Management Plan for the

Conservation of Wolverines

in Idaho 2014–2019

Prepared by **IDAHO DEPARTMENT OF FISH AND GAME**

July 2014

Recommended Citation:

Idaho Department of Fish and Game. 2014. Management plan for the conservation of wolverines in Idaho. Idaho Department of Fish and Game, Boise, USA.

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Release of Wolverine F4, a study animal from the Central Idaho Winter Recreation/Wolverine Project, from a live trap north of McCall, 2011. Photo by Blakeley Adkins.

Costs associated with this publication are available from IDFG in accordance with Section 60-202, Idaho Code. Approved July 2014 Idaho Fish and Game Commission Meeting. Printed 8/2014/50/PCA 47872

Acknowledgments

We thank those who contributed to the development of this Plan, notably the researchers whose field studies have illuminated our understanding of wolverine ecology and population dynamics in Idaho and the Intermountain West: Keith B. Aubry, Jeffrey P. Copeland, Kimberly S. Heinemeyer, Robert M. Inman, John Krebs, Audrey J. Magoun, Kevin S. McKelvey, Michael K. Schwartz, and John S. Squires. In addition, we wish to thank University of Idaho faculty John T. Abatzoglou, Jeffrey A. Hicke, and Timothy E. Link for insights and expertise on climate science. We are grateful to Jeffrey P. Copeland, Robert M. Inman, and Michael K. Schwartz for generously sharing research products for use in this document. We are also grateful to Kristy L. Pilgrim and the USDA Forest Service Rocky Mountain Research Station for invaluable assistance analyzing wolverine genetic samples. Hundreds of volunteer citizen scientists have contributed thousands of hours observing, collecting, and recording data to increase our collective knowledge of wolverines in Idaho. We sincerely thank these individuals, organizations, and businesses for their commitment and valuable contributions. We also thank all of the stakeholders who have taken time to comment on this volume.

Photo by Diane Evans Mack.

This Plan has benefited greatly from early collaboration and insights provided by Dustin T. Miller and Sam Eaton of the Idaho Governor's Office of Species Conservation. Previous drafts of this document were improved through reviews by Regan Berkley, Toby Boudreau, Jeff Gould, Charlie Justus, Sharon Kiefer, Jim Mende, Steve Nadeau, Jon Rachael, Lacy Robinson, Mary Terra-Berns, Gregg Servheen, Kathleen Trever, Martha Wackenhut, and Greg Wooten. Kelly Kennedy Yokoyama expertly managed the layout and publication of the document. Rex Sallabanks provided guidance and feedback through all stages of the planning process.

Development of this Plan was possible through a grant from the U.S. Fish and Wildlife Service Cooperative Endangered Species Conservation Fund (Section 6 of the Endangered Species Act), which provides grants to states to support voluntary conservation projects for listed and candidate species. Requisite matching funds were derived from voluntary state sources, including Wildlife License Plates, state income tax check-off, and donations to Idaho Department of Fish and Game's Wildlife Diversity Program. We thank all Idahoans who contribute to these sources for this vital program support.

Executive Summary

The wolverine (*Gulo gulo*) is a large, wide-ranging mustelid that occurs throughout arctic, alpine, and boreal forest habitats of North America and Eurasia. The southern-most extant population of wolverines in North America occupies the Rocky Mountains of Idaho, Montana, and Wyoming, and the north Cascade Range of Washington. Wolverines have specialized habitat needs, including enormous space requirements and affinity to areas characterized by persistent snow cover and cool temperatures.


Photo by Blakeley Adkins.

Wolverines naturally occur in low densities across their global range. Current western U.S. population estimates range from 250 to 318 individuals, reflecting the estimated population prior to European settlement. These levels suggest that wolverines have reclaimed large expanses of their historical range in the contiguous U.S. after historical lows or local extirpations in the early 1900s. This pattern is evident in Idaho, where wolverines have been reported in 34 of 44 (77%) counties and presently occur in most, if not all, historically occupied habitat in Idaho. This resurgence is likely attributed to the important refugia provided by Idaho's large wilderness areas and the wolverine's status as a state-protected species since 1965. The wolverine is recognized as an Idaho Species of Greatest Conservation Need in the Idaho State Wildlife Action Plan based on low rangewide populations and lack of state population trend information.

In February 2013, the U.S. Fish and Wildlife Service (USFWS) published proposed rules to list wolverines in the contiguous U.S. as a threatened species, citing the primary threat of habitat and range loss due to climate change. The proposed listing has stimulated extensive debate on the USFWS's interpretation of climate change impacts on wolverine populations and habitat suitability. The State of Idaho maintains that a threatened determination is not warranted due to the high level of uncertainty related to climate change effects on wolverines and their habitat.

Idaho Department of Fish and Game's (IDFG) mission with respect to species conservation is to preserve, protect, perpetuate, and manage all Idaho's wildlife to ensure their persistence and to preclude the necessity of protection through Endangered Species Act listing. This Management Plan for the Conservation of Wolverines in Idaho (Plan) was prepared to proactively lead state efforts to maintain viable populations of wolverines in Idaho. We envision the Plan to serve as a voluntary guidance document to lead conservation efforts at the state and local level, and advance communication and collaboration among wildlife and land managers and the various constituencies important to wolverine conservation in Idaho.

The Plan is organized into the following sections:

- Background context and IDFG policy and legal framework for developing the plan;
- Information on wolverine ecology, distribution, and conservation status;
- Identification and discussion of potential threats to wolverine populations in Idaho;

- Identification of priority areas for wolverine conservation in Idaho;
- An outline of objectives, strategies, and conservation actions to maintain viable wolverine populations and enhance knowledge of wolverine ecology in Idaho.

The Plan identifies 7 conservation objectives, with strategies and conservation actions to achieve those objectives, to be implemented over the next 5 years (2014-2019). Objectives are:

- Collaborate across multiple jurisdictions and spatial scales to achieve wolverine conservation.
- Facilitate connectivity among wolverine subpopulations to enhance genetic exchange and population demographics.
- Conserve habitat to support viable wolverine populations.
- Support the development and use of inventory and monitoring systems to assess wolverine vulnerability to climate change.
- Further understand potential impacts to wolverine population viability as a result of disturbance from dispersed snow sports recreation.
- Continue to minimize injury and mortality of wolverines from incidental trapping and shooting.
- Generate support and partnerships for wolverine conservation by promoting education, awareness, and stewardship of wolverines and alpine/subalpine ecosystems.

IDFG is committed to establishing collaborative working relationships with all stakeholders to maintain viable wolverine populations into the future. We look forward to actively implementing the actions in this Plan to benefit wolverines and the habitats they rely on in Idaho.

Wolverine summer habitat in Idaho is associated with high-elevation whitebark pine communities with steep slopes and coarse talus. Photo by Beth Waterbury.

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Introduction

The wolverine (*Gulo gulo*) is a rare mustelid that occurs throughout arctic, alpine, and boreal forest habitats of North America and Eurasia. The southern-most extant population of wolverines in North America occupies the Rocky Mountains of Idaho, Montana, and Wyoming, and the north Cascade Range of Washington. Within this landscape, wolverines inhabit remote, mountainous environments where cold, snowy conditions exist for much of the year. Wolverine populations are characterized by large home ranges, long-distance movements, and the need for large and interconnected ecosystems to maintain population viability.

After retractions experienced in the early to mid-1900s, current wolverine distribution in Idaho is considered similar in extent to historical levels. Wolverine recolonization in Idaho occurred through natural expansion from Canadian populations facilitated by the presence of a large complex of protected wilderness in central Idaho and state species protections established in 1965. Given that wolverine populations are not subject to hunting or trapping seasons in Idaho, the primary drivers for wolverine population management will be programs affecting habitat suitability and land uses that affect breeding success and mortality in the adult population, and programs affecting wolverine prey species and food resources.

The wolverine is recognized as an Idaho Species of Greatest Conservation Need (SGCN) and has been proposed for listing under the Endangered Species Act (ESA) since 2010. In February 2013, the U.S. Fish and Wildlife Service (USFWS) published proposed rules to list wolverines in the contiguous U.S. as a threatened species, citing the primary threat of habitat and range loss due to climate change. The proposed listing has stimulated extensive debate on the USFWS's interpretation of climate change impacts on wolverine populations and habitat suitability. The State of Idaho maintains that a threatened determination is not warranted due to the high level of uncertainty related to climate change effects on wolverines and their habitat.

As the state agency with legal responsibility to preserve, protect, perpetuate, and manage Idaho's wildlife resources, the Idaho Department of Fish and Game (IDFG) developed this *Management Plan for the Conservation of Wolverines in Idaho* (hereafter Plan) to proactively lead state efforts to ensure the long-term persistence of wolverine populations in Idaho. The Plan provides an initial framework for identifying and prioritizing research and management actions over the next 5 years. The Plan provides a statewide synthesis of wolverine status and distribution, factors that affect populations and habitat, priority areas for conservation, and supporting actions to benefit wolverine populations at state and local scales. Wolverine populations occur over vast geographic areas influenced by multiple political jurisdictions. Because wolverine populations in Idaho are part of the western U.S. metapopulation, IDFG will seek an integrated, collaborative approach to wolverine conservation among western states and Canadian provinces. We also recommend integrating wolverine conservation with multispecies and multiuse initiatives to increase effectiveness, reduce costs, and contribute to the conservation of other native species with overlapping distributions and similar habitat requirements.

Law and Policy

The Plan has been developed in accordance with Idaho Code and policy, which define IDFG's mission to "preserve, protect, perpetuate, and manage" the state's wildlife resources and provide continuing supplies for hunting, fishing, and trapping. The Idaho Fish and Game Commission is charged with administering state wildlife policy through supervision and management of IDFG.

Idaho Code 67-1903 requires state agencies to develop strategic plans expressing how they will meet core mission requirements that identify outcome-based goals and performance measures. The current IDFG strategic plan, The Compass, calls for the development of "action plans" that describe programs, projects, and activities necessary to meet strategic plan goals (IDFG 2005a). This Plan tiers to The Compass, functioning as the action plan for wolverine management in the state.

The IDFG is entrusted to protect and manage wildlife resources for all Idaho citizens. This authority is an integral responsibility of state governments. As trustees for natural resources owned in common among all citizens, state governments take actions that preserve and protect public ownership to provide for continued use by citizens of their valuable resources. Although IDFG is the State's lead fish and wildlife manager, federal agencies including the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) have stewardship responsibility for public lands (i.e., habitat). In deference to state authority for wildlife management, federal agencies are not required to restore native wildlife populations, but they must ensure that the required habitat is maintained to support those populations whether the species actually occurs or not. In addition, federal treaties with Native American tribes (e.g., Nez Perce Treaty of 1855, Fort Bridger Treaty of 1868) include agreements about traditional and cultural uses of that wildlife that must be recognized by federal land management agencies including the USFS and BLM.

Planning Process and Public Involvement

In January 2013, IDFG assembled a team in coordination with the Idaho Governor's Office of Species Conservation to develop state management direction and strategies necessary to conserve the wolverine, one of several ESA candidate and listed species in Idaho. In May 2014, the draft Plan was previewed to the Idaho Fish and Game Commission and subsequently released for a 21-day public review and comment period. Outreach to partners and stakeholders was conducted through electronic communications and advertising through IDFG media outlets. IDFG developed a webpage where the public could review and download the draft Plan, respond to a questionnaire, and submit comments online. On June 3, 2014, IDFG hosted an online Live Chat to engage and converse with stakeholders about the draft Plan and other topics related to wolverines. Comments on the draft Plan were reviewed and incorporated into this document.

Relevant IDFG Planning Documents

- Idaho State Wildlife Action Plan, formerly known as the Idaho Comprehensive Wildlife Conservation Strategy (IDFG 2005b)
- Idaho Elk Management Plan 2014-2024 (IDFG 2014a)
- Mule Deer Management Plan 2008-2017 (IDFG 2008)
- Bighorn Sheep Management Plan (IDFG 2010)
- Idaho Wolf Conservation and Management Plan (Idaho Legislative Wolf Oversight Committee 2002)
- The Compass, IDFG Strategic Plan (IDFG 2005a)
- Bureau of Communications Strategic Plan 2011-2015 (IDFG 2011)

The Idaho State Wildlife Action Plan (SWAP) provides an integrated framework for conserving Idaho's 229 Species of Greatest Conservation Need (SGCN) and the habitats they depend on. It is the state's guiding document for managing and conserving at-risk species before they become too rare and costly to protect. Proactive guidance in the SWAP promotes recovery efforts and appropriate land-use measures, and builds and strengthens partnerships to conserve Idaho's wildlife heritage.

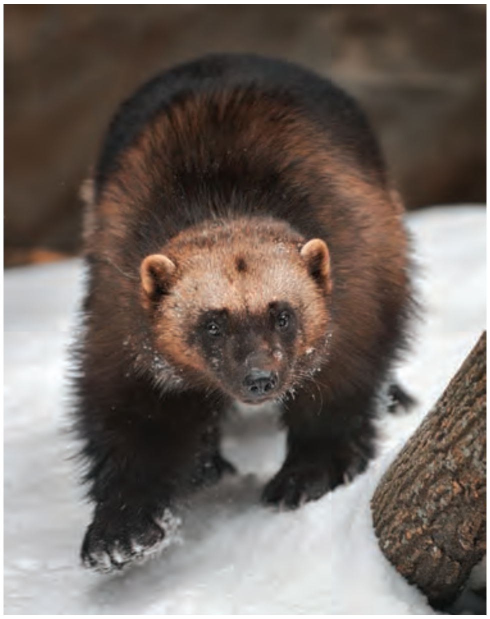
Big game management plans address population objectives, hunter preferences, management strategies, and major issues affecting these species. Because wild ungulate carrion is a primary food resource for wolverine (Hornocker and Hash 1981), management that maintains healthy, productive big game populations is likely to benefit wolverine foraging success (Banci 1994, Copeland 1996). Gray wolf (*Canis lupus*) management is also relevant to wolverine. Where their ranges overlap, wolves may subsidize wolverines by providing carrion (Khalil et al. 2014), but also expose them to a higher risk of injury or predation (Boles 1977).

The Bureau of Communications Strategic Plan provides direction to Communications staff to help IDFG be more strategic in its information, outreach, and education efforts to further build and retain the support of Idaho's hunters, anglers, trappers, wildlife watchers, elected officials, and all who care about wildlife.

The robust tracks of a wolverine showing the 2-2 "bounding" gait pattern displayed by members of the Mustelidae family. Photo by R. M. Inman.

Wolverine Ecology and Status

Wolverines are large mustelids known for expansive home ranges, low densities, and long-distance movements. The species resembles a small bear with a bushy tail, a broad head, small eyes, and short, rounded ears. The wolverine is robust in appearance with short legs, large feet with curved claws, and heavy musculature of the head, neck, and shoulders—adaptations that allow it to travel on snow and feed on frozen carrion (Banci 1994). The wolverine typically has glossy, dark-brown fur, a silvery or "grizzled" face mask, and buff-colored lateral stripes along its flanks. The species has well-developed anal musk glands and employs scent-marking as a means of communication.



Distribution

The wolverine is a cold-adapted inhabitant of circumboreal tundra and boreal coniferous forest zones of North America and Eurasia (Wilson 1982; Fig. 1). The species thrives in areas where snow and cold are prevalent much of the year (Magoun and Copeland 1998, Copeland et al. 2010, McKelvey et al. 2011, Inman 2013a). Historical distribution in North America included most of Canada and Alaska and the northern tier of the U.S. including the Rocky Mountains as far south as northern New Mexico (Banci 1994). Wolverine distribution in the contiguous U.S. substantially contracted by the mid-1920s, with range loss most evident in the Sierra Nevada, southern Rocky Mountains, and Great Lakes region (Aubry et al. 2007). Reasons for this decline are not well understood; however, mortality from broad-scale predator trapping and poisoning programs is implicated in this decline (Krebs et al. 2004, Aubry et al. 2007).

