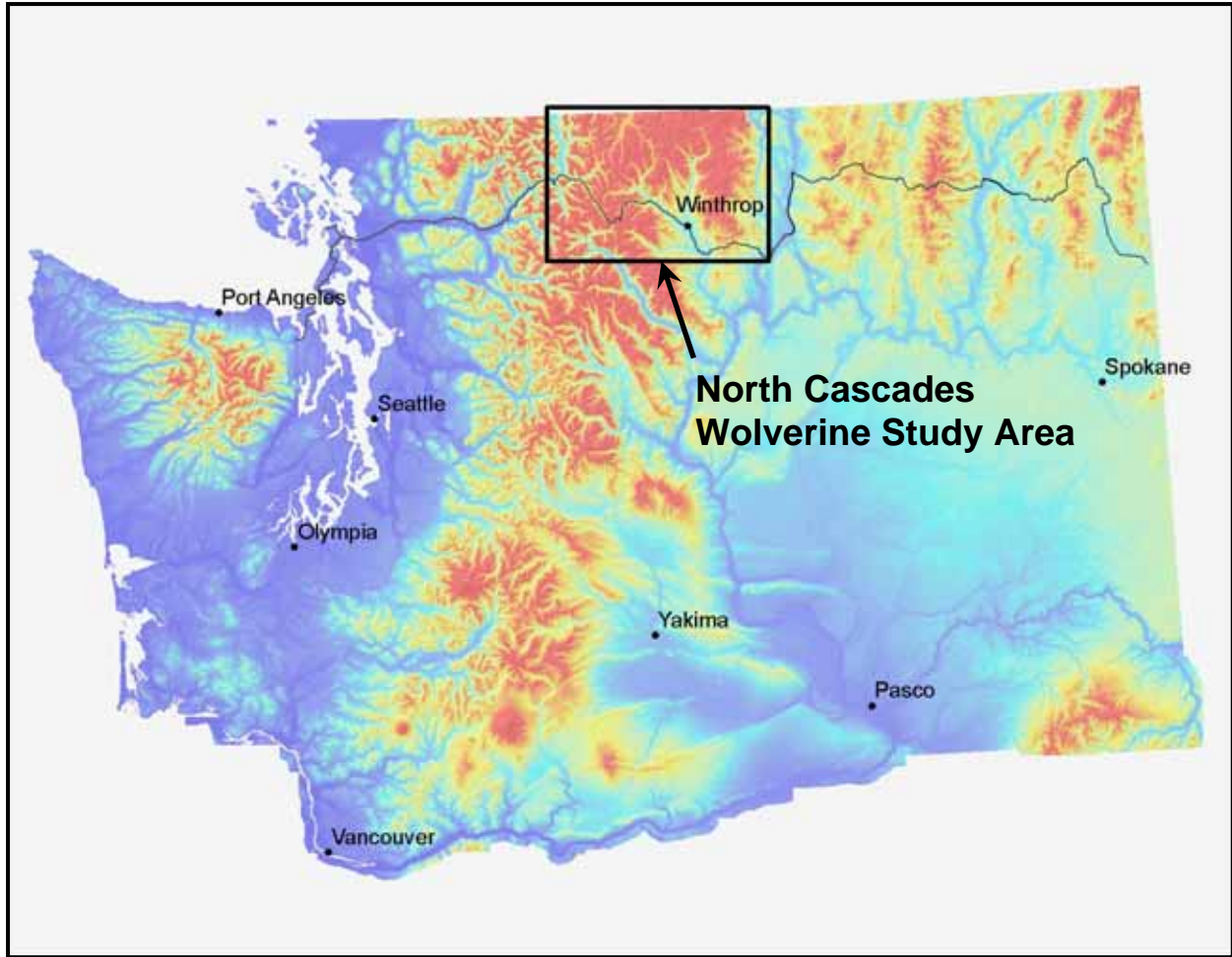


Figure 1. Primary area of research activities during the winters of 2005/06 and 2006/07 for the North Cascades Wolverine Study. Colors show the topographic gradient based on a digital elevation model; “cool” colors are lower in elevation than “warm” colors.

ft in subalpine mixed-conifer forest; the Cutthroat trap was located approximately 2 mi east of the Cascade Crest at 4,400 ft in subalpine mixed-conifer forest; the Twisp River trap was located approximately 7 mi east of the Cascade Crest at 3,600 ft in montane mixed-conifer forest; and the Baldy Pass trap was located at 6,400 ft in subalpine mixed-conifer forest (Figure 3). The Baldy Pass trap is located approximately 35 mi east of the Cascade Crest on the ridgeline between the Methow River and Okanogan River watersheds. The traps were baited with parts of



Figure 2. Wolverine live-trap at Hart's Pass, Methow Valley Ranger District, Okanogan-Wenatchee National Forest, WA (left), and the trigger mechanism at the back of the trap (right).

road-killed mule deer, beaver carcasses, and/or salmon carcasses, and monitored daily via a trapsite transmitter that indicated whether the trap lid had closed. We visited all traps twice per week to ensure that they were functioning properly.

