JASON WILMOT

The wolverine is one of the least studied carnivores in North America, particularly in the contiguous United States where it occurs at the southern extent of its range. This project documented the distribution of wolverines in the eastern portion of Yellowstone National Park and adjoining areas of national forest and their population characteristics, habitat requirements, and movements. Here, Dan Tyers of the US Forest Service displays the attributes of wolverine F3.

Wolverines in Greater Yellowstone

Kerry Murphy, Jason Wilmot, Jeff Copeland, Dan Tyers, and John Squires

This article is an adaptation of "Wolverine Conservation in Yellowstone National Park," a 2011 report on a four-year research project funded by the Yellowstone Park Foundation. Additional funding or indirect support was provided by the Gallatin National Forest, the Greater Yellowstone Coordinating Committee, the Rocky Mountain Cooperative Ecosystems Studies Unit, the Rocky Mountain Research Station, the Shoshone National Forest, the Northern Rockies Conservation Cooperative, the Wildlife Conservation Society, the Wolverine Foundation, Wolverine World Wide, Inc., the Wyoming Game and Fish Department, and Yellowstone National Park. The complete report is available at the Greater Yellowstone Science Learning Center, www.greateryellowstonescience.org.

Wolverines are widely distributed in Canada and Alaska, but have been extirpated from most of their historical range in the contiguous United States, where they may currently reside only in higher elevation habitats in Idaho, Montana, Washington, and Wyoming (Aubrey et al. 2007). These populations are small and isolated due to their naturally fragmented habitat (Aubry et al. 2007; Ruggerio et al. 2007), large spatial requirements, and infrequent exchange of wolverines between mountain ranges (Cegelski et al. 2003; Kyle and Strobeck 2001, 2002). These attributes make the wolverine especially vulnerable to extirpation (Copeland and Whitman 2003).

The Wildlife Conservation Society (WCS) has been studying wolverines in the western and southern portion of the greater Yellowstone ecosystem (Inman et al. 2007, 2008). The objectives of our project were to document (1) the distribution of wolverines in the eastern portion of Yellowstone National Park and adjoining areas of national forest; (2) their population characteristics, including reproduction, survival, sources of mortality, and food habits; (3) their habitat

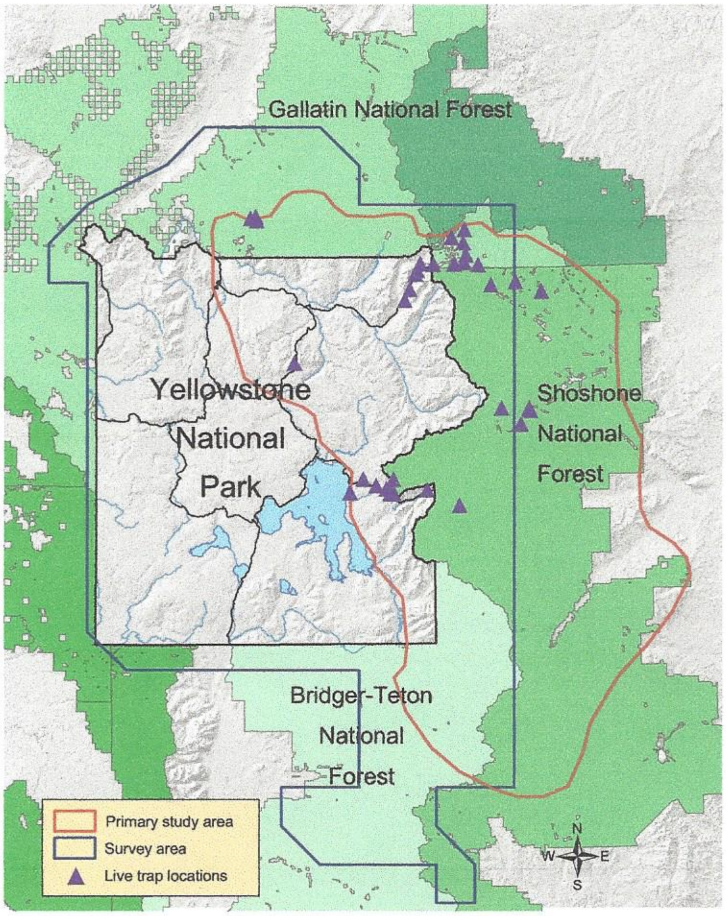

Figure 1. Primary Absaroka-Beartooth study area with locations of wolverine live traps maintained during winters 2005–2006 to 2008–2009, and the area surveyed for wolverine tracks using a helicopter, 2008–2009.

requirements, particularly those related to natal and maternal denning; and (4) their movements, including any that provide connectivity with populations in other ecosystems.

