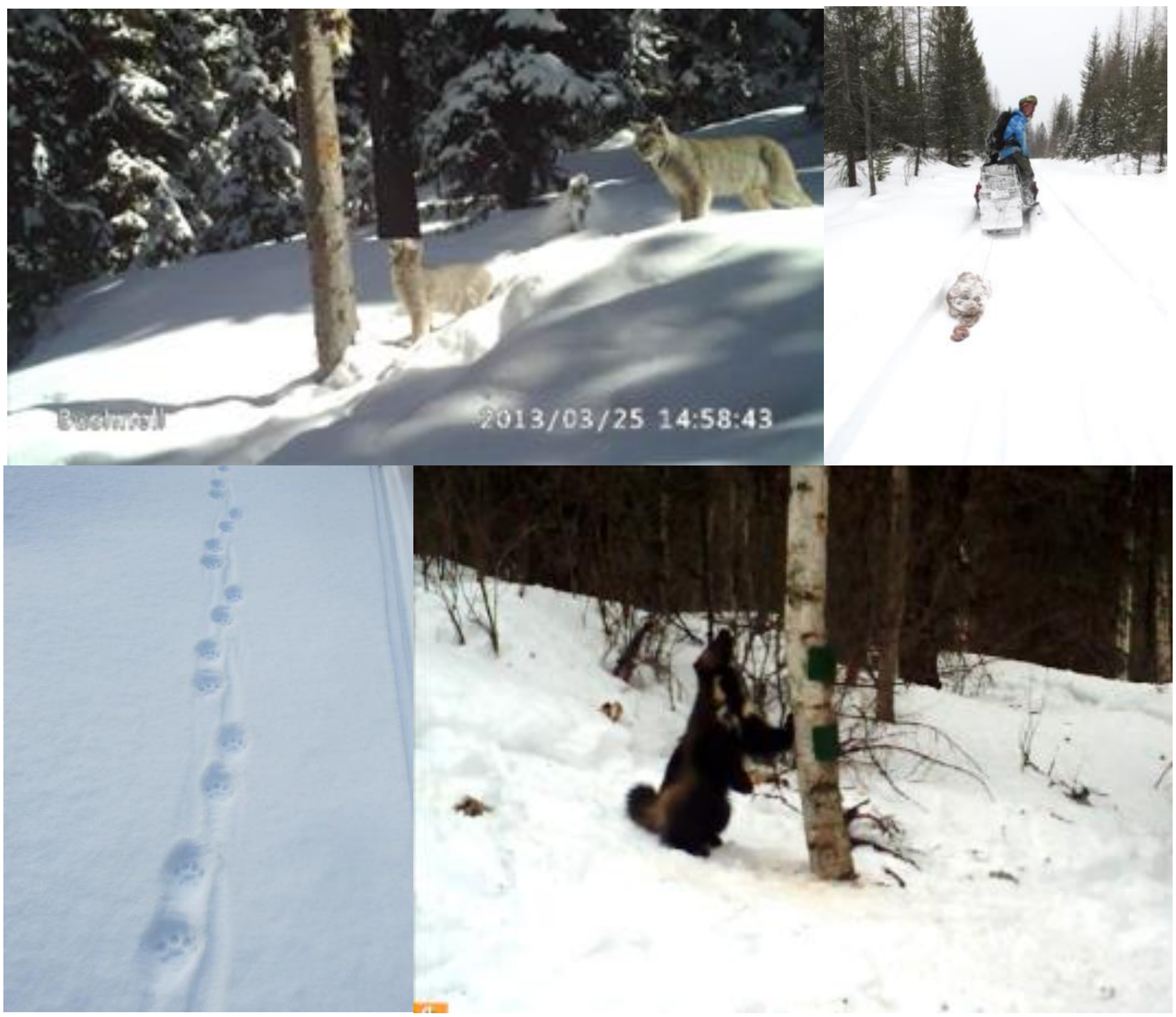
Forest Carnivore Monitoring in the Southwestern Crown of the Continent: Final Baseline Report 2013-2016



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Executive Summary:

The Southwestern Crown of the Continent (SW Crown) is a mostly-forested landscape in the Rocky Mountains of western Montana. The SW Crown was chosen as one of the first ten project areas nationally to be awarded funding under the federal Collaborative Forest Landscape Restoration Program (CFLRP). The CFLRP requires multi-party monitoring to assess the positive or negative ecological, social, and economic effects of restoration projects implemented under the program. The monitoring effort described herein was designed to systematically survey the SW Crown for forest carnivores, particularly focusing on lynx, fisher, and wolverine. The primary objective of monitoring forest carnivores in the SW Crown was to facilitate and coordinate the adaptive management and conservation of wolverines, Canada lynx, and fisher by agency managers across the landscape. This monitoring project was designed to provide a baseline of the current distribution of the focal species in the SW Crown and to allow for tracking changes in that distribution over time.

The SW Crown carnivore project utilizes non-invasive survey methods to maximize the ability to detect multiple species across a large landscape in an efficient and cost effective manner. We conducted snow track surveys and used DNA collection methods (back-tracking, hair snares, and bait stations) developed by researchers with the USFS Rocky Mountain Research Station. In addition, a subset of bait stations was equipped with motion-sensor photo or video cameras to capture the activity of individuals at bait stations. In order to standardize sampling across the SW Crown, a 5 x 5 mile grid was overlaid on the entire landscape with surveys and bait stations deployed systematically in these grid cells. Field seasons were started in the beginning of January and run through the end of March. DNA samples were processed by the Rocky Mountain Research Station and identified to species and individual. Across all four years (2013-2016), we surveyed 82 of the 129 grid cells that fall, at least partially, within the SW Crown, and conducted snow-track surveys on over 1,000 miles each year within those grid cells.

Across the 1.5 million acre SW Crown, lynx were detected in a total of 33 grid cells from 2013-2016. DNA samples identified 39 unique Canada lynx: 23 males and 16 females. Of these animals, 32 were new to regional databases. Survey work also identified an area of regular use for lynx within the Lincoln Ranger District. Over the course of the survey period, wolverines were detected in a total of 52 grid cells with DNA samples identifying 32 unique wolverines: 16 males and 16 females. Wolverines were detected at elevations ranging from 3,409-7,198 feet. Despite intense effort across the SW Crown over the course of four field seasons, the Carnivore Project Monitoring Team did not detect any fisher. The survey methods did, however, lead to the documentation of a suite of other wildlife species across the landscape, including marten, mink, short-tailed weasel, red fox, coyote, wolf, bobcat, mountain lion, and snowshoe hare.

The four years of monitoring effort described in detail in this report have led to significant improvements in our understanding of the (1) current presence/absence and distribution of Canada lynx, wolverine, and fisher across the SW Crown; (2) most effective monitoring protocols for Canada lynx and wolverine, and (3) cost efficiencies associated with monitoring protocols that maximize the detection of multiple species at once. The data and results are currently being used to inform a wide variety of local and regional management efforts.

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Introduction

Background

The Southwestern Crown of the Continent (SW Crown) is a mostly-forested landscape in the Rocky Mountains of western Montana (Figure 1). It contains three Forest Service Ranger Districts, one each on the Flathead National Forest (FNF), Swan Lake Ranger District, the Lolo National Forest (LNF), Seeley Lake Ranger District, and the Helena National Forest (HNF) Lincoln Ranger District. This landscape forms the southern boundary of the Bob Marshall Wilderness Complex in western Montana, and encompasses forests and communities in the Blackfoot, Clearwater, and Swan River valleys.

The SW Crown was chosen as one of the first ten project areas nationally to be awarded funding under the federal Collaborative Forest Landscape Restoration Program (CFLRP). The program objectives are to:

- Reduce the risk of uncharacteristic wildfire
- Improve fish and wildlife habitat
- Maintain or improve water quality and watershed function
- Maintain, decommission, and rehabilitate roads and trails
- Prevent or control invasions of exotic species, and
- Use woody biomass and small-diameter trees produced from restoration projects.

The Southwestern Crown Collaborative (SWCC) is a group of partners including representatives from several levels (i.e. District, Forest, Region) of the Northern Region of the Forest Service (Region 1), local non-government organizations (NGOs), private entities, and the University of Montana that came together to develop and implement restoration projects under CFLRP in the SW Crown landscape.

The CFLRP requires multi-party ecological, social, and economic monitoring. As such, monitoring in the SW Crown is focused on examining the effects of forest restoration treatments at multiple spatial scales. Forest carnivore monitoring is one of over 20 monitoring projects supported with CFLRP funding in the SW Crown. Due to the wide-ranging nature of most forest carnivores, it is difficult to determine the effects that small-scale treatments may have on these species. However, forest carnivores may benefit from the efforts to effect larger landscape-scale changes, including restoration of habitat conditions and disturbances, reducing roads, and restoring habitat for prey species. In the winter of 2012, members of the SWCC Wildlife Working Group began systematic, landscape-scale carnivore monitoring efforts within the SW Crown. This first field season was considered a pilot year to help determine the best approach for conducting surveys and collecting genetic material. This report summarizes our results from 2013-2016; what we consider a baseline inventory of meso-carnivore populations in the SW Crown landscape.

Project Objectives

The primary objective of this monitoring project was to establish a baseline understanding of the relative abundance and distribution of forest carnivores throughout the SW Crown, so that changes over time can be tracked. This will help facilitate the adaptive management of wolverines, Canada lynx, and fisher by agency managers across the landscape. Empirical information can be used to inform management decisions and conservation strategies. More specifically, by monitoring changes to carnivore populations during implementation of the CFLR Program, managers have the ability to learn more rapidly about the effectiveness of project goals for forest carnivores. Table 1 describes the more specific, initial goals of the project.

Multiple factors can influence carnivore populations, and our monitoring was not designed to determine the causal factors for any changes, but to perhaps point towards areas where more attention is needed. With the emphasis on restoration of vegetative communities throughout the SW Crown associated with CFLRP activities (and the Blackfoot Swan Landscape Restoration Project), populations could see a positive increase in numbers and/or distribution, as species are able to inhabit areas that have previously not provided suitable habitat. In particular, this may be the case in parts of the SW Crown that were involved in the Montana Legacy Project, as these former timber lands are now being managed for multiple ecosystem benefits rather than solely managed for timber production. However, not all treatments are expected to benefit carnivores or their prey. In addition to vegetation restoration, efforts to reduce road densities and to increase security habitat for wildlife species could allow for both an expansion in distribution and/or increases in population numbers for these species.

At the same time, climate change may affect distribution, in terms of which areas continue to provide suitable habitat. If vegetation communities become drier and warmer, the subalpine fir/spruce forests that lynx rely upon could be reduced, shrinking habitat and thus changing the distribution and/or abundance of lynx. Similarly if warming trends decrease the amount or distribution of areas with persistent spring snow, changes in the distribution or abundance of wolverines may occur. Again, this monitoring project was not intended to determine the causes of change, but rather to monitor the distribution and abundance over time so that we can explore any changes that may be observed.

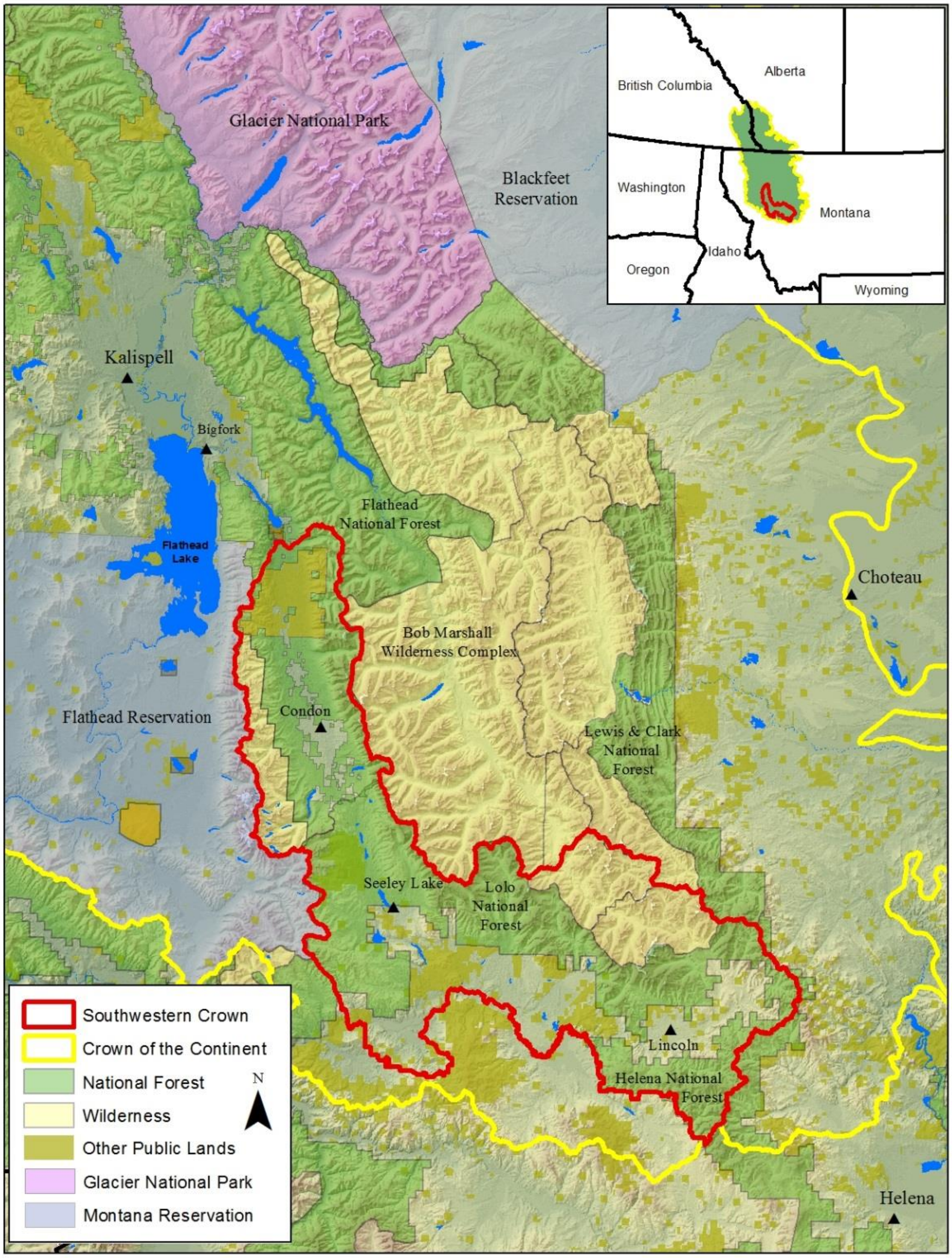

Figure 1. Location of Southwestern Crown of the Continent within the larger Crown-of-the-Continent Ecosystem. Forest Service lands and other public lands within the survey area have been highlighted with color-coding. Areas not highlighted are privately-owned.

Table 1. The initial objectives identified for the SWCC carnivore monitoring project.

Develop a better understanding of the distribution of forest carnivores, with a focus on lynx, wolverine, and fisher, across the project area.
Collect genetic material from the three focal species to establish important baseline information (individual identification and sex, sub-population genetics) and add to the existing body of knowledge of these species in the Northern Rockies.
Better understand travel routes and coarse habitat selection for these species.
Make a concerted effort to survey roadless and wilderness areas that have received very little survey effort to date.
Complement ongoing research and monitoring efforts in the region, including reporting on wolf pack activity and lynx habitat mapping efforts.
Identify potential study areas where more intensive research could be conducted (e.g. GPS collar deployment to study specific habitat use).
Improve the cost effectiveness and efficiency of surveying forest carnivores at large scales and over time.
Raise community awareness, provide information, and increase support among partners and the general public for forest carnivore conservation.

Species of Interest and Why They Were Chosen for Monitoring

A variety of mid-sized, forest carnivores inhabit the SW Crown's 1.5 million acre landscape, including animals in the cat family (mountain lion, Canada lynx, bobcat), the dog family (gray wolf, coyote, foxes), and the weasel family (wolverine, fisher, marten, long-tailed weasel). These forest carnivores are among the most wide-ranging species within the SW Crown and utilize vast areas with a variety of habitat types. While some of these species are fairly abundant and have widespread distributions across the state, others are less common, and less is known about their distribution and abundance. Previous survey efforts, research, and fur trapping records have indicated the presence of multiple forest carnivores in the SW Crown; however, no landscape-wide survey efforts had been conducted to identify individuals. This monitoring effort was designed to systematically survey the SW Crown for forest carnivores, particularly focusing on lynx, fisher, and wolverine. These species were chosen because of their management importance to the US Forest Service.

- **Canada lynx** (lynx; *Lynx canadensis*) are listed as Threatened under the Endangered Species Act (ESA) and the SW Crown represents the southern-most extent of critical habitat (Figure 2) occupied by the species in the contiguous United States (US). Lynx management and recovery is currently a high profile issue for federal land management agencies.
- **Wolverines** (*Gulo gulo*) have been a Sensitive species for Region 1 of the Forest Service for many years. After a 2013 proposed listing as threatened under the ESA, the USFWS decided not to list the species in 2014. However, in 2016, a federal judge overturned that decision and sent it back to USFWS for further review. The Crown of the Continent serves as an important linkage between wolverine

populations in Canada and remaining populations in the contiguous US (Figure 3; Cegelski et al. 2006).

- **Fisher** (*Pekania pennanti*) have been petitioned several times for listing under the ESA and are currently managed as a "Sensitive" species in Region 1 of the Forest Service.