Since the mid-1900s, wolverine populations have expanded into portions of their former range (Aubry et al. 2007). Current range in the contiguous U.S. includes northern and central Idaho, western Montana, western Wyoming, north-central Washington, and northeast Oregon (Fig. 2). Recent verified records from California (Moriarty et al. 2009) and Colorado (Inman et al. 2009) may represent dispersal events.

Wolverines have been reported in 34 of 44 (77%) counties in Idaho. Distribution records documented during the past decade suggest wolverines presently occur in most, if not all, historically occupied suitable habitat in Idaho. Most historical (1891-1960) records in Idaho are from high elevation montane habitats in the northern and central part of the state (Aubry et al. 2007). Populations appear to have declined during the late 1800s and early 1900s contemporary with declines documented elsewhere in North America (Groves 1988). Davis (1939) characterized distribution as: "Probably extinct in Idaho; if not, restricted to the more inaccessible mountainous central portion of the state." He also remarked: "Trappers in the Sawtooth and Salmon River mountains claim that none has been seen or reported in those areas in the last twenty years." Even by mid-20th century, the wolverine was regarded as an exceptionally rare species in the state (Pengelley 1951). Groves (1988) summarized wolverine distribution in Idaho based on reported sightings, showing an increasing number of observations from the 1960s through the 1980s

Idaho wolverine distribution is related to snow, cold temperatures, and rugged terrain and occurs in high-elevation montane habitats centered near alpine tree line (Copeland 1996, Copeland et al. 2010, Inman et al. 2013a). To define potential

Figure 1. Worldwide distribution of wolverine (Swedish University of Agricultural Sciences et al. 2005).

distribution in Idaho, IDFG adopted a composite union of 2 habitat models. The first is based on persistent spring snow cover (Copeland et al. 2010). The second model is based on a resource selection function that uses Greater Yellowstone Ecosystem (GYE)-based radiotelemetry locations and several habitat covariates (e.g., latitude-adjusted elevation, terrain ruggedness, April 1 snow depth, road density, etc.) to predict relative quality of wolverine habitat (Inman et al. 2013a). The composite habitat model concurs with 87% of IDFG's current dataset of verified wolverine records for Idaho (Fig. 3; Table 1) (IDFG 2014b).

Table 1. Wolverine observations in Idaho by type, frequency, and percent concurrence within the IDFG composite habitat model (IDFG 2014b).

Type of Observation	Total Observations	No. Observations in Composite Model	% of Observations in Composite Model
Unverified	380	256	67
Verified	490	425	87
DNA confirmed	25	25	100
Targeted capture	123	123	100
Nontarget capture	14	7	50
Observation	87	59	68
Photograph	53	44	83
Specimen	19	13	68
Indirect (tracks)	169	154	91
Total no. observations	870	681	78

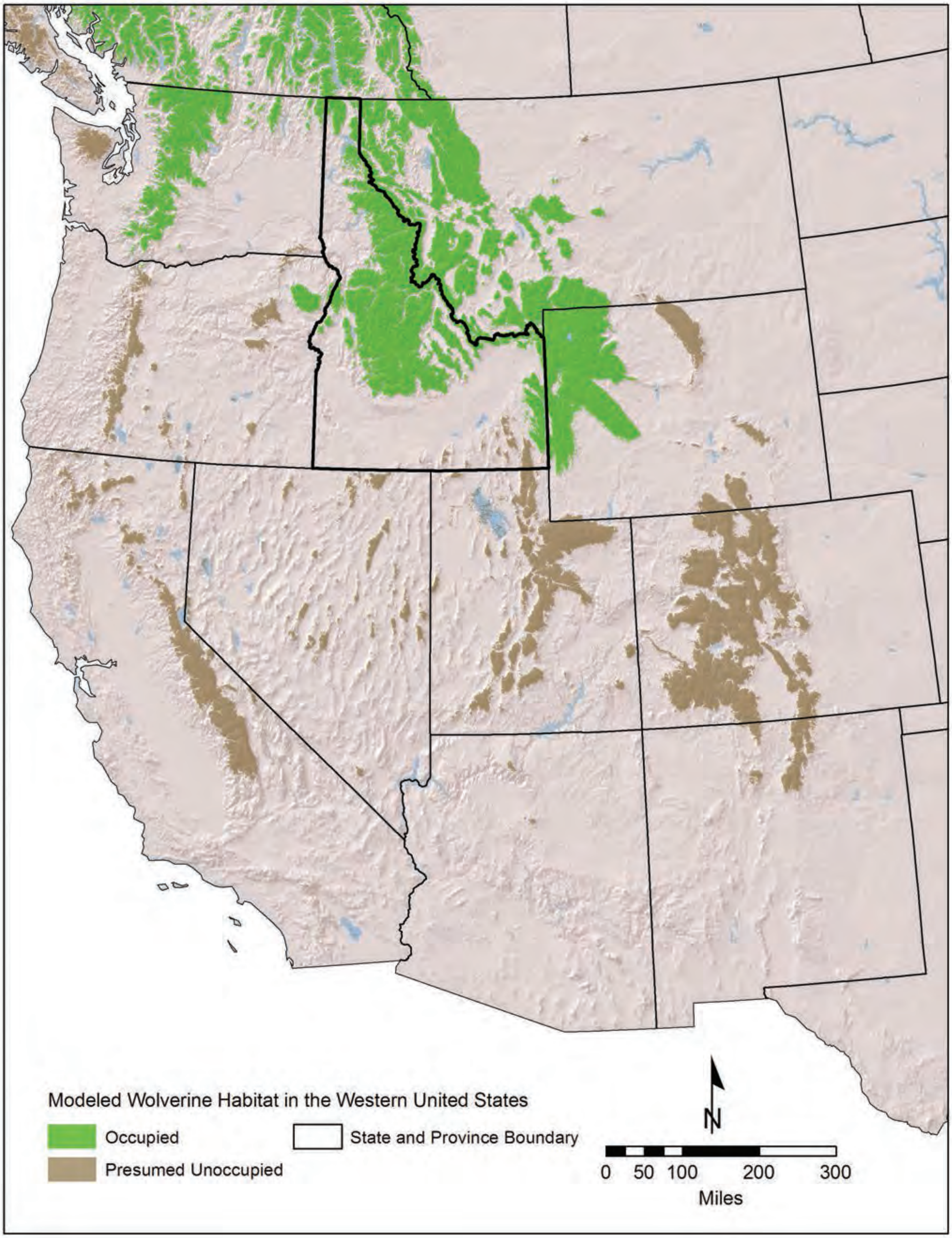


Figure 2. Modeled wolverine habitat in the western United States derived from a composite union of habitat models presented in Copeland et al. (2010) and Inman et al. (2013a). Occupancy status is derived from USFWS (2013a).

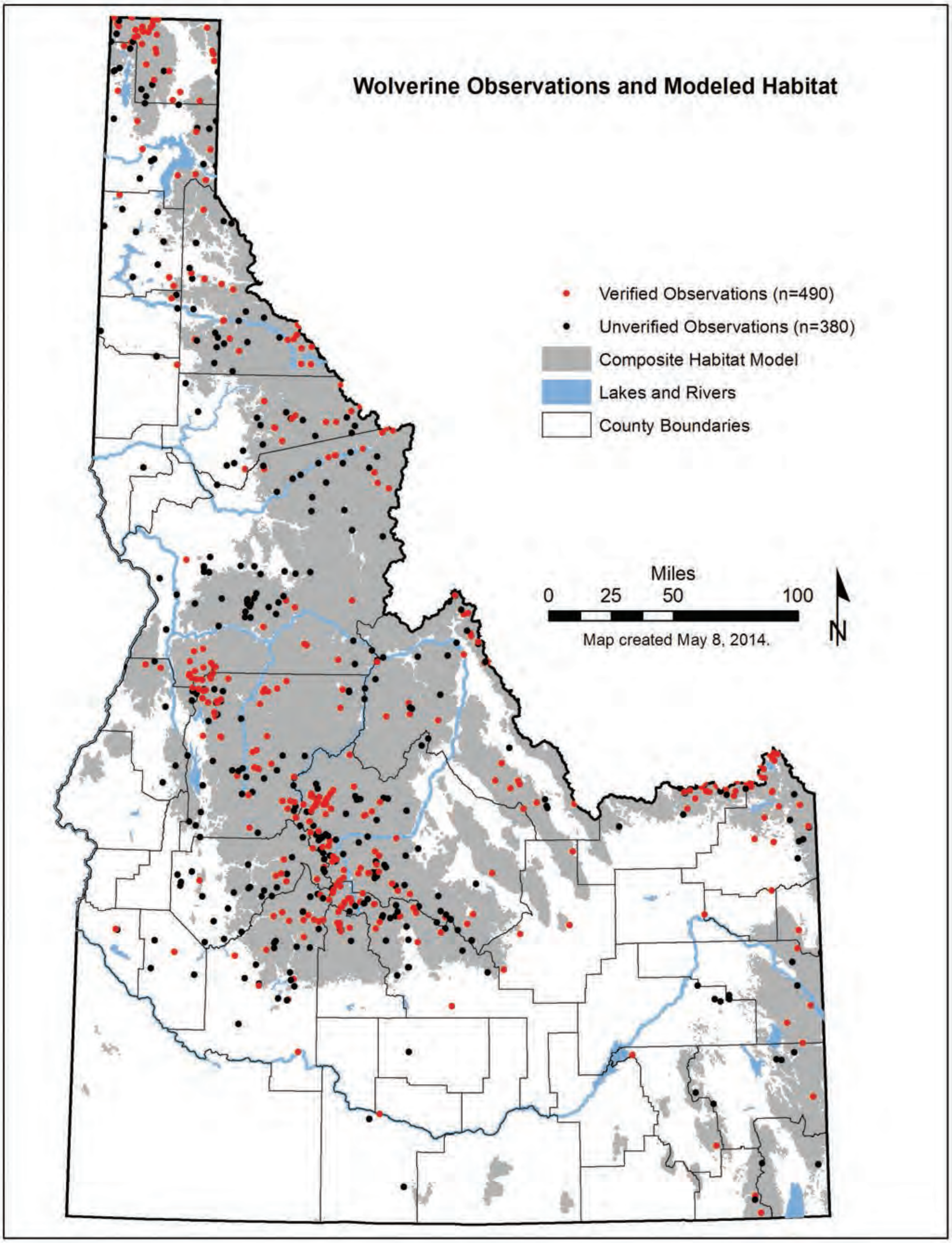


Figure 3. Wolverine observations in Idaho, 1908-2014, and predicted wolverine habitat. Point data are from the IDFG's Idaho Fish and Wildlife Information System, Species Diversity Database (IDFG 2014b) as of 1 April 2014. The composite habitat model is derived from a union of habitat models presented in Copeland et al. (2010) and Inman et al. (2013a).

Reproduction and Denning

Wolverine reproduction includes a polygamous mating system, an extended mating period (May to August), and delayed implantation (Rausch and Pearson 1972, Banci 1994). Males appear to reach sexual maturity at about 2 years of age (Rausch and Pearson 1972). Females attain sexual maturity at about 15 months, but rarely produce successful litters at this age (Persson 2005). Adult females appear to mate every year, but the proportion that successfully rear young appears to be low (Banci 1994, Inman et al. 2012). Loss of young may occur early in pregnancy and is presumably related to winter body condition, which is governed by the energetic demands of lactation and winter food availability (Persson 2005). Females typically give birth in February to mid-March (Magoun and Copeland 1998, Inman et al. 2012) and produce average litter sizes of 1–2 kits. Kits are weaned at 9–10 weeks (Iversen 1972) and are nearly full-grown at 8–9 months, although some individuals remain closely associated with their natal home range for up to 2 years (Copeland 1996, Vangen et al. 2001).

Food Habits

Wolverines are opportunistic omnivores in summer and primarily scavengers in winter (Hornocker and Hash 1981). Food habit studies from North America have demonstrated the importance of large mammal carrion in the wolverine diet (Banci 1994). Elk (*Cervus elaphus canadensis*), mule deer (*Odocoileus hemionus*), and domestic cattle carrion were the most common food sources in central Idaho during both summer and winter (Copeland 1996). Small mammal prey, including rodents and lagomorphs, were used to a lesser extent, but these may be key during important periods of reproduction (Inman et al. 2012). Investigations at winter foraging sites of GPS-collared wolverines in central Idaho suggest that mountain goat (*Oreamnos americana*) carcasses may be a locally important food source where goats overlap with wolverines (K. Heinemeyer, personal communication). Food caching is a common behavior of wolverines in all seasons.

Mortality

Wolverines contend with 4 primary mortality risks: starvation, accidents, predation, and human-caused mortality. Starvation is relatively common and likely an important mortality factor for young and very old wolverines (Banci 1994, Krebs et al. 2004). Injuries sustained from pursuing prey, such as debilitation from North American porcupine (*Erithizon dorsatum*) quills, or from altercations with conspecifics or other carnivores can also lead to starvation. Wolverines are occasionally killed in accidents, primarily avalanches or falls from cliffs (J. Copeland, personal communication). Wolverines are occasionally attacked and killed by wolves, mountain lions (*Puma concolor*), American black bears (*Ursus americanus*), and golden eagles (*Aquila chrysaetos*) (Boles 1977, Banci 1994, Inman et al. 2008). Death caused by other wolverines was the primary source of mortality for juveniles in Scandinavia (Persson et al. 2003). Intra-specific strife occurs, as would be expected with a strongly territorial species like the wolverine. Sources of human-caused mortality include vehicle and train collisions and trapping-related mortality. In jurisdictions with regulated wolverine trapping and hunting programs (e.g., Alaska, western Canada), harvest is a significant mortality factor, particularly for subadult and transient males (Banci 1994, Krebs et al. 2004, Lofroth and Ott 2007).

Spatial Use

Wolverines are highly mobile and have large spatial requirements. Adult home ranges vary in size depending on sex and age of the animal (Sandell 1989, Banci 1994). Rangewide, the average home range size varies from 422–1,522 km^2 for males and 73–384 km^2 for females (Magoun 1985, Whitman et al. 1986, Copeland 1996, Persson et al. 2010). Males and females in central Idaho had the largest home ranges reported for the species (Copeland 1996). Food resource availability and dispersion, habitat and topography, and spatial arrangements of conspecifics have all been suggested to influence home range size for wolverine (Copeland 1996). Adult male home ranges excluded other males but encompassed 1–3 female home ranges; female home ranges did not overlap (Copeland 1996). Peak periods of exploratory and dispersal movements generally occur at 10-15 months of age but may continue to 36 months of age (Inman 2013a). Mortality during dispersal is assumed to be high (Banci 1994). Dispersal distance for both sexes can exceed 150 km (Copeland 1996, Inman et al. 2011). Genetics suggest dispersal is more likely to occur through areas covered by spring snow in the U.S. Rocky Mountains (Schwartz et al. 2009). Natural topographical features do not seem to block movements of wolverines (Hornocker and Hash 1981), nor is there strong evidence that anthropogenic development is currently impeding dispersal movements (Packila et al. 2007, Schwartz et al. 2009).

Habitat Use

Wolverine habitat in the western U.S. is broadly associated with high-elevation montane areas with alpine climatic conditions and isolation from human activity (Aubry et al. 2007). These features likely reflect wolverine life history needs including availability of seasonal food resources, predator avoidance, and apparent avoidance of human activity (Lofroth and Krebs 2007). Wolverine habitat selection is strongly influenced by seasonal food supply, suggesting that wolverine populations are food-limited in the cold, low-productivity environments they occupy (Persson 2005). In summer, both sexes shift to slightly higher-elevation subalpine and alpine habitats where small mammals and birds comprise a majority of the diet (Hornocker and Hash 1981, Krebs et al. 2007). Wolverines exhibit consistent use of avalanche chute habitats in all seasons given the prevalence of avalanche-killed large mammals in winter and availability of marmots (*Marmota* spp.) and ground squirrels (*Urocitellus* spp.) in summer (Krebs et al. 2007).

