Bridge River Bat Assessment

2010

Prepared for:
British Columbia Hydro Bridge Coastal Fish and Wildlife Restoration Program and for
Matt Manuel-Lillooet Tribal Council

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BC HYDRO FISH & WILDLIFE BRIDGE COASTAL RESTORATION PROGRAM

INDIAN GOVERNMENT LILLOOET TRIBAL COUNCIL

Lillooet Naturalist Society

Executive Summary

A combination of mist nets, acoustic monitoring, telemetry and community outreach was used to assess the bat fauna of the Lillooet area. The project area included the Bridge, Seton and Fraser River drainages and Cayoosh Creek. We sampled bats, using mist nets, for 21 nights at 18 sites (three sites were replicated). Passive acoustic monitoring was generally conducted concomitant to netting; a total of 20 sites were sampled.

Prior to this study very little information existed regarding the species composition and distribution of the bat fauna in the project area – only five species of bat had been documented to occur in Lillooet. At the conclusion of the project a total of 142 bats had been captured and the number of confirmed species had been increased to 12, with two more species considered likely (based on morphometric measurements of captured bats and interpretation of acoustic recording); DNA evidence was sampled for these two species and analysis is pending. In addition, preliminary evidence, to support the potential occurrence of three more species was detected via acoustic monitoring. This work represents significant expansions to the previously known range for several of the new species documented.

Through telemetric monitoring of nine bats, we confirmed roost sites, roost site characteristics, and foraging habitat associations for Townsends Big-eared Bats (n=3) and Western Long-eared Myotis (n=3). We also found roost sites for a Big Brown Bat (n=1), a Silver-haired Bat (n=1) and a Fringed Myotis (n=1).

Aided by the Lillooet Naturalist Society were able to engage the community and local First Nations to increase their awareness and appreciation for bats whilst collecting information for additional significant bat roost and/or maternity structures. To encourage project legacy, an educational sign was also installed to ensure continued promotion of community appreciation for important bat habitats in this area.

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Introduction

British Columbia boasts the highest bat species diversity of all of the Canadian provinces and represents the northern range limit for many bat species (RISC 1998). Seven (37%) of British Columbia's nineteen bat species (16 confirmed; 3 unconfirmed) are considered at risk (Table 1). Conservation of bat roosting and foraging habitat can be challenging, as these habitat are often located in valley-bottom corridors that face several pressures including factors associated with urban development, forestry and hydroelectric development (Barclay and Brigham 1996; Kellner and Rasheed 2002).

Bats are an important component of our ecosystems and contribute services through control of insect populations (Duchamp *et al.* 2010). Despite their ecological role and significant contribution to British Columbia's biodiversity, there is a paucity of even basic information regarding bat species' distribution and habitat use in the province. Their nocturnal activity cycle, their diminutive size and their elusive habits make collection of information regarding roost sites and maternity areas challenging (Kunz and Parsons. 2009). This scenario has contributed to the Committee on the Status of Endangered Wildlife (COSEWIC) in Canada listing several bat species as data deficient.

The project area included the Bridge, Seton and Fraser River drainages and Cayoosh Creek near Lillooet. The diversity of ecosystems in this study area, including the abrupt change from the dry interior into the wet coastal bioregion, provides opportunity to host a diverse ensemble of bat species (Table 1).

Table 1: List of nineteen species of bat that occur, or potentially occur, in BC.

Common Name	Scientific Name	Species. Code[1]	CDC Status
Fringed Myotis	*Myotis thysanodes*	MYTH	Blue
Western Small-footed Myotis	*Myotis ciliolabrum*	MYCI	Blue
California Myotis	*Myotis californicus*	MYCA	Yellow
Keen's Myotis	*Myotis keenii*	MYKE	Red
Long-legged Myotis	*Myotis volans*	MYVO	Yellow
Little Brown Bat	*Myotis lucifugus*	MYLU	Yellow
Yuma Myotis	*Myotis yumanensis*	MYYU	Yellow
Western Long-eared Myotis	*Myotis evotis*	MYEV	Yellow
Northern Myotis	*Myotis septentrionalis*	MYSE	Blue
Western Red Bat	*Lasiurus blossevillii*	LABL	Unconfirmed
Eastern Red Bat[2]	*Lasiurus borealis*	LABO	Pending
Hoary Bat	*Lasiurus cinereus*	LACI	Yellow
Silver-haired Bat	*Lasionycteris noctivagans*	LANO	Yellow
Townsend' Big Eared Bat	*Corynorhinus townsendii*	COTO	Blue
Pallid Bat	*Antrozous pallidus*	ANPA	Red
Spotted Bat	*Euderma maculatum*	EUMA	Blue
Big Brown Bat	*Eptesicus fuscus*	EPFU	Yellow
Canyon Bat	*Parastrellus hesperus*	LABL	Unconfirmed
Big Free-tailed Bat	*Nyctinomops macrotis*	NYMA	Accidental

1: bats may be referred to by their species code within the report.
2: a single reporting of a Western Red Bat specimen (from the Skagit Valley) has recently been confirmed as an Eastern Red Bat (D.Fraser. pers.com March 2011)

Goals and Objectives

Impacts to bat populations may occur at both the local and landscape level. These impacts may influence species diversity, population connectivity, productivity, survival and dispersal for resident bat fauna. Hydro-electric development within the Bridge River area has associated impacts such as draw down, flooding and loss of riparian habitat, loss of upland habitat, and loss of wetland habitat; these activities have likely affected bats negatively. Table 2 indicates residual impacts of hydro-electric development in the Bridge River area and required actions for mitigating those impacts and enhancing habitat to positively influence local bat populations.

Table 2: Summary of impacts and potential mitigating actions within the BCRP planning area.

Residual Impacts	Hectares Lost	Action
Loss of valley bottom and valley side coniferous, deciduous, and wetland habitats, incl. riparian	Carpenter 4,669ha land flooded 552ha main riparian 165ha tributary riparian Wetland 46ha Downton 2,234ha Land flooded 390ha main riparian 75ha tributary riparian Wetland 237ha Seton 2,503ha Land Flooded 3ha main riparian	-Identification of restoration/enhancement efforts to promote bat foraging and roosting, e.g. planting or bioengineering -Development of a dichotomous habitat prescription for upland and riparian bat roosting and foraging enhancement -Securement of critical roosting habitat through the establishment of Wildlife Habitat Areas and Wildlife habitat features under FRPA. -Roost augmentation (bat houses)
Fluctuating reservoir water levels	Downton 49 meters Carpenter 44 meters	-Identification of Cottonwood seeding and bioengineering actions to compensate for water fluctuations

In order to inform management and recovery actions for bats within the BCRP footprint area a scientific baseline understanding of species presence, species habitat associations and species distribution is required. The 2010 bat assessment project included the following objectives:

1. To examine bat species distribution (by mist-netting bats). Sites were selected from two based on perceived (expert opinion) habitat suitability within the BCRP footprint area,
2. To confirm day or maternity roosting occurrences of tree and cave roosting bats through radio-tracking and describe habitat associations based on bat use,
3. To conduct acoustic sampling for bats; and,
4. To promote awareness, understanding and respect for the ecological role and importance of bats within the local community.

An improved understanding of the diversity and presence of species within the BCRP footprint area will enable land use planners to address habitat needs and requirements for several key bat species within the Bridge River area Achievement of the project goals will facilitate recognition of habitat attributes that are important for bat conservation. For example, roosts are a critical habitat component for bats and may influence their survival and fitness (Waldien *et al* 2000). Roosts are also sensitive to anthropogenic disturbance (Hill *et al.* 2006); as such, roosts sites will be designated as Wildlife Habitat Areas or as conservation areas under the *Land Act* (where applicable) to ensure significant features are conserved.

Information gained through project implementation also provides a foundation to enable more considerate resource management within BC Hydro's Bridge River impact area. The information presented in this report should be integrated into future enhancement and management of key habitats.

Study Area

The study area extends west, from Lillooet, to the eastern boundary of the Downton Lake-Bridge River confluence (Figure 1). The Bridge River Basin, Seton and the other watersheds in the study area are situated in the xeric rain-shadow of the southern coastal mountains within the Cascades Forest District (BCWF Volume 2). The Bridge River project consists of the La Joie Dam, which impounds Downton Lake, and the Terzaghi Dam which impounds Carpenter Lake (BCWRP Volume 2). The project area occurs within the Southern Chilcotin eco-section. Most of the study area falls within the dry cool (dk) and very cool (xc) variants within the Interior Douglas-Fir (IDF) biogeoclimatic subzones. The interior Douglas-fir zone features a continental climate characterized by warm dry summers, a fairly long growing season and cool winters (Hope *et al.* 1991). The study area also includes the very hot and dry Ponderosa Pine subzone (PPxh2). The western boundary of the study area is comprised of, and contrasted by, the sub-montane very wet maritime Coastal Western Hemlock subzone (CWHvm1) however, due to lower expected bat diversity in this area this zone was not extensively sampled during this project (n=1).

Within the more arid ecosystems sampled in 2010 the diversity of habitat types; including hot south aspect cliffs, cool shaded riparian areas and dry old-growth forest habitat. These ecological conditions were suspected to support a high diversity of bat species within the Bridge River footprint area.

The Bridge River Basin also occurs within the territory of several First Nation groups, including St'at'imc member bands of the Lillooet Tribal Council; as such, these groups were engaged in project delivery from its inception through to completion and reporting.

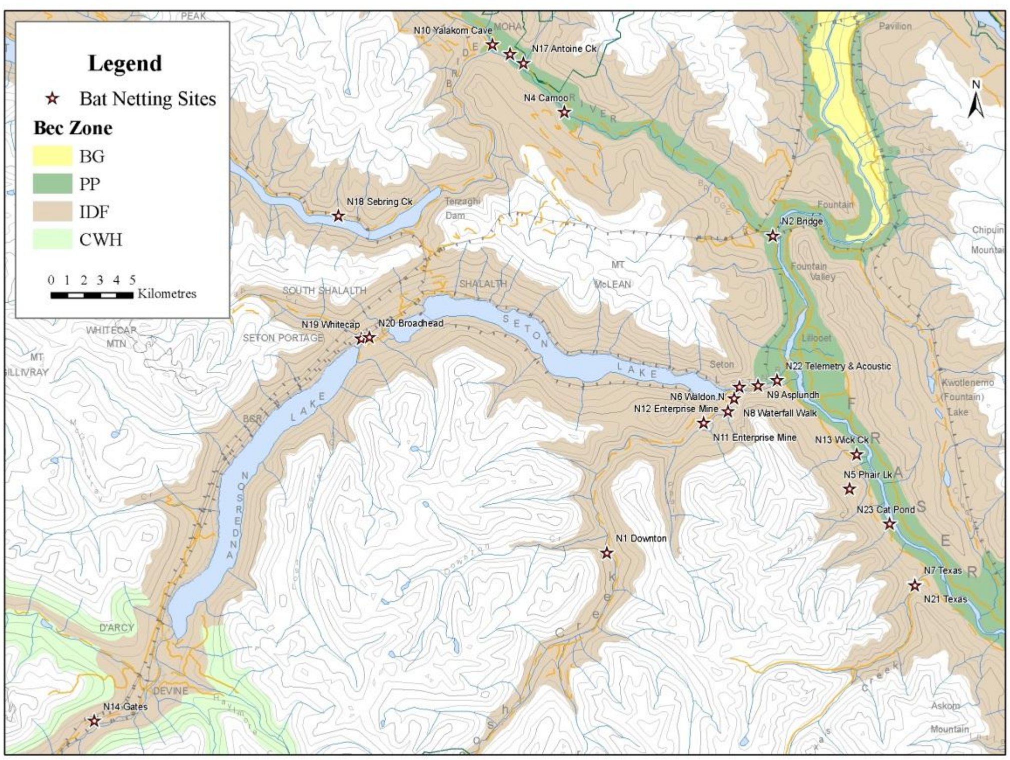

Figure 1: Acoustic and mist netting sampling stations within the study area.

Methods

In order to meet project objectives one (*species presence/distribution*), two (*acoustic monitoring to augment information on species presence and distribution*) and three (*telemetric monitoring to enable detection of roosting habitats and to collect information regarding night-time habitat use patterns*) we used mist nets, bat detectors and visual searches to sample bat fauna throughout the project area. As bats exhibit seasonal shifts in their selection of roost structures (dependent on phenology), we conducted two capture and detection sessions (Lewis 1996; RISC 1998). Potential bat habitat within the study area was broadly stratified into two habitat classes: riparian/wetland and upland. This was done to accommodate differences in habitat preferences and distribution between species, and to compensate for discontinuous distributions that may occur at northerly range extents (RISC 1998). Twenty acoustic sampling and 18 mist-net sample stations were non-randomly assigned within each of the two broad habitat types (riparian vs. upland). Data was collected on species diversity within each strata type (using mist-netting techniques) to sample bat fauna at the site scale. In addition, telemetric monitoring of selected bats was also conducted to allow the collection of information on nighttime bat foraging use patterns (using telemetric monitoring to track individual bat movement patterns). In addition, valuable information regarding day/maternity roost identification was also obtained through the use of radio-telemetry. Finally, to meet objective four, local outreach was conducted. This work resulted in opportunities to confirm roosting bat colonies within the project area. Once notified of active colonies, we used ladders or existing structures to gain access to the roost sites to document present of bat species.

Methods followed provincial guidelines as outlined under the Standards for Components of British Columbia Biodiversity No. 20 Inventory Methods for Bats 1998 (RISC 1998). All field work was led by a qualified professional consultant(s) with extensive previous bat work experience in British Columbia. Relevant data has been submitted to the provincial Species Inventory Database and all rare habitat element occurrence information has been submitted to the BC Conservation Data Centre (CDC). Bat capture and telemetry was approved, prior to project initiation, under Wildlife Act Permit VI10-62301. The Live Animal Capture and Handling Guidelines for Bats and White-Nose Syndrome guidelines (Anon 2009) were followed at all times.

Bat Mist-netting

At each capture site, mist nets were deployed to capture low-altitude foraging bats. Net placement (number and array design) was, by necessity, catered to accommodate site specific variables so net effort was inconsistent between sites. This approach was followed with the intent of maximizing capture efficiency by tailoring array design to suit unique site conditions. Morphometric measurements, following RISC standards, were collected for each captured bat, to enable species identification (RISC 1998). Reproductive status of captured bats was also noted. In addition, acoustic recording stations (using Anabat detectors) were established at each capture site (n=18) in an attempt to document occurrence of additional species that evaded capture. Provincial bat experts were used to oversee all aspects of the project to maximize efficiency and to ensure accurate identification of each species. Wing punches were taken to obtain DNA samples from any bat species if required for identification (e.g. *M. keenii, M. evotis*) or for bats captured that were at the northern extent of their currently described global range.

Mist nets (from Avinet) of various sizes (Net Length: 2.6m to 18m, Net Height: 2.4m) were placed along suspected potential bat movement corridors in an attempt to capture bats. Nets were set at varying heights, depending on site specific conditions, to intersect suspected flight paths. Nets were set prior to dusk and generally taken down between ~ 01:00 and 0:400. Whilst set, nets were monitored regularly (approximately five-minute intervals) to reduce the amount of stress imposed on bats captured in the nets. In addition, frequent examination prevented excessive tangling and/or escape. Captured bats were removed from the net and placed in cloth bags for subsequent processing.

Captured bats were typically processed within 30 minutes of extraction. During processing, field staff would determine and record:

- the species identification (using available dichotomous key and/or expert examination)
- forearm length,
- weight,
- gender,
- estimated age
- reproductive condition; and,
- body condition.

For some species in the genus Myotis, where exact species identification can be challenging, field staff would collect “wing punches” (these are performed by removing a small round piece of skin from the wing with a biopsy punch) to allow subsequent DNA analysis. These were most commonly collected for the long eared bat clade. In addition, these samples will be used in a separate and concurrent initiative to assist a genetic study of this species complex.

After processing, bats were released and, in some cases reference calls were recorded using an Anabat SD1 detector. To collect reference calls field staff would release the bat and track its departure using the Anabat SD1; the release time was noted for subsequent analysis of calls that were known to be collected specifically from the released bat. In addition to aiding identification, reference calls are an important component of the development of an echolocation call library to aid with future acoustic identification research.

Nets and equipment that came into contact with bats were washed with a solution comprised of 90% water and 10% bleach solution in compliance with provincial protocols for the prevention of spread of white nose syndrome (NB: this lethal bat pathogen has not yet been documented in BC; however, it is present in Ontario and is spreading westward across North America).

