INVESTIGATING THE INTERACTIONS BETWEEN WOLVERINES AND WINTER RECREATION USE: 2010 ANNUAL REPORT

OCTOBER 1, 2010

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EXECUTIVE SUMMARY

BACKGROUND AND MOTIVATION

Backcountry winter recreation is one of the fastest growing sectors of the recreation industry. This growing popularity combined with increasingly powerful snowmobile technology has resulted in winter recreation use expanding onto public forest lands that were largely undisturbed during winter months. This expanding recreational use is increasingly overlapping habitats preferred by wolverines during winter and reproductive denning seasons and may potentially represent a novel and growing impact on the species. The wolverine is currently being considered for listing under the Endangered Species Act and has been a species of management priority for National Forests and state wildlife departments throughout its current range in the United States. The potential effects of winter recreation on wolverine reproduction, behavior, habitat use and ultimately, on populations are unknown and the management of winter recreation for wolverine persistence has little scientific foundation.

The Rocky Mountain Research Station, in collaboration with a number of government and non-government organizations, has initiated research to understand the interaction between wolverine and winter recreation. We are using a unique combination of approaches to simultaneously and intensively monitor both wolverines and winter recreation including GPS monitoring of wolverines and winter recreationists, and additional recreation monitoring through aerial surveys and trail use counts.

PROJECT GOALS AND APPROACH

The over-arching project goal is to increase our understanding of the spatial and temporal interaction between winter recreation and wolverine habitat use, movements, and denning. Specific objectives of the research include: 1) assessing the spatial and temporal patterns of wolverine movements and habitat use relative to the distribution and relative intensity of recreation; and 2) investigating denning behavior in relation to recreation patterns.

The study is located in central Idaho including the Payette, Sawtooth and Boise National Forests. A significant challenge to any research on a rare species such as wolverine is the inherently low density of animals and subsequent small sample size. We will address this issue by establishing multiple study areas with each study area monitored for 1-3 years. The first study area was established north and east of McCall, Idaho in an area popular for backcountry winter recreation that also had confirmed presence of wolverines.

The goal and objectives of the project require that, from a logistical standpoint, two simultaneous and spatially-overlapping projects be conducted: an intensive monitoring of wolverines; and an intensive monitoring of winter recreation. During the first year of the study, we focused on the development and refinement of methodological approaches.

WOLVERINE MONITORING METHODS AND RESULTS

Seven log box-traps were built during the fall and trapping was initiated on 8 January 2010. Traps were closed during early denning from late February through 20 March. Traps were re-opened through April to replace or remove collars. Captured wolverines were immobilized and instrumented with GPS collars that also had VHF beacon transmitters. Collars were programmed to recorded GPS locations every 20 minutes for 24-hour periods for 4 days each week. Two of these days represented higher recreation use days (Saturday, Sunday) and 2 days represented lower recreation use days (Tuesday, Wednesdays).

We captured and collared 3 adult female and 3 adult male wolverine. Over the course of the trapping season, all animals were captured at least twice and some animals were captured relatively frequently. The average number of trap-nights per wolverine capture was 11.2, with a total of 416 trap-nights and 37 wolverine captures through the season. In addition to wolverine, red fox (*Vulpes vulpes*) were captured 26 times (16 trap-nights/capture) and American marten (*Martes americana*) were captured 13 times (32 nights/capture).

Given the expected small sample size of wolverines from any single study area and year, we must be careful to not over-extend the analyses of the data. Thus, we have focused primarily on summarizing the data collected to date, providing initial data exploration and assessing and refining the usefulness of the field methods.

All 3 females initiated denning in mid- to-late February. One female (F1) stopped denning in March, and her teats were documented to dry up by late April. The other two females maintained dens throughout the monitoring period and were actively lactating when collars were removed in late April. Dens were visited during the summer to document evidence of wolverine presence and denning activity.

Minimum convex polygons (MCP) were calculated to estimate home range extent and overlap with winter recreation. The estimated home ranges for the 6 wolverines showed strong intrasexually-exclusive territories (i.e., territories are largely non-overlapping within a sex) but extensive intersexual overlap. Home range sizes varied, with female home ranges (ranging from 93.8 mi^2 to 141.6 mi^2) smaller than male home ranges (ranging from 170 – 383 mi^2).

The locations of animals were used to calculate the distances moved, and from this, to calculate the hourly movement rates of animals. This information was used to look for patterns in diel activity within and across individuals. Movement rates varied by individual wolverine, but overall, males had higher average ($\pm$ st. dev.) movement rates (4380.9 $\pm$ 1404.4 m/hr) than females (1393.8 $\pm$ 855.9 m/hr). There is a general pattern of higher movement rates during daylight hours implied by the average movement rates of males and females classified by light conditions. One female (F2) showed a shift in hourly movement rates to move more during night and early morning hours during denning compared to pre-denning movements. The movement rates and daily distance travelled by the two females that maintained dens increased through time and were eventually higher than those observed during the pre-denning.

Winter Recreation Monitoring Methods and Results

We implemented and evaluated 4 independent and complementary methods to gather data on spatial and temporal recreation use across the study area: GPS tracking of recreation groups; aerial surveys; trail use counts; and, parking lot vehicle counts. Parking lot counts were of minimal utility compared to other methods, and we do not present parking lot information in this report to focus on more informative data.

To collect GPS tracks of recreationists, we identified access points commonly used by winter recreationists and stationed 1-2 technicians at a parking lot to ask recreationists to in carrying a small GPS data logger. We undertook the sampling on Saturday and Sunday as relatively high recreation days and Tuesday and Wednesday as relatively low recreation days. Over 90% of the recreationists asked to carry a GPS data logger were willing to do so and the return rate of the units was also over 90%. In addition, we collected GPS tracks of guided cat-skiing that originated at Brundage Ski Resort. Between early January and mid-April, we collected 714 GPS tracks carried by recreationists in our study area. Of these, 34 tracks were backcountry skiers, 12 were backcountry snowboarders, 24 were from the guided cat-skiers and 644 were snowmobilers. The average size of recreation groups varied by type of recreation with the guided cat-skiers having the largest groups (9.9 people per group), the backcountry skiers having the smallest group size (2.9 people) and the snowmobile groups averaging 4.6 people. The number of recreationists represented by a GPS unit averaged 1.7 people/GPS for backcountry skiers and 3.2 people/GPS for snowmobilers. Overall, the 714 tracks represent monitoring of a sample of 2,398 recreationists clustered into 539 groups. The cumulative spatial density of recreation intensity through the field season varied across the study area with the highest density recreation in the Goose Lake area, and more generally, higher density recreation along groomed routes and closer to access points.

We used aerial surveys as an independent data source to validate the relative intensity of recreation use across the study area indicated by the GPS monitoring of recreationists. We also used aerial surveys to identify the spatial extent of the recreation footprint, which we might expect to be under-estimated with the GPS monitoring of a sample of recreationists. To remove potential observer biases, we used repeated presence-absence observations to score the relative intensity of recreation use across the study area. The sampling was conducted based on a grid of 6.25 km^2 (2.5 km x 2.5 km) cells with 30-second intervals between sequential observations that allowed an average of 3 independent observations within each grid cell. The relative intensity of recreation use within each grid cell was scored as the number of 'presents' out of the total samples taken within each cell. Over the course of the winter, 3 aerial surveys were completed. The observed relative intensity of recreation across the study area estimated by the aerial surveys is reflective of the GPS recreation track sampling. As expected, the aerial surveys generally show a larger recreation footprint with some sampling units showing recreation use in areas where there are no GPS samples.

Infra-red trail use counters (trial counters) provided our third primary source of data on recreation use. We established 20 trail counters along snowmobile routes and on access routes for backcountry skiers. The counters were programmed to summarize the number of times the infra-red beam was broken each hour and we assume each count represents a recreationist. Here, we focus on data from 5 of the trail counters that best represent the number of recreationists entering the study area from the 3 primary access points. We assumed that each recreationist entered and left the study area by the same route on the same day and is double-counted in the data. Therefore, we divided the hourly counts by 2 to estimate the number of recreationist that travelled by any trail counter. Over the monitoring period (January 20 – April 27), 7,014 recreationists are estimated to have accessed trails north of the Upper Elevation Parking area, 6,595 were recorded on roads and trails likely accessed by the Warren Wagon Road parking area, and 549 were recorded along the Lick Creek Road. Saturday had the highest daily averages and Saturday averages were highest in February, when an average of over 200 winter recreationists estimated to be using each of the Upper Elevation Parking area and the Warren Wagon Parking Area. Peak activity for backcountry skiers using the Lick Cr Road was also highest on Saturday with an average of 10 recreationists/day in January and February. Use declined in March and April with the lowest daily averages in April. The lowest recreation days were Monday and Tuesday with each day representing less than 10% of the weekly use for both snowmobile and non-motorized recreation activities. For both types of recreation, there is a peak in activity at 1000 hours, as people left trailheads to enter the study area, and an additional peak in activity at 1600 hours, as people are returning to trailheads and passing by the trail counters for a second time.

Preliminary Results of Wolverine and Winter Recreation Patterns

With only a single year of data on 3 female and 3 male wolverines, limited analyses can be done and conclusions cannot be reached regarding any potential interactions between wolverines and winter recreation. Still, the monitoring indicates that the home range boundaries estimated for the 6 wolverines contained variable amounts of winter recreation including areas of the highest intensity recreation as well as large areas of no recreation use. The home ranges of 4 animals contained extensive recreation use, with recreation intensity ranging from high to nil within different regions. The home range of 2 other animals contained low levels of recreation based on our recreation monitoring efforts. The den sites chosen by two females were within landscapes that support lower levels of recreation intensity, but were within several hundred meters of pockets of higher recreation activity. The den site of the third female was within an area with no recreation activity.

There appears to be no difference in wolverine movement rates between high recreation days (i.e., Saturday and Sunday) and lower recreation days (i.e., Tuesday and Wednesday). Movement rates of 2 females show a daily pattern of low movement rates during peak recreation times. The third female had no recreation within the large drainage where her den was located and had increased movement rates during daylight hours.

Conclusions and Next Steps

We had high success in all the field methodologies we invested in. In particular, the quality and amount of data provided by the intensive GPS monitoring of recreationists, combined with the aerial surveys and the trail counters, provides an unparalleled opportunity to investigate potential interactions between wolverine and winter recreation. Data analyses will be on-going, and will require additional years of data to increase sample size and evaluate potential variability in responses. This initial year has shown the utility of the study design and field methods. It has also provided an initial opportunity to evaluate questions regarding potential interactions between wolverine and winter recreation.

The study will be repeated in the McCall, Idaho study area during the winter of 2011. In addition, we will be expanding the study area to the south onto the Boise National Forest in the Warm Lake area with the establishment of additional trapping and recreation monitoring. We are also initiating a study area on the Sawtooth National Forest near Stanley, Idaho. Refinements to the study design, based on the information presented here, will be incorporated into the efforts in 2011.

Background

The growing popularity of winter backcountry recreation combined with improved snowmobile technology has resulted in an expanding winter recreation footprint across previously undisturbed public lands. Winter recreationists seek steep, open areas, typically on north-facing slopes for ideal snow conditions. Committed enthusiasts search for undisturbed 'virgin' slopes and continually expand the recreation footprint in their search for new snow. Public lands provide ideal opportunities for winter recreationists as multi-use public lands typically have the access via existing roads (which, in some areas are groomed for ease of winter recreation access) to areas for snowmobiling and backcountry skiing. Snowmobile technology provides skilled riders access to nearly any topography and provides the opportunity and the challenge of accessing rugged and remote terrain. Increasingly, backcountry skiers are also using snowmobiles to gain access to remote areas that provide preferred skiing conditions.

The expanding recreation footprint is increasingly overlapping habitats preferred by wolverines during winter and reproductive denning and kit rearing seasons and potentially represents a relatively novel and growing impact on the species. The potential effects of winter recreation on wolverine reproduction, behavior, habitat use and ultimately, on populations, are unknown and the basis for management of winter recreation for wolverine persistence has little scientific foundation. This is particularly problematic as current management is, due to this lack of information, based primarily on anecdotal and conflicting accounts of wolverine response to human-related disturbance. Given the uncertain status of wolverine within the United States and elsewhere, there is growing concern regarding the potential negative effects of winter recreation on wolverine and particularly in areas potentially used by female wolverine for reproductive denning (Carroll et al. 2001, Rowland et al. 2003, May et al. 2006, Copeland et al. 2007, Krebs et al. 2007).

Project Description

This research effort is led by the Rocky Mountain Research Station, in collaboration with Round River Conservation Studies, the Payette, Boise and Sawtooth National Forests; Idaho Department of Fish and Game; University of Montana; the Idaho State Snowmobile Association and the Central Idaho Recreation Coalition. The research was initiated to increase our understanding of potential interactions between winter recreation and wolverine demography and habitat use. In 2008, winter aerial surveys were completed to provide information on the distribution of wolverine and both motorized and non-motorized winter recreation across the 3 National Forests (Copeland 2009). These surveys indicated that, at a regional scale, there are areas of extensive recreation use within potential wolverine denning habitat, and also that, in some of these areas, wolverine are present.

The current project focuses on understanding the spatial and temporal interactions between wolverine and winter recreation within the regions of overlap identified during the aerial surveys. We are using a unique combination of approaches to simultaneously and intensively monitor both wolverine movements and activities and winter recreation spatial and temporal patterns. This approach includes GPS monitoring of wolverines and winter recreationists, as well as additional recreation monitoring through aerial surveys, trail counts and parking lot counts.

A significant challenge to any research on wolverine is the inherently low density of animals and subsequent small sample size. We will address this issue by simultaneously or subsequently establishing multiple study areas in landscapes with known winter recreation and wolverine presence. Each study area will be monitored for 1-3 years. The approach of multi-year, multi-study area monitoring will provide data on both temporal and spatial variability in wolverine responses to winter recreation and provide opportunities to evaluate the variability in wolverine responses across a diversity of landscapes and winter recreation use patterns.

PROJECT GOALS

The over-arching project goal is to increase our understanding of the spatial and temporal interaction between winter recreation and wolverine habitat use, movements and denning. The specific objectives of the research include:

1) Determine wolverine winter and denning habitat selection;
2) Understand the spatial and temporal patterns of recreation use, including the distribution and intensity of use;
3) Assess the spatial overlap between winter recreation and wolverine potential habitats and known winter home ranges;
4) Assess the spatial and temporal patterns of wolverine movements and habitat use relative to the distribution and relative intensity of recreation; and
5) Document denning behaviors and locations, particularly in relation to recreation patterns.

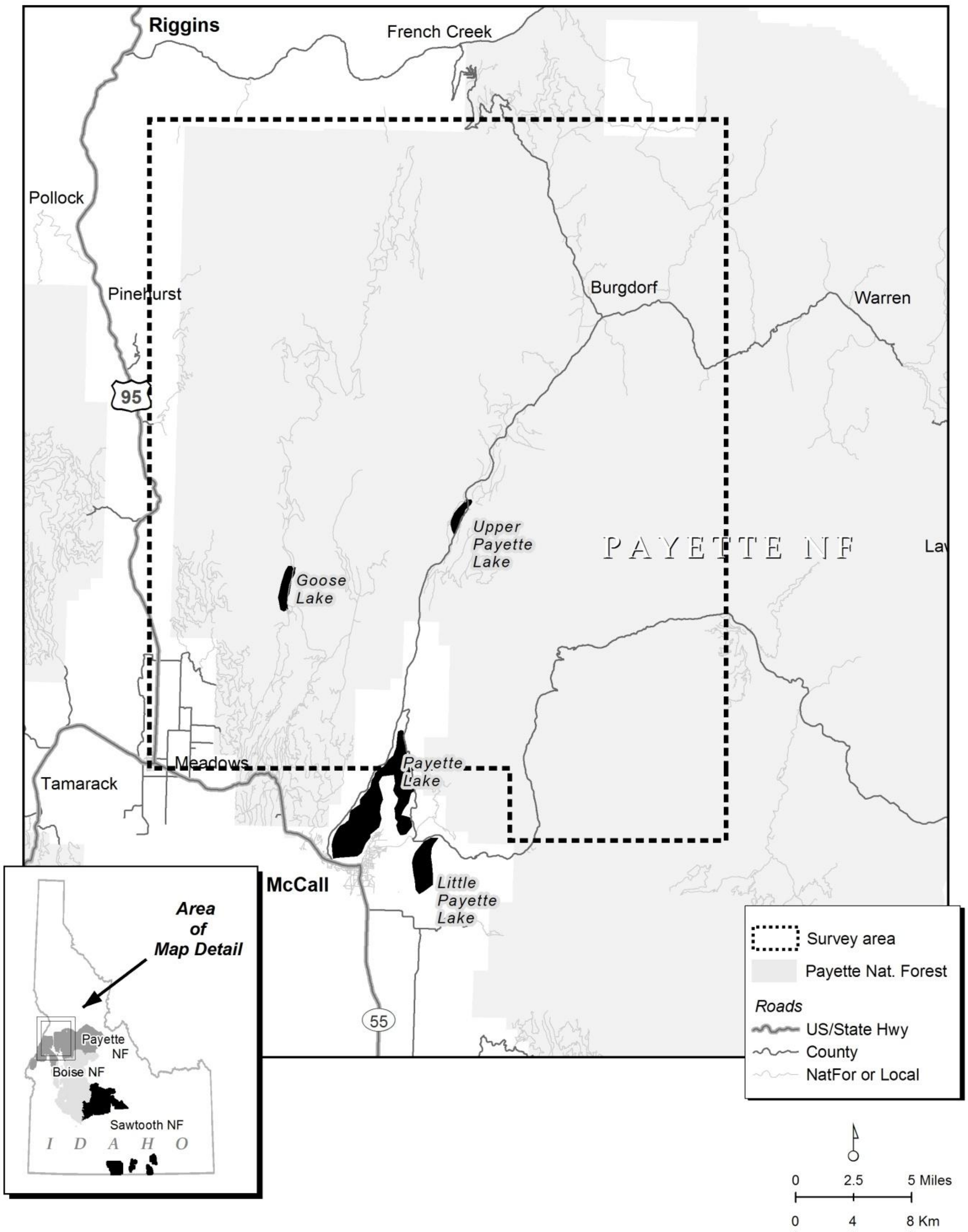
Objectives 1 and 2 provide the basic analyses that allow us to address and investigate the primary objectives 3 – 5.