Predation risk may influence female wolverine selection of reproductive sites (Magoun and Copeland 1998). Natal dens are located in high-elevation, rugged, and complex terrain where security from predators is presumably greater. These areas are typically snow-covered alpine and subalpine habitats associated with large wood or

Jeff Copeland conducted a landmark study of wolverine ecology in central Idaho in 1992-1995. Photo by The Wolverine Foundation.

rock structures. These include avalanche debris, large talus rubble and rock fields, and large downed woody debris that appear to provide large subnivean spaces (Fig. 4), or may be temporary structures within the snow layer itself (Magoun and Copeland 1998). Persistent, stable snow cover appears to be an important feature of denning habitat and may aid in kit survival by providing reduced predation risk, thermal benefits, or proximity to quality rearing habitat (Magoun and Copeland 1998). In central Idaho, wolverines did not spatially associate with elk winter range, perhaps to reduce the probability of encounters with gray wolf, mountain lion, and coyote (*Canis latrans*) (Copeland et al. 2007). Wolverines scavenged carrion in winter in mid-elevation forests often associated with hunter camps and wounding mortality (Copeland 1996).

Occupied wolverine habitat is generally spatially separated from human habitation, including roads, infrastructure, and backcountry recreation (May et al. 2006, Copeland et al. 2007, Inman et al. 2013a). This relationship likely suggests wolverines' preference for alpine and subalpine habitats, which are typically inhospitable to human development, rather than avoidance of human activity per se (Copeland et al. 2007).

Figure 4. Natal den site north of McCall, Idaho, located as part of the Idaho Wolverine-Winter Recreation Study. Photo by Diane Evans Mack.

Wolverine researchers generally agree that wolverines' association with a particular vegetation type is likely attributed to some other ecological component of that habitat, such as greater abundance of food, thermoregulatory benefit, or avoidance of anthropogenic impacts (Hornocker and Hash 1981, Banci 1994, Copeland et al. 2007). Hatler (1989) stated that no particular vegetation components can be singled out for wolverines and that the success of wolverines "may relate to the availability of large areas of remote, rugged uplands that are difficult to access to humans, and which have rarely been subject to competing land uses."

Population Status

Wolverines were first documented in Idaho during the late 1800s (Merriam 1891). Through the middle of the 20th century, the species was considered to be exceptionally rare and perhaps extirpated (Davis 1939, Pengelley 1951). This apparent decline in Idaho in the early 1900s coincided with a North American range contraction (Aubry et al. 2007). The number of observations in Idaho subsequently increased from the 1960s through the 1980s (Groves 1988), at the same time historically-occupied habitat was being recolonized by individuals immigrating from Canada (Newby and Wright 1955, Newby and McDougal 1964, McKelvey et al. 2013, Aubry et al. 2007). The current Idaho distribution is believed to be similar to historical extent; however, we lack information to determine if density and productivity are similar to historical levels.

The number of individuals that occupy habitat in Idaho is unknown. In some areas, minimum numbers have been determined through capture and radiotelemetry. Reproduction has been documented in 3 radiotelemetry studies (Copeland et al. 2007, Inman et al. 2008, Heinemeyer et al. 2010). Non-invasive hair-snag and camera-trap protocols have been developed that are capable of identifying individuals (Magoun et al. 2011). Using research data and incidental sightings, IDFG has compiled a dataset of 870 observations from 1908-2014. The majority of these are based on physical evidence, such as museum specimens, molecular samples, and diagnostic photographs, or on captures and species expert observations of wolverines or tracks.

The carrying capacity of habitat in the contiguous U.S. was evaluated by Inman et al. (2013a) combining models of habitat distribution and information on the quality and amount of habitat required by each wolverine. The carrying capacity of both occupied and unoccupied habitat in the western contiguous U.S. was modeled to be about 644 individuals (95% Confidence Limits = 5060–1881) (Inman et al. 2013a). Based on this published model (Inman et al. 2013a), estimated population capacity for Idaho was calculated at 127 individuals (95% Confidence Limits = 100-172). Table 2 presents estimates of wolverine population capacity by major blocks (>100 km^2) of primary wolverine habitat in Idaho (Fig. 5). These estimates can be used as preliminary baseline numbers to validate or refine through future survey and monitoring efforts.

Table 2. Preliminary estimates of wolverine population capacity by region and mountain range in Idaho (Fig. 5) based on resource selection function habitat modeling of wolverine telemetry data collected in the GYE region 2001–2010 (Inman et al. 2013a).

Region	Mountain Range	Estimated Population Capacity[a]	Reasonable Range	
			Lower	Upper
Central Linkage Ecosystem	Beaverhead Mountains	2	2	4
	Cabinet Mountains West	1	1	2
	Centennial Range	1	1	1
	Lemhi Range	7	5	9
	Lost River Range	2	1	4
	Purcell Mountains	0	0	0
	Selkirk Range	3	3	5
	Region Subtotal	16	13	25
Great Basin Ecosystem	Bear River Range	1	1	1
	Region Subtotal	1	1	1
Greater Yellowstone Ecosystem	Absaroka-Teton-Gros Ventre Ranges	1	1	1
	Madison-Gallatin Ranges	0	0	0
	Region Subtotal	1	1	1
Salmon Selway Ecosystem	Allen Mountain	0	0	1
	Bitterroot Range	14	11	18
	Clearwater	14	12	20
	Farrow Mountain	0	0	0
	Gospel Hump Mountains	0	0	0
	Salmon Mountain	1	1	2
	Salmon-Smoky Mountains	72	58	95
	Seven Devils Mountains	1	0	1
	Soldier Mountains	1	0	1
	Trinity Mountain	1	0	1
	War Eagle Mountain	2	1	2
	Yellowjacket Mountains	3	2	4
	Region Subtotal	109	85	145
Idaho	**Grand Total**	**127**	**100**	**172**

[a]Estimate of capacity within each primary habitat patch >100 km2 was rounded down to the nearest integer. Estimates based on population size of 15.2 wolverines (95% CI = 12.3–42.0) in the GYE study area where 11 individuals were known to be in the area and 20 was considered a reasonable upper limit (Inman et al. 2013a).

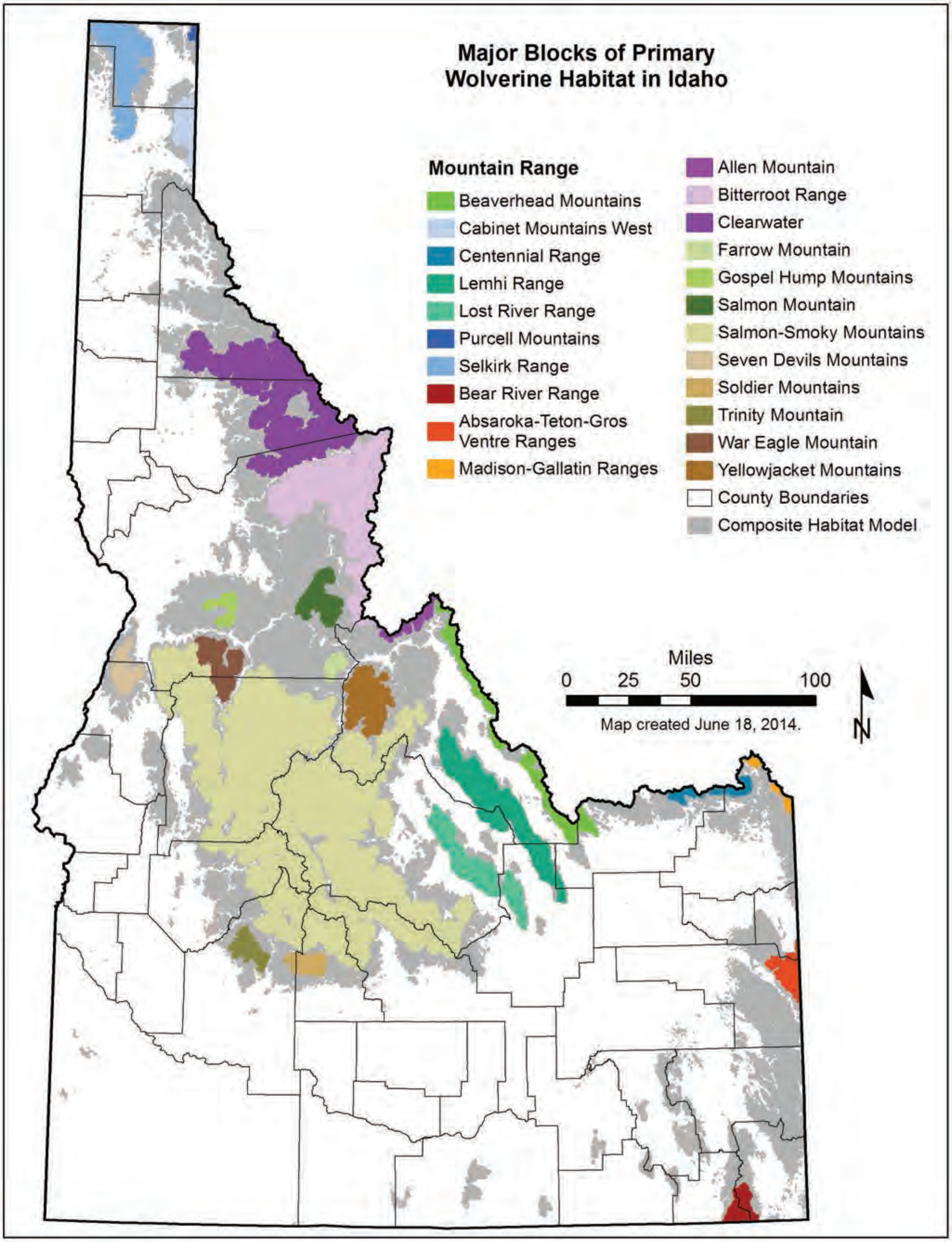


Figure 5. Major blocks (>100 km^2) of primary wolverine habitat (suitable for use by resident adults) in Idaho based on resource selection function habitat modeling of wolverine telemetry data from the GYE region 2001–2010 (Inman et al. 2013a).

Conservation Status

No harvest season for wolverines has been open in Idaho since 1965. The species is currently classified by the State of Idaho as a Protected Nongame Species. This designation precludes take or possession (i.e., harvest or capture) without a scientific collection permit (IDAPA 13.01.06). The species has been designated a SGCN in the SWAP (IDFG 2005b), making conservation projects directed at wolverine eligible for funding under the State Wildlife Grants program administered by USFWS.

In February 2013, USFWS published proposed rules to list the Distinct Population Segment (DPS) of the North American wolverine in the contiguous U.S. as a threatened species, citing the primary threat of habitat and range loss due to climate change (USFWS 2013a). The USFWS also proposed a special rule under 4(d) of the ESA to "prohibit take of wolverine when associated with or related to trapping, hunting, shooting, collection, capturing, pursuing, wounding, killing, and trade." The 4(d) rule proposed to exempt certain risk factors, including dispersed recreation, land management activities (e.g., timber harvest, wildland firefighting, prescribed fire), and infrastructure development, due to the small scale of habitat alteration involved in these activities. The USFWS also proposed to establish a nonessential experimental population area for the DPS in the southern Rocky Mountains under section 10(j) of the ESA to facilitate potential state-led reintroduction efforts. The USFWS intends to issue a final decision on these rules by August 4, 2014.

Regions 1, 4, and 6 of the USFS, with 9 National Forests in Idaho, and the Idaho Office of BLM classify the wolverine as both Proposed and Sensitive Species. These classifications direct each agency to consider consequences of management actions on wolverine habitat and populations. Wolverine status in adjacent states and provinces varies. In British Columbia, the wolverine is classified as a furbearer and Species of Special Concern. Wolverine trapping and hunting are open in British Columbia's Region 8, located immediately north of the Idaho Panhandle. In Montana, the wolverine is classified as a furbearer and Species of Concern. Trapping for wolverines in Montana has been closed since 2012. In Wyoming, the wolverine is classified as a protected nongame mammal and SGCN. Oregon lists the wolverine as a threatened species under the Oregon Endangered Species Act. In Washington, the wolverine is a state candidate species for listing as threatened or endangered and a SGCN.

Land Management and Protection Status in Idaho

USFS lands comprised 88% (66,725 km^2) of predicted wolverine habitat in Idaho (Table 3; Fig. 6). Of lands in predicted habitat, 22% were identified as "permanently protected" (e.g., designated wilderness, wilderness study area), 7% as Inventoried Roadless Area (category 1B-1: areas recommended for wilderness designation in forest plans and where road construction and reconstruction is prohibited), 66% as "subject to multiple use," and 5% with "no known mandate for protection" (Fig. 7). The Frank Church-River of No Return and Selway-Bitterroot wilderness areas comprise the majority of permanently protected federal lands in Idaho. Collectively, these areas comprise the core of the Salmon-Selway Ecosystem, 1 of 4 major blocks of primary wolverine habitat in the western U.S. that supports resident and dispersing wolverines (Inman et al. 2013a). The vast majority of USFS lands in Idaho are managed for multiple use including outdoor recreation, range, timber, minerals, energy, watersheds, and fish and wildlife values. The degree to which certain multiple-use activities (e.g., forestry, mineral extraction, winter recreation, roads) fragment or disturb wolverine habitat, and whether these activities impact wolverine populations, requires additional assessment.

Table 3. Summary of National Forest administered lands (USFS 2014) within Idaho by total area (km²), the area and proportion within modeled wolverine habitat, and the relative contribution of habitat within each forest to the overall predicted distribution in Idaho.

USFS Region	National Forest	National Forest Area (km²)	Predicted Wolverine Habitat (km²)	% of National Forest Predicted to be Wolverine Habitat	% of Predicted Wolverine Habitat in Idaho
1	Bitterroot National Forest[a]	1894.1	1782.5	94.1	2.4
4	Boise National Forest	10221.5	6793.7	66.5	8.8
4	Caribou-Targhee National Forest[a]	11176.4	8586.9	76.8	11.1
1	Idaho Panhandle National Forests[a]	11311.2	7074.6	62.5	8.4
1	Kootenai National Forest[a]	204.9	200.1	97.7	0.3
1	Nez Perce-Clearwater National Forest	16479.9	12734.9	77.3	16.5
4	Payette National Forest	9745.8	8168.6	83.8	10.5
4	Salmon-Challis National Forest	17787.8	16383.5	92.1	21.5
4	Sawtooth National Forest	8489.9	6455.7	76.0	8.3
6	Wallowa-Whitman National Forest[a]	595.4	293.7	49.3	0.4
Totals		87906.9	68474.3	78.0	88.0

[a]National Forests spanning Idaho and an adjacent state (MT, OR, WA, WY).

The Selkirk Mountains of northern Idaho typify the cold, snowy, and rugged environments inhabited by wolverines in the U.S. Rocky Mountains. Photo by M. Lucid.

