

Gulo gulo

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INTRODUCTORY

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Photo by Gerald and Buff Corsi, California Academy of Sciences

AUTHORSHIP AND CITATION:

Luensmann, Peggy. 2008. Gulo gulo. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/animals/mammal/gugu/all.html> [2017, August 2].

FEIS ABBREVIATION:

GUGU

COMMON NAMES:

wolverine
glutton
stink-bear
little bear
carajou

TAXONOMY:

The scientific name of wolverine is *Gulo gulo* L. It is a member of the weasel family, Mustelidae [8,85,118]. Subspecies in North America include [47,85,118]:

Gulo gulo katschemakensis Matschie, Kenai wolverine
Gulo gulo luscus (L.), North American wolverine
Gulo gulo luteus Elliot, California wolverine
Gulo gulo vancouverensis Goldman, Vancouver Island wolverine

SYNONYMS:

Gulo luscus L. [47] =
Gulo gulo luscus (L.)

ORDER:

Carnivora

CLASS:

Mammal

FEDERAL LEGAL STATUS:

None

OTHER STATUS:

Information on state-level protected status of animals in the United States is available at [NatureServe](#), although recent changes in status may not be included.

WILDLIFE DISTRIBUTION AND OCCURRENCE

SPECIES: *Gulo gulo*

- [GENERAL DISTRIBUTION](#)
- [PLANT COMMUNITIES](#)

GENERAL DISTRIBUTION:

The wolverine is a circumpolar species occurring primarily in boreal and tundra ecosystems of North America, Europe, and Asia. In North America, the distribution extends from the Aleutian Islands of Alaska east through Canada and south to the northern Rocky Mountains. Verifiable sightings within the United States since 1985 occurred in Montana, Idaho, Washington, Oregon, Wyoming [5,31], and Alaska [42,75]. Based on genetic records, a wolverine sighted in California in 2008 migrated from Idaho [109]. Thus, it is likely a transient individual rather than from a naturalized California population. The status of other populations within the United States are either imperiled or presumed extirpated [5,83]. [NatureServe](#) provides a distributional map of wolverine.

PLANT COMMUNITIES:

Wolverines in the continental United States are primarily found in stands dominated by subalpine fir (*Abies lasiocarpa*), California red fir (*A. magnifica*), Pacific silver fir (*A. amabilis*), Douglas-fir (*Pseudotsuga menziesii*), mountain hemlock (*Tsuga mertensiana*), Engelmann spruce (*Picea engelmannii*), blue spruce (*P. pungens*), or lodgepole pine (*Pinus contorta*) [21,31,41,54,82].

Montana: Mature forests dominated by subalpine fir and Douglas-fir are preferred [3,54]. Grand fir (*A. grandis*), western larch (*Larix occidentalis*), lodgepole pine, and Lombardy poplar (*Populus nigra*) are common seral species within wolverine habitat. Ridge tops, mid- and upper slopes are characterized by subalpine fir-beargrass (*Xerophyllum tenax*), Hitchcock's smooth woodrush (*Luzula glabrata* var. *hitchcockii*), whitebark pine

(*Pinus albicaulis*), or big huckleberry (*Vaccinium membranaceum*). Moist, high-elevation sites on north and east aspects are dominated by subalpine fir, menziesia (*Menziesia ferruginea*), Sitka alder (*Alnus viridis* subsp. *sinuata*), and grouse whortleberry (*Vaccinium scoparium*). The dominant associate in drainage bottoms and lower slopes is bluebead (*Clintonia* spp.) [54].

Idaho: Alpine habitats above 8,900 feet (2,700 m) are characterized by talus and open mountain tops. Subalpine forest occupied by wolverine is dominated by whitebark pine and subalpine fir interspersed by talus slopes and cirque basins. A mosaic of Engelmann spruce-fir (*Abies* spp.) forest and savanna habitats occurs mid-slope. Dense, low-elevation forest habitats are dominated by lodgepole pine. Lower elevation communities used by wolverine are characterized by a mix of sagebrush-grass associations interspersed with willow-meadow communities on mesic sites [31].

Oregon: Wolverine habitat is characterized by whitebark pine, mountain hemlock, and subalpine fir above 6,000 feet. During winter, low-elevation habitats characterized by lodgepole pine, western white pine (*Pinus monticola*), white fir (*Abies concolor*), Shasta red fir (*Abies* × *shastensis*), and mountain hemlock are also used [55].

California: In northern California, wolverine habitat includes Douglas-fir/tanoak (*Lithocarpus densiflorus*) forest [21]. On the Tahoe National Forest, a wolverine was photographed in habitats dominated by Jeffrey pine (*P. jeffreyi*)/California red fir, California red fir, Sierra mixed conifer, and Sierra lodgepole pine (*P. contorta* var. *murrayana*). The wolverine was lured to bait stations, so habitat selection may have been influenced by baiting [125].

Wyoming: Habitats that may support wolverines include Rocky Mountain lodgepole pine (*P. contorta* var. *latifolia*), Engelmann spruce, subalpine fir, or Douglas-fir. Grasslands, sagebrush (*Artemisia* spp.) steppe, wet meadows, alpine tundra, rock escarpments, and talus were also within the study area [82].

Alaska: In southern Alaska, wolverines are found above and below treeline in forests dominated by white spruce (*Picea glauca*) and black spruce (*P. mariana*). Above treeline, plant associates included diamondleaf willow (*Salix pulchra*), rough fescue (*Festuca altaica*), white arctic mountain heather (*Cassiope tetragona*), black crowberry (*Empetrum nigrum*), mountain cranberry (*Vaccinium vitis-idaea*), alpine azalea (*Loiseleuria procumbens*), pincushion plant (*Diapensia lapponica*), eightpetal mountain-avens (*Dryas octopetala*), bog birch (*Betula glandulosa*), and lichens [101]. In another study from southern Alaska, white spruce-black spruce habitats were primarily used December to April. Use of tundra habitats peaked in May and September to November. Use of riparian brush habitats peaked from June to August, with limited use during the rest of the year. Upland brush habitats were utilized year round with peaks during July and December. Rock outcrops were used throughout the year with a peak in August [115].

British Columbia: Wolverine habitats are dominated by mature Engelmann spruce-subalpine fir-western redcedar (*Thuja plicata*)-western hemlock (*Tsuga heterophylla*) forests at low- and mid-elevations [1,36]. Limber pine (*Pinus flexilis*) and alpine larch (*Larix lyallii*) characterize high-elevation habitats [1]. Wolverines occupy alpine meadows in summer and lowland coniferous forests in winter [36].

Yukon Territory: Wolverines occupy an area characterized by regenerating lodgepole pine, white spruce, quaking aspen (*Populus tremuloides*), subalpine fir, and willow (*Salix* spp.) with remnant patches of mature forest and alpine tundra, 28 to 36 years after fire [102].

Northwest Territories: Tundra habitats are used in winter, while forest habitats dominated by white spruce are utilized year round [79].

BIOLOGICAL DATA AND HABITAT REQUIREMENTS

SPECIES: *Gulo gulo*

- [LIFE HISTORY](#)
- [PREFERRED HABITAT](#)
- [COVER REQUIREMENTS](#)
- [FOOD HABITS](#)
- [PREDATORS](#)
- [MANAGEMENT CONSIDERATIONS](#)

LIFE HISTORY:

Wolverines are sexually dimorphic. Adult males average 24 to 61 pounds (10.9-27.5 kg), while adult females average 15 to 41 pounds (7-19 kg) [[50,64,69,75,91](#)]. The skull and teeth of wolverines are more robust than those of other carnivores of similar size. Wolverines are capable of eating frozen meat and crushing bones of large prey including deer (*Odocoileus* spp.), caribou (*Rangifer tarandus*), and moose (*Alces alces*) ([[46](#)], reviews by [[50,85](#)]).

