CASCADE WILDLIFE MONITORING PROJECT
WINTER 2006-2007 FIELD SEASON REPORT

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Abstract:

The Cascade Wildlife Monitoring Project uses trained volunteers to monitor the location and movement of wildlife, through snow tracking surveys, in the vicinity of proposed wildlife crossing structures along Interstate-90 in the Washington Cascades between Snoqualmie Pass and Easton. The first field season was successful in meeting multiple objectives: collecting an initial data set on existing wildlife along the interstate; training and utilizing approximately 50 volunteers to carry out a rigorous data collection protocol; and creating a structure for ongoing citizen monitoring of wildlife over time before and after highway construction activities. Nearly all expected common mammal species predicted in the study area were detected, while no rare, threatened, or endangered species were noted. Recommendations for next season include: expanding tracking surveys to non-snow seasons, making minor adjustments to field protocols, adding of a control transect, and minor adjustments to volunteer coordination and training.

The Cascades Wildlife Monitoring Project: Overview

The Cascade Wildlife Monitoring Project (CWMP) is a joint project of Wilderness Awareness School (WAS), an environmental education organization, and Conservation Northwest (CN), a conservation organization. CWMP uses trained volunteers to monitor the location and movement of wildlife in the vicinity of proposed wildlife crossing sites along Interstate-90 in the Washington Cascades between Snoqualmie Pass and Easton. The proposed crossings are a part of the I-90 Snoqualmie Pass East Project. As a high profile project at a major recreation destination, there is substantial interest from citizens who would like to understand and be involved in the decision making process. The Cascade Wildlife Monitoring Project aims to improve understanding of the impact on wildlife of this major highway renovation. CWMP also aims to involve and educate the public regarding road ecology and wildlife tracking. This document reports results from the first year of monitoring.

The project has been designed to answer these questions:

1.) What species of wildlife are present in the habitat adjacent to the interstate and what are their current patterns of use in areas proposed for construction of crossings?
2.) Will these patterns be affected by the addition of crossing structures and if so how?
3.) There are ungulates and rare carnivores in the area which are of high interest to conservationists and wildlife managers. Which of these are present in the areas of the proposed crossings, and what are their discernable behaviors in relation to the road?
4.) How effectively can a volunteer based citizen science effort carry out a rigorous scientific endeavor to answer the first three questions?

Through snow tracking surveys, CWMP volunteers collected data on the location and movement patterns of wildlife along the Interstate at sites with planned crossing structures. Through this report and reports to come in subsequent years, findings will be made available to land managers, the Washington State Department of Transportation, and public interest groups with the intention of helping to guide final decisions about the location and type of construction. Monitoring will continue during and after the construction period. Data obtained before, during and after highway construction will help test the function of crossing structures and assess changes in permeability of the Interstate for medium and large mammals.

In addition to winter snow tracking surveys, several motion-sensing cameras are managed by volunteers from Conservation Northwest along the Interstate corridor. Cameras are active year round and supplement information gathered through tracking surveys. (Data from these cameras is not presented in this report.) Starting in the Spring of 2007, tracking surveys will be piloted quarterly during non-snow seasons.

During the first field season (winter 2006-2007) six transects were monitored using snow tracking methods. Five of the survey sites coincide with planned wildlife crossings (Gold Creek, Price/Noble Creek East, Price Noble Creek West, and Easton Hill North and South). The remaining location, Hyak/Silver Fir, is the site of a proposed expansion to the Snoqualmie Summit ski resort and is not adjacent to the Interstate (see Appendix **A** for site maps.) Over 50 volunteers participated in this field season to produce the findings in this report.

Literature Review

Road Ecology and Wildlife Crossing Structures

Roads of various kinds have been shown to affect the behavior of wildlife in numerous ways (e.g. Forman *et al* 2003). Large divided highways such as Interstate 90 have been shown to significantly impede the migration and dispersal of large mammals across a landscape. This is due to both the “barrier” effect which discourages animals from attempting to cross, and roadkill mortality (Forman *et al.* 2003). A study in Alberta demonstrated that a four-lane divided highway was a complete barrier for adult female grizzly bears and a partial barrier for adult males (Gibeau 2000). The increasing recognition among researchers and decision makers of these and other detrimental environmental impacts of highways has led to the development of road ecology as a field, arising from the need to improve understanding of wildlife-highway interactions and inform highway development decisions.

One recent outcome of the road ecology discourse has been that building wildlife crossings over or under highways has become a serious consideration for policy makers. Crossing structures, when sited at strategic animal movement points along a highway corridor, can greatly alleviate the collision dangers to both humans and wildlife, as well as reduce the barrier effect and habitat fragmentation caused by the road (Forman *et al.* 2003). One noteworthy precedent for wildlife crossings projects is along the Trans-Canada Highway in Banff National Park, Alberta. (A comprehensive list of US projects can be viewed at http://www.wildlifecrossings.info/beta2.htm). Crossing structures include both underpasses and overpasses, and designs vary depending on the target species (Forman *et al.* 2003). However, building wildlife crossings is often considered secondary to the priority of road expansion and therefore many projects have not included an analysis of wildlife movement patterns before and after road expansion and the construction of crossings (Hardy *et al*. 2004; Clevenger and Waltho 2003). Collecting several years of data before and during construction to compare with post-construction data allows for a more thorough analysis of actual effects of wildlife crossing structures (Hardy *et al.* 2004).

The I-90 Snoqualmie Pass East Project

The I-90 Snoqualmie Pass East highway project is located on a 15-mile stretch of Interstate-90 in Kittitas County, Washington, which passes through the Wenatchee National Forest. The purposes of the highway project include meeting projected traffic demands, improving public safety, reducing avalanche and rock-fall risk, replacing damaged pavement, and improving wildlife habitat connectivity (WSDOT and USDOT *Draft Environmental Impact Statement,* 2005). The project is led by the Federal Highway Administration and the Washington State Department of Transportation and is planned to involve widening and straightening sections of the highway, as well as adding wildlife crossings. Construction is scheduled to start in Spring 2010, and several options of varying expense are being considered to meet project goals. More detail and updates concerning the I-90 Snoqualmie Pass East project can be obtained from Washington State Department of Transportation at http://www.wsdot.wa.gov/Projects/I90/HyaktoKeechelusDam/.