Captured wolverines were immobilized with a mixture of ketamine and medetomidine administered via a jab stick. Tissue samples were taken from all captured wolverines for genetic profiling, and data were gathered on the sex, age, and condition of captured animals. A small, brightly colored plastic tag was attached to each ear. Study animals were fitted with radio-collars containing both Argos satellite transmitters and standard VHF transmitters. During the first year of the pilot study (winter 2005/06), satellite transmitters were programmed to be on for only 5 hr each day so that the transmitters would gather location data for >1 yr. However, this duty cycle resulted in very few satellite locations from radio-collared wolverines, indicating

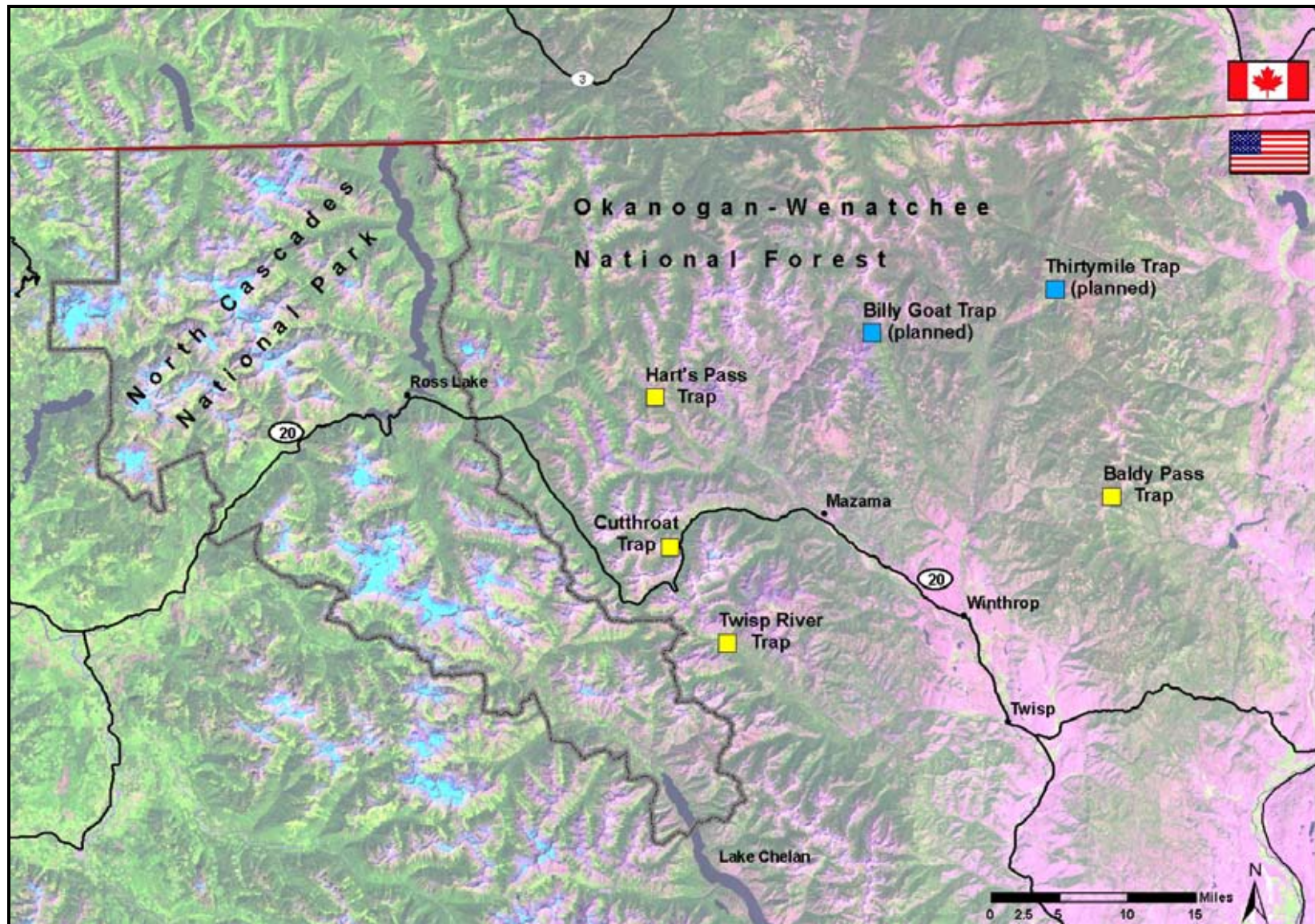


Figure 3. General extent of the North Cascades Wolverine Study Area showing locations of the 4 wolverine live-traps operated from January through March 2007. The Baldy Pass trap was only used during this year's field season, whereas the other 3 traps were also used last year. We plan to build 2 additional traps near the Billy Goat and Thirtymile trailheads during the fall of 2007.

that a longer duty cycle was needed to obtain a sufficient number of high-quality locations to investigate habitat use by wolverines. To correct these problems, we programmed satellite transmitters used this year to be “on” for 48 hr and “off” for 24 hr, and to transmit a signal every 60 sec while on. The VHF transmitters were programmed to be on continuously. The satellite transmitters have a battery life of 4 months, the VHF transmitters, 12 months.

The satellite transmitters provide general location and movement data collected remotely via an internet-based connection to the Argos Data Collection System. The VHF transmitters enable us to obtain fine-scale location data when possible, to locate natal and maternal dens of reproductive females, and to locate radio-collars if they are removed prematurely by the animal.

To obtain additional information on wolverines in our study area, we installed remote camera stations baited with deer carcasses near the Hart’s Pass and Twisp River traps. A Trailmaster 500 was used at the Hart’s Pass trap, and a Trail Watcher S600 was used at the Twisp River trap.