STUDY AREA

The study is located in the Rocky Mountains of central Idaho, including the Payette, Sawtooth and Boise National Forests. The first study area is north and east of McCall, Idaho and was identified during the initial aerial surveys as an area of known wolverine presence overlapping both snowmobile and backcountry ski recreational uses. The McCall study recreation monitoring area covers approximately 1875 km^2 (724 mi^2) while the area actually travelled by GPS-tagged wolverines covers significantly more area (Map 1).

Additional study areas are being identified for expansion of the project to other locations across the 3 National Forests or within other suitable regions. For the 2010-11 effort, we will complete a second year of research at our initial study area near McCall with potential expansion south onto the Boise National Forest in the Warm Lake area. In addition, a second study area on the Sawtooth National Forest near Stanley, Idaho is being considered for the 2010-11 effort.

The goal and objectives of the project require that, from a logistical standpoint, two simultaneous and spatially-overlapping projects be conducted: an intensive monitoring of wolverines and an intensive monitoring of winter recreation. During the first year of the study, we focused on the development and refinement of methodological approaches.



MAP 1. THE WOLVERINE-WINTER RECREATION STUDY IS LOCATED IN CENTRAL IDAHO INCLUDING THE PAYETTE, BOISE AND SAWTOOTH NATIONAL FORESTS, WITH THE INTIAL STUDY AREA LOCATED NEAR MCCALL, IDAHO.

WOLVERINE MONITORING FIELD METHODS

The suite of project objectives spans multiple spatial and temporal scales and requires information on wolverine movements, habitat use and behaviors be collected at fine scales, with the ability to generalize this information to also address broader spatial scale questions. At the finest scales, we hope to understand wolverine responses to varying intensities of winter recreation activities, including potential changes in wolverine movement characteristics (velocity, tortuosity), space use relative to winter recreation activities, changes in foraging and resting patterns and diel activity patterns.

WOLVERINE CAPTURE AND TAGGING

We built 7 log box-traps (Copeland et al. 1995) on site using standing dead lodgepole pine from the immediate vicinity. Traps were built during the fall prior to trapping efforts. Trap locations were primarily determined based on previously documented presence of wolverine as indicated through baited camera and hair snares operated by the Idaho Department of Fish and Game.

Traps were pre-baited with road-kill deer in mid-December. In addition, deer or trapper-caught beaver was hung out of wolverine reach and a long-distance lure was used to attract wolverine to the trap area. Traps were set operational 8-10 January 2010 and fitted with remote trap monitors (TBT-600HC, Telonics, Mesa, AZ) that transmits VHF signals that change in pattern if the trap lid closed. Trap signals were monitored once or twice daily. Traps were physically inspected and maintained every 3 days and re-baited as needed with lure, deer or beaver. Trapping occurred from early January through late February, when traps were closed for the early denning season. Traps were reopened on 20 March through April to recapture animals for collar maintenance or removal.

Captured wolverines were immobilized by jab stick with a Domitor (Medetomadine/1.0 mg/ml: 0.050 mg/kg)/Ketamine (100mg/ml: 8.0 mg/kg) solution. Captured wolverines were instrumented with GPS collars that also had VHF beacon transmitters. Study animals were weighed and standard measures taken. We monitored heart, respiration, and body temperature during processing every 5-7 minutes and collected tissue and hair samples for DNA profiling. Individuals were aged subjectively based on physical characteristics as subadult or adult. A colored ear-tag was attached to assist in future identification of the animal. The animals were inspected for injuries and ectoparasites. Animal trapping and handling was reviewed and approved under the University of Montana IACUC (University of Montana AUP 061-09).

WOLVERINE MONITORING

Two different types of collars were fitted on captured wolverines. Store-on-board GPS data loggers and activity monitors with VHF beacon transmitters (Lotek Inc GPS 6000SL) were fitted on males. Remote downloadable GPS data loggers with activity monitors and VHF beacon transmitters (Telemetry Solution Quantum 4000) were fitted on females. Both types of collars provided a mortality signal triggered by >8 hours of inactivity. Both types of collars also had a cotton 'rot away' spacer to ensure the collar drops off animals.

The GPS collars allow for advanced programming of data collection schedules but are limited in battery life given the small size required for wolverine. Thus, our study design seeks to provide a balance between obtaining fine-scale location data while maximizing the life of the collar through the winter and denning seasons. Collars were programmed to record GPS locations every 20 minutes for 24-hour periods for 4 days each week. Two of these days represented higher use recreation use days (Saturday, Sunday) and 2 days represented lower use recreation use days (Tuesday, Wednesdays). During the other 3 days each week, the GPS collars were variably programmed to collect either no locations or locations every 8 hours. The estimated life of the GPS collars with this schedule is approximately 6 weeks. Activity data was recorded every 1 minute through the life of the collar. VHF transmitters were programmed to transmit from 6am to 8pm every day and have an estimated life of approximately 300-330 days.

Female location data was remotely downloaded whenever feasible, including during aerial flights or when they were recaptured. If males were recaptured less than 14 days from initial capture or after the last collar maintenance, the animal was released without handling (or downloading data). Males captured greater than 14 days following collar fitting or the last collar maintenance may have been anesthetized to download data or replace collars or collar batteries, as required.

After collaring, locations of tagged wolverines were obtained from the ground as feasible or, when deemed necessary, fixed-wing flights were used to monitor animal locations and remotely download female location data. The frequency of flights increased from March thru mid-April to closely monitor females during the denning season.

Minimal data analyses can be completed with a single winter season collected to date. Minimum convex polygon home range boundaries were used to estimate the approximate winter home range size for each individual animal and assess levels of winter recreation within these home ranges. The locations of animals were used to calculate the distances moved, and from this, to calculate the hourly movement rates of animals. This information was used to look for patterns in diel activity within and across individuals.

RECREATION MONITORING FIELD METHODS

A critical component of the study is to gather information on the spatial and temporal patterns and intensity of recreational use across the study area. We need to collect appropriately fine-scale, high quality data on winter recreation to match the high quality of data we are able to collect on wolverines. Thus, we implemented and evaluated 4 independent and complementary methods to gather data on spatial and temporal recreation use across the study area.

GPS MONITORING OF RECREATION USERS

The finest resolution data we can collect on recreation use is to map the actual paths of a representative sample of recreation users. This approach requires recreationists to voluntarily carry GPS loggers. We identified 4 primary access points and associated parking areas for winter recreationists into our study area. Three of these access points were primarily used by snowmobile recreationists and 1 access point was primarily used by backcountry ski recreationists. We stationed 1-2 technicians at a parking lot to approach recreationists with information about the study, including a project brochure, and seek their cooperation in carrying a small GPS data logger (Qstarz BT-Q1300s). These data loggers were programmed to attempt to obtain a location every 5 seconds. Technicians approached each group of recreationists (i.e., group of people recreating and traveling together within the study area) and requested 1 person for every 3-4 people in the group carry a GPS data logger. Throughout the season, we occasionally sought to sample at variable intensities, from every other person carrying a GPS data logger to every person carrying a data logger. These data may allow us to evaluate the required sampling intensity for future work.

We undertook the recreation sampling on the same days as the wolverine GPS collars were programmed to collect wolverine location data: Saturday and Sunday for relatively high recreation days; and Tuesday and Wednesday for relatively low recreation days. Staffing limitations did not allow us to sample all parking lots on all sampling days so parking areas were sampled on a rotating basis, with a bias towards sampling the higher use parking lots more frequently.

Drop-boxes were established at each parking lot and recreationists were asked to leave the GPS data loggers in these boxes or others set up in the nearby town of McCall. In McCall, drop boxes were placed at Forest Service and Idaho Fish and Game District Offices. Some local businesses also accepted the return of the GPS data loggers and offered discounts or free merchandise for the return of a data logger.

We also monitored the guided cat-skiing that originated at Brundage Ski Resort and accessed the Brundage Cat-Ski tenure area using snowcat vehicles. One GPS data logger was carried by the primary guide within each group of skiers.

The accumulated GPS data from recreationists was used to calculate a relative density of recreation activity across the study area. Each individual GPS file was attributed with the number of recreationists the file represented, as noted when the GPS unit was handed out. The number of recreationists represented by a GPS unit was used to weight each file such that a GPS track representing 4 people would be weighted 4 times more heavily than a GPS unit representing only a single person. The point file representing the path of each sampled recreationist was used in a point density analysis weighted by the number of recreationists represented. The density estimation was based on a search radius of 270m, and the density score (i.e., count of GPS points) was summarized to a 30m grid. This resulted in relatively fine-scale analyses of relative density of recreation tracks. Because the GPS units are programmed to obtain locations based on time and not distance, it is expected that slower moving recreationists (e.g., skiers, versus snowmobilers) will acquire a higher density track. Thus, the resulting density analysis incorporates a measure of time spent recreating within an area and not just the number of recreationists that may have passed through a site.

Aerial Recreation Monitoring

Aerial monitoring provides a snapshot picture of recreation use and extent. Aerial monitoring of recreation use is not influenced by the willingness of recreationists to carry GPS units or limitations in our sampling effort– two important considerations of the GPS monitoring of recreationists. Aerial surveys are influenced by a number of different factors including sightability, snow tracking conditions and time since last snowfall. Because the potential biases between the two monitoring approaches are distinct and unrelated, we used aerial surveys as an independent data source to validate the relative intensity of recreation use across the study area indicated by the GPS monitoring of recreationists. We also used the aerial survey data to identify the spatial extent of the recreation footprint, which we might expect to be under-estimated with the GPS monitoring of a sample of recreationists.

While using aerial approaches to identify and classify recreation intensity is not new, most methods use a visual evaluation of relative recreation intensity or amount of area disturbed and, therefore, requires that observers be standardized in their estimates. This standardization is problematic and reduces the utility of the monitoring by making comparisons between surveys using different personnel, across years or between study areas unreliable.

To remove potential observer biases, we utilized repeated presence-absence observations to score the relative intensity of recreation use across the study area. Observers recorded whether recreation tracks were present and what types of recreation tracks were present when prompted to take a sample. This approach requires no interpretation by the observers of areal extent or intensity.

The aerial surveys were conducted based on a grid of 6.25 km^2 (2.5 km x 2.5 km) sample units, mapped using ArcGIS across the extent of the study area (Map 2). The surveys were completed from a fixed-wing aircraft using a navigator in the front seat next to the pilot and two observers in the back (one on the right and one on the left side of the plane). A single transect along the boundary of adjacent sample units was flown, with observers recording data for the sample unit visible from each side of the plane. The navigator used a computer and live-tracking GPS software to guide the pilot in following the sample unit boundaries that form the transect line. The navigator cued the 2 observers every 30 seconds to look out their respective side of the plane every 30 seconds. The observers independently marked either the presence or absence of recreation activity and whether the activity is by snowmobiles, skiers or both; observation locations are marked with a handheld GPS and were associated with their respective sample units. For example, an east-west transect flown along the boundary of sample units allows the observer facing north to observe the northern units and the observer facing south to observe the southern sample units (see example shown in Map 2). The 30-second intervals between sequential observations provide sufficient time (distance travelled) to reduce probability of double sampling (i.e., each observation is of a new landscape) while allowing an average of 3 observations to be completed within each sample unit.

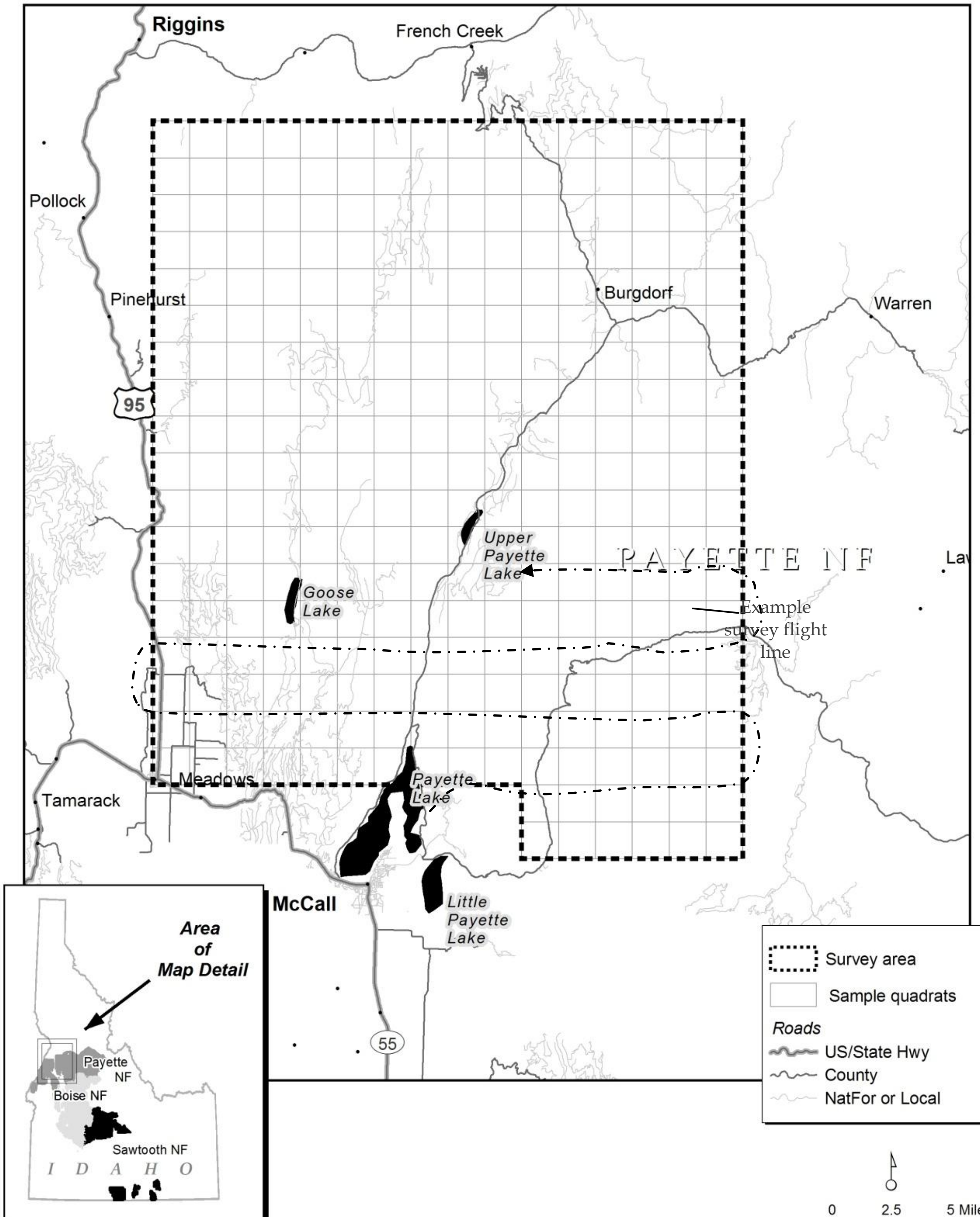
The surveys were undertaken at least 2 days following a "track-clearing" snow event of greater than 2 in. of new snow. While this amount of snow would not erase the evidence of prior snowmobile or ski activity, it was generally sufficient coverage to allow observers to distinguish fresh recreation tracks made after the snow event from recreation tracks made prior to the snow event. To the extent feasible, observers attempted to ignore older tracks made prior to the snow event.