The barrier effect of Interstate-90 may be a significant impediment to the dispersal and healthy functioning of wide ranging species in the Cascades and may also be a limiting factor in the regeneration of depleted populations of currently rare low-density species. Wolverine (*Gulo gulo*) and lynx (*Lynx canadensis*) have been documented on both sides of the highway while there have also been probable detections of grizzly bears (*Ursus horribilis*) and gray wolves (*Canis lupus*) in the region. The most recent sightings of fisher (*Martes pennanti*) in the region were in 1976 (Singleton and Lehmkuhl 2000).

Snow Tracking

Animal tracking, and particularly snow tracking, is increasingly recognized as a reliable and rigorous method for wildlife research. Indeed, snow tracking is one of the key methods recommended by the United States Forest Service for certain kinds of wildlife surveys, for example in the detection of rare carnivores (Zielinksi and Kucera 1995). Some studies have found snow tracking to be more effective for detecting target species than other methods when compared (Bull et al. 1992, cited in Zielinksi and Kucera 1995; and Copeland, J., cited in Zielinksi and Kucera 1995). Collection of tracking data during non-snow seasons requires observers with a higher degree of skill but has been incorporated into other road ecology surveys (Barnum 2003, van Manen *et al.* 2001).

Tracking is a relatively established methodology for monitoring animals at wildlife crossing structures and along road corridors (for instance: Clevenger et al 2002, van Manen et al 2001, Barnum 2003, Singleton and Lehmkuhl 2000). The procedures vary depending on the natural conditions on the ground, time of year, and specific goals of the research. Methods include the use of track plates and artificially prepared ground specifically at crossing sites (Clevenger 2003, Singleton and Lehmkuhl 2000), and transects along which track and sign data is collected (Barnum 2003, Singleton and Lehmkuhl 2000).

One previous study of wildlife connectivity was conducted in the I-90 Cascades corridor by Singleton and Lehmkuhl (2000) as part of the planning process for the I-90 Snoqualmie East Project. Singleton and Lehmkuhl combined snow tracking data with road kill records, habitat and terrain parameters, motion sensing cameras and track plates to inform the choice of locations for the planned I-90 wildlife crossings.

Citizen Science

The concept of citizen science has been employed for decades by organizations such as the Audubon Society and the British Trust for Ornithology for bird counts. The website of Citizen Science Central states that "across North America and beyond, increasing numbers of organizations" are becoming involved in citizen science (Accessed 12 April 2007, <http://www.birds.cornell.edu/citscitoolkit>), which not only enables researchers to gather substantially more data than would be possible without volunteer assistance, but "augments more conventional approaches, [and] also results in the emergence of new knowledge and insights" (Lee *et al.* 2006, p. 1). This approach of involving a network of volunteers can therefore have multiple benefits that extend beyond the confines of the research itself.

Wildlife tracking has already been the focus of successful citizen science projects elsewhere. A noteworthy example is the San Diego Tracking Team (www.sdtt.org), which has used citizen trackers for more than a decade to collect data used in planning transportation and urban development projects in Southern California. Another important example is Keeping Track (http://www.keepingtrack.org/article/articleview/3332/1/390/), a Vermont-based non-profit organization which trains participants to use tracking to monitor changes in wildlife populations over time for land management and conservation purposes.

Methodology

Snow tracking methods were chosen for this project for several reasons. Snow provides an excellent medium for detecting and identifying tracks and the snow season at the location lasts for several months. A transect method was chosen for the survey similar to that employed by Singleton and Lehmkuhl (2000) so that data from the two studies could be comparable. Data collection designs from the San Diego Tracking Club and the Forest Service were examined and both have influenced the design of data collection in this survey.

In this study, surveyors snowshoe along a set transect which runs parallel to the interstate, approximately 150 meters from the roadway. Transects are done on both sides of the interstate and are each around 1 km long. Tracks of all mammal species larger then snowshoe hare (Lepus americanus) are documented along with information on direction of travel, forest stand data, and snow conditions. Selected animals are trailed both forward and backward to ascertain their behavior in relationship to the road (crossing, attempted crossing, etc.) on the return leg of the transect.

Personnel and Training

This survey was designed and executed by volunteer naturalists and trackers, in consultation with professional wildlife biologists in government agencies or other organizations concerned with the I-90 Snoqualmie Pass East Project. The fieldwork was carried out in small teams of 3-5 volunteers each with a team leader. All participants received basic training in the fieldwork procedures and track identification, the team leaders having attended a more detailed training in addition to their prior experience. (See Appendix B for transect leader qualifications.) Teams conducting non-snow season transects will consist of members with more training and experience.

To improve data consistency and site comparability, sites were visited by different team leaders throughout the season. Team leaders were responsible for conducting surveys at three sites with a team between December 31st 2006 and March 31st 2007, for entering the team's data (from data forms) into the computer database, and for emailing a description of their field day and useful information about a given site to other team-leaders.

Fieldwork Locations

In its first season, CWMP conducted wildlife transect surveys at six locations along the I-90 corridor chosen by Conservation Northwest (CNW). Each transect site coincided with a wildlife crossing proposed for the I-90 Snoqualmie Pass East project, except the Hyak/Silver Fir site which was of interest to CNW owing to a proposed ski resort development. Where appropriate, each site involved two parallel half-mile transects, forming a pair, one on either side of the highway. However, there are two sites that do not fit this pattern. The Hyak/Silver Fir site is not along the highway, and involves two transects perpendicular to each other, designed thus for logistical reasons as well as to survey a better cross-section of the locale; and the Easton Hill site, owing to difficulty of access, has been designated as two separate one-mile transects.

Field locations were visited by project designers prior to sending team-leaders into the field for transect days. Basic directions to each site were provided to team-leaders in a written Survey Protocol guide, and early teams marked their precise locations with surveyors tape for later teams to follow. After each field day, team-leaders were requested to email field reports to provide detailed descriptions of transect terrain and precise route recommendations for future teams at each site. A brief description of each transect site is included in Appendix C.

Field Procedures

Transect field days were chosen according to volunteer and team leader availability, road safety, and snow conditions. An attempt was made to space transects throughout the field season. All transects along the highway were parallel to the roadway at a distance of approximately 150 meters, after Singleton and Lehmkuhl (2000), depending on the navigability of the terrain. Tracks and sign of all mammals larger than snowshoe hare (and including mink) were recorded with GPS points, snow track quality, and habitat data. If the spoor was seen while walking the transect but did not cross the transect line, its distance from the transect was also recorded.

