

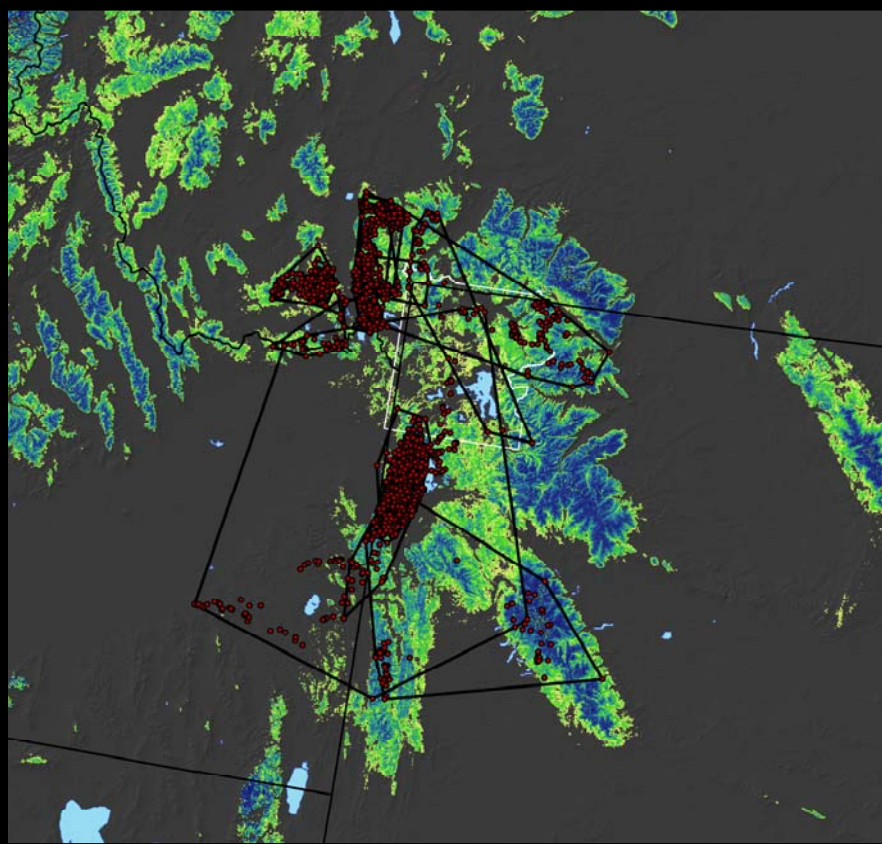


# GREATER YELLOWSTONE WOLVERINE PROGRAM

Cumulative Report May 2007

Wildlife Conservation Society • North America Program

Wolverine Program Field Office • 121 Trail Creek Road • Ennis, Montana 59729 • USA



The following chapters are in the form of draft manuscripts. Some have been submitted for publication, whereas others will be supplemented with additional field data before submission for publication. The chapters have been reviewed internally; some, but not all, have been reviewed by colleagues external to WCS.

**These chapters are not peer-refereed as printed herein.**

Our goal is to submit each to the peer-review process at the appropriate time. Some will no doubt change form before submission and during the peer-review process. These chapters represent our best effort to summarize the data collected thus far into a form that conveys our current understanding of wolverine ecology and that can, in some cases, be valuable information for managers.

Other chapters/draft manuscripts are in preparation, including method for monitoring winter recreational use on public lands and an analysis of the spatial overlap between wolverines and areas used by snowmobile and ski recreationists.

**THIS REPORT CONTAINS SENSITIVE INFORMATION  
REGARDING WOLVERINE LOCATIONS  
AND SHOULD NOT BE FURTHER DISTRUBUTED.**





# TABLE OF CONTENTS

## PHASE I

### FOUNDATIONS FOR WOLVERINE CONSERVATION STRATEGIES IN GREATER YELLOWSTONE

<b>Chapter 1</b>	<b>Wolverine Space Use in Greater Yellowstone</b> Determining an effective geographic scale for wolverine conservation strategies. Home range size, spatial organization, movements, density and dispersal. <i>R. M. Inman, K. H. Inman, A. J. McCue, M. L. Packila, G. C. White, and B. C. Aber</i> .....	1
<b>Chapter 2</b>	<b>Broad-scale Wolverine Habitat in the Conterminous Rocky Mountain States</b> Creating a map of wolverine habitat at the scale necessary for collaborative regional planning. Primary wolverine habitat, ownership of primary habitat, and implications for conservation. <i>B. L. Brock, R. M. Inman, K. H. Inman, A. J. McCue, M. L. Packila, and B. Giddings</i> .....	21