Results

We operated the Baldy Pass trap for a total of 46 nights from February 2 to March 28, 2007 (Table 1). We found no evidence of visitation by wolverines to the Baldy Pass trap, and none were captured in that trap. The trap was visited often by martens, however, and a marten was trapped and released on 2 occasions. We operated the Twisp River trap for a total of 52 nights from January 16 to March 30, 2007. Two wolverines were each captured twice at the Twisp River trap (Table 2). This trap was also visited often by martens, and a bobcat was captured and released on 4 occasions. We operated the Cutthroat trap for a total of 62 nights between

Table 1. Trapping results for 4 wolverine live-traps operated in the northeastern Cascade Range during the winter of 2006/07.

Trap	Trap Nights	Wolverine Captures	Non-Target Captures
Baldy Pass	46	0	2 marten
Cutthroat	62	1 (escaped)	1 marten
Hart's Pass	20	1	0
Twisp River	52	4	4 bobcat
Total	180	6	7

Table 2. Capture data and measurements for 3 wolverines radio-collared in the northeastern Cascade Range during the winter of 2006/07.

Capture Date	Trap	Name	Sex	Estimated Age	Weight (kg)	Length (cm)	Ear Tag Color
January 24	Twisp	Chewbacca	M	2-4	13.6	112	blue
February 11	Twisp	Xena	F	1-2	8.0	101	red
February 14	Harts	Melanie	F	2-3	9.6	100	yellow
March 17	Twisp	Chewbacca	M	2-4	14.6	112	blue
March 26	Twisp	Xena	F	1-2	8.0	101	red

January 9 and March 25, 2007. We captured a wolverine (probably Chewbacca) in this trap on March 22 but he escaped by pushing the lid open before we got to the trap. This trap was also visited often by martens, and a marten was trapped and released on 1 occasion. We operated the

Hart's Pass trap for a total of 20 nights from January 31 to March 1, 2007. Safety concerns resulting from a large rock slide across the Hart's Pass road prevented snowmobile access to the trap, and limited our ability to operate the trap this winter. One wolverine was captured at the Hart's Pass trap (Table 2).

On January 23, 2007, we captured a young male wolverine (Chewbacca) in the Twisp River trap and recaptured him at the same trap on March 17, 2007 (Table 2). We fitted him with a refurbished radio-collar at first capture, and replaced it at his second capture with a new-design collar that was smaller and lighter than last year's (Figure 4). Between January 23 and July 13, 2007, we obtained 80 high-quality locations for Chewbacca, resulting in an activity area of approximately 730 mi²; about 90% of his activity area overlapped that of Xena's (Figure 5). Note that an activity area does not represent a home-range estimate. We created 100% minimum convex polygons around all data in Argos location classes 1-3 to delineate activity areas; the estimation of home ranges requires careful data screening and more rigorous analytical procedures. Data on the areal extent of wolverine activity areas are presented here solely to provide a general idea of spatial use by our study animals.

On February 11, 2007, we captured a young, nulliparous female wolverine (Xena) in the Twisp River trap, and recaptured her in the same trap on March 26, 2007 (Table 2). We fitted her with a refurbished radio-collar from last year's field work at her first capture, and replaced it at her second capture with a new-design collar (Figure 4). From February 11 to July 31, 2007 we obtained 120 high-quality satellite locations for her. Her "activity area" was approximately 760 mi² (Figure 5). This area centered on the southeast portion of North Cascades National Park and