Wolverines are solitary [[85](#)]. While they are primarily nocturnal [[46,55](#)], they also travel during daylight hours [[7,46](#)]. Wolverines are active year round [[10,54,64,75,115](#)]. Rather than maintaining territories, wolverines scent mark to advertise their current positions [[54](#)]. Individual home ranges may overlap extensively with those of other individuals [[10,54](#)].

Males and females reach sexual maturity at 2 to 3 years of age [[10,13,91](#)]. Some males reach sexual maturity at 14 to 15 months of age [[91](#)]. Occasionally, females produce litters as yearlings [[10,13,91](#)]. Most females produce litters every 2 to 3 years [[31,54,64](#)]. Physical condition and age may be a factor in whether females reproduce each year [[31,87](#)].

Rausch and Pearson [[91](#)] speculated that wolverines are polygamous. Observations of the breeding biology of wolverines suggest that females are [monoestrous](#) [[13,90,91](#)]. The mating season spans April to August, with a peak in late May and June [[64,91](#)]. Male breeding condition peaks April to June. Delayed implantation typically occurs in late January or early February [[91,124](#)], but may happen anytime from November through March [[10,13,91](#)].

Parturition (births) occurred 215 to 272 days after copulation in captive wolverines [[81](#)]. Active gestation lasts 30 to 40 days [[91](#)]. Births peak February to March [[46,77,85,90,91](#)], but may occur at any time from January through April [[31,75,90,91](#)]. Wolverine parturition may correspond with periods when carrion is most abundant [[91](#)], such as caribou calving season [[29](#)].

Litter sizes range from 1 to 6 kits per litter, with an average of 2.2 to 3.0 kits per litter [[46,54,90](#)]. Average litter size for females in northwestern Alaska was 1.75 kits after dens were abandoned. This did not include newborn mortality [[75](#)].

Kits are weaned by 10 weeks of age [[31,64](#)] and remain with their mothers up to 2 years [[64,112](#)]. The average dispersal age for males and females in Scandinavia was 13 months [[112](#)].

According to a review, average annual survival may range from 0.80 to 0.975 [[11](#)]. More recent studies have recorded survival rates that deviate slightly from the range. Average first-year survival for juveniles in Scandinavia was 0.68 [[88](#)]. Average annual survival in Idaho and Montana was 0.80 excluding licensed trapping, and 0.57 including licensed trapping [[105](#)]. In a 12-study synthesis, overall annual survival for all age and sex classes in untrapped populations was >0.84. Overall annual survival for all age and sex classes in trapped populations was <0.75 [[62](#)].

Average life expectancy of wild wolverines in Montana is 4 to 6 years, with few exceeding 8 years of age according to unpublished data by Hash [[50](#)]. According to a review, wild wolverines may reach 8 to 10 years old

[57]. The oldest wolverine examined by Rausch and Pearson [91] in Alaska and the Yukon Territory was a 13-year-old female.

PREFERRED HABITAT:

- [General Habitat](#)
- [Seasonal Variation](#)
- [Elevation](#)
- [Home Range](#)
- [Density](#)
- [Movements](#)

General Habitat: Wolverines appear to have few specific habitat requirements aside from extensive wilderness dominated by coniferous forest of sufficient size to support wide-ranging, solitary individuals [2,30,104]. In the continental United States, wolverines are primarily found in stands dominated by fir (*Abies* spp.), spruce (*Picea* spp.), hemlock (*Tsuga* spp.), Douglas-fir, or lodgepole pine [41,54,55]. In Oregon, [source habitats](#) include alpine tundra and all subalpine and montane forests. Within these habitats, all structural stages except the [stem exclusion stage](#) act as source habitats [119].

Wolverines are positively associated with snags, downed logs, large hollow trees, talus [29,120], remote undisturbed wilderness or wilderness with minimal motorized access [29,54], numerous denning sites, and abundant prey [29]. Denning sites may be a critical and limiting resource in wolverine habitats [31]. Other habitat attributes for wolverines in the northern Rocky Mountains and southwestern Canada include significant ($P \leq 0.05$) preferences for high elevations, topographic complexity, high annual snowfall, cirque denning habitat, and low human population density. A distribution model indicates a positive relationship with snowfall, cirque habitat, and forest edge, suggesting that alpine and subalpine habitats are important for the wolverine. Another interpretation for the model suggests that wolverines are limited to regions of low human activity rather than by vegetation structure and type [26]. Road densities of ≤ 0.44 km/km² were most likely to benefit wolverines in the interior Pacific Northwest, according to another habitat model. In the same model, low human population density was also a reliable predictor of wolverine presence [94].

Numerous forest cover types and open habitats are utilized by wolverines. Individuals in Idaho traveled through cover types ranging from dense timber to open ridgetops. Specific examples include low-elevation forested drainages to high-elevation cirque basins with low overstory cover [30]. A wolverine in British Columbia or Alberta traveled through a burned upland area dominated by second-growth lodgepole pine, which formed a low dense canopy [122]. Dense, homogenous black spruce stands in British Columbia and Alberta were used for traveling [123]. Summer and winter habitat use for males in British Columbia was positively correlated with moose winter range, bottomland forests, and avalanche chutes [61]. In northwestern Montana, 70% of all radio-collared wolverine relocations were in large areas of low- to medium-density, mature forest habitat. The other 30% of relocation sites were in ecotonal areas, small forested pockets, or rocky forested benches. Wet and dry forest were used 23% and 31% of the time, respectively. Alpine areas were utilized 16% of the time. On rare occasions, wolverines were relocated in burned or wet meadow areas. Dense, young forest was used less than all other habitat types [54]. Preferred habitats in the Yukon Territory were subalpine coniferous forest, boreal coniferous forest, and subalpine shrub. Other habitats favored by females include alpine shrub, subalpine mixed forest, and boreal mixed forest [10]. Males showed a strong preference for subalpine coniferous forest and subalpine shrubland in the Yukon Territory [10,12]. Riparian habitat was utilized in proportion to its availability in the Yukon Territory [12]. In south-central Alaska, use of tundra was lower than expected in winter, and use of forests was lower in summer [116].

Preferences for other habitat attributes are highly variable. Preferences for cover, aspect, slope, and elevation varied widely by individual in the Yukon Territory [10,12]. Northerly aspects were used significantly more ($P < 0.05$) than other aspects in Idaho [31,32]. In northwestern Montana, basins, eastern and southern aspects, and edge habitats were preferred. Slopes were used 36%, basins 22%, wide river bottoms 14%, and ridge tops 8% of the time [54].

Wolverines crossed clear-cuts and recent burns in northwestern Montana but appeared to move through them quickly. Wolverines were located within 0.6 to 1.7 miles (1-3 km) of clear-cuts and active roads 12 times during the northwestern Montana study [54]. Roads, which were generally in low-lying areas, were avoided in Idaho. Wolverines were not associated with maintained trail systems or elk winter range [32].

Seasonal Variation: In general, wolverines prefer high-elevation habitats in summer and low-elevation habitats in winter [46,115]. Selection may be influenced by seasonal variation in prey selection or abundance, human disturbance, or denning requirements [31,61]. Habitat use for males in winter was negatively associated with helicopter skiing. Females were negatively associated with helicopter and backcountry skiing in winter. Overall, wolverines appear to avoid areas that are heavily utilized by people [61].

