BC Environment

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ABSTRACT

A systematic survey of the bat fauna of the dry interior of British Columbia was undertaken to investigate the extent of the distributions of seven species Red- and Blue-listed for the province [Red List: Pallid Bat (*Antrozous pallidus*), Southern Red Bat (*Lasiurus blossevilli*), Northern Long-eared Myotis (*Myotis septentrionalis*); and Blue List: Spotted Bat (*Euderma maculatum*), Townsend's Big-eared Bat (*Plecotus townsendii*), Fringed Myotis (*Myotis thysanodes*), and Western Small-footed Bat (*Myotis ciliolabrum*)]. Sixty-four different locations were sampled on 76 nights, for a total of 241 net/trap nights. The average nightly sampling period was approximately three hours, starting at one-half hour before sunset. The average number of bats captured was 7.2/night (SE = 16.4). The average nightly number of species (including number of Spotted Bats heard and additional species heard on QMC bat detectors) was 2.1 (SE = 1.69). There were 27 nights with no captures. Including Spotted Bats and additional species (Hoary Bats, *Lasiurus cinereus*) heard on bat detectors, there were 539 bats recorded during this survey. Significant range extensions (to points south and west of Williams Lake near the Fraser River) were recorded for the Spotted Bat, the Fringed Myotis and the Western Small-footed Myotis. As well, possible sightings of the Pallid Bat in the Williams Lake area (as yet unconfirmed) indicate that it may also have a distribution much further north than previously reported. Habitat descriptions for each site where bats were caught and reproductive condition for species by date are summarized. Recommendations for future studies, education, and population and habitat management are made.

INTRODUCTION

In the early 1980s, the first surveys of bats in the South Okanagan Valley indicated that there were species present that represented significant extensions of their known ranges (Fenton *et al.* 1980; Woodsworth *et al.* 1981). These findings indicated that British Columbia was home to the most diverse bat fauna in Canada. The characteristics that make the southern Okanagan unique to the rest of Canada are its high temperatures, long growing season and rare vegetation associations. From 1980 to 1991, numerous studies on bats have been made in this area focusing on the rare Spotted Bat (*Euderma maculatum*; see Collard *et al.* 1990 for review). Recently in the southern Okanagan, researchers have found breeding individuals of Pallid Bat (*Antrozous pallidus*), a bat characteristically found in the arid desert regions of the southwestern United States (Collard *et al.* 1990; Chapman *et al.* 1994). There are only 19 records of the Pallid Bat from the southern Okanagan (Collard and Barclay 1991; Nagorsen and Brigham 1993; Chapman *et al.* 1994). This species is Red-listed in B.C.

Three interior species are classified as Red-listed (i.e., species being considered for legal designation as endangered or threatened) in B.C.: Pallid Bat (*Antrozous pallidus*), Western Red Bat (*Lasiurus blossevilli*), and Northern Long-eared Myotis (*Myotis septentrionalis*.). A fourth Red-listed species, *Myotis keenii*, occurs on the British Columbia coast. Four Blue-listed species (i.e., vulnerable or sensitive), Spotted Bat (*Euderma maculatum*), Townsend's Big-eared Bat (*Plecotus townsendii*), Western Small-footed Myotis (*Myotis ciliolabrum*) and Fringed Myotis (*Myotis thysanodes*) are also known to occur in the southern Okanagan (Nagorsen and Brigham 1993).

Much of the habitat of these species in the southern Okanagan is classified as Bunchgrass Biogeoclimatic Zone, a habitat type that extends well into the central interior of British Columbia, including areas in the northern Okanagan Valley, along the North and South Thompson River valleys within the Kamloops region, and along the Fraser River Valley (Minist. of Forests, Res. Branch 1988).

Bat records from the above areas are based largely on returns from people concerned about rabies, although a few collections were made in the early part of this century (van Zyll de Jong 1985; Nagorsen and Brigham 1993). Before 1992, no extensive survey of the bat fauna of the Bunchgrass Zone had been undertaken, although there was no reason why the species "unique" to the southern Okanagan would not be present in other areas with similar available habitat. This report reviews the results of a survey of the bat fauna of the dry interior of B.C. with a focus on the seven bat species that have been placed on the provincial Red or Blue lists. Reproductive data is summarized for each species and a report of habitat types (including biogeoclimatic zones and wildlife habitat classes) is given for each site where listed species were captured. Insufficient data were collected to draw conclusions about specific critical habitat types for each species, but general conclusions from the survey results are made regarding general habitat associations and timing of reproduction.

METHODS

Survey Area

The survey focused on the Bunchgrass Biogeoclimatic Zone of south-central B.C., since this zone was determined to be the primary habitat type associated with the Red- and Blue-listed species found in the southern Okanagan Valley area (Collard *et al.* 1990; Chapman *et al.* 1994). Associated transition zones adjacent to this Bunchgrass zone were also surveyed in the following areas: Similkameen Valley, North Okanagan Valley (Penticton-Vernon), Kamloops region (North and South Thompson River valleys, Shuswap Lake, Adams Lake), and the Cariboo region (Fraser River Valley, plateau south of Williams Lake, Alkali Lake, Chilcotin River Valley and north).

Netting Sites

Netting sites were chosen on the basis of their proximity to water and to topographic and vegetative structures (Kunz and Kurta 1988). Habitat

structures or vegetative structures influence netting success. Areas that bats funnel through on their way from roosting to foraging sites (known as "flyways") make ideal sites to set nets because it appears that bats fly these routes by memory and are not constantly using echolocation, making them more susceptible to capture in mist nets. Large open areas are much more difficult to sample because the bats are more dispersed. The assumption was made that wet areas within the habitat zones represented areas of higher insect abundance and areas of concentrated bat activity, since bats are known to emerge and drink after spending the day in a hot roost.

Setup

Typically, four nets were set up on any given night, but this varied from one to five, depending on the habitat and the number of suitable sites for nets. Two harp traps (Tuttle 1974) were used in buildings suspected to be used as night roosts starting in mid-season after the traps had been modified to ensure capture success.

Captures

Captured bats were held in soft cloth bags until nets were taken down (to ensure that we did not recapture the same bat). Netting sessions usually started 30 minutes before sunset and continued until midnight or 1:00 a.m. Netting occasionally ended later or earlier, depending on ambient temperature and amount of bat activity detected with a QMC bat detector.

Bats were held for at least one hour before their mass was taken, to ensure that food ingested had cleared the digestive tract. Standard forearm measurements were recorded, as were sex, age (based on epiphyseal gap closure; see Anthony 1988), and reproductive condition (for females, palpation of abdomen indicated presence or absence of a fetus, expression of milk indicated lactation, worn area around nipples but no milk expression indicated post-lactation; for males, relative size of testes was recorded; see Racey 1988).

Captured Red- and Blue-listed individuals were banded with a numbered plastic split-ring (on the right forearm for females; on the left forearm for males) (Barclay and Bell 1988). Number and position of bands were recorded on data sheets.

Spotted Bat

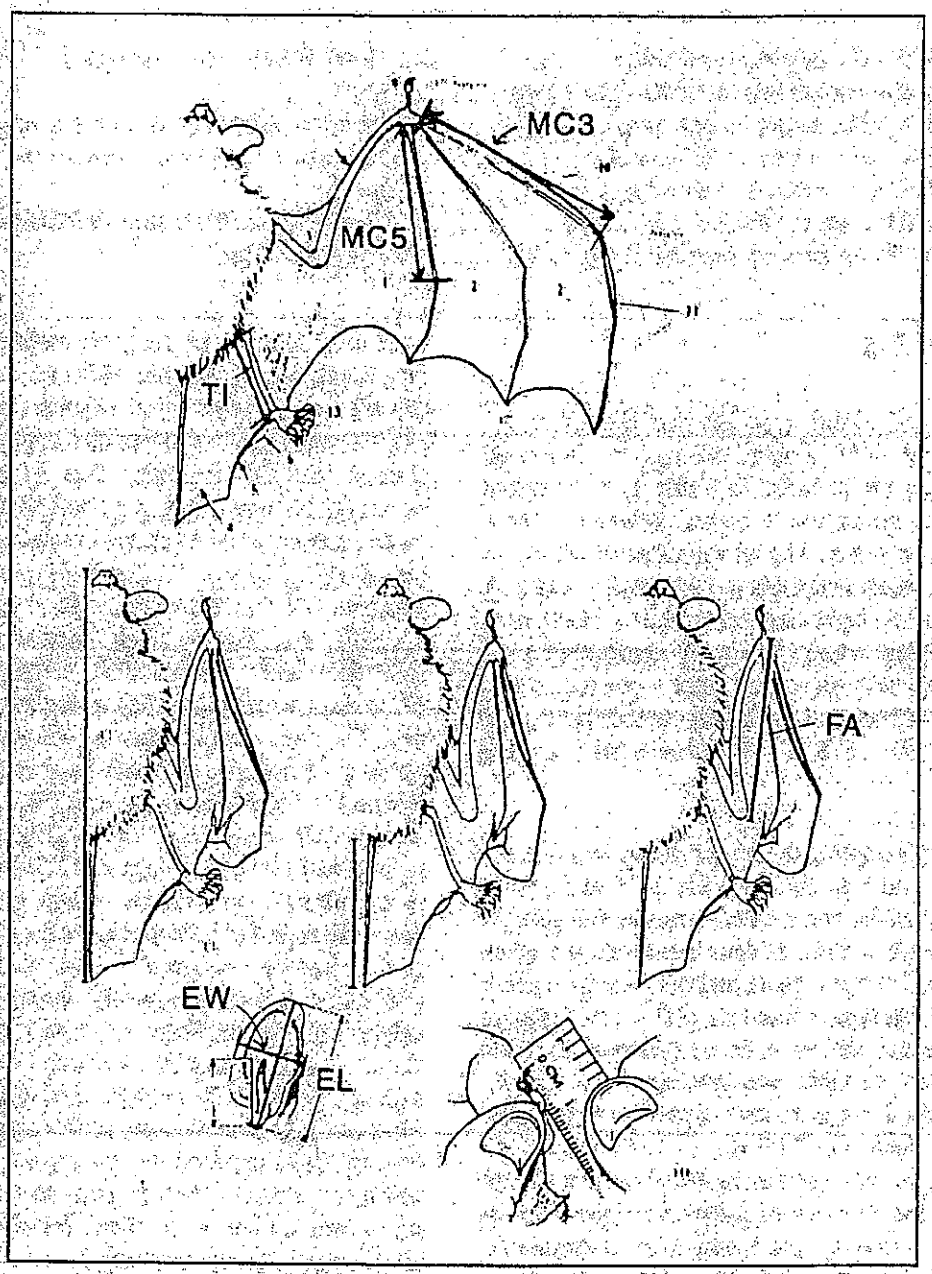
Spotted Bats were counted on the basis of the number of echolocation calls heard with our unaided ears on any given netting night (Fenton *et al.* 1987). Since individual Spotted Bats forage over specific areas or territories following specific routes (Woodsworth *et al.* 1981; Leonard and Fenton 1983; Wai-Ping and Fenton 1989), the number of passes were recorded and the actual number of bats in the area was estimated. In all cases except at Gallagher Bluff in Oliver, Spotted Bat calls were recorded from foraging or commuting individuals. Repeated passes, in an identifiable orbit, were counted as one bat.

Long-eared Myotis

Additional measurements were made on long-eared bats, either Western Long-eared Myotis or Northern Long-eared Myotis (*M. evotis*, *M. septentrionalis*), in an attempt to find a field characteristic that would discriminate between the species of long-eared bats in the province. As well as the standard forearm (FA) measurement (mm) and mass (g), length of the first metacarpal of the third (MC3) and fifth (MC5) digits, tibia (TI) length and ear length (EL) and width (EW) (mm) were also measured (Figure 1). Descriptive data were collected on each bat. These included presence or absence and colour of the shoulder patch, colour of ears and wing membranes, and the relative number of hairs on the edge of the tail membrane (uropatagium).

Bat Detectors

Bat detectors were not used in a consistent sampling fashion. Rather, they were used as a tool to indicate whether bats were active in an area during a given night. As well, on evenings with activity, species that could be identified on the basis of their calls were recorded as being present (Fenton and Bell 1981). The following key to echolocation calls was used to identify output from QMC mini bat-detectors (simplified from Fenton and Bell 1981):



MC5: first metacarpal of the fifth digit measured with top of calipers set at wrist between the third and fourth fingers, with wing fully extended, to the midpoint of the knuckle between the first and second metacarpal.

MC3: first metacarpal measured from the point where the bone meets the wrist to the midpoint of the knuckle between the first and second metacarpal.

TI: left tibia measured from the top of the knee to the ankle at the proximal end of the calcar.

FA: right forearm measured from the elbow to the wrist.

EL: ear length measured from the base to tip while ear was fully and naturally extended.

EW: ear width measured at the widest point with ear fully and naturally extended.

Figure 1. Measurements taken of long-eared bats (*Myotis evotis/septentrionalis*) (from van Zyll de Jong 1985).

1. 20-25 kHz, output a tonal chirp ..... Hoary Bat (*Lasiurus cinereus*)
1'. Calls not detectable in the 20-25kHz range ..... see 2.
2. 25-30 kHz, output a tonal chirp ..... Silver-haired Bat (*Lasionycteris noctivagans*)
2' 25-30 kHz, output a 'put' sound ..... Big Brown Bat (*Eptesicus fuscus*)
2''. 25-30 kHz, calls not detectable ..... see 3.
3. 40 kHz, output a tonal chirp ..... Southern Red Bat (*Lasiurus blossevillii*)
3'. 40 kHz (or greater), output a sharp 'tick' ..... any *Myotis* spp.

RESULTS

We sampled 64 different sites over the survey period (some were sampled twice). Locations and site names are included in Table 1. Nets and/or traps were set up on 76 nights. Seventy of these involved nets only. The total number of net-nights (one net set on one night = 1 net-night) was 214, with a mean nightly sampling period of approximately three hours. The total number of trap-nights (one trap set on one night = one trap-night) was 27, with average sampling periods lasting the entire night. In total, there were 241 net/trap nights.

Of the 76 sampling nights, 27 nights had no captures, 26 had 1-5 captures, 15 had 10-20 captures, and 8 nights had more than 20 captures (Figure 2). The average number of bats captured on a given night was 7.2 (SE = 16.4), and the average number of species captured was 1.51 (SE = 1.69) (Figure 3). If species that were heard (Spotted Bats and bats heard on QMC bat detectors) are also included, the average number of species recorded on a given night was 2.09 (SE = 1.69) (Figure 4). This shows that when using bat detectors and including the number of individual Spotted Bats heard on a given night, the number of species recorded as present in a given area increases.

Overall, 484 bats were captured in either nets or harp traps. An additional 55 bats (Spotted Bats, Hoary Bats, and Pallid Bats) were either heard, detected, or seen, for a total of 539 bats. Adult females comprised 59.3% of the 484 captured bats, adult males accounted for 28.1%, juvenile females 6.4%, and juvenile males 5.8% (Figure 5).

Almost 60% of all captures were made using nets, 40% using harp traps (Figure 6). Some species were more likely to be caught in harp traps: Western Small-footed Myotis (*Myotis ciliolabrum*) (68.4%), and Long-legged Myotis (*M. volans*) (82.7%) although both were also captured in nets (Figure 6). Silver-haired Bats (*Lasionycteris noctivagans*) were only captured in nets and a large proportion of Western Long-eared Myotis (*M. evotis*) (94.9%), California Myotis (*M. californicus*) (88.9%), Yuma Myotis (*M. yumanensis*) (71.6%), Big Brown Bats (*Eptesicus fuscus*) (63.3%), and Townsend's Big-eared Bats (*Plecotus townsendii*) (60%) were also captured in nets. The remaining species had almost equal proportions of captures in either traps or nets: Little Brown Myotis (*M. lucifugus*) (56.7%) and Fringed Myotis (*M. thysanodes*) (50%) (Figure 6). The large proportion of bats captured in harp traps may be a result of trapplacement. A large proportion of bats were captured in harp traps in the Cariboo Region, a largely unpopulated area, with buildings and barns scattered sparsely throughout. Bats commonly use buildings for night roosting. The choice of buildings in the Cariboo is limited, resulting in either a concentration of species at one roost or a higher probability of researchers setting up traps in an appropriate building (or both). We had less success with harp traps in areas further south, where there were higher concentrations of abandoned buildings and barns.

Almost 60% of all bats captured were adult females, of which 54.7% were reproductively active (Figure 7). Of the remaining adult females, 36.6% were non-reproductive, 4% appeared to have lost their pups (bare patch around nipple, no milk expressed and nipple not chewed-looking), and the remaining 4.5% were of undetermined reproductive status (Figure 7). High proportions of reproductively active individuals were found for Silver-haired Bats (100%), Big Brown Bats (85.7%), Yuma Myotis (71%), Fringed Myotis

Table 1. Site number, name, code, UTM grid reference and elevation for each census site in the survey.