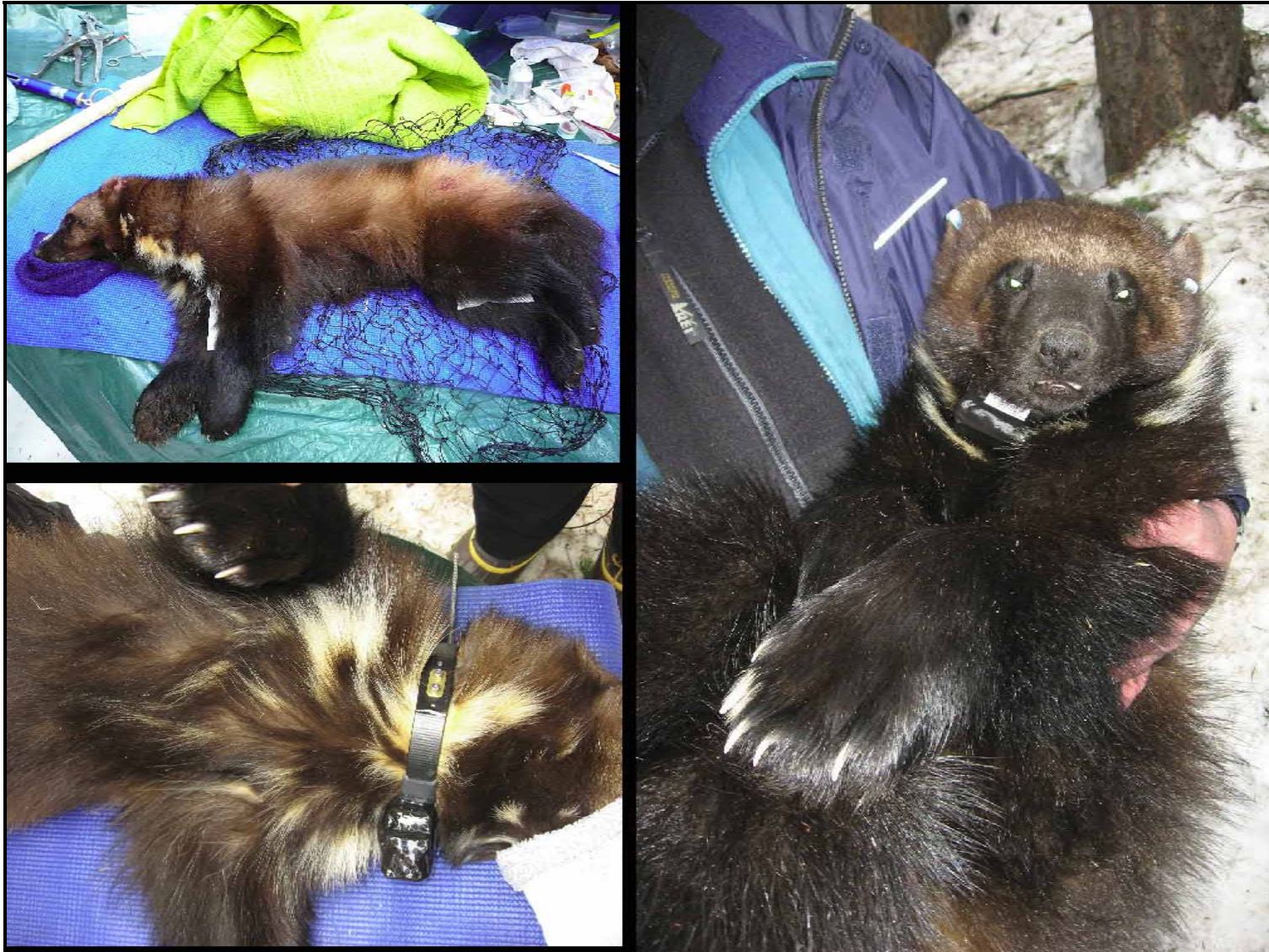


Figure 4. New study animals captured during the winter of 2006/07; Xena, a juvenile female, recently immobilized (upper left) and wearing our new smaller and lighter radio-collared device (bottom left); and Chewbacca, a young male (right), ready to be returned to the trap for full recovery prior to release (note the blue ear tags).

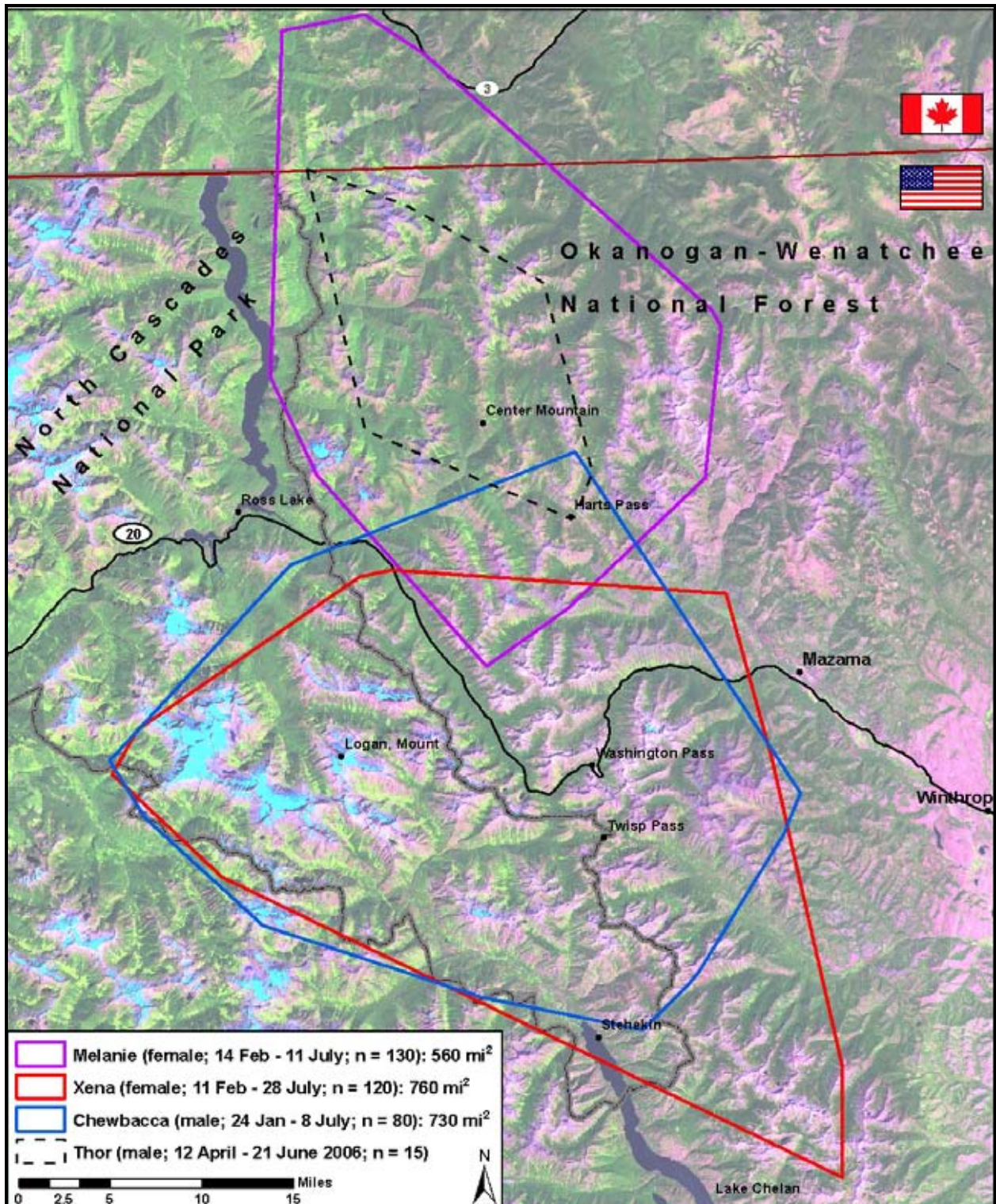


Figure 5. Activity areas (not home ranges) of 3 wolverines monitored during the winter of 2006/07; Thor's partial activity area based on only 15 locations from 2005/06 is also shown. Activity areas are 100% minimum convex polygons delineated using Argos satellite data in location classes 3 (<150 m), 2 (150-350 m), and 1 (350-1,000 m) for the dates indicated. The background image is Landsat TM Bands 543. These are preliminary results for information only, and should not be cited or used for any other purpose.

the adjacent Lake Chelan-Sawtooth Wilderness and North Cascades Scenic Highway Corridor of the Okanogan-Wenatchee National Forests.