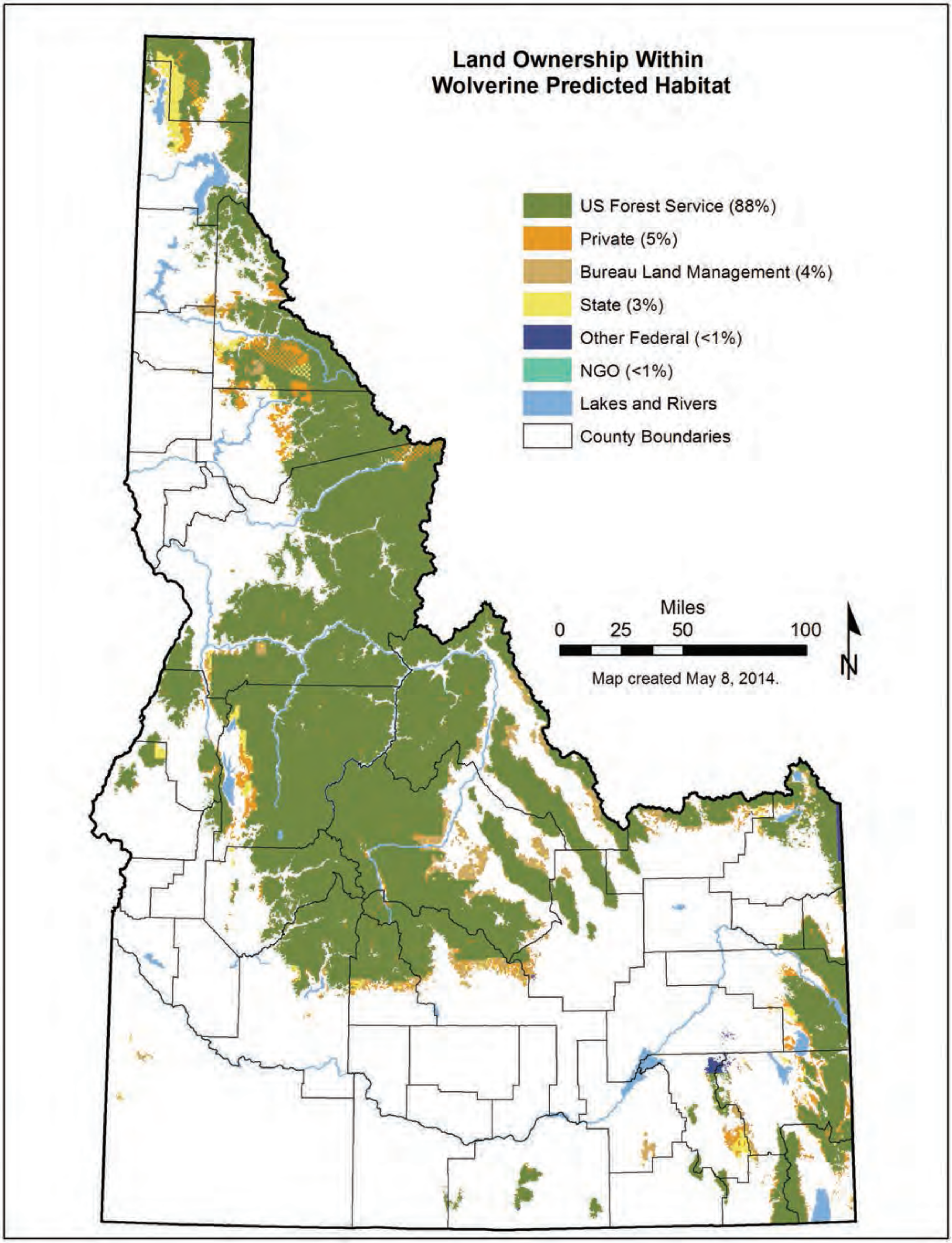


Figure 6. Landownership within predicted wolverine habitat in Idaho. Ownership data are from the Protected Areas Database of the United States (USGS 2012). The composite habitat model is derived from a union of habitat models presented in Copeland et al. (2010) and Inman et al. (2013a).

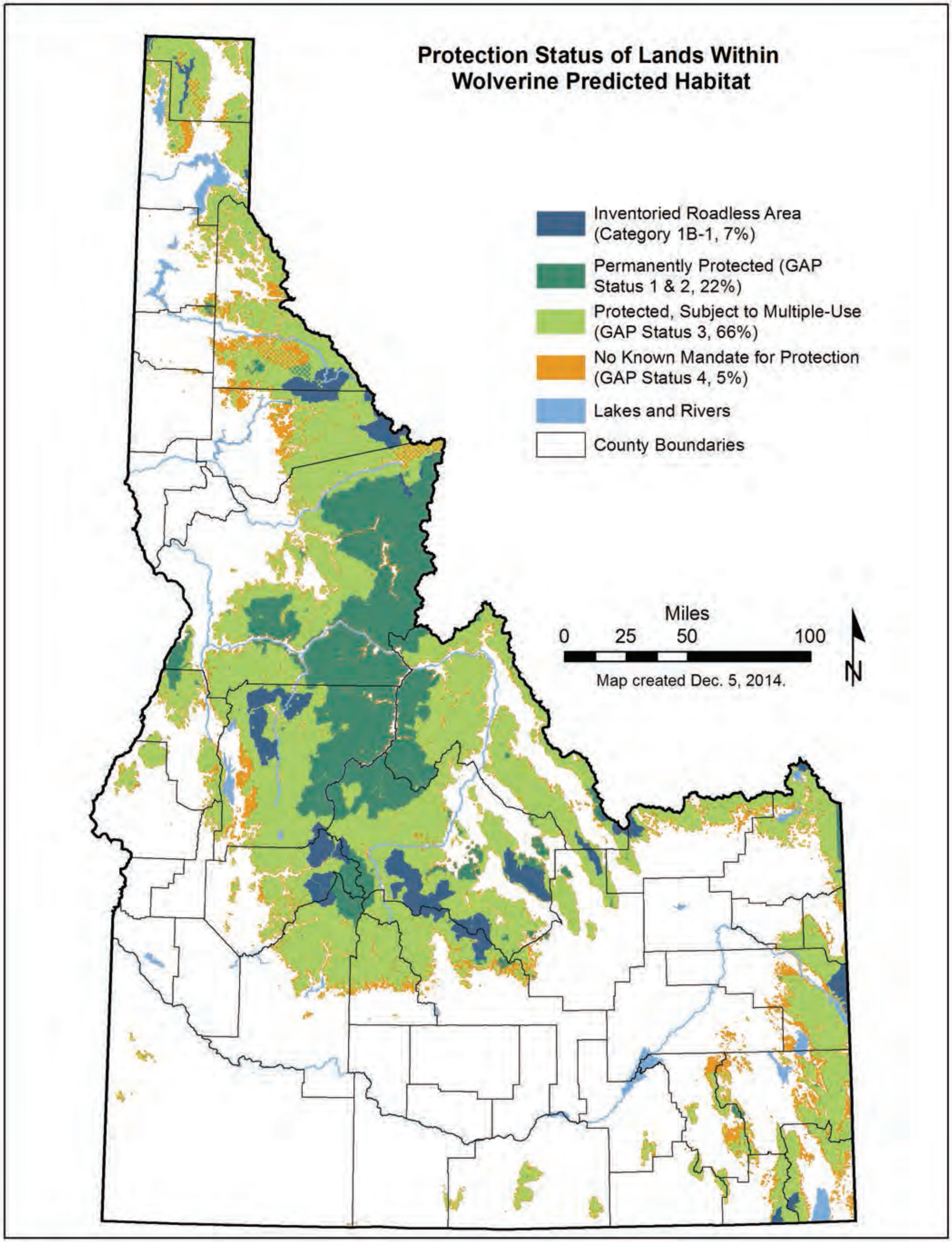


Figure 7. Land protection status within predicted wolverine habitat in Idaho. Ownership data are from the Protected Areas Database of the United States (USGS 2012). Predicted wolverine habitat model is derived from a union of habitat models presented in Copeland et al. (2010) and Inman et al. (2013a).

Threats, Limiting Factors, and Opportunities

Wolverine habitat in the Selkirk Mountains, Boundary County, Idaho. Photo by M. Lucid.

In this section, we discuss potential threats to wolverines and their habitats as identified in the SWAP, as well as other limiting factors or opportunities relevant to wolverine conservation in Idaho. These issues are presented in alphabetical order and are not intended to be a ranking or weighting by level of significance. Threats addressed in this section will vary in scale, scope, and intensity across the state and conservation approaches will vary accordingly. The next section (Wolverine Priority Conservation Areas) addresses this variability at more localized scales.

The issues presented in this section encompass most of the threat factors analyzed by USFWS in their proposed listing rule (USFWS 2013b). IDFG deemed the issues addressed in this section to be relevant based on SWAP direction and comprehensive review of pertinent published and unpublished literature. Even with the significant new information on wolverine ecology and population dynamics in the last decade, there remain critical information gaps that limit our ability to draw conclusions on various threat impacts to wolverines and their habitats.

Climate Change

Changing climates may put wolverine populations at risk given their relationship with snow and cold temperatures (Copeland et al. 2010, Inman et al. 2012). Observed and projected changes in climate vary widely in time and space, however, and with Idaho's great diversity and complexity of landscapes, effects of climate change will not be consistent across the state. In addition, climate in the Pacific Northwest (PNW) has significant natural variability which can dampen or amplify projected effects (e.g., Abatzoglou et al. 2014), leading to Idaho's substantial uncertainty about expression of climate change and effects on wolverine persistence.

During the 20th century, average annual temperature in the PNW increased approximately 0.8 °C, with winter temperatures increasing more than other seasons, daily minimum temperatures rising faster than daily maximum temperatures, extreme cold conditions becoming more rare, and the freeze-free season lengthening (Kunkel et al. 2013, Abatzoglou et al. 2014). Trends in annual precipitation are more variable, depend on time frame analyzed, and are not statistically significant (Kunkel et al. 2013). Even so, the proportion of precipitation that falls as snow versus rain, particularly early spring snows, is changing in the PNW (Knowles et al. 2006, Abatzoglou et al. 2014). Furthermore, some areas have experienced declines in Snow Water Equivalent at low- to mid-elevations (approx. ≤2000 m, depending on latitude) while trends have been stable or even increasing at higher elevations (Regonda et al. 2005, Pierce et al. 2008). Similarly, declines in snowfall and snow cover were most notable at low elevations as is an earlier onset of snowmelt (Brown and Mote 2009, Pederson et al. 2013).

During the 21st century, most projections predict progressively warmer and wetter conditions in the PNW, although summer drought may worsen. Temperatures in the region will increase 0.1–0.6° C per decade through at least 2050, and although warming is expected across all seasons, the largest temperature increases will occur in summer (Kunkel et al. 2013). These increases are expected to be accompanied by great overall variability (e.g., record cold temperatures even as record highs become increasingly frequent) (Meehl et al. 2009). For example, although central Idaho may not experience a significant increase in extreme heat days (i.e., max. >35° C), extreme cold days (i.e., min. <-12° C) will likely decrease significantly from 2041 to 2070 (Kunkel et al. 2013). Precipitation projections generally indicate increases during fall and winter months, with little change or additional drying during summer months. Model results are variable, however, with projected changes in precipitation smaller than normal year-to-year variation at least through 2035 (Kunkel et al. 2013). Given projected temperature increases, much of the western U.S. is expected to transition from a snow-dominated system to one more rain-dominated, spring snowpack is expected to decline, especially at warmer low to mid-elevations, and existing snow is expected to continue melting earlier (Pierce and Cayan 2013).

Wolverine natal den site in the Beaverhead Mountains of Idaho. Photo by Rob Spence, Wildlife Conservation Society.

Potential effects of increased temperature and decreased snow depth and cover on wolverine habitat in Idaho have been described by McKelvey et al. (2011) and Peacock (2011). McKelvey et al. (2011) predicted Idaho will lose 43% of current spring snow cover by the 2030–2059 time period and 78% by 2070–2099 using an ensemble mean of 10 Global Climate Models (GCMs) downscaled to 6-km resolution, a moderate greenhouse gas emission scenario, and the "spring snow cover" model by Copeland et al. (2010). Similarly, Peacock (2011) projected a decline in mean snow depth across Idaho using a more current GCM (approx. 100-km resolution) and 3 emission scenarios. Each of the 4 months assessed (January–April) showed downward trends to extremely low snow depth values by 2100 under all 3 emission scenarios. Model projections from McKelvey et al. (2011) and Peacock (2011) indicate a large range of variation and uncertainty due to spatial scale of the data, particularly in topographically complex areas. Peacock (2011) predicted winters with little or no snow depth and winters in which snow depth will approximate the 20th-century mean, regardless of emission scenario.

Any assessment of projected climate change effects on a species includes some degree of uncertainty and relies on numerous assumptions. Thus, we are faced with ≥3 primary challenges in projecting effects on wolverines and using projections in a management context. First, climate projections range widely in magnitude, across space, and through time. While GCMs provide credible estimates at global and continental scales (IPCC 2013), the models operate under several assumptions (e.g., Knutti et al. 2010, Knutti and Sedlácek 2013). Additional analyses necessary to relate models to wolverine habitat (e.g., downscaling, developing snow variables) all require several more assumptions (e.g., Mote et al. 2005, Daniels et al. 2012). Variation in model inputs and projections, or violation of assumptions can lead to over- and underestimations of local climatic changes (e.g., Salathé et al. 2010, McKelvey et al. 2011) and, thus, over- or underestimation of effects on wolverine habitat.

Second, discerning localized effects on snow is difficult because complex topography can create local climate conditions that may counteract or buffer effects, offering climate refugia (e.g., Moritz and Agudo 2013). Whereas current downscaling methods account for topographical variability, the scale is often still too coarse for most management applications. For example, although McKelvey et al. (2011) downscaled data to 6x6-km grid cells (36 km^2), the spatial resolution was still inadequate to characterize the complex central Idaho topography, where elevations can range >2,200 m within each grid cell. Similarly, the spatial scale of some remotely-sensed data (e.g., MODIS) used to estimate snow cover, and thus wolverine habitat, can result in unreliable estimates, particularly in fragmented landscapes.

Lastly, our knowledge of climate sensitivity and adaptive capacity of wolverines is somewhat limited. We must assume: 1) the temporal and spatial scales of modeled variables (e.g., snow depth and cover) match those perceived by wolverines, 2) modeled variables adequately reflect biological needs of wolverines, and 3) the relationships between these variables and habitat use will remain constant. Whereas most authors agree that deep, persistent spring snow cover is a consistent component of reproductive denning habitat (Aubry et al. 2007, Magoun and Copeland 1998, Copeland et al. 2010, Inman et al. 2012), there is still some debate regarding what constitutes "deep, persistent spring snow cover," as well as the magnitude and length of the relationship (Magoun 2013, Inman 2013b). Large inter-annual variability in observed snow cover (e.g., Pederson et al. 2013, Abatzoglou et al. 2014) and monthly variability in modeled snow cover lead to uncertainty in spatial predictions of wolverine habitat. Furthermore, additional variables (e.g., land cover, topography, road density, human population density, snow depth) may alter estimates of suitable habitat (Inman et al. 2013a, Fisher et al. 2013). Given that wolverines are potentially at risk due to changes in climate, a better understanding of the ecology, behavior, and physiology of wolverines with respect to temperature thresholds and dependence on snow cover and/or depth is needed.

Connectivity, Small Populations, and Extirpation Risk

Wolverines were likely extirpated, or nearly so, from the contiguous U.S. in the first half of the 20th century (Aubry et. al 2007). Thus, genetic structure likely includes a founder effect (i.e., recolonization by a limited number of individuals) coupled with limited connectivity among subpopulations and genetic drift. Across much of Canada and Alaska, haplotype diversity is high (Tomasik and Cook 2005, Schwartz et al. 2007) and genetic structure is low to insignificant (Wilson et al. 2000, Kyle and Strobeck 2001, 2002, Chapell et al. 2004, Tomasik and Cook 2005). This is presumably due to the strong dispersal capability of wolverines (which is predominantly male-mediated) and well-connected habitats. In contrast, populations at the southern part of the current range have low haplotype diversity and high genetic structure. For example, Schwartz et al. (2007) found that only 3 of 9 haplotypes known in Canada have been found in the northern Rockies, and 71 of 73 genetic samples from western U.S. populations had 1 haplotype, which suggests genetic diversity is low, genetic drift is high, and connectivity with Canadian populations is low. Cegelski et al. (2006) found wolverines in Idaho to have the lowest genetic diversity levels among 8 populations evaluated across the Rocky Mountains and high levels of genetic structure. They concluded despite some evidence of immigration of wolverines from Canada to the U.S., Idaho populations were genetically isolated, even from populations in Montana.

Overall, wolverines in the northern Rockies exist as small and semi-isolated subpopulations within a larger metapopulation that requires regular dispersal of individuals between habitat patches for maintenance (Aubry et al. 2007, Inman et al. 2013a). Given subpopulations are small (essentially family groups) and movement between subpopulations is limited, inbreeding is likely over the long term (Kyle and Strobeck 2001, Cegelski et al. 2006, Schwartz et al. 2009). The best current estimate of wolverine abundance in the northern Rockies is approximately 300 individuals (Inman et al. 2013a), while estimates for “effective” population size average 35 individuals (credible limits = 28–52) for Idaho, Montana, and Wyoming (Schwartz et al. 2009). A population’s “effective” size (N_e) is a measure of that portion of the actual population that contributes to future generations. The smaller the N_e, the more reproduction is monopolized by a few individuals, and the more susceptible a population may be to loss of genetic diversity.

