Western Gray Squirrel Distribution in the Upper Methow Valley, Washington

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Asako M. Yamamuro
asako.yamamuro@gmail.com

Kim Romain-Bondi
kim@northcascadesbasecamp.com

Peter H. Morrison
pm@pacificbio.org

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Pacific Biodiversity Institute
P.O. Box 298
Winthrop, Washington 98862
509-996-2490

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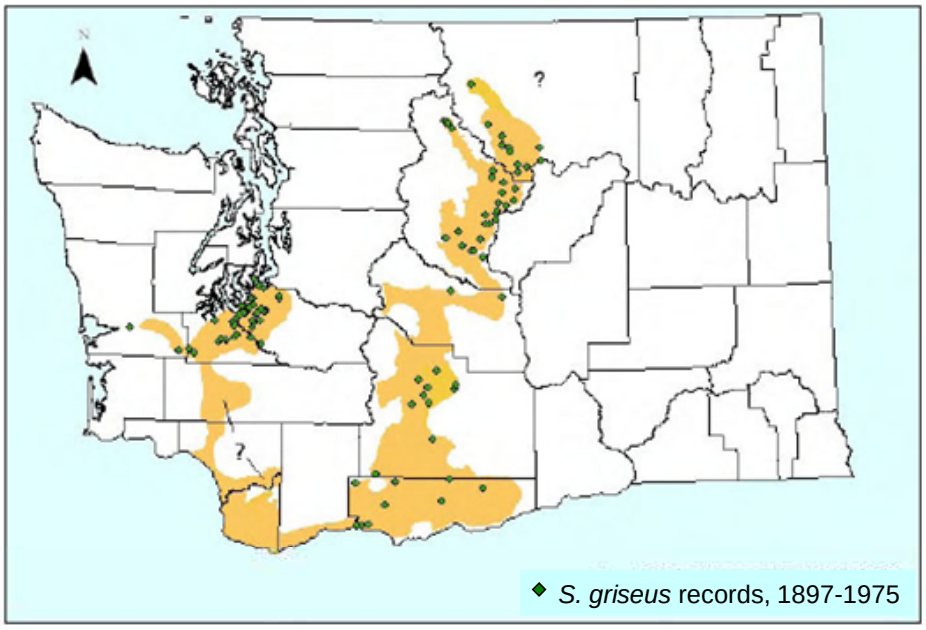
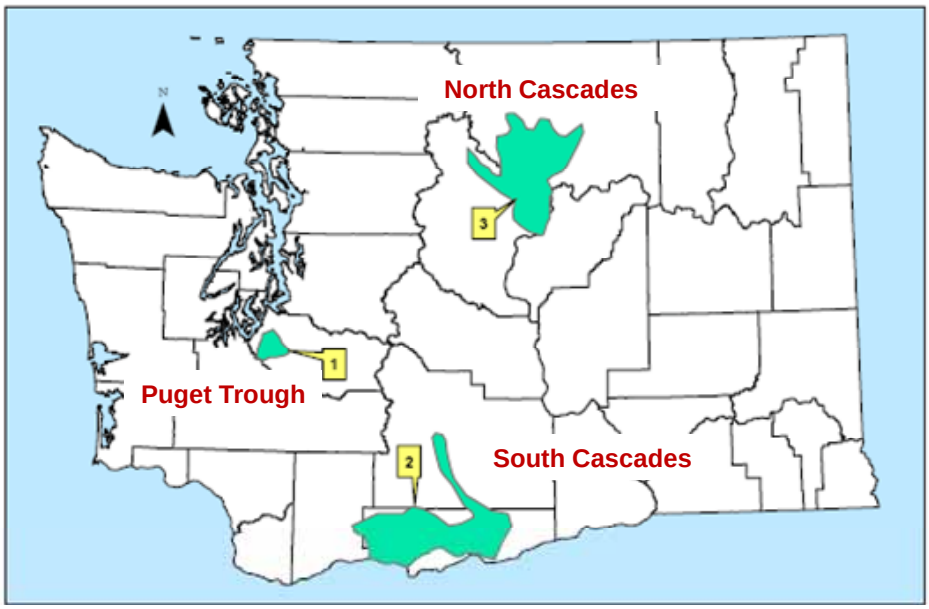
INTRODUCTION

The western gray squirrel (*Sciurus griseus*) has been listed as Threatened in the state of Washington since 1993 (WAC 232.12.011; Linders & Stinson 2007), however very little is known about its northern range. It currently inhabits mixed oak and conifer forests in Washington, Oregon, and California. To aid in conservation and recovery efforts, it is necessary to determine fundamental information such as the species distribution. Historically in Washington, western gray squirrels inhabited the Columbia River gorge and low- to mid-elevations on the east and west sides of the Cascade Mountains in Washington (Figure 1; Dalquest 1948; Ingles 1965). Currently, the western gray squirrel is known to exist in only three isolated remnant populations in Washington: 1) Puget Trough, 2) South Cascades, and 3) North Cascades.

Causes of threatened status

Habitat loss has been determined to be the largest factor contributing to declines in the Washington population of western gray squirrels. Habitat losses have occurred from urbanization (Rodrick 1986), logging removing large, mast producing trees and eliminating an interconnected canopy (Noss et al. 1995; Vander Haegen et al. 2004), fire exclusion (Kertis 1986), and overgrazing (Weaver 1961). Additionally, road-kill deaths (Ingles 1947; Verts and Carraway 1998; Weston 2005), mange (Bryant 1921; Shannon 1922), and competition with non-native squirrels (Byrne 1979) have also led to western gray squirrel population declines. *Sciurus niger* and *Sciurus carolinensis* are introduced tree squirrels which compete with the western gray squirrel for resources (Byrne 1979). An additional threat to population recovery of the three remnant populations is low genetic diversity (Warheit 2003).





Current distribution = 3 populations (modified from Linders and Stinson 2007)

Figure 1. (upper map) Historical and (lower map) current western gray squirrel distribution in Washington state.

Ecological importance

Western gray squirrels are the largest native tree squirrel in Washington and are ecologically important as fungi dispersers, tree seed dispersers, and food for predators. One major food source for western gray squirrels is hypogeous fungi which are mycorrhizal and increase water and nutrient uptake with roots of associated trees (Stienecker and Browning 1970; Asserson 1974; Maser et al. 1981). Western gray squirrels disperse fungal spores as they defecate. Western gray squirrels also tend to be scatter hoarders which leads to them aiding tree seed dispersal by burying individual pine and fir cones and acorns away from the parent tree (Smallwood et al. 2003). Predators of western gray squirrels include red-tailed hawks, northern goshawks, golden eagles, coyotes, bobcats, fishers, and house cats (Carraway and Verts 1994; Zielinski et al. 1999; Vander Haegen et al. 2005).

Western gray squirrel species description

Western gray squirrels (*Sciurus griseus*) are mammals of the order Rodentia, suborder Sciurognathi, and family Sciuridae. *S. griseus* has uniformly silvery-gray fur on its back and white fur on its belly. It also has large ears and a long, plumose tail (Bailey 1936; Hall 1981). *S. griseus* has a body length (not including the tail) of 265-323 mm and a tail length 240-309 mm (Crase 1973; Ingles 1965; Nelson 1899). Mass may be between 520-942 g (Crase 1973; Hall 1981; Ingles 1965).

Western gray squirrel behavior

S. griseus is mostly arboreal and tends to be wary (Cross 1969). Spherical stick nests (shelter nests), platform stick nests, and cavity nests are used by western gray squirrels as predator protection and shelter (VanderHaegan et al. 2004), in addition to being a location to raise young. *S. griseus* spherical stick nests consists of a few concentric layers with the largest sticks on the outside and sequentially smaller and insulating layers lining the inside (Merriam 1930; Cross 1969). Western gray squirrels tended to select larger diameter trees, interconnected canopies, and trees with mistletoe when making nests in Black Canyon in the lower Methow Valley, Washington (Gregory et al. 2010). Western gray squirrels are active year round. Their activity peaks a couple hours after sunrise (Cross 1969), and is documented to change seasonally in the North Cascades area during winter months (per comm. Katy Stuart). When disturbed, western gray squirrels may "freeze" in place. If the danger does not seem high, they may bark, "chewnnk-chewnnk-chewnnk", while foot-stamping and tail-flicking (Cross, 1969; Ingles 1947). However they are more known to be a quiet and passive squirrel species, often times not making any sounds; this is evident in comparison to the vocal red squirrel (*Tamiasciurus hudsonicus*) who inhabits similar habitat in Washington State (pers comm. Katy Stuart). Typically, western gray squirrels eat cones by cutting them off the tree, letting the cone fall, then retrieving the cone on the ground. Then, the squirrel will carry individual cones to a branch, hold the cone in its forefeet, and remove conescales to eat the pinenuts (Grinnel and Storer 1924). They are typically known to eat ponderosa pine and Douglas fir seeds in the North Cascades region (pers. comm. Katy Stuart; Gregory 2005).

Gaps in knowledge of the North Cascades population of western gray squirrels

The North Cascades population and ecosystem differ from the populations and habitats other remnant populations of western gray squirrels in Washington State. The North Cascades population inhabits the northern-most extent of the western gray squirrel's range, which lacks oaks, is a primarily dry forest ecosystem, and experiences harsher winters (Gregory et al. 2010). The least is known about the North Cascades remnant population of western gray squirrels

compared to the Puget Trough (Fimbel & Freed 2008; Ryan & Carey 1995; Vander Haegen et al. 2007; Vander Haegen and Orth 2009) and South Cascades populations (Cornish et al. 2001; Linders et al. 2004; Vander Haegen et al. 2004; Vander Haegen et al. 2005). The South Cascades population occurs where oak and pine forests merge (Linders and Stinson 2007); the Puget Trough population occurs in areas primarily of Oregon white oak and Douglas-fir (Linders and Stinson 2007). Acorns make up much of the western gray squirrel diet in the South Cascades and Puget Trough (Verts and Carraway 1998). The North Cascades ecosystem lacks oaks and the western gray squirrels occur in ponderosa pine and Douglas-fir forests (Bartels 1995; Gregory 2005; Hamer et al. 2005). The North Cascades population of western gray squirrels experiences a much harsher winter than either the Puget Trough or South Cascades population (Table 1). The northern habitat of the North Cascades population (our focal region) is colder and snowier in the winter than the southern region of the North Cascades, Puget Trough, or the South Cascades ecosystems.

Within the North Cascades population, the southern extent of the western gray squirrel population has received attention over the last decade (Gregory 2005; Hamer et al. 2005; Gregory et al. 2010; Bartels 1995; Bartels 2000), however little is known about the western gray squirrels inhabiting the northern portion of the North Cascades. The Methow Valley is located in this area. It is composed of approximately 75 percent coniferous forest and 14 percent shrub steppe. As part of the coniferous forest, four percent of the Methow Valley is ponderosa pine forest which may provide the best western gray squirrel habitat. The upper Methow Valley has an average minimum temperature of -12.0 °C in January and an average maximum temperature of 30.4 °C in July. This region also has an average annual precipitation of 36 cm and an average total annual snowfall of 180 cm (104-yr averages; Western Regional Climate Center 2010). The southern area of the North Cascades population, where the majority of previous work has been conducted (lower Methow Valley), has an average minimum temperature of -8.4 °C in January and an average maximum temperature of 31.3 °C in July. This region has an average annual precipitation of 32 cm and an average total annual snowfall of 108 cm (40-yr averages; Western Regional Climate Center 2010). In contrast, the Puget Trough area has an average minimum temperature of 2.2 °C in December and an average maximum temperature of 25 °C in August. Average annual precipitation in the Puget Trough is 100 cm and average total annual snowfall is 1 cm (28-yr averages; Western Regional Climate Center 2010). The South Cascades region has an average minimum temperature of -4.9 °C in January and an average maximum temperature of 29.8 °C in August. The average annual precipitation in the South Cascades is 44 cm and the average total annual snowfall is 65.3 cm (105-yr averages; Western Regional Climate Center 2010). Understanding more about western gray squirrels in the upper Methow Valley will aid in the effectiveness of recovery efforts for squirrels living in this unique habitat at their northern-most distribution.

Table 1. Regional differences in climate for western gray squirrel habitats based on weather logging stations.

Region	City	Avg. Minimum Temperature (°C)	Avg. Maximum Temperature (°C)	Avg. Annual Precipitation (cm)	Avg. Total Annual Snowfall (cm)	# of Years Averages Are Based On
North Cascades	Winthrop	-12	30	36	180	104
North Cascades	Methow	-8	31	32	108	40
North Cascades	Stehekin	-5	28	87	314	104
South Cascades	Goldendale	-5	30	44	65	105
Puget Trough	Tacoma	2	25	100	1	28

Study objectives

The primary objective of this study was to determine regions used by western gray squirrels in the northern-most portion of their range to aid in their recovery. The upper Methow Valley has different ecosystem qualities than the other areas where much of the research has been conducted on western gray squirrels. Therefore, increasing the knowledge base of this northern-most extent of the species distribution will provide needed information to help in recovery efforts where western gray squirrels experience a different habitat that lacks oaks and has harsher winters. We focused our efforts on the upper Methow Valley to cover a larger area and add to previously gathered western gray squirrel distribution sampling data from Okanogan County from 2006-2009 by the Washington Department of Fish and Wildlife (Figure 2). Community outreach to engage volunteers, landowners, and the public was also a large component of this western gray squirrel project. Our study is unique because we concentrated our efforts in the northern area (Figure 3) and utilized volunteers to set up and conduct the study which allowed more locations to be monitored in a larger area than would have been possible without volunteer participation. We conducted a hair-sampling tube distribution survey to determine western gray squirrel occurrence, in addition to recording nest and sighting information. Because the western gray squirrel is vulnerable to habitat loss and low genetic diversity, a better understanding of areas where they occur is needed in a timely manner to help managers protect critical habitats.