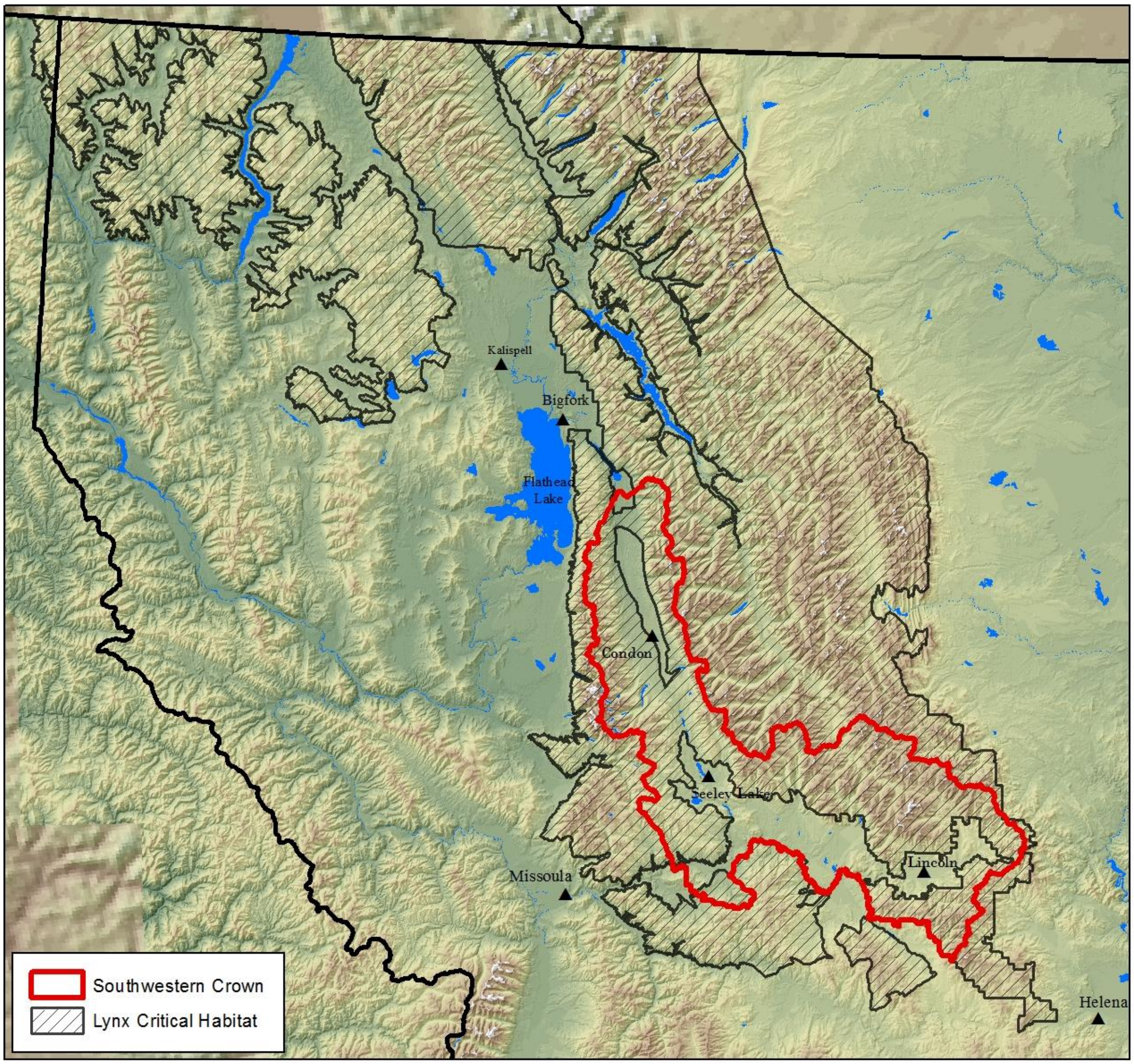

Figure 2. Canada lynx critical habitat in western Montana.

A primary focus of National Forest management in the SW Crown, and the CFLR Program, is maintaining or restoring a healthy landscape that supports these three species. As such, forest managers must consider the impacts to these species before implementing any major forest management, including building or removing roads, fuels reduction, and forest restoration projects.

Table 2 shows the state of knowledge at the beginning of this effort within the Northern Region (R1) regarding the three focal species and the management guidelines provided by relevant agencies for these species. Relative to lynx, less is known about the distribution and habitat needs of wolverine and fisher. There has been substantial research conducted on lynx in the region focusing on habitat needs and reproductive ecology (Squires et al. 2008, 2010, 2012, 2013), which is reflected in vegetation management guidance for the Forest Service. However, the USFWS has only recently developed a timeline for completing a recovery plan for the species. A USFWS Recovery Outline for lynx from 2005 recognized the importance of monitoring to detect population trends over time and suggested to: "Monitor lynx use in lynx analysis units or other appropriate management units at least once every 10 years to determine distribution and occupancy within the core area." The SW Crown is within this core lynx area. Schultz et al. (2013) also recognized that indirectly estimating a species' status and trend based on spatial distribution was a less expensive and more efficient way to monitor a species compared to direct estimates of population parameters using methods such as mark-recapture.

Lynx and wolverine may also be particularly susceptible to changes in climate due to their reliance on deep fluffy snow. Lynx inhabit boreal forest types and rely on deep snow environments where they have a competitive advantage over other carnivores. Based on Intergovernmental Panel on Climate Change (IPCC) projections, the area of potential lynx habitat may decrease by two-thirds in the lower 48 by the year 2100 (Gonzalez et al. 2007). Wolverine denning sites and habitat use have been shown to be highly correlated with persistent spring snow cover (Copeland et al. 2010, Aubry et al. 2007). Based on climate projections and habitat models, wolverine populations are expected to persist through the first half of the 21st century, but they may become smaller and more isolated (McKelvey et al. 2011). In contrast, fisher habitat (Figure 4) may increase under future climate conditions, though their persistence will rely on their ability to disperse through developed landscapes and persist in smaller patches of habitat (Olson et al. 2014).

Detecting forest carnivores and monitoring population demography can be difficult, as carnivores are often inconspicuous, patchily distributed, and territorial. Many forest carnivores occupy large home ranges or territories (e.g. 150 km^2 and 70 km^2 for male and female lynx, respectively; Aubry 2000). Therefore, monitoring efforts must be employed across large landscapes for multiple years. The initial goal of this monitoring was to obtain three consecutive years of data early in the CFLR Program and repeat the monitoring later in the 15-year program. This will provide information on distribution and relative abundance of forest carnivores in the SW Crown, while still considering annual variations in weather and snow conditions that can substantially alter species' habitat use and distribution as well as detection probabilities.

Forest carnivore monitoring in the SW Crown combined multi-species snow track surveys with non-invasive DNA collection methods (bait stations) using protocols developed by researchers with the USFS Rocky Mountain Research Station (RMRS; Schwartz et al. 2006; Squires et al. 2004).

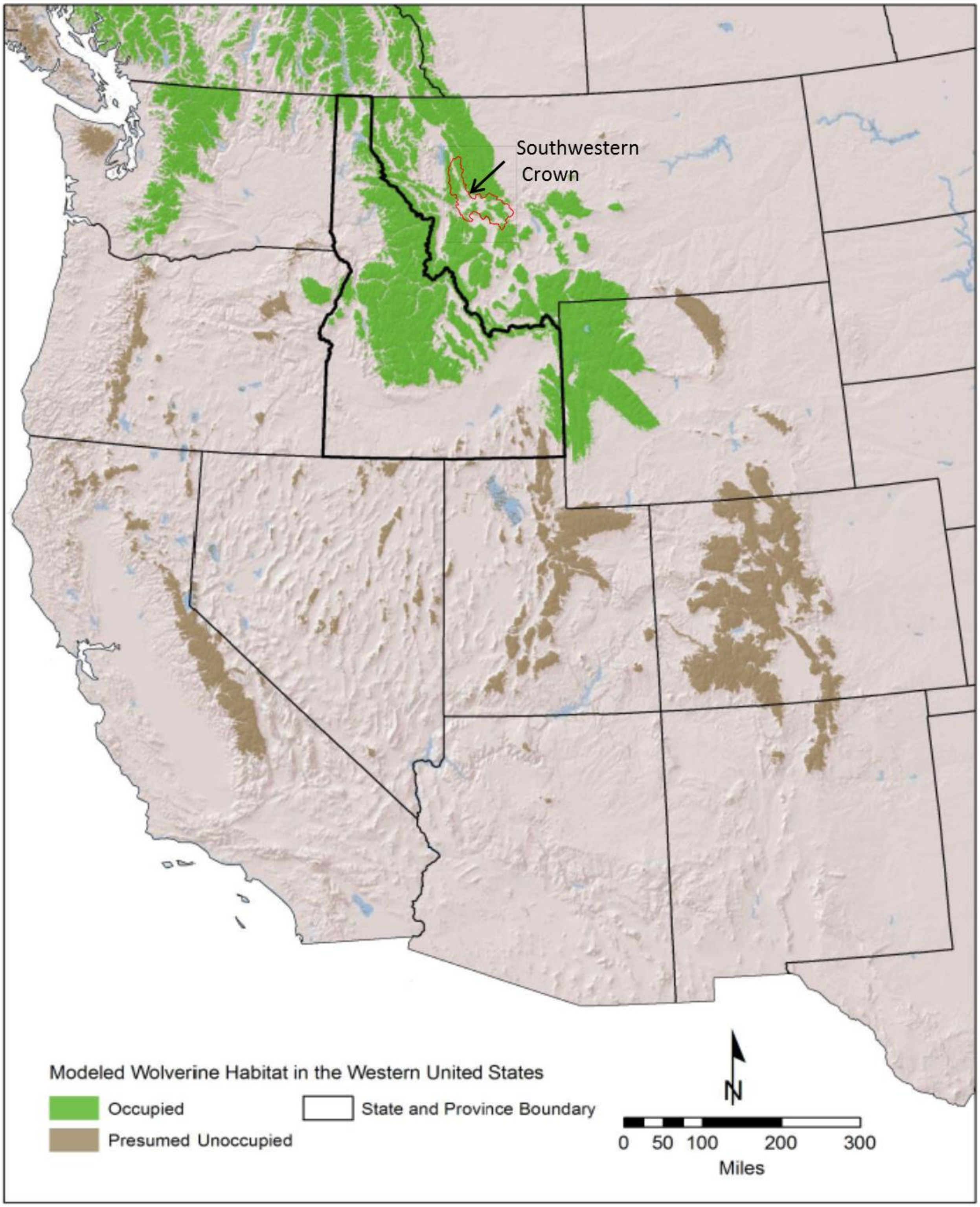

Figure 3. Modeled wolverine habitat in the western United States. Map derived by combining habitat models presented in Copeland et al. (2010) and Inman et al. (2013a, female dispersal). Occupancy status was derived from USFWS (2013). (*From* Idaho Department of Fish and Game 2014)

Figure 4. Current distribution of fisher habitat in Montana and Idaho. Map based on environmental, climatic, and topographic variables as modeled by Olson et al. (2014).

Table 2. Assessment of current information regarding lynx, wolverine, and fisher in the Northern Rockies region as understood by the project team at the onset of this monitoring project.

Color codes: Well understood/guidance provided | Somewhat understood/some guidance | Not understood/little to no guidance

Topic	Lynx	Wolverine	Fisher
Historic distribution	General historic distribution in Region 1 (R1) somewhat understood	General historic distribution in R1 somewhat understood	General historic distribution in R1 somewhat understood
Current distribution	General current distribution in R1 fairly well understood – this distribution is primarily based on where sub populations occur – not just detections of single individuals	General current distribution in R1 fairly well understood depending on whether distribution is defined by persistent sub populations of just dispersing or isolated individuals	General current distribution in R1 fairly well understood depending on whether distribution is defined by persistent sub populations of just dispersing or isolated individuals
Distribution limiting factors	Reasons for current distribution unclear (i.e. lack of habitat, inability of species to recolonize, connectivity barriers, human mortality factors)	Reasons for current distribution unclear (i.e. lack of habitat, inability of species to recolonize, connectivity barriers, human mortality factors)	Reasons for current distribution unclear (i.e. lack of habitat, inability of species to recolonize, connectivity barriers, human mortality factors)
Core areas	Core areas delineated (i.e., Critical habitat units)	No core areas delineated	No core areas delineated
General habitat needs	Moderate to good understanding of species general habitat needs based on empirical data collected within the region	Limited understanding of species habitat needs based on empirical data collected within the region	Limited to poor understanding of species habitat needs based on empirical data collected within the region
Specific habitat needs	Good understanding of species dependence on snowshoe hares and on spruce fir forests. Moderate understanding of age class/size class habitat needs and how these shift seasonally	Limited to poor understanding of specific habitat types and of associated prey needed for species persistence	Limited to poor understanding of specific habitat types and of associated prey needed for species persistence
Life history traits	Moderate understanding of life history parameters such as home range size, litter size, survival, dispersal movements based on empirical data collected within the region	Limited understanding of life history parameters such as home range size, litter size, survival, dispersal movements based on empirical data collected within the region	Limited understanding of life history parameters such as home range size, litter size, survival, dispersal movements based on empirical data collected within the region
Mortality factors	Moderate understanding of mortality factors impacting the species at a regional level	Poor understanding of mortality factors impacting the species at a	Poor understanding of mortality factors impacting the species at a

		regional level	regional level
USFS management guidance	Canada Lynx Conservation Assessment Strategy (LCAS), Northern Rockies Lynx Management Direction (NRLMD) and Critical Habitat rule all provide agency guidance in how to manage the species and species habitat	No real guidance in the region on how to manage for wolverine and no conservation strategy	No real guidance in the region on how to manage for fisher and no conservation strategy
USFWS Recovery Plan	Recovery plan being drafted	No clear picture of what recovery for this species looks like and no recovery plan being drafted	No clear picture of what recovery for this species looks like and no recovery plan being drafted
Existing monitoring strategy	No existing monitoring strategy tied to any spatial scale such as a core area	No existing monitoring strategy tied to any spatial scale such as a core area	No existing monitoring strategy tied to any spatial scale such as a core area

This work builds on existing efforts in the region that have been ongoing for several years, working with RMRS to better integrate surveys for rare carnivores in the Northern Rockies. Several forests began implementing passive hair snare surveys for fisher in 2007 (using the protocol by Schwartz et al. 2006). In 2010, the Lolo NF began implementing a multi-species carnivore approach on parts of the forest that involved using snow track surveys in conjunction with the fisher hair snare effort. These efforts were continued in 2011 with several new partners (i.e., Montana Department Natural Resources and Conservation, Great Burn Study Group, Northwest Connections) surveying additional areas and/or providing financial support. In 2012, the SWCC Wildlife Working Group began a pilot year of the Southwest Crown multi-species monitoring, employing fisher hair snares and conducting snow tracking surveys within the three ranger districts of the SW Crown. In 2013, we switched to multi-species bait stations and track surveys. In 2013, the Flathead NF also extended the multi-species survey methods to other areas of the forest outside of the SW Crown boundary (Curry et al. 2017).

Monitoring Questions

This monitoring project was designed to provide a baseline of the current distribution of the focal species in the SW Crown and allow for tracking changes in that distribution over time. Table 3 lists the potential topics addressed through monitoring or research and which of those questions this work focused on. We attempted to address these topics at multiple scales including: 1) the survey grid cell (5 mi x 5 mi), 2) Lynx Analysis Unit (LAU), 3) Ranger District, and 4) the full SW Crown landscape.

Table 3. General monitoring and research questions identified by participants at a January 2014 Forest Carnivore Monitoring and Information Sharing Workshop in Seeley Lake, MT. Questions this project attempted to address are identified.

Topic	Question	Are we addressing?
Presence	Is the species present in a given area (i.e. grid cell, district, entire SW Crown)?	Yes
Distribution	Where within a given area (i.e. district, SW Crown) is it found and how does it change over time?	Yes
Relative abundance	How common is the species in a given area (i.e. grid cell, district, entire SW Crown) and does it change over time?	Yes
Population trend	Is the population increasing/decreasing within a given area (i.e. SW Crown) through time?	No, but possibly could in future
Population estimate	How many individuals are there within a given area (i.e. SW Crown)?	Minimum number of individuals
Habitat use/ relationships	What habitat components are consistently associated with the presence of the species?	No, but possibly could at a coarse scale
Population viability	Can the species persist in a given area (i.e. SW Crown) over time given current and future projected conditions?	No

Methods

Forest ecosystems of the SW Crown are biologically diverse relative to other forested regions in the Rocky Mountains. This diversity is the result of the convergence of maritime and continental climatic influences as well as topographic complexity and steep elevation gradients. Elevation range is 927 – 2859 m (3,041-9,380 ft) and average annual precipitation ranges from approximately 38-66 cm (15 -26 in). The current distributions of tree species and forest types in this region depend on topographic, edaphic, and climatic factors, as well as on past land use and natural disturbance. In the SW Crown, mid- and upper-elevation forests are dominated by cool and cold subalpine fir forest types. Douglas fir, western larch, ponderosa pine, and lodgepole pine type forests dominate lower elevations, with a relative abundance and size distribution of species driven by water availability, soil types, past harvesting methods, and fire.

The SW Crown carnivore project utilizes multiple non-invasive survey methods to maximize our ability to detect multiple species across a large landscape in an efficient and cost effective manner. In order to standardize the approach across the SW Crown, a 5 x 5 mile grid (roughly 8 km x 8 km), which represents an area slightly smaller than an average female lynx home range (Aubrey et al. 2000), was overlaid on the entire landscape. There are 129 grid cells that at least partially intersect the SW Crown landscape, and about 80 of those are fully or mostly in the SW Crown boundary. Those grid cells were targeted to conduct snow track surveys and deploy hair snare bait stations to monitor target carnivore species and meet the project objectives.

Snow track surveys and bait stations were prioritized in areas of upcoming forest management projects, particularly in portions of project areas where lynx, wolverine, or fisher habitat models suggested potential habitat exists, or where biologists have received recent reports and/or historic reports of species occurrence. However, as much of the SW Crown landscape was surveyed as possible for a more complete landscape-level picture of carnivore distribution.

Field seasons were started in the beginning of January and ran through the end of March. Field work was coordinated and conducted by a collaborative group within the SWCC Wildlife Working Group; including, Forest Service biologists on the Lolo, Flathead, and Helena National Forests, and two local conservation non-profits, Swan Valley Connections and Blackfoot Challenge. Genetic analyses were conducted by RMRS.

Snow tracking is an effective way to detect lynx (Squires et al. 2004), and the addition of backtracking to obtain genetic samples (hair or scat) along tracks can provide important information about demographics of a species (e.g. gender and individual). Fisher spend much time in trees or under snow, making it is less likely that they will leave tracks that can be observed in track surveys. In addition, fisher tracks vary from marten tracks only in their size. Sexual dimorphism in both species makes it difficult to discern a large male marten from a small female fisher. Thus, hair snares at strategically placed bait stations were used to collect genetic samples that can provide proof of their presence and information regarding demographics. Bait stations have also been shown to be effective in attracting wolverine. In addition, motion-sensor cameras were mounted at some bait stations to help with species verification and monitor effectiveness of survey methods.

Multi-species Snow Track Surveys

Snow track surveys were based on methods developed by John Squires of RMRS to detect forest carnivores across a large landscape (Squires et al. 2004). The goal was to cover as much ground as efficiently as possible, in a manner that allowed us to determine if forest carnivores were present (or not detected) in the area.

