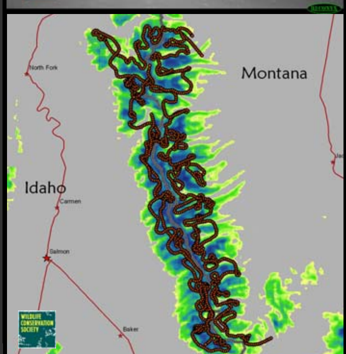
Greater Yellowstone Wolverine Program

Practical, Science-based Solutions for Wolverine Conservation

Progress Report – November 2008



Female Wolverine Missing Foot Reproduces Near Atlanta, Idaho.

Wolverine Program Shifts Emphasis into Central Linkage Ecosystem

Remote Camera Provides First Look at Den-related Behavior

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Spring 2008 Fixed-wing Den Surveys Yield Promising Results for Distribution & Monitoring Technique, Dispersal Data

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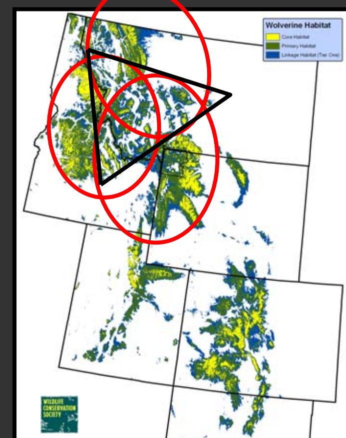
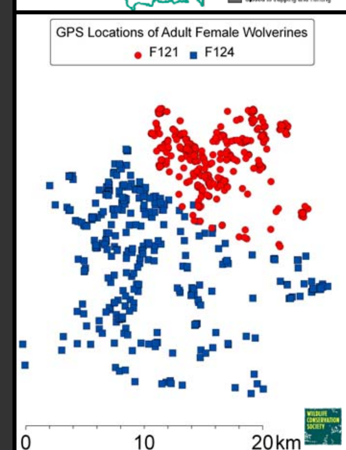
Successful Den Captures In the Central Linkage Ecosystem





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Wildlife Conservation Society • North America Program

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November 2008

Hello All,

We have been quiet for a while, but busy. Since the 2007 Wolverine Workshop, we have been focused on implementing conservation actions made possible by the first phase of the program and developing a second phase of work. The Ph.D. program that Bob is undertaking in Sweden has allowed us to incorporate a great deal of knowledge from the 15 years of wolverine research experience accumulated by the Swedish Wolverine Project. Between these interactions, the ideas generated by the biologists who attended the wolverine workshop, and the pilot studies we conducted this past spring, we are ready to move forward. The section on the Central Linkage Ecosystem explains where we will focus our efforts, and the Spring Den Surveys section explains how.

Our target all along has been providing managers with information and techniques that can advance wolverine conservation. We need your input to make the work that we do as useful as possible. Please read the section on Spring 2008 Den Surveys. We have some great opportunities at hand this winter. If you are interested in helping determine the current distribution of reproductive females and developing a wolverine monitoring technique, please contact us. We have experienced personnel that can be dedicated to den surveys during March, April, and May 2009.

We have put the info for this program update together in what we hope will be a ‘user-friendly’ format. Please, print it out and put it in the break-room. It is formatted for double-sided color printing.

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:
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Greater Yellowstone Wolverine Program

Quick Data Summary

Number of Wolverines Radio-marked	32
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Natal Dens	5
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2008 ACKNOWLEDGEMENTS

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In addition, we thank the numerous individuals who assisted in permitting, facilitating, and conducting the project. Brent Brock, Ryan Eisfeldt, Dr. Eric Klaphake, and Ivan Segerström have helped with analyses and field work during the year. Peter Segerström and Audrey Magoun have generated ideas, passed along their experiences, and provided support and encouragement. We extend a special thanks to and all of those who attended the June 2007 Greater Yellowstone Wolverine Workshop. Your knowledge and participation generated ideas that have helped guide the work we will attempt to undertake in the future.

Caribou-Targhee National Forest
Beaverhead-Deerlodge National Forest
Bridger-Teton National Forest
Gallatin National Forest

Grand Teton
National Park

Laura Moore
Cunningham
Foundation

Bullitt
Foundation

Canyon Creek
Foundation

Tapeats
Fund

WCS Wolverine Program Summary 2001-2008

The Greater Yellowstone Wolverine Program was initiated in 2001 as a collaborative effort by the Hornocker Wildlife Institute; the Wildlife Conservation Society; Grand Teton National Park; Montana Dept. of Fish, Wildlife and Parks; Idaho Dept. of Fish and Game; Wyoming Dept. of Game and Fish; the Caribou-Targhee National Forest; Gallatin National Forest; Beaverhead-Deerlodge National Forest; and the Bridger-Teton National Forest.

At the inception of this program, only two telemetry-based wolverine research projects had ever been undertaken in the Lower 48 United States, wolverines had been petitioned to be listed as an endangered species, and managers had almost no information upon which to make wolverine-related decisions. In fact, both the historical and present distribution of the species was largely undefined. Furthermore, descriptions of critical habitat features such as reproductive dens were limited to 2 natal and 6 maternal sites. Even food habits were poorly understood, and data on reproductive rate was limited to 9 adult female-years and 4 litters. Rare, elusive, and difficult to observe, the wolverine had remained an enigma into the 21st century.

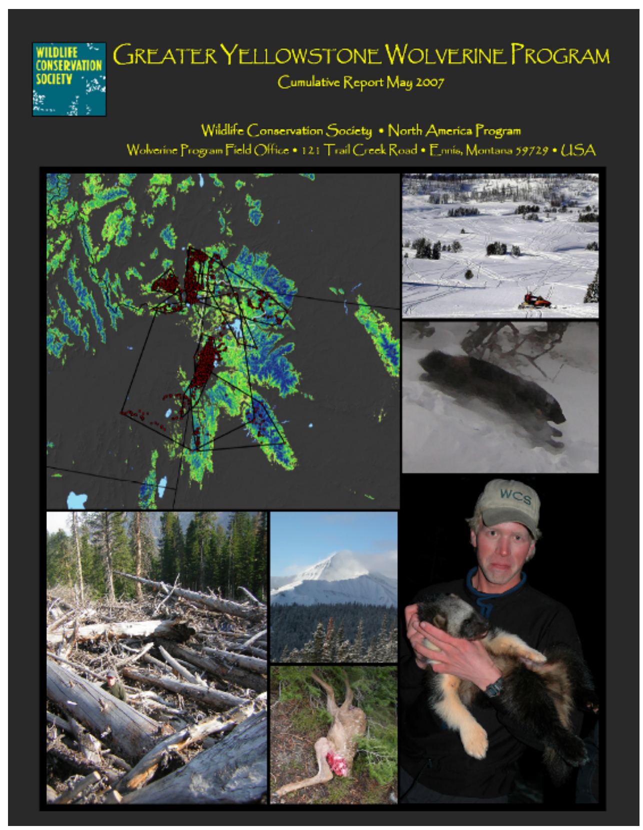
At the same time, concerns over the persistence of this obscure carnivore were raised due to increasing levels of winter recreational use in the backcountry, questions about the sustainability of legal fur-trapping of wolverines, new housing and recreational developments in alpine areas, and expanding human populations in the region.

Our goal was to conduct the first telemetry-based field study of wolverine ecology in the Yellowstone Region in order to provide facts that would allow more informed management of the species.

Learning about an animal that exists at such low densities and reproduces as infrequently as the wolverine requires innovative thinking and a long-term commitment. To date, the eight years of collaborative effort that this program represents have resulted in the capture and monitoring of 32 individual wolverines. And although 32 is not a large number, it is the largest number of wolverines ever monitored by a single research project in the Lower 48. From these wolverines we have made great strides toward understanding the basic ecology of the species here at the southern periphery of its global distribution. Our program was the first to utilize GPS collar technology on a wolverine, we have provided one of two rigorous density estimates from the Lower 48, and we helped establish a cooperative wolverine genetics agreement that has been utilized for several important genetic-related analyses. Overall, we have significantly improved the understanding of wolverine survival rates, causes of mortality, reproduction, denning habitat, activity pattern, density, and dispersal here in the contiguous U.S.

We have also analyzed and presented our data in a manner that has provided managers from Greater Yellowstone and beyond with a foundation for developing conservation strategies for wolverines. The initial scientific manuscripts we produced answered fundamental questions about 1) the geographic scale over which management strategies must be designed in order to be successful (Inman et al. 2007) and 2) where wolverine habitat exists at that scale (Brock et al. 2007). Together, these two manuscripts provide the best empirical evidence for the existence of a wolverine metapopulation here in the Lower 48. They clearly demonstrate that wolverines, more so than any other terrestrial species in the Lower 48, require collaborative, cross-jurisdictional planning over a vast geographic area. And they provide a basis (habitat map) for thinking about how to get it done over that vast area.

These two manuscripts formed the foundation of the first Greater Yellowstone Wolverine Workshop. WCS organized this event and, along with B-Bar Ranch, hosted over 30 biologists representing 7 federal and state management agencies and 2 Universities from Idaho, Montana, Wyoming, and Sweden. Our goal was to present managers with the most current wolverine information and provide a format where they could



Hard copies of our May 2007 Cumulative Scientific Report can be obtained by contacting WCS's Bozeman office at 406-522-9333. Abstracts from the 8 manuscripts contained within are available as a pdf online at www.wcs.org/globalconservation/northamerica/yellowstone/wolverine develop ideas on what a collaborative, landscape-level conservation strategy would look like for wolverines. An important outcome of this workshop was the concept of the 'Central Linkage Ecosystem' (CLE), an area that lies between the three major blocks of public land in the Northern Rocky Mountain States and which is critical to the wolverine metapopulation. Several of the sections within this document provide more detailed information related to the Central Linkage Ecosystem. These sections also point to the practical application of these efforts in making real progress toward wolverine conservation. For instance, these data, the CLE concept, and the workshop were influential in helping Montana refine its wolverine regulations to be consistent with the existence of a wolverine metapopulation that is collaboratively managed across multiple states.

At present, we have published two peer-reviewed scientific papers and prepared 8 additional manuscripts that cover a variety of topics. Much of this forms the basis for the Ph.D. program that Bob Inman is currently undertaking in Sweden under the direction of Dr. Jens Persson and Prof. Henrik Andrén. Manuscripts include:

- Wolverine Space Use in Greater Yellowstone: Life History Strategy, Scale, and Conservation.
- Habitat of the Wolverine Metapopulation in the Rocky Mountain States.
- Wolverine Reproductive Rates and Maternal Habitat in Greater Yellowstone.
- Wolverine Mortality in Greater Yellowstone: Causes, Rates, and Potential Biases.
- Does Winter Recreation Influence Wolverines?
- Wolverine Linkage Zones: Moving Toward a Socially Acceptable Network of Protected Areas.
- Wolverine Reproductive Chronology.
- Wolverine Road Crossings in Western Greater Yellowstone.
- Diel Winter Activity of Wolverines in Greater Yellowstone.
- Wolverine Food Habits in Greater Yellowstone.

Our program has also provided data used in several collaborative publications and manuscripts lead by other researchers. These include wolverine locations used by Aubrey et al. (2007) to help delineate current wolverine distribution, genetic samples used by Schwartz et al. (2007) to aid in determining the historical geographic isolation of California wolverines, and wolverine den and telemetry locations used by Copeland et al. (in prep) to test the correlation of wolverine den sites with a model of spring snow cover. Our wolverine data are also being utilized as part of an attempt to assess the impacts of climate change on wolverines (Gonzalez et al. in prep), and the genetic samples have also been used by Schwartz et al. (in prep) as part of an analysis that attempts to determine if the spring snow cover layer is predictive of wolverine gene-flow.

We have also collaborated with Yellowstone National Park and the Absaroka-Beartooth Wolverine Project in an attempt to develop a wolverine survey technique. We provided a radio-marked sample of wolverines, knowledge of their home ranges, a habitat model, personnel, and some flight time to help determine a track detection rate. We hope that the information from this effort along with methods testing alternative detection strategies that we undertook this past spring (den surveys section) can eventually lead to an efficient and reliable wolverine monitoring technique.

In addition to these management oriented applications, we have also given dozens of presentations about wolverine ecology and conservation to a wide variety of audiences. These include everyone from 4th grade classes to the biologists of the United Sates Fish & Wildlife Service charged with determining whether wolverines should be listed as Threatened or Endangered; snowmobile user groups, national recreation planners, and wilderness advocates; several US Forest Service offices, Montana, Idaho, and Wyoming's Wildlife Agencies, and Grand Teton National Park; The Colorado Division of Wildlife, BLM personnel, and Land Trust Organizations focused on conservation easements; University Ecology Departments, Fly-fishing festivals, and the National Museum of Wildlife Art. In each of these cases, we have attempted to generate interest in wolverines, share knowledge of the species, and discuss conservation issues in a clear, fact-based, and unbiased manner. We have also made efforts to promote an understanding of all wolverine constituencies' perspectives and the critical need for collaborative solutions focused on the most important management issues.

Our program's 70 wolverine-years of survival data, 30 adult-female-years of reproductive data, and 5 natal dens represent about half of what has been documented within the Lower 48. Again, relative to many species, this is a meager amount of information. Developing these type of datasets is only possible with the support of organizations willing to invest in fundamentals that can pay-off over a long-term conservation horizon. We have made great strides, and will continue to work to improve our basic knowledge of wolverines. But, as described herein, we will move forward with new focus and more powerful techniques that can get answers to the most challenging management questions.

Thank you for your help and support.

Greater Yellowstone Wolverine Program

2008

UPDATE & PROGRESS REPORT

We have attempted to put this document together in a more readable style than the typical scientific report. It does not contain answers to questions based on hypothesis tests. We are working on publications and will disseminate them upon completion. Instead, this document contains interesting bits of information that relate to wolverine biology and conservation, descriptions of new techniques we have used in the field, and info on recent conservation actions.

Because we have been transitioning to a new phase of our program, the report provides a description of where and how we plan to work in the future. We need your input to make the work that we do as useful as possible. Please read the section on Spring 2008 Den Surveys. We are optimistic about its utility and have some great opportunities coming up.

This document is formatted for double-sided color printing. Please, print it out and put it in a place where you and others can browse through it. We hope that it can provide some interesting discussion material.

WILDLIFE CONSERVATION SOCIETY

Female Wolverine Missing Foot Reproduces Near Atlanta, Idaho.

