Pacific Water Shrew Survey

2003 - 2004

Ron Altig photo

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May 2004

Abstract

The Pacific water shrew (*Sorex bendirii*) is red listed by British Columbia provincial government and considered threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The Pacific water shrew (PWS) is considered rare throughout its range and is very difficult to capture. Past studies have positively identified only nine specimens within BC (Galindo-Leal and Zuleta, 1993). Habitat loss, limited distribution, and specialized habitat requirements continue to threaten British Columbia's PWS population.

The objective of this study was to determine if the presence of PWS can be efficiently detected through identification of aquatic invertebrate parts and exoskeletons found within collected scats. Furthermore, are intentions were to (1) assess the feasibility of using bait tubes as a method of determining the presence of PWS and; (2) to determine whether PWS are present in BC's Fraser Valley.

Three study areas were chosen within the Lower Fraser Valley based on historical and recent captures of PWS. Study sites were located at Aldergrove Lake Regional Park, Campbell Valley Regional Park, and Sumas Mountain.

For collection of scats, 20 plastic bait tubes were placed at each study site. Constructed from PVC pipe; tubes were blocked at one end with metal screen and baited with yellow mealworm (*Tenebrio molitor Linnaeus*). Collected scat was then dried and examined for evidence of aquatic invertebrates.

Of 180 scat samples collected, 83-percent originated from deer mice and 16.5-percent were deposited by small mammals other then PWS. One sample may have been deposited by PWS. Although presence of PWS in surveyed portions of the Fraser Valley remains unconfirmed, the bait tube survey method was successful. Tubes are inexpensive, easily constructed, and compared to live trapping shrews, require very little field time. Throughout the survey, bait tubes were utilized extensively by small mammals and shrew scats were readily distinguishable from that of other rodents. Furthermore, with appropriate expertise, it appears that aquatic exoskeleton remains in scat can be readily distinguished from terrestrial invertebrate remains.

Acknowledgements

We would like to thank Ross Vennesland, Species at Risk Recovery Biologist, BC Ministry of Water, Land and Air Protection for the opportunity to contribute to this project. Many thanks as well to Vanessa Craig for sharing her expertise. We would also like to thank Roger Bean, Janice Jarvis, and Nancy Arcand for their cooperation and allowing us to access Campbell Valley and Aldergrove Lake Regional Parks. We are grateful as well to Rex Kenner for sharing his expertise and making his lab at UBC available to us. Finally, we wish to express our appreciation to Doug Ransome for his ongoing advice and support.

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1 Introduction

1.1 Background

Also know as marsh shrew or Bendire's shrew, the Pacific water shrew (*Sorex bendirii*) is the largest shrew in British Columbia. The Pacific water shrew (from here on in referred to as PWS) weighs approximately 13.2 g and averages 15.4 cm in length (Nagorsen, 1996 cited in PWSRT, 2003). It is easily recognized by its large size and colouration (Figure 1). The shrew appears dark brown overall but the hair on its back is darker than that of its underside. Its legs are brown and presence of short, stiff hairs on its rear feet improve its ability to negotiate streams and slow moving water. Like the four other species of shrew occurring in the Fraser Valley; common water shrew (*Sorex palustris*), dusky shrew (*S. monticolus*), vagrant shrew (*S. vagrans*), and Trowbridge's shrew (*S. trowbridgii*), the PWS has a pointy snout with whiskers, short ears, a long tail, and five-clawed toes on each foot.

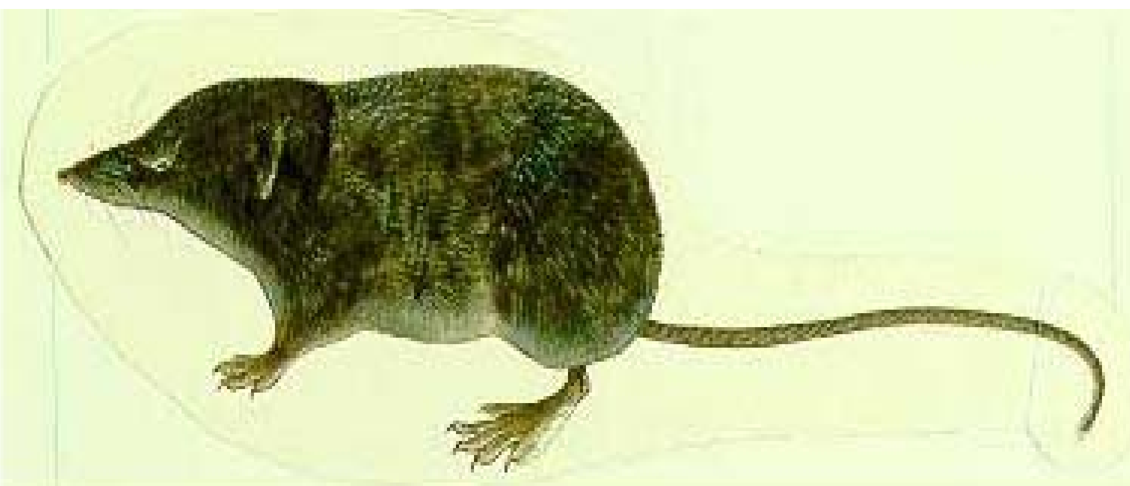

Figure 1. Pacific water shrew (Canadian Museum of Nature picture). PWS spend majority of their time foraging in and around riparian areas. Its appearance varies little from other shrews within its range, however, with exception of common water shrews, its coat appears darker than others. Other distinguishing features include a long tail and presence of short, stiff hairs on its rear feet; an adaptation to its riparian niche.

In North America the PWS occurs along the west coast from northern tip of California to British Columbia's Fraser Valley. In BC, this riparian-habitat specialist is found only in the extreme southwest corner, from Point Grey in the west, to Chilliwack River Valley in the east, and as far north as Seymour River (PWSRT, 2003) (Figure 2).