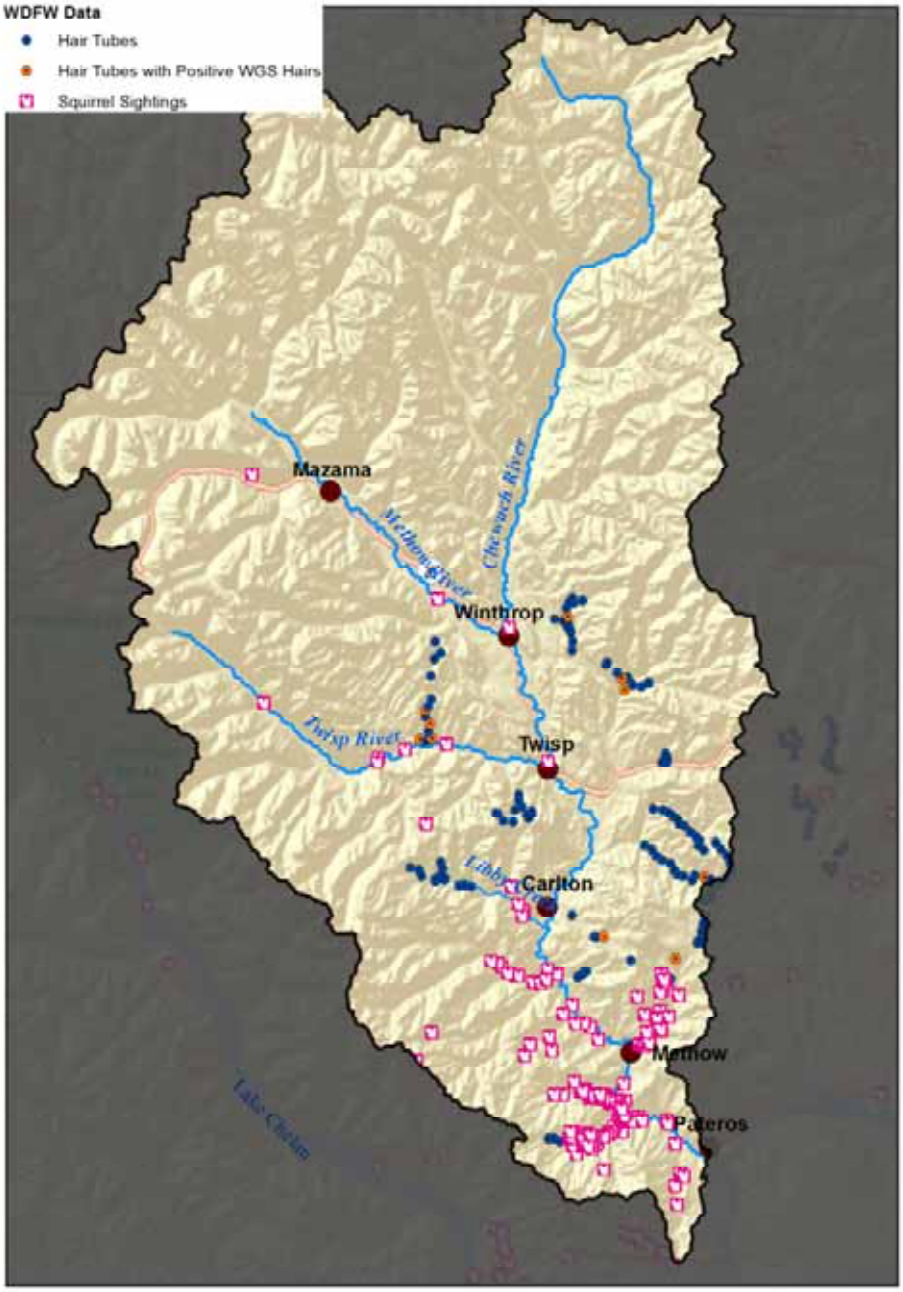


Figure 2. Western gray squirrel hair-sampling tube distribution survey from 2006-2009 by the Washington Department of Fish and Wildlife (WDFW) and historical sightings in Okanogan County.

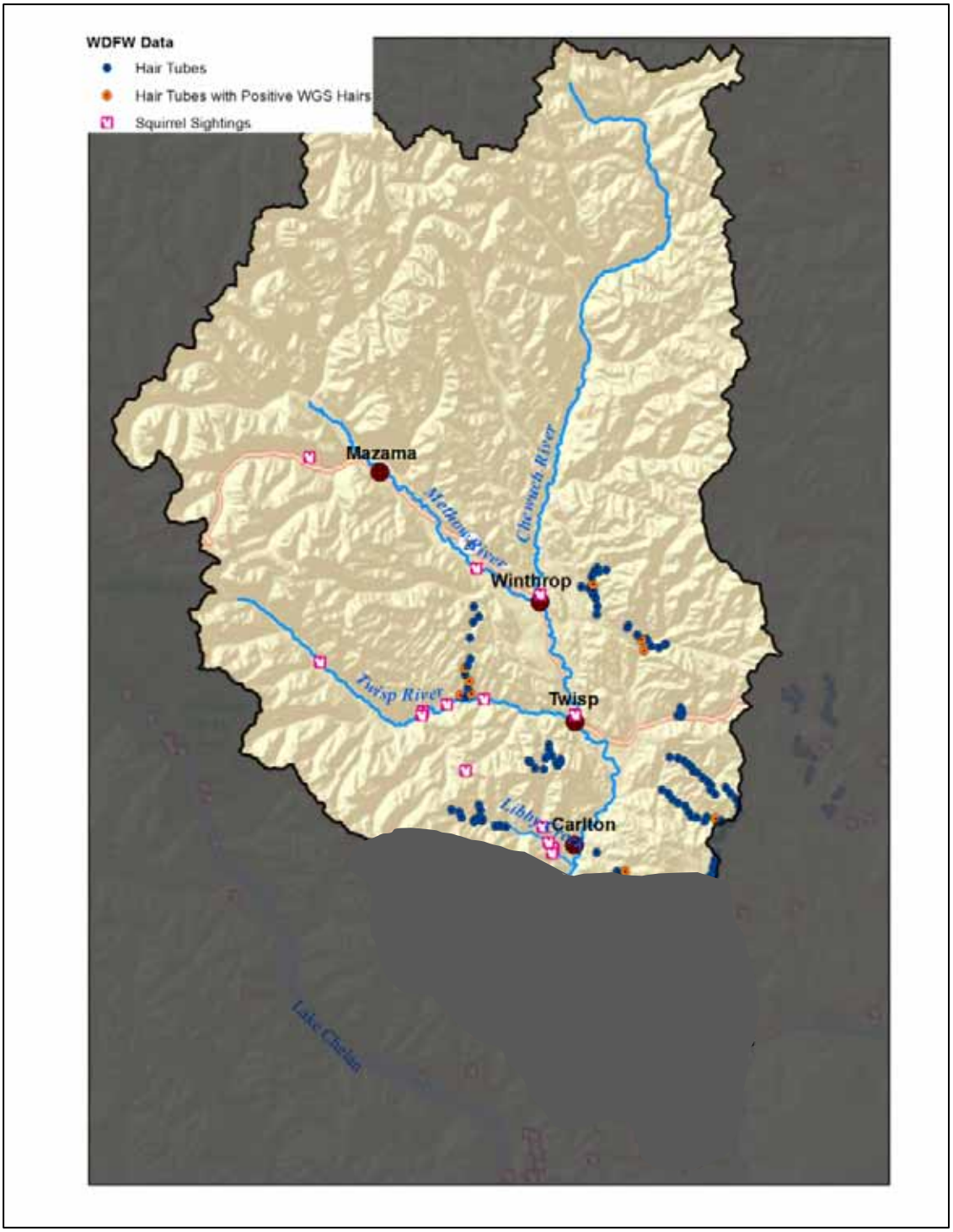


Figure 3. Study Area for Western gray squirrel hair-sampling tube distribution survey in 2010 by Pacific Biodiversity Institutes (PBI) and historical sightings and hair tube surveys conducted by WDFW in Okanogan County.

METHODS

Community education on western gray squirrels

Pacific Biodiversity Institute (PBI) sought to educate Methow Valley community members on western gray squirrel status, threats, and conservation needs. Community education was conducted through: i) newspaper articles seeking volunteers and any western gray squirrel sighting information, ii) involving volunteers and private landowners in conducting the western gray squirrel distribution surveys, and iii) a public talk open to community members interested in learning more about western gray squirrels and specifics on our project. We were interested in informing landowners about stewardship of the squirrels throughout the valley, since the increased knowledge may lead to greater interest in managing the landscape for western gray squirrels. Additionally, we encouraged community members to report western gray squirrel sightings and locations, especially if they were hit on the road.

Utilizing volunteers to monitor western gray squirrels in the upper Methow Valley

PBI sought volunteers to assist with western gray squirrel surveys in the Methow Watershed during the 2010 field season (March-October). Local volunteers, including some landowners with western gray squirrel habitat on their property, were involved in conducting distribution and nest count surveys. On March 5, 2010, volunteers helped build 200 non-invasive hair-sampling tubes to collect hair that can be used to identify the species (Figure 4). We had a community field day on March 20, 2010 for training in western gray squirrel identification, survey methods, ecology, and conservation measures. Specifically, volunteers were trained how to recognize the difference between the more rare western gray squirrel and the common red squirrel (Figure 5 & 6), determine good habitat for the species, deploy and check non-invasive hair-sampling tubes, and help conservation of the North Cascade western gray squirrel population. Additionally, volunteers were trained to recognize the type of preferred habitat and visually identify western gray squirrel nests and signs (e.g., feeding, hoarding) (Figure 7). We used the lower Methow Valley Black Canyon study area as a control site, where ongoing studies have been conducted by WDFW and research studies were conducted by University of Washington graduate student Sarah Gregory in 2005, to test methodologies and nest identification skills. Once the volunteers had placed their first set of hair-sampling tubes, a PBI intern/volunteer went out to the tube locations to address any concerns community volunteers might have had and also suggested better and/or other locations to place hair-sampling tubes. The PBI intern/volunteer also regularly updated community volunteers on project progress and provided further assistance in the field when necessary.

Figure 4. Volunteers work on hair-sampling tube construction (A & B). A finished hair-sampling tube (C) and hair-sampling tube deployed in the field with photo identification

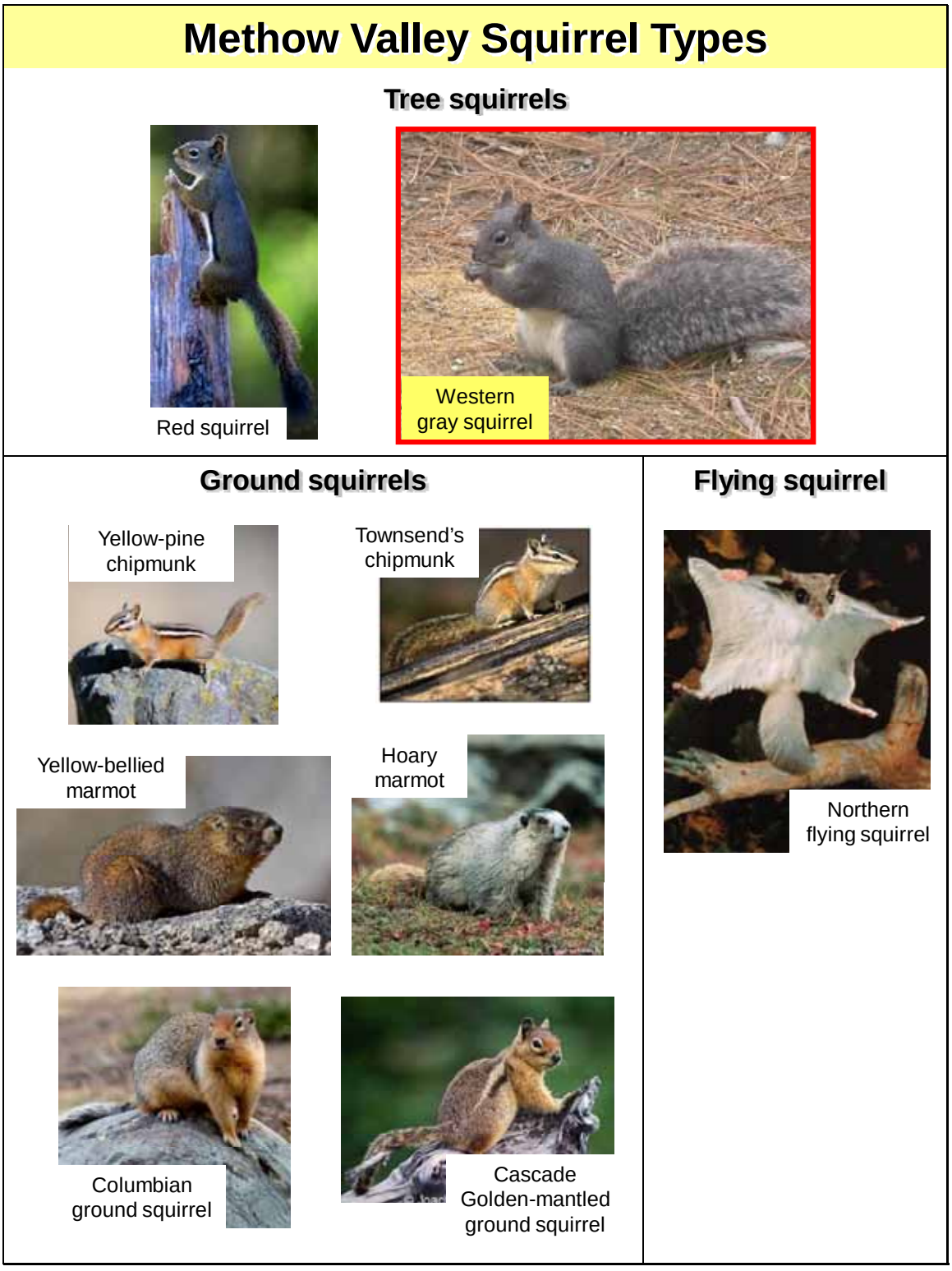


Figure 5. Different squirrel taxa found in the Methow Valley, Washington.

Western Gray vs. Red Squirrel

- Head & body = 9-12 inches
- Tail = 10-12 inches
- Large, gray body, very bushy tail, white belly
- Tends to be quiet

- Head & body = 6-8 inches
- Tail = 4-6 inches
- Small, rust-red to grayish-red body and tail, white or grayish-white belly
- Very noisy chatter, more aggressive & territorial

Figure 6. General differences between western gray squirrels and red squirrels.

Figure 7. Squirrel activity signs western gray squirrel distribution project volunteers were shown to illustrate favorable squirrel habitats.

Hair-sampling tubes for distribution surveys

Hair-sampling tubes were used to study the distribution of western gray squirrels between March and October 2010. This methodology has been previously used in western gray squirrel studies to determine presence at specific locations (Fimbel & Freed 2008; Vander Haegen & Orth 2009). This is a low cost, noninvasive sampling technique, which allows for more sites to be monitored compared to other sampling techniques such as trapping. If a hair-sampling tube is positive for western gray squirrels, we can conclude that a western gray squirrel was in the area, but we cannot determine whether this region is part of the squirrel's home range territory or if it was a dispersing individual. Similarly, hair-sampling tubes do not allow us to quantify squirrels in an area or determine western gray squirrel densities. Additionally, if hair is not collected in a hair-sampling tube, we cannot conclude that there are no squirrels in the area; the squirrel may not have found the hair-sampling tube and entered it.

The hair-sampling tube is a 7.6cm diameter, 45.7cm long pipe of black ABS within which we glued (important to use nontoxic) one English walnut in the center of the tube to the inner wall. The walnut is glued to the "bottom" of the tube (side to be placed on the ground). On the opposite inner wall of the tube (top), approximately 3.8cm from the ends, flat aluminum bars (5.8 x 2.5cm) were secured into place with nuts and bolts. The metal bars were covered with a double-sided sticky tape (3M Double-Sided Foam Tape, 0.2 cm thick & 2.5cm wide). The walnut lures the squirrel into the tube and as it walks through, the squirrel will leave back and/or tail hair on the sticky tape. Each tube had a unique number associated with it to help keep track of individual tubes, which are recorded on each photopoint with number cards. Each location was given a unique identifying code (e.g., LIBB relates to Libby Creek). Each location could have different tubes at different times, since tubes were switched out during the sampling season.

Hair-sampling tubes were placed at the base of a tree and the tree flagged to aid in relocating it (Figure 8). Surveyors double-checked that the hair-sampling tube was placed flat with the sticky tape on top, walnut on bottom, and that both open ends of the tube were not obscured. Since the squirrel must enter the tube to reach the inner walnut and leave a hair sample, surveyors prevented the hair-sampling tube from moving by securing it with natural materials such as rocks and wood. One loose bait walnut was placed outside the tube by both openings (two walnuts total) to get the squirrel acclimatized to walnuts and to aid in luring the squirrel into the tube to get the third walnut. GPS locations were recorded for mapping and to help find the tube during revisits. Volunteers recorded the hair-sampling tube GPS location and site information, including drainage, dominant overstory, and dominant understory (Appendix A).

