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ROOSTING BEHAVIOUR OF TOWNSEND'S BIG-EARED BATS FOUND AT FORT SHEPHERD

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January 2004

Roosting behaviour of Townsend's Big-eared Bats (*Corynorhinus townsendii*) and comments on other bat species found at Fort Shepherd in the West Kootenay of British Columbia

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ABSTRACT

Townsend's Big-eared Bats (*Corynorhinus townsendii*) have been a focus of many biological investigations in North America, largely due to the species' rarity and perceived sensitivity to disturbances at roosts. Furthermore, these roosts are often in human-built structures such as mines and buildings that are frequently destroyed when they are no longer in use. Effective conservation of this species is dependent on an understanding of the species' habitat requirements and threats at a landscape level, and especially of their use of critical habitat features, such as day roosts.

This project used the fortuitous observations from two previous studies (Vonhof and Gwilliam 2000 and Schaeffer *et al*. 2002) to examine the roosting behaviour of Townsend's Big-eared Bats at Fort Shepherd in the West Kootenay of British Columbia. Townsend's Big-eared Bats had been observed day-roosting as solitary individuals in several cavernous colluvial caves at the base of a cliff, later coined Laurie's Cliff. In one instance in 2002, a female cluster was observed during the spring, but not later that summer. This project used radiotelemetry to identify roosting features that the female colony uses, particularly to locate the maternity (parturition and lactation) roost.

Potential roosts were monitored during the spring of 2003 in anticipation of the arrival of the cluster of female bats. The caves at Laurie's Cliff consist of voids amongst large, blocky colluvium, with varying degrees of exposure. The female cluster was first detected on 24 May in the same cave where they had been seen the previous season. During the next seven weeks, a total of six females were radiotagged in order to identify a maternity roost in the vicinity. During this time, the adult female bats used a total of four different colluvial caves and one mine adit. When they dispersed, members of the cluster used at least six abandoned buildings (5 via telemetry and another via visual inspection). Two of these were located in Washington State, one of which was thought to be the maternity roost, but could not be confirmed as access was restricted by the landowner. All located roosts were within 8 kilometres of the original roost used in early spring.

Mist netting at four locations provided additional information on two other species of bats, Big Brown Bat and Western Long-eared Myotis, including inferences on roosting strategies.

The Fort Shepherd area appears to provide important seasonal rock roosting opportunities for several bat species in this portion of the Columbia Valley.

INTRODUCTION

The Fort Shepherd project area is located along the west side of the Columbia River, immediately north of the International Boundary (Figure 1). The area lies within the very dry and dry, warm variants of the Interior Cedar Hemlock biogeoclimatic subzones. Vegetation communities are highly variable, depending on elevation, soils, soil moisture regimes, and aspect (Marcoux 1997). Drier sites, usually situated on river terraces and warm aspect slopes, are dominated by open stands of ponderosa pine and Douglas-fir with an understory of bunchgrass and shrubs (e.g., snowbrush, saskatoon). Moist areas are dominated by Douglas-fir, paper birch, aspen, and numerous species of shrubs (e.g., birch-leaved spirea, snowberry, choke cherry, ocean spray). Glaciers carved this valley, eventually forming the large meltwater channel for the Columbia River, which dominates the valley bottom. Elevated riverine terraces flank the river, and then the valley wall rises steeply. Past glacial action has carved these slopes, leaving steep, exposed volcanic outcrops (Deschenes 2003). The failure of these faces created large, blocky colluvium that forms irregular cavernous features of varying exposures. These features are used as day roosts by Townsend's Big-eared Bats.

Figure 1: Location of Fort Shepherd, near Trail, BC.

The project area currently is uninhabited by people, although it is heavily used for recreation purposes throughout the year. Originally, the area was the site of Fort Shepherd, a Hudson's Bay trading post. The fort was constructed from trees that were harvested from the immediate area. The fort was eventually abandoned and later burned to the ground. During the last century, sulfur-dioxide fume emissions from a smelter and severe forest fires devastated the remaining vegetation (McDonaugh and Hamilton 2000). Natural regeneration has been occurring since the 1960s. The recovery of the Fort Shepherd area has been augmented with help from the Trail Wildlife Association to improve habitat for ungulates.