Remote camera photo of Wolverine F546 bringing a cub to the den, April 12, 2008

F546 is the female wolverine who was incidentally caught in a foot-hold trap at the southern end of the Lost River Range near Howe, Idaho in Feb 2006. Wolverines are protected in Idaho, so the recreational trappers notified Idaho Dept. of Fish & Game (IDFG). The wolverine was immobilized and taken to the Driggs Veterinary Clinic because she had incurred a significant injury to her left front foot. Attending to the injuries required removal of all toes and approximately half of her "palm" on the foot. There was debate as to whether she should be placed in captivity due to the injury or be released back into the wild. WCS scientists supported the decision to release the wolverine and supplied an implant transmitter so that survival implications for this type of injury could be assessed. She was fit with an implant and released back into the Lost River Range.

F546's transmitter was heard on active mode several times post-release, and she was eventually located repeatedly near the Sawtooth Wilderness, approximately 100 miles from the trap/release site. Almost two years after her release, March of '08, we heard her telemetry signal several times at the same location. The habitat in the area was similar to that of the other wolverine den sites documented during the study. As with other potential dens, we made a very brief visit to take a GPS point at the potential den. This is done so that habitat characteristics of the site can be documented if evidence of wolverine cubs is obtained (i.e., determined a reproductive site rather than just feeding).

In the case of this potential den site, we decided to use a novel technique for determining if the wolverine had in fact reproduced. We placed a remote camera near the den with the aim of documenting if and how many cubs might be present. The camera functioned well and the photographs confirmed reproduction and use of the site as a den. It appears that the litter consisted of 1 cub. This information was significant, but the camera yielded much more. We obtained an interesting series of photos regarding wolverine sociality and behavior at den sites (see section below).

Because her radio-transmitter is soon due to fail (battery-life) and maintaining a sample of adult

F546's tracks. Photo – R Spence

Boulder at F546's den. Note backpack for scale. Photo – M Packila females for demographic data is important, we made an attempt to capture F546 during May. We also wanted to capture the cub so that it could be monitored for dispersal. Budgetary considerations and the distance from our usual study area limited us to one helicopter-based attempt. We staged in Boise Idaho and when the weather finally broke, flew to the area and located F546. No cubs were travelling with her. As we exited the helicopter and attempted to follow F546's tracks back to a rendezvous site where the cub would be stashed, the clouds began obscuring visibility of the surrounding mountains. Safety required us to depart the area. We did not detect any evidence of the cub, but were not able to conduct a full search on the ground or make a second attempt.

Although unfortunate, this series of events provided some valuable information. Incidental captures of wolverines in traps set for other species does occur. The case of F546 suggests that even in the situation where there is a serious injury it is worthwhile to return an animal to the wild where it can live naturally and contribute to the population rather than the alternative of placing it in captivity for the remainder of its life or euthanasia. In addition, an effort to provide information to trappers on how to recognize wolverine field sign and avoid incidental capture would be valuable. Also of note, cameras placed at den sites could be an important part of developing a wolverine distribution and monitoring technique (see Spring Den Surveys section beginning on Page 12).

WCS Shifts Emphasis of Wolverine Program into Central Linkage Ecosystem

As a result of discussions we had at the Greater Yellowstone Wolverine Workshop during June 2007, we have adapted our program as we enter a second phase of the work. Why? Because persistence of the wolverine metapopulation in the U.S. Rocky Mountains depends on informed efforts to retain open space that provides connectivity in the "Central Linkage Ecosystem." An explanation follows.

Wolverines of the Rocky Mountain States exist as a metapopulation whose persistence depends on successful dispersal. Here at the southern periphery of the species global distribution, resident adult wolverines utilize high-elevation, alpine habitats that exist in island-like fashion (Fig. 1). The patchy nature of these suitable or "primary" habitats along with the huge territory requirements of adults often result in small local populations.[1] For example, the Madison, Gravelly, Henrys Lake, and Snowcrest Ranges of southwestern Montana appear to contain 3 adult male and 6 adult female territories (inset in Fig. 1). Together these local populations, or "demes" make up a metapopulation whose viability depends upon successful dispersal among the mountain ranges of Montana, Idaho and Wyoming. The need for successful dispersal is made even more critical by the fact that wolverines do not typically reproduce for the first time until ≥3 years of age, they reproduce infrequently thereafter (1 cub/2–3 yrs), and longevity appears to be less than 15 years.[2]

[1]Annual home range size averaged 400 km^2 for adult F wolverines and 1,200 km^2 for adult M; Wolverine density was estimated to be 1 wolverine/212 km^2 of primary habitat in the Madison, Gravelly, and Centennial Ranges of southwestern Montana (Inman et al. 2007*a*).
[2] Estimates of reproductive parameters and longevity from Persson et al. (2006), and Inman et al. (2007*b*).

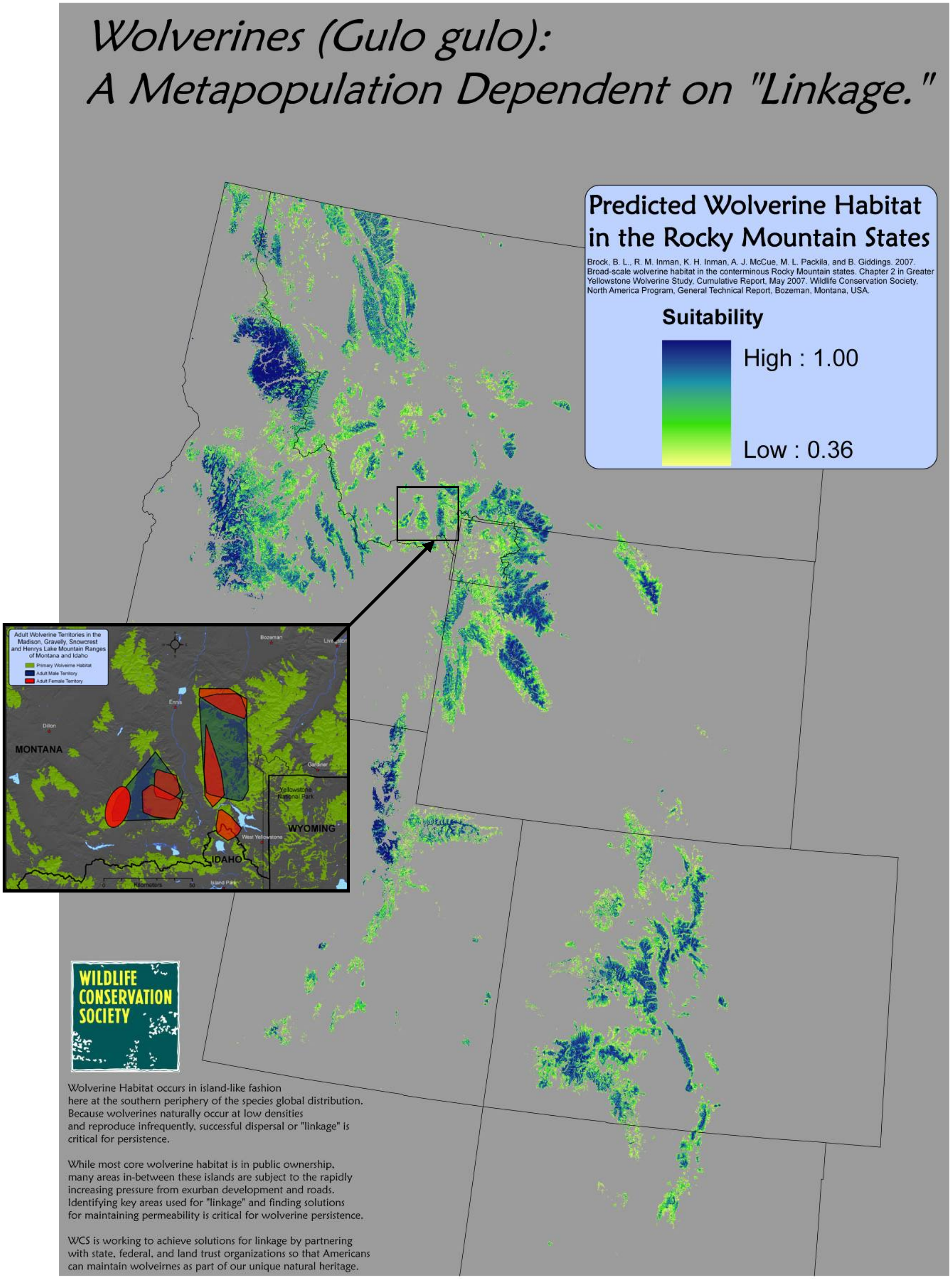


Figure 1. Areas suitable for use by resident adult wolverines in the Rocky Mountain States (Brock et al. 2007). Inset contains home ranges of males (blue) and females (red) in the Madison, Gravelly, and Snowcrest Ranges.

Facilitating dispersal among the demes of the tri-state area requires an understanding of the metapopulation function of the various habitat patches. During June 2007, we convened a group of 30 biologists from Montana, Idaho, Wyoming, and Sweden at the Greater Yellowstone Wolverine Workshop. After presentations and discussion of the currently available science regarding wolverines, we attempted to define management units suitable for landscape-level, metapopulation management. Participants suggested that the traditional use of a Greater Yellowstone Ecosystem, a Northern Continental Divide Ecosystem, and a Salmon-Selway Ecosystem, as was done with grizzly bears, is inappropriate for wolverines (Fig. 2A). Rather, the biology of wolverines provides an obvious example of why the traditional perception of the "boundaries" of these separate ecosystems should be expanded such that they overlap. When this is done, the resulting overlap forms a "Central Linkage Ecosystem" (Fig. 2B), which the participants suggested receives relatively little conservation attention although it appears critical for wolverine persistence (more on why it is critical below).

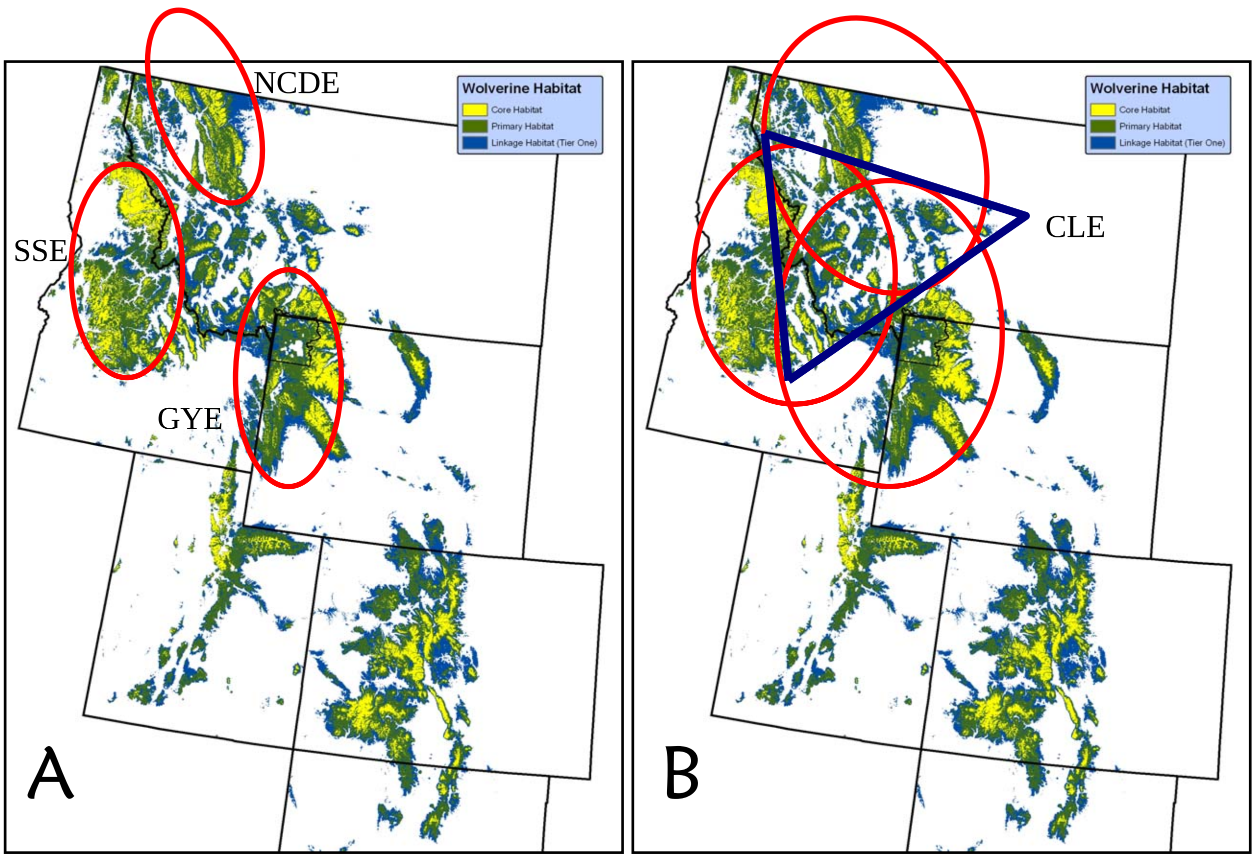


Figure 2. A) Red ovals indicate areas traditionally referred to as the Greater Yellowstone, Northern Continental Divide, and Salmon-Selway Ecosystems. When the "boundaries" of these 3 ecosystems are expanded, as in B), they overlap in an area that we began referring to as the "Central Linkage Ecosystem" or CLE, which is generally represented here by the blue triangle.

Since the workshop, we have put additional effort into defining wolverine demes (local populations) and the area that would compose the Central Linkage Ecosystem (CLE). We did this by identifying all primary wolverine habitat patches >100 km^2 in size in Montana, Idaho, and Wyoming.[3] We then aggregated these 72 patches into "major demes" based on the degree to which they appear to be linked by smaller patches of primary habitat (<100 km^2) and Tier 1 linkage habitat. We also considered the presence of major roads and geographic features. This resulted in 14 major demes in the Northern Rocky Mountain States (Fig. 3).

[3] The minimum adult female home range size in the conterminous U.S. is approximately 100 km^2 (Hornocker and Hash 1981, Copeland 1996, Squires et al. 2006, Copeland and Yates 2006, Inman et al. 2007*a*).

Only 4 of these major demes appear to have the potential for their individual wolverine "population" to consist of >50 animals; these are the Yellowstone, Salmon, Bitterroot, and Northern Continental Divide.[4] These 4 areas likely function as cores, or "Regional Population Centers." The vast majority of wolverine habitat within each of these 4 ecosystems is in public ownership (Brock et al. 2007). However, in order for wolverines to disperse successfully among these Regional Population Centers, the areas in-between must function appropriately. It is these areas in-between that compose the Central Linkage Ecosystem (Anaconda, Gravelly, Elkhorn, Lemhi, Belt and Mission demes, Fig. 3).