Volunteers were advised in deciding where to place the hair-sampling tubes. Previous studies in the lower Methow Valley had concluded that large diameter ponderosa pines, interconnected canopy, and an open understory were favored by western gray squirrels (Gregory 2010). Therefore, volunteers were directed to place hair-sampling tubes in areas with these preferences in mind. Volunteers were also trained to identify squirrel signs such as cut cones, cone scales, and dig holes to aid in finding potentially favorable squirrel habitats to place hair-sampling tubes. However, criteria were not strict since all preference criteria were difficult to meet, it can be difficult to tell the difference between red squirrel and western gray squirrel signs in the area, and we were not sure whether known habitat and behavioral preferences based on research conducted in the lower Methow Valley would be the same for squirrels in the upper Methow study area.

Figure 8. Diagram of deploying hair-sampling tubes by western gray squirrel distribution study volunteers.

Hair-sampling tubes were placed on both public and private lands. But, hair-sampling tubes were only placed on private land after written permission was granted. Hair-sampling tubes were placed at least 200 m apart and checked every three to four weeks to determine whether hair was collected on the sticky tape. Data collected during hair-sampling tube checks include: date deployed, date checked, observers, tube status, whether hair was collected, tube action, and notes. Additional data collected included whether the hair-sampling tube looked disturbed (e.g., rolled) and whether walnuts were missing or present (Appendix A). We replaced bait walnuts if they were missing. If hair was detected, the hair-sampling tube was removed and a replacement hair-sampling tube was put in the exact same place to replace it. Additionally, during each check, the stickiness of the sticky tape was checked and if it feels less adhesive, the tape was replaced by attaching another tape layer to the metal bar (up to three layers).

The hair collected was visually analyzed to determine what animal it was from. The tape was removed from the aluminum bars and examined under a dissecting microscope at 30x magnification. Hair color patterns and hair size were used to categorize the hair into the following categories: western gray squirrel, red squirrel, yellow-pine chipmunk, or unknown. We compared our hair sample collected from the tubes with back, tail, and belly/chin hair collected from road-kill specimens. Hair samples were categorized by two people to reduce observer bias. We documented tube number, date, and location for each hair sample collected. Throughout the field season, GIS maps were updated with hair-sampling tube locations with and without western gray squirrel hair. Data forms are were entered into a Microsoft Access Database.

Western gray squirrel sightings

In addition to utilizing hair-sampling tubes to determine western gray squirrel distributions in the upper Methow Valley, volunteers were asked to record any visual sightings of western gray squirrels (Appendices B & C). If a positively identified western gray squirrel was sighted, location notes were recorded along with whether it was an adult male, adult female, subadult, unknown, or young of year, time of detection, and behavior (i.e., nest building, perched on tree, perched in nest, perched on ground, perched on rock or stump, copulating, vocalizing, foraging, aggressive, defensive, courtship, excavating, playing, feeding, running on ground, and/or climbing in tree). All sightings were also entered onto Washington Department of Fish and Wildlife, Wildlife Observation Forms to be added to the WDFW Heritage database.

Western gray squirrel nest surveys

Nest detection indicates that an area was occupied by western gray squirrels (Appendices B & D). Preliminarily, we used the Black Canyon study area in the lower Methow Valley, where nests are known from radio-telemetry data (Gregory 2005), to test our methodology and nest identification skill. During our nest surveys, we systematically searched for western gray squirrel nests to gain information about areas that western gray squirrels occupy. Nest searches were conducted in areas where confirmed western gray squirrels have been sighted or positive western gray squirrel hair was collected in hair-sampling tubes this field season. First, we created a map of the location with the best potential habitats clearly identified. We determined an approximate layout of nest search survey transects. Nest searchers stood 20-30 m apart (marked by paces) in a line, abreast, and in view of one another. Each person used a walkie-talkie for communication between observers. Nest searchers on either end of the search transect took a starting GPS reading. Nest searchers walked along a transect or contour of a steep slope using a compass bearing. Nest searchers walked for approximately five minutes while looking for nests and stopped for a more detailed search with binoculars (looking around 360 degrees) for one minute systematically, or a detailed search was coordinated via walkie-talkies when potential nest trees or complicated canopy was encountered. During this detailed search, nest searchers also realigned themselves. One person in the middle of the search line announced on the walkie-talkies when one minute of detailed searching had ended and the walking search continued. When a nest was located, all nest searchers marked their location (visually or with temporary flagging) and gathered to collect nest data and fill out vegetation sampling forms describing forest structure and habitat condition of the area. Nest searchers returned to their previous locations to resume the nest survey. Once the nest search was completed, the ending GPS locations were recorded.

RESULTS

Community education on western gray squirrels

The start of Pacific Biodiversity Institute's (PBI) research and education project focused on the western gray squirrels in the Methow was described in two articles in the Methow Valley News (Appendices E & F). Fourteen volunteers participated in the May 5, 2010 workshop to build hair-sampling tubes, and 19 volunteers participated in the March 20, 2010 field workshop. Articles were printed in the Wenatchee World newspaper and Methow Valley News on volunteer participation for the field workshop (Appendices G & H). On October 5, 2010, we presented an hour and a half PowerPoint presentation in the Methow Conservancy First Tuesday Lecture Series at the Twisp Grange. This Methow Conservancy lecture series invites speakers to discuss nature-related topics of interest to local community members. For the talk, we partnered with Katy Stuart, a University of Washington graduate student working on western gray squirrels in the Squaw Creek watershed (lower Methow Valley) and Stehekin (adjacent to Lake Chelan in the lower Methow Valley). Advertisements for the presentation were run in the Methow Valley News, the Methow Conservancy website, and posted on bulletin boards throughout Winthrop and Twisp, WA. There were approximately 50 people in attendance; we presented information on squirrels, adaptations, their ecological diversity, and specifically about the North Cascades western gray squirrels and their unique habitats found in the region. Stuart presented her research and preliminary findings, while PBI presented their project scope and findings. Hands-on examples of western gray squirrel sampling equipment (radio collars, traps, and hair-sampling tubes) were on display, along with a WDFW western gray squirrel study skin, and hair samples of different small mammals for comparisons to the species of interest.

Pacific Biodiversity Institute also continually updated its website with a western gray squirrel project page (www.pacificbio.org/initiatives/wgs/gray_squirrel_background.html), volunteer advertisement (www.pacificbio.org/helpout/volunteer-western-gray-squirrel.html), and page for volunteers to access data sheets and sampling guides (www.pacificbio.org/initiatives/wgs/wgs-volunteer-page.html).

Volunteer involvement in western gray squirrel distribution sampling

Volunteers put in a total of 1782 hrs overall. Eighteen volunteers spent approximately twenty to forty hours on the western gray squirrel distribution project. Seventeen of the volunteers live in the Methow Valley year round and one volunteer resides in the Okanogan Valley. A volunteer appreciation evening was held on November 4, 2010 at the Pacific Biodiversity Institute office to show appreciation to all volunteers involved in the western gray squirrel distribution study and to discuss their experiences working on the project.

Hair-sampling tube distribution results

Volunteers placed hair-sampling tubes in a total of 176 locations in the upper Methow Valley (Figure 9). Of the 176 locations, hair-sampling tubes from 17 locations collected western gray squirrel hair (Figure 10). Some of the hair-sampling tubes that were positive for western gray squirrel hair were concentrated in the same region, resulting in eight regions occupied by western gray squirrels (Figure 11). After comparing our distribution data with previously gathered data by Washington Department of Fish and Wildlife staff, we found that our study produced five new areas that previously were not known to have western gray squirrels (Figure 12).

We identified hair type collected in hair-sampling tubes as western gray squirrel, red squirrel, yellow-pine chipmunk, or unknown. Some locations collected hair on more than one occasion. We collected a total of 134 hair samples from tubes, 17 of which were western gray squirrel hair. 61 samples were identified as "unknown" since they were not comparable to our reference hair samples. Fifty five samples were identified as red squirrel, and 11 were identified as yellow-pine chipmunk. There appears to be no obvious patterns between western gray squirrel locations and red squirrel and/or yellow-pine chipmunk locations (Figure 13).

Six volunteers had both live and road-kill western gray squirrel sightings (Figure 15). One volunteer had three separate observations in the Benson Creek region. During his first sighting, the western gray squirrel was chased by a red squirrel down a ponderosa pine tree. A western gray squirrel was seen climbing a ponderosa pine and investigating a manmade structure previously used as a nest by a red squirrel. The third sighting involved two western gray squirrels running together. Also in the Benson Creek watershed, another volunteer regularly saw a western gray squirrel frequently visit his bird feeders. In the Libby Creek watershed, a volunteer saw a western gray squirrel climb down a ponderosa pine and eventually run down a hill. Within the Little Bridge Creek region, a volunteer observed a western gray squirrel foraging and running on the ground. Two separate sightings were made, also in the Little Bridge Creek region. A western gray squirrel was also seen by a volunteer running across a Highway153 near the town of Methow. During the span of this year's study, there were also four road-kill western gray squirrels brought in to our office and locations were recorded.

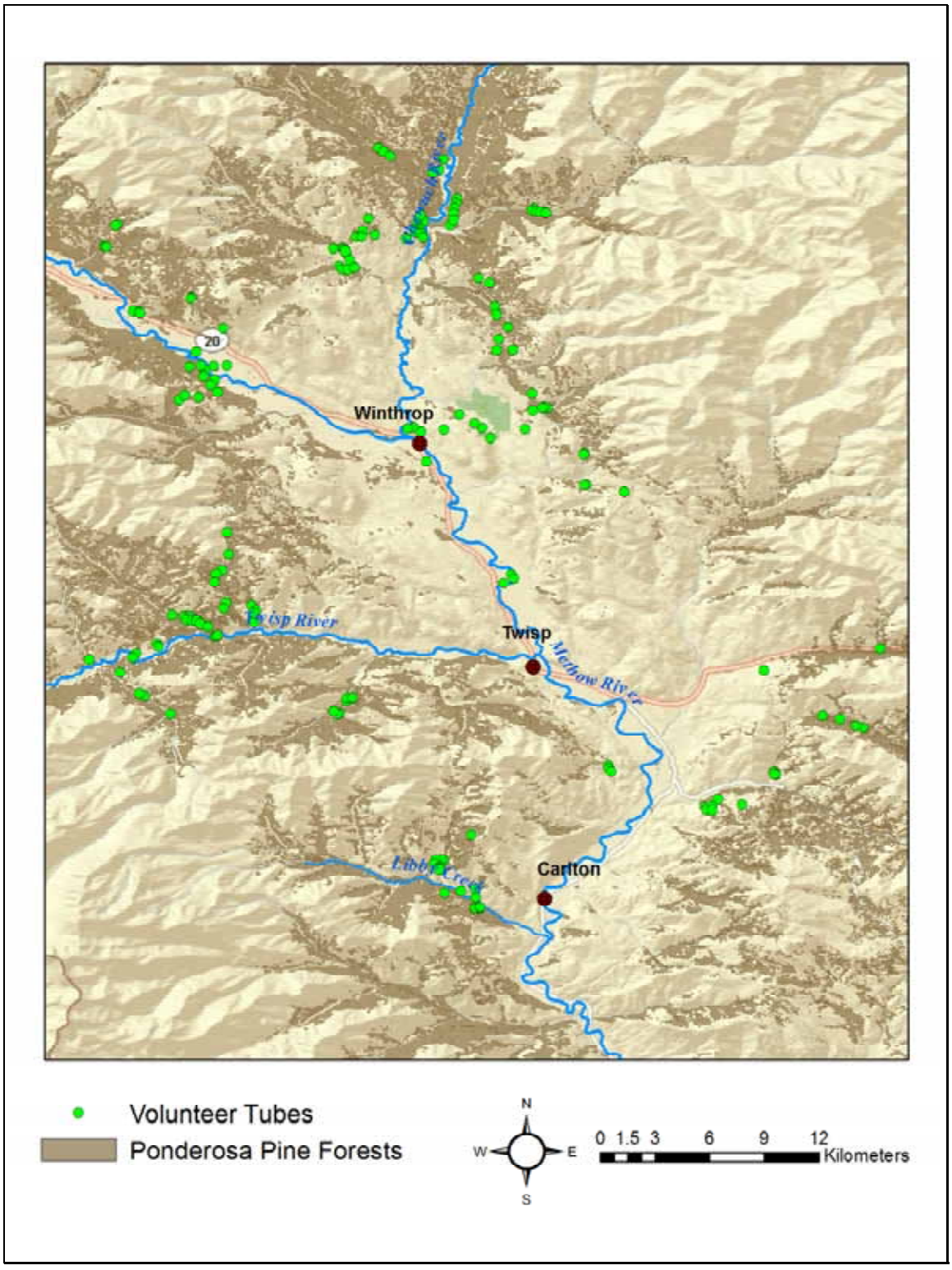


Figure 9. Pacific Biodiversity volunteer hair-sampling tube locations in the upper Methow Valley.

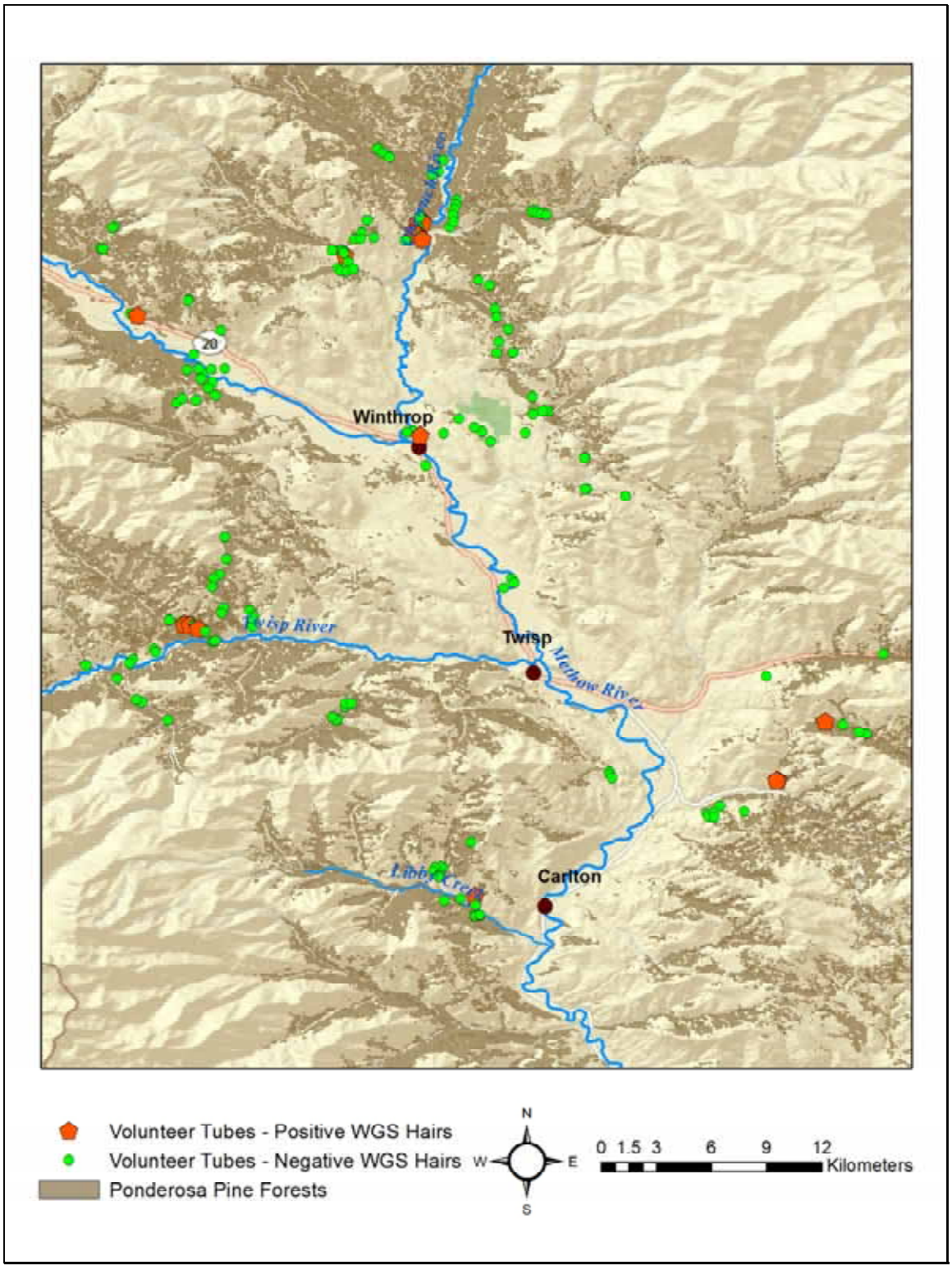


Figure 10. Pacific Biodiversity Institute volunteer hair-sampling tube locations with western gray squirrel (WGS) hair collected and without WGS hair collected.