Species were assigned levels of priority for recording and documenting based on their conservation significance or the likelihood of their providing insight into multispecies movement patterns through the landscape in the I-90 corridor. (See the Species Priority List in Appendix D.) Spoor of Level 1 species, if found, was to be documented in more detail including photography and sketches, and to be trailed even at the expense of completing a transect; Level 2 species were trailed on the return leg of the transect. Trailing involved following the animal towards the highway to document behaviors with respect to the road, time and safety permitting. This included taking GPS points for direction and gait changes, stopping, using cover, and other behaviors. Level 3 species were not trailed but recorded on transect data sheets with all other detected species.

Once recorded on data sheets, tracks were clearly marked such that, in the absence of intervening snowfall, future teams would not duplicate the recording of tracks previously documented.

Data Analysis Methods

Excluding 2 records where behavioral observations associated with track and sign were considered reliably indicative of species (aquatic mustelids entering and exiting waterways and displaying sliding behavior), all observations associated with poor track quality (*Snow Track Quality* equal to 1) were not considered reliable and thus are not included among the data presented. Similarly treated were observations where species were recorded as ambiguous or unknown. Of 10 such observations, 9 were associated with poor snow track quality, as might be expected.

To account for unequal sampling effort, detection rates were standardized between sites, using visits (or completed transects) as the base unit of effort by which to index detections. Additionally, Shannon's Diversity Index ($H' = -\sum p_i \ln p_i$) metrics were constructed for each site to facilitate comparison between sites (Magurran 1988).

Discussion

<u>Wildlife Presence and Patterns of Use</u>

Data:

No Level 1 species were detected during the field season (see Appendix D). A single cougar (*Puma concolor)* was detected and subsequently trailed, at Price-Noble Creek. Bobcat (*Lynx rufus*) comprised nearly half of all reliable detections, and was found at all highway transect sites (Figure 1). Coyote (*Canis latrans*) was detected at all sites, including the lower elevations of the Hyak site, except Easton Hill, and after bobcat, was the most frequently detected species. American marten (*Martes Americana*) was detected with regularity, though only at the highest elevation portions of the Hyak/Silver Fir site. It is likely that these records represent a single individual. The species was not detected at any of the highway sites. We found evidence of two species, raccoon (*Procyon lotor*) and river otter (*Lutra Canadensis*), predicted by habitat to be marginal or absent within the study area (Table 1). The only large mammal species predicted but not detected was porcupine (*Erethizon dorsatum*).

It is important to note that detection frequency would be best regarded primarily as an indicator of presence, and secondarily as an index of intensity of use. Detection frequency is not an index of population size, or of density. Even in the imaginary situation in which all species were distributed at equal densities across the landscape, it is unreasonable to assume equal probability of encountering sign of all species, due to ecological differences between them.

Of the four animals trailed at highway sites three (bobcat, coyote, and cougar), clearly moved along parallel to the highway for distances of 100 yards or more. The single cougar trailing effort was cut short due to nightfall before a relationship to the road was discerned, though the data that was collected suggests that the animal was moving parallel and perpendicular to the road.

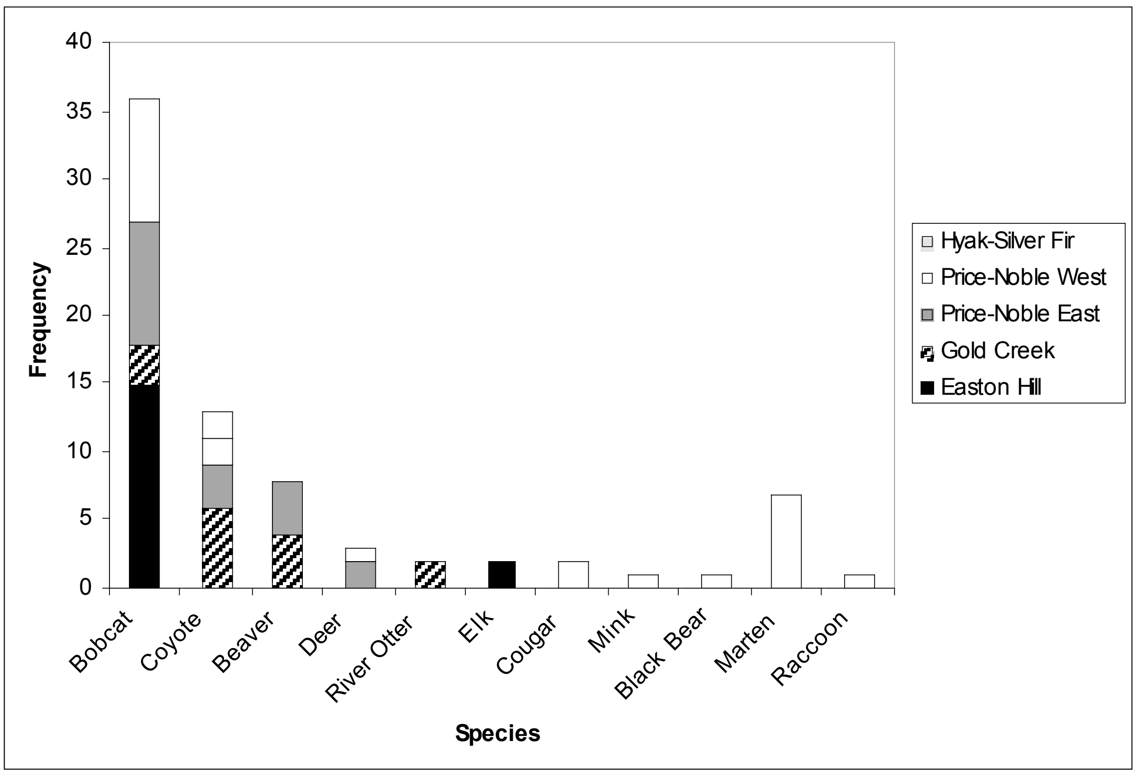

Figure 1. Frequency of species detections partitioned by site.

Species	Detected	Washington GAP Status/Notes
Beaver	x	present
Black Bear	x	present/seasonal
Bobcat	x	present
Cougar	x	present
Coyote	x	present
Elk	x	present
Fisher		extinct
Hoary Marmot		marginal/seasonal
Marten	x	present
Mink	x	present
Mountain Goat		marginal
Mule Deer	x	present
Porcupine		present
Raccoon	x	marginal/absent
Red Fox		rare
River Otter	x	marginal
Wolverine		extremely rare

Table 1. Expected and detected species. Expected species list based on 1997 Washington GAP Analysis (Johnson and Cassidy 1997)

Site	Visits	Detections/Visit	Shannon's Diversity Index (H' = -∑plnp)
Easton Hill	2	8.5	0.3622
Gold Creek	3	5	1.3095
Price-Noble East	3	6	1.2236
Price-Noble West	2	8	1.3634
Hyak-Silver Fir	3	3.33	0.8018

Table 2. Site variables.