SITE NAMES AND UTM GRID REFERENCES; SURVEY OF THE BAT FAUNA OF THE B.C. INTERIOR

SITE #	SITE NAME	SITE CODE	MAP SHEET	ZONE	EASTING	NORTHING	ELEVATION
1	Vaseaux Lake Bird Sanctuary	VLBS-1	82E/5	11	3155	54642	340 m
2	Okanagan Falls Provincial Park	OFPP-1	82E/5	11	3126	54684	360 m
3	Gallagher Bluff	GB-1	82E/4	11	3167	54573	769 m
4	Old Hedley Road #1	OHR-1	92H/8	11	3151	54736	720 m
5	Old Hedley Road #2	OHR-2	92H/8	11	2975	54793	580 m
6	Ollala	OLLALA-1	82E/5	11	2946	54607	520 m
7	Daly Slough	DS-1	82E/4	11	2959	54525	420 m
8	Ginty's Pond	GINP-1	82E/4	11	2985	54500	420 m
9	Old Grist Mill, Keremeos	OGM*K-1	82E/4	11	2956	54550	521 m
10	Lake Burnell	LB-1	82E/4	11	3098	54536	700 m
11	Chute Lake Resort#1	CLR-1	82E/12	11	3172	55072	365 m
12	Chute Lake Resort#2	CLR-2	82E/12	11	3171	55072	365 m
13	Darke Lake Provincial Park	DLPP-1	82E/12	11	2935	55104	500 m
14	Trout Creek - Summerland	TC(SUMM)-1	82E/12	11	2087	55942	380 m
15	Lake Oyama	LOYAM-1	82L/3	11	3371	55536	410 m
16	Green Bay Resort - Westbank	GBR(WESTBANK)-1	82E/13	11	3151	55231	360 m
17	Lakeview Road - Westbank	LV(WESTBANK)-1	82E/13	11	3160	55271	460 m
18	Knox Mtn. - Kelowna	KM(KELOWNA)-1	82E/14	11	3223	55306	520 m
19	Gallagher Canyon Golf Course	GCGC-1	82E/14	11	3288	55234	500 m
20	Gallagher Canyon - top of bluff	GC(BLUFF)-1	82E/14	11	3311	55240	700 m
21	Enderby (Riverside Campground)	ERC-1	82L/11	11	3496	56026	365 m
22	Silver Creek - Moore's Farm	SC(MOORES)-1	82L/11	11	3335	56047	395 m
23	Rattlebox Sheep Farm - Falkland	RATFALK-1	82L/5	11	3162	55962	610 m
24	Willard Place - Westwold	WPW-1	82L/5	11	3090	55943	610 m
25	Mouth of Adams River	MADR-1	82L/13	11	3203	56412	365 m
26	Roderick Haig-Brown Provincial Park	RHB(LIT)-1	82L/13	11	3194	56414	365 m
27	Adams Lake Sawmill	ALS-1	82L/13	11	3114	56490	425 m
28	Squaam Bay - Agate Bay Resort	SQB(ABR)-1	82M/4	10	7049	56618	425 m
29	Louis Creek (Pasture with Max)	LC(PWMX)-1	92P/2	10	7073	56602	610 m
29B	Agate Bay Road (Crazy horse)	ABR(CH)-1	82M/4	11	2901	56647	640 m
30	Genier Lake	GL-1	92P/1	10	7006	56789	580 m
31	Skull Mountain (Corral Lake)	SM(CL)-1	92P/1	10	6979	56697	825 m
32	Tranquille	T-1	92I/10	10	6749	56222	365 m
33	Juniper Beach Provincial Park	JBPP-1	92I/14	10	6355	56267	335 m

Table 1. (Continued).

SITE #	SITE NAME	SITE CODE	MAP SHEET	ZONE	EASTING	NORTHING	ELEVATION
34	Wallhachin	W-1	92I/15	10	6418	56246	365 m
35	Ashcroft Slough	AS-1	92I/14	10	6239	56235	305 m
36	Williams Lake River Canyon	WLCC-1	93B/1	10	5532	57793	490 m
37	Hawks Creek/Fraser River confluence	WL(HCFR)-1	93B/8	10	5489	57948	425 m
38	Soda Creek - Ian Fotheringham's	SCIF-1	93B/8	10	5414	58079	425 m
39	Williams Lake (Scout Island Nature Centre)	WL(SINC)-1	93B/1	10	5607	57745	640 m
40	Williams Lake - Roberts' Place	WL(RP)-1	93B/1	10	5654	57732	580 m
41	Alkali Lake - Public viewing point	AL(PVP)-1	92O/16	10	5500	57360	640 m
42	Alkali Lake - old barn	AL(OB)-1	92O/16	10	5356	57489	640 m
43	Gang Ranch (upper pastures)	GR-1	92O/9	10	5444	57118	610 m
43B	Gang Ranch (Gaspard Creek)	GR(GC)-1	92O/9	10	5442	57122	610 m
44	Gang Ranch (reservoir)	GR(RES)-1	92O/9	10	5434	57103	730 m
45	Dog Creek (Hay meadows honey farm)	DC(HMHF)-1	92O/9	10	5528	57143	700 m
46	Lillooet (BC Hydro campground)	L-1	92I/12	10	5716	56133	215 m
47	Lytton - St. George's barnyard	L(SGB)-1	92I/5	10	5998	55692	215 m
48	Upper Bench Road (Keremeos)	UBR-1	82E/4	11	2987	54536	520 m
49	Keremeos (old barn)	K(B)-1	82E/4	11	2931	54533	420 m
50	Suzie Mine (Oliver)	SM(O)-1	82E/4	11	3113	54548	540 m
51	Coldstream Ranch (Vernon)	CR(VERNON)-1	82L/3	11	3435	55657	460 m
52	McAllister Marsh (Vernon)	MM(VERNON)-1	82L/3	11	3484	55657	620 m
53	McAllister Marsh - back poplar stand (Vernon)	MM-BPS(VERNON)-1	82L/3	11	3485	55658	620 m
54	Kamloops (Westsyde Road - 3600 block)	K(WESTSYDE)-1	92I/16	10	6877	56290	365 m
55	Whitewood Lake	WL-1	92P/1	10	6861	56638	1370 m
56	Louis Creek Cablin (south of Fadear Road)	LC(CAB)-1	92P/1	10	7085	56587	640 m
57	Peterson Creek Park (Kamloops)	PCP(KAM)-1	92I/9	10	6888	56162	425 m
58	Tunkwa Cabin (east of Tunkwa Lake)	TC-1	92I/10	10	6547	56073	1160 m
59	Durand Creek Valley (Tunkwa Lake Road)	DCV-1	92I/10	10	6557-58	56110-200	1065-455 m
60	Woodfrog Lake Road - Lac la Hache	WFL-CNP(LLH)-1	92/P13E	10	5919	57488	855 m
61	Bull Canyon	BC-1	93B/3	10	4758	57702	715 m
62	Chilcotin Marsh (ranch site)	CHM(RS)-1	93B/5	10	4385	58028	1050 m
63	Chilanko Marsh	CHILANKO-1	93C/1	10	4139	57742	945 m
64	Redstone Bridge - Forestry road	REDB-S	93B/4	10	4507	57767	840 m

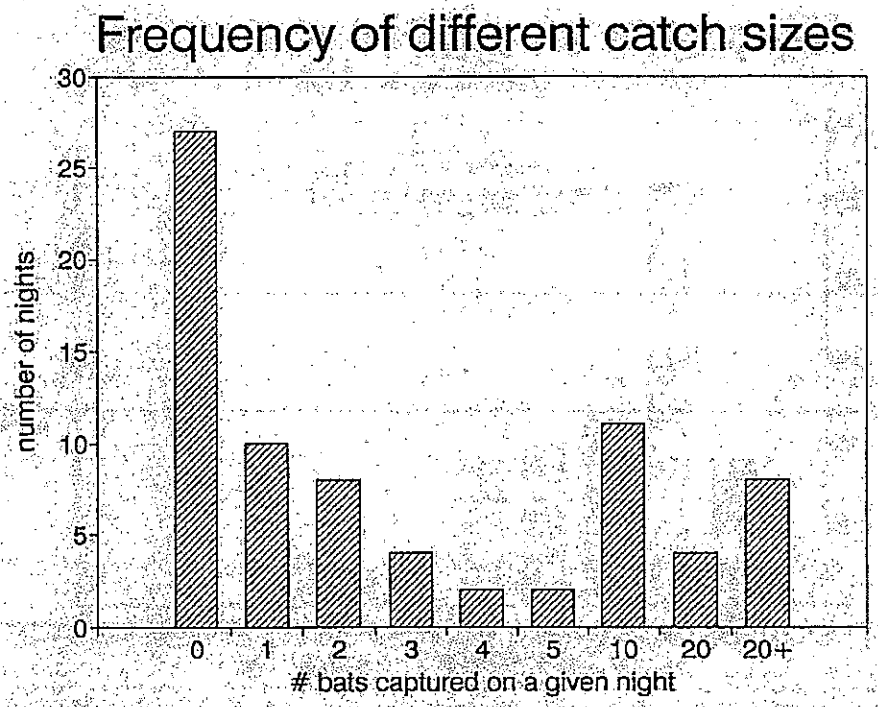


Figure 2. Frequency distribution of nights with varying capture success.

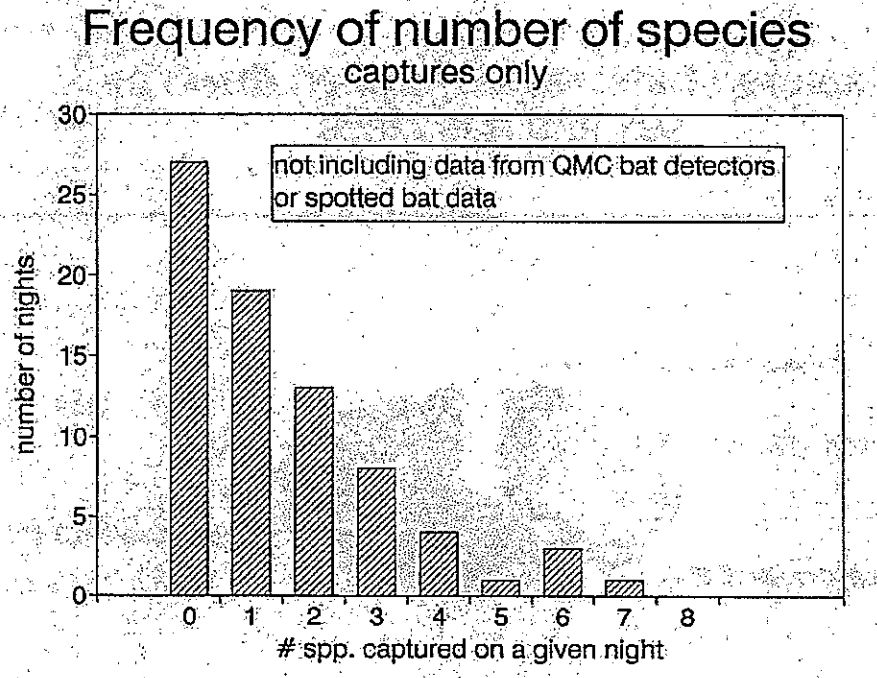


Figure 3. Frequency distribution of nights with varying number of species captured (does not include Spotted Bats, species heard on bat detectors, or species sighted).

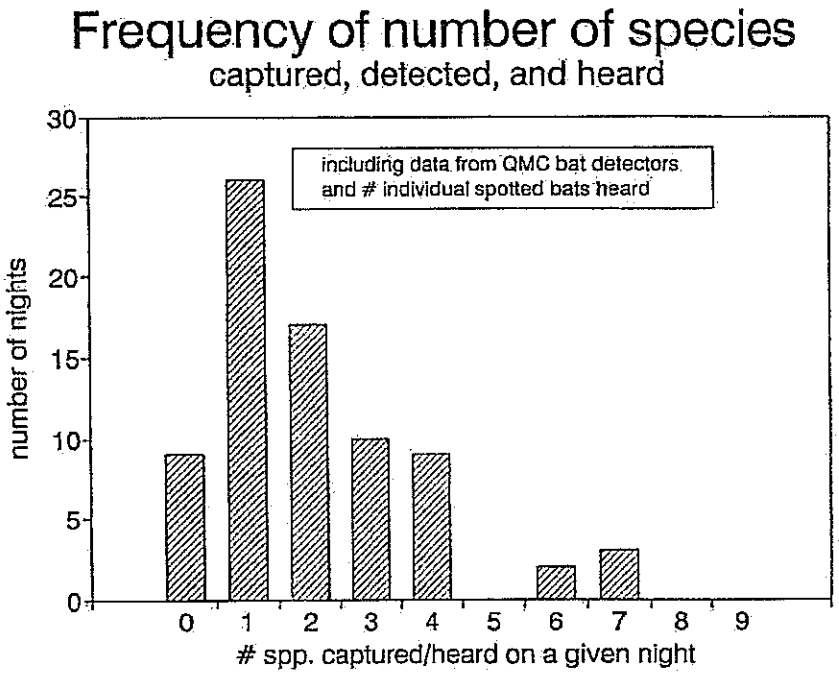


Figure 4. Frequency distribution of nights with varying number of species either captured, heard, or detected on bat detectors.

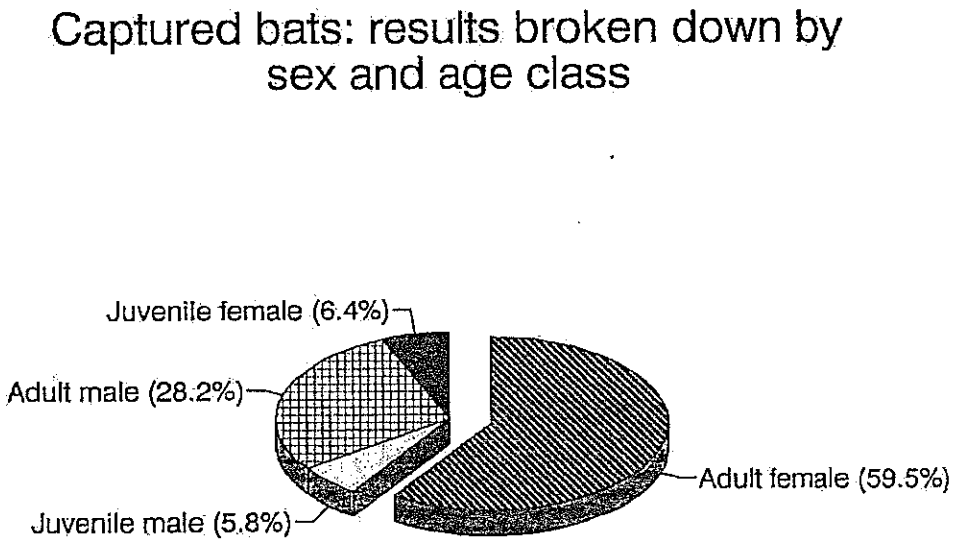


Figure 5. Proportion of adult females, adult males, juvenile females and juvenile males captured over the entire survey area.

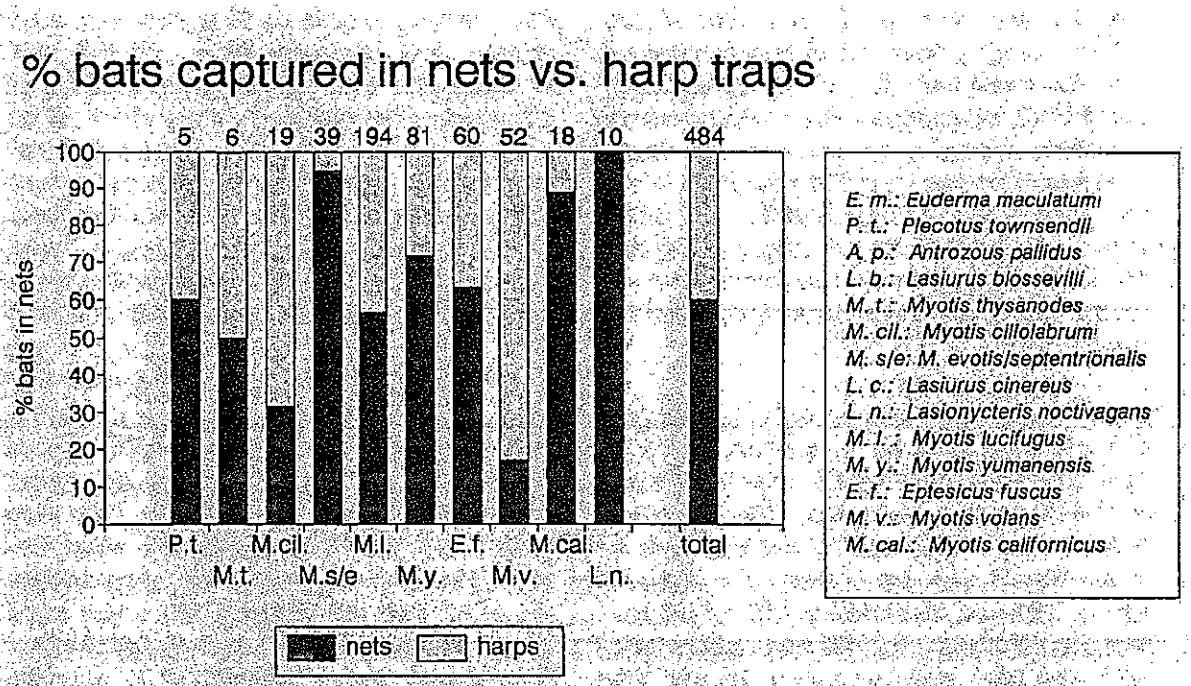


Figure 6. Proportion of each species captured in either mist nets or harp traps over the entire survey period (numbers above bars indicate sample size).

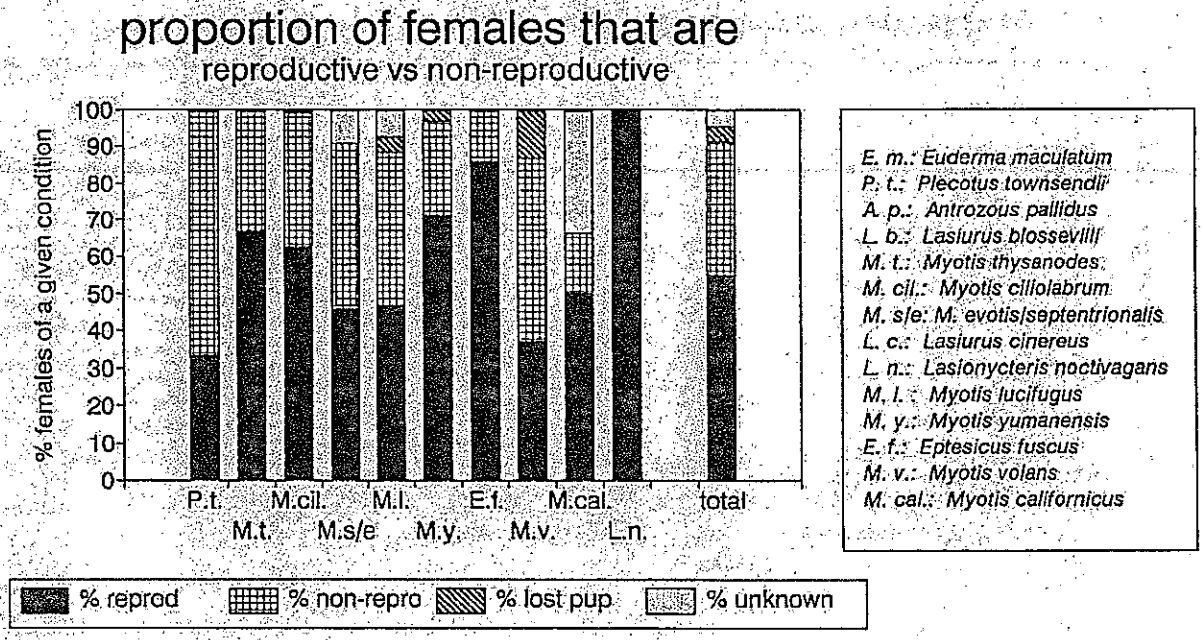


Figure 7. Reproductive status of adult females captured.