Nine species of bats, representing 479 observations, were encountered during a five-year bat survey in the nearby Pend d'Oreille Valley (Vonhof and Gwilliam 2000). Males and females of most species were caught and all species showed signs of being reproductively active, based on the presence of reproductive females, males with enlarged testes, or juveniles. During the five-year study, a series of caves were investigated in Fort Shepherd, and a solitary male Townsend's Big-eared Bat was found roosting in 1996. This same cave was visited in June of 2002 during a biodiversity inventory (Schaeffer *et al*. 2002) and approximately 24 female Townsend's Big-eared Bats were observed in a tight cluster. It was speculated that this might be a pre-maternity staging roost. Solitary Townsend's Big-eared Bats were observed in two other cave features on four of eight visits later in the year, when the female cluster was not present.

Radiotelemetry was considered the only viable option for monitoring roosting behaviour of these bats. This technique permits real-time tracking of select individuals and for locating individuals that have moved large distances or roost in inaccessible locations. However, there are a number of concerns about the sensitivity of Townsend's Big-eared Bats to being tagged, resulting in special guidelines for bat researchers to follow (RISC 1998a).

METHODS

The methods used in this project involved mist netting bats in a variety of habitats, recording and analyzing bat echolocation calls, visual inspections of suspected roost sites in caves and buildings and radio-tracking Townsend's Big-eared Bats. All inventory activities were conducted from April to October 2003, in the vicinity of Fort Shepherd, south of Trail, BC (Figure 2).

Mist nets were set at four stations during four consecutive nights. Each station contained a minimum of five nets in configurations that were likely to intercept flying bats along flyways and foraging circuits. Nets were set about one half hour before sunset and usually not taken down until after midnight. Habitats at netting stations included riverside, marshland, and colluvial slopes (Table 1). Netting took place in early August to take advantage of capturing less experienced young that might be feeding in the area. Captured bats were identified to species, weighed, sexed, aged, forearms measured, and reproductive condition noted. All bats were released within one hour of capture. Wing punches were taken from some individuals of *Myotis* and *Corynorhinus* species to assist genetic research being done for another study looking at genetic variation within the species (Vonhof pers. comm.).

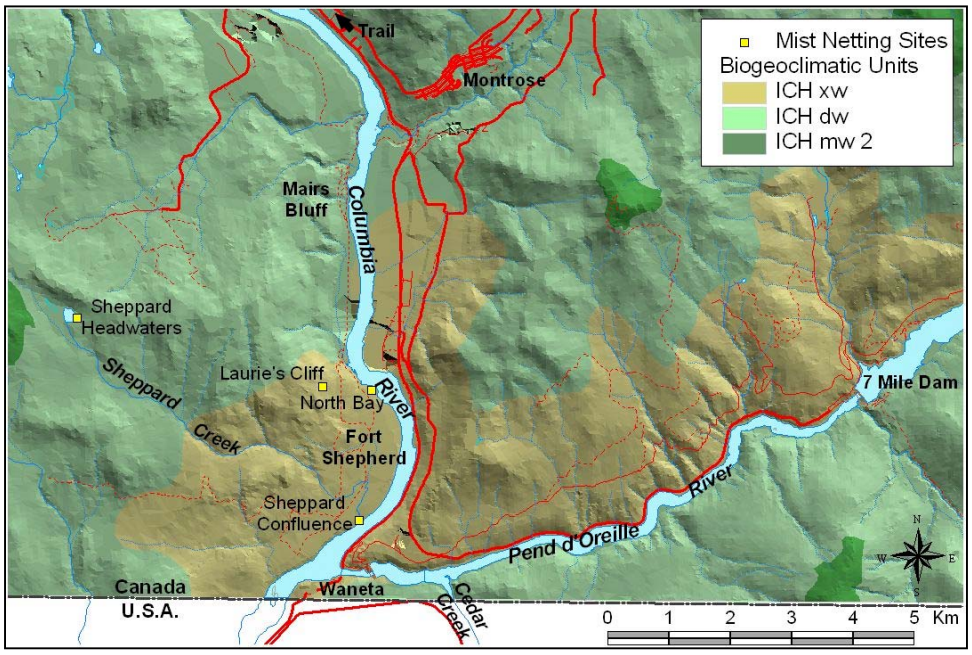

Figure 2: The biogeoclimatic subzones of Fort Shepherd and the surrounding area with mist netting locations.

