SPECIES ASSESMENT FOR WOLVERINE (*GULO GULO*) IN WYOMING

prepared by

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Introduction

The wolverine (*Gulo gulo*) is the largest terrestrial member of the family Mustelidae. This blocky and bear-like mammal has been bestowed colorful names such as devil bear, carcajou, devil beast, and skunk bear (Fitzgerald et al. 1994). The latter may be the most fitting because of the broad yellow-brown lateral stripes that sweep from the neck to the rump (Banci 1994; Figure 1), and the anal musk glands that produce the pungent odor typical of mustelids (Hash 1987).

Wolverines have a circumboreal distribution. In North America wolverines once occupied most of Alaska, Canada, the northern tier of the contiguous U.S., and major mountain ranges such as the Sierra Nevada and Rocky Mountains as far south as central California and northern New Mexico. Currently, wolverines still occupy much of Alaska and Canada, but in the U.S. are restricted primarily to the mountains of the Pacific Northwest and the Northern and Central Rocky Mountains (Figure 2).

The wolverine is commonly associated with remote and mountainous wilderness. Wolverines appear rather sensitive to human disturbance, and have such low population densities and reproductive rates that even a small amount of human-caused mortality can substantially reduce population persistence. Viable populations may require expansive wilderness areas with minimal human presence (Hornocker and Hash 1981, Ruediger 1996, Ruediger et al. 1999). Similar to other large mammalian carnivores in the Rocky Mountains (e.g., *Ursus arctos*, *Canis lupus*), the current distribution of wolverines may be more determined by intensity of human settlement than by biophysical factors such as vegetation type or topography (Kelsall 1981, Banci 1994, Carroll et al. 2001).

Wolverines depend strongly on carrion from large mammals for their basic diet. Populations in both the U.S. and Canada co-occur with large populations of several ungulate species (e.g., *Cervus elaphus, Alces alces*) as well as an array of large mammalian predators (e.g., *Puma concolor, Canis lupus*) (Van Zyll de Jong 1975, Hornocker and Hash 1981, Banci 1994).

It is generally accepted that wolverines have decreased in abundance and distribution in the continental U.S. over the past 150 years. Occupied range has contracted to the north along the Sierra Nevada and Rocky Mountains. Documented occurrences in California and Colorado are now infrequent; currently these states may support only rare dispersers from more northern areas. Wolverines are regularly observed in northwestern Wyoming, and occasionally observed in other areas of the state. Northwestern Wyoming is now thought to support the southernmost population of the species in North America.

The major limit on population growth and expansion into formerly occupied range is likely increased human-caused mortality and disturbance to wolverines, and possibly also to other large carnivores that produce the carrion utilized by wolverines. Persistence of wolverines on the southern edge of their current range will likely depend on how these factors are managed. However, it should be noted that wolverine life histories and population dynamics are poorly known from this region; more research is clearly needed to inform wolverine management here.

Natural History

Morphological Description

The wolverine resembles a small bear, with dark brown fur and a hunched posture (Figure 1). Like other mustelids the wolverine has small eyes, relatively poor eyesight (Jackson 1961 from Hash 1987), and short, rounded ears (Pasitschniak-Arts and Lariviere 1995). Pelage color is

variable, although not with season, and ranges from medium brown to almost black (Hash 1987, Banci 1994). Wolverines have a white or orange patch on the throat and chest, and, in contrast to bears, often a pale facial mask and large bushy tail that is about 20% of the body length (Stroganov 1969 from Pasitschniak-Arts and Lariviere 1995, Wilson 1982, Wooding 1982, Hash 1987). The dense underfur is 2-3 cm long; the coarse and glossy guard hairs are 6-10 cm long (Hash 1987) and frost-resistant, which has made wolverine pelts rather valuable and widely used for parkas and other clothing in northern regions (Hardy 1948 from Hash 1987).

To facilitate their scavenging lifestyle wolverines have evolved robust skulls, strong teeth, powerful jaws, and a generally athletic musculature that allow them to crush large bones, consume frozen carrion, and excavate large carcasses buried in deep snow (Haglund 1966, Stroganov 1969 from Pasitschniak-Arts and Lariviere 1995, Douglas and Strickland 1987, Hash 1987).

Wolverine tracks are relatively easy to distinguish from those of similar species. Well-formed wolverine tracks show all 5 toes (in contrast to the 4 toes shown in tracks of felids and canids); the 1-3-1 grouping of the toes helps distinguish wolverine tracks from those of bears. Additionally, the chevron-shaped interdigital pad sets wolverine tracks apart from those of other mammalian families (Halfpenny and Biesiot 1986, Forrest 1988, Zielinski and Kucera 1995). Tracks of other mustelids (e.g., *Mustela erminea, Martes americana*) have the same number of toes, toe grouping, and interdigital pad shape. However, wolverine tracks are much larger, and their trails have longer strides and wider straddles, than those of its relatives.

Taxonomy and Distribution

Taxonomy

A generally-accepted systematic classification of the wolverine is as follows:

> Kingdom Animalia; Phylum Chordata; Subphylum Vertebrata; Class Mammalia; Subclass Theria; Infraclass Eutheria; Order Carnivora; Suborder Fissipedia; Family Mustelidae; Subfamily Mustelinae; Genus *Gulo*; Species: *gulo*

Gulo gulo is considered the only extant member of the genus. The North American and Eurasian forms are often given separate subspecific designations, with *G. ggulo* in the Old World and *G. g. luscus* in the New World (Nowak and Paradiso 1983, Bryant 1987, Wilson and Reeder 1993, Banci 1994, Pasitschniak-Arts and Lariviere 1995). Wolverines probably evolved in Eurasia and migrated across Beringia into North America during the mid-Pleistocene (Kurten 1968). Subsequent independent evolution on each continent is assumed to have led to divergence at the subspecific level.

Distribution

Wolverines have a circumboreal distribution (Kvam et al. 1988 from Pasitschniak-Arts and Larivière 1995), occupying Scandinavia, Eastern Europe, a broad swath of northern Asia, and much of northern North America (Wilson 1982). In North America, wolverines historically occupied nearly all of Alaska and Canada, the northern tier of the contiguous U.S., the Cascade Mountains and Sierra Nevada as far south as central California, and the Rocky Mountains as far south as northern New Mexico (Banci 1994, Pasitschniak-Arts and Lariviere 1995; Figure 2).

Wolverines currently occupy the northernmost portion of their historical range in the contiguous U.S., with regular observations of the species in Washington, Oregon, Idaho, Montana,

and Wyoming (Figure 2). Discrete populations are difficult to define due to the extremely low density and large area requirements of wolverines. The Central and Northern Rocky Mountains (i.e., western Wyoming, western Montana, central and northern Idaho) appear to support the most consistent wolverine occupation. Smaller "satellite" populations may occur in Washington, Oregon, and southern Wyoming. Wolverines occasionally seen in Colorado and northern Utah may be individuals dispersing from more northern areas (see Nead et al. 1985, Fitzgerald et al. 1994).

Wolverines were probably never as abundant or widespread in Wyoming as in more northern regions such as Alaska and western Canada. A precise estimate of the extent of suitable wolverine habitat in Wyoming is not available, and formulating such an estimate is complicated by the paucity of information on wolverine habitat use in this region. Eliminating the grasslands of eastern Wyoming and most of the sagebrush-dominated basins in the rest of the state provides a rough estimate of about 33% of the state as suitable wolverine range.