Acoustic Monitoring

An Anabat SD1 recording device was used to record the ultra-sonic calls of bats at each of the capture stations (except on two occasions where alternate sites were recorded). The Anabat SD1 recorder was turned on at dusk and left on until the end of the capture night. Data was downloaded from flashcards in the unit using CFRead software. Files of the calls were labeled, by location on a laptop for subsequent storage and analysis.

Cori Lausen PhD. of Birchdale Ecological Ltd. conducted the final call analysis. Each file was examined in AnalookW 3.8q (March 2011, Chris Corben). Recording locations and category labels were entered into the header of each file using Global Header change, along with miscellaneous notes. Data from headers were downloaded using Anahead within AnalookW. Activity in each category was summarized using Count Labels tool in AnalookW, followed by Pivot Table construction in Excel.

Bat echolocation can be simply categorized into four basic ultrasonic call types, including: search phase calls, approach calls, feeding buzzes, and social calls. Search phase calls are emitted as bats navigate and search for food; these calls tend to have set pulse rates and the structure (frequency output) of the calls is repeated. The consistency of search phase calls makes this call type the most characteristic call for a given species and hence search phase calls were used for species identification for the acoustic monitoring phase of the project.

Despite the relative consistency of search calls, there is still enough variation that calls can have overlapping traits between bat species. In addition to this variation, bats often have slightly different calls when they are in cluttered environments versus open areas. There can also be intraspecific regional variation in dialect, or call characteristics. Finally, recording quality and duration (number of pulses recorded) can also affect the ability to discriminate a recorded call to an exact species. Subsequently, it is necessary to sometimes group calls. Appendix IV identifies the categories of calls and their characteristics that were used to differentiate recorded calls for this study.
In conclusion, search phase calls are characterized by a number of attributes, including minimum and maximum frequency, duration, slope, and intensity; Figure 2 provides an example of a typical search phase call that was analyzed using these methods.

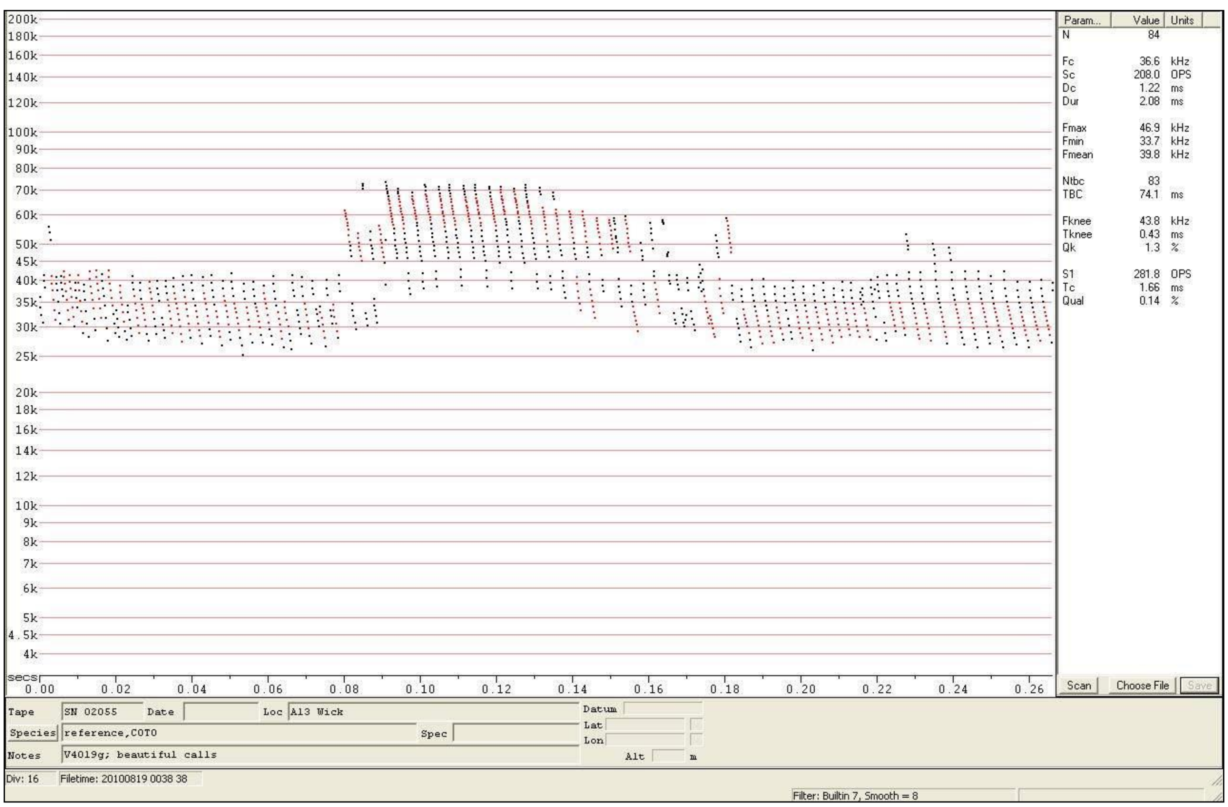

Figure 2: A sonogram of a Townsend's Big-eared Bat calls released at Wick Creek.

Bat Telemetry

The project field component was divided into two consecutive sessions. In session one (late June into early July), selected bats were chosen for telemetric monitoring based on: species rarity, reproductive condition (lactating females were prioritized), bat weight and capture location. This work was conducted in an attempt to locate maternity roost sites. The second session (late August) occurred when young had finished nursing and become volant. The second session was intended to allow capture of lactating females and other target bat species that had been identified as candidates for telemetric monitoring. Criteria for bat selection for telemetry in session two again included species rarity, bat weight, capture location, and reproductive condition (post-partum females were prioritized).

Daytime roost and maternity roost locations were identified through the use of radio-telemetry. Holohil transmitters, including models: LB-2N (0.35g) and BD-2N (0.47g) were applied, using skin-bond surgical adhesive, to selected bats that were captured. The model of transmitter applied was selected based on the weight of the species being tracked (to ensure transmitter weight did not exceed 5% of the bats total weight. Holohil Systems Ltd radio-transmitters (LB-2N at 0.41g and LB-2X at 0.30g) were attached between the shoulder blades of bats using Skin Bond surgical adhesive (Smith and Nephew United, Inc. Largo, FA). To mitigate the impairment of flight from the application of transmitters and prevent excessive movement of units across the back, we trimmed a small amount of hair between the shoulder blades before adhering transmitters to bats.

Once the adhesive had set, marked bats were released and monitored for the duration of the transmitters 7-10 day battery life. Attempts were made to relocate marked bats on a daily basis as field staff capacity and logistics allowed, as bats may move between roost sites. Marked bats were generally relocated by ground, however, helicopters were used when required. NAD 83 UTM coordinates were recorded for all confirmed or potential roost sites that were detected as a result of telemetric monitoring. At each confirmed roost site location, elevation, aspect and forest cover type were documented. If multiple bats were observed at a roost site (including roost sites located from incidental reports) the approximate number of bats was also estimated and recorded.

Day Roost and Maternity Roost Identification

Bats were tracked, during the daytime, in an attempt to locate both daytime and maternity roosts. Lotek STR_400 or STR_ 1000 telemetry receivers (Lotek Engineering Inc., Newmarket Ontario) were used to track bats from foot, vehicle, or helicopter (aerial radio-telemetry was used twice when ground telemetry was unsuccessful). If bats were detected roosting in areas of inaccessible terrain (cliff faces) telemetry stations were established to allow triangulation of an estimated position for the marked bat. Multi-azimuth triangulations (3 – 4) from telemetry stations were analyzed using the program Locate III (Naams 2006). Telemetry error was estimated in Locate III by calculating error ellipsoids for all roost estimates using the Maximum Likelihood Estimator (MLE). The mean area of the ellipsoids was calculated, following the assumption that this area was circular, to a corresponding radius that was used as our estimate of telemetry error (*r=163 meters)*.

Foraging Habitat-use Patterns

Bats were also tracked at dusk and into the early evening, as they emerged from their day roosts and travelled towards foraging areas. To collect information on foraging patterns field staff would check for signals upon emergence (at sunset) from telemetry stations that were established in the vicinity of day roosts and/or capture locations. Once a strong signal was received (i.e.; the signal was registered on the power graph function of the telemetry receiver), a bearing and distance was estimated before moving rapidly to the next telemetry station. Telemetry stations were situated at an approximate 90 degree angle to the station where the first signal was received. This procedure was performed as quickly as possible to try and pinpoint the general location of the foraging bat. If the approximate location of the bat being monitored was determined, and access deemed safe, field staff would hike into the area where the bat was foraging and monitor the signal throughout the initial foraging bout. If the area could not be accessed safely, field staff would monitor the signal from the nearest safely accessible telemetry station. Within the foraging area, we determined were bat foraging efforts were concentrated by reducing the gain on the telemetry receiver to the lowest possible setting at which signal strength was still registered on the power graph output. A high reading (i.e. strong signal) on the Lotec receiver's power graph, in association with a low gain value, would serve as indication that the marked bat was in the immediate vicinity of the surveyor. If capacity permitted, we would use two telemetry stations with simultaneous monitoring between two field staff to estimate approximate locations of the marked bat's foraging activity.

Community Outreach

Local media, such as newspapers and radio, were used to communicate upcoming events to the public. Project biologists attended three public engagement events: 1) Salmon in the Canyon and 2) two Public Open houses held at the Lillooet Friendship Centre. The first public session featured a bat capture and detection session. These events were led by Ministry of Environment Biologists. Participants were given an opportunity to engage in a biological census of the bat fauna at each site. These efforts were coordinated with the assistance of the Lillooet Naturalist Society.

Results

In order to meet project objectives one (*species presence/distribution*), two (*acoustic monitoring to augment information on species presence and distribution*) and three (*telemetric monitoring to enable detection of roosting habitats and to collect information regarding night-time habitat use patterns*) we used mist nets to sample bat fauna, at night, at 18 sites distributed throughout the project area. Bat mist-netting was conducted at eighteen sites, over twenty-one nights (three sites were sampled twice), in two sessions. In addition to 21 nights spent netting bats, field staff also conducted two nights of telemetric monitoring (no nets deployed). Finally, to meet objective two, Anabat SD1 recording units were deployed while netting at 18 of the net nights, and two additional sites were recorded during telemetric monitoring for a total of 20 sites that were monitored acoustically.

Bat Mist-netting

Bat mist-netting was conducted at 18 sites in two sessions. The first session, from June 25 through July 6 (11 sites, 12 nights-see Table 3), was intended to allow capture of pregnant and post-partum females. In session one, selected bats were chosen for telemetric monitoring based on: species rarity, reproductive condition, bat weight and capture location. This work was conducted in an attempt to locate maternity sites. The second session, from August 18 through to August 28 (nine sites, nine net nights), occurred when young had finished nursing and become volant. The second session was intended to allow capture of lactating females, volant young, and other target bat species that had been identified as candidates for telemetric monitoring. Criteria for bat selection for telemetry in session two therefor included species rarity, bat weight, capture location, and reproductive condition.

In total, 162 nets; including net lengths from 2.6m to 18m (net height=2.4m), were deployed during both sessions of the project. This equates to ~3,978m^2 of net deployed over 21 nights. The total time nets were deployed varied by site however a total net 'effort' of ~15,246 net hours was recorded for the project. The total number of bats captured was 142 individuals; representing a total of 12 species of bat[1] captured within the project area (ten confirmed; two pending DNA analysis results). Two additional species were detected as a result of acoustic monitoring-these results are reported separately. The highest number of bats captured in a single night was 28, with an average of seven bats/night (refer to Table 3). No bats were captured during three of the 21 net nights.

Table 3 reports data on the relative effort applied to bat capture at the 21 nights (18 sites) at which nets were deployed during the project. Caution should be applied when interpreting the relative success of bat capture between stations. Success was calculated as the "number of bats captured" per "unit effort", where effort is summarized as "square metres (length X width) of net deployed" multiplied by the "time (hrs.) of net deployment". Although success may provide a relative indication of bat diversity and abundance between stations, capture success is likely to be influenced by several variables including array design (i.e.; net placement), environmental conditions (lunar phase, wind, precipitation, temperature), habitat quality, habitat type, bat behavior and bat 'skill' (at evading capture).

[1] *Genetic results are pending and are required for confirmation of MYSE and MYKE*

Table 3: Summary of effort and success at 21 stations at which bat mist nets were deployed.

Net Night	Location	# nets	Nets (metres^2)	Net Hours	Effort	# bats captured	Success
Session 1							
N1	Downton	6	187.2	2.25	421.2	0	0.000
N2	Bridge	7	230.4	2.25	518.4	2	0.004
N3	Upper Spawn	9	273.6	2.25	615.6	19	0.031
N4	Camoo	10	256.8	8	2054.4	3	0.001
N5	Phair	6	194.4	2.4	466.56	0	0.000
N6	Walden North	13	367.2	2.5	918	7	0.008
N7	Texas	5	122.4	3	367.2	0	0.000
N8	Waterfall Walk	9	165.6	3	496.8	23	0.046
N9	Asplundh	7	194.4	2.75	534.6	1	0.002
N10	Yalakom Cave	5	129.6	3	388.8	2	0.005
N11	Enterprise Mine	1	6.24	2.3	14.352	6	0.418
N12	Enterprise Mine	3	36	2.75	99	1	0.010
Session 2							
N13	Wick	6	127.2	4.5	572.4	4	0.007
N14	Gates	7	158.4	4.5	712.8	3	0.004
N15	Waterfall Walk	14	280.8	4.5	1263.6	28	0.022
N16	telemetry	0	n/a	n/a	n/a	n/a	n/a
N17	Antoine Creek	11	228	4.5	1026	14	0.014
N18	Sebring Creek	11	273.6	4.5	1231.2	4	0.003
N19	Whitecap	8	170.4	4.5	766.8	1	0.001
N20	Broadhead	9	172.8	4.5	777.6	16	0.021
N21	Texas	7	172.8	5.25	907.2	1	0.001
N22	telemetry	0	n/a	n/a	n/a	n/a	n/a
N23	Cat Pond	8	230.4	4.75	1094.4	7	0.006
Summary		**162**	**3978.24**	**77.95**	**15246.91**	**142**	

Although we attempted to stratify habitat types by “upland” versus “riparian” individual site variation within each BEC zone sampled was too inconsistent to allow any statistically supported conclusions to be derived based on unquantified stratification. Instead, bat diversity between habitat types is best characterized at the level of BEC classification. Table 4 presents bat abundance data (based on bat capture data only) at each station relative to BEC zones. This may provide some insight of habitat use by bats, at a course scale, within the study area; however this comparative data must be interpreted with caution as it is influenced by sampling effort (allocated to each BEC zone), bat behavior (including foraging height and skill at evading capture), sampling conditions (lunar phase, temperature, wind, precipitation) and site specific variables such as net array design. In addition, although the table allows relative comparisons of bat ‘abundance’ between BEC zones this cannot be interpreted to be demonstrative of individual selective preferences between species and/or BEC zones, as it is not presented in the context of ‘use versus availability’.

Table 4: Summary of number of bats captured, by species within each BEC zone that was sampled during the project.

Species	Spp. Code	# bats	PPxh2	IDFxc	IDFww1	CWHvm1
California Myotis	M-MYCA	39	11	18	10	0
Western Small-footed Myotis	M-MYCI	5	2	3	0	0
Little Brown Myotis	M-MYLU	31	3	23	5	0
Yuma Myotis	M-MYYU	7	0	5	2	0
Long-legged Myotis	M-MYVO	8	7	0	1	0
Western Long-eared Myotis	M-MYEV	37	4	32	1	0
Northern Myotis[1]	M-MYSE	4	1	3	0	0
Fringed Myotis	M-MYTH	1	1	0	0	0
Big Brown Bat	M-EPFU	5	1	3	1	0
Silver-haired Bat	M-LANO	1	0	1	0	0
Townsend's Big-eared Bat	M-COTO	4	2	2	0	0
Total	#	142	32	90	20	0
Percentage of bats captured	%	100	23	63	14	0
Percentage of net effort	%	100	29	52	14	5

Sampling occurred in all low elevation available biogeoclimatic subzones variants (BEC) within the study area including the: PPxh2, IDFww1, IDFxc, and CWHvm1. Upper elevation BEC zones were not sampled during this project as bat diversity and abundance was anticipated to be lower at higher elevations. The effort applied, relative to the number of bats captured within each BEC zone, is summarized as follows:

- PPxh2: six locations sampled (29%) and 23% of bats captured in this BEC unit
- IDFxc: eleven locations sampled (NB: two sites were sampled twice) (52%) and 63% of bats captured in this BEC unit.
- IDFww1: three locations (14%) and 14% of bats captured in this BEC unit; and,
- CWHvm1: one location (5%) with 0% of bats captured in this BEC unit.

