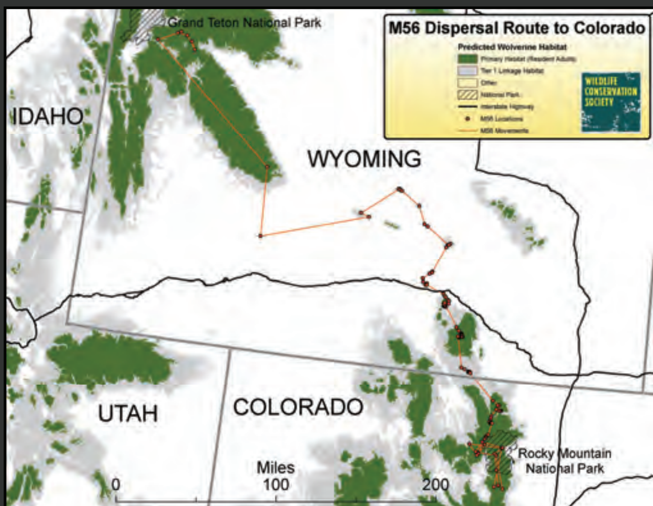
GREATER YELLOWSTONE WOLVERINE PROGRAM

Practical, Science-based Solutions for Wolverine Conservation

Progress Report – December 2009



Male Wolverine Travels 900 km and Crosses I-80 on His Way to Colorado, the First Documented Occurrence There Since 1919

Oxygen – An Essential Component for Wolverine Immobilization in the Rocky Mountains

Warning: Ice Accumulation on wolverine GPS collars

Robert Inman, Mark Packila, Kris Inman, Bryan Aber, Rob Spence, Deborah McCauley
Wildlife Conservation Society • North America Program

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December 2009

Hello,

2009 was an interesting and productive year for the project. The most unique event was the dispersal of a young male wolverine from northwestern Wyoming. We radio-monitored him while he covered over 900 kilometers, crossed a portion of the Great Divide Basin, successfully navigated Interstate-80 on Memorial Day weekend, and eventually made his way to Rocky Mountain National Park in Colorado. This event marked the first verified occurrence of a wolverine in Colorado since 1919, nearly a century ago. This dispersal generated quite a bit of wolverine media coverage and hopefully will help get the public interested in the species and conservation efforts for wolverines.

The section titled "Why do wolverines need metapopulation-level conservation actions and what would the priorities be?" is essentially a beginning point for a discussion we would like to engage in with others. If you have a moment to give feedback on additional or other priorities, potential techniques, or ways to build a cooperative effort focused on continued wolverine recovery and management, please contact us. We will be actively seeking input this summer and hope to host a third Wolverine Workshop aimed at moving forward.

We have included capture and handling related sections in the report that we believe contain important considerations for anyone capturing and handling wolverines here in the Rocky Mountains or using GPS collars on wolverines.

We also report on the progress made to date with our spring den surveys in an effort to develop a distribution and monitoring technique.

Thanks,

The Greater Yellowstone Wolverine Program Team

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If you find information or ideas contained within this report to be valuable, please consider citing it as follows: Inman, R. M., M. L. Packila, K. H. Inman, B. Aber, R. Spence, and D. McCauley. 2009. Greater Yellowstone Wolverine Program, Progress Report – December 2009. Wildlife Conservation Society, North America Program, General Report, Bozeman, Montana, U.S.A.

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2009 Acknowledgements

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We extend a special thanks to Elk Meadows Ranch and all who attended Wolverine Workshop 2009.

Caribou-Targhee National Forest
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Gallatin National Forest

Grand Teton
National Park

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Why Do Wolverines Need Metapopulation-level Conservation Action & What Would the Priorities Be?

Conserving wolverines in the lower 48 over the course of the 21st century may prove to be one of the more difficult challenges among the many that wildlife and land managers will face. It is expensive and often dangerous to access the places where wolverines live and give birth in an attempt to understand what is happening with the population and how to manage it. Add to these difficulties the scale over which coordination and conservation must occur (the western states and provinces), and the task becomes even more daunting. Top that with climate change, potential impacts from backcountry recreation, rural sprawl, and the fact that many people don't know and possibly don't even care what a wolverine is, and one might ask – why even try?

However, wolverines can be viewed as a vehicle, an opportunity if you will, to take some of these difficult challenges head-on and advance the legacy of conservation in North America. What will it take to conserve wolverines?

We will have to address the issues of scale and protected areas. When our national parks and public lands were established, we did not understand the true scale over which populations of terrestrial wildlife functioned. The original boundaries of the world's first national park, Yellowstone, were drawn around scenic wonders and geothermal features. Wildlife was a bit of an afterthought, but soon we learned that the park could function as a refugia. Nearly a century later, we learned that conserving grizzly bears in Yellowstone required us to think beyond the park as a refugia and begin managing the park along with its surrounding public lands as a unit (the Greater Yellowstone Area). Now we know that wolverines require us to take the next step and begin developing a network of open space among the National Parks and Public Lands of the western U.S. – Connectivity between Glacier, Grand Teton, and Rocky Mountain National Parks for instance. Perhaps instead of a daunting task for wolverines, this is an opportunity to build western communities in a way that preserves the character and open space so valuable to residents here. With rural sprawl knocking at the door, diverse interests may find common ground in maintaining open space. If these efforts can be informed by wildlife research on dispersal and migrations, then it is possible that we can overcome this major challenge for wildlife conservation.

Conserving wolverines will also require that we make smart moves aimed at coming through climate change. Perhaps most challenging, we will have to implement a wolverine monitoring program so that we can understand what exactly needs to be done and be able to gauge our success. This will include the hard work of determining and adjusting (if necessary) for the increased amount of backcountry recreation.

So there are significant challenges. But was it less challenging at the start of the 20th century with decimated wildlife populations, commercial hunting, a lack of public lands, no state agencies focused on wildlife management, and the Great Depression? Our degree of success will improve if we identify, prioritize, and act upon the things that need to be done. Here is our current thinking on why and how to go about conserving wolverines here during the 21st century. We invite your help in refining this suggested course of action and moving the right things forward.

Overview

Within the conterminous U.S., wolverines are dependent on landscape-level collaboration among wildlife and land-management agencies across the western states. There are two priority management actions that will help ensure the long-term persistence of wolverines here. First, restore wolverines to "climate-safe" areas where they have been functionally extirpated. This action is important to the persistence of the small, demographically vulnerable metapopulation and could function to establish continental-level refugia for the species as climate change occurs. Priority two is establishing a cooperative wolverine monitoring program. This action is the most efficient means for providing critical but currently unavailable information necessary for scientifically defensible management of the species, i.e., population distribution and trajectory, priority linkage areas, and whether there are population level effects on reproduction by winter recreation. Together these two priority actions represent the greatest potential progress for ensuring the persistence of wolverines in the conterminous U.S. (Fig.1).

Priority 1 – Restoration of wolverines to formally occupied habitat is important to the persistence of a small, demographically vulnerable metapopulation in the conterminous U.S. and could function to establish continental-level refugia for the species as climate change occurs.

Wolverines of the conterminous US exist as a small, demographically vulnerable metapopulation because they are dependant on cold, snowy environments. Wolverines have a circumpolar distribution and are found in tundra, taiga, boreal, and alpine biomes. These relatively unproductive habitats are areas where daily low temperatures can fall below freezing most of the year, growing seasons are short, and snow persists into the summer months. The wolverine's niche appears to be based on the species' ability to access the scarce resources available in these environments despite the presence of deep snow-cover and then cache them in cold, rocky areas that inhibit competition from insects, bacteria and other scavengers. Exploiting this relatively unproductive niche requires the extremely large home ranges that wolverines regularly traverse, a social system that provides exclusive access to resources (territoriality), along with the low densities and reproductive rates that wolverines display across their range (Magoun 1985, Persson 2003, Inman et al. 2007a, Inman et al. 2007b). These conditions also require wolverines to give birth during late winter in a den site that is insulated by snow-cover (Copeland et al. in press). As a result, suitable habitat here in the conterminous U.S. has been limited to high-elevation, alpine areas that occur in island-like fashion (Fig. 2, Brock et al. 2007, Copeland et al. in review, Inman et al. in prep). The major blocks of wolverine habitat capable of accommodating more than 20 resident adults are likely limited to the Northern Continental Divide, Salmon-Selway, Greater Yellowstone, Colorado, Northern Cascade, and Sierra-Nevada ecosystems (Fig. 2). However, none of these ecosystems are likely to have ever had populations of more than approximately 100 adults. Thus, wolverines of the conterminous US have likely always existed as a small, demographically vulnerable metapopulation.

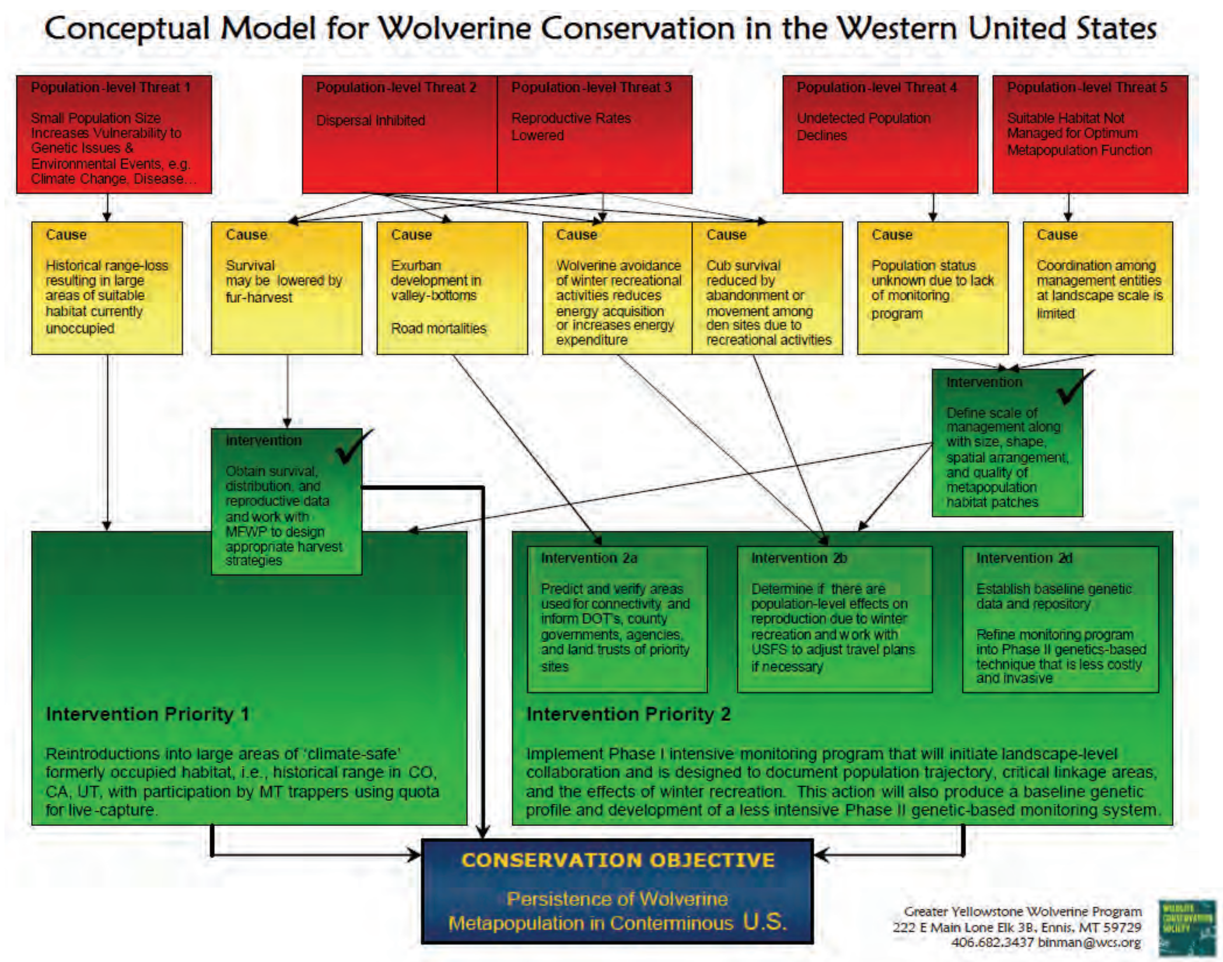


Figure 1. This diagram illustrates the major population-level threats for wolverines in the conterminous US (red boxes) along with their potential causes (yellow boxes) and interventions (green boxes). These priority actions will also facilitate the landscape-level cooperation that is necessary for successful management of the wolverine metapopulation in the conterminous US.