(66.7%), and Western Small-footed Myotis (62.5%). Large proportions of non-reproductive individuals were found for Townsend's Big-eared Bat (66.7%), and approximately equal proportions of reproductive and non-reproductive individuals were found for Long-legged Myotis (50%), Western Long-eared Myotis (45.45%), and Little Brown Myotis (41.8%). Of California Myotis, 16.7% were found to be non-reproductive but another 33% of this species were of undetermined reproductive status (Figure 7).

Little Brown Myotis was the most common species caught during the survey, accounting for 40% of all bats captured (194/484) (Figure 8). Of these bats, 63% were adult females, 25% were adult males, and the remaining 12% were juvenile bats. Yuma Myotis was the second most common species captured, representing 16% of all bats captured. Of this sample, 38% were adult females, 46% were adult males, and the remaining 16% were juveniles. The third largest group was Big Brown Bat with 12.4% of all bats captured (60/484). Seventy percent of these bats were adult females, 20% were adult males, and 10% were juveniles. The fourth largest group consisted of Long-legged Myotis, representing 10.7% of all bats captured (53/484). This sample resulted almost entirely from setting harp traps on two consecutive evenings at a night roost in Alkali Lake. Of this sample, 88.5% were adult females, the remainder were adult males, and no juveniles of this species were captured. Spotted Bat (*Euderma maculatum*) ranks as the fifth most common species, with 50 individuals heard. Spotted Bats represent 9.28% of all bats either heard, captured, detected, or seen (50/539) (Figure 8). Over half of the 39 Western Long-eared Myotis (*M. evotis*) captured (56%) were adult females, 25% were adult males, and the remaining 17% were juveniles. Long-eared bats represent approximately 8% of the total bats captured. There were equal proportions of adult male and female Western Small-footed Myotis captured (42%), plus one juvenile female which accounted for 5% of the 19 bats handled. Western Small-footed Myotis repre-

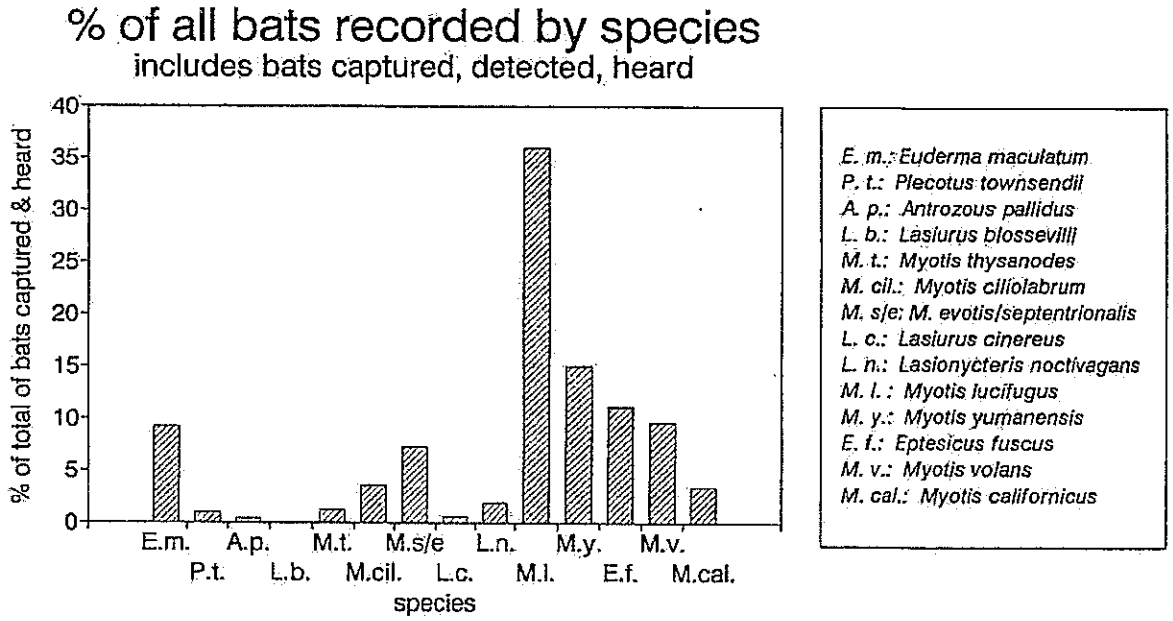


Figure 8. Proportion of total number of bats captured (including Spotted Bats that were heard) represented by each species.

sented approximately 4% of all bats captured. California Myotis represented 3.7% of all bats captured (18/484); 33% were adult females, 50% were adult males, and approximately 17% were juveniles. There were 10 Silver-haired Bats captured, representing 2.1% of all captures. Forty percent were adult females, 30% were adult males, and the remaining 30% were juvenile bats. Only six Fringed Myotis were captured, (three males, three females) and five Townsend's Big-eared Bats (three adult females and two juveniles). Hoary Bats were heard at three sites and Pallid Bats were tentatively identified in two areas.

The total number of bats captured (broken down by species, sex and age groups) is given in Table 2. Little Brown Myotis was the most common species captured and Townsend's Big-eared Bat the least common. The few sightings believed to be of Pallid Bats need to be confirmed with captures. The low number of calls heard attributed to Hoary Bats may have been an artifact of our random sampling with the bat detectors; these bats typically forage high above the ground where we could not set our nets.

The relatively large proportion of Spotted Bats reported during the survey (9.28%) is misleading (Figure 8). Twenty-nine of these bats were from known roosts in the southern Okanagan, making a total of 24 "new" records distributed over a very wide area. Nowhere did we find high numbers of Spotted Bats and, based on what is known about them, we would not expect to find an area supporting large numbers of these bats (Table 3).

Habitat types where species were captured are summarized for each species captured (see Appendix 1). Included are dates of capture, individuals (sex, age, reproductive condition if relevant), habitat description, elevation, biogeoclimatic zone, and wildlife habitat class (Appendix 2). Weight, age, and reproductive condition measurements of captured bats are listed in Appendix 3.

TABLE 2. Total captures of bats, from 1992 survey of the Dry Interior of British Columbia (by sex and age class).

SPECIES	TOTAL	ADULT FEMALES	ADULT MALES	JUVENILE FEMALES	JUVENILE MALES
RED-LISTED					
Pallid Bat (*Antrozous pallidus*) *	2	-	-	-	-
Southern Red Bat (*Lasiurus blossevilli*)	0	0	0	0	0
Northern Long-eared Myotis (*Myotis septentrionalis*) or Western Long-eared Myotis (*Myotis evotis*)	39	22	10	5	2
BLUE-LISTED					
Spotted Bat (*Euderma maculatum*) **	50	-	-	-	-
Townsend's Big-eared Bat (*Plecotus townsendii*)	5	3	0	1	1
Western Small-footed Myotis (*Myotis ciliolabrum*)	19	8	10	1	0
Fringed Myotis (*Myotis thysanodes*)	6	3	3	0	0
FOLIAGE-ROOSTING					
Hoary Bat (*Lasiurus cinereus*) ***	3	-	-	-	
Silver-haired Bat (*Lasionycteris noctivagans*)	10	4	3	1	2
OTHERS					
Little Brown Myotis (*Myotis lucifugus*)	194	122	48	18	6
Yuma Myotis (*Myotis yumanensis*)	81	31	37	1	12
Big Brown Bat (*Eptesicus fuscus*)	60	42	12	2	4
Long-legged Myotis (*Myotis volans*)	52	46	6	0	0
California Myotis (*Myotis californicus*)	18	6	9	2	1
TOTAL	539	287	138	31	28

* visual sightings

** records based on audible calls

*** records based on QMC detected bats.

Table 3. Results from surveying for Spotted Bats. (Actual number of passes heard plus estimated number of bats).

SITE #	SITE NAME	SITE CODE	MAP SHEET	ZONE	UTM GRID EASTING	NORTHING	ELEVATION	DATE	# PASSES	# BATS
3	Gallagher Bluff	GB-1-1	82E/4	11	3167	54573	769m	May 14	3	3
3	Gallagher Bluff	GB-1-2	82E/4	11	3167	54573	769m	May 15	11	11
1	Vaseaux Lake Bird Sanctuary	VLBS-1-1	82E/5	11	3155	54642	340m	May 17	0	-
4	Old Hedley Road #1	OHR-1-1	92H/8	11	3151	54736	720m	May 18	3	1
5	Old Hedley Road #2	OHR-2-1	92H/8	11	2975	54793	580m	May 19	20-30	5-6?
6	Ollala	Ollala-1-1	82E/5	11	2946	54607	520m	May 20	1	1
7	Daly Slough	DS-1-1	82E/4	11	2959	54525	420m	May 21	8	1-2
8	Ginty's Pond	GINP-1-1	82E/4	11	2985	54500	420m	May 22	11	2?
9	Old Grist Mill - Keremeos	OGM*K-1-1	82E/4	11	2956	54550	521m	May 23	0	-
10	Lake Bumell	LB-1-1	82E/4	11	3098	54536	700m	May 24	5	2
11	Chute Lake Resort #1	CLR-1-1	82E/12	11	3172	55072	1200m	May 26	0	-
12	Chute Lake Resort #2	CLR-2-1	82E/12	11	3171	55072	1200m	May 27	0	-
13	Darke Lake Prov. Park	DLPP-1-1	82E/12	11	2935	55104	500m	May 31	0	-
14	Trout Creek - Summerland	TC-1-1	82E/12	11	2087	55942	380m	Jun 01	0	-
15	Lake Oyama	LOYAM-1-1	82L/3	11	3371	55536	1350ft	Jun 02	0	-
16	Green Bay Resort - Westbank	GBR-1-1	82E/13	11	3151	55231	360m	Jun 03	0	-
17	Lakeview Rd. - Westbank	LV-1-1	82E/13	11	3160	55271	460m	Jun 04	0	-
18	Knox Mtn. - Kelowna	KM-1-1	82E/14	11	3223	55306	520m	Jun 06	0	-
19	Gallagher Canyon Golf Course	GCGC-1-1	82E/14	11	3288	55234	500m	Jun 08	0	-
20	Gallagher Canyon - top of bluff	GC(bluff)-1	82E/14	11	3311	55240	700m	Jun 10	2	1
21	Enderby (Riverside campground)	ERC-1-1	82L/11	11	3496	56026	365m	Jun 14	0	-
22	Silver Creek - Moore's Farm	SC(Moore)-1	82L/11	11	3335	56047	395m	Jun 15	0	-
23	Rattlebox Sheep Farm - Falkland	RATFALK-1	82L/5	11	3162	55962	610m	Jun 17	0	-
24	Willard Place - Westwold	WPW-1-1	82L/5	11	3090	55943	610m	Jun 18	0	-
25	Mouth of Adams River	MADR-1-1	82L/13	11	3203	56412	365m	Jun 20	0	-
26	Roderick Haig-Brown Prov. Park	RHB(Lit)-1-1	82L/13	11	3194	56414	365m	Jun 21	0	-
28	Squaam Bay - Agate Bay Resort	SQB(ABR)-1-1	82M/4	10	7049	56618	425m	Jun 22	0	-
29	Louis Creek (Pasture with Max)	LC(PWMX)-1-1	92P/2	10	7073	56602	610m	Jun 23	0	-
29b	Agate Bay Rd (Crazy horse)	ABR(CH)-1-1	82M/4	11	2901	56647	640m	Jun 24	0	-
30	Genier Lake	GL-1-1	92P/1	10	7006	56789	580m	Jun 25	0	-
31	Skull Mtn. (Corral Lake)	SM(CL)-1-1	92P/1	10	6979	56697	825m	Jun 26	0	-
32	Tranquille	T-1-1	92I/10	10	6749	56222	365m	Jun 29	0	-
33	Juniper Beach Prov. Park	JBPP-1-1	92I/14	10	6355	56267	335m	Jun 30	0	-
34	Walhachin	W-1-1	92I/15	10	6418	56246	365m	Jul 01	0	-
35	Ashcroft Slough	AS-1-1	92I/14	10	6239	56235	305m	Jul 02	6	2?
36	Williams Lake Creek Canyon	WLCC-1-1	93B/1	10	5532	57793	490m	Jul 04	0	-
37	Hawks Cr/Fraser R. junction	WL(HCFR)-1-1	93B/8	10	5489	57948	425m	Jul 05	0	-
38	Soda Creek - Ian Fotheringham	SCIF-1-1	93B/8	10	5414	58079	425m	Jul 06	0	-
38	Soda Creek - Ian Fotheringham	SCIF-1-2	93B/8	10	5414	58079	425m	Jul 07	0	-
39	Williams Lk (Scout Island Nature Centre)	WL(SINC)-1-1	93B/1	10	5607	57745	640m	Jul 08	1?	1?
41	Alkali Lake - Public Viewing Point	AL(PVP)-1-1	92O/16	10	5500	57360	640m	Jul 09	9-12	2?

Table 3. (Continued).

SITE #	SITE NAME	SITE CODE	MAP SHEET	UTM GRID ZONE	EASTING	NORTHING	ELEVATION	DATE	# PASSES	# BATS
42b	Alkali Lake - Old barn	AL(OB)-1-1	92O/16	10	5356	57489	640m	Jul 10	>10	3
43	Gang Ranch (Upper Pastures)	GR-1-1	92O/9	10	5444	57118	610m	Jul 11	2-3	2-3?
44	Gang Ranch (Reservoir)	GR(RES)-1-1	92O/9	10	5434	57103	730m	Jul 12	0	-
45	Dog Creek (Hay Meadows Honey Farm)	DC(HMHF)-1-1	92O/9	10	5528	57143	700m	Jul 13	17	5-6
46	Lillooet (BC Hydro Campground)	L-1-1	92I/12	10	5716	56133	215m	Jul 15	0	-
47	Lytton - St. George's barnyard	L(SGB)-1-1	92I/5	10	5998	55692	215m	Jul 16	7	2-3
5	Old Hedley Road #2	OHR-2-2	92H/8	11	2975	54793	580m	Jul 17	0	-
8	Ginty's Pond	GINP-1-2	82E/4	11	2985	54500	420m	Jul 18	0	-
48	Upper Bench Rd. (Keremeos)	UBR-1-1	82E/4	11	2987	54536	520m	Jul 18	1	1
49	Keremeos (Old barn)	K(B)-1-1	82E/4	11	2931	54533	420m	Jul 19	0	-
9	Old Grist Mill (Keremeos)	OGM*K-1-2	82E/4	11	2956	54550	521m	Jul 22	0	-
51	Coldstream Ranch (Vernon)	CR(VERNON)-1-1	82L/3	11	3435	55657	460m	Jul 30	0	-
52	McAllister Marsh (Vernon)	MM(VERNON)-1-1	82L/3	11	3484	55657	620m	Jul 31	0	-
53	McAllister Marsh-Back poplar stand (Vernon)	MM-BPS (VERNON)-1-1	82L/3	11	3485	55658	620m	Aug 01	0	-
23	Rattlebox Sheep Farm - Falkland	RATFALK-1-2	82L/5	11	3162	55962	610m	Aug 02	0	-
26	Roderick Haig-Brown Prov. Park	RHB(LIT)-1-2	82L/13	11	3194	56414	365m	Aug 03	0	-
54	Kamloops (Westsyde Rd-3600 bl)	K(WESTSYDE)-1-1	92I/16	10	6877	56290	365m	Aug 05	0	-
54	Kamloops (Westsyde Rd-3600 bl)	K(WESTSYDE)-1-2	92I/16	10	6877	56290	365m	Aug 06	0	-
55	Whitewood Lake	WL-1-1	92P/1	10	6861	56638	1370m	Aug 07	0	-
56	Louis Creek Cabin (S of Fadear Rd)	LC(CAB)-1-1	92P/1	10	7085	56587	640m	Aug 08	0	-
31	Skull Mtn. (Corral Lake)	SM(CL)-1-2	92P/1	10	6979	56697	825m	Aug 09	0	-
28	Squaam Bay - Agate Bay Resort	SQB(ABR)-1-2	82M/4	10	7049	56618	425m	Aug 10	0	-
25	Mouth of Adams River	MASR-1-2	82L/13	11	3203	56412	365m	Aug 11	0	-
57	Peterson Creek Park (Kamloops)	PCP(KAM)-1-1	92I/9	10	6888	56162	425m	Aug 12	0	-
58	Tunkwa Cabin (E of Tunkwa Lk.)	TC-1-1	92I/10	10	6547	56073	1160m	Aug 13	0	-
59	Durand Creek Valley (Tunkwa Lk Rd.)	DCV-1-1	92I/10	10	6557-58	56110-200	1065-455m	Aug 14	0	-
35	Ashcroft Slough	AS-1-2	92I/14	10	6239	56235	305m	Aug 15	3	1
60	Woodfrog Lake - Lac la Hache	WFL-CNPLLH-1-1	92P/13	10	5919	57488	855m	Aug 16	0	-
61	Bull Canyon	BC-1-1	93B/3	10	4758	57702	715m	Aug 17	4	1?
62	Chilcotin Marsh (Ranch site)	CNM(RS)-1-1	93B/5	10	4385	58028	1050m	Aug 18	0	-
63	Chilanko Marsh	CHILANKO-1-1	93C/1	10	4139	57742	945m	Aug 19	0	-
64	Redstone Bridge-Forestry Road	REDB-1-1	93B/4	10	4507	57767	840m	Aug 20	0	-

DISCUSSION

The following includes a brief account of each of the Red- and Blue-listed species (under the heading SPECIES ACCOUNTS) covering Range, Habitat (Foraging, Roosting), Diet, and Reproduction. New information collected as a part of this survey, as well as general comments and recommendations for each species have been included. A brief summary of the non-listed species is also included, broken down as Foliage-roosting Species and Others. A conclusion is given with overall recommendations for policy, education, and continued research on bats in British Columbia.