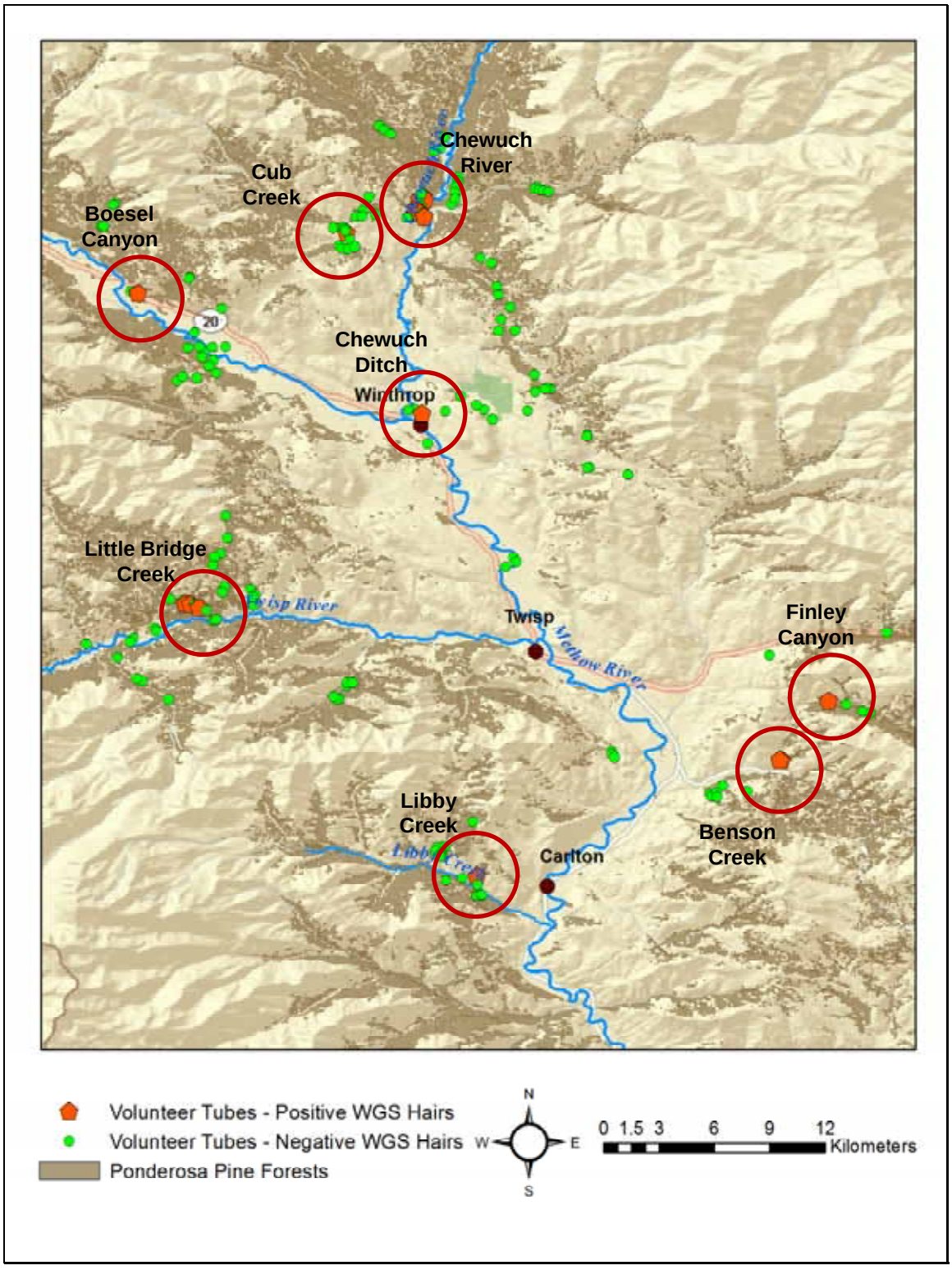


Figure 11. Pacific Biodiversity Institute volunteer hair-sampling tube locations with emphases on regions (red circle) that were positive for western gray squirrel (WGS) hair.

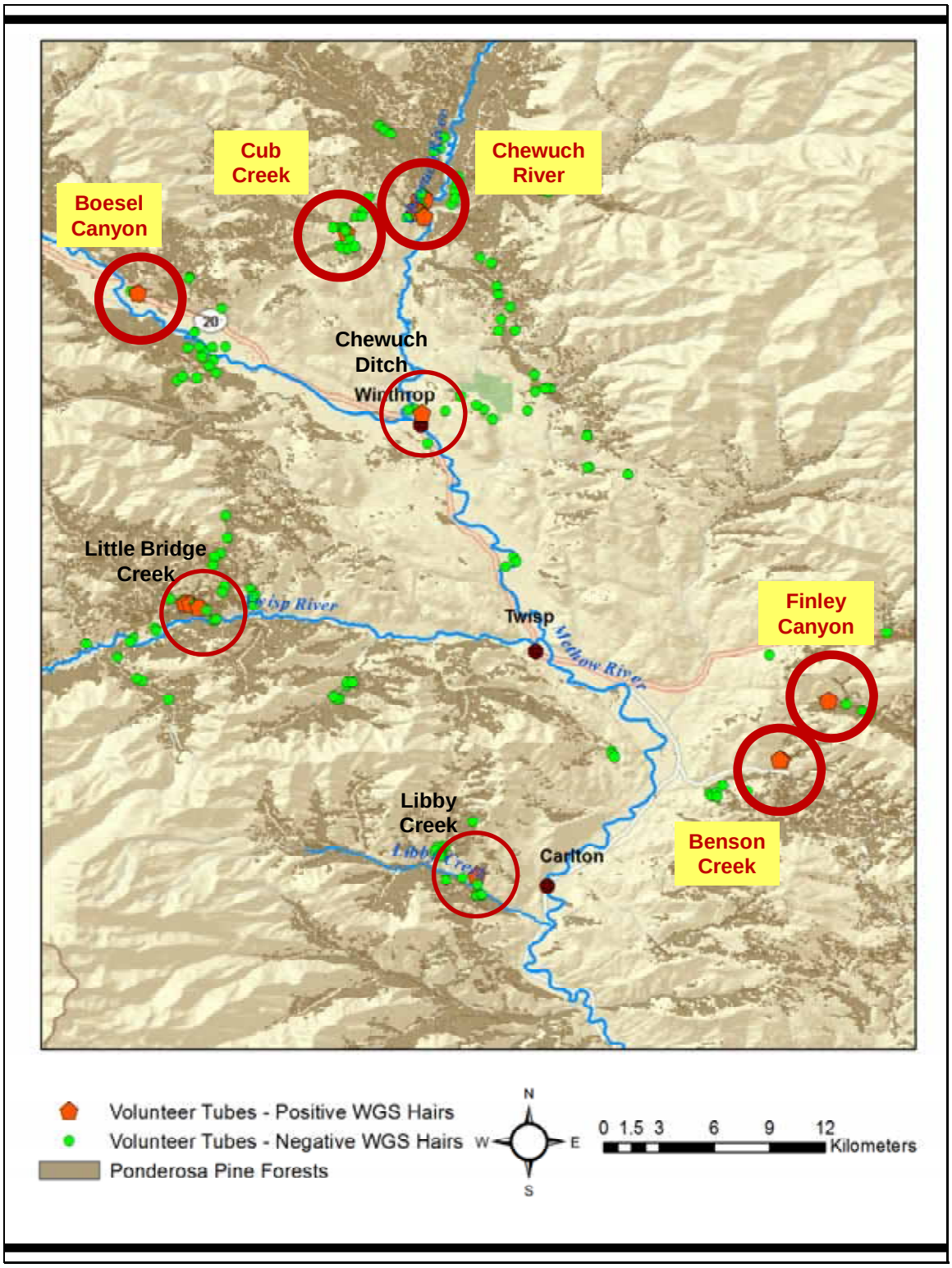


Figure 12. Pacific Biodiversity Institute volunteer hair-sampling tube locations with emphasis on five new locations (thicker red circles) not previously known to have western gray squirrels (WGS).

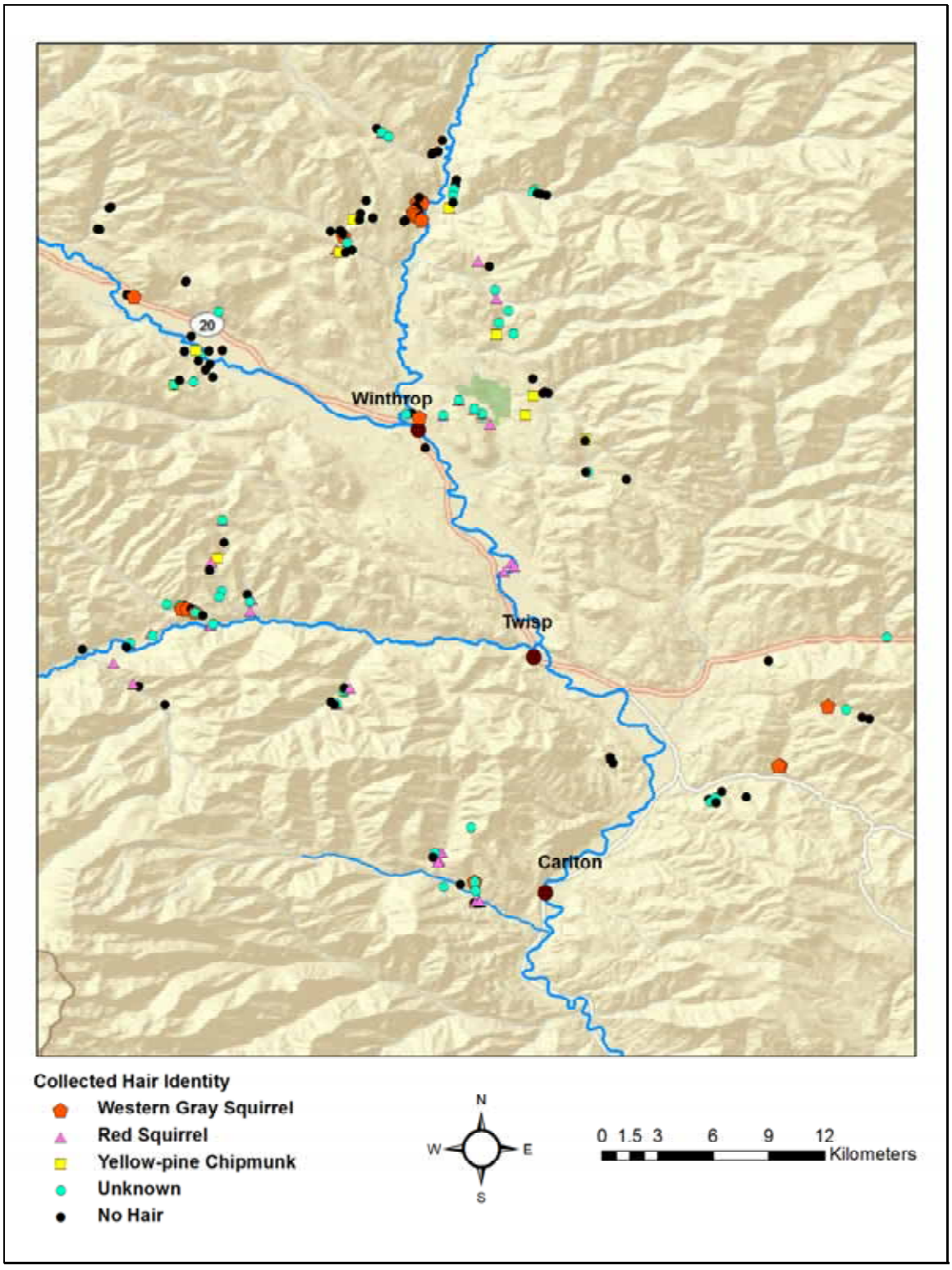


Figure 13. Pacific Biodiversity Institute volunteer hair-sampling tube locations indicating the identity of hair collected.