Historical evidence suggests that wolverines were extirpated, or very nearly so, from the conterminous U.S. by about 1930 (Grinnell et al. 1937, Newby and Wright 1955, Aubry et al. 2007). The species' limited distribution and inherent demographic vulnerability were likely significant factors in historic lows for wolverines occurring earlier than other carnivores that were specifically persecuted and more accessible to humans, e.g., wolves and grizzly bears (Schwartz et al. 2003, Paquet and Carbyn 2003). Wolverines have recovered to some degree within portions of their historical distribution, most likely due to influx from Canadian populations (Newby and Wright 1955, Newby and McDougal 1964, Anderson and Aune 2008). Breeding populations currently occur in Montana, Idaho, and portions of Wyoming and Washington (Copeland 1996, Inman et al. 2007b, Rohrer et al. 2008, Inman et al. 2008, Anderson and Aune 2008). However, as of 2007, no confirmed records of wolverine presence were documented for nearly a century within major publically-owned blocks of wolverine habitat in Colorado, Utah, and California (Aubry et al. 2007). These areas represent approximately one-third of the wolverine habitat within the conterminous US (Brock et al. 2007, Copeland et al. in review, Inman et al. in prep) and thus have significant capacity to be an important component of the lower 48 population.

Recent records of wolverines in California (2008) and Colorado (2009) were both instances of individual males captured on camera (Moriarty et al. 2009) or radio-tracked while dispersing (Inman et al. in prep). While these events suggest the possibility of natural recolinization, it's important to consider that female wolverines have not been documented dispersing similar distances or across arid valley bottoms like those that lie in-between currently occupied areas and Colorado or California (Vangen et al. 2001, Inman et al. 2007a, Fig. 2). Research on past sightings and surveys conducted in Colorado and California (Miller and Halfpenny 1981, Nead et al. 1985, Kucera and Barrett 1993, Zielinski et al. 2005, Aubry et al. 2007, Garcelon et al. 2009) suggests that the presence of a viable, breeding population currently existing in these areas is extremely unlikely.

Restoring wolverines to areas without a currently viable breeding population would serve to increase the redundancy, genetic diversity, and resiliency of wolverines in the conterminous US and could function to establish a continental-level refugia for the species as climate change occurs. Redundancy of areas occupied by a species is important for withstanding random perturbations such as disease, fire, or other factors that could lead to severe local declines or extinctions (USFWS 2008). Wolverines in the conterminous US exist as a metapopulation where large areas of formerly occupied, high-quality habitat are somewhat disjunct from other large blocks of habitat (Fig. 2). Thus, restoration to this unoccupied habitat would serve to increase redundancy of the conterminous US population and provide some degree of geographic separation in the case of threatening external factors.

Restoration to formerly occupied habitat could also serve to improve the genetic diversity of wolverines in the conterminous US. Recent genetic work suggests that wolverines of the conterminous US have experienced genetic drift and contain only four of the thirteen haplotypes found in Canadian populations (Wilson et al. 2000, Cegelski et al. 2006). Restoration would provide an opportunity to select individuals representing the range of genetic diversity within North America, resulting in a heterozygous population that harbors a wider range of genetic diversity than is currently present in the conterminous US.

Resiliency of a population is improved with occupation of areas that are relatively large, high-quality habitats or are less susceptible to certain threats than other portions of the species range (USFWS 2008). In the case of wolverines, areas such as Colorado and California would function to improve resiliency because of the large contiguous blocks of high-quality wolverine habitat. These areas are also unique in that they are somewhat separate from other large blocks of habitat, but within range of occasional dispersers. Thus it would achieve some degree of separation for redundancy but is also capable of producing an occasional natural genetic exchange to provide resiliency and improve genetic heterozygosity.

Perhaps most importantly, the high elevation mountainous areas in the conterminous U.S. could function as continental-level refugia for wolverines with regard to the effects of climate change. Interestingly, the southern periphery of the wolverine's global distribution occurs in the conterminous US, thus it seems counter-intuitive to suggest that it could serve as a "climate-safe" refugia. However, much of the wolverine's distribution in the far north consists of areas that are near sea-level and topographically flat. As global temperatures rise, these flat, low elevation areas may see snowpack recede with greater rapidity than will occur at high elevations in rugged terrain that includes large portions of north-facing slope. The high elevations and rugged terrain within the conterminous U.S. may serve to retain the cold temperatures and snow-cover necessary for wolverines to a greater degree than other portions of the specie's range. While climate change will not likely improve the suitability of wolverine habitat in the conterminous US, 50 to 100 years from now these areas may be some of the best remaining wolverine habitat within North America.

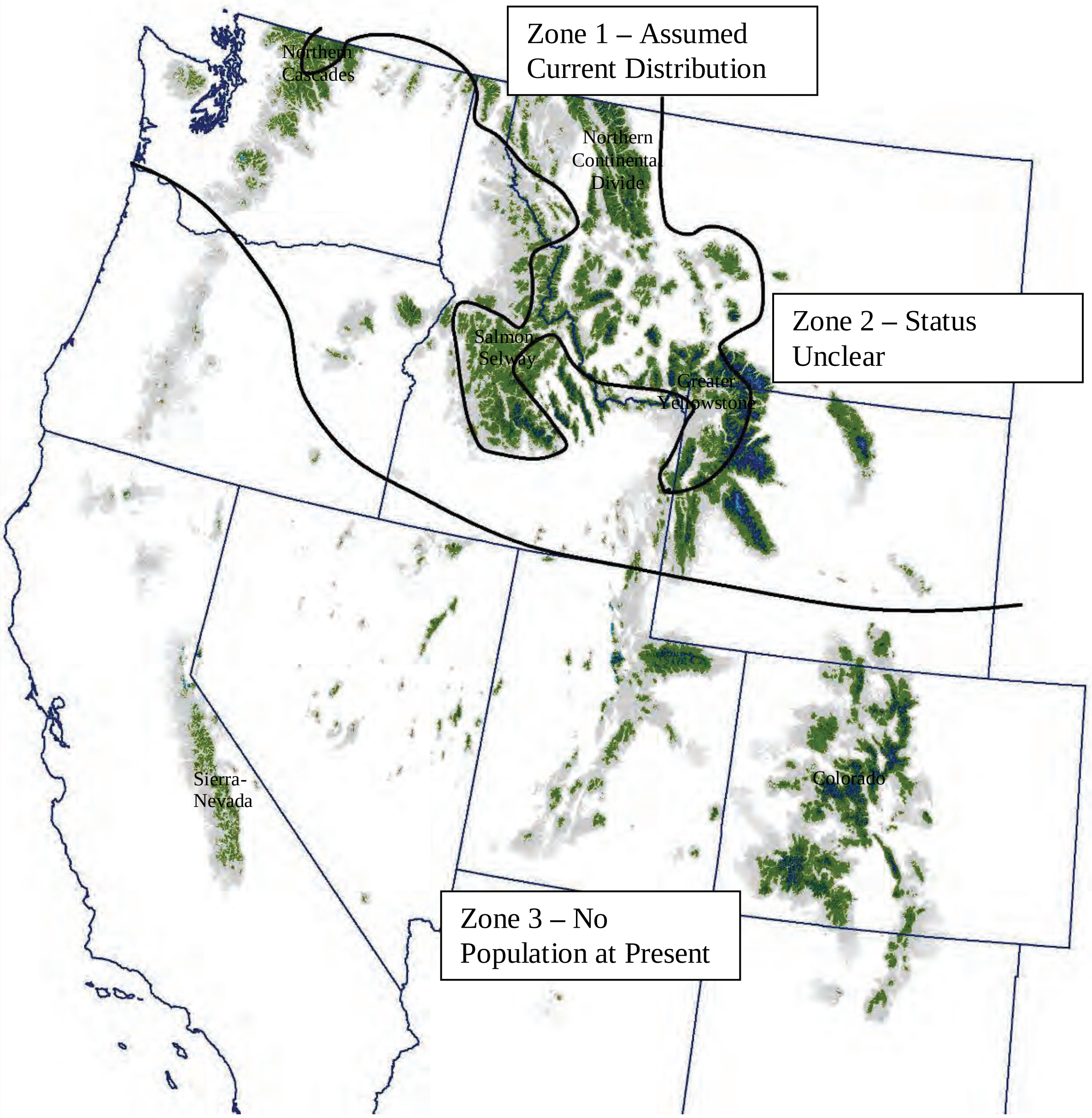


Figure 2. Suitable wolverine habitat in the western United States is indicated by green and blue shading; areas most likely utilized for dispersal are gray (Inman et al. in prep). Black lines delineate 3 areas in relation to current distribution and status. All areas were likely extirpated by about 1930 (Aubry et al. 2007). Zone 1 is the area either documented as re-occupied by reproductive females or widely assumed to be based on occasional records of occurrence. Zone 3 is the area where a lack of verified records occurred for nearly a century and it is assumed to be unoccupied by a breeding population at present. Distribution and status in Zone 2 is less clear.

Priority 2 – **Establishing a cooperative wolverine monitoring program is the most efficient means for providing critical but currently unavailable information necessary for scientifically defensible management of the species, i.e., population distribution and trajectory, critical linkage areas, and whether there are population level effects on reproduction by winter recreation.**

While wolverines have recovered to some degree from historical causes of decline, the species remains inherently vulnerable and is facing a new set of challenges. Nineteenth century activities that caused early declines of wolverines were all directly related to human-caused mortality. These included unregulated commercial trapping of furbearers, killing and poisoning to prevent wolverines from raiding trap-lines, conflicts with high-elevation sheep grazing, and the widespread practice of poisoning carcasses to kill large predators (Aubry et al. 2007). Many of these activities were eventually eliminated or reduced, and after reaching a population low-point around 1930, wolverines appear to have rebounded to some degree. Much of the recovery may have been fueled by immigration from larger Canadian populations (Newby and Wright 1955, Newby and McDougal 1964). Current (1995-2005) verifiable records exist from Washington, Idaho, Montana, and Wyoming, and reproduction has been documented recently in each of these states as well (Copeland 1996, Inman et al. 2007b, Aubry et al. 2007, Anderson and Aune 2008, Copeland and Yates 2008, Inman et al. 2008, Rohrer et al. 2008,).

Despite some recovery from historical causes of decline, wolverines remain inherently vulnerable and new, different threats must be anticipated in order to ensure that wolverines do not decline again. These new threats are not just related to human-caused mortality; rather, they are the result of new human activities (winter recreation) and recent or impending changes to habitat (connectivity and climate change).

Winter recreation is an issue of management concern for wolverines due to their precarious energetic balance in relation to reproduction (Persson 2005, Inman et al. 2007a, 2007c) and the possibility of lowered cub survival due to human disturbance at dens (Copeland 1996). Wolverines are purported to be sensitive to human presence (Copeland 1996, Rowland et al. 2003). They generally reside and give birth in remote areas that have been, until recently, largely inaccessible to humans during winter. However, the number of recreationists in the backcountry appears to be increasing (GYCC 1999), and the technology available to access the remote, extreme terrain that wolverines frequent has advance rapidly. Snowmobiles, which were invented in 1935, can now travel at speeds over 100 miles per hour and traverse nearly vertical terrain. Use of helicopters allows skiers to access previously unreachable peaks. As a result, wolverines are likely encountering humans in more places and with greater frequency. <u>If</u> wolverines are sensitive to human presence, they may be expending calories moving away from humans, or they may be inhibited from accessing calories due to the presence of humans near feeding sites. In either case, a reduction in the amount of energy available for reproduction could affect birth rates, recruitment, and dispersal of wolverines. Furthermore, if disturbance at den sites can lead to abandonment or increased movements, the effect could be compounded. Reproductive failures or even lowered reproductive rates may prove overwhelming for a species whose densities and reproductive rates are lower than grizzly bears and whose core habitats exist in somewhat island-like fashion with increasing levels of human impact in between.