## PHASE II

### WOLVERINE ECOLOGY, VITAL RATES, & INTERACTIONS WITH HUMANS

<b>Chapter 3</b>	<b>Wolverine Reproductive Chronology</b> Identifying periods important for management and formulating hypotheses regarding population dynamics and wolverine behavior with information on the timing of reproductive events and food availability. Mating season, parturition date, natal den use, rendezvous site use, independence, and dispersal. <i>R. M. Inman, A. J. Magoun, J. Persson, D. N. Pedersen, J. Mattison, and J. K. Bell</i> .....	55
<b>Chapter 4</b>	<b>Wolverine Reproductive Rates and Maternal Habitat in Greater Yellowstone</b> Documenting reproductive rates along with the habitats and foods used while rearing young. Annual birth rate, age at first reproduction, litter size, recruitment rate, natal denning habitat, rendezvous site habitat. <i>R. M. Inman, K. H. Inman, M. L. Packila, and A. J. McCue</i> .....	65
<b>Chapter 5</b>	<b>Wolverine Harvest in Montana: Survival Rates and Spatial Aspects of Harvest Management</b> Comparing survival rates of conterminous U.S. wolverines between a population subject to a 2½ month season with a limit of 1 wolverine per trapper vs. an unharvested population, identifying potential biases in wolverine survival rates, and examining spatial considerations for harvest via population capacities. Survival rates, causes of mortality, ratio of untrapped:trapped habitat, population capacities by mountain range. <i>R. M. Inman, K. H. Inman, A. J. McCue, and M. L. Packila</i> .....	85
<b>Chapter 6</b>	<b>Diel Winter Activity of Wolverines in Greater Yellowstone</b> Are wolverines nocturnal? Providing empirical data on activity patterns of wolverines. Winter activity patterns of 2 males, 2 females, and 1 reproductive female. <i>A. J. McCue, R. M. Inman, K. H. Inman, and M. L. Packila</i> .....	97
<b>Chapter 7</b>	<b>Wolverine Road Crossings in western Greater Yellowstone</b> Providing insight into the effects of roads and identifying wolverine linkage zones. Locations of 43 wolverine crossings of U.S. or State highways and 67 additional crossings in the Big Sky, MT area. <i>M. L. Packila, R. M. Inman, K. H. Inman, and A. J. McCue</i> .....	103
<b>Chapter 8</b>	<b>Wolverine Food Habits in Greater Yellowstone</b> Documenting wolverine food habits at the southern extent of the species distribution. 61 food items. <i>M. L. Packila, A. J. McCue, R. M. Inman, and K. H. Inman</i> .....	121

## Chapter 1

# Wolverine Space Use in Greater Yellowstone

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Dr 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Dr 1A, Bozeman, MT 59715, USA*

ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Dr 1A, Bozeman, MT 59715, USA*

MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Dr 1A, Bozeman, MT 59715, USA*

GARY C. WHITE, *Department of Fish, Wildlife and Conservation Biology, Colorado State University, Fort Collins, CO 80523, USA*

BRYAN C. ABER, *United States Forest Service, 3726 Highway 20, Island Park, ID 83429, USA*

**ABSTRACT** A principal foundation for effective wolverine (*Gulo gulo*) conservation in the Greater Yellowstone Area (GYA) includes determining an appropriate geographic scale for coordination of management. We captured 28 wolverines at 2 study sites in GYA between January 2001–May 2007 and examined space use by these individuals to provide insight into the life history strategy of the species as it relates to the development of conservation strategies. Mean annual (1 Mar–28 Feb) 95% fixed kernel home range size was 453 km<sup>2</sup> for adult females ( $n = 15$  wolverine years) and 1,160 km<sup>2</sup> for adult males ( $n = 13$  wolverine-years). Mean percent area overlap of same-sex adults was <1% (SE = 0.00, range = 0–2%,  $n = 12$  pairs) using annual 100% minimum convex polygon home ranges. Straight-line 2-hr movement distance from GPS data averaged 1.92 km (SE = 0.10 km,  $n = 554$  2-hr movement distances,  $n = 6$  wolverines [5 M, 1 F]). Weekly and seasonal movement patterns indicated that a large portion of the annual home range is used over a short time-period. We located dispersing-age individuals a maximum of 170 km (M) and 173 km (F) from the center of the mother's home range, however this may underestimate the capability of the species. Dispersal appears to initiate at about 1 yr of age and can occur over multiple years. We estimated population size of the Madison, Gravelly and Centennial Ranges in northwestern GYA to be 15 (95% CI = 12–42) wolverines, with a corresponding density estimate of 1 wolverine/273 km<sup>2</sup> of wolverine habitat (95% CI = 1/99–337 km<sup>2</sup> of wolverine habitat). We located 75% of wolverines monitored >1 month within  $\geq 3$  major land management units, e.g., a national forest or national park. Our data suggest that wolverine populations in GYA occupy a relatively marginal niche and that a single, inherently vulnerable population is subject to the cumulative impacts of numerous jurisdictional authorities. Persistence of a wolverine population in GYA would benefit from and may depend on multi-jurisdictional, collaborative planning at the regional level that includes an emphasis on linkage to other regional populations.