The Wyoming Natural Diversity Database (WYNDD; University of Wyoming) currently archives 205 records of wolverine observations in Wyoming (WYNDD, unpublished data), nearly all of which come from the northwestern quarter of the state (Figure 3). Based on this dataset and a limited knowledge of habitat use, it is likely that northwestern Wyoming supports the only persistent population of wolverines in the state. Individuals dispersing from this region occasionally turn up elsewhere, possibly moving as far as northern Colorado and Utah, where reproduction and survival may be very low.

As discussed in more details under "Trends", some evidence suggests that wolverines are expanding somewhat in both range and numbers in the region. However, this may also be an

artifact of an increasing frequency of wolverine observations as people occupy formerly remote areas in the Rocky Mountains.

Habitat Requirements

General

The wolverine is typically associated with remote, undisturbed, and mountainous wilderness. It is clearly adapted to colder climates, which explains its broad-scale association with higher latitudes and altitudes; the species may be physiologically unable to persist in warmer and drier grasslands and high deserts.

Within this climatic envelope wolverines usually co-occur with large populations of several ungulate species (e.g., *Cervus elaphus, Odocoileus hemionus*) and an array of large primary predators (e.g., *Puma concolor, Canis lupus*). Such a mammalian community is a common feature of extant wolverine populations in Alberta, British Columbia, Yukon Territory, Alaska, and remaining centers of occurrence in the lower 48 United States (Van Zyll de Jong 1975, Hornocker and Hash 1981, Banci 1994). The importance of these other species to wolverines appears to be straightforward: ungulates are the ultimate source of the carrion upon which wolverines depend, and primary predators help convert live ungulates to carrion.

In general, human-caused mortality and disturbance is the major limiting factor on population expansion of most large mammalian carnivores in the Rocky Mountains (e.g., Beck 1991, Anderson et al. 1992, Wieglus et al. 1994, Mace et al. 1996; see also Noss et al. 1996). Wolverines appear to be no exception; in northern Montana, 15 of 18 wolverines studied by Hornocker and Hash (1981) died as a result of trapping, and many of their other study animals had missing toes and broken teeth, presumably from leg-hold traps. The Wildlife Conservation

Society (Bronx, New York) has also documented high trapping mortality to wolverines in southwestern Montana (R. Wigglesworth, Wildlife Conservation Society, personal communication). Banci (1994) and Weaver et al. (1996) have suggested that a human-induced mortality rate of only 7-8 % will cause wolverine populations to decline.

In any given region there is probably a positive relationship between human density and human-caused mortality of wolverines via trapping, poisoning, predator/ nuisance control activities, vehicle collisions, and other factors. Also, a high human density can reduce the diversity and abundance of the ungulates and large mammalian carnivores associated with wolverines. In this context, and considering "habitat" broadly as the complete suite of environmental factors that promote persistence of a taxon, one of the most important habitat features required by wolverines may be minimal human density. Many researchers have suggested that wolverine distribution better reflects areas of minimal human settlement than any particular pattern of vegetation or topography (Hornocker and Hash 1981, Kelsall 1981 from Banci 1994, Carroll et al. 2001). Carroll et al. (2001) suggest that road density may be a relatively robust surrogate for human impacts on wolverines; this may be an important physical factor to use to map wolverine habitat.

It is important to note that trapping of wolverines is not permitted in Wyoming. Accidental trapping of wolverines, and illegal deliberate trapping and shooting of wolverines, is assumed to occur in Wyoming, but the extent of such activities is unknown. Trapping of wolverines is legal in Montana, and because wolverines travel over extensive areas it is assumed that many wolverines in northern Wyoming are at risk of being trapped in Montana at some point during their lives. Also, because there appear to be very few wolverines in Wyoming, the persistence of

the species in the state may depend largely on individuals dispersing southward from Montana. Thus, high trapping mortality in Montana may translate into fewer wolverines in Wyoming.

Spring and Summer

Wolverines generally seek higher elevations in the spring and summer months. This may reflect a preference for cooler temperatures and fewer recreationalists; it may also show that wolverines track the movement of ungulate herds as the snow-line recedes (Hornocker and Hash 1981, Whitman et al. 1986). Whitman et al. (1986) found that forest was avoided by wolverines from April-October, whereas shrub, tundra, and rock-ice types were used according to their availability. This may be another expression of a general upward movement into alpine and subalpine settings during this season.

Also, parturition occurs in the spring (usually March or April) in unlined natal dens in log jams, rockpiles, tree root wells, or other debris structures (Stroganov 1969, Wilson 1982, Hash 1987, Fitzgerald et al. 1994). Natal dens are often located in alpine cirques and covered by deep snow (Carroll et al. 2001). Snow cover of dens appears to be important in protecting kits from predation, and dens at higher altitudes would retain snow cover for longer periods (Magoun and Copeland 1998). Also, dens may be more frequently located in alpine areas because this becomes better rearing habitat as the season progresses. Cooler temperatures and higher abundances of small mammals and ground nesting birds in the summer may prompt reproductive females to place dens at high elevations in the spring. In addition, remnant snowdrifts at high elevations serve as refrigerators for wolverines, extending the viability of food caches longer into the summer (Magoun and Copeland 1998). Durable food caches may be especially important for females raising young.

Winter

Wolverines move to lower elevations in the winter, presumably to avoid excessively harsh climatic conditions and because their prey also move to lower elevations (Hornocker and Hash 1981, Wilson 1982). Whitman et al. (1986) found that tundra was avoided from November-March, whereas forest, shrub, and rock-ice types were used in proportion to their availability.

With their oversized feet and relatively light bodies, wolverines are well-adapted for moving over deep snow. This likely gives them a competitive advantage over other carnivores such as coyotes (*Canis latrans*) and bobcats (*Lynx rufus*); wolverines may be able to use snowbound areas from which these other carnivores are excluded. In this context, packed snow-machine trails and plowed roads may reduce the quality of winter habitat for wolverines by providing travel corridors into formerly snowbound areas for generalist carnivores, which then compete with wolverine. This topic, as with most aspects of wolverine ecology, requires more study.

Landscape-scale Habitat Use

Hornocker and Hash (1981) found that wolverines in Montana preferred landscapes composed of scattered stands of mature conifers, and also favored hillslopes and headwater basins over wide river bottoms and ridgetops. River bottoms and ridgetops may be preferred by larger predators such as grizzly bears (*Ursus arctos*) and gray wolves (*Canis lupus*), which may explain avoidance of these areas by wolverines. Forest mosaics dominated by mature timber, yet rich in patch edges and ecotones (e.g., swamps, blowdowns, meadows, avalanche chutes, cliffs), may produce more carrion and live prey than other landscape types (Hornocker and Hash 1981). Occasional rock outcroppings and large trees provide important escape cover (Banci 1994); presumably talus slopes and large accumulations of coarse-woody debris would also serve this purpose.

Stand-scale Habitat Use

Very little is known about wolverine habitat use at the stand scale, especially in the Central and Southern Rocky Mountains (Banci 1994). Hornocker and Hash (1981) suggested that wolverines in Montana preferred stands of mature timber year-round. These stands were mainly comprised of *Abies lasiocarpa;* stands of mature *Larix occidentalis* (absent from Wyoming) and *Pinus contorta* were also used. It may be that fine-scale habitat use by wolverines is directed more by the distribution and abundance of food (carrion and live prey) in the vicinity than by the structure or composition of particular stands (Gardner 1985, Banci 1987 from Banci 1994).