Land-use conversion due to development and roads is so prevalent throughout the western US that habitat loss, fragmentation, and connectivity are major issues for many species. But because of their extremely large territories and low population densities, no terrestrial species requires connectivity at the landscape-scale like the wolverine. We now understand that wolverines of the conterminous US have existed as a demographically vulnerable metapopulation dependent on successful dispersal across arid valley bottoms lying in-between islands of high-mountain habitat. These valley bottoms are most often in private ownership and are increasingly subject to conversion from ranchland to subdivision (Gude et al. 2007). Clearly, persistence of wolverines in the conterminous US depends on establishing a network of open space among the large blocks of public lands from Canada to Colorado and California.

Climate change is also likely to impact wolverines. The species is morphologically, demographically, and behaviorally adapted for snow and cold temperatures. Its feet are extremely large relative to body size, it is estimated to have a low threshold for thermoneutrality of -40° C, it caches food for long periods to use during lactation, and its birthing site is always under snow (Iverson 1972, Magoun 1987, May 2007, Copeland et al. in review). Direct effects are likely to be increased competition for food resources and less successful den site selection. Climate change will also likely exacerbate the effects from other modern threats like connectivity and winter recreation.

Despite the relatively vulnerable position that wolverines are in, our perception of fundamental population characteristics such as distribution and trajectory is guided by information that is weak at best, and the specific actions necessary to address new conservation challenges remain undefined.

Our perception of the improved distribution and trajectory of wolverines during the latter half of the 20th century boils down to this: Montana appears to have a fairly stable population and other areas that were once extirpated produce occasional records. In Montana, the 355 records obtained via harvest of wolverines over the past 32 years (~11/year) indicate that distribution is widespread within suitable habitat. Breeding is also occurring throughout the state; Anderson and Aune (2009) documented 70 instances occurring over a 22 year period (1984-2005), and telemetry studies have documented 20 litters being born (Inman et al. 2007b, Copeland and Yates 2008). Thus the population is assumed to be stable based on continued presence, reproduction, and widespread distribution along with a 50:50 sex ratio and an appropriate age-structure of the harvest (Montana Fish Wildlife and Parks, unpublished data). On the other hand, genetic studies indicate that only 4 haplotypes exist within Montana whereas 13 haplotypes are known to exist in populations further north in Canada (Wilson et al. 2000, Cegelski et al. 2006). In addition, effective population size in the northern Rockies of the US was estimated to be 35, which is lower than considered appropriate (Schwartz et al. 2009).

Outside of Montana, our perception of distribution and trajectory is based on far weaker information. In fact, observations of breeding or reproduction are limited to a total of 4 instances in Idaho, 1 in Washington, and 3 in Wyoming over an 18-year period (1992-2009). All these instances were documented during opportunistic telemetry studies. Otherwise, only 15 verifiable, non-telemetry-study records of occurrence exist in these 3 states between 1995-2005 (Aubry et al. 2007). If we assume that healthy numbers of wolverines exist within the mountainous areas of Idaho, Wyoming, and portions of Washington, we base that in large part on 31 confirmed records, 8 documented reproductions, and occasional unconfirmed reports of tracks over an 11 year period. This could well be the case, as no state has undertaken specific efforts to document distribution or abundance of wolverines within its borders. However, recent work in Wyoming suggests that this assumption may not be valid, as capture efforts and aerial track surveys in eastern Yellowstone indicated that few if any wolverines are currently present there (K. Murphy, Yellowstone National Park, pers. com.). This begs the question – Are we willing, in the absence of opportunistic telemetry studies, to assume that we know distribution and status of this inherently vulnerable population based on about 15 verified occurrences and a handful of unconfirmed reports per decade?

In addition to these fundamental aspects of population status, we still do not have an adequate understanding of the exact measures to take to conserve wolverines. Clearly, conserving open space for connectivity is critical. Recent progress in understanding the habitat characteristics that facilitate wolverine dispersal allows us to make some rough predictions of which areas are important for wolverines (Brock et al. 2007, Schwartz et al. 2009, Balkenhol et al. in review, Inman et al. unpublished data). However, easements and purchases aimed at retaining private lands as open space are extremely expensive and require prioritizing very specific parcels. Therefore it is important to test our rough predictions with actual dispersal data in order to make confident recommendations to agencies, land trusts, counties, and transportation departments.

Dispersed winter recreation on public lands is a multi-billion dollar industry (International Snowmobile Manufacturers Association 2009). It represents a significant portion of the local economy in many small rural communities. If this activity does influence wolverines negatively, instituting changes will undoubtedly require the most rigorous level of scientific evidence. The information presently available consists of a few observations of females moving den sites upon discovering humans nearby (Copeland 1996), and a single habitat analysis suggesting that winter recreation was a negative influence on selection by wolverines (Krebs et al. 2007). Additional research regarding the influence of recreation on spatial use, movement rates, and activity patterns is in preparation (Inman et al. unpublished data). While there is certainly a logic based on the species biology and some indication that the issue may influence wolverines, the potential for population-level effects on reproduction has not been investigated.

Climate change will impact wolverines. Reversing this situation is obviously necessary for long-term success, but this is beyond scope of wildlife biologists outside of communicating the relevance of such actions. What is imperative now for wolverines is action designed to best withstand the changes due to a warming climate. Priority action one, restoration to currently unoccupied areas, is a step toward that goal. However, this emerging issue adds impetus to determining the status and management actions necessary to ensure persistence within the conterminous US metapopulation. Virtually all wolverine habitat in the conterminous US is mountainous and could be continental-level refugia.

Wolverines are unique in that they are so uncommon and inhabit such rugged, remote terrain, that sudden, precipitous declines could occur and would likely go unnoticed for years. This combined with their inherent vulnerability and the new 21st century challenges suggests that it is imperative to begin proactive efforts to obtain information that can guide management.

The most efficient means of answering questions fundamental to conserving wolverines in the conterminous US is a well-designed, cooperative monitoring program that utilizes a widely dispersed but coordinated field effort. Monitoring to determine the following is critical for confident decisions regarding wolverine conservation. Do reproductive females actually reside in all of the areas widely assumed to represent current distribution? Is the metapopulation stable, increasing, or declining? Is population growth rate different in areas with and without motorized winter recreation? Which specific parcels of land are most important for connectivity?

Most or all of these questions could be answered with genetic, occupancy, or radio-telemetry data. But no matter which approach would be used, the vast geographic area containing the wolverine metapopulation along with the extremely remote and rugged terrain where individuals are located poses a formidable problem. Answering any *one* of the questions above would require a broadly distributed sample (multiple states) and extremely difficult logistics. The fact that wolverine distribution overlaps with grizzly and/or black bears makes matters more difficult because the odds of encountering wolverines (instead of bears) greatly improves during bear hibernation. This along with the fact that wolverine reproduction occurs during February necessitates winter field efforts. As a result, answering any single management-relevant question requires a sampling effort distributed across several western states in extremely rugged and remote terrain that is accessed during winter. Clearly the logistics involved with wolverines represent a rather extreme situation and are a major reason why this species may be the least studied carnivore in North America.

Overcoming the logistical and financial constraints involved with answering questions imperative to successful wolverine conservation requires a well-designed cooperative monitoring program. Such a program can provide the necessary information at a cost that is much less than the sum of its individual parts. Establishing this program can also initiate the landscape-level coordination that must occur in order to manage the metapopulation of the conterminous US. In the absence of such a program, wolverine "management" will continue to be based on assumptions and will consist of inaction. This despite the population's inherent vulnerability and significant conservation challenges that lay ahead. Clearly there is need for an efficient and effective monitoring program that informs specific management actions.

Monitoring Program Development – Next Steps

MacKenzie et al. (2006) suggested that monitoring of animal populations is not a stand-alone activity of great inherent utility; rather it is more usefully viewed as a component of the process of scientific management. This is the approach we recommend here. We seek to aid in the development and implementation of a monitoring program that is designed to inform management decisions: Metapopulation trajectory as it is relevant to the ESA; Population-level effects of winter recreation as relevant to USFS travel planning; and Specific dispersal data to inform and prioritize conservation easements and road projects. Because of the specific, logistic-related characteristics of the wolverine (metapopulation, extreme terrain, winter surveys), we seek an approach that can guide all of these important management decisions with one metapopulation-level field effort. Obviously this type of effort would require input from and participation by a number of organizations.

As part of the ongoing monitoring protocol discussion, we hosted a meeting during July 2009 attended by several wolverine biology experts. Here we discussed benefits and drawbacks of various methods that could be used to monitor wolverines over a wide area. Techniques discussed included DNA samples (baited hair snag stations, snow tracking, sniffer dogs), aerial tracking (presence/absence, calculate density, occupancy, den detection), remote cameras (individual ID, in combination with hair snares), and capture/telemetry. While we discussed many potential techniques and their pros and cons, we did not begin trying to estimate costs of applying the various techniques within the wolverine habitat of the lower 48.

During 2010, we will attempt to host a third interagency Wolverine Workshop. Generally this would be a collaborative effort involving agency personnel, population monitoring statisticians, and wolverine field-biology experts gathering to design an effective wolverine metapopulation monitoring protocol and beginning the process of funding and implementing the protocol. Several potential field techniques are possible and each will have its pros and cons related to cost, obtaining specific information directly applicable to management decisions, and statistical validity. The overall approach will be to use a current definition of wolverine metapopulation habitat (sampling area) to estimate the cost of various approaches and then weigh their overall effectiveness (the precision with which they obtain the necessary info to inform management actions). Our goal would be delineation of an agreed-upon monitoring protocol and initiation of efforts to fund and implement this program. If you are interested in participating, please contact us.

Photo 1-2. Cub wolverine tracks (above) or visual observation (below) are two examples of ways to verify reproduction. The tracks above were found during follow-up to a potential den site located from the air using fixed-wing den survey methods described in our 2008 report. These tracks confirmed reproduction and lead to the capture of a family group. By capturing this group we were able to radio-mark them and establish the territory of an adult female along with determining survival, dispersal, and reproductive info, including that of known-age cubs.

Research Summary 2009

We started the 2008/2009 winter season with 11 wolverines on the air, 6 of which were adult females. As a result of our den survey efforts during spring 2008, we also had information on areas that may hold an additional 18 wolverines – 10 adult females, 5 adult males, and 3 dispersing-aged wolverines. Based on the locations of these unmarked wolverines we ran a small but targeted capture effort during December '08-February'09. These efforts resulted in 7 wolverine captures (5 new captures, 2 recaptures) during a total of 138 trap-nights (1 wolverine capture/20 trap-nights for this targeted effort). One of these individuals was not radio-implanted due to a heart condition. We also radio-implanted and GPS collared an additional wolverine that was incidentally captured by a recreational trapper on Menan Buttes in Idaho, and we recaptured a dispersing-aged female in the Gravellys. A total of 7 wolverines were handled during the winter, including 6 new individuals. At present we are radio-monitoring 9 wolverines (5 adult females, 3 dispersing-age wolverines, and 1 adult male). We lost 4 due to expiration of their implant batteries (3M 1F), and are currently unable to relocate another 4 (2M 2F) who have either moved large distances or their implants have failed prematurely.

We adapted our handling protocol to include use of a pulse-oximeter, administration of oxygen, and improved thermal regulation. We also decided to end targeted box-capture efforts by February 15 in areas known to contain reproductive aged females in order to avoid capturing late-term pregnant females and/or lactating females with cubs.

This spring's den detection test was successful in that the blind search using the fixed-wing technique matched exactly with what the telemetry and follow-up data indicated. However, it was less informative than we had hoped because both techniques indicated that none of the 6 adult females successfully reproduced this year. So, although the technique determined what actually happened, we did not come away with a den detection rate. So the question remains – If 10 wolverine dens are present, how many can we detect with blind, fixed-wing surveys? We were however able to show that the technique can provide a relatively inexpensive method of aerial track detection and thus wolverine distribution.