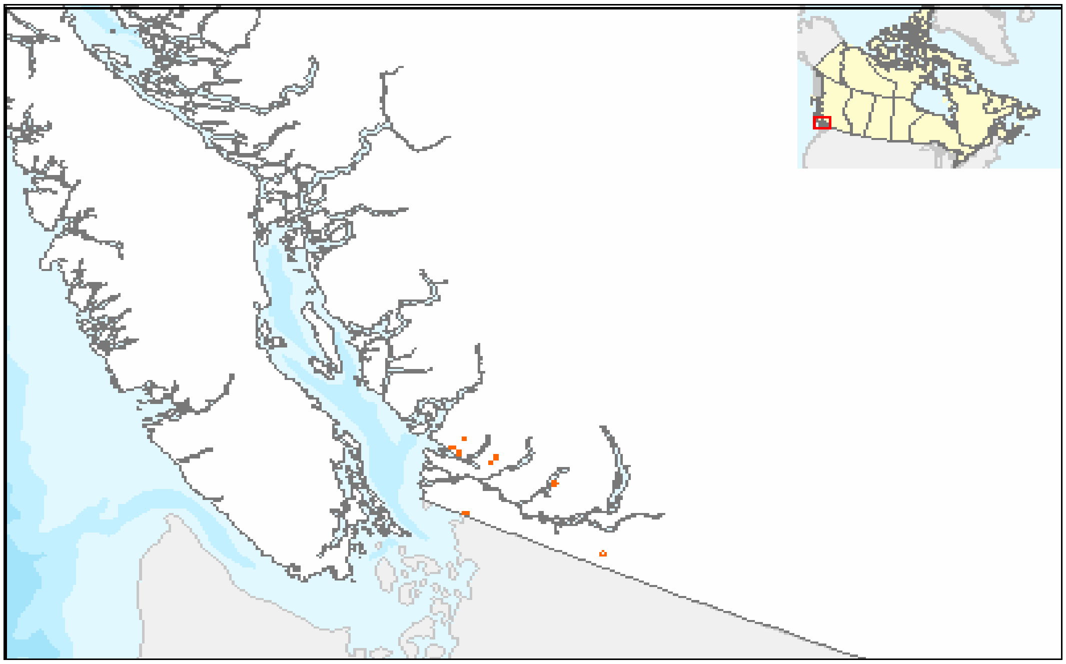

Figure 2. Range of Pacific water shrew in the Fraser Valley. Historic capture sites are indicated by red dots (Canadian Museum of Nature map). In British Columbia, shrew capture sites and areas of confirmed presence are limited to the extreme south-west corner of the province.

Throughout their range, PWS relies heavily on riparian habitat. Previous research and historic capture sites within the Fraser Valley indicate that these animals spend majority of their time within 50 meters of low-elevation streams, creeks, wetlands, ponds, and marshes (Vennesland, 2003). In her report on shrew management practice guidelines, Craig (2003a) stated that PWS is usually captured within 25 meters of a stream or other water bodies. It should be noted, however, that this distance may reflect both sampling effort and the shrew's habitat requirements. Apart from water, the shrew's habitat is generally characterized by presence of vegetation species such as skunk cabbage (*Lysichiton americanum*), salmonberry (*Rubus spectabilis*), and red alder (*Alnus rubra*). In portions of their range, PWS is known to inhabit areas up to 1300 meters in elevation but within BC they are restricted to regions below 850 meters (WLAP, 1995). Very little is known about home range or movement patterns of PWS. However, due to its association with riparian areas, the shrew's home range covers long, narrows strips of land adjacent to still or slow moving water.

Soft-bodied aquatic invertebrates comprise as much as 25 percent of the shrew's diet and this water-adapted animal is able to spend up to 3.5 minutes foraging below water's surface (Craig, 2003a). Prey captured in water is carried to shore where it is consumed. PWS also forage on shore among the forest's detritus and coarse woody debris. Whitaker and Maser (1976, cited in PWSRT, 2003), found that contents of shrew's stomachs contained insect larvae, slugs, snails, ground beetles, harvestman, and earthworms. Due to their high metabolic rate, these shrews spend majority of their time foraging.

The PWS is considered rare throughout its entire North American range and their abundance and distribution in British Columbia are currently unknown. To date, population surveys have been met with limited success. In the past 20 years, only nine specimens have been positively identified in BC (Galindo-Leal and Zuleta, 1993). In general, PWS accounts for less than one percent of small mammals present within historic survey areas (WLAP, 1995). Within the Fraser Valley, much of the shrew's traditional range has been developed into farmland, industrial sites, and residential area. Combination of extensive loss of habitat, rare occurrence within its range, limited distribution, low reproductive rate, and specialized habitat requirements, pose a significant threat to the shrew's continued existence in BC.

In 1993 the BC provincial government recognized PWS as a candidate for threatened or endangered status and assigned the shrew to the red list. In 1994 the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated PWS as threatened. This status protects PWS and its habitat under the Species at Risk Act (SARA) by mandating identification and protection of critical habitat and designing recovery plans and strategies on federal, provincial, and private land.

In light of the shrew's status, the BC Ministry of Water, Land and Air Protection assembled the Pacific Water Shrew Recovery Team (PWSRT) in October, 2002. The team's mandate is to guide work to maintain PWS populations and habitat in Canada

(Craig, 2003a). In her report, Craig (2003a) listed three recovery goals: (1) to ensure current PWS populations are maintained with no further loss of populations; (2) to restore the species to its historical range, where suitable habitat still exists, or can be rehabilitated and; (3) to ensure that PWS in British Columbia reaches a self-sustaining population. The PWSRT listed three steps to reach these goals: (1) to determine distribution of PWS; (2) to develop an efficient method of detecting PWS presence and; (3) to provide more information on PWS habitat and movements (Craig, 2003a).

1.2 Objectives

Our objectives were to develop an efficient method of detecting PWS presence, as outlined in step two of PWSRT objectives. Our two main purposes were: (1) To assess the feasibility of using bait tubes as a method of determining presence of PWS and; (2) to determine whether PWS are present in three specific surveys areas within the shrew's traditional range in BC's Fraser Valley.

Recent research outlined in Churchfield *et al*. (2000) showed that presence of water shrews (*Neomys fodiens*) can be determined based on presence of aquatic invertebrates in their scat. Galindo-Leal and Zuleta (1994) confirms the viability of this method.

2 Study Area

Three study sites were selected in southwestern BC's Fraser Valley: Aldergrove Lake Regional Park, Campbell Valley Regional Park, and Sumas Mountain. Each area was known to have historic PWS populations and contain sufficient habitat requirements for the shrew (Vennesland, 2003).