Considering that wolverines are territorial and have extremely large habitat requirements, connection among reproductive habitat blocks is needed to sustain wolverines within any single continuous block.

Franklin (1980) proposed a “50/500 rule” suggesting an N_e of 50 is needed to maintain genetic diversity for the short-term and 500 for the long-term. However, the empirical basis for the rule has been repeatedly questioned in the literature, so should be used with caution (Allendorf and Luikart 2007). More appropriately, the 50/500 rule is useful as a general guideline to signal that a population may be vulnerable to loss of genetic diversity, and may warrant action to remain viable. Based on current best estimates for the northern U.S. Rockies (short-term N_e = 35, insufficient habitat area to achieve a long-term N_e of 500), genetic exchange with the larger Canadian/Alaskan population would likely be required for long-term genetic viability in the contiguous U.S. At present, no deleterious effects to the contiguous U.S. population of wolverines have been documented due to low N_e (USFWS 2013a).

Idaho supports numerous wolverine subpopulations that vary greatly in their connection relative to each other. Previous studies have identified that wolverine habitat (i.e., habitat in which wolverines are able to successfully reproduce) is not one large continuous block, but rather a collection of discontinuous habitats. Considering that wolverines are territorial and have extremely large habitat requirements, connection among reproductive habitat blocks is needed to sustain wolverines within any single continuous block. Impediments to movement may ultimately affect the persistence of this metapopulation structure through time.

Idaho currently has a diverse assemblage of wolverine habitat. Central Idaho’s wilderness and surrounding remote mountainous areas contain large, well-connected blocks of habitat. Other areas not only represent reproductive habitat but also are corridors used for dispersal between other core areas (Fig. 8). Schwartz et al. (2009) and Traill et al. (2010) identified the Bitterroot Mountains between Montana and Idaho as a critical artery of gene flow. This area genetically links wolverines of central Idaho to those in the Bob Marshall Wilderness and Glacier National Park in Montana, and through them on to Canada. The Centennial Mountains in southeast Idaho also link wolverines in the Sawtooth Mountains to those in the GYE (Schwartz et al. 2009). McKelvey et al. (2011) concluded Idaho will lose disproportionately more persistent spring snow cover as a result of predicted climate change than Montana or Wyoming. If this prediction results in a change in landscape permeability, it may alter metapopulation dynamics among subpopulations of wolverines in the northern U.S. Rockies, leading to further isolation and localized extirpation risk. Thus, connectivity between wolverine habitats is a critically important factor that will determine the expanding range of wolverines in the lower

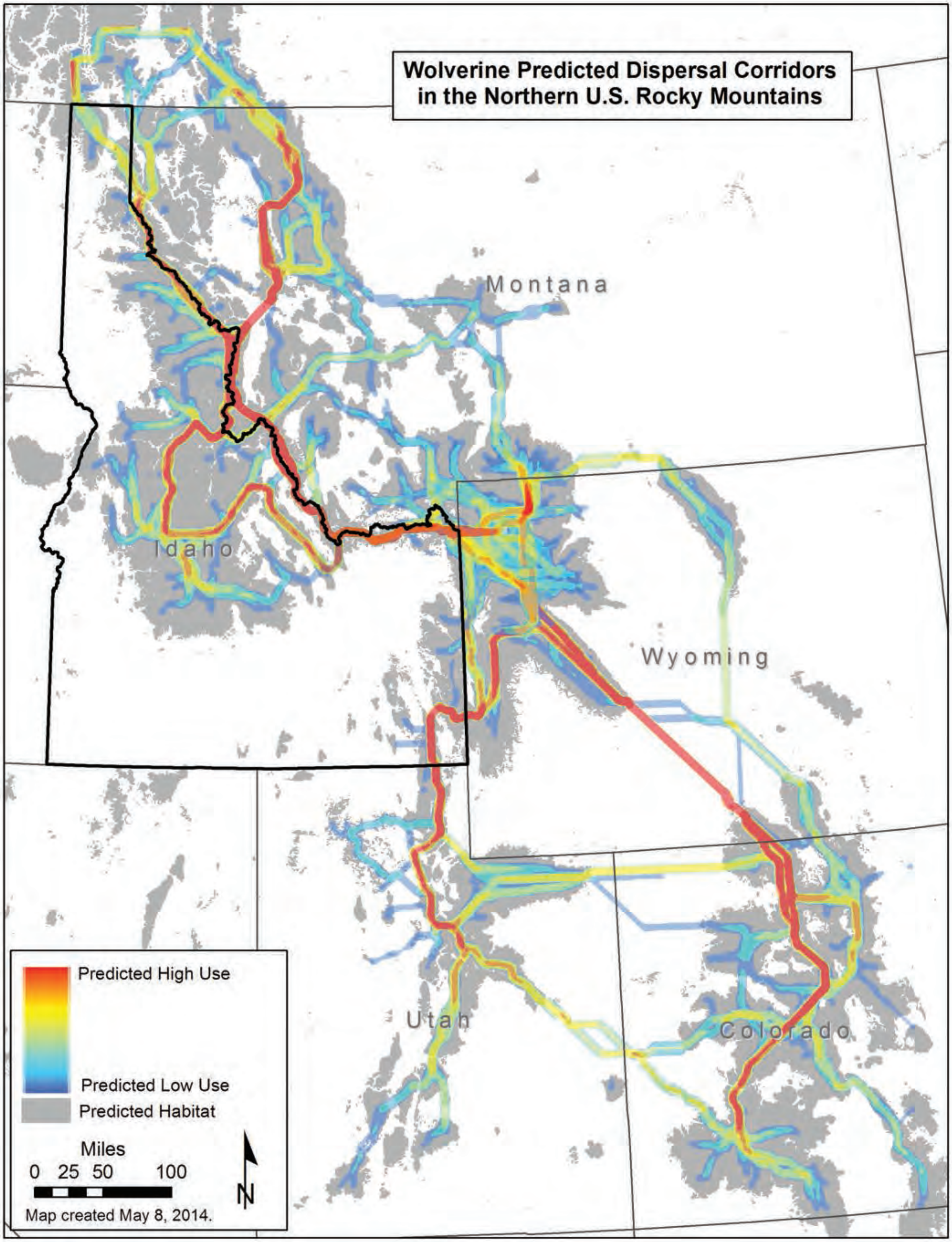


Figure 8. Wolverine predicted dispersal corridors (least-cost pathways) in the northern U.S. Rocky Mountains (Schwartz et al. 2009). Paths in red and orange are predicted to be used more often than those in blue. Corridor model data do not include southwest Idaho, Nevada, Oregon, and Washington.

48, and will increase their chances of persisting within the context of a changing climate.

There are two prevalent rangewide connectivity models for wolverine habitat in the continental U.S. The first model considers the presence of snow on 15 May as a factor that will influence wolverine locations between known habitats using least-cost path modeling (McKelvey et al. 2011). A limitation of this model is its basis on a single variable, persistent spring snow cover, rather than a range of landscape features in the connectivity path. A second connectivity model predicts probable inter-habitat corridors based on resource selection function (RSF) estimates from wolverine location data collected from wolverines fitted with VHF and GPS tracking devices and circuit theory (Inman et al. 2013a; Bergen and Inman *in preparation*). The RSF estimates are more favorable (e.g., lower cost for movement) for those areas with similar habitat qualities (measured across several factors) that influence wolverine locations. These 2 models differ in resolution (1 km compared to 360 m) and scale (northern Rocky Mountains compared to 11 western states). A consortium of state and federal agencies and conservation organizations in the High Divide Region of the northern U.S. Rockies (region between the GYE, Salmon-Selway, and Northern Continental Divide ecosystems) will run comparative analyses on these 2 connectivity models once current logistical limitations are resolved.

Because of the great interest by natural resource agencies and nongovernmental organizations (NGO) in wolverine connectivity, there is a coordinated effort to further model wolverine genetic relatedness by combining RSF movement estimates with genetic relatedness across the northern U.S. Rockies where genetic samples from wolverine are available within a reasonable period of time (1990-2013). Results from this analysis will provide more information concerning prevalent wolverine corridors within Idaho, connection of Idaho populations to neighboring state populations, and provide further information concerning how and where isolated wolverine habitats are connected and related. By comparing the information provided by all wolverine connectivity models, IDFG will be in a stronger position to help facilitate connectivity among wolverine subpopulations and conserve habitat to support viable wolverine populations in Idaho.

Dispersed Snow Sports Recreation

The bioclimatic envelope hypothesis proposed by Copeland et al. (2010) that links wolverine distribution to persistent spring snow cover has changed the perception of why wolverines occur where they do. Whereas the wolverine was once described as an animal inhabiting remote areas, possibly to avoid human activity, current theory describes the wolverine as an animal that inhabits areas providing a specific bioclimatic niche defined by thermoregulatory constraints and limited interspecific competition (Copeland et al. 2010, McKelvey et al. 2011, Inman 2013a). In other words, wolverines may inhabit more remote high-elevation environments because their physiology requires colder temperatures and they face less competition with other large mammals that are not present in winter. The degree to which human activity in these high-elevation areas affects wolverine populations is unknown. What is known is that the human footprint is expanding into previously inaccessible areas, particularly during winter. Although wolverines are uniquely adapted to inhabit and survive extreme climates and conditions, the winter months are challenging. Wolverines are scavenging more than hunting live prey and reproductive females are entering the most energetically demanding period of the year. Low reproductive success (hypothesized to be linked to winter energy constraints) across the wolverine's range illustrates some potential

Winter backcountry recreation spatially overlaps with suitable and occupied wolverine habitats in Idaho. Photo by Darrins/CC BY-SA 3.0.

for disturbance during winter that may affect productivity (May et al. 2006, Krebs et al. 2007).

Winter backcountry recreation is one of the fastest growing recreational activities in the U.S. and Idaho (Cook and O'Laughlin 2008). Recreational opportunities include snowshoeing, skiing, snowcat-skiing, heli-skiing, and snowmobiling. At least 4 snowcat-skiing operations occur at developed ski areas in Idaho, and 2 heli-skiing operations provide access to the Pioneer, Boulder, Smoky, Sawtooth, and Teton mountain ranges. Idaho has over 7,200 miles of snowmobile trails, more than any other western state, and ranks among the West's top snowmobiling destinations (SnowTracks 2013). Snowmobiling participants in Idaho doubled between 1995 and 2011 (IDPR 2012). A popular snowmobile trailhead near McCall registered ≥7,000 users in a 3-month period in 2010 (Heinemeyer and Squires 2012). Advanced technology has created more powerful snowmobiles, which allows access to areas that were previously unreachable because of their remoteness or rugged terrain. For example, 56% of survey participants in 2004 reported spending most of their time off groomed trails (Cook and O'Laughlin 2008). State and federal natural resource managers have expressed concerns about potential effects of winter motorized and non-motorized recreation on wolverine populations since the 1980s (Copeland 2009).

Growth in winter recreation appears in the number of people recreating, variety of recreation opportunities being pursued, and areas where recreation occurs. In Idaho, many of these places spatially overlap suitable wolverine habitat and, more specifically, areas occupied by wolverines (Heinemeyer and Squires 2012; IDFG, unpublished data). Documented wolverine response to disturbance is limited and equivocal. Some research supports female avoidance of heli-skiing and backcountry skiing areas (Krebs et al. 2007) or den abandonment after human disturbance (Copeland 1996), but also instances where human disturbance did not result in den abandonment (Magoun and Copeland 1998). To date, only 1 study initiated in 2009 in Idaho (Idaho Wolverine-Winter Recreation Study), has directly examined spatial and temporal interactions between winter recreation and wolverine habitat use, movements, and denning (Heinemeyer et al. 2010, Heinemeyer and Squires 2012).

Preliminary data from the Idaho study demonstrate that some wolverines maintain stable home ranges in areas used by winter recreationists. Peak winter recreation activity in central Idaho, measured as the number of recreationists passing infrared trail-use counters, occurs in February, coinciding with the time female wolverines are selecting and entering dens (Heinemeyer et al. 2010). Individual wolverines experience varying levels of recreation within their home ranges (Heinemeyer and Squires 2012). Collectively across all study areas, individuals, and recreation levels, wolverines did not adjust the times of day they were active in response to recreation activity. However, 2 denning females in areas used by winter recreationists shifted their daily patterns during denning, becoming more active during non-peak recreation times, whereas a third denning female with no winter recreation in her home range did not shift the timing of her activity (Heinemeyer et al. 2010, Heinemeyer et al. 2012). Although general conclusions on denning female behavior cannot be drawn from this small sample, further study is warranted. In contrast to overall daily pattern, preliminary analyses identified changes in movement rates as a potential behavioral response to recreation across all study areas. At a fine scale, wolverines demonstrated greater daily movement rates in areas characterized by relatively high recreation levels (Heinemeyer et al. 2012).

Research in central Idaho is ongoing and poised to provide more conclusive results as sample sizes increase. IDFG will evaluate final results from this study, anticipated in 2018, and other emerging science to assess if directed conservation actions are appropriate and, if so, what measures best address wolverine energetics, reproductive success, and species persistence.

Human Infrastructure

Permanent structures associated with human developments in North American wolverine habitats include housing, oil and gas wells, energy transmission lines, highways, campgrounds, ski areas, and development associated with timber harvest and mining. Potential effects of infrastructure development on wolverine populations include direct elimination and fragmentation of habitats, disruption of movement and dispersal, direct mortality (e.g., vehicle collisions), and indirect loss of habitats due to displacement from suitable habitats (May et al. 2006, Squires et al. 2006, Fisher et al. 2013, Inman 2013a). Given the extensive habitat needs of wolverines, home ranges invariably are embedded in multiuse landscapes with varying degrees of development.

Transportation Corridors

High-use interstate or secondary roads are relatively uncommon in wolverine habitat but can negatively affect wolverine movements. Wolverines avoided areas <100 m from the Trans Canada Highway at Kicking Horse Pass (an important north-south travel corridor for wolverines on the Continental Divide), preferred areas >1,100 m from the highway, and selected for areas where the distance across the highway right-of-way was relatively narrow (<50 m) (Austin 1998). Wolverines that attempted to cross the highway repeatedly approached and retreated, crossing only 50% of the time. In the GYE, Packila et al. (2007) documented 43 crossings of U.S. and state highways by 12 wolverines. Road crossing locations were indicative of linkage areas. Dispersing wolverines from this same GYE study altered their course to avoid human developments and navigate through traffic (Inman et al. 2009). A young male wolverine dispersing from Togwotee Pass, Wyoming to Rocky Mountain National Park, Colorado successfully navigated across Interstate 80, 3 U.S. highways, and 5 state highways (Inman et al. 2008). Wolverines did not use areas near roads in central Idaho (Copeland et al. 2007). However, most of the roads were sited at lower elevations and peripheral to the study site, and low use was attributed to unequal availability across the study area. Similarly, Inman et al. (2013a) found a negative relationship between wolverine use and road densities at higher elevations where wolverines typically occur.

Transportation corridors have the potential to reduce population viability by increasing mortality from vehicle collisions. Although incidents are rare, wolverine mortalities from vehicle collisions have been reported rangewide. Road- and rail-killed wolverines accounted for 3 of 62 mortalities (4.8%) from 12 radiotelemetry studies conducted in North America between 1972 and 2001 (Krebs et al. 2004). Wolverines may also be vulnerable to collisions with vehicles while scavenging vehicle-killed wild ungulates (Squires et al. 2006).