Over the spring/summer we monitored 3 individuals during their dispersal movements. This included the movement of a subadult male from northwestern Wyoming to Colorado, making him the first confirmed wolverine in Colorado since 1919.

During calendar years 2008 and 2009 we radio-monitored 20 different wolverines for a total of 23-wolverine-years. This included reproductive observations of 7 different females during a total of 12 reproductive opportunities with one reproduction documented (1 cub of unknown sex). We also recorded one mortality during this period (a juvenile male).

Photo 3. A camera bait site and the resulting picture that was used to identify a known age subadult female whose VHF transmitter had failed prematurely. This subadult was then target trapped during January 2009 to continue monitoring her for dispersal and age at first reproduction (for information about identifying individual wolverines from photographs see Magoun et al. 2008).

Capture

Capture & Handling Protocol Adaptations

We have refined our handling protocol to include the use of bottled oxygen during anesthesia and now consider this essential for safe handling of wolverines here in the western U.S. at the elevations where wolverines occur.

Fahlman et al. (2008) showed that wolverine anesthesia in Sweden resulted in poor blood oxygen pressure, partially due to elevation. The elevation of our study area is significantly higher than the highest capture sites in Sweden (only 500-1,300 m above sea level there), suggesting the potential for an even greater elevation effect here in the Rockies. During 2008-2009, we used a pulse oximeter to evaluate SpO_2 levels of anesthetized wolverines. Initial SpO_2 readings of all 5 wolverines that had SpO_2 measured prior to oxygen application were between 50-74%, which is much lower than the target of >90%. We were able to raise the SpO_2 very quickly to >90% using an oxygen flow rate of 0.5 - 1.5 liters per minute (lpm). A small human neonate size nasal cannula was used to deliver the bottled oxygen (Photo 4). We continue to use oxygen and now consider oxygen essential for all wolverine anesthesia.

Photo 4. Pulse-ox attached to tongue and oxygen supplied via nasal cannula.
A snug, shortened sleeping bag was modified for surgery and used for warmth.

To deliver the compressed medical-grade (USP) oxygen we used a size M6 aluminum oxygen cylinder tank, a CGA 870 0-8 lpm oxygen regulator, and a human neonate size nasal cannula. We used an N-20 PA pulse oximeter (Nellcor, Boulder, CO, USA) with a printer. The pulse-ox was attached to the tongue to measure heart rate and SpO_2. We used a continuous read DataTherm II (Geratherm Medical AG, Geschwenda, Germany) temperature monitor to measure rectal temperature and record 1 minute interval temperatures. Combined, the oxygen cylinder, regulator, hoses/cannula; pulse oximeter; and thermometer weigh 3.2 kg (7 lbs) (Photo 5). This setup is easy to transport to wolverine capture sites accessed on foot, or by snowmobile or helicopter. We were concerned with the potential for a drop in body temperature due to administration of cold oxygen (due to the cold ambient temperatures we are typically working in and the temperature drop of released compressed oxygen). However this has not been an issue, at least with the current equipment we use to maintain wolverine body temperature.

Photo 5. Pulse oximeter and continuous read thermometer along with the oxygen cylinder, regulator, and nasal cannula that are now integral components of our wolverine handling equipment. Total weight <7 lbs.

We also decided to end our box-capture efforts by February 15 for two reasons. First, we were concerned that immobilizing near-term, pregnant females could potentially affect the pregnancy. This was based on our review of the literature associated with the immobilization drugs. Second, we did not want to hold recently parturient females overnight in a box trap when they would have small altricial cubs at a den site. The chance of one or the other of these situations occurring rise dramatically in mid-February. The chance of these situations occurring also begin to decline by mid-March. It is important to note that both of these situations can be avoided with captures that occur at den (rendezvous) sites in May; by this time all females that are going to give birth have done so and cubs are weaned and large enough to travel. We are not positive that either of these 2 situations could be detrimental. However we decided to end our capture efforts at Feb 15 and are trying to gather more information on the potential for drugs to affect reproduction and the vulnerability of young cubs to 24-48 hour absences of the mother.

Winter 08-09 Field Season: A Targeted Effort in the CLE

As outlined in the last WCS Wolverine Progress Report (Nov. '08), we conducted aerial den surveys in the Central Linkage Ecosystem (CLE) during spring 2008. Two confirmed dens of unmarked wolverines were aerially located in the CLE that year. The recognized presence of a reproductive wolverine population, including dispersal aged subadults, spurred a winter field trapping session in the Beaverhead and Pintler Ranges of the CLE. Dispersing-aged subadults were targeted for capture and fitting with GPS collars prior to dispersal, which could provide valuable inter-mountain range connectivity data. Resident females of this area were also targeted to acquire reproductive data.

Last winter field season, we experimented with a portable trap design (Lofroth et al. 2008) constructed of commercial 4"x4" untreated lumber that can be pre-assembled and transported in the field as needed with snowmobiles (Photo 6). We also drilled numerous small holes in the top and sides to prevent condensation and potential hypothermia. This trap differed from the log box trap design we had used previously which was constructed in the field of dead and down wood found on site and not capable of being transported. Three of these portable traps were used in the Wisdom, MT area trap line; one log trap was constructed in the Pintler Wilderness.

Four new wolverines were captured in the CLE area, all in the Anaconda Range. M558, was captured in January, implanted with VHF and collared with a GPS collar. A previously reproductive adult female, F551, was captured in the same trap a couple of days later and was also fit with a VHF implant and GPS collar. Both animals are currently in the southern Anaconda Range. F551 is notable in that she is an adult female that appears to have a home range overlapping a state and a US highway. She also used portions of 3 National Forests – the Salmon-Challis, Bitterroot, and Beaverhead Deerlodge (Fig. 3). The third wolverine captured was F541, a juvenile female captured in the Pintler Wilderness and presumably one of the cubs observed on May 16, 2008 at the Pintler Wilderness rendezvous site (one of the dens aerially located). Also captured in the Pintler Wilderness was F540, a previously reproductive adult female.

F540's capture event was noteworthy because when she was anesthetized she had an irregular heartbeat. In spring 2008, the WCS Wolverine Program revamped its capture gear to include a veterinary pulse oximeter, bottled oxygen setup, and more warming equipment to battle hypothermia. The importance of the new equipment was validated during this capture, as the pulse oximeter aided in diagnosing the irregular heartbeat, and adequate oxygen perfusion to tissues was able to be maintained using bottled oxygen despite the circulatory system anomaly. We chose not to implant F540 with VHF due to her heart condition, but she was fit with a GPS collar. Based on the GPS data, F540 returned to normal movements after the capture.

Photo 6. Portable wolverine trap being hauled to a capture site in southwest Montana, 2009.

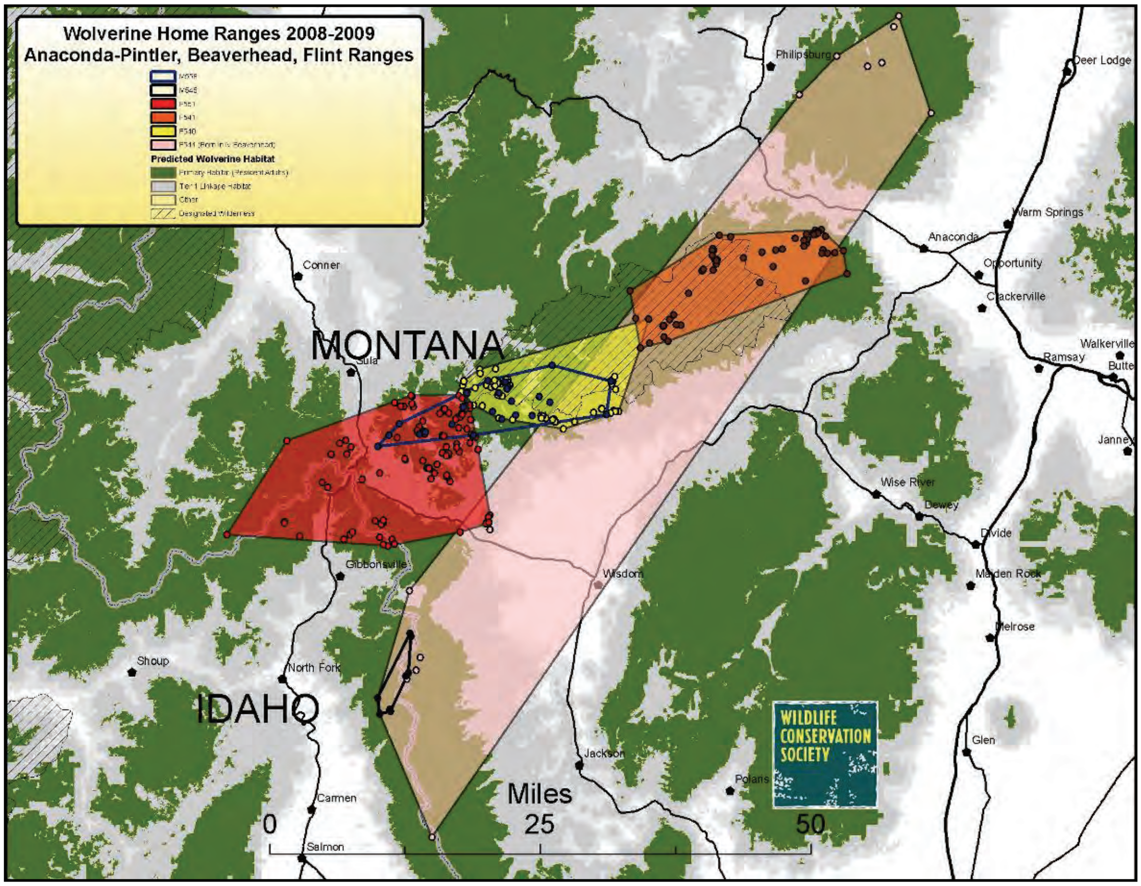


Figure 3. Home ranges of 4 females and 2 males in the Anaconda and Beaverhead Ranges of Montana and Idaho. Note the overlap of F551 with 2 major highways. F551 also uses portions of the Salmon-Challis, Bitterroot, and Beaverhead-Deerlodge National Forests.

Photos 7-9. Remote cameras were used as part of an efficient capture effort. With limited personnel and time to trap a large area we relied on remote cameras to learn when a wolverine was using a bait prior to setting up a portable trap and beginning the daily trap checking routine. This method saved time and resources compared to running all traps all winter – with the majority of the time the traps not having wolverine activity.

Aerial Locations 2008-2009

During 2008 and 2009, we radio-located 20 wolverines (12 F, 8 M) a total of 1,026 times. These wolverines were spread over a large geographic area including 4 different states (Montana, Idaho, Wyoming, and Colorado, Fig. 4).

