Wyoming Wolverine Management Plan

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Approved by
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July 17, 2020

EXECUTIVE SUMMARY

Wolverines (*Gulo gulo*) are found throughout the northern latitudes of North America, Europe, and Asia. They were nearly eliminated from the contiguous U.S. by 1920 due to unregulated harvest, habitat loss and broad-scale carnivore poisoning. Wolverines began recolonizing their former range in the 1930s and have recently been documented as far south as Utah and Colorado.

Wolverines in Wyoming are classified as Nongame Wildlife and defined as a protected animal by state statute. They are further classified as a Species of Greatest Conservation Need in Wyoming's State Wildlife Action Plan and are currently listed as a proposed threatened species under the Endangered Species Act. Currently the USFWS is reviewing the "not warranted" decision for wolverines in the contiguous U.S. (USFWS 2016).

In Wyoming, wolverine habitat is restricted to mountain ranges in the western, north central and south central regions of the state. Wolverine home ranges are widely dispersed and often defined by food availability. Populations are slow to expand because of low pregnancy and birth rates.

During the winter of 2016-17, the Wyoming Game and Fish Department (Department) in cooperation with the Western Association of Fish and Wildlife Agencies (WAFWA) participated in a range-wide occupancy survey for wolverines. The survey, planned to be repeated at five year intervals confirmed the broad distribution of wolverines across the region and documented population recovery above their historic lows. For the first time ever, wolverines were detected in the Gros Ventre Mountains and the southern Wind River Range.

Specific management actions of the plan include:

- Collaborate with the Western States and partners within Wyoming to evaluate monitoring protocols and repeat a range wide survey every 5 years starting during the 2021-22 winter.
- Explore opportunities to conduct wolverine research that help determine population status and vital rates of wolverines in Wyoming.
- Work with the Federal Land management agencies and other stakeholders to insure wolverines are considered in land use decisions.
- Engage the public and stakeholders through media releases and other outreach efforts.

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INTRODUCTION

Wolverines (*Gulo gulo*) are the largest terrestrial member of the weasel family and are found throughout the northern latitudes of North America, Europe, and Asia. Historically, wolverines were documented throughout the western U.S. as far south as California and New Mexico (Pasitschniak-Arts and Larivière 1995), although their historic distribution is unknown (Aubrey et al. 2007). Wolverines were nearly eliminated from the contiguous U.S. by the mid-1920s, primarily due to unregulated harvest, habitat loss, and broad-scale carnivore poisoning (Aubry et al. 2007, McKelvey et al. 2014). Wolverines began to recolonize their former range in the 1930s through natural dispersal from larger populations in northern Montana and western Canada (Newby and Wright 1955, Newby and McDougal 1964, Pasitschniak-Arts and Larivière 1995, McKelvey et al. 2014). Wolverines have been documented as far south as Utah and Colorado, but wolverines remain rare in the contiguous U.S. (Packila et al. 2017). As a result of current small population size and concerns regarding potential effects of climate change, the species was petitioned for listing under the Endangered Species Act (ESA) in 2000 (see Legal Status, page 2).

Wolverines are found in high-elevation coniferous forests and alpine habitat (Pasitschniak-Arts and Larivière 1995). Little is known about wolverine populations in Wyoming, including population status, distribution, densities, and trends (WGFD 2017). Although wolverines have been recently observed in Colorado and Utah, reproduction has not been documented in these states. At present, it is unclear where the southern extent of breeding populations of wolverines occurs in North America, but Wyoming likely represents the southernmost extent of reliable wolverine occupancy (Inman et al. 2013, 2015).

In response to a petition to list the wolverine under the ESA, the Western Association of Wildlife Agencies (WAFWA) established the Wildlife Chiefs' Wolverine Subcommittee (Subcommittee) in January 2015. Membership included Wildlife Chiefs from Idaho, Montana, Washington, and Wyoming (i.e., states where wolverines existed when the Subcommittee was developed), as well as California, Colorado, Oregon, and Utah. Although management of wolverines remained with each state, the Subcommittee provided a framework for regional conservation efforts. Objectives of the Subcommittee include:

1. Develop a statistically defensible multi-state monitoring plan where wolverine populations exist (WY, MT, ID, WA);
2. Seek funding to implement the monitoring plan;
3. Coordinate development of individual state wolverine conservation plans for states with suitable wolverine habitat; and
4. Coordinate and prioritize research efforts.

As a result, state agencies in collaboration with federal, tribal, and university partners initiated the Wolverine Working Group (Working Group) under the leadership of the Subcommittee. The primary charge and key conservation priority of the Working Group was to develop and implement a multi-state monitoring strategy (Inman et al. 2013, Multi-state Wolverine Working Group 2016).

Legal Status

Wolverines are defined by Wyoming state statute W.S. § 23-1-101 as a protected animal (State of Wyoming 1973) and identified as nongame wildlife in Chapter 52 of the Wyoming Game and Fish Commission regulations (WGFC 2016). In addition, wolverines are classified as a Species of Greatest Conservation Need by the Department (NSS3 [Bb], Tier II; WGFD 2017) and as a Proposed Species by Region 2 of the U.S. Forest Service (Rocky Mountain Region; USFS 2018).

Wolverines were first petitioned for listing in 1994. The USFWS determined the petition did not contain substantial information to indicate that listing was warranted (USFWS 1995). The wolverine was again petitioned for listing in 2000, and the USFWS determined that listing was not warranted (USFWS 2003). A 12-month review initiated in 2007 (USFWS 2007) concluded that wolverines in the contiguous U.S. were not a listable entity and therefore not warranted for listing (USFWS 2008). With the addition of Distinct Population Segments (DPS) as a listable entity under the ESA, the North American wolverine DPS was found to be warranted for listing but precluded by higher priority actions. In 2010, the USFWS proposed the wolverine for listing as a threatened species (USFWS 2013b) and proposed the establishment of a nonessential, experimental population in the southern Rocky Mountains of Colorado, northern New Mexico, and southern Wyoming in 2013 (USFWS 2013a). Both rules were withdrawn in 2014 when new information indicated that factors affecting the DPS were not as significant as believed at the time of the proposed listing (USFWS 2014). This decision was later vacated by the District Court for the District of Montana in 2016, reverting wolverines throughout the contiguous U.S. back to proposed threatened status (USFWS 2016).