- **Winter:** Suitable winter range appears to overlap with forested areas and deep spring snow cover [5,32]. Forested, birch-willow-alder (*Betula* spp.-*Salix* spp.-*Alnus* spp.), and rock-ice habitat types are used in south-central Alaska [116]. In Idaho, low-elevation Douglas-fir and lodgepole pine habitats are utilized [32]. Wolverines in Sweden spent their time on low mountains or in coniferous forests bordering high mountains [46]. Lowland coniferous forests are utilized in British Columbia [36]. In mid-winter, wolverines in British Columbia and Alberta appear to prefer dense climax forest with lower snow depth over stands with high snow depth [122]. Montane coniferous forests in Idaho were preferred over other habitat types, but the difference was not significant ($P>0.05$). Rock habitats were avoided during winter in Idaho [31]. Wolverines in Idaho were associated with streams in winter, possibly because they provided travel corridors at that time of year, which were unnecessary in summer [32]. At least one wolverine in Idaho may have been following elk downstream [7]. The habitats preferred by females in the Yukon Territory were alpine talus, subalpine conifer, and boreal conifer [10]. Wolverines traveled in areas with significantly lower snow depth than random areas ($P<0.01$) [122].
- **Summer:** In general, wolverines use more open areas in summer than in winter. In summer, wolverines in Idaho utilized high-elevation whitebark pine habitat [32] and showed a significant preference ($P<0.05$) for rock cover [31]. In south-central Alaska, tundra, birch-willow-alder, and rock-ice habitat types are utilized [116]. In the Yukon Territory, the most preferred habitats were alpine shrub, subalpine shrub, subalpine grass, subalpine conifer, and boreal conifer forest [10]. Females were positively associated with alpine and avalanche habitats with abundant hoary marmots (*Marmota caligata*) and Columbia ground squirrels (*Spermophilus columbianus*) [61]. In British Columbia, wolverines occupy alpine meadows [36]. Females avoided roads and recently logged areas in British Columbia [61].

Elevation: Elevational and vegetation use varies by season [115]. In Norway, wolverines selected habitats at significantly higher elevations in summer than in winter ($P<0.001$) [65]. Average elevations used by wolverines in northwestern Montana are 4,500 feet (1,371 m) in winter, 5,500 feet (1,676 m) in spring, 6,300 feet (1,920 m) in summer and 6,200 feet (1,889 m) in fall [54]. Winter populations in Idaho ranged from 5,800 to 7,800 feet (1,800-2,400 m) [7]. In southern Alaska, wolverines are widespread above and below treeline [101]. Wolverine tracks in British Columbia and Alberta were found only in upland habitats [123]. Significantly ($P<0.05$) higher elevations were used during winter (3,130 feet (954 m)) than in summer (2,870 feet (874 m)) in Alaska [115]. On average, wolverines were found at 2,000 to 3,900 feet (600-1,200 m) [116], with a range of 1,000 to 5,900 feet (300-1,800 m) [42,115,116]. Elevations of 4,000 to 5,000 feet (1,219-1,523 m) were significantly avoided ($P<0.05$) in Alaska [115]. Movements to lower elevations during winter in Idaho may be correlated to an increase in carrion abundance attributed to big game hunting seasons [31].

Home Range: Wolverine home ranges may overlap, and adults do not actively defend territories [10,54]. Home range overlap most often occurs between resident adults and related subadults [31]. Adult females exclude unrelated females from their home ranges but allow offspring to occupy the same area [75]. Males generally tolerate females and juvenile males [31,75] but exclude other adult males from their home ranges [64,75,115]. Home ranges of juveniles and transient adult males may overlap the home ranges of resident males for unknown periods of time. When one male is in the overlapping area, the other male is typically not in the near vicinity [39].

Wolverine home range size can vary widely. The variation may be associated with differences in the abundance or distribution of food ([31], review by [11]). The average annual home ranges for adult males and males of unknown age are 139 to 257 mi² (359-666 km²) [54,75,115]. The average annual home range for female wolverines is 150 mi² (388 km²) in Montana [54]. Annual home ranges for females in Alaska averaged 40 to 41 mi² (103-105 km²) [75,115]. Average summer home range for females in northwestern Alaska was 36 mi² (94 km²). Average summer home range for adult males in northwestern Alaska was 242 mi² (626 km²) [75].

Many wolverines make temporary long-distance excursions [12,54,75]. These excursions can skew home range estimates. As a result, several methods have been developed to estimate the size of the areas primarily used by wolverines. Copeland [31] estimated harmonic mean core home ranges for wolverines in Idaho. Harmonic mean core home range is the area within the home range that is used more than expected based on an assumption of uniform usage [31,96]. Rather than determine the size of the area with the highest concentration of use for wolverines in the Yukon Territory, Banci and Harestad [10,12] estimated a core home range based on the size of the area that circumscribed 90% of the relocations of radio-collared wolverines.

Home ranges for wolverines in Idaho were larger than for other populations in North America. The following home range results from Idaho are based on annual estimates. Average home range for adult females was 148 mi² (384 km²), while the average harmonic mean core home range for adult females was 98 mi² (254 km²) [31]. For subadult females in Idaho, the average home range was 205 mi² (532 km²), with an average harmonic mean core home range of 88 mi² (227 km²). For adult males, average home range was 588 mi² (1,522 km²), and the average harmonic mean core home range for adult males in Idaho was 314 mi² (813 km²). Average home range for subadult males was 426 mi² (1,104 km²), while the average harmonic mean core home range for subadult males in Idaho was 201 mi² (520 km²) [31].

Reproductive activities may also influence wolverine home range size. Spring and summer home ranges tend to be larger for females without young than for females with kits [10,75]. A denning female captured several times from November to January in the Yukon Territory had a 5.4 mi² (14 km²) home range and relied heavily on baited traps [12]. The average March to August home range for lactating females in northwestern Alaska was 27 mi² (70 km²). Adult females without young had an average home range of 37 mi² (97 km²) March to August [75]. Core home ranges in the Yukon Territory were 18 mi² (47 km²) for a female with kits, and 52 mi² (134 km²) and 49 mi² (128 km²) for 2 females without young [10]. Similarly, home range estimates from the Yukon Territory that excluded temporary long-distance movements were 29 mi² (76 km²) (female with kits) and 59 to 61 mi² (153-157 km²) (females without kits) [12]. By comparison, core home ranges in the Yukon Territory were 109 mi² (283 km²) for a subadult male and 73 mi² (188 km²) for an adult male [10].

Total home range size estimates for wolverines in North America		
Age/Gender	Annual home range (km ²)*	Spring/Summer home range (km ²)*
Adult or unknown aged male	238-2,400	46-898 [10,12,16,31,54,69,75,115]
Juvenile/subadult male	46-2,940	41-437 [10,31,75]
Adult or unknown aged female (reproductive status unknown)	53-637	38-515 [10,16,31,54,75,115]
Female with young	139	55-293 [10,31,54,75]
Female (postpartum)	72-137	...** [115]
Female without young	202-343	68-210 [10,12,75]
Juvenile/subadult female	370-646	... [31]
*Estimated minimum and maximum limits of annual and seasonal home range.		
**No data.		

Density: Wolverine densities are typically very low. An average density of 1 wolverine/65 km² was recorded for northwestern Montana [54]. Density estimates in Alaska ranged from 1 wolverine/48 km² to 1 wolverine/193

km² [17,75]. In the Yukon Territory estimates ranged from 1 individual/37 km² to 1 individual/778 km² [10,12]. Wolverine density in the Northwest Territories was estimated at 1 wolverine/136 km² to 1 wolverine/226 km² [69]. In British Columbia, wolverine density in high-quality habitats averaged 1 individual/161 km², in moderate-quality habitats 1 individual/244 km², and in low-quality habitats 1 individual/500 km² [73].

Movements: Wolverines are capable of traveling long distances within short periods of time. In California, wolverines traveled 15 miles (24 km) or more per day searching for food [16]. Males easily travel over 19 miles (30 km) in a day [31,46,64,75,90]. Daily movements for males were significantly greater ($P=0.041$) than for females in Idaho [31]. A young male in the Greater Yellowstone Ecosystem traveled an average minimum distance of 12.9 miles (20.8 km) per day over a 42 day period from late March to early May [56]. Maximum daily distances traveled by males in the Yukon Territory were 10.7 miles (17.3 km). Estimated maximum daily distance traveled by females in the Yukon Territory was 7.0 miles (11.3 km) [10]. Daily movements for females in Idaho ranged 0 to 12.3 miles (19.8 km) [31]. Males moved a straight line average of 7.6 miles (12.3 km) per day during summer in northwestern Alaska. The greatest straight line distance covered by females in a single day was 9.7 miles (15.6 km). Males in northwestern Alaska moved up to 6.6 miles (10.6 km) per hour, while females moved up to 5.0 miles (8.0 km) per hour [75]. A young male in the Greater Yellowstone Ecosystem traveled 8.6 miles (13.8 km) in a 2-hour period [56].