From the presence-absence data, the relative intensity of recreation use within each grid cell can be scored as the number of 'presents' out of the total samples taken within each cell. If desired, the scores can be rolled up to larger sample units by combining the scores of cells (e.g., 25 km^2 cells can be created by combining 4 of the 6.25 km^2 cells).

In addition to the standardized surveys described above, we also mapped onto hardcopy maps any recreation tracks we observed near potential reproductive dens of our collared female wolverines.

Trail Use Counters

Infra-red trail use counters (trail counters), placed along established recreation access routes to different portions of the study area, provided a census of passing recreation users from January 20 through April 27, 2010. We established 20 trail counters (Trafx Infrared Trail Counters, Trafx, Canmore, Alberta) along snowmobile routes and on access routes for backcountry skiers. Trail counters were strategically located to provide counts of users above major intersections, facilitating the collection of coarse-scale data on the spatial distribution and relatively intensity of recreation use across the study area.



MAP 2. GRID SYSTEM USED IN AERIAL RECREATION SURVEYS COMPLETED DURING WINTER 2010 NEAR MCCALL, IDAHO.

The data recorded is a count of all times the infra-red beam was broken each hour of the day. A delay between counts of 1.25 seconds balances the probability of double-counting slow moving recreationists with under-counting recreationists that are tightly clustered. The counter will count recreationists that are moving through the beam side-by-side as a single count.

Because recreationists are typically out for a single day, we can expect each recreationist to be counted twice by counters stationed along their route: once heading out and once heading in. Obvious exceptions to this include recreationists doing loop trails, though in most cases within our study area it will be likely that these loops still result in back-tracking along the same route close to the access points. We assumed that all recreationists were double-counted and divided the total count by 2 to estimate the number of recreationist that travelled by any trail counter.

A number of general summary statistics have been calculated from the trail counter data to estimate the relative recreation use from each of the 3 primary access areas that were monitored. Two of these access points are primarily snowmobile access parking lots (referred to as Upper Elevation Parking area and Warren Wagon Rd Parking area) and 1 access point is a snowmobile trail that is primarily used by backcountry skiers to access an area closed to snowmobile use (referred to as Lick Creek Road). The configuration and width of the trails leading from the access areas determines the ability to successfully establish a trail counter. On both the Upper Elevation parking area and the Lick Creek Road, we were able to establish monitors close to the trailhead and count recreationists immediately leaving these parking areas. The Warren Wagon Road parking area was configured such that it was not possible to establish a trail counter that would effectively capture the traffic leaving the parking area and a series of 3 counters were established to capture traffic along 3 primarily trails that are accessed primarily by the Warren Wagon Road parking area. Additional trail counters were established across the study area to capture relative levels of use along different secondary trails and routes.

Parking Area Counts

At the coarsest level, it is inexpensive and straightforward to obtain an index of relative patterns of recreation use by monitoring the number of vehicles in the parking lots used by recreationists to access the study area. We collected parking lot counts during the GPS recreation monitoring on Saturday, Sunday, Tuesday and Wednesday or during trapping activities on other days of the week. Relative to the other data collection, these data have limited additional value to understand recreation use within our study area, and we do not present these data here. Still, parking lot counts are widely used to monitor recreation activity and collecting this information concurrent with our other recreation data may allow us to identify patterns of recreation use usefully indexed by low-cost parking lot counts.

Results and Discussion

We will undertake preliminary analyses each year to evaluate the success of the field methodologies, improve our field design and provide insights as appropriate through the life of the project. Given the expected small sample size of wolverines from any single study area and year, we must be careful to not over-extend the usefulness of the data. Thus, with a single year of data collected from January – April, 2010, we have focused primarily on assessing and refining the usefulness of the field methods.

Wolverine Trapping and Monitoring

We captured and collared 3 adult females and 3 adult males over the winter. The first animal, an adult female, was captured on 28 January and the last individual, another adult female, was captured on 20 February. Over the course of the trapping season, all animals were captured at least twice and some animals were captured relatively frequently. The average number of trap-nights per wolverine capture was 11.2, with a total of 416 trap-nights and 37 wolverine captures through the season. Recaptures varied widely across the different animals, potentially due partly to the placement of traps within their respective home ranges and to differences in individual animal responses. In addition to wolverine, red fox (*Vulpes vulpes*) were captured 26 times (16 trap-nights/capture) and American marten (*Martes americana*) were captured 13 times (32 nights/capture).

All wolverine appeared healthy upon capture; none had any notable wounds or scars and all appeared to be adults. One animal, F3, had notable wear on her teeth and several missing incisors, as well as broken premolars and molars. Standard measurements were taken on animals (Appendix I).

Attempts were made to monitor all animals from initial capture through the end of April. In some cases, we were able to consistently recapture animals to perform collar maintenance. In other instances, collar battery life limited the full extent of the data collected on individuals who were not recaptured. Fortunately, even for animals for which collar maintenance was not possible, collars functioned well and significant data were collected on all collared animals (Table 1).

Minimum convex polygons (MCP) were calculated to estimate home range size and extent. These show a strong intrasexual non-overlap in territories but extensive intersexual overlap (Map 3). Home range sizes (Table 1) tend to be similar to other reported home range size estimates for wolverine.

Summary of Individual Wolverine Monitoring

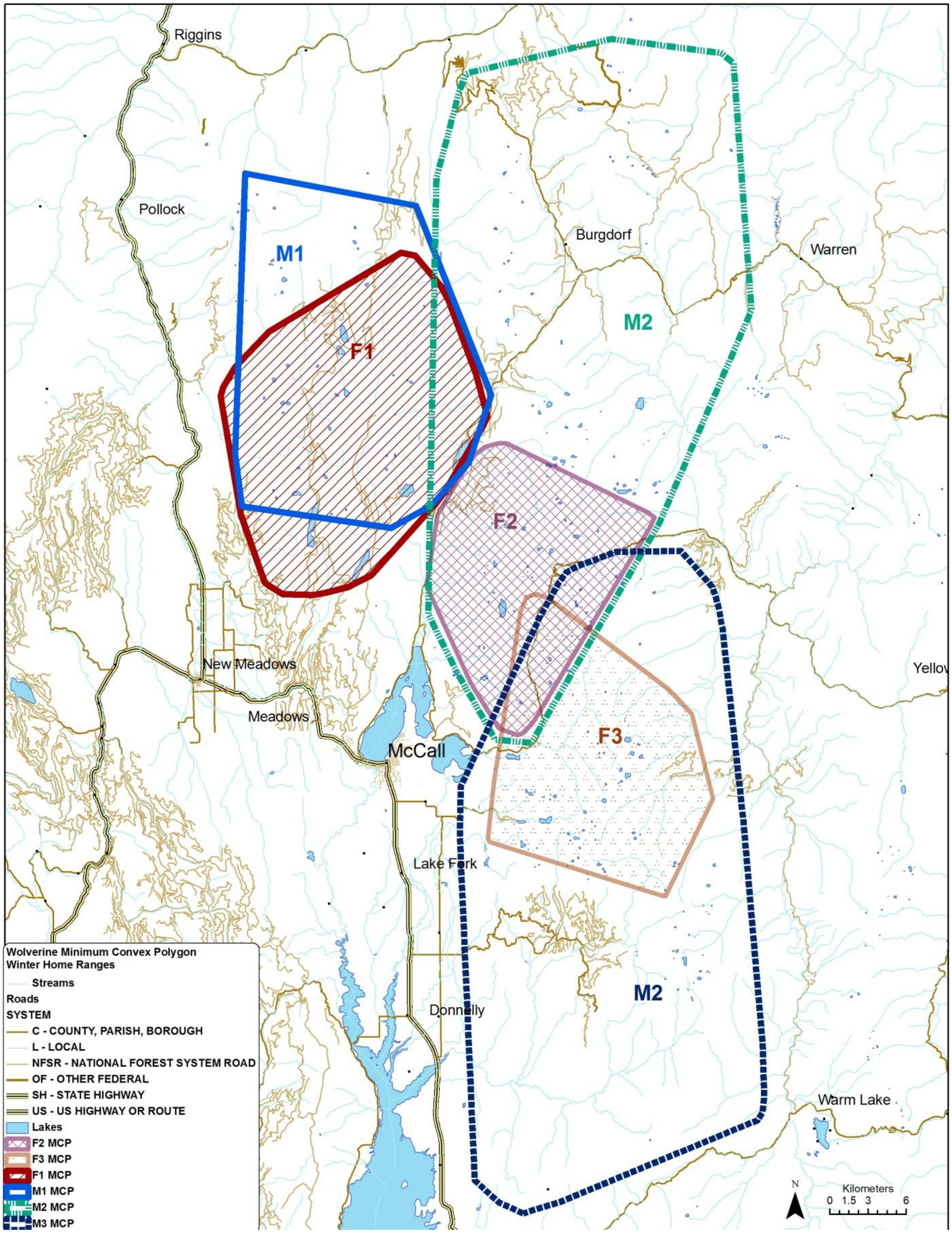
Adult Female F1:

Female F1 was initially captured on 28 January 2010 and fitted with a GPS collar. She was recaptured multiple times through the field season, with a total of 15 captures. On 17 February, her collar was replaced to ensure batteries lasted through the denning season. At this processing, her condition indicated she was likely pregnant. On or shortly before 21 February, she entered a den, and we recorded no movement until 27 February, when she left the den for 4 hours and forayed relatively close by. Each day we monitored her thereafter, she took similar forays from the den always returning to it. We were able to locate and observe the den using spotting scopes.

TABLE 1. SUMMARY OF DATA COLLECTED THROUGH GPS COLLARING OF 6 WOLVERINES DURING THE WINTER OF 2010 NEAR MCCALL, IDAHO.

Animal	N	Dates	MCP* Area (mi²)	MCP* Area (km²)
F1	965	Jan 29 - Mar 31	141.6	380.9
F2	1050	Jan 30 – Mar 21	93.8	243.0
F3	819	Feb 20 – Apr 3	107.5	278.5
M1	1023	Jan 31 – Mar 10	169.8	439.9
M2	2079	Feb 5 – Apr 20	371.3	961.7
M3	2356	Feb 11 – Apr 14	382.8	991.5

*MCP: 100% minimum convex polygon home range size estimates



MAP 3. MINIMUM CONVEX POLYGON WINTER HOME RANGE ESTIMATES FOR WOLVERINES MONITORED DURING THE WINTER 2010 NEAR MCCALL, IDAHO.

Female F1 slipped her collar off on 2 March, when it became wedged in a narrow rock slot in a boulder field away from her denning area. On 17 March, we initiated trapping efforts to replace her collar and recaptured her on 21 March, when another collar was fitted. Following the resumption of data collection, we never documented her returning to her original natal den area nor any other apparent denning site; her movements showed no pattern indicating denning. When we replaced her collar, her teats appeared typical of lactation with some swelling and notable enlargement of the nipples but the fluid expressed from them was uncharacteristically opaque in color and not classic 'milk' colored. Consultation with a veterinarian (Mark Drew, State Veterinarian, IDFG) indicated that this would be expected if the teats were drying up (e.g., she had been lactating, but had lost her kits). We recaptured F1 on 15 April to remove her collar. At that time, no liquid could be expressed from her teats and they appeared to have dried up completely. Subsequent downloading of the GPS locations showed that the collar had only functioned through 31 March.

Female F1 movements indicate a resident animal with fairly well established boundaries indicating territoriality. Over the course of the winter, we collected 965 locations on F1 between 28 January and 31 March (Table 1) with a notable gap in data collection from 2 March to 21 March after she slipped her collar and before we replaced it. We estimated the size and location of her home range using MCP; her winter home range estimate is 381 km^2 (142 mi^2).

We visited F1's apparent natal den site on 18April at which time an opening in the snow still existed into a large boulder field but no wolverine tracks were evident on the surface of the snow. While there was evidence of wolverine use (i.e., tracks in protected sites within the hole and prey remains in the form of fur and bones from a pika), we were unable to identify an exact site where kits may have been whelped and we did not find hair or scat from kits to collect. We returned to the site again in early August 2010, with similar results.

Adult Female F2

Adult female F2 was initially captured on 30 January and fitted with a GPS remote downloadable collar. She entered an apparent natal den on or shortly before 16 February, and no movement from the den was noted until 27 February. Initial movements were short in duration and she returned consistently to the den site. On 7 March, it appears she moved her kits to a maternal den within 1 km of the natal den and continued gradually more extensive movements, which always were initiated and ended at the new den site. She was recaptured on 24 April but her GPS data logger collected locations only through 21 March. Her collar was removed at this recapture.

Female F2 movements indicate a resident animal with well established boundaries indicating territoriality. Over the course of the winter, we collected 1,050 locations on F2 between 30 January and 21 March (Table 1). We estimated the size and location of her home range using MCP; her winter home range estimate is 243 km^2 (94 mi^2).

We visited her natal den and her maternal den in early August, 2010. Both were within large boulder fields with many caves, cracks and crevices. While there was evidence of wolverine activity in the form of scats, as well as prey remains (i.e., portion of an elk leg), we did not find a confirmed den site where kit hair could be identified and collected.

Adult Female F3

Adult female F3 was initially captured on 20 February and fitted with a GPS remote downloadable collar. She entered a natal den on 23 February and no movement from the den was noted until 2 March. Initial movements were short in duration and she returned consistently to the den site. Through time, the periods spent away from the dens increased but she always returned to the den site. She never appeared to move the kits from the natal den area. She was recaptured on 12 April but her GPS data logger collected locations only through 3 April. Her collar was removed at this recapture.

Female F3 movements indicate a resident animal with well established boundaries indicating territoriality and a home range that falls primarily in an area difficult to access by humans in the winter. Over the course of the winter, we collected 819 locations on F3, between 20 February and 3 April (Table 1). We estimated the size and location of her home range using MCP; her winter home range estimate is 278 km^2 (108 mi^2).

We visited her natal den in early August, 2010. It was located at the edge of a large boulder field and included large diameter downed woody debris and thick alder, to create a system with extensive tunnels, cracks and crevices. There was significant evidence of wolverine activity in the form of scats and hair and one site appeared to potentially be where kits may have lain as evidenced by a large amount of hair in the bedding material.

Adult Male M1

Adult male M1 was initially trapped on 31 January and a store-on-board GPS collar was fitted. Following release, he was recaptured 2 times thru 6 February and released without handling. He was recaptured on 10 April in the same area of his earlier captures. At that time, his collar was replaced with a store-on-board with a blow-off capability. The blow-off did not function properly and we have not yet been able to retrieve the collar.

His movements indicate a resident animal but with an atypically small estimated MCP home range size (440 km^2; 170 mi^2), potentially due to the limited time period monitored. We obtained 1,023 locations on M1 between 31 January and 10 March (Table 1). His home range encompasses portions of F1's home range (Map 3) and movement data indicate that they both visited some of the same sites which are assumed to be foraging sites.

Adult Male M2

Adult male M2 was initially trapped on 5 February and a store-on-board GPS collar was fitted. He was recaptured on 17 February and anesthetized to replace the collar batteries and download data. He slipped his collar on 22 March but was recaptured and the collar replaced on 24 March such that there was minimal data lost. We recaptured him on 20 April and removed his collar. Over the course of the season, we recaptured M2 a total of 6 times.

His movements indicate a resident animal with his home range encompassing all F2's home range (Map 3). A total of 2,079 locations were recorded between 5 February and 20 April (Table 1) resulting in an estimated MCP home range size of 1040 km^2 (402 mi^2). Movement data indicate that M2 and F2 both visited some of the same sites, one of which was confirmed to be a foraging site with a fall-killed elk carcass.