This heavily urbanized, agricultural area is the only known habitat of PWS in Canada. The Fraser Valley lies within the Coastal Western Hemlock biogeoclimatic zone and is characterized by mild temperatures and heavy rainfall (Meidinger and Pojar, 1991). Dominant vegetation species within the region include: western hemlock (*Tsuga* *heterophylla*), western red-cedar (*Thuja plicata*), Douglas-fir (*Pseudostuga menziesii*), salal (*Gaultheria shallon*), dull Oregon-grape (*Mahonia nervosa*), and red huckleberry (*Vaccinium parvifolium*). Moist, mild climate, and prolonged growing seasons associated with temperate low elevation Douglas-fir forests provide suitable habitat for small mammals.

2.1 Aldergrove Lake Regional Park

Aldergrove Lake Regional Park has significant gravel deposits, and gravel extraction has occurred during the past decade reshaping park landscape. The gravel pit is now reclaimed and serves as a man-made lake. The southern third of the park is highly modified and is currently leased for raspberry and cattle farming. The park is covered with early successional deciduous forests and surrounded by industrial areas (gravel pits) and agricultural land. Consequently, the park is isolated and experiences heavy human use most of the year. Some park uses include swimming, picnicking, walking, horseback riding, and cycling.

The survey area is located on Pepin creek, which flows south into Washington State and eventually the Nooksack River. Within the park, the creek is somewhat protected but portions of the creek are only protected by a brush buffer zone of a few meters (Figure 3). There is little remaining natural riparian area outside the park due to intensive agricultural development.

The survey site is located on Pepin Creek approximately 60 meters east of the bridge located one kilometer south of the main entrance (Figure 4).

Figure 3. 2003/2004 Pacific water shrew survey area on Pepin Creek at Aldergrove Lake Regional Park, Aldergrove, BC (N. Dykshoorn photo). Dominant vegetation in the area included salmonberry, red alder, paper birch (*Betula papyrifera*), vine maple (*Acer circinatum*), black cotton wood (*Populus balsamifera trichocarpa*), and Indian plum (*Oemleria cerasiformis*).

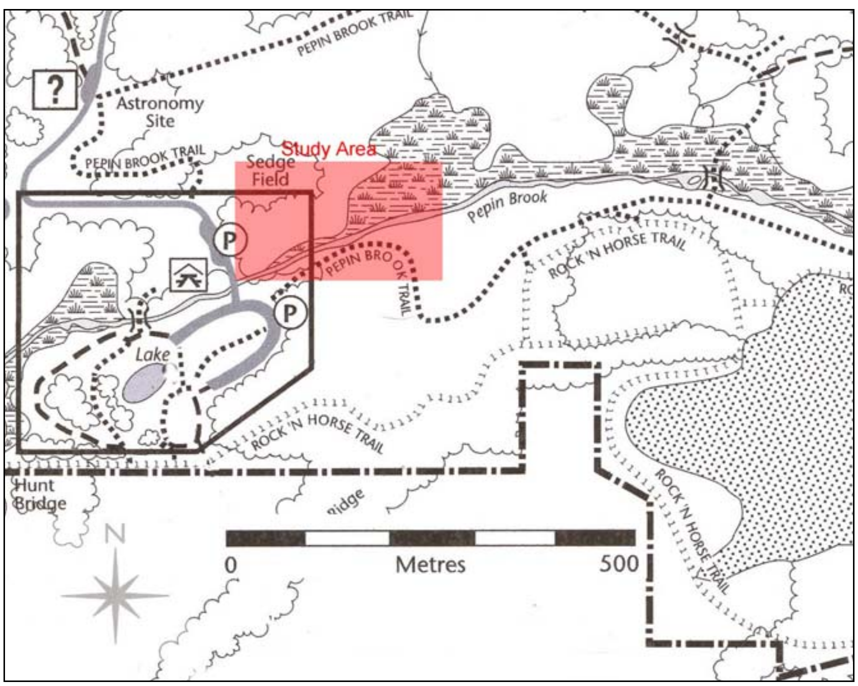

Figure 4. 2003/2004 Pacific water shrew survey area location at Aldergrove Lake Regional Park, Aldergrove, BC (map adapted from Aldergrove Lake Regional Park). The survey area is shaded red on the map and UTM coordinates at the west end of the survey transect are N 539056, E 5428940 as found on NTS map 92G/2.

2.2 Campbell Valley Regional Park

Site two is located in Campbell Valley Regional Park (CVRP) along the banks of Little Campbell River in Langley, BC. Like Aldergrove Regional Park, this park exhibits a highly modified ecosystem. CVRP provides many types of recreation to local public. The area is characterized by a mixed coniferous and deciduous stand with low lying marsh lands. Little Campbell River meanders east to west through the park and provides habitat for PWS. The survey area is located on an unnamed tributary of Little Campbell River. This small creek experiences flash flood episodes during times of high precipitation. For this reason, bait tubes were placed above the wet rooted width of the creek so no tubes were washed away. A 50-meter riparian vegetation buffer on either side of the creek prevented park users from entering the creek. Moist vegetation and large amount of course woody debris along the creek contained habitat characteristics used by PWS (Figure 5). Dominant vegetation in the park included western red-cedar, red alder, vine maple, red elderberry (*Sambucus racemosa*), salmonberry, and sword fern (*Polystichum munitum*). The site is located one kilometer north from CVRP's south dog off-leash area along Raven Trail loop (Figure 6). This trail runs parallel to Little Campbell River and is subject to only light use by park visitors.

Figure 5. 2003/2004 Pacific water shrew survey area at Little Campbell River in Campbell River Valley Regional Park, Langley, BC (K. Miyazaki photo). Dominant vegetation within the survey area included western red-cedar, red alder, vine maple, salmonberry, and sword fern.