Live trapping wolverines

To apply monitoring devices and physically examine wolverines, we built 33 log box traps (Copeland et al. 1995) and installed them along eight trap lines in our core study area, which covered about 13,000 km^2 (5,019 mi^2) (fig. 1). Three of the trap lines were in Yellowstone National Park, three in the Gallatin National Forest, and two in the Shoshone National Forest. The traps were located at elevations ranging from 2,097 to 2,870 m, and were typically within 200 m of hiking trails or roads open to wheeled vehicles or snowmobiles. Each trap was baited with a skinned beaver carcass obtained from Montana fur trappers and had a transmitter that signaled up to 29 km (18 mi) distant when the trap was triggered. Project personnel checked for signals 1–4 times per day and the traps themselves a minimum of every 3–4 days.

During the four winters (2005–2006 to 2008–2009) of our project, the traps caught two adult males, one subadult male, and one subadult female a total of seven times. Three of the wolverines were first captured near the Absaroka-Beartooth Wilderness, Gallatin National Forest, and one near Sylvan Pass in Yellowstone. The wolverines were anesthetized, weighed, and measured; their vital signs were monitored, and blood, skin, and ectoparasite samples were collected. The two adult males weighed 14.2–14.6 kg (31.2–32.1 lbs). Each wolverine was fitted with an ear tag and equipped with an intraperitoneal implant (VHF transmitter) and a GPS/VHF radio collar.

Estimating home ranges

We conducted aerial surveys to locate the collared wolverines at approximately 10-day intervals and collect information on home ranges, movements, spatial organization, survival, and habitat use. In addition to the four wolverines we had collared, we monitored one female and two males that immigrated into our study area after WCS biologists had radio-marked them: two captured in the western portion of the Yellowstone ecosystem and one near Togwotee Pass in the Shoshone National Forest. The female immigrant, captured as a young kit in 2006 in the northern portion of the Gallatin Range, had dispersed into the Thorofare Region by April 2007.

Four of the seven wolverines we monitored resided north of Yellowstone National Park, principally in the Absaroka-Beartooth Wilderness, and three in the Thorofare Region (southeast Yellowstone National Park, and the Teton and Washakie Wilderness areas). Two of the wolverines were monitored in 2006, five in 2007, three in 2008, and five in 2009. A wolverine we captured and collared in March 2006 was legally harvested the following February by a Montana trapper; another collared wolverine we could locate only once, shortly after its capture in March 2007.

During the February–May denning period, we attempted to locate the two female wolverines at least once a day over periods of three days, weather permitting. Born in February or March, 2006, they would have been able to reproduce for the first time in 2008; however, no evidence of denning behavior or kits was observed.

The overlap between our resident male and female wolverines was substantial, similar to that found in other studies (Magoun 1985; Inman et al. 2007; Copeland 1996). Sizes of home ranges for the five wolverines for which we obtained sufficient locations are estimated in Table 1. These ranges are

Jason Wilmot and project technician Ben Jimenez display the attributes of collared wolverine M1 in 2006.

Jason Wilmot performs a physical exam of wolverine M1 at its capture site in 2006.

larger than those found in other studies using the same methods of estimation (Hornocker and Hash 1981, in northwest Montana; Inman et al. 2007, in the western and southern portion of the GYE). Habitat, food availability, topography, and the availability of den sites may influence home range sizes (Gardner 1985; Hornocker and Hash 1981; Krott 1959). Because neither females nor males show much intra-sex overlap (Magoun 1985; Inman et al. 2007, Hornocker and Hash 1981), our resident wolverines may have used larger ranges because they were unconfined by same-sex individuals with adjacent ranges.