Red-listed Species:
- Pallid Bat - *Antrozous pallidus*
- Southern Red Bat - *Lasiurus blossevilli*
- Northern Long-eared Myotis/ Western Long-eared Myotis - *Myotis septentrionalis/ Myotis evotis*
  (Note: *M. evotis* is not Red-listed.)

Blue-listed species:
- Spotted Bat - *Euderma maculatum*
- Townsend's Big-eared Bat - *Plecotus townsendii*
- Fringed Myotis - *Myotis thysanodes*
- Western Small-footed Myotis - *Myotis ciliolabrum*

Non-listed Species:
- Foliage-roosting species
  - Silver-haired Bat - *Lasionycteris noctivagans*
  - Hoary Bat - *Lasiurus cinereus*
- Others
  - Big Brown Bat - *Eptesicus fuscus*
  - Long-legged Myotis - *Myotis volans*
  - California Myotis - *Myotis californicus*
  - Yuma Myotis - *Myotis yumanensis*
  - Little Brown Bat - *Myotis lucifugus*

SPECIES ACCOUNTS

Pallid Bat

Range — In Canada, Pallid Bats (*Antrozous pallidus*) are restricted to the southern Okanagan Valley, with the earliest record being an individual collected near Oliver in 1931 (van Zyll de Jong 1985). This population represents the northern limit of the species' distribution (Chapman *et al.* 1994). Pallid Bats range from Mexico throughout the western United States (van Zyll de Jong 1985; Nagorsen and Brigham 1993). There are isolated colonies in Oklahoma, Kansas (Hibbard 1934; Morse and Glass 1960), and eastern Wyoming (Stromberg 1982). The distribution in Mexico is known generally from populations in the states of Jalisco (Watkins *et al.* 1972) and Queretaro (Schmidly and Martin 1973).

There are only 19 records of Pallid Bats from the southern Okanagan (Nagorsen and Brigham 1993; Chapman *et al.* 1994) (Figure 9). Reproductive individuals have been reported (Grindal *et al.* 1991).

No captures of Pallid Bats were made during this study, although there were three possible sightings made by Gina and Anna Roberts in the Cariboo Region. These sightings were made between approximately one hour past sunset and 1:00 a.m. while they were looking for Common Poorwills (*Phalaenoptilus nuttallii*). On two occasions, a "large, pale honey-coloured bat was seen flying low across the road" in front of their vehicle. This occurred once on the backroads of Gang Ranch and once west of Williams Lake on a ranch located on the Chilcotin River. As well, Gina Roberts reported sighting a bat in the Williams Lake Creek canyon just west of Williams Lake that may have been a Pallid Bat.

We believe that there is a high probability that Pallid Bats live in this northern area. The habitat seems to be appropriate (a small proportion of the region has a micro-climate equivalent to year-round climates in the Okanagan, G. Roberts, pers. comm.), although due to the short season and cool temperatures generally characteristic of the region during spring, fall, and winter, the population size is likely small. Unfortunately, netting for Pallid Bats means setting mist nets in areas where there is a low probability of capturing other species. A survey would need to be made specifically for Pallid Bats or for all bats in a smaller area.

There was one other anecdotal report of a suspected Pallid Bat from the east side of Lake

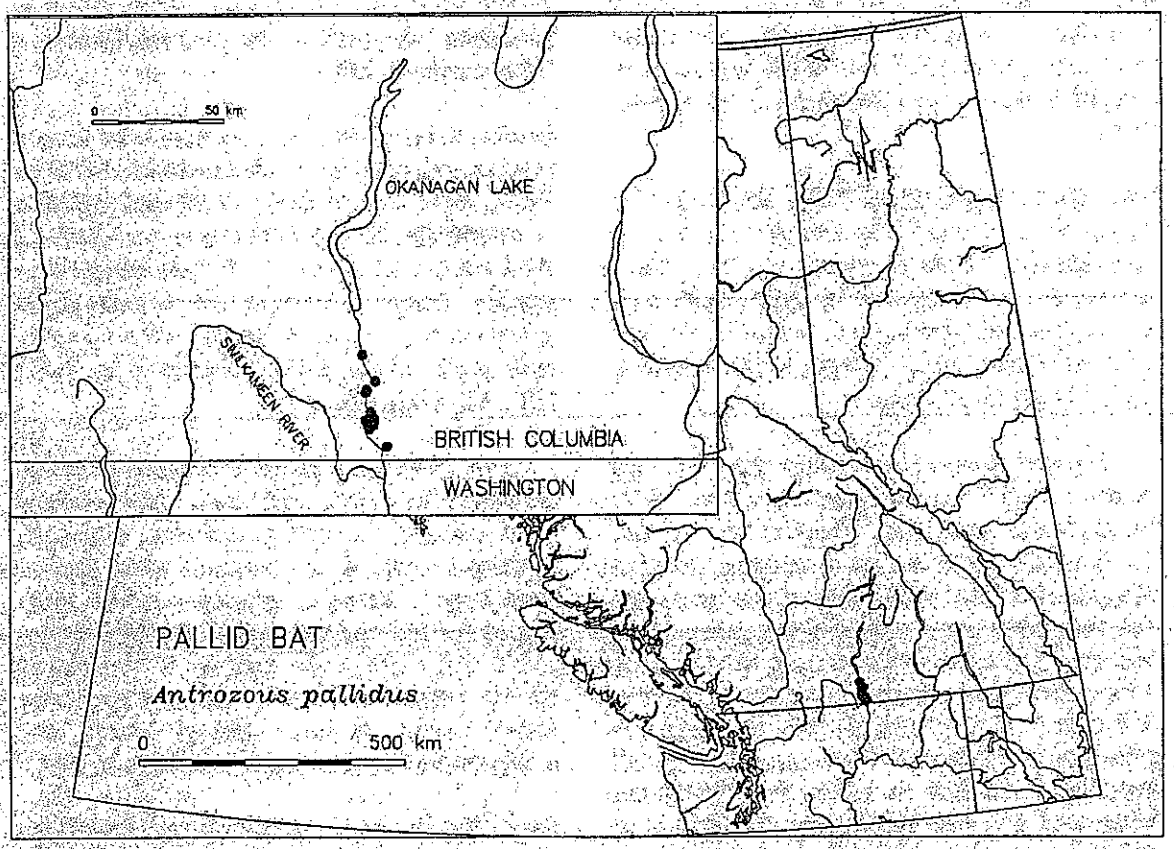


Figure 9. Known distribution of Pallid Bats (*Antrozous pallidus*) in British Columbia (Nagorsen and Brigham 1993).

Okanagan, west of Chute Lake. The woman who runs the resort at the lake was picking rocks beside the abandoned railway track on the south side of the old railroad tunnel. Under one rock was a fairly large pale bat with big ears. This area is close to the known distribution of Pallid Bats in the south Okanagan and it was possibly a Pallid Bat.

Habitat: Foraging — In B.C., known habitat of Pallid Bats is restricted to the Southern Okanogan Basin Ecosection at the south end of the Okanagan Valley (Chapman *et al.* 1994). The Pallid Bat is common throughout the deserts and grasslands of the southwestern United States (Hermanson and O'Shea 1983) and most abundant in the Sonoran life zones (Orr 1954). In Washington, they are found in the Sonoran and Transitional life zones, and in New Mexico in arid areas especially near rocky outcrops and a water source, although occasionally this is not the case (Findley *et al.* 1975). Pallid Bats are common in the dry canyonlands of southwestern Colorado (Armstrong 1972), and are found at sites up to 2440 m (Black 1974; Martin 1974). However, Pallid Bats are less abundant in these higher elevation evergreen and mixed forests than in typical lowland habitats (Jones 1965).

In a study of Pallid Bat habitat use in the southern Okanagan, seven Pallid Bats carrying radiotransmitters were found to forage over lengthy tracts (at least 0.5 km long) of exposed sandy soil with sparse vegetation, [primarily sagebrush (*Artemisia* spp.), greasewood (*Purshia* spp.), rabbitbrush (*Chrysothamnus* spp.), bunchgrass (*Agropyron* spp.), and cactus (*Opuntia* spp.)] (Chapman *et al.* 1994). Most of these areas were bordered on at least one side by a stand of ponderosa pine, which was used for roosting while consuming captured

prey (Chapman *et al.* 1994). Pallid Bats are known to prefer uncluttered foraging habitat with sparse vegetation (Black 1974; Bell 1982) and are considered a desert bat (Hermanson and O'Shea 1983).

The reported sightings of Pallid Bats from this survey were of bats flying low over the road in open grassland areas (Appendix 1). More study is required to determine if these were truly Pallid Bats that were sighted, where Pallid Bats are, and where they are foraging and roosting in these more northerly areas.

Habitat: roosting — Pallid Bats use day roosts primarily in rock crevices (Orr 1954; Packard and Judd 1968; Vaughan and O'Shea 1976; Lewis 1990), but show seasonal variation in types of crevices used for roosts. In spring and fall, they prefer to use vertically-oriented crevices with low morning temperatures and warm evening temperatures that allow torpor early in the day and then passive rewarming prior to emergence (Vaughan and O'Shea 1976). Lewis (1990) found breeding Pallid Bats in 1-2 m long, 10-30 cm wide rock crevices. Roosts are thought to be chosen on the basis of their inaccessibility to predators (Vaughan and O'Shea 1976).

Females may choose horizontal crevices for summer maternity colonies because these allow for easier retrieval of fallen young (Hermanson and O'Shea 1983). Pallid Bats also use stone piles and hollows in trees (Hall 1946; Orr 1954) for summer day roosting.

Colony size ranges from single individuals to 200 bats (Orr 1954; Twente 1955; Packard and Judd 1968; Vaughan and O'Shea 1976). Ninety-five percent of the roosts found by Vaughan and O'Shea (1976) had more than 20 individuals.

Night roosts vary, and include rock shelters, open buildings, porches, bridges, shallow caves and mines, and other man-made structures (Dalquest 1947a, 1947b; Pearson *et al.* 1952; Krutzch 1954; Orr 1954; Twente 1955; Beck and Rudd 1960; Herreid 1961; Barbour and Davis 1969; O'Shea and Vaughan 1977; Brown and Grinnell 1980; Howell 1980; Bell 1982; Lewis 1990), as well as ponderosa pine trees in the southern Okanagan (Chapman *et al.* 1994).

In winter, Pallid Bats are assumed to be largely inactive and to hibernate (Hermanson and O'Shea 1983). Most winter records are of small numbers of individuals, ranging from one to four (Grinnell 1918; Alcorn 1944; Hall 1946; Orr 1954). Occasionally, Pallid Bats were active over desert springs during winter in Nevada when temperatures were around 2 C (O'Farrell *et al.* 1967; O'Farrell and Bradley 1970).

Diet — Pallid Bats are considered to be opportunists (Bell 1982) and take a wide variety of prey, including scorpions, crickets, solpugids, darkling beetles, scarab beetles, carrion beetles, grasshoppers, katydids, praying mantids, long-horned beetles, and sphingid moths (Hermanson and O'Shea 1983). An analysis of the diet of the Okanagan Pallid Bats showed that they were eating mainly beetles, although moths and neuropterans were also taken (Grindal *et al.* 1990).

Based on tooth and skull morphology, Pallid Bats are adapted for feeding on large, hard-bodied insects (Freeman 1981). They are also known to feed on the fruit and seeds of organ pipe cactus (Howell 1980) and, although this was thought to occur incidentally while bats were feeding on insects that were feeding in the flowers, recent studies have shown that Pallid Bats do opportunistically feed on nectar and pollen of these flowers (Herrera *et al.* 1991).

Reproduction — The Pallid Bat has a reproductive pattern typical of a temperate vespertilionid, with mating occurring in fall prior to the wintering period. Females store sperm and ovulate, fertilize, and implant blastocysts in early spring (Hermanson and O'Shea 1983). Length of gestation varies with the climate and amount of time spent in torpor (Orr 1954; Racey 1973). On average, the gestation period is about nine weeks (Orr 1954). Parturition occurs between May and June in the southwestern part of the United States (Orr 1954; Beck and Rudd 1960; Barbour and Davis 1969; O'Shea and Vaughan 1977). Litter size varies between one and three

pups per year, depending on the location (Grinnell 1918; Hall 1946; Orr 1954; Twente 1955; Findley *et al.* 1975). A litter of three is probably rare, twins being more common, and single young being produced by yearling females are most common (Davis 1969). Lactation occurs between early May and mid-August (Orr 1954; Martin 1974).

Recommendations—

1. Intensively survey the Cariboo Region, where Pallid Bats are suspected to be present. Continue surveying for Pallid Bats in other regions, especially the dry open areas near Kamloops and in the South and North Thompson River valleys. The survey should focus on Pallid Bats, since it is unrealistic to expect to catch this species foraging with other aerial insectivores because their foraging areas are so distinct.

2. Determine overwintering habitat. It would be interesting to know if Pallid Bats are overwintering in B.C. or migrating south and remaining active year round. If they are remaining and hibernating, overwintering habitat would be critical to maintain populations. However, determining the behaviour of Pallid Bats at the end of the breeding season may not be feasible because they are difficult to capture, and movements at the end of the season may not be predictable or observable.

Southern Red Bat

General notes — Southern Red Bats (*Lasiurus blossevilli*) are sexually dimorphic; the male is redder than the female. They are moderate in size for a lasiurine, ranging between 7 and 13 g (Shump and Shump 1982a). Virtually nothing is known about the Southern Red Bat in B.C.

Range — Southern Red Bats range from Central America through the western United States (Nagorsen and Brigham 1993). In British Columbia, they have been recorded from the Skagit Valley and the Okanagan Valley (*ibid.*). Sarell and McGuiness (1993) have reported them in Washington; otherwise, the nearest populations known are from northern California and Utah. The B.C. population is probably at the northern edge of the summer range (Nagorsen and Brigham 1993). There are only two records for the province (Figure 10). One is a specimen collected in B.C. in 1905, which was thought to be an accidental. The other record is from Okanagan Falls, where the echolocation calls, thought to be of this species, were recorded (Fenton *et al.* 1980), suggesting a summer population in the area (Nagorsen and Brigham 1993). Repeated netting efforts in the South Okanagan have failed to produce any animals.

No Southern Red Bats were captured or heard on bat detectors during this survey.

Habitat: foraging — Virtually nothing is known about Southern Red Bats. Red bats are typically associated with forested habitats along rivers (Nagorsen and Brigham 1993), although this may not necessarily hold true in all parts of their range. Based on wing morphology and echolocation call, foraging probably occurs in open areas above the forest canopy and in forest clearings (Norberg and Rayner 1987). Red bats are known to forage opportunistically around street lights, taking advantage of the concentrated patches of insects that form around bright lights (Hickey and Fenton 1990; Nagorsen and Brigham 1993), and will regularly forage over the same area (Davis 1960; Hickey and Fenton 1990).

Habitat: roosting — A related species, the Northern Red Bat (*L. borealis*), which occurs in eastern North America, is a solitary foliage-roosting species that is known to use large shrubs and trees in edge habitats bordering forests, rivers, cultivated fields, and urban areas (Constantine 1958, 1966; Kunz 1973; Mumford 1973; Barclay 1984). Nagorsen and Brigham (1993) state that cottonwoods may be important in B.C. but because so little is known about the Southern Red Bat, no definitive statement can be made about tree species that may be part of its critical habitat. Eastern species are known to use both deciduous and coniferous trees for roosting (B. Hickey, pers. comm.). Roosts generally provide dense shade and cover from above and to the sides, but are open from below (Shump and Shump 1982a).

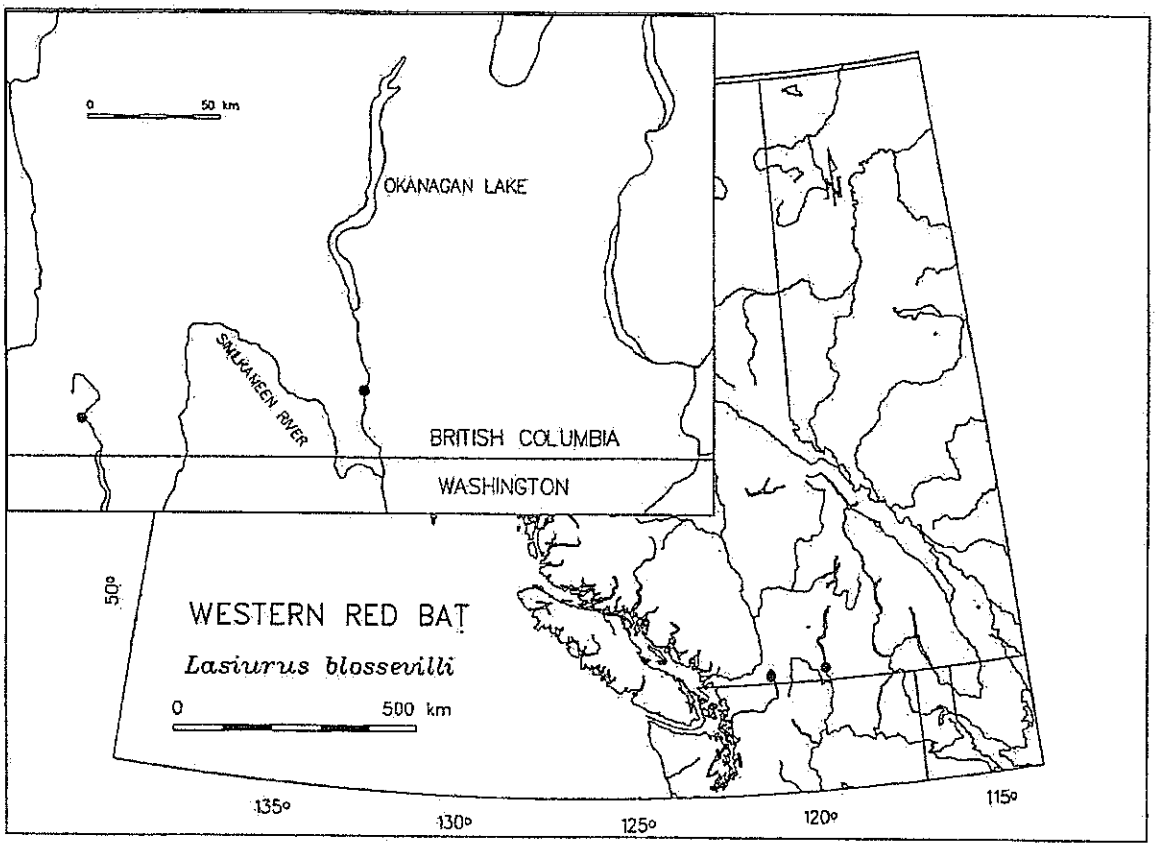


Figure 10. Known distribution of Southern (Western) Red Bat (*Lasiurus blossevilli*) in British Columbia (Nagorsen and Brigham 1993).