Area Requirements

Wolverines are considered non-migratory (Wilson 1982), but individuals do undertake regular altitudinal shifts in habitat use and travel over rather large areas. Wolverines depend primarily on carcasses large mammals for food, and daily hunting movements of 30-40 km may be normal. Documented home ranges vary from <100 km^2 to >900 km^2; home range size is presumed to be strongly and negatively correlated with food availability (Banci 1994). Male wolverines are more mobile than females (Pasitschniak-Arts and Lariviere 1995), and have much larger home ranges (Hornocker and Hash 1981, Magoun 1985, Hash 1987, Whitman et al. 1986). In Scandinavia, male home ranges were three times the size of those of females (Vangen et al. 2001). Small female home ranges are likely due in part to females having to tend young in dens for at least part of the year.

Wilson (1982) reported that wolverines are able to travel distances up to 65 km without rest if pursued. Krott (1960) observed a juvenile wolverine moving 33 km in one night. Gardner et al. (1986) documented an adult male traveling 378 km from southcentral Alaska to the Yukon Territory in Canada. The Wildlife Conservation Society, with support from the Wyoming Game

and Fish Department (WGF), is currently tracking 6 wolverines in northwestern Wyoming and adjacent Idaho. One study animal has traveled >320 km from Pocatello, Idaho, through Yellowstone National Park, and onto the Wind River Mountains (R. Wigglesworth, Wildlife Conservation Society, personal communication). These distances clearly illustrate the tremendous capacity for travel by wolverines.

With such large area requirements, it is no surprise that wolverines occur at lower densities than other mammalian carnivores. Using data from Krott (1959) from Scandinavia and Mech (1970) from North America, Van Zyll de Jong (1975) determined that, even in optimal habitats, wolverines are less abundant than gray wolves.

Currently there is no information to suggest that wolverines are strongly territorial in the lower Rocky Mountains. Hornocker and Hash (1981) hypothesized that it would be too difficult for wolverines to defend a territory due to their large area requirements. Rather, the species' scavenging lifestyle has produced a more flexible movement strategy that allows wolverines to discover carrion, concentrate activities nearby until the carrion is consumed, then move on. Intrasexual territoriality may develop in some northern and coastal areas where food is relatively abundant (Banci 1994).

Movement and Activity Patterns

General

Wolverines are mainly nocturnal, do not hibernate, and range widely year-round (Banci 1994, Fitzgerald et al. 1994). As discussed previously, individual wolverines have been known to travel several hundred kilometers when seeking new home ranges, dispersing, or pursued.

Young may disperse from their natal areas anytime from January - May (Magoun 1985 from Banci 1994). In years of abundant food offspring may be allowed to remain in the natal home range (Banci 1994, Vangen et al. 2001), but are eventually forced to disperse once food declines. In Scandinavia, 83% of wolverines had dispersed by sexual maturity (Vangen et al. 2001). As with many mammals, young wolverines probably disperse from natal ranges in response to social pressure from adults, reproductive competition, and food competition (Gardner 1985, Magoun 1985, Copeland 1996, Vangen et al. 2001).

Although not statistically significant, more males than females dispersed from natal areas in Scandinavia (Vangen et al. 2001). Females usually establish home ranges within or adjacent to their natal home ranges (Banci 1994). Males typically disperse longer distances and usually conduct extensive exploratory movements prior to dispersal (Magoun 1985, Banci 1987 from Banci 1994). Vangen et al. (2001) reported that 25% of their study animals demonstrated substantial pre-dispersal movements, but cautioned that this is an underestimation because many individuals may have made movements that were undetected.

Wolverines are capable of extensive movements and may disperse into adjacent states when Wyoming densities are high. Although there are recent sightings of wolverines in Colorado (Rocky Mountain National Park and Colorado Division of Wildlife, unpublished data), the amount of reproduction occurring in the state is unknown and assumed to be very low.

Reproduction and Survivorship

Breeding Behavior

Wolverines are polygamous (Wilson 1982), and during the breeding season males and females form pairs that last 2-3 days (Pasitschniak-Arts and Lariviere 1995). Males do not assist in the rearing of young (Jackson 1961, Liskop et al. 1981 from Hash 1987).

Parturition occurs in natal dens that are accessed by snow tunnels up to 60 m long (Magoun and Copeland 1998, Banci 1994). Natal dens are used only briefly, and the kits are soon moved to maternal dens until later in the spring. Adult females may travel a considerable distance from dens in search of food. Snow cover is important in protecting natal dens against predators (Magoun and Copeland 1998). Dens are often located in talus slopes and alpine cirques that retain their snow cover into the spring (Copeland 1996). Banci (1994) suggests that dens may be overly represented in alpine areas because they are more easily discovered by researchers in such locales. Greater search effort should be focused on forested areas where dens would be more hidden.

A relatively long time to first reproduction (>2 years old for both sexes; see below), difficulty finding mates in low-density populations, and high kit mortality may all contribute to generally low reproductive output for wolverines (Hash 1987, Banci 1994, Fitzgerald et al. 1994). Weaver et al. (1996) calculated the average lifetime production of a female wolverine to be only two female offspring.

Successful reproduction probably depends strongly on food supply. Magoun (1985) reported that none of the adult female wolverines produced young when caribou were scarce in her study area. Banci (1994) noted that female body condition prior to implantation may be the most

important factor determining successful birth, but perhaps not in determining the survival of young.

Wolverine advocacy groups commonly cite disturbance to natal and maternal dens as having a large negative affect on wolverine populations (Biodiversity Legal Foundation et al. 2000, Wolverine Foundation 2002). Banci (1994) suggests that den disturbance by winter recreationalists can reduce kit survival by causing adult females to move kits to unsuitable den sites.

Breeding Phenology

Breeding typically occurs in the summer, followed by delayed implantation of the blastocyst during November - March (Wilson 1982, Banci 1994). Adult females may breed yearly under good conditions (Magoun 1985). Alternatively, breeding may occur every other year (Ewer 1973 from Wilson 1982) due to a longer period of post-weaning maternal care.

Females may reproduce at 1 year old, but usually do not produce litters until >2 years old (Liskop et al. 1981, Wilson 1982). Banci (1994) reviewed literature from Rausch and Pearson (1972), Liskop et al. (1981), Magoun (1985), and Banci and Harestad (1988), and concluded that there are varying proportions of subadults (1-2 year olds) that breed. She notes discrepancies between how subadults were classified in the studies and that in some cases adults were included in the subadult age class.

Most males are not sexually mature until >2 years old (Rausch and Pearson 1972, Liskop et al. 1981, Banci and Harestad 1988 from Banci 1994). Adult males are in breeding condition by March (Liskop et al. 1981 from Banci 1994). Rausch and Pearson (1972 from Banci 1994) found that breeding activity in male wolverines reached a peak in June based on testis weights.

Blastocyts, fertilized during the summer breeding season, implant in the uterine wall during November - March (Fitzgerald et al. 1994, Banci 1994). Post-fertilization gestation lasts 215-272 days; more precise estimates are difficult because of variation in implantation dates. Post-implantation gestation lasts 30-40 days (Fitzgerald et al. 1994).

Parturition usually occurs in March or April (Stroganov 1969 from Pasitschniak-Arts and Lariviere 1995; Wilson 1982, Hash 1987, Fitzgerald et al. 1994), when carrion abundance is high (Banci 1994). In Norway, parturition occurs when reindeer (*Rangifer tarandus*) carrion is available and live reindeer are stressed and vulnerable (Haglund 1966). As many as 5 kits may be born, but typically only 2-3 survive long enough to exit the maternal den (Banci 1994). Newborns are altricial and covered with a fine white fur (Fitzgerald et al. 1994). Kits are weaned at 9-10 weeks, and are adult size at 7 months (Krott 1960, Magoun 1985 from Banci 1994). Young disperse from their natal ranges as early as January or as late as May (Magoun 1985 from Banci 1994).