Technicians on snowmobiles surveyed primarily along roads, with some trail and off trail travel within each grid cell, and recorded any carnivore tracks that were observed. To increase the detection probabilities of target species, field technicians used the following general protocols, largely based on work developed by Squires et al. (2004) for determining lynx distribution. However, technicians also targeted fisher and wolverine with these protocols and deployed bait stations. Survey routes were traced on a map then digitized in Global Information Systems (GIS). The full field protocols and an example datasheet are in Appendix A.

- Minimum survey distance of 10 km (6.2 miles) per grid cell
- Conduct at least two surveys per grid cell per year (often done while deploying or checking bait stations)
- Preference given to routes that traverse forested habitats with high horizontal cover and mature stands
- Conduct surveys all winter with the understanding that days with optimal tracking conditions (i.e. 3-7 days after snowfall [Figure 5]) increase detection probabilities, but are limited in occurrence. More common are days with less optimal tracking conditions that still allow opportunities to detect carnivore presence.

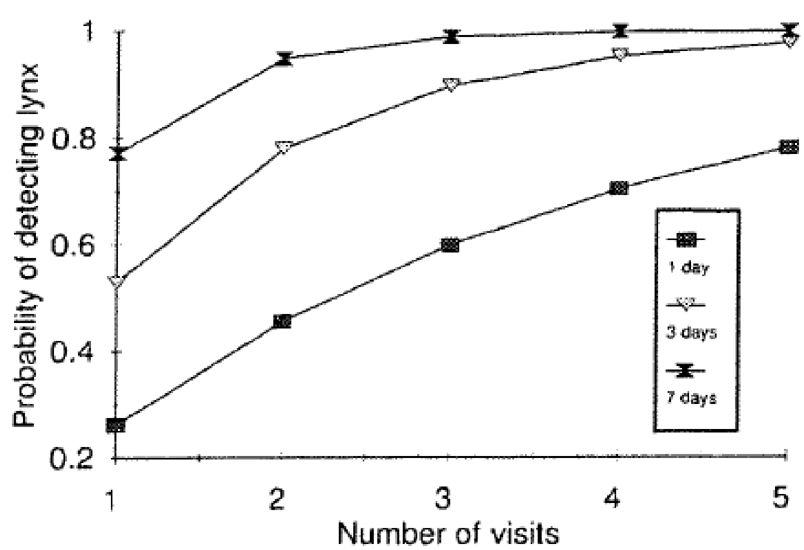

Figure 5. Lynx detection probabilities and the number of visits. Computer-modeled relationship between the probability of detecting lynx and the number of visits to an 8 km survey transect pixel relative to the number of days since last snow. Detection probabilities are relatively high with 2-3 visits when conducted several days after a snowstorm. From Squires et al. (2004).

Technicians recorded tracks of all suspected target species (lynx, wolverine, and fisher) as well as secondary target species (marten, mountain lion, wolf, and bobcat). Only the first documented secondary carnivore species tracks were recorded for each grid cell. Technicians also measured tracks (i.e. stride, straddle, length, width; Halfpenny et al. 1995) and recorded GPS coordinates.

When a suspected target species track was detected, field technicians followed the trail (i.e. backtrack) to collect genetic samples (e.g., hair, scat). Hair samples were often found in tracks and/or at rest locations such as day beds or on vegetation the animal passed through while traveling. Hair samples were stored in vials with desiccant and scat samples were dried and stored in paper bags. All genetic samples were sent to the RMRS Wildlife Genetics Laboratory in Missoula, Montana for DNA extraction and analysis. Depending on the quality, samples were amplified to verify species and individual.

Bait Stations and Hair Snares

In 2012, methods described by Schwartz et al. (2006) were followed for conducting fisher hair snaring. Within each grid cell, a minimum of four snares were placed along roads or trails at approximately 0.5 mile intervals, with preference given to areas with likely fisher habitat. Snares consisted of a triangular-shaped plastic tube in which a piece of raw chicken was hung in the center (Figure 6). Wire gun-cleaning brushes were placed at various angles on either side of the chicken, so that when an animal entered the snare to get the chicken, hair was snagged in the gun brushes. Hair snares were left in place in the field for approximately 21 days. Technicians then returned and collected any hair samples, which were sent to RMRS for DNA extraction and analysis.

Figure 6. Fisher hair snare used in 2012.

This method, in which at least four snares were placed per grid cell, had a 97.7% probability of detecting fisher in a sampling unit in an area with a known fisher population (Schwartz et al. 2006). Schwartz et al. suggest that placing more snares per unit might be appropriate in areas with fewer fishers, and recognize the limitations of these methods for detecting individual fisher or small populations.

After detecting no fishers during the 2012 field season, fisher hair snare stations were changed to a multispecies bait station that has been successful in detecting multiple carnivore species, including fisher, lynx, and wolverine (M. Lucid, Idaho Fish and Game, personal communication). The new methodology uses a bait pole (i.e. a tree with bait attached six feet up) with gun brushes under the bait to collect hairs of any carnivores that climb the tree to get the bait (Figure 7). Lynx may be more hesitant to climb the tree than other species (M. Lucid, personal communication), and thus the methodology was modified to include the use of lynx hair pads, similar to the National Lynx Survey Protocol (McKelvey et al. 1999). We also added a long-distance scent lure to the bait and catnip oil (both from Minnesota Trapline Products) on the lynx pads. Flashy attractants such as compact discs or pie tins were hung in nearby trees as visual attractants to lynx, which often rely more on visual cues than olfactory cues to identify prey. We attempted to check, and re-bait or remove, bait stations every 21-30 days.

Figure 7. Multi-species bait station. Station used in 2013 showing bait, gun brushes, and lynx pad.

Finally, a subset of bait stations was equipped with motion-sensor photo or video cameras to capture the activity of individuals at bait stations (Figure 8). We used Bushnell Natureview HD Max trail cameras at opportunistically selected bait stations. We affixed cameras to trees about 4.5 - 5 feet off the ground and about 30 feet from the bait station. We formatted our cameras to take one-minute videos when triggered by motion and heat. Some camera performance issues experienced during the study were probably related to cold temperatures as the cameras are not rated to work properly below -5° F.

Figure 8. Wolverine and lynx images. Captured by motion activated camera traps at bait stations in 2014.

Genetic Analyses

DNA extractions were performed using standard protocols for non-invasive samples. Two DNA extractions were performed for any samples that looked to have morphologically different types of hair. Conversely, maximizing amplification success rates, while keeping costs down, was a concern for samples containing very few hairs. Therefore, some samples were combined into a single extraction tube when they were collected from the same grid cell/station/date if the hair looked morphologically identical.

Genomic DNA was extracted from hair samples using the QIAGEN Dneasy Blood and Tissue kit according to manufacturer's instructions for tissue and using modifications for hair samples from Mills et al. (2000). Genomic DNA from scat samples was extracted using the QIAGEN QIAamp Stool Kit following manufacturer's protocols. Samples were processed in a satellite laboratory dedicated to non-invasive samples. Samples were tested for species identification using 344 base pairs from the control region of mitochondrial DNA (mtDNA). The quality and quantity of template DNA were determined by 1.6% agarose gel electrophoresis. DNA sequence data was obtained using the Big Dye kit and the 3700 DNA Analyzer (ABI; High Throughput Genomics Unit, Seattle, WA). DNA sequence data were viewed and aligned with Sequencher (Gene Codes Corp. MI) and compared to reference databases to identify species.

DNA from wolverine samples were amplified for individuals using a panel of microsatellite loci used previously on wolverine (Schwartz et al. 2009). Samples were also tested using an SRX/SRY analysis to determine sex (Hedmark et al. 2004). DNA from lynx samples were analyzed using a panel of microsatellites for lynx (Carmichael et al. 2001) and a sex test (Pilgrim et al. 2005). The resultant products were visualized on a LI-COR DNA analyzer (LI-COR Biotechnology). All non-invasive samples were amplified using the multi-tube approach (Eggert et al. 2003, Schwartz et al. 2004) and data were error checked using the program Dropout (McKelvey and Schwartz 2005).

Results and Interpretation

Monitoring Effort

Across all four years (2013-2016), we surveyed 82 of the 129 grid cells that at least partially fall within the SW Crown (see Figure 13). We conducted snow-track surveys on over 1,000 miles each year (including revisits) within those grid cells (Table 3, Figure 9). Surveys were done during an average of 53 field days each year between January 9 and April 14. Generally, we had three teams of two individuals working five days a week.

We focused primarily in areas accessible by snowmobile and areas where forest management activities were likely. The number of miles surveyed within a grid cell was largely dependent on the presence of accessible roads in that cell. Cells with minimal roads make access more difficult, time consuming, and costly.

Table 3. Snow-track survey effort from 2013-2016 for all target species.

Year	Number of survey days	Number of grid cells[a] surveyed at least once	Total miles surveyed[b]	Average miles/grid cell/survey[c] (range)
2013	51	73	1130	6.6 (0.2 - 16.0)
2014	52	62	1257	6.5 (0.2 - 18.8)
2015	52	76	1690	6.2 (0.4 – 22.5)
2016	55	82	2380	6.8 (0.2 - 31.6)
2013-16 (Avg)	53	73	1614	6.5

[a] There are 129 grid cells that at least partially intersect the SW Crown landscape (see Figure 4), and 87 of those have their majority in the SW Crown boundary.
[b] Includes revisits to the same survey route.
[c] The average value used here was based on the number of miles covered on snowmobile or foot in each grid cell per survey effort, including revisits to the same grid cell (see Methods section).

From 2013-2016, multi-species bait stations were deployed across 82 unique grid cells (Figure 9). In 2014, we targeted higher elevation cells, instead of lower elevation marginal habitat, which took more time to reach and reduced the number of bait stations deployed (Table 4).

Table 4. Summary of bait stations and hair snares deployed from 2013-2016.

Year	Number of bait stations	Number of grid cells[a] with at least one bait station or hair snare	Avg. number of bait stations/grid cell	Avg. bait station elevation in feet (range)	Avg. number of days of bait station deployment (range)[b]
2013	162	77	2.2	4967 (3123-7095)	44 (19-121)
2014	107	51	2.1	5515 (3185-7849)	47 (13-87)
2015	161	70	2.3	5634 (4165 – 7211)	48 (14 - 171)
2016	181	63	2.9	5627 (3242 - 6892)	44 (7 – 76)
2013-16 (Avg)	153	65	2.4	5436	46

[a] There are 129 grid cells that at least partially intersect the SW Crown landscape, and 87 of those have their majority in the SW Crown boundary.
[b] Fisher hair snares were used in 2012. Some of these stations were re-baited during the deployment period. In 2013 and 2015, a few sets were placed in the backcountry and could not be revisited until summer; hence, the long deployment period.

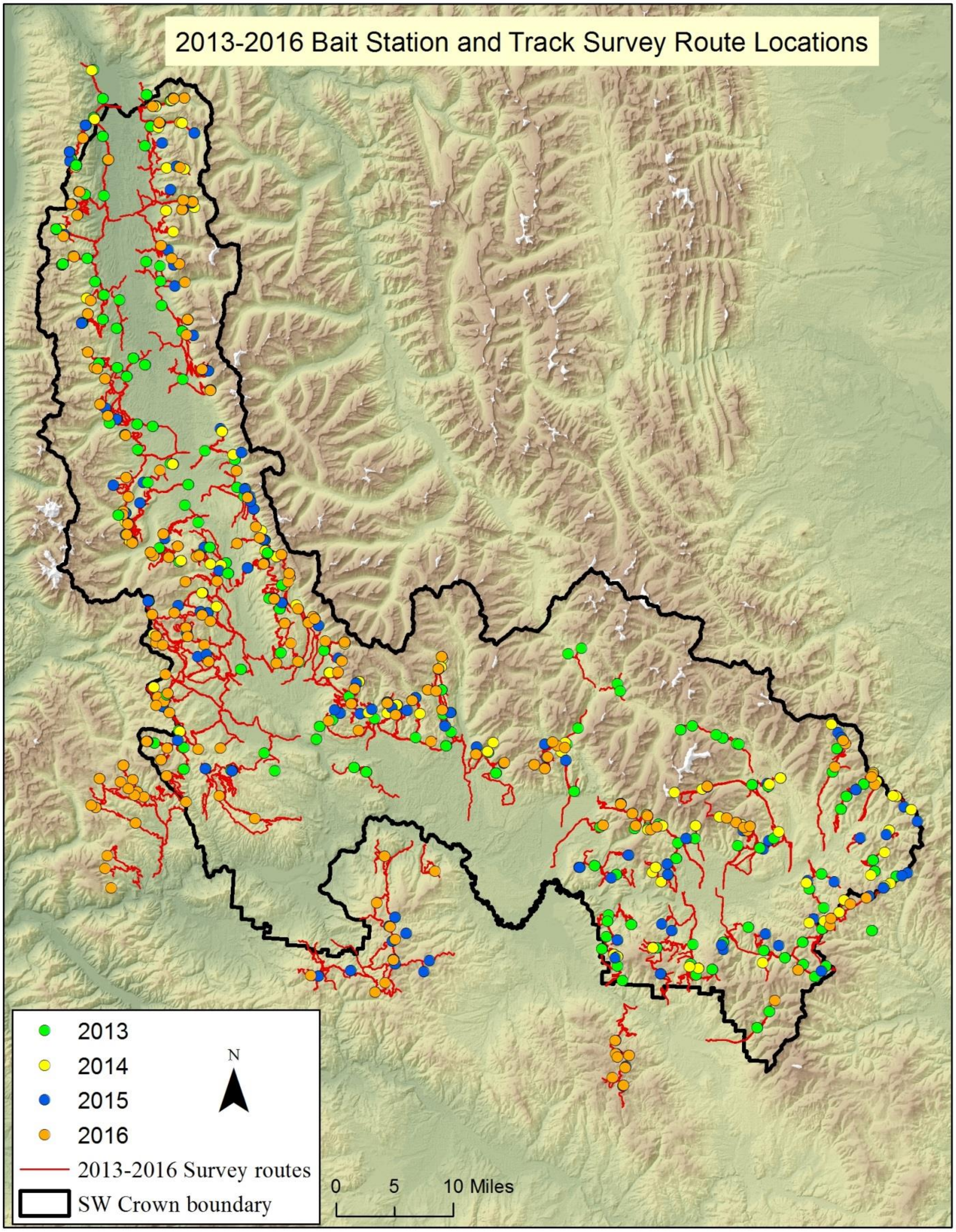

Figure 9. Locations of track survey routes and bait stations in the SW Crown 2013-2016.

Lynx

Across all four years (2013-2016), lynx were detected in a total of 33 different grid cells in the SW Crown (Table 6 and Figure 10). The number of grid cells with lynx detections from track surveys was very similar across years and was considerably higher than cells with lynx bait station detections. There were lynx track observations, of high confidence, from 32 of the detection cells and genetic analysis of back-tracked samples confirmed lynx in 22 of these cells.

Lynx were detected at bait stations in 18 cells. There was only one instance, in 2013, where a lynx was detected in a cell by bait station alone, though tracks were observed in subsequent years. Both methods consistently captured unique individuals (see Table 8). The reasons genetics did not confirm lynx presence in all of the track detection cells include: samples on backtracks may not have been found, lynx in a grid cell may not have visited a bait station, or the DNA samples were of too low of quality to amplify to species.

The number of grid cells with detections by bait stations doubled between 2013 and 2014 (Table 6). We started using lynx pads in 2013 and modified them in 2014 to include gun brushes, which may have increased the number of samples.

Lynx tracks were detected within an elevation range of 3,986 – 6,808 ft (mean = 5,517 ft). Less than 1% of the locations were below 4,200 feet, even though we had many surveys and bait stations below this elevation. This is similar to Squires et al. (2010) who found lynx forage primarily above 4,166 feet in winter.

Table 6. Lynx detections in the SW Crown from 2012-2016 by detection method.

Year	Grid cells w/ track detections[a] (number confirmed by genetics)	Grid cells w/ bait station detections[b]	Total number of grid cells w/ detections by both methods (number confirmed by genetics)	Number of individuals[c] (males, females)
2012	20 (9)	n/a	20 (9)	4 (3m, 1f)
2013	19 (9)	5	20 (12)	7 (5m, 2f)
2014	19 (11)	10	19 (13)	13 (10m, 3f)
2015	16 (12)	10	18 (16)	17 (13m, 4f)
2016	20 (13)	13	22 (16)	27 (15m, 12f)
Total unique	32 (22)	18	33 (26)	39 (23m, 16f)

[a] Includes tracks of "high" confidence; number of these confirmed by genetics results is in parentheses. Reasons that not all are confirmed include: no sample found, samples did not magnify due to poor DNA, magnified to another species (e.g., snowshoe hare) due to mixture of DNA.
[b] From genetics results. In 2012, fisher hair snares were used, which were not designed to detect lynx.
[c] Not all genetics samples can be identified to individual due to poor quality.

On average, in 35.8% of the grid cells visited each year we met the full protocol described in Squires et al. (2004)(Table 7). The primary criteria of the protocol are: at least 2 surveys >6.2 miles per survey under adequate snow tracking conditions. The greatest factor in whether the protocol was met was the presence of sufficient snowmobile-accessible roads in a cell. Snow conditions were usually sufficient for confidently identifying tracks, even without recent snowfall.

Table 7. Summary of track surveys completed to protocol described in Squires et al. (2004).

Year	Number of grid cells[a] surveyed at least once	Cells w/at least 1 survey of ≥ 6.2 miles	Cells with 2 surveys of ≥ 6.2 miles	Cells with 2 surveys of ≥ 6.2 miles, and good tracking conditions[b]	Grid cells with lynx track detections[c]
2012	65	47	36	31 (47.7%)	21
2013	73	51	29	26 (35.6%)	19
2014	62	39	26	25 (40.3%)	19
2015	76	35	18	13 (17.1%)	16
2016	82	55	43	41 (50.0%)	20
2013-16 Avg	73	45	29	26 (35.8%)	19

[a] There are 129 grid cells that at least partially intersect the SW Crown landscape.
[b] Tracking conditions were recorded in the field as: Excellent, Good, Fair, or Poor. Here we counted Excellent, Good, and Fair conditions. (Percent of cells surveyed completed to protocol).
[c] Only those observations with "high" confidence were counted.

We identified 39 individual lynx, 23 males and 16 females, through genetic analysis of backtracking and bait station samples in 2013-2016 (Table 8). Seven of these had previously been identified through work done by the Rocky Mountain Research Station. The number of individuals identified each year has climbed steadily across years, possibly due to improved efficiency in collecting, handling, and analyzing samples.