On February 14, 2007, we captured a young female wolverine (Melanie) in the Hart's Pass trap. We originally captured her on February 10, 2006, but her radio-collar malfunctioned last year and detached prematurely 1 week later. We knew her identity, because she was still wearing 1 yellow ear tag. We fitted her with a new-design collar and obtained 130 high-quality locations for her from February 14 to July 31, 2007, resulting in an activity area of approximately 560 mi² (Figure 5). Her activity area was centered in the western half of the Pasayten wilderness on the Okanogan-Wenatchee National Forest, and included parts of the North Cascades Scenic Highway Corridor, and Manning Provincial Park in British Columbia, Canada.

A behavioral trait we observed in our study animals was the tendency to travel along more or less circular or "figure-eight" routes within a large portion of their activity areas over relatively short periods of time (generally <2 weeks), often returning close to their starting point. As other researchers have speculated, such routes may reflect the most efficient way to mark territories and/or locate ungulate carcasses during the winter, or they may have some other function.

Examples of this behavior for all 3 of our study animals are presented in Figure 6. From March 17 to March 27, 2007, Melanie moved at least 65 mi in 10 days, including a movement of 8 mi during a 4-hr period (Figure 6a); from April 14 to April 23, 2007, Xena moved at least 86 mi in 9 days, including a movement of 20 mi during a 14-hr period (Figure 6b); and from April 25 to May 7, 2007, Chewbacca moved at least 94 mi in 12 days, including a movement of 16 mi during a 13-hr period (Figure 6c).