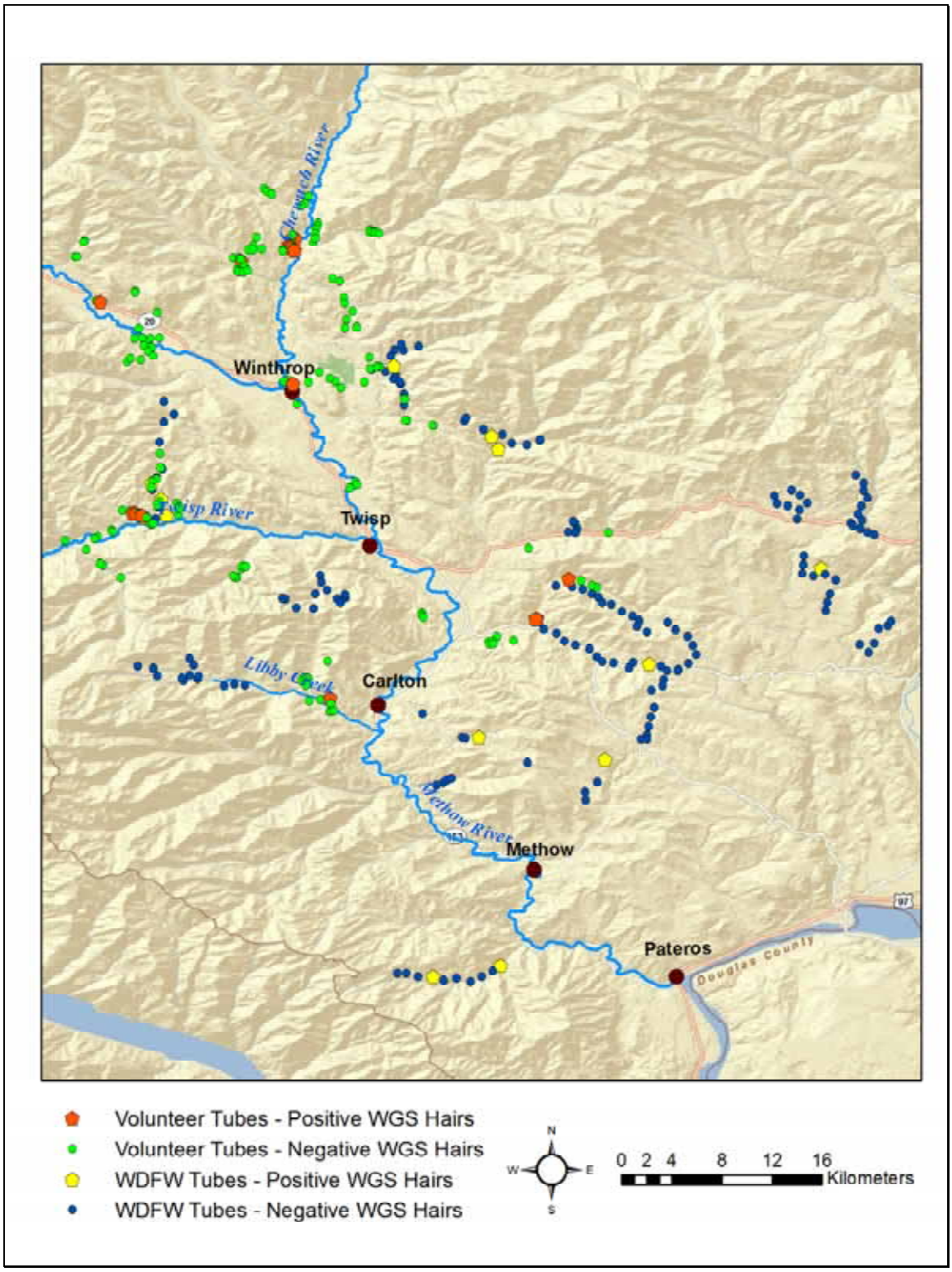


Figure 14. Western gray squirrel (WGS) occurrence documented in the Methow Valley based on Pacific Biodiversity Institute volunteer and Washington Department of Fish and Wildlife (WDFW) hair-sampling tube locations.

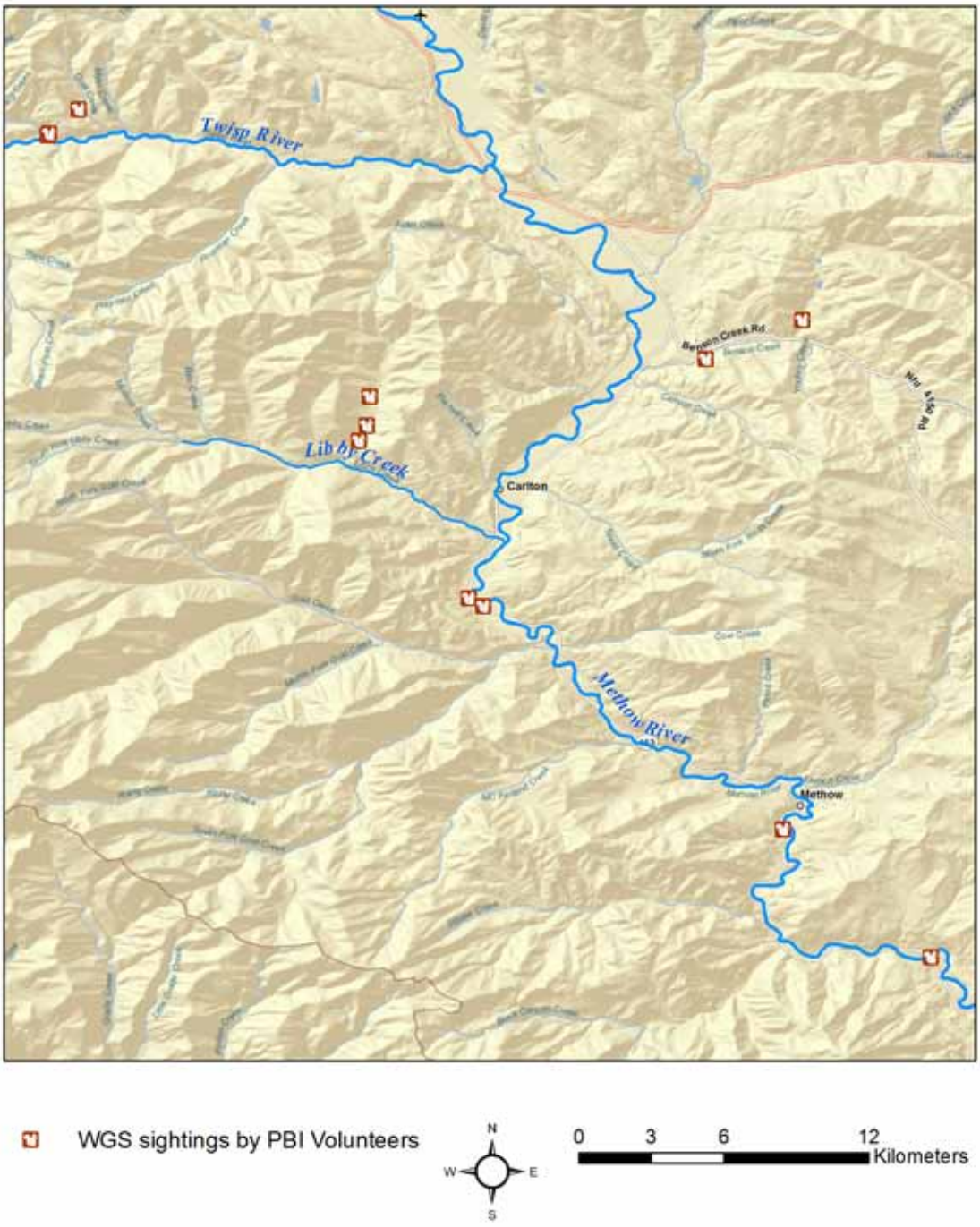


Figure 15. Pacific Biodiversity Institute volunteer western gray squirrel sighting locations in 2010.

Western gray squirrel nest surveys

Nest surveys were completed in two separate areas. First, we conducted a nest survey in the Chewuch River drainage, where we had many hair-sampling tubes that had collected western gray squirrel hair. Within the nest search area, we found one nest that looked like it was not actively used based on the nest having gaps between structural branches and it lacked newer green or red pine needles and instead had black decomposed needles. Our second nest survey was conducted in the Benson Creek watershed where hair-sampling tubes had collected western gray squirrel hair and squirrels were observed on three separate occasions. During this nest search we did not find any nests.

DISCUSSION

Volunteer efforts

We have identified five new areas in the upper Methow watershed where western gray squirrels were previously not documented. Our findings expand the knowledge base for the northern range of known western gray squirrel distribution in the North Cascades. Volunteers were effective in deploying and checking hair-sampling tubes for western gray squirrel hair throughout the field season. They were confidently able to choose locations to place tubes in potential western gray squirrel habitats. Hair-sampling tubes baited with walnuts were effective in luring squirrels through the tubes, however we do not know to what extent they used the tubes based on their encounters. One tube placed by bird feeders on a volunteer's property allowed for visual observation of a western gray squirrel encountering the hair-sampling tube and immediately picking up one of the walnuts outside of the tube and running away with it. This activity was documented in photographs. A majority of the tubes did not collect western gray squirrel hair. While hair tubes are not used to determine density estimates, based on the numbers of tubes with western gray squirrel hair, the species does not appear to be in high densities in the upper Methow Valley. Additionally, throughout the field season (March-October), there were few reported western gray squirrel sightings, and even fewer nests found throughout the study area.

Hair-sampling tube techniques

Some interpretations cannot be made based on our hair-sampling tube distribution survey techniques. For example, since hair-sampling tubes were checked every three to four weeks, we were unable to differentiate whether multiple squirrels entered the tube, or only one. Similarly, we were unable to determine whether hair-sampling tubes in the same region that collected western gray squirrel hair were visited by the same individual or different squirrels. However, collected hair indicates that a squirrel was in the area, but we cannot conclude that this is part of their home range or whether they were dispersing through the area. In order to learn more about western gray squirrel home ranges in the upper Methow Valley, radio-telemetry data would be more effective. However, if a hair-sampling tube collects repeated samples of western gray squirrel hair over a several month period, this would provide evidence that the hair-sampling tube location may be part of an individual's home range that is used for a longer term. In contrast, if a hair-sampling tube only collects western gray squirrel hair once, but is never revisited over a long time period, we predict that the squirrel was dispersing through the area where the hair-sampling tube was placed. Hair collected for a period of time (e.g., two months) may indicate that the western gray squirrel has a seasonal residency in the area. Also, hair-sampling tubes located in areas that did not collect hair does not mean that squirrels are not present. We can only conclude that either they were not in the area, they were not familiar with the lure and therefore did not leave hair when they encountered a hair-sampling tube, or they did not encounter the tube even when in the area.

Western gray squirrel nest surveys

Based on our experience with western gray squirrel nest searches, we found that in the upper Methow Valley, walking nest searches may not be the most efficient method for finding nests. The upper Methow Valley appears to have a lower density of squirrels than other areas where similar walking nest searches have been conducted (Hamer et al. 2005). The ponderosa pines, Douglas fir trees, as well as abundant mistletoe growths all provide excellent cover to hide nests and therefore nests are likely to go unobserved by nest searchers. Additionally, the terrain is often steep in many areas of the upper Methow Valley. This slows down the walking pace,

which prevents coverage of large areas searched for potential low densities of well-hidden nests. Other western gray squirrel researchers (pers comm. Katy Stuart, Sarah Gregory) find nests most effectively by using radio-telemetry to follow radio-collared squirrels.

Future work

This study helped identify areas that western gray squirrels occupy in the upper Methow Valley and outreached to private landowners in areas where western gray squirrels were documented. Our findings provide data to local agencies and organizations to help protect western gray squirrels and their habitat during land management activities. We at Pacific Biodiversity Institute can now further our research in these particular areas to better understand how to protect this state-threatened species.

Potential western gray squirrel habitats to be surveyed

Pacific Biodiversity Institute aims to continue the same work to understand their distribution in the Methow Valley since they may occupy currently unknown areas. Additionally, we were limited on the number of hair-sampling tubes available to put in the field and there are areas within the upper Methow Valley that may not have been adequately surveyed. To address this, we have initially identified additional regions for a future hair-sampling tube distribution study by using aerial photography on GIS to identify areas with large ponderosa pines and Douglas fir trees. For example, Beaver Creek and Cub Creek would be good places to sample in future years because it is identified by local biologists and GIS aerial photography as excellent western gray squirrel habitat with large ponderosa pine and Douglas fir trees, and it has not been surveyed using hair sampling techniques.

Improvements in hair-sampling tube and other non-invasive sampling methods

We recommend that future hair-sampling tube sampling efforts consider leaving the tubes in place during the entire field season, regardless of whether positive hair samples are collected. The tubes should be checked every 2-4 weeks and a record of all the positive hair samples should be made. This will allow us to better determine if the squirrel(s) accessing the walnuts in the hair-sampling tube are residents or dispersers.

The use of remote wildlife cameras or video could help determine use patterns in areas where a positive hair sample was collected. A wildlife camera focused on the hair-sampling tube and walnuts could provide documentation of the amount of activity around a hair tube. Likewise, a camera positioned on a squirrel nest could record information about a squirrel's activity and use of a nest, as well as their travel from the ground up or canopy down into the nest. This would require tree climbing expertise.

Assessing habitats that western gray squirrels occupy

Pacific Biodiversity Institute wants to learn more about the habitat that western gray squirrels utilize. In areas where western gray squirrel hair was collected in hair-sampling tubes, sightings occurred, or nests were found, we initiated detailed habitat field surveys to accurately describe tree density and size, and plant community composition. Eventually, we will compare our findings among regions in the upper Methow Valley and between regions previously surveyed in the lower Methow Valley, the South Cascades, and Puget Trough to determine whether there are regional specific habitat preferences. Using GIS, we created habitat polygons around areas where western gray squirrels were present that appear to have similar forest structure (i.e., relatively uniform habitat conditions) based on aerial photographs. We also created polygons

around habitats with relatively uniform conditions immediately adjacent to the polygon with dissimilar habitat conditions containing the positive western gray squirrel hair-sampling tube or nest. These surrounding habitat types might also be utilized by western gray squirrels. Within each polygon, we created a fixed grid in GIS which identified equidistantly spaced sampling points. The GPS coordinates for these sampling points were recorded and we centered our detailed habitat surveys at each of these sampling points. At each sampling point, we used a basal area factor of 20 to sample trees and snags and recorded the tree species, height, and diameter at breast height for each tree within the variable radius plot. We also recorded the number of trees in smaller size categories (0-1, 1-3, 3-5 inch diameter trunks) and decay classes of dead trees within an 8.5 m radius plot. Additionally, we assessed the habitat plant associations for each polygon by walking through the polygon and characterizing the dominant trees, shrubs, and herb species and noting an estimated forest canopy cover to one of six Daubenmire cover classes. The percent cover classes of each in addition to percent cover classes of nonorganic habitat such as gravel. The polygon was also characterized by land-use impacts such as grazing and erosion. The labor-intensive methodology of these habitat surveys only allowed time for assessing five polygons in the Benson Creek watershed where there were frequent western gray squirrel sightings and two nests (Figure 16). One polygon was also characterized in the Chewuch River watershed. Future work includes surveying additional polygons in the Chewuch River watershed and other areas where western gray squirrels were determined to occur.

Figure 16. Vegetation polygons (purple outline) and sampling points (yellow triangles) for detailed habitat field surveys in the Benson Creek watershed.

Connectivity between areas occupied by western gray squirrels

Our findings of where western gray squirrels are distributed in the upper Methow Valley have generated questions of corridor connectivity between occupied areas, dispersal between these locations. Future work may concentrate on existing connectivity as corridors for western gray squirrels in the Methow Valley. These connections are vital to recovery efforts which aim to help maintain healthy populations of western gray squirrels since young squirrels disperse when they are weaned from their mother, males travel substantial distances to find females that are in estrous one day out of the year, and squirrels travel to find food resources (Linders & Stinson 2007). Corridors between individual gray squirrel home ranges and between source population centers are vital to increase genetic variability within a breeding population since low genetic diversity is a threat to western gray squirrels in Washington State (Linders & Stinson 2007). There may be potential movement corridors on larger (Figure 17) and smaller scales (Figure 18) between regions we have identified as occupied by western gray squirrels. Future studies can help determine whether individuals move along river riparian zones, or stay within ponderosa pine and/or Douglas fir forests. An effort could be made to determine large landscape connections, such as whether and how western gray squirrels disperse between major watersheds (e.g., between Lake Chelan/Stehekin and the Methow Valley, or between Okanogan Valley and the Methow Valley) (Figure 21). An example of dispersal was observed on June 17, 2000, when a western gray squirrel was observed at high elevations in open, whitebark pine forests along the Chelan-Sawtooth Crest (Morrison 2000, personal communication and WDFW Heritage sighting database).