Adult Male M3

Adult male M3 was initially trapped on 11 February and a store-on-board GPS collar was fitted. He was recaptured on 25 March and anesthetized to replace the collar. The initial collar only functioned through 21 February due to a programming glitch resulting in it acquiring locations every 5 minutes rather than every 20 minutes. We recaptured him on 27 April and removed his collar. Over the course of the winter, we recaptured M3 a total of 5 times.

His movements indicate a resident animal with his home range encompassing all F3's home range (Map 3). With the 5 minute location acquisition, we collected an intensive data set on M3 for a total of 2,356 locations (Table 1) resulting in an estimated MCP home range size of 994 km^2 (384 mi^2). Most of his movements are beyond the extent of our existing recreation monitoring.

Wolverine Movements and Activity Patterns

Movement rates varied by individual wolverine (Table 2), but overall, males had higher average (± st.dev.) movement rates (4380.9 ± 1404.4 m/hr) than females (1393.8 ± 855.9 m/hr). There is a general pattern of higher movement rates during daylight hours implied by the average movement rates of males and females classified by light conditions (Figure 1) but hourly movement rates are highly variable across different individual animals (Figure 2); some individuals show daily patterns that indicate a preference for movement during daylight hours (e.g., F1, M2) while others appear to have no clear diel activity pattern.

One female (F2) has sufficient monitoring both before and during her denning to examine any potential changes in diel movement patterns during the denning season. This female shows a shift in hourly movement rates to move more during night and early morning hours when she is denning compared to pre-denning movements (Figure 3).

The movement rates and daily distance travelled by the two females (F2, F3) that maintained dens increased through time, with the lowest rates and distances recorded during the first week following den initiation. Following the first or second week of denning, movement rates and distances increased above those observed during the pre-denning (Figure 4). Total distance moved during each period also shows the same pattern observed in movement rates, indicating that the increased movement rates resulted in increased travel distances (as opposed to traveling more rapidly over the same distance, as could be observed if the strategy is to reduce the overall time away from the den).

Recreation Monitoring

The recreation monitoring has provided excellent information on recreation use within the study area. Basic results from each of the 4 types of monitoring that we undertook are provided here.

TABLE 2. AVERAGE TOTAL DISTANCE MOVED PER DAY AND AVERAGE MOVEMENT RATE FOR 6 WOLVERINES MONITORED WITH GPS COLLARS DURING THE WINTER, 2010 NEAR MCCALL, IDAHO.

Animal	Distance (Average ± St. Dev.) km/day	Movement Rate (Average ± St. Dev.) m/hr
F1	11.76±8.56	903.72±1231.42
F2	10.56±7.25	1609.37±1250.34
F3	12.77±12.44	1180.82±1677.60
M1	17.24±13.87	745.55±1768.08
M2	18.68±14.53	727.19±1398.06
M3	21.64±17.20	1151.33±5602.35

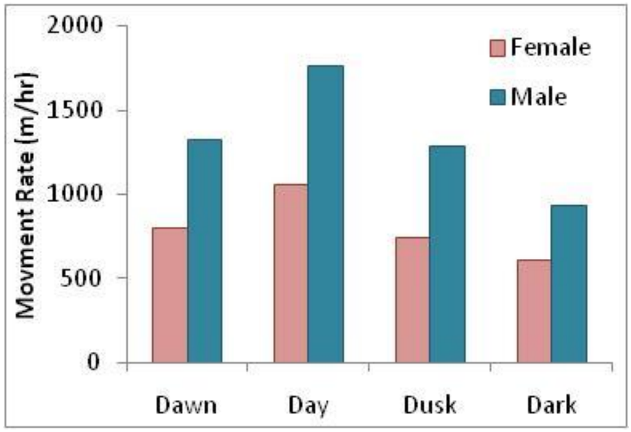


FIGURE 1. AVERAGE MOVEMENT RATES OF 3 MALE AND 3 FEMALE WOLVERINES, CLASSIFIED BY LIGHTING CONDITIONS; MOVEMENT RATES BASED ON GPS LOCATIONS OBTAINED AN AVERAGE OF EVERY 20 MINUTES FOR 24 HOUR MONITORING PERIODS THROUGH THE WINTER, 2010 NEAR MCCALL, IDAHO.

GPS MONITORING OF INDIVIDUAL RECREATIONISTS

Over 90% of the recreationists asked to carry a GPS data logger while recreating were willing to do so and the return rate of the units was also over 90%. Between early January and mid-April, we collected 714 GPS tracks carried by recreationists in our study area. Of these, 34 tracks were backcountry skiers, 12 were backcountry snowboarders, 24 were from the guided cat-skiers and 644 were snowmobilers (Map 4). All of the unguided ski or snowboard recreationists used snowmobiles to access the area and the majority of this recreation occurred from Lick Creek Road. The guided cat-ski activity was limited spatially to a well-defined area within the existing tenure held by Brundage Ski Area for this activity. The snowmobile recreation occurred more broadly, likely partly due to the ease of snowmobile travel. Most snowmobile recreationists took advantage of the series of groomed snowmobile routes within the study area and either strictly toured along these routes or used these routes to access off-trail areas and terrain.

The average size of recreation groups varied by type of recreation, with the guided cat-skiers having the largest groups (9.9 people per group, on average) and backcountry skiers having the smallest group size (2.9 people, on average); the snowmobile groups averaged 4.6 people. Because we attempted to equip large groups multiple GPS data loggers, the average number of people represented by a GPS data logger was smaller than the average group size except for cat-skiers where only the guide was equipped, regardless of the group size. The number of recreationists represented by a GPS unit averaged 1.7 people/GPS for backcountry skiers and 3.2 people/GPS for snowmobilers. Overall, the 714 tracks represent monitoring of a sample of 2,398 recreationists clustered into 539 groups over the winter. We expect that some individuals were monitored multiple times as they returned to recreate in the study area and were repeatedly a monitored group.

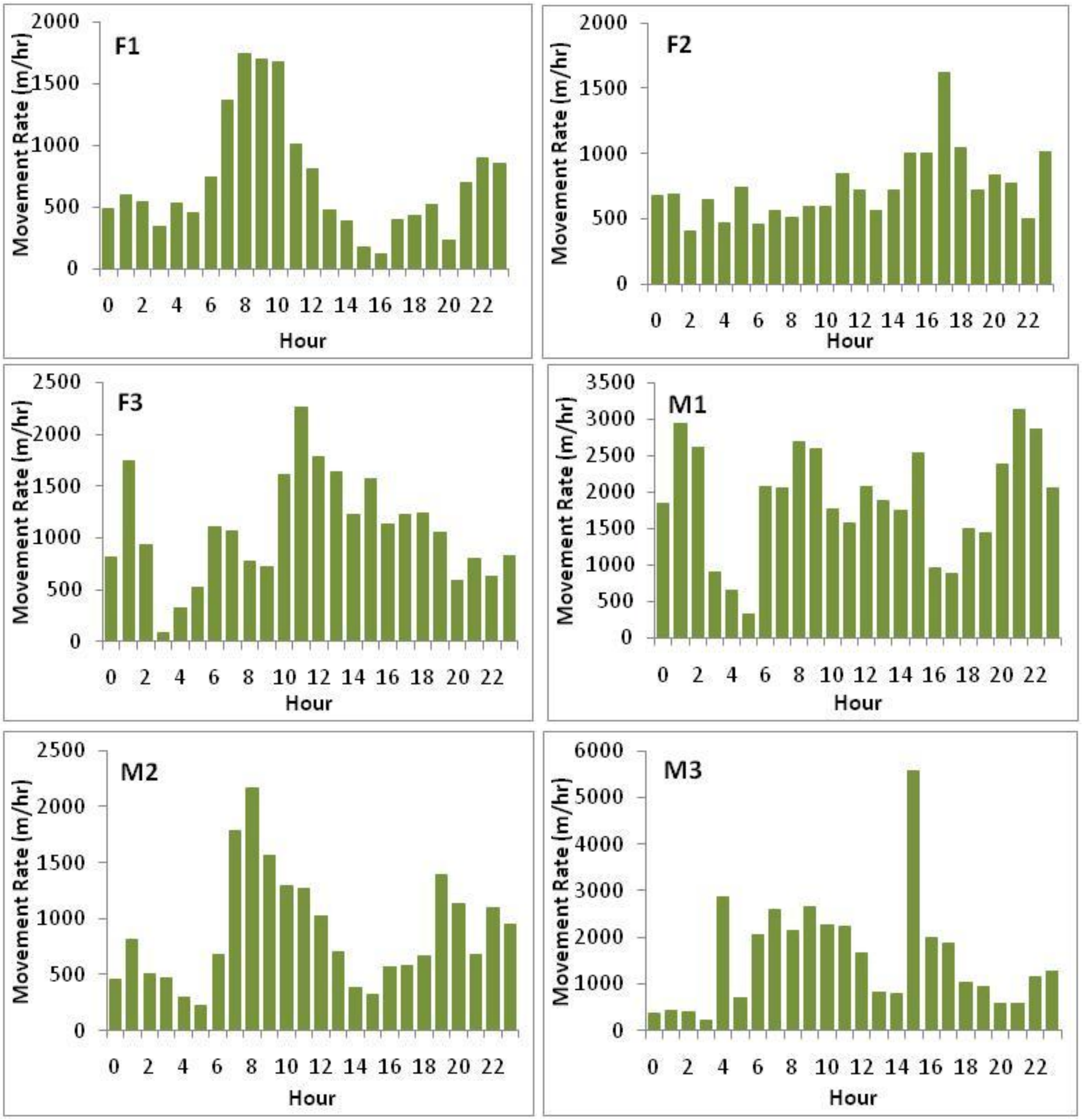


FIGURE 2. AVERAGE HOURLY MOVEMENT RATES FOR 6 WOLVERINES, BASED ON GPS LOCATIONS ACQUIRED AN AVERAGE OF EVERY 20 MINUTES DURING 24 HOUR MONITORING SESSIONS OVER THE WINTER 2010 NEAR MCCALL, IDAHO.

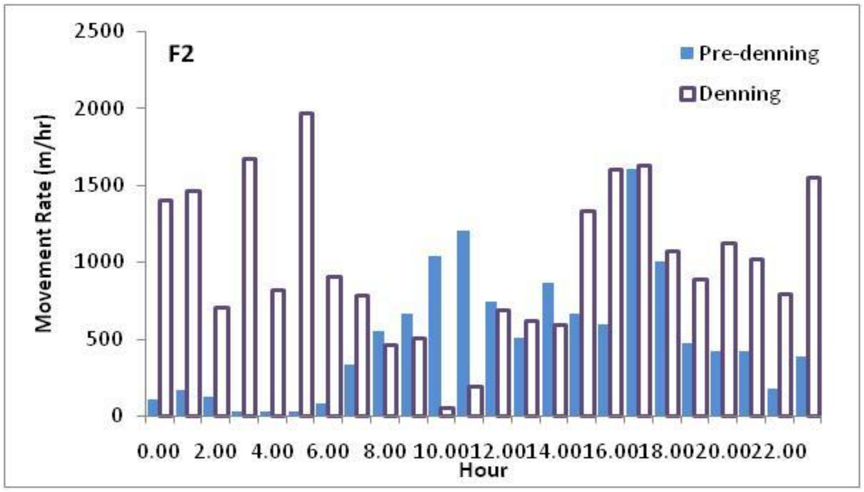


FIGURE 3. HOURLY MOVEMENT RATES OF F2 PRIOR TO AND DURING DENNING, AS CALCULATED FROM GPS LOCATIONS OBTAINED APPROXIMATELY EVERY 20 MINUTES DURING 24 HOUR MONITORING SESSIONS OVER THE WINTER 2010, NEAR MCCALL, IDAHO.

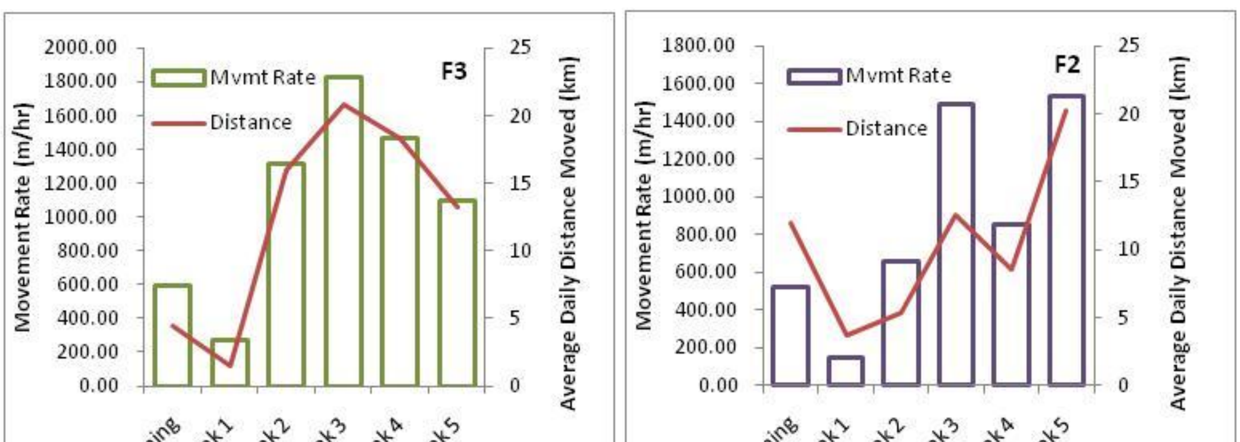
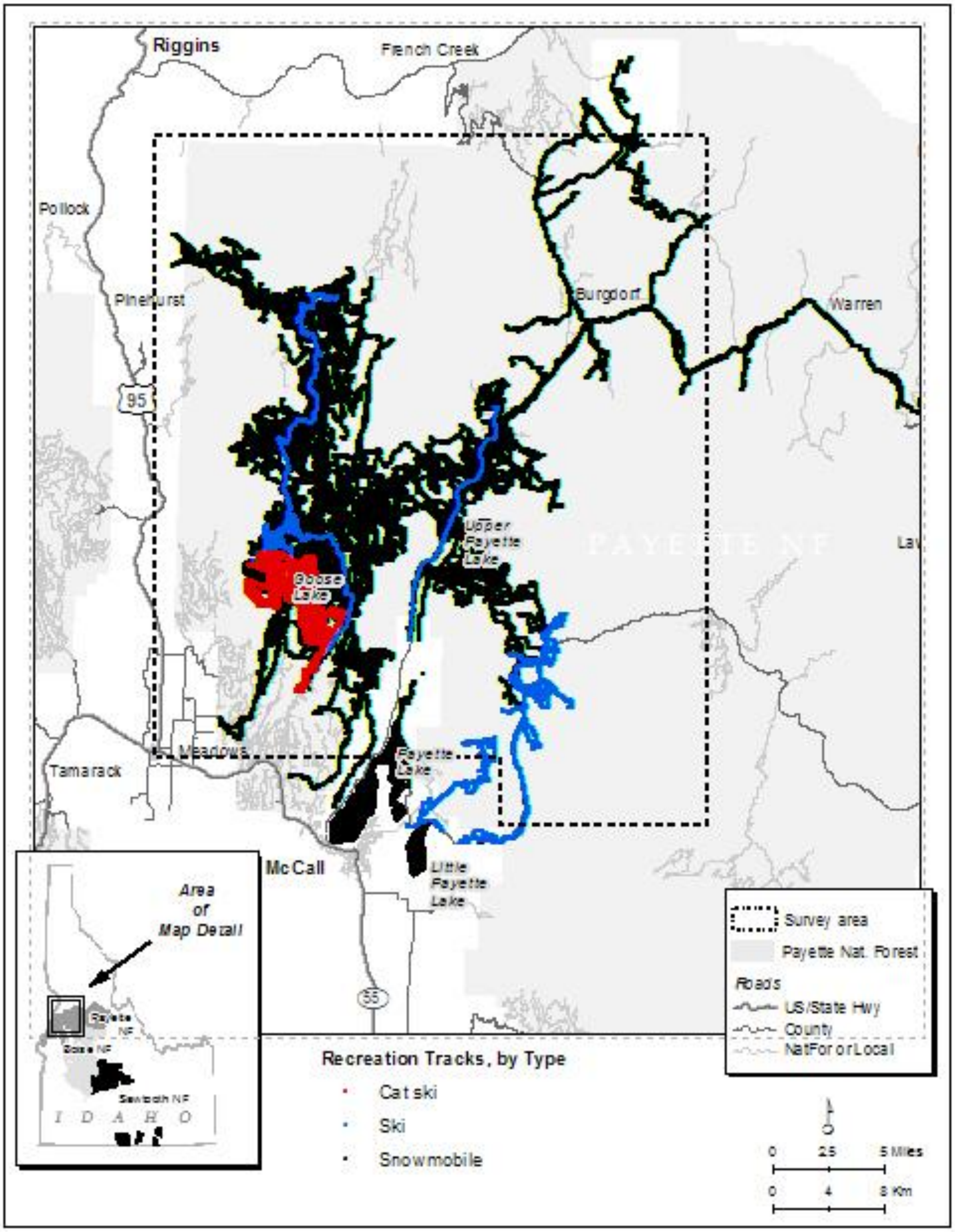


FIGURE 4. AVERAGE MOVEMENT RATES AND AVERAGE DAILY DISTANCES MOVED FOR TWO DENNING FEMALE WOLVERINES IN THE PERIOD BEFORE DENNING AND BY WEEK FOLLOWING DENNING; WOLVERINE WERE MONITORED USING GPS COLLARS DURING WINTER 2010 NEAR MCCALL, IDAHO.