Management Plan

The purpose of the Plan is to guide decisions and actions that promote wolverine conservation in Wyoming. Goals include: 1) promote long-term viability, 2) support expansion into suitable habitat, 3) participate in the interstate monitoring, and 4) manage wolverines as a protected animal. This plan is divided into 4 sections: ecology, distribution and occupancy, threats and risk factors, and management and conservation strategies. The Department collaborated with the USFWS, Eastern Shoshoni and Northern Arapaho Tribes, National Park Service (NPS), Bureau of Land Management (BLM), and U.S. Forest Service (USFS) to draft this plan.

WOLVERINE ECOLOGY

Wolverines are the largest terrestrial mustelid, typically weighing 8.5-14.5 kg. The species has a circumpolar distribution in North America that historically extended south to California and New Mexico (Pasitschniak-Arts and Larivière 1995). Their range has since retracted northward, with the Greater Yellowstone Ecosystem (GYE) of Wyoming representing the southernmost extent of reliable wolverine occupancy (Inman et al. 2013; see Distribution and Occupancy, page 4). Wolverines are well-adapted to winter conditions and are able to move in soft, deep snow because of their relatively large feet (Pasitschniak-Arts and Larivière 1995). Distribution in North America

is often associated with high elevation alpine and subalpine habitats, increased topographic ruggedness, and persistent spring snow cover (Krebs et al. 2007, Copeland et al. 2010, Fisher et al. 2013, Inman et al. 2013).

Wolverine habitat use varies between sexes and summer and winter seasons. In Idaho, wolverines selected for higher elevations, northerly aspects, steep slopes, and montane-park habitat and selected against grass-shrub habitats and rock (Copeland et al. 2007). Although males moved to lower elevations in winter, likely in response to prey availability, females remained at higher elevations regardless of season, likely for snow cover used for denning (Copeland et al. 2007; see Distribution and Occupancy, page 4). Heinemeyer et al. (2019) also found differences in habitat use in winter in Idaho, Montana, and Wyoming. Within home ranges, wolverines selected for riparian areas, forest edges, and less rugged topography. Females selected for areas likely to support denning habitat, including talus areas with persistent spring snow cover and lower solar radiation (Heinemeyer et al. 2019). Wolverines in the GYE were positively associated with elevation, topographic ruggedness, and snow depth, and negatively associated with distance to high-elevation talus, tree cover, and snow >2.5 cm (Inman et al. 2013). In general, wolverines selected for areas >2,600m latitude-adjusted elevation, with winter use at slightly lower elevations than summer use. Although wolverines wintered at lower elevations, they still remained at elevations above ungulate winter ranges, potentially to avoid predators and competitors (Inman et al. 2012).

Wolverines are opportunistic carnivores with carrion being a large part of their diet (Pasitschniak-Arts and Larivière 1995). In the GYE wolverines consume prey from 13 families and ≥21 species (Inman and Packila 2015). The most frequently consumed species included deer (*Odocoileus spp.*), elk (*Cervus elaphus*), marmots (*Marmota flaviventris*), bighorn sheep (*Ovis canadensis*), and red squirrels (*Tamiasciurus hudsonicus*; Inman and Packila 2015). Diet differs by season, with large ungulates constituting a major food source in winter. Summer diet is more diverse, and includes ground squirrels and other small mammals, eggs of ground nesting birds, insect larvae, and berries (Pasitschniak-Arts and Larivière 1995). In the GYE, small prey, especially marmots, constitute the majority of the summer diet (Inman and Packila 2015). Wolverines cache excess food, which is likely important for reproductive females (Pasitschniak-Arts and Larivière 1995).

Wolverine scavenging behavior drives use patterns that result in large home ranges, large seasonal movements, solitary behavior, and low density (Pasitschniak-Arts and Larivière 1995, Inman et al. 2012). Wolverine home ranges in Idaho, Montana, and Wyoming are large relative to body size, differ by sex, and have limited overlap with individuals of the same sex (Inman et al. 2012). Heinemeyer et al. (2019) documented average winter home range sizes of 289 km^2 for females and 1,273 km^2 for males. Similarly, Inman et al. (2012) documented average annual home ranges of 303 km^2 for females and 797 km^2 for males. Female home ranges were smaller when raising kits. Home ranges of wolverines in the GYE can be 2-3 times larger than home ranges farther north (Pasitschniak-Arts and Larivière 1995). Males move farther than females, and both sexes can move the diameter of their home range in <2 days (Inman et al. 2012). One male originally captured as a kit travelled ≥411 km from the Wind River Mountains to the Medicine Bow Mountains (Packila et al. 2017). Female wolverines move shorter distances during dispersal compared to males (average maximum distance of 57 km for females and 102 km for males), although both sexes are capable of long-distance dispersal (≥170 km; Inman et al. 2012). Within

the GYE, Inman et al. (2012) estimated wolverine density as 3.5 wolverines per 1,000 km^2, among the lowest densities reported in North America.

Wolverines breed from May through August and display delayed implantation. Females use dens, typically built in snow or under downed forest debris for birthing and lactation (Pasitschniak-Arts and Larivière 1995). In the GYE, natal dens were used from early February through late April and were primarily in north facing high-elevation alpine habitat near tree line, and most often associated with downed logs within avalanche debris (Inman et al. 2007b). Kits are born from January through April with most births occurring before late March. Range-wide, litter size ranges from 1 to 6 kits with an average litter size of 1.75 to 3.5 (Pasitschniak-Arts and Larivière 1995). Average litter size in the GYE may be much smaller (average 1.1 kits; Inman et al. 2007b). Young mature quickly, reaching adult size by early winter, with juvenile dispersal occurring in November. Females may reproduce as early as 2 years of age across their range (Pasitschniak-Arts and Larivière 1995). Reproduction by females <4 years of age is uncommon in the GYE with some females not reproducing until ≥6 years of age (Inman et al. 2007b). Only 38-57% of females breed within a given year, with annual birth rates ranging from 0.43 to 0.89 young per female per year (Magoun 1985, Copeland 1996, Krebs and Lewis 1999, Lofroth 2001, Persson et al. 2006). Inman et al. (2007b) found females in the GYE do not appear to reproduce annually, with only 26% of females reproducing within a given year. Pregnancy rates in Montana differ by region ranging from 77% in the northwest to 48% in the southwest (Anderson and Aune 2008).