Management strategies for and conservation efforts in the Central Linkage Ecosystem are paramount to successful wolverine dispersal and metapopulation persistence. The Central Linkage Ecosystem contains a significant amount of primary wolverine habitat that is in public ownership, and it does support reproductive females. These areas are critically important because successful reproduction *within* the Central Linkage Ecosystem is the most likely means of achieving successful dispersal among the Regional Population Centers. While the regional population centers are large blocks of publicly owned wolverine habitat, the Central Linkage Ecosystem consists of smaller habitat patches that are often separated by privately owned valley bottoms. Because the CLE consists of a matrix of publicly/privately owned lands and numerous roads it is particularly susceptible to the rapidly increasing pressures from exurban development and traffic volumes (Gude et al. 2007). These factors likely result in higher mortality risk and reduced permeability for dispersing wolverines. Maintaining an appropriately functioning Central Linkage Ecosystem requires successful management strategies for 1) areas of primary habitat that are capable of supporting reproductive females, and 2) areas that serve as functional linkage zones between primary habitats.

In summary, proactive, science-based conservation efforts in the Central Linkage Ecosystem are critical to the wolverine metapopulation because of the area's geography related to dispersal and the nature of it's land ownership. Collaborative solutions for retaining open space in areas where increasing levels of development could inhibit wolverine dispersal will be key. For these reasons, we have moved into a new phase of work where we will focus our research efforts in the Central Linkage Ecosystem (Anaconda, Gravelly, Elkhorn, Lemhi, Belt, and western Yellowstone demes; Fig. 3). We have worked with Montana Fish, Wildlife & Parks and Idaho Fish and Game to obtain permits for wolverine capture in these new areas. Additional coordination efforts are ongoing.

WCS Wolverine Program Phase II Goals

I. SECURE CONNECTIVITY
- Predict wolverine linkage zones and develop methods for ranking their relative significance.
- Test predicted linkages with GPS data from dispersing wolverines.
- Work with local communities, land trust organizations, and local, state and federal governments to find solutions for maintaining open space that provides connectivity.
- Inform Transportation Departments of areas where wolverines are most likely to cross roads.

II. INFORM WOLVERINE METAPOPULATION MANAGEMENT
- Develop technique to survey predicted habitat for wolverine presence, occupancy by reproductive female wolverines, and genetic samples.
- Obtain Central Linkage Ecosystem specific data on population size, reproductive rates, survival rates, and genetics.
- Continue to compile critical data on denning habitat and the effects of winter recreation.

III. DEVELOP MONITORING TECHNIQUE
- Test the effectiveness of monitoring the wolverine population with an index of documented reproductions (possibly during established ungulate population surveys conducted by state wildlife agencies) and/or genetic samples obtained during den-surveys.

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[4] Based on total area of primary wolverine habitat within each major deme and a density estimate of 1 wolverine/212 km^2 of primary wolverine habitat from the Madison, Gravelly, and Centennial Ranges of Montana and Idaho (Brock et al. 2007, Inman et al. 2007*a*).

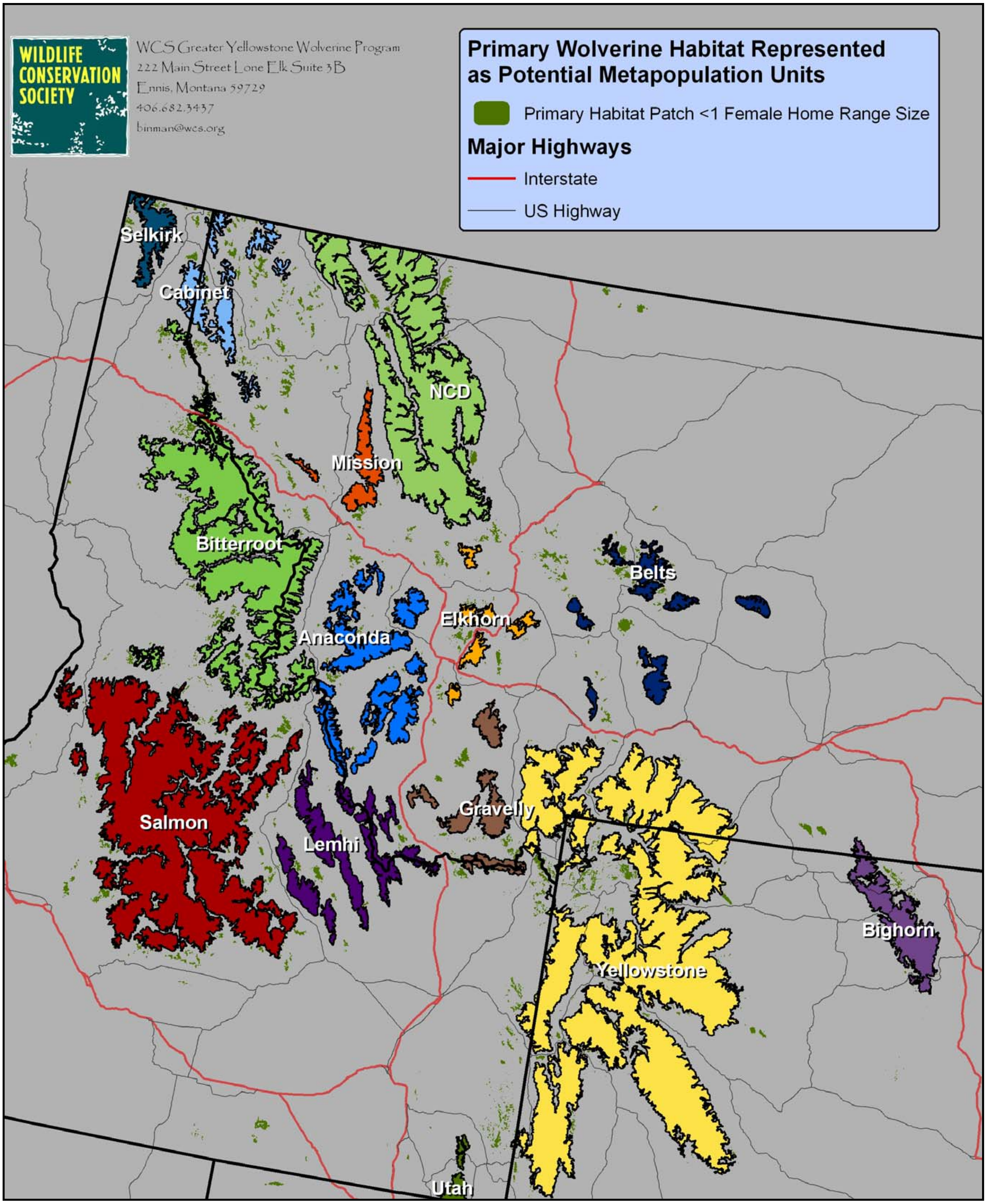


Figure 3. Colored areas, each of which is labeled, represent potential wolverine metapopulation demes/units of the Northern Rocky Mountain States. These units are based on the presence of primary wolverine habitat patches large enough to support at least one adult female (>100km^2), the degree of apparent connectivity via smaller patches of primary habitat and tier one linkage habitat, geographic features, and major roads.

Bryan Aber Takes Collaborative Bear, Wolf, Wolverine Position

Bryan was recently hired into a unique position where he will "cross jurisdictional boundaries." The duties of the position are designed to consolidate several independent, but closely-related tasks for the Idaho Dept. of Fish & Game, the Caribou-Targhee National Forest, and the Wildlife Conservation Society. For instance, as grizzly bears have expanded from Yellowstone back into the Island Park, Idaho area, the need for appropriate food-storage will be critical for bear presence and human tolerance. Achieving this will depend on coordinated actions – food storage at public campgrounds administered by the Forest Service, responses to bear conflict situations by IDFG, and development of a bear-proof system of dumpsters for Fremont County (a WCS interest).

For the wolverine program, Bryan's role will be coordinating our field activities. As we expand efforts into the Central Linkage Ecosystem and begin utilizing the den survey and capture methodologies that have proven effective in Scandinavia, Bryan will coordinate permits, arrange field logistics, and participate in capture efforts. We are fortunate to have Bryan as a part of our team because he has a wealth of knowledge and expertise from his 27 years of experience with the US Forest Service around Island Park. This includes directly participating in wolverine den survey efforts (Heinemeyer et al. 2001). Bryan also brings an extensive knowledge of the details of Yellowstone conservation history – development of the grizzly bear plan across Greater Yellowstone's National Forests, the Lynx planning process, the roles of various agency and private organizations, what has worked well and what has not. Bryan knows the area and it's people well. He has spent an exceptional amount of time in the field and knows pretty much every drainage, how to get there best, and which animals use it for what reason. We will benefit from Bryan's direct participation in the wolverine program and are confident that he can help achieve more effective conservation in this unique position.


Bryan Aber constructing a trap used to capture wolverines for the research program.

Remote Camera Provides First Look at Wolverine Behavior at Den Sites

Between 1993–2001, Swedish researchers radio-monitored 80 juvenile wolverines and found intra-specific aggression (being killed by other wolverines) to be the most important cause of juvenile mortality (Persson et al. 2003). The young wolverines were killed during two periods. The first was during May–June when the juveniles were still altricial (dependent on the parents). This type of intra-specific aggression is referred to as "infanticide." There are several means by which evolutionary theory suggests infanticide could be adaptive. Young males that have dispersed into a new area can be more successful in passing on their genes if they kill the young of an unrelated male and are then able to reproduce with the resident female more quickly (because the female wolverine will not incur the costs of raising the unrelated litter and would be more likely to produce and raise related offspring the following spring). Neighboring female wolverines might also increase success of their offspring through infanticide (by reducing competition for food resources and territories between their own and other offspring). There is a considerable literature regarding this phenomenon in other carnivores.

In the case of wolverines, the common assumption has been that "parents" consists of the female. The male, as with bears, has been assumed to be uninvolved. But could the male improve his likelihood of passing on more of his genes (improve his fitness) by helping to defend the young? If so, he would likely be present at the den site. During our study, we have made a few anecdotal observations suggesting that males may be near dens at times (a few telemetry points in relative proximity to a known den, large tracks alongside smaller tracks, etc…). This winter we obtained the first series of photographs ever made (to our knowledge) at the den site of a reproductive wolverine. Several of the photos, in sequence, are on the following page. The photos are also viewable on our website as a video. Click here for a link - www.wcs.org/globalconservation/northamerica/yellowstone/wolverine

A close look reveals that there are multiple wolverines visiting the site. The female and her offspring are present, but there is also a larger individual with a more distinct lateral stripe. This individual appears to visit the den on 3 occasions, and each time it "squats" and scent-marks the entrance to the den. In one case, this wolverine visits the site and scent marks it just 19 minutes after the female has departed. But we never see it enter the den. So, do male wolverines play a role in parental care? Quite possibly. What are the conservation implications if males defend offspring from immigrants? How does this relate to human-caused mortality of wolverines? Gene flow? Could the cubs be moved among a series of den sites (maternal dens) fairly frequently as a means of deterring infanticide by immigrating males or neighboring adult females? If so, how might this relate to the few observations of disturbance by humans at den sites? How complete is our knowledge of what happens at a wolverine den as far as assessing if and how winter recreation is managed?

As usual, new information raises as many questions as it answers. We are considering carefully placed and appropriately designed cameras along with GPS collar data to follow-up on this interesting observation. Please contact us if you have any questions or ideas related to this or resources to dedicate to this type of effort.

An interesting series of photographs made at a wolverine den provide a first look at behavior associated with the den. In this photo, the presumed father scent-marks the entrance to the den site.

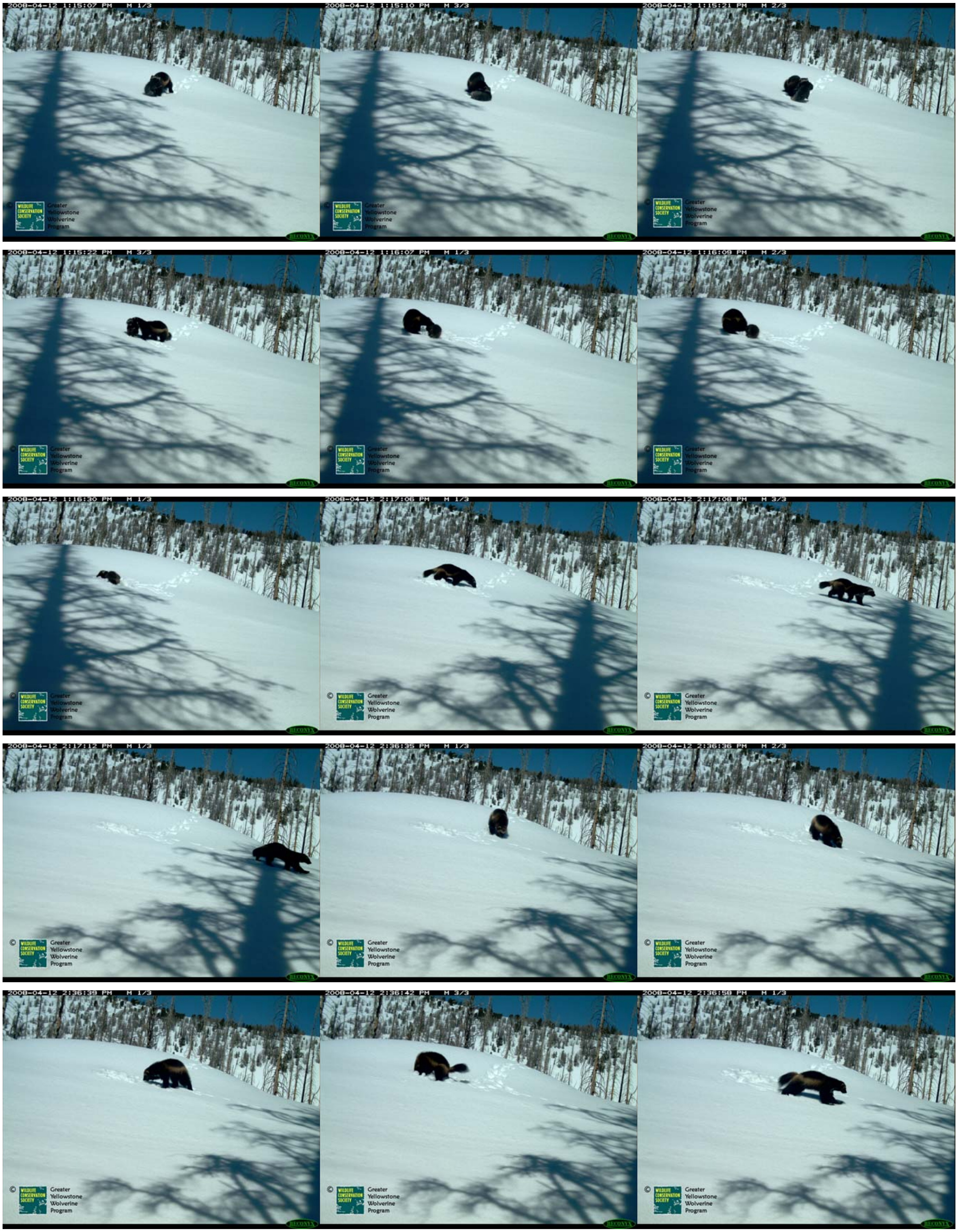


Photo series from April 12, 2008 where wolverine F546 brings a cub into a den-site (1-6) and exits soon thereafter (7-10). Another wolverine, presumably the father, then approaches the den entrance, scent-marks it, and departs (11-15). Photos put together as a video viewable at www.wcs/globalconservation/northamerica/yellowstone/wolverine

Montana Steps Forward with Metapopulation Management Strategy

This spring, the Greater Yellowstone Wolverine Program was invited to speak with managers of the Montana Dept. of Fish, Wildlife and Parks in Helena. We shared the information obtained during 7 years of field research. The biologists were interested to obtain new wolverine information and use it to inform their discussions about management.