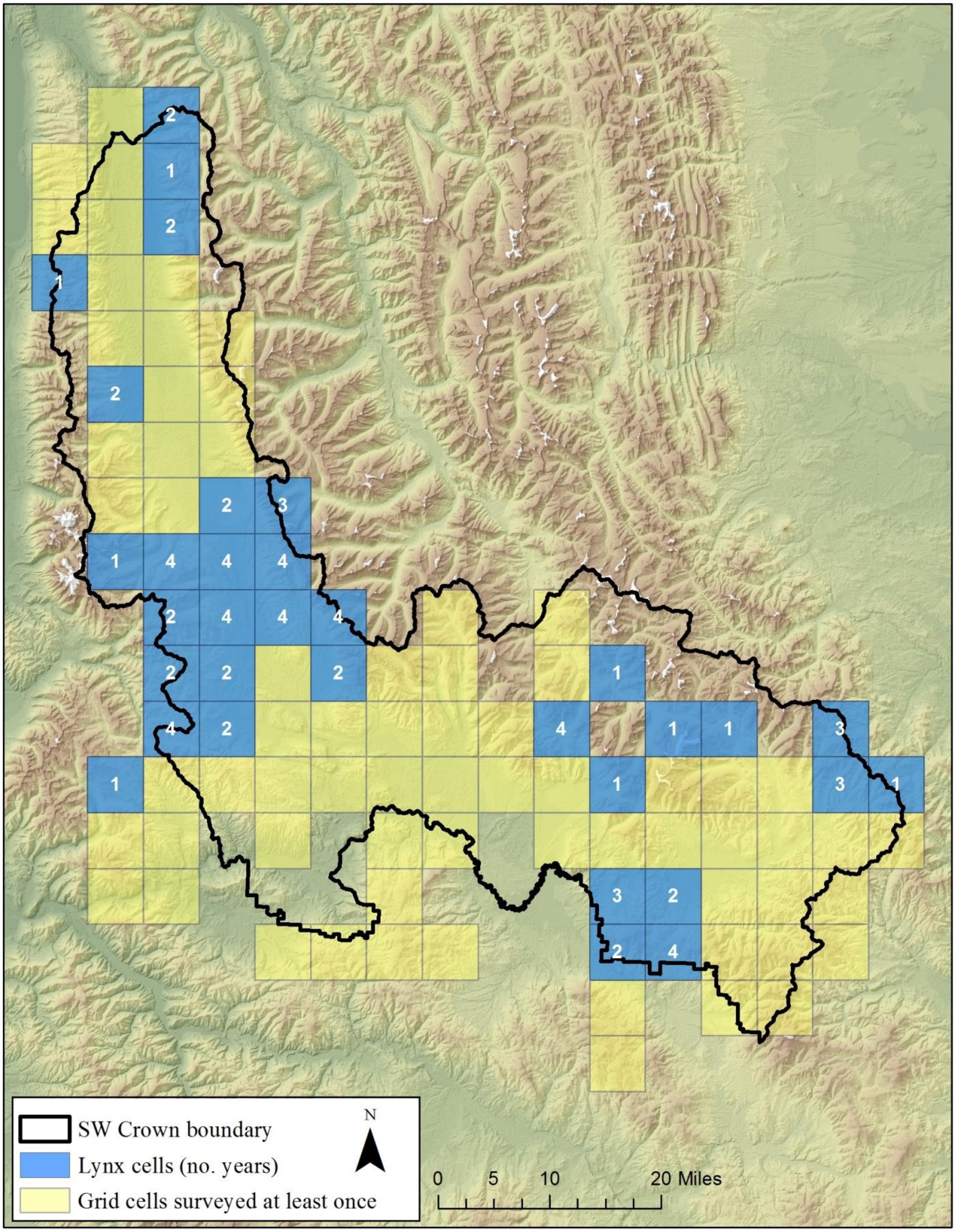

Figure 10. Grid cells (blue) with lynx detections 2013-2016 using both track surveys and bait stations. Yellow cells are other cells surveyed at least once in that time period. The number inside the cell indicates the number of years lynx were detected in the cell (out of a maximum of 4).

Table 8. Individual lynx identified through track surveys and bait stations 2012-2016, including sex, Forest Service District, number of years detected, initial detection study, and method of detection of individual with grid cell numbers.

Lynx ID	Sex	FS Dist	No. Years Detect	Study First ID'd	2012	2013		2014		2015		2016	
					Snow track	Snow track	Bait Stn	Snow track	Bait Stn	Snow track	Bait Stn	Snow track	Bait Stn
M059	M	Seeley	4	RMRS			2163		2163		2222 2163	2163	2163
M080	M	Swan, Seeley	3	RMRS			2105	2048	2048 2105	2048	2048 2105		
M092_M174	M	Seeley	3	RMRS					2045		2045	2045	1989 2045
M147	M	Seeley	4	RMRS			2104 2105	2104		2104	2104	2104	1989 2045 2104
M163	M	Lincoln	3	RMRS				2542	2542			2542	
SWCC_12_M01	M	Swan	1	SWCC	2106								
SWCC_12_M02	M	Seeley	2	SWCC	2446					2446			
SWCC_12_M03	M	Lincoln	2	SWCC	2595			2687					
SWCC_12_F04	F	Seeley	1	SWCC	2104								
SWCC_13_M05	M	Lincoln	1	SWCC		2546							
SWCC_13_F06	F	Seeley	3	SWCC		2164			2164	2164			
SWCC_13_F07	F	Swan	1	SWCC		2055							
SWCC_13_M08	M	Seeley	2	SWCC		2164			2164				
SWCC_14_F09	F	Seeley	1	SWCC				2045	2045				
SWCC_14_F10	F	Seeley	2	SWCC					2164	2164	2164		
SWCC_14_M11	M	Seeley	2	SWCC					2163				2163 2164
SWCC_14_M12	M	Lincoln	3	SWCC					2686 2687	2686		2687	
SWCC_14_M13	M	Seeley	3	SWCC					2104	2163	2163 2164	2165	2164 2165
SWCC_15_M14	M	Seeley	1	SWCC							2046		
SWCC_15_M15	M	Seeley	1	SWCC							2165		
SWCC_15_F16	F	Lincoln	2	SWCC						2542		2492	
SWCC_15_M17	M	Swan, Seeley	2	SWCC							1993		1989 2046 2048 2105
SWCC_15_M18	M	Seeley	2	SWCC						2104			2164
SWCC_15_M19	M	Seeley	1	SWCC						2105			
SWCC_15_M20	M	Lincoln	2	SWCC						2687			2687
SWCC_15_F21	F	Seeley	2	SWCC						2045	2045	2045	
12_F167_K2	F	Seeley	1	RMRS								2446	
F141	F	Seeley	1	RMRS								2163	

SWCC_16_M22	M	Seeley	1	SWCC								2044	1989
SWCC_16_F23	F	Swan, Seeley	1	SWCC								2046	2048
SWCC_16_F24	F	Swan, Seeley	1	SWCC								2105 2048	
SWCC_16_F25	F	Seeley	1	SWCC								2046 2104	
SWCC_16_M26	M	Seeley	1	SWCC								2047	
SWCC_16_F27	F	Seeley	1	SWCC								2047	
SWCC_16_F28	F	Seeley	1	SWCC								2104	
SWCC_16_M29	M	Seeley	1	SWCC								2104 2105	
SWCC_16_F30	F	Seeley	1	SWCC								2164	
SWCC_16_M31	M	Lincoln	1	SWCC								2542 2492	
SWCC_16_F32	F	Seeley	1	SWCC									2048 2104
SWCC_16_M33	M	Lincoln	1	SWCC								2492	
SWCC_16_F34	F	Lincoln	1	SWCC								2542	

Wolverine

Across the four years, wolverines were detected in a total of 52 grid cells (Table 9 and Figure 11). The number of grid cells with wolverine detections increased each year. The number of grid cells with wolverine detections from track surveys was usually more than those detected from bait stations (Table 9). Unlike lynx, wolverines were detected each year in some grid cells solely by bait stations and not from tracks. A total of 32 unique wolverines (16 male, 16 female) were identified from genetics (Table 10). Wolverines were detected within the elevation range of 3,409 – 7,198 ft (mean = 5,538 ft).

Table 9. Summary of wolverine detections using both track surveys and bait stations from 2012-2016.

Year	Grid cells w/ track detections[a] (number confirmed by genetics)	Grid cells w/ bait station detections[b]	Total number of grid cells w/ detections by both methods (number confirmed by genetics)	Number of individuals[c] (males, females)
2012	8 (3)	2	9 (5)	1 (1f)
2013	12 (6)	9	16 (11)	10 (4m,6f)
2014	29 (13)	16	31 (20)	10 (4m, 6f)
2015	23 (12)	27	32 (29)	15 (8m, 7f)
2016	35 (14)	33	43 (35)	18 (10m, 8f)
Unique	49 (29)	41	52 (44)	32 (16m, 16f)

[a] There are 129 grid cells that at least partially intersect the SW Crown landscape (see Figure 4).
[b] In 2012, fisher hair snares were used not multi-species bait stations.
[c] See Table 10 for information on individuals.

Table 10. Individual wolverine identified through track surveys and bait stations 2012-2016, including sex, Forest Service District, number of years detected, initial detection study, and method of detection of individual with grid cell numbers.

Wolverine ID	Sex	No. Yrs Detect	District	Study First ID'd[a]	2012	2013		2014		2015		2016	
					Bait Stn	Snow track	Bait Stn	Snow track	Bait Stn	Snow track	Bait Stn	Snow track	Bait Stn
SWCC_13_M01	M	1	Lincoln	SWCC			2590						
SWCC_13_F02	F	1	Swan	SWCC			1994						
SWCC_13_F03	F	4	Seeley, Swan	SWCC		1996	1996 1997	2104 2046	2048 2104		2048	2048	1994 2047 2048 2104 2105
SWCC_13_F04	F	1	Swan	SWCC		1997	1996 1997						
SWCC_13_F05	F	4	Seeley, Lincoln	SWCC	2545		2164	2221	2222	2164	2164		2163 2164 2165
SWCC_13_F06	F	3	Swan	SWCC		1945	1945	1945	1945		1945		
SWCC_13_M07	M	1	Seeley	SWCC			2046						
SWCC_13_M08	M	4	Swan, Seeley	SWCC			1994		1994 2048 2105		1945 1995 1996		1996
SWCC_13_M09	M	3	Swan	SWCC			1947		1947	1947	1999 2000		
SWCC_13_F10	F	1	Seeley	SWCC			2164						
SWCC_14_F11	F	2	Swan	SWCC				2056	2054 2056		2056		
SWCC_14_F12	F	2	Swan	SWCC					1994 1997 2056 2108	1994	1997		
HFW10-M3	M	1	Lincoln	WTU				2492					
BDF10-M6	M	3	Seeley, Lincoln	WTU				2542	2495 2542		2492 2542 2639 2684		2446 2495 2545 2639
HFW12-F7	F	1	Lincoln	WTU				2492	2492 2542				
SWCC_15_M13	M	1	Seeley, Lincoln	SWCC						2339 2393	2339 2495		
SWCC_15_M14	M	2	Swan, Seeley	SWCC						1994 2048		2044 2045	1994 2048

												2048	2104 2105
SWCC_15_M15	M	2	Seeley, Swan	SWCC						1999	1945 1946 1947 1999 2000	1945	1945 1946 1947 1997
SWCC_15_F16	F	2	Swan	SWCC							2054		2054
SWCC_15_F17	F	1	Seeley	SWCC							2045		
SWCC_15_M18	M	1	Swan	SWCC							2056		
SWCC_15_M19	M	2	Lincoln	SWCC							2545		2221
HFW12-F8	F		Seeley	WTU									2222 2279
CSKT16-F2	F	1	Seeley	CSKT									2045
SWCC_16_M20	M	1	Swan, Seeley	SWCC								2045 2046 2048	
SWCC_16_M21	M	1	Swan	SWCC								2054	2053 2054
SWCC_16_F22	F	1	Lincoln	SWCC								2594	
SWCC_16_F23	F	1	Seeley	SWCC									1989
SWCC_16_M24	M	1	Swan	SWCC									1996
SWCC_16_M25	M	1	Seeley	SWCC									2047
SWCC_16_M26	M	1	Swan	SWCC									2052 2055 2056
SWCC_16_F27	F	1	Swan	SWCC									2054

[a] SWCC = Southwestern Crown Collaborative, WTU = Wild Things Unlimited, CSKT = Confederated Salish and Kootenai Tribes.

Fisher

We did not detect any fisher in the SW Crown project area through any of our methods over the course of 2012-2016, despite intensive efforts. This included hair snares directed specifically at fisher in 2012 and bait stations in potential fisher habitat and a wide range of elevations. We did detect many other species, including species with similar habits as fisher, such as marten and long-tailed weasel. See data for other species detected in Appendix C.

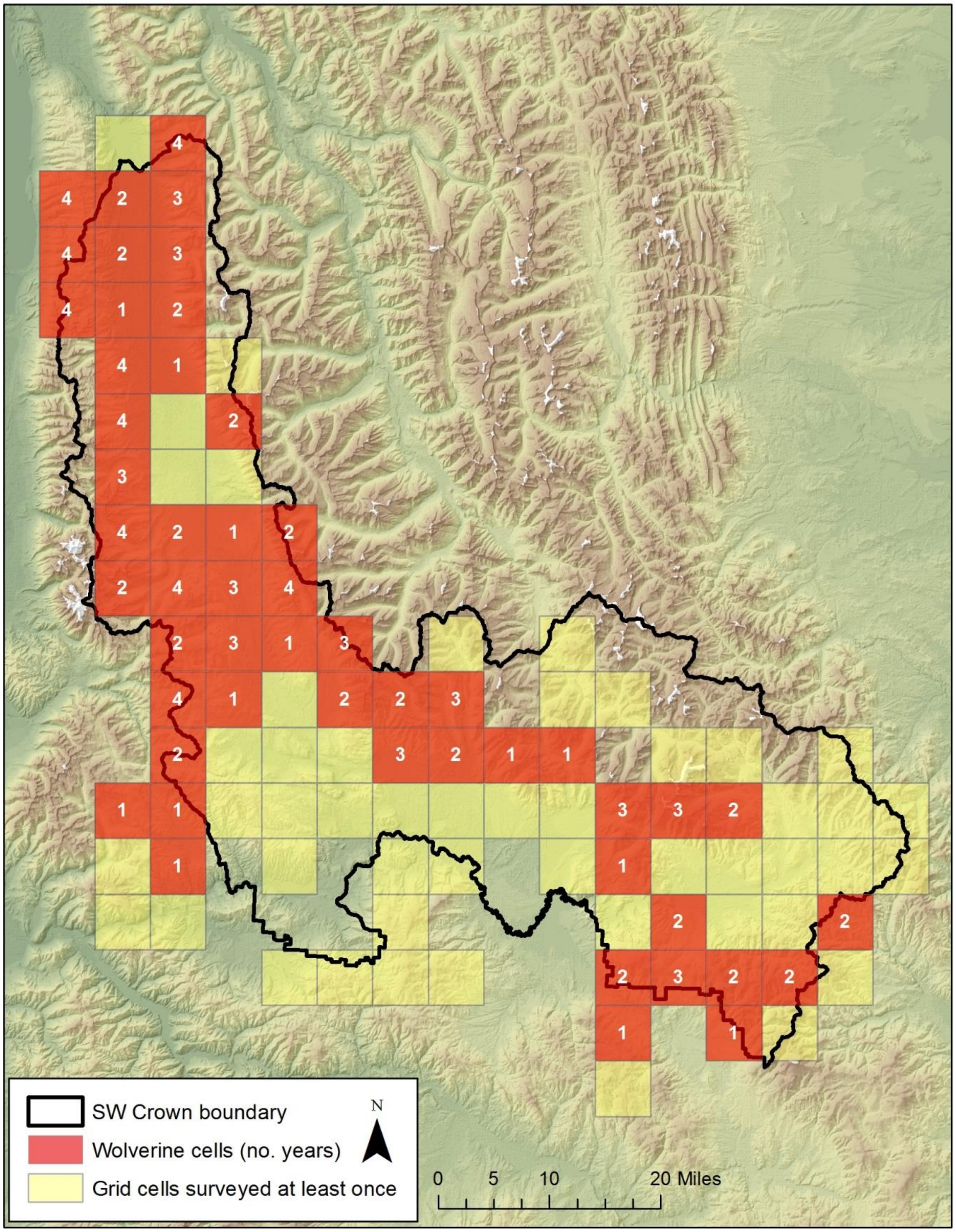

Figure 11. Grid cells (red) with wolverine detections 2013-2016 using both track surveys and bait stations. Yellow cells are other cells surveyed at least once in that time period. The number inside the cell indicates the number of years wolverine were detected in the cell (out of a maximum of 4).

Discussion

Abundance and Distribution

There are multiple ways to measure relative abundance of a species. One metric is the number of individuals detected each year (i.e. minimum number alive). However, since many genetic samples are not of adequate quality to identify to individual, this is likely an underestimate of actual abundance. The number of grid cells in which the species was detected can be used to monitor relative abundance across years, though probably not as an estimate of the actual abundance. The number of grid cells in which a species was detected is also a metric of distribution, and an indication that a breeding population is present. The difference is that when looking at distribution, the spatial element can be more revealing than just simple quantities.

Abundance and Distribution of Lynx

Considering both methods of detection (i.e. snowtrack surveys and bait stations), lynx were detected in roughly the same number of grid cells from 2013-2016 (range: 16-20 grid cells). Some cells were surveyed a majority of years, though perhaps not all years, and the number of cells in which we conducted surveys remained reasonably stable (range: 62-82 grid cells).

Given a fairly consistent amount of survey effort and consistent grid cell results, we can be reasonably confident in saying that the relative abundance of lynx, as indexed by the number of cells in which they were detected, remained roughly the same over the four years of survey. This sets a great baseline for future monitoring, knowing that for this 4-year snapshot in time, with the amount of effort exerted, we found lynx in roughly 19 of the cells each year. For future monitoring, if the effort remains the same and the number of cells in which we detect lynx either increases or decreases, we can begin to infer some changes are occurring in the distribution and/or the population that may warrant more investigation.