MAP 4. DISTRIBUTION OF SNOWMOBILE (SHOWN IN BLACK), GUIDED CAT-SKIING (SHOWN IN RED), AND BACKOUNTRY SKI AND SNOWBOARD (SHOWN IN BLUE) PATHS, AS CAPTURED FROM GPS DATA LOGGERS CARRIED BY RECREATIONISTS DURING THE WINTER, 2010 NEAR MCCALL, IDAHO.

The cumulative spatial density of recreation intensity through the field season varied across the study area (Map 5) with the highest density recreation associated with popular snowmobile routes and play areas found broadly around the Goose Lake area, but extending also along most of the groomed snowmobile routes accessed from either the Upper Elevation parking area or the Warren Wagon Road parking area. Backcountry skiing significantly contributes to the low and moderate density of recreation activities seen off of Lick Creek Road in the southeastern portion of our recreation monitoring area.

AERIAL RECREATION MONITORING

Over the course of the winter, 3 aerial surveys were completed to index the relative intensity and the footprint of winter recreation activities. Surveys were completed on March 2, March 16 and April 19, following 3 inch, 7 inch and 3 inch snow events, respectively, and with at least a 2-day track accumulation window for each survey (Table 2). Surveys were completed within 3 hours and all sample units with sufficient snow were surveyed. Several sample units were not surveyed during the April 19 survey because of extensive areas of bare ground at the lower elevations.

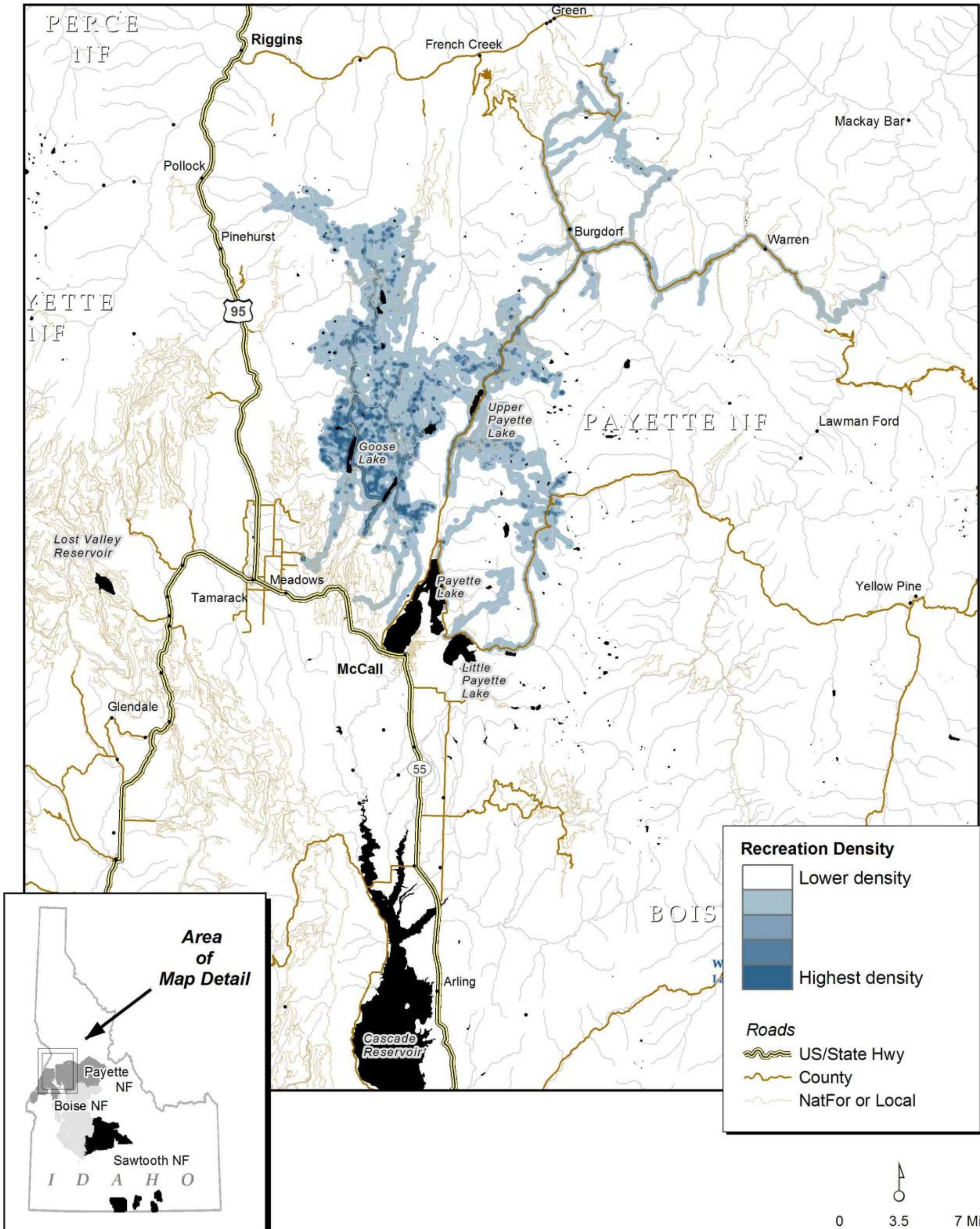
Scores for each 6.25 km^2 sample unit were calculated based on the number of positive observations/total observations, with 'positive' indicating that recreation tracks were recorded. The number of observations per sample unit ranged from 2 to 4 with an average of 3. Scores ranged from 0 to 1, with possible scores including 0, 0.33, 0.5, 0.66 and 1. These are classified as none, low, moderate, high and very high, respectively (Map 6 -Map 8). We also recorded the type of recreation activity with each observation so that the cells can be attributed with this information; we show an example of this in Map 9.

COMPARISON OF GPS RECREATION TRACKS AND AERIAL SURVEYS

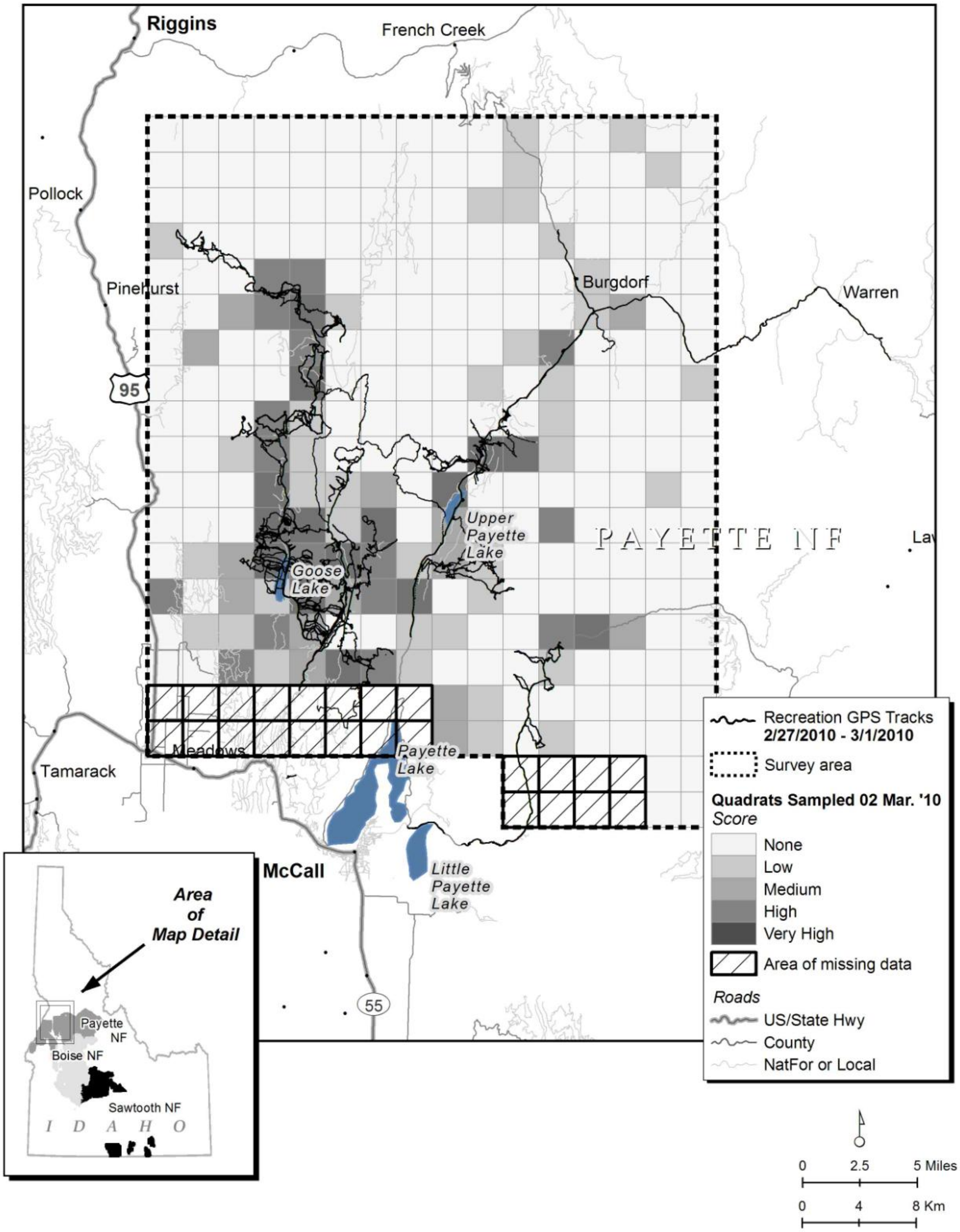
The aerial survey results are reflective of the GPS individual track sampling (Table 3) that was completed during the same time windows (Map 6 -Map 8). As expected, the aerial surveys generally show a larger recreation footprint with some sampling unit cells showing low to high use in areas where there are no GPS samples. Based on the results of the March 2 aerial survey, showing recreation use in the southwestern portion of the survey area, we added GPS monitoring from a trailhead for that region. The aerial survey from March 16 shows low to high use in an area northwest of the Lick Cr Summit and southeast of Upper Payette Lake; further consideration will be required to determine if this area is being accessed by routes not currently sampled by our GPS recreation tracking.

TABLE 3. SUMMARY OF AERIAL RECREATION SURVEY EFFORTS COMPLETED NEAR MCCALL, IDAHO, INCLUDING THE NUMBER OF GPS TRACKS OF RECREATIONISTS DURING THE SAMPLING WINDOW.

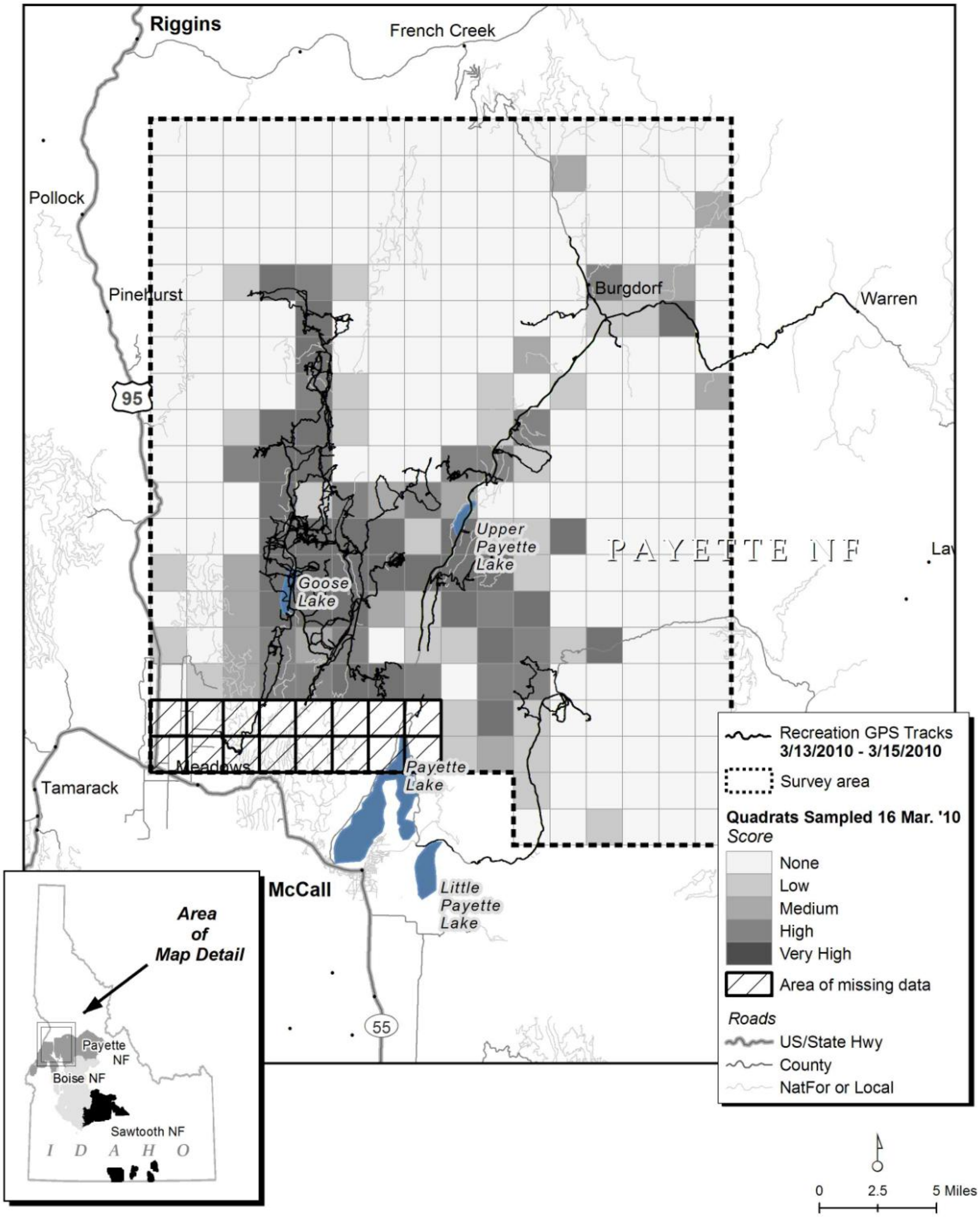
Date (mm/dd/yy)	Date of Snow Event	Track Accumulation	Snow Event Depth Estimate	GPS monitoring effort between snow event and aerial survey
3/02/10	2/27/10	3 days	3 inches	23 samples Upper Elev. 22 samples Warren Wagon
3/16/10	3/13/10	3 days	7 inches	20 samples Upper Elev. 17 samples Warren Wagon 7 samples Wallace Ln 5 samples Lick Cr. Rd
4/19/10	4/14/10	5 days	3 inches	9 samples Upper Elev. 9 samples Warren Wagon