After contemplation and further discussion, Montana has adapted its wolverine regulations for the 2008 season. Changes include both where wolverines can be taken and how many. The new regulations are more conservative and are based on managing wolverines as a metapopulation that exists over a large geographic extent.

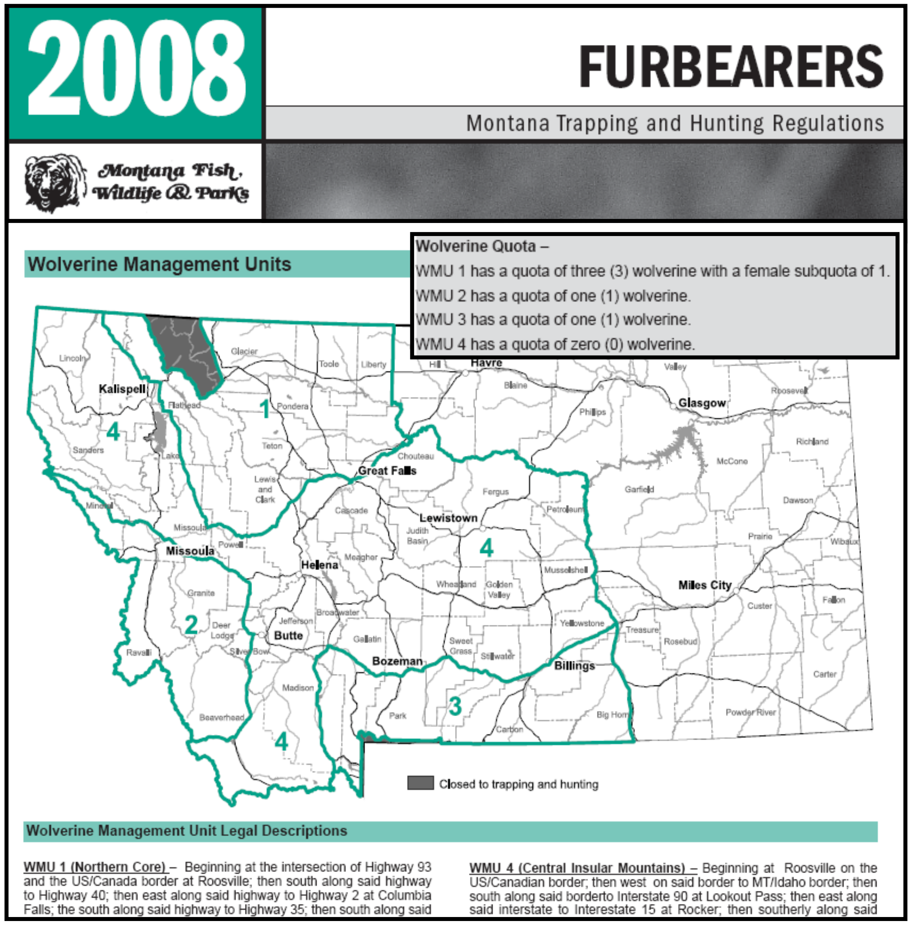


Figure 4. New wolverine management units and quotas for 2008 as they appear in the Montana Dept. of Fish, Wildlife & Parks 2008 furbearer regulations. Available online at http://fwp.mt.gov/hunting/trapping/default.html WMU 4, the central insular mountains, is protected and recognizes the importance of landscape-level connectivity.

The new management strategy is founded on improving dispersal and gene-flow among the 3 largest publicly-owned blocks of land in the northern Rocky Mountain States (Northern Continental Divide, Salmon-Selway, and Yellowstone Ecosystems). These 3 areas are recognized as Wolverine Management Units 1, 2, and 3, respectively (Fig. 4). In order to achieve dispersal and gene-flow among these core areas, wolverines are protected in WMU 4, the Central Insular Mountains. This area composes a large portion of the state and is positioned in-between the 3 large ecosystems (Fig. 4). In addition to the new spatial arrangement, the total quota was lowered and provisions for a female sub-quota were established. WMU 1, which appears to contain the highest quality habitat in the state, has a total quota of three wolverines with a female sub-quota of one. In WMU's 2 and 3, the quota is one wolverine in each. WMU 4 is closed. Overall, this means the statewide quota is 3–5 wolverines and important 'linkage' areas such as the Centennial Range, Bridgers, and Belts are closed to wolverine trapping.

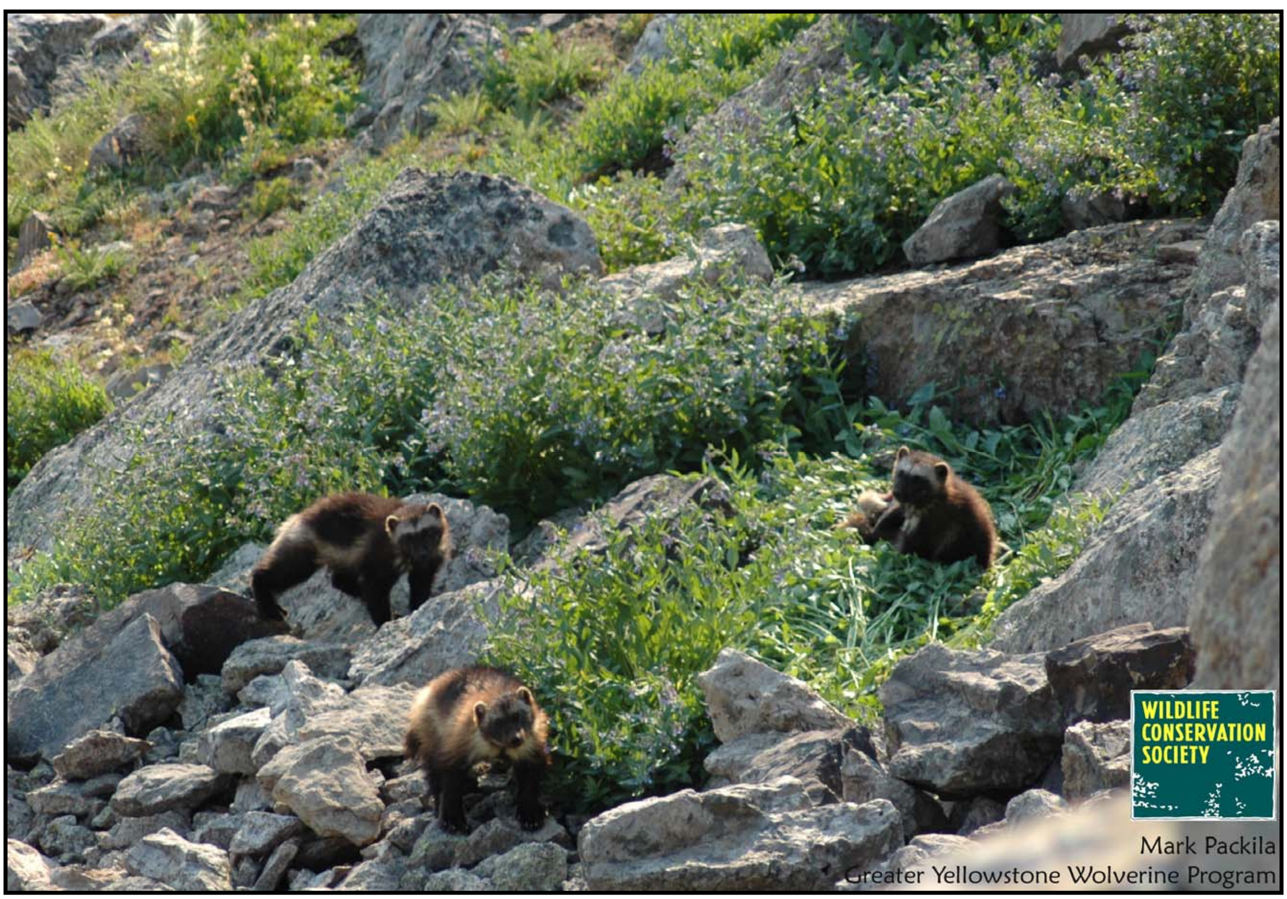
What is the biology behind this? In a nutshell, these central insular mountains are smaller ranges that hold relatively few wolverines. But they do hold reproductive females. And because of their geographic position, reproduction and subsequent dispersal from within these areas may be the most likely way of exchanging wolverine genes among the 3 big ecosystems. Protection in these central insular mountains could result in higher adult female survival, which is influential in population growth rate (Persson et al. 2006). Protection in WMU 4 could also result in higher survival of young dispersing wolverines as they move through these mountain ranges. In essence, protection in WMU 4 maximizes the chance that these areas are source areas rather than sinks.

Montana's recognition of specific areas (the central insular mountains) as crucial for wolverines provides a precedent for shaping other landscape-level management thinking, for example winter recreation. This is important because managing mortality is only one part of the picture. If the central insular mountains are going to function as source areas, adult females must survive AND their ability to reproduce can not be compromised. So, if reproductive rates are affected by winter recreation, then, like harvest, managing these activities more cautiously in the Central Linkage Ecosystem could take on increased significance. Successful management over such a vast landscape and across so many jurisdictions requires a commitment on the part of individual jurisdictions to achieve common goals. Montana has taken an important step toward managing wolverines as a collaborative, multi-state metapopulation.

The wolverine is beginning to be recognized as an "umbrella species" with regard to landscape-level connectivity. This is because the biology of the species, the configuration of its habitat, and the scale over which a viable population exists absolutely requires successful dispersal among publicly-owned lands at a multi-state extent. Thus, Montana's new wolverine regulations can also be viewed as a concept applicable to management of other low-density species that would benefit from connectivity (e.g., mountain lions, grizzly bears, wolves [USFWS 2008a], and lynx).

At the end of the 2007 Wolverine Workshop, Montana committed to re-thinking their management based on landscape-level connectivity of the metapopulation. They have, over the ensuing year, worked to share the newly available information within the department and come to a consensus on how to act upon it. Given the legal challenges regarding listing wolverines as threatened or endangered that have been ongoing during this period of time, it is worth noting that Montana's decisions were made after the March 2008 U.S. Fish & Wildlife Service finding that wolverines did not warrant protection under the Endangered Species Act (USFWS 2008b).

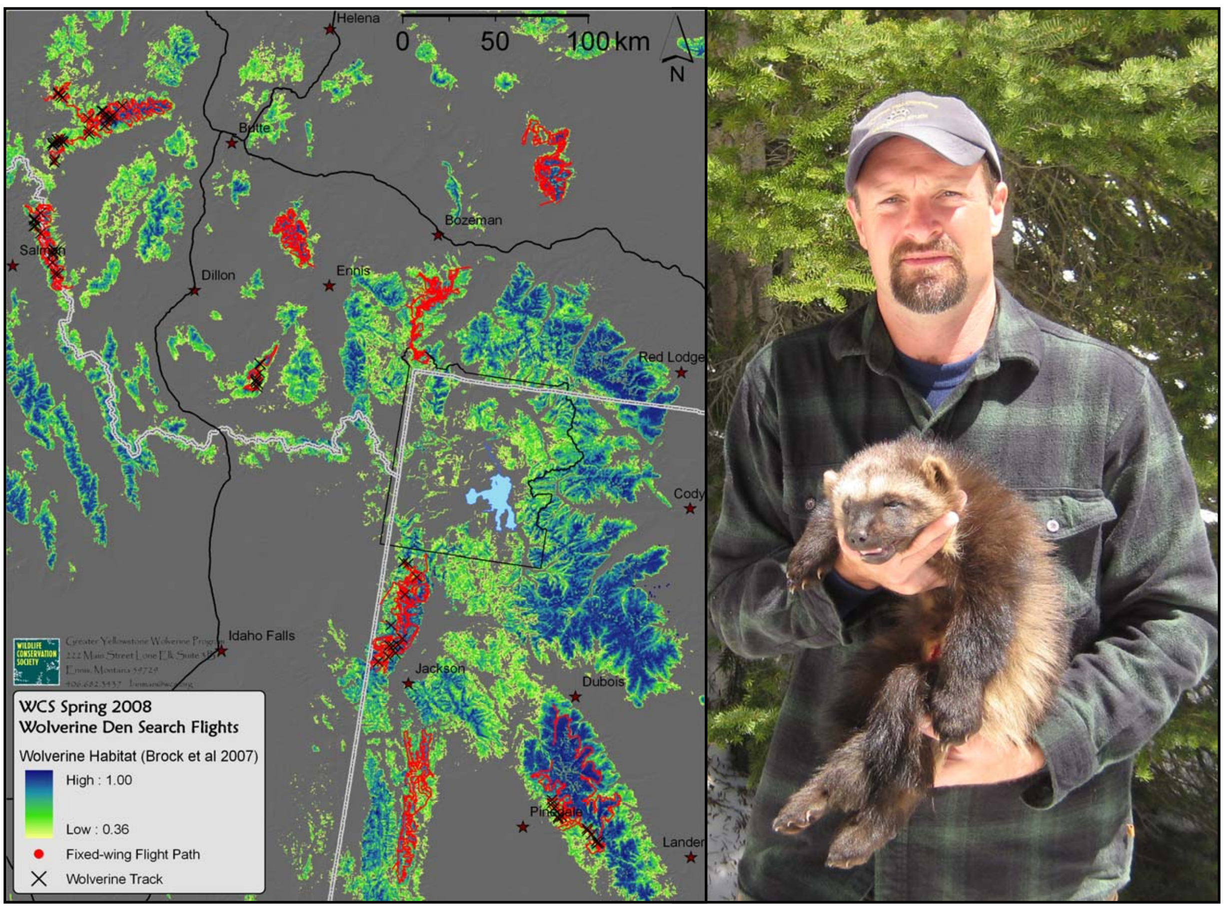
Montana has also opened the door to directly involving several important wolverine constituencies in moving wolverine conservation forward at the metapopulation scale. One possibility that has been discussed is working with trappers to use the state-wide quota for live-capture of wolverines that would then be relocated into areas of the lower 48 where the species was once distributed but does not currently exist (e.g., Colorado, California, Utah). Montana's trappers have expressed interest in participating in this type of conservation effort. In the most recent document regarding the litigation on T&E status for wolverines (Page 5, Sections 14 and 15, Preso et al. 2008, http://www.earthjustice.org/library/legal_docs/wolverine-final-complaint.pdf , the plaintiffs describe their reasons for desiring the continued presence of wild wolverine populations in their native habitat. If you take the time to read it, you will see that the reasons given by the plaintiffs are precisely the same reasons that wolverine trappers in Montana would list. This potential project is an open door for positive, metapopulation management actions (reintroductions) that can also build conservation partnerships where unproductive social divisions currently exist.



