ANNUAL REPORT 2010

Resource selection, movement, recruitment, and impact of winter backcountry recreation on bighorn sheep (*Ovis canadensis*) in the Teton Range, northwest Wyoming

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PROJECT BACKGROUND

The Teton Range bighorn sheep herd resides year-round at high elevations in Grand Teton National Park and on the Bridger-Teton and Caribou-Targhee National Forests. Although the herd historically wintered at lower elevations in Jackson Hole and Teton Basin, they now winter exclusively in wilderness areas at high elevation on windswept ridges and slopes. It is Wyoming's smallest and most isolated native herd- a remnant population of approximately 100-150 sheep derived from a much larger bighorn sheep complex that historically lived in northwest Wyoming. Unlike many other bighorn sheep herds in the Rocky Mountain West, the Teton herd has yet to undergo a transplant to augment population size. However, the population's hold on the future is tenuous, owing to its small size, genetic isolation from surrounding herds, and the combined effects of loss of historic winter ranges, habitat alteration due to fire suppression, and potential impacts by increasing winter backcountry recreation. Much of the current information regarding these threats and the status of this native population is incomplete. The data from our study will provide the most extensive and complete picture of bighorn sheep habitat use, seasonal distribution, movement, and recruitment (lamb survival) in the Teton Range to date.

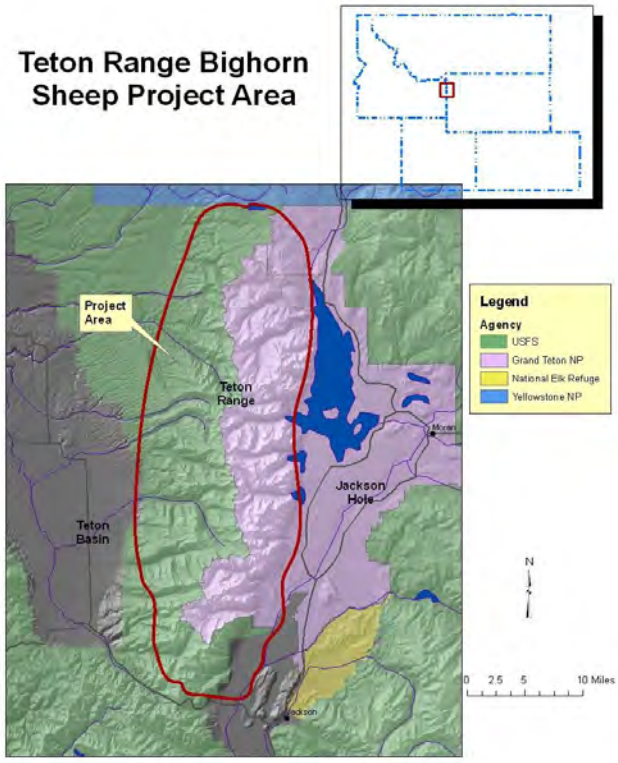

Figure 1. Project study area.

Growing recognition of the tenuous status of the Teton Range bighorn sheep population and the need for interagency cooperation in managing the herd and its habitat led to the formation of the Teton Range Bighorn Sheep Working Group (TRBSWG) in 1990. In the mid-1990's, the working group developed a strategic plan for managing bighorn sheep in the Teton Range and identified an objective of maintaining a population of at least 150 to 200 bighorn sheep over the long-term through coordinated management. The plan outlined a number of

problems facing the herd and strategies for resolving them. A number of these problems will be directly addressed by this project, which will contribute to more informed bighorn sheep management decisions.

Substantial progress has been made to address the threats to the long-term survival of the herd by TRBSWG members. Disease concerns were significantly reduced with retirement of the last remaining domestic sheep allotment in the Tetons in 2005 (with significant cooperation and contributions from the Wyoming Wild Sheep Foundation (formerly Wyoming FNAWS) and other partners). Since 2001, Grand Teton National Park has implemented seasonal closures of bighorn sheep winter ranges to reduce human disturbance. Recent results from a genetics study by Grand Teton National Park indicate that the Teton herd is genetically isolated from the nearby Jackson herd and that the northern and southern segments within the Teton herd exhibit a very low level of interbreeding. Uncertainties still remain regarding the current and historical distribution of the sheep herd, crucial seasonal habitat areas, basic recruitment and survival rates, and bighorn sheep avoidance of human winter backcountry travel routes. Consequently, there is a critical need to assess the habitat selection patterns and general population status of this isolated sheep herd.