Across the four years, the number of unique cells in which lynx were detected (n=33) was much higher than the number of cells in which there were detections annually (avg. n=19). This was due, in part, to the fact that our surveys were not completely consistent in terms of which cells were surveyed each year. For example, in 2013 we made trips into the Webb Lake area on the Lincoln District, which requires at least a 3 day cross-country ski trip. We detected lynx in the cells associated with that survey, but in 2014 we did not go into that area, and did not have detections for those cells. Thus, we can look at the lynx detection rate by grid cell, which is the number of years in which lynx were detected, divided by the number of years we surveyed in that cell, to better assess the consistency of detecting lynx in a particular cell. Those cells that only had lynx detections in, for example, one out of three years in which we surveyed, may be areas that lynx were traveling through or using periodically, but not regularly inhabiting. However, cells where we consistently detected lynx every year were areas that we can assume were regularly inhabited by lynx. Monitoring the consistency of inhabitation over time can help to indicate whether lynx are expanding or retracting their local ranges, or moving to adapt to environmental changes, such as regeneration of forests after large fires. In an ideal scenario, we would be consistently surveying the same exact cells every year, with consistent effort each year, in order to assess changes in distribution or relative abundance. However, given the uncertainty of annual tracking conditions, and limited capacity and funding for covering the entire landscape each year, we need to use metrics that fit well with our survey abilities.

There appear to be areas where lynx were consistently detected and other areas where lynx were either not detected, or were only sporadically detected (Figure 10). Lynx detections were less common throughout much of the Swan Valley, with the exception of the north-eastern portion of the Swan, where lynx were detected multiple years, which is consistent with what Squires and crews observed in the late 1990s/early 2000s.

Because of the logistics of winter surveys, we were not able to survey every grid cell each year to the protocols suggested by Squires et al. (2004) (annual avg.=36% of cells surveyed). We cannot rule out that lynx may have been present in cells where they were not detected, but with multiple years of survey and no detections, we become more confident that those cells were not used by lynx at the time of the surveys. Given that we did have multiple cells that were not surveyed “to protocol,” but where we still detected lynx, we saw that it was quite possible to document presence, even when not “to protocol;” whereas it is more challenging to document the degree of certainty of non-presence. Many of the cells that we surveyed were done to protocol, and we did not detect lynx in those cells. Several cells in the Swan fit this description, where despite multiple surveys over multiple years, lynx were not detected. The same was true for areas directly east and west of Seeley Lake (much of which burned in the Jocko Fire of 2007), parts of the Lincoln District, and the cells at and around Monture and Dunham Creeks.

Across the four years, we detected 39 individual lynx, with the number of individuals detected increasing each year. This was partly due to increased effort to get backtrack samples, especially for females in later years. More males than females were detected at bait stations, given that female lynx are more trap-wary than males (observations from Squires’ research). Also, males tend to travel around more during the mating season in search of females (late Feb and March), which would increase chances of detecting males.

A few of the lynx detected through this monitoring were individuals that were previously identified through John Squires’ research. Many of the lynx we have detected, however, have been “new” individuals that have not previously been identified. Information on their genetics, including individual genotypes, has been made available to other scientists to complement ongoing research on lynx in Montana.

Abundance and Distribution of Wolverine

Considering both methods of detection, track surveys and bait stations, wolverine detections increased each year of the survey. It is difficult to know whether this apparent increase in wolverines was due to a real increase in population, or if it was due to improvements in detection probabilities due to our survey methods, or a combination of both. However, our methods remained relatively constant for wolverine, especially in 2014-2016, and the observed increase could suggest a real population increase within our study area.

Wolverines were distributed throughout the SW Crown, with some apparent concentrations of multiple individuals in certain areas, indicating a breeding population. In particular, the area south of Lincoln has been a focus for wolverine monitoring by a non-profit, Wild Things

Unlimited (WTU), for several years. We have purposely avoided duplicating efforts with WTU, so our time in that area was reduced compared to other areas.

In a few instances we had multiple wolverine individuals at the same bait station at the same time (captured on video), and other bait stations had multiple wolverines visit them in one season. We also have detected individual wolverines traveling at least 30 miles between years (e.g. the individual called SWCC_13_GuloF03). One wolverine, BDF 10-M6 was observed on both sides of Hwy 200 in the Lincoln area. This individual was originally identified on the Beaverhead-Deerlodge National Forest, illustrating the ability for these animals to travel and disperse over large distances across the landscape.

Because we were using baited stations, and wolverines are strongly olfactory with an ability to travel long distances, it would be difficult to extract much more information about habitat suitability based on our detections, as our sampling methodology could bias their distribution. However, we have been able to detect multiple individuals, and will be able to use that metric, as well as the number of grid cells in which we detect wolverine, for tracking relative occupancy over time.

Abundance and Distribution of Fisher

From 2012-2016, we did not detect any fisher in the SW Crown, indicating fairly strongly that fisher were not present, or at least not on a regular basis, within this landscape during the survey period. In 2012, we used the fisher hair snares that were designed by Schwartz et al. (2006) specifically to detect fishers. These snares have a 90%+ chance of detecting a fisher when at least four snares are placed within a grid cell. We followed this protocol, placing an average of 4 snares per cell in 2012, and did not detect fisher. Although no one has yet done the research to determine detection probabilities for fishers using multi-species bait stations, anecdotal information from other study areas (the Idaho Panhandle, and the Lochsa and Selway River areas) indicates that these bait stations are effective at detecting fishers (M. Lucid, IDFG, and C. Lewis, USFS field observations).

Fisher were detected in the SW Crown in the recent past, with the last confirmed detection from a fisher hair snare east of Seeley Lake in 2011 (see Appendix D). Other fisher records date back to the early 1980's (MTFWP trapping records). Modeled fisher habitat from Olson et al. (2014) (Figure 4) shows the best potential for fisher in the Swan Valley. Comparing it to our bait station locations (Figure 10) in the same area suggests that we would have detected fisher had they been present. It seems unlikely, given our level of survey effort and lack of detections, that there is a persistent population of fishers in the SW Crown at this time. Fisher may infrequently disperse to/through the SW Crown.

Analysis of Field Methods

Bait Stations

In our pilot year of 2012, we used fisher hair snares to collect genetic samples. During the winters of 2013-2016 we discontinued the fisher hair snare boxes and combined snowtrack surveys with tree-bole based bait stations targeting multiple species (lynx, wolverine, and fisher). We made this change for several reasons: 1) the need to target multiple species, 2) bait in the fisher boxes were small and often were eaten quickly by small rodents, 3) fisher boxes were deployed on the ground and often became covered by deep snow, reducing chance of detection and

4) we were not successful in detecting fisher in 2012. Conversely, at bait stations we use large baits (deer or elk quarters) placed on a tree bole above the snow. These baits persist for long periods of time and, when combined with a commercial trapping lure, emit a strong scent, increasing our ability to attract a target species. While deployment of bait stations and subsequent collection of genetic samples (hair) takes more time, the ability to survey for multiple carnivore species is worth the effort.

We had considerable success in our detections of wolverine and lynx at bait stations (see Tables 5 and 8). These results indicate that both lynx and wolverine are attracted to bait (ungulate quarters) in trees. Most individuals of both species will readily climb trees to access bait, leaving behind hair on gun brush snares below the bait. However, video footage taken at various bait stations reveals that lynx are somewhat more apprehensive at climbing to baits and that some individuals do not choose to climb at all. These anecdotal observations are substantiated by the fact that we sometimes collected lynx hair at a catnip/castor scented carpet pad placed low on the tree at the bait station but did not get lynx hair on the gun brushes located under the bait higher on the tree. These results validate our original belief that using a combination of the scented carpet pads, as well as gun brushes under baits, increases collection success of viable genetic material.

We did not see video footage of wolverine appearing apprehensive to climb for bait nor did we detect wolverine hair on carpet pads frequently. Based on the known behavioral difference between cats and mustelids, this was not surprising. Lynx (and cats in general) are less olfactory and are more of a specialist predator relying heavily on eyesight to hunt snowshoe hares. Consequently, lynx are less likely to climb a tree and scavenge on an ungulate quarter than a wolverine - which is highly olfactory and much more of a generalist when it comes to food and habitat. This same logic can be applied to fisher and marten. Both are highly olfactory mustelids and both readily climb trees. Thus, tree based carrion baits should be effective at attracting and detecting both of these species. Our genetic results indicate this to be true for marten. A significant number of our bait stations were visited by martens across the study area (see Table C2). We assume the same would hold true for fisher were they present within the study area.

Cameras at Bait Stations

We deployed remote cameras triggered by motion/heat opportunistically at bait stations in all years. The cameras were capable of shooting still photographs or video. We chose to gather video footage in most applications as it provides more information on behavior and unique pelage markings. Some of this video can be viewed at (https://www.swanvalleyconnections.org/wildlife-videos/).

The information gathered from the cameras is useful in a variety of ways. It is educationally valuable to show interested partners and the public footage of these rare animals and how they interact with the bait stations. In addition, we documented some interesting behaviors such as a pair of wolverines traveling together and playfully jumping off the bait tree into the snow. We also captured footage of a pair of lynx vocalizing at a bait station. The cameras were also used to help confirm which animals visited the stations and whether we were successful in collecting genetics from all visiting individuals. However, the cameras could be somewhat unreliable due to cold temperatures. Based on our experience, cameras are an integral addition to bait stations, but the collection of genetic material far exceeds the capability of the cameras to provide useful and rigorous information.

Track Surveys

Our track survey methodology was fairly consistent over the four field seasons with only minor changes/improvements being employed. In general, as the project evolved we spent less time looking at and recording tracks of non-target species and focused on covering more ground to detect target species tracks. We also emphasized spending more time trying to collect genetic material along backtracks of our target species. Part of this change also involved our field personnel becoming more experienced at track ID and not needing to look so closely at tracks. In addition, we realized that recording only the initial detection of non-target species for each grid cell was probably sufficient and fit within the constraints of time and effort given our capacity.

We attempted to maximize our track surveys in each grid cell, but found trying to meet the exact protocols suggested by Squires et al (2004) to be ineffective in our landscape. The goal of those protocols is to conduct 6.2 miles of track survey twice per grid cell during periods of optimal tracking conditions. Optimal tracking conditions are defined as occurring 3-7 days after a snowfall, under good or excellent tracking conditions (a subjective measure). Given our logistical limitations, the expansive area we were attempting to cover, and the varying weather and access conditions we have opted to be in the field as often as safely practicable. As such, many track survey days occur during times of suboptimal conditions. Even so, we have been quite successful in locating tracks of the target species and in following these tracks and collecting viable genetic material.

Observations and Recommendations on Methods

Overall, we feel we have implemented an effective two-tiered methodology that works well for collecting viable genetic material from targeted species. This methodology has allowed us to meet most of our initial project objectives with primary goals to establish baseline occupancy, distribution, and abundance information for lynx, wolverine, and fisher across the SW Crown landscape.

Some additional observations and recommendations about our methods:

- Track surveys are the most effective method for detecting lynx PRESENCE in a grid cell. Bait stations rarely indicate presence in locations where we have not already detected presence via tracks.
- However, bait stations have added insight as to ABUNDANCE of lynx within a grid cell (e.g., cell 2164 had 3 individuals detected from bait stations in 2014; track detections did not indicate multiple individuals).
- In general, bait stations add value to track surveys by increasing the chances of obtaining high quality genetic samples that will inform about individuals, and hence abundance as well as other genetic measures (e.g. genetic connectivity, etc.).
- Due to varying snow conditions between years, multiple years of surveys are recommended to get a more complete picture of abundance and distribution.
- It is important that crew members are well-trained in safe winter travel, survey protocols, and track identification.
- Including scent pads and gun brushes lower down on the tree can increase chances of getting lynx samples.

- Genetic samples are best kept separated in the field if a technician believes more than one species or individual has visited a bait station.
- Genetic samples should be checked if new desiccant is needed. Wet samples can absorb the entire initial desiccant.
- Having at least one additional snowmobile available can help keep the surveys on schedule.

We collected a great deal of important data in a way that is repeatable and systematic. This should allow us to track changes in the distribution and relative abundance of these species over time within the SW Crown.

What Do Results Mean for Managers?

We have developed and tested a rigorous methodology for monitoring changes in abundance and distribution over time for multiple carnivore species simultaneously. This methodology can be deployed by managers throughout these species' ranges and the results can be used at multiple scales.

At the forest project planning scale, lynx and wolverine detection locations are used when deciding where and when management actions should occur. They can help identify areas of potential use by these species and where improvements to habitat may be appropriate. They can also be used in effects analyses for Environmental Assessments and Environmental Impact Statements conducted under the National Environmental Policy Act (NEPA).

At the landscape scale, the data and results have the potential to inform a wide variety of regional management efforts. Some of these include (but are not limited to): the development of new Forest Plans under the 2012 Planning Rule; the Blackfoot Swan Landscape Restoration Project (BSLRP) being conducted for the SW Crown CFLR project; the development of collaborative restoration projects by local restoration committees; the evaluation of lands included in Wilderness Inventories under Chapter 70 of the 2012 Forest Planning Rule; monitoring programs for Region 1 of the U.S. Forest Service; and to inform management planning for these species by the U.S. Fish and Wildlife Service and Montana Fish, Wildlife & Parks. The field work conducted for this project has also helped inform a monitoring protocol being developed and tested for Forest Service regional efforts.

Finally, this project strongly shows the benefits of multi-party monitoring. Monitoring partnerships between federal agencies and outside partners can provide additional expertise, capacity, and funding. For example, participating team members bring at least a 20% match when receiving federal funds for this work. In addition, multi-party efforts help generate trust among the agency and the public.

Ongoing and Future Efforts

We are currently working with researchers at RMRS to help complete multiple analyses of baseline data collected on lynx and wolverine from 2013-2016 throughout the SW Crown landscape. The analyses are expected to provide statistical modeling results related to occupancy, population estimates, and field method comparisons. We intend to publish these results in the near future. We also expect to repeat our survey efforts in coming years to monitor changes over time.

Additional monitoring efforts have also begun in lands surrounding the SW Crown. The Flathead National Forest has expanded surveys to parts of the Forest outside the SW Crown and these efforts are expected to continue. In 2015 and 2016, we received funding from the Bureau of Land Management (BLM) to expand our efforts onto their lands both inside and outside the southern portion of the SW Crown. In 2015, we also started surveys in adjacent lands owned by The Nature Conservancy south and west of the SW Crown. Many land managers recognize the value of multi-species monitoring methods and that obtaining current data on these species is integral to management decisions.

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Appendix A: List of Acronyms

BLM: Bureau of Land Management
BSLRP: Blackfoot Swan Landscape Restoration Project
CFLRP: Collaborative Forest Landscape Restoration Program
DNA: Deoxyribonucleic acid
ESA: United States Endangered Species Act
FNF: Flathead National Forest
ft: feet
GIS: Geographic Information System
GPS: Global Positioning System
HNF: Helena National Forest
IPCC: Intergovernmental Panel on Climate Change
km: kilometer
LAU: Lynx Analysis Unit
LCAS: Canada Lynx Conservation Assessment Strategy
LNF: Lolo National Forest
MTFWP: Montana Fish, Wildlife and Parks
NEPA: US National Environmental Policy Act
NGO: Non-governmental organization
NRLMD: Northern Rockies Lynx Management Direction
R1: Region 1 of the US Forest Service
RMRS: United States Forest Service Rocky Mountain Research Station
SWCC: Southwestern Crown Collaborative
SW Crown: Southwestern Crown of the Continent landscape (see Figure 1)
US: United States
USFS: United States Forest Service
USFWS: United States Fish and Wildlife Service
WTU: Wild Things Unlimited

Appendix B: Field Datasheets

Date Data Entered: __________

Field Form for Carnivore Track Surveys

** Remember to staple a field map to this form, and trace your survey route on the map*

Survey ID[1]:__________________ **Date:**__________ **Estimate of distance covered:** __________________ (miles / km)
Observer(s):__________ **Observer(s) Affiliation:** USFS FWP NWC GBSG Other:
Weather (circle all that apply): Sunny P.cloudy Overcast Windy Below freezing Above freezing Lt. snow Heavy snow
Days since snowfall: ______ **Tracking conditions:** Excellent Good Fair Poor **Complete Survey Conducted?:** Yes / No
Comments:

Track Observations (more space for track observations on the back of this sheet)

Track ID[2]: Genetics ID[3]:				Easting		Northing	Datum/ Zone[4]	Species (best guess)	Confidence (High Med Low)	# Individuals
Stride: **Straddle:**	**Width:** **Length:**	**Gait** ____ Walk ____ Bound ____ Lope ____ Other	**Condition** ____ Excellent ____ Good ____ Fair ____ Poor		**Back-tracked?** Yes No **Backtrack ID:**	**Photo ID's, if taken:** **Other Comments:**				
Track ID[2]: Genetics ID[3]:				Easting		Northing	Datum/ Zone[4]	Species (best guess)	Confidence (High Med Low)	# Individuals
Stride: **Straddle:**	**Width:** **Length:**	**Gait** ____ Walk ____ Bound ____ Lope ____ Other	**Condition** ____ Excellent ____ Good ____ Fair ____ Poor		**Back-tracked?** Yes No **Backtrack ID:**	**Photo ID's, if taken:** **Other Comments:**				

1- survey route nomenclature: PixelID_Date; for example, if you're surveying pixel 1469 on Feb 6, you'll call the route "1469_020611")
2- Track ID nomenclature: TR(Track #)_PixelID_Date; for example, the first carnivore track you encounter on your route would be "TR01_1469_020611". NOTE: If you and your partner have split up to survey the grid cell, please append your initials to the end of the track ID (e.g. "TR01_1469_020611_mm")
3- If you collect a genetics sample from the track, not from a backtrack. For example, if you see some lynx tracks going down the road and come across a scat pile right along your route. Genetics ID nomenclature: Gen(sample #)_(grid cell)_(date); e.g. "Gen01_1469_020611". See note above about adding your initials to the end if you and your partner have split up
4- If possible, record waypoints in UTMs (Zone 11 or 12, depending on where you are), NAD 83; if other than this datum, please specify the datum/zone you recorded the waypoint in

Date Data Entered: ___________

Track ID[2]: Genetics ID[3]:				Easting	Northing	Datum/ Zone[4]	Species (best guess)	Confidence (High Med Low)	# Individuals
Stride: **Straddle:**	**Width:** **Length:**	**Gait** ____ Walk ____ Bound ____ Lope ____ Other	**Condition** ____ Excellent ____ Good ____ Fair ____ Poor	**Back-tracked?** Yes No **Backtrack ID:**	**Photo ID's, if taken:** **Other Comments:**				