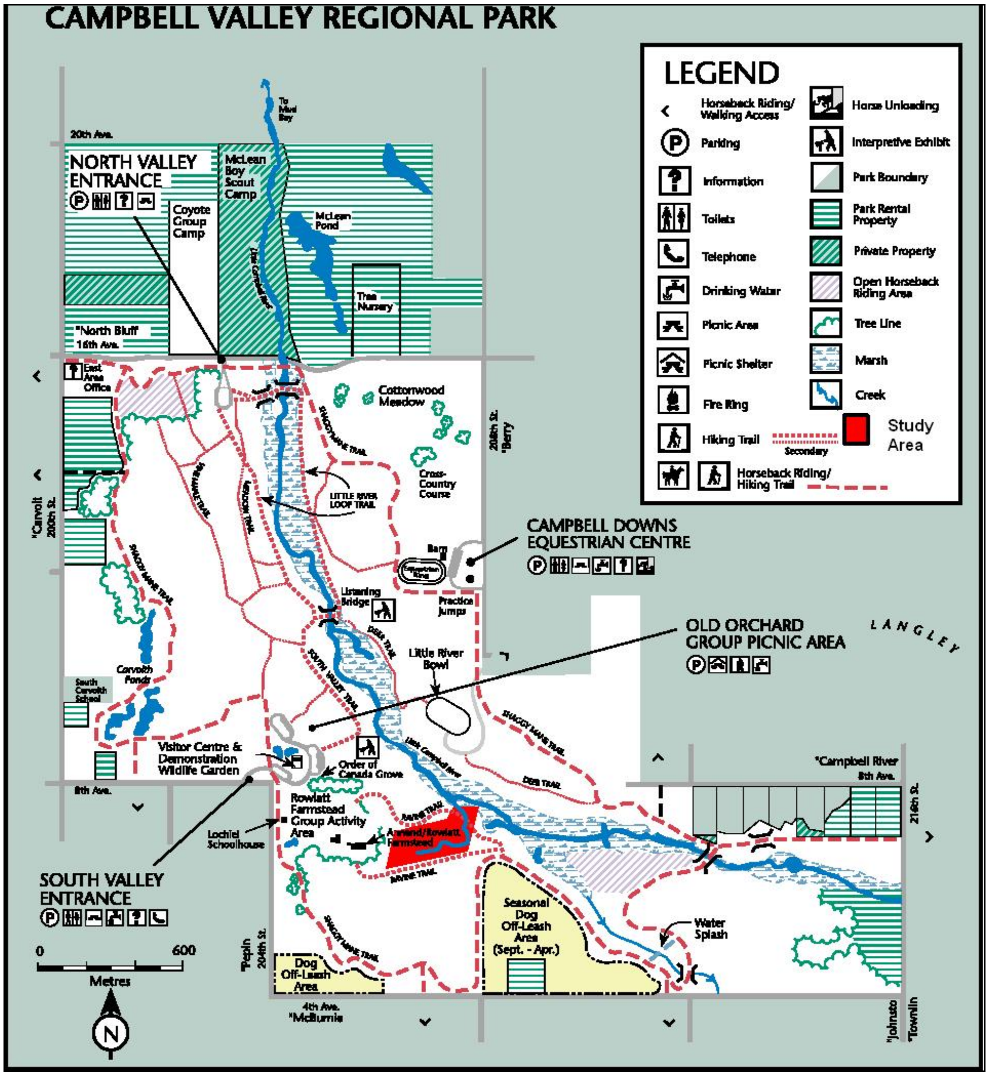

Figure 6. 2003/2004 Pacific water shrew survey area location at Campbell Valley Regional Park in Langley, BC (map adapted from Campbell Valley Regional Park). The survey area is shaded in red and UTM coordinates at the west end of the survey transect are N 538919, E 5427830 as found on NTS map 92G/2.

2.3 Sumas Mountain

Site three is located on Sumas Mountain in Abbotsford, BC. The survey area lies along the banks of the upper portion of Clayburn Creek (Figure 7). The creek flows north in a gully from Sumas Mountain and eventually into the Fraser River south of Mission (Figure 8). From Blausom Boulevard, the creek is accessed by an old gravel road that now serves as a trail. The creek is bordered on the east side by a subdivision and to the west lies an inaccessible, mixed, coniferous/deciduous forest. Although surrounding areas are heavily developed with residential housing, the survey area is protected from human disturbance. Thick tangles of Himalayan blackberry (*Rubus discolor*) run adjacent to the access trail, and a large berm restricted visibility of those passing by. None of the bait tubes were tampered with or removed from study site.

Vegetation immediately adjacent to the creek is characterized by the presence of red alder, red elderberry, salmonberry, sword fern, and five-stamened miterwort (*Mitella pentandra*).

Figure 7. 2003/2004 Pacific water shrew survey area at Clayburn Creek on Sumas Mountain in Abbotsford, BC (D. Driediger photo). Dominant vegetation in study area included red alder, red elderberry, salmonberry, sword fern, and five-stamened miterwort.

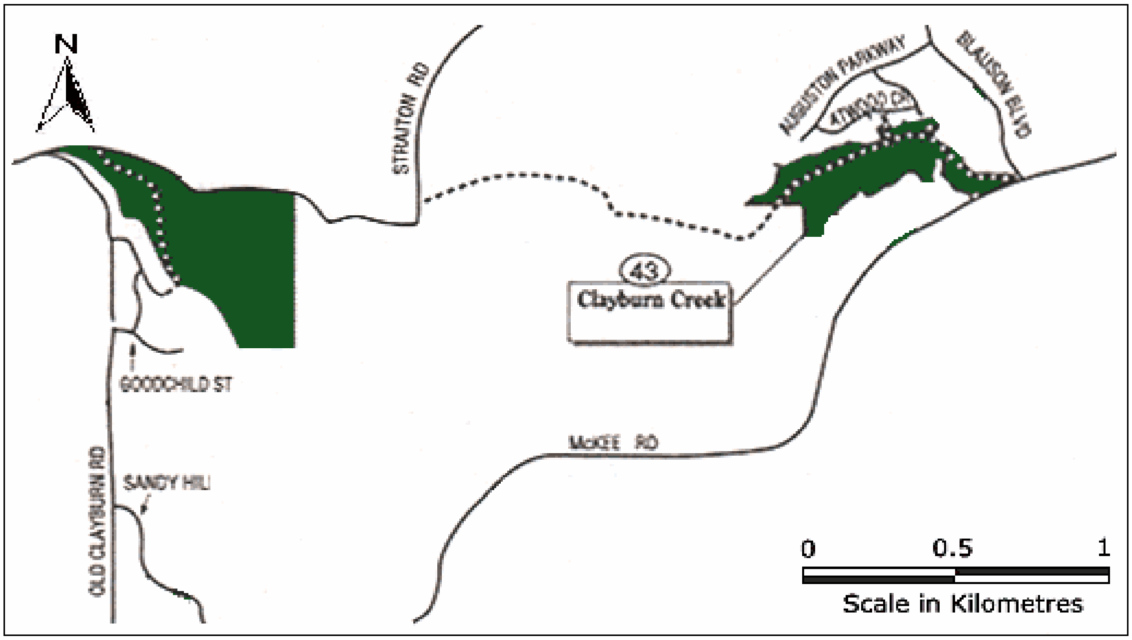

Figure 8. 2003/2004 Pacific water shrew survey area location at Clayburn Creek on Sumas Mountain in Abbotsford, BC (map adapted from City of Abbotsford). Survey area is labeled and shade in green on the right side of the map. UTM coordinates at the south east end of the survey transect area N 557839, E 5353080 as found on NTS map 92G/1.