This data suggests that the greatest number of bats captured, relative to effort applied, were within the IDFxc BEC unit, however, inclusion of acoustic monitoring results yields a different interpretation (see Table 5). In short, although the IDF appears to have yielded higher bat abundance when mist-netting results are examined in isolation (NB: within the context of the aforementioned uncontrolled variables), combining netting and acoustic monitoring results suggest that the PPxh2 appears to have yielded the highest bat diversity, relative to effort..

Table 5: Summary of Bat Species diversity recorded for each BEC unit. This data includes data derived from both mist-netting and acoustic monitoring.

BEC Unit	# of Species-Netted	# of Sps-Acoustic[2]	Total # of Species
PPxh2 (29% of sample effort)	9	10	13
IDFxc (52% of sample effort)	9	7	11
IDFww1 (14% of sample effort)	6	6	9
CWHvm1 (5% of sample effort)	0	1	1

1: Final species confirmation of MYSE and MYKE are pending DNA analysis (NB: MYKEI was not included as a recorded species as its identity is only tentative -four potential MYKE were treated as MYEV until DNA results are available).
2: Species were included in the Acoustic tally only if the species identification was confirmed. Unconfirmed species were not included here.

Acoustic Monitoring

Mist-netting cannot be used as a complete measure of bat diversity in an area due to species-specific differences in foraging behavior. Some bat species are less effectively recorded using mist netting techniques because they; forage high above the ground, they are able to avoid capture due to their maneuverable flight capabilities and/or they echolocate at higher frequencies, and are thus more likely to detect the net and avoid it. As such, Anabat SD1 detectors were passively deployed at 18 of the netting stations (concomitant with mist-netting) and at an additional two sites where netting was not conducted, for a total of 20 nights surveyed. A total of 94.5 hours of recordings were made, resulting in 1,940 bat sequence files.

The number of bat files produced from recordings cannot be used to generate a value of the number of individual bats, as one bat could be making multiple passes, but it can give a relative level of activity. At the simplest level, acoustic monitoring can yield information regarding the relative level of bat activity at each site. Table 6 provides the dates, hours of recordings, the total bat files generated (by night) and the number of bat files generated per hour for each recording station.

Table 6: Acoustic monitoring stations and bat call productivity

Station	BEC	Date	Hours Recorded	Total # Bat Files	Bat Files/ Hour
N1 Downton	CWHvm1	25-Jun-10	2.75	15	5.5
N2 Bridge	PPxh2	26-Jun-10	4.00	102	25.5
N3 Upper Spawn	IDFxc	27-Jun-10	3.00	76	25.3
N4 Camoo	PPxh2	28-Jun-10	3.25	196	60.3
N5 Phair Lk	IDFxc	29-Jun-10	2.00	25	12.5
N6 Waldon N	IDFxc	30-Jun-10	3.00	197	65.7
N7 Texas 1	IDFxc	1-Jul-10	2.75	6	2.2
N8 Waterfall Walk	IDFxc	2-Jul-10	6.00	213	35.5
N9 Asplundh	IDFxc	3-Jul-10	2.00	123	61.5
N10 Yalakom Cave	PPxh2	4-Jul-10	3.00	71	23.7
N13 Wick	PPxh2	18-Aug-10	4.50	116	25.8
N14 Gates	IDFww1	19-Aug-10	10.50	119	11.3
N16 Horseshoe	PPxh2	21-Aug-10	9.50	170	17.9
N17 Antoine	PPxh2	22-Aug-10	3.25	63	19.4
N18 Sebring	IDFxc	23-Aug-10	12.50	50	4.0
N19 WhiteCap	IDFww1	24-Aug-10	3.25	27	8.3
N20 Broadhead	IDFww1	25-Aug-10	7.50	57	7.6
N21 Texas 2	IDFxc	26-Aug-10	5.00	107	21.4
N22 Lower Spawn	PPxh2	27-Aug-10	2.00	82	41.0
N23 Cat Pond	PPxh2	28-Aug-10	4.75	125	26.3
		Total	**94.50**	**1,940**	

At a more complex level of analysis, acoustic monitoring is confounded by interspecific overlap and intraspecific variation of call characteristics however acoustic monitoring results provided confirmation of two species (Spotted Bat and Hoary Bat) and the potential addition of an additional three species (Pallid Bat/Canyon Bat and Eastern/Western Red Bat) to the total bat diversity measured during the project. Several observations of both Spotted Bats and Hoary Bats as well as tentative observation of a few notable additional species including the Pallid Bat, the Canyon Bat and the Red Bat (refer to Table 7) were recorded. By necessity, some calls were grouped (as detailed in Appendix IV) as acoustic recordings lacked sensitivity to discriminate between species in all cases.

Table 7: Summary of confirmed and significant unconfirmed bat species detected at each station.

Survey Night	Location	BEC Unit	Species Netted	Species Confirmed species (acoustic)	Significant Unconfirmed species (acoustic)	Total # Species. Detected
1	Downton Creek	CWHvm1	n/a	EPFU	none	1
2	Bridge River	PPxh2	MYVO, EPFU	MYLU, MYEV, LANO	none	5
3	Upper Spawn	IDFxc	MYLU, MYEV, MYCA, EPFU, MYCI	MYEV	MYSE	5
4	Camoo Creek	PPxh2	MYCA, MYCI, MYVO		none	3
5	Phair Lake	IDFxc	n/a	LANO, MYTH	PAHE/LABL/LABO	2
6	Walden North	IDFxc	MYCA, MYLU, MYYU, MYSE, LANO	LANO	PAHE/LABL/LABO	5
7	Texas Creek	IDFxc	n/a		none	0
8	Waterfall Walk	IDFxc	MYCA, MYLU, MYYU, MYEV, COTO	MYEV, COTO	LACI, LACI/ANPA	5
9	Asplundh	IDFxc	EPFU		none	1
10	Yalakom Cave	PPxh2	MYVO	COTO	none	2
11	Enterprise Mine	IDFxc	MYEV	n/a	n/a	1
12	Enterprise Mine	IDFxc	MYSE	n/a	n/a	1
13	Wick Creek	PPxh2	MYCA, MYSE, COTO	MYEV, MYSE, MYTH, COTO	MYSE, PAHE/LABL/LABLO	4
14	Gates Creek	IDFww1	MYCA, MYVO, MYEV	MYEV, COTO	MYSE, PAHE/LABL/LABLO, ANPA	4
15	Waterfall Walk	IDFxc	MYCA, MYCI, MYLU, MYEV, EPFU	n/a	n/a	5
16	Horseshoe Bend	PPxh2	n/a	MYYU, MYEV, EPFU	none	3
17	Antoine Creek	PPxh2	MYCA, MYCI, MYLU, MYEV, COTO	MYEV, LACI	PAHE/LABL/LABLO	6
18	Sebring Creek	IDFxc	MYCA, MYLU, MYSE	MYEV	none	4
19	Whitecap Creek	IDFww1	MYCA	MYEV	none	2
20	Broadhead	IDFww1	MYCA, MYLU, MYYU, EPFU	MYYU, MYEV, EPFU, LACI		6
21	Texas Creek	IDFxc	MYCA		none	1
22	Lower Spawn	IDFxc	n/a	MYCA, MYYU	none	2
23	Cat Pond	PPxh2	MYCA, MYLU, MYVO, MYEV, MYTH	MYVO, MYEV, MYTH	MYSE	5

1: PAHE-Canyon Bat (*Parastrellus hesperus*) which currently is not confirmed from BC

Bat Telemetry

Telemetric monitoring of bats was conducted to collect information regarding roosting requirements, foraging movements, and habitat use patterns. During both sessions we tracked a total of nine bats, representing five species, and collected data as described in Table 8. For more detailed results, including roost site UTM coordinates, please refer to Appendix V.

Table 8: Summary of telemetry results from radio-tracking in July and August 2010.

Bat	Sex	General Location	# of Day Roosts	Roost Type	Comments
Session 1					
LANO 093	Non-reproductive Male	Walden North	1	Tree	Suspected radio-transmitter failure; only one roost site identified.
COTO 171	Non-reproductive Male	Cayoosh Creek	5	Rock	Five roost site locations were estimated. All were located on cliff faces.
COTO 152	Non-reproductive Male	Cayoosh Creek	2	Rock	One roost site was confirmed; four roost sites were estimated as these were located on cliff faces.
EPFU 493	Non-reproductive Male	Cayoosh Creek	1	Rock	Four roost site locations were estimated. All were located on cliff faces.
MYEV 014	Reproductive Female	Cayoosh Creek	1	Rock	Although the exact location could not be determined the post-partum condition of this bat, and repeated return to the same estimated location, indicates this site is a maternity roost.
MYEV 034	Reproductive Female	Cayoosh Creek	1	Rock	Although the exact location could not be determined the post-partum condition of this bat, and repeated return to the same estimated location, indicates this site is a maternity roost.
Session 2					
COTO 294	Reproductive Female	Antoine Creek	2	Rock	A suspected maternity roost site was located (by helicopter) on a small cliff face near Hell Creek. An additional day roost was located near the capture location (visual), which was located in large boulders along Bridge River. Finally, one night roost in a building was also confirmed (at the capture location.
MYEV 144	Reproductive Female	Antoine Creek	1	Rock	A single roost site location was used for six consecutive days. The site is likely a maternity roost located at the top of a small cliff face immediately above the capture site.
MYTH 072	Non-reproductive Male	Cat Creek, S of Lillooet	1	Rock	One roost site was confirmed, with suspected multi-day use, in small outcrop on the east side of the Fraser.

A summary of each telemetered bat, including a description of movements, behaviors and habitat use patterns, is provided below.

Session One

Silver-haired Bat (LANO 093) - Cayoosh Creek

Only one roost was identified (the day after capture) for the single male Silver-haired Bat (LANO 093) that was captured on June 30th. Transmitter malfunction is suspected, as efforts to locate this bat were unsuccessful on subsequent days of monitoring. The roost identified was a 35cm diameter DBH Douglas fir snag (*Pseudotsuga menziesii*), decay class 3, approximately 12 – 14 meters in height. The snag occurred on the upper edge of a small opening created by Armillaria root rot (*Armillaria ostoyae*) along the north side of Cayoosh Creek approximately 1.5 km from the capture location. This bat was likely roosting beneath the sloughing bark on the exposed solar face of the snag (see Figure 3).

Figure 3: Capture and roost locations for LANO 093 in the lower Cayoosh/Seton watershed.

Townsend's Big-eared Bat (COTO 152 and 172) - Cayoosh Creek

Both of these male Townsend's Big-eared Bats were captured on July 2nd, 2010. Subsequent telemetric monitoring of COTO 152 and 172 demonstrated repeated use of the riparian habitat in the valley bottom of the lower reaches of Cayoosh Creek and the parallel Seton River (Figure 4). One of the bats (COTO 152) was observed on the first day of monitoring, roosting alone (in state of torpor) within a small cave that was located within a north aspect talus slope (internal roost dimensions ~2 x 3 meters). All additional roost locations were inaccessible and, as such, were approximated using the program Locate III. Subsequent monitoring of COTO 152 resulted in the detection of additional roosting sites on four consecutive nights within a southwest facing cliff band located immediately above the capture site along Cayoosh Creek. The cliff face was heavily fractured and likely provided ample opportunities for roosting, however, the exact roost location could not be determined as it was on an inaccessible cliff face. The other Townsend's Big-eared Bat (COTO 172) appeared to roost in at least two locations, both on the south facing cliffs above the Seton River. Estimated roost locations were within geological features similar to those described for COTO 152.

Although both bats had ready access to both upland and riparian habitat types that were located proximally to their estimated roost locations both bats appeared to forage exclusively within the Cayoosh Creek riparian corridor. Five successive nights of monitoring (July 3rd-July 8th, 2010) revealed a consistent foraging pattern for these two marked bats. Upon emergence both bats immediately flew down into the Cayoosh Creek corridor and began foraging. Both bats utilized the riparian habitat along Cayoosh Creek, between the BC Hydro campgrounds continuing downstream for ~2km to the Lightfoot Gas Station at the interface of the residential of Lillooet. Neither of these bats was detected foraging over the Seton reservoir, within the dry ponderosa pine/Douglas fir forests or the extensive areas of talus slopes, cliff faces or sagebrush benches, despite the equivalent proximity of these other habitat types.

Long-eared Myotis (MYEV 014 and 034) - Cayoosh Creek

MYEV 014 and 034 were both reproductive females captured at the same location on July 2nd, 2010 (N8-Waterfall Walk). Subsequent telemetric monitoring from July 4th – July 8th, 2010 revealed a pattern of repeated use of the same (inaccessible) roost area by both of these marked bats. Although the exact roost location could not be accessed for inspection (i.e.; inaccessible), the post-partum condition of both of these bats, and their repeated return to the same estimated day roost location, indicate this site was a maternity roost. This area is characterized by a hot south-west aspect cliff face with extensive lateral vertical fracturing (Figure 4).

A similar pattern of foraging activity was observed for both marked reproductive female bats and their foraging patterns were consistent for those described for COTO 152 and COTO 172 (see section above).

Big Brown Bat (EPFU 493) - Seton River

A single male Big Brown Bat (EPFU 493) was marked for telemetric monitoring on July 3rd, 2010. This bat was monitored for four days. Each day EPFU 493 returned to the same cliff face (estimated roost site location). Coincidentally, the roost site used by EPFU 493 was located in close proximity to the roost sites that were estimated as maternity roosts for two Long-eared Myotis bats that were also tracked in session one. The roost area for all three bats was located immediately west of the Seton reservoir (Figure 4). This area featured excellent roosting habitat and is characterized by a hot south-west aspect cliff face with extensive lateral vertical fracturing.

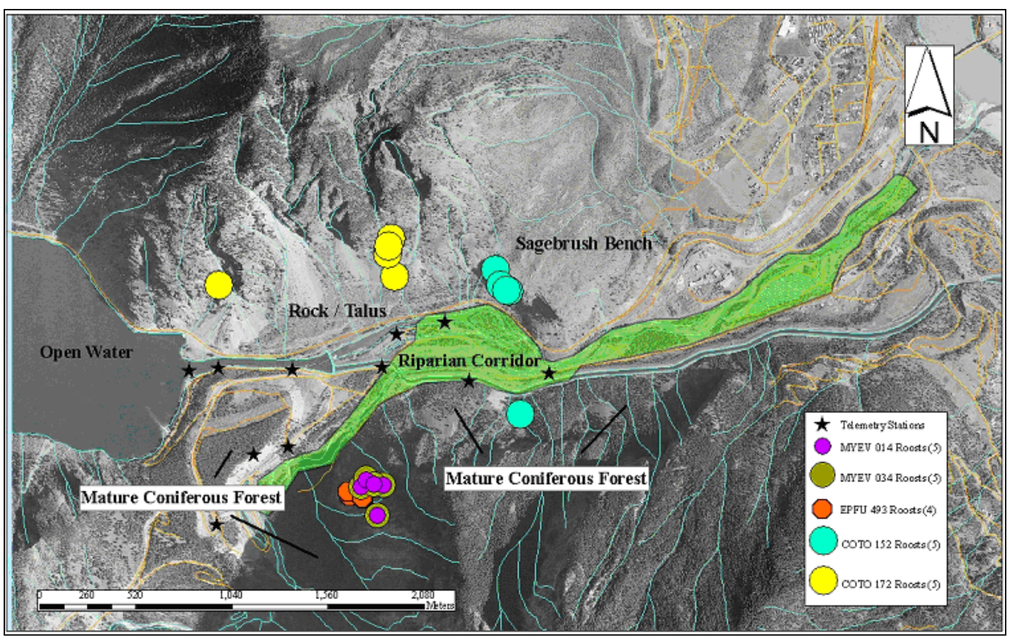

Figure 4: Capture (cluster of orange dots) and Roosting locations for COTO 171, COTO 152, EPFU 493, MYEV 034 and MYEV 014 in the lower Cayoosh/Seton watershed monitored during session one.