Discussion

Shannon's H', confirming what cursory analysis suggests, shows that Easton Hill and Hyak-Silver Fir sites are less diverse that other sites sampled, though this hypothesis was not statistically tested, as environmental factors were not accounted for in our sampling methods. Of the four highway sites, Easton Hill is the only site which can be said to be exclusively upland, with all other sites incorporating a diversity of upland and riparian habitats, and it is likely this factor which accounts for the observed differences in H'. Likewise, it is apparent on the ground at the Hyak-Silver Fir site that there is far less diversity associated with cover and habitat structures than at the riparian associated sites along I-90.

As one of the goals of the CWMP study is to detect rare carnivores within the I-90 corridor, we consider the almost one-to-one correspondence between expected and detected large mammal species, as well as the detection of species predicted by GAP Analysis as absent or marginal, to be indicative of sound methodology in regard to ability to construct an accurate, representative presence-absence database.

Based on location data (See Figure 5, Appendix A), it is likely that a baited camera trap placed in the vicinity of Hyak Lake would be successful in documenting the presence of American marten, a species of concern, during non-winter months. It may be possible in the future to utilize trailing records to create and assess the utilization distributions of individual animals within the study area, such as the presumed individual marten at the Hyak Creek. However, such work is typically accomplished via telemetry, and the methodologies to do so using trailing data have been neither developed nor tested.

Efficacy of Citizen Science

Data

Approximately 50 volunteers participated in the survey for 1268 total hours of volunteered time. Seventeen transects were completed and results from each were entered into the database. See the chart below for a breakdown of the volunteer hours and activities.

Volunteer Activity:	# of People	Hours	Total
Project Leadership Team (PLT):Scouting	3	16	48
PLT: Protocol Development	3	40	120
PLT: In season Management	3	20	60
PLT: Season End Report	3	40	120
Team Leader Training	12	6	72
Volunteer Training 1	19	8	152
Volunteer Training 2	30	8	240
T-1	4	12	48
T-2	2	12	24
T-3	4	12	48
T-4	6	12	72
T-5	5	12	60
T-6	4	12	48
T-7	2	12	24
T-8	5	12	60
T-9	3	12	36
T-10	6	12	72
T-11	2	12	24
T-12	4	12	48
T-13	4	12	48
T-14	4	12	48
T-15	4	12	48
T-16	4	12	48
T-17	4	12	48
	TOTAL VOLUNTEER HOURS:		1268

Table 3. Volunteer Hours

Paid Activity: Project Manager (PM)			
PM: Volunteer Coordination	1	40	40
PM: Protocol Development	1	40	40
PM: Training Prep and Delivery	1	60	60
PM: Transect Scouting	1	24	24
PM: Transect Oversight	1	36	36
PM: Season End Report	1	40	40
PM: General	1	40	40
	TOTAL PAID HOURS:		280

Table 4. Paid Staff Hours

Discussion

The first season of fieldwork was a success in regard to the project's volunteer and public outreach goals. Through emails and web reports (http://www.i90wildlifebridges.org/monitoring.htm), CN and WAS further increased the profile of this issue beyond the volunteers directly involved in the project.

The integrity of the data was ensured through the use of "team leaders" who were ultimately responsible for data, and whose name is attached to all the data collected from transects they lead. The project manager reviewed photographs and datasheets from the field, joined transects lead by several different team leaders, and discussed the findings of each team leader with them individually to get an assessment of the accuracy of the data collected. Through this process there were no glaring errors found. The ability to list a species as "ambiguous" successfully helped ensure that team leaders were not compelled to record obscure track and sign as identified.

Recommendations for Next Year

Hardy et. al. (2004) recognizes that a pilot period for survey methods is required to refine methods, logistics, and budgetary needs. As stated above, our survey methods have proven effective for collecting data in general. However, there are a number of changes which the authors recommend for the survey design and implementation (none of which should negate the use of this season's data in comparison with following seasons). These changes are listed bellow.

Protocol:	• *Road Related Behavior:* Shift return route to follow more closely along the edge of the road to identify more road related behavior of animals. • *Spring-Summer-Fall Data Collection:* Adapt protocol for non-snow season transect data collection in order to collect more information on animal use and movement in the non-snow seasons. • *Flagging transects:* Ensure each transect is flagged well and clearly, so that from one flag team members can see both the next and the one behind. • *Number of Visits:* Ensure the target of 3 visits to each location in a winter is met. (In this season we successfully visited each location 2 to 3 times.) • Add a control transect on the westside of Snoqualmie Pass at an elevation comparable to the current sites on the eastside.
Database:	• *Microsoft Access:* Comply with suggestions for changes to current database, mostly for ease of input.

	• *Cybertracker:* Consider shifting to Cybertracker database and data collection system using handheld computers. • *Data management:* Recruit a volunteer skilled in database management.
Volunteer Management:	• *Tracking Teams:* Create static teams at the beginning of the field season to enable relationship building and efficiency both in the field and in pre-visit coordination. • *Observer Reliability:* Maintain rotation of different teams to different locations to ensure that all transects are being visited by multiple observers. • *Communication:* Continue to use group email procedures and group website for posting documents. Assist volunteers in setting up their accounts. Ensure that team leaders communicate personally with their team members to ensure no one falls through the cracks. • *Team Leader Expectations/Contracts:* Create a role description and a contract in order to ensure that team leaders are aware of, prepared for, and committed to all of the responsibilities entailed in their role. • *New Team Leaders:* Enact a specific structure for training and certifying entry level volunteers to eventually take on the role of new team leaders. (See Appendix B.)
Trainings:	• *Team Leader Training:* Increase quality of team leader training through including a Transect Training: run an actual transect with team leaders, ideally in snow conditions. • Continue focus on helping teams to identify the actual species we will find in the actual conditions we will encounter. (See "Resources" below.) • More specific training on estimating canopy cover, dominant tree species, and other forest/tree data.
Resources:	• *Tracking Resources:* Provide a standardized identification resource for team leaders, specifically designed for the needs of this project (i.e. waterproof and focused on the species of this survey). • *Communication:* Continue to ensure team leaders have up to date information about past team observations through email. • *Snow Depth:* Provide each team with a snow depth probe.