Rising spring temperatures may be a cue for female wolverines to relocate kits from the natal den to the maternal den. Wolverines in Idaho moved their kits when they were as young as 13 days, and often moved kits more than 3 times before they were weaned (Magoun and Copeland 1998).

Fecundity and Survivorship

The proportion of adult females that maintain pregnancies in a given season varies widely (50 - 92%), and is probably largely determined by body condition and food availability (Banci 1994).

Banci (1994) summarized age-specific mortality from five studies conducted in Alaska, Yukon, Montana, and Idaho. She found a 57% mortality rate for adults, 7% for subadults, and

36% for young of the year. Mortality rates of juveniles are underestimated because long dispersal distances lead to many unknown fates. Krott (1982 from Banci 1994) suggested that 33-50% of subadults die during dispersal. Two studies had young and very old wolverines that died of starvation. A potentially significant cause of mortality that has not been adequately studied is predation on kits, including predation by male wolverines (Banci 1994). Precise estimates of wolverine survivorship are difficult to formulate due to small sample sizes in relatively few scientific studies. Banci (1994) suggested that researchers investigate survivorship rates and other population parameters to construct mathematical models to help direct future research.

Population Demographics

Limiting Factors

The current dearth of information on wolverines, especially from the southern portion of their range, makes it difficult to identify the ultimate factors that limit populations. In general, human-caused mortality and disturbance is the major limiting factor on population expansion of most large mammalian carnivores in the Rocky Mountains (e.g., Beck 1991, Anderson et al. 1992, Wieglus et al. 1994, Mace et al. 1996; see also Noss et al. 1996, Beauvais 2000). Banci (1994) stated that the greatest impact on wolverines is habitat fragmentation from human activities. Wolverines appear intolerant of land use activities that permanently change habitats, such as cultivation and suburban and urban development. With typically low densities and reproductive rates, wolverine populations may not be able to persist under additional mortality from trapping, vehicle collisions, and other human activities.

In the absence of more specific information, it seems reasonable to assume that human-caused mortality varies positively with human density, and human density in turn varies positively with

the density of roads. In the winter, human density may be best explained by the density of plowed roads and packed trails.

Metapopulation Dynamics

There is not nearly enough information on wolverine distribution, habitat use, or dispersal to determine whether or not the species forms formal metapopulations. It currently appears that wolverines in Wyoming occur mostly frequently in the northwestern mountains (Figure 3), with individuals occasionally dispersing from this area to other parts of the state and region. The amount of wolverine reproduction in other parts of the state is not known, but is assumed to be low. In this sense, northwestern Wyoming can be described as a regional source population. It is reasonable to assume that this source population receives individuals dispersing from other population centers to the north and west. The relative contributions of wolverines born in Wyoming, and those that immigrate into Wyoming, to persistence in the state is unknown. This topic needs to be studied in order to inform wolverine management.

The genetic analyses of Kyle and Strobeck (2001) suggest that wolverines in the Rocky Mountains of the U.S. are largely separated from populations to the north in Canada, with only occasional cross-border dispersal. Other genetic studies point to the fragmentation of once continuous wolverine populations (Wilson et al. 2000, Kyle and Strobeck 2002, Cegelski 2002).

Genetic Concerns

Gulo gulo is the only extant species of wolverine. The Eurasian (*G. g. gulo*) and North American (*G. g. luscus)* forms are considered separate subspecies. Wolverines in Alaska and Canada appear to form a single genetic unit. However, populations in Idaho and areas further south on the Rocky Mountains have less genetic variation than northern populations (A. Magoun,

Alaska Department of Fish and Game, personal communication). This may indicate that southern wolverines have become increasingly separated from populations to the north (Kyle and Strobeck 2001). There is also some evidence of genetic distinction between populations on the Rocky Mountain Front, Gallatin Mountains, Teton Mountains, and Crazy Mountains (A. Magoun, Alaska Department of Fish and Game, personal communication).

Isolation and subsequent loss of genetic variation may be a concern if connectivity is lost between current populations in Idaho, Montana, and Wyoming. Also, at this time it is not known if wolverines in the contiguous U.S. can persist without immigration of individuals from Canada (Banci 1994).

Food Habits

Food Items

Wolverines are primarily scavengers of carrion from large mammals, especially in winter, but they do take advantage of other food sources. Wolverines might be best described as "opportunistic omnivores" in the summer when they eat berries, insect larvae, small mammals, ground nesting birds, and even fish. The importance of berries in wolverine diets may be underestimated (Banci 1987 from Banci 1994).

All forms of carrion are important year-round, with ungulates providing the most important packages. When food is scarce wolverines will eat bones, skin, and fur from old carcasses (Haynes 1982 from Banci 1994). Hornocker and Hash (1981) found that wolverines in Montana most frequently consumed mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) carcasses. It is assumed that Wyoming wolverines similarly depend on these species, with occasional

consumption of carcasses of moose (*Alces alces*), bighorn sheep (*Ovis canadensis*), pronghorn (*Antilocapra americana*), bison (*Bos bison*), and livestock.

Foraging Strategy

Wolverines are solitary and range widely in search of food. As discussed previously, wolverines move to higher elevations in the spring and lower elevations in the fall, possibly in partial response to the seasonal movements of ungulate herds. In the northern portions of their range wolverines follow the seasonal movements of caribou (Banci 1994).

With their strong teeth, powerful jaws, and athletic musculature wolverines are well-adapted to feeding on large, frozen carcasses (Haglund 1966, Stroganov 1969 from Pasitschniak-Arts and Lariviere 1995, Douglas and Strickland 1987, Hash 1987). Wolverines can kill injured or snowbound ungulates more than 10 times their own size. However, it is most likely that ungulates killed by weather, disease, starvation, or other predators form the majority of wolverine food. Small live prey such as ground-nesting birds, and plant material such as berries, may be consumed opportunistically as they are encountered during carcass searches.

Wolverines will cache food items, and may seek deep and persistent snow drifts in which to store food to protect from decay and other scavengers (Magoun and Copeland 1998). Such durable caches may be especially important for females tending young.

Foraging Variation

Wolverine diet varies with the ungulate species dominating any particular region. Caribou are important in the north; elk and mule deer are the predominant wolverine food in the south, and are assumed to be the primary food source in Wyoming. Banci (1994) suggested that inter-sexual differences in diet may occur when females are tending young and thus are restricted in

movement, whereas males can range more widely. Also, differences in foraging success may lead to differences in the diets of juveniles and adults. Very young and old animals can starve to death, indicating that foraging efficiency may decline with age (Banci 1994).

Community Ecology

Predators and Competitors

Natural predation on adult wolverines does not appear to be a major mortality factor in northern populations. However, this may not be the case for the smaller and more dispersed southern populations; predation on wolverines in the Central Rocky Mountains needs further study. Wolverines may occasionally be attacked and killed by gray wolves, mountain lions, and other large carnivores, but they are seldom eaten (Boles 1977, Banci 1994). Kits are vulnerable to many carnivores, including eagles. The frequency and importance of predation on kits is unknown, but may be a significant limit on wolverine populations. It is presumed that adult male wolverines may kill kits, but this has not been documented (Banci 1994).

Because of their very low densities and scavenging lifestyle, wolverines are probably not a major competitor to large hunting carnivores such as mountain lions and gray wolves (Hornocker and Hash 1981, Banci 1994). Interspecific aggression is assumed to occur at least occasionally at carcass sites, especially during the winter when food stress is high and most carnivores resort more to scavenging. Also in winter, plowed roads and packed snow-machine trails may allow carnivores such as bobcats and coyotes to access areas from which they were formerly excluded by deep snow. The extent to which this has increased competition between these species and the more snow-adapted wolverine is a topic that requires more research.