Table 1: Habitat descriptions of mist netting locations.

Location	Habitat Description	Elevation (m asl)
North Bay	River edge with bay and rock outcropping	415
Laurie's Cliff	Talus slope below steep rock outcropping	690
Sheppard Creek Headwater	Swamp with surrounding stand of spruce and cedar	1100
Sheppard Ck - Columbia River confluence	Confluence with incised stream channel, bay, and sparse stand of cottonwood	400

Echolocation calls were detected using Anabat II detectors (Titley Electronics), and recorded onto handheld cassette recorders. Recordings were made during netting sessions to both detect bats that were not captured, and to obtain reference calls from captured bats. Echolocation calls that were not associated with a bat capture were analyzed using Anabat software to attempt species identification.

Roosts were identified by examining cavernous rock features and abandoned buildings. These structures were visually inspected throughout the duration of the project, although most rock roosts were more frequently inspected during spring and early summer, and buildings were inspected less frequently. Investigators approached roosts quietly and used red filters on flashlights while in potential roosts. If bats were observed, their numbers were noted and the investigator promptly left the roost.

Radiotelemetry was conducted on adult female Townsend's Big-eared Bats to assist documenting roosting behaviour. Adult females were only captured in or near their pre-maternity roosts in caves and mines. Captures consisted of hand netting at the entrance to the roost or hand capturing individuals. Individuals were quickly processed (approx. 20 minutes) to obtain basic measurements and then Holohil Systems Ltd.; LB-2 transmitters were attached using Skin Bond. Initially the hair between the shoulder blades was not trimmed (as per RISC standards, 1998a) but transmitters moved too freely and were suspected to impair flight. Subsequently, the hair between the shoulder blades was trimmed to about half its normal length. There was no excessive movement of transmitters when the hair was trimmed to this length. No bonding agent (Skin Bond) was allowed to touch the skin on the back. Light plastic bands were also placed on the forearms to identify bats that had been previously tagged but transmitters fallen off. The 5% transmitter to bat weight ratio (Aldridge and Brigham 1988) was achieved on three of the six bats. Two ratios were slightly more than the 5% rule and the third was 6.2%. Radio tracking was done using a Lotek SureTrack 1000 receiver from foot or vehicle, and fixed-wing aircraft if detection could otherwise not be made.

Permission to access the area was obtained from TeckCominco in Trail, who own the property. A permit to conduct this research under Sections 19 and 108 of the Wildlife Act was obtained from the Ministry of Water, Land, and Air Protection in Cranbrook (Permit DCB0348). The primary author has completed the Resource Inventory course for Bat Inventory (Certification WIS1-0570, 1997). All inventory methods and data collection were consistent with the Resource Inventory Committee's Inventory Methods for Bats (RISC 1998a, RISC 1998b).

RESULTS

During the general bat inventory portion of this project, at least six bat species were captured at four locations and at least six bat species were detected from echolocation call analysis at these same locations. However, the primary component of this project was to examine roosting behavior of Townsend's Big-eared Bats, as determined from roost inspections and radiotelemetry. The results are separated into each component of the project.

General Bat Inventory

Mist Netting

Mist netting was used to capture bats at four locations within the Fort Shepherd project area (Figure 2). All sampling nights were in early August 2003. The habitats varied from a colluvial slope, swamp, creek confluence with the river, and a bay in the river (Table 1). A total of 23 bats were captured at the four stations (Table 2), over a duration of 90.5 net hours, representing 0.25 bats/net hour trapping success (Appendix 1 and 2).

The most productive site was the talus slope below the steep rock outcropping (Laurie's Cliff) near the Townsend Big-eared Bats roosts, although that species was only captured once. This site had the greatest diversity of species (possibly 4). Most captures occurred shortly after emergence, suggesting that the bats were likely roosting in rock features in the vicinity. The only species that appeared to be using the roost (rock) features as lactation roosts were Big Brown Bats (*Eptisicus fuscus*). Three adult male Western Long-eared Myotis (*Myotis evotis*) were captured here as well.