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REFERENCES

Barnum, S. Identifying the best locations to provide safe highway crossing opportunities for wildlife. In: Irwin C.L., Garrett P., McDermott K.P., editors. Proceedings of the 2003 International Conference on Ecology and Transportation; 2004; Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 246-252.

Bull, E.L., Holthausen, R.S., Bright, L.R. Comparison of three techniques to monitor marten. Wildlife Society Bulletin. 1992. 20: p. 406-410.

Citizen Science Central, accessed April 12 2007, http://www.birds.cornell.edu/citscitoolkit

Clevenger, A.P., Chruszcz, B., Gunson, K., and Wierzchowski, J. Roads and wildlife in the Canadian Rocky Mountain Parks – Movements, mortality, and mitigation. 2002. Final report to Parks Canada. Banff, Alberta, Canada.

Clevenger, A.P., Chruszcz, B., Gunson, K. Spatial patterns and factors influencing small vertebrate fauna road-kill aggregations. Biological Conservation. 2003. 109: p15-26.

Clevenger A.P. and Waltho N. Long-term, year-round monitoring of wildlife crossing structures and the importance of temporal and spatial variability in performance studies. In: Irwin, C.L., Garrett, P., McDermott, K.P., editors. Proceedings of the 2003 International Conference on Ecology and Transportation; 2004. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 293-302.

Copeland, J. (Wildlife Biologist, Dept of Fish and Game). Stanley, ID. [Personal communication, 1994, cited in: Zielinski, W.J., Kucera, T.E., editors. 1995. American PSW-GTR_157. Albany, CA: Pacific Southwest Research Station, Forest Service, US Dep of Agriculture, pp. 163

Forman, R.T.T., Sperling, D., Bissonette, J.A., Clevenger, A.P., Cutshall, C.D., Dale, V.H., Fahrig, L., France, R., Goldman, C.R., Heanue, K., Jones, J.A., Swanson, F.J., Turrentine, T., Winter, T.C. Road Ecology: Science and Solutions. Washington D.C.: Island Press; 2003.

Gibeau, M.L. A Conservation Biology Approach to the Management of Grizzly Bears in Banff National Park, Alberta [dissertation]. Calgary, (Alberta) University of Calgary; 2000 *cited in:* Forman, R.T.T., et al Road ecology: Science and solutions. Washington D.C.: Island Press; 2003.

Hardy, A., Clevenger, A.P., Huijser, M. and Neale, G. An overview of methods and approaches for evaluating the effectiveness of wildlife crossing structures: emphasizing the science in applied science. In: Irwin, C.L., Garrett, P., McDermott, K.P. editors. Proceedings of the 2003 International Conference on Ecology and Transportation; 2004. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 319-330.

Johnson, R,E,, Cassidy, K,M. Mammals of Washington State: Location data and modeled distributions. Seattle, WA.: Washington Cooperative Fish and Wildlife Research Unit; 1997.

Keeping Track (http://www.keepingtrack.org/article/articleview/3332/1/390/)

Lee, T., M. Quinn, S. and Duke, D. Citizen, Science, highways, and wildlife: Using a web-based GIS to engage citizens in collecting wildlife information. Ecology and Society [serial online] 2006; 11(1): p.11. URL: http://www.ecologyandsociety.org/vol11/iss1/art11/ Accessed 2007 April 15.

Magurran, AE. Ecological diversity and its measurement. Princeton University Press: Princeton, NJ; 1988.

San Diego Tracking Team, www.sdtt.org

Singleton, P.H., Lehmkuhl, J.F. I-90 Snoqualmie Pass Wildlife Habitat Linkage Assessment. Final report March 2000. Wenatchee, (WA): USDA Forest Service, FSL.

US Dept. of Transportation (USDOT) and WA State Dept. of Transportation (WADOT). 2005. Executive Summary of the Draft Environmental Impact Statement and Section 4(f) Evaluation, I-90 Snoqualmie Pass East. URL: http://www.wsdot.wa.gov/NR/rdonlyres/E385CDE9-8CE3-4B39-8CEF-67C1E17D46F0/0/FinalExecutiveSummary.pdf Accessed 2007, May 21.

van Manen, F.T., Jones, M.D., Kindall, J.L., Thompson, L.M. and Scheick, B.K. Determining the potential mitigation effects of wildlife passageways on black bears. In: Irwin, C.L., Garrett, P., McDermott, K.P. editors. Proceedings of the 2001 International Conference on Ecology and Transportation; 2001; North Carolina State University, Raleigh, NC: Center for Transportation and the Environment, pp. 435-446.