Wolverine F121 and her 2 cubs, Central Linkage Ecosystem of Idaho, Montana, and Wyoming, Summer 2007.

Spring 2008 Fixed-wing Den Surveys Yield Promising Results for Distribution & Monitoring Technique, Dispersal Data

Background This spring we began testing our ability to shift our field efforts toward documenting the presence of reproductive den sites (for distribution and monitoring purposes) and capturing family groups at those sites (for dispersal and demographic data). Our ideas on what to do and how to do it have been influenced by the time that Bob Inman has spent with the Swedish wolverine project. Bob is currently in a Ph.D. program at the Swedish University of Agricultural Sciences (known as SLU). SLU houses Grimsö Wildlife Research Station, one of the leading carnivore research centers in Europe and the location of the Swedish wolverine program for 15 years. Since 1996, the Swedes have monitored their wolverine population at a national level by identifying over 700 reproductive dens during springtime den surveys. They use this information to assess where they stand in relation to the national population goal of at least 90 annual reproductions for this red-listed (endangered) species. They have also captured 230 wolverines, including 140 known-age cubs, and have never built a log box trap. Instead, their capture efforts are focused on family groups at dens. After spending time with the Swedish biologists and conducting pilot studies this past spring, we believe we can adapt their monitoring and research techniques to our area. Thus in developing the second phase of our program we have identified the Central Linkage Ecosystem as the place to focus our efforts, and we believe that the techniques described below are the way to get it done.



Den surveys are the first step in obtaining dispersal data and can also be the basis for distribution and monitoring work. The WCS Greater Yellowstone Wolverine Program was able to survey 9 mountain ranges during spring 2008. We used a combination of fixed-wing aerial surveys during March and April along with helicopter and horseback access during May to locate and verify 2 reproductions and capture 2 known-age cubs. Wolverine F544 (pictured) and her male sibling were born in the Beaverhead Range this spring. Each was fit with a radio-implant in hopes of eventually learning how they will disperse among the islands of wolverine habitat in the Central Linkage Ecosystem.

As we began developing ideas on how to go about working in the Central Linkage Ecosystem, we drew upon our experiences participating in den captures in Sweden and the techniques used there to monitor their population. This led us to ask several questions: Can we locate reproductive dens of unmarked females and capture wolverines for dispersal and demographic data in a manner similar to the Swedish program? Den captures have never been the primary method of capture in North American wolverine studies outside of Alaska (Hornocker and Hash 1981, Copeland 1996, Lofroth and Krebs 2007, Squires et al. 2007, Rohrer et al. 2008), but the Central Linkage Ecosystem will present exceptional logistical difficulties regarding box-traps due to the vast extent of the area. And working at this scale is critical for understanding and conserving wolverines. So can it be done? Can we 'blind locate' dens and capture non-radioed wolverines in the terrain and management scenarios (wilderness) of the Lower 48? If we are going to be searching for dens to capture wolverines, can we design these den survey efforts in a manner that would allow us to determine current distribution of reproductive females and possibly even develop it into a monitoring technique? Aerial surveys have been attempted here with some success (Edelmann and Copeland 1999, Heinemeyer et al. 2001). But these efforts relied on helicopters, were expensive, and were abandoned to pursue techniques similar to those used for lynx which were thought to be more applicable over a large geographic extent. But is it possible to used fixed-wing aircraft rather than helicopters to search for dens over a broad area in a more cost-efficient manner? Obviously if this were to develop into a distribution/monitoring technique we would need to be able to confirm wolverine presence and reproduction by some means that does not ultimately depend on an airborne observer's assessment that tracks are in fact wolverine or the site is a den. So can we confirm wolverine presence and reproduction as part of this process? As described below, the results of our work last spring suggest t the answer to all these questions is YES.

Distribution, dispersal, demographics, and monitoring. This is what we are aiming for with the work in the Central Linkage Ecosystem. A slightly modified version of the Swedish approach to wolverine field-work, adapted for our area and research needs. It boils down to fixed-wing aerial surveys during March and April when wolverines have young at a den site, followed by efforts to confirm reproduction and, if desired, capture during May when cubs can be fit with a radio.

What can be gained? We will learn more about which areas wolverines are likely occupying through observation of probable tracks. But more importantly, we will learn more about which areas have reproductive females. Unlike tracks, reproduction is a reliable indication of a population. How can tracks be misleading? In 2003 the first GPS collar ever deployed on a wolverine revealed the true capability for movement by this species. The collar recorded locations of a dispersing-aged male travelling from the vicinity of Jackson Hole, Wyoming north for over 50 miles through the interior of Yellowstone Park until he was on Mount Washburn, not far from Gardiner, Montana. He made this movement during a 72-hr period. He stayed on Washburn for 2 days, then turned around and came back another 65 miles during the next 3 days (Inman et al. 2004). We have also documented other short-duration, long-distance movements. These types of movements might not be uncommon, and they result in a lot of tracks being put down over a large area that does not necessarily have resident wolverines. So, tracks do provide some information, but dens provide more critical and more reliable information.

What else, in addition to wolverine presence and distribution of reproductive females, would be gained? Potential dens identified during March–April can not be confirmed as a reproductive site until there is evidence of cubs. There are several options for confirming reproduction, and selection of which option to use would depend on site-specific objectives. This is discussed more below, but one option is a visit to the site during May to confirm, count, and, if desired, capture the wolverines. Over time, this will produce important information about wolverine reproduction – denning habitat, reproductive rate, age at first reproduction. We will also be marking a sample of wolverines for survival rates that is unbiased by trap placement issues and at

An experienced observer can utilize a fixed-wing aircraft as an effective and relatively cost-efficient means of locating wolverine tracks and dens. They are commonly used in Alaska to find wolverine tracks and have been employed successfully in wolverine research (Magoun et al. 2007). We have also had success finding wolverines prior to and during the efforts described here.

the appropriate scale for understanding patterns in mortality. We would also obtain important genetic samples.

But that is not all. Dispersal is critical for the wolverine metapopulation. And the only way to get dispersal data is with GPS collars on wolverines that are dispersing. Genetics can reveal a lot, but it can not tell us where the wolverine crossed the road, or if there is a fine-resolution, habitat-related pattern to dispersal movements. So how do we get these data? The cubs marked at dens during May will disperse the following spring. Now that they are radioed, we can more easily recapture and GPS them as the dispersal season initiates. Adult females radioed during den captures could also be recaptured to apply a GPS collar that can be put into the sample used to examine interactions with recreational use.

So, we believe there is a lot to be gained with this approach. And we have been gearing up to launch this type of effort since the June 2007 Greater Yellowstone Wolverine Workshop. The first step was to do some preliminary work to test our ability to actually do what we thought might be possible. The following summarizes those efforts, what we learned, and next steps.

March–April 2008 Fixed-wing Den/Distribution Surveys

During March/April we used a fixed-wing aircraft to search for wolverine tracks and potential den sites in 9 mountain ranges. We searched areas identified as primary wolverine habitat by Brock et al. (2007). Movements of denning females can be limited, and denning habitat is often at the interface of timbered and open habitats (avalanche chutes; Inman et al. 2007b). Therefore our search pattern was targeted as a complete search of all open, snow-covered areas near or above alpine timberline (Figs. 5–6). This essentially meant that we flew every major drainage and passed over nearly all open areas looking for potential wolverine tracks. We did not survey portions of a sampling grid or limit our search to cirque basins. We also chose a fixed-wing aircraft over a helicopter because the difference in cost per hour allowed us to survey all of a mountain range with an intense search pattern and, overall, more total area.

A potential wolverine den that was located during fixed-wing aerial surveys and visited on the ground to mark the location. This site in the Beaverheads was eventually confirmed as wolverine den.

When we observed wolverine tracks we recorded positions, followed them, and searched for potential den sites. Sites where there was a hole in the snow and indications of extensive wolverine use were noted. These potential den sites were inspected via the airplane several times during the next few weeks to see if there was continued use. Sites indicating prolonged use were then visited on the ground at which time the location of the entrance was recorded (photo to right), any available genetic samples were obtained (scats along tracks), and, in one case, a remote camera was placed near a potential den. Then, during May, we visited these sites again and attempted to confirm the presence of wolverine cubs. Because of our specific study objectives, we also attempted to capture and radio-mark the wolverines.

We were able to survey 8 mountain ranges completely and a portion of the Wind River Range (Table 1, Figs. 5–6). Complete initial surveys for individual mountain ranges averaged about \$1,500 per 1,000 km^2 of primary wolverine habitat and one person-day. We observed tracks that we classified as wolverine in 5 of the 9 mountain ranges. We observed a non-radioed wolverine in one case. We also located 3 potential den sites, one in the Beaverhead Range, one in the northern Anaconda Range, and another in the southern Anaconda Range. Aerial follow-up visits to these 3 potential dens suggested that wolverines were using each site regularly over an extended period. These follow-up visits, including fixed-wing flights to assess prolonged use and ground visits to mark the potential den, retrieve the remote camera, and collect DNA and habitat data added approximately \$750 and 6 person-days to the cost. An appropriate remote camera costs about \$750.

Table 1. Wolverine den-survey results, fixed-wing, Spring 2008, Idaho, Montana, and Wyoming.

Mountain Range	Area (km^2) of Wolverine Habitat[a]	Search Time (hrs)	Search Effort ($hr/100km^2$)	Cost	Wolverine Tracks Observed	Potential Dens	Confirmed Reproductions	May Capture Access	New Wolverines Identified	Wolverines Captured
Anaconda	1,131	6.3	0.6	$ 1,575	Yes	2	1	W, H	5	0
North Beaverhead	674	4.8	0.7	$ 1,188	Yes	1	1	H	4	2
Teton	1,346	9.3	0.7	$ 2,325	Yes	0	0	W	1	0
Snowcrest	404	2.0	0.5	$ 500	Yes	0	0	H	1	0
Gallatin (North-Central)	1,212	5.1	0.4	$ 1,275	Poss	0	0	H	0	0
Tobacco Root	495	5.0	1.0	$ 1,250	No	0	0	H	0	0
Crazy	614	5.3	0.9	$ 1,333	No	0	0	H	0	0
Wyoming	1,547	4.8	0.3	$ 1,208	No	0	0	H	0	0
Wind River	4,362	6.3	0.1	$ 1,570	Yes	0	0	W	0	0
Total	11,785	49	0.4	$12,223		3	2		11	2

May 2008 Den Confirmation/Cub Captures

Veterinarian Dr. Deborah McCauley during an after-midnight hike (post-hole) deep into the Anaconda-Pintler Wilderness in an attempt to capture an unmarked reproductive female wolverine and her 2 cubs.

During May, we visited the 3 potential den sites and attempted to confirm the presence of wolverine cubs. The first potential den that we attempted was located above 8,000 ft. elevation in the Anaconda-Pintler Wilderness. We were able to access the area on foot and confirm the presence of a wolverine and 2 cubs (tracks and direct observation). Unfortunately, the wolverines departed the site before we could get the capture equipment and veterinarian to the site. Frankly, we were caught off-guard by the ease with which we located these wolverines (no radio-transmitters) and were able to follow them to a rendezvous site. We began this attempt with the thought that we would be fortunate to simply document the presence of cubs, if it was in fact a den site. In the future, we will set our goals higher.

The second potential den site was in the Beaverhead Range. We were able to access this site with a helicopter. On the day of the attempt, we departed Salmon, Idaho and headed for the area of the potential den. Within 15 minutes, we had located fresh tracks and followed them until we saw 4 wolverines travelling together. There were 2 large wolverines (adults) and 2 small wolverines (cubs). As we hovered, the wolverines made their way to a site they had been using recently. We landed, exited, and followed their tracks to a hole in the snow that led to a series of tunnels under a large downed tree. Three sets of tracks entered the hole–1 adult and 2 cubs. Another set of adult-sized tracks continued away from the site (male?). After a bit of snow excavation, we were able to capture the cubs by hand. Each was fit with a radio-implant.

The third potential den was in the southern end of the Anacondas, outside the Anaconda-Pintler Wilderness. We flew to the site in a helicopter and searched for evidence of cubs. We were able to follow fresh wolverine tracks for some distance, and we ground-inspected a few sites where the wolverine had entered holes that could have been a den. However, we were not able to confirm the presence of any wolverine cubs. We were financially-limited to this one attempt with the helicopter. When inspecting this site during summer, we observed 2 wolverines in the vicinity of the potential den.

Several other bits of info are relevant. In 2006, we located the den of an unmarked reproductive female in the Gallatin Range using similar methods, and we were successful in documenting the presence of wolverines there, confirming reproduction, capturing the litter, and obtaining genetic and den habitat data. We have also captured cubs at den sites or confirmed reproduction on 7 occasions via radio-marked adult females.