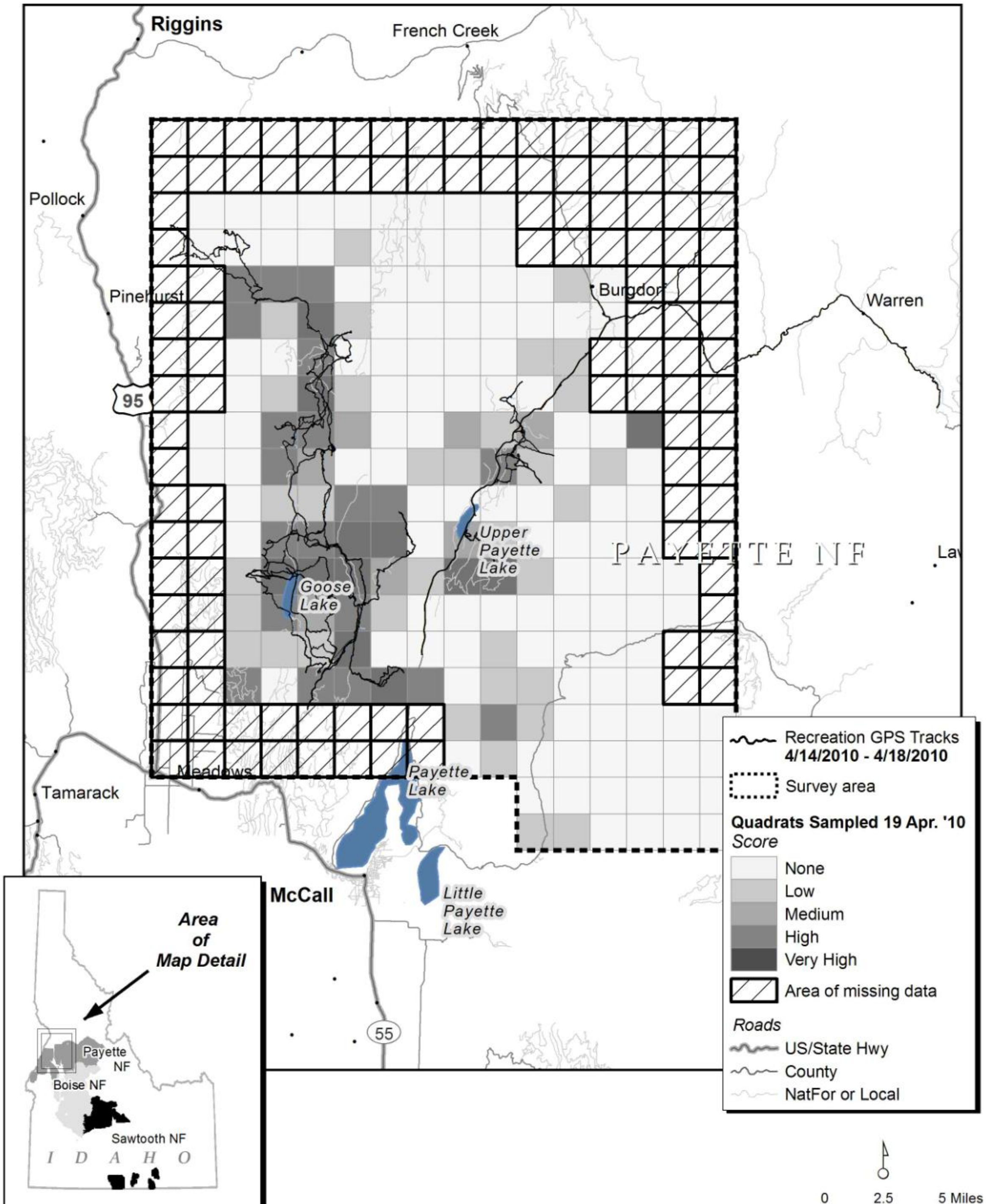
MAP 5. DENSITY OF WINTER RECREATION, BASED ON GPS TRACKING OF A SAMPLE OF WINTER RECREATIONISTS DURING THE WINTER, 2010, NEAR MCCALL, IDAHO.



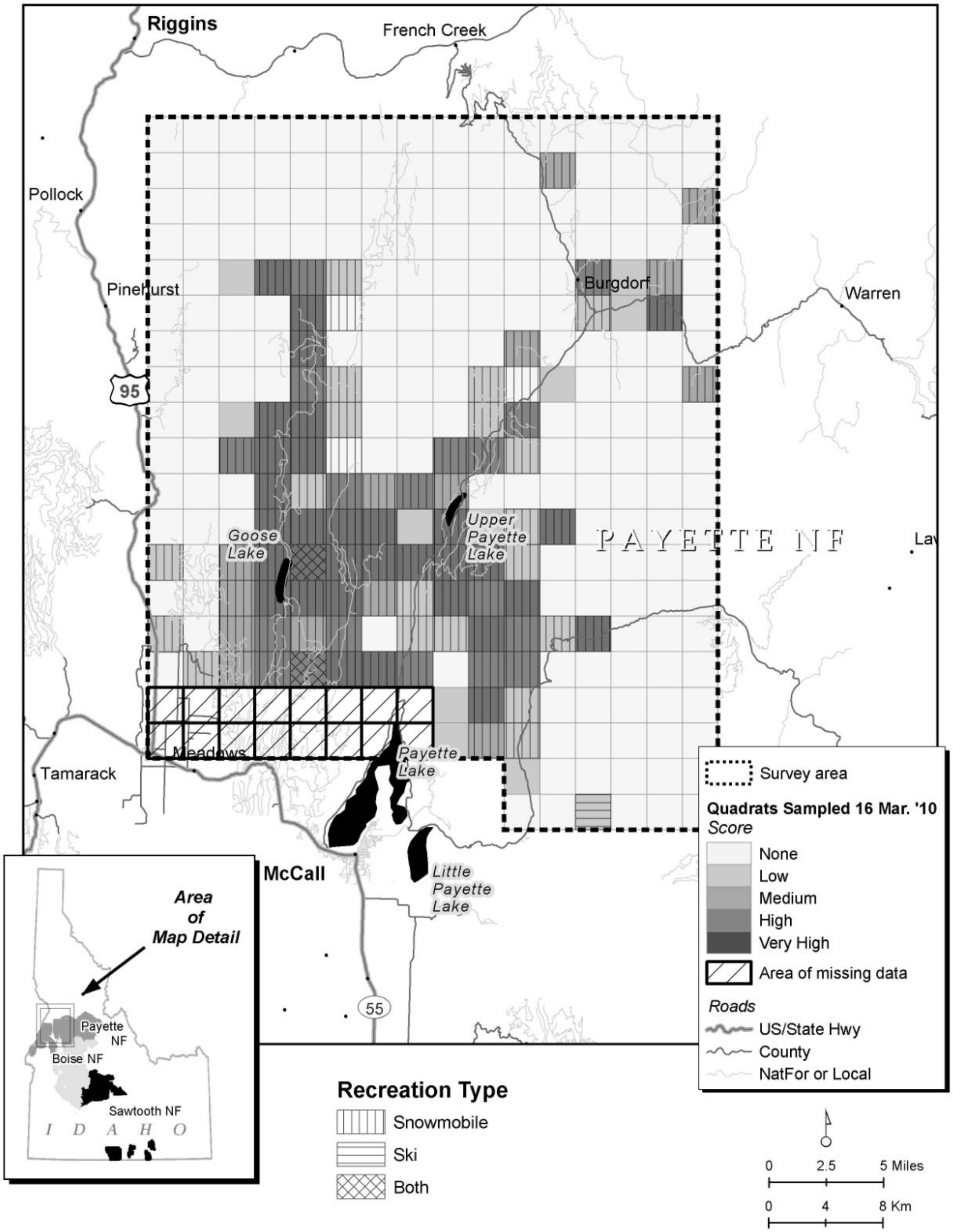
MAP 6. RELATIVE RECREATION DENSITY WITHIN 6.25 KM^2 SAMPLE UNITS, BASED ON AN AERIAL SURVEY COMPLETED ON MARCH 2, 2010; ALSO SHOWN ARE THE GPS TRACKS OF RECREATIONISTS SAMPLED BETWEEN FEBRUARY 27 - MARCH 1, 2010, NEAR MCCALL, IDAHO.



MAP 7. RELATIVE RECREATION DENSITY WITHIN 6.25 KM^2 SAMPLE UNITS, BASED ON AN AERIAL SRUVEY COMPLETED MARCH 16, 2010; ALSO SHOWN ARE THE GPS TRACKS OF RECREATIONISTS SAMPLE BETWEEN MARCH 13-MARCH 15,2010 NEAR MCCALL, IDAHO.



MAP 8. RELATIVE RECREATION DENSITY WITHIN 6.25 KM^2 SAMPLE UNITS, BASED ON AN AERIAL SURVEY COMPLETED ON APRIL 19, 2010; ALSO SHOWN ARE THE GPS TRACKS OF RECREATIONISTS SAMPLED BETWEEN APRIL 14 - APRIL 18, 2010 NEAR MCCALL, IDAHO.



MAP 9. RELATIVE RECREATION DENSITY AND TYPE OF RECREATION OBSERVED WITHIN 6.25 KM^2 SAMPLE UNITS, BASED ON AN AERIAL SURVEY COMPLETED ON MARCH 16, 2010 NEAR MCCALL, IDAHO.

Trail use counters

The data collected from the infra-red trail use counters provide information on the total number of recreationists using the study area, using different portions of the study area and on level of use both during our sampling days and non-sampling days. The time stamp on the counts also provides a temporal accounting of winter recreation use and can be used to test for biases in the temporal components of the GPS recreation monitoring data (due to times we hand out GPS units, for instance). For ease of interpretation, we have divided all counts by 2 accounting for the fact that the counters will record a recreationist traveling each way on any trail (i.e., entering and leaving an area).

We counted all recreation use from 2 of the primary recreation access points (Upper Elevation parking area, and access on Lick Creek Road) and also along roads and trails primarily accessed by recreationists leaving from the Warren Wagon Road Parking Area. It was not feasible to set up a counter to monitor traffic immediately at this parking lot so estimates are based on monitoring set up along roads and trails primarily accessed from this parking lot. The counter stationed at one potential route used by recreationists from the Warren Wagon Road Parking Area malfunctioned during a portion of the winter, such that 32 days of data are missing and so recreation use from Warren Wagon Road between February 21 and March 25 is likely underestimated.

Caution must be used in interpreting the counts provided by the trail use counters, as we assume that a recreationist passed by a single counter only 2 times in 1 day and did not pass by any of the other counters associated with a different access point. Additionally, the Warren Wagon Road access estimate assumes that a recreationist only passed by 1 of the 3 trail counters established on different routes associated with this access point (as with other routes, it is assumed the recreationist passed by a single counter twice). In reality, it is likely that some recreationists returned briefly to the trailhead or travelled near other trailheads and triggered trail counters associated with those other access points and so it is likely that the counts exaggerate the number of people using the area for winter recreation. Still, we expect these errors to represent a relatively low percent of the total counts and that the trail counters almost certainly provide the best estimate of total recreation use through the winter.

Overall recreation counts from trail counters

Over the 101-day monitoring period (January 20 – April 27), 7,014 recreationists are estimated to have accessed trails north of the Upper Elevation Parking area, 6,595 were recorded on roads and trails likely accessed by the Warren Wagon Road Parking area, and 549 were recorded along the Lick Creek Road.

Relative use estimated by the trail counters varied by month and across different access points (Figure 5), with the highest average daily use for the trails accessed primarily by the Warren Wagon Road parking area with peak use in February (110/day) and the lowest use in April (22/day). Use of Upper Elevation parking area followed a similar pattern, with peak use in February (91/day), then declining use over the next 2 months to a low of 23/day in April. The Lick Creek Road access, primarily used by backcountry skiers, had relatively low use compared to the snowmobile dominated access areas, with a high average of 7/day in February to a low average of 2 counts/day in April.

Weekly Patterns of Use

There were differences in the level of use through the week with Saturdays having the highest amount of recreation use, representing 30.5% and 18.3% of the weekly use for snowmobile and backcountry skiing, respectively. Other high recreation days were Friday and Sunday for both snowmobile and backcountry skiing

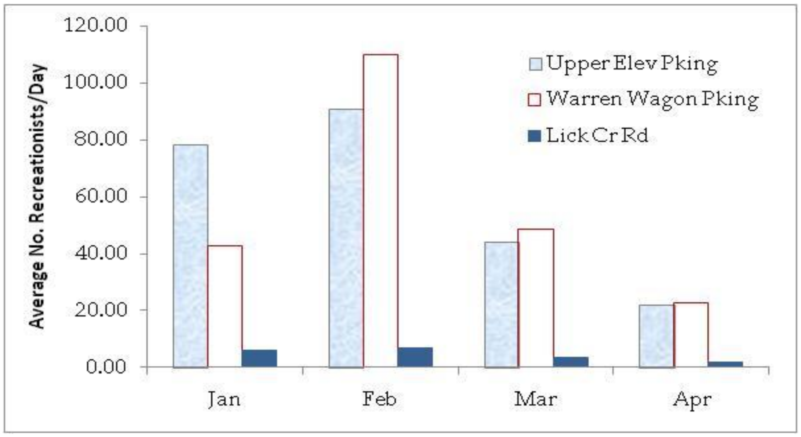


FIGURE 5. AVERAGE NUMBER OF WINTER RECREATIONISTS PER DAY FOR EACH MONTH OF MONITORING, USING INFRA-RED TRAIL USE COUNTERS NEAR EACH OF THE 3 MAJOR RECREATION ACCESS POINTS FOR THE STUDY AREA NEAR MCCALL, IDAHO.

(Figure 6) and Wednesday shows high use on Lick Creek Rd which is predominantly used by backcountry skiers. The lowest recreation days were Monday and Tuesday, with each day representing less than 10% of the weekly use for both snowmobile and non-motorized recreation activities.

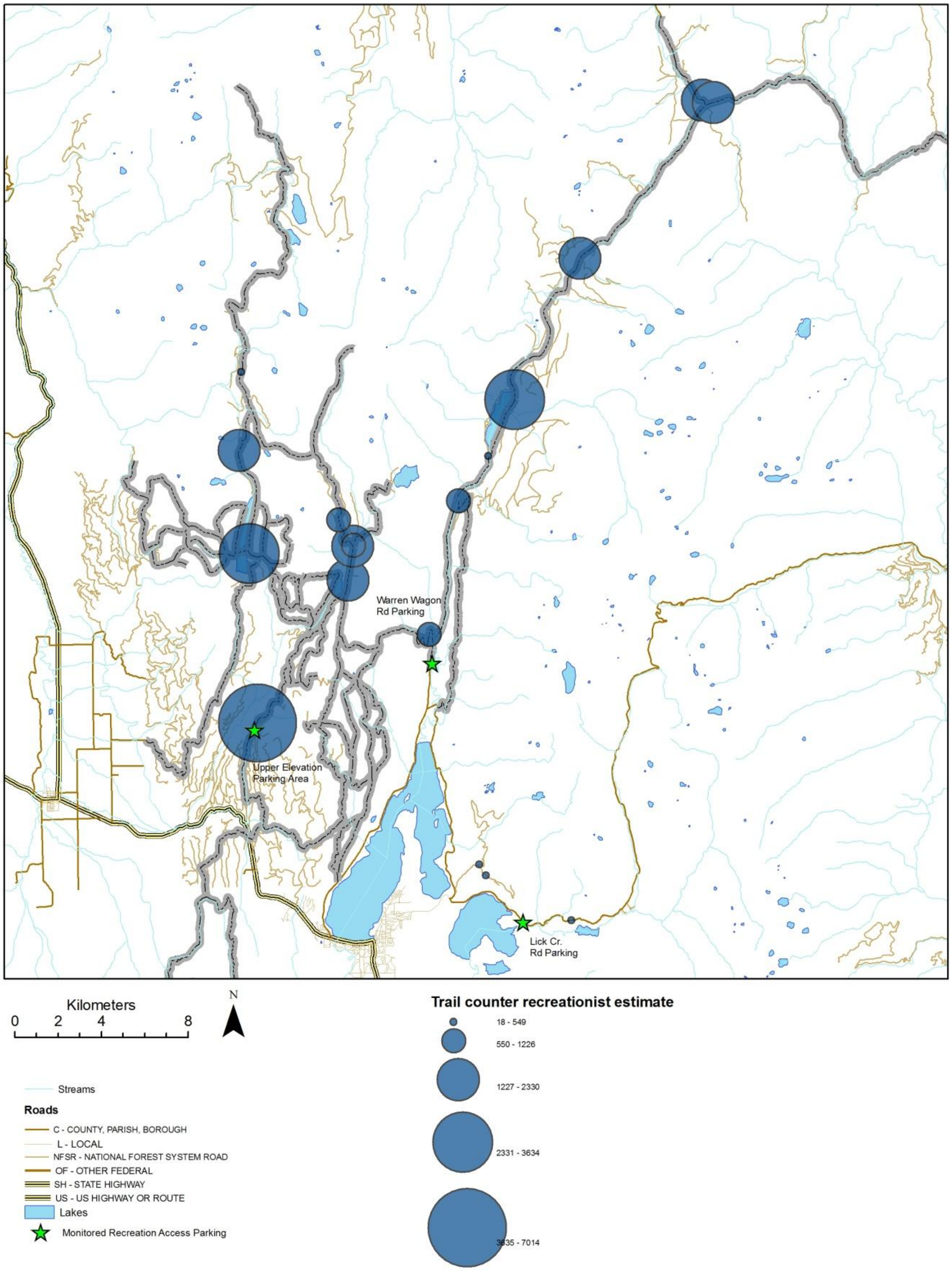
Daily averages peaked on Saturdays in February, with an average of over 200 winter recreationists using each of the Upper Elevation Parking area and the Warren Wagon Parking Area for primarily snowmobile recreational activities (Table 4). Peak activity for backcountry skiers using the Lick Cr Rd was also January and February, with a Saturday average of 10 recreationists/day.