OBJECTIVES

The overall goal of this research project is to improve our understanding of how and why bighorn sheep use the Teton landscape, and how an ungulate population that has lost its historical migration routes has been able to persist on summer range year-round. Our objectives are closely aligned with management needs as laid out in the Teton Range Bighorn Sheep Working Group's Strategic Plan (1996).

The primary objectives of this study are to:

1. Compile and map historic sheep distribution using historical data sources;
2. Document locations, characteristics, and use patterns in seasonal habitats and movement corridors;
3. Quantitatively assess the habitat selection patterns of the herd (in winter and summer);
4. Quantitatively assess avoidance of winter habitats by bighorn sheep due to human recreation activities;
5. Evaluate the effects of retiring domestic sheep allotments on the Teton Range bighorn sheep herd;
6. Determine lamb production and lamb survival to late summer for the sample of GPS-collared ewes;
7. Evaluate summer diet selection, compared to migratory bighorn sheep herds in similar habitats;
8. Evaluate summer time-budgets, compared to migratory bighorn sheep herds in similar habitats; and
9. Provide community education on bighorn sheep and the project in the form of public presentations, written materials, local media, etc.

METHODS

Figure 2. Wes Livingston from Leading Edge Aviation processes a bighorn ewe, 2008. Photo: Mark Gocke, WGFD

Capture and GPS-collaring

Seasonal habitats and movement corridors will be identified by tracking a sample of 28 GPS-collared bighorn ewes over 2 ½ years (Fig. 2). In 2008, we successfully captured and collared 20 ewes in the Teton Range, and we captured an additional 8 ewes in 2009. Ewes were fitted with GPS collars that collected locations every five hours, and were programmed to automatically drop off of the animals on 15 July 2010. Blood, fecal, tissue, and hair samples and tonsil, nasal, and ear swabs were collected from each ewe for pregnancy and disease testing at the Wyoming State Veterinary Laboratory. The average estimated age of captured ewes was 4 years (min = 1 year, max = 8 years). Average weight of ewes in 2009 was 130 pounds (min = 110, max = 145).

Pregnancy and disease testing

Ninety-percent of reproductive aged ewes were pregnant in 2008, and 100% were pregnant in 2009. These percentages suggest that sheep are gaining sufficient fat during summer on high-elevation range to become pregnant and maintain reproductive status through late-winter. In both years, all ewes tested negative or had extremely low titers for 12 common bighorn sheep diseases (caprine arthritis encephalitis, ovine progressive pleuropneumonia, infectious bovine rhinotracheitis, bovine viral diarrhea, parainfluenza virus, respiratory synctial virus, bluetongue, Johne's disease, *Brucella ovis*, wildlife brucellosis serology, epizootic hemorrhagic disease virus, and *Psoroptes* mites), indicating very low previous exposure for this isolated population. *Mannheimia haemolytica* was isolated from tonsil and nasal swabs from one captured ewe, although she remains alive and shows no visual signs of being affected by the bacteria.

Adult mortality

Eight GPS-collared bighorn ewes died during the study period (February 2008 – July 2010) (Fig. 3). Four ewes died in winter and spring avalanches, three from unknown causes, and one from mountain lion predation. This mortality rate for adult females appears high, especially for a relatively small population, however it should be noted that our sample size is low.