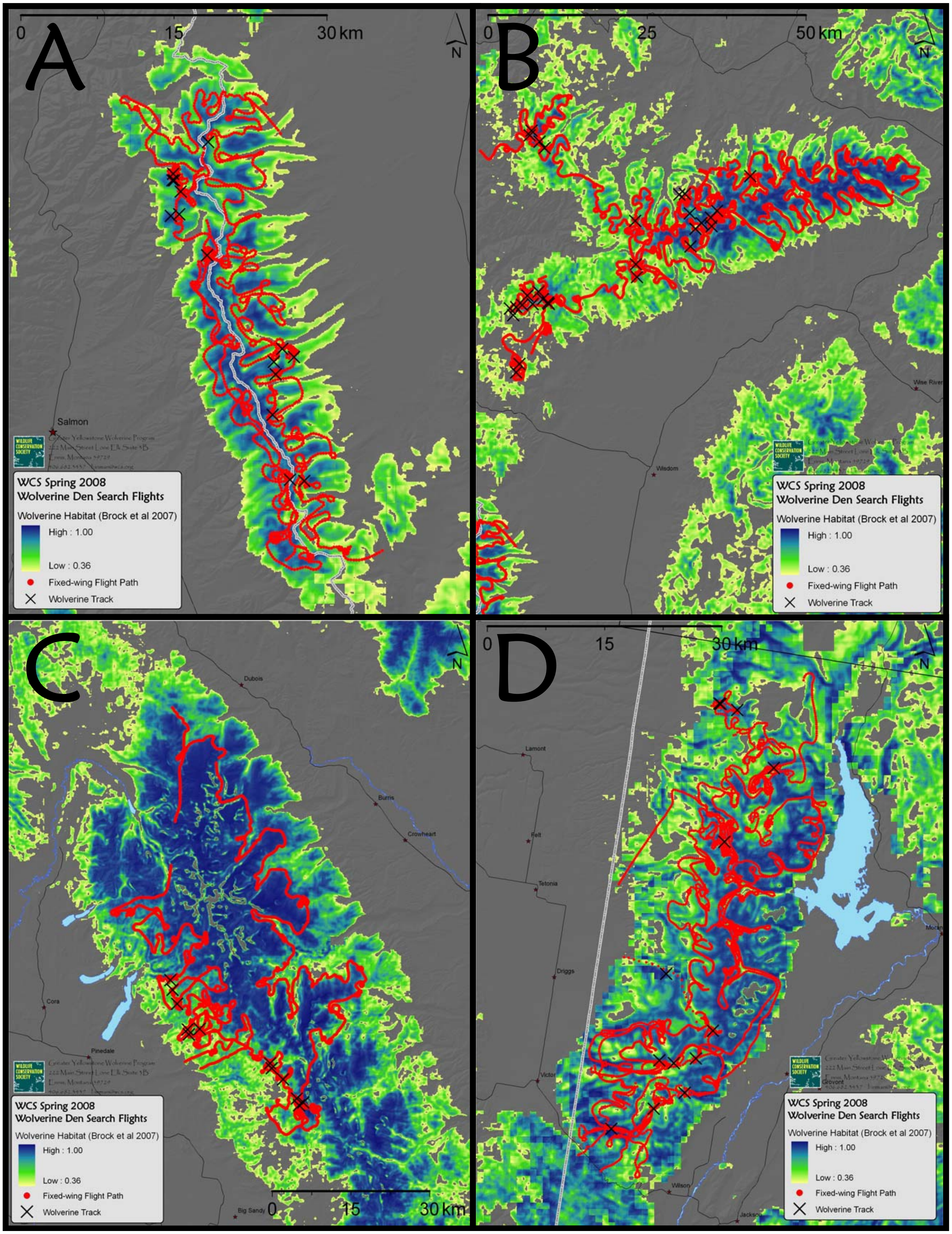


Figure 5. Spring 2008 wolverine distribution surveys conducted via fixed-wing aircraft in the (A) Northern Beaverhead, (B) Anaconda, (C) Wind River, and (D) Teton Mountain Ranges of Wyoming, Idaho, and Montana. Black X's indicate a wolverine track location. These fixed-wing flights were the first step in verifying the presence of reproductive females. Three potential den sites were identified, and two were confirmed as such in May. Results, including costs are in Table 1.

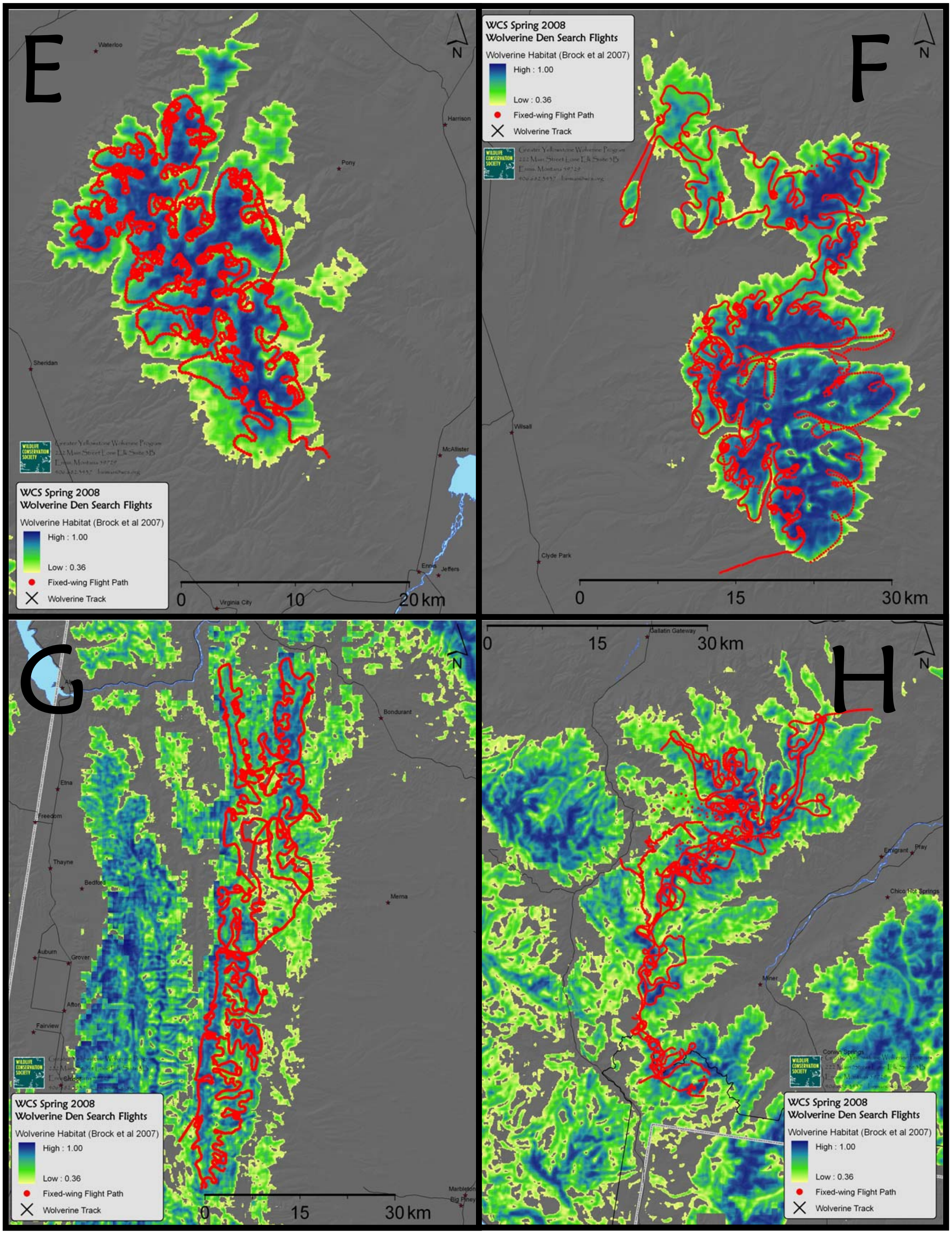


Figure 6. Spring 2008 wolverine distribution surveys conducted via fixed-wing aircraft in the (E) Tobacco Root, (F) Crazy, (G) Wyoming, and (H) Gallatin Mountain Ranges of Montana and Wyoming. No wolverine tracks were observed in these four mountain ranges. Results, including costs are in Table 1.

Conclusions

An attempt to refine the Scandinavian monitoring techniques to better suit our area and specific research and management needs led to several initial questions: 1) Can we (a) 'blind locate' wolverine dens using fixed-wing aircraft in the terrain and habitat of the Lower 48? (b) confirm the presence of wolverines and reproduction in a way that does not hinge on an airborne observer's assessment of tracks? and (c) capture non-radioed wolverines at den sites in the terrain and habitat of the Lower 48? 2) How effective is the fixed-wing technique at confirming all reproductions that occur? And 3) How much does it cost to survey for wolverine dens and confirm reproduction using fixed-wing aircraft? The results of our work last spring were positive and provide answers to two of these three questions.

1. The first questions (1a-c) related to field techniques. We demonstrated that it is in fact possible to 'blind locate' wolverine dens in the Lower 48 using complete, intensive surveys of primary wolverine habitat in fixed-wing aircraft. We also demonstrated that it is possible to confirm the presence of wolverines and reproduction with a variety of techniques that do not ultimately depend on an airborne observer's assessment of tracks in the snow (remote cameras, visual confirmation on skis in wilderness, visual confirmation in a helicopter…). Other techniques for confirming reproduction are possible, including genetic samples, definitive track photos, and summer site-visit criteria as developed by the Scandinavians. We have also demonstrated that it is possible to capture family groups at dens under a variety of conditions including designated wilderness.

2. The second question pertained to accuracy of the technique as related to the potential for monitoring. We have established that it is possible to detect wolverine dens, but we do not yet know the rate at which we are able to successfully detect dens. Determining a den detection rate requires a sample of radio-marked adult females, preferably fit with GPS collars. None of the five radio-marked adult females that we were monitoring last year reproduced, and we did not obtain any data on den detection rate. As described below, we will continue to pursue these data.

3. The third question pertained to cost. We estimated the cost of conducting these fixed-wing, spring den surveys to be approximately \$3,000 per 1,000 km^2 of primary wolverine habitat and 7 person-days. This estimate of cost and personnel time includes:

i) An initial examination that intensively surveys all potential denning habitat at an appropriate resolution, i.e. all potential habitat is surveyed rather than a sub-sample of grid cells that are based on an annual home range size (1 person-day);
ii) Flight time to follow-up on potential dens and assess prolonged use of a few sites (1 person-day);
iii) The purchase of a high-quality remote camera; and
iv) Ground visits to a potential den that can produce evidence of wolverine presence, evidence of wolverine reproduction, genetic samples, and denning habitat data (5 person-days).

These estimates of cost are used for two purposes under next steps below. First, as fuel for discussion, we present an overview of total costs associated with utilizing this technique in a large scale monitoring effort (Idaho, Montana, & Wyoming). And second, we describe the opportunities available during Spring 2009 that would allow us to refine cost estimates, provide additional information on the current distribution of reproductive females, and make progress toward radio-marking wolverines for dispersal, demographic, and winter recreation data.

Next Steps

Spring 2009: Continued Development as a Potential Monitoring Technique

The next step in testing the utility of the technique as a wolverine monitoring tool is to determine how effectively dens can be located. The fact that our radio-marked sample of 5 adult females did not reproduce last year may suggest that there is a greater chance of reproduction this year. We also know the general location of another 5–10 females. We will attempt to capture these females during pre-denning period this winter (Dec–Feb). We will then use our sample of radioed females to conduct a 'blind-test' of our ability to locate the dens they establish using the den survey technique described above. If we are successful in capturing females in the areas we know were recently occupied, den detection surveys of ranges where we currently and could have radio-marked adult females will cost approximately $12,000. We currently have the personnel and funds available to complete these den detection tests.

In an Appendix we provide a rough look at what it might cost to implement these surveys as a collaborative monitoring technique over a broad geographic area (Idaho, Montana, & Wyoming). Overall costs presented in these tables are still large, but within the range utilized across a multi-state extent for other low density carnivores (e.g. grizzly bears, wolves). Please note that we are not suggesting that this technique has been developed to the point of implementation for monitoring. These tables are simply provided as a basis for discussion. Having said that, we have confirmed that the methods described here can currently provide much-needed information on distribution of reproductive females, genetic samples, and denning habitat data. It can also lead to captures for radio-monitoring purposes that could include delineation of female home ranges in relation to winter recreational use, GPS data that can be related to recreation, dispersal routes, etc….

Spring 2009: An Opportunity to Improve Knowledge on Distribution and to Radio-mark Wolverines for Dispersal, Demographic and Winter Recreation Data

Coordinated, inter-jurisdictional surveys over large areas would eventually be necessary for monitoring if the technique proves capable of that task. However, since we are at the development stage for the technique, Spring 2009 den surveys of individual areas could provide useful information toward advancing the technique (refine cost estimates) in addition to site-specific info on wolverine presence, distribution of reproductive females, genetic samples, and denning habitat. Spring 2009 surveys of individual areas could also provide an opportunity to radio-mark wolverines for dispersal, demographic, and winter recreation data.

We currently have personnel and financial resources available to survey the Snowcrest, Flint Creek, and Highland Ranges of the Central Linkage Ecosystem during Spring 2009. These areas along with the den detection areas are unlikely to fully utilize our personnel time during March, April, and May. <u>Thus we have experienced personnel that can be dedicated to den surveys during March-May, but are currently limited by our budget for flight time. Additional funding for flights and cameras this spring could yield exceptional results.</u> Tables 2–4 are provided as a means of assessing whether funds can be arranged to conduct a survey of particular areas of interest. If you are interested in surveying a particular area please contact us (see page i for contact info).

Summer 2009: Wolverine Workshop II

Depending on our ability to test the den detection rate (i.e. females actually reproduce) and the resources that can be put together to match the available personnel time that we have to dedicate to den surveys this spring, it may be useful to have a second Wolverine Workshop. We are tentatively planning an August 2009 meeting where results from our surveys along with other potential monitoring techniques can be presented and discussed. If appropriate, this time could also be used to develop collaborative plans for undertaking additional surveys.

Table 3. Cost estimates for potential den surveys during Spring 2009 in the Central Linkage Ecosystem metapopulation units (Fig. 3 page 6).   <u>We have experienced personnel that can be dedicated to den surveys during March-May, but are currently limited by our budget for flight time.</u> Spring 2009 den surveys of individual areas could provide site-specific info on wolverine presence, distribution of reproductive females, genetic samples, and denning habitat. Spring 2009 surveys of smaller survey units could also provide an opportunity to radio-mark wolverines for dispersal, demographic, and winter recreation data. If you are interested in surveying a particular area please contact us.

Costs here are based on fixed-wing methods described herein at \$3,000/1,000km² primary wolverine habitat (Brock et al. 2007). This includes initial purchase of a remote camera. Costs are broken down by state and federal jurisdiction in proportion to the amount of wolverine habitat that falls within each jurisdiction.