Wolverines tend to utilize areas that make traveling easy. Wolverines generally travel along forested ridges and creek bottoms in Oregon [55]. Winter travel for wolverines in British Columbia and Alberta was limited to upland boreal forest [122]. Wolverines utilize trails created by skiers and snowshoers, which make travel easier in deep snow [6]. In Idaho, they commonly travel downstream along small streams in winter. They also travel through riparian areas, meadows and timber stands [7]. Wolverines are adept swimmers [64,93]. Thus, lakes and rivers most likely do not impede movements.

Temporary, long-distance, seasonal movements are common for males and females [12,54,75]. The reason for these extensive movements is largely unknown. These sudden increases in movement may be a response to the presence of other individuals in breeding condition moving into the same area. Another possible explanation is adjacent residents may attempt to occupy a vacated home range following the death or departure of the resident wolverine [75]. Movements in northwestern Montana were most extensive in spring and lowest in winter [54].

Movements by both females and males decline during the breeding season. Movements by males were influenced by breeding behavior from late winter to summer in northwestern Alaska. Raising young restricted the movements of adult females in northwestern Alaska [75].

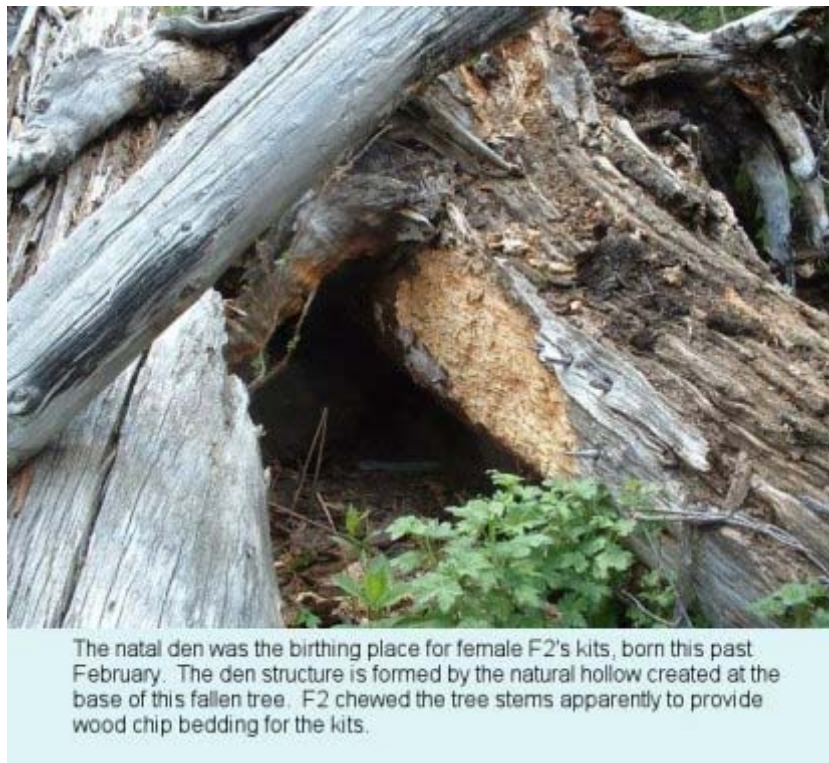
Both male and female juveniles disperse [75], although some female kits remain in their mothers' home ranges [75,112]. Typically, all males disperse in Scandinavian populations [112]. Juveniles and transient subadults may disperse 19 to 235 miles (30-378 km) from their natal range [39,75,112]. A 2-year-old male traveled 235 miles (378 km) from Alaska (starting late March to mid-April) to the Yukon Territory (late November) [40]. A young tagged female believed to be from northwestern Alaska was trapped 186 miles (300 km) outside the original study area. The identity of the young female could not be verified [75].

COVER REQUIREMENTS:

- [Denning](#)
- [Resting Sites](#)

Denning: Female wolverines dig snow dens that are used primarily during parturition (natal dens) and lactation (maternal dens) [31,46,77,90]. When creating dens, females tunnel into hardened snowdrifts near talus boulders or large fallen trees covered in deep snow [7,31,46,77,90]. A den in Finland was located inside a decaying, hollow spruce, while others were in deep ravines on fell (high barren field or moor) slopes, at timberline on gentle fell slopes, or in spruce-pine peat bogs [90]. Most dens are located in alpine, subalpine, taiga, or tundra habitat associated with tree roots, boulders, rock ledges, or deep snow, but rarely in lower elevation forest [46,77,90]. Occasionally, dens are located within rockslides below coniferous forests [46].

Natal dens built by wolverines are often located in rocky outcrops or tunneled into snow drifts adjoining rock formations [46]. According to unpublished data from Montana, natal dens are associated with tree roots, log jams, or boulders covered by snow [50]. Natal dens in Idaho were located in subalpine cirque basins above 8,200 feet (2,500 m) and characterized by large boulder (>6 feet (2 m) diameter) talus sites up to 300 feet (100 m) wide surrounded by trees [31,77]. Natal dens in Alaska were complex tunnel systems dug into deep snowdrifts along minor drainages at 1,840 to 2,050 feet (560-625 m) [77].



Previously used natal den in Glacier National Park, Montana. Photo by Rick Yates, U.S. Department of Agriculture, Forest Service

Natal den use varies by location. In Idaho, natal dens were discovered in mid- to late February. In contrast, natal dens in Alaska were not discovered until early March to late April. Natal dens were abandoned when daily high temperatures were above freezing for several days [77].

Wolverine maternal dens are similar in structure to natal dens. Maternal dens are also constructed by digging snow tunnels leading to natural openings beneath large boulders or to the root masses and boles of fallen trees [31,77]. In Alaska, maternal dens were located either in a snow drift or in a rock cave [77]. A maternal den in the Northwest Territories was located in a large snowdrift on a southeastern facing rock outcrop [70]. Maternal den systems in Finland were 3 to 130 feet (1 to 40 m) in length [90]. Maternal dens in Alaska were located 2.0 to 2.4 miles (3.2-3.8 km) from natal dens [77]. Females in Idaho and Alaska used 4 to 6 maternal dens in a season [31,77]. Both natal and maternal dens are occasionally reused during consecutive years [31,70,77].

Maternal den use varies by location. In Idaho, maternal dens were used mid-March to late April [77]. Maternal dens in northwestern Alaska were abandoned by late April to early May when the snow began to thaw [75,77].

Human disturbance at wolverine den sites may result in den abandonment but not in kit abandonment [31]. Females may or may not move their kits to a new den following a disturbance by humans [31,75,77,90]. However, females periodically move to new dens regardless of whether the old den was disturbed [75].

After dens are no longer used, females leave their kits at rendezvous sites when hunting [31,75]. In northwestern Alaska, rendezvous sites are characterized by remnant snow drifts or tunnels undercut by spring meltwater [75]. Rendezvous sites in Idaho were located on talus slopes or within riparian conifer forest. The talus sites were in subalpine cirque basins characterized by large boulder talus with or without snow. Coniferous riparian forest was characterized by lower slope spruce-fir riparian habitat with mesic, dense shrub and regenerating conifer understory with multiple layered downed woody debris [31].

Resting Sites: Wolverine resting sites are typically shallow depressions on snow or duff or in open areas, such as hillsides, snow banks, or ridges, which afford views of the surrounding area [31,54,69,123]. Beds are

often in stands that afford cover [54]. Resting sites may also be found at the base of trees, within snow dens, hollow logs, on talus, or near prey remains [31]. Wolverines occasionally rest in holes dug under carcasses [46].