APPENDIX A: Maps of Locations of Transects

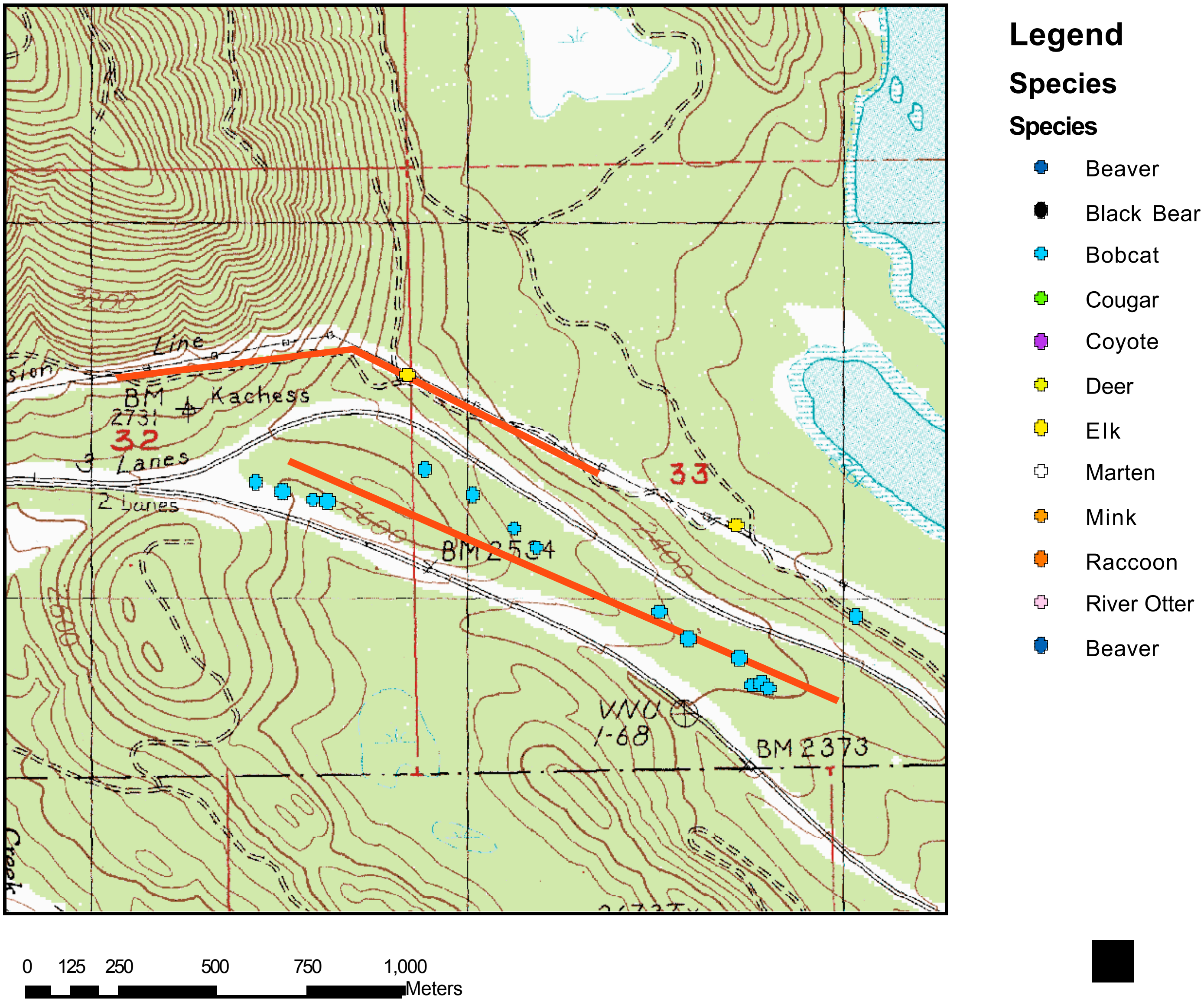

Figure 2. Easton Hill Site.

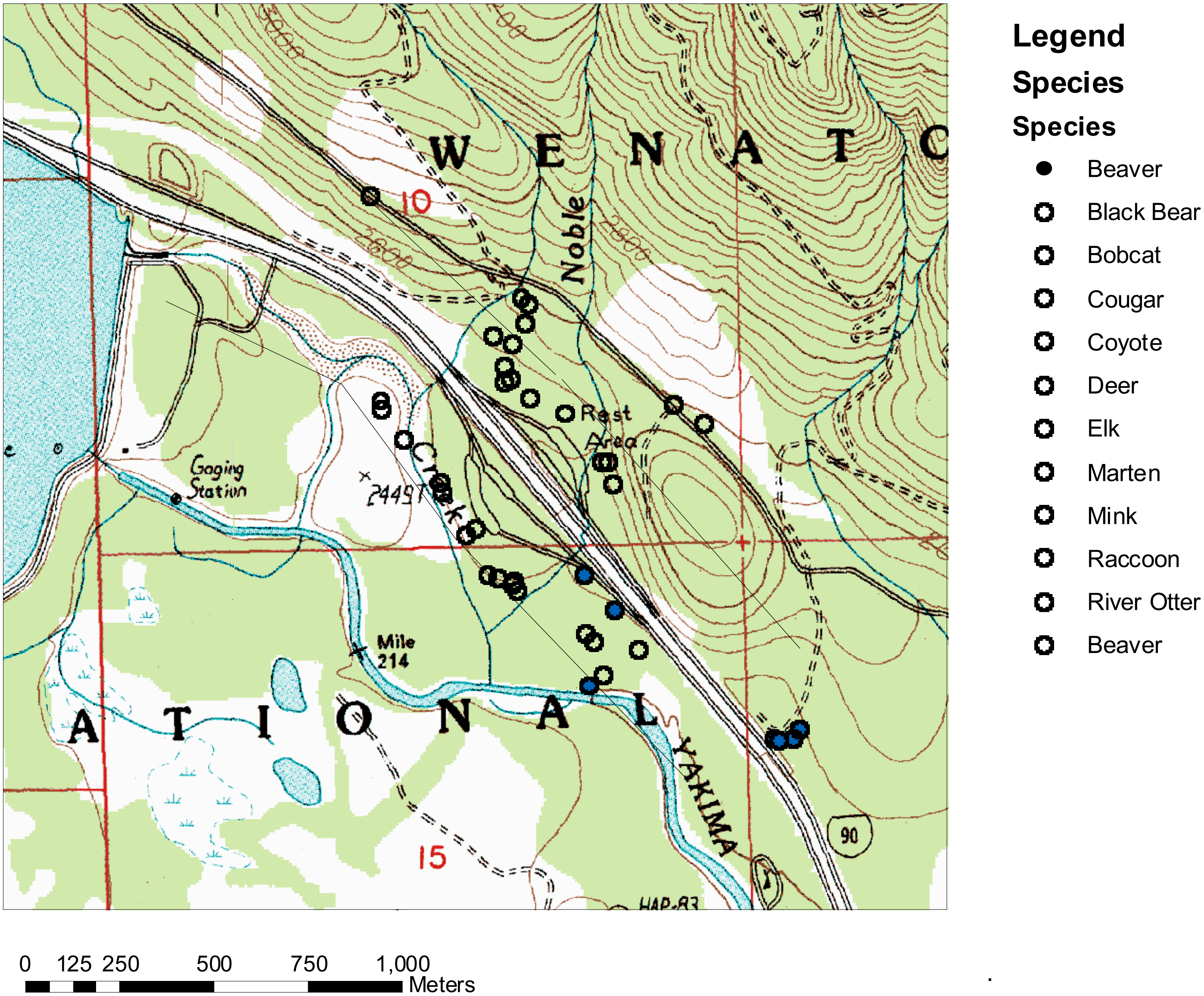

Figure 3. Price-Noble Creek East and West Sites.