HOURLY RECREATION ACTIVITY PATTERNS

Recreationists were counted at the infra-red trail counters to hourly summaries, allowing us to look at how recreation activity is distributed through the day. Both snowmobile and backcountry ski recreationists tend to have a bi-modal distribution of activity near the trailheads, as may be expected (Figure 7). For both types of recreation, there is a peak in activity at 10:00 as people left trailheads to enter the study area and an additional peak in activity at 16:00 as people head back to trailheads and pass by the trail counters for a second time. Recreation activity is seen as early as 07:00 in the morning and as late as 22:00, though numbers are quite small. The low level of use observed during late night and early morning hours is likely primarily due to night time trail grooming and some wildlife activity along the trail system.

DISTRIBUTION OF RECREATION USE ACROSS THE STUDY AREA

Infra-red trail counters were strategically placed across the study area to capture relative use of different access routes. The resulting counts provide a similar impression of the distribution of recreation use across the study area as is provided by the GPS monitoring of recreationists and the aerial surveys (Map 10). While trail counters provide a more complete count, accumulated hourly over a 4-month period, they do not provide information on the final destination or 'play areas' that may have been accessed away from the monitored trail system. Additionally, the same recreationists are being counted multiple times across the suite of trail counters. The



MAP 10. PROPORTIONAL COUNTS OF RECREATIONISTS ALONG SNOWMOBILE ROUTES AS RECORDED BY INFRA-RED TRAIL USE COUNTERS THROUGH THE WINTER 2010 NEAR MCCALL, IDAHO.

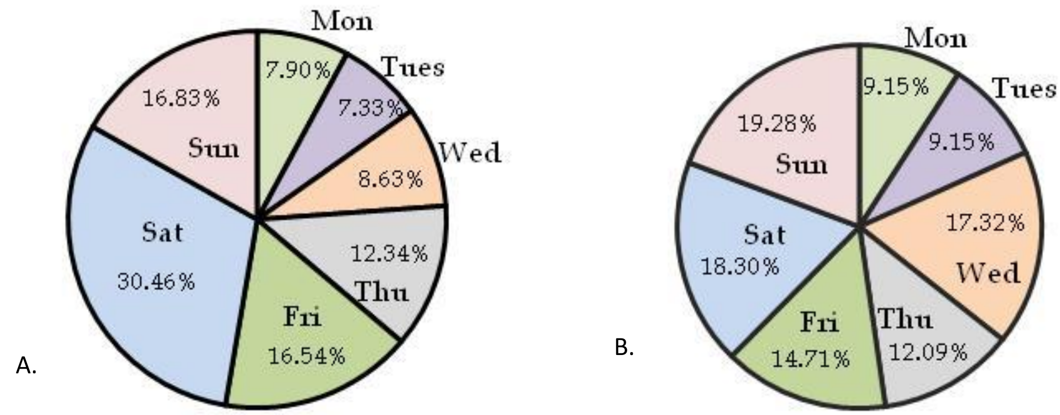


FIGURE 6. RELATIVE PERCENT OF WINTER RECREATION ACTIVITY THROUGH THE WEEK FOR A. THE TWO PRIMARY SNOWMOBILE ACCESS AREAS AND B. THE BACKCOUNTRY SKI ACCESS AREA THAT WERE MONITORED USING INFRA-RED TRAIL COUNTERS IN THE STUDY AREA NEAR MCCALL, IDAHO.

TABLE 4. AVERAGE DAILY ESTIMATE OF RECREATIONISTS ACCESSING THE STUDY AREA FROM THE 3 PRIMARY ACCESS POINTS THAT WERE MONITORED USING INFRA-RED TRAIL COUNTERS.

	January	February	March	April
Upper Elevation Parking	162	209	105	62
Warren Wagon Parking	87	205	114	38
Lick Creek Rd	10	10	2	3

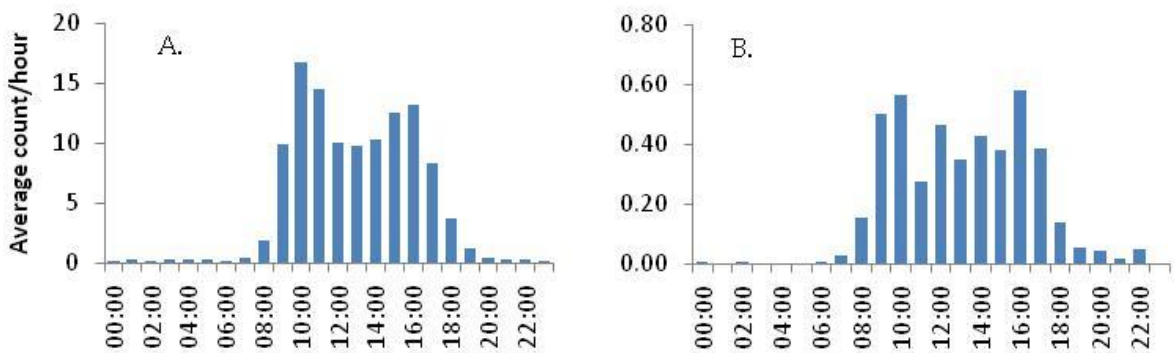


FIGURE 7. HOURLY AVERAGES OF RECREATION USE FOR A. SNOWMOBILE RECREATION FROM THE 2 PRIMARY SNOWMOBILE ACCESS AREAS, AND B. BACKCOUNTRY SKI RECREATION FROM THE SINGLE BACKCOUNTRY ACCESS ROAD MONITORED WITH INFRA-RED TRAIL COUNTERS OVER THE WINTER 2010 NEAR MCCALL, IDAHO.

relative intensity of use, as shown in (Map 10), provides a coarse assessment of how recreationists distribute themselves across the landscape with counts diminishing with distance from trailheads in most cases.

Preliminary comparison of wolverine and winter recreation information

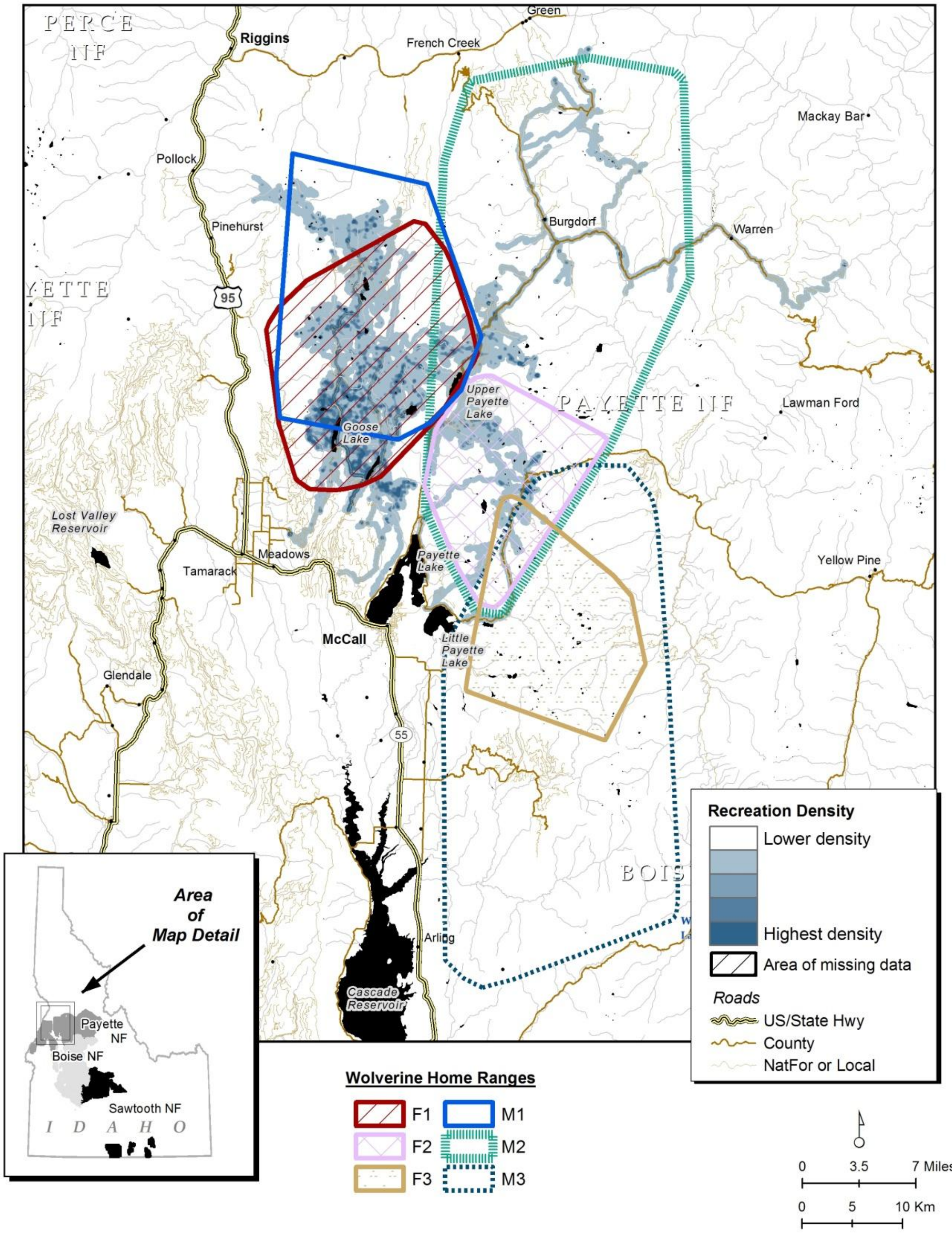
Caution must be used in interpreting and generalizing any results presented here as the data represent a small number of animals, a single winter season and only preliminary evaluation of the data.

Home range and movements relative to winter recreation landscapes

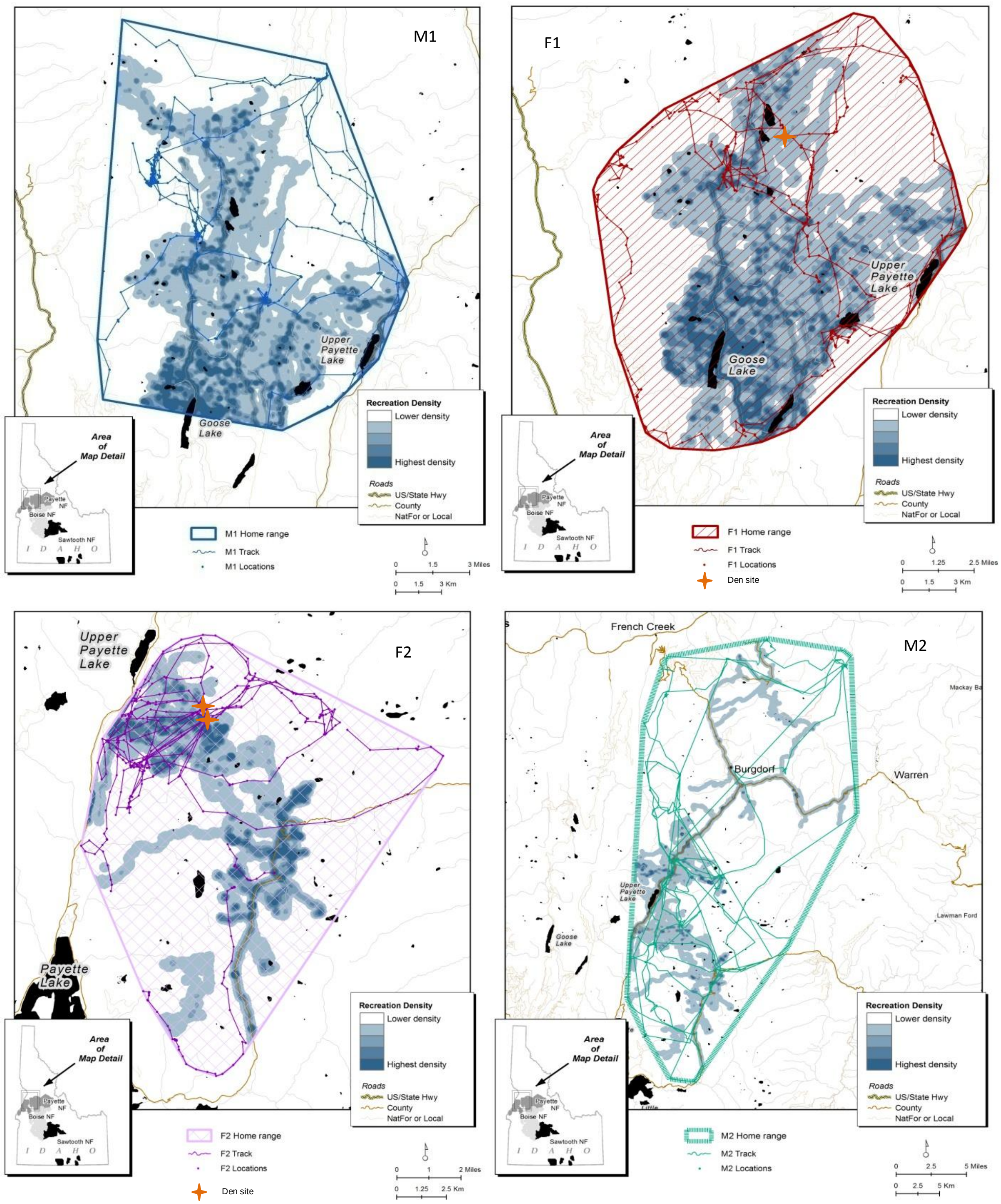
Previous aerial surveys for wolverine presence and winter recreation activity indicated that, at a regional scale, wolverines and winter recreation appear to occur in the same landscapes (Copeland 2009). The GPS monitoring of wolverines and winter recreation completed over the 2010 winter season indicates an overlap between areas occupied by wolverines and areas used for winter recreation at the landscape and home range scale (Map 11). Wolverines F1 and M1 have the highest density recreation landscapes within their home ranges, and these recreation areas cover a significant portion of the southern portions of both home ranges (Map 11). Wolverines F2 and M2 also have a notable amount of winter recreation within their home ranges, with pockets of high-density recreation landscapes. Alternatively, F3 and M3 have a very limited amount of low density recreation within their home ranges. It should be noted that data were not collected on recreation south of Little Payette Lake through much of the home range of M3 although recreation is known to occur in this area. Nearly all of the home range of F3 and the northern third of the home range of M3 are in areas with no motorized access and limited or no winter recreation activity.

We recalibrated the density maps of the recreation intensity to look only at relative levels of recreation intensity within each home range. At the home range scale, the movements of F1 and M1 are not common in the highest density recreation landscapes in the southern portions of their home ranges but are found in moderate and low recreation areas (Map 12). Alternately, F2 movements are common through the highest recreation density landscapes found within her home range while M2 movements are broadly distributed across all types of recreation landscapes (Map 12).

The den sites chosen by F1 and F2 were within landscapes that support lower levels of recreation intensity (Map 12), but were within a few hundred meters of pockets of higher recreation activity. The immediate areas around the dens were not conducive for winter recreation, being in large boulder fields. Still, we recorded snowmobiles within 100 m of the den of F1 on 3 occasions during her denning period between February 23 and February 27. On February 13, a group of 13 snowmobiles came within 65m of the den, traveling below and then around it to climb the headwall of the drainage. Our researchers unknowingly got within 50m of the den site while attempting to download data from F1 on February 24. A group of 3 snowmobiles travelled within 100m below the den on February 27. Alternatively, there were no recorded snowmobile tracks from our recreation GPS tracking within the drainage or immediate areas surrounding the natal den site of F2 during her stay at this den. On 1 instance, our researchers may have unknowingly come within 100m of the den site in an effort to download data from the female’s collar. There was also no recorded recreation activity within 250m of her maternal den site, which she moved to in early March. We did record a group of 5 snowmobiles on January 24 and another group of 9 snowmobiles on February 7 that spent a considerable amount of time on the slope immediate adjacent to the maternal den later established by F2 (on March 7).