FOOD HABITS:

- [Diet Selection](#)
- [Foraging Behavior](#)

Diet Selection: Ungulates are generally the most important foods for the wolverine. Moose, elk, caribou, deer, and other large animals are typically taken as carrion [46,54,76,90,92,104]. Carrion is usually abundant in late winter and early spring [46,55,69]. In a 12-study synthesis, Krebs and others [62] concluded that the primary food sources for wolverines in Idaho, Montana, and Wyoming were white-tailed deer (*Odocoileus virginiana*), mule deer (*Odocoileus hemionus*), and moose. In north-central British Columbia, primary foods were moose and caribou, while in southeastern British Columbia, moose, caribou, mountain goats (*Oreamnos americanus*), and elk (*Cervus elaphus*) were most commonly eaten [62]. Moose and caribou are common in wolverine diets in Alaska [24,75,91,92]. In the Yukon Territory, ungulates consumed in winter include elk, mule deer, caribou, moose, Dall's sheep (*Ovis dalli stonei* and *Ovis dalli dalli*), and mountain goat [10]. Caribou carcasses are likely critical to the survival of wolverines in northwestern Alaska during winter [76] and possibly elsewhere if herds are present. Wolverines in Labrador declined at the same time that the woodland caribou population in the area declined [15], suggesting that wolverines are dependent on caribou as a food source in some areas.

A variety of small- to medium-sized mammals are captured by wolverines [10,75,76,92,104,115]. North American porcupines (*Erethizon dorsatum*) appear to be consumed regularly where they are locally abundant [10,91,92]. Quills often puncture digestive tracts and other tissues, causing infections [91] or death (review by [14]), and making the North American porcupine a particularly dangerous prey animal. Snowshoe hares are captured primarily in winter [10,46,54,80,91,104,115]. Wolverine populations were not correlated with snowshoe hare populations in the Yukon Territory [20], suggesting that snowshoe hares are not an important food source for wolverines in that area. Hoary marmots, arctic ground squirrels (*Spermophilus parryi*), Columbian ground squirrels (*S. columbianus*), and other squirrels (Sciuridae) are important summer foods where abundant [10,62,75,76,91,92,115].

Voies and lemmings are also prominent in wolverine diets [10,46,75,76,91]. Common species include northern red-backed voles (*Myodes rutilus*), tundra voles (*Microtus oeconomus*), taiga voles (*Microtus xanthognathus*), singing voles (*Microtus miurus*), western heather voles (*Phenacomys intermedius*), Peary Land collared lemmings (*Dicrostonyx groenlandicus*), and Nearctic brown lemmings (*Lemmus trimucronatus*) [10,75,76,92]. Mice and rats (Cricetidae), shrews (*Sorex* spp.), pocket gophers (Geomyidae), and other small mammals are hunted less frequently [10,46,54,75,76,80]. Voies, lemmings, ground squirrels, and other small mammals are typically captured in summer and cached for use in winter [75]. In winter, cached arctic ground squirrels can provide a steady diet of carrion for wolverines in arctic Alaska [76]. Other small mammals and birds that sustain wolverines during winter in Alaska and the Yukon Territory may be captured and cached in summer as well.

Wolverines feed on other animals if there is opportunity. Small to medium sized mammals, including carnivores, are hunted or scavenged. Prey items in winter in the Yukon Territory include American pikas (*Ochotona princeps*), American beavers (*Castor canadensis*), American martens (*Martes americana*), American mink (*Mustela vison*), short-tailed weasels (*Mustela erminea*), wolverines, coyotes (*Canis latrans*), gray wolves (*Canis lupus*), and Canada lynx (*Lynx canadensis*) [10]. In northwestern Montana, wolverine diets consisted of American beavers, weasels (*Mustela* spp.), and other wolverines [54]. Red fox (*Vulpes vulpes*) carcasses were found in dens in Finland [90]. On the Alaskan coast, wolverines feed on whale (Cetacea), walrus (*Odobenus rosmarus*), and seal (Otariidae or Phocidae) carcasses that wash up on shore [91].

Birds, bird eggs, fish, and insects are consumed when available [10,11,46,54,75,76,80,91,92,104,115]. Ptarmigan (*Lagopus* spp.) are the most commonly captured birds [19,75,76,90]. Winter foods in Alaska include European magpie (*Pica pica*), hawks, others birds, and fish [92]. Wolverines consume salmon in southeast

Alaska, but it is unclear whether they catch salmon directly or scavenge for leftover carcasses [117]. Wolverines prey on bald eagle (*Haliaeetus leucocephalus*) and northern goshawk (*Accipiter gentilis*) chicks, corvids (Corvidae), owls (Strigidae), gulls and terns (Laridae), grouse (Tetraonidae), and fish in the Yukon Territory [10,35]. A great horned owl (*Bubo virginianus*) nest may have been raided by a wolverine in the Yukon Territory as well [35]. Wolverines in Nunavut killed Ross's geese (*Chen rossii*), lesser snow geese (*Chen caerulescens caerulescens*), and their eggs. The geese and most of the eggs were cached for later use. Wolverines in Nunavut also stole geese carcasses from arctic foxes (*Alopex lagopus*) [95]. When opportunities arise, wolverines forage on insects and bird eggs [10,75,80].

Vegetation, including seeds, mountain cranberries, bog blueberries (*Vaccinium uliginosum*), kinnikinnick (*Arctostaphylos uva-ursi*) berries, and other fruits, is consumed seasonally [10,46,55,91,104].

Coyotes, bobcats, mountain lions, and fishers compete directly with wolverines for food [55]. Wolverines also raid caches created by red foxes and grizzly bears [75]. Wolverines commonly raid baited traps and kill trapped furbearers [54]. In an account recorded by Grinnell [44], a native hunter in Alaska observed a wolverine defending a caribou carcass from a bear (*Ursus* spp.). During the fight, the bear was mortally wounded and found dead 200 to 300 yards (180-270 m) from the caribou. The bear had been disembowelled by the wolverine [44], but it is unclear whether this occurred during the fight or after the bear was already dead.

In an exceptional circumstance, the remains of 5 wolverines and 2 American martens were discovered in a dry wooden water tank within an Engelmann spruce-subalpine fir forest in Banff National Park, Alberta. Only 1 wolverine carcass remained intact when observed on May 26, 1963. The observers presumed that dead or dying individuals trapped in the tank were cannibalized as new individuals became trapped until only the single female wolverine remained. The last female apparently starved to death after the other individuals had been consumed [38].

Foraging Behavior: Wolverines are primarily scavengers and depend on gray wolves (*Canis lupus*) and other predators to provide ungulate carrion [11,46]. They travel long distances searching for carrion and other feeding opportunities [54]. However, they rarely hunt as other predators do [46,54]. Wolverines occasionally hunt large prey such as moose or caribou calves and yearlings [46,91,101]. When hunting, wolverines charge after caribou, moose, and other prey, often giving their potential prey ample time to escape [46,55,64]. The longest chases recorded in Sweden were 0.6 miles (1 km) [46]. Hunts are most successful during early spring when deep, soft snow limits the movement of large ungulates [46,91]. Wolverines may hunt mountain goats, but kills have not been observed [27,45]. Successful hunts for small prey such as hoary marmots, snowshoe hares, deer mice, and red squirrels are more common [54].

Excess food is cached under soil or snow, in water wells, or in trees [46,64]. Less common cache locations include crevices and rock piles [46]. Holes dug 3 to 7 feet (1-2 m) into the snow are used for either food storage or as protected areas for feeding [69]. Cache sites in British Columbia and Alberta were primarily in open areas with views of the surrounding area and were accessed by multiple trails created by the wolverines. Food caches were in climax or "overmature" black spruce or conifer dominated stands of mixed complexity. Cache sites were not located in dense homogeneous black spruce stands. One cache contained moose remains on a linear corridor regenerating to lodgepole pine. Additional caches were created from the carcass remains. A second cache was located near a linear corridor with compacted snow in a climax stand of black spruce with stunted growth. A third cache was found in a highly complex climax stand with a relatively open canopy dominated by conifers [123].