Recreational trapping, starvation, predation, road and rail collisions, and avalanches are among the most common causes of wolverine mortality in western North America (Krebs et al. 2004, Inman et al. 2007a). Predators include wolves (*Canis lupus*), mountain lions (*Puma concolor*), black bears (*Ursus americanus*), and other wolverines (Krebs et al. 2004, Inman et al. 2007a). Wolves are likely the most important natural predator of wolverines range-wide, although human-caused habitat loss and mortality have an effect (Pasitschniak-Arts and Larivière 1995). Annual survival in untrapped populations can be high (>0.84) depending on age and sex (Krebs et al. 2004, Inman et al. 2007a). In Glacier National Park, juvenile survival past year 1 was 0.58, subadult survival to adulthood was 0.53 and annual adult survival was 0.85-0.96 (Copeland and Yates 2008). A female wolverine born in 2006 and thought to have spent much of her life in northwestern Wyoming (Murphy et al. 2011b) was observed by a monitoring camera in 2017. This observation documents a female over 10 years of age in Wyoming. Overall wolverine life expectancy is short averaging 4 to 6 years. Captive wolverines may live much longer (>17 years; Pasitschniak-Arts and Larivière 1995).

DISTRIBUTION AND OCCUPANCY

Historically, wolverines were documented throughout the western U.S. By the mid-1920s, they were nearly eliminated from the contiguous U.S. by unregulated harvest, habitat loss, and broad-scale carnivore poisoning (Aubry et al. 2007, McKelvey et al. 2014). Researchers recently have attempted to identify habitat and climate characteristics to predict wolverine presence and distribution. Aubry et al. (2007) found wolverines in the Rocky Mountains were associated with high-elevation montane areas, alpine meadows, and alpine life zones with >50% probability of snow cover during the denning period. Copeland et al. (2010) used residual snow cover from 24

April to 15 May (end of denning period) and average maximum August temperature to model the circumboreal range of wolverines. Inman et al. (2013) used a resource selection function from telemetry locations in the GYE (Inman et al. 2012) to model primary, maternal, male and female dispersal habitat in the western U.S. This model included variables for latitude-adjusted elevation, terrain ruggedness, 1 April snow depth, road density, interpolated human density, distance to high-elevation talus, tree cover, and 1 April snow >2.5 cm (Inman et al. 2013; Figure 1).

Wolverines began recolonizing their former range in the 1930s and dispersed from larger populations in northern Montana and western Canada (Newby and Wright 1955, Newby and McDougal 1964, Pasitschniak-Arts and Larivière 1995, McKelvey et al. 2014). Wolverine recolonization in Wyoming followed similar, but slower trends. Aubry et al. (2007) reviewed historical wolverine records and documented 10 records in Wyoming prior to 1900 and 8 records between 1901 and 1930. Only 1 individual was documented over the subsequent 65 years until an increase in records beginning in 1995, which were bolstered by capture locations from telemetry studies (Aubry et al. 2007; Murphy et al. 2011b, Inman et al. 2012; J.P. Copeland, unpublished data). Recently, wolverines have been documented in Utah and Colorado, but they remain rare in the contiguous U.S. (Packila et al. 2017). Wyoming represents the southernmost extent of reliable wolverine occupancy in North America (Inman et al. 2012) and has the potential to support ~20% of the population in the western U.S. (Inman et al. 2013).

The Working Group established a monitoring program to evaluate populations in 5-year intervals. The Working Group combined the habitat models developed by Copeland et al. (2010) and Inman et al. (2013; primary habitat) to identify survey areas. They delineated a 225-km^2 grid system over the entire western U.S. and included any grid cell that contained ≥50% of predicted modeled habitat. Grid cells containing <50% of predicted habitat were included when there was a likelihood of detecting a resident wolverine. The Wyoming grid system included 175 cells for a total of 36,944 km^2 of predicted habitat distributed throughout the GYE, Bighorn Mountains, and Medicine Bow Mountains. Only the GYE and Bighorn Mountains were included within the survey effort (Figure 2).