Soil nutrient regime, amount of course woody debris, and successional stage were similar at all three sites (Table 1) and vegetation species were representative of potential shrew habitat (Table 2).

Table 1. Site descriptions for three survey areas of 2003/2004 Pacific water shrew survey.

Site	**Soil Nutrient Regime**	**Coarse Woody Debris**	**Successional Stage**
Aldergrove Lake Regional Park	07	43.6m^2 per ha	5 (broadleaf)
Campbell River Regional Park	07	39.7m^2 per ha.	5 (broadleaf)
Sumas Mountain	07	34.9m^2 per ha.	5 (broadleaf)

Table 2. Percent cover of vegetation in three layers (A, B1, and B2) for three study areas of 2003/2004 Pacific water shrew survey.

	Aldergrove Lake			**Campbell River**			**Sumas Mountain**		
Species	**A**	**B1**	**B2**	**A**	**B1**	**B2**	**A**	**B1**	**B2**
Alnus rubra	70			50			50		
Betula papyrifera	2								
Acer macrophylum	3			10					
Acer circinatum				25			10		
Physocarpus capitatus		28							
Thuja plicata		2		15			5		
Oemleria cerasiformis		5						5	
Sambucus racemosa					25			40	
Rubis spectabilis		45			60			70	
Rubus parviflorus					10			10	
Ribes bracteosum								20	
Oplopanax horridus						5			3
Lysichiton americanum			3						2
Polystichum munitum						20			35
Dryopteris expansa			15			10			2
Equisetum telmatiea									3
Mitella pentandra									75
Claopodium crispifolium									8
Rhytidiadelphus loreus									7
Rubis discolor			2						
Polypodium glycyrrhiza			0.5						
Hylocomium splendens						10			

A: Vegetation greater than 10 m tall.
B1: Vegetation from 2-10 m tall.
B2: Vegetation less than 2 m tall.

3 Methodology

3.1 Materials and Bait Tube Construction

To construct bait tubes, two-inch ABS Cellcore pipe was cut to 24-cm lengths (10 tubes from one eight-foot section of pipe). Churchfield *et al*. (2000) found no difference in use of bait tubes of different lengths. Aluminum screen (window screen) was cut to size and secured with a two-inch hose clamp to block entrance on the baited side of the tube and allow bait to be detected through the screen (Figure 9). This allowed animals to be attracted by bait, yet force them to enter bait tubes from the open side. While eating, small mammals often defecate, leaving scat for collection and species identification. Trap and permit numbers were marked on bait tubes to identify traps and for public knowledge.

Figure 9. Bait tube used in 2003/2004 Pacific water shrew survey (D. Driediger photo). Bait tubes were staked to the ground with 12-gauge wire and labeled with a paint marker.

Sections of nylon stockings were used to create small 1.5-centimeter diameter balls containing yellow mealworm (*Tenebrio molitor linnaeus*) bait. Twenty-two-gauge brass tie wire was used to secure the mealworm within the cut out section of nylons. The wire holding the nylon-wrapped ball of mealworm was further used to secure bait in tubes. In the field, 12-gauge wire was cut to half meter lengths and bent into a "U" shape to press into the ground and secure tubes in place. Flagging tape was used to mark location of each bait tube.

3.2 *Methods*

Following methods outlined in Churchfield *et al*. (2000), we evaluated the effectiveness of bait tubes as an inventory method for PWS in the Fraser Valley. At each site, several foot surveys were conducted to choose the most suitable area for tube placement. Study areas were characterized by riparian areas containing standing or running water with adequate invertebrate populations (forage), dense surrounding vegetation, sufficient amount of CWD, mature forests with structural stages four through seven, as well as younger structural stage two to three with the habitat components listed (Craig, 2003 b).

Twenty bait tubes were baited and placed at 5 to10 m. intervals along a continuous transect at each site. Wherever possible, micro sites containing an abundance of CWD were chosen, since PWS are thought to prefer this type of cover (Vennesland, 2003). All bait tubes were placed within 10 meters of water, yet out of reach of high water events. In the past, PWS have generally been captured within 25 meters of streams or water bodies (Craig, 2003a). Once baited, tubes were checked for bait consumption and scat deposit every seven days. No agents, chemical or otherwise, other than yellow mealworm were used to attract shrews to tubes. Following a two-week period, tubes were emptied, rinsed with water, and re-baited. Scat samples were then labeled according to date, location, and tube number, and frozen until such time as they could be conveniently dried.

To assess habitat, 10-meter vegetation plots were used to determine percent cover of each plant species. Two line transects were conducted to measure amount of cover (coarse woody debris) and habitat available for PWS. Successional stage of surrounding forest was also determined since PWS prefer forests of stage of 4-7

(Vennesland, 2003). Soil nutrient regime was determined for each study site since PWS are more prevalent in very wet habitats (Craig, 2003b).

3.3 Data Analysis

Presence of PWS can be determined through identification of freshwater invertebrates in their scat (Galindo-Leal and Zuleta, 1994). Rodent and shrew scat were distinguished based on appearance, consistency, and contents (Churchfield *et al.,* 2000). Shrew scat tends to crumble easily and has a granular composition due to an abundance of arthropod chitin (Churchfield *et al*., 2000). Furthermore, dried shrew scat tends to be grayish in colour, and may contain white pieces of crustacean exoskeleton, which are often visible with the naked eye (Churchfield *et al*., 2000). In contrast, firm scat of deer mice is significantly smaller, darker in colour, and contains an abundance of white hair. The only sure way of distinguishing scats of water shrews from those of terrestrial shrews is through identification of freshwater invertebrate remains in water shrew scat (Churchfield *et al*., 2000).

Once dry, samples were analyzed at BCIT using a 40-power microscope, tweezers, probe, and Petri dishes. Samples likely to contain aquatic invertebrates were labeled and set aside for further analysis at UBC under the guidance of Rex Kenner. With his help, we were able to analyze approximately six samples per person an hour.