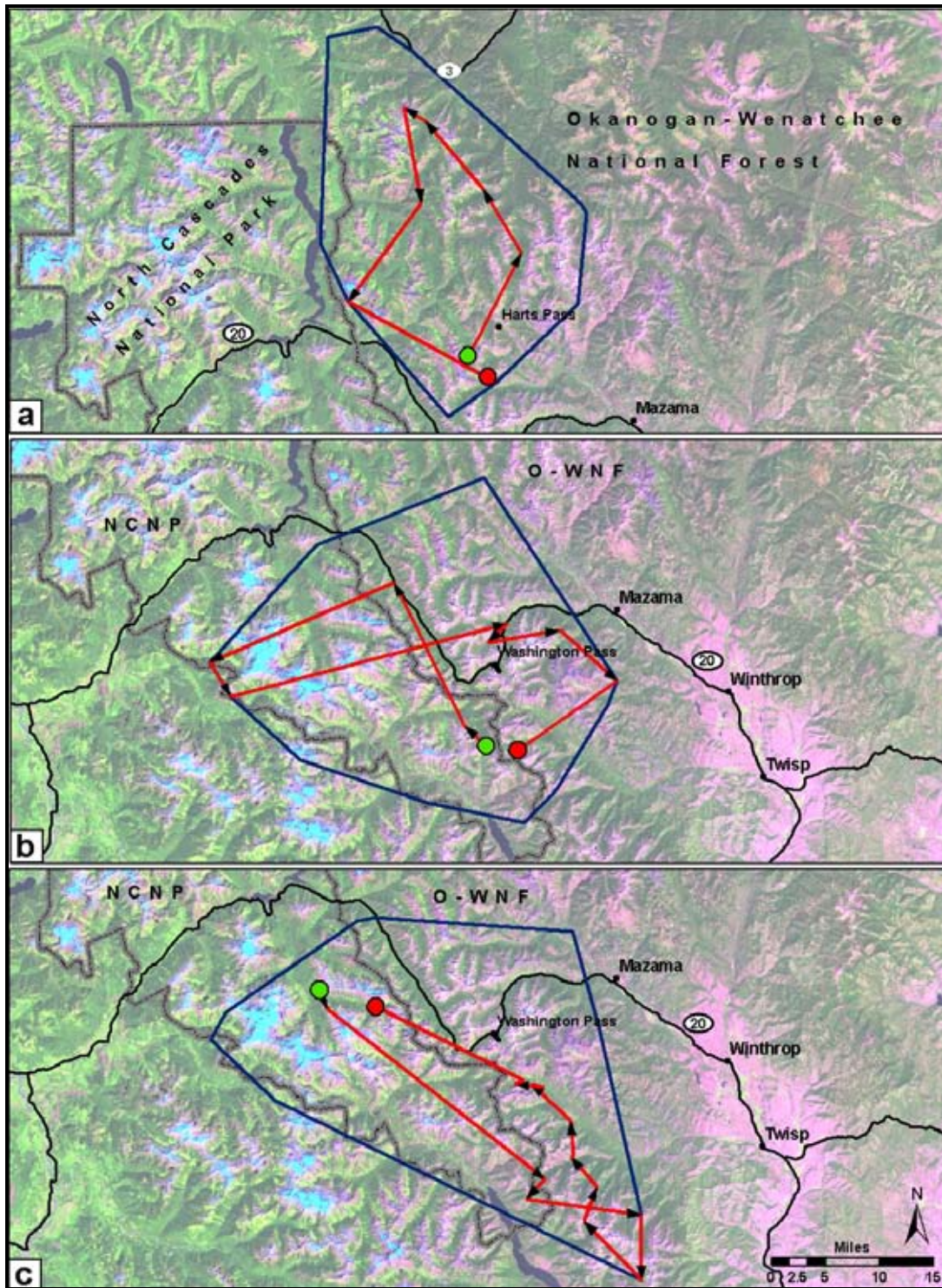


Figure 6. Examples of short-term circular or “figure-eight” travel routes used by our study animals in 2007. Blue polygons are activity areas, red lines are travel routes, arrows show the direction of travel, green dots are the starting points and red dots are the end points. Figure 6a shows Melanie’s movements over a 10-day period in late March; Figure 6b shows Xena’s movements over a 9-day period in late April; and Figure 6c shows Chewbacca’s movements over a 12-day period in late April and early May. See text for additional details. These are preliminary results for information only, and should not be cited or used for any other purpose.

To investigate elevation zones that may be preferred by our study animals, we used ArcGIS software to place a circular buffer 1.2 mi² in size (1-km radius) around all wolverine locations in Argos classes 1-3, and calculated the percent occurrence of the following elevation bands within the buffers: $\leq 4,400$ ft, 4,401–5,900 ft, 5,901–7,400 ft, and $> 7,400$ ft. We then compared those results with the percent occurrence of these elevation bands in each wolverine activity area. We selected these elevation bands based on our field observations and professional judgements solely to provide a preliminary assessment of habitat use by wolverines along an elevational gradient; selection of elevation zones and associated habitat conditions by wolverines will be analyzed in more detail in subsequent reports and publications.

For all 3 study animals, the low-elevation band ($\leq 4,400$ ft) was used at levels below availability, the moderate-elevation band (4,401–5,900 ft) was used at levels comparable to availability, the high-elevation band (5,901–7,400 ft) was used at levels exceeding availability, and the highest elevation band ($> 7,400$ ft) was used at levels comparable to availability (Table 3). In our study area, treeline generally occurs at elevations ranging from 6,000 to 7,000 ft. suggesting that, in the North Cascades, wolverines may select relatively high-elevation habitats at or near treeline (Figure 7).

Melanie had grown in length by 4.4 inches and increased in weight by 2.2 lb between February 11, 2006 and February 14, 2007. Our physical examination of her on February 14, 2007 also revealed that she was pregnant (distended nipples and at least 1 fetus felt during palpation). Over a 17-day period in late February and early March, we obtained 5 high-quality locations for Melanie in a localized area near Center Mountain (7 mi NW of Hart's Pass), which indicated that

Table 3. Composition of wolverine activity areas by elevation band compared to the area of buffered wolverine locations (1.2-mi² circle around Argos telemetry points in location classes 1–3) for each study animal; overlapping buffers were dissolved into a single use area. We used a 30-m DEM (digital elevation model) for all calculations. These are preliminary results for information only, and should not be cited or used for any other purpose.

Elevation bands used by each study animal	Activity area (%)	Area of buffered locations (%)
Melanie (N = 130)		
<4,400 ft	17	8
4,401 – 5,900 ft	50	46
5,901 – 7,400 ft	31	43
>7,400 ft	2	3
Xena (N = 120)		
<4,400 ft	25	17
4,401 – 5,900 ft	36	39
5,901 – 7,400 ft	35	40
>7,400 ft	4	4
Chewbacca (N = 80)		
<4,400 ft	26	19
4,401 – 5,900 ft	38	38
5,901 – 7,400 ft	33	40
>7,400 ft	3	3