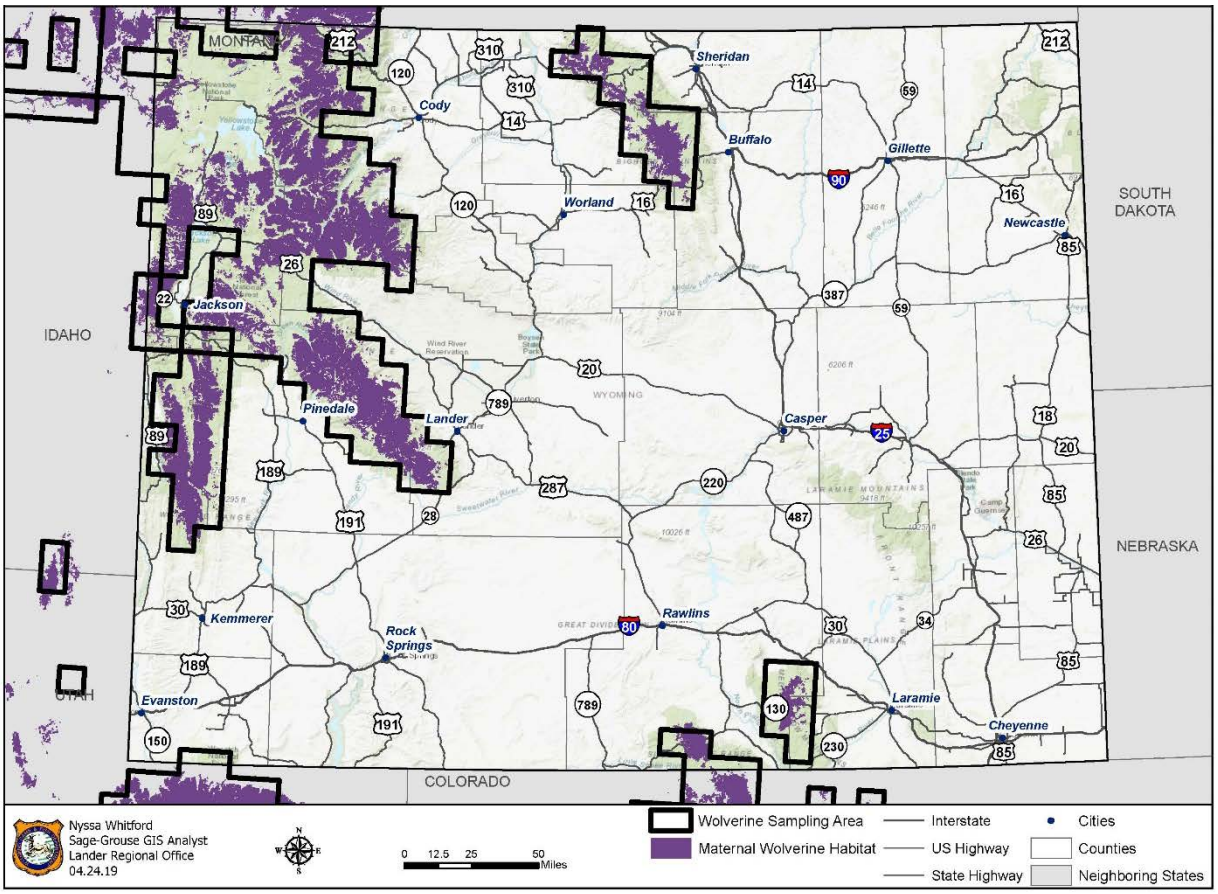

Figure 1. Potential wolverine habitat (Copeland et al. 2010, and Inman et al. 2013) and maternal habitat (Inman et al.2013) in Wyoming.

From 2015-2017, the Department surveyed wolverine habitat in the Wyoming Range, Yellowstone National Park, Absaroka, Bighorn, Gros Ventre, Salt River, Teton, and Wind River Mountains. The surveys detected 6-8 unique wolverines in the Absaroka and Wind River Mountains. Identification of individuals was based on pelage patterns, genetic analysis, and spatial distribution. Of these wolverines, 5 were genotyped to individual (2m:3f). Wolverines were broadly dispersed, including a male and 2 unique females found in the Wind River Mountains on the southern edge of the GYE (Atkinson et al. 2018). At least 3 individuals have been documented over multiple years. Track sightings and wolverine observations near the remaining locations were common, but individual identification could not be determined. In total, wolverines were detected at 6 of 51 survey locations for a 15% probability of occupancy (95% CI: 7-26%) throughout the Wyoming survey area (P. Lukacs, unpublished data).

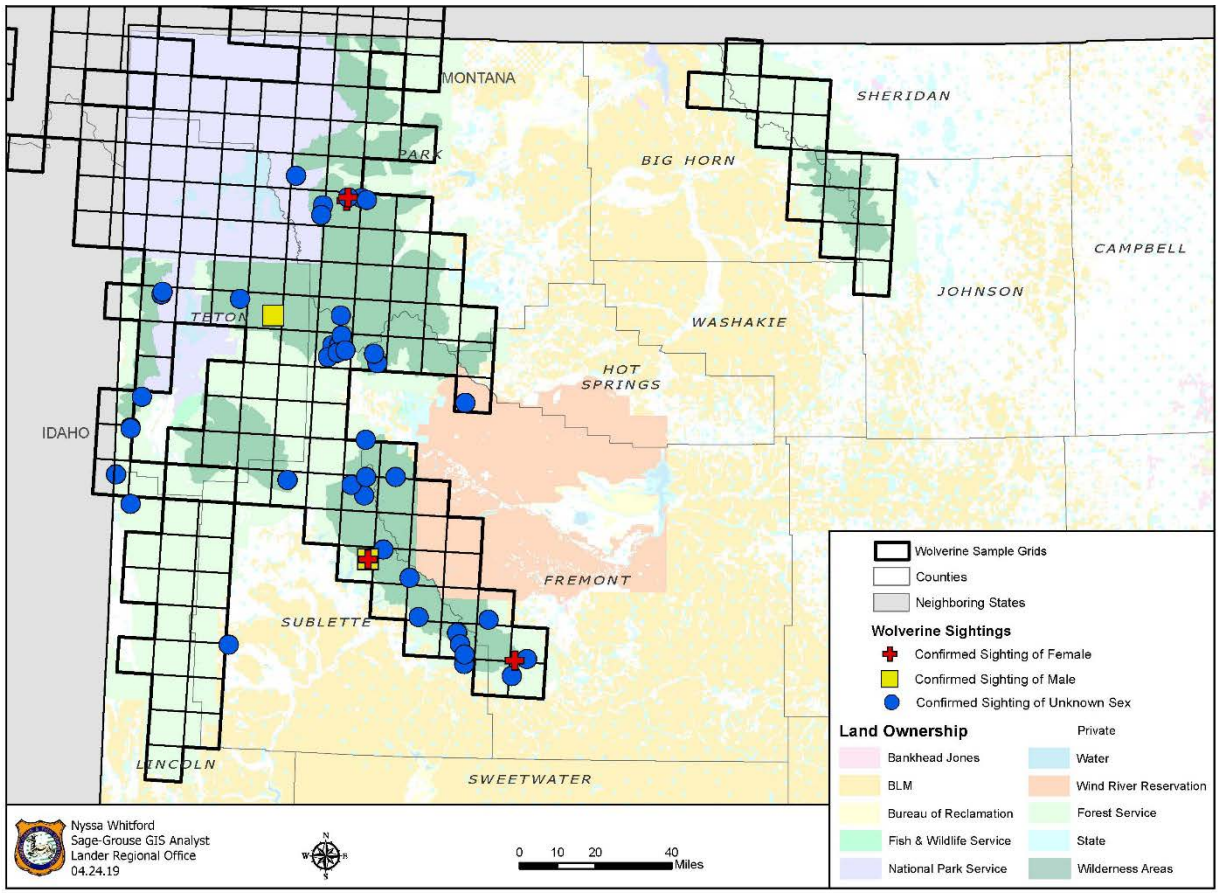

Figure 2. Confirmed wolverine sightings from January 2014 through March 2019 overlaid on the wolverine survey grid system in Wyoming.

The GYE wolverine population in Wyoming appears to be well distributed when incidental sightings are included. Recent confirmed observations remain rare in the southern Wyoming Range and Yellowstone National Park, both of which had documented wolverines in the past (Murphy et al. 2011a, b; Inman et al. 2012) suggesting these areas warrant additional surveys (Atkinson et al. 2018; Figures 2 and 3).