## Chapter 2

# Broad-Scale Wolverine Habitat in the Conterminous Rocky Mountain States

BRENT L. BROCK,<sup>1</sup> *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

BRIAN GIDDINGS, *Montana Department of Fish, Wildlife & Parks, Box 200701 Helena, MT 59620, USA*

**ABSTRACT** Information on broad-scale wolverine (*Gulo gulo*) habitat in the conterminous U.S. is essential for developing collaborative, multi-jurisdictional, conservation strategies for wolverines over a large geographic area. We estimated the distribution of primary wolverine habitat in the conterminous Rocky Mountains with logistic regression of 1,284 telemetry locations of 16 wolverines captured in the Greater Yellowstone Area, habitat variables appropriate for broad-scale prediction, and validation with 3 independent datasets. We also estimated the number of potential adult female territories within habitat complexes, and identified federal administrators of primary habitat. Cross correlation and testing with independent datasets indicated that the combined sex and season model, which included latitude-adjusted elevation, terrain ruggedness index, conifer cover, snow depth, forest edge, and road density, is robust to extrapolation and can provide a foundation for collaborative, landscape-level planning in the Rocky Mountain states. Primary wolverine habitat in the Rocky Mountain States is island-like and appears to be capable of supporting up to approximately 460 (234–1,133) adult female wolverines, the majority of which would occur within 6 habitat complexes. This information combined with recent genetic work suggests that maintaining connectivity among wolverine habitat complexes may be necessary to ensure persistence of the species in the conterminous U.S. This model likely represents historic and potential wolverine distribution more precisely than previous descriptions, and is valuable in determining which publicly owned lands may or may not need to address wolverine conservation in their management (with the critical exception of linkage habitat). Other potential uses include identification of private-land targets for conservation easements and establishment of a sampling framework for determining current distribution of wolverines. Wolverine habitat in Colorado is relatively isolated and natural recolonization could require decades; our results can provide valuable information on general locations, spacing, and criteria for assessing success if reintroduction were to occur.

## Chapter 3

# Reproductive Chronology of Wolverines

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive, Suite 1A, Bozeman, MT, 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden.*

AUDREY J. MAGOUN, *Wildlife Research and Management, 3680 Non Road, Fairbanks, AK, 99709, USA.*

JENS PERSSON, *Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden.*

DALE N. PEDERSEN, *Pedersen Game Farm, PO Box 40, Graham, WA, 98338, USA.*

JENNY MATTISSON, *Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden.*

JENNIFER K. BELL, *Wildlife Conservation Society, 2023 Stadium Drive, Suite 1A, Bozeman, MT, 59715, USA.*

**ABSTRACT** A consolidation of information regarding the timing of wolverine reproductive biology will help focus research and management on specific events that are most relevant to wolverine ecology and conservation. We summarize the available literature, add new information on wolverine reproductive events, and present a chart with ranges and peak periods associated with reproductive events. We also discuss adaptive strategies related to reproductive chronology. June is the peak of an extended mating season. After a period of delayed implantation, most nidation occurs during January. Gestation occurs for approximately 45 days and the peak period of parturition is mid-February through mid-March. Types of reproductive dens include natal dens (location of birth), maternal dens (used subsequent to natal den but prior to weaning), and rendezvous sites (used subsequent to natal den but after weaning; Magoun and Copeland 1998). The peak period of natal den use occurs from mid-February through mid-May. Use of maternal dens sites occurs during March and April, however in most cases natal dens are used through the time of weaning with a direct move from the natal den to a rendezvous site. Rendezvous sites are typically used during May and June, after which cubs travel with the mother. By August cubs travel independently within the home range of their mother. The primary period of exploratory and dispersal movement (outside of the mother's home range) appears to be January–May; February–March may be the peak. If managers seek to separate human recreational activity from wolverine natal and maternal denning habitat, the principal time period to do so would be mid-February through mid-May; separation from rendezvous site habitat would need to occur during May and June. Although population dynamics would not change with the harvest of recently parturient females vs. pregnant females, fur-harvest that ends prior to mid-February reduces the risk of cub death via starvation, i.e. when females have recently given birth and cubs are altricial. Survival of dispersers could benefit from efforts to quickly remove food sources (ungulate road-kills) from highways during January–May.