Specifically we looked for antenna, legs and exoskeletons of aquatic prey. Certain characteristics of aquatic invertebrate parts were searched for in determining whether prey was terrestrial or aquatic. Terrestrial invertebrates (specifically beetles) tend to have a more convex wing shape than the flatter shape of aquatic invertebrates. Antenna, as well as legs of terrestrial invertebrates, tend to be round where as aquatic invertebrates have a flattened appearance (Cummins and Merritt, 1996). Keeping this in mind, we carefully analyzed the scat samples.

4 Results

Aldergrove Lake Regional Park, Campbell Valley Regional Park, and Sumas Mountain had a combined total of 2520 sample nights. At Aldergrove Lake Regional Park, 90 percent of bait tubes were stripped of bait, and feces were left behind over four collection periods (Figure 10). The Campbell Valley Regional Park transect experienced 88-percent removal of the bait, with feces left behind over three collection periods. Sumas Mountain experienced 100-percent bait removal, with subsequent defecation over three collection periods as well.

On average, bait was completely removed from bait tubes at 82.7-percent frequency and throughout the entire survey area, in cases where bait was completely removed, scat was always present. Of 180 scat samples collected, 83-percent originated from deer mice and 16.5-percent were deposited by small mammals other than PWS. Only one scat (0.5-percent of samples) was likely deposited by PWS.

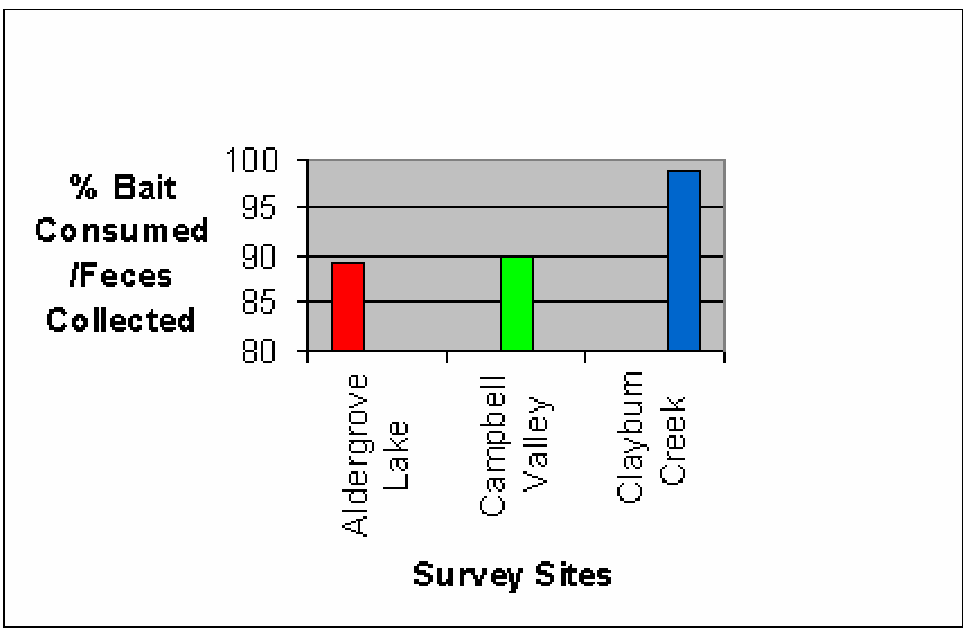

Figure 10. Average percent of bait consumed and feces present during collection periods for three study areas of 2003/2004 Pacific water shrew survey.

5 Discussion

The bait tube survey method proved to be an efficient means of collecting scat of small mammals, and to that end, the survey was successful. Results however, do not confirm the presence of PWS in survey areas. Nonetheless, it is possible that one scat collected on Sumas Mountain may have been deposited by PWS. The grey scat was larger than that of deer mouse and contained a large amount of shell particles. Due to limitations in determining the shell's origin, the sample was submitted to Ministry of Water, Land and Air Protection to establish whether the shell fragments were from a terrestrial or aquatic invertebrate.

We collected 180 samples, of which one sample may have originated from a PWS. Increasing survey intensity however, might provide a greater number of PWS samples. Bait tube techniques can only be used as a presence detected survey because it is not possible to enumerate a population of shrews by their feces.

Pending approval of the Ministry of Water, Land and Air Protection, Ross Vennesland plans to expand on this study when funding becomes available. Live trapping will be conducted in areas between Chilliwack and Abbotsford from April through June to positively identify PWS scat. Further study of the bait tube method will be conducted in September and October to confirm the validity of this survey method. In both cases, 10 traps/tubes will be placed at three different sites on a three week rotation and samples will be analyzed at UBC. If scat contents cannot be confirmed, hair sampling and DNA testing may be implemented.

6 Recommendations and Conclusion

Bait tube surveying is an efficient method of collecting scat of small mammals. However, future bait tube surveys may benefit from the following recommendations:

1. Live trapping with scat collection is required to develop a reference scat sample based on known occupancy of live traps. These scats can than be used either in

comparing known PWS scats to collected scats, or as a process of elimination in identifying all other scats.

2. Increasing the survey intensity will enhance the probability of successful sampling on areas containing PWS.

3. Using bait with soft, digestible body parts such as ground beef, blowfly pupae, or earthworms. While mealworm successfully attracted rodents to bait tubes, it increased the amount of exoskeleton in scat they deposited. Soft-bodied bait may pass through small mammals without creating a difficult background for detection of aquatic invertebrates, thereby increasing efficiency of scat analysis

4. Surveyors should ensure that no foreign material is placed in bait tubes other than bait. If mealworm bait is used, care should be taken to prevent worm packing material from contaminating tubes.

5. Future studies should consider survey timing. Winter conditions may have contributed to our study's low sample numbers.

6. To prevent sample deterioration, scat should be removed from bait tubes every seven days rather than every 14 days.

7. Compiling an aquatic and terrestrial invertebrate catalogue might increase scat analysis efficiency by providing whole reference samples.

Although presence of PWS in surveyed portions of the Fraser Valley remains unconfirmed, the bait tube survey method was successful. Tubes are inexpensive, easily constructed, and compared to live trapping shrews, require very little field time. Throughout the survey, bait tubes were utilized extensively by small mammals and shrew scats were readily distinguishable from that of other rodents. Furthermore, with appropriate expertise, it appears that aquatic exoskeleton remains in scat can be readily distinguished from terrestrial invertebrate remains.