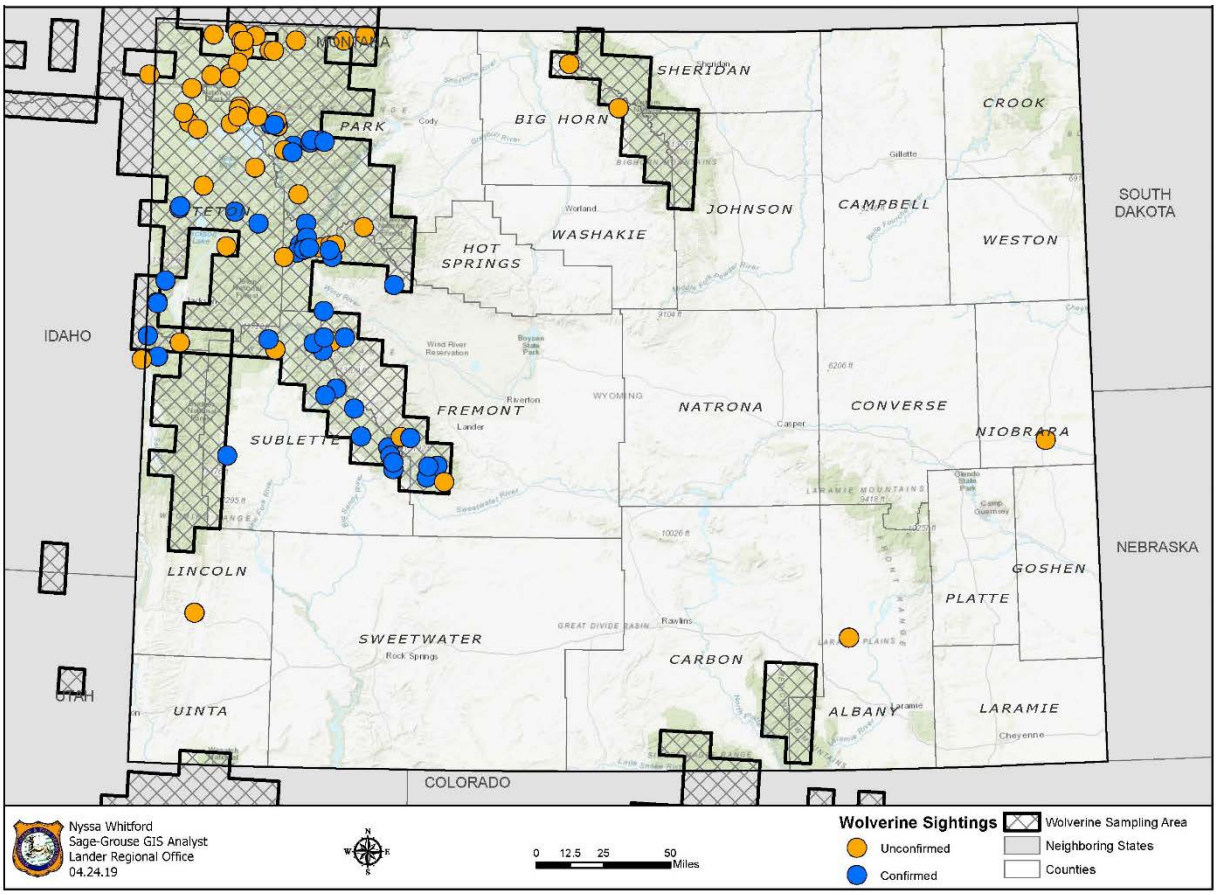

Figure 3. Confirmed and unconfirmed sightings of wolverines in Wyoming from January 2014 through March 2019.

Within the GYE and Bighorn Mountains, most predicted wolverine habitat is located on federal lands (Table 1, Figure 2). Combined, the USFS and NPS (Grand Teton and Yellowstone National Parks and the John D. Rockefeller, Jr. Memorial Parkway) lands encompass >90% of wolverine habitat in Wyoming. These federal lands provide for greater regulatory certainty, as managing habitat for fish and wildlife resources is a key responsibility. National Parks and wilderness areas focus on preservation and minimizing anthropogenic disturbances. Nearly 33% of predicted wolverine habitat in Wyoming is within a designated wilderness. Combined with NPS lands these federally protected areas encompass >55% of all predicted wolverine habitat in the GYE and Bighorn Mountains in Wyoming (Table 1, Figure 2).

Table 1. Land ownership, area (km^2), and percentage of area within grid cells containing predicted wolverine habitat in the Greater Yellowstone Ecosystem and Bighorn mountains of Wyoming. Note: National Forests may not add up to U.S. Forest Service total due to differing data sources.

Landowner	Area (km^2)	Percentage
U.S. Forest Service	23,769	68.7
Bridger-Teton National Forest	*11,734*	*33.7*
Shoshone National Forest	*7,999*	*22.9*
Bighorn National Forest	*3,269*	*9.4*
Caribou-Targhee National Forest	*940*	*2.7*
National Park Service	7,813	22.6
Bureau of Indian Affairs (Wind River Indian Reservation)	1,319	3.8
Private	821	2.4
Bureau of Land Management	622	1.8
State of Wyoming	162	0.4
Water	76	0.2
Bureau of Reclamation	3	<0.1
U.S. Fish and Wildlife Service	1	<0.1

THREATS AND RISK FACTORS

As of the development of this plan, wolverines were proposed for listing as a threatened species (USFWS 2016). The primary threat identified for wolverines throughout the DPS was habitat loss due to climate change, specifically the potential effects of reduced snow pack and earlier spring runoff on maternal denning. Other potential threats include habitat degradation due to human use and disturbance (winter recreation, infrastructure development, transportation corridors, and land management activities), incidental trapping, and small population sizes. No single threat is thought to have population-level effects (USFWS 2016).

Climate Change

Wolverines are associated with persistent snow cover throughout their range, particularly during the latter part of the denning period in late spring (Aubry et al. 2007, Brodie and Post 2010, Copeland et al. 2010, Inman et al. 2013). Spring snow cover is a common variable in habitat models and has been suggested as a requirement for maternal denning (Copeland et al. 2010). While climate models suggest that climate change may result in a loss of wolverine habitat, these

predictions are not consistent across the various models. McKelvey et al. (2011) projected the GYE was one of only a few areas predicted to maintain spring snow cover. However, snow cover in Wyoming is still predicted to decrease 25% by mid-century and 54% by the end of the century under a moderate greenhouse gas emissions scenario (McKelvey et al. 2011). Peacock (2011) used a high emissions scenario to predict a decline in spring snow depth in Wyoming by 2100; however, Wyoming is predicted to maintain deeper snow cover than either Idaho or Montana in both low and medium-low emissions scenarios (Peacock et al. 2011). Despite decreases in snow cover overall, USFWS (2017) models suggested continued presence of spring snow cover throughout the Rocky Mountains through at least 2055.