Track ID[2]: Genetics ID[3]:				Easting	Northing	Datum/ Zone[4]	Species (best guess)	Confidence (High Med Low)	# Individuals
Stride: **Straddle:**	**Width:** **Length:**	**Gait** ____ Walk ____ Bound ____ Lope ____ Other	**Condition** ____ Excellent ____ Good ____ Fair ____ Poor	**Back-tracked?** Yes No **Backtrack ID:**	**Photo ID's, if taken:** **Other Comments:**				

Track ID[2]: Genetics ID[3]:				Easting	Northing	Datum/ Zone[4]	Species (best guess)	Confidence (High Med Low)	# Individuals
Stride: **Straddle:**	**Width:** **Length:**	**Gait** ____ Walk ____ Bound ____ Lope ____ Other	**Condition** ____ Excellent ____ Good ____ Fair ____ Poor	**Back-tracked?** Yes No **Backtrack ID:**	**Photo ID's, if taken:** **Other Comments:**				

Track ID[2]: Genetics ID[3]:				Easting	Northing	Datum/ Zone[4]	Species (best guess)	Confidence (High Med Low)	# Individuals
Stride: **Straddle:**	**Width:** **Length:**	**Gait** ____ Walk ____ Bound ____ Lope ____ Other	**Condition** ____ Excellent ____ Good ____ Fair ____ Poor	**Back-tracked?** Yes No **Backtrack ID:**	**Photo ID's, if taken:** **Other Comments:**				

Date Data Entered: ___________

Field Form for Carnivore Backtracks & Collection of Genetics Samples

Backtrack ID[1]:_____________________ **Associated Survey Route[2]:** _________________ **Date:**_____________

Observer(s) initials:_____________ **Observer(s) Affiliation:** USFS FWP NWC Other:

Species (best guess): Lynx Fisher Wolverine **Confidence:** High Med Low **Distance Backtracked (mi):** ___

Weather[3]: Sunny P.cloudy Overcast Windy Below freezing Above freezing Lt. snow Heavy snow

Days since snowfall: _______ **Tracking conditions:** Excellent Good Fair Poor **Genetics found:** Yes No

Backtrack Comments:

Genetics sample ID[4]: _________________________ **Type:** Hair Scat Other (describe):

Location of Genetics sample: Daybed Brush Kill site Other (describe):

Waypoint[5]: ____________E _________________N **Datum/Zone:**______________________

Genetics Sample Comments (e.g. number of hairs):

Genetics sample ID[4]: _________________________ **Type:** Hair Scat Other (describe):

Location of Genetics sample: Daybed Brush Kill site Other (describe):

Waypoint[5]: ____________E _________________N **Datum/Zone:**______________________

Genetics Sample Comments:

Notes:

1- Backtrack nomenclature: BT(Backtrack #)_PixelID_Date; for example, the first backtrack you do that day in pixel 1469 on Feb 6 will be called "BT01_1469_020611"

2- This is the survey route you were working on when you came across this track; survey route nomenclature: (PixelID)_Date; for example, if you're surveying pixel 1469 on Feb 6, you'll call the route "1469_020611)

3- Circle all that apply

4- Genetics samples should be named so they're clearly associated with the backtracking effort; nomenclature: Gen(sample#)_BT(backtrack#)_PixelID_Date; for example, the second hair sample you pick up on the first backtrack in pixel 1469 on Feb 6 would be called "Gen02_BT01_1469_020611"

5- If possible, record waypoints in UTMs (Zone 11 or 12, depending on where you are), NAD 83; if other than this datum, please specify the datum/zone you recorded the waypoint in

Date Data Entered: ___________

Genetics sample ID[4]: ________________________ **Type:** Hair Scat Other (describe):

Location of Genetics sample: Daybed Brush Kill site Other (describe):

Waypoint[5]: ____________E ________________N **Datum/Zone:**______________________

Genetics Sample Comments:

Genetics sample ID[4]: ________________________ **Type:** Hair Scat Other (describe):

Location of Genetics sample: Daybed Brush Kill site Other (describe):

Waypoint[5]: ____________E ________________N **Datum/Zone:**______________________

Genetics Sample Comments:

Genetics sample ID[4]: ________________________ **Type:** Hair Scat Other (describe):

Location of Genetics sample: Daybed Brush Kill site Other (describe):

Waypoint[5]: ____________E ________________N **Datum/Zone:**______________________

Genetics Sample Comments:

Genetics sample ID[4]: ________________________ **Type:** Hair Scat Other (describe):

Location of Genetics sample: Daybed Brush Kill site Other (describe):

Waypoint[5]: ____________E ________________N **Datum/Zone:**______________________

Genetics Sample Comments:

Field Form For Carnivore Bait Stations

Location Data

Grid Cell:________ **Bait Station ID:**________________ (i.e. Year_Grid Cell_Station Number)

Easting:______________ **Northing:**__________________ **UTM Datum/Zone:**__________

Ranger District:____________________ **General Area:** _________________________

Comments on Location (to help someone else find it in the future):

Set Up Data

Observer(s): ________________________ **Affiliation:** USFS NWC FWP Other:

Date Set:___________________ **Bait Used:** ______________ **# Dangles:**____ **# Lures:**______

Camera Used: Y N **Camera Model:**________________ **Serial #:** ______________________

Distance between bait and camera trees:_____ feet

Revisit #1 Data

Observer(s): ________________________ **Affiliation:** USFS NWC FWP Other:

Date:___________________ **Snow height on tree:** _______ feet **# lynx pads visible:**_______

Action(s) Taken (circle all that apply): station removed station re-baited station re-lured

Bait condition (circle one): untouched partially consumed skeleton all gone

 # Photos on Memory Card:________ **Memory card replaced:** Y N **Camera batteries replaced:** Y N

Tracks observed in the area: Y N **Scat?:** Y N **Suspected species:** ______________________

 # Gun brushes w/ hair samples: _____ **# Lynx pads w/ hair samples:** __________

Sample IDs: (for gun brushes= StationID_GB#, for lynx pad= StationID_LP#), for scat= StationID_SC#)

____________________ ____________________ ____________________

____________________ ____________________ ____________________

____________________ ____________________ ____________________

____________________ ____________________ ____________________

Comments:

Revisit #2 Data

Observer(s): ___________________________ **Affiliation:** USFS NWC FWP Other:

Date:_____________________ **Snow height on tree:** ________ feet **# lynx pads visible:**________

Action(s) Taken (circle all that apply): station removed station re-baited station re-lured

Bait condition (circle one): untouched partially consumed skeleton all gone

 # Photos on Memory Card:_________ **Memory card replaced:** Y N **Camera batteries replaced:** Y N

Tracks observed in the area: Y N **Scat?:** Y N **Suspected species:** ________________________

 # Gun brushes w/ hair samples: ______ **# Lynx pads w/ hair samples:** ___________

Sample IDs: (for gun brushes= StationID_GB#, for lynx pad= StationID_LP#), for scat= StationID_SC#)

_______________________ _______________________ _______________________

_______________________ _______________________ _______________________

_______________________ _______________________ _______________________

_______________________ _______________________ _______________________

Comments:

Bait Station Tips/Reminders:

Set-up: Pick bait tree (8-12" diameter), apart from other trees (so animal can only access bait from bottom). Remove all 'resting' branches from bait tree. Wire bait securely to bait tree (bottom of bait 6' off ground)
Screw 12 gunbrush holders to bait tree in two concentric circles: 12" below bait, second circle 18" below bait. In each holder, place one gunbrush from above and tighten.
Nail 2 lynx hair pads onto the starting at 18" above current snow level, another pad 12" above the first one. Pads should be pre-soaked with lure and have dried catnip sprinkled on them.
Hang and flag lure sponge (≤10 meters from bait).

If using a camera: Pick camera tree 8-12' from bait tree. Attach criminal tape to bait tree, in view of camera, extending from bait to snow. Nail station name placard below bait. Confirm memory card and charged batteries are in camera. Record camera model and serial number. Lock camera to tree making sure camera is at same height as bait. 'Walktest' camera, flag camera tree

Rebaiting: If applicable: Turn off camera, Replace batteries if level is below 80%, Replace memory card. Examine each gunbrush closely for hair. Without touching hair, place each gunbrush with hair in a separate vial (1 gun brush per vial) and write Sample ID on vials with Sharpie (permanent marker. Replace gunbrushes taken as samples with clean gunbrushes, leave gunbrushes with no hair untouched. Hang new bait, refresh lure. Re-arm camera!!

Removing station: Collect and name samples as above. Place gunbrushes without hair into a Ziploc bag labeled "Clean Gunbrushes" after burning them with a lighter and letting them cool. Remove all hardware and flagging. Collect lure sponge. Remove all wire from bait carcass before discarding in woods.

Appendix C: Non-target Species

We detected several other mammal species while conducting track surveys and at the bait stations (Table C1). Wolf, bobcat, mountain lion, and marten tracks were all very prevalent throughout the landscape (Figure C1). Marten was the most prevalent species at bait stations (Figure C2) and were detected in 63 grid cells (Figure C3) from 2013-2016 by combining both methods. Bobcats were detected in 62 grid cells (Figure C4).

Other small carnivores were often detected at bait stations, including mink, short-tailed weasel, long-tailed weasel, red fox, and striped skunk. Snowshoe hares were often detected in genetic samples due to being common prey items of carnivores. We did not detect coyote or wolf at the bait stations, though hair snares in 2012 did detect a few wolves. Deer were commonly detected in DNA samples from the bait stations because deer quarters were used for bait.

For most of these species, results should not be interpreted as a representation of their distribution because bait stations and track surveys may not be the most appropriate method for detecting them. For example, many of the gun brushes had hair from multiple species in them, often a carnivore and its prey species. However, bait stations are probably an effective method for sampling marten and potentially bobcat.

Table C1. Non-target mammal species and the number of grid cells they were detected through either track surveys or bait stations from 2012-2016.

	2012		2013		2014		2015		2016	
Species	Track	Hair snare	Track	Stations	Track	Stations	Track	Stations	Track	Stations
Marten	29	18	20	28	31	29	22	19	24	23
Wolf/dog	23	5	21		31		46		42	
Mountain Lion	26		21	4	18		28	1	29	3
Bobcat		9		14	18	9	31	13	37	16
Red squirrel	1	25		8		4		3		5
Snowshoe hare		16		3	1				5	
Striped skunk		15		1		1		1		2
Short-tailed weasel	1			10	1	4				4
Flying squirrel		7		6				1		2
Red fox		3		4	2				1	4
Deer mouse		6		2				2		
Coyote	1				5		4		3	1
Long-tailed weasel				5						2
Beaver		1		1						
Mink				2						1
Grizzly							5			

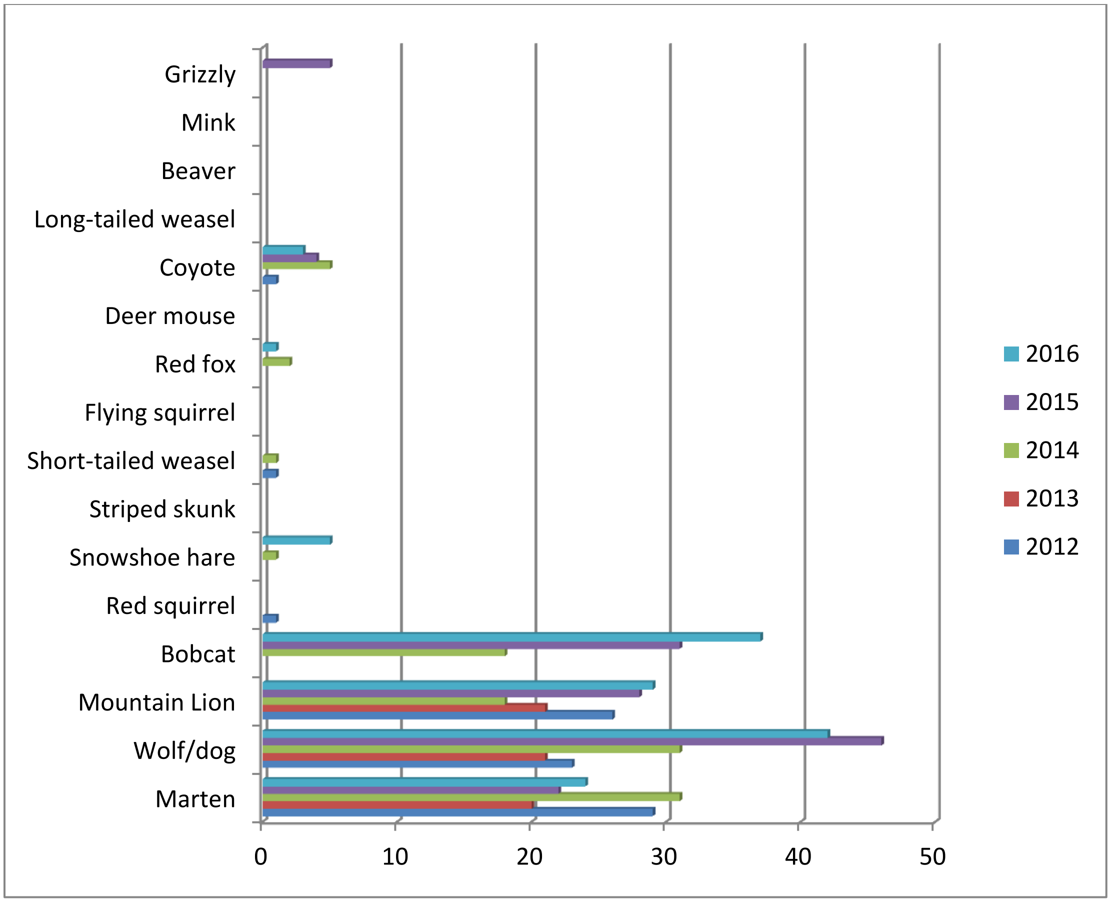

Figure C1. Number of grid cells with detections from track surveys for all non-target species (targeted towards lynx, wolverine, and fisher) in the Southwestern Crown of the Continent 2012-2016.

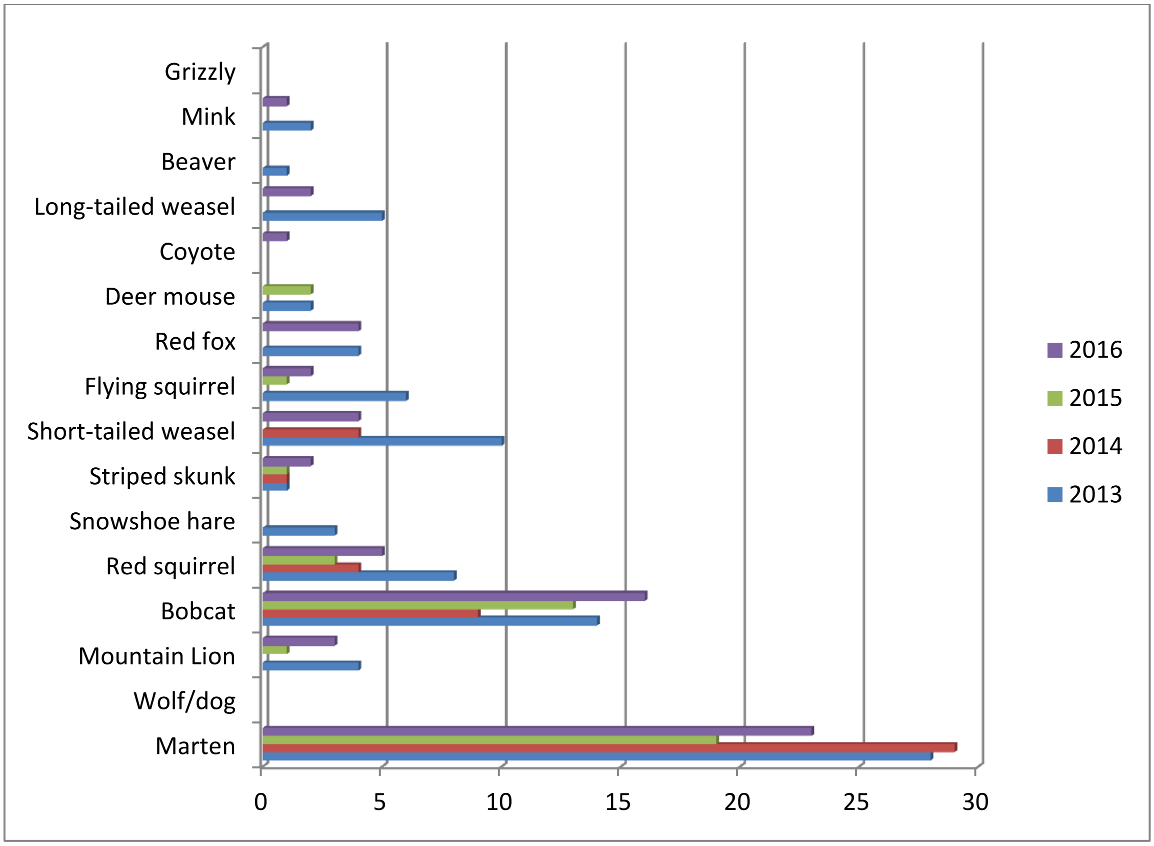

Figure C2. Number of grid cells with detections from bait stations for all non-target species (targeted towards lynx, wolverine, and fisher) in the Southwestern Crown of the Continent 2013-2016.