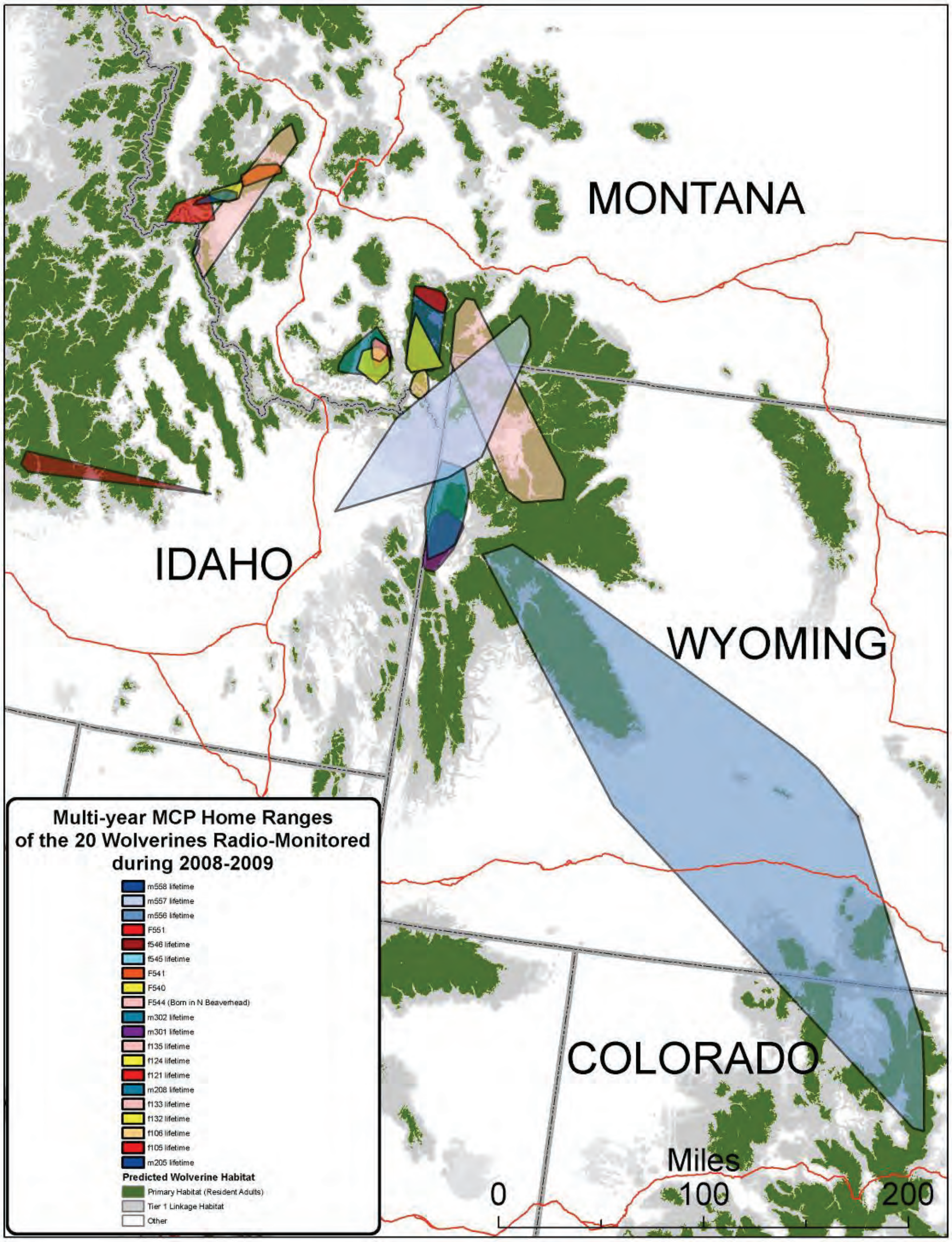


Figure 4. Multi-year MCP home ranges of wolverines radio-monitored during calendar years 2008 and 2009. This included 6 individuals in the Anaconda/Beaverhead Ranges, 8 in the Madison/Gravelly Ranges, 2 in the Teton Range, 2 in the Gallatin/Absaroka Ranges, 1 in the Smoky Mountains of Idaho, and 1 who dispersed to Colorado from northwestern Wyoming.

WARNING : Ice Formation on GPS Collars Deployed on Wolverines

Since 2004, the Greater Yellowstone Wolverine Program has deployed Lotek GPS 3300SL collars 16 times on 13 individual wolverines in Montana, Idaho, and Wyoming. We retrieved 7 of these collars during winter, when ice formation would be visible (others retrieved during summer or lost). Out of these 7 collars, we have documented 3 occasions (2 individual wolverines) that an ice-ball weighing up to 7 pounds had formed on the battery pack (see Photos below). The first and second occurrences were from the same individual; she was recaptured without her collar and collared a second time before the first collar could be retrieved from the drop site. Upon retrieval we discovered that each had an ice-ball that appeared to have formed while on the wolverine. Since we had not seen this problem on other collars at that point, we assumed that it must have been an odd feature such as a regular stream crossing within this individual's home range that was resulting in the problem. We have not re-collared this individual. The following winter we collared a new wolverine and subsequently discovered an ice-ball on the dropped collar. We have not deployed any Lotek 3300SL collars since that time. We have not visually verified that the other collars have not had an ice-ball on them nor have we witnessed a wolverine wearing a collar with an ice-ball. However, we do not believe the ice forms after the collar comes off, but rather while the collar is on the animal due to hair, forest debris (needles, twigs, etc), and 'growth rings' as the ice appeared to accumulate. Time frame for ice formation (based on the last visual of an ice-free collar to date of pull-off) ranges from 4 days to 45 days. This means that in one instance the iceball formed in less than 4 days. We suspect that it could form in as little as a few hours. In each of the 3 occasions, the wolverine pulled the collar off prior to the scheduled release date or other misfortune.

Photo 10. A collar retrieved with accumulated ice.

All collars that were verified as having an ice-ball were deployed between December and March. We do not know the reason for ice-ball formation. One idea is that it could be similar to ski 'glopping'. In this situation there is a thin layer of melting snow at the surface of the snowpack with cold, powdery snow remaining under the melted layer. A ski continuously moves between the wet, melting layer at the surface and the cold layer beneath. The water from the melting layer freezes on the cold ski and this semi-frozen accumulation collects cold snow from beneath. The wet snow and frozen snow quickly accumulate and can form large, heavy, condensed snow 'glop' (Photo 11). We speculate that a similar situation could allow 'glop' to form on the collar's plastic battery case.

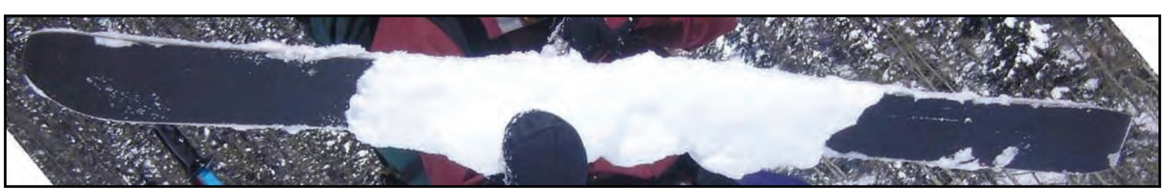


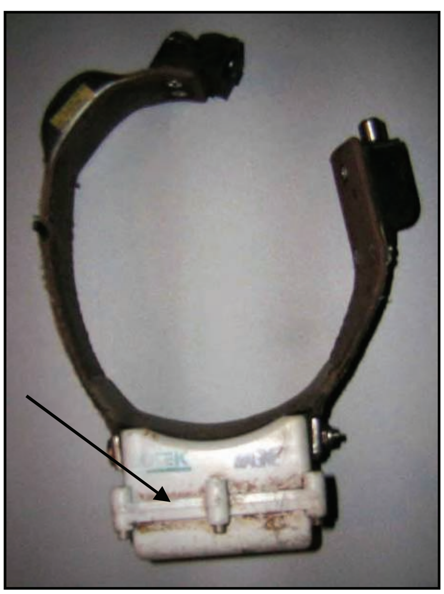
Photo 11. An example of ski 'glopping.'

The following is an account of the collar deployment that resulted in ice formation for which we have the most information. This collar was deployed on a subadult female in the Gravelly Range, Montana. The female was released from the trap, on 12/12/07. The collar was ice-free when she was recaptured on 12/14, 12/16, and 12/31. During this time the maximum temperature at the most representative Snotel site in the area remained below freezing (Table 1). The day the collar was pulled off by the wolverine, 1/3/08, was the first day of above freezing temperatures. With powdery snow on the ground, the first day of above freezing temperatures is generally prime condition to develop 'glop' and could potentially be the reason that the collar developed ice when it did. In this case, it doesn't appear that a normal activity (crossing creeks, drinking, etc.) caused ice formation, or else the collar should have collected ice throughout the time the collar was on. This is simply one theory as to how ice can form on the collar, we do not know the true situation.

Table 1. Clover Meadows Snotel maximum temperatures (°C).

date	tmax
12.12.07	-8.8
12.13.07	-5.9
12.14.07	-10
12.15.07	-10.7
12.16.07	-6.6
12.17.07	-6.4
12.18.07	-5.6
12.19.07	-4.8
12.20.07	-3.9
12.21.07	-3.3
12.22.07	-11
12.23.07	-7.1
12.24.07	-1.8
12.25.07	-0.8
12.26.07	-10.9
12.27.07	-11.6
12.28.07	-12.1
12.29.07	-11.8
12.30.07	-10.4
12.31.07	-9.9
01.01.08	-11.3
01.02.08	-3.3
01.03.08	2.2

The Lotek 3300SL is somewhat unique in its "shelved" battery case (Photo 12.) Perhaps this feature or something else specific to this model of collar is conducive to ice formation, but we can not be sure. We have used other GPS collars and have not had any indication of ice-ball formation with those models. Wolverine fur is somewhat unique in its ability to shed ice buildup; a property that has made wolverine pelts valuable as ruff material on parkas because frost from human breath is easily shed. Could it be that this property of wolverine fur is adaptive due to their almost constant contact with snow and the potential to suffer regularly from 'glop?' Is this phenomenon unique to the dry powder snow of the Yellowstone region? We have included this description in our report so that anyone thinking of collaring wolverines can be aware of this potential problem. This is obviously a potentially serious issue and if anyone has other observations of similar phenomenon please contact us.



Photos 12-13. Left: "Shelved" battery case of the Lotek 3300SL GPS collar. Could this affect ice accumulation? Above: This collar collected ice over a four-day period. Interestingly it appears that the neck could not have fit in the collar with the iceball as seen in this photo made at recovery. The collar had been chewed. Could the chewing have resulted in additional ice accumulation?

Determining Den Detection Rate for Fixed-wing Surveys

During spring 2008, we began developing a fixed-wing aerial wolverine distribution/den survey method. The method focuses on confirmation of a breeding population rather than only the presence of wolverine tracks. Locating a den leaves no doubt as to the presence of a population, and tracks are documented while searching for a den anyway. Using this method to locate dens could also prove to be useful as an index of wolverine reproduction and can produce other important info, e.g., den habitat, DNA, known-age cubs for demographic data, etc… Before this technique can be deemed useful for indexing wolverine reproduction, it needs to be tested for it's capability to "blind-locate" dens that are known (via telemetry) to be present. We began this test during spring 2009. The test consisted of a comparison between the number of dens found on the study area via telemetry locations vs. the number found by an observer using the blind search den survey method. The observer was of course unaware of the telemetry locations of the marked females or whether we suspected that any of them had reproduced.

Survey Areas We determined the area to be searched for tracks/dens by calculating the minimum habitat score (based on Brock et al. 2007) of all 28 natal den and rendezvous sites that we have documented during the study (Inman et al. 2007b). We considered all areas scoring as high as these den sites to be "maternal habitat," and searched all survey grid cells overlapping maternal habitat. We did not search areas consisting of <100km^2 of primary wolverine habitat (Brock et al. 2007) because this is the minimum female home range size (Hornocker and Hash

Photo 14. A wolverine den located during a fixed-wing search for dens and tracks during 2008.

1981, Copeland 1996, Squires et al. 2006, Copeland and Yates 2006, Inman et al. 2007*a*).

Survey Timing Three factors influenced our decision on timing of conducting surveys, i.e., the length of time after a track-clearing snowfall to wait and let tracks accumulate before searching: 1) maximizing the number of 'flyable days' considering the commonly inclement weather during the spring survey period, 2) minimizing the flight/personnel time and cost spent investigating extraneous tracks (non-target species), and 3) minimizing the flight/personnel time and cost required to follow a wolverine track to a den site. Thus we wanted to fly as soon as possible after a track clearing snowfall. Conversely, we are cautious about flying after long periods with no covering snowfall because tracks can melt during spring or a lot of tracks can accumulate, both wolverine and non-target species, potentially making it more difficult and time consuming to follow a myriad of tracks to determine if they are wolverine and/or follow wolverine tracks back to a den. These factors guided our determination of an appropriate grid-cell size.

Survey Grid Cell Size Using GPS collar movement data from a female rearing cubs, we calculated movement areas and determined that hexagonal survey cells of 12.5km^2 would be the right size to allow track detection of a reproductive female in as little as 24 hours after a track clearing snowfall. This relatively small grid cell size would result in 8 cells within the minimum female home range size. This density of cells ensures adequate coverage of all areas within the home range. Survey cells were arranged to completely overlap the maternal habitat outlined above.