Parasites and Disease

Several diseases and parasites have been documented in wolverines, but the extent to which they impact wild populations is unknown. Captive wolverines have died from tooth and throat infections, and tuberculosis. Endoparasites such as flukes, tapeworms, roundworms, trematodes, cestodes, and nematodes are common. Ectoparasites include fleas, ear canker mite, and dog ticks (Pasitschniak-Arts and Lariviere 1995).

Symbiotic and Mutualistic Interactions

Wolverines generally benefit from the activities of large predators such as gray wolves, mountain lions, and bears that produce ungulate carcasses.

Conservation

Conservation Status

Federal Endangered Species Act

The wolverine was petitioned for protection under the Endangered Species Act (ESA) in August 1994 and July 2000 (Biodiversity Legal Foundation et al. 2000). In October 2003 the USDI Fish and Wildlife Service ruled that the latest petition did not present sufficient evidence for such protection (USDI Fish and Wildlife Service 2003). Wolverines currently have no official status under the Endangered Species Act (Table 1).

Bureau of Land Management

The Wyoming State Office of the USDI Bureau of Land Management (BLM) has listed the wolverine as a Sensitive Species (USDI Bureau of Land Management 2001), which requires the agency to consider the consequences of management actions on wolverine habitat and populations.

Due to the current uncertainty over wolverine habitat use and abundance in the region, the precise amount of wolverine habitat managed by the BLM in Wyoming is unknown. It is likely that BLM lands on the flanks of major mountain ranges (e.g., Wind River Range, Absaroka Mountains) are the most important agency parcels for wolverine in Wyoming, especially if they support concentrations of wintering ungulates.

Forest Service

The USDA Forest Service (USFS) has listed the wolverine as a Sensitive Species in Regions 1, 2, 4, and 6, which requires the agency to consider the consequences of management actions on wolverine habitat and populations in those regions (USDA Forest Service 1994). Wyoming encompasses portions of Region 2 (Bighorn, Black Hills, Shoshone, and Medicine Bow-Routt National Forests; Thunder Basin National Grassland) and Region 4 (Bridger-Teton, Caribou-Targhee, Wasatch-Cache, and Ashley National Forests). With the exceptions of the Thunder Basin National Grassland and Black Hills National Forest, all of these units support relatively large amounts of wolverine habitat. The Shoshone and Bridger-Teton National Forests support the most wolverines, and the most wolverine habitat, in the state (Figure 3).

State Wildlife Agencies

The Wyoming Game and Fish Department classified the wolverine as a non-game species in 1977, providing protection from deliberate shooting and trapping (Hoak et al. 1982). Currently, WGF considers the species rare and has ranked it NSS3. This rank indicates that (1) habitat is not restricted, but populations are greatly restricted or declining; or (2) habitat is restricted or vulnerable and populations are declining or restricted in numbers or distribution; or (3) significant habitat loss is on-going but the species is widely distributed and population trends are thought to be stable (Fertig and Beauvais 1999, Keinath et al. 2003).

Heritage Ranks

The non-profit group NatureServe (Arlington, Virginia) and WYNDD have ranked the wolverine G4/ S2. The "G4" indicates that the species has an apparently low risk of extinction from the continent, although it may be quite rare in portions of its range. The "S2" indicates a relatively high chance of extinction from the state of Wyoming (Keinath et al. 2003).

Biological Conservation Issues

Abundance

It is generally accepted that wolverine abundance in the Rocky Mountains, including Wyoming, has declined over the past 150 years. Wolverines have probably always been somewhat rare in Wyoming, based on the scarcity of documented observations and rough estimate of only 33% of the state as suitable habitat. Current abundance in the state is clearly lower than in British Columbia, Yukon Territory, and other northern sites.

The Wildlife Conservation Society, with support from the WGF, is currently studying wolverines in the Teton Range (Wyoming) and Madison Range (Montana). The majority of the Teton Range study area is located in Grand Teton National Park and the Jedediah Smith Wilderness (Caribou-Targhee National Forest). To date, the Teton study has captured 7 wolverines, one of which has died in an avalanche. One of the remaining wolverines has traveled a considerable distance, from an area near Pocatello, Idaho, through Yellowstone National Park to the Wind River Mountain Range (R. Wigglesworth, Wildlife Conservation Society, personal communication).

Although northwestern Wyoming supports the majority of wolverines in the state, dispersing individuals may occur in other parts of the state with less suitable habitat (Figure 3). Survival and reproduction of such dispersers is unknown, but is presumed to be low.

Trends

Abundance and Distribution Trends

In the Rocky Mountains wolverines have declined rather markedly in abundance and distribution over the past 150 years, perhaps reaching a low in the mid 20th century. In 1927, Skinner (1927 from Banci 1994) suggested that there were <10 wolverines in the Yellowstone region and that the local population was near extinction. However, wolverines may be currently expanding in the region. As mentioned above, The Wildlife Conservation Society is currently tracking at least 6 wolverines in only a small portion of the Yellowstone region. Other recent authors (e.g., Newby and McDougal 1964, Hoak et al. 1982 from Banci 1994, Clark and Stromberg 1987) have suggested that wolverines are expanding into southwestern Wyoming. Maj and Garton (1992 from Banci 1994) summarized 100 observation records of wolverines in Wyoming from 1961 to 1991, all in the western third of the state. Currently, WYNDD documents 205 observations of wolverines from Wyoming, with 45 having been made from 1991 - 2004 (WYNDD, unpublished data).

The apparent rebound in numbers and range is possibly due in part to the ca. 1970 ban on widespread poisoning of carnivores in the region. Wide ranging scavengers such as wolverines would have been very susceptible to poisoned baits and carcasses, and predator control campaigns in western North America undoubtedly took a heavy toll on the species (Banci 1994). Furthermore, wolverine populations have such low densities and reproductive rates that 20-30 years of post-poisoning recovery may have been required before an increase in numbers and

distribution became noticeable. Three other important changes have occurred over this time period: (1) fur prices have dropped, causing a reduction in fur trapping across the Rocky Mountains, (2) elk populations have increased substantially in many areas of Wyoming and the region, possibly providing a larger prey base for wolverines; and (3) gray wolves were reintroduced (and subsequently experienced rapid population growth) in northwestern Wyoming and adjacent regions in 1995, possibly increasing the availability of carrion over a large area.

Importantly, the number of people occurring in wolverine range has also increased markedly over the past several decades. This raises the possibility that the apparent increase in wolverines is not due to more wolverines, but rather more wolverine observations in formerly remote country. An organized inventory of wolverines in western North America, and in Wyoming in particular, is needed to establish baseline estimates of abundance and distribution.

Wolverine populations are not known to experience regular fluctuations or cycles. Abundance in Wyoming may depend in part on the number of individuals dispersing into the state from population centers to the north. More research is needed to estimate the number of wolverines dispersing into the state, the number produced within in the state by resident adults, and the relative importance of these 2 sources of recruitment to population persistence.

The arid Wyoming Basins ecoregion is a rather well-known barrier separating boreo-alpine mammals on the Central Rocky Mountains and Southern Rocky Mountains (e.g., Findley and Anderson 1956, Maj and Garton 1992 as cited in Banci 1994, Beauvais 2000). However, because wolverines are rather tolerant of a variety of environmental conditions and can travel long distances, it is unlikely that this area is a complete barrier to their movements (Banci 1994). No

studies have been conducted in Wyoming on potential corridors for wolverine travel, or on the effects of fragmentation on wolverine populations.