Southern Red Bats are migratory, but little is known about timing or destination of the species (Nagorsen and Brigham 1993). The Northern Red Batare known to migrate as far south as Mexico. Movements away from summer areas in eastern Canada occur between late August and October and the bats return in May. Northern Red Bats have been captured at Delta, Manitoba while migrating north in early June and again on the return south in late July and early August (Barclay 1984). Timing of migration of Southern Red Bats in B.C. may be similar because the latitude is similar, but this is not known. Migrating Northern Red Bats may travel in groups (LaVal and LaVal 1979) but are otherwise generally solitary. Northern Red Bats in eastern North America are also known to be capable of hibernating and have been found in caves and tree cavities with stable internal temperatures (Fassler 1975).

Diet — The Northern Red Bat eats primarily large moths (>10 mm body length) (Ross 1967; Hickey and Fenton 1990), but will also eat beetles and katydids (Hickey and Fenton 1990). There are no records of diet analysis for the Southern Red Bat and, due to its slightly smaller body size, it may not be comparable to the Northern Red Bat.

Reproduction — Northern Red Bats produce one to four young per litter and are exceptional among bats in this respect (Shump and Shump 1982a). There is no information available regarding litter size of the Southern Red Bat in British Columbia.

Recommendations — The Southern Red Bat likely forages very high, at or above the tree canopy, which makes capturing these animals quite difficult. Given that the population size may be quite low and that the degree of difficulty in capturing these animals is high, this will be a difficult species to study. We suggest monitoring the results of other bat research projects in the province of B.C. If Southern Red Bats are cap-

tured in other parts of the province, initiate a study to identify critical habitats.

Long-eared Myotis

Keen's Long-eared Myotis (*Myotis keenii*) and Northern Long-eared Myotis (*M. septentrionalis*) are both Red-listed species in British Columbia. Western Long-eared Myotis (*M. evotis*) is considered to be common. Results from the west coast/ Vancouver Island/Queen Charlotte Islands survey by Firman *et al.* (1993) found that the key to B.C. bats (Nagorsen and Brigham 1993) was inadequate when attempting to discriminate among the three long-eared myotis species in the field. The characteristic of length of ear extending past the tip of the nose when flattened along the rostrum was highly variable and did not accurately distinguish species.

Using van Zyll de Jong's (1979) analysis of the systematic relationships of long-eared myotis, Western Long-eared Myotis can be discriminated from Northern Long-eared Myotis based on the shoulder spot (which is variable in its degree of distinctiveness) and the number of hairs along the border of the uropatagium. Unfortunately, all of these characteristics appear to be highly variable and attempts to use them in the field were unsuccessful. Based on this, all long-eared myotis caught in this survey have initially been referred to as Western Long-eared Myotis, because this species has been previously viewed as the most common in B.C.[1]

In addition to the general measurements of forearm length (mm) and mass (g), a number of other quantitative and qualitative measures were noted for all specimens when possible. The length of metacarpal 3 (MC3) and metacarpal 5 (MC5) and the tibia TI (Figure 1) were measured with dial calipers to the nearest 0.05 mm. As with forearm measurements, three measurements were taken and the average is used in the data listed in Appendix 3. Length and width of the ear (at the widest point) were also taken when the subject was cooperative enough to allow the measurements to be taken. Qualitative observations of distinctiveness and colour of the shoulder spot, colour of the ears, and the relative number of hairs on the edge of the uropatagium were made. Hair samples, with follicles intact, were also collected for future DNA analysis.

Included here are literature reviews of Western Long-eared Myotis and Northern Long-eared Myotis and a summary of habitat types where long-eared myotis were captured and of the reproductive status of these individuals. The reader is cautioned that the results of this survey may include any or all of the three species of long-eared myotis because there is currently no adequate way of discriminating among these species in the field.

Northern Long-eared Myotis

Range — The Northern Long-eared Myotis (*Myotis septentrionalis*)(formerly *M. keenii* in the eastern part of its range; *M. keenii* is now restricted to the west coast and associated islands)is distributed across the eastern United States and Canada, west to the southern portion of the Northwest Territories (in Nahanni National Park) and eastern British Columbia, where it appears to be at the western periphery of its range (Nagorsen and Brigham 1993). There are two records for the province of B.C.: one from Hudson's Hope in the Peace River area and the other from a survey of the bats of Mount Revelstoke National Park (Fenton *et al.* 1983) (Figure 11). However, recent work with long-eared myotis in B.C. indicates that these identifications may be incorrect if the key to B.C. bats had been used (Firman *et al.* 1993). *M. septentrionalis* is suspected to be present in Kootenay and Glacier national parks (Nagorsen and Brigham 1993), although this has yet to be confirmed.

Habitat: foraging — The Northern Long-eared Myotis is generally associated with boreal forests (Nagorsen and Brigham 1993). In Mount Revelstoke National Park, it was found in western hemlock - western redcedar forests at approximately 700 m a.s.l. (Fenton *et al.* 1983). These bats forage over small ponds and in forest clearings under the tree canopy, foraging mostly 1-3 m

[1] During the summer of 1993, Holroyd captured a number of Western Long-eared and Northern Long-eared Myotis in Mt. Revelstoke National Park. The two species were easily distinguishable based on the colour of pelage and flight membranes and ears. Northern Long-ears had light brown fur, ears, and membranes; Western Long-ears had blonder fur with black ears and membranes. (Draft report submitted to B.C. Hydro, Mica Wildlife Compensation Area.) Further study is required to clarify the situation in other parts of the province.

above the ground and just above the understorey (LaVal *et al.* 1977; Fenton *et al.* 1983). Northern Long-eared Myotis is probably a gleaner (P. Faure, pers. comm.), very like Western Long-eared Myotis (Faure *et al.* 1990; Faure and Barclay 1992).

Habitat: roosting — In eastern North America, Northern Long-eared Myotis have been found in buildings and under the bark of trees (Caire *et al.* 1979; Fitch and Shump 1979; van Zyll de Jong 1980), although there are no records for B.C. Possible night roosts include caves and buildings, and these are separate from day roosts (Fitch and Shump 1979).

Northern Long-eared Myotis is a hibernator and, although there are no records for B.C., it probably holds true that in the western part of its range, it prefers cool, moist sites, where the air is still, for hibernating (Fitch and Shump 1979). It may use caves or mines and roost singly or in small clusters in tight crevices or drill holes (van Zyll de Jong 1985; Nagorsen and Brigham 1993).

Reproduction — The Northern Long-eared Myotis is a typical vespertilionid bat. It mates in the fall. Females store sperm over the winter, ovulate, and become pregnant in spring with one young (Fitch and Shump 1979). Breeding data for B.C. suggest that young are born in late June and early July (Nagorsen and Brigham 1993).

Western Long-eared Myotis

Range — The Western Long-eared Myotis is found in temperate North America, ranging throughout central and southern B.C. (north to Smithers and Summit Lake near Prince George, southwest to Victoria and up the coast to Kimsquit) (van Zyll de Jong 1985) and on Vancouver Island, but not on the more northerly Queen Charlotte Islands (Firman *et al.* 1993). It ranges across southern Saskatchewan and Alberta,

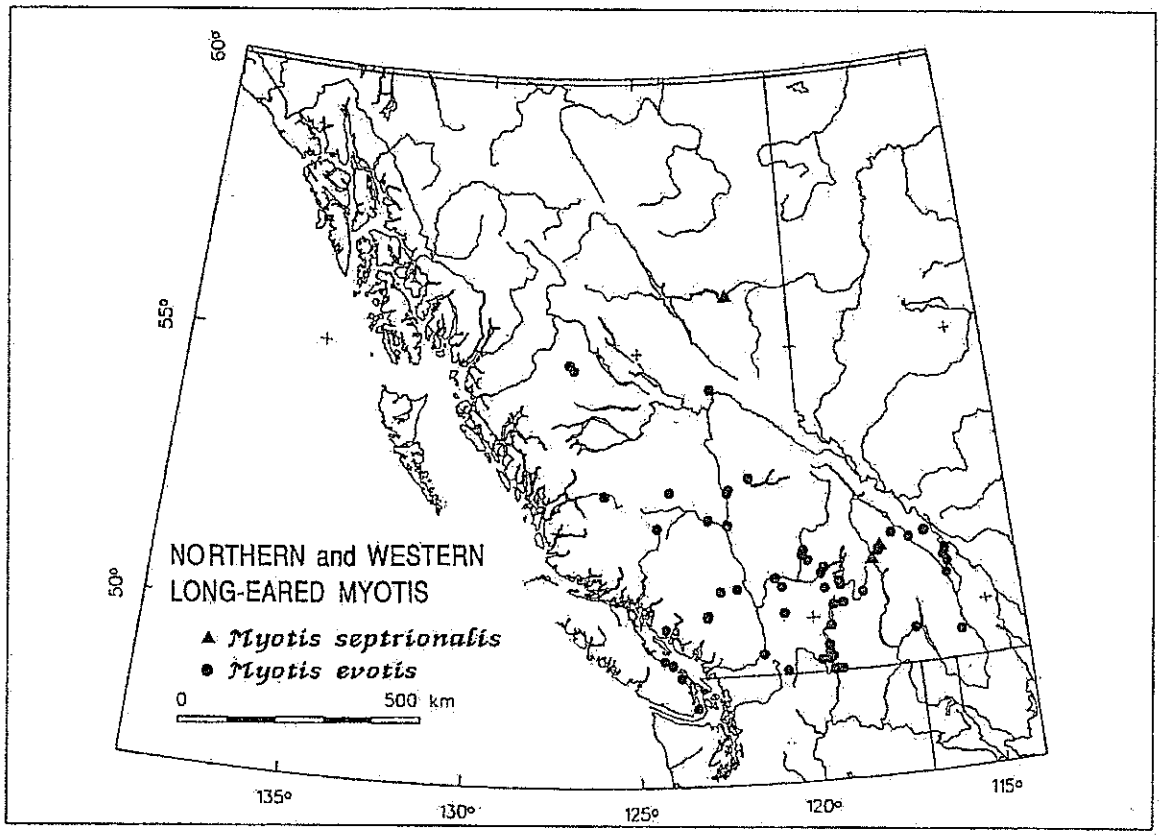


Figure 11. Known distribution of Northern and Western Long-eared Myotis (*Myotis septentrionalis, M. evotis*) in British Columbia (Nagorsen and Brigham 1993).

south along the Pacific Coast to Baja California, east to Montana and Idaho and across to the western Dakotas (Jones and Choate 1978), and from Nevada, Utah, Wyoming and Colorado to New Mexico and Arizona (Hall 1981). Altitudinal range is from near sea level (Grinnell 1933) to about 2830 m in Wyoming (Long 1965).

Habitat: Foraging — The Western Long-eared Myotis is associated with a wide range of habitats, including ponderosa pine forests and rocky outcroppings in coniferous forests in the Pacific coast and western mountain regions (Manning and Jones 1989). In Alberta and Saskatchewan, it is found in riparian areas within the arid badland regions (van Zyll de Jong 1985). It is consistently found at high elevations in western Canada (Nagorsen and Brigham 1993). It forages between and within treetops and over woodland ponds, exhibiting a flight style described as slow and manoeuvrable (van Zyll de Jong 1985), which allows it to hunt in heavy vegetation. Barclay (1991) had most captures (97.8%) in mist nets over land, primarily along paths and roads, as well as a few captures over water within 2 m of the shoreline. Faure *et al.* (1990) determined that the Western Long-eared Myotis is a gleaner (takes prey from the surfaces of vegetation or from the ground), but it is also known to take aerial prey (Manning and Jones 1989; Barclay 1991; Faure and Barclay 1992). This flexible feeding strategy has allowed the Western Long-eared Myotis to invade cool high sites where flying insects are scarce (Barclay 1991).

Habitat: roosting — Western Long-eared Myotis day roosts include sites under loose bark in hollow trees, caves, and sink holes (Manning and Jones 1989), and rock crevices or fissures in clay banks (van Zyll de Jong 1985). Maternity roosts in buildings have been found in B.C., and these bats are known to night roost in caves during summer (van Zyll de Jong 1985).

Although there is no information on hibernacula in B.C., the Western Long-eared Myotis is known to be a hibernator that uses caves and mine adits (van Zyll de Jong 1985; Manning and Jones 1989).

Diet — The Western Long-eared Myotis feeds on beetles and moths (Black 1974; Whittaker *et al.* 1977) and, in the Kananaskis Valley, Alberta, primarily on moths, although they will take chironomids among a wide variety of other insect groups (Barclay 1991).

Reproduction — In B.C., pregnant females (some full term) have been captured in late June and early July (Cowan and Guiguet 1965; Fenton *et al.* 1980). In the Kananaskis Valley, Alberta, early pregnancies were recorded between May and early June (Barclay 1991). Records for pregnancies from elsewhere in its range include: 19 May to 8 June in California, 11 June in northern Idaho (Manning and Jones 1989), and between 14-24 June in Nevada (Hall 1946). Newborns have been recorded from western Washington in mid-July (Manning and Jones 1989). In New Mexico, lactating females and volant young were found in late July (Findley *et al.* 1975).

Summary For Long-eared Myotis

Range — No new points outside the known range in B.C. were found during this survey. Locations and habitats where long-eared myotis were captured are summarized in Appendix 1.

Habitat — Results of the survey are consistent with what is known for this species. Most sites where long-eared myotis were captured were within areas of heavy vegetation (Appendix 1).

Reproduction — Reproductively active long-eared myotis were found at eight different sites during the survey (Table 4). Pregnant and lactating females were captured in Roderick-Haig Brown Provincial Park on 21 June, and lactating females and flying juveniles were captured in the same area during the first week of August. Births probably occur in this area during the last half of June. Pregnant and lactating females were captured on Skull Mountain, just west of Barriere, on 26 June, and flying juveniles were captured about four weeks later at the same site. Lactating females were also captured at Wallhachin and Alkali Lake during the first week of July, and flying juveniles were captured at the end of July in Vernon and Falkland, indicating the presence of reproductively active populations at all of these locations.

Table 4. Reproductive condition of captured Western Long-eared Myotis (*Myotis evotis*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	RHB(LIT)	26	June 21	1
	SM(CL)	31	June 26	2
Lactating	RHB(LIT)	26	June 21	2
	SM(CL)	31	June 26	1
	W	34	July 01	2
	AL(PVP)	41	July 09	1
	RHB(LIT)	26	Aug 03	1
Post-lactating	—	—	—	0
Flying juveniles	CR(VERNON)	51	July 30	1
	MM(VERNON)	52	July 31	2
	RATFALK	23	Aug 02	1
	SM(CL)	31	Aug 09	1
	MADR	25	Aug 11	1

General notes — An adult male long-eared myotis captured at Chute Lake Resort just outside Okanagan Mountain Provincial Park may have been a Northern Long-eared Myotis (*M. septentrionalis*), due to the light brown colour of its ears and wing membranes. As well, a non-reproductive adult female captured and banded on Skull Mountain (26 June) may have been a Western Long-eared Myotis (*M. evotis*), although it was classified as Fringed Myotis (*M. thysanodes*) due to the extensive number of hairs along the edge of the uropatagium.

Recommendation — Determine an accurate method of discriminating among the three species of long-eared myotis that are found in B.C. This would involve more extensive sampling of long-eared myotis. If DNA analysis of hair follicle samples can be used to identify species, visual discrimination between species may then be possible provided there is/are field characteristic(s) that separate(s) them. Once this method has been established, determine the extent of the range of Northern Long-eared Myotis (*M. septentrionalis*) and Keen's Long-eared Myotis (*M. keenii*) in the province.

Spotted Bat

Range — The Spotted Bat (*Euderma maculatum*) has a widespread distribution over the southwestern United States. The most southerly point of its range is in the state of Queretaro, Mexico (Schmidly and Martin 1973) and, until the present survey, the most northerly known point of its range was thought to be in the southern Okanagan and Similkameen valleys and Spences Bridge area of British Columbia (Collard and Barclay 1991; Sarell and Woodgate 1991; Nagorsen and Brigham 1993). Spotted Bats have recently been reported in Dinosaur National Monument Park, Colorado (Navo *et al.* 1992) and, as in that study, we expect that Spotted Bats will continue to 'appear' as more trained observers continue to survey likely habitat.

Spotted Bats were heard on 19 nights in 17 locations (Table 3). Excluding the bats heard at previously known locations (14 at Gallagher Bluff and 2 at Lake Burnell in the southern Okanagan; 7 along the Old Hedley Rd., 1 at Ollala and 4 at Ginty's Pond and Daly Slough in the Similkameen; total 29), there were (maximum estimate) 24 additional bats heard in the rest of the survey area (Figure 12). New sites include Ashcroft (South Thompson River Valley), Lytton (south Fraser River), Alkali Lake, Gang Ranch, and Dog Creek (all in the Cariboo Region along the Fraser River canyon area), as well as Bull Canyon (along the Chilcotin River in the Cariboo), which represents the furthest known point west, and Williams Lake, the furthest known point north, for Spotted Bats (see Appendix 1 for summary of locations sampled).