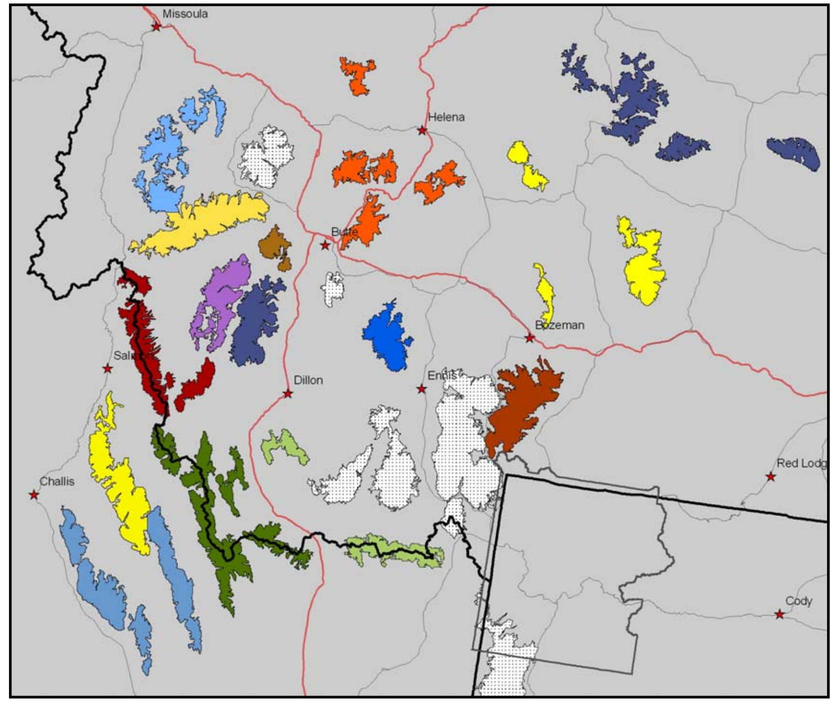


Figure. Central Linkage Ecosystem wolverine metapopulation deme divided into potential den survey units as referred to in table below.   White areas will be surveyed this spring with personnel and financial resources that have been secured.

Spring 2009 Survey Opportunities

Central Linkage Ecosystem

Den Survey Cost by Jurisdiction Based on Proportion Wlvrn Habitat in Jurisdiction

			1/3 Total UnitCost Divided Among State Wildlife Agencies		2/3 Total Unit Cost Divided Among Federal Land Management Agencies									
					National Forests								BLM	
Metapopulation Unit	Survey Unit	Wolverine Habitat (km²)	MFWP	IDFG	Bvrhd-Drldg	Btrroot	Carib-Trghee	Gallitn	Helna	Lewis Clark	Lolo	Salmn-Chlls	Dillon	Total Expenses
Anaconda	Fleecer	209	\$ 213	.	\$ 414	.	.	.	.	.	.	.	.	\$ 627
	East Pioneer	742	\$ 757	.	\$ 1,469	.	.	.	.	.	.	.	.	\$ 2,226
	Anaconda	1,103	\$ 1,125	.	\$ 1,725	\$ 459	.	.	.	.	.	.	.	\$ 3,309
	N Beaverhead	835	\$ 562	\$ 290	\$ 1,141	.	.	.	.	.	.	\$ 513	.	\$ 2,505
	Sapphire, John Long	986	\$ 1,006	.	\$ 742	\$ 781	.	.	.	.	\$ 430	.	.	\$ 2,958
	West Pioneer	728	\$ 743	.	\$ 1,441	.	.	.	.	.	.	.	.	\$ 2,184
Belts	Crazy, Bridger, Big Belt	967	\$ 986	.	.	.	.	\$ 1,149	\$ 345	\$ 421	.	.	.	\$ 2,901
	Little Belt, Big Snowy	1,365	\$ 1,392	.	.	.	.	.	.	\$ 2,703	.	.	.	\$ 4,095
Elkhorn	Black Mtn., Elkhorn, Boulder, Whitetail	1,080	\$ 1,102	.	\$ 1,198	.	.	.	\$ 941	.	.	.	.	\$ 3,240
Gravelly	Centennial, Blacktail	719	\$ 433	\$ 301	\$ 43	.	\$ 584	.	.	.	.	.	\$ 797	\$ 2,157
	Tobacco Root	504	\$ 514	.	\$ 998	.	.	.	.	.	.	.	.	\$ 1,512
Lemhi	N Lemhi	1,048	.	\$ 1,069	.	.	.	.	.	.	.	\$ 2,075	.	\$ 3,144
	N Lost River	802	.	\$ 818	.	.	.	.	.	.	.	\$ 1,588	.	\$ 2,406
	S Beaverhead	1,731	\$ 830	\$ 936	\$ 1,611	.	\$ 1,200	.	.	.	.	\$ 617	.	\$ 5,193
	S Lemhi, S Lost River	893	.	\$ 911	.	.	\$ 442	.	.	.	.	\$ 1,326	.	\$ 2,679
Western Yellowstone	N Gallatin	1,014	\$ 1,034	.	.	.	.	\$ 2,008	.	.	.	.	.	\$ 3,042
Total		**14,726**	**\$ 10,697**	**\$ 4,324**	**\$ 10,781**	**\$ 1,240**	**\$ 2,225**	**\$ 3,157**	**\$ 1,286**	**\$ 3,124**	**\$ 430**	**\$ 6,119**	**\$ 797**	**\$ 44,178**

Table 3. Cost estimates for potential den surveys during Spring 2009 in the Yellowstone metapopulation unit (Yellowstone deme in Fig. 3 page 6). <u>We have experienced personnel that can be dedicated to den surveys during March-May, but are currently limited by our budget for flight time.</u> Spring 2009 den surveys of individual areas could provide site-specific info on wolverine presence, distribution of reproductive females, genetic samples, and denning habitat. Spring 2009 surveys of smaller survey units could also provide an opportunity to radio-mark wolverines for dispersal, demographic, and winter recreation data. If you are interested in surveying a particular area please contact us.

Costs here are based on fixed-wing methods described herein at \$3,000/1,000km^2 primary wolverine habitat (Brock et al. 2007). This includes initial purchase of a remote camera. Costs are broken down by state and federal jurisdiction in proportion to the amount of wolverine habitat that falls within each jurisdiction.

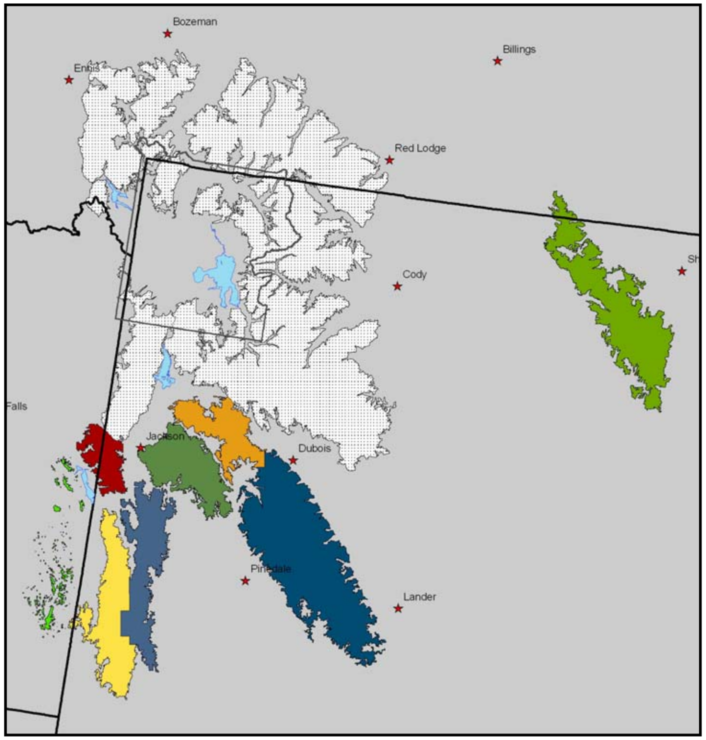


Figure. Yellowstone wolverine metapopulation deme divided into potential den survey units referred to in table below. White areas will be surveyed as part of den detection tests or are part of Central Linkage Ecosystem or Absaroka-Beartooth Study Area.

Spring 2009 Survey Opportunities

Greater Yellowstone Ecosystem

			Den Survey Cost by Jurisdiction Based on Proportion Wlvrn Habitat in Jurisdiction							
			1/3 Total Unit Cost Divided Among State Wildlife Agencies		2/3 Total Unit Cost Divided Among Federal Land Management Agencies					
					National Forests & Tribes					
Metapopulation Unit	Survey Unit	Area (km^2) Wolverine Habitat[a]	IDFG	WGF	Bghrn	Brigr-Teton	Carib-Trghee	Shoshn	Wind Rvr	Total Cost
Yellowstone	Gros Ventre	1,460	.	\$ 1,489	.	\$ 2,867	.	.	.	\$ 4,379
	Snake River Range	751	\$ 331	\$ 435	.	\$ 441	\$ 1,042	.	.	\$ 2,252
	Caribou	500	\$ 500	.	.	.	\$ 1,000	.	.	\$ 1,500
	Liedy	967	.	\$ 987	.	\$ 1,624	.	\$ 289	.	\$ 2,902
	Wind River	4,362	.	\$ 4,449	.	\$ 3,816	.	\$ 2,929	\$ 1,770	\$ 13,086
	Wyoming	1,547	.	\$ 1,578	.	\$ 2,992	.	.	.	\$ 4,641
	Salt	1,779	\$ 12	\$ 1,802	.	\$ 3,337	\$ 24	.	.	\$ 5,336
Bighorn	Bighorn	2,810	.	\$ 2,676	\$ 5,145	.	.	.	.	\$ 8,430

Table 4. Cost estimates for potential den surveys during Spring 2009 in the Salmon metapopulation unit (Salmon deme in Fig. 3 page 6). <u>We have experienced personnel that can be dedicated to den surveys during March-May, but are currently limited by our budget for flight time.</u> Spring 2009 den surveys of individual areas could provide site-specific info on wolverine presence, distribution of reproductive females, genetic samples, and denning habitat. Spring 2009 surveys of smaller survey units could also provide an opportunity to radio-mark wolverines for dispersal, demographic, and winter recreation data. If you are interested in surveying a particular area please contact us.

Costs here are based on fixed-wing methods described herein at \$3,000/1,000km² primary wolverine habitat (Brock et al. 2007). This includes initial purchase of a remote camera. Costs are broken down by state and federal jurisdiction in proportion to the amount of wolverine habitat that falls within each jurisdiction.

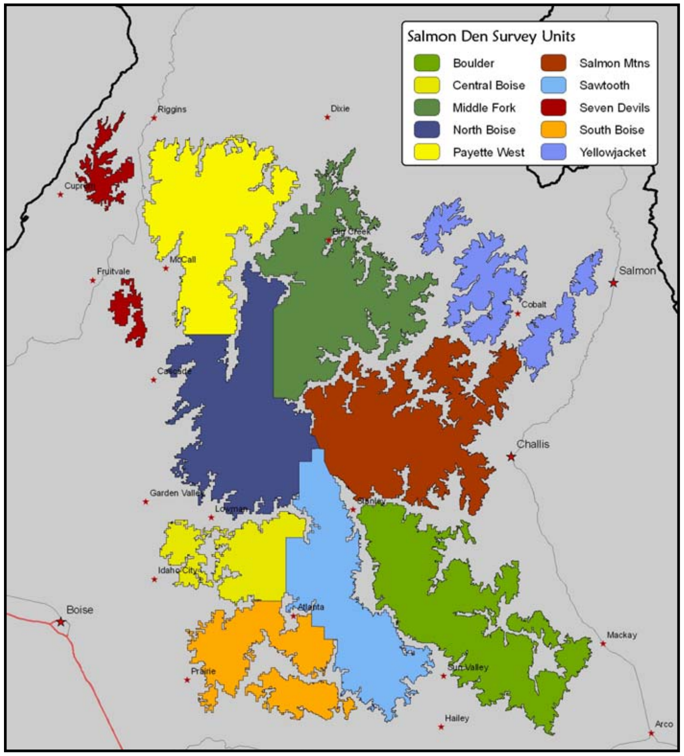


Figure. Salmon wolverine metapopulation deme divided into potential den survey units as referred to in table below.

Salmon-Selway Ecosystem

			Den Survey Cost by Jurisdiction Based on Proportion of Wolverine Habitat in Jurisdiction							
			1/3 Total Unit Cost Divided Among State Wildlife Agencies	2/3 Total Unit Cost Divided Among Federal Land Management Agencies						
				National Forests						
Metapopulation Unit	Survey Unit	Area (km^2) Wolverine Habitat[a]	IDFG	Boise	NzPrc	Payette	Salmn-Chlls	Sawtoth	Wallw-Whitmn	Total Cost
Salmon	West Payette	2,429	$ 2,478	$ 121	.	$ 4,689	.	.	.	$ 7,287
	Seven Devils	475	$ 485	$ 48	$ 20	$ 650	.	.	$ 222	$ 1,425
	North Boise	2,979	$ 3,039	$ 5,338	.	$ 356	$ 205	.	.	$ 8,937
	Central Boise	1,138	$ 1,161	$ 2,189	.	.	.	$ 64	.	$ 3,414
	South Boise	1,547	$ 1,578	$ 1,872	.	.	.	$ 1,191	.	$ 4,641
	Sawtooth	2,368	$ 2,415	$ 192	.	.	$ 158	$ 4,339	.	$ 7,104
	Boulder	3,051	$ 3,112	.	.	.	$ 2,558	$ 3,483	.	$ 9,153
	Middle Fork	2,932	$ 2,991	$ 555	.	$ 3,369	$ 1,881	.	.	$ 8,796
	Salmon Mtns.	3,164	$ 3,227	.	.	.	$ 6,162	$ 103	.	$ 9,492
	Yellowjacket	1,355	$ 1,382	.	.	$ 148	$ 2,535	.	.	$ 4,065
Total		**21,438**	**$ 21,867**	**$ 10,315**	**$ 20**	**$ 9,211**	**$ 13,499**	**$ 9,179**	**$ 222**	**$ 64,314**

GPS Collars on 5 Adult Female Wolverines Provide Valuable Data Related to Winter Recreation

During the winter of 2006-07, we were able to place GPS collars on 5 adult female wolverines. These collars were provided by Bob Walker and Brain Giddings of Montana Dept. of Fish Wildlife and Parks. The collars were programmed to collect a location once every hour. We obtained a total of 2,066 locations of the 5 females. In addition, the collars contained dual-axis motion sensors and recorded activity data every 5 minutes. So we ended up with over 75,000 5-min samples of wolverine activity level (some reported in McCue et al. 2007).

The data from these collars provides further evidence that wolverines utilize their exceptionally large annual home ranges over a very short period of time (on the order of weeks; Fig. 7). The data also provide further evidence for territoriality (Fig. 7 bottom middle). More importantly, we can use these data to compare movement rates, activity patterns, and locations of these females in relation to winter recreation (snowmobile and ski activity). This analysis is part of the Ph.D. program that Bob Inman is undertaking in Sweden right now.