Habitat Trends

Clearly there has a been a loss of suitable wolverine habitat in the Rocky Mountains over the past 150 years as cities, road networks, surface mines, and other vestiges industrial human society have appeared. Conversion of wild and semi-wild landscapes to human-dominated landscapes continues in Wyoming and surrounding states. A recently-denied petition to list the wolverine under the Endangered Species Act (Biodiversity Legal Foundation et al. 2000) argued that medium sized carnivores like the wolverine need to occupy most of the region extending from west-central Wyoming to mid-British Columbia and Alberta for long-term persistence. As argued by Ruediger et al. (1996), maintaining wolverine occupancy across this region is becoming increasingly difficult due to increasing tourism, traffic, road construction, and rural subdivision. It is well-known that the Yellowstone region is experiencing dramatic increases in rural subdivision. If, as suggested by current information, the Yellowstone region is the only area south of Montana with consistent wolverine occupation, continued rapid development could hamper wolverine recolonization of historic range to the south.

Range Context

Considering the broad area of wolverine occupation in Canada and Alaska, Wyoming has always encompassed a rather small portion of the southern periphery of wolverine continental range. Wolverines historically occurred as far south as northern New Mexico, and still are occasionally documented in Colorado and northern Utah. In the contiguous U.S. wolverines are now consistently observed only in northwestern Wyoming, central and northern Idaho, western Montana, and northern Washington (Figure 2).

Extrinsic Threats and Reasons for Decline

Anthropogenic Impacts

Given the limited amount of data on wolverine ecology in the Central Rocky Mountains, it appears that the main anthropogenic threat to wolverine populations here is mortality from trapping, shooting, vehicle collisions, predator/ nuisance control activities, and other actions (Hornocker and Hash 1981, Banci 1994, Biodiversity Legal Foundation et al. 2000, Carroll et al. 2001). Secondary to such direct mortality may be human-caused reductions in the abundance and diversity of ungulates and large carnivores with which wolverines are associated, and disturbance to wolverine dens by increasing numbers of recreationalists and light industrial activities (e.g., petroleum extraction, road building) (Biodiversity Legal Foundation et al. 2000, Wolverine Foundation 2002).

Invasive Species

At this time wolverines are not known to be threatened by invasive species.

Genetic Factors

Recent genetic studies (Kyle and Strobeck 2001; A. Magoun, Alaska Department of Fish and Game, personal communication) indicate that wolverines in the contiguous U.S. may have relatively low genetic diversity, which could be a result of increasing separation from the main continental center of occurrence in Canada. This is an issue that demands more study, inasmuch as genetic isolation and low genetic diversity can threaten the viability of small populations.

Stochastic and Environmental Factors

Severe drought, which is a relatively frequent occurrence in the Central Rocky Mountains, could impact wolverine populations by reducing snow cover, which in turn makes kits more susceptible to predation and reduces the effectiveness of food caches. Drought, as well as severe

winter conditions, may also reduce numbers of ungulates that provide the majority of wolverine food.

Avalanches are known to occasionally kill wolverines in Wyoming (R. Wigglesworth, Wildlife Conservation Society, personal communication), but the extent of avalanche mortality has not been adequately estimated.

Natural Predation

Based on the rather small amount of information on wolverines, it appears that predation by other carnivores is not a major source of mortality. This issue requires more study, however, especially in Wyoming and surrounding states.

Intrinsic Vulnerability

Habitat Specificity and Fidelity

Wolverines are not habitat specialists in the classic sense of strongly preferring a particular type of vegetation or landform. They range rather widely across gradients of elevation, topography, and vegetation, and are apparently restricted only generally to ecosystems occurring above cold deserts and true grasslands. Within this broad zone wolverines concentrate in areas of minimal human presence, abundant and diverse ungulate populations, and an array of large mammalian carnivores. Given that the first feature of "minimal human presence" is increasingly rare in the Central and Southern Rocky Mountains (and also given that abundance of ungulates and large carnivores varies in part with human presence), it might be argued that wolverines are specialists because they prefer an unusual and uncommon environment. In this sense wolverines may be somewhat like grizzly bears and gray wolves in the Rocky Mountains; their current

distribution and habitat use is driven by the limits imposed by people, and do not reflect the environments within which survival and reproduction were maximized historically.

Using allozymes and mitochondrial DNA Wilson et al. (2000) determined that wolverines in the Northwest Territories exhibit fidelity to specific areas. In the absence of more specific information, it is assumed that wolverines in the lower Rocky Mountains also have high fidelity to particular areas.

Territoriality and Area Requirements

Wolverines are highly mobile, and viable populations require rather large areas of suitable habitat. Area requirements for wolverine populations are on the order of those needed by grizzly bears, Canada lynx (*Lynx canadensis*), and gray wolves. Some authors argue that in order for wolverines (and other large carnivores) to persist in the Rocky Mountains of the U.S. the species should occupy almost all suitable habitat from western Wyoming to mid British Columbia and Alberta (Ruediger et al. 1999, Biodiversity Legal Foundation et al. 2000).

Although several diseases and parasites have been documented in wolverines, the extent to which such infections affect wolverine populations is unknown.

Dispersal Capability

Wolverines can travel great distances when dispersing, and appear to be at least somewhat tolerant of a variety of environmental settings. It is unlikely that dispersal is restricted to particular habitats, and it appears that much of wolverine historic range is within dispersal distance of known centers of occurrence. As with most wide-ranging carnivores, mortality during dispersal is assumed to be rather high (Krott 1982 from Banci 1994).

Reproductive Capacity

Wolverines have extremely low reproductive capacity, especially in relation to other mammals of similar size. Various life history factors contribute to this low reproduction, including an advanced age of first reproduction, difficulty locating mates in low density populations, and potentially high kit mortality (Hash 1987, Fitzgerald et al. 1994, Weaver et al. 1996). Habitat quality, especially food availability, may have a large affect on reproduction in a given season (Magoun 1985, Banci 1994).

Sensitivity to Disturbance

Wolverines appear to be sensitive to disturbance in general, and disturbance to dens in particular (Banci 1994, Biodiversity Legal Foundation et al. 2000, Wolverine Foundation 2002). Winter recreationalists, especially snow-machine users, are typically cited as the primary source of disturbance. Several experts (e.g., Kelsall 1981 from Banci 1994, Banci 1994, Carroll et al. 2001) contend that occurrence of wolverines is negatively correlated with occurrence of humans, and most wolverine observations come from areas of low human density and impact.

The wolverine study currently being conducted in northwestern Wyoming and adjacent states by the Wildlife Conservation Society should help illuminate the effects of recreation on wolverines. One study goal is to compare wolverine use of areas with varying amounts of recreational use (R. Wigglesworth, Wildlife Conservation Society, personal communication).

Protected Areas

Wolverines inhabit some of the most remote areas in Wyoming and surrounding states. These same areas are often under some form of statutory protection for wildlife and wildland values. Wolverines occur in Grand Teton and Yellowstone National Parks, as well as the designated

USDA Forest Service Wilderness (primarily in the Bridger-Teton and Shoshone National Forests) adjacent to these parks. Indeed, the rather large complex of protected lands in northwestern Wyoming is likely the reason why wolverines have persisted this far south.

Land managed for multiple use by the USDA Forest Service, and to a lesser extent by the USDI Bureau of Land Management, also supports wolverines in Wyoming. Wolverines undoubtedly use private lands in this region, but because such lands typically occur at low elevations they may not form a substantial amount of wolverine habitat. However, an important topic of research is to determine the relative contribution of high-elevation and low-elevation habitat to wolverine populations. It is possible that even though wolverines use low-elevation sites infrequently, such habitat is critical because it supports the majority of ungulates, especially in the winter, that form the base of wolverine diet.