Search Method The test flight was scheduled to begin after March 7th because most females that are going to den should have initiated by this time (Inman et al. 2007*b*). Each of 163 12.5 km^2 cells was searched for tracks using a pilot/observer chosen route, the only requirement being that all cells were searched. There was no minimum time required per cell, only sufficient time that the experienced observer was satisfied that all open areas were searched adequately for tracks. Open areas without dense tree cover included avalanche chutes, talus fields, alpine meadows, and thin alpine timber. Wolverine tracks and areas that appeared to have concentrated activity and perhaps a hole (a 'potential den'), were marked using a GPS. Single sets of tracks that did not lead to an area of concentrated activity or suspicious hole were noted, but not investigated further. Within two weeks of the initial survey, sites with concentrated activity were either investigated by air, ground, or both to determine if use of the site was continued. If use was not continued, the site was not considered a potential den. However, the area around the original concentrated activity, including adjacent drainages, was searched to determine if the female had moved the cubs from the initial area of activity viewed during the search. If use of the site was continued it was considered a potential den and verification of cub presence was required to confirm reproduction. A visual on cubs or cub tracks, remote camera capture of cubs, or genetic verification can be used to confirm reproduction.

Table 2. Track and den detection rate results.

	Year (Spring)	
	2009	2010
Adult female home ranges surveyed	6	6
Home ranges with tracks detected during survey	6	?
Track dection rate	1.0	?
Adult females radio-monitored for reproduction	6	6
Actual dens (telemetry & follow-ups)	0	?
Survey method dens located	0	?
Den detection rate	.	?

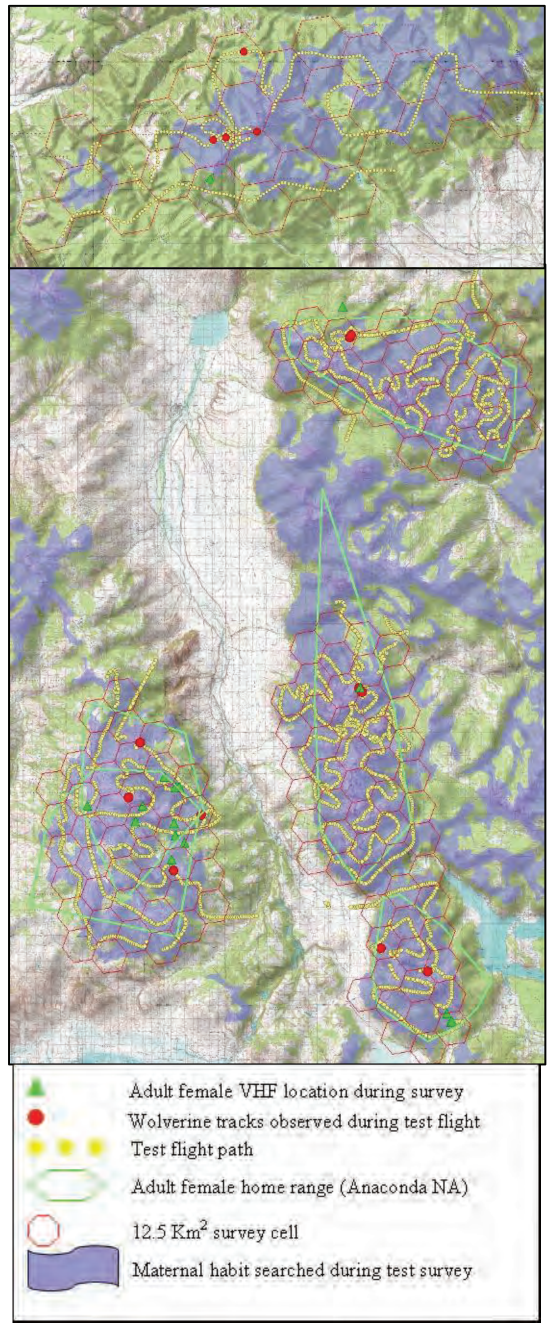
Results of the Spring 2009 Den Detection Rate Test Six radio implanted adult females being monitored for reproduction using VHF telemetry flights were used to test our aerial den detection survey method (Fig. 5). In early April, after almost a month of weather delays, an observer without knowledge of the telemetry location results conducted the blind den detection survey within the home ranges of the marked females. The observer identified tracks as wolverine within each of the female's home ranges and identified concentrated tracks/activity in 4 of 6 female home ranges. This initial flight was followed up with ground visits (weather too poor to fly) at 2 of the 4 concentrated activity sites. At one site there was no new activity and at the other site there was a mtn. goat carcass, but no new activity. The other 2 of 4 sites with concentrated activity were aerially inspected one week after the initial flight. One site showed no activity in the drainage. The other site had one set of wolverine tracks moving through the drainage, but no concentrated activity. This track prompted a second flight 5 days later that showed no activity in the area.

Without continued use at any of the 4 sites of concentrated activity, the test den detection survey concluded that none of the 6 females had reproduced. This matches the results of the VHF telemetry flights during the denning period plus the subsequent observations and camera work through the summer (details of efforts used to determine reproduction via telemetry and follow-up efforts are below in the Demographics section). Unfortunately, the lack of reproduction prevented us from obtaining a den detection rate at this time (0/0) (Table 2). However, we were able to gain insight into our ability to find tracks with this relatively inexpensive method.

Tracks recorded as wolverine were found in each of the six female home ranges searched. This information can be useful for suggesting current distribution and could be valuable in occupancy modeling.

The test flight occupied a pilot and observer for about two days (11.25 total flight hrs, 6 survey hrs & 5.25 ferry hrs). The flight crew searched 163 cells (2037 km²) for an averaged of 2.2 min/12.5 km² cell. Follow up to check areas with concentrated activity consisted of 1.5 days for 2 technicians to check areas of activity on the ground and <1 hour (3.7 hours including ferry) of flight time to check areas of activity from the air. Total cost was similar to that outlined in our 2008 report – approximately \$3,000 per 1,000km² of habitat and 7 person-days. This includes ferry time and purchase of a remote camera. If the effort was limited to simply surveying for tracks, the cost would be about \$750 per 1,000 km² without ferry time to the site.

Figure 5. Test den survey in the Anaconda Range (top) and Madison Area (bottom)



Dispersal

Monitoring a Long-Distance Dispersal, Northwest WY to Northeast CO

On December 20, 2008 WCS captured a young male wolverine, M56, near Togwotee Pass, Wyoming. He was implanted, fit with a GPS collar, and released.

Over the next several months (Jan-Mar) M56 was located in the Leidy Highland area between Togwotee Pass and the Gros Ventre River. We thank the Absaroka Beartooth Wolverine Project for providing several additional telemetry flights during this period. However, there were two flights when M56 was missing, and we began wondering if this young male had begun to make exploratory movements. The last location in the Leidy Highlands was in mid-March and by the end of March it was apparent M56 was no longer in the area. WCS conducted extensive search flights and on April 6th we found M56 in the southern Wind River Range near Lander with the GPS collar still on. The collar was scheduled to fall off by this date, thus the collar release mechanism had failed to function. Three days later an oil-field worker reported to WY G&F that he saw a wolverine running on a dirt road near Freighter Gap, Wyoming (between the southern Winds and Rock Springs, WY). The man stated that "if the wolverine was wearing a collar, it was white", a description that matches M56's collar. Wyoming Game and Fish visited the site and verified wolverine tracks (M. Grenier, Wyoming Game and Fish, pers. comm.).

Poor weather prevented search flights until later in April when we found M56 in the Green

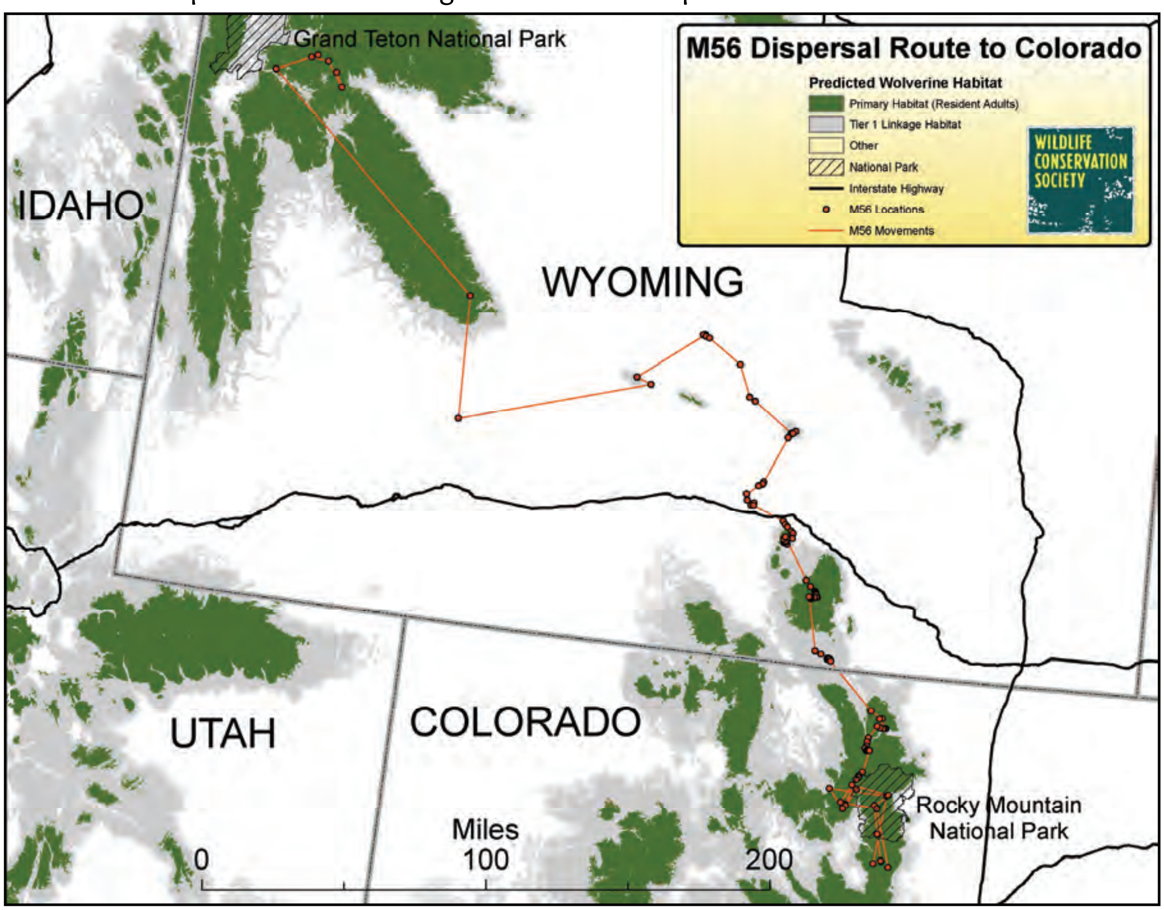


Figure 6. M56 dispersal route to Colorado. This event marked the first verified record of a wolverine in the state of Colorado since 1919. M56 crossed I-80 on Memorial Day weekend. He also landed on at least 2 out of the 3 islands of habitat predicted by our telemetry-based habitat modeling efforts while he moved between the Greater Yellowstone and Colorado Rockies Ecosystems. This movement of at least 942 km (541 straight line distance) may be the longest movement ever recorded for a wolverine.

Mountains, east of the Wind River Range, leaving us wondering where all he had been on his excursion through the Great Divide Basin and hoping that his GPS collar might tell us. M56 next moved north to the Granite Mountains, but at this point the GPS collar's VHF could no longer be heard. In the Granite Mountains M56 was found scavenging a dead cow near the Bug Ranch and Bug Ranch and WCS personnel were able to get a visual on M56 and verify that he was still wearing the GPS collar. So now the collar VHF had failed in addition to the release mechanism failing. This is the last time M56's collar has been seen. It is no longer on M56, so the collar is somewhere between central Wyoming and northeast CO.

Through the middle of May, M56 moved east, crossing the North Platte River to the Shirley Mountains. After a break in the Shirley Mountains, M56 started moving south towards Interstate 80. Aerial and ground telemetry leads us to believe that M56 crossed I-80 near where Dana Ridge meets the interstate sometime between midnight and 4 AM on Memorial Day. He was first located south of I-80 at 5:30 AM on May 23rd (Photo 15) and he continued to move that morning until about 10 AM when he moved into tree cover on the east side of Elk Mountain.