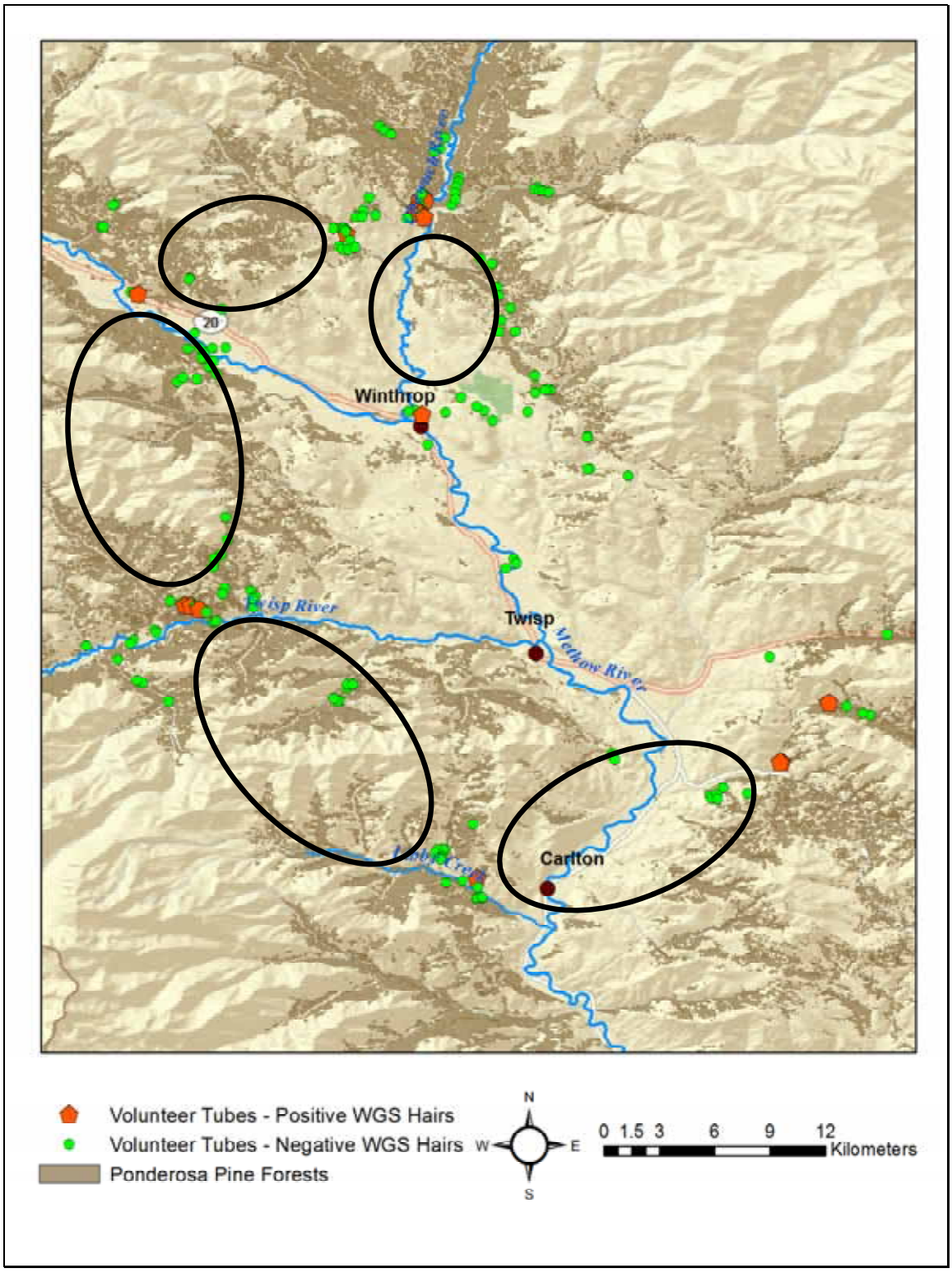


Figure 17. Potential corridors of connectivity (black ovals) between known western gray squirrel locations in the upper Methow Valley.

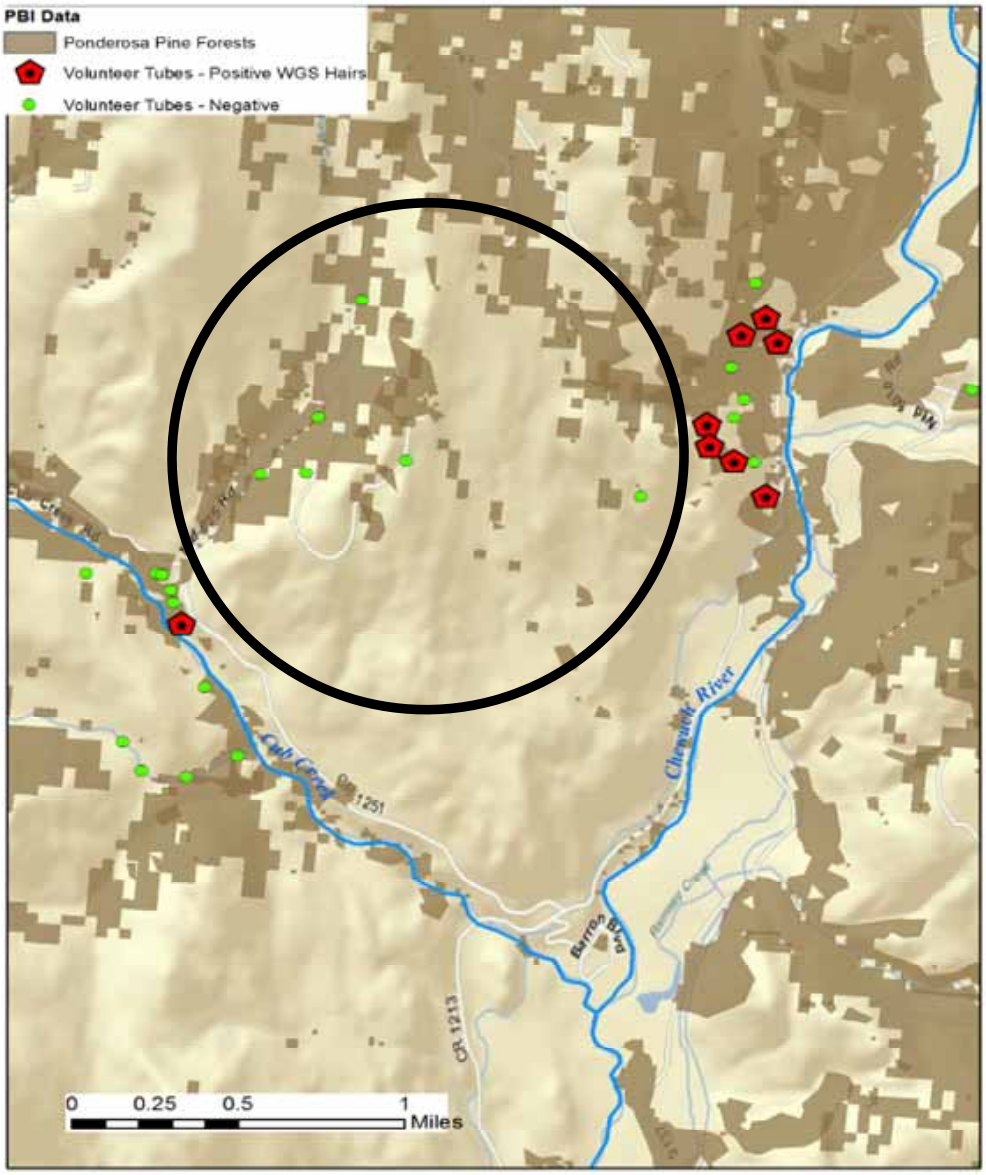


Figure 18. Potential corridor of connectivity (black circle) between western gray squirrel locations in the Chewuch River watershed and the Cub Creek watershed.

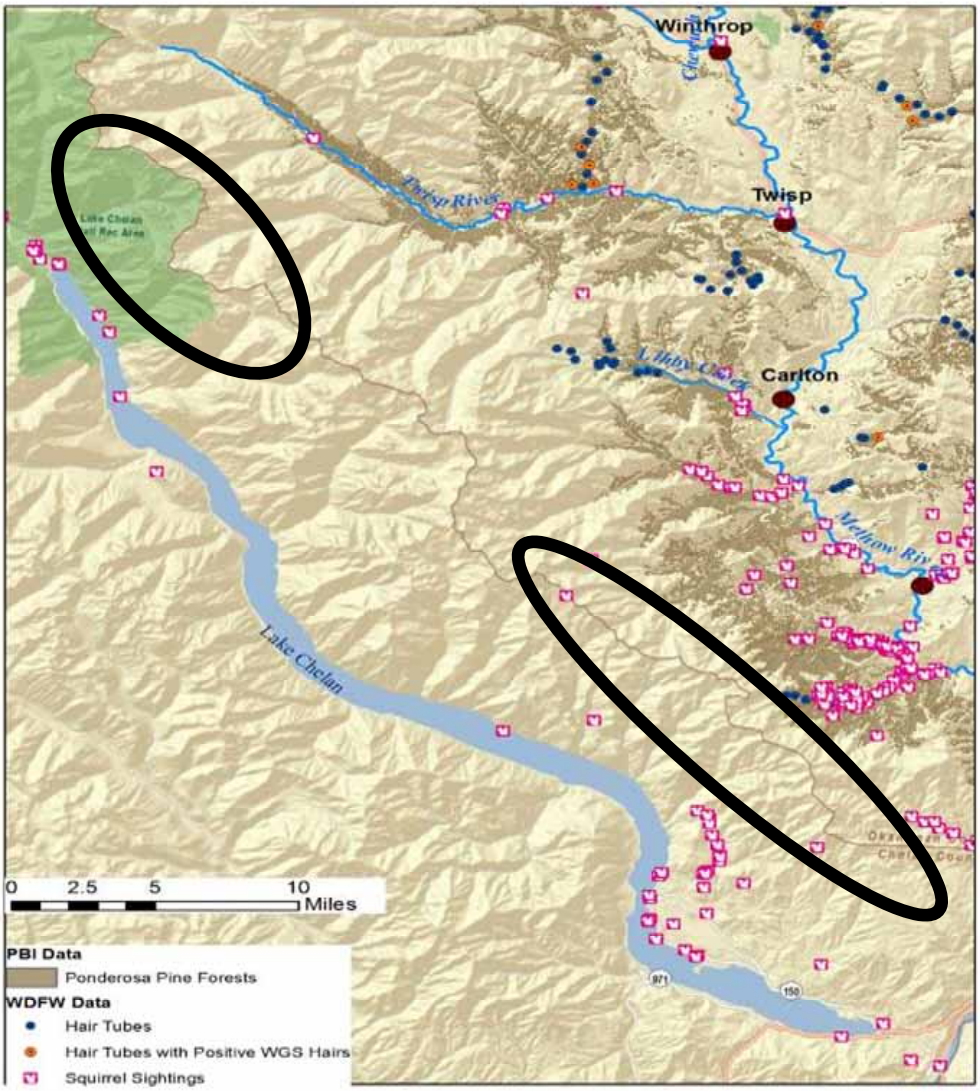


Figure 19. Potential corridors of connectivity (black ovals) between western gray squirrel locations near Lake Chelan/Stehekin region and the Methow Valley.

Reducing road-killed western gray squirrels

We are interested in reducing the number of road-killed western gray squirrels in the Methow Valley. Volunteers were urged to record any road-kill western gray squirrel sightings on car trips. Recording road-kill locations and sighting date may help determine seasonal use of more established routes used by western gray squirrels. One possibility for reducing road-kill deaths is to identify areas where road-kill accidents are at a higher density and erect warning signs urging motorists to slow down since this is a road crossing area for the state threatened western gray squirrels. Common road crossing areas for western gray squirrels may put them at a high mortality risk and hinder recovery efforts.

Western gray squirrel conservation implications

Our study has helped identify five new western gray squirrel areas, which has expanded the knowledge base for the upper Methow Valley, a northern part of their distribution range. Landowners and managers may make informed management practice decisions knowing they have western gray squirrels in the vicinity. Our study provided important information for agencies, private landowners, and local working groups for ongoing management activities such as timber harvest, prescribed burning, and livestock grazing that could potentially affect western gray squirrels and their habitats. Our findings of western gray squirrel distributions will also help guide conservation prioritization of western gray squirrel habitats by local conservation agencies in Okanogan County. Additionally, our community education component has allowed locals to be aware of their "backyard biodiversity". During our community education, we suggested potential ways to enhance western gray squirrel habitat. Suggested enhancements include promoting the growth of large trees which squirrels use for feeding and nesting, maintaining tree canopy connection so squirrels can travel between trees, and avoiding livestock overgrazing which leads to erosion and habitat degradation of squirrel foraging areas.

ACKNOWLEDGEMENTS

Pacific Biodiversity Institute would like to thank the Washington Department of Fish and Wildlife Aquatic Lands Enhancement Account (ALEA) Volunteer Cooperative Grant #09-1351 & #10-1353 and Pacific Biodiversity Institute Special Projects Grant for funding our project. Many volunteers helped with data collection: Joyce Bergen, Marjorie Barker, Dorothy and Ed Hudson, Jim and Cathy Habermehl, Sam and John Owen, Dave and Ann Tate, Morgan Allen-Tate, Craig Olson, Patricia Leigh, Alan Fahnestock, George Wooten, Sharon Clark, John Alexios, Jane Gilbertsen, Don Johnson, Larry Lund, Stephen Nourse, Patricia Sears, Vicky and Ed Welch, and Chris and Olga Cripps. Katy Stuart was also key in providing information on western gray squirrels in the lower Methow Valley.

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Appendix A - Western Gray Squirrel Hair-sampling tube SurveyDatasheet, Okanogan-Methow Valley (2010-2011)

Tube Number: _____Drainage: _____Date Deployed (mm/dd/yyyy):_____
Observers Names:
_____
Site Code: _____ Flagging color and location:
_____
Site Location
Notes:_____
_____
_____
_____
GPS Location (Long/Lat, WGS 84): _____Accuracy (meters):_____

Adjacent Landowner consent needed? Y N N/A
Dominant Overstory: Ponderosa Douglas_Fir Cottonwood Other _____
Dominant Understory: Grass/Forbs Shrubs Bare-Ground Shrub/Young-Conifers

Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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_____
Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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_____
Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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Notes:
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Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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_____
Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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_____
Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed

_____

Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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Date Checked: _____
Tube: Present Rolled Missing **Hair Collected:** Y N **Tube**: Rebaited (same location) Removed
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Notes:
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Appendix B - Western Gray Squirrel Observation Form

Western Gray Squirrel Observation Form

Okanogan-Methow Valley (2010-2011)

Observers Name(s):____

Date	Point of Interest	Drainage	Site Code	Lat/Long (Datum ___)	Accuracy (meters)	Photo #s
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Point of Interest: Nest = **ne** Squirrel sighting = **sq** Tracks = **tr** Carcass=**ca** Scat=**st** hair=**ha** cut cones=**cc** cut sprigs=**cs** cone scales: scattered=**sc** cone scales: piles=**cp** Other = **ot** (describe)

If western gray squirrel or nest observed, fill out Squirrel Sighting/Nest Observation Form.