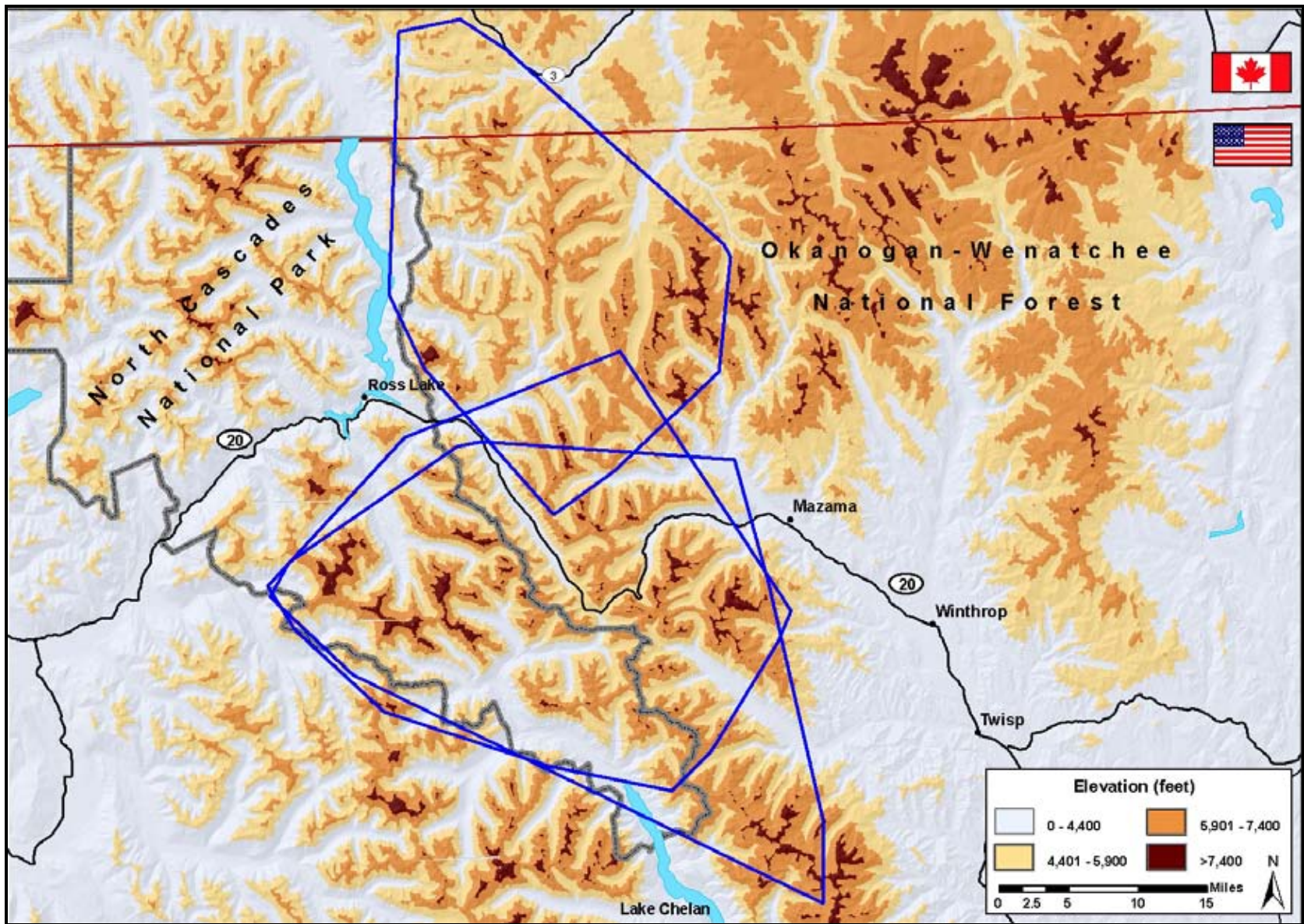


Figure 7. Wolverine activity areas overlain on the 4 elevation bands we selected for preliminary analyses of elevational use by wolverines. These are preliminary results for information only, and should not be cited or used for any other purpose.

she may have established a natal den. However, soon thereafter, she apparently left that site and did not return. We arranged for several helicopter flights during the spring of 2007 to verify reproduction by Melanie by tracking the VHF signal and visually observing her on the ground accompanied by kits. We flew on May 10, 2007, but could not locate her VHF signal or her tracks, even though we had a high-quality satellite location for her on the morning of the flight. We used both hand-held and externally mounted telemetry antennas without success, despite ground-testing our equipment prior to the flight. We flew again on June 25, 2007 incidental to mountain goat surveys being conducted in the same area by the Washington Department of Fish and Wildlife. During this flight, we were able to locate Melanie's VHF signal and narrowed her location to a single sub-drainage. However, we could not pinpoint her location and were unable to obtain a visual observation. We discovered that the helicopter occasionally produced extreme interference using either hand-held or external antennas, particularly while hovering; consequently, we adjusted our flight pattern to compensate for this problem. Even with these adjustments, we could not obtain an accurate bearing on the source of the signal. Signal interference, combined with significant tree cover and rugged terrain makes visually locating study animals from the air during the snow-free season extremely difficult. Thus, we concluded that future telemetry flights to locate radio-collared wolverines in forested terrain should only be attempted when there is adequate snow cover for locating tracks from the air. We also plan to explore ways to improve reception of VHF signals during telemetry flights, including different configurations for the antenna on the radio-collar, and different configurations for telemetry equipment on the aircraft. Although our location data suggest that Melanie may have lost her kits, such data can be misleading (J.P. Copeland, U.S. Forest Service, personal communication). Consequently, at the present time, Melanie's reproductive status in 2007 remains unknown.

On April 13, 2007, we obtained 8 photographs of a wolverine at the remote-camera station near the Hart's Pass trap (see photo on cover page). Green ear tags and the radio-collar he was wearing verified that it was Thor, a young male wolverine we captured last year at Hart's Pass on April 11, 2006. Prior to obtaining this photo, we were unable to gather any information about Thor's status during the winter of 2006/07. However, these photos suggest that if we had been able to maintain the Hart's Pass trap throughout the winter, we probably would have captured Thor again this year.

Discussion

Because of the substantial logistical challenges involved in conducting a radio-telemetry study of wolverines in the North Cascades of Washington, the primary objectives of the 2-year pilot study we conducted during the winters of 2005/06 and 2006/07 were to determine if we could: (1) safely and effectively live-trap and radio-collar wolverines in the North Cascades of Washington, and (2) use Argos satellite telemetry to investigate their distribution, movement patterns, habitat use, and reproductive ecology. The results from the first year of our pilot study last winter were both encouraging and disappointing. By placing the traps in strategic locations, we were able to capture and radio-collar 2 wolverines, including a juvenile female and a sub-adult male, but we were unable to obtain strong data sets using Argos satellite telemetry. Problems involved both the design of the radio-collar and issues related to obtaining satellite locations in our study area. One collar malfunctioned soon after being deployed, and dropped off before we could collect more than a few locations and, although the second collar operated for several months, it failed to provide an adequate number of high-quality satellite locations. The mechanical failure was the manufacturer's fault, and they subsequently redesigned their collars to correct that problem.