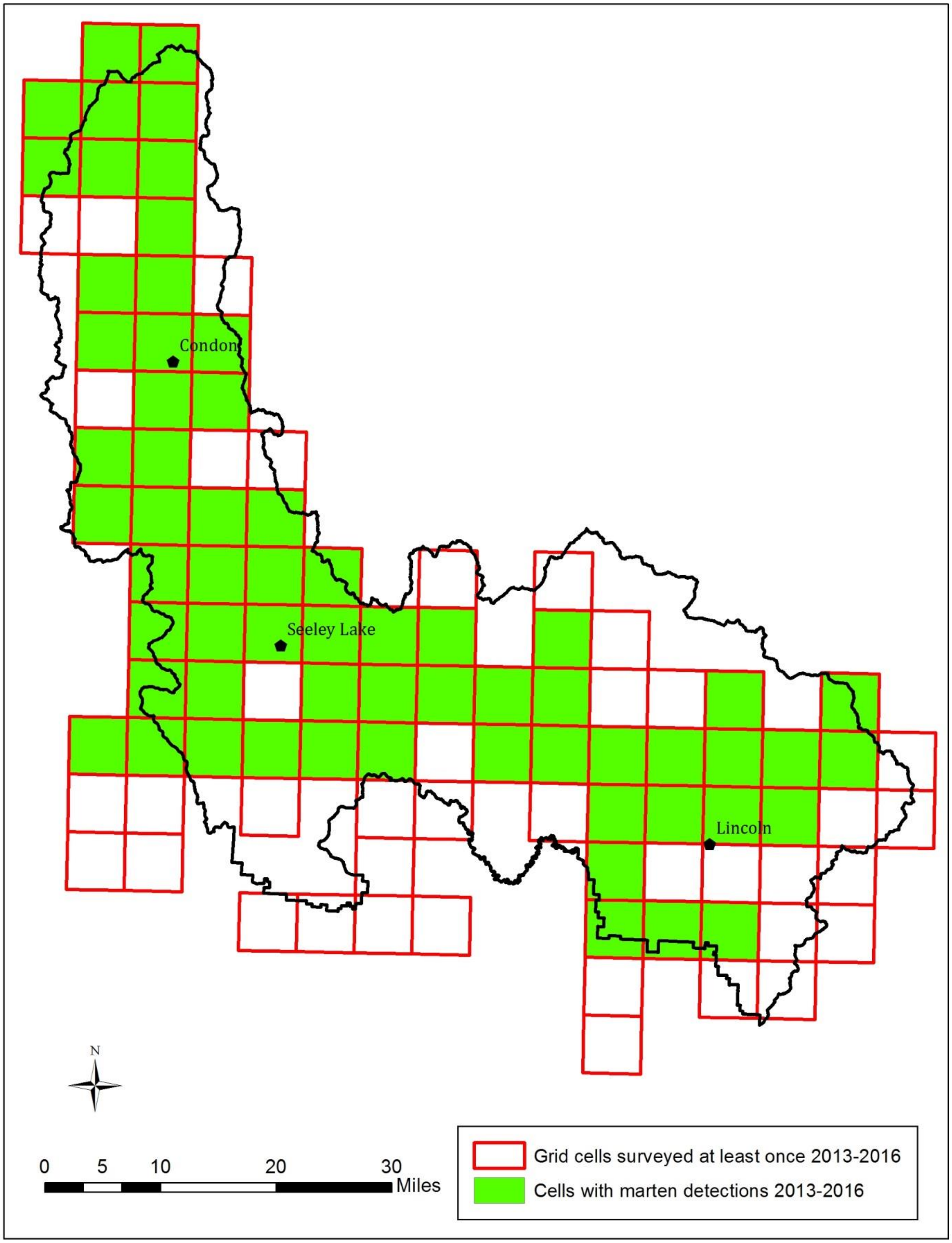

Figure C3. Grid cells in which marten were detected through snowtrack surveys or bait stations in the Southwestern Crown 2013-2016.

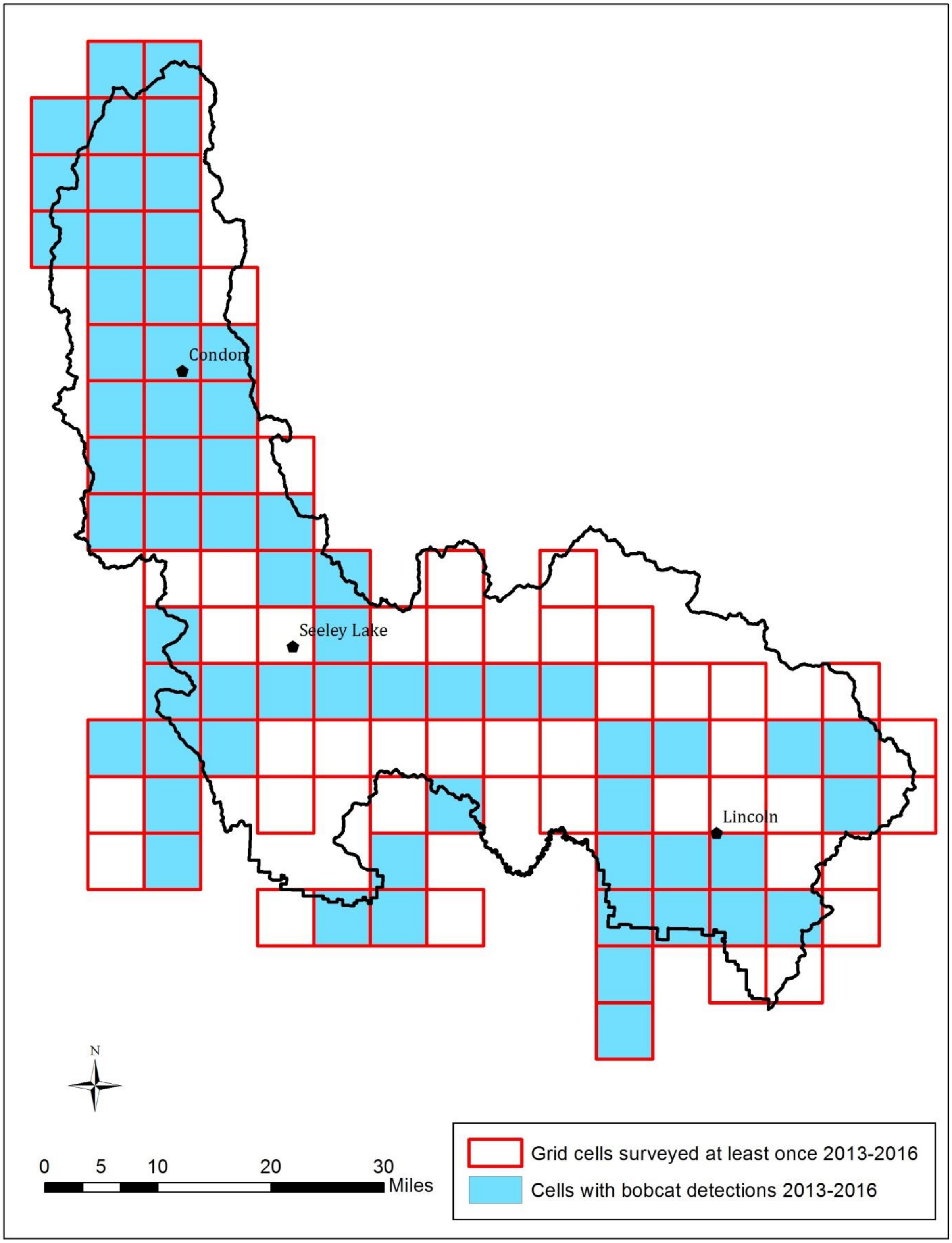

Figure C4. Grid cells in which bobcats were detected through snowtrack surveys or bait stations in the Southwestern Crown 2013-2016.

Appendix D: Fisher detections in the Southwestern Crown (1980-2012)

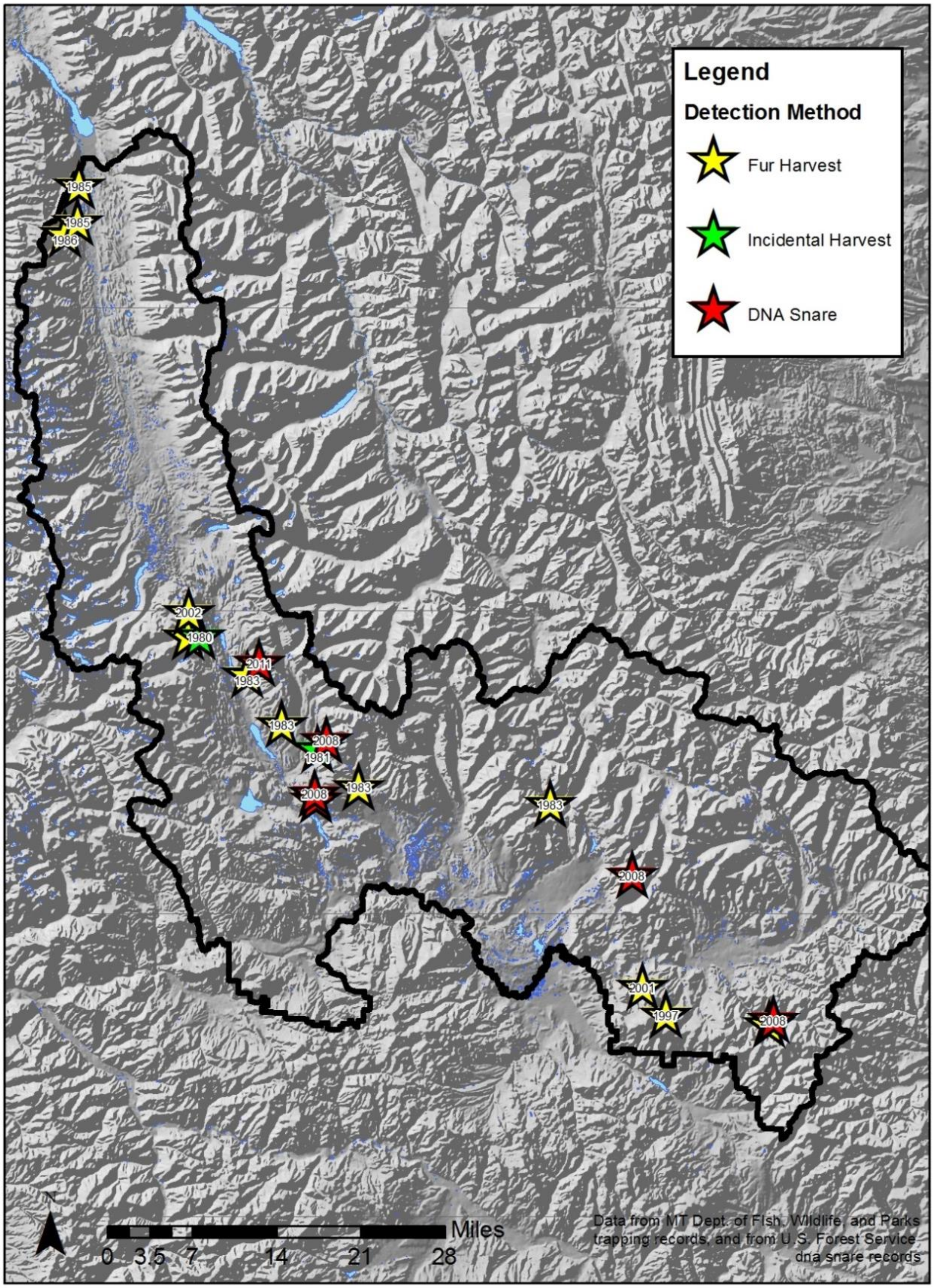

Figure D1. Locations and years of fisher detections in the Southwestern Crown (1980-2012). Data include harvest records from MT FWP and noninvasive surveys from USFS. No fisher were detected by any methods in 2012-2016.

Appendix E: Summary of Results from BLM Lands

Thorough surveys on BLM land were started in 2015. Prior to 2015, a few opportunistic surveys were completed in 2012-2014. Each year in 2015 and 2016, 16 bait stations were deployed on or directly adjacent to BLM land. A lynx was detected in cell 2277 on track surveys in 2016. A wolverine was detected during a 2014 track survey in cell 2494, though it was not on BLM land, and no genetic sample was collected. A wolverine was detected from a bait station in 2016 (lab could not ID individual) on BLM land in cell 2491. Fishers were not detected in any year. Bobcats, martens, mountain lions, and wolves were detected on several surveys in multiple years.

Table E1. Summary of survey results from cells with BLM land.

Year	Cells surveyed	Species recorded by track survey	Species confirmed by bait station*
2012	2494	Marten, Wolf	
2013	2444		
	2494		Marten
2014	2494	Wolf, **Wolverine**	Marten
2015	2216	Coyote, Mtn Lion, Wolf	Bobcat
	2275	Bobcat, Wolf	Bobcat
	2276		Bobcat
	2334	Wolf, Coyote	
	2335		
	2444	Wolf	
	2490		Bobcat
	2491	Mtn Lion	
	2494	Bobcat, Marten, Wolf	Marten
2016	2216	Bobcat, Mtn Lion	
	2275	Mtn Lion, Wolf	
	2276	Bobcat	Bobcat
	2277	**Lynx**, Mtn Lion, Wolf	
	2336	Bobcat, Mtn Lion	
	2444		
	2490		
	2491	Bobcat, Mtn Lion	Bobcat, **Wolverine**
	2494		

* Genetic samples were only tested if there was suspicion of a lynx, wolverine, or fisher.

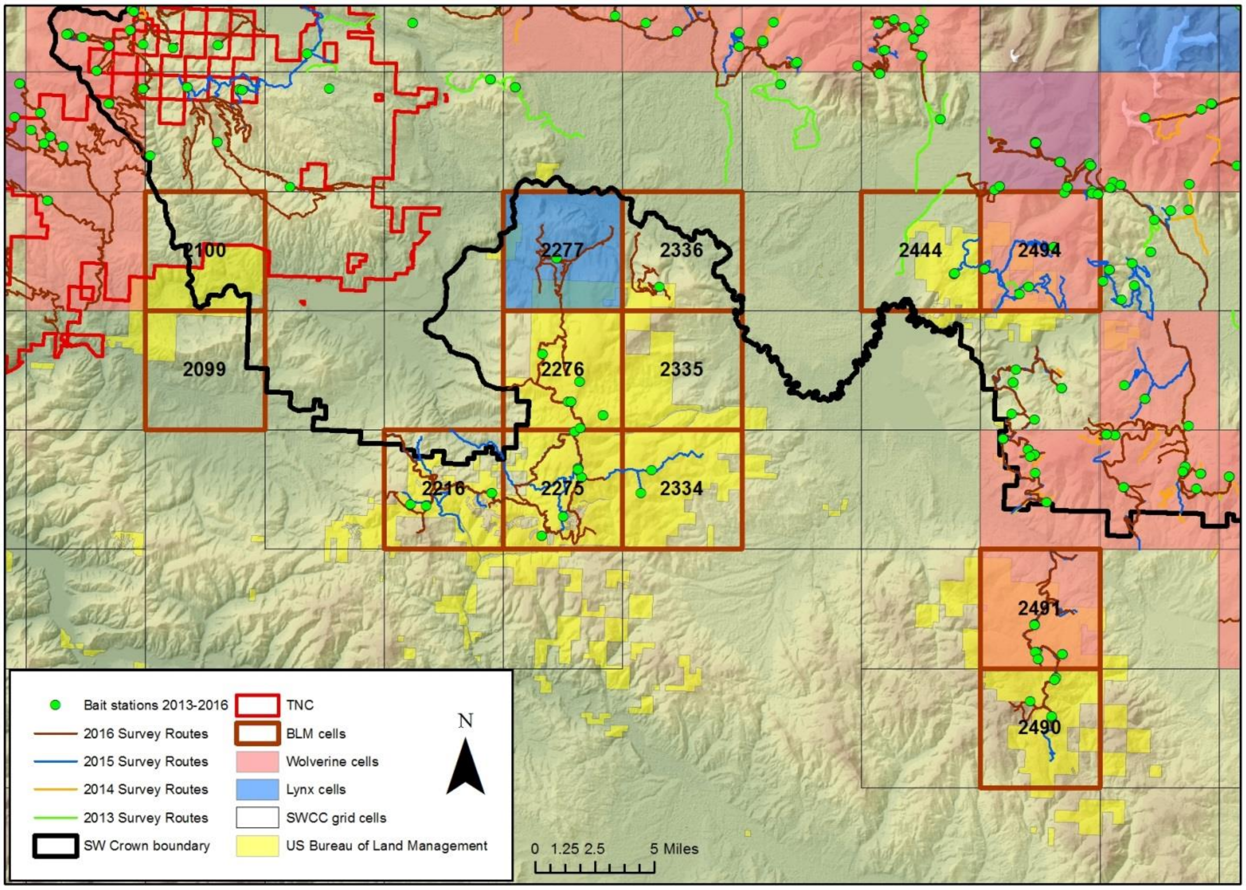

Figure E1. Cells surveyed on BLM lands.

Appendix F: Summary of Results from The Nature Conservancy Lands

Report prepared by Swan Valley Connections

2016-2017 Progress Report

In 2016, Swan Valley Connections expanded the SWCC Carnivore Project surveys to include grid cells that contain sections owned by The Nature Conservancy from the Clearwater/Blackfoot Project. This document serves as a progress report that will include a summary of effort and preliminary results where possible. It is important to note that this report refers specifically to field work completed in areas where the SWCC Carnivore Project survey grid overlaps with TNC lands from the Clearwater/Blackfoot Project (Figure F1). Please also note that the results from genetic samples collected from the 2017 field season will not be available until next winter (2018).

Background

The primary objective of monitoring forest carnivores in the SW Crown of the Continent is to facilitate and coordinate the adaptive management of wolverine, Canada lynx, and fisher habitat by land managers across the landscape. This monitoring project was designed to provide a baseline of the current distribution of the focal species in the SW Crown and to allow for tracking changes in that distribution over time. While the primary focus is on wolverines, Canada lynx, and fisher, we also collect and record the presence and distribution of bobcats, wolves, mountain lions, and pine marten.

Methods

The SW Crown carnivore project utilizes non-invasive survey methods to maximize the ability to detect multiple species across a large landscape in an efficient and cost-effective manner. These survey protocol uses snow track surveys and bait stations developed by researchers with the USFS Rocky Mountain Research Station. In order to standardize the approach across the SW Crown, we overlaid a 5 x 5 mile grid on the entire landscape. We conduct track surveys and deploy bait stations systematically in these grid cells. Our field season starts in the beginning of January and runs through the end of March. DNA samples from suspected target species are processed by the Rocky Mountain Research Station and identified to species. In addition, samples that are confirmed as fisher, lynx, and wolverine are further analyzed to individual and sex.