Appendix C - Western Gray Squirrel Sighting Form

Western Gray Squirrel Observation Information:

Date	Site Code	Adult # M / F / S / U	Young of the year # M / F / U	Time of Detection	Behavior Codes
		/ / / /	/ / /		
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		/ / / /	/ / /		

Behavior Codes: nest building=**nb** perched on tree=**pe** perched in nest=**pn** perched on ground**=pg** perched on rock or stump**=pr/s** copulating=**co** vocalizing=**vo** foraging=**fo** aggressive=**ag** defensive=**de** courtship=**cr** excavating=**ex** playing=**pl** feeding=**fe** running on ground=**rg** climbing in tree=**ct**

Notes and Observations:

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Appendix D - Western Gray Squirrel Nest Form

Date Observed: _____ **Site Code:** _____ Observers

Nest Status: Occupied: ☐ Not Occupied: ☐ Not sure: ☐

Nest Condition: Repaired: ☐ Fresh Material: ☐ Disrepair: ☐ Unknown: ☐

Nest Color: Green: ☐ Rusty/Red: ☐ Brwn/Blk: ☐ Unknown: ☐

Nest Type: Shelter: ☐ Cavity: ☐ Platform: ☐

Nest Composition: Needles: ☐ Leaves: ☐ Sticks/twigs: ☐ Mistletoe: ☐ Mud: ☐ Grass: ☐

Nest Aspect:	**Tree Species:**	**Dead or LiveTree:**	**Tree Height:**	**Nest Height:**

Notes and Observations:

_____

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_____

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_____

Date Observed: _____ **Site Code:** _____

Nest Status: Occupied: ☐ Not Occupied: ☐ Not sure: ☐

Nest Condition: Repaired: ☐ Fresh Material: ☐ Disrepair: ☐ Unknown: ☐

Nest Color: Green: ☐ Rusty/Red: ☐ Brwn/Blk: ☐ Unknown: ☐

Nest Type: Shelter: ☐ Cavity: ☐ Platform: ☐

Nest Composition: Needles: ☐ Leaves: ☐ Sticks/twigs: ☐ Mistletoe: ☐ Mud: ☐ Grass: ☐

Nest Aspect:	**Tree Species:**	**Dead or LiveTree:**	**Tree Height:**	**Nest Height:**

Notes and Observations:

_____

_____

_____

_____

_____

_____

Date Observed: _____ **Site Code:** _____

Nest Status: Occupied: ☐ Not Occupied: ☐ Not sure: ☐

Nest Condition: Repaired: ☐ Fresh Material: ☐ Disrepair: ☐ Unknown: ☐

Nest Color: Green: ☐ Rusty/Red: ☐ Brwn/Blk: ☐ Unknown: ☐

Nest Type: Shelter: ☐ Cavity: ☐ Platform: ☐

Nest Composition: Needles: ☐ Leaves: ☐ Sticks/twigs: ☐ Mistletoe: ☐ Mud: ☐ Grass: ☐

Notes and Observations:

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Appendix E - Methow Valley News Online Western Gray Squirrel Article (March 1, 2010)

Squirrel study seeks volunteers

Pacific Biodiversity Institute's Western gray squirrel project is gearing up as spring approaches and juveniles start emerging from nests.

Volunteers are needed to assemble 200 hair-sampling tube traps, which will be set up in Western gray squirrel habitat throughout the Methow Valley in the following weeks. Project assembly will take place on Saturday, March 5, from 9 a.m. to noon at the PBI office, 517 Lufkin Lane, in the residential area off Castle Road in Winthrop. No skills or tools required. Snacks and drinks will be provided.

PBI is also hosting a training day for Western gray squirrel project volunteers on Saturday, March 20, from 9 a.m. to 4 p.m. Those gathered will discuss the ecology of Western gray squirrels, their conservation issues, and how to conduct distribution surveys using hair-sampling tube traps. Participants will be in the field using hands-on field sampling techniques, so wear weather-appropriate outdoor clothing and boots, and bring your binoculars, a camera, sack lunch and water. The group will carpool to field sites from the PBI office.

The project is part of a grant provided by Washington Department of Fish and Wildlife that will help determine the extent of Western gray squirrel activity in the region.

RSVP for both volunteer opportunities to Pacific Biodiversity Institute at 996-2490 or send an e-mail to Kim Romain-Bondi, kim@pacificbio.org.

File photo by Sue Misao

Appendix F – Methow Valley News Online Western Gray Squirrel Article (March 10, 2010) **Date:** 03-10-2010 | **Volume:** 107 | **Issue:** 31

Study of rare gray squirrel will involve public observers

By Joyce Campbell

There isn't a lot known about the Western gray squirrel, but researchers plan to change that with a study in the Methow Valley, one of the last places in the state where the distinctly large and grizzled, bushy-tailed rodent has survived.

The Pacific Biodiversity Institute in Winthrop has teamed up with the Washington Department of Fish and Wildlife and the U.S. Forest Service to gain a better understanding of where the squirrel is located and involve the public in conservation efforts to help it survive here, according to PBI's senior wildlife biologist Kim Romain-Bondi.

The large, native squirrel is absent from most of the state and listed as a threatened species. The gray-colored squirrel only exists in three relatively small populations in Washington state. They are found on the Fort Lewis Army base, in the Klickitat area and here in the North Cascade ecosystem, according to Romain-Bondi.

PBI will be surveying for the rare squirrels in ponderosa pine habitat in French Creek, McFarland Creek, Gold Creek, Texas Creek, Benson Creek, Libby Creek, Twisp River, Beaver Creek, Fraser Creek, Pearrygin Creek, Ramsey Creek, Chewuch River, Middle Methow River and Big Valley.

The organization expects to involve local volunteers, including some landowners with prime Western gray squirrel habitat on their property, to conduct distribution and nest count surveys. Volunteers will receive training on Western gray squirrel ecology, identification skills and how to conduct distribution and nest count surveys. PBI is interested in informing landowners about stewardship of the squirrels throughout the valley.

"The gray squirrel is unique, it doesn't cause harm and doesn't eat livestock," said PBI director Peter Morrison. He said the animal has suffered a lot of decline until recently. "It's overlooked and often run over trying to cross the road." He said the more people know about the gray squirrels and their habitat, the more likely they will take an interest in managing the landscape for the rare squirrel as well as other wildlife species that depend on ponderosa pine forests.

In January, volunteers will help build and place 200 non-invasive hair-tubes to collect hair that can be used to identify the species. The animal enters an open-ended PVC tube, attracted by their favorite food, walnuts. Sticky tape attached to the inside of the tube collects hair samples.

There will be at least two community field days for training in Western gray squirrel identification, survey methods, ecology and conservation measures. From mid-March to April volunteers will conduct nest counts in areas where squirrels have been identified. The animals nest in tree cavities and also build stick nests that they reuse over and over, said Romain-Bondi.

PBI encourages folks to call in sightings and locations for these rare squirrels, especially if the animals are hit on the road. Sightings will be followed up with the survey and educational outreach project, said Romain-Bondi.

PBI received a grant from the WDFW ALEA Volunteer Grant Program for volunteer travel, per diem and equipment. PBI matched the grant to provide funds for staff time and logistics. The Methow Valley Ranger District and DFW Region 2 have partnered with PBI on the project.

PBI is taking applications for a skilled conservation biology intern to assist with the surveys and related research. For information on internships visit www.pacificbio.org/about/jobs/jobs.html. To learn more about Western gray squirrel ecology and citizen science volunteer opportunities contact kim@pacificbio.org or call 996-2490.

File photo by Sue Misao: The Western gray squirrel has been observed in just three places in Washington state, including the Methow Valley. The animal will be the subject of a study by the Pacific Biodiversity Institute, the state Department of Fish and Wildlife and the Forest Service.

Appendix G – Wenatchee World Western Gray Squirrel Article (March 22, 2010)

Volunteers learn about threatened gray squirrel

By K.C. Mehaffey
World staff writer

Monday, March 22, 2010

Volunteers and scientists caught a glimpse of a Western gray squirrel Saturday in the Methow Valley.

METHOW — Most eyes were focused upward, at their beanbag chair-sized nests built of twigs and branches of the tall ponderosa pines and cottonwoods. Then someone spotted one bounding through the grass.

The Western gray squirrel quickly disappeared up a steep wooded hill before many of the volunteers who came to learn about them Saturday caught more than a glimpse. But it was an exciting moment, nonetheless.

Western gray squirrels are threatened in Washington state and a species of concern nationally. The North Cascades population — which includes parts of the Okanogan, Methow and Lake Chelan valleys — is one of only three populations that remain in the state.

The nonprofit Pacific Biodiversity Institute in Winthrop wants to know more about this understudied population, and it's getting help from 30 volunteers.

Twenty volunteers showed up Saturday for a full day of training, learning the difference between a Western gray and the smaller and more common red squirrel, or the intrusive and non-native Eastern gray squirrel, which frequents the Chelan Valley but has not yet been spotted in the Methow.

"This is the stronghold for Western gray squirrels," Kim Romain-Bondi told the group, stopped at the side of Black Canyon Road, south of Methow. "It's the best habitat that is known."

Romain-Bondi is a senior wildlife biologist for the Institute, and is heading up the study.

She'd counted about 20 nests in pines, Douglas firs and cottonwood trees in this one area, but said probably only about four are currently being used.

Klickitat County in southwest Washington probably has the largest population of Western gray squirrels, she said. And only a small population hangs on in Fort Lewis, where scientists are working to reintroduce them.

Not much is known about this population, at least in North Central Washington. The squirrels are found only in California, Oregon and Washington. The Methow Valley population is at the far northern edge of the squirrel's range. It's so far north that it's outside the oak tree forests commonly known as its best habitat, Romain-Bondi said.

Here, they eat seeds or nuts from pines and firs, and search the ground for mushrooms. They may eat other things, too, Romain-Bondi said, adding, "That's a lot of what we're trying to find out."

As part of the study, they'll be asking land owners to allow volunteers to place hair snag tubes on their property — particularly if a likely nest, or the telltale signs of scattered rather than piled pine and fir cone remains, are seen nearby.

The handmade tubes are black PVC pipes, with a walnut lightly glued to the bottom, and sticky tape attached to the top. A walnut at either end provides incentive for the squirrel to enter, Romain-Bondi said. Then, when the squirrel enters, it removes the walnut and leaves behind some hair, which is distinctive enough to distinguish from other kinds of squirrels or rodents, she said.

She said they use walnuts because other rodents don't often go for the hard-to-open shells.

Dovetailing with the Pacific Biodiversity Institute study is one led by University of Washington graduate student Katy Stuart, who is beginning her third year of gathering data.

Stuart worked out of Stehekin for the last two years, when she live-captured and radio-collared 20 of the threatened squirrels and monitored their range, located nest sites and studied how forest fires and forests managed by thinning and prescribed burns impact the habitat.

She's now using radio collars to monitor gray squirrels in the lower Methow Valley.

The squirrels generally live about two years, and they don't reach mating maturity until they're a year and a half, she said.

In Stehekin, all but four of the radio-collared squirrels that she was monitoring died — most from predators, including a martin and a goshawk.

But people also are contributing to their demise, said Peter Morrison, executive director of the Pacific Biodiversity Institute.

He said habitat loss is usually the culprit in most species that are threatened or endangered. "Loss of tree cover is definitely an issue," he said.

In addition, western gray squirrels are particularly vulnerable to getting hit by cars, Morrison said, adding, "One of my goals with this whole project is to get people aware of this, and get them to drive a little slower.

More information about them will help scientists determine how to save them, he said, adding, "Our native squirrels are pretty cool. It would be really sad for the state to lose them."

K.C. Mehaffey: 997-2512 mehaffey@wenatcheeworld.com

Appendix H – Methow Valley News Online Western Gray Squirrel Article (March 24, 2010)

Have you seen this squirrel?

Nearly two dozen volunteer scientists of all ages gathered for field training on Saturday (March 20) to learn how to survey for the state-threatened Western gray squirrel. Pacific Biodiversity Institute intern Asako Yamamuro, who has a doctorate in ecology, handed out project training materials at the Carlton fishing hole, before carpooling to a known nesting area for the large rodent, which, according to the scientists, is likely to become endangered without cooperative efforts like this survey project.

Photo by Joyce Campbell

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Appendix I – Pacific Biodiversity Institute Volunteer Hair-sampling tube Data

Location Code	Drainage	Observer	Date Deployed	Latitude	Longitude	Squirrel Hair ID
BEAR1	Cougar	Owen	31-Mar-10	48.4682	-120.0972	Yellow-pine Chipmunk
BEAR2	Cougar	Owen	31-Mar-10	48.4678	-120.0974	
BEAR3	Bear	Owen	31-Mar-10	48.4524	-120.0960	Unknown
BEAR4	Bear	Owen	31-Mar-10	48.4526	-120.0970	
BEAV1	Jack	Wooten & Clark	07-Apr-10	48.3720	-119.9513	Unknown
BEAV2	Fraser	Wooten & Clark	07-Apr-10	48.3610	-120.0085	
BEAV3	Bowan	Owen	31-Mar-10	48.4491	-120.0772	
BEAV4	Bowan	Owen	31-Mar-10	48.4489	-120.0773	
BENS1	Finley	Wooten & Clark	04-May-10	48.3329	-119.9596	
BENS10	Benson	Olson	11-Apr-10	48.2938	-120.0375	
BENS11	Benson	Olson	11-Apr-10	48.2923	-120.0364	Unknown
BENS12	Benson	Olson	04-Aug-10	48.2975	-120.0313	
BENS13	Benson	Olson	04-Aug-10	48.2948	-120.0192	
BENS2	Finley	Wooten & Clark	04-May-10	48.3338	-119.9631	
BENS3	Finley	Wooten & Clark	04-May-10	48.3373	-119.9710	Unknown
BENS4	Finley	Wooten & Clark	04-May-10	48.3387	-119.9795	Western Gray Squirrel
BENS5	Benson	Alexios	06-May-10	48.3109	-120.0037	Red Squirrel
BENS6	Benson	Alexios	06-May-10	48.3099	-120.0026	Western Gray Squirrel
BENS7	Benson	Alexios	06-May-10	48.3098	-120.0033	Western Gray Squirrel
BENS8	Benson	Olson	06-Jun-10	48.2941	-120.0342	Unknown
BENS9	Benson	Olson	11-Apr-10	48.2921	-120.0339	
BOUL1	Chewuch	Yamamuro	25-May-10	48.5805	-120.1633	Red Squirrel
BOUL1	Chewuch	Yamamuro	25-May-10	48.5805	-120.1633	Yellow-pine Chipmunk
BOUL2	Boulder	Yamamuro	13-Apr-10	48.5892	-120.1218	Unknown
BOUL3	Boulder	Yamamuro	13-Apr-10	48.5883	-120.1227	Unknown
BOUL4	Boulder	Yamamuro	13-Apr-10	48.5875	-120.1206	
BOUL5	Boulder	Yamamuro	13-Apr-10	48.5873	-120.1187	
BOUL6	Boulder	Yamamuro	13-Apr-10	48.5868	-120.1160	
BUTT1	Twisp	Barker	28-Apr-10	48.3397	-120.3011	
BUTT2	Twisp	Barker	28-Apr-10	48.3484	-120.3138	
BUTT3	Twisp	Barker	28-Apr-10	48.3495	-120.3165	Red Squirrel
BUTT4	Twisp	Barker	28-Apr-10	48.3599	-120.3259	Red Squirrel
CANY1	Twisp	Barker	26-Apr-10	48.3664	-120.3411	
CUBC1	First	Hudson	28-Jun-10	48.5841	-120.2036	
CUBC10	First	Hudson	17-Apr-10	48.5669	-120.2143	Western Gray Squirrel
CUBC11	Cub	Habermehl	15-Apr-10	48.5636	-120.2126	Red Squirrel
CUBC11	Cub	Habermehl	15-Apr-10	48.5636	-120.2126	Unknown
CUBC12	Cub	Habermehl	27-Mar-10	48.5606	-120.2178	Red Squirrel
CUBC13	Cub	Habermehl	15-Apr-10	48.5591	-120.2164	Yellow-pine Chipmunk
CUBC14	Cub	Habermehl	27-Mar-10	48.5589	-120.2135	
CUBC15	Cub	Habermehl	27-Mar-10	48.5601	-120.2102	
CUBC2	First	Hudson	21-May-10	48.5779	-120.2061	
CUBC3	First	Hudson	21-May-10	48.5748	-120.2096	Yellow-pine Chipmunk
CUBC4	Cub	Hudson	05-Jul-10	48.5750	-120.2067	
CUBC5	Cub	Habermehl	15-Apr-10	48.5693	-120.2207	