Session Two:

Long-eared Myotis (MYEV 144) – Antoine Creek

MYEV 144 was marked for telemetric monitoring on August 22nd, 2010 (net night 17). The capture location was located on private property, near Antoine Creek, and featured riparian habitat associated with Antoine Creek.

Subsequent telemetric monitoring of MYEV 144 resulted in the detection of a roost structure located within a large vertical fissure near the top of a granite bluff immediately above the capture location at Antoine farm (Figure 5). Based on the reproductive condition of this female (post-partum lactating female) it is suspected that this roost site is a maternity roost.

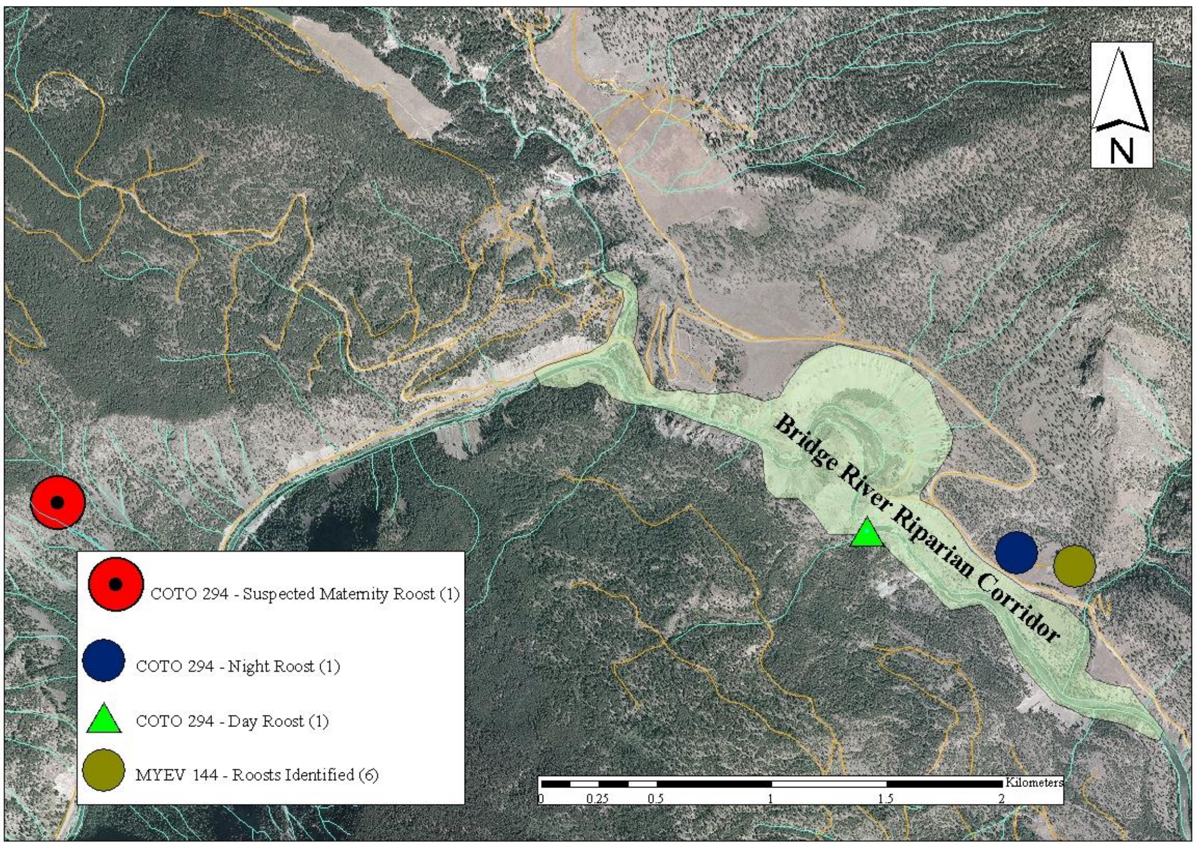

Figure 5: Telemetry relocation locations of COTO 294 (lactating female) and MYEV 144 (lactating female), with foraging confined to the Bridge River riparian corridor (green polygon) on all five suitable nights of tracking for COTO 294.

Townsend's Big-eared Bat (COTO 294) - Antoine Creek

In session two a single post-partum (lactating) Townsends Big-eared Bat (COTO 294) was marked for telemetric monitoring on August 22nd, 2010 (net night 17). The capture location was located on private property, near Antoine Creek, and featured riparian habitat along the Bridge River, Yalakom River and Antoine Creek.

Despite repeated efforts to locate a maternity roost for COTO 294 during the first five days of ground-based telemetry COTO 294 was only observed roosting only once, in a state of torpor, on the morning of August 27th, following a torrential rain storm. This roost site was located beneath a large boulder immediately adjacent to the Bridge River. After five days or repeated attempts to locate the maternity roost a helicopter was used to locate the maternity roost site. The roost was located ~2.5km upstream from the Bridge-Yalakom confluence (see Figure 5) in an area of rugged terrain with extensive cliff complexes. The bat roost location was estimated to be located within a rock outcrop on a south-west aspect cliff face approximately 400m upslope from the Bridge River on the north side of the valley. Topographic features would have made detection of the telemetry signal, from the road 400m below, very difficult. It seems likely that COTO 294 was repeatedly using this roost and, based on repeated use and the reproductive condition, this site is likely a maternity roost.

A single night roost was identified for COTO 294 at the site of the bats capture. The night roost was used on at least two nights during the monitoring period and was located in an abandoned cabin on Antoine farm. This also was the same site where the bat was captured.

The foraging behavior patterns observed for COTO 294 were similar to patterns observed for COTO 152 and COTO 172 as described for Session one at Cayoosh Creek. COTO 294 was observed utilizing the remaining riparian habitats associated with the Bridge River from the roost site near Hell Creek and continuing downstream for ~6km as far east as the capture site at Antoine Cabin. Upon emergence COTO 294 would forage in the most extensive Cottonwood habitat complex at the Bridge-Yalakom confluence before continuing downstream towards Antoine Creek. COTO 294 was also observed foraging, for extended periods, within the cottonwood riparian habitat at 'Horseshoe Bend' (see Figure 6).

Although this area provides easy access to both upland and riparian habitat types that are located along the movement corridor COTO 294 appeared to forage exclusively within the Bridge River riparian corridor. COTO 294 was never detected foraging within the dry ponderosa pine/Douglas fir forests immediately adjacent to these riparian areas.

Figure 6: Image of Horseshoe Bend (Note the removal of riparian habitat from active development).

Fringed Myotis (MYTH 072) – Fraser River

A single Fringed Myotis (MYTH 072) was captured, on the last net-night of the project, near Cat Creek pond on August 28th, 2010 (net night 23). Subsequent telemetric monitoring of this bat was hindered by the bat's propensity to make rapid long distance movements across the Fraser River with ease (Figure 7). In addition, land tenure (extensive areas of privately owned lands) made it difficult to establish telemetry stations as required. As such, it was impossible to effectively assess foraging behavior for MYTH 072. On night one (August 29, 2010) MYTH 072 emerged from a roost site on the east side of the Fraser River ~3km upstream from the capture location. The bat moved towards the Fraser following an un-named ravine along an ephemeral creek with limited riparian habitat before crossing the Fraser to forage on the West side of the Fraser River near Towinock Creek (Cat Creek Pond). Shortly after, MYTH 072 moved rapidly north until the signal became too weak to allow reliable estimation of the bats location. This pattern was repeated on the second night of monitoring on August 30, 2010.

On August 31st we used a helicopter to track MYTH 072 to a daytime roost location. The roost site was located within a deep fissure near the top of a small (15m height) south-west aspect rock-outcrop ~1.3km upslope from the Fraser River on the east side of the valley. The fracture was 1.5 meters tall and 3.5 centimeters wide. It should be noted that, on the day prior to the identification of this roost via helicopter, we were able to receive a faint signal from the same location, suggesting at least two consecutive days of roosting at this site.

Figure 7: A single day roost site was identified for MYTH 072. The feature occurred within a fracture cave feature on a south west aspect above the Fraser River.

The area MYTH 072 was observed (briefly) foraging, in the vicinity of Cat Pond, features a mosaic of habitats including abandoned orchards, grassland/sage habitat and upland IDF forest. We know that this bat spends a short duration foraging in the creek draw immediately below the day roost before moving across the river to forage throughout the Cat Pond area, but because the patchy nature of the different habitats and limited access to conduct telemetry, we were unable to document foraging habitat use patterns more thoroughly.

Incidental Bat Roost Observations

Site One: Twenty-three Camels Bridge

Roost sites for Little Brown Myotis were found in several anthropogenic structures. A large colony (n=>3000) was found in the west end of the "Twenty-three Camels Bridge" in Lillooet (Figure 8). The colony was utilizing a gap in the concrete where the abutment met the suspended slab. The size of the colony suggests that it is a maternity colony but parturition and rearing of young was not confirmed as no young were visible when the colony was visited on July 5th , 2010 . (UTM in Appendix V-Table 11).

Figure 8: A portion of the Little Brown Myotis colony inhabiting 23 Camels Bridge.

Site Two: Jones Attic

A second large colony of Little Brown Myotis (n=>3000) was observed in the Jones farmhouse attic, south of Lillooet. This colony has occupied this site for many years, as observed by the property owner and as evidenced by the accumulation of guano and encrusted urine. Parturition and rearing of young has not been confirmed at this site however, due to the size and persistence of the colony, it is suspected that this is a maternity site. The property owners have attempted to prevent the bats from using the attic for roosting however previous attempts have been unsuccessful at deterring the bats (UTM in Appendix V-Table 11).

Site Three: Seton Attic

A relatively small maternity colony of Little Brown Bats (n=300) was reported in the attic of a house in Seton Portage. The site was visited on August 26th and young were observed in the colony. The property owners were aware of the bats but were not attempting to exclude or eliminate the colony (UTM in Appendix V-Table 11).

Site Four: Seton Community Hall

A suspected Townsend's Big-eared Bat colony was inspected in BC Hydro's community hall in Seton Portage. The colony had already vacated the site prior to our visit (August 26th, 2010) but evidence of previous use (guano accumulation and crystallized urine), by bats, suggest that the site must have been active for many years previously. The guano pile was conical, suggesting a small colony of tightly huddled bats, which is typical for Townsend's Big-eared Bats. Unfortunately the community hall burned down in the fall of 2010 shortly after our visit (UTM in Appendix V-Table 11).

Community Outreach

The public open house held by project biologists was well received by members of the public. Approximately 50 people attended the evening session at the Lillooet Friendship Center on June 27, 2011. Admission to the event was by donation to the local food bank, non perishable items were accepted at the door. Community members enjoyed a 45 minute presentation (by Jared Hobbs and Francis Iredale) during which, we outlined project objectives and highlighted bat diversity within the Lillooet area. The second half of the evening presentation was led by Mike Sarell as he demonstrated standard provincial capture and detection protocol for bats at the upper spawning channels.

The "Salmon in the Canyon Festival" held August 21st, 2011, in Lillooet, provided project biologists with another excellent outreach opportunity to engage local community members. Educational material was provided to interested community members. In addition, project awareness within the community was also enhanced through publications with the Lillooet Newspaper. In partnership with the Lillooet Naturalist Society, project biologists produced three newspaper articles and a promotional article highlighting upcoming public outreach events (see Appendix III BCRP recognition).

A final open house was held November 4, 2011 at the Lillooet Friendship Centre. This venue provided an opportunity to showcase the results all three BCRP funded projects. This event was also a success.

Discussion

Conservation and management of bat fauna within watersheds requires the documentation of bat species presence and the identification of critical habitat elements such as maternity roost sites, hibernation sites, and foraging areas (Holroyd and Friis 2005). Bat research in British Columbia has advanced significantly since the 1980's, however; research and inventory have primarily been focused within a few specific locations in several areas of the province (e.g. South Okanagan). Within BC Hydro's tenured activity areas several bat projects have been completed within the Columbia Basin region, however, to date; BCRP has primarily focused on only two watersheds (Grindal 1996; Kellner and Rasheed 2001). To address this issue, the province applied to the BC Hydro Bridge Coastal Fish and Wildlife Compensation program to attain funding to document bat species presence and roosting locations within the Bridge Coastal watersheds. The implementation of this project represents the most comprehensive formal bat assessment conducted to date, for bat species, within the Lillooet BCRP project area. Previous efforts included D.Burles (2010) baseline study within the restoration area, a 2009 inventory conducted by Rescan Environmental Services (M.Firman 2003) and an early inventory conducted by Holroyd et al (1994). The assessment conducted in 2010 (this project) advanced our understanding of the bat fauna in the Bridge River area significantly.

A total of 12 of the 19 bat species known to occur within British Columbia were confirmed within the project area with two more species considered likely; Northern Myotis and Keen's Myotis. Both of these final two species have been tentatively accepted based on morphometric measurements of captured bats and interpretation of acoustic recording; DNA evidence was sampled for these two species and analysis is pending. In addition, preliminary evidence, to support the potential occurrence of three more species (Pallid Bat, Canyon Bat and Red Bat) was detected via acoustic monitoring. This work represents significant expansions to the previously known range for several of the new species documented including: Western Small-footed Myotis, Fringed Myotis, Townsend's Big-eared Bat, and the Northern Myotis. The Lillooet area is now recognized as a hot-spot for bat biodiversity in BC.

Mist Netting

Thermoregulation plays an important role within the bats life cycle. Warm ambient night time temperatures within south facing roosts regulate energy demands for bats during reproduction and digestion periods. In addition, foraging quality is also affected by ambient temperatures. Dry weights of "light-trapped" insects were significantly correlated with night time temperatures (Richards 1989). Both of these considerations influenced our selection of trapping locations as we attempted to maximize our detection of the bat diversity within the project area. In short, warm dry biogeoclimatic zones featured higher abundance of bat species and as such these BEC zones were disproportionately sampled (relative to availability at the landscape scale) during the project.

In order to maximize detection of species during the project, and in recognition of funding constraints, we elected to sample most areas only once rather than adhering to the suggested RISC protocol of sampling each site twice. Two exceptions included Texas Creek and Waterfall Walk. Texas Creek was sampled twice as we anticipated high detection success based on expert review (M. Sarell) however the narrow canyon and downdraft of cooler air from the headwaters of Texas Creek likely resulted in very low capture success at this site. Waterfall Walk was also sampled twice (once per session) to allow capture of long-eared bats for as they were targeted for genetic sampling.

Several key observations were apparent in our results from the mist-netting component of the project:

1. Bats that may be ecologically classified as generalists (e.g.; California, little brown and long-eared Myotis) were noted in higher numbers within three of the four biogeoclimatic zones sampled. Although these numbers do not represent abundance, as a number of these bats may represent recaptures, the broad representation of these bats attests to their ecological plasticity.
2. In contrast, Townsend's Big Eared Bats were detected, and monitored, foraging in a more restricted manner, within mature riparian cottonwood stands. This observation mirrors those observations of Hill et al. 2006. As such, the protection/enhancement of riparian habitat for foraging purposes is a critical component of managing for riparian specialists such as the Townsend's Big Eared Bats. Existing research demonstrates that this species needs relatively large areas of foraging habitat to meet the energetic demands of lactating females, especially within northern climates with relatively shorter active seasons (Hill *et al.* 2006).
3. The successful capture and tracking of a single *M. thysanodes* merits special attention as this species is listed by COSEWIC as data deficient.
4. Overall, the observed high diversity of bats within the project area is likely best attributed to the adjacency of high quality foraging and roosting habitats.
5. Finally, the observed high diversity of bat species captured during mist-netting is also a reflection of observer skill. For example, the identification of potential night roosting locations likely facilitated increased detection/capture rates at several sites including Antoine Creek and Enterprise Mine.
6. Finally, the capture of bats, using mist-netting techniques, enabled recording of 'reference calls' (calls recorded upon release of bats with known or suspected confirmed identity) that may serve as a useful reference to assist with future acoustic identification of bats in BC.

Acoustic Monitoring

The acoustic monitoring component of this project served to provide additional confirmation of species identification for several key species of bats captured. In addition, acoustic monitoring provides evidence of the potential occurrence of several new species of provincially significant bat species in the area however some limitations of this method are discussed below.