With WCS biologists, we cooperatively monitored the male wolverine they captured in December 2008 near Togwotee Pass for two-and-a-half months in upper Blackrock Creek, upper Spread Creek, and the Gros Ventre River watershed. In April 2009, the WCS documented his movement into the Wind River Range and onto high sagebrush steppe in central Wyoming. Later that spring he crossed Interstate 80, the Medicine Bow Mountains (south-central Wyoming), and entered northern Colorado, the first confirmed wolverine in that state in 90 years. As of January 2011, he was being jointly monitored by the WCS and the Colorado Division of Wildlife.

Estimated home ranges for the five wolverines for which we obtained sufficient locations are larger than those found in other studies.

Evaluating wolverine habitat models

We evaluated the ability of models developed by Copeland et al. (2010) and Brock et al. (2007) to predict wolverine occurrence at a large spatial scale (major watershed) in our study area and identify areas that were unsuitable habitat. Copeland et al. found that the wolverines' fundamental niche was defined by the coverage of April 24–May 15 snowpack and ambient temperature. They found high concordance between these variables and the distribution of wolverine radio locations and natal den sites documented for the Northern Hemisphere, including those from the Wildlife Conservation Society and our study area. Brock et al. determined that elevation, ruggedness, conifer cover, snow depth, forest edge, and road density identified habitat selected by radio-marked wolverines on two Wildlife Conservation Society study areas in south-central Montana, western Wyoming,

Table 1. Average and range of annual estimated wolverine home ranges, Absaroka-Beartooth project, 2006–2009.

		Minimum Convex Polygon		95% Fixed-Kernel	
Wolverines	**# of Locations**	**Average**	**Range**	**Average**	**Range**
Males	24 GPS, 128 VHF	908 km^2	446–1,268 km^2	1,815 km^2	1,355–2,501 km^2
(n=3)		(351 mi^2)	(172–490 mi^2)	(701 mi^2)	(523–966 mi^2)
Females	124 GPS, 107 VHF	447 km^2	261–782 km^2	893 km^2	348–1,673 km^2
(n=2)		(173 mi^2)	(100–302 mi^2)	(345 mi^2)	(134–646 mi^2)

GARDINER RANGER DISTRICT

Wolverine F3 revisiting a live trap which did not capture her, 2008. Remote cameras like the one that took this photo were used to record wolverine activity at the live traps. Each trap was baited with a skinned beaver carcass obtained from Montana fur trappers and had a transmitter that signaled up to 29 km (18 mi) when the trap was triggered.

and southeast Idaho. They extended model predictions to the entire northern and southern US Rocky Mountains, including our core study area.

To compare the efficiency of the two models, we plotted 388 wolverine radio-locations from our entire project area and calculated the percent of points that fell within predicted habitat under each model. We also constructed a single 100% minimum convex polygon using the aggregate radio locations and calculated the enclosed habitat for each model coverage. Although there was substantial overlap in the maps resulting from the two models (figs. 2A and B), they differed in that the Copeland model included much of the Yellowstone caldera (including Yellowstone Lake), the Pitchstone Plateau, and the Beartooth Plateau where late-season snowpack was persistent, while the Brock model encompassed more lower -elevation areas (<2,450 m; 8,000 ft).

At a large spatial scale, an efficient model would maximize the number of telemetry points that fell within predicted habitat and minimize the acreage of predicted habitat. By those criteria, the Brock model was slightly more efficient for our study area, probably because it was developed using data from the Yellowstone ecosystem. It accounted for 378 (97%) of our wolverine radio locations and encompassed 77% of the minimum convex polygon constructed from the aggregate locations. The Copeland niche model, developed using a global data set, accounted for 368 (95%) of points and 84% of the minimum convex polygon.