PREDATORS:

Gray wolves are the primary predators of wolverine adults and kits [19,24,114]. An adult male in Idaho was killed by a mountain lion [31]. American black bears, grizzly bears, mountain lions, and golden eagles prey upon young, inexperienced wolverines [54]. Wolverines seek safety in trees when threatened [44] and are most vulnerable to predation when unable to climb a tree or when caught in traps [19,24]. Deep, complex den systems dug into snow offer protection to wolverine kits because predators have difficulty accessing the dens [77].

According to a review, wolverines are highly aggressive, and males occasionally kill other males [11].

MANAGEMENT CONSIDERATIONS:

- [Population Status](#)
- [Threats](#)
- [Management Recommendations](#)

Population Status: Wolverine populations in the United States and Canada have been reduced from historical population levels [111]. Population estimates for the Sawtooth and Salmon-Challis National Forests in Idaho totaled 6 to 7 individuals as of 1990 [7]. Genetic analysis of a male wolverine sighted on the Tahoe National Forest in February 2008 indicated that the wolverine was genetically linked to populations from Idaho and was not a descendent of original California populations [109]. Original wolverine populations in California may now be extinct [126]. Populations in some parts of the northern Rocky Mountains, Cascade Ranges, and Sierra Nevada were showing signs of increasing as of 1973 [55]. Aubry and others [5] speculated that these increases were related to extreme dispersal events from populations in southwestern Canada and Montana and not from increases in locally established populations. Populations in Alaska were "reasonably secure" as of 1973 [55]. In 2007, Aubry and others [5] speculated that conditions in the Great Lakes region and in other parts of the United States may no longer be suitable for wolverines due to global warming.

As of 1975, wolverine populations in eastern Canada had declined rapidly, while populations in western Canada declined at a slower rate and were showing signs of increasing. Despite the increases, most of these populations were still below historical estimates [111]. The continued existence of the wolverine in Quebec and Labrador was uncertain as of 2003 [28]. Populations in Ontario had declined noticeably as of 1975, while the southern extent of wolverine range in Manitoba had receded northward [111]. Populations in western Canadian provinces were generally stable but potentially declining locally as of 2003 [28]. Larsen [68] speculated that wolverines were common in western Canada as of 1980 because the area also supported large and diverse ungulate populations.

Threats: The most common causes of wolverine mortality outlined in a 12-study synthesis were hunting or trapping, starvation, and predation [62]. Overtrapping and habitat loss are the largest threats facing the wolverine [54,108]. Wolverines are highly attracted to traps baited with carrion as well as those that have already trapped another animal [55]. Wolverines are considered a pest by trappers because they mutilate trapped furbearers and destroy traps [11,44,55]. Hunting and trapping may lead to local declines in wolverine populations. Surrounding wolverine populations may recolonize overhunted areas [33]. Many untrapped areas have wolverine populations with positive growth that can act as restocking refugia for neighboring populations experiencing negative growth [62]. Hornocker and Hash [54] concluded that protected wilderness areas along with limited hunting pressure would allow wolverines to persist in northwestern Montana. Thus, it may be possible to establish a balance between maintaining stable wolverine populations and preserving local hunting and trapping traditions in some areas.

Other human activities, such as agriculture, development, and eradication campaigns against other predators, have negative indirect effects on wolverine populations. Large scale poisoning of gray wolves in the 1970s had a negative impact on wolverines in Canada because wolverines rely on carrion from kills by gray wolves for survival [28]. Agriculture, silvicultural practices, and oil, gas, and mineral development can fragment habitats, which could have negative effects on wolverine populations [11]. Large hydroelectric reservoirs may threaten wolverine habitat and prey [115]. The effects of villages on wolverine populations in Alaska were unknown [75]. As stated in a review, populations are likely limited by clear-cut logging, road construction, and snowmobile and other off-road vehicle use that can disturb large wilderness areas [84]. Silvicultural practices that reduce the overstory would be detrimental to wolverine populations in winter [122]. Wolverines cross clear-cuts and burns in western Montana, but they appear to spend as little time within these areas as possible. Males in Montana are found further from active roads, clear-cuts, and burns than females [54].

Roads divide habitats and may impede wolverine movements, isolating populations. Wolverines along the British Columbia-Alberta border avoided areas <330 feet (100 m) off the Trans Canada Highway and showed a preference for areas >3,600 feet (1,100 m) off the highway. They also avoided sections of a ski trail that were within 660 feet (200 m) of the highway and preferred trails >3,600 feet (1,100 m) from the highway. Wolverines crossed the Trans Canada Highway 50% of the time when approached but only where the rights-of-way were shortest. Railway rights-of-way did not impede wolverine crossing when the railways were not associated with the Trans Canada Highway. Wolverines may be more vulnerable to traffic when road rights-of-way are wide. An ideal road design would be straight roads with rights-of-way <160 feet (50 m) [6].

Management Recommendations: Limits to human activity have been proposed to protect wolverine habitats. Wolverines in northwestern Montana preferred basins, southerly and easterly slopes, and edge and ecotonal areas. To protect wolverine habitat, Hornocker and Hash [54] advised in 1981 that these areas be left intact. They also recommended that use of logging roads be strictly regulated, particularly in winter. In summer, wolverines naturally separate themselves from human activity, reducing potential conflict along high-elevation logging roads or clear-cut areas. In winter and early spring, however, logging roads could bring about disturbance and conflict via snowmobile or all-terrain vehicle access as well as easy access for fur trappers [54]. In contrast, Magoun [75] speculated that oil and gas development was not affecting wolverines in northwestern Alaska. Ingram [55] suggested that logging had had minimal impact as of 1973 because wolverines occupy remote habitats. However, Ingram [55] also concluded that intensive human activity could limit wolverine populations.

Allen [2] recommended that management of wolverine populations should include "providing a variety of successional stages; maintain or encourage cover-type mosaic through cutting or burning; maintain travel corridors between extensively managed areas and wilderness." Additional information on the management concerns and research needs for wolverine reproduction, food habits, habitat use, and conservation is outlined in a review by Banci [11].

FIRE EFFECTS AND USE

SPECIES: *Gulo gulo*

- [DIRECT FIRE EFFECTS ON ANIMALS](#)
- [HABITAT-RELATED FIRE EFFECTS](#)
- [FIRE MANAGEMENT CONSIDERATIONS](#)



Boreal forest burning in Innoko National Wildlife Refuge, Alaska, where wolverines likely occur. Photo by the U. S. Department of the Interior, Fish and Wildlife Service.

DIRECT FIRE EFFECTS ON ANIMALS:

As of 2008, the direct effects of fire on wolverines are unknown. Since wolverines are capable of traveling long distances in a short time (see [Movements](#)), it is unlikely that many individuals would be trapped by approaching flames or smoke. Additionally, kits are born during periods of heavy snow cover (see [Denning](#)) when fire risk is low, thus limiting the potential effects of fire on young.

HABITAT-RELATED FIRE EFFECTS:

Postfire habitat is less suitable for wolverines than unburned habitats [\[51\]](#). Fire temporarily displaces wolverines, which depend on late successional habitats [\[43\]](#). Wildfires in western Montana have removed climax coniferous forests from some areas, which were replaced by stands of seral or intermediate species [\[54\]](#). In the Yukon Territory, wolverines occupied an area characterized by regenerating lodgepole pine, white spruce, quaking aspen, subalpine fir, and willow with remnant patches of mature forest and alpine tundra, 28 to 36 years after fire [\[102\]](#). A wolverine in British Columbia or Alberta traveled through a burned upland area dominated by second-growth lodgepole pine, which formed a low, dense canopy [\[122\]](#). Lowlands in northeastern British Columbia and northwestern Alberta had reached early- to mid-seral growth dominated by quaking aspen or pine (*Pinus* spp.) approximately 50 years after fire. Wolverines avoided these lowland areas in favor of uplands with continuous coniferous forest cover that did not burn in the fire [\[123\]](#).