## Chapter 4

# Wolverine Reproductive Rates and Maternal Habitat in Greater Yellowstone

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

**ABSTRACT** Documentation of wolverine (*Gulo gulo*) reproductive rates and maternal habitat is crucial for developing conservation strategies for the species in the conterminous U.S. Prior to initiation of this study, reproductive data from the conterminous U.S. was limited to observations of 13 female-years, 4 litters, and 2 natal dens. We studied wolverines in the Greater Yellowstone Area (GYA) of Idaho, Montana, and Wyoming where we captured 17 female wolverines between January 2002–May 2007 and monitored them for reproduction during 40 female-years. Based on observations of known-age females and estimates of minimum possible age at first capture, reproduction at <4 years appears to be uncommon, and at least 1 female had not given birth by 5 years of age. Proportion of adult ( $\geq 3$  years of age) females reproducing was 0.26 ( $n = 23$  adult-female-years) and annual birth rate was 0.30 cubs/adult female/year ( $n = 23$  adult-female-years). Mean litter size was 1.1 cubs ( $n = 7$  litters). We estimated a minimum interbirth interval of 2.3 years ( $n = 7$ ) based on several assumptions that could only bias the estimate low. Recruitment rate was 0.27 cubs/adult female/year ( $n = 15$  adult-female-years). Mean parturition date was 16 February. Elevation of natal dens ( $n = 5$  specific sites and 2 general sites) ranged from approximately 2,200–2,822 m (7,218–9,259 ft). The primary structural component of the 5 specifically identified natal dens was avalanche debris consisting of downed logs, and macro aspect was north at each of these sites. Six of 7 natal dens were located in designated wilderness (4), a wilderness study area (1), or a National Park (1); one natal den was located in a multiple use area that was occasionally used by snowmobilers. Natal dens were typically used through at least late April and use of maternal dens was rare. Rendezvous sites ( $n = 9$ ) were located at a 2,195–2,865 m elevation (7,201–9,400 ft) and ranged from 2.3–14.7 km from their respective

natal dens. The primary structure at rendezvous sites was large boulders (44%), logs in avalanche debris (33%), or downed logs (22%); snow >1m was common at these sites during May and June. Eighty-one percent of natal dens and rendezvous sites ( $n = 16$ ) were located in subalpine habitats, near timberline, where boulder talus and open meadows were interspersed with forested areas. Two natal dens and one associated rendezvous site occurred at lower elevation in heavily forested areas. Reproductive rates of wolverines in GYA appear to be as low as or lower than rates reported from other areas. Given the inherently vulnerable nature of wolverine populations in general and the possibility that this vulnerability could be exacerbated in the conterminous U.S. because of the island-like nature of habitat, conservation strategies for wolverines therein should include efforts to limit mortality of adult females and insure that reproductive capacity is not compromised in any way. While successful reproduction is likely critical in all habitats used by a metapopulation of wolverines in the conterminous U.S., reproduction in smaller mountain ranges that are in-between “regional population centers” (RPCs) may be of greatest importance given their increased likelihood of accomplishing genetic exchange among RPCs.