Maintaining connectivity among wolverine metapopulations in the island-like habitat of the conterminous U.S. is critical to the long-term conservation of the species. Transportation networks are 1 component of many landscape resistance factors that may affect wolverines. Mitigating effects of roads to enhance permeability for wolverines is difficult given the species' large spatial requirements, mobility, and generalist response to landscape features (Squires et al. 2006). From a highway planning perspective, structural mitigation features such as overpasses, underpasses, or culverts may be ineffective for such a wide-ranging species. Furthermore, fencing or concrete barriers used to funnel wildlife to passages may be less effective given the wolverine's climbing and digging abilities. The most appropriate mitigation approach for wolverine is to identify linkage zones at local and regional scales and conserve these corridors through proactive landscape planning, including land exchanges and easements (Ruediger 2005, May et al. 2006, Squires et al. 2006, Packila et al. 2007, Inman 2013a). Within linkage zones, site-specific mitigation may include maintaining continuous forest cover that links habitat patches, minimizing distance between cover, and removing discord elements that affect wildlife movement (e.g., bright metal objects, signing, construction debris, over-confining fencing) (Ruediger 2005). Given limited data on wolverine response to highway mitigation projects, pre- and post-mitigation monitoring to evaluate project effectiveness and inform future mitigation approaches is important.

Residential and Commercial Development

Although year-round wolverine habitat and human settlements are largely spatially separated (Copeland et al. 2007), potential exists for human infrastructure to inhibit aspects of wolverine ecology. Ski resorts comprise the largest developments in wolverine habitat (USFWS 2013a). Ski resort infrastructure, including ski lifts, resort and lodging development, parking lots, ski trails, utility lines, water storage, and waste disposal, can have localized impacts on fragile mountain ecosystems (Mackenzie 1989, Wipf et al. 2005, Rolando et al. 2007). In Colorado, the state with the highest number of ski areas in the range of the wolverine, approximately 26 ski resorts occupy 0.6% of available wolverine habitat (Colorado Division of Wildlife 2010). Of Idaho's existing 18 ski resorts, 12 are located in predicted wolverine habitat. Although the scale at which ski resorts impact the landscape is small relative to wolverine home range size, potential impacts on wolverine habitat values, particularly natal denning habitat, require careful consideration by land and resource managers.

Infrastructure development on private lands in the western U.S. has rapidly accelerated in recent decades, increasing the network of permanent dwellings and roads in intervening valleys between core wolverine habitats.

Infrastructure and activities associated with extractive industries (e.g., mining and logging) are potential sources of habitat alteration and disturbance to wolverines (Krebs et al. 2007, Fisher et al. 2013). Impacts associated with mining may include habitat fragmentation (e.g., roads, loss of forest cover) and disturbance from noise, humans, and machinery. Economic forecasts for Idaho's mining industry indicate steady growth through 2015, with surging metal prices fueling increased renovation and exploration activity (IDFM 2012). It is unknown whether accelerated mining development would occur at a scale that would have population-level effects on wolverines. Likewise, little is known about effects of forestry-associated infrastructure and activities on wolverines. Areas suitable for intensive timber management tend not to overlap alpine and subalpine habitats selected by wolverines. Where they do overlap, temporal and spatial impacts of forestry-related infrastructure do not occur at a scale that is likely to adversely impact wolverine populations. Logging and mining operations sometimes result in plowing roads that are not usually maintained during the winter. This may allow more recreationists to access wolverine habitat (Krebs et al. 2007).

Infrastructure development on private lands in the western U.S. has rapidly accelerated in recent decades (Hansen et al. 2002, Gude et al. 2007), increasing the network of permanent dwellings and roads in intervening valleys between core wolverine habitats. Although evidence suggests wolverines are able to navigate the current landscape to new home ranges, the threshold at which increasing road and housing densities might inhibit wolverine survival and gene flow is unknown. May et al. (2006) found wolverines located home ranges in Norway in undeveloped areas where infrastructure was concentrated in forested valleys between high alpine plateaus and peaks. Furthermore, anthropogenic disturbance in once-remote areas made habitat less optimal or unsuitable, impeding wolverine ability to perform essential life-history activities. Copeland (1996) suggested high road densities, timber sales, or housing developments on fringes of subalpine habitats may inhibit winter foraging and kit rearing and increase potential for human-caused wolverine mortality. Habitats used by wolverines during dispersal or exploratory movements may encompass numerous jurisdictions subject to potential development. Inman (2013a) identified the relative value of lands in the Central Linkage Region (western Montana–Idaho divide) based on their potential contribution to wolverine dispersal and gene flow. He found nearly one-half of the highest scoring lands were in private ownership. Therefore, maintaining a network of suitable connectivity corridors among core reproductive habitats is deemed critical for long-term wolverine persistence (Gude et al. 2007, Schwartz et al. 2009, Inman et al. 2013a).

Incidental Trapping and Shooting

Trapping and hunting wolverines is currently prohibited in the lower 48 states. However, licensed trappers setting traps for other legal furbearers, such as bobcat (*Lynx rufus*), wolf, and coyote, have incidentally caught a small number of wolverines, about half of which were live releases. A few wolverines have also been shot by recreational shooters or hunters who mistook wolverines for other species. In Idaho, any wolverines unintentionally trapped by licensed trappers are considered nontarget catches (any species caught for which the season is closed or a season does not exist). Furbearer trapping regulations require that all nontarget species caught alive be immediately released. For nontarget catches resulting in death, trappers are required to record the date and species caught, notify IDFG within 72 hours of capture, and transfer the animal to IDFG possession. Trappers complete a mandatory furtaker harvest report form at the end of each trapping season to include nontarget catches and whether the animal was released alive or found dead. Although IDFG does not have a method to assess accuracy of incidental capture reporting rates, reporting is incentivized by reimbursing trappers $10 for each incidentally trapped wolverine turned in.

Fourteen incidentally trapped wolverines have been reported during Idaho furbearer seasons since 1965 (the year wolverines were designated as state-protected). Eight of the incidental catches were released alive, and 6 resulted in mortality. From 1965–2014, nontarget catches accounted for an average 0.29 wolverines annually (0.12 for catches resulting in mortality). This count included 4 wolverines incidentally trapped during the 2013-2014 furbearer season (3 released alive; 1 mortality). We do not know if 4 catches indicates an increasing rate of incidental trapping or if it is merely a single season anomaly. For example, were the 4 nontarget captures in 2013-2014 correlated to increased trapper numbers? Averaged sales of Idaho trapping licenses in 2011-2014 nearly doubled over the previous 5-year average of 1,181, largely in response to increased fur prices attributed to expanding Asian markets. Twenty-five percent of the increase in trapping license sales also reflected additional licenses sold during the first few years of Idaho's wolf trapping season. Fur prices have since declined, which may result in a corresponding decline in future trapper numbers. Rates of incidental capture may also be attributed to weather conditions (i.e., lack of snow allowing trapper access to remote wolverine habitats) or indicate an increasing wolverine population.

Since wolf reintroduction in 1995, 3 wolverines were trapped incidental to wolf control actions authorized by the USFWS or IDFG for the protection of livestock. Two wolverines were released alive and 1 was euthanized. Additional preventative measures were adopted in 2010 to further reduce the likelihood of incidental capture events.

Two wolverines are known to have been shot and killed in Idaho. In 2001, a male wolverine was shot by teenagers near the Snake River northwest of Twin Falls. In 2007, a male wolverine was shot by a hunter on Boise Ridge east of Horseshoe Bend, who claimed he mistakenly identified the animal as an American badger (*Taxidea taxus*). In both cases, the wolverines were encountered in atypical habitat.

To put Idaho's level of nontarget wolverine mortality in context, it is informative to examine the information available from neighboring Montana. Wolverines were a legally harvested furbearer in Montana up until 2012. There was no limit to harvest (seasons or bag limits) for the 50 years between the species' apparent extirpation from the lower 48 states (around 1920) and the mid-1970s, yet during this period wolverines appear to have recovered to occupy their historical range within Montana. From the mid 1970s through 2012, when seasons and bag limits were in place, an average of 12 wolverines were trapped each year (>400 wolverines). All of the presently available information suggests that wolverines still occupy suitable habitats in Montana and there is substantial evidence of reproduction (Squires et al. 2007; Inman et al. 2008; Anderson and Aune 2009; Montana Fish, Wildlife and Parks, unpublished data).

Incidental trapping risk to wolverines is deemed very low in the contiguous U.S. (Hiller and White 2013, USFWS 2013a). To ensure the level of wolverine incidental trapping remains low in Idaho, IDFG has proactively implemented educational measures to minimize nontarget capture of wolverine during trapping seasons. The IDFG's 2014-2015 Furbearer Seasons and Rules brochure includes a full page of guidelines to reduce trap-related injuries and minimize nontarget catches of wolverine and Canadian lynx (*Lynx canadensis*). Licensed wolf trappers are required to take a Wolf Trapper Education course where specific instruction is provided on avoiding incidental catch of wolverine, lynx, and other nontarget species by employing proper snare height and pan-tension on foothold traps. From November 2011 to March 2014, about 2,000 individuals were certified through the course, although only about 12% of certified licensed trappers elected to trap wolves.

In recent years, IDFG has adopted regulatory mechanisms to minimize nontarget capture of wildlife during trapping seasons. These measures require that ground set snares be equipped with a break-away device or cable stop incorporated within the loop of the snare. IDFG will continue to monitor the effectiveness of these mechanisms in minimizing nontarget capture of wolverines in the course of legal trapping activities directed at other species.

IDFG issues permits allowing live capture, handling, and release of wolverines for scientific studies. These studies generally employ log box-traps that do not cause physical injury to trapped wolverines. In recent years, the IDFG has issued scientific collection permits to the Wildlife Conservation Society, USFS Rocky Mountain Research Station, and Round River Conservation Studies for research involving capture, chemical immobilization, and placement of GPS or VHF radiomarkers on wolverines. Employees of IDFG also lead and participate in wolverine research capture activities. Permittees and IDFG employees adhere to animal trapping and handling protocols approved by IDFG's Wildlife Health/Forensic Laboratory and other animal welfare and research institutions. Two wolverine deaths have been documented as a result of live capture activities in Idaho over the past 20 years.

Knowledge Gaps

While knowledge of wolverine ecology in Idaho has been significantly advanced by peer-reviewed research, there remain critical information gaps on wolverine ecological requirements, demography, and response to anthropogenic activities. Closing these gaps is challenging given wolverines are inherently difficult to study. Wolverines occur at low densities, are difficult to detect, range widely, and inhabit remote and rugged landscapes away from human populations. Because of these logistical challenges and sampling required across vast areas, wolverine studies are labor intensive and expensive to implement. Consequently, capacity to conduct wolverine research and monitoring is contingent on adequate funding supported by multiple partners.

Researchers and agency resource managers have identified several research and monitoring needs for wolverine in the contiguous U.S. The following is a partial list of information needed to inform future policy, conservation planning, and management decisions for this species.

The noninvasive camera/hair-snag station is an effective method for monitoring cryptic forest carnivores such as the wolverine. Photo by IDFG.

Wolverine Distribution and Abundance

Estimates of wolverine population and habitat distribution and abundance are fundamental data to assess conservation status, extirpation risks, population changes over time, and responses to resource management actions. At present, we possess basic knowledge of broad distribution patterns of wolverines in Idaho, but do not have the resolution required to assess population abundance and trends. Several western states, including Idaho, are engaged in ongoing, small-scale wolverine monitoring efforts that employ a range of techniques (e.g., camera/DNA stations, GPS/VHF tracking, aerial track/den surveys, ground-based track surveys). These studies are valuable at subpopulation scales, but do not comprise a cohesive strategy to monitor population distribution, abundance, and trend across the contiguous U.S. The need for a metapopulation monitoring program distributed across multiple western states, provinces, and jurisdictions is identified as a priority action by numerous multiagency workshops convened to address wolverines and climate change (Inman et al. 2013b).

Depending on scale and objectives, a well-designed and executed monitoring program might detect changes in wolverine occupancy and relative abundance, distribution of reproductive females, reproductive rates, gene flow within and among ecological and political boundaries, local landscape use, and rates and sources of mortality. Considering wolverine life history traits and logistical challenges described above, it is critical to evaluate the statistical power of monitoring schemes to detect population size and trends. Ellis et al. (2013) used simulations to investigate the statistical power of monitoring protocols to detect changes in U.S. Rocky Mountain wolverine population abundance over time. Based on an occupancy monitoring approach using camera stations and hair snares in 100 km^2 sample cells, the authors estimated that about 100-150 cells would need to be sampled per year to reach an 80% probability of detecting a 50% decline in the current U.S. Rocky Mountain population. For small populations ($n = 30$), the statistical power to detect population trend was limited. If an objective is to detect population changes over time, a wolverine monitoring program would be most effective designed at the metapopulation level. The development of such a monitoring program should be undertaken by wolverine researchers, conservation biologists, and statisticians with attention to cost and logistical feasibility. Cooperation and coordination among western states and provinces would be vital to the successful implementation of this effort.

Natal and Maternal Den Selection

Factors important to reproductive female wolverines in den site selection are not well understood. Further research is needed to understand how den structure contributes to kit survival and how other characteristics (e.g., forest cover type, aspect and slope, distance to roads, human disturbance, etc.) influence den site selection. Investigations are also needed to understand the relevance of summer food availability to den site selection. While den sites align with a bioclimatic niche defined by spring snow cover (Copeland et al. 2010), research is needed to better understand how snow characteristics (i.e., depth, water content, rate of snowmelt) influence wolverine denning success, particularly in the context of a warming climate.

Wolverine Use of Forested Habitats

Research is necessary to understand how landscape-scale habitat features (e.g., wildfire, insect outbreaks, timber harvest blocks, forest seral stages, locations of travel corridors) may influence wolverine use of managed forests. Studies are also needed at the stand level to provide a basis for developing forest management guidelines for harvest prescriptions, road densities, and human footprint thresholds to maintain wolverine habitat and stable, viable wolverine populations.

Wolverine Response to Climate Change

Available scientific literature demonstrates that Idaho's climate is changing. However, climatic projections and their potential impacts to wolverine habitat contain a range of uncertainties. Continuing research and monitoring is needed to

IDFG Senior Research Wildlife Biologist Lacy Robinson trains citizen naturalists to participate in wolverine surveys. Photo by M. Lucid.

understand the magnitude of climate change, its influence on snow pack, and resulting effects on wolverines.

Public Outreach and Education

The long-term engagement and commitment of Idaho citizens in wolverine conservation is essential to its success. A critical component of generating this support is to ensure that all stakeholders are provided information on wolverine ecology and conservation requirements, and that this information is readily available through traditional and innovative communication methods. IDFG uses newsletters, public meetings, workshops, media outlets, internet, and other communication tools to share information with stakeholders. However, the way society receives information is ever changing and will continue to evolve. IDFG strives to keep pace with evolving media formats and communications strategies. This approach is demonstrated by ongoing development of innovative website tools designed to engage and inform the public (e.g., Report Observations, Report Roadkill, Hunt Planner, Fishing Planner). Likewise, stakeholder input is integral to helping IDFG make sound resource management decisions. IDFG is committed to working in partnership with all stakeholders to seek and take into account their knowledge, experience, and perspectives.

Citizen support for wolverines and other wildlife is increasingly channeled through volunteerism. The ever growing collaboration between IDFG and citizen scientists not only serves to engage the time, skills, and energies of a dedicated constituency, but actively contributes important biological data to assess the status of native fish, wildlife, and plants. In 2013, over 4,000 volunteers donated over 60,000 hrs to IDFG projects statewide, which is equivalent to nearly $1.5 M dollars donated to wildlife conservation (IDFG, unpublished data). The Multi-Species Baseline Initiative, a collaborative project to survey for a variety of wildlife species and climate indicators across the Idaho Panhandle, has engaged hundreds of citizen naturalists to assist with forest carnivore camera/bait station monitoring. For instance, over the past 4 years, Friends of Scotchman Peaks Wilderness has engaged over 200 volunteers who have contributed >3,000 hrs and thousands of vehicle miles to monitor 70 camera/bait stations. Contributions from NGOs and individual volunteers, such as the hundreds of winter recreationists who have volunteered to carry data loggers for the Idaho Wolverine-Winter Recreation Study, significantly leverage data collection, staffing, and cost-share capacity of monitoring projects targeting wolverines. The IDFG views NGOs, citizen scientist volunteers, and Idaho's general public as essential partners in the stewardship of wolverines and all native fish, wildlife, and plants in Idaho.