Surveying for wolverine tracks

We also conducted three replicated surveys by helicopter for wolverine tracks in 2008 and 2009, covering a larger area (16,400 km^2, 6,330 mi^2) than our core study area. Although more expensive than an airplane, the use of a helicopter enabled us to hover and closely inspect tracks where windy conditions were common and terrain was often highly incised and extensively covered with conifers. We partitioned the study area into 10 km x 10 km cells and included in the survey only cells with > 25% overlap with areas that had May snowpack for at least one year from 2000 to 2006. We surveyed every other cell (69 to 74 total) by flying transects along the cell diagonals (figs. 3A and B). This pattern allowed us to survey continuously without having to fly over non-survey cells. Each replicate averaged 13.2 hours of flight time over three days, but poor weather conditions typically precluded work on consecutive days. We detected a total of 13 sets of wolverine tracks, nearly all in areas where we had wolverine radio locations (fig. 4).

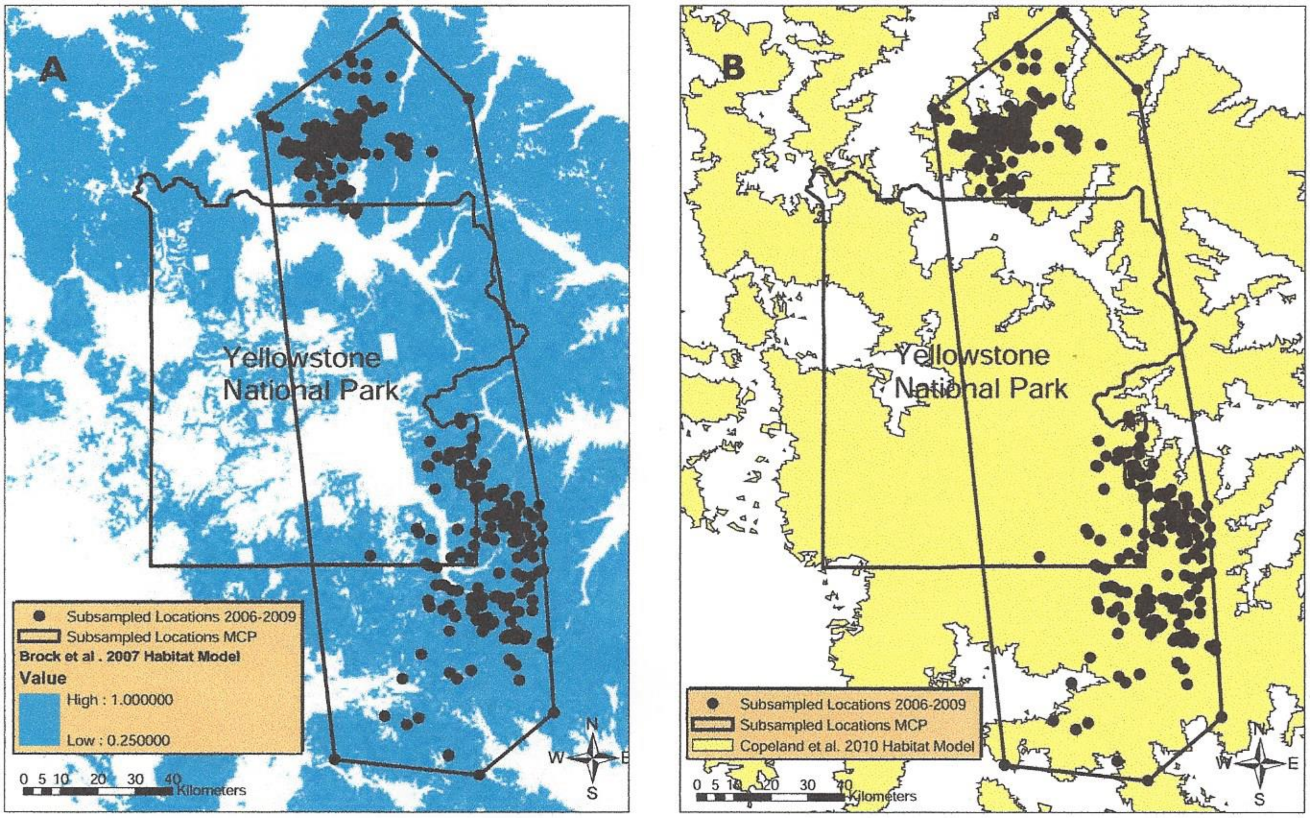

Figure 2. Coverage of wolverine habitat predicted by the (A) Brock et al. (2007) and (B) Copeland et al. (2010) models, as compared to a minimum convex polygon formed from 388 radio-locations for Absaroka-Beartooth wolverines, 2006–2009.