Three stations (Camoo (60.3 files/hour), Waldon North (65.7 files/hour) and Asplundh (61.5 files/hour)) featured exceptionally high levels of acoustic activity (e.g. over 60 bat calls/hour) with relatively low rates of bat captures through mist-netting alone. Conversely, three stations (Upper Spawn (n=25.3), Waterfall Walk (n=35.5), Antoine Creek (n=19.4)) featured only moderate levels of acoustic activity with relatively high rates of bat captures through mist-netting. The discrepancy between acoustic activity and netting success is likely due to sampling conditions, array design (i.e. net placement) and site conditions (i.e. ability to place nets in bat travel corridors). Habitat quality and type, in isolation, doesn't provide a complete explanation for these results. This exemplifies why netting, without augmentation by acoustic monitoring, does not necessarily provide an accurate measure of bat diversity at a site.

Secondly, there is only a weak correlation between the bats species captured via mist-netting techniques and bat species detected via acoustic monitoring techniques. This is likely due to the necessary aggregation of bat recordings that cannot be identified to species using conventional available technologies (Note: this was observed during collection of reference calls of hand released bats where their identification was confirmed based on morphometric characteristics but could not be confirmed through analysis of acoustic data alone).

Despite the inherent challenges that confound acoustic monitoring there are still significant gains that result from the use of this technique. The main motivation to perform concomitant acoustic monitoring in bat surveys is the efficacy of this technique in augmenting mist-net (capture) data with detection of additional species that are not typically captured through mist-netting techniques alone. In our study the use of acoustic monitoring resulted in the following very significant findings:

1. Northern Myotis (MYSE) were captured at only four locations (final species confirmation is pending, awaiting genetic analysis). Acoustic analysis identified Northern Myotis at an additional location (Horseshoe Bend). In addition, one location (Wick Creek) detected MYSE through both capture and acoustic detection methods. This provides strong supports that this species was correctly identified. The possibility of Northern Myotis being present in the study area was previously thought to be very unlikely as they are known more from the wet biogeoclimatic zones of the Rockies and northern BC.
2. Townsend's Big-eared Bats are considered a provincially significant species (blue-listed); they were captured at three locations in the study area however acoustic analysis identifies them at two additional locations (Gates and Yalakom Cave). (Note: the Townsend's Big-eared Bat recording at Yalakom Cave may have been the same bat that was eventually captured at Antoine Creek and tracked by telemetry as telemetric monitoring demonstrated that it was using this area). The Bridge River study area now forms the most westerly extent of this species in the Province.
3. The Fringed Myotis was captured, using mist-netting, at only one location, yet it was detected in the acoustic monitoring analysis at two additional locations (Phair Lake and Wick Creek). The Bridge River study area now forms the most westerly range extent of this species in the Province.
4. A significant range expansion was noted, as a result of acoustic monitoring, for the Spotted Bat: the single detection at Carpenter Lake represents the furthest west documented occurrence of this species in British Columbia.
5. Several echolocation calls were also recorded that exhibited characteristics of two provincially significant species; the (Eastern & Western) Red Bat and the Canyon Bat. These species are very difficult to distinguish based on acoustic analysis alone, and as such, are grouped in our reported observations. The detection of any of these species is a significant project observation and would greatly expand their known ranges.
6. Finally, echolocation calls that resemble reference calls for the red-listed Pallid Bat were recorded at Cayoosh Creek (Waterfall Walk net station) and at Horseshoe Bend Antoine Creek net station)(See results: Table 7). These potential detections also would represent very significant range expansions for the Pallid Bat in BC.

Overall, the project findings demonstrate significant expansions to known ranges of several provincially significant rare species. In total, we captured 142 bats, providing confirmation of ten bat species with another two species suspected to be present (Northern Myotis and Keen's Myotis). Confirmation of these two species is pending genetic analysis of wing punches.

Telemetric Monitoring

The documentation of foraging patterns for three Townsend's Big-eared Bats that were telemetrically monitored in the study allows further confirmation of foraging patterns for this species observed in other parts of the province (e.g. Williams Lake (Roberts and Roberts 1996) and the West Kootenay region of BC (Hill *et al* 2006). Although the majority of information available concerning the foraging behavior of this species is descriptive (Holroyd and Craig 2001, Fellers and Pierson 2002, Roberts and Roberts and Roberts 1996, this project) there has been some research that has taken a quantitative approach to understanding foraging requirements. As a part of their research in the West Kootenays, Hill and others (2006) observed that populations of Townsend's Big-eared Bat tend to occur as meta-populations separated by large tracts of landscape that appear to be less suitable for use by the species. Due to the extensive development in the lowland portions of their study area, and the occurrence of Townsends Big-eared Bat populations in areas where valley bottom habitats were relatively intact, they hypothesized that Townsend's Big-eared Bats rely on lowland ecosystems for foraging requirements. They used radio-telemetry to determine foraging behavior of female Townsend's Big-eared Bats and examined use versus availability of habitat types within foraging home ranges to test this hypothesis. They hypothesized that they would find the majority of foraging activity occurring within black cottonwood ecosystems, with bats avoiding areas of open water and upland coniferous forest. Their best supported model (based on multivariate logistic regression for 56 models describing foraging habitat use) identified bats selecting for black cottonwood ecosystems and avoiding both upland coniferous forests and areas of open water, supporting their hypothesis. The results of this study support our project results; we observed similar, albeit unquantified, habitat use patterns during our tracking efforts. The three bats monitored in our project had access to proximal upland habitats, and open water habitats (for the two bats monitored at Cayoosh) and, despite the availability of coniferous forests, open water and grasslands in our study area, this species was observed feeding exclusively in riparian areas. This observation may be at least partially explained by the fact that the Townsend's Big-eared Bat is a moth specialist. Riparian areas have a higher capability to facilitate moth production compared to other habitats in the vicinity due to the abundance and diversity of deciduous vegetation within riparian areas. Indeed, riparian areas likely present optimal conditions for noctuid moth production.

Similar foraging ecology has been observed for the Long-eared Myotis; the use of riparian areas for foraging has been well documented in other studies. The observation of Long-eared Myotis foraging exclusively in riparian areas during this project provides further support for the ecological value of riparian habitats. In general, foraging in areas with abundant prey maximizes net energy intake; this is beneficial for reproductive females burdened by high energy demands associated with fetal growth and lactation. The confirmation, through telemetric monitoring of foraging habitat use patterns, provides further confirmation of the quality of this habitat for foraging bats.

Finally, a preference for rock structures, as roosting habitat, was observed in four of five species that were telemetrically monitored. Rock has the ability to absorb solar radiation and retain heat throughout the nights. Two of the detected roosts were in course talus and all of the other roosts were in warm-aspect cliff faces.

Community Outreach

Engagement with the local community in regard to the conservation of bats will be a lasting legacy of this project. The number of incidental roost locations serves as testament of local interest in bat fauna. Attendance at public outreach events coordinated with the Lillooet Naturalist Society enabled project biologists to reach out to a wide audience. It is hoped that education through outreach will elicit support for local bat populations and recruit the next generation of habitat and bat stewards. Further, if it weren't for community interaction it is very unlikely that we would not have received the entanglement report of M. evotis in burdock, which is a significant observation.

Conclusion

This project provides confirmation that the Bridge River study area currently supports a high diversity of bat species – almost all of BC's bat species have now been confirmed within the BCRP footprint area. The study area occurs within, or along, the continental transition from coastal to interior climates providing a diversity of climatic and vegetative conditions within a concentrated area. The apparent habitat variability may provide a partial explanation for the occurrence of such a diverse array of bat species, with many of these species at the outer extent of their ranges. As an example, significant range expansions were documented for the Spotted Bat, the Western Small-footed Myotis, the Fringed Myotis, Townsend's Big-eared Bat and the Northern Myotis. In addition, acoustic monitoring provides preliminary support for the potential occurrence of up to three more species within the BCRP project area including the (Eastern) Red Bat, the Pallid Bat, and the Canyon Bat. Future studies will be required to enable confirmation of these final three species. In summary, of BC's nineteen species of bats, the project provides confirmation of 12 species, likely confirmation of two more (awaiting DNA) and potential occurrence of three more species (based on acoustic data analysis). The Lillooet area is now recognized as a hot-spot for bat biodiversity in BC.

It is hoped that the results from this assessment project will assist BC Hydro by providing a scientific basis for more effective management of key biotic ecosystem components that are often overlooked, such as critical bat roosting and foraging habitat.

Management Recommendations

Throughout British Columbia there has been extensive loss of valley bottom habitats and associated riparian plant communities, particularly in the southern third of the province. These anthropogenic changes can be attributed to forestry, urban development, agricultural activities, mining and hydro-electric development.

Within the Bridge River area these riparian plant communities are ecologically vital; in dry landscapes they are tightly restricted to creek and lakeshore corridors. Even small losses of this habitat type, in these areas, tend to have significant negative consequences for species that rely on riparian ecosystems for some part of their life cycle. The importance of riparian areas for foraging bats is apparent in the results of this study.

In order to mitigate historic losses the following expert-based recommendations are provided, for incorporation into wildlife management planning and best management practices. The authors recognize that management of bat habitat can occur at both the local and landscape scale, that a 'science-informed' approach is required, and that mitigative options will evolve.

Habitat Management

1. Promote and assist the maintenance and restoration of riparian areas: Riparian ecosystems were demonstrated to provide critical foraging habitats for many species of bats; this is likely due to the availability of surface drinking water, insect prey abundance, and use as movement corridors. As such, conservation, preservation, creation and enhancement of a mosaic of structural stages is recommended to ensure bats have access to suitable foraging habitat. Specifically, and in addition, natural vegetation buffers should be retained between right of way and sensitive wildlife habitat such as riparian or toe of cliffs and native shrub growth should be promoted in these areas.
2. Develop wetland and side channels around impoundment structures: At both Walden North and Terzaghi impoundments BC Hydro should promote enhancement of foraging and drinking opportunities for bats. Promote natural vegetation growth around ponds using representative vegetation to enable insect propagation.
3. Manage, and conserve, roosting habitats in rock features: Avoid extracting talus. This study demonstrated that rock features provide important summer roosts for bats however hibernacula could occur in cool aspect sites. Where necessary, ensure, through inventory that the area is not being used for roosting or hibernation and manage known roost locations to ensure connectivity between roosting and foraging habitat (Holroyd and Friis 2005).
4. Manage, and conserve, roosting habitats in tree features: Retain wildlife trees and enhance tree roosting opportunities through topping and stumping activities. Manage known roost locations to ensure connectivity between roosting and foraging habitat (Holroyd and Friis 2005). Several species of bats are obligatory tree roosters, although others can roost in trees or in rock features.
5. Avoid pollution and nutrient enrichment of aquatic environments: Avoid use of pesticides. Pollution can reduce aquatic invertebrate production (Holroyd and Friis 2005).
6. Provide alternate roosting opportunities for bats: Install bat boxes and cavernous roosts at BC Hydro controlled properties to provide alternate roosting opportunities for bats in an effort to recover some local populations of bats that have been affected by losses of roosting habitat in the landscape.
7. Implement an invasive plant control program: A single incidental observation of *M. evotis* entanglement with burdock was reported during out project (photo: on file with provincial government). This represents the second reported incident on record (Hendricks et al. 2003), although other accounts of this also exist in unpublished literature. A burdock control program could be implemented to avoid bat entanglement in Burdock seed heads. Burdock grows in riparian areas, where most bat species spend much of their time foraging.
8. Implement a no-net loss policy for bat roosting features: A potential Townsend's Big-eared Bat roost, in the attic of the Seton-Portage Community Hall, was destroyed in a fire in fall 2010. A new roost structure should be built at, or near, this site. The constructed roost should feature an enclosed attic erected on posts (~12'x18'), with a slotted entry in one 'gable' end to provide access for bats.
9. Protect known roosting locations under the Land Act, Ministry of Forest Lands and Natural Resources staff to develop Section 17 notifications under the Land Act for the protection of roosting locations.

Inventory and Research

1. Continue to obtain distribution ranges and habitat use on rare bats within the study area: The 2010 bat assessment projected documented the presence of 10 species, the potential confirmation of two more species pending and suspected detection of three more species. In total, as many as 15 species occur, or are suspected to occur, within the BCRP area. In addition, two of these species are currently listed by COSEWIC as data deficient (including: Keen's Myotis and Fringed Myotis). Confirmation, and improved understanding of species distribution and habitat associations, will require further inventory, including genetic and acoustic sampling, and telemetry (COSEWIC 2004). Assess sub-population status of Pallid bat.
2. Examine bat use of penstock structures: Visual surveys and acoustic detectors could be used to determine the summer use, by bats, of these features. Acoustic detectors could be installed to passively monitor these sits for the summer to derive baseline information. Enhancement of the penstock structures would probably not be considered as future maintenance or decommissioning of an occupied structure would likely impact any bats that had come to rely on them. However, understanding the current bat use of structures would help avoid unnecessary impacts to the bats and allow for mitigative planning and adoption of bat deterrence features at these structures.
3. Conduct bat hibernacula work, including the mine and cave surveys: Mines and caves in the area should be catalogued and investigated during the winter for hibernating bats, where it is safe to do so. Acoustic detectors could be placed at strategic locations (e.g. where hibernacula are suspected or where development is being considered) to determine whether fall "swarming" occurs (NB: swarming often occurs prior to copulation in the late fall, just before bats enter hibernation).

Mitigation

1. Control light pollution in key foraging areas: Bat vision is affected by artificial illumination which can cause disruption in natural patterns of movement and foraging. Mitigation options include implementation of a light curfew throughout April to September at sites such as Walden North and Terzaghi Dam. In addition, light sources should be switched to low pressure sodium lamps and shrouded at impoundment structures (Fure 2006).

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Appendices

Appendix I: Financial Statement

	BUDGET		ACTUAL	
	BCRP	**Other**	**BCRP**	**Other**
INCOME				
Total Income by Source	43,800.00		43,800.00	1,000.00
Grand Total Income (BCRP + other)				
EXPENSES	**Note: Expenses must be entered as negative numbers (e.g. – 1000, etc.) in order for the formulas to calculate correctly.**			
Project Personnel				
Wages (biologists)	27,150.00	1,000.00	36,550.00	1,000.00
Consultant Fees				
(List others as required)				
MOE in-kind		15,000.00		15,000.00
Materials & Equipment				
Equipment Rental				
Materials Purchased				
Holohil Bat tags	2,250.00		3,074.80	
Helicopter	3,000.00		2,975.19	
Travel Expenses				
Satellite Phone		1,000.00		1,000.00
Permits	110		0	
(List others as required)				
Administration				
Admin		500.00		
Photocopies & printing				
Outreach Promotion	150.00		466.89	
(List others as required)				
Total Expenses	32,660.00	***17,500.00***	***43,066.88***	***17,000.00***
Grand Total Expenses (BCRP + other)	***50,160.00***		***60,066.88***	
BALANCE (Grand Total Income – Grand Total Expenses)	The budget balance should equal $0		*The actual balance might not equal $0** ***+733.12***	

* Any unspent BCRP financial contribution to be returned to: BC Hydro, BCRP
6911 Southpoint Drive (E04)
Burnaby, BC V3N 4X8
ATTENTION: SCOTT ALLEN

Appendix II: Performance Measures-Actual Outcomes

Performance Measures – Target Outcomes													
			Habitat (m^2)										
Project Type	**Primary Habitat Benefit Targeted of Project (m^2)**	**Primary Target Species**	Estuarine	In-Stream Habitat – Mainstream	In-stream Habitat – Tributary	Riparian	Reservoir Shoreline Complexes	Riverine	Lowland Deciduous	Lowland Coniferous	Upland	Wetland
Impact Mitigation													
Fish passage technologies	Area of habitat made available to target species												
Drawdown zone revegetation/stabilization	Area turned into productive habitat												
Wildlife migration improvement	Area of habitat made available to target species												
Prevention of drowning of nests, nestlings	Area of wetland habitat created outside expected flood level (1:10 year)												
Habitat Conservation													
Habitat conserved – general	Functional habitat conserved/replaced through acquisition and mgmt	Bats					X	X		X			
	Functional habitat conserved by other measures (e.g. riprapping)												
Designated rare/special habitat	Rare/special habitat protected	Bats							X	X	X		
Maintain or Restore Habitat forming process													
Artificial gravel recruitment	Area of stream habitat improved by gravel plmt.												
Artificial wood debris recruitment	Area of stream habitat improved by LWD plcmt												
Small-scale complexing in existing habitats	Area increase in functional habitat through complexing												
Prescribed burns or other upland habitat enhancement for wildlife	Functional area of habitat improved												
Habitat Development													
New Habitat created	Functional area created												