Although wolverines are highly associated with spring snow cover, the scale at which snow is needed is unclear. Reproduction occurs outside of areas containing or predicted to contain persistent spring snow cover in Alaska (Magoun et al. 2017), Canada (Webb et al. 2016), and Sweden, where wolverines are expanding south and further outside distribution predicted by snow cover models (Aronsson and Persson 2016). Snow cover during the latter part of the denning season has been hypothesized to be important for the thermal and protective benefits provided by snow and associated underlying structures e.g., bolder talus (Pulliainen 1968, Magoun and Copeland 1998). If this is the case, localized snow cover at the den-site scale may be more important than landscape-wide snow availability (Magoun et al. 2017) potentially providing some flexibility for wolverines in the face of climate change.

Habitat models incorporating spring snow cover also predict a decrease in habitat availability and connectivity (e.g., Schwartz et al. 2009, McKelvey et al. 2011). In general, the amount of habitat, and large blocks of habitat are projected to decrease along with the availability and diversity of corridors between large habitat patches (McKelvey et al. 2011). However, one wolverine in Wyoming was tracked during dispersal through areas not containing any snow at all (Packila et al. 2017).

The availability of food is a major factor in determining wolverine habitat use (e.g., Krebs et al. 2007) and while wolverines have a diverse diet, they are capable of taking advantage of the seasonal availability of prey (Inman and Packila 2015). During winter, prey availability is important to the reproductive success of wolverines (Persson 2005). Reproducing females will shift their food habits relative to other cohorts in the winter (Lofroth et al. 2007). Overall, ungulates and ungulate carcasses are important food sources in winter (Krebs et al. 2007, Lofroth et al. 2007, Inman and Packila 2015) and a decline in snow cover may decrease prey availability by allowing ungulates to move across the landscape easier. Lower snow depths may also increase competition for prey by allowing other predators' access to previously snow-covered areas. Milder winter conditions may also reduce ungulate mortality and diminish scavenging opportunities. Conversely, reduced snow cover may allow more ungulates to winter in areas occupied by wolverines.

Anthropogenic Habitat Loss and Fragmentation

Wolverine response to anthropogenic disturbance may vary by location. Inman et al. (2013) found wolverine occurrence was negatively associated with road density and interpolated human density. Fisher et al. (2013) found higher abundance of wolverines in protected, rugged wilderness areas

compared to adjacent areas exposed to anthropogenic development. Wolverine occupancy was negatively correlated with density of seismic lines for oil and gas exploration and development as well as regenerating areas following timber harvest and fires (Fisher et al. 2013). Krebs et al. (2007) found habitat selection by female wolverines was negatively associated with recently logged areas and positively associated with roadless areas. Scrafford et al. (2017) also found female wolverines avoided logged areas in summer. Both sexes avoided the interior of areas of timber harvest, active oil and gas well sites, and low-traffic winter roads year-round (Scrafford et al. 2017). In suitable habitats, anthropogenic disturbance may provide a predation refuge for ungulates by displacing predators, thereby decreasing food availability for wolverines, or provide a refuge for other predator species. This can increase competition for prey and predation risk for wolverines (Fisher et al. 2013).

Anthropogenic development does not always result in avoidance. For example, habitat use by females in the winter and males year-round was positively associated with recently logged areas (Krebs et al. 2007). Scrafford et al. (2017) found wolverines selected for edges of logged areas and areas with borrow pits and older, regenerating seismic lines. It is possible these areas had increased prey availability, especially borrow pits with water that supported beavers (*Castor canadensis*) (Scrafford et al. 2017). One study, however, found habitat selection by females was negatively associated with recently logged areas in the summer (Krebs et al. 2007).

Anthropogenic development can also hinder wolverine movement between habitat patches. In the GYE, a telemetry-based study documented 12 wolverines crossing U.S. and state highways 42 times (Packila et al. 2007). Most crossings were completed at night when traffic was minimal and were made by subadults during dispersal or exploratory movements primarily from January through March (Packila et al. 2007). At a larger scale, a male wolverine radio tracked while dispersing from the southern Wind River Mountains to the Medicine Bow Mountains avoided road crossings and housing developments and timed road crossings at night (Packila et al. 2017). Within the GYE of Idaho, Montana, and Wyoming, human population growth has doubled since 1970, and housing density has tripled (Hansen and Phillips 2018). Increasing human populations require additional roads and infrastructure that result in increased vehicular traffic. Although most development is outside predicted wolverine habitat in Wyoming (Figure 4), development can potentially affect connectivity at a larger scale.