The confluence of Sheppard Creek into the Columbia River was the second most productive site (captures=6) but only California Myotis and Big Brown Bats were captured. Individuals of both species were from lactation colonies.

Mist netting at both the North Bay and Sheppard Creek headwaters sites produced 6 captures represented by potentially five species. All species are common to the southern interior of BC, except the capture of a bat that appeared to be a Northern Long-eared Myotis.

Table 2: Captures and roost type of at each of the mist netting locations.

Species	North Bay		Laurie's Cliff		Sheppard Cr. Headwater		Sheppard Cr. Confluence	
	Rep	N_R	Rep	N_R	Rep	N-R	Rep	N_R
Big-Brown Bat	1	0	5	1	0	0	4	0
Silver-haired Bat	1	0	0	0	1	0	0	0
Western Long-eared Bat	0	0	0	3	0	0	0	0
Yuma Myotis	1	0	0	0	0	0	0	0
California Myotis	0	0	0	0	1	0	2	0
Long-legged Bat (?)	0	0	0	0	1	0	0	0
Northern Long-eared Bat (?)	0	0	0	1	0	0	0	0
Townsend's Big-eared Bat	0	0	0	1	0	0	0	0

Rep: individual from a maternity colony, either adult female with signs of young rearing or juvenile
N-R: an adult male, presumably not from a maternity colony

Two individual bats could not be morphologically identified to species due to overlapping external characteristics between the species. These individuals were recorded as the closest match to that species, notes taken on the anomalies, and wing punches were taken for genetic confirmation (results not available at time this report was prepared).

Echolocation Call Analysis

Echolocation calls were collected at the same locations that bats were trapped using mist nets. Although confidence of the identification to species of many of the call sequences is low, an analysis of these calls generally revealed results that complemented netting efforts (Appendix 3). However, a few anomalies occurred, including not trapping high flying bat species (e.g. *Lasiurus cinerus*) and failing to capture bats that use high frequency echolocation calls that easily detect nets (e.g. *M. evotis),* except near roosts. The Townsend's Big-eared Bat was only detected near the known roosts for that species. The species with the widest range of detections was the Silver-haired Bat (*Lasionycteris noctivagans*), followed closely by the Big Brown Bat and either Little Brown or Yuma Myotis (*M. lucifugus* and *M. yumanensis*), which were indistinguishable.

Table 3: Number of echolocation call sequences identified from each of the mist netting locations.

Species*	North Bay	Laurie's Cliff	Sheppard Cr. Headwater	Sheppard Cr. Confluence
M-COTO?	0	1	0	0
M-EPFU	9	7	5	0
M-LANO	28	11	38	13
M-LANO/EPFU	4	5	1	3
M-LANO/LACI	0	0	2	1
M-MYCA/MYCI	0	1	0	0
M-MYEV	0	24	15	0
M-MYLU/MYYU	27	10	3	0
M-MYLU/MYYU/**LABL**	8	0	0	0
M-????	0	0	1	24

* Species codes use the first two letters from the genus and species

Roosting Behaviour

Prior to this project, the only known roosts of Townsend's Big-eared Bats in the Columbia Valley, south of Trail, were all in close proximity to each other and consisted of one pregnancy roost and several solitary, adult male roosts. Telemetry was used to progressively tag two bats from the pregnancy cluster to locate any additional pregnancy, lactation, and possibly hibernacula roosts. Cavernous rock features and buildings were the only two types of roost structure used.

Rock Roosts

One rugged hillside at Fort Shepherd (Laurie's Cliff) consists of steep rock outcropping and a large slope of blocky colluvium. The colluvium forms cavernous features, suitable for

roosting bats. Previous sightings consisted of a pregnancy cluster of approximately 24 adult female Townsend's Big-eared Bats on 11 June 2002. They were not observed on subsequent visits during the same year between 08 July and 16 October, suggesting that advanced fetal development, parturition, and lactation were occurring elsewhere.