Appendix III: BCRP Recognition

Western Bat Working Group Newsletter

Issue No. 17 **Autumn 2010**

Lillooet Bat Inventory

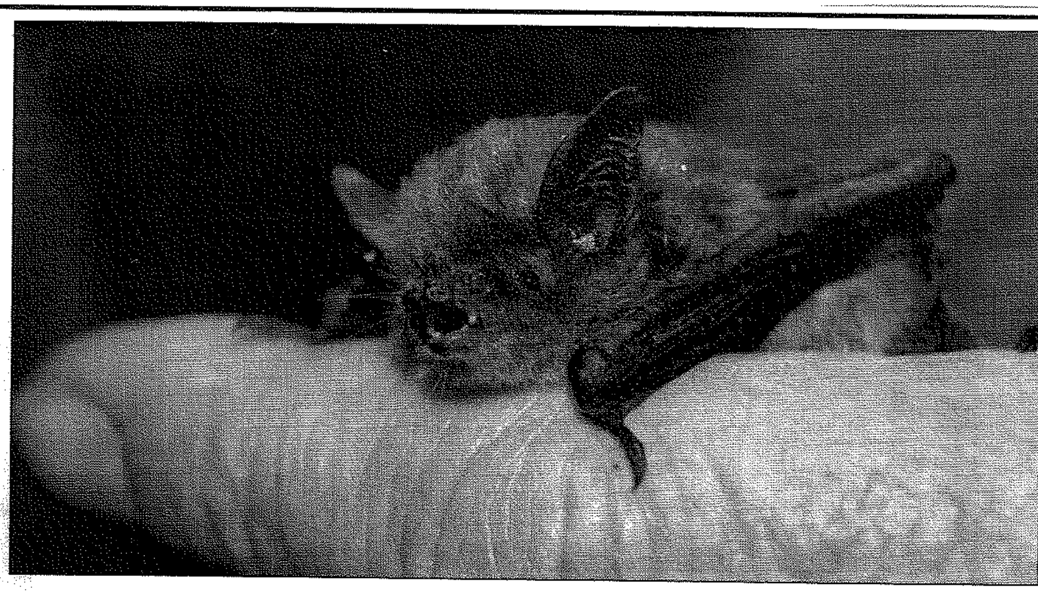
Mike Sarell, Ophiuchus Consulting

BC Hydro Fish and Wildlife Compensation Program (FWCP) and the Ministry of Environment funded the sampling of over 20 sites in the Lillooet area. The study area has a rugged topography and ranges from dry bunch-grass ecosystems along the Fraser River west into the wet watersheds toward the coast. This summer was the first time that the bat fauna in Lillooet was extensively sampled. We captured a total of 10 species. In addition to the usual suspects, we confirmed the presence of townsend's big-eared bats, western small-footed myotis and the fringed myotis, which are range expansions for these species. We also reconfirmed that spotted bats are present, albeit in low numbers. DNA and acoustic call analysis may yield additional species. Five bats were tracked using radiotransmitters. The most significant finding was townsend's big-eared bats using natural caves as roosts and foraging almost exclusively in riparian areas. Similar behaviour also was observed with a fringed myotis.

This project was successful in meeting all objectives and could not have been possible without support from the community of Lillooet and the Lillooet Tribal Council. In particular, the Lillooet Naturalist Society volunteered over 250 person hours for the project. Two community outreach events were a definite highlight for project biologists, these events drew over 100 people and provided everyone an opportunity to get involved in a night of mist netting while learning more about these elusive animals.

The bat team consisted of Mike Sarell, Thomas Hill, Jared Hobbs and Francis Iredale. Special thanks to Vivian Birch-Jones and Ian Routley, as well as many other keen volunteers, that assisted with the project. Breanne Patterson (FWCP) oversaw the project and enthusiastically helped on several nights.

Lillooet Newspaper article:



Mouse on wings

Fifty people attended a presentation on local bat life at the Lillooet Friendship Centre led by B.C. Environment Ministry biologists Jared Hobbs and Francis Iredale Sunday night. An outdoor session at the upper Cayoosh salmon spawning channels followed the presentation. There, the crowd was able to meet bat expert Mike Sarell at work trapping and surveying bat species (and meet the bats themselves, like the little brown myotis above, the most common species in the area). The ministry, Lillooet Naturalist Society, and Lillooet Tribal Council are studying the local bat population and distribution with funding from the Bridge Coastal Restoration Program.

Lillooet Newspaper article:

community

This is the Lillooet Naturalist Society's and MOE's first documented proof of the Western Small-footed Myotis in this area.

Bat chat and field trip well-attended

VIVIAN BIRCH-JONES
Special to the News

A well-attended BAT education evening with a field trip was held in Lillooet, Sunday evening, June 27th.

Research on bats in the Bridge and Seton watersheds is being funded by BC Hydro's BCRP program this year, and experts Mike Sarrell RPBio, and MOE biologists Jared Hobbs RPBio/MSc and Francis Iredale RPBio are currently working on this project in our area. Jared and Francis led a presentation at the Friendship Centre and we also enjoyed refreshments and bat chat there.

A raffle was held and a couple visiting from New Zealand won a prize, a First Nations hummingbird print, and local naturalist, Ursula Stephan, won the other prize - the last copy of the first edition of the Lillooet Hiking Guide. Profits from the joined the researchers (once we found them in the dark) and observed them mist-netting and identifying local bats.

Nineteen captures representing six species, Little Brown Myotis, Yuma Myotis, California Myotis, Western Long-eared Myotis, Western Small-footed Myotis and Big Brown Bat plus an auditory detection of the Spotted Bat brought the tally to seven species for the night.

The evening was a success, in terms of research as well as community participation and education. This research session is the first of two that will be help over the summer. Updates and a final report will be available on the website www.lillooetnaturalistsociety.org.

For people wishing to learn more about the project, the next bat education session will be held in conjunction with the Salmon

Lillooet Community Outreach Poster:

Little Brown Bat Photo:
Jared Hobbs,
Hobbs Photo images Co

Sunday June 27, 2010

Time: *7:30 – 8:30 pm* **Presentation**
8:30 – 9:00 pm **Refreshments and Bat Chat**
9:15 – 10:00 pm **Bat Outreach** at the Lower Spawning Channel
To 'hear' and see bats and observe mist netting. Join us for all or part

Where: ***Presentation and Refreshments*** at the Lillooet Friendship Centre
Bat Outreach follows at the Lower Spawning Channel

Admission by donation to the Friendship Centre Food Bank

Everyone Welcome!

British Columbia boasts the highest bat species diversity of all of the Canadian provinces and represents the northern range limit for many bat species. The Ministry of Environment, in partnership with the Lillooet Tribal Council and Lillooet Naturalist Society, have obtained funding through the BC Hydro Fish and Wildlife Bridge Coastal Restoration Program to implement field studies to determine bat species presence and distribution within the Lillooet area.
Please join British Columbia's leading bat expert Mike Sarell and Ministry of Environment Biologists Jared Hobbs and Francis Iredale as they introduce you to the fascinating world of bats. We invite you to spend an evening getting to know these amazing creatures and to observe a bat mist netting session. Please dress accordingly for the weather as a portion of the evening will be spent outside listening to and observing bats.

Lillooet Naturalist Society

BC HYDRO FISH & WILDLIFE BRIDGE COASTAL RESTORATION PROGRAM

BRITISH COLUMBIA

Lillooet Riparian Areas -sign:

Appendix IV: Call characteristics used for acoustic analysis

Table 9: Categories of echolocation calls used to differentiate bat species and/or species groups.

Category Label	General Description	Species Potentially Belonging to Category	Defining characteristics of category
40K	40 kHz Myotis	Myotis volans, M. ciliolabrum, M. lucifugus (less likely but possibly M. septentrionalis)	minimum frequency approximately 40 kHz; calls of moderate slope
50K	50 kHz Myotis	M. californicus, M. yumanensis (possibly M. septentrionalis)	minimum frequency 45-50 kHz
COTO	Big-eared bat	Corynorhinus townsendii	steep calls with minimum frequencies around 25 kHz; split harmonics prevalent
EPFU	Big brown bat	Eptesicus fuscus	calls with minimum frequency less than 23 kHz; moderate to low sloped calls
EPFU/ LACI	Hoary or Big brown bat	Lasiurus cinereus, Eptesicus fuscus	calls with minimum frequency 20-25 kHz; moderate slope; few pulses in sequence such that pattern cannot be deduced
EPFU/ LACI/ LANO	Big brown bat, or Hoary, or Silver-haired	Lasiurus cinereus, Eptesicus fuscus or Lasionycteris noctivagans	calls with minimum frequency 25-35 kHz; moderate slope; few pulses in sequence such that pattern cannot be deduced
EPFU/ LANO	Big brown or silver-haired bat	Eptesicus fuscus or Lasionycteris noctivagans	calls with minimum frequency (Fmin) 25-35 kHz; moderate to low slope; sequence of pulses maintain consistent Fmin pattern
HighFreq	High Frequency bat	M. volans, M. ciliolabrum, M. lucifugus, M. septentrionalis, M. californicus, or M. yumanensis and although less likely, possibly M. evotis (remote possibility: Parastrellus hesperus and Lasiurus borealis if in area, but these species not reported to be present).	poor quality pulses above 35 kHz that are clearly bat but fragments do not allow further identification
LACI	Hoary bat	Lasiurus cinereus	calls with minimum frequency (Fmin)<20 kHz with low slope; or calls with Fmin 20 - 30 kHz with moderate slope and a sequence of pulses that clearly undulate up and down in Fmin pattern
LANO	Silver-haired bat	Lasionycteris noctivagans	calls with minimum frequency >23kHz; flat pulses of near zero slope
Long-ear	Long-eared Myotis or Northern Myotis	M. evotis or M. septentrionalis	steep calls with minimum frequencies >35Hz
LowFreq	Low Frequency bat	Lasiurus cinereus, Eptesicus fuscus, Lasionycteris noctivagans, Corynorhinus townsendii, M. thysanodes (unlikely, but also could include Antrozous pallidus--although not known from area)	poor quality pulses < 35 kHz that are clearly bat but fragments do not allow further identification
MYCA	Californian Myotis	M. californicus	easily confused with M. yumanensis; known only due to identification in hand (reference calls)

Category Label	General Description	Species Potentially Belonging to Category	Defining characteristics of category
MYEV	Long-eared Myotis	M. evotis	steep calls with minimum frequency (Fmin) 30 kHz or higher; confused with steep calls of M. septentrionalis above 35 kHz
MYLU	Little brown Myotis	M. lucifugus	easily confused with other 40 kHz Myotis; identifiable only with minimum frequency is ~35 kHz with moderate to low sloped calls that have a prominent elbow
Myotis Sps	all 40 or 50 kHz Myotis	M. volans, M. ciliolabrum, M. lucifugus, M. californicus, M. yumanensis, M. septentrionalis	calls that have minimum frequencies between 40-50 kHz; multiple bats, Fmin at exactly 45 kHz and/or highly fragmented pulses lead to this categorization
MYSE	Northern Myotis	M. septentrionalis	steep calls (with time between calls at least 80 ms) with minimum frequencies higher than 40 kHz; potential confusion can occur with 40kHz or 50kHz bats in high clutter producing approach phase pulses
MYTH	Fringed Myotis	M. thysanodes	steep calls with minimum frequencies of 25 kHz; no split harmonics
MYTH/ MYEV	Fringed or Long-eared Myotis	M. thysanodes or M. evotis	steep calls with minimum frequencies ~27kHz; no split harmonics
MYVO	Long-legged Myotis	M. volans	easily confused with other 40 kHz Myotis; usually identifiable only due to identification in hand (reference calls), although occasional presence of upsweep at start of call is diagnostic
MYYU	Yuma Myotis	M. yumanensis	easily confused with M. californicus; Fmin 45-50 kHz with moderately low slope and elbow producing S-shaped pulses
Non ID Bat	Non-identifiable bat	likely one of: M. evotis, C. townsendii, M. lucifugus, Eptesicus fuscus, Lasionycteris noctivagans (Antrozous pallidus also possible but not known from area)	due to fragmented pulses (poor quality recording) fragments ranging from 25-35 kHz cannot be assigned to High or Low Frequency category
Buzz	Feeding Buzz	all bats can produce these	indicative of foraging, these pulses have short time between calls (<50 ms) and generally rise up in frequency from the preceding search and approach-phase calls; not easily recorded by Anabat so will be under-represented
Poor Quality	not bat	none	a fragment of one pulse present, but not conclusively bat; to qualify as bat, there must be either one very clear high quality pulse, or at least 2 moderate quality pulses
Noise	not bat	none	scattering of dots not from bat ultrasound

Appendix V: Project Data

Table 10: Interpretation of search phase calls for all stations in the study area.

Station	40K	50K	Coto	Epfu	Epfu Laci	Epfu Laci Lano	Epfu Lano	High Freq	Laci	Lano	Long ear	Low Freq	Myca	Myev	Mylu	Myotis	Myse	Myth	Myth Myev	Myvo	Myyu	Non IDBat	Total
A01 Downton	1	2		1			4				1					2							11
A02 Bridge	19	22				5	16	8		2				2	1	18						1	94
A03 Upper Spawn	5	5									3			2		4							19
A04 Camoo	35	59					2	5			1					94							196
A05 Phair Lk	3	2					7			9		1			1			1				1	25
A06 Waldon N	62	16				2	26	10		1						94							211
A07 Texas 1	1					1		1															3
A08 Waterfall Walk	54	50	2			6	4	3			7	8		27		51			3			4	219
A09 Asplundh	26	15		10	2	24	29	1			1					12						1	121
A10 Yalakom Cave	43	4	1		1		7	7								8						1	72
A13 Wick	11	69	1			1	1	7				1	1	3		24	2	2				1	124
A14 Gates	15	46	1			1	3	3			1	1		10		24						2	107
A16 Horseshoe	24	69		11			12	6						7		39					1		169
A17 Antoine	17	12			1	1	2	1	1			1		3		25							64
A18 Sebring	22	6												16		6							50
A19 WhiteCap		13						2						2		4							21
A20 Broadhead	10	20		10	1		4		1					4		4					2	1	57
A21 Texas 2	32	33					4	7								25						1	102
A22 LowerSpawn	34	23					1	2					1			21					3		85
A23 Cat Pond	12	52			1	1		13			1			3		27		1		1		1	113
Grand Total	426	518	5	32	6	42	122	76	2	12	15	12	2	79	2	482	2	4	3	1	6	14	1863

Table 11: Incidental bat maternity and day roosts confirmed during the project.

Roost ID	Date	Elevation	Surveyor	Species	Z	Easting	Northing
Confidential	July 5, 2010	173 m	MS, JH, FI	M-MYYU	10	Confidential	Confidential
Confidential	June 28, 2010	358 m	MS, JH, FI	M-MYLU	10	Confidential	Confidential
Confidential	August 26, 2010	273 m	MS, JH, FI	M-MYYU	10	Confidential	Confidential
Seton Community Centre	August 26, 2010	273 m	MS, JH, FI	M-COTO	10	553300	5619851

Table 12: Telemetric monitoring data, including estimated roost locations of bats tracked.