## Chapter 5

# Wolverine Harvest in Montana: Survival Rates and Spatial Considerations for Harvest Management

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*  
ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*  
MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

**ABSTRACT** Wolverine (*Gulo gulo*) populations are inherently vulnerable due to low densities and limited reproductive capacity. Populations within the conterminous U.S. experienced significant declines, have rebounded in some areas (including some that have been subject to harvest), but remain absent from major portions of historical range. Wolverines have been petitioned for listing as endangered in the conterminous U.S. and the petitioners cited current fur-harvest in Montana as a factor that could contribute to population decline therein. A recent synthesis of wolverine survival data from North America (Krebs et al. 2004) suggested that there are differences in survival of harvested and unharvested populations, and that a 2:1 ratio of unharvested:harvested habitat or a harvest rate of <7% of a population is necessary to sustain harvest. We conducted 3 separate analyses that are all related to wolverine survival and management of harvest. First, we used our telemetry data to determine wolverine survival rates and causes of mortality, including a test for differential survival between non-harvested areas (Idaho and Wyoming i.e., Teton study site) and areas where wolverines were harvested during a 2.5 month season with a limit of 1 wolverine/trapper/year (Montana i.e., Madison study site). Second, we used new information on broad-scale wolverine habitat in the conterminous U.S., wolverine space-use, and road access to determine whether a 2:1 ratio of unharvested:harvested habitat exists within Montana or within the 3-state area that likely contains the vast majority of current wolverine distribution in the conterminous U.S. (Montana, Idaho, and Wyoming). And third, we used information on broad-scale habitat, wolverine density, and statewide data on wolverine harvest in Montana to identify maximum levels of harvest that are sustainable within (i.e., <7% population capacity), and the relative vulnerability of, mountain complexes in Montana. For the first analysis, we radio-monitored 26 wolverines (16 F, 10 M) for 50.5 wolverine years during which 11 mortalities occurred; 5 resulted from natural causes (2 black bear predation, 2 avalanche, 1 unknown) and six were human related (5 fur-harvest, 1 road-kill). Despite differences in harvest regulations between Montana and the areas studied by Krebs et al. (2004), our estimate of annual survival was similar, i.e., <0.75 for the harvested population and >0.84 for the unharvested population. However, there are several potential sources of bias in our and other measures of wolverine survival rates (Appendix A). Thus, determining whether harvest of wolverines under the current regulations in Montana is sustainable or not requires measurement of survival and reproductive rates over a larger area (e.g., southwestern Montana) and time period (10 years) than our telemetry study currently provides along with attention to potential biases due to research methods. With our second analysis we estimated the ratio of unharvested:harvested habitat to be 1:9 within Montana and 1.6:1 within the 3-state area. The currently available information on wolverine genetics and dispersal coupled with observations of trapping mortality during our study suggest that immigration from outside of Montana may demographically support the harvested populations in Montana, but that this immigration may be ineffective at countering genetic drift. Our third analysis indicated that the capacities of 8 of 16 mountain complexes as we identified them were low enough that harvest rate of 6% of the estimated capacity was <1 wolverine. In addition, 14 of 16 mountain complexes had at least 1 year where the percentage of the estimated population capacity that was harvested was >15%. Thus while statewide harvest averaged <6% of our estimated population capacity on an annual basis over a 29-year period, smaller mountain ranges appear to be susceptible to over-harvest, and all areas can legally be over-harvested even under the current quota system. Overall, there is no direct, unbiased, and irrefutable evidence currently available indicating that harvest of wolverines in Montana is leading to population declines. However, our analyses and other pertinent information indicate that extreme caution is warranted when harvesting wolverines that likely exist as a metapopulation, as in the conterminous U.S. The degree of risk becomes greater in smaller or more isolated mountain ranges, especially those where reproduction would likely result in dispersal into a regional population center or that serve as linkage routes between regional population centers. A harvest management strategy that uses smaller units delineated on the basis of their landscape context and population capacities would likely reduce the probability of local declines and improve long-term genetic viability within Montana and the conterminous U.S. Managing wolverine fur-harvest as part of a collaborative, regionally-oriented, multi-jurisdictional strategy that includes a system of refugia designed to contend with harvest and other issues (e.g., winter recreation, housing development) by ensuring reproductive capacity and effective dispersal is more likely to achieve wolverine persistence in the conterminous U.S. Delineation of refugia in areas likely to be linkage zones may be important.

## Chapter 6

# Diel Winter Activity of Wolverines in Greater Yellowstone

ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

**ABSTRACT** Reports of wolverine (*Gulo gulo*) activity pattern vary and few empirical data exist. We captured and instrumented 8 wolverines (5 F, 3 M) with GPS collars that contained continuously recording, dual-axis motion sensors. To date we have obtained 222 days of activity data between 29 January and 24 April from 5 wolverines (3 F, 2 M) during 3 winters. All wolverines exhibited distinct diel activity peaks; male activity counts peaked morning and evening whereas non-reproductive female activity counts peaked during morning. One female exhibited variation in activity among 3 reproductive phases with minimal activity for 2 weeks immediately post-partum. Data on activity pattern can be valuable in determining if wildlife species are influenced by human activities. The data we have obtained thus far include observations from home ranges with varying levels of winter recreational use (primarily snowmobile). These data will be included in future spatial and temporal analyses intended to determine whether or not wolverines are influenced by the presence of winter recreation.