Inspection of caves and crevices started on 09 April 2003. Initially, there were only six cave features inspected, but over the course of the season a total of 15 cave features were identified (Appendix 4). All but two of these were caves formed by blocky colluvium. The other two were short adits created by historic mining. All caves had an easterly exposure. The mouths of the caves on the upper slope have light vegetation and the few caves on the lower slopes are shaded by heavier vegetation. The inner volume of the rock roosts was highly irregular but most had a total volume of about 10 m^3 and a ceiling height of more than one metre, although one cave used as a pregnancy roost had a ceiling height of less than one metre. Many of these caves are also used by a number of other animals, including Black Bear, Cougar, Bushy-tailed Woodrat, and Canyon Wren. Western Long-eared Myotis and Big Brown bats appear to use these cave and crevice features, as ascertained from mist net captures in the immediate vicinity.

Townsend's Big-eared Bats were first observed on 25 April 2003. Early observations consisted only of solitary roosting bats. Solitary bats continued to use a total of 12 caves until 23 October 2003 (last day of sampling). Individuals were rarely handled, so gender and age were usually not determined. The few solitary bats that were examined during spring and early summer were all adult males, except one yearling female (as determined by incomplete ossification of the epiphyses of the metacarpal-phalangeal joints) that did not roost with the adult females on 25 June. Solitary bats did not roost in the same cave feature as the early-pregnancy cluster of female bats.

The early-pregnancy cluster of female bats was not observed at the rock roosts until 24 May 2003. Numbers of individuals ranged from 2 at the onset to approximately 24 prior to abandoning the area. The cluster moved between at least five cavernous rock roosts (some roosts may not have been detected) before they were entirely gone from the rock roosts by 07 July 2003. At least some females returned with young by 25 September, forming roosting pairs of bats. One other roost, identified through radio-telemetry, was approximately three kilometers north of Laurie's Cliff and consisted of a crevice in a rock face.

Building Roosts

Summer roosts in buildings were suspected to be used primarily for the advanced development, parturition, and nurturing of young. Potential building roosts were identified by searching abandoned buildings and by radio-tracking six adult female bats (Appendix 5). The first two females were radio-tagged at the rock roosts on 27 May, and within several days had roosted in three buildings between the two of them, although at least one of them returned to a rock roost before dropping the transmitter (Appendix 6a). The next two bats, tagged on the 05 June, switched roosts, but only one briefly roosted in a building before returning to a rock roost (Appendix 6b). The last two bats tagged (25 June) changed roosts, but one stayed in rock roosts and the other moved to and stayed in a building (Appendix 6c).

All building roosts identified through radio-tracking bats (n=5) were within eight kilometers of the primary rock roosts. Most of the movement was within the ICHxw, which is eastwards and southwards. There was a tendency to avoid the ICHdw, which is northwards up the Columbia Valley, or westward up the mountain slopes (Figure 2).

DISCUSSION

This project obtained further knowledge of the bat fauna of the Fort Shepherd area, by building on research conducted the previous year (Schaeffer *et al*. 2002). The bat fauna appears consistent with that found from a five-year study in the nearby Pend d'Oreille Valley (Vonhof and Gwilliam 2000), although the Fort Shepherd area has greater rock roosting opportunities and therefore provides roosting opportunities for bats during the winter and other critical stages as well as the potential for additional bat species that are solely dependent on rock roosts. Discussions of bat species for which significant data was collected, including the Western Long-eared Myotis, Big Brown Bat, and Townsend's Big-eared Bat are presented. A brief discussion on the possibility of two unconfirmed species is also included.

Western Long-eared Myotis (*M. evotis*) were found at one site and detected by echolocation analysis at another. All individuals at the one site were males, captured shortly after emergence at the mouth of a cave that, earlier in the year, was the primary roost for the early-pregnancy female Townsend's Big-eared Bats. In contrast, mostly female bats were found in the Pend d' Oreille, using trees as roosts (Vonhof and Gwilliam 2000). This suggests that it may be the same population, and males and females are segregating themselves by the thermal nature of available roosts (periodic high temperatures in tree roosts for pregnant females and developing young, and cool but thermally constant temperatures for energy-minded adult males). Females in southern Saskatchewan selected rock crevices throughout the active season but used roosts that would warm and cool quickly during pregnancy and warm, but thermally constant roosts during lactation (Chruszcz and Barclay 2002). It is likely that the entire population uses the deep colluvium at Laurie's Cliff for hibernating.