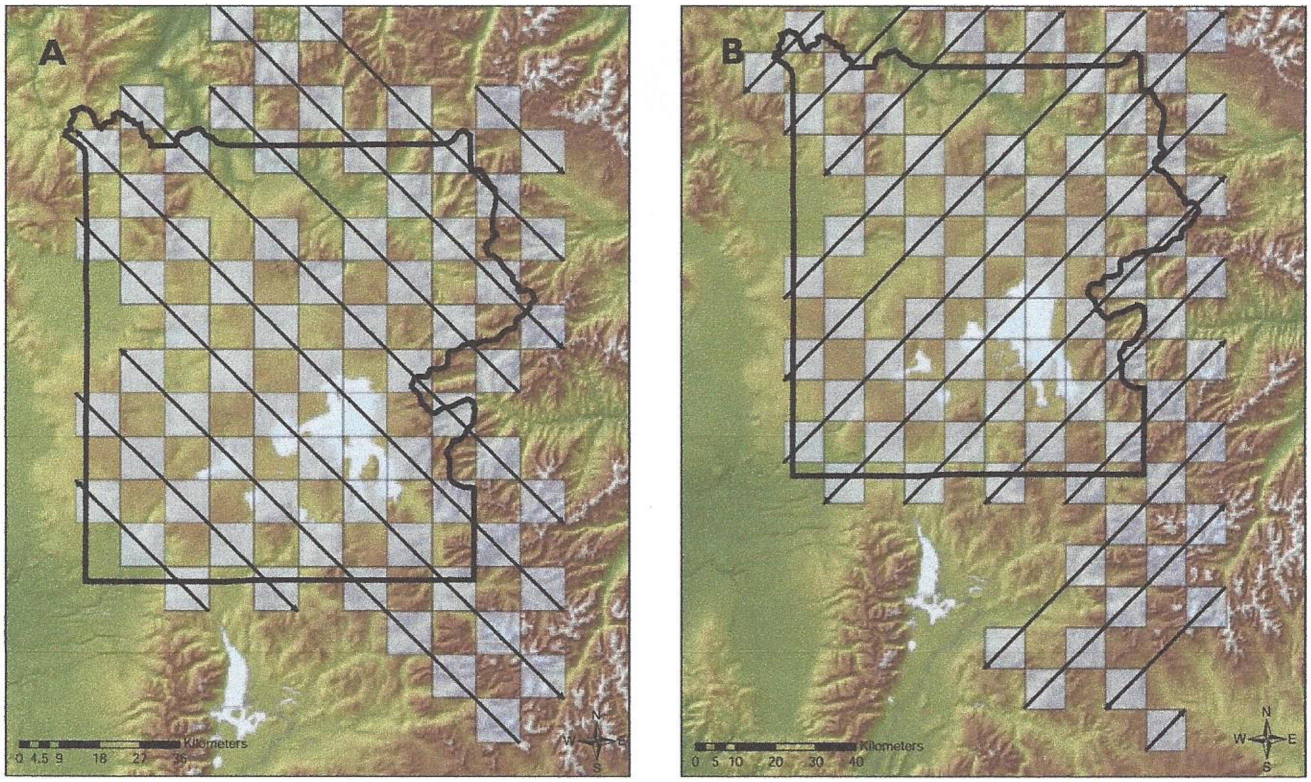

Figure 3. Survey cells (10 km x 10 km) and transect lines for two helicopter surveys for wolverine tracks completed during February–March (A) and March–April (B) 2009, Yellowstone National Park and vicinity.