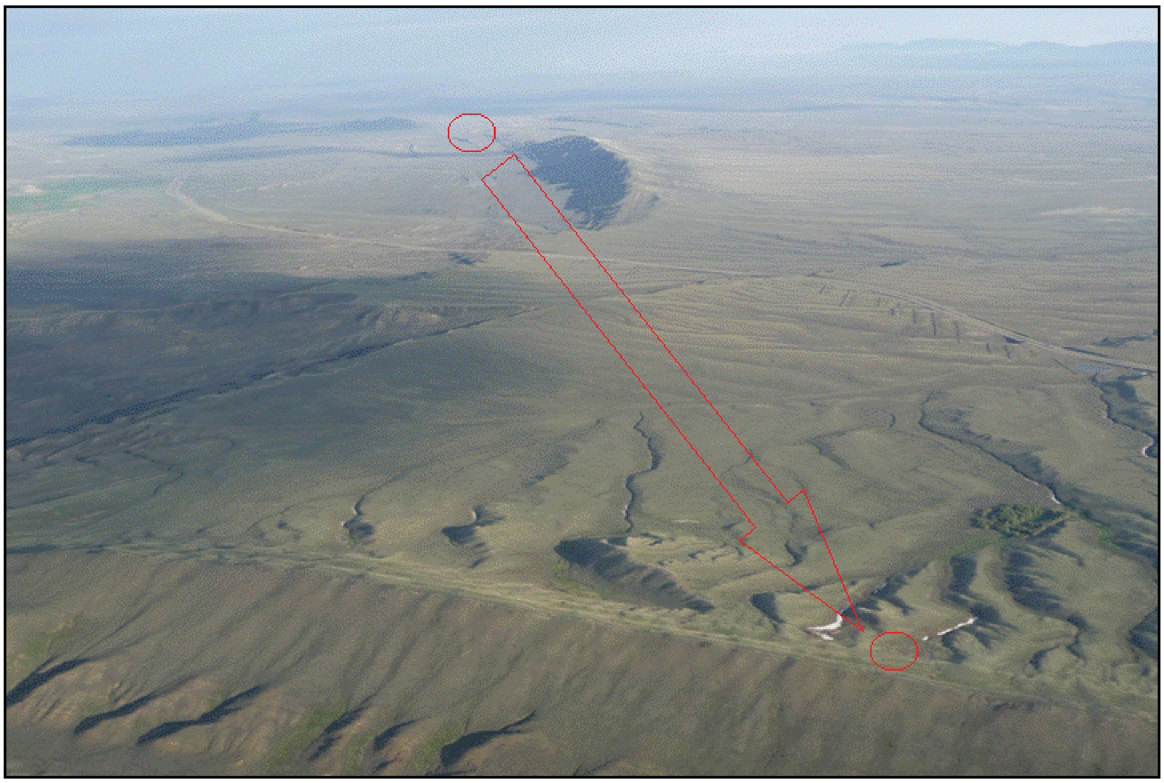


Photo 15. This is the area where M56 crossed Interstate 80. Red circles represent VHF locations before and after crossing.

After spending a week on Elk Mountain, M56 continued south to the Snowy Range. While near the crest of the Snowies, we were able to watch an aborted attempt to cross WY Hwy 130 at 8:31 AM (Photo 16). M56 approached WY Hwy 130 and, just as he got on top of a small rise above the road, two cars heading east came past. This made him stop. Just after the two cars passed, a motorcycle heading west came by and this made him run into a small patch of trees away from the road and off the rise. M56 continued west along the north side of the road and didn't cross the road before weather forced us to stop flying.

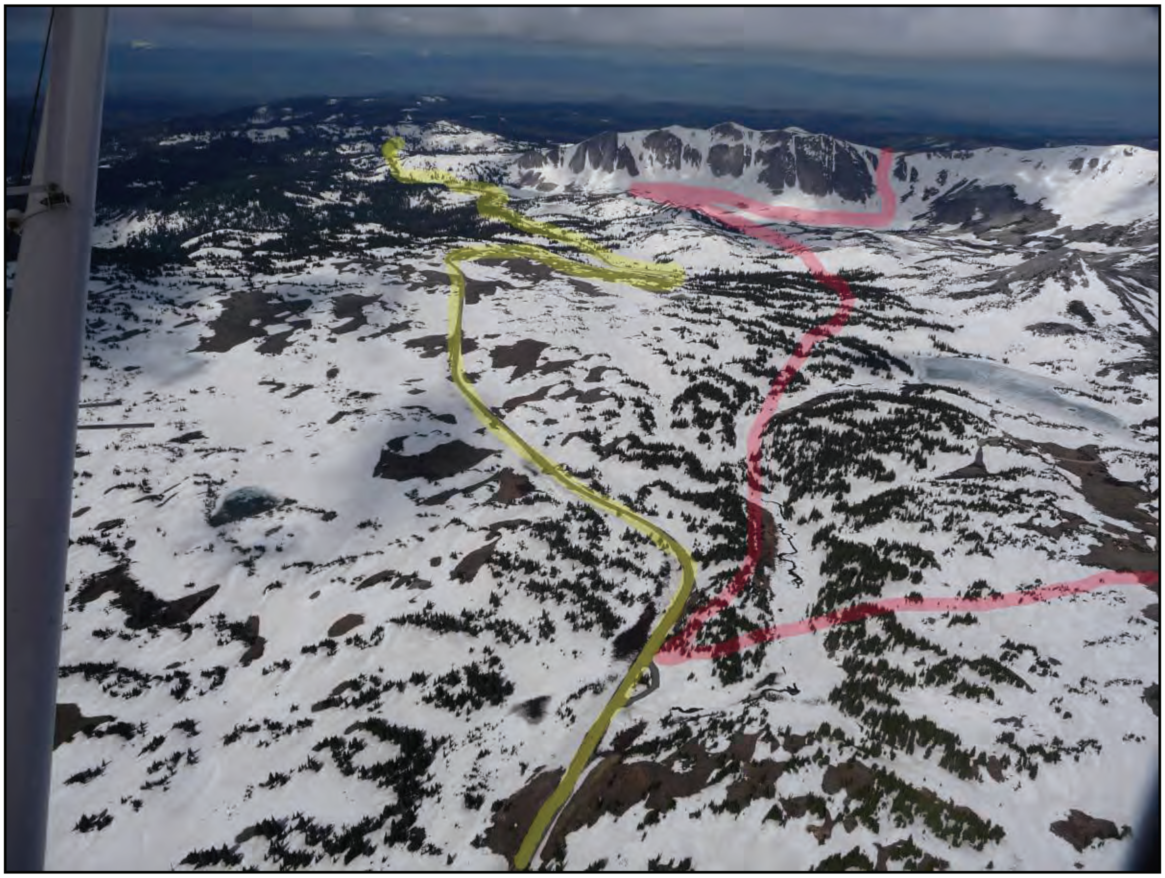


Photo 16. M56's path (red) as he moved from the lower right side of the picture, encountered traffic on Hwy 130 (yellow), and took an alternate route that included a steep climb.

The failed road crossing attempt didn't stop M56 from continuing south. The next morning he was over 10 miles south, moving a minimum of 31 miles in 24 hours. Near Mountain Home, WY aerial locations indicated he bumped into a housing development. He went straight north away from the development about a half mile before continuing east and crossing WY Hwy 230 between 9:00 and 9:06 AM (Photo 17). At this point he was within three miles of the CO border. Poor weather prohibited flying the next morning (6/2/09), but a window in the afternoon allowed a flight. M56 was over 20 miles southeast into CO on the Roosevelt National Forest at that time. After a brief slow down in the Roosevelt NF, M56 crossed CO Hwy 14 (between 12:30 and 12:45 PM) and was in Rocky Mountain National Park. He has continued to use the area around Rocky Mountain NP and the surrounding Routt, Roosevelt, and Arapaho National Forests during the summer. The Colorado Division of Wildlife has been aerially monitoring him during the summer and fall.

This movement was exciting to watch, and it also generated significant interest in wolverines, not only in Colorado, but around the nation. Over 150 media outlets covered the story of the first wolverine documented in Colorado since 1919, including a front page article in the Denver Post, a feature article in the New York Times, and several outlets outside of North America. This movement confirmed that long distance dispersal through large areas of arid, treeless habitat is possible for certain wolverines and genetic exchange is possible between areas like Colorado/California and the northern Rockies/Cascades. This movement between two major habitat blocks (Greater Yellowstone and Colorado) is an excellent example of why wolverines need to be managed as a metapopulation within the western states.

Photo 17. M56 bumps into a small subdivision and skirts around it and across WY Hwy 230.

M56 – The Numbers as of July 1, 2009

-Straight line distance from point of capture to furthest location was 541 km (336 miles).

-Minimum distance traveled since capture was 942 km (585 miles).

-Located on 6 National Forests, 3 BLM Districts, 1 National Park, WY and CO State Lands, and Private Lands

-Average rate of movement during dispersal (April 6 – June 9) was 9.8 Km/day. To approximate minimum distance travelled within 24 hours, we grouped VHF locations into separate 21-27 hour periods and the general pattern of movement was either travelling, 17.8 – 57.6 Km (average 36.1 Km, n=6, time 22.0-27.0 hours) or not travelling, 0.3 – 5.9 Km (average 2.2 Km, n=11, time 22.0 – 25.8 hours).

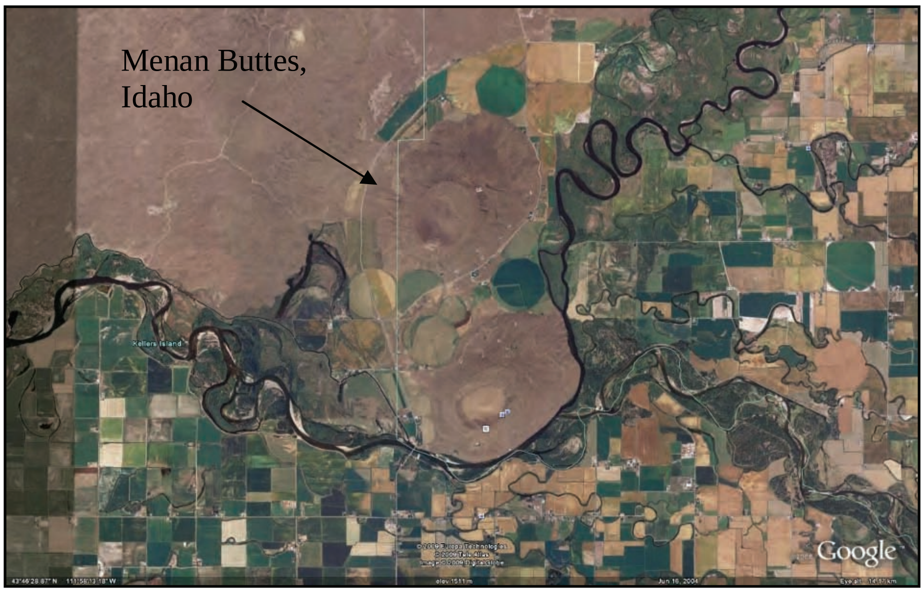
-9 significant roads crossed:

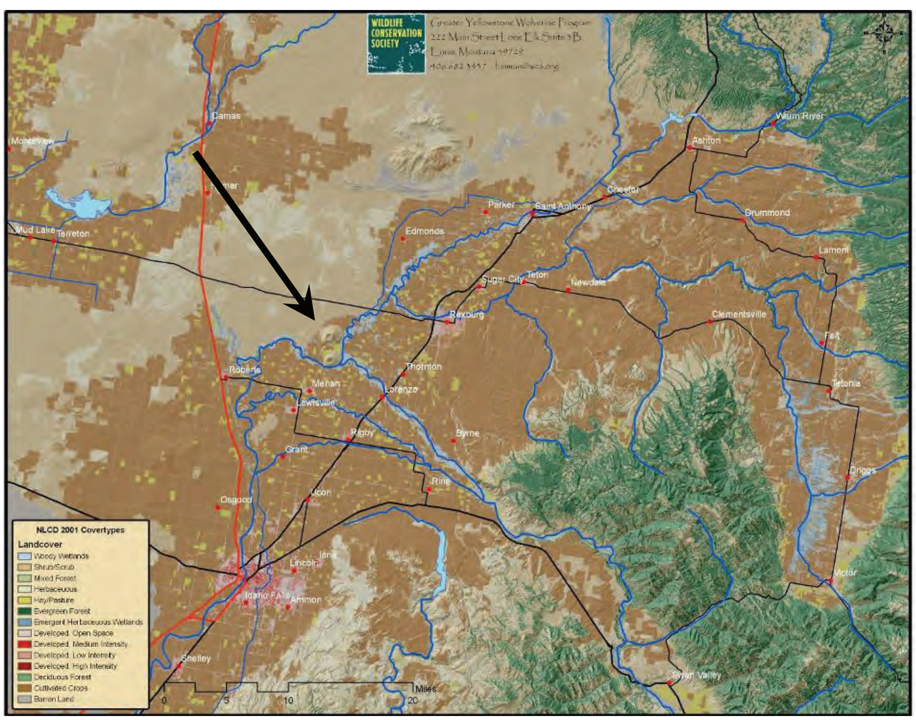
1 interstate: I80; 3 US highways: 287 (twice), 34 (within RMNP); 5 state highways: WY 28, WY 220, WY 130, WY 230, CO 14

M56 Remote camera photo, Wyoming.