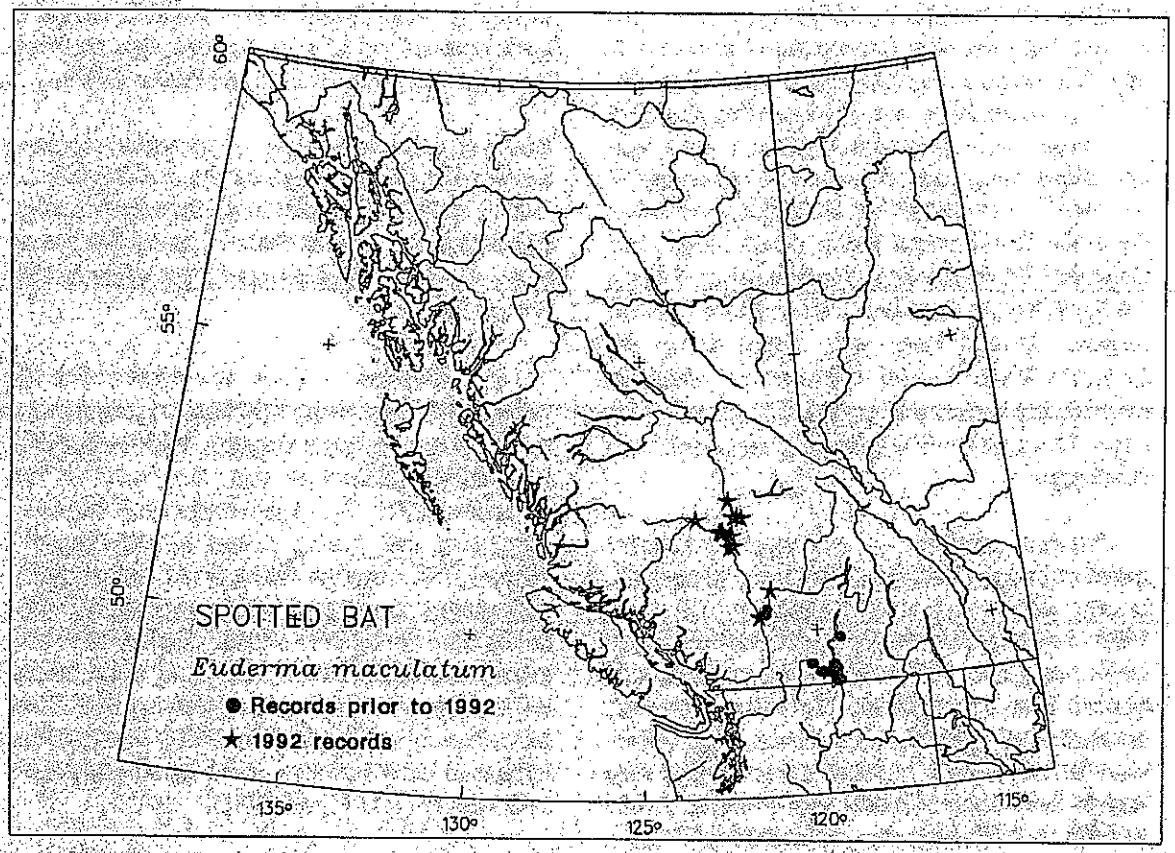


Figure 12. Known distribution of Spotted Bat (*Euderma maculatum*) in British Columbia (Nagorsen and Brigham 1993).

Habitat: foraging — In the southern Okanagan, Spotted Bats have been associated with arid areas dominated by sagebrush (*Artemisia* spp.), with short grasses in the lowlands, and with open ponderosa pine (*Pinus ponderosa*) forests in the foothills (elevation 500-1500 m a.s.l.) (Woodsworth *et al.* 1981). Feeding areas in the southern Okanagan are varied and have been listed as open areas surrounded by ponderosa pine, old fields [dominant ground vegetation of knapweed (*Centaurea* spp.), with patches of bunchgrass (*Agropyron* spp.) and scattered ponderosa pine at old field edges], and hayfields [irrigated valley planted with alfalfa (*Medicago sativa*) with numerous ponderosa pine at field edges] (Leonard and Fenton 1983). Activity in burned and forested areas seemed mainly for commuting (Leonard and Fenton 1983). Findley and Jones (1965) felt that these bats were closely associated with ponderosa pine. Handley (1959) believed they were associated with desert shrub vegetation, while Wai-Ping and Fenton (1989) found Spotted Bats foraging over marsh areas. Navo *et al.* (1992) found that Spotted Bats in northwestern Colorado foraged over a wide range of habitat types, from pinyon-juniper to riparian conditions, over sand and gravel bars, over the river in the canyon, and over the campgrounds in the national park area of their study.

Our results agree with the previous findings. Spotted Bats were found flying and foraging in a wide variety of habitats (Appendix 1), although in all cases the bats were within 1-2 km of areas with steep cliffs (presumably used for roosting), and there was always some form of water (usually a lake, stream or river) in the immediate area. However, foraging may take place over either upland areas or aquatic habitat. Foraging habitat varied from distinctly marshy areas in the Similkameen

Valley to arid, upland areas near Alkali Lake and Gang Ranch. Dog Creek offered dry, upland areas as well, but there was also riparian habitat available that the bats may have been using. Riparian habitat, dominated by cottonwoods (*Populus* spp.) and dense shrubs [waterbirch (*Betula* spp.), willow (*Salix* spp.), and dogwood (*Cornus* spp.)], was associated with Spotted Bats flying and foraging in the Similkameen Valley (Daly Slough and along the Old Hedley Road) and in Ashcroft along the South Thompson River Valley. In the Cariboo Region, Spotted Bats were heard along the Chilcotin River at Bull Canyon and, although riparian, this habitat was dry and dominated by interior Douglas-fir (*Pseudotsuga menziesii*) and bunchgrass.

Habitat: roosting — All reported summer roosts of Spotted Bats have very high, steep cliffs, usually with a vertical drop (Woodsworth *et al.* 1981; Leonard and Fenton 1983; Collard *et al.* 1990; Navo *et al.* 1992). Wintering roosts of B.C. Spotted Bats are unknown. There are, at present, no studies of Spotted Bat overwintering behaviour, although there is some evidence that they stay in their summer roosts year-round in southwestern Utah (Ruffner *et al.* 1979; Poche 1981).

Past work in the southern Okanagan (Collard *et al.* 1991) suggested that Spotted Bats may shift from roosting on one side of the valley during the early part of the breeding season to the other side of the valley later on. The absence of Spotted Bats from the Cawston area and the Old Hedley Road in the Similkameen Valley in late summer may reflect a habitat shift made by the bats in response to changing roost temperatures and thermoregulatory needs.

Foraging behaviour — Many have reported that Spotted Bats forage in circuits or follow elliptical foraging routes (Woodsworth *et al.* 1981; Leonard and Fenton 1983; Navo *et al.* 1992). Radiotelemetry studies of Spotted Bats in the southern Okanagan indicated that foraging areas were not exclusive but were well defined (i.e., there is some overlap with neighbours) (Wai-Ping and Fenton 1989). They also showed that Spotted Bats foraged all night, with a one-way commuting distance of 6-10 km from their day roost site. Spotted Bats forage under a variety of conditions, including wind, cloud cover, ambient temperatures from 4.4 to 18.3 C, and during light showers, but not heavy rain (Leonard and Fenton 1983).

Based on this information, we identified repeated Spotted Bat passes at a given site as a single individual, in an attempt to estimate the actual number of bats present. The number of Spotted Bat passes heard at a site is not a count of the number of bats present (Table 3).

Reproduction — There is evidence that the Spotted Bat follows the reproductive pattern for a typical temperate zone vespertilionid. Individuals are sexually mature in their first year of life (Watkins 1977). Testes descend in late summer, suggesting that mating occurs in fall (Easterla 1965; 1973), although Poche (1981) found males with mature sperm present in spring months. Females store sperm over winter. Ovulation, fertilization, and implantation take place upon spring emergence and a single young (Findley and Jones 1965; Easterla 1971; Watkins 1977; Poche 1981) is born in early summer, mid-May to early June (Watkins 1977; O'Farrell 1981).

Diet — Spotted Bats are believed to forage primarily on moths (Watkins 1977; Fullard *et al.* 1983).

Summary — If we assume that Spotted Bats travel 6-10 km from preferred roost sites (steep cliffs) (Wai-Ping and Fenton 1989) to forage in a fairly defined area, following regular foraging routes or circuits (Leonard and Fenton 1983; Wai-Ping and Fenton 1989), then we can use this information to locate potential roost sites. Usually, when a Spotted Bat is located in an area based on the observer hearing its echolocation call, potential roost sites can easily be identified by scanning the topography for cliff faces. In areas where Spotted Bats are heard echolocating, locations of specific cliff areas used as roosts by Spotted Bats can be determined by listening at the base of cliffs for exiting bats after sunset. Once a roost site is located, it should be protected from human disturbance and development; protection should be year-round until it is established whether Spotted Bats migrate or hibernate. Roost

sites are probably the most critical factor in maintaining bat populations, although protecting suitable foraging habitat may also be important. There is a tendency for summer roost sites and foraging areas to be close to a water source. This may be important for drinking or as a site of concentrated prey populations. Collard and Barclay (1991) postulated that human activities may have a negative impact on Spotted Bat populations and that disturbance from traffic noise may be a factor influencing roost site selection by Spotted Bats. All sample sites in this survey were remote, so conclusions regarding effects of disturbance cannot be addressed, but it is an issue that may be important as areas continue to be developed.

Recommendations—

1. Determine roost sites in new areas where Spotted Bats have been heard [Kelowna (Gallagher Canyon/Mission Creek Valley), Ashcroft, South and North Thompson River valleys, Williams Lake, Dog Creek (check out the Dog Creek Dome as a possible roost site), Gang Ranch, Bull Canyon (canyon here is a possible roost site), and the Chilcotin River Valley] and protect sites with Spotted Bats.

2. Involve local naturalist clubs in recording Spotted Bat sightings. They may be interested in locating roost sites by listening for echolocation calls at the bottom of cliff faces. A tape recording of Spotted Bat echolocation calls could be used as a demonstration to ensure accurate identification of this species, since calls are easily recognized once heard.

3. Determine critical foraging habitat and associated prey. Determine whether feeding patterns shift during the season to different habitats (or if there is a shift in roost habitat).

4. Investigate overwintering habits of Spotted Bats. Determine whether they migrate (if so, where?) or if they stay and hibernate (again, where?). We suspect that if Spotted Bats are distributed as far north as Bull Canyon, they may hibernate somewhere in B.C. If so, these hibernacula should be identified and protected. If Spotted Bats migrate across the international boundary, perhaps federal legislation to protect this species may be in order, similar to the Federal government's current legislation for migratory bird species. The Spotted Bat is listed as "rare" by the United States Department of the Interior.

Townsend's Big-eared Bat

Range — Townsend's Big-eared Bat (*Plecotus townsendii*) is seldom abundant, but is widespread and found in a variety of habitats (Barbour and Davis 1969). This species ranges over most of west-central North America from points south in Mexico, east to the Black Hills of South Dakota, and across western Texas east to Edwards Plateau (Kunz and Martin 1982). The recorded northern limit of its range is from Williams Lake, British Columbia (van Zyll de Jong 1985; Nagorsen and Brigham 1993). Other known points in B.C. include the Adams River, the Kootenay River near Creston, and points on Vancouver Island (van Zyll de Jong 1985; Nagorsen and Brigham 1993) (Figure 13). Isolated relic populations occur in Kansas, Kentucky, Arkansas, Oklahoma, Texas, Mississippi, Virginia and West Virginia (Kunz and Martin 1982).

Results from this survey included captures of Townsend's Big-eared Bat from previously known locations (Williams Lake and the southern Okanagan) and from the Vernon area (Appendix 1).

Habitat: foraging — Townsend's Big-eared Bat is common in the highland areas of western North America (Jones and Suttkas 1972), with the majority of captures in evergreen forests during summer in New Mexico and the least in arid shrublands (Jones 1965). Humphrey and Kunz (1976) found Townsend's Big-eared Bats commonly associated with riparian habitat near gypsum mines in mid-grass prairie in Kansas and Oklahoma. Handley (1959) and Jones (1965) both found this species to be uncommon in arid and prairie areas, although it has been found in lower elevations of arid plateau regions in north-central Mexico (Handley 1959). In California and Washington, this species is found in coastal lowlands in cultivated valleys with nearby hills covered with mixed vegetation (Dalquest 1947a; Pearson *et al.*

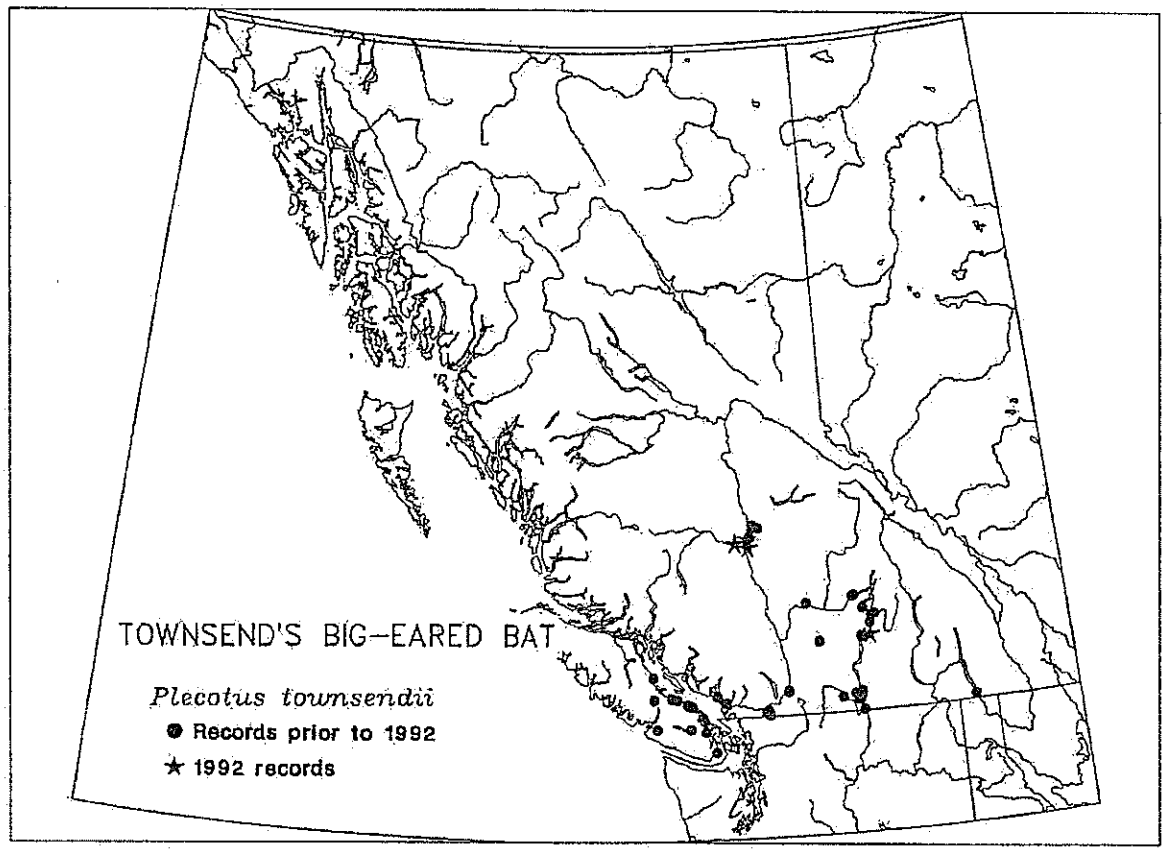


Figure 13. Known distribution of Townsend's Big-eared Bat (*Plecotus townsendii*) in British Columbia (Nagorsen and Brigham 1993).

1952; Kunz and Martin 1982). It is generally found in mesic habitats characterized by coniferous and deciduous forests (Dalquest 1947a; Jones 1965), but it is absent from extreme desert regions (Barbour and Davis 1969). It has, however, been reported from the dry interior of Washington (Dalquest 1948, Sarell and McGuiness 1993).

In this survey, Townsend's Big-eared Bats were found in areas of interior B.C. that are classified as the Bunchgrass and Interior Douglas-fir biogeoclimatic zones. The Bunchgrass zone is characteristically hot and dry, with bunchgrass, sagebrush, and dry ponderosa pine forest as the dominant vegetation types. Interior Douglas-fir is the second warmest forest zone of the dry southern interior and often becomes savannah-like along its drier limits (Minist. of Forests, Res. Branch 1988). However, within these biogeoclimatic zones are small areas of wet habitat associated with streams, lakes, and small marshes. These wet microhabitats are the sites where Townsend's big-eared Bats were captured, presumably while foraging, although a juvenile male was found night-roosting in a building at one location in Vernon (Appendix 1). Dominant vegetation types of these microhabitats included dense deciduous forest [willows (*Salix* spp.), cottonwoods (*Populus* spp.), and waterbirch (*Betula* spp.)], and dense shrubs (e.g., dogwood) which were usually located next to a water source of some type (e.g., Vaseux Lake, Williams Lake, small marshy pond in Vernon).

Habitat; roosting — Townsend's Big-eared Bats are known to use gypsum mines and limestone caves (especially in more southerly latitudes where summer temperatures inside these structures are relatively warm) as well as buildings for summer maternity roosts (Dalquest 1947a; Pearson *et al.* 1952; Kunz and Martin 1982). Summer roost sites in the eastern part of this species' range are found in caves, cliffs, rock ledges, (all associated with well-drained oak-hickory forests), and buildings (Barbour and Davis 1969).

No summer roosts of Townsend's Big-eared Bats were found during this survey, although the presence of a lactating female and two volant young on the Coldstream Ranch in the Vernon area suggests that there may be a maternity roost in the immediate vicinity. Two maternity roosts of notable size were reported in buildings in the Nanaimo area in summer 1992 (L. Friis, pers. comm.), although this was not included in our survey.

Townsend's Big-eared Bats have been found hibernating in mines and caves from the Okanagan Valley to the Williams Lake region (Nagorsen *et al.* 1993). Reports indicate that these animals use a number of exposed roost sites and move between caves during the wintering period (A. and G. Roberts, pers. comm.). Townsend's Big-eared Bats generally hibernate during winter in temperate areas within their range, but have non-hibernating populations in tropical and subtropical areas (Kunz and Martin 1982). During hibernation, big-eared bats roost singly, although some form clusters ranging from a few up to several dozen individuals (Kunz and Martin 1982). Townsend's Big-eared Bats prefer relatively cold places for hibernation, often near entrances and in well-ventilated parts of caves and mines (Pearson *et al.* 1952; Barbour and Davis 1969; Kunz and Martin 1982). These bats may move into more thermally stable areas deep in caves and mine chambers if more exposed roosts become too cold (Kunz and Martin 1982). They have been reported to hibernate in buildings in central California (Pearson *et al.* 1952).

Reproduction — The reproductive pattern of Townsend's Big-eared Bats is similar to that of other temperate bats. Mating occurs in fall, females store sperm over winter, and ovulation and fertilization occur in spring (Kunz and Martin 1982).