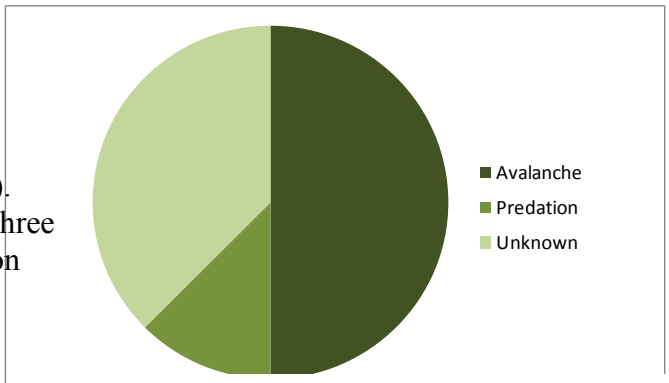

Figure 3. Causes of GPS-collared sheep mortalities.

Analyzing habitat use and selection

GPS location data from the collars will be analyzed to evaluate habitat use and selection, and habitat use patterns will be modeled using a resource selection function (RSF). An RSF (a statistical model) will be created to estimate the relative frequency of sheep use of the entire study area as a function of habitat attributes (such as elevation, vegetation type, slope, distance to

escape terrain, snow cover, etc.). The RSF will be mapped back onto the study area to create a spatially continuous map of sheep habitat quality as indexed by frequency of use. This predictive habitat map will allow managers to evaluate the conservation value of various types of sheep habitat (based on the physical attributes of the habitat) irrespective of their current occupancy by the Teton Range bighorn sheep. This analysis will be completed during spring and summer 2011.

Measuring effects of winter recreation

In order to evaluate whether bighorn sheep avoid areas of different levels of human recreation use in winter, we are quantifying patterns and intensity of backcountry use in the southern Tetons and incorporating these data into the winter RSF as an additional predictor variable of bighorn sheep habitat use. Winter sampling took place from January to mid-April in 2009 and 2010. We contacted backcountry skiers, snowboarders, and ice climbers at 11 backcountry access points throughout the winter seasons, and asked them to carry handheld GPS tracking units for the day. GPS units were programmed to collect a GPS fix every five seconds, producing detailed tracks of backcountry recreation routes. These data are easily integrated into a Geographical Information System (GIS) and compared spatially and temporally with bighorn sheep movement data.

The RSF analysis will allow us to determine if human activity is a significant predictor of bighorn sheep habitat use (or avoidance). The predictive map of bighorn sheep probability of use across the landscape produced from the RSF will indicate if bighorn sheep are avoiding suitable winter range areas where backcountry travel is occurring. If possible, we will seek to determine if there is a detectable threshold level of human use that causes bighorn sheep to abandon winter range areas.

PRELIMINARY RESULTS

On 15 July 2010, the collars automatically dropped off of the bighorn sheep. From mid-July through September 2010, we collected 18 collars from the field. We were unable to locate two collars because their VHF batteries had failed. One collar appears to have failed to initialize and contained no data. In total, we obtained nearly 61,000 usable GPS locations from 25 collars (including 8 collars that had previously been collected from bighorn sheep mortalities) (Fig. 4).

Data from the collars showed that bighorn sheep were, for the most part, segregated into a southern group and northern group. We documented one collared ewe that travelled between the north and south and back in summers 2008 and 2009. Bighorn sheep winter range is more constricted than summer range and is concentrated around Jensen Canyon, Mt. Hunt, Prospectors Mountain, Static Peak, and Avalanche Canyon in the south and Doane Peak, Ranger Peak, Elk Mountain, and Owl Peak in the north. However, bighorn sheep used some lower elevation areas in Fox Creek and Moose Creek, particularly during winter 2009/2010. On average, bighorn sheep wintered at 3044 meters (9987 feet) and summered at 2969 meters (9740 feet) in elevation. This similarity is due to bighorn sheep use of high elevation wind-scoured ridgelines and slopes during the winter where snow depths are shallower than at mid and low elevations. Interestingly, the average elevation for bighorn sheep in spring is 2642 meters (8668 feet), which is more than 1000 feet lower than the average summer or winter elevations. This is likely because bighorn sheep are descending to low elevations in the spring to take advantage of areas with early snow melt and plant emergence.