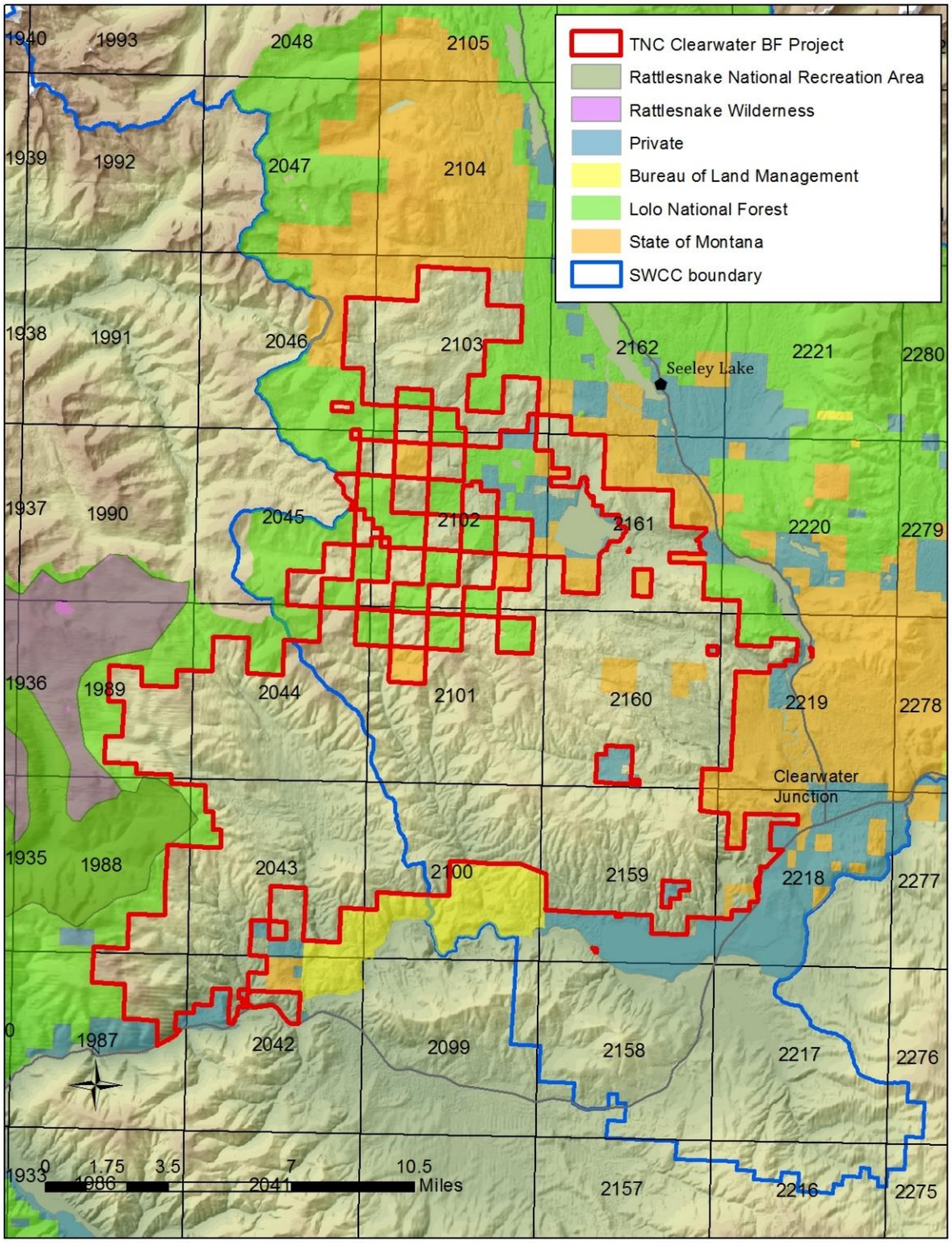

Figure F1. The Nature Conservancy lands surveyed in 2016-2017.

2016 Bait Station Results

In 2016, crews deployed 32 bait stations across 11 cells from which we collected 93 genetic samples. From those samples, the lab was able to amplify DNA and identify 10 species (Figure F2). It is important to note that these multi-species bait stations are designed to detect meso carnivores that are likely to climb trees for a food resource. While our DNA results include several non-target species, they are considered incidental captures and it would be inappropriate to make any inferences of their distribution and abundance. Moreover, samples that amplified to deer are most likely from the bait. Field crews have learned to minimize contamination issues between genetic samples and bait by skinning deer quarters prior to securing it to the tree.

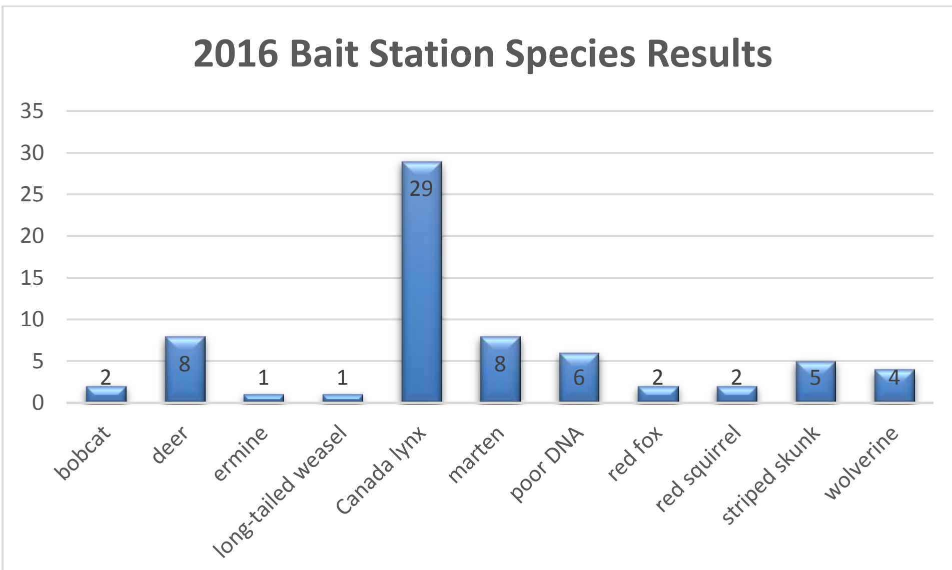

Figure F2. 2016 Bait station species results.

From these species results, the lab took all 29 Canada lynx and four wolverine samples and further analyzed them to sex and individual identification. Of the four wolverine samples, the lab was able to identify two female wolverines (Table F1). One wolverine is a new--previously unknown female (SWCC_16_GuloF23), and the other (CSKT16_F2) is considered a recapture—first detected by Confederated Salish and Kootenai wildlife crews conducting similar surveys on adjacent tribal lands.

Table F1. 2016 bait station genetic results for wolverine.

Grid Cell	Sample ID	Sex	Individual ID	New Individual or Recapture
1989	1989_02_030816_GB01	Female	SWCC_16_GuloF23	New
2045	2045_02_030116_GB01	Female	CSKT16_F2	Recapture

Of the 29 Canada lynx samples from bait stations, the lab was able to identify four unique individuals, all of which were males (Table F2). Three of the males were recaptures (M092_M174, M147, and SWCC_15_LynxM17), while one individual is new to the database (SWCC_16_LynxM22).

Table F2. 2016 Bait station genetics for lynx.

Grid Cell	Sample ID	Sex	Individual ID	**New Individual or Recapture**
1989	1989_01_022316_LP03	Male	SWCC_16_LynxM22	New
1989	1989_03_022416_GB01	Male	M092_M174	Recapture
1989	1989_03_022416_GB02	Male	M092_M174	Recapture
1989	1989_03_022416_GB03	Male	M092_M174	Recapture
1989	1989_03_022416_LP01	Male	M092_M174	Recapture
1989	1989_03_022416_LP02	Male	M092_M174	Recapture
1989	1989_03_030816_GB01	Male	M147	Recapture
1989	1989_03_032216_GB01	Male	SWCC_15_LynxM17	Recapture
1989	1989_03_032216_LP01	Male	SWCC_15_LynxM17	Recapture
1989	1989_03_033116_GB01	Male	M147	Recapture
2045	2045_01_021916_GB01	Male	M092_M174	Recapture
2045	2045_01_021916_LP01	Male	M092_M174	Recapture
2045	2045_01_021916_LP02	Male	M092_M174	Recapture
2045	2045_01_030116_LP01	Male	M092_M174	Recapture
2045	2045_01_030116_LP02	Male	M092_M174	Recapture
2045	2045_01_031516_GB01	Male	M147	Recapture
2045	2045_01_032316_GB01	Male	M092_M174	Recapture
2045	2045_01_032316_GB02	Male	M092_M174	Recapture
2045	2045_01_032316_GB03	Male	M092_M174	Recapture
2045	2045_02_031516_GB01	Male	M092_M174	Recapture
2045	2045_02_032316_GB01	Male	M092_M174	Recapture
2045	2045_02_032316_GB02	Male	M092_M174	Recapture
2045	2045_02_032316_GB03	Male	M092_M174	Recapture
2045	2045_03_030116_GB01	Male	M092_M174	Recapture
2045	2045_03_030116_LP01	Male	M092_M174	Recapture
2045	2045_03_031516_GB01	Male	M147	Recapture
2046	2046_03_032316_GB01	Male	SWCC_15_LynxM17	Recapture

2016 Track Survey Results

In 2016, we conducted 44 track surveys across 12 cells, and collected 35 genetic samples from suspected Canada lynx and wolverine backtracking efforts. We detected wolverine tracks in 6 unique cells and collected 16 genetic samples from backtracking efforts. Canada lynx tracks were detected across 6 unique cells as well, and we collected 19 genetic samples from backtracking efforts. We did not have any confirmed or suspected fisher detections from tracks or bait stations.

From those samples, the lab was able to identify two individual wolverines and five Canada lynx. The two wolverines identified from track survey samples are both males (Table 3). One male wolverine is a recapture (SWCC_15_GuloM14), while the other male is a new individual (SWCC_16_GuloM20).

Table F3. 2016 genetic sample results from backtracks for wolverine.

Grid Cell	Sample ID	Sex	Individual ID	New Individual or Recapture
2044	2044_022316_BT01_GEN01	Male	SWCC_15_GuloM14	Recapture
2045	2045_021916_BT01_GEN03	Male	SWCC_15_GuloM14	Recapture
2045	2045_021916_BT01_GEN06	Male	SWCC_16_GuloM20	New

Of the five Canada lynx identified from backtracking efforts, three are females and two are males (Table F4). Two individuals are recaptures (M092_M174, SWCC_15_LynxF21), while the other three were previously unknown individuals (SWCC_16_LynxM22, SWCC_16_LynxF23).

Table F4. 2016 genetic results from backtracks for lynx.

Grid Cell	Sample ID	Species	Sex	Individual ID	New Individual or Recapture
2044	2044_012816_BT01_GEN01	Lynx	Male	SWCC_16_LynxM22	New
2045	2045_011916_BT01_GEN01	Lynx	Male	M092_M174	Recapture
2045	2045_020916_BT01_GEN02	Lynx	Female	SWCC_15_LynxF21	Recapture
2045	2045_020916_BT01_GEN04	Lynx	Female	SWCC_15_LynxF21	Recapture
2046	2046_011216_BT01_GEN03	Lynx	Female	SWCC_16_LynxF23	New
2046	2046_011216_BT01_GEN07	Lynx	Female	SWCC_16_LynxF25	New
2046	2046_011216_BT01_GEN09	Lynx	Female	SWCC_16_LynxF25	New

While Canada lynx, wolverine, and fisher make up our primary target species, we also detected carnivores that make up our 2nd tier target species on tracks surveys. 2nd tier species for this study include: bobcat, pine marten, mountain lion, and wolf (Figure F3). We record these detections, but do not collect genetic samples.

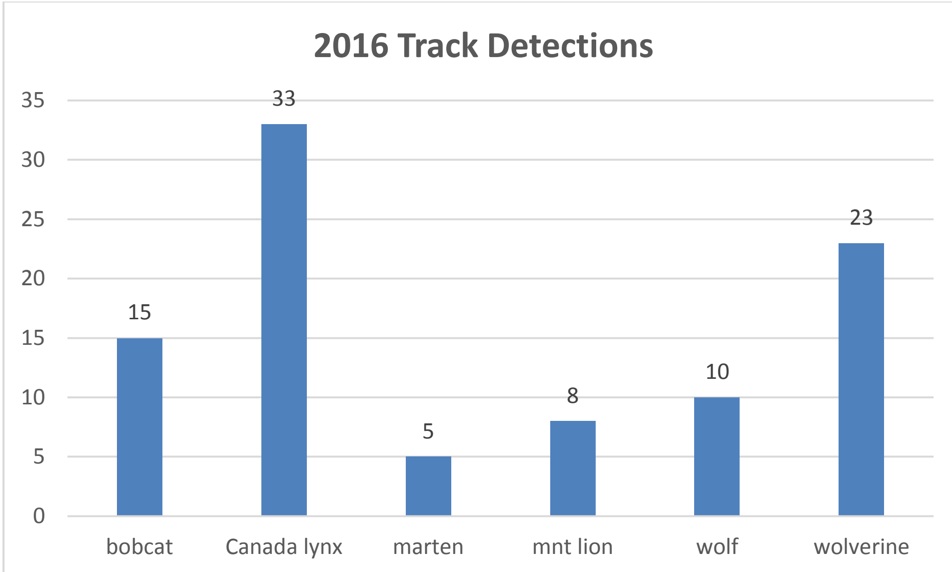

Figure F3. 2016 track detections by species.

Anecdotal accounts of coyote, short-tailed and long-tailed weasel, and skunk tracks, suggest they are ubiquitous across the project area. Badger tracks and activity were common in the upper reaches of the W.F. and main stem of Gold Creek. Additional badger activity was detected in the Finley Creek and Fawn Creek areas. Red fox tracks were also identified and frequently detected in the Gold Creek watershed.

2016 Bait Station and Track Survey Results Combined

In total, four unique individual wolverines were identified in 2016 (Table F5). Two males were detected via track surveys, and two females were detected at bait stations. The combination of both methods doubled the number of individuals detected.

Table F5. 2016 individual wolverine genetic results by method.

Species	Individual	Sex	New Individual or Recapture	Method of Detection	Grid Cells Detected
Wolverine	SWCC_15_GuloM14	Male	Recapture	Track Survey	2044, 2045
Wolverine	SWCC_16_GuloM20	Male	New	Track Survey	2045
Wolverine	SWCC_16_GuloF23	Female	New	Bait Station	1989
Wolverine	CSKT16_F2	Female	Recapture	Bait Station	2045

In total, seven unique individual Canada lynx were detected in 2016 (Table F6). Two individuals were detected by bait stations only, while three individuals were identified only by track surveys. Two of the seven individuals were detected by both methods.

Table F6. 2016 Individual lynx genetic results by method.

Species	Individual ID	Sex	New Individual or Recapture	Method of Detection	Grid Cells Detected
Lynx	M092_M174	Male	Recapture	Track Survey, Bait Station	2045 (both), 1989 (bait)
Lynx	SWCC_15_LynxF21	Female	Recapture	Track Survey	2045
Lynx	SWCC_16_LynxF23	Female	New	Track Survey	2046
Lynx	SWCC_16_LynxF25	Female	New	Track Survey	2046
Lynx	SWCC_16_LynxM22	Male	New	Track Survey, Bait Stations	2044 (track), 1989 (bait)
Lynx	M147	Male	Recapture	Bait Station	1989, 2045
Lynx	SWCC_15_LynxM17	Male	Recapture	Bait Station	1989, 2046

2017 Field Season Summary

Field crews deployed 29 bait stations across 9 grid cells and collected 77 genetic samples. In addition, crews conducted 62 tracks surveys across 11 cells and collected 52 genetic samples. Of these 52 samples, 17 were collected from wolverine tracks, and 35 samples were collected from lynx tracks (Figure F4).

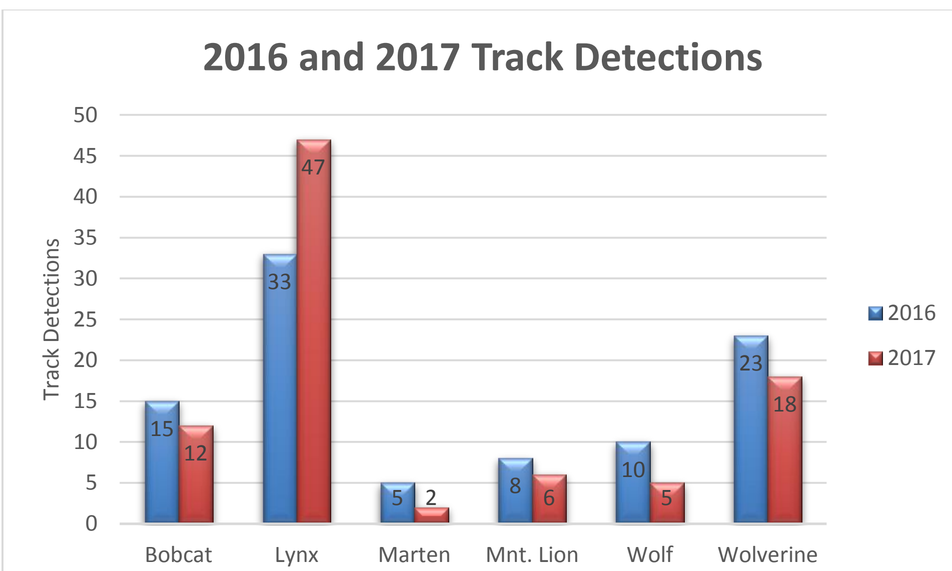

Figure F4. 2016 and 2017 track detections by species.

2017 Field Notes

Field crews continued to document Canada lynx presence in a few key spots across the project area. Through a combination of backtracking, game cameras, and encounters, field crews detected three Canada lynx family groups, each consisting of a mother and two kittens, in the Fawn Creek area, Boles/Elk Meadows area, and the Gold Creek area.

Crews discovered where lynx were feeding on a deer carcass in the Fawn Creek drainage. A bait station and game camera were deployed adjacent to the carcass. Game camera footage captured a substantial amount of lynx activity including a female with two kittens.

In addition to identifying a family group through snow tracks, a field crew encountered a family group in Boles Meadows while snowmobiling into that area in March. Crews visually identified a mother with two kittens. This was the first encounter with this family group, but the third sighting of a lynx in this general area for the season.

In January, crews cut a set of fresh tracks from a family group of lynx in the Gold Creek drainage. Again, a mother and two kittens were identified, this time via snow tracking. Crews tracked the family group to a fresh kill site where they had captured and fed on a snowshoe hare. Several genetic samples were collected in the general area including multiple scats.

Wolverines continue to be detected using the project area as well. Less wolverine activity was detected in the northern portion of the project area compared to the 2016 field season, while tracks were regularly found between Mineral Peak ridge and the Second Creek drainage. In addition, crews followed multiple sets of wolverine tracks to a buried black bear carcass in the creek bottom of Gold Creek. From there, crews also tracked a wolverine that traveled through Primm Meadows along the West Fork of Gold Creek. There appear to be a lot of wintering ungulates in this area that might be drawing wolverines in when/if they perish before or during winter.

While Gold Creek and Boles Creek seem to be hot spots for both Canada lynx and wolverine detections thus far, the Belmont drainage and Game Ridge areas have not produced detections from either of those species. In addition, the project area from Mineral Peak south, including the entire Twin Creek drainage, has also not produced any target species detections. Despite the lack of detections in these drainages, the project area as a whole appears to be providing resources for both Canada lynx and wolverine that are likely interconnected with populations across the larger region.