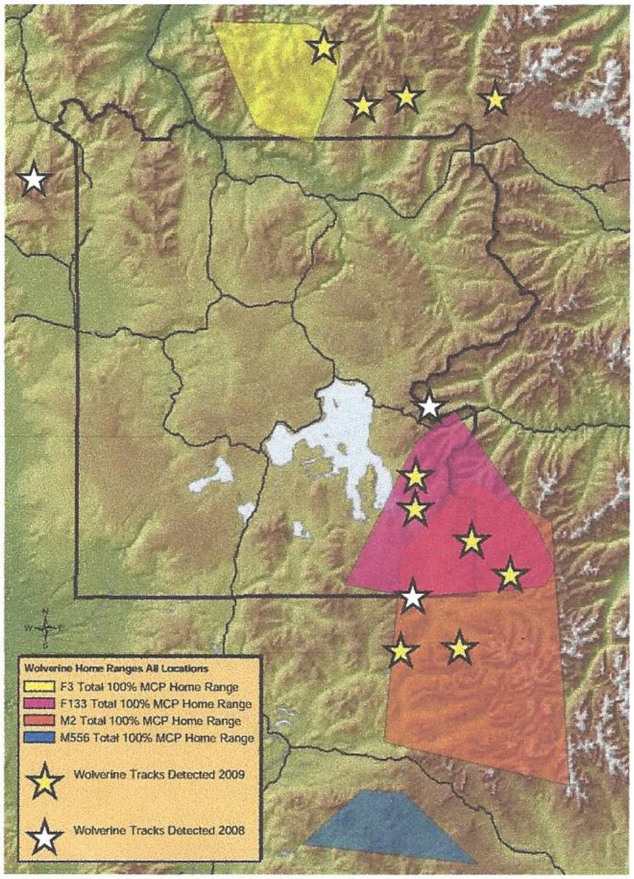

Figure 4. Distribution of wolverine tracks detected in Yellowstone National Park and vicinity, 2008–2009, during helicopter surveys. F133 and M556 were originally captured and radio-instrumented by the Wildlife Conservation Society's Greater Yellowstone Wolverine Program.

Wolverine distribution in Yellowstone and vicinity

Resident wolverines in our study area were largely limited to high-elevation (> 2,450 m; 8,000 ft) mountainous areas with the persistent snow cover needed to maintain the warmth and security of offspring in reproductive dens during late winter and spring, and for compensating warm temperatures during the summer (Magoun and Copeland 1998; Aubry et al. 2007; Copeland et al. 2010). Although Hornocker and Hash (1981) found that wilderness and remote country were essential to wolverine population viability, wolverines may select these areas because of their physical characteristics rather than avoidance of anthropogenic activity (Copeland et al. 2007; Brock et al. 2007; Rowland et al. 2003; May et al. 2006; Krebs et al. 2007).

Despite sporadic sightings and recent models that suggest an abundance of suitable habitat (Brock et al. 2007; Copeland et al. 2010), wolverines are rare and limited in distribution throughout the park and in the national forests along its northeast, east, and southern boundaries. This conclusion was supported by our minimal capture results, and track surveys conducted on foot and from aircraft throughout the entire region also suggested a limited distribution. We documented resident wolverines only in the Absaroka-Beartooth Wilderness north of the park boundary and in the Thorofare region. The WCS documented wolverines with home ranges that extended into the park along the northwest and southwest boundaries (Inman et al. 2007) and were associated with well-established populations in the northern portion of the Gallatin Range, the Madison Range, and the Teton Range.

DYLAN BROWN

Project technician Ben Jimenez checks a live trap in Yellowstone National Park, 2006. Traps were checked at least every three to four days and remotely monitored using radio transmitters.

JIM WOOD

Project technicians maintain a live trap near Cooke City, Montana, in 2006. Traps were typically located within 200 meters of roads or hiking trails.

Wolverines are rare and limited in distribution throughout the park and in the national forests along its northeast, east, and southern boundaries.

We hypothesize that several factors account for the dearth of wolverines in our study area. The species experienced significant population declines throughout its range in the conterminous United States during late 1800s and early 1900s. Trapping, shooting, and poisoning of predators were widespread in the region, including in Yellowstone, through the 1930s (references in Schullery and Whittlesey 1999; Aubry et al. 2007). Following improved regulation of furbearer trapping and predator control, wolverine populations had partially recovered in northwest Montana by 1955, apparently because of immigration from Canada and adjacent Glacier National Park (Newby and Wright 1955). By 1963, wolverine breeding range extended into west-central and southwest Montana, including the Yellowstone region (Newby and McDougal 1963). Thus, wolverines in the ecosystem, particularly our study area, may still be recovering in numbers and improving in distribution.