Wolverine Priority Conservation Areas

One of the most pressing issues facing natural resource agencies and the conservation community is how to distribute limited resources (funding and capacity) to achieve highest conservation value. Many conservation prioritization analyses have been undertaken globally, using a range of criteria primarily related to biological importance and levels of threat. Because resource shortages also apply to Idaho, IDFG conducted a structured, objective assessment to identify Priority Conservation Areas (PCA) within the state. Identification of PCAs provides a framework to step down statewide management direction to local scales, where community-based conservation is an essential level of implementation. The flexibility inherent in locally-driven approaches allows wolverine conservation to fit local situations. As such, we consider PCAs to be inherently dynamic. Prioritization scores can be recalculated as new data become available, appropriately at the local working group level. This process will help ensure that limited and valuable resources have the greatest possible impact on the conservation status of wolverine in Idaho.

Our process for identifying PCAs involved assessment of current information on wolverine distribution and habitat use with 5 categories of potential threats to discern how their influence may differ geographically within the state. We elected to use IDFG's 99 game management unit (GMU) boundaries as our spatial unit, as GMUs are inclusive across landownerships, defined in state administrative rules, and tiered to IDFG regional management responsibility (i.e., implementation). Importantly, predicted wolverine habitat occurs only in portions of each GMU identified as a PCA; thus, GMUs are over-inclusive of key conservation areas. Prioritization methods and results are summarized in Appendix A.

The assessment process identified a network of PCAs expected to deliver the greatest benefits to wolverine conservation in Idaho over the next 5 years (Fig. 9). Based on final scoring values, PCAs were categorized as Tier I, Tier II, or Tier III (Appendix A; Table A.1). Tier 1 PCAs were the highest-scoring GMUs (final score >27) based on potential wolverine use, cumulative threats, and amount of unprotected habitat. Tier II PCAs were moderate- to high-scoring GMUs (final score >20 and ≤27) based on the same attributes evaluated for Tier 1 PCAs. Tier III PCAs were low-scoring GMUs (final score ≤20 with >2% of GMU within the composite model) that included both 1) GMUs with high proportions of permanent protection and low levels of cumulative threats, and 2) GMUs with low potential wolverine use and low-moderate cumulative threats. GMUs with ≤2% of the wolverine composite model within the unit were not categorized as PCAs and were therefore considered the lowest priority for conservation actions.

Many of the GMUs comprising core wolverine habitat in Idaho were not ranked as Tier 1 PCAs due to permanent protections provided by wilderness and roadless designations, which limit potential threats. This ranking does not infer that Idaho's core population areas are immune to threats or less important to wolverine conservation. Rather, the ranking seeks to prioritize those GMUs with more immediate potential threats for which tangible conservation actions can be taken within a 5-year Plan implementation timeframe. Furthermore, the objectives, strategies, and conservation actions outlined in the next section (Statewide Management Direction) will apply to all GMUs regardless of their PCA ranking.

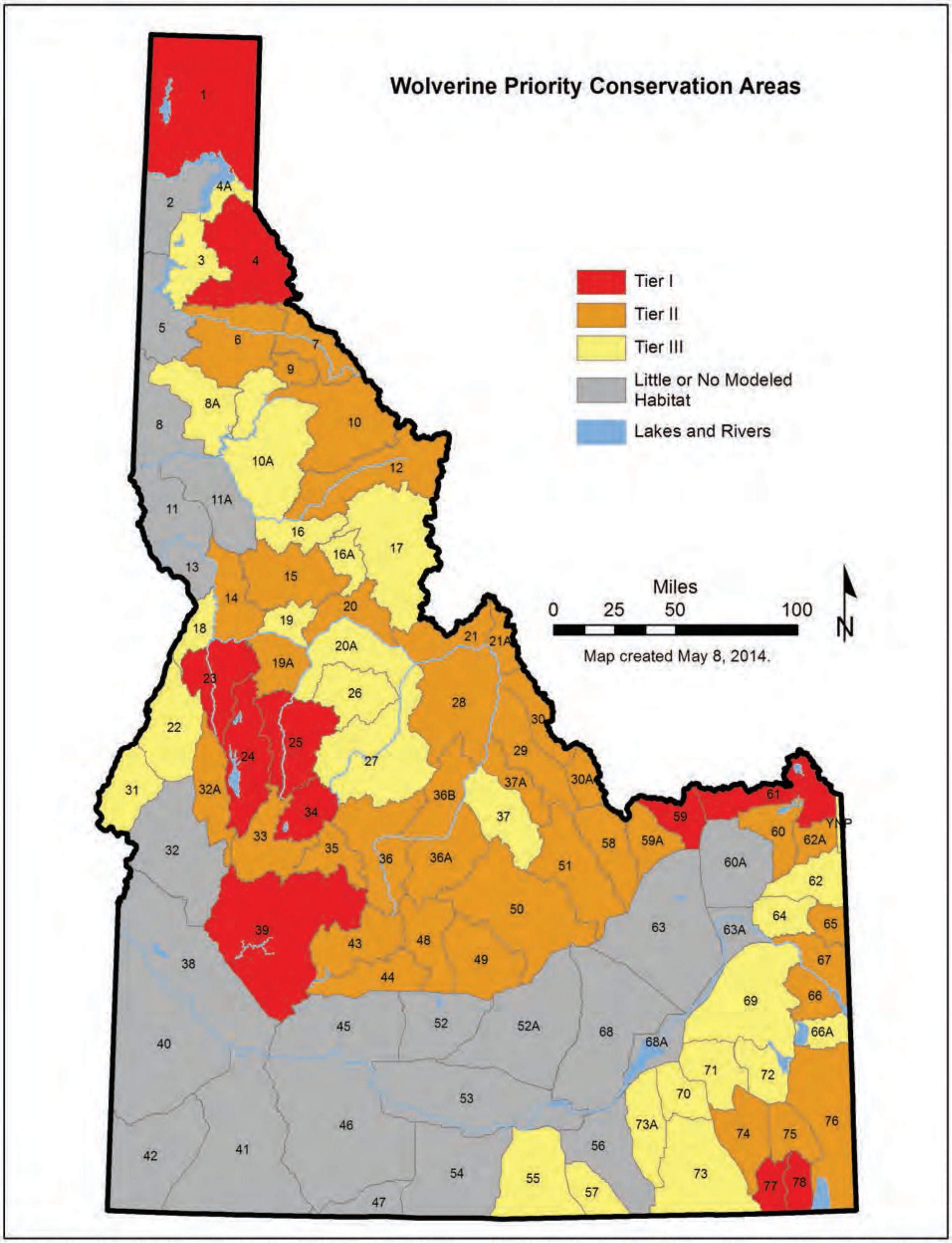


Figure 9. Wolverine Priority Conservation Areas in Idaho. Tiers were determined through an additive process evaluating potential wolverine use and conservation threats for each Game Management Unit (GMU). Tier 1 (red) are highest scoring GMUs based on potential wolverine use, cumulative threats, and amount of unprotected habitat. Tier II (dark gold) are moderate-high scoring GMUs based on these same attributes. Tier III (yellow) are low scoring GMUs based on: a) a high proportion of permanent protection within the GMU (e.g., wilderness area) and low cumulative threats, or b) low potential wolverine use and low-moderate cumulative threats. Gray-shaded GMUs contain <2% or No Modeled Habitat.

Statewide Management Direction

This section describes 7 objectives with associated strategies and actions to guide conservation and management of wolverines in Idaho over the next 5 years (2014-2019). The objectives, strategies, and actions outlined below (Table 4) are subject to revision as new information becomes available. Progress toward completion of these actions is contingent on workload prioritization and further acquisition and reallocation of resources within IDFG and from outside sources.

Table 4. Statewide management direction for wolverine conservation in Idaho.

Strategies	Actions	Timeline	Conservation Issues Addressed
Objective 1: Collaborate across multiple jurisdictions and spatial scales to achieve wolverine conservation.			
Strategy 1.1: Support the development of a collaborative, multistate/province wolverine monitoring program.	1.1.1: IDFG will participate with other peer agencies and provinces to develop a landscape-scale population monitoring protocol.	2014–2019	• Knowledge gaps • Genetic and habitat connectivity
	1.1.2: To the extent possible given existing resources, IDFG will implement the wolverine monitoring protocol referenced in Action 1.1.1.	2014–2019	
	1.1.3: Share wolverine data (observations, genetic samples, spatial products) with cooperators through a designated, centralized database to facilitate broad-scale analytical applications.	2014–2019	
Strategy 1.2: Develop a state organizational framework to coordinate, prioritize, and implement wolverine conservation activities to protect resilient landscapes in Idaho.	1.2.1: IDFG will convene a state wolverine technical working group with broad representation to: Develop shared priorities for wolverine population/habitat conservation and management; Identify opportunities for shared funding and logistical support for priority actions; Determine the best platform to share information and data across jurisdictions to facilitate communication and analytical applications, and assign responsibility to build the information-sharing platform; Review, and if warranted, revise criteria and/or data used to identify and rank Wolverine Priority Conservation Areas.	Winter 2014	• Knowledge gaps • Climate change • Genetic and habitat connectivity • Public outreach and education

Strategies	Actions	Timeline	Conservation Issues Addressed
Strategy 1.3: Facilitate local conservation actions tiered to statewide objectives.	1.3.1: As appropriate, establish and support local working groups to advise conservation activities in Wolverine Priority Conservation Areas.	2014–2019	• Knowledge gaps • Climate change • Genetic and habitat connectivity • Public outreach and education
Objective 2: Facilitate connectivity among wolverine subpopulations to enhance genetic exchange and population demographics.			
Strategy 2.1: Identify and characterize movement corridors important for maintaining genetic exchange and diversity among wolverine subpopulations.	2.1.1: Refine and aggregate wolverine movement corridor and genetic exchange models to predict existing movement pathways.	2016	• Genetic and habitat connectivity • Knowledge gaps • Climate change
	2.1.2: Contribute wolverine genetic samples, as available, to connectivity model analyses.	2014–2016	
Objective 3: Conserve habitat to support viable wolverine populations.			
Strategy 3.1: Secure appropriate conservation status on priority wolverine movement corridors to achieve an ecologically connected network of public and private conservation areas to facilitate migrations, range shifts, and other transitions caused by climate change.	3.1.1: Conserve corridors and transitional habitats between ecosystem types through both traditional and nontraditional mechanisms (e.g., land exchanges, conservation easement tax incentives, Land and Water Conservation Fund) to enhance habitat values and maintain working landscapes under climate change.	2014–2019, ongoing	• Genetic and habitat connectivity • Knowledge gaps • Climate change
	3.1.2: Identify, assess, and prioritize critical connectivity gaps and needs across current conservation areas, including areas likely to serve as refugia in a changing climate (using models developed under Action 2.1.1).	2018–2019, ongoing	• Genetic and habitat connectivity • Knowledge gaps • Climate change

Strategies	Actions	Timeline	Conservation Issues Addressed
Strategy 3.2: Develop partnerships to protect and preserve landscapes and corridors critical to wolverine dispersal and movement.	3.2.1: Assist private landowners with information and resources to conserve wildlife corridors across their properties.	2014–2019, ongoing	• Human infrastructure • Genetic and habitat connectivity • Climate change • Public outreach and education
	3.2.2: Support and strengthen conservation programs (e.g., Farm Bill, Forest Legacy, Land and Water Conservation Fund, Transportation Bill, conservation easement tax incentives, Partners for Wildlife Program, etc.) that provide resources for purposes of conserving wolverine habitat and connectivity.	2014–2019, ongoing	
	3.2.3: Provide wolverine and other wildlife data and maps to county/municipal, land managers, and transportation departments to promote the avoidance, minimizing, and mitigating of impacts of new infrastructure developments on wolverine populations and habitats.	2014–2019, ongoing	
Strategy 3.3: Ensure safe passage of wolverines and other wildlife across highways and other transportation infrastructure.	3.3.1: Continue the partnership with Idaho Transportation Department (ITD) and Federal Highway Administration (FHWA) to develop and monitor traffic volume, wildlife-vehicle collisions, and other metrics needed to identify connectivity and high risk areas for road mortality or road crossing avoidance.	2014–2019, ongoing	• Human infrastructure • Genetic and habitat connectivity • Climate change • Public outreach and education
	3.3.2: Work with ITD to design connectivity and crossing mitigation consistent with FHWA *Handbook for Design and Evaluation of Wildlife Crossing Structures in North America.*	2014–2019, ongoing	
	3.3.3: Work with ITD to avoid and reduce barriers or impediments (e.g., fencing, safety barriers, retaining walls) to connectivity and crossings.	2015	
Objective 4: Support the development and use of inventory and monitoring systems to assess wolverine vulnerability to climate change.			
Strategy 4.1: Support, coordinate, and where necessary develop inventory, monitoring, observation, and information systems at multiple scales to detect and describe potential climate impacts on wolverines.	4.1.1: Develop, refine, and implement monitoring protocols that provide key information needed for managing and conserving wolverine and alpine/subalpine communities in a changing climate.	2014–2019, ongoing	• Climate change • Genetic and habitat connectivity • Knowledge gaps

Strategies	Actions	Timeline	Conservation Issues Addressed
Strategy 4.2: Conduct research into ecological aspects of climate change to increase understanding of how wolverines and their habitats are likely to respond to changing climate conditions.	4.2.1: Work with researchers to develop regionally downscaled Global Climate Models (using the most current models and emission scenarios) and associated climate indicators (e.g., snow data) to support a wolverine vulnerability assessment.	2014–2019, ongoing	• Climate change • Genetic and habitat connectivity • Knowledge gaps
	4.2.2: Produce regional to subregional projections of future climate change impacts on physical, chemical, and biological conditions for Idaho ecosystems, particularly alpine and subalpine communities.	2016–2019	• Climate change • Genetic and habitat connectivity • Knowledge gaps
Objective 5: Further understand potential impacts to wolverine population viability as a result of disturbance from dispersed snow sports recreation.			
Strategy 5.1: Increase knowledge of the relationships between dispersed snow sports recreation and wolverine behavior.	5.1.1: Continue to support the Idaho Wolverine-Winter Recreation Study to its conclusion to promote increased sample size, statistical power, and inference of results.	2014–2018	• Dispersed snow sports recreation • Knowledge gaps • Climate change
	5.1.2: Identify additional research areas in Idaho or within the inland Rocky Mountains to conduct recreation-focused research.	2014–2017	

Strategies	Actions	Timeline	Conservation Issues Addressed
Strategy 5.2: Predict areas of potential overlap of wolverines and dispersed snow sports recreation.	5.2.1: Develop map to show areas of predicted early spring snowpack in 50 years.	2017	• Dispersed snow sports recreation • Knowledge gaps • Climate change • Genetic and habitat connectivity • Public education
	5.2.2: Use known occurrence and wolverine home range sizes in Idaho to predict areas of overlap.	2014–2019	
	5.2.3: Work with federal land management agencies and user groups on travel planning and access issues.	2018	
	5.2.4: Coordinate with the Idaho Governor's Office of Species Conservation to join federal land management agencies travel planning ID teams and use results of published studies to promote travel management that is compatible with conservation of secure wolverine denning areas.	2014–2019	
	5.2.5: Promote public reporting of wolverine occurrence though education, including information signs at winter recreation trailheads, education pamphlets, and requests to report sightings of tracks or animals via the IDFG web site.	2014–2019	
	5.2.6: Work with recreation user groups to promote awareness and interest in wolverine ecology. Encourage the development of peer-driven programs that enhance recreationists' desire to avoid potential conflict with wolverines.	2014–2019	
Objective 6: Continue to minimize injury and mortality of wolverines from incidental trapping and shooting.			
Strategy 6.1: Review current trapping regulations and techniques to assess potential to continue to minimize incidental trapping of wolverine.	6.1.1: Review literature, research, and databases to evaluate traps and trapping methods most effective in minimizing injury and mortality to wolverine and other nontarget species. Summarize results and consider findings in developing furbearer trapping regulations.	2016	• Incidental trapping • Public education • Knowledge gaps
	6.1.2: Continue to engage with IDFG Regional Working Groups to review and recommend trapping technology and methods to further minimize nontarget wildlife captures, including wolverines.	2017	