## Chapter 7

# Wolverine Road Crossings in western Greater Yellowstone

MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA*

**ABSTRACT** Populations of rare carnivores, including wolverines, are particularly vulnerable to the direct and indirect impacts of roads. Information on areas used by wolverines as they cross roads would be valuable for addressing potential impacts, but these data are sparse to non-existent in the Greater Yellowstone Area (GYA). As part of a larger telemetry-based study of wolverine ecology in GYA, we documented 43 crossings of U.S. or State highways by 12 wolverines. The most concentrated areas of wolverines crossing U.S. or State highways occurred at Teton Pass (WYO22); near the Henrys Lake Range at Earthquake Lake (US287) and Reynolds Pass (ID/MT 87); in Yellowstone National Park (US191); at Palisades Reservoir (US26); and across the Snake River Canyon between Hoback Junction and Alpine, Wyoming (US89/26). Subadults making dispersal or exploratory movements comprised the majority of road crossings, most of which were made during January–March. We documented U.S. or State highway crossings in <8% of the annual home ranges of resident adults ( $n = 28$  annual home ranges). Sixty-two percent of road crossings occurred at night and 38% occurred during the day ( $n = 13$ ). We considered the Big Sky, MT area separately because the characteristics of MT64/Jack Creek Road differ greatly (road type and traffic volume) and we obtained only 1 site-specific crossing. Wolverines crossed MT64/Jack Creek Road a minimum of 67 times; the majority of crossings were made by the Madison Range's resident adult male whose annual home range spanned the Spanish Peaks south to Hebgen Lake. Habitat modeling, a few VHF locations, and data from a single GPS collar (the e one site-specific crossing in this area) suggest that crossings in this area are now most likely to occur through the head of Jack Creek (west side of divide, private Jack Creek road, less development and traffic). We consider road crossing locations indicative of linkage areas and discuss 4 examples of possible mitigation: 1) general management techniques applicable to all road situations, 2) maintaining permeability in an area where a major road passes through linkage habitat that is mostly private lands, 3) maintaining permeability in an area where a major road passes through public lands that are primary wolverine habitat, and 4) maintaining permeability in an area where the potential for significant private development occurs in primary wolverine habitat. Linkage is a necessary component of wolverine's existence in the island-like habitat of the conterminous U.S.; because of the relatively permanent nature of human-induced habitat changes affecting linkage (e.g., road expansions, housing developments, human population growth), proactive management is required more so than with any other management issue.

## Chapter 8

# Wolverine Food Habits in Greater Yellowstone

MARK L. PACKILA, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA.*

ANTHONY J. MCCUE, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA.*

ROBERT M. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA, and Swedish University of Agricultural Sciences, Dept. of Ecology, Grimsö, SE - 730 91 Riddarhyttan, Sweden.*

KRISTINE H. INMAN, *Wildlife Conservation Society, 2023 Stadium Drive 1A, Bozeman, MT 59715, USA.*

**ABSTRACT** Knowledge of fundamental species biology such as food habits is essential for successful management, yet no report on the food habits of wolverines in the Greater Yellowstone Area (GYA) exists. As part of a larger study of wolverine ecology, we identified food items used by wolverines ( $n = 61$ ) and collected wolverine scats ( $n = 55$ ) from 2004–2007 while snow tracking, visiting den and rendezvous sites, and examining concentrated locations of activity derived from VHF telemetry and GPS collar locations. Wolverines obtained food in a variety of ways including actively preying on marmots, other small animals, and newborn ungulates in addition to scavenging of ungulate carcasses. Similar to other areas of wolverine distribution, ungulates (*Cervus elaphus*, *Alces alces*, *Odocoileus hemionus*) appear to be the primary food during winter. Yellow-bellied marmots (*Marmota flaviventris*) were prevalent during late spring and summer. Small mammals and birds may have been underrepresented and likely supplement primary food items throughout the year. Maintaining adequate populations of those species used as foods by wolverines is important for viability of this slowly reproducing species.