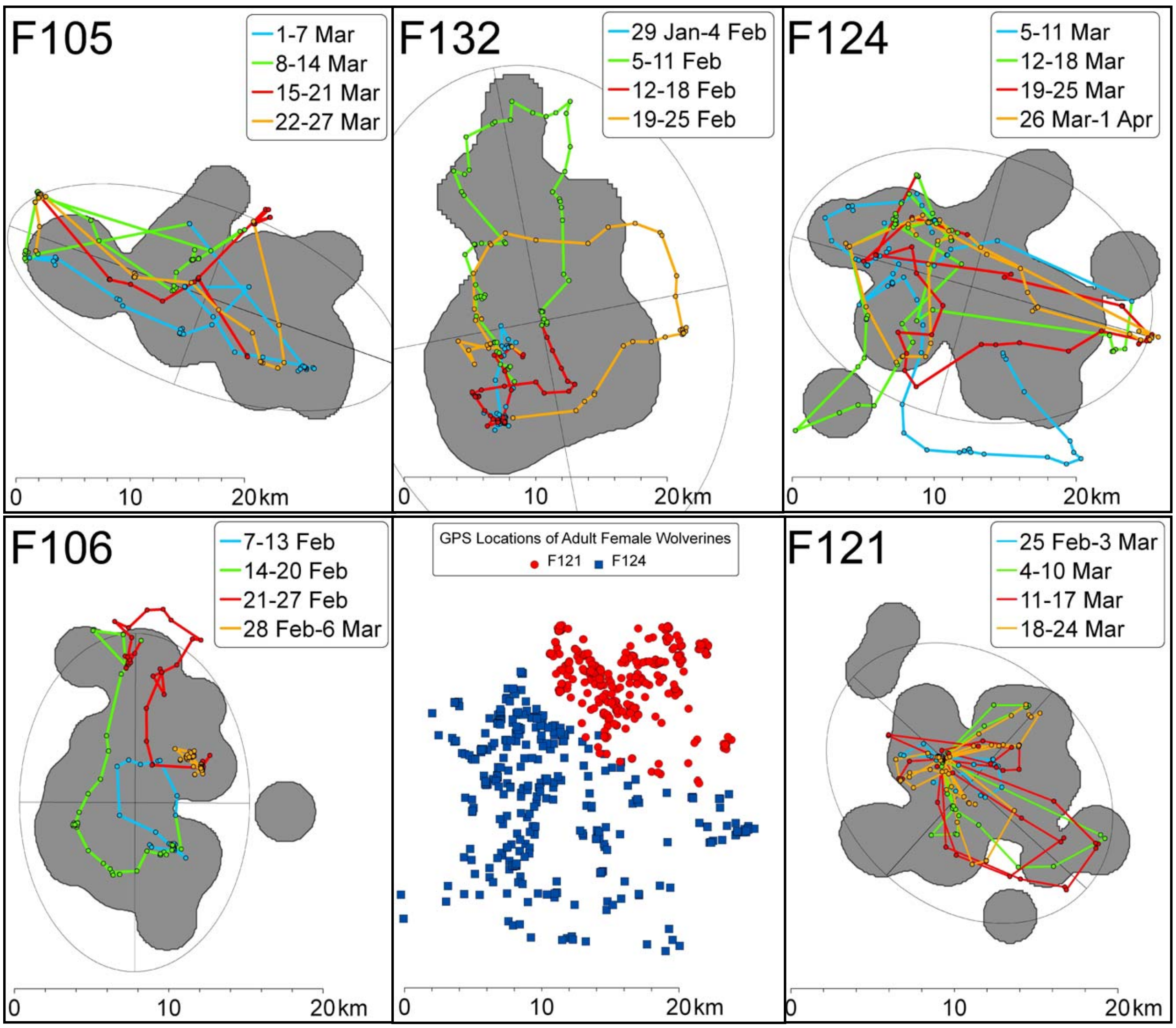


Figure 7. A sample of locations obtained with GPS collars placed on 5 adult female wolverines.

WCS Provides Wolverine Samples Relevant to California Wolverine Work

This spring, biologists working in the Tahoe National Forest of California obtained the first evidence of wolverines being present in the state in nearly a century. The photo was big news and soon after it was made additional efforts were put forth to survey for wolverines in the area. The genetic samples that we have collected from wolverines captured during our research effort have played a role in the California wolverine story. Our genetic samples, along with those collected by Montana Fish, Wildlife and Parks, the University of Idaho, and the US Forest Service Rocky Mountain Research Station are housed in Missoula under a Wolverine Genetics Agreement that we helped established several years ago. These samples, along with museum specimens from California, were used to delineate the unique genotype historically in California from other Rocky Mountain populations (Schwartz et al. 2007).

The Greater Yellowstone Wolverine Program has also provided biologists with the Conservation Canine Program at the University of Washington with scat samples from wild wolverines. These dogs are working in the areas near the California wolverine sighting, and the samples we provided will be used to train dogs to locate wolverine scats. If the dogs find wolverine scats, they can be genetically analyzed to determine the sex and even individual from whence they originated. Importantly, these samples can also reveal whether any wolverines that might be located in California are a remnant California population that has eluded detection for nearly a century. Visit the following link for more information about the wolverine in California. http://www.dfg.ca.gov/news/issues/wolverine/

Appendix 1. Rough approximations of spring den survey cost for wolverine metapopulation units (Fig. 3 Page 6) using fixed-wing methods described herein. These survey cost estimates are provided here as an example of what may be possible and how it might be accomplished in a collaborative and highly coordinated manner. The technique ahs not been fully developed at this time. Costs here are based on $3,000/1,000km² primary wolverine habitat (Brock et al. 2007) which includes initial purchase of a remote camera. Costs are broken down by state and federal jurisdiction in proportion to amount of wolverine habitat that falls within each jurisdiction. Surveys based on metapopulation units seem more reasonable than surveys of individual units (e.g. a national forest) due to the ability to share costs and also the nature of wolverine home ranges and habitat use–Jurisdictional borders are often located at the crest of a mountain range whereas wolverines typically center a home range on the crest and utilize both slopes. Therefore it might not be effective or cost-efficient to survey one slope but not the other. Personnel time was estimated to be 7 person-days per 1,000 km² of wolverine habitat and is not represented in the costs. Personnel time required for ground visits could be higher in areas with designated wilderness or with more than 1 den per 1,000 km² of habitat. Because camera costs are built-in, multiple years of surveying would reduce this portion of the cost.

Central Linkage Ecosystem

			Monitoring Cost by Jurisdiction Based on Proportion of Wolverine Habitat in Jurisdiction[b]											
			1/3 Total Unit Cost Divided Among State Wildlife Agencies		2/3 Total Unit Cost Divided Among Federal Land Management Agencies									
	Area (km²)				National Forests									Tribe
Metapopulation Unit	Wolverine Habitat[a]	Total Cost	MFWP	IDFG	Bvrhd-Drldg	Btrroot	Carib-Trghee	Flathd	Gallitn	Helna	Lewis Clark	Lolo	Salmn-Chlls	Flathd
Anaconda	5,389	$ 16,167	$ 4,980	$ 355	$ 7,944	$ 1,204	.	.	.	.	.	$ 424	$ 618	.
Belts	2,333	$ 6,999	$ 2,310	.	.	.	.	.	$ 1,143	$ 406	$ 3,031	.	.	.
Elkhorn	1,212	$ 3,636	$ 1,200	.	$ 1,378	.	.	.	.	$ 936	.	.	.	.
Gravelly	2,388	$ 7,164	$ 2,070	$ 294	$ 3,004	.	$ 585	.	.	.	.	.	.	.
Lemhi	4,474	$ 13,422	$ 802	$ 3,627	$ 1,353	.	$ 1,452	.	.	.	.	.	$ 5,310	.
Mission	1,372	$ 4,116	$ 1,358	.	.	.	.	$ 760	.	.	.	$ 689	.	$ 1,285
Total CLE	**17,168**	**$ 51,504**	**$ 12,720**	**$ 4,277**	**$ 13,679**	**$ 1,204**	**$ 2,037**	**$ 760**	**$ 1,143**	**$ 1,342**	**$ 3,031**	**$ 1,113**	**$ 5,927**	**$ 1,285**

Salmon-Selway Ecosystem

			Monitoring Cost by Jurisdiction Based on Proportion of Wolverine Habitat in Jurisdiction[b]											
			1/3 Total Unit Cost Divided Among State Wildlife Agencies		2/3 Total Unit Cost Divided Among Federal Land Management Agencies									
	Area (km²)				National Forests									
Metapopulation Unit	Wolverine Habitat[a]	Total Cost	MFWP	IDFG	Btrroot	Boise	Clrwtr	Idaho Pnhdl	Kootn	Lolo	Nz Perce	Payette	Salmn-Chlls	Sawtoth
Bitterroot	14,619	$ 43,857	$ 2,958	$ 11,515	$ 5,427	.	$ 10,830	$ 4,694	$ 92	$ 2,270	$ 3,782	.	$ 757	.
Salmon	21,829	$ 65,487	.	$ 21,611	.	$ 10,340	.	.	.	.	$ 20	$ 9,237	$ 13,518	$ 9,192
Total	**36,448**	**$ 109,344**	**$ 2,958**	**$ 33,125**	**$ 5,427**	**$ 10,340**	**$ 10,830**	**$ 4,694**	**$ 92**	**$ 2,270**	**$ 3,803**	**$ 9,237**	**$ 14,275**	**$ 9,192**

Appendix 2. Rough approximations of spring den survey cost for wolverine metapopulation units (Fig. 3 Page 6) using fixed-wing methods described herein. These survey cost estimates are provided here as an example of what may be possible and how it might be accomplished in a collaborative and highly coordinated manner. The technique ahs not been fully developed at this time. Costs here are based on \$3,000/1,000km² primary wolverine habitat (Brock et al. 2007) which includes initial purchase of a remote camera. Costs are broken down by state and federal jurisdiction in proportion to amount of wolverine habitat that falls within each jurisdiction. Surveys based on metapopulation units seem more reasonable than surveys of individual units (e.g. a national forest) due to the ability to share costs and also the nature of wolverine home ranges and habitat use–Jurisdictional borders are often located at the crest of a mountain range whereas wolverines typically center a home range on the crest and utilize both slopes. Therefore it might not be effective or cost-efficient to survey one slope but not the other. Personnel time was estimated to be 7 person-days per 1,000 km² of wolverine habitat and is not represented in the costs. Personnel time required for ground visits could be higher in areas with designated wilderness or with more than 1 den per 1,000 km² of habitat. Because camera costs are built-in, multiple years of surveying would reduce this portion of the cost.

Greater Yellowstone Ecosystem			Monitoring Cost by Jurisdiction Based on Proportion of Wolverine Habitat in Jurisdiction[b]												
			1/3 Total Unit Cost Divided Among State Wildlife Agencies			2/3 Total Unit Cost Divided Among Federal Land Management Agencies									
						National Forests							National Parks & Tribes		
Metapopulation Unit	Area (km²) Wolverine Habitat[a]	Total Cost	MFWP	IDFG	WGF	Bvrhd-Drldg	Bghrn	Brigr-Teton	Carib-Trghee	Custr	Gallitn	Shoshn	Ylwstn	Grnd Teton	Wind Rvr
Bighorn	2,810	$ 8,430	$ 106	.	$ 2,676	.	$ 5,145	.	.	.	.	.	.	.	.
Yellowstone	32,761	$ 98,283	$ 7,848	$ 397	$ 25,172	$ 1,107	.	$ 20,568	$ 2,660	$ 3,251	$ 10,206	$ 15,532	$ 6,791	$ 1,091	$ 2,511
Total GYE	**35,571**	**$ 106,713**	**$ 7,954**	**$ 397**	**$ 27,848**	**$ 1,107**	**$ 5,145**	**$ 20,568**	**$ 2,660**	**$ 3,251**	**$ 10,206**	**$ 15,532**	**$ 6,791**	**$ 1,091**	**$ 2,511**

Northern Continental Divide Ecosystem			Monitoring Cost by Jurisdiction Based on Proportion of Wolverine Habitat in Jurisdiction[b]								
			1/3 Total Unit Cost Divided Among State Wildlife Agencies		2/3 Total Unit Cost Divided Among Federal Land Management Agencies						
					National Forests						National Parks & Tribes	
Metapopulation Unit	Area (km²) Wolverine Habitat[a]	Total Cost	MFWP	IDFG	Flathd	Helna	Idaho Pnhdl	Kootn	Lewis Clark	Lolo	Glacr	Blkft
Cabinet	2,596	$ 7,788	$ 2,024	$ 545	.	.	$ 968	$ 3,919	.	$ 255	.	.
NCD	13,345	$ 40,035	$ 13,212	.	$ 11,860	$ 1,058	.	$ 708	$ 4,903	$ 1,545	$ 5,475	$ 497
Selkirk	1,204	$ 3,612	.	$ 1,192	.	.	$ 1,443	.	.	.	.	.
Total NCD	**17,145**	**$ 51,435**	**$ 15,235**	**$ 1,737**	**$ 11,860**	**$ 1,058**	**$ 2,411**	**$ 4,627**	**$ 4,903**	**$ 1,800**	**$ 5,475**	**$ 497**

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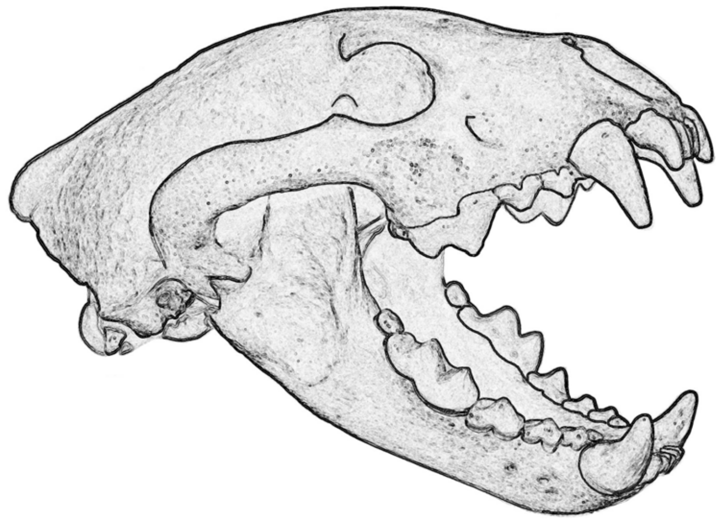

WOLVERINE (*Gulo gulo*)

Greater Yellowstone Wolverine Program


Photo – R. Spence

Wildlife Conservation Society

The Wildlife Conservation Society, founded in 1895 as the New York Zoological Society, is a private, non-profit organization involved in conserving wildlife and wild lands in North America, Africa, Asia, Latin America, and the Marine Environment. www.wcs.org