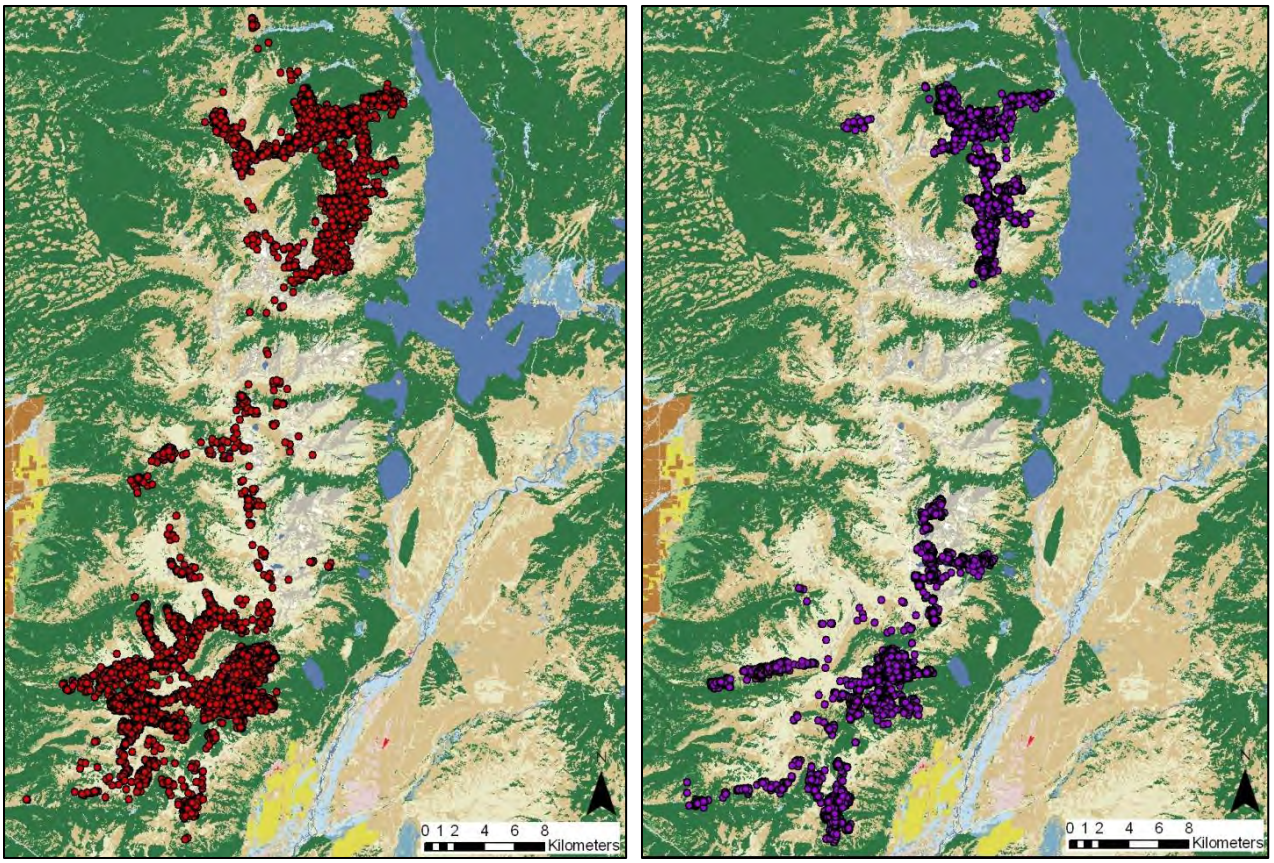

Figure 4. GPS-collared bighorn sheep locations in summer (red) and winter (purple) in the Teton Range, 2008 – 2010.