Bat ID	Date	Z	Easting	Northing	Location
LANO CAP	01-Jun-10	10	571861	5612244	Walden
lano_093	01-Jul-10	10	570690	5611868	Cayoosh
COTO 1ST CAP	July 2 2010	10	572262	5613005	Cayoosh
coto_152	03-Jul-10	10	573271	5613266	Cayoosh
coto_152	05-Jul-10	10	573134	5614045	Cayoosh
coto_152	06-Jul-10	10	573163	5613959	Cayoosh
coto_152	07-Jul-10	10	573207	5613928	Cayoosh
coto_152	08-Jul-10	10	573196	5613931	Cayoosh
coto_171	03-Jul-10	10	572591	5614006	Cayoosh
coto_171	05-Jul-10	10	572554	5614130	Cayoosh
coto_171	06-Jul-10	10	572569	5614211	Cayoosh
coto_171	07-Jul-10	10	571640	5613961	Cayoosh
coto_171	08-Jul-10	10	572559	5614169	Cayoosh
EPFU CAP	03-Jul-10	10	573795	5613769	Cayoosh
epfu_493	05-Jul-10	10	572349	5612828	Cayoosh
epfu_493	06-Jul-10	10	572338	5612854	Cayoosh
epfu_493	07-Jul-10	10	572424	5612816	Cayoosh
epfu_493	08-Jul-10	10	572418	5612818	Cayoosh
MYEV CAP 1	July 2 2010	10	572262	5613005	Cayoosh
myev_034	21-Aug-10	10	572498	5612722	Cayoosh
myev_034	22-Aug-10	10	572407	5612875	Cayoosh
myev_034	24-Aug-10	10	572436	5612920	Cayoosh
myev_034	25-Aug-10	10	572527	5612887	Cayoosh
myev_034	26-Aug-10	10	572477	5612888	Cayoosh
myev_014	21-Aug-10	10	572498	5612722	Cayoosh

Bat ID	Date	Z	Easting	Northing	Location
myev_014	22-Aug-10	10	572407	5612875	Cayoosh
myev_014	24-Aug-10	10	572437	5612912	Cayoosh
myev_014	25-Aug-10	10	572527	5612887	Cayoosh
myev_014	26-Aug-10	10	572477	5612888	Cayoosh
MYEV CAP 2	22-Aug-10	10	560181	5634052	Antoine
myev_144	23-Aug-10	10			bridge river
myev_144	24-Aug-10	10	560288	5634157	bridge river
myev_144	25-Aug-10	10	560288	5634157	bridge river
myev_144	26-Aug-10	10	560288	5634157	bridge river
myev_144	27-Aug-10	10			bridge river
myev_144	28-Aug-10	10	560288	5634157	bridge river
COTO CAP 2	22-Aug-10	10	560181	5634052	Antoine
coto_294	27-Aug-10	10	559363	5624225	bridge river
coto_294	31-Aug-10	10	555856	5634348	bridge river
MYTH CAP		10	581468	5604947	Texas fsr
myth_072	31-Aug-10	10	582248	5607727	Fraser river

Appendix VI: Species Accounts

The following accounts detail findings, on a species-by-species basis, for each bat species encountered during the field component of the project.

California Myotis

California Myotis (*Myotis californicus*) are widespread in the southern third of the province (Nagorsen and Brigham. 1993). Their flexible roosting and foraging requirements enable this bat to exploit a broad variety of ecosystems. The species also appears to be very cold tolerant; several reports of winter feeding exist. A total of 39 individuals were captured in this study in 13 netting locations (Figure 19), making them the most common bat netted.

Western Small-footed Myotis

Western Small-footed Myotis (*Myotis ciliolabrum*) are restricted to the southern interior of the province. The species is Blue-listed (Garcia and others 1995). The discovery of these bats in the Bridge River study area constitutes the most westerly known population in the province (NB: they may have been documented in the Skagit Valley (M. Firman pers. com.). This species is often associated with rocky environments as it uses rocky areas for both roosting and foraging. Only five individuals were captured at four locations during our project. All sites were within close proximity to warm aspect rocky areas (Figure 9). These bats are as small as California Myotis but have bare snouts and have very pale fur with contrasting dark skin.

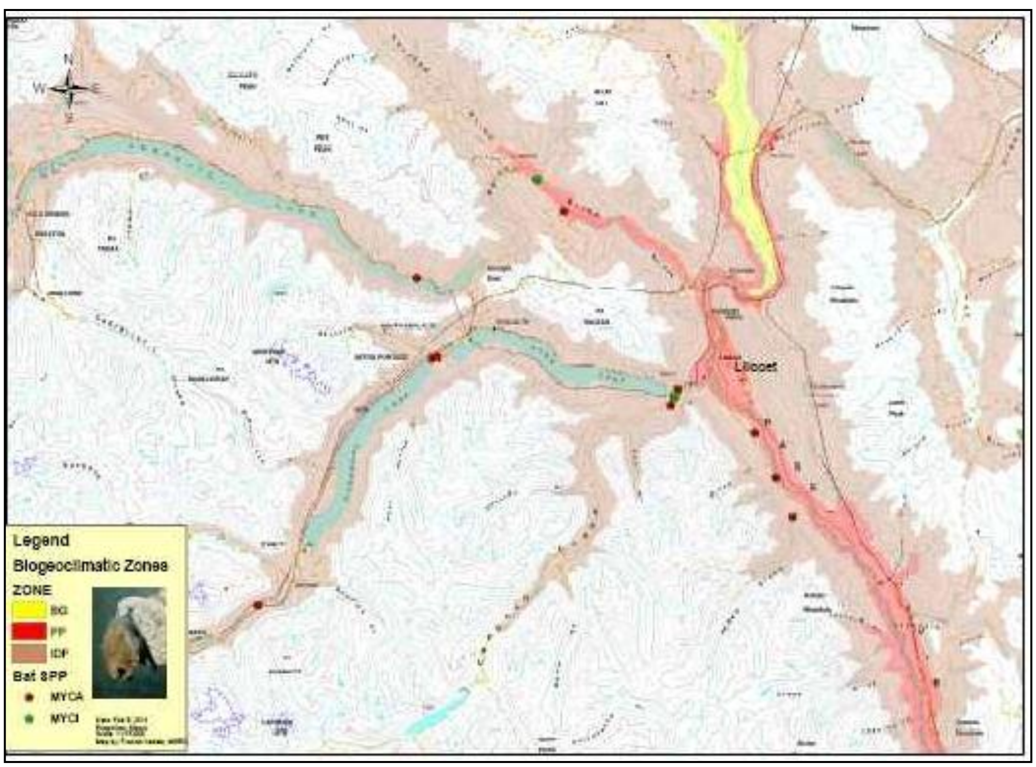


Figure 9: Capture locations of California and Western Small-footed Myotis.

Little Brown Myotis

The Little Brown Myotis (*Myotis lucifugus*) is the most widely distributed species of bat in the Province. Much like the California Myotis, this species ability to utilize many diverse roost features and its ubiquitous foraging strategies enables the species to persist in many different ecosystems. Only 31 individuals were captured in eight locations during our project however two large maternity roosts were documented in the Lillooet area. Their ability to consume large volumes of mosquitoes makes this bat an important species for communities in the study area.

Yuma Myotis

Yuma Myotis (*Myotis yumanensis*) inhabit the southern third of the province and are common within their documented range. They not only look very similar to Little Brown Myotis but they are also known to occupy the same niches. As such, it is plausible that some of the Yuma Myotis and Little Brown Myotis bats identified in this project may have been mistakenly identified, especially when just viewing them within a roost. A total of seven individuals were captured in four locations (Figure 9). Based on our capture data the Yuma Myotis does not appear to be as common as the Little Brown Myotis in the study area.

Northern Myotis

The Northern Myotis (*Myotis septentrionalis*) was once thought to be very uncommon in the BC but continued, and ongoing, bat fauna studies have confirmed the species occurrence at a number of discrete localities within the central and northern part of Province. As a member of the long-eared Myotis clade, the Northern Myotis in BC actually resembles most closely a Little Brown Myotis with slightly longer ears. Genetic analysis is often the only reliable way to distinguish the two species. The Northern Myotis typically roosts in trees forages in heavily forested areas. Their high frequency echolocation calls provide a high resolution representation of their environment, enabling them to catch small prey, navigate in cluttered environments and avoid being ensnared by mist nets. A total of only four individuals were captured at four separate locations within our study area. All were in dense forest locations with the singular exception of one individual that was captured as it tried to enter a mine. Wing punches for genetic analysis were taken.

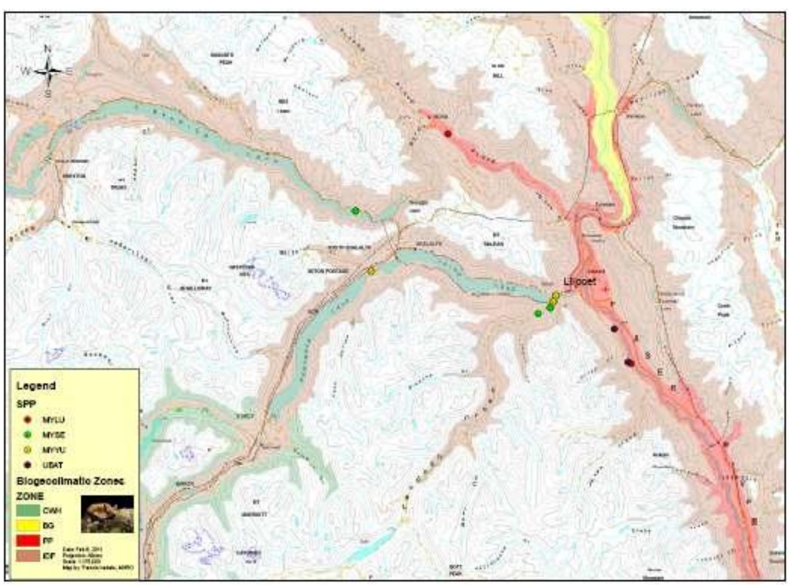


Figure 10: Locations of Little Brown, Yuma and suspected Northern Myotis encounters.

Long-legged Myotis

Long-legged Myotis (*Myotis volans*) are moderately common within their range. They have been found throughout most of the Province and have very broad roosting and foraging relationships. Despite being widely encountered, very little is known about their hibernacula or maternity roosts. In fact, only two maternity roosts have been documented (Nagorsen and Brigham 1993). A total of eight individuals were captured during this project (Figure 11). Two lactating females were captured at Yalakom rock shelter and more than 10 were observed emerging from a crevice just above the top of the entrance to the rock shelter (Figure 10).

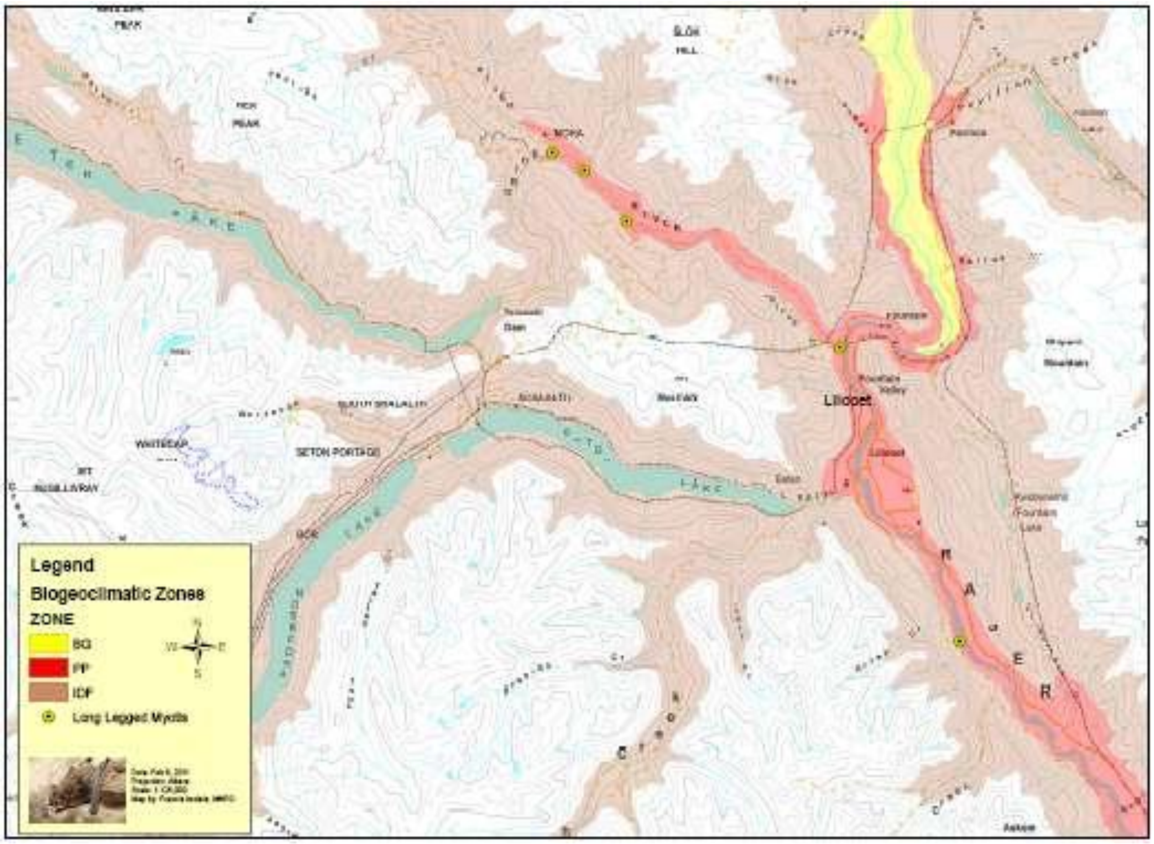


Figure 11: Capture locations of Long-legged Myotis

Western Long-eared Myotis

Long-eared Myotis (*Myotis evotis*) are a resident species that occurs throughout the southern half of the Province. They are known to occur within a large elevation gradient and are known to roost in a variety of structures, including rock crevices (Nagorsen and Brigham 1993). A total of 37 individuals were captured, making this species the second most common bat encountered during this study. Long-eared Myotis were captured in six locations that were widely distributed throughout the study area (Figure 12). Within our study area parturition was observed to occur in late June and into early July. Telemetry was conducted on three Long-eared Myotis including two from the Cayoosh/Seton watershed and one from the Bridge River area. All three bats monitored were lactating females; they each used warm aspect solar rock features for day roosting. This observation of maternity roost sites located within insolated rock features is consistent with existing knowledge regarding the roosting ecology of these species in Canada (Chruszcz and Barclay 2002, Hill and others 2006, Nagorsen and Brigham 1993).

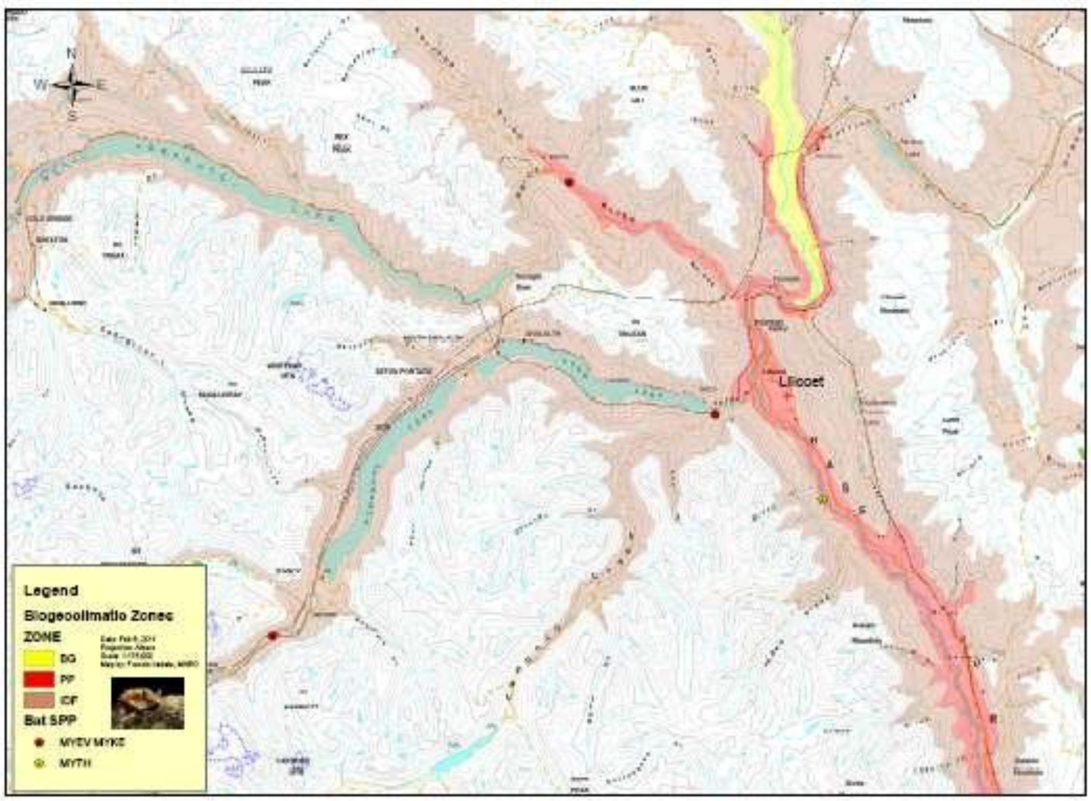


Figure 12: Capture locations of Long-eared and Fringed Myotis.