MAP 11. INDIVIDUAL WINTER HOME RANGES, ESTIMATED USING MINIMUM CONVEX POLYGONS, FOR 6 WOLVERINES MONITORED OVER THE WINTER 2010 OVERLAP AREAS WITH WINTER RECREATION ACTIVITIES, SHOWN HERE AS A DENSITY OF RECREATION BASED ON GPS TRACKING OF A SAMPLE OF WINTER RECREATIONISTS.



MAP 12. MINIMUM CONVEX POLYGON HOME RANGE ESTIMATES SHOWN WITH THE RELATIVE RECREATION DENSITY WITHIN EACH HOME RANGE, AS CALCULATED FROM GPS TRACKING OF RECREATIONISTS WITHIN EACH AREA DURING THE WINTER, 2010, NEAR MCCALL, IDAHO.

DIEL ACTIVITY PATTERNS AND MOVEMENTS RELATIVE TO RECREATION ACTIVITY

Animals may respond to disturbance through a shift in when they tend to be active. Movement rates are highly variable within individuals and no pattern in changes in movement rate are seen when comparing these rates on high recreation days (i.e., Saturday and Sunday) to relatively lower recreation days (i.e., Tuesday and Wednesday; Figure 8). Responses may also occur within the daily cycle and we examined this as well. Female F1 shows a relative stable diel cycle throughout the time we monitored her. When this is overlain with the hourly recreation count data from an infra-red trail counter within her home range, there is a pattern of low movement rates during peak recreation times (Figure 9). Similarly, F2 shows a distinct diel cycle in movement rates during the period of denning that results in low movement rates during the peak recreation activity based on infra-red trail counts from a counter stationed within her home range (Figure 9). Finally, F3 shows limited pattern in diel movement rate patterns and these patterns do not appear to result in low movements during peak recreation periods (Figure 9). Female F3 has limited recreation activity within her home range and no recreation within the large drainage where her den was located; we would not expect her to modify her movements in response to recreation. Indeed, it appears that F3 has higher movement rates during the daylight hours while denning; such a diel pattern could reduce thermoregulatory stress on young kits by minimizing her absence from the den during the coldest nighttime temperatures.

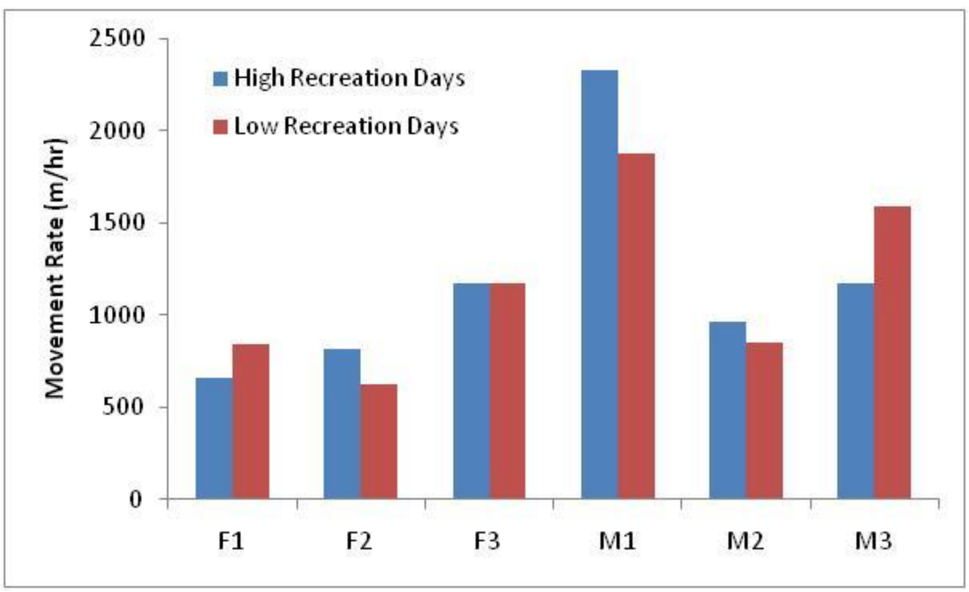


FIGURE 8. AVERAGE MOVEMENT RATES OF 6 WOLVERINES, SHOWN FOR MOVEMENT DATA FROM DAYS WITH HIGHER LEVELS OF RECREATION AND FROM DAYS WITH LOWER LEVELS OF RECREATION; DATA FROM WINTER 2010 NEAR MCCALL, IDAHO.

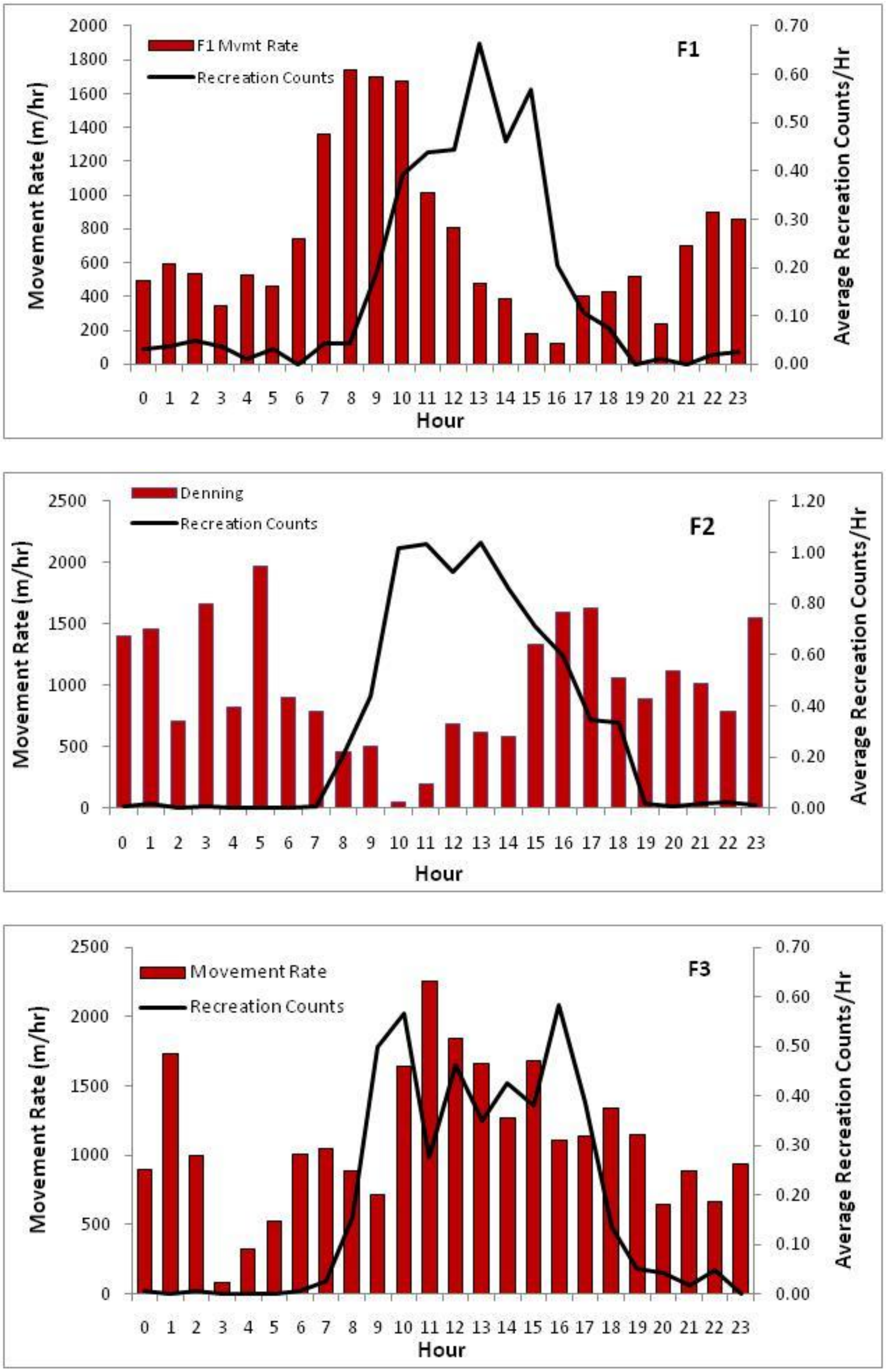


FIGURE 9. HOURLY MOVEMENT RATES OF FEMALE WOLVERINES SHOWN WITH AVERAGE RECREATION COUNTS WITHIN THEIR RESPECTIVE HOME RANGES BASED ON INFRA-RED TRAIL COUNTERS; DATA COLLECTED OVER THE WINTER 2010 NEAR MCCALL, IDAHO.

Conclusions and Next Steps

During the initial year of the study, we focused on testing proposed field methods for monitoring both wolverines and winter recreation and collecting information based on these methods that allows us to begin to evaluate potential interactions between wolverines and recreation. We had high success in all the field methodologies we invested in and will be using these data to explore any refinements to future field efforts.

In particular, the GPS tracking by volunteer recreationists was very successful and provides high quality and fine-scale data on recreation use. The primary challenge faced in implementing this approach is the field capacity to adequately sample multiple parking areas and dispersed recreation access. Limitation of capacity will likely prove challenging as we attempt to explore finer scale interactions with limited temporal windows within which we have both wolverine and recreation GPS data. Future field efforts will focus on increasing our ability to sample recreationists concurrent both spatially and temporally with GPS monitoring of wolverines. Still, at most spatial and temporal resolutions of interest, the quality and amount of data provided by the intensive GPS monitoring of recreationists that we achieved will provide an unparalleled opportunity to investigate potential interactions between wolverine and winter recreation. The effectiveness of the approach in other study areas will be partially dependent upon both the distribution of winter recreation access routes into the study area and the staffing capacity to ensure sufficient sampling. These should be primary considerations when exploring the establishment of new study areas.

Our approach to aerial surveys removes subjective interpretation of recreation intensity and footprint, which has been a common and widespread challenge of this type of recreation monitoring approach. We believe the grid-based, multiple presence-absence approach provides an effective and repeatable index of the extent and relative intensity of winter recreation while not relying upon observer interpretation. Additionally, the approach proved to be efficient, with each survey of the monitoring area completed within 3 hours from fixed-wing aircraft. The logistic challenge of these surveys is the need to have flight tracking capability to ensure the transect lines are followed closely. On-board flight tracking systems common in helicopters and larger aircraft are not commonly available in the smaller crafts and, therefore, the surveys require a laptop computer equipped with a GPS interface. While this technology is readily available, it can be challenging on the navigator responsible for watching the computer screen to ensure the flight lines are followed due to difficult lighting conditions and vulnerability to air sickness. The aerial surveys proved useful in identifying regions of the study area where the GPS monitoring was not adequately capturing recreation use, and we were able to modify our GPS sampling during the field season to capture additional recreation access areas we initially overlooked. For areas where we are unable to GPS monitor recreation, the aerial surveys provide a standardized approach to gathering information on distribution and relative intensity of recreation that is effective and can be repeated multiple times per winter.

The infra-red trail counters fill in important data gaps left by the GPS monitoring and aerial surveys since they provide continuous counting of recreation activity over the entire season. It is important to understand the actual level of use an area may receive by recreationists, as well as how that use is distributed in space and time. The trail counters provide total counts of users and, importantly, when that use occurs – by date and by hour. Additionally, it is possible to refine the spatial resolution of the data by strategic placement of counters along secondary or tertiary access points that may provide access to certain portions of the study area. They were easily established early in the season and required minimal maintenance. Proper and careful installation and maintenance is key to the success of the infra-red trail counters, as snow accumulation and weighting of tree and shrub branches can all effect the ability and accuracy of the counters. Given the relative low effort required to gather significant information about recreation use, the trail counters may be used in areas where it is not possible to undertake GPS sampling of recreationists. This, in combination with the aerial surveys will provide significant information on recreation use.

In this first year of the project, we also successfully captured and monitored 6 resident adult wolverines. The animals wore the GPS collars well, with only two collars slipped (and subsequently replaced) over the duration of the season. We did not surgically implant any wolverines with transmitters and avoided the stress and invasive nature of implants but, in so doing, we are foregoing the certainty of longer-term VHF contact with the animals. We were able to recapture animals to successfully maintain and manage collar data and battery life. The collars themselves acquired high quality data on locations and activity, but battery life will continue to be a challenge to the project. In particular, the battery life will limit the length of monitoring if we are unable or unwilling to recapture animals. In particular, recapturing females near or during denning season is questionable and must be limited or eliminated entirely. Thus, with a 6-week estimated battery life on the collars used in 2010, the capture and collaring of females had to be timed (to the extent possible) to ensure collar life is maximized over the denning season, as this is of particular focus for this research. The collars used on females weighted approximately 200 g or an estimated 2% of a typical female weight. Collars with a larger battery would reduce the need to capture or recapture females close to denning and will be considered for future collaring. Significantly more battery life can be expected from a 300g collar, while still being well under the recommended 5% of female adult weight. Certainly, a balance must be sought to reducing stress on animal due to recapture for collar maintenance and the potential stress due to a heavier or more bulky collar.

Data analyses will be on-going and will require additional years of data to increase sample size and evaluate potential variability in responses. This initial year has primarily shown the utility of the study design and field methods. It has also provided an initial opportunity to evaluate questions regarding potential interactions between wolverine and winter recreation. The first winter of data has shown that resident adult wolverines have established home ranges across a landscape with a range of recreation activities and levels or recreation intensity. All 3 females established dens within these home ranges, although one female lost kits to unknown causes relatively early in the denning period. There may be some indication of behavioral responses or adaptations of wolverines in the preliminary data exploration such as shifts in the diel activity periods to reduce movements during peak recreation periods. We will continue to explore metrics of wolverine responses to recreation. Certainly, additional seasons and wolverine numbers will be required to understand any patterns related to wolverine behavioral or demographic responses to winter recreation.

The study will be repeated in the McCall, Idaho study area during the winter 2011. In addition, we will be expanding the study area to the south onto the Boise National Forest in the Warm Lake area, with the establishment of additional trapping and recreation monitoring. We are also exploring opportunities to establish another study area on the Sawtooth National Forest near Stanley, Idaho. Both these areas offer excellent opportunities to monitor both wolverines and a diversity of recreation use and intensity. Refinements to the study design, based on the information presented here, will be incorporated into the efforts in 2011.

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APPENDIX I. WOLVERINE LIVE-TRAPPING AND PROCESSING DATA

Six wolverines were live-trapped and anesthetized as part of the project. The data on their condition and morphological measures are summarized

Appendix I. Capture and work up information for the wolverine live-trapping and GPS collaring effort during the winter, 2010 near McCall, Idaho.

Date	ID	Capture	Sex	Weight (kg)	General Condition	Length (cm)	Tail Length (cm)	Chest Girth (cm)	Neck Girth (cm)	Head Circ. (cm)	Notes
1/28/2010	F1	Initial	F	9.3	Excellent	89.5	16.5	37	27.5	30.5	
1/30/2010	F2	Initial	F	8.6	Excellent	88	17	38.5	29.3	31.2	
2/1/2010	M1	Initial	M	13.8	Excellent	99	20	49	37.2	39.7	
2/5/2010	M2	Initial	M	12.6	Good	97	18	49.5	38.4	39.5	
2/11/2010	M3	Initial	M	11.4	Excellent	96	17	45.8	35	36.7	
2/17/2010	F1	Recapt.		9.75	Excellent						Swollen belly
2/17/2010	M2	Recapt.									Light anesthesia; no measurements
2/20/2010	F3	Initial	F	8.8	Good						Low skin elasticity - dehydrated. Reversed asap
3/21/2010	F1	Recapt.		8.4	Excellent						Lactating an opaque fluid, not white/milk colored.
3/24/2010	M2	Recapt.		12.3	Excellent						No hair damage or rubbing from collar
3/25/2010	M3	Recapt.		11.8	Excellent						
4/10/2010	M1	Recapt.		12.4	Good						
4/12/2010	F3	Recapt.		8.5							Milk extracted from teats. Nipples enlarged and teats slightly swollen.
4/15/2010	F1	Recapt.		9.3							
4/20/2010	M2	Recapt.		12.3	Good						

4/24/2010	F2	Recapt.		Hind and middle teats are noticeably bagged. Milk- all 6 teats.
4/27/2010	M3	Recapt.	Good	Light anesthesia; no measurements