Strategies	Actions	Timeline	Conservation Issues Addressed
Strategy 6.2: Strengthen hunter and trapper education and awareness programs to continue to minimize wolverine nontarget trapping and shooting and potential injury and mortality.	6.2.1: Work with Idaho Trappers Association to advance education, awareness, and practice of Best Management Practices to reduce incidental capture of wolverines.	2014–2016, ongoing	• Incidental trapping • Public education
	6.2.2: Modify and format "How to avoid incidental take of wolverine during regulated trapping activities" (Hiller and White 2013) into a pocket-sized pamphlet specific to Idaho. Provide pamphlet to all trapping license purchasers.	2015	
	6.2.3: Continue to address avoidance of wolverine nontarget captures as part of Wolf Trapper Education course curriculum; provide the modified Hiller and White (2013) pamphlet to each enrolled trapper.	2014–2019, ongoing	
	6.2.4: Provide wolverine and American badger illustrated comparisons in IDFG Furbearer Seasons and Rules brochures to differentiate the species, emphasizing that wolverines are wide-ranging and may be encountered in any habitat.	2016	
	6.2.5: Develop online and print 'Wolverine Identification Guide' product to distinguish wolverines from other mammals (badgers, marmots, bears) that share similar habitats.	2015	
	6.2.6: Require review of this section of the Plan as part of Hunter Education curriculum, emphasizing that dispersing wolverines may be encountered in a wide range of habitats.	2015–2019, ongoing	
	6.2.7: Enhance and document IDFG Enforcement presence, patrol, and monitoring related to trapping compliance and wolverine protection; document and report nontarget catch; encourage reporting by licensed trappers.	2014–2019, ongoing	

Strategies	Actions	Timeline	Conservation Issues Addressed
Strategy 6.3: Strengthen IDFG workforce effectiveness in responding to wolverine nontarget captures.	6.3.1: Develop a response protocol for incidental captures of wolverines and other nontarget species to include standardized reporting, data collection, handling, and disposition of deceased animals; ensure that data are contributed to the Idaho Fish and Wildlife Information Systems database.	2015	• Incidental trapping • Public education
	6.3.2: Provide each IDFG Regional Office with a wolverine handling kit to include restraining equipment, immobilization drugs, DNA sampling kit, satellite tracking collar, and first aid supplies.	2015	
	6.3.3: Use the modified Hiller and White (2013) pamphlet to include 24/7 contact information for ≥2 IDFG employees per Region certified to administer wildlife immobilization drugs.	2015	
	6.3.4: Provide Trapper Education training for Conservation Officers and Wildlife staff to include safe release of nontarget wildlife, including wolverines, from traps.	Fall 2015	

Strategies	Actions	Timeline	Conservation Issues Addressed
Objective 7: Generate support and partnerships for wolverine conservation by promoting education, awareness, and stewardship of wolverines and alpine and subalpine forest ecosystems.			
Strategy 7.1: Promote education and engagement of Idaho citizens in wolverine ecology and conservation.	7.1.1: Develop and implement a communications plan to enhance education and awareness of wolverine conservation among Idaho citizens.	2015–2016	• Public outreach and education • Knowledge gaps
	7.1.2: Develop and conduct "Project WILD about Wolverines" workshops for K-12 educators.	2016	
	7.1.3: Develop portable information displays featuring wolverines and other forest carnivores for use at regional offices, county fairs, schools, libraries, sports shows, conferences, and other public venues.	2016	
	7.1.4: Continue to provide training to state and federal agency biologists, Master Naturalists, non-governmental organizations and their volunteers, citizen scientists, and other interested individuals to enlist their participation in organized monitoring programs and large-scale studies for wolverines and other forest carnivores.	2014–2019, continuing	
	7.1.5: Expand outreach and education programs to winter recreation user groups, industries, and communities to further science-based understanding of the relationship between wolverines and winter recreation.	2014–2019, continuing	
	7.1.6: Promote public reporting of wolverine observations on IDFG's online web page.	2014–2019, continuing	
Strategy 7.2: Ensure that information on wolverine conservation is widely available to all stakeholders.	7.2.1: Continue to use both traditional and new media formats and communication strategies to better inform the public about wolverine ecology, management, research, and policy.	2014–2019, continuing	• Public outreach and education
	7.2.2: Provide stakeholder access to the Plan on the IDFG website and at regional offices.	Summer 2014	
	7.2.3: Widely distribute electronic and hardcopies of the Plan.	Fall 2014	

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APPENDIX A

Development of Wolverine Priority Conservation Areas in Idaho

Wolverine focal areas in Idaho reflect the relative scoring of potential wolverine use and potential threats within each Game Management Unit (GMU) across the state. Scoring was based on a 4-category rank (none, low, medium, high) and considered several factors including modeled habitat, modeled corridors, current verified observations, protection status of the habitat, vulnerability to climate change, road density, interstate highways, and winter recreation amenities. The spatial data used to depict each of these factors and the score definitions used are discussed below. All spatial analyses were conducted in ArcGIS 10.1 (ESRI 2012).

Potential Wolverine Use

Habitat Model

Several models of different aspects of wolverine habitat have been developed for Idaho. We used a composite of two wolverine habitat models, spring snow cover modeled by Copeland et al. (2010) and female dispersal habitat modeled by Inman et al. (2013a), to depict available habitat. We calculated the percent of each GMU in the composite model and assigned the following scores.

Value	Score
<1 = 0	0
1-9.9%	1
10-29.9%	3
>=30%	5

Corridor Model

Schwartz et al. (2009) identified potential corridors for wolverine dispersal. We applied a threshold value (100) to their model to create a binary (corridor/not corridor) map. We calculated the percent of each GMU in the potential corridor model and assigned the following scores.

Value	Score
<1 = 0	0
1-9.9%	1
10-29.9%	3
>=30%	5

Current Observations

The IDFG's Idaho Fish and Wildlife Information System Species Diversity Database (IDFG, unpublished data) is the most comprehensive and current set of observations for species in Idaho. We selected all wolverine observations and filtered for those considered verified as of 1 April 2014. We then identified GMUs with recent verified observations and assigned the following scores.

Value	Score
No verified record	0
Historical records (≤1989)	3
Recent records (≥1990)	5

Potential Threats to Wolverine

Unprotected Habitat

Much of Idaho is considered to be permanently protected (Gap Status 1 or 2, USGS 2012) or is managed as such (e.g., Inventoried Roadless Areas, Category 1B-1). Using the Protected Areas Database of the U.S. (USGS 2012) and the USFS Inventoried Roadless Area (USFS 2010), we calculated the percent of wolverine habitat in each GMU considered to be unprotected and assigned the following scores.

Value	Score
<1 = 0	0
1-9.9%	1
10-29.9%	3
>=30%	5

Climate Vulnerability

Lankford (2013) modeled the potential vulnerability of wolverine to climate change using the maximum dissimilarity of climate between 1960–1990 and 2070–2099 based on 12 climate variables and the estimated species sensitivity to those variables. We averaged the relative climate vulnerability scores across each GMU and assigned the following scores.

Value	Score
Low	1
Medium	3
High	5

Road Density

Numerous road data sets are available for Idaho. We used a compilation of the most current Idaho Geospatial Data Clearinghouse (IGDC) roads data (IGDC 2014) and the 2013 TIGER/Line shapefiles (U.S. Census Bureau 2013) for the counties that did not have IGDC data. These 2 datasets include all roads currently mapped in Idaho. We summed the total length of roads (km) in each GMU, calculated density based on GMU area (km^2), and assigned the following scores.

Value	Score
<0.5 km/km^2	1
0.5-1.0 km/km^2	3
> 1.0 km/km^2	5

Interstate Highways

Using the 2013 TIGER/Line shapefiles (U.S. Census Bureau 2013), we identified Interstate highways (Type = I) and calculated the length (km) of Interstate within each GMU. We assigned the following scores.

Value	Score
0 km	0
1-50 km	3
≥ 50 km	5

Winter Sports Amenities

No comprehensive dataset exists for all winter sports amenities in the state. To quantify and spatially characterize these amenities in Idaho, we queried the Idaho Division of Tourist Development, Idaho Ski Areas Association, and Idaho Outfitters & Guides Association websites for a range of amenities including ski resorts, Nordic ski trails, snowcat-skiing and heli-skiing operations, snow sports trailheads, and licensed outfitters engaged in winter recreation activities. Each amenity was mapped and quantified by GMU. We assigned the following scores.

Value	Score
No amenities	0
≤1 = Low	1
2-3 = Medium	3
≥4 = High	5

Overall Score

Scores for potential use, potential threats, and overall were calculated by summing the respective data categories. The overall score was used to identify the highest priority (Tier I), medium priority (Tier II), low priority (Tier III), and non-habitat GMUs for wolverine conservation and management.

Tier	Overall Score
I	>27
II	>20 and ≤27
III	≤20 and >2% of GMU in composite model
Non-habitat	≤2% of GMU in composite model

Table A.1. Scores for each of the attributes used in defining wolverine focal areas in Idaho. See text for description of score values.

GMU	POTENTIAL WOLVERINE USE				POTENTIAL THREATS TO WOLVERINES						Overall Score
	Habitat Model	Corridor Model	Current Observ.	**Use Score**	Unprotected Habitat	Climate Vulnerability	Road Density	Inter-state Hwys.	Winter Sports Amenities	**Threat Score**	
1	5	5	5	15	5	1	3	0	5	14	29
2	0	0	3	3	0	3	5	5	0	13	16
3	1	0	3	4	1	3	5	5	0	14	18
4	5	3	5	13	5	1	3	5	3	17	30
4A	5	3	3	11	5	1	3	0	0	9	20
5	0	0	0	0	0	3	5	3	0	11	11
6	5	3	5	13	5	1	5	0	0	11	24
7	5	5	5	15	5	1	5	0	0	11	26
8	0	0	0	0	0	3	5	0	0	8	8
8A	1	0	0	1	1	3	5	0	0	9	10
9	5	5	5	15	5	1	3	0	0	9	24
10	5	5	5	15	5	3	1	0	0	9	24
10A	3	0	5	8	3	3	1	0	1	8	16
11	0	0	0	0	0	3	3	0	0	6	6
11A	0	0	0	0	0	3	3	0	1	7	7
12	5	5	5	15	5	3	1	0	0	9	24
13	0	0	0	0	0	3	1	0	0	4	4
14	5	3	5	13	5	3	1	0	1	10	23
15	5	3	5	13	5	3	1	0	1	10	23
16	5	3	0	8	5	3	1	0	0	9	17
16A	5	5	0	10	5	1	1	0	0	7	17
17	5	5	3	13	1	3	1	0	1	6	19
18	5	0	0	5	1	3	1	0	0	5	10
19	5	5	3	13	3	3	1	0	0	7	20
19A	5	3	5	13	5	3	1	0	0	9	22
20	5	5	5	15	5	3	1	0	0	9	24
20A	5	5	5	15	1	3	1	0	0	5	20
21	5	5	5	15	5	3	1	0	0	9	24
21A	5	5	5	15	5	5	1	0	0	11	26
22	5	0	0	5	3	5	5	0	0	13	18
23	5	3	5	13	5	3	5	0	5	18	31
24	5	5	5	15	5	5	5	0	3	18	33
25	5	5	5	15	5	5	3	0	0	13	28
26	5	3	5	13	3	3	1	0	0	7	20
27	5	3	5	13	1	3	1	0	0	5	18
28	5	5	5	15	5	3	1	0	0	9	24
29	5	5	5	15	5	5	1	0	0	11	26
30	5	5	0	10	5	5	1	0	0	11	21
30A	5	5	5	15	5	5	1	0	0	11	26
31	3	0	0	3	3	5	3	0	0	11	14
32	0	0	0	0	0	5	5	0	0	10	10
32A	5	3	0	8	5	5	5	0	0	15	23
33	5	3	0	8	5	5	3	0	0	13	21
34	5	5	5	15	5	5	3	0	0	13	28
35	5	5	5	15	3	5	1	0	0	9	24
36	5	5	5	15	5	3	1	0	3	12	27
36A	5	3	5	13	5	3	1	0	0	9	22
36B	5	5	3	13	5	3	3	0	0	11	24
37	5	3	0	8	3	3	3	0	0	9	17

GMU	POTENTIAL WOLVERINE USE				POTENTIAL THREATS TO WOLVERINES						Overall Score
	Habitat Model	Corridor Model	Current Observ.	**Use Score**	Unprotected Habitat	Climate Vulnerability	Road Density	Inter-state Hwys.	Winter Sports Amenities	**Threat Score**	
37A	5	5	5	15	5	5	1	0	0	11	26
38	0	0	5	5	0	3	5	5	0	13	18
39	5	3	5	13	3	5	3	5	3	19	32
40	0	0	0	0	0	3	3	0	0	6	6
41	0	0	0	0	0	5	3	0	0	8	8
42	0	0	0	0	0	5	1	0	0	6	6
43	5	3	5	13	5	3	3	0	0	11	24
44	5	0	5	10	5	3	5	0	3	16	26
45	0	0	5	5	0	3	5	5	0	13	18
46	0	0	0	0	0	5	5	3	0	13	13
47	0	0	0	0	0	5	3	0	0	8	8
48	5	3	5	13	5	3	1	0	5	14	27
49	5	3	5	13	5	3	1	0	5	14	27
50	5	3	5	13	5	3	3	0	0	11	24
51	5	5	5	15	5	3	1	0	0	9	24
52	0	0	5	5	0	3	5	0	0	8	13
52A	0	0	0	0	0	3	3	0	0	6	6
53	0	0	5	5	0	5	5	5	0	15	20
54	1	0	0	1	1	5	5	0	0	11	12
55	1	0	0	1	1	5	5	3	1	15	16
56	0	0	0	0	0	5	5	5	0	15	15
57	1	0	0	1	1	5	5	5	0	16	17
58	5	5	5	15	3	5	3	0	0	11	26
59	5	5	0	10	5	3	5	5	0	18	28
59A	5	3	0	8	3	5	5	0	0	13	21
60	5	3	5	13	5	3	5	0	0	13	26
60A	0	0	0	0	0	3	5	5	0	13	13
61	5	5	5	15	5	3	3	3	3	17	32
62	3	0	3	6	3	3	3	0	1	10	16
62A	5	3	5	13	5	3	3	0	1	12	25
63	0	0	0	0	0	3	3	5	0	11	11
63A	0	0	5	5	0	3	5	3	0	11	16
64	3	0	0	3	3	3	3	0	0	9	12
65	5	0	3	8	5	3	5	0	3	16	24
66	5	3	5	13	5	3	1	0	0	9	22
66A	5	1	5	11	5	3	1	0	0	9	20
67	5	5	5	15	5	3	1	0	1	10	25
68	0	0	0	0	0	3	3	5	0	11	11
68A	1	0	5	6	1	3	5	5	0	14	20
69	1	0	0	1	1	3	3	3	0	10	11
70	1	0	0	1	1	3	5	5	0	14	15
71	3	0	0	3	3	3	3	5	1	15	18
72	1	0	0	1	1	5	3	0	0	9	10
73	1	1	0	2	1	3	5	5	0	14	16
73A	1	0	0	1	1	3	3	3	0	10	11
74	3	3	3	9	3	5	3	3	0	14	23
75	5	5	0	10	5	5	5	0	0	15	25
76	5	3	5	13	5	5	3	0	0	13	26
77	5	5	5	15	5	5	5	0	0	15	30
78	5	5	5	15	5	5	5	0	0	15	30
YNP[1]	5	5	0	10	0	3	1	0	0	4	14

[1]Yellowstone National Park

Management Plan for the

Conservation of Wolverines

in Idaho 2014-2019