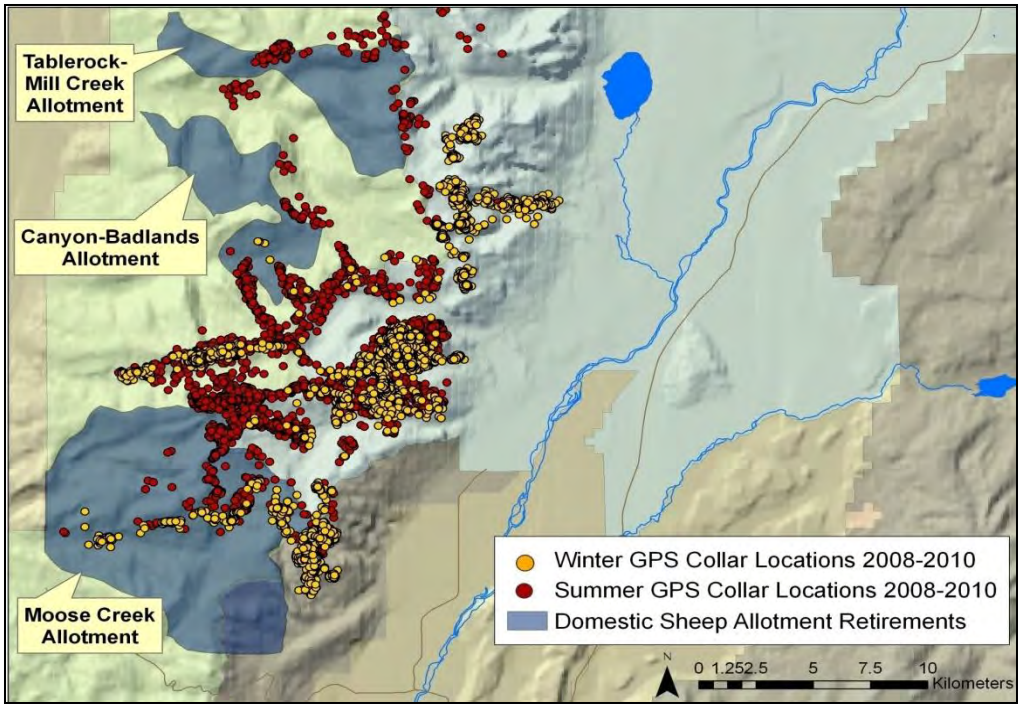

Figure 5. GPS-collared bighorn sheep use of recently retired domestic sheep allotments on the west slope of the Teton Range. Use occurred during summer (red) and winter (yellow) from 2008 to 2010. These allotments were retired in a willing seller – willing buyer agreement using funds from the Wyoming Wild Sheep Foundation and other partners.

We found evidence that bighorn sheep are making use of the retired domestic sheep allotments on the west slope of the Teton Range during all seasons (Fig. 5). Of particular note is the winter use at low elevations in Moose Creek and Fox Creek, which are areas that are known historical bighorn sheep winter habitat (Whitfield 1983). Most of this use occurred during winter 2009/2010, which was comparatively mild, suggesting that these areas could serve as important winter ranges for bighorn sheep during certain years. Prior to this study, the extent of bighorn sheep use of these areas was unclear, but these results show the importance of retiring these allotments for bighorn sheep.

Data collected during three summers of field work (2008-2010) revealed that bighorn sheep lambs exhibit a typical summer survival rate (Fig. 6) compared with other populations (Geist 1971, Valdez & Krausman 1999). Summer vegetation transects revealed that on average, bighorn sheep foraging areas are comprised of 70% bare ground, 23% forbs, 12% grasses and sedges, 4.5% shrubs, and 3% other (the total is greater than 100% because vegetation was measured in 3-dimensional space). We identified 76 genera of plants within bighorn sheep summer foraging areas, however, only 40 of those genera were present in bighorn sheep fecal samples. We identified 11 genera that bighorn sheep showed significant selection for (the percentage in the diet was statistically greater than the percentage available on the ground), including several genera of grasses (*Bromus* spp. and *Poa* spp.), sedges (*Carex* spp.), milk-vetch (*Astragalus* spp.), sweet-vetch (*Hedysarum* spp.), geraniums (*Geranium* spp.), lupines (*Lupinus* spp.), and buttercups (*Ranunculus* spp.) (Fig. 7). Summer time-budgets during periods of feeding are still being analyzed and compared to migratory bighorn sheep populations.