Population Viability Analyses (PVAs)

To our knowledge no formal PVAs have been conducted for wolverines. Currently there is very little hard data on age-specific survivorship, recruitment, reproductive output, and similar attributes with which to parameterize a life cycle model. Based on a general knowledge of life cycle models for other mid-sized mammalian carnivores with low reproductive outputs, it is likely that population persistence of wolverines depends mostly on the survival of adult females. At this point, however, this statement is an untested hypothesis that should not be used as the basis for management action.

Conservation Action

Existing or Future Conservation Plans

Existing Regulatory Mechanisms

Wolverines in Wyoming are protected somewhat at the state level by their designation as a non-game species by the WGF. This protects wolverines from deliberate harvest, although accidental and illegal deliberate killing is assumed to occur. Also, as mentioned above, wolverines can be legally harvested in Montana, and because they travel so widely most wolverines in northern Wyoming are assumed to be subject to harvest in Montana at some point. At the federal level, wolverines are protected broadly by their designation as a Sensitive Species by the USDI Bureau of Land Management and USDA Forest Service Region 2 and 4. These designations direct each agency to consider the consequences of management actions on wolverine habitat and populations.

Existing Management Plans

We are unaware of any management plans that specifically address wolverine populations or habitat in Wyoming.

Existing Conservation Strategies

Many authors have proposed a regional-scale system of refugia for the conservation of wolverines (Banci 1994, Magoun and Copeland 1998, Wilson et al. 2000). These authors recognize that single management units, such as individual national parks, are not large enough to support a wolverine population over the long term. Rather, a network of protected management units or "refugia", connected by suitable travel and dispersal corridors and extending over most of

the Central and Northern Rocky Mountains, is proposed as the only way to ensure long-term occupation of the region.

Conservation Elements

Key Elements

Wolverines in Wyoming and surrounding regions are difficult to manage because they are rare and range over large areas, and very little is known about the species. Based on our general knowledge of life history and habitat use, it appears that management actions that minimize human presence, promote diverse and abundant ungulate populations, and promote the presence of large hunting carnivores will benefit wolverines.

Clearly, such general recommendations are difficult to implement. Assuming that human presence varies positively with road density, and given that the presence of large hunting carnivores varies negatively with road density (see Beauvais 2000), management of roads (and, in the winter, management of plowed roads and packed snow-machine trails) may be the best tool with which to manage wolverine populations, at least until more specific information on the species is developed. Habitat management that maintains large and well-distributed herds of ungulates, especially mule deer and elk, may be a similarly effective tool at this point. Lastly, modifying regulations pertaining to fur trapping seasons (e.g., minimize trapping in areas of known wolverine occupation) and equipment (e.g., leg hold trap jaws <3 inches wide may allow wolverines to escape) in Wyoming may minimize accidental captures of wolverines.

Inventory and Monitoring

To our knowledge there has not been an organized inventory of wolverines in Wyoming. Snow-tracking surveys for Canada lynx, American marten (*Martes americana*), and other species

have generated some wolverine observations in the recent past (WYNDD, unpublished data). As outlined previously, a study of wolverines in the Teton Mountains, under the direction of the Wildlife Conservation Society and with support of the WGF, is currently underway.

The Colorado Division of Wildlife has conducted statewide surveys for wolverines; their experience could inform similar efforts for Wyoming (S. Wait, Colorado Division of Wildlife, personal communication). Further details on inventory and monitoring techniques can be found in Ruggiero et al. (1994), with special attention to Banci (1994) and the subsequent publication of Zielinski and Kucera (1995).

Habitat Preservation and Restoration

Until more specific information on wolverine habitat use is developed for this region, the broad recommendations outlined above under "Key Elements" will have to stand as general habitat management guides. Clearly, habitat restoration is difficult to address in detail with current information.

Captive Propagation and Reintroduction

To our knowledge there are no captive propagation programs with the aim of providing wolverines for reintroduction being undertaken at this time.

Information Needs

Most existing information on wolverines comes from the northern part of their range. Good information on almost all aspects of wolverine ecology from the Central Rocky Mountains would greatly enhance the ability to manage this species in Wyoming. A statewide inventory that establishes a baseline for abundance and distribution is probably most needed at this point.

Banci (1994) prioritized research needs for wolverines. Some of these needs have since been addressed, but most remain. One important topic requiring study is the extent to which wolverine populations in the contiguous U.S. are self-sustaining, and the extent to which their persistence depends on immigration from Canada. This same issue needs to explored at a finer scale for the state of Wyoming. If wolverine persistence in the state depends mostly on immigration from northern areas, then management resources may be better spent working with adjacent states to maintain travel corridors into Wyoming rather than improving Wyoming habitat.

One way to explore this issue is via genetic analyses. Not only can genetic analysis estimate the relatedness of Wyoming wolverines to more northern population segments, but it can also estimate the genetic diversity within the Wyoming population segment itself. This could reveal whether or not Wyoming wolverines have sufficient genetic diversity to help avoid local extinction.

Given that natural resource managers impact wildlife populations primarily by managing habitat rather than the wildlife themselves, managers in this region clearly need more information on wolverine habitat use. Traditional radio-telemetry studies of Wyoming wolverines could illuminate several aspects of habitat use with management utility, including the relative frequency of use of landscapes with varying amounts of human impact, degree to which roads and snow-machine trails are used or avoided, and the relative contributions of high- and low-elevation ranges to wolverine populations. Additionally, such studies could help identify major sources of mortality to wolverines in Wyoming, with specific attention to the relative importance of human-caused mortality, natural predation, and starvation. The Wildlife Conservation Society study currently underway in northwest Wyoming should develop some of the above information; expansion and replication of this stud y is encouraged.

Tables and Figures

Table 1: Management and conservation status of wolverines in Wyoming.

Agency	USFWS, ESA	BLM	USFS	WGFD	WYNDD Heritage Rank
Conservation Status	N/A	Sensitive	Sensitive, Regions 1, 2, 4, 6	NSS3	G4 / S2

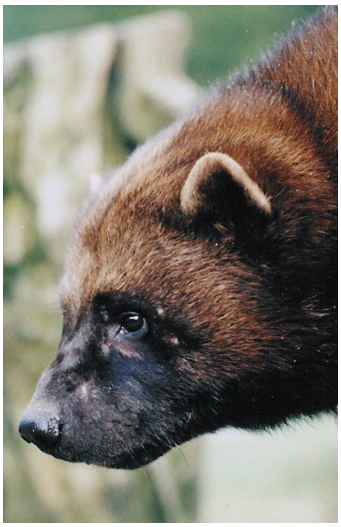
Figure 1: Adult wolverines. Photographs A, B, and C are copyrighted to Clinton D. Long, The Wolverine Foundation Inc. Photographs D and E are copyrighted to Roy Anderson, The Wolverine Foundation Inc.