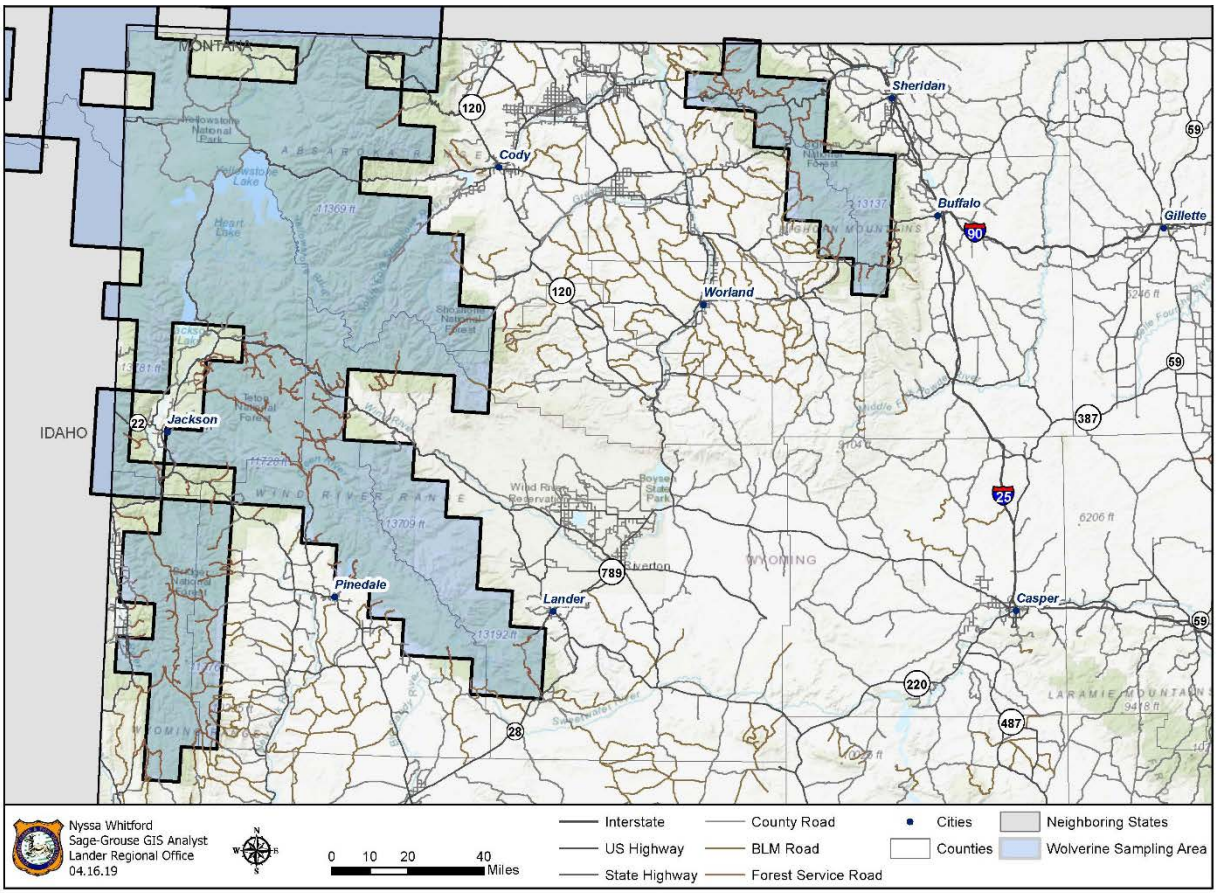

Figure 4. Roads and human population centers in and surrounding potential wolverine habitat in the GYE and the Bighorn Mountains of Wyoming. Potential habitat based on a composite model from Copeland et al. (2010) and Inman et al. (2013).

Winter Recreation

Snowmobiling and skiing are popular throughout the Intermountain West and in some areas these activities occur in wolverine habitat. Krebs et al. (2007) found wolverine habitat use was negatively associated with heli-skiing and that habitat use by female wolverines was negatively associated with backcountry skiing. Heinemeyer et al. (2019) evaluated wolverine habitat and home-range use in relation to the intensity of winter recreation in Idaho, Montana, and Wyoming. Wolverines exposed to varying amounts of winter recreation avoided areas used for winter recreation and as recreational use increased so did wolverine avoidance. Heinemeyer et al. (2019) found that this avoidance was stronger for females. Wolverines also showed a greater avoidance of areas with off-road recreation than in areas where recreation was restricted to trails and roads.

Small Population Sizes and Genetic Viability

Small populations can display reduced genetic variability, resulting in increased potential for inbreeding and genetic drift. Small populations also have a decreased ability to genetically adapt to changing conditions. A haplotype is a group of genes inherited from a single parent, so having many haplotypes equates to more wolverine "parents" and a lower chance to have inbreeding. Historically, wolverines in the contiguous U.S. displayed a more diverse assemblage of haplotypes (genetic lineages) than modern wolverine populations. Recent studies suggest that genetic diversity has been lost, with 83% of recent wolverine samples characterized as haplotype A, the most common haplotype throughout North America. When compared to only 10% of historical samples (collected from prior to 1922), researchers found 2 haplotypes that appeared to have been completely lost (McKelvey et al. 2014). In general, southern populations of wolverines in the contiguous U.S. show increased genetic structuring indicative of reduced gene flow (Kyle and Strobeck 2002, Cegelski et al. 2006, Schwartz et al. 2009). Gene flow in wolverines is male-mediated and southern populations have some genetic drift, despite some immigration from Canada (Cegelski et al. 2006). To ensure genetic viability in Wyoming, Cegelski et al. (2006) estimated ≥200 breeding pairs or 1-2 migrants per generation (i.e., every 2-6 years) are needed. Schwartz et al. (2009) estimated the effective population size of wolverines in Idaho, Montana, and Wyoming to be only 35, suggesting low abundance throughout these states. Wolverines in the contiguous U.S. demonstrate genetic isolation by distance (Cegelski et al. 2006, Schwartz et al. 2009), where genetic differences between individuals increase with increasing geographical distance. Incorporating persistent spring snow cover into gene flow models provides a better explanation for genetic dissimilarity between individuals than straight-line geographic distance alone (Schwartz et al. 2009). Given the small populations and limited gene flow that occurs in the southern extent of wolverine range in the U.S., identifying and maintaining connectivity may be particularly important.

Human-caused Mortality

Wolverines are rare in Wyoming, and even limited mortality may have a functionally high effect due to the overall small population size, low density, and slow reproductive rate. Wolverines in Wyoming are defined as a Protected Animal by state statute W.S. §23-1-101 (State of Wyoming 1973) and are protected from lethal take. Range-wide wolverines may still be subject to human-caused mortality via illegal shooting, incidental capture, vehicular collisions, and other human-caused mortalities. The Department has only 2 records of human-caused mortalities in Wyoming (in past >45 years) since they were protected in 1973. Both mortalities were almost certainly dispersing individuals, given their locations far from predicted habitat. The Department requires that any Protected Animal incidentally captured in a trap set for furbearers be released unharmed and any capture that results in death or injury that may result in death be reported to the Department as soon as possible. Human-caused mortality is an extremely rare occurrence in Wyoming. Regardless, low pregnancy and birth rates coupled with the late onset of reproduction documented in the GYE may make wolverine populations sensitive to the loss of individuals. Continuing to minimize human-caused mortalities wherever possible will be particularly important in Wyoming.

MANAGEMENT AND CONSERVATION STRATAGIES

Population Monitoring

Wolverine populations require routine monitoring to document distribution, determine occupancy, and monitor trends. During the winters of 2015-2017, the Department collaborated with Idaho, Montana, and Washington to develop and implement a monitoring strategy to evaluate range-wide distribution of wolverines in the contiguous U.S. (see Distribution and Occupancy, page 4). The Department will continue to collaborate with these western states and partners within Wyoming to evaluate protocols and repeat this survey every 5 years.