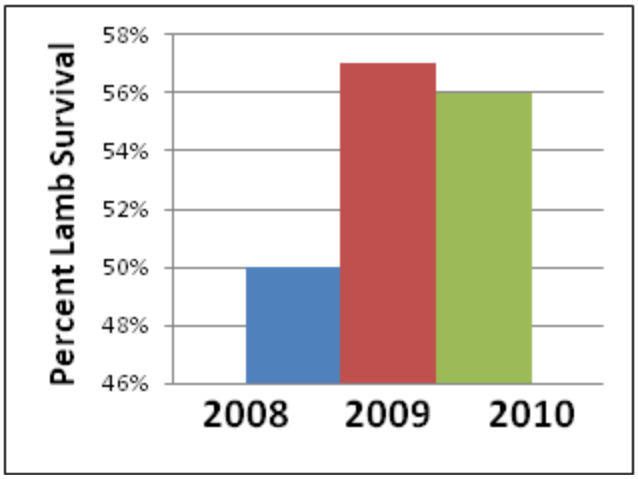

Figure 6. Lamb survival rates to late summer for GPS-collared ewes. Survival rates were 50% in 2008, 57% in 2009, and 56% in 2010.

Over two winters of field work, we collected 768 GPS tracks originating from 11 trailheads representing backcountry recreation routes in the Teton Range (Fig. 8).

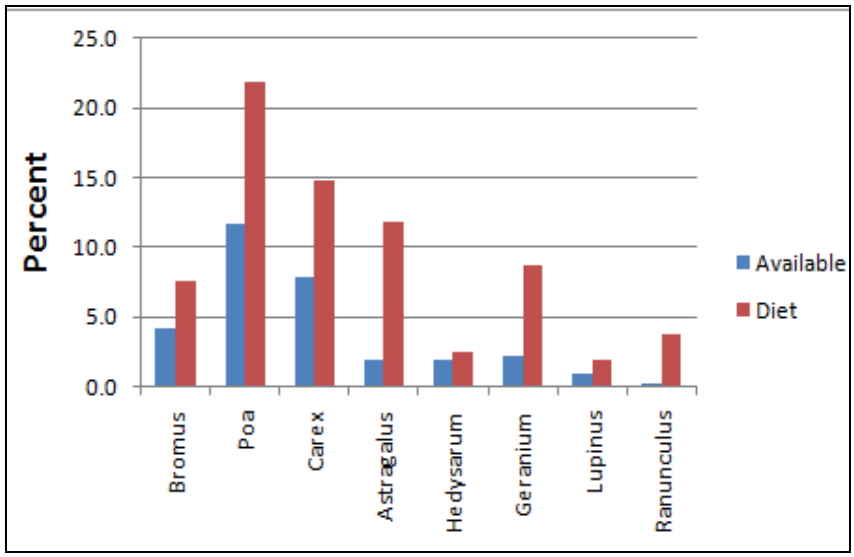

Figure 7. Examples of 8 plant genera that occurred at significantly higher percentages in bighorn sheep diets than in vegetation surveys in bighorn sheep foraging areas.