Wolverine use of a western redcedar-western hemlock-Engelmann spruce-subalpine fir lowland forest in British Columbia was reduced following a fire that denuded most of the forest in the lowland areas. The 1926 fire spread with "explosive intensity", completely burning boles of mature trees and affecting approximately 200 mi² (520 km²) of the lowland forest. The fire had a minimal effect on the subalpine forests on higher slopes. By

postfire year 27, 60% of the burned area below 4,000 feet (1,200 m) had recovered to an early-seral stage dominated by willow, quaking aspen, and birch [36].

Fire Effects on Predators and Prey: Wolverines depend on other predators, such as the gray wolf, to provide deer, elk, moose, and caribou carrion [11,46]. Thus, it is reasonable to expect that the effects of fire on wolverines would partially depend on the effects of fire on gray wolves and prey species.

- [Gray Wolf](#): According to a review, gray wolves avoid burned and harvested stands immediately following disturbance. Gray wolves typically are not abundant throughout early succession, although they may recolonize these areas to some extent shortly after disturbance [37]. A mosaic of postfire or postlogging successional stages within a pack's territory is necessary to sustain healthy populations of prey species [53].

Gray wolf populations were monitored following 2 wildfires on the Kenai Peninsula, Alaska [89,98]. The populations were observed in postfire years 9 to 19 on the first site (fire occurred in 1969) and postfire years 31 to 41 on the second site (fire occurred in 1947). Gray wolves were absent from the Kenai Peninsula at the time of the fire in 1947 and reestablished in the area sometime later [98]. Gray wolves may have been attracted to the area after an increase in moose populations following the 1947 fire. Gray wolf density was high (11.1-19.5 gray wolves/1,000 km²) following the 2 wildfires [89,98]. Density estimates were not significantly different between the 2 areas [98].

A mixed-severity wildfire in northwestern Alaska, which occurred June 15 to mid-August 1988, burned 210,000 acres (85,000 ha) of white spruce-black spruce boreal forest. Many white spruce and black spruce trees were killed. In some areas, the fire burned down to mineral soil, especially where reburning occurred. The fire had no apparent negative short-term effects on 2 gray wolf packs in the area. A year before the wildfire, the pre-burn area was used by the first pack more than expected based on availability during summer, winter, and annually ($P < 0.001$). The same area was also used disproportionately more during the fire and in the year the fire occurred compared to areas that did not burn ($P < 0.001$). The burned area was utilized as expected based on availability ($P = 1.0$) during winter. The pack used the burned area proportionally less during summer ($P = 0.04$), winter ($P = 0.09$), and annually ($P = 0.03$) in 1988 to 1989 than before the burn (1987-1988). One to 2 years after the fire (1989 to 1990), the pack utilized the burned area more than expected in summer ($P = 0.01$) and annually ($P < 0.001$), but in proportion to availability in winter ($P = 0.18$). The burned area was used less in the second year after fire than before the fire ($P \leq 0.02$) [9].

After 1990, the entire pack was killed by hunting or disease. Shortly afterwards, a second pack moved into the area. They initially used the burned area in proportion to its availability in winter ($P = 0.30$) but less than expected during summer ($P = 0.01$) and annually ($P < 0.001$). During 1991 to 1992 (3-4 years after fire) the burn was used more than expected in summer ($P < 0.001$) and annually ($P = 0.005$) and in proportion to availability in winter ($P = 0.67$). Overall, the 2 gray wolf packs showed a general preference for areas within the fire boundary than outside of it both before and after the fire [9].

During the first 2 winters following the fire, the gray wolves used the burned area less than they had before the fire. This shift in habitat use may have reflected a shift in caribou use of the area rather than a negative effect of the fire on the gray wolf packs. By the third year, gray wolf use of the area in winter had returned to prefire levels [9].

In summer, caribou and moose were the predominant food items for the gray wolf packs following the 1988 wildfire in northwest Alaska [103]. Thus, these prey items were evidently present in sufficient numbers during summer to support gray wolves and any potential carrion scavengers, such as the wolverine.

- [Caribou](#): Caribou typically have a negative response to fire because lichen forage is often destroyed [37]. Lichen forage recovers slowly following fire, forcing many caribou herds to find new feeding areas after fire. Often lichens require at least 50 years to recover before the supply is sufficient to support a caribou herd [99,107]. Thus, any wolverine populations that depend largely on caribou as a major prey species would likely suffer for decades following a fire.

In the same northwestern Alaska wildfire mentioned for the gray wolf, sheathed cottonsedge (*Eriophorum vaginatum*) quality and availability had increased by 1990. It created attractive feeding sites for caribou in late winter [97], which may have provided a larger prey base for gray wolves and wolverines in the area. The improved forage quality was likely short-lived and the overall availability of food for caribou was most likely reduced several years after the fire [97].

- [Elk](#): In a review, Kramp and others [60] stated that clearings of 1.2 to 8.6 acres (0.5-3.5 ha) were optimal for elk. Following fall burns, the availability of spring and summer grasses, often favored by elk, increased. Regenerating quaking aspen was a highly favored browse species as well [60]. Elk use of burned units in Glacier National Park, Montana was influenced by vegetation type rather than stand age [100].

Elk use of an area burned by wildfire in west-central Alberta increased steadily during the first 3 years after fire. As a whole, the fire was characterized as a high-severity fire. Overall use of the burned sites by elk for the first 3 postfire years peaked in July, with general use highest in May to October. Based on radio telemetry, elk showed a preference for burned-only sites but generally avoided salvage-logged and cut-and-burned sites after the wildfire. Pellet counts for elk were lowest in salvage-logged areas compared to burned-only and cut-and-burned treatments ($P < 0.10$). Pellet counts indicated that elk use of cut-and-burned sites was significantly higher ($P < 0.10$) than in salvage-logged or burned-only sites. Elk may have avoided salvage-logged sites because of an increase in predation risk, especially from gray wolf packs, compared to burned-only and cut-and-burned sites that provided additional cover and less coarse woody debris [52].

- [Moose](#): Moose generally respond favorably to fire. In a review, Fisher and Wilkinson [37] asserted that moose colonize newly burned areas to take advantage of abundant regeneration of quaking aspen and other browse species. Wolf and Zasada [121] reported that quaking aspen stands provided the most browse 1 to 5 years after fire, while birch and willow stands provided the most browse 10 to 16 years after fire. In a review of Alaskan populations, LeResche and others [72] suggested that moose densities peak 20 to 25 years after fire, with the positive effects of fire on habitat becoming negligible after 50 years. In the Kenai Peninsula, winter browse was most abundant 20 to 30 years after fire. Moderate levels of browse were available 7 to 10 years after fire, while browse availability was lowest 70 to 80 years after fire [113].

Deciduous trees that sprout prolifically after fire, such as aspen, birch, willow, maple, and pin cherry, are heavily utilized by moose [63,86]. Browse critical for moose is characteristic of secondary stages of forest succession [71]. Unless snow packs are deep, moose may take advantage of regenerating forage within large recent burns. Recent burns may provide an area for dispersal of yearling moose. In mid-winter following a fire in Minnesota, moose moved away from the burn to nearby evergreen forest where snow cover was lower allowing access to browse [86].

Moose densities decline following a reduction in early-seral browse species. Moose densities on the Kenai Peninsula were high 9 to 19 years after fire (3.3-3.7 moose/km²) in response to high quality habitat. On a nearby burned site, moose were at a moderate density (1.3 moose/km²) around 31 years after fire. Moose on the second site declined 41 years after fire (0.3 moose/km²) [98]. Winter moose densities following the wildfires on the Kenai Peninsula were highest 17 to 26 years (2.0-3.6 moose/km²) after a fire in 1947.