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7.3 Personal Communication

Ross Vennesland, Species at Risk Recovery Biologist. BC Ministry of Water, Land and Air Protection. Personal Communication. September 24, 2003.
Contact: Ross.Vennesland@gems4.gov.bc.ca

Rex Kenner, Curator. Cowan Vertebrate Museum. University of British Columbia. Personal Communication. March 16, 2004.
Contact: Kenner@zoology.ubc.ca

Appendix A

Bait Tube Construction

Following materials were used in construction and placement of bait tubes:

- Aluminum screen
- 2-inch ABS Cellcore pipe
- 2-inch hose clamps
- 22-gauge brass tie wire
- 10,000 mealworms
- White paint pen
- Nylon (stockings)
- 12-gauge wire
- Flagging tape.

Materials for bait tube construction cost approximately $3.50 per tube. An additional $100 was spent on 10,000 mealworms.

Appendix B

2003/2004 Pacific Water Shrew Survey Sample Data

Collected: Nov 7, 2003 **Aldergrove Lake Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Deer mouse scat
2	Yes	Yes	One large deer mouse scat with white spots
3	Yes	No	Deer mouse scat with white hair
4	Yes	No	Deer mouse scat
5	Yes	No	Deer mouse scat
6	Yes	No	Deer mouse scat with white hair
7	Yes	Yes	Unusual deer mouse scat with white hair
8	Yes	No	Likely deer mouse scat
9	Yes	Yes	1 Grainy brown scat, likely deer mouse
10	Yes	No	Tube contained only deer mouse scat
11	Yes	No	Tube contained only deer mouse scat
12	No	No	N/A
13	No	No	N/A
14	Yes	No	Tube contained only deer mouse scat
15	Yes	No	Tube contained only deer mouse scat
16	Yes	No	Tube contained only deer mouse scat
17	Yes	No	Tube contained only deer mouse scat
18	Yes	No	Tube contained only deer mouse scat
19	Yes	No	Tube contained only deer mouse scat
20	No	No	N/A

Collected: Nov 19,2003 **Aldergrove Lake Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Several deer mouse scats with mealworm content
2	Yes	Yes	4 Deer mouse scats; 3 with grainy texture
3	Yes	Yes	3 Dark deer mouse scats with flaky content and white hair
4	Yes	Yes	8 Deer mouse scats lumped together
5	Yes	Yes	3 Deer mouse scats
6	Yes	No	Tube contained only deer mouse scat
7	Yes	Yes	7 Deer mouse scats
8	Yes	Yes	Likely deer mouse scat
9	Yes	Yes	4 Deer mouse scats with white hair
10	Yes	Yes	Several unknown scats with mealworm and 1 vole tooth
11	Yes	Yes	12 Deer mouse scats
12	Yes	No	Tube contained only deer mouse scat
13	No	No	N/A
14	Yes	Yes	Several deer mouse scats with white hair
15	No	No	N/A
16	Yes	No	Tube contained only deer mouse scat
17	Yes	Yes	Unknown scat cluster with light brown spots
18	Yes	No	Tube contained only deer mouse scat
19	Yes	Yes	Scat cluster with mealworm content
20	Yes	Yes	10 Deer mouse scats, most with white hair

Collected: Dec 3, 2003 **Aldergrove Lake Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	15 Deer mouse scats
2	Yes	Yes	13 Deer mouse scats, some with white hair
3	Yes	Yes	15 Deer mouse scats
4	Yes	Yes	16 Deer mouse scats with white hair
5	No	No	N/A
6	Yes	Yes	9 Deer mouse scats; 1 very grainy
7	Yes	Yes	10 Deer mouse scats; most with white hair
8	Yes	Yes	14 Deer mouse scats; smaller than average
9	Yes	Yes	9 Deer mouse scats with white hair
10	Yes	Yes	Deer mouse scats with white hair, and beetle wing
11	Yes	Yes	Unusual deer mouse scat
12	Yes	Yes	Unusual deer mouse scat
13	Yes	Yes	Long grey deer mouse scat
14	Yes	Yes	Unusual deer mouse scat
15	No	No	N/A
16	Yes	Yes	10 Deer mouse scats with white hair
17	Yes	No	Tube contained only deer mouse scat
18	Yes	No	Tube contained only deer mouse scat
19	Yes	Yes	Several deer mouse scats with white hair
20	Yes	Yes	Deer mouse scat

Collected: Dec 18,2003 **Aldergrove Lake Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	No	Tube contained only deer mouse scat
2	Yes	Yes	3 Deer mouse scats, 1 very grainy
3	Yes	Yes	Deer mouse cluster with brown hair, and leg portions
4	Yes	No	Tube contained only deer mouse scat
5	Yes	Yes	Deer mouse scat
6	Yes	Yes	2 Scats with crumbly consistency and white hair
7	Yes	No	Tube contained only deer mouse scat
8	Yes	No	Tube contained only deer mouse scat
9	Yes	Yes	2 Small deer mouse scats with mealworm content
10	No	No	N/A
11	Yes	Yes	Several deer mouse scats with white hair
12	Yes	Yes	Deer mouse scat cluster with mealworm content
13	Yes	Yes	Several deer mouse scats
14	Yes	No	Tube contained only deer mouse scat
15	Yes	Yes	Tube contained only deer mouse scat
16	No	No	N/A
17	Yes	Yes	Several deer mouse scats with mealworm content
18	Yes	Yes	2 Deer mouse scats with white hair
19	Yes	Yes	Deer mouse scat cluster
20	Yes	No	Tube contained only deer mouse scat

Collected: Nov 12, 2003 **Campbell Valley Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	1 Deer mouse scat with white hair
2	Yes	Yes	Deer mouse scat cluster
3	Yes	Yes	8 Deer mouse scats with mealworm content
4	Yes	Yes	Deer mouse scat cluster with white hair
5	Yes	Yes	6 Deer mouse scats with mealworm content
6	No	No	N/A
7	No	No	N/A
8	No	No	N/A
9	Yes	Yes	2 Unknown grey, grainy scats with mealworm
10	Yes	Yes	1 Unknown grey, grainy scat with mealworm
11	Yes	Yes	5 Deer mouse scats with mealworm content
12	Yes	Yes	1 Unknown grey, grainy scat
13	Yes	Yes	2 Small deer mouse scats with mealworm
14	Yes	Yes	4 Small deer mouse scats with mealworm
15	No	No	N/A
16	No	No	N/A
17	Yes	Yes	Deer mouse scat cluster with white hair
18	Yes	Yes	4 Deer mouse scats with mealworm content
19	Yes	Yes	Unknown scat with mealworm content
20	Yes	Yes	1 Unknown grey, grainy scat