In Wyoming, the Working Group originally limited survey efforts to the GYE and Bighorn Mountains. The GYE is part of a larger, relatively contiguous tract of wolverine habitat (Copeland et al. 2010, Inman et al. 2013) that extends to Canada and is at least partially within the expected distribution of breeding populations of wolverines (Inman et al. 2013). The Bighorn Mountains were included because they are within the dispersal distance of wolverines from the GYE (~170 km; Inman et al. 2012) and contain suitable habitat. The Medicine Bow Mountains contain potential habitat, but were excluded because of the minimal amount of habitat in Wyoming and distance from the GYE and Bighorn Mountains. The Department will consider expanding surveys to include the Medicine Bow Mountains in future surveys (Figure 1).

Remote camera stations and DNA analyses to determine sex and individual identification are important tools for wolverine monitoring. From a combination of genetic analyses and unique pelage patterns, the Department documented ≥6 unique wolverines within the GYE in 2015-2017 (Atkinson et al. 2018; see Distribution and Occupancy, page 4). Continuing to incorporate DNA collection with routine monitoring efforts will provide a comprehensive evaluation of population structure, distribution, abundance, relatedness, residency, genetic continuity, and reproductive potential.

Many partners are interested in monitoring wolverines and other forest carnivores and have implemented routine monitoring efforts into their wildlife programs. For example, USFWS biologists and Tribal Fish and Game wardens from the Wind River Indian Reservation maintained camera stations for wolverines beyond the length of the multi-state monitoring effort, resulting in a wolverine detection in the Owl Creek Mountains where the previous survey effort failed to document a wolverine (Atkinson et al. 2018). Additionally, camera surveys conducted by the USFS for Canada lynx documented 2 wolverines (J. Wilmot, personal communication), 1 of which was in the Teton Mountains near a grid cell surveyed as part of the multi-state effort.

ACTION: During the winter of 2021-22 the Department will participate in the multi-state monitoring program to evaluate range-wide wolverine distribution and incorporate DNA collection and analysis into the survey to evaluate population structure. In FY22 seek approximately $200,000 through grants and the Departments Maintenance and Operations budget to complete the survey in FY22.

Data and Research Needs

Key questions remain regarding population status, ecological requirements, anthropogenic threats, dispersal, potential corridors, management and monitoring strategies. Although not comprehensive, below is a list of research needs.

- Determine the residency status of individual wolverines, particularly females by using the best available science and incorporating DNA analysis.

- Conduct research to evaluate the persistence of wolverines in Wyoming (immigration versus recruitment from within the state.)

- Evaluate the effects of winter recreation on wolverine fitness or reproductive success.

- Determine reproductive rates in Wyoming and what factors and habitat conditions are important to den selection.

- Wyoming-specific estimates of litter frequency, litter size, kit survival, and disperser survival will be vital to developing and employing effective management and conservation strategies.

- Wolverines exhibit behavioral plasticity (are adaptable). Additional information is needed to evaluate potential threats and limiting factors to identify potential mitigation.

- Implement efficient, cost-effective, and robust monitoring techniques throughout Wyoming. These data will help to address larger questions pertaining to population status, abundance, and connectivity.

ACTION: Explore funding opportunities in FY21 and FY22 to bolster monitoring efforts and to insure DNA analysis is adequately funded to determine the residency status of individual wolverines. Include a wolverine research project in the Department's research proposal process for FY22 funding consideration.

Habitat Conservation and Management

Wolverine habitat occurs in island-like patches within most of the contiguous U.S. (Inman et al. 2013) where dispersal could be more difficult (Schwartz et al. 2009). Additional research is being conducted among collaborating states (i.e., Idaho, Montana, Washington, and Wyoming) to assess movement and genetic connectivity. Consequently, researchers have modeled habitats that may support wolverine dispersal in the western U.S. (e.g., Schwartz et al. 2009, McKelvey et al. 2011, Inman et al. 2013). When this analysis becomes available, findings will be incorporated with previous efforts to identify potential habitat areas within Wyoming that could be considered for conservation efforts.

The majority of wolverine habitat in Wyoming is contiguous within the state, with disjunct habitat in the Bighorn and Medicine Bow Mountains. Mountains within the GYE are primarily managed by the USFS and NPS, providing protected habitats and roadless areas, which may facilitate connectivity within this large habitat patch. However, dispersing individuals must cross ≥200 km of open, arid land atypical of wolverine habitat where numerous roads, including Interstate 80 and human activity centers are located to reach the Medicine Bow Mountains (Packila et al. 2017; Figure 1).

It will be important to work with the transportation departments as wolverines often cross highways that bisect forested habitats. For example, WYO 22 over Teton Pass, US 191 in Yellowstone National Park, and US 26/89 between Hoback Junction and Alpine are important highways because of their concentrated use by wolverines (Packila et al. 2007).

Suggested mitigation measures along these highways may include removing road-kills that attract predators, implementing slower speed limits, using wildlife detection warning systems and developing crossing structures (Packila et al. 2007).

Roads, energy development, and timber harvest can influence movement and habitat use within home ranges (see Threats and Risk Factors, page 9). Winter recreation can also affect space use within home ranges, effectively eliminating what would otherwise be high-quality winter habitat. Heinemeyer et al. (2019) found that wolverines showed a strong avoidance to areas with high levels of non-motorized recreation in the southern Teton Mountains. However, wolverines may be capable of modifying behaviors to adapt to these habitat modifications. For example, wolverines are present in areas with anthropogenic development and, in some cases, select for these areas.

ACTION: The Department will continue to work with partners (WYDOT, BLM, USFS, USFWS, Tribal Councils, NPS), to ensure wolverines are considered in habitat management and land use planning efforts.

Outreach, Education, and Collaboration

Outreach, education, and collaboration are an important part of wolverine conservation and management. The Department will continue to be an active participant in the Subcommittee while working closely with partners to conduct wolverine monitoring on the Bighorn, Bridger-Teton, Caribou-Targhee, Medicine Bow, and Shoshone National Forests, Grand Teton and Yellowstone National Parks, and the Wind River Indian Reservation. The Department will continue to engage stakeholders in wolverine conservation and management (e.g., citizen scientists, recreational trappers, and winter recreationists). The Department will continue to engage the public and citizen science groups through media releases, public meetings, observation requests, and monitoring assistance.

ACTION: Following the FY22 survey, post updates on the status of the state's wolverine population on the web and social media sites.

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