An extensive study of Townsend's Big-eared Bats in California showed that yearling females are more likely to fail to produce young (either by failing to have fertilized eggs, resorbing embryos or aborting fetuses) than are older females (Pearson *et al.* 1952). Pups are capable of flight in two and a half to three weeks and are fully weaned in six weeks (Kunz and Martin 1982). Juvenile males leave maternity roosts before juvenile females, although non-breeding females are the first to leave maternity roosts (Pearson *et al.* 1952).

Reports of breeding Townsend's Big-eared Bats in B.C. indicate that births occur sometime in mid-July (Nagorsen and Brigham 1993), although the exact dates may be variable within a one-month period (Pearson *et al.* 1952).

Of the three adult females caught during this survey, two were non-reproductive and the other was lactating. The lactating female was caught at the Coldstream Ranch in Vernon, along with two flying juveniles, on 30 July 1992 (Table 5). This suggests the presence of a reproductive population in the immediate vicinity. The non-reproductive individuals could have been either very young animals that chose not to reproduce (Pearson *et al.* 1952) or older individuals that emerged from hibernation in poor condition due to environmental conditions over the winter or disturbance at winter roosts (Thomas *et al.* 1990).

Diet — There are no records for the diet of Townsend's Big-eared Bats in B.C., but elsewhere this species feeds primarily on moths (Ross 1967), especially microlepidopterans (Kunz and Martin 1982), and small amounts of other insects (Coleoptera, Diptera, Hymenoptera, and Neuroptera (van Zyll de Jong 1985).

Table 5. Reproductive condition of captured Townsend's Big-eared Bats (*Plecotus townsendii*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	—	—	—	0
Lactating	CR(VERNON)	51	July 30	1
Post-lactating	—	—	—	0
Flying juveniles	CR(VERNON)	51	July 30	2

Recommendations—

1. Protect maternity and hibernation sites. Restrict access to these colonies because Townsend's Big-eared Bats are reported to be extremely sensitive to human disturbance.

2. Identify critical roosting and foraging habitats. Foraging habitat for lightweight bats such as Townsend's Big-eared Bats should be assessed with light tags (Buchler 1976) and behavioural observation, because current radiotelemetry equipment is still too heavy for use on bats that weigh less than about 12 grams (Aldridge and Brigham 1988).

3. Locate maternity roosts in the province and protect them. This species may use buildings and could be mistaken for one of the more common species by people unfamiliar with bats. If people can be convinced that they have something novel, helpful, and harmless in their attics, they may be more inclined to allow these animals to stay.

Fringed Myotis

Range — The Fringed Myotis (*Myotis thysanodes*) is distributed widely across western North America from southern British Columbia to Veracruz and Chiapas in Mexico, with disjunct populations in the Black Hills of Wyoming and South Dakota (O'Farrell and Studier 1980). In B.C., records are from Vernon, Oliver and Osoyoos (van Zyll de Jong 1985), and from the mouth of the Adams River, Shuswap Lake area (Nagorsen and Brigham 1993).

Fringed Myotis were captured at a known night roost at the Suzie Mine near Oliver, as well as near Alkali Lake, within 5 km of the Fraser River Valley area, while they foraged and night-roosted (Appendix 1). Captures at Alkali Lake represent a significant northward extension of their known range (Figure 14).

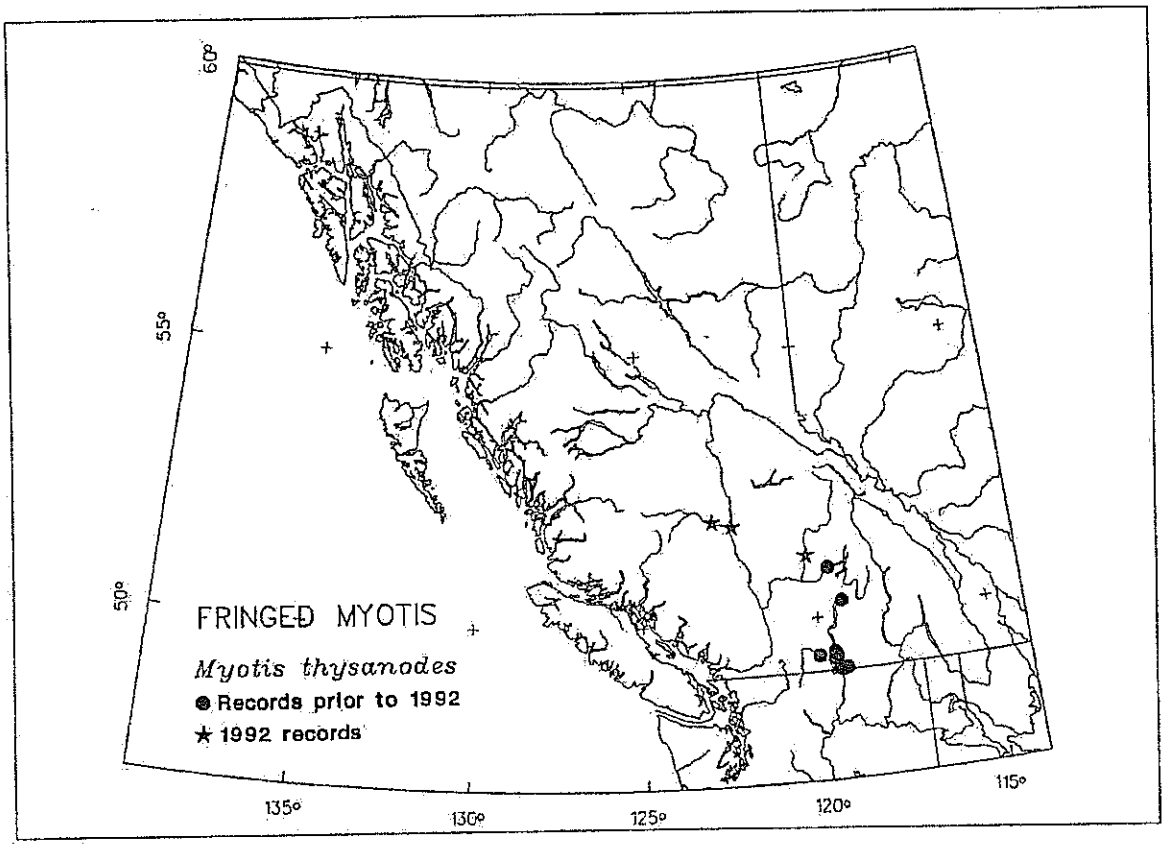


Figure 14. Known distribution of Fringed Myotis (*Myotis thysanodes*) in British Columbia (Nagorsen and Brigham 1993).

Habitat: foraging — Fringed Myotis are found primarily in middle elevations, between 1200 and 2100 m, in desert grass and woodland habitats (O'Farrell and Studier 1980). In New Mexico, they are found at 2550 m in spruce-fir forests (Barbour and Davis 1969; Findley *et al.* 1975), and are exclusively associated with evergreen forests in the Mogollon Mountains of New Mexico and Arizona (Jones 1965). There are also a few populations at low elevations along the west coast (Orr 1956), and in the sagebrush grasslands in Washington (Williams 1968, Sarell and McGuiness 1993). A number of investigators have found that Fringed Myotis were most commonly associated with oak-pinyon woodlands (Roest 1951; Hoffmeister and Goodpaster 1954; Cockrum and Ordway 1959; Jones 1965; Findley *et al.* 1975). All desert and steppe areas within the range of *M. thysanodes* were within a one-hour flight from forested or riparian areas (O'Farrell and Studier 1980). In southern B.C., Fringed Myotis are associated with open semi-arid areas and dry ponderosa pine forest between 300 and 760 m (Fenton *et al.* 1980).

During this survey, Fringed Myotis were captured in a harp trap when entering a night roost, as well as in nets at two sites near Alkali Lake. One Fringed Myotis was captured in a net set over dense *Scirpus* at the edge of Alkali Lake, while a second was captured approximately 4 km southwest of this point in the valley bottom beside the creek in a net set up by the Roberts'. This last site was similar to the creek area outside the night roost but was more heavily vegetated with low trees and shrubs (Appendix 1).

Habitat: roosting — Fringed Myotis may use caves, rock crevices, mine tunnels, and buildings for night or day roosts (Burt 1934; Cahalane 1939; Pearson *et al.* 1952; Orr 1956; Musser and Durant 1960; Commisaris 1961; Baker 1962; Easterla 1966, 1973; Studier 1968). There are no reports of known hibernacula (O'Farrell and Studier 1980), but fall fat deposition patterns and fat composition are consistent with species preparing for hibernation (Ewing *et al.* 1970; O'Farrell and Studier 1976). In southern regions, this bat is known to make migrations between summer and winter (Studier and O'Farrell 1972) with periodic bouts of activity during the winter months. There is nothing known about its winter habits in Canada (van Zyll de Jong 1985).

Diet — Fringed Myotis eat mostly beetles and some moths (Black 1974), as well as harvestmen and crickets (Whitaker *et al.* 1977). They are also reported to eat flies, leafhoppers, and lacewings (Nagorsen and Brigham 1993). Based on its flight abilities, this species probably gleans insects from surfaces as well as capturing insects aerially (van Zyll de Jong 1985).

Reproduction — The pattern of reproduction is typical of vespertilionid bats, with mating in fall, sperm storage over winter, and ovulation, fertilization and implantation occurring upon spring emergence (O'Farrell and Studier 1973). Fringed Myotis produce one young per year (Barbour and Davis 1969). In New Mexico, parturition takes place between 25 June and 7 July (O'Farrell and Studier 1973). Data from a nursery colony in B.C. suggests that parturition occurs between late June and early July (Nagorsen and Brigham 1993).

There is a known population of Fringed Myotis in the southern Okanagan (Collard *et al.* 1990), and a previously banded lactating female was captured in the area in late summer during this survey. One of the adult females captured in the Alkali Lake region was lactating in early July, indicating that a reproductive population exists in that area (Table 6).

Table 6. Reproductive condition of captured Fringed Myotis (*Myotis thysanodes*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	—	—	—	0
Lactating	AL(PVP)	41	July 09	1
	SM(OLIVER)	50	July 29	1
Post-lactating	—	—	—	0
Flying juveniles	—	—	—	0

Recommendations—

1. Continue to survey populations of Fringed Myotis. Assess abundance of this species in the Alkali Lake, Gang Ranch areas in greater detail and investigate the extent of the range of this species in that region. Survey the Kamloops Region in more detail. (The Thompson River Valley has abundant dry habitat, but there was insufficient time to thoroughly investigate it.)

2. Assess foraging habitat for this species in the regions where it is now known to exist. Using light tags (Buchler 1976), individuals can be followed to determine foraging areas.

Western Small-footed Myotis

General notes — Very little is known or published on the natural history and distribution of Western Small-footed Myotis (*M. ciliolabrum*) although there is a reasonable amount of literature on Eastern Small-footed Myotis (*M. leibii*), a morphologically similar species in eastern North America. Although wing morphology and echolocation calls are similar, suggesting some similarity in habitat use, the two species may not have similar habitat preferences (Norberg and Rayner 1987). The Western Small-footed Myotis is small, weighing between 2.8 and 7.1 g (van Zyll de Jong 1985).

Range — The Western Small-footed Myotis is distributed throughout most of western North America, from Mexico through the United States to Saskatchewan, Alberta, and British Columbia (van Zyll de Jong 1985; Nagorsen and Brigham 1993). In B.C., Western Small-footed Myotis have been found in the Okanagan and Similkameen valleys, ranging to Oyama and Keremeos respectively (van Zyll de Jong 1985; Nagorsen and Brigham 1993).

Western Small-footed Myotis were captured at four new sites outside the previously known range (Appendix 1) and another site along the Old Hedley Road represents the furthest known point north along the Similkameen Valley. New sites were along the South Thompson River Valley (Wallhachin) and the Fraser River Valley area (Alkali Lake, Gang Ranch, and Dog Creek) (Figure 15).

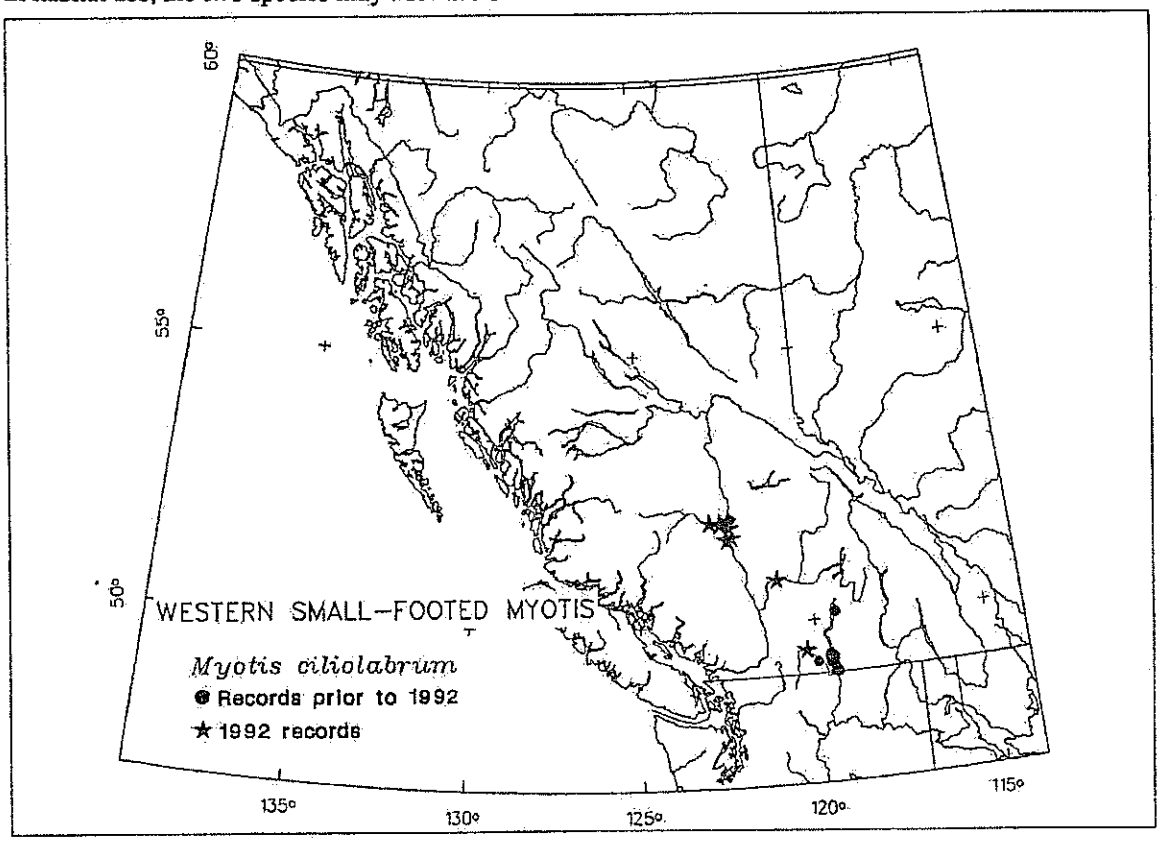


Figure 15. Known distribution of Western Small-footed Myotis (*Myotis ciliolabrum*) in British Columbia (Nagorsen and Brigham 1993).

Habitat: foraging — The Western Small-footed Myotis is associated with cliffs and rocky outcrops in arid valleys and badlands, and hunts over the edges of rocky bluffs, rarely over open water (Schowalter and Allen 1981; Nagorsen and Brigham 1993). In B.C., elevation records are from 300 to 700 m a.s.l.

During this survey, *M. ciliolabrum* was captured in predominantly dry bunchgrass areas that were within the vicinity of water (usually less than 0.5 km). However, the netting site along the Old Hedley Road was wet and swampy, and the immediate area was characterized by a dense stand of mature cottonwood, with dense stands of Douglas-fir in the upland area. All sites within the Fraser River Valley area were captures from harp traps set in buildings used as night roosts (Appendix 1).

Habitat: roosting — The Western Small-footed Myotis roosts in cliffs, vertical banks, talus slopes, and under boulders (Nagorsen and Brigham 1993), beneath bark and in barns (van Zyll de Jong 1985). Maternity colonies are often protected sites in which the micro-environment is dry and hot (between 27-33 C). Western Small-footed Myotis will also use houses as maternity roosts. Night roosts include small caves, abandoned mine adits, and buildings (Nagorsen and Brigham 1993).

The Western Small-footed Myotis is a hibernator (van Zyll de Jong 1985) and, in the southern Okanagan, has been found in mine adits where individuals wedge themselves into tight crevices or depressions in the ceilings of hibernacula with their heads facing out (Nagorsen and Brigham 1993). Anna and Gina Roberts recently discovered hibernating Western Small-footed Myotis in a cave near Williams Lake that was also occupied by Big Brown Bats (*Eptesicus fuscus*) and Townsend's Big-eared Bats (*Plecotus townsendii*) (Nagorsen and Brigham 1993). Western Small-footed Myotis are most often found hibernating singly rather than in clusters (Genter 1980).

Reproduction — The Western Small-footed Myotis is a typical temperate zone vespertilionid, with mating occurring in fall and pregnancy initiated upon arousal from hibernation. There is little reproductive information available. From B.C., previous records show females are probably pregnant between late June and mid-July, while lactating females can be found between mid-June and early August (Grindal *et al.* 1992). From this it is inferred that young in southern B.C. are born between late June and mid-July.

Pregnant females were captured on 11 and 12 July at Gang Ranch. Lactating females were captured during the first two weeks of July and, while in captivity, one adult female gave birth to a single healthy pup on 9 July at Alkali Lake (Table 7).

Diet — Studies of Western Small-footed Myotis near Vaseux Lake indicate that their diet consists primarily of caddisflies, although they also take flies, beetles, and moths (Woodsworth 1981), as well as Hemiptera (van Zyll de Jong 1985).

Recommendations—

1. Continue to survey populations of Western Small-footed Myotis. Assess abundance of this species in the Alkali Lake, Gang Ranch area in greater detail and investigate the extent of the

Table 7. Reproductive condition of captured Western Small-footed Myotis (*Myotis ciliolabrum*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	GR	43	July 11	1
	GR(RES)	44	July 12	1
Lactating	W	34	July 01	1
	AL(OB)	42	July 09	1
	OHR	5	July 17	1
Post-lactating	—	—	—	0
Newborn juveniles	AL	42	July 09	1
Flying juveniles	—	—	—	0

range of this species in that region. Survey the Kamloops Region in more detail. (The Thompson River Valley has abundant dry habitat, but there was insufficient time to thoroughly investigate it.)