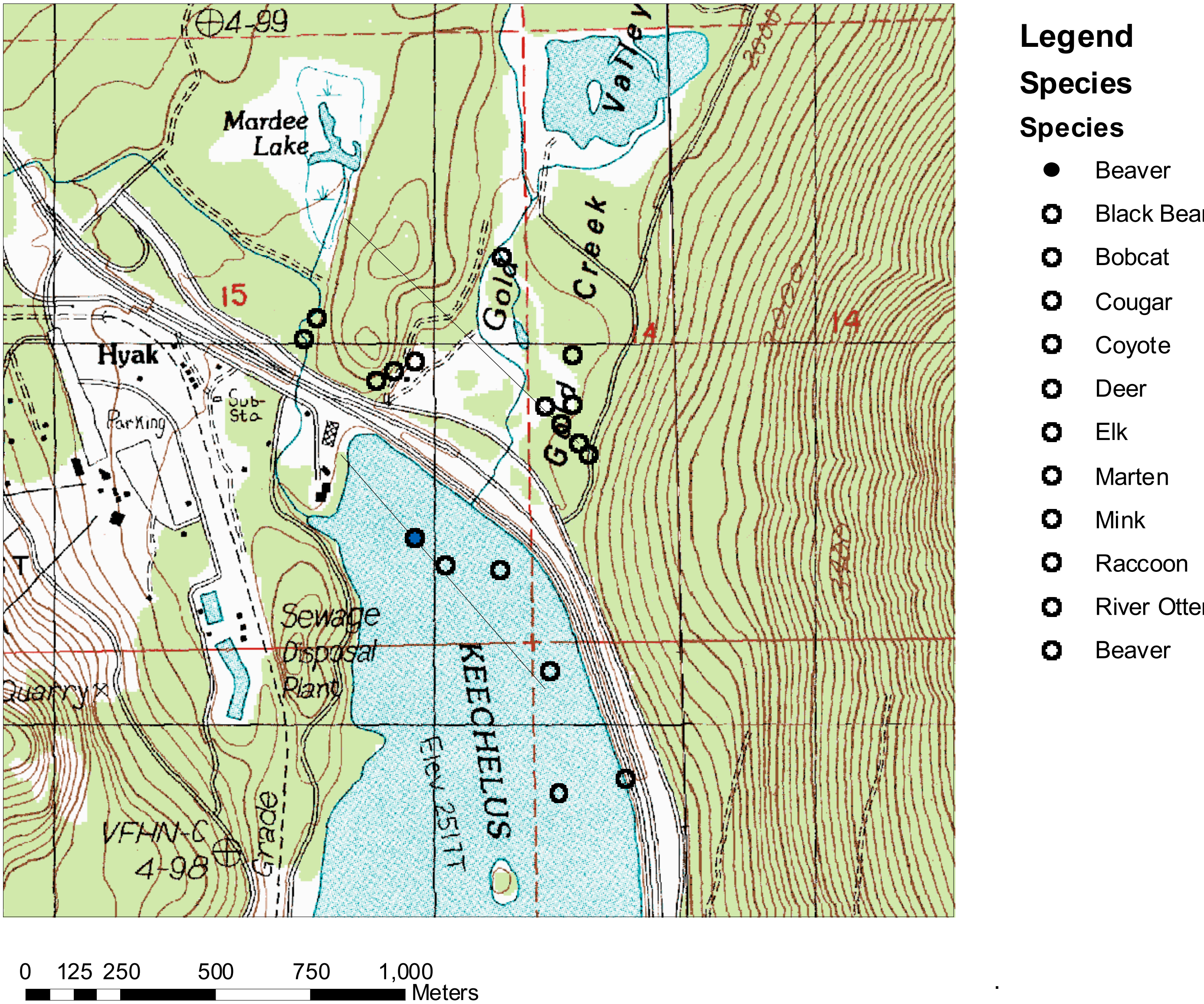

Figure 4. Gold Creek Site.