Trends in Big Brown Bats (*E. fuscus*) were also noted. Most of the bats captured were adult females and young. Only one adult male was captured. It appears that both genders roost in rock features at Laurie's Cliff, and perhaps even in the primary roost used by early-pregnancy Townsend's Big-eared Bats. Big Brown Bats used buildings and trees for roosts in the Pend d'Oreille (Vonhof and Gwilliam 2000). Studies of maternity roosts in rock features for this species have found that they regularly shift roosts to have thermally variable roosts during pregnancy and more stable and warmer roosts during lactation (Lausen and Barclay 2003).

This project confirmed that Townsend's Big-eared Bats rely on cavernous rock features for early pregnancy roosting and that they shift roosts regularly. This supports observations of frequent, yet predictable movements throughout the year elsewhere in its range (Sherwin *et al*. 2003). Movements to buildings during the latter stages of pregnancy were not done *en masse,* and individuals frequently returned to rock roosts until the entire cluster appeared to leave the rock roosts, presumably to leave for warmer maternity roosts. None of the female bats in the cluster were ever observed to be in torpor. This suggests that the females are achieving rapid embryo development by huddling to conserve energy and maximize body

temperatures in a cool and stable roost. Five buildings were used as roosts by adult females during the latter stages of pregnancy. Parturition and lactation roosts were not found, but could have been in one of the buildings that a radio-tagged bat went to in Washington State, about eight kilometers from the rock roost area. Females and young were first detected back at the rock roost area are on 25 September.

Solitary, adult males roosted in many of the same caves as the females, but never when the female cluster was present. The males also used some roosts that were never used by the female cluster. Solitary individuals (presumably males or solitary females prior to, or after forming clusters) were observed using rock roosts throughout the season (25 April to 23 October), although there were virtually none detected between 24 May and 19 June. It is quite conceivable that some of these bats moved to the Pend d'Oreille.

Although a greater understanding of the roosting behaviour of Townsend Big-eared Bats has been attained, there are still several important questions left unanswered:

1. Are these adult females hibernating in the deep recesses of the colluvium, or are they hibernating elsewhere and specifically only using the Fort Shepherd area for pre-maternity requirements?
2. Are parturition and lactation roosts in buildings, and are these in Washington State as suggested by the data collected this year?
3. Are males hibernating in the colluvium, or elsewhere and using the area only for summer roosts when females are absent?
4. Are some yearling female Townsend Big-eared Bats not reproducing due to lack of maturity or lack of success attracting males?

It is still uncertain whether the following three species of bats occur in the project area. Echolocation calls collected the previous year (Schaeffer *et al*. 2002) and this year have distinct characteristics of the Western Red Bat (*Lasiurus blossevilli*). Attempts to capture this bat species were unsuccessful. Two bats that were captured could not be identified with complete certainty. The closest match to one was the Northern Long-eared Myotis (*M. septentrionalis*). This species is not known to occur in the West Kootenay and is most common in the very wet Interior Cedar Hemlock biogeoclimatic zones. A wing punch was taken and awaits genetic analysis. There also are a large number of echolocation calls collected from the Sheppard Creek confluence site that do not resemble known echolocation calls of any bat in BC.

It is quite conceivable that Laurie's Cliff at Fort Shepherd is critical habitat for several bat species throughout the active season and likely provides hibernacula for these species during the winter.

ACKNOWLEDGEMENTS

This project was funded and administered by the Columbia Basin Fish and Wildlife Compensation Program (CBFWCP) out of Nelson, BC. Staff contributed an admirable amount of energy to this project. Thomas Hill (coauthor) and Aaron Reid did much of the radiotelemetry work and data compilation. Other members of the CBFWCP that contributed considerable time to this project include Ross Clarke, Nicole Thomas, and Tim Van Wijk. Additional members of Ophiuchus Consulting, Allison Haney, Wade Alcock, and Karen Nelson, also helped with inventory work and Allison prepared some of the maps. TeckCominco permitted access to the project area, and the Ministry of Water, Land and Air Protection provided the permit for this work. None of this work would have been possible if it were not for the initial observations of local sportsman and outdoorsman, Laurie Bursaw.

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