However, we concluded that our failure to obtain a large number of high-quality satellite locations from the other collar was probably due to the high topographic relief of our study area, and resulting difficulties in obtaining high-quality satellite locations during only 5 hr each day.

Based on our experiences and on recommendations from colleagues, we modified the duty cycle on our collars so that the transmitters were seeking satellite uplinks continuously during a 48-hr period, and then turned themselves off for 24 hr to extend the battery life to 4 months; we also reduced the width and thickness of the strap and eliminated the timed-release mechanism to reduce the size and weight of the radio-collars, and to reduce the possibility of mechanical failures. With these modifications, we achieved both of our objectives this year. We captured 2 new wolverines, recaptured the juvenile female from last year, and documented the first known reproductive event for wolverines in Washington state. We captured wolverines 6 times in 180 trapnights for a capture rate of 1 wolverine per 30 trapnights, which is higher than the capture rate reported by Copeland (1996) in Idaho (1 wolverine per 47 trapnights). We were unable to re-capture the sub-adult male from last year, but that was probably due to our inability to maintain the Hart's Pass trap throughout the winter. All 3 of our new-design radio-collars remained on our wolverines throughout the winter, and generated 80-130 high-quality locations for each study animal during a 5-6 month period (Figure 5).

With these data, we were able to delineate activity areas for 3 wolverines, which indicate that Chewbacca and Xena, and probably Thor and Melanie, represent reproductive pairs (Figure 5). Although we do not know the fate of Melanie's offspring, we have documented that reproduction is occurring among Washington wolverines. Furthermore, during the past 2 winters, the activity

areas for all 4 of our study animals were located primarily in Washington, demonstrating that there is a resident population of wolverines in the state. Clearly, recent verifiable wolverine occurrence records in Washington did not simply represent Canadian wolverines that occasionally wander into Washington; rather, our results provide support for the current range of wolverines described by Aubry et al. (2007). However, the extent and location of the activity areas we delineated suggest that a relatively small number of wolverines may be capable of establishing home ranges within the state. The conservation of wolverines in Washington will depend on reliable knowledge of their distribution, population status, and habitat relations. This knowledge can only be gained by long-term field research; thus, it is essential that we continue this research and find ways to expand the scope of our activities beyond the boundaries of our current study area.

Future Research

During the summer of 2007, we are working with volunteers at Conservation Northwest in Bellingham, WA to conduct remote-camera surveys for wolverines and other forest carnivores in the northwestern portion of North Cascades National Park, west of Ross Lake. We are hopeful that this work will document the presence of wolverines in other areas of northern Washington, and enable us to expand our study area farther west of the Cascade Crest. We plan to continue our trapping efforts next year using all 4 existing traps, and expand our capture opportunities by constructing wolverine traps along the southeastern edge of the Pasayten wilderness near the Billy Goat and Thirtymile trailheads (Figure 3).

There is growing evidence that wolverine distribution throughout their holarctic range is determined primarily by the availability of suitable denning habitat. In montane regions, denning habitat appears to be related to a combination of relatively deep snow cover near treeline that persists into the spring for natal dens, and remoteness from human activities (Aubry et al. 2007; Magoun and Copeland 1998). Thus, one of the primary objectives of our future research on wolverines in Washington will be to locate natal and maternal dens, and document reproductive attainment. Although, GPS radio-collars provide substantially better location data than Argos collars, we used Argos collars during the pilot study because location data could be obtained remotely via satellite, and we were uncertain whether we would be able to reliably recapture wolverines and download GPS location data. However, our recapture rate this year suggests that GPS collars may be a viable alternative to Argos collars for tracking wolverine movements in Washington. Thus, we plan to experiment with at least 1 GPS collar next year to determine if we can expand our research capabilities, and improve our ability to locate the natal and maternal dens of reproductive females.

Acknowledgments

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Literature Cited

- Aubry, K.B., K.S. McKelvey, and J.P. Copeland. 2007. Distribution and broad-scale habitat relations of the wolverine in the contiguous United States. *Journal of Wildlife Management* 71:in press.
- Banci, V. 1994. Wolverine. Pages 99-127 in L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski, tech. eds. *The scientific basis for conserving forest carnivores: American marten, fisher, lynx and wolverine in the western United States*. USDA Forest Service. General Technical Report RM-254, Fort Collins, CO.
- Copeland, J.P. 1996. *Biology of the wolverine in central Idaho*. Thesis, University of Idaho, Moscow.
- Copeland, J.P., E. Cesar, J.M. Peek, C.E. Harris, C.D. Long, and D.L. Hunter. 1995. A live trap for wolverine and other forest carnivores. *Wildlife Society Bulletin* 23:535-538.
- Copeland, J.P., J.M. Peek, C.R. Groves, W.E. Melquist, K.S. McKelvey, G.W. McDaniel, C.D. Long, and C.E. Harris. 2007. Seasonal habitat associations of the wolverine in central Idaho. *Journal of Wildlife Management* 71:in press.
- Krebs, J., E.C. Lofroth, and I. Parfitt. 2007. Multi-scale habitat use by wolverines in British Columbia, Canada. *Journal of Wildlife Management* 71:000–000.
- Magoun, A.J., and J.P. Copeland. 1998. Characteristics of wolverine reproductive den sites. *Journal of Wildlife Management* 62:1313-1320.
- Squires, J.R., J.P. Copeland, T.J. Ulizio, M.K. Schwartz, and L.F. Ruggiero. 2007. Sources and patterns of wolverine mortality in western Montana. *Journal of Wildlife Management* 71:000–000.