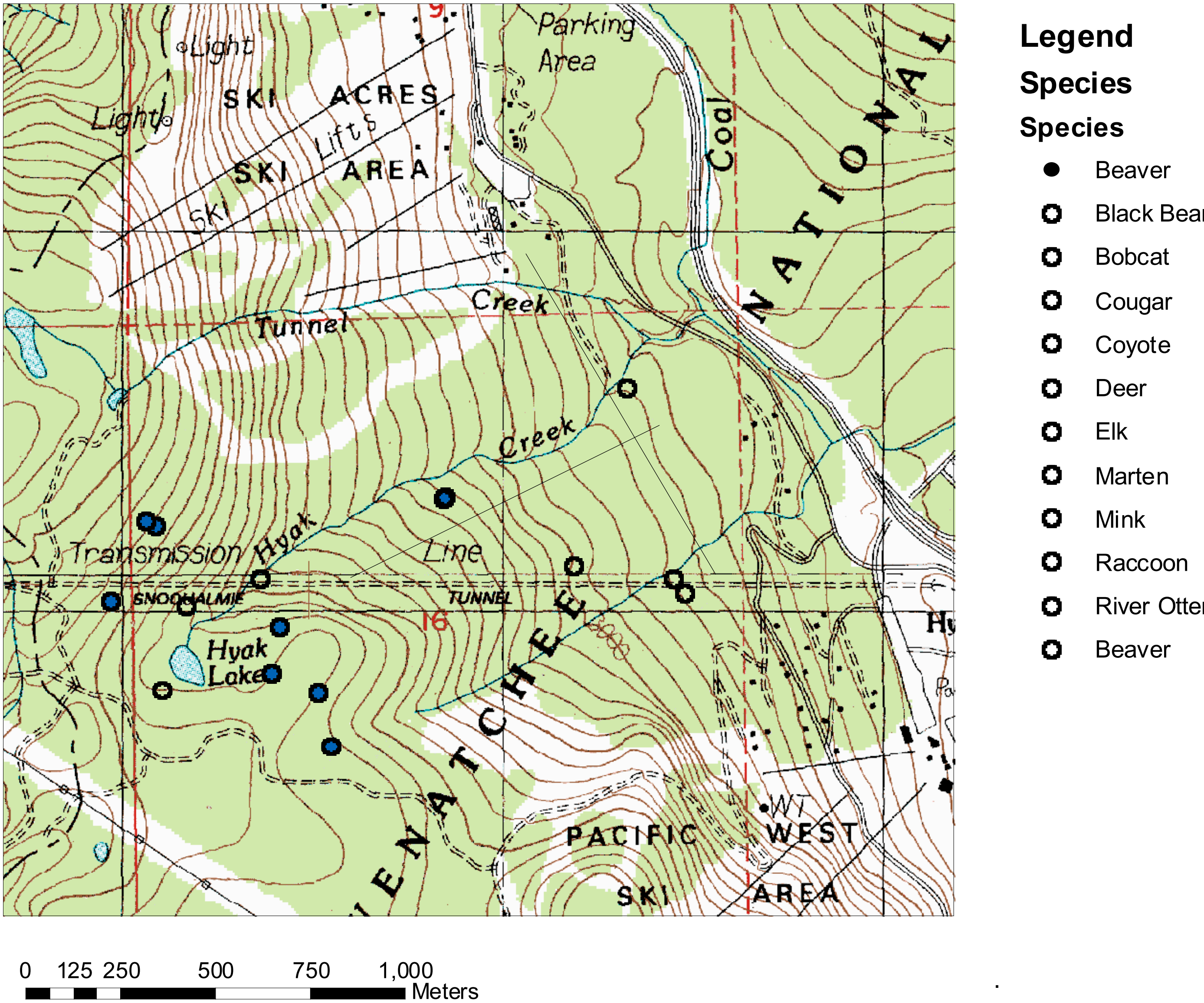

Figure 5. Hyak/Silver Fir Site

APPENDIX B: Team Leader Qualifications and Training

Goal: Ensure consistent accurate collection of data for project and smooth communication and logistical coordination with project volunteers.

Qualifications of Team Leaders for Pilot Season:
The 11 initial team leaders for the project were selected based on their past experience with wildlife tracking and/or wildlife research, as well as group management skills in the outdoors. All team leaders have a *minimum* of three years experience with wildlife tracking, and most of them had significantly more than this. Several of the team leaders are instructors for WAS while others are or have been students in one of the schools intensive training programs for trackers and naturalists. Each team leader went through two days of training before the field season on: the specific protocols of the survey, identification of target species tracks and sign in the expected field conditions, and survey team management.

Qualifications for New Team Leaders:
- 100 Hours Documented Dirt Time (on transects, classes, tracking club, trainings, field time with other transect leader)
- Completion of Volunteer Training, Team Leader Trainings
- Demonstration of Competence under supervision of existing Team leader on an actual transect.

Questions Contact: David Moskowitz, davem@wildernessawareness.org

Existing Team Leaders:	
Mallory Clarke (research coordinator)	Emily Gibson
Roy Ashton (research coordinator)	Shannon O'donnell
Shannon Kachel (training coordinator)	Marcus Reynerson
David Moskowitz (project manager)	Mike Prince
Greg Sommer	Angie Jordan
Jill Cooper	

Current Trainings/Classes/Dirt Time Available	
Tracking Club *(Free for CWMP volunteers)*	April 21, May 19, September 15, October 20, November 17
Spring Trainings	April 15, May 26
Animal Tracking For Wildlife Research	April 13-15
Idaho Wolf Tracking Expedition	July 29-Aug 4

Tracking Intensive	September 2007-June 2008
Fall Volunteer Training	November 10, December 9 *(Dates Tentative)*
Fall Team Leader Training	December 10 *(Dates Tentative)*
Fall Team Leader Field Transect Training	To Be Announced

CASCADE WILDLIFE MONITORING PROJECT
TEAM LEADER FIELD TIME DOCUMENTATION

Date	Event/Activity	Hours	Team Leader/Instructor

APPENDIX C: Transect Site Descriptions

HYAK / SILVER FIR

This, the highest altitude transect site, was accessed from the Silver Fir ski lift parking lot at Hyak. This was the only site not involving transects that parallel I-90, thus was the only non-highway transect. Road-oriented items on data sheets were therefore not collected for this site. The Hyak site was of conservation interest because there is a proposal to expand the ski resort. The transects started a few meters from the parking area. One transect followed the trajectory of an existing trail; the other ran perpendicular to the trail, following a creek uphill. The Hyak—Creek transect ran parallel to the creek through relatively mature coniferous forest as far as the ski-corridor following the linear clearing beneath overhead power lines; the Hyak—Trail transect ran along the contour through coniferous forests, crossing a small creeks, also terminating at power lines.

GOLD CREEK

The Gold Creek site was located between approximately Mileposts 55.2 and 55.8 of I-90. Two parallel half-mile transects were surveyed at Gold Creek, one on each side of the highway. Gold Creek North transect crossed a relatively narrow section of the Gold Creek valley where stream channels were braided and included steep wooded tracts either side of the creek floodplain. Gold Creek South spanned a willow-studded section of the west end of the Keechelus Lake basin (which was frozen over), also crossing Gold Creek.

PRICE CREEK / NOBLE CREEK transects

There were **two pairs of transects** in this area, located just beyond the Eastern end of Keechelus Lake, at around Milepost 61. We have called these transects Price/Noble Creek West, and Price/Noble Creek East, and each of these is divided into North and South transects for each side of I-90. Thus a team scheduled for Price/Noble Creek West, for example, walked the South-West and North-West half-mile transects in a single field day.

PRICE/NOBLE CREEK WEST
PRICE CREEK/NOBLE CREEK EAST
EASTON HILL transects

At Easton Hill, owing to the difficulty of accessing sites on both sides of the highway in a single day, the area was divided into two longer, one-mile transects, each of which constituted a single days' fieldwork and covered only one side of the highway. The sites were located around Milepost 67.8, where the highway split into two leaving a large vegetated island in between. However, there were no exits at this point, so the transects were accessed via exit 70 and smaller roads.

APPENDIX D: Species Priority List

Tracking priority for this study
in descending order

Level 1
Wolverine
Fisher
Lynx
Wolf
Mountain Goat
Grizzly Bear

Level 2
Cougar
Marten
Elk
Mule Deer
Mountain Red Fox

Level 3
Black bear
Bobcat
Coyote
Raccoon
River Otter
Beaver
Mink
All other species larger than Snowshoe Hare

Do not record
Snowshoe Hare and smaller animals

KEY
Level 1 species were to be trailed wherever possible, and as far as possible to gather maximum information about these critical rare species. These species would be trailed even before a transect was completed if there was risk of considerable track degradation before the return leg.
Level 2 species were trailed in the absence of Level 1 species, after completing the outward leg of a transect, where time was available. Animals were trailed towards the road primarily, and their behaviors recorded.
Level 3 species were recorded on the transect data sheet with all other species but were not trailed unless all other transect activities were completed.