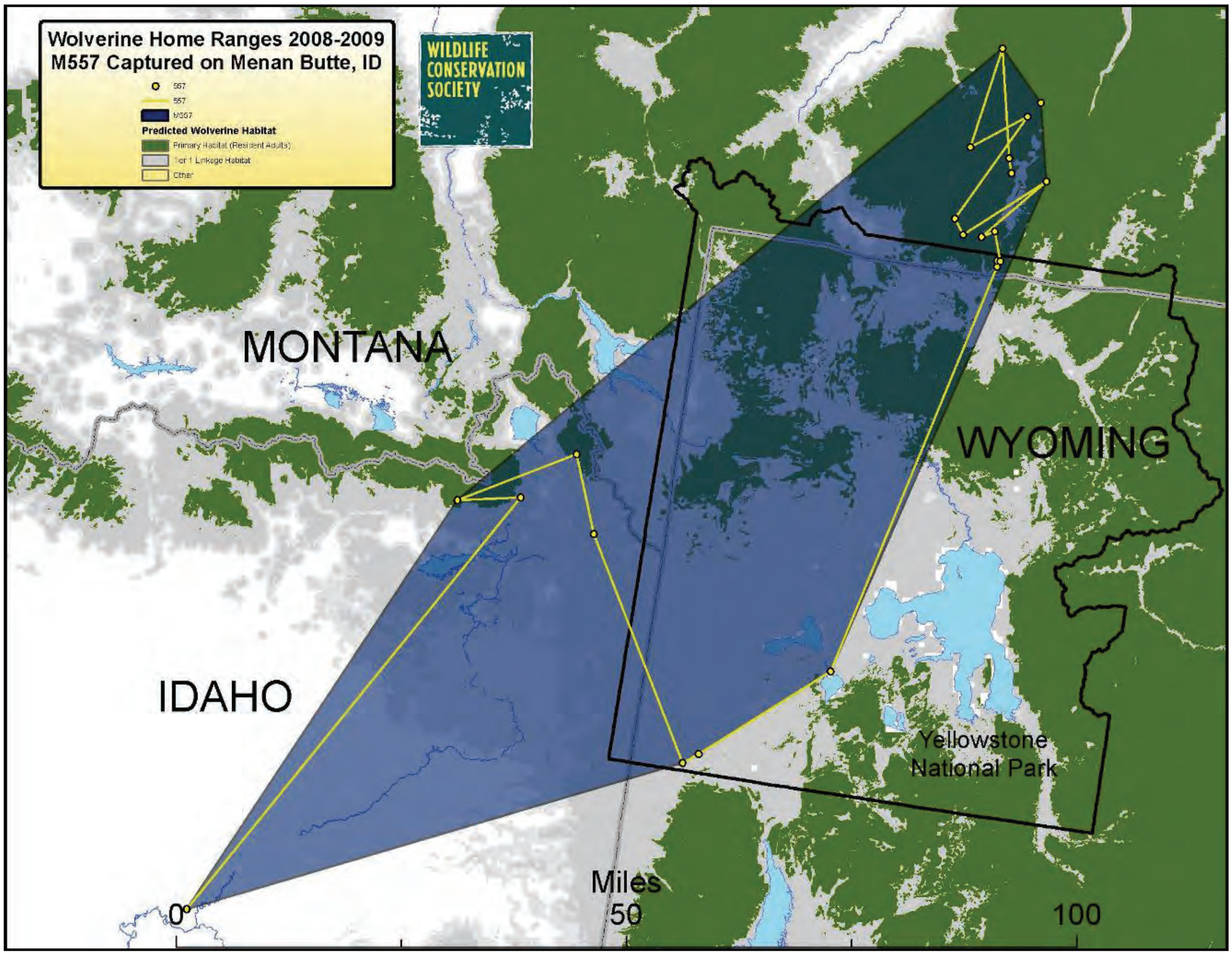
Menan Buttes Capture and Subsequent Dispersal

On January 22, 2009 a bobcat trapper caught a wolverine on Menan Buttes west of Rigby, ID and contacted Idaho Fish and Game regarding how to handle or release the animal. IDFG employees, including Bryan Aber, met the trapper at Menan Buttes later that day and sedated the animal. The wolverine had been caught in a #3 coil-spring trap. Its foot and body condition were evaluated and the wolverine was determined to be in good condition. The wolverine was transported in a large (cougar/wolf) aluminum transport box to the Driggs Vet Clinic where he was held overnight and a full examination was planned for the next morning. On January 23, the wolverine (M57) was examined and a foot x-ray showed the only damage to be one dislocated joint in the center toe. Overall, M57 appeared to be in good condition and was fit with an implant and GPS collar. M57 was transported to the Willow Creek area in the Centennial Mountains and released.





Relocations during early and mid-February indicated M57 was still in the southeastern Centennials. At the end of February, M57 moved east to Two Top Mountain and by mid-March had started moving south towards Big Springs, which means he likely traveled through the Upper Henry's Fork Conservation Challenge area. M57 continued south to the SW corner of YNP before circling back north. He crossed YNP south to north over a period of less than three weeks and settled into the area NE of Jardine, MT for the summer (62 miles straight line distance from the release point, but the actual distance moved was at least double that, a minimum of 130 miles). It is notable that a female wolverine is being monitored in the same area. Currently, WCS along with Jason Wilmot of the Northern Rockies Conservation Cooperative and Dan Tyers of the Gallatin National Forest are cooperating in monitoring these wolverines.



F544's dispersal from the Beaverhead Mountains

We also documented dispersal within the CLE. F544, the sibling of M545 (see mortality below), was captured in the North Beaverhead Range in May 2008 (Fig. 3 above). She was found consistently in the northern Beaverheads until November 2008, but was often missing during Beaverhead telemetry flights at the end of December and January. However, poor winter weather prevented us from making extensive searches when she was missing. Her first documented exploratory movement was to the southern Anaconda Range. Based on a southbound track crossing MT Hwy 43 and telemetry locations showing her return to the North Beaverhead, she appears to have crossed back into the Beaverheads on about 1/18/09. The last telemetry location in the Beaverhead range was 1/21/09. A month later she was found in the Flint Creek Range, Montana and was located there until June 2009. Her implanted radio-transmitter had malfunctioned and was transmitting at twice the normal rate, which uses twice the battery power. We have not been able to locate her since June; this could be due to implant battery failure, but we will continue to scan for her during telemetry flights.

Demographics

Reproduction

None of the six adult females we monitored during spring 2009 showed evidence of successful reproduction. From February 1 through April 8, the number of VHF locations ranged from 16 – 19 for 5 adult females and 10 VHF plus 65 GPS locations for one adult female. This included periods of intensive locations when two locations per day allowed a better understanding of their movements. One female (F121) raised some suspicion during the VHF telemetry relocations because she appeared to be restricting movement during early spring to a smaller than expected area of her normal home range. F121 was investigated further during late spring and summer to determine if she had cubs. Three sites that she used on more than one occasion during the VHF telemetry flights were investigated and five instances of snow tracking, remote camera photographs, and on the ground visuals failed to reveal any indication that F121 had cubs (Photo 18).

So far we have radio-monitored almost 40 adult female (>3yrs) reproductive-years. Total reproductive rate is 0.24 cubs per female per year, or approximately 1 cub every 4 years per adult female. Average litter size is 1.4 (n=10 litters) and the sex ratio of litters so far is 3F:1M (n=5 litters).

Photo 18. F121 leaving a rock hole alone. Observations suggest that she slept here overnight and did not return to this spot during the next 24 hours. Considering our observations of F121 with cubs in the past, this type of behavior was additional evidence leading us to believe she did not rear cubs during 2009.

Mortality

One mortality was documented during calendar years 2008 and 2009. M545 was the male cub implanted in the North Beaverhead Range during May 2008. On October 6, 2008 the telemetry flight indicated mortality. His body was retrieved in Rock Creek, Beaverhead Range on October 7, 2008 (Photo 19). The carcass was necropsied at the Montana Fish, Wildlife & Parks lab in Bozeman. M545 had several puncture wounds, fractured ribs, and his back was broken in two places. He had been bitten and muscle bruising around the bite marks indicated that at least some bites happened before death. Thus, the cause of death was due to another animal, species unknown.

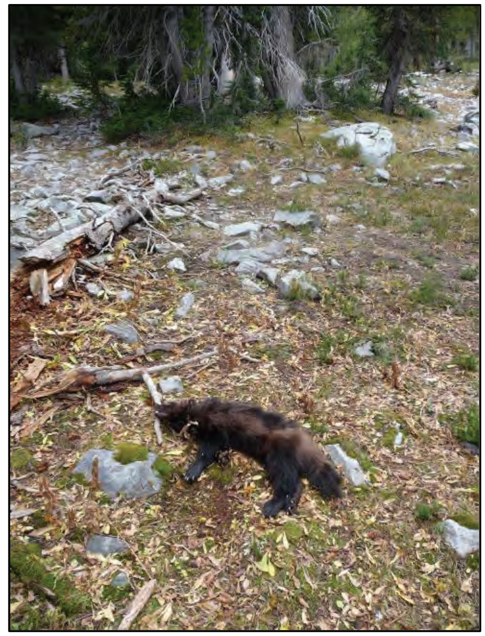


Photo 19. The mortality site of M545 in the Beaverhead Range, MT.

M56 in the Granite Mountains of central Wyoming. Location is in the far left portion of the upper photo.

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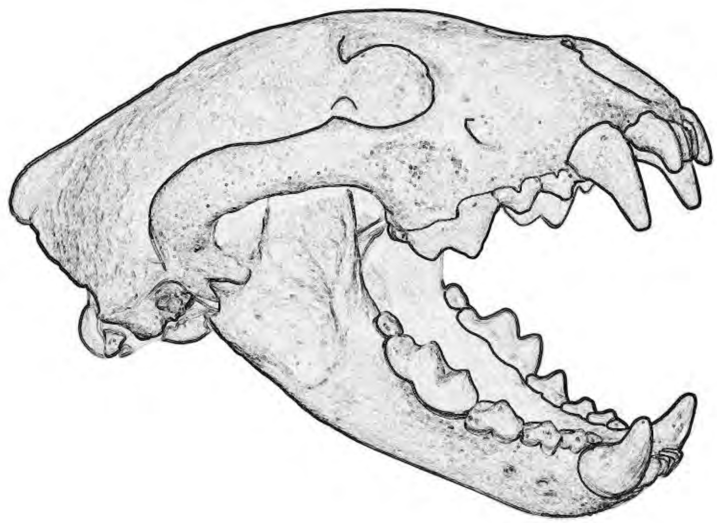

WOLVERINE (*Gulo gulo*)

Greater Yellowstone Wolverine Program

M56's tracks near Freighter Gap, Wyoming on his way to Colorado