Wolverine prey on rodents and other small mammals; they may attack large game, especially those that are physically weakened or bogged in deep snow, but most ungulate remains in their diet are usually from carrion (Magoun 1985). Wolverine numbers and distribution in our study area were apparently not strongly limited by the availability of carrion during winter. By travelling long distances and relying on its extraordinary sense of smell, the wolverine can detect carrion that is widely distributed (Hornocker and Hash 1981). Our two aerial winter surveys for ungulates, and our observations made incidental to wolverine surveys, suggested that adequate numbers of ungulates, primarily bighorn sheep, were available as a supply of carrion in most parts of our study area that appeared to lack resident wolverines.

Wolverines did not use areas of the park interior that support wintering elk and bison, such as the Firehole River corridor, Hayden Valley, and Pelican Valley, but the near absence of moose, elk, and bison in the extensive lodgepole pine and spruce-fir forests in the park interior could mean that winter food limitations currently preclude wolverine residency in those areas.

Implications for wolverine conservation

Because wolverines typically occur at low density and occupy habitat islands, wolverine populations in the northern US Rocky Mountains are likely to be genetically and demographically interdependent. Even at full capacity, wolverine habitat in the Yellowstone ecosystem would support too few female home ranges to maintain genetic viability unless there were genetic exchange with populations in peripheral mountain ranges (Cegelski et al. 2006; Brock et al. 2007). Ingress from habitat such as the Gallatin and Madison Ranges, or even areas outside the Yellowstone ecosystem, may be critical for wolverine persistence in Yellowstone.

Increasing temperature may degrade wolverine habitat quality and quantity in the conterminous United States during the 21st century, triggering reductions in the size of wolverine habitat patches and their connectivity (Schwartz et al. 2009; Copeland et al. 2010). Due to its importance for the security and thermoregulation of neonates, spring snow cover may limit the wolverine's distribution and abundance, yet this habitat component is declining across the species' geographic range due to global climate change (Aubry et al. 2007; Copeland et al. 2010). Reductions in the coverage of spring snow due to a warming climate have already occurred (Mote et al. 2005). Because it has some of the largest and most contiguous patches of wolverine habitat in the conterminous United States (Brock et. al. 2007; Copeland et. al. 2010), the Yellowstone ecosystem is likely to play an increasingly important role in the population dynamics and persistence of wolverine populations as the regional-scale coverage of spring snow declines.

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JASON WILMOT

We conducted three replicated surveys by helicopter for wolverine tracks in 2008 and 2009. The aerial survey design of this project can be broadly applied in the contiguous United States to document the distribution and abundance of wolverines.

JASON WILMOT

During this project, **Kerry Murphy** was a wildlife biologist with the Wildlife Resources Team of the Yellowstone Center for Resources. He was responsible for mid-sized (e.g., wolverine, Canada lynx) carnivore management and endangered species conservation. His career has also included work with mountain lions, gray wolves, and black bears. Kerry is currently a wildlife biologist employed by the USDA Forest Service, Bridger-Teton National Forest, in Jackson, Wyoming.

KERRY MURPHY

Jason Wilmot is the executive director of the Northern Rockies Conservation Cooperative in Jackson, Wyoming. He has been involved in wolverine research since 2000, on projects in Glacier and Yellowstone national parks and Mongolia.
Jeff Copeland was involved in wolverine research for 20 years as a research biologist for Idaho Fish and Game and the Forest Service's Rocky Mountain Research Station in Missoula, Montana, prior to retirement in 2010. He has led efforts to develop wolverine detection methodology, and wolverine ecology studies in central Idaho, western Wyoming, Glacier National Park, and Yellowstone National Park.
During this project, **Dan Tyers** was employed as a wildlife biologist by the USDA Forest Service in Gardiner, Montana. He holds a PhD in wildlife biology from Montana State University–Bozeman. Dan is currently the Greater Yellowstone Ecosystem Bear Management Coordinator for the USDA Forest Service.
John Squires is a research wildlife biologist at the Rocky Mountain Research Station, Forestry Sciences Laboratory in Missoula, Montana.

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