(A)

(B)

(C)

(D)



(E)

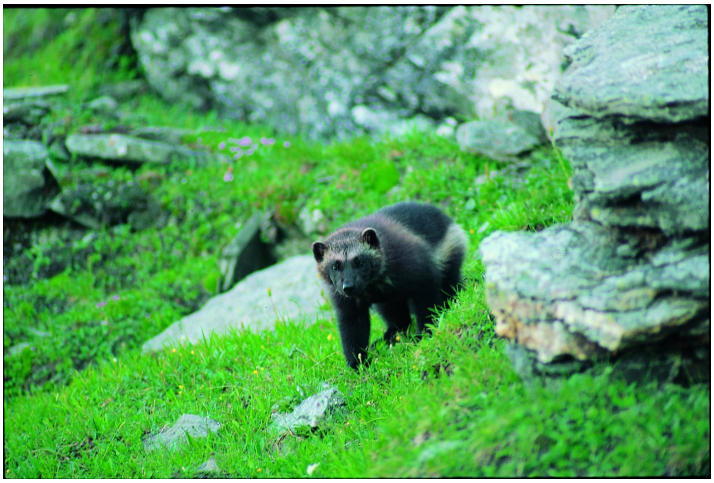


Figure 2: Distribution of wolverines in North America. Green shading indicates current distribution; purple lines approximate southern extent of historical distribution, and also encompass occasional dispersers from the more permanent centers of occupation shown in green. Map based on data from Maj and Garton (1994), Gehman and Robinson (2000), Predator Conservation Alliance (2002), Wolverine Foundation (2002), Patterson et al. (2003), NatureServe unpublished data, Montana Department of Fish, Wildlife, and Parks unpublished data.

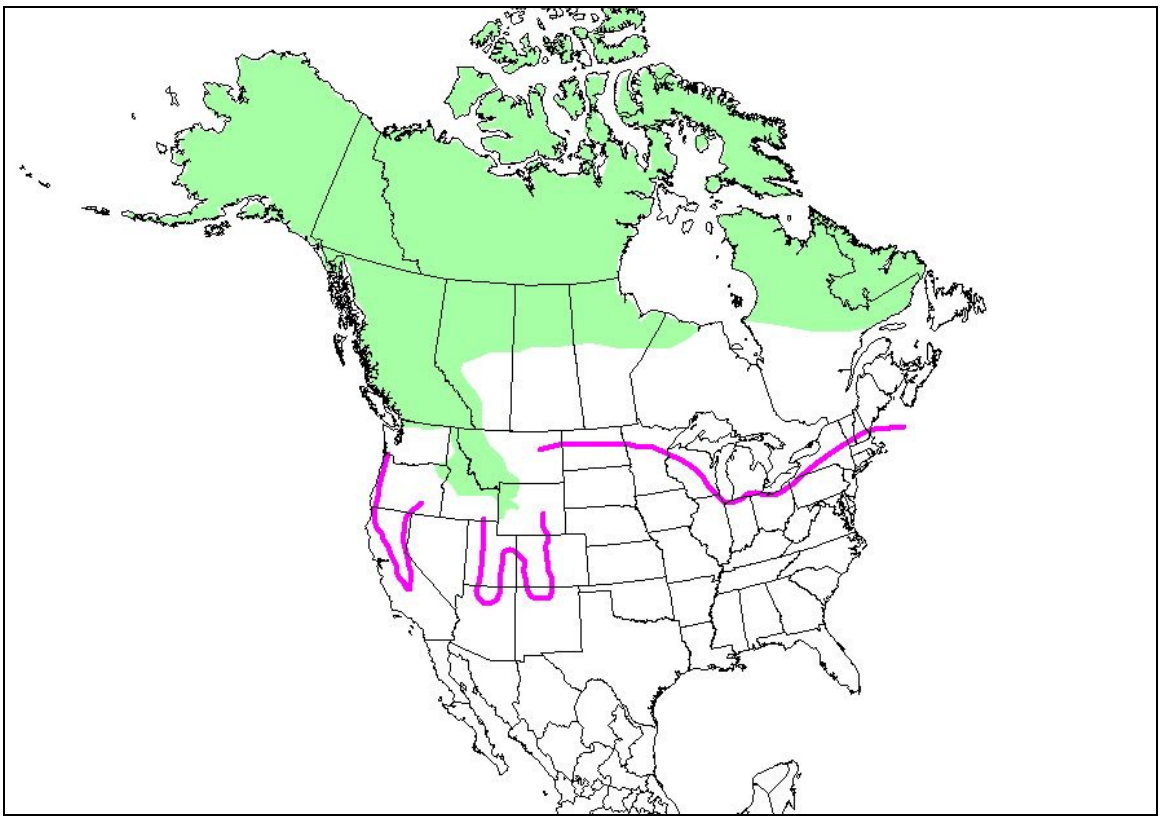
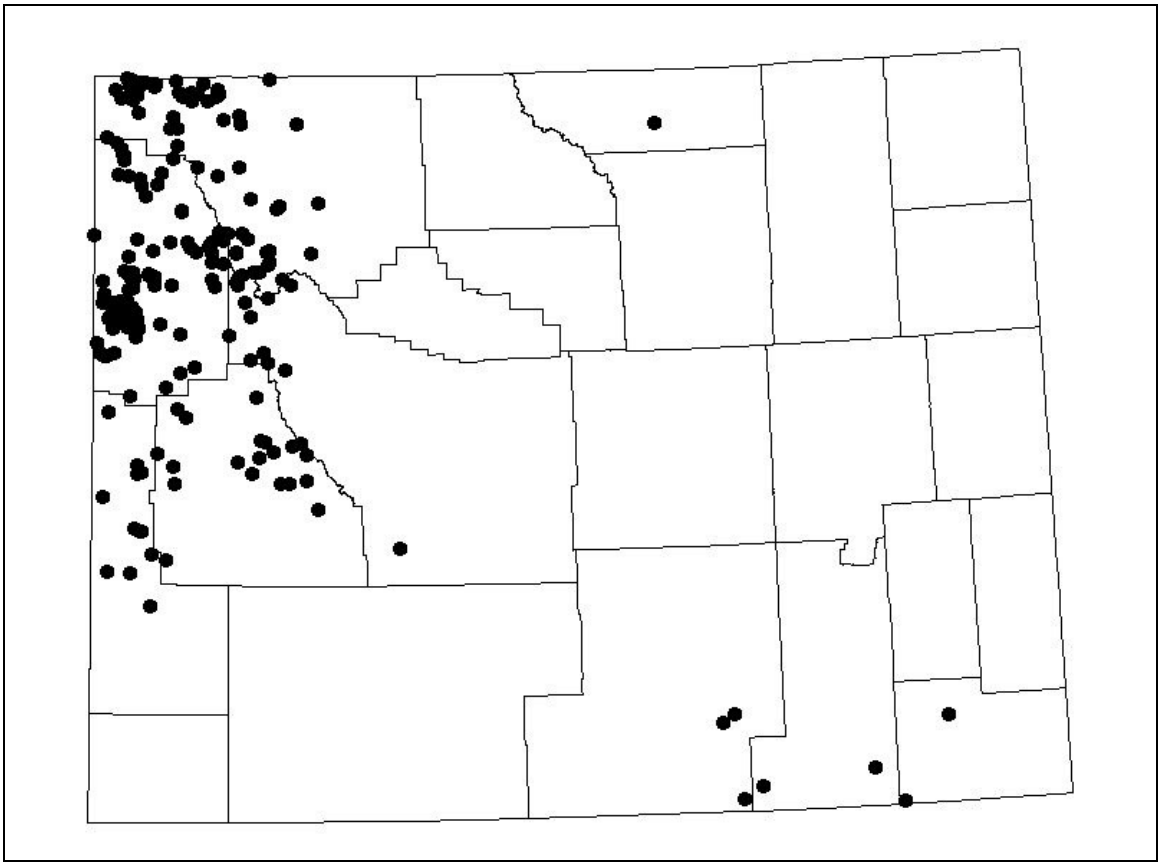


Figure 3: Documented occurrences of wolverines in Wyoming, 1857-2004. Each black dot represents 1 of 205 observation records on file at the Wyoming Natural Diversity Database (University of Wyoming).



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