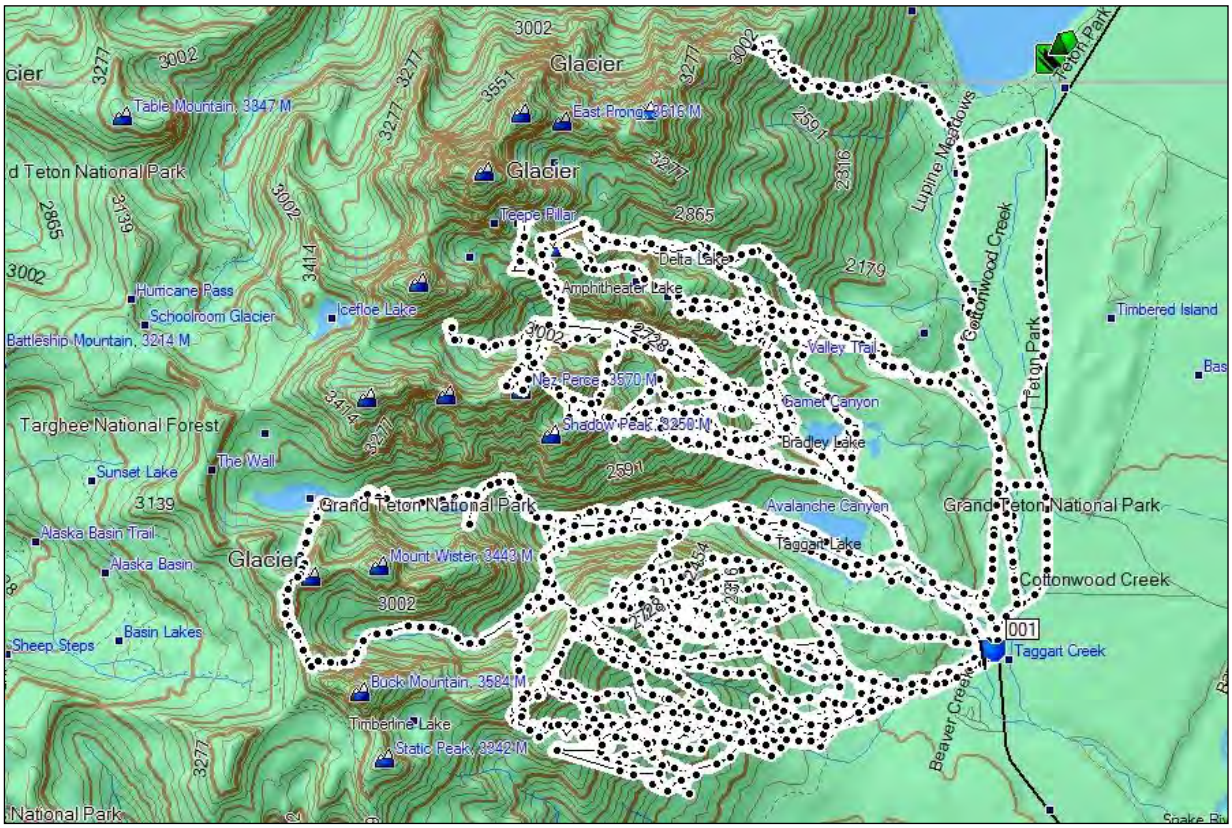

Figure 8. An example of GPS tracks of winter backcountry use collected from the Bradley-Taggart trailhead in Grand Teton National Park, January - April 2010. We collected winter backcountry recreation data from 10 other trailheads in the Teton Range over winters 2008/2009 and 2009/2010.

Overall, we had a 77% compliance rate from backcountry users to participate in the study. Compliance was higher at trailheads in Grand Teton National Park and Caribou-Targhee National Forest (90%) compared to backcountry access points on Jackson Hole Mountain Resort and Grand Targhee Resort (70%). This is likely due to the different demographics of recreationists using these access points. During winter 2010, we also collected trail counter data at 8 trailheads in order to measure total recreation use; these data are currently being analyzed.

ONGOING WORK

We are currently developing bighorn sheep habitat selection models for winter and summer, based on GPS collar locations (Manly et al. 2002). Landscape attributes used to predict bighorn sheep seasonal habitat use will potentially include slope, elevation, solar radiation (a substitute for aspect), distance to escape terrain, distance to conifer cover, snow cover, distance to mineral licks, and vegetation type.

The winter GPS tracks of human recreation routes will be combined with trail counter data to quantify the patterns and intensity of human recreation in and near bighorn sheep winter range. These data, combined with the bighorn sheep winter habitat selection model, will illuminate if and how bighorn sheep habitat selection patterns change due to winter backcountry

recreation. This information will help to guide future management of crucial bighorn sheep winter range areas.

The results from this study will provide the most detailed and complete picture of seasonal habitat use, movement, recruitment, and impact of winter backcountry recreation on bighorn sheep in the Teton Range to date. This information will aid managers in identifying the most important habitat areas for sheep conservation and future herd expansion. Final reports to agencies and funding partners, as well as manuscripts for publication, will be prepared by summer 2011.

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A yearling bighorn sheep checks out the summer field crew in Darby Creek in the Teton Range