Collected: Nov 26, 2003 **Campbell Valley Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Several deer mouse scats with mealworm
2	Yes	Yes	6 Deer mouse scats with white hair
3	Yes	Yes	Several deer mouse scats with mealworm
4	Yes	Yes	Several deer mouse scats with mealworm
5	Yes	Yes	Several deer mouse scats with mealworm
6	No	No	N/A
7	Yes	Yes	Unknown scat cluster with mealworm content
8	No	No	N/A
9	Yes	Yes	7 Deer mouse scats
10	Yes	Yes	1 Large deer mouse scat
11	Yes	Yes	1 Unknown grey, grainy scat with white hair
12	Yes	Yes	4 Deer mouse scats
13	Yes	Yes	2 Large brown scats with mealworm content
14	Yes	Yes	Several deer mouse scats with mealworm
15	Yes	Yes	Several deer mouse scats with mealworm
16	No	No	N/A
17	Yes	Yes	7 Deer mouse scats
18	Yes	Yes	2 Unknown grey, grainy scats with white hair
19	Yes	Yes	Several deer mouse scats
20	Yes	Yes	2 Unknown scat clusters

Collected: Dec 3, 2003 **Campbell Valley Regional Park**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Several deer mouse scats with mealworm
2	Yes	Yes	Several deer mouse scats with mealworm
3	Yes	Yes	1 Unknown grey, grainy scat
4	No	No	N/A
5	Yes	Yes	7 Deer mouse scats with white hair
6	Yes	Yes	Several deer mouse scats with mealworm
7	Yes	Yes	Several deer mouse scats with mealworm
8	No	No	N/A
9	No	No	N/A
10	Yes	Yes	2 Unknown grey, grainy scats with mealworm
11	Yes	Yes	1 Unknown grey, grainy scat with white hair
12	Yes	Yes	Unknown scat cluster with mealworm content
13	Yes	Yes	1 Large brown deer mouse scat
14	Yes	Yes	5 Deer mouse scats with mealworm content
15	Yes	Yes	2 Large black scats with mealworm content
16	Yes	Yes	Several deer mouse scats with mealworm
17	Yes	Yes	Several deer mouse scats with mealworm
18	No	No	N/A
19	Yes	Yes	Unknown scat cluster with white hair
20	Yes	Yes	4 Deer mouse scats with mealworm content

Collected: Nov 12, 2003 **Sumas Mountain**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Deer mouse scat with mealworm content
2	Yes	Yes	1 Unknown scat with brown hair
3	Yes	Yes	5 Deer mouse scats
4	Yes	Yes	Deer mouse scat and 1 unknown larger grey scat
5	Yes	Yes	Deer mouse scat with white hair and mealworm content
6	Yes	Yes	Deer mouse scat cluster with white hair and mealworm
7	Yes	Yes	Deer mouse scat with white hair
8	Yes	Yes	2 Deer mouse scat clusters
9	Yes	Yes	Deer mouse scat with white hair and mealworm content
10	Yes	Yes	Deer mouse scat with white hair and mealworm content
11	Yes	Yes	Deer mouse scat with white hair and mealworm content
12	Yes	Yes	2 Unknown small black scats
13	Yes	Yes	Deer mouse scat with white hair
14	Yes	Yes	6 Deer mouse scats
15	Yes	Yes	Deer mouse scat with white hair and mealworm content
16	Yes	Yes	Deer mouse scat with white hair and mealworm content
17	Yes	Yes	Deer mouse scat cluster with white hair and mealworm
18	Yes	Yes	Deer mouse scat with white hair and mealworm content
19	Yes	Yes	Deer mouse scat
20	Yes	Yes	Unknown scat cluster, likely deer mouse

Collected: Nov 26, 2003 **Sumas Mountain**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Deer mouse scat with mealworm content
2	Yes	Yes	Deer mouse cluster with white hair and mealworm
3	No	No	N/A
4	Yes	Yes	2 Long, slender scats with mealworm
5	Yes	Yes	Unknown scat cluster with dark hair
6	Yes	Yes	Deer mouse scat cluster with white hair
7	Yes	Yes	Deer mouse scat
8	No	No	N/A
9	Yes	Yes	Unknown scat cluster, likely deer mouse
10	Yes	Yes	Deer mouse scat with white hair and mealworm
11	Yes	Yes	Deer mouse cluster with white hair and mealworm
12	Yes	Yes	Deer mouse scat with white hair and mealworm
13	Yes	Yes	Deer mouse scat with white hair
14	Yes	Yes	Deer mouse scat
15	Yes	Yes	Black saturated mass with black hair and mealworm
16	Yes	No	Tube contained only deer mouse scat
17	Yes	Yes	Deer mouse cluster with white hair and mealworm
18	Yes	Yes	Deer mouse scat with white hair and mealworm
19	Yes	No	Tube contained only deer mouse scat
20	Yes	Yes	Deer mouse scat with white hair and mealworm

Collection Date: Dec 12, 2003 **Sumas Mountain**

Sample #	Sample Present	Sample Collected	Description
1	Yes	Yes	Deer mouse scat with white hair and mealworm content
2	Yes	Yes	Unknown scat cluster, likely deer mouse
3	No	No	N/A
4	Yes	Yes	2 Long slender scats with mealworm
5	Yes	No	Tube contained only deer mouse scat
6	Yes	No	Tube contained only deer mouse scat
7	Yes	No	Tube contained only deer mouse scat
8	No	No	N/A
9	Yes	Yes	Deer mouse scat with white hair and mealworm content
10	Yes	Yes	Deer mouse scat with white hair and mealworm content
11	Yes	Yes	Deer mouse scat cluster with white hair and mealworm
12	Yes	Yes	Unknown black scat cluster with brown hair
13	Yes	Yes	Deer mouse scat with white hair
14	Yes	Yes	Deer mouse scat
15	Yes	Yes	Large brown scat with mealworm content
16	Yes	No	Tube contained only deer mouse scat
17	Yes	Yes	Deer mouse scat with mealworm content
18	Yes	Yes	Saturated grey mass with mealworm and white hair
19	Yes	No	Tube contained only deer mouse scat
20	Yes	Yes	Deer mouse scat