Figure 13: Comparison of hairless ears of Long-eared Myotis (left) to Fringed Myotis (right) with a prominent band of hair on the medial inner ear.

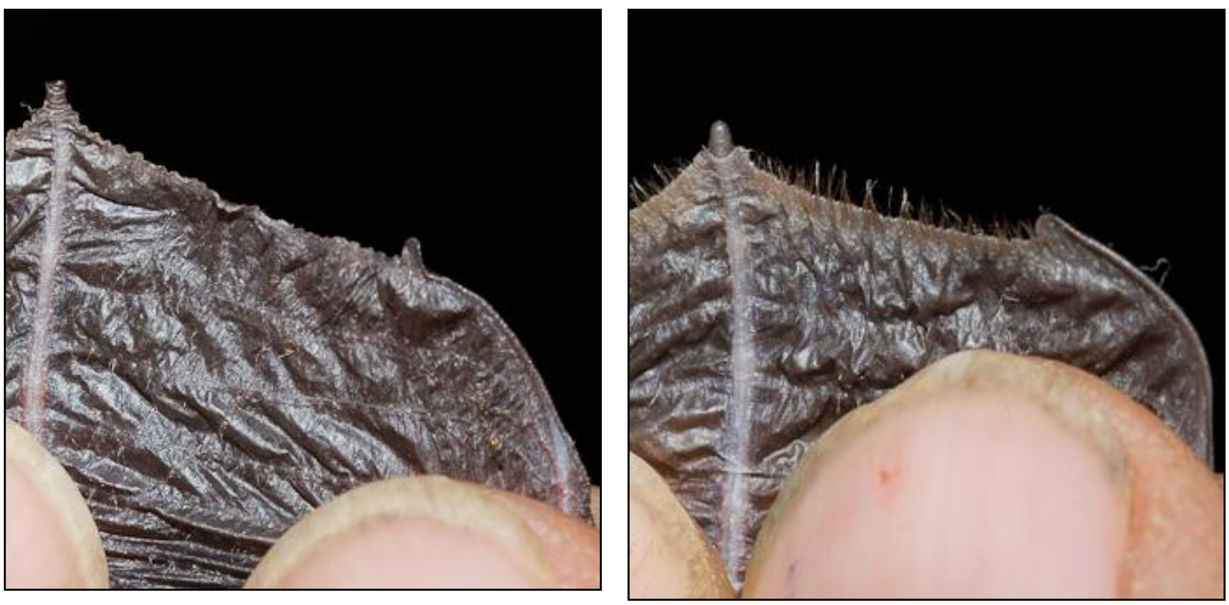


Figure 14: Comparison of symmetric tab of Long-eared Myotis (left) Fringed Myotis (right) with coarse long hairs and tabs pointing toward tail.

Fringed Myotis

The Fringed Myotis (*Myotis thysanodes*) inhabits the dry southern interior of the Province and is Blue-listed. The species is considered Data Deficient by COSEWIC. Prior to this study there were no records for this bat species in the Lillooet area (COSEWIC 2004). This study resulted in the capture, and telemetric monitoring, of a single adult male Fringed Myotis on the last night of netting in the main Fraser valley in an area ~20km south of Lillooet (Figure 11). The bat was observed roosting on the other side of the Fraser Valley within a fracture near the top of a small rock outcrop. It is most likely that Fringed Myotis are uncommon bat species in the study area, as only one was captured. Refer to Figure 13 and Figure 14 for photographs.

Keen's Myotis

The Keen's Myotis (*Myotis keenii*) is a coastal species and has the smallest documented range of any North American bat. Morphologically, this species bears a very resemblance to the Long-eared Myotis; we suspect this bat was captured during this study but further discussion will is pending genetic analysis of wing punches. In the interim, suspected Keen's Myotis were recorded as Long-eared Myotis.

Hoary Bat

Hoary Bats (*Lasiurus cinereus)* are also a tree roosting species and are migratory within their range in BC. This species is rarely reported in abundance but is thought to be widespread across all of North America. No Hoary Bats were captured during the study however several were detected as a result of acoustic monitoring. This result is consistent with our expectations; this species typically forages high above the forest canopy and is often difficult to capture.

Western Red Bat

Very little is known about the ecology and distribution of the Western Red Bat (*Lasiurus blossevillii*) in BC. It has been detected, using acoustic monitoring, in the Okanagan valley and a single specimen was reported from the lower Skagit Valley however this specimen was recently confirmed as an Eastern Red Bat (*Lasiurus borealis*). The status of the Western Red Bat in BC is 'unknown' . None were captured during this study however a single acoustic detection of a Red Bat (species uncertain) was recorded near Cayoosh Creek on night eight. Future surveys are required to confirm the presence of the either the Eastern or Western Red Bat within the study area.

Big Brown Bat

The Big Brown Bat (*Eptisicus fuscus*) is a common species in BC and is widely distributed in the southern half of the BC and in the northeastern corner of BC, along the Peace River valley. This bat aggregates in small colonies and has been confirmed roosting in trees, buildings and rock crevices. Big Brown Bats forage high above the ground and are thought to be of a generalist in there foraging habitat selection relative to other species. Despite being a relatively common bat species in the area, only five individuals were captured and each capture was recorded at separate sites (Figure 15). A single adult male was marked for telemetric monitoring near Lillooet; it was subsequently tracked and an estimated roost location was reportedly re-used over five consecutive days in early July. The estimated roost site was located within a warm aspect rock face.

Silver-haired Bat

The Silver-haired Bat (*Lasionycteris noctivagans*) is widely distributed across the Province; they appear to be an obligatory tree roosting species. The species is suspected to migrate, from its range in BC, to overwinter in the US. In general, the species is thought to be migratory, as this has been documented elsewhere, yet some records of overwintering hibernation exist for the Province. Only one Silver-haired Bat was captured during this study (Figure 15). The adult male that was captured was marked for telemetric monitoring however only a single roost location was discovered within a Douglas-fir snag. The transmitter subsequently failed or the bat made a large scale move as we were unable to detect it after the first day of tracking. Although we were only able to identify one roost for this bat, the use of sloughing bark on a snag in an intermediate decay class is consistent with what observations for the species elsewhere in BC (Vonhof and Gwilliam 2000) and Canada (Parsons and others 1986).

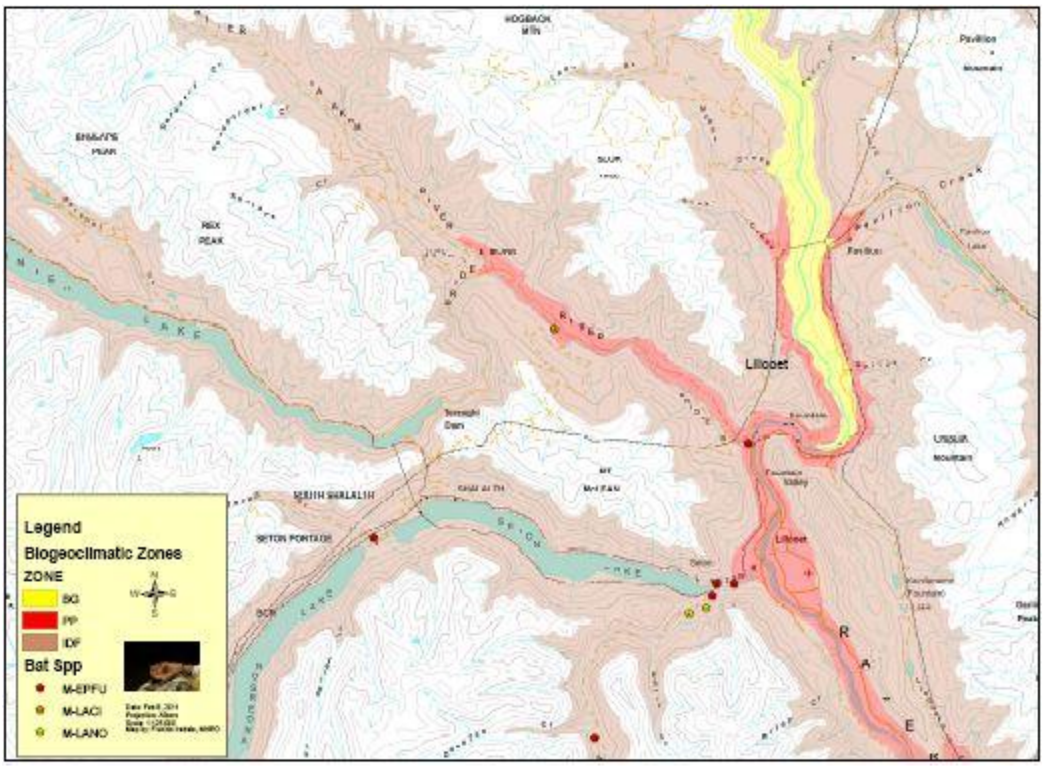


Figure 15: Capture locations of three Big Brown Bats and a single Silver-haired Bat.

Townsend's Big-eared Bat

The Townsend's Big-eared Bat (*Corynorhinus townsendii*) is considered rare throughout its range yet it has been the focus of several ecological studies. To date, Townsends Big-eared bats have only been documented roosting in cavernous features; historically this behavioral trait may have limited roost availability for the species to caves in bedrock or blocks of talus. More recently, Townsend's Big-eared Bats have been recorded roosting in attics; in fact, anthropogenic structures are now the most commonly reported structure used as maternity roost sites. A total of four Townsend's Big-eared Bats were captured in this study, of which only one was a female. Two were captured during night eight (Cayoosh Creek-Waterfall Walk) and the other two were captured at Antoine Creek and Wick Creek on night 13 and night 17 respectively (Figure 16).

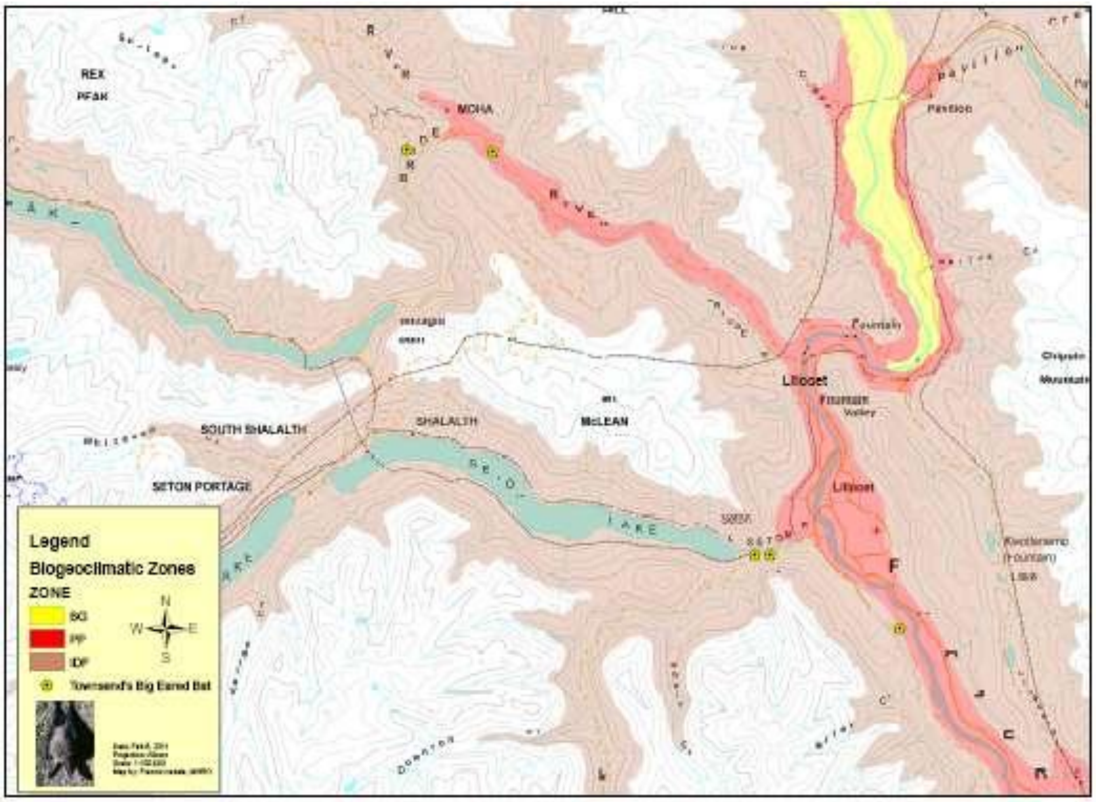


Figure 16: Capture and roost locations for Townsend's Big-eared Bats

Spotted Bat

Spotted Bats (*Euderma maculatum*) have only recently been confirmed to occur in BC. The first detections of this species occurred in the south Okanagan and were the result of recognition, by researchers, of their audible echolocation calls (Fenton and others 1987). Subsequent to their initial detection in BC, Spotted Bats have also been detected in the Thompson and Cariboo regions and in the Lillooet area (Hobbs. pers obs. 2002). The Spotted Bat has a distinctive and spectacular appearance; they have large pink ears, a black base pelage and three white spots on their back.

Spotted Bats are known to roost singly, in fissures within tall vertical cliff faces. As such, viable populations likely require an abundance of roosting opportunities throughout their home range. In total, nine potential and three confirmed audible detections were recorded in the study area (Figure 15). Our most significant spotted bat detection occurred at Sebring Creek, on August 24th, 2010. This record represents the most westerly detection of this species in BC.

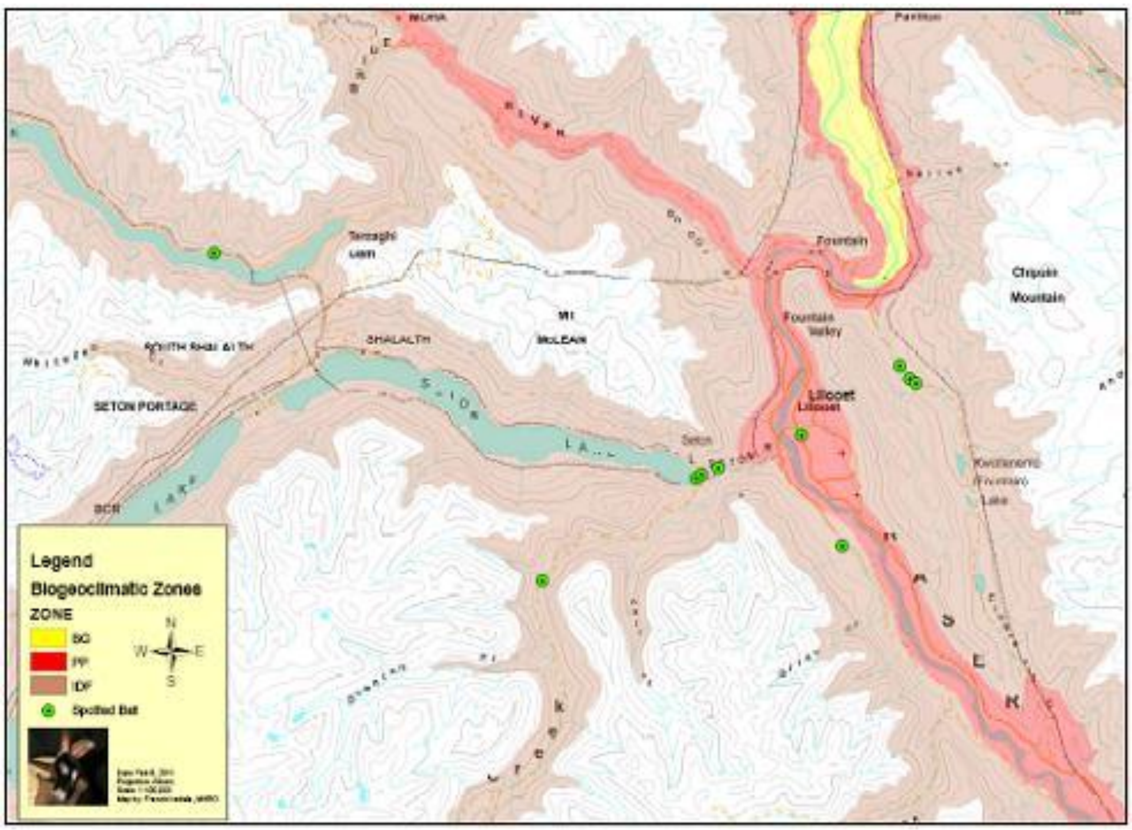


Figure17: Audible detection locations of Spotted Bats.