CUBC6	First	Hudson	28-Mar-10	48.5694	-120.2161	
CUBC7	First	Hudson	05-Jul-10	48.5694	-120.2158	
CUBC8	First	Hudson	17-Apr-10	48.5686	-120.2152	
CUBC9	First	Hudson	28-Mar-10	48.5679	-120.2149	
EIMI1	Eight Mile	Yamamuro	07-Jul-10	48.6190	-120.1984	
EIMI2	Eight Mile	Yamamuro	07-Jul-10	48.6171	-120.1960	Red Squirrel
EIMI2	Eight Mile	Yamamuro	07-Jul-10	48.6171	-120.1960	Unknown
EIMI3	Eight Mile	Yamamuro	07-Jul-10	48.6150	-120.1927	Unknown
FAWN1	Fawn	Leigh	13-May-10	48.5811	-120.3273	
FAWN2	Fawn	Leigh	09-Jul-10	48.5806	-120.3280	
FAWN3	Fawn	Leigh	13-May-10	48.5702	-120.3338	
FAWN4	Fawn	Leigh	09-Jul-10	48.5701	-120.3329	
FAWN5	Fawn	Leigh	09-Jul-10	48.5701	-120.3326	
LIBB1	Smith Canyon	Tate	27-Mar-10	48.2800	-120.1528	Unknown
LIBB10	Libby	Yamamuro	09-Mar-10	48.2523	-120.1578	
LIBB11	Libby	Yamamuro	23-Mar-10	48.2535	-120.1508	Western Gray Squirrel
LIBB11	Libby	Yamamuro	23-Mar-10	48.2535	-120.1508	Unknown
LIBB12	Libby	Yamamuro	09-Mar-10	48.2490	-120.1504	Unknown
LIBB13	Libby	Johnson	31-Mar-10	48.2436	-120.1511	
LIBB14	Libby	Johnson	31-Mar-10	48.2436	-120.1505	Red Squirrel
LIBB15	Libby	Johnson	31-Mar-10	48.2440	-120.1485	Red Squirrel
LIBB16	Libby	Johnson	31-Mar-10	48.2441	-120.1483	Red Squirrel
LIBB2	Smith Canyon	Tate	27-Mar-10	48.2674	-120.1665	Red Squirrel
LIBB3	Smith Canyon	Tate	27-Mar-10	48.2678	-120.1675	Red Squirrel
LIBB4	Smith Canyon	Tate	27-Mar-10	48.2675	-120.1703	Unknown
LIBB5	Smith Canyon	Tate	27-Mar-10	48.2656	-120.1711	
LIBB6	Smith Canyon	Tate	27-Mar-10	48.2641	-120.1681	Red Squirrel
LIBB7	Smith Canyon	Tate	27-Mar-10	48.2633	-120.1684	Red Squirrel
LIBB8	Smith Canyon	Tate	27-Mar-10	48.2628	-120.1686	Red Squirrel
LIBB9	Smith Canyon	Tate	27-Mar-10	48.2512	-120.1659	Unknown
LIBR1	Little Bridge	Yamamuro	24-Jun-10	48.3881	-120.3003	Unknown
LIBR2	Little Bridge	Yamamuro	24-Jun-10	48.3877	-120.2944	Unknown
LIBR3	Little Bridge	Yamamuro	24-Jun-10	48.3878	-120.2917	
LIBR4	Little Bridge	Yamamuro	24-Jun-10	48.3860	-120.2929	Western Gray Squirrel
LIBR5	Little Bridge	Yamamuro	11-Mar-10	48.3858	-120.2901	Western Gray Squirrel
LIBR6	Little Bridge	Barker	26-Mar-10	48.3860	-120.2884	
LIBR7	Little Bridge	Yamamuro	11-Mar-10	48.3856	-120.2881	
LIBR8	Little Bridge	Yamamuro	11-Mar-10	48.3843	-120.2861	Western Gray Squirrel
LIBR8	Little Bridge	Yamamuro	11-Mar-10	48.3843	-120.2861	Unknown
LIBR9	Little Bridge	Barker	26-Mar-10	48.3829	-120.2827	
LOCH1	Chewuch	Yamamuro	07-Jul-10	48.6133	-120.1664	
LOCH10	Chewuch	Yamamuro	10-May-10	48.5839	-120.1771	Western Gray Squirrel
LOCH11	Chewuch	Yamamuro	10-May-10	48.5830	-120.1786	Western Gray Squirrel
LOCH12	Chewuch	Yamamuro	10-May-10	48.5827	-120.1762	Western Gray Squirrel
LOCH13	Chewuch	Yamamuro	10-May-10	48.5813	-120.1792	
LOCH14	Chewuch	Yamamuro	10-May-10	48.5796	-120.1782	
LOCH15	Chewuch	Yamamuro	13-Apr-10	48.5786	-120.1788	
LOCH16	Chewuch	Yamamuro	13-Apr-10	48.5783	-120.1806	Western Gray Squirrel
LOCH17	Chewuch	Yamamuro	13-Apr-10	48.5772	-120.1803	Western Gray Squirrel
LOCH18	Chewuch	Yamamuro	13-Apr-10	48.5764	-120.1787	Western Gray Squirrel

LOCH19	Chewuch	Yamamuro	03-Jun-10	48.5764	-120.1774	
LOCH2	Chewuch	Yamamuro	07-Jul-10	48.6080	-120.1687	
LOCH20	Chewuch	Yamamuro	03-Jun-10	48.5746	-120.1765	Western Gray Squirrel
LOCH21	Chewuch	Yamamuro	03-Jun-10	48.5744	-120.1847	
LOCH22	Chewuch	Hudson	05-Jul-10	48.5758	-120.2002	
LOCH23	Ramsey	Bergen	30-Apr-10	48.5546	-120.1491	Red Squirrel
LOCH24	Ramsey	Bergen	10-Apr-10	48.5523	-120.1439	
LOCH25	Ramsey	Bergen	11-Apr-10	48.5406	-120.1412	Unknown
LOCH26	Ramsey	Bergen	30-Apr-10	48.5365	-120.1404	Red Squirrel
LOCH27	Ramsey	Bergen	10-Apr-10	48.5306	-120.1347	Unknown
LOCH28	Ramsey	Bergen	11-Apr-10	48.5248	-120.1393	Unknown
LOCH29	Ramsey	Bergen	03-Aug-10	48.5191	-120.1321	
LOCH3	Chewuch	Yamamuro	07-Jul-10	48.6066	-120.1716	
LOCH30	Ramsey	Bergen	10-Apr-10	48.5189	-120.1403	Red Squirrel
LOCH30	Ramsey	Bergen	10-Apr-10	48.5189	-120.1403	Yellow-pine Chipmunk
LOCH31	Pearrygin	Owen	14-Apr-10	48.4977	-120.1228	
LOCH32	Bear	Owen	14-Apr-10	48.4906	-120.1152	
LOCH33	Bear	Owen	14-Apr-10	48.4911	-120.1168	
LOCH34	Bear	Owen	14-Apr-10	48.4906	-120.1178	
LOCH35	Bear	Owen	14-Apr-10	48.4893	-120.1225	Yellow-pine Chipmunk
LOCH36	Bear	Owen	01-Apr-10	48.4800	-120.1263	Yellow-pine Chipmunk
LOCH37	Pearrygin	Bergen	26-Mar-10	48.4759	-120.1434	Red Squirrel
LOCH38	Pearrygin	Bergen	26-Mar-10	48.4806	-120.1474	Red Squirrel
LOCH38	Pearrygin	Bergen	26-Mar-10	48.4806	-120.1474	Unknown
LOCH39	Pearrygin	Bergen	26-Mar-10	48.4828	-120.1511	Red Squirrel
LOCH39	Pearrygin	Bergen	26-Mar-10	48.4828	-120.1511	Unknown
LOCH4	Chewuch	Yamamuro	25-May-10	48.5941	-120.1598	
LOCH40	Pearrygin	Bergen	26-Mar-10	48.4871	-120.1587	Red Squirrel
LOCH40	Pearrygin	Bergen	26-Mar-10	48.4871	-120.1587	Unknown
LOCH41	Chewuch	Yamamuro	23-Jun-10	48.4809	-120.1812	
LOCH42	Chewuch	Yamamuro	23-Jun-10	48.4804	-120.1841	Unknown
LOCH43	Chewuch Ditch	Yamamuro	10-Mar-10	48.4788	-120.1776	Western Gray Squirrel
LOCH44	Chewuch	Yamamuro	02-Jul-10	48.5741	-120.1851	
LOCH45	Ramsey	Bergen	30-Apr-10	48.5191	-120.1321	Unknown
LOCH5	Chewuch	Yamamuro	25-May-10	48.5917	-120.1603	
LOCH6	Chewuch	Yamamuro	25-May-10	48.5895	-120.1612	Unknown
LOCH7	Chewuch	Yamamuro	25-May-10	48.5864	-120.1615	Unknown
LOCH8	Chewuch	Yamamuro	25-May-10	48.5832	-120.1615	
LOCH9	Chewuch	Yamamuro	10-May-10	48.5857	-120.1779	
MIME1	Boesel Canyon	Leigh	10-May-10	48.5384	-120.3193	
MIME10	Big Valley	Gilbertsen & Nourse	23-Apr-10	48.5114	-120.2733	
MIME11	Big Valley	Gilbertsen & Nourse	23-Apr-10	48.5112	-120.2798	
MIME12	Methow	Hudson	16-Apr-10	48.5090	-120.2839	Unknown
MIME13	Methow	Hudson	16-Apr-10	48.5062	-120.2848	
MIME14	Wolf	Yamamuro	04-May-10	48.5046	-120.2791	
MIME15	Wolf	Yamamuro	04-May-10	48.5020	-120.2813	
MIME16	Wolf	Yamamuro	04-May-10	48.4985	-120.2777	
MIME17	Wolf	Yamamuro	05-May-10	48.4947	-120.2968	Yellow-pine Chipmunk
MIME17	Wolf	Yamamuro	05-May-10	48.4947	-120.2968	Unknown

MIME18	Wolf	Yamamuro	05-May-10	48.4969	-120.2941	
MIME19	Wolf	Yamamuro	05-May-10	48.4960	-120.2872	Unknown
MIME2	Boesel Canyon	Leigh	10-May-10	48.5380	-120.3168	
MIME20	Studhorse	Bergen	24-Mar-10	48.4797	-120.1663	Red Squirrel
MIME20	Studhorse	Bergen	24-Mar-10	48.4797	-120.1663	Unknown
MIME21	Methow	Hudson	17-Apr-10	48.4642	-120.1748	
MIME22	Thompson Ridge	Yamamuro	13-May-10	48.4290	-120.2731	Red Squirrel
MIME22	Thompson Ridge	Yamamuro	13-May-10	48.4290	-120.2731	Unknown
MIME23	Methow	Habermehl	28-Mar-10	48.4085	-120.1329	Red Squirrel
MIME24	Methow	Habermehl	28-Mar-10	48.4067	-120.1317	Red Squirrel
MIME25	Methow	Habermehl	28-Mar-10	48.4042	-120.1368	Red Squirrel
MIME26	Alder	Yamamuro	23-Apr-10	48.3143	-120.0852	
MIME27	Alder	Yamamuro	23-Apr-10	48.3127	-120.0849	
MIME28	Alder	Yamamuro	23-Apr-10	48.3113	-120.0840	
MIME3	Boesel Canyon	Leigh	10-May-10	48.5374	-120.3158	Western Gray Squirrel
MIME4	Grizzly	Leigh	09-Jul-10	48.5452	-120.2908	
MIME5	Grizzly	Leigh	09-Jul-10	48.5445	-120.2910	
MIME6	Boesel Pond	Leigh	10-May-10	48.5300	-120.2752	Unknown
MIME7	Big Valley	Gilbertsen & Nourse	23-Apr-10	48.5183	-120.2883	
MIME8	Methow	Hudson	16-Apr-10	48.5109	-120.2916	
MIME9	Methow	Hudson	16-Apr-10	48.5114	-120.2859	Yellow-pine Chipmunk
MLTW1	Thompson Ridge	Yamamuro	13-May-10	48.4183	-120.2725	
MLTW10	Twisp	Barker	26-Apr-10	48.3849	-120.2597	Red Squirrel
MLTW11	Twisp	Yamamuro	24-May-10	48.3741	-120.3078	Red Squirrel
MLTW12	Twisp	Yamamuro	24-May-10	48.3729	-120.3071	Unknown
MLTW13	Twisp	Barker	26-Mar-10	48.3693	-120.3181	Red Squirrel
MLTW13	Twisp	Barker	26-Mar-10	48.3693	-120.3181	Unknown
MLTW14	Twisp	Barker	26-Apr-10	48.3675	-120.3198	
MLTW15	Twisp	Yamamuro	20-Aug-10	48.3781	-120.2793	Red Squirrel
MLTW16	Twisp	Yamamuro	24-May-10	48.3779	-120.2788	Red Squirrel
MLTW17	Twisp	Yamamuro	24-May-10	48.3786	-120.2779	Unknown
MLTW2	Thompson Ridge	Yamamuro	13-May-10	48.4106	-120.2756	Yellow-pine Chipmunk
MLTW3	Thompson Ridge	Yamamuro	13-May-10	48.4087	-120.2786	Red Squirrel
MLTW4	Thompson Ridge	Yamamuro	13-May-10	48.4047	-120.2796	
MLTW5	Thompson Ridge	Yamamuro	13-May-10	48.3946	-120.2736	Unknown
MLTW6	Thompson Ridge	Yamamuro	13-May-10	48.3918	-120.2749	Unknown
MLTW7	Twisp	Barker	26-Apr-10	48.3931	-120.2611	
MLTW8	Meyer	Barker	26-Mar-10	48.3904	-120.2590	Red Squirrel
MLTW9	Twisp	Barker	26-Apr-10	48.3892	-120.2599	Unknown
POOR1	Poorman	Yamamuro	10-May-10	48.3399	-120.2178	Red Squirrel
POOR1	Poorman	Yamamuro	10-May-10	48.3399	-120.2178	Unknown
POOR2	Poorman	Yamamuro	10-May-10	48.3396	-120.2189	
POOR3	Poorman	Yamamuro	10-May-10	48.3409	-120.2206	
POOR4	Poorman	Yamamuro	10-May-10	48.3460	-120.2143	Yellow-pine Chipmunk

POOR4	Poorman	Yamamuro	10-May-10	48.3460	-120.2143	Unknown
POOR5	Poorman	Yamamuro	10-May-10	48.3478	-120.2142	
POOR6	Poorman	Yamamuro	10-May-10	48.3476	-120.2113	Red Squirrel