Thirteen to 21 years after a 1969 fire, winter moose densities increased (3.6-4.4 moose/km²). In older forests, winter moose densities were much lower at 0.1 to 0.8 moose/km² [74].

- [White-tailed deer/ Mule deer](#): According to a review by Kramp and others [60], low-severity fire that creates small forest openings up to 1.2 acre (0.50 ha) is preferred by white-tailed and mule deer. Larger openings allow for greater snow accumulation, which impedes movements and feeding ability while increasing the risk of predation [60].

In areas with deep snow cover, forage plants are often completely covered by snow in winter, preventing white-tailed deer from foraging [86]. White-tailed deer in Idaho preferred bluebunch wheatgrass/Sandberg bluegrass (*Agropyron spicatum/Poa sandbergii*) habitats in February because they were the only habitats at that time of year that were snow-free. By March, snow began to melt within forested habitats freeing up forage that was previously unavailable. Mule deer in the Idaho study showed a preference for burned Douglas-fir/ninebark (*Physocarpus malvaceus*) and burned ponderosa pine/bluebunch wheatgrass habitats throughout winter. Snow-free bluebunch wheatgrass/Sandberg bluegrass habitats were not as important for mule deer as they were for white-tailed deer [59].

In a wildfire study from west-central Alberta (details discussed in [elk](#) subsection), deer pellet abundance was higher in burned-only and cut-and-burned sites than in salvage-logged sites ($P < 0.10$). Deer may also have avoided salvage-logged sites due to increased risks for predation [52].

The following table provides fire regime information that may be relevant to wolverine. Find further fire regime information for the plant communities in which this species may occur by entering the species name in the [FEIS home page](#) under "Find Fire Regimes".

Fire regime information on vegetation communities in which wolverine may occur. For each community, fire regime characteristics are taken from the [LANDFIRE Rapid Assessment Vegetation Models](#) [67]. These vegetation models were developed by local experts using available literature, local data, and/or expert opinion as documented in the PDF file linked from the name of each Potential Natural Vegetation Group listed below. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.

[Pacific Northwest](#)
[California](#)
[Northern Rockies](#)

Pacific Northwest

- [Northwest Woodland](#)
- [Northwest Forested](#)

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northwest Woodland					
Pine savannah (ultramafic)	Replacement	7%	200	100	300
	Surface or low	93%	15	10	20
Subalpine woodland	Replacement	21%	300	200	400

	Mixed	79%	80	35	120
Northwest Forested					
Douglas-fir-western hemlock (dry mesic)	Replacement	25%	300	250	500
	Mixed	75%	100	50	150
Douglas-fir-western hemlock (wet mesic)	Replacement	71%	400		
	Mixed	29%	>1,000		
Mixed conifer (southwestern Oregon)	Replacement	4%	400		
	Mixed	29%	50		
	Surface or low	67%	22		
California mixed evergreen (northern California)	Replacement	6%	150	100	200
	Mixed	29%	33	15	50
	Surface or low	64%	15	5	30
Mountain hemlock	Replacement	93%	750	500	>1,000
	Mixed	7%	>1,000		
Pacific silver fir (low elevation)	Replacement	46%	350	100	800
	Mixed	54%	300	100	400
Pacific silver fir (high elevation)	Replacement	69%	500		
	Mixed	31%	>1,000		
Subalpine fir	Replacement	81%	185	150	300
	Mixed	19%	800	500	>1,000
Mixed conifer (eastside mesic)	Replacement	35%	200		
	Mixed	47%	150		
	Surface or low	18%	400		
Red fir	Replacement	20%	400	150	400
	Mixed	80%	100	80	130
Spruce-fir	Replacement	84%	135	80	270
	Mixed	16%	700	285	>1,000
California					
California Forested					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval	Minimum interval	Maximum interval

			(years)	(years)	(years)
California Forested					
California mixed evergreen	Replacement	10%	140	65	700
	Mixed	58%	25	10	33
	Surface or low	32%	45	7	
Jeffrey pine	Replacement	9%	250		
	Mixed	17%	130		
	Surface or low	74%	30		
Interior white fir (northeastern California)	Replacement	47%	145		
	Mixed	32%	210		
	Surface or low	21%	325		
Red fir-white fir	Replacement	13%	200	125	500
	Mixed	36%	70		
	Surface or low	51%	50	15	50
Red fir-western white pine	Replacement	16%	250		
	Mixed	65%	60	25	80
	Surface or low	19%	200		
Sierra Nevada lodgepole pine (cold wet upper montane)	Replacement	23%	150	37	764
	Mixed	70%	50		
	Surface or low	7%	500		
Sierra Nevada lodgepole pine (dry subalpine)	Replacement	11%	250	31	500
	Mixed	45%	60	31	350
	Surface or low	45%	60	9	350
Northern Rockies					
Northern Rockies Forested					
Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northern Rockies Forested					
Western redcedar	Replacement	87%	385	75	≥1,000
	Mixed	13%	>1,000	25	

Douglas-fir (warm mesic interior)	Replacement	28%	170	80	400
	Mixed	72%	65	50	250
Mixed conifer-upland western redcedar-western hemlock	Replacement	67%	225	150	300
	Mixed	33%	450	35	500
Western larch-lodgepole pine-Douglas-fir	Replacement	33%	200	50	250
	Mixed	67%	100	20	140
Grand fir-lodgepole pine-larch-Douglas-fir	Replacement	31%	220	50	250
	Mixed	69%	100	35	150
Persistent lodgepole pine	Replacement	89%	450	300	600
	Mixed	11%	>1,000		
Whitebark pine-lodgepole pine (upper subalpine, Northern and Central Rockies)	Replacement	38%	360		
	Mixed	62%	225		
Lower subalpine lodgepole pine	Replacement	73%	170	50	200
	Mixed	27%	450	40	500
Lower subalpine (Wyoming and Central Rockies)	Replacement	100%	175	30	300
Upper subalpine spruce-fir (Central Rockies)	Replacement	100%	300	100	600

***Fire Severities:**

Replacement=Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.

Mixed=Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.

Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [49,66].

FIRE MANAGEMENT CONSIDERATIONS:

Forests in a stem exclusion stage are limiting to wolverines [119], so a fire that reduces canopy cover in these forests may improve habitat conditions for the wolverine. Conard [29] speculated that fire in western Montana would increase the structural diversity of forested stands, which would improve wolverine habitat.

Major prey species, including moose, white-tailed deer, mule deer, and elk, prefer habitats and browse species that are widely available following fire. For elk, [fire-return intervals](#) of 5 to 15 years may maintain adequate forage (see [habitat related fire effects](#) for elk). Moose populations peak 20 to 30 years after fire [72,113]. Fire may help reestablish moose populations when they begin to decline. Fire-return intervals required to maintain deer browse depend on the plant community. Appropriate fire-return intervals for white-tailed deer range from 3 to 5 years in southern pine forests [48] to 40 to 80 years in aspen stands in the interior western United States [34]. For more information, see [habitat related fire effects](#) for white-tailed deer. Mule deer in bunchgrass communities benefit from fire every 4 to 6 years [58], while populations in climax chaparral communities

benefit from a fire-return interval of approximately 30 years [18]. For more information, see [habitat related fire effects](#) for mule deer.

Since major prey species require habitats at different successional stages, a mosaic of successional stages across a large landscape that support each species may provide consistent food sources for wolverines. If a limited number of prey species are present within wolverine habitat, however, then promoting successional stages that would be beneficial to those species could be more beneficial for wolverines.

FIRE REGIMES : Find fire regime information for the plant communities in which this species may occur by entering the species name in the [FEIS home page](#) under "Find Fire Regimes".

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