2. Assess foraging habitat for this species in the regions where it is now known to exist. Using light tags (Buchler 1976), individuals can be followed to determine foraging areas. Foraging activity can be determined by using mini-detectors and monitoring feeding buzzes of light-tagged individuals (Note: This technique may not be appropriate at sites where there are high concentrations of bats).

Foliage-roosting Species

The lasiurines [Southern Red Bat (*Lasiurus blossevilli*), Northern Red Bat (*L. borealis*) and Hoary Bat (*L. cinereus*)], as well as the Silver-haired Bat (*Lasionycteris noctivagans*), are known to be heavily dependent on trees for roost sites (Kunz 1982; Shump and Shump 1982a,b; Barclay 1984; Barclay *et al.* 1988). Red Bats and Hoary Bats roost singly or as family groups (consisting of the mother and one to two offspring for Hoary Bats, one to five for Red Bats) (Shump and Shump 1982a,b; Barclay 1989). Males may use entirely different habitats and may be spatially segregated from the breeding females and young during the breeding season (Kunz 1971; Barclay 1984). Silver-haired Bats may roost alone or in small colonies, usually under the sloughing bark of old trees (Kunz 1982; Barclay *et al.* 1988).

All of these species are known to migrate to some extent (Kunz 1982; Shump and Shump 1982a,b; Barclay 1984). The destination of Red Bats may be the southern United States or Mexico, while the final destination of Hoary Bats is still unknown (Findley and Jones 1964). The lasiurines are thought to be active year-round, while Silver-haired Bats, although considered migratory, hibernate upon arrival at their wintering grounds in the southern United States (Kunz 1982; Perkins and Cross 1988). In B.C., however, Silver-haired Bats have been found at all seasons. They have been reported hibernating most often in trees, but also in attics and old mines (Nagorsen *et al.* 1993).

Tree roosts tend to be high, wide open from below, and along edge habitats (Shump and Shump 1982a,b), and trees may be deciduous or coniferous (Barclay, 1989; Hickey, pers. comm.). In Manitoba, Hoary Bats tend to use very tall, mature cottonwood (*Populus* spp.), burr oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*), and Manitoba maple (*Acer negundo*) (Barclay 1989; S.L. Holroyd, pers. observ.). Studies in Pinery Provincial Park in southwestern Ontario have shown Hoary Bats using mature white and red pines (*Pinus strobus*, and *Pinus resinosa* respectively) located close to the edges of flyways (roads or river channels) and Northern Red Bats using trees with heavy grapevine (*Vitus* spp.) overgrowth (B. Hickey, pers. comm). Tree species were mainly pines that were close to edge habitat onto open savannah or open woodland areas. For both species, roost sites were always very close to feeding sites (B. Hickey, pers. comm).

Hoary bats were heard on QMC bat detectors at four locations (Appendix 1). All sites were classified as Interior Douglas-fir Biogeoclima -tic Zone. All sites bordered areas with very mature cottonwood (*Populus* spp.), Douglas-fir (*Pseudotsuga menziesii*) or western redcedar (*Thuja plicata*) (Appendix 1). No Hoary Bats were captured during this survey.

Silver-haired Bats represented 2.1 % of all bats captured (Fig. 8). Silver-haired Bats were either detected or captured on five nights at four separate locations (Appendix 1). In all cases, the biogeoclimatic zone was Interior Douglas-fir and nets were located near water. At two sites where individuals were captured, the presence of either pregnant, lactating or post-lactating females, or flying juveniles indicated that local populations were reproductively active (Table 8).

Other Species

Little Brown Myotis

The Little Brown Myotis (*Myotis lucifugus*) was the most commonly captured species during our survey. This may be due to the fact that it is very common and has a wide distribution, but may also be due to its tendency to be caught in groups. It is

Table 8. Reproductive condition of captured Silver-haired Bats (*Lasionycteris noctivagans*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	—	—	—	0
Lactating	MM(VERNON)	52	July 31	1
Post-lactating	MM(VERNON)	52	July 31	2
Flying juveniles	MM(VERNON)	52	July 31	2
	RATFALK	23	Aug 02	1

widely recognized among bat researchers that one squawking Little Brown Myotis in a mist net attracts others. A large proportion of the Little Brown Myotis we captured were captured in harp traps set at night roosts. All factors considered, this is still likely the most common species found in most areas. Reproductive data from this survey is summarized in Table 9.

Yuma Myotis

The Yuma Myotis (*Myotis yumanensis*) was the second most common species captured during the survey. Yuma Myotis seem to be as widespread throughout the province as Little Brown Bats, as they were captured in 12 different sites from all regions we covered. Reproductive data is summarized in Table 10.

Table 9. Reproductive condition of captured Little Brown Myotis (*Myotis lucifugus*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	GINP	8	May 22	7
	LOYAM	15	June 02	1
	GBR	16	June 03	2
	WPW	24	June 18	1
	GL	30	June 25	8
	AS	35	July 02	2
Lactating	WPW	24	June 18	2
	RHB(LIT)	26	June 21	1
	GL	30	June 25	1
	WL(SINC)	39	July 08	1
	AL(PVP)	41	July 09	9
	AL(OB)	42	July 10	8
	GR	43	July 11	5
	CR(VERNON)	51	July 30	1
	RATFALK	23	Aug 02	1
Post-lactating	RATFALK	23	Aug 02	2
	CHILANKO	63	Aug 19	3
	RFSR(FB)	64	Aug 20	1
Flying juveniles	AL(PVP)	41	July 09	2
	AL(OB)	42	July 10	1
	CR(VERNON)	51	July 30	6
	RATFALK	23	Aug 02	7
	CHILANKO	63	Aug 19	6
	RFSR(FB)	64	Aug 20	2

Table 10. Reproductive condition of captured Yuma Myotis (*Myotis yumanensis*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	GBR	16	June 03	4
Lactating	RHB(LIT)	26	June 21	5
	T	32	June 29	1
	GR	43	July 11	4
	CR(VERNON)	51	July 30	1
Post-lactating	CR(VERNON)	51	July 30	3
	RHB(LIT)	26	Aug 03	2
	MADR	25	Aug 11	1
Flying juveniles	CR(VERNON)	51	July 30	13

We visited the Yuma Myotis colony located in the attic of an abandoned church near Squilax, B.C., on the Shuswap Lake. There were an estimated 1500 bats in the colony in late June (C. Harris, pers. comm.), and pups were about one to six days old at this time (S.L. Holroyd, pers. observ.). The colony seems to be on a slight decline (C. Harris, pers. comm.) although long-term monitoring of the population will more accurately show if this is true. Interestingly, we captured three adult males (which originally had been banded at the colony in Squilax) in the attic of a house beside the Adams Lake Sawmill, approximately 15 km up the lake from the Squilax colony. The colony at the sawmill is a maternity colony of approximately 140 individuals. Pups were visible and were approximately five to seven days old on 22 June (S.L. Holroyd, pers. observ.).

A larger maternity colony was reported in the attic of a summer home on the west arm of Lake Okanagan. Estimated colony size was 3000 to 4000 adults on 01 August. We visited this colony on the day that the homeowners decided to keep the colony. This decision was largely based on the position taken by BC Environment in Penticton, whereby the Ministry agreed to clean up and seal the attic from the rest of the home if the residents kept the colony. Two biologists from the Ministry office in Penticton came to the house, handled the bats and explained some of the basic ecology of these bats to the residents. We believe this had a significant impact on the decision made by the residents of the house. From speaking to these people, we recommend that an effort be made to minimize the amount of disturbance by Ministry personnel to the residents of the house (human and bat).

Big Brown Bat

Distribution of the Big Brown Bat (*Eptesicus fuscus*) is widespread (Appendix 3). Individuals were captured in a wide variety of habitat types. Big Brown Bats are easily distinguishable on the QMC bat detectors because their calls are distinct and loud (Fenton and Bell 1981). Their calls were heard on many net nights when no bats were captured. Sixty individuals were captured over the summer, representing 12.4% of the total captures. A maternity colony of approximately 25 females was found in a barn in Lytton [L(SGB)-1-1; site #47] and it was likely individuals from this colony that were caught in our harp trap. Reproductive data is summarized in Table 11.

Long-legged Myotis

Long-legged Myotis (*Myotis volans*) represented 10.7% of the total catch. This number would seem to indicate that these bats are fairly widespread and abundant. This was not the case, however, because most (31 of a total of 52 caught) were captured during two nights trapping at a night roost in Alkali Lake. A large proportion of captured Long-legged Myotis were non-reproductive (17 of 31 adult females), and another five appeared as though they had started lactating but lost their pups (small bare patch, nipple exposed but not chewed, no milk expressed). The remaining nine bats were lactating (see Table 12).

Table 11. Reproductive condition of captured Big Brown Bats (*Eptesicus fuscus*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	OFPP	2	May 13	2
	MADR	25	June 20	4
	RHB(LIT)	26	June 21	3
	W	34	July 01	1
Lactating	MADR	25	June 20	2
	RHB(LIT)	26	June 21	5
	WLCC	36	July 04	1
	L(SGB)	47	July 16	11
Post-lactating	MM(VERNON)	52	July 31	3
	AS	35	Aug 15	1
Flying juveniles	L(SGB)	47	July 16	6

California Myotis

We captured only 18 California Myotis (*M. californicus*) during the survey and these were distributed over six different sites. The farthest point north and west where California Myotis were caught was in the Louis Creek Valley (Appendix 3). Of the adults captured, about half were female. Juveniles were also captured at Vernon and at Louis Creek. A summary of reproductive data is given in Table 13.

Table 12. Reproductive condition of captured Long-legged Myotis (*Myotis volans*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	OGM(K)	9	May 23	1
	RHB(LIT)	26	June 21	1
Lactating	RHB(LIT)	26	June 21	2
	AL(OB)	42	Jul 09/10	9
	L(SGB)	47	July 16	1
	CR(VERNON)	51	July 30	1
	LC(CABIN)	56	Aug 08	1
Post-lactating	WL(LLH)	60	Aug 16	1

Table 13. Reproductive condition of captured California Myotis (*Myotis californicus*).

Reproductive condition	Site	Site number	Date	Number of bats
Pregnant	RHB(LIT)	26	June 21	1
Lactating	CR(VERNON)	51	July 30	1
Post-lactating	RHB(LIT)	26	Aug 03	1
Flying juveniles	CR(VERNON)	51	July 30	1
	LC(CABIN)	56	Aug 08	2

SUMMARY

The Survey

Our survey found individuals of five species of bats, currently either Red- or Blue-listed, in new areas within the dry interior of B.C. The area involved in the survey was extensive, making it impossible to spend more than one or two nights at any given site. Consequently, interpreting critical habitat types and species abundance from the data is difficult. Current methods census of bat populations make it difficult to infer species abundance because to ensure netting success, nets are set up specifically in areas of high bat activity. Habitat use can be assessed via radio-tracking or light-tagging (chemiluminescent tags) which enables the researcher to follow bat activity throughout the evening (light-tagging see Buchler 1976; radio-tracking see Wilkinson and Bradbury 1988). Mist netting does not reveal what the behaviour of the animal was at the time of capture, because captured individuals may be foraging, commuting to other areas, or drinking from calm pools of water. More intensive studies are needed to determine critical habitats either by examining a specific species or by studying a smaller area.

Behaviour and Reproductive Strategy

The bats in British Columbia are colonial, with the exception of the foliage-roosting species Southern Red Bat (*Lasiurus blossevilli*) and Hoary Bat (*L. cinereus*). Colonial animals may face a greater risk of population decline than more dispersed species. Disturbance at a roost site (especially a maternity roost) may affect large numbers of breeding individuals and may have significant long-term effects on local populations. Wildlife managers need to monitor populations closely and conserve summer and winter roost sites if population levels are to be maintained. A basic understanding of bat reproductive ecology and of the energetic constraints faced by breeding bats is necessary to effectively manage bat populations.

All temperate vespertilionids are under the same basic constraints while breeding and overwintering (although migratory species may have different problems, see Koehler 1991). During the breeding season, temperature and precipitation determine whether individuals forage or not (Rydell 1989; Grindal *et al.* 1992). Aerial insectivore foraging patterns are influenced by prey availability, which in turn is affected by ambient temperature (Rydell 1989). Bats in temperate-zone Sweden, for instance, forage only when ambient temperatures are above 10 C, which is when prey levels are high enough to make hunting energetically profitable (Rydell 1989). Bats also make use of a physiological mechanism that allows them to save energy. By using daily torpor (similar to the state entered while hibernating but used on a daily basis), individuals reduce the costs associated with homeothermy and can quickly rebuild fat reserves lost over winter. Torpor also allows them to survive periods of environmental extremes when food availability is low (Racey and Speakman 1987; Thomas *et al.* 1990).

Populations at the northernmost limit of their range, such as many of the bat species in B.C., may be under more severe and variable environmental conditions than more southerly populations. Short growing seasons and long winters may mean that females do not reproduce in their first year and that during particularly cold or variable springs, individuals in poor condition may choose not to breed. Bats are long-lived animals (Fenton and Barclay 1980; Tuttle and Stevenson 1982) and may opt out of reproduction in years where doing so risks their survival to the following breeding season (S. Holroyd, pers. observ.). This means that the number of reproducing individuals in a population may vary from year to year depending on the environmental conditions. As well, overwinter survival rates for yearling bats is generally 30-40% (Tuttle and Stevenson 1982; S. Holroyd, pers. observ. for *E. fuscus* in southeastern Alberta), which means that the recruitment rate for any given year is relatively low. Population recoveries would thus be slow and there may be a critical group size (e.g., for thermoregulation in roosts) that is necessary for the survival of individuals.

Bats and Forests

In British Columbia, the Southern Red Bat (*Lasiurus blossevilli*) and Hoary Bat (*L. cinereus*)

are solitary and hang from the foliage of trees. Many of the other species of bats roost in forests using hollows in trees or cracks in and under bark [e.g., Silver-haired Bat (*Lasionycteris noctivagans*), most *Myotis* spp.: Fitch and Shump 1979; Kunz 1982; Barclay 1985; van Zyll de Jong 1985; Barclay *et al.* 1988]. Habitat studies of bats in Oregon (Perkins and Cross 1988) and in Pacific coast forests (Thomas 1988) have shown that bats prefer the oldest age class forests. In Oregon, adult male Hoary Bats and Silver-haired Bats prefer the Douglas-fir/western hemlock forest stands generally exceeding 200 years old (Perkins and Cross 1988). It has been suggested that crevices created either by shed limb holes or between plates or ridges of bark are first seen at approximately 80 years and become apparent in trees of 150 years of age or older (*ibid.*). This oldest Douglas-fir age class also contained the greatest number of snags (*ibid.*). It is these crevices and snags that are used as roost sites by Silver-haired Bats (Barclay 1985; Barclay *et al.* 1988) and many other bat species (Barclay and Cash 1985). Older trees are also more open from below, thus leaving high open roosts that are protected by foliage from above. It is this roost-type that is used by lasiurines (Shump and Shump 1982a,b; Barclay 1989).

In the Pacific Northwest, there is a burst of activity within the first 15-30 minutes after dusk, and this activity is highest in old-growth stands (Thomas 1988). These stands were mainly old-growth Douglas-fir (>200 years of age), and it was concluded that the old growth forests were critical roosting habitat but that bats were foraging elsewhere (*ibid.*).

Clearly, more work is needed in defining natural roosting habitat for most species, as well as foraging habitat, which may be spatially separate from roost sites. It is also evident that old stands of trees represent important roost habitat for almost all species (Perkins and Cross 1988; Thomas 1988).

Recent work in the Pacific Northwest redwood forests (*Sequoia sempervirens*) has shown that bats make use of basal hollows and are responsible for a significant amount of nutrient input (specifically, nitrogen) at both a local and community level (Rainey *et al.* 1992). Bats at a local level play a significant role in upslope nutrient transport (101 to 102 g/tree/yr of guano containing 10% nitrogen against a background flux of approximately 2-3 g N/m2/yr) into remaining old-growth habitats (Rainey *et al.* 1992). This represents a significant nutrient input that foresters may have previously overlooked.

Suggested Future Work

Spotted Bats (*Euderma maculatum*) may exhibit a seasonal shift in habitat use. Our survey indicated that at least in the Similkameen Valley, Spotted Bats foraged at one site early in the season, but not later on. This could be examined more closely by monitoring Spotted Bats in specific areas over the entire reproductive period.

Roderick Haig-Brown Provincial Park on Shuswap Lake in the Kamloops Region had a remarkable variety (seven or more species) and abundance (44 bats captured in nets within two hours) of bats. However, our early season netting efforts resulted in much higher numbers of bats than late season efforts. This may again reflect a shift in habitat use, with bats moving to higher elevations in late summer when valley bottoms become hot and dry. Bats could be following insect outbreaks, which occur later in the season as the ambient temperature at higher elevations begins increase. Further studies could address this question perhaps in relation to bats as predators on forest insect pests, although some of this foraging activity may be concentrated on late-occurring insect hatches over higher elevation (>3500 feet) lakes and ponds (D. Low, pers. comm.).

Although we did not survey the Nicola Valley, it has extensive riparian habitat dominated in several places by large stands of cottonwoods. These areas could potentially represent areas of high bat activity based on the pattern of capture-site characteristics found this summer.

Comparatively little time was spent in the Vernon area, although a large number of bats were captured in the three days that we were there. Eight species and a total of 74 bats were captured, representing 15.3% of all bats captured during the survey. The northern Okanagan in general should

be surveyed more intensively. Of all the areas we surveyed, this area is probably most threatened by residential development. For the northern Okanagan in particular, we suggest enlisting the help of local naturalists who know the area well. Naturalists can be exceedingly helpful in pointing out areas within developed regions that are still relatively natural. This sort of discrimination is difficult to make from topographic maps, especially if habitats are small and isolated.

It is our experience that naturalist clubs are very helpful when it comes to bat fauna because bats are relatively poorly known and naturalists are eager to contribute to the body of natural history information. Light-tagging (Buchler 1976) is probably the most useful method for examining foraging habitat use, especially by small bats. This technique is most effective with large numbers of observers (a perfect evening activity for a group of enthusiastic volunteer naturalists). A recent modification of the light-tagging technique involves using chemiluminescent fishing lures in place of gel capsules (which must be manually filled with a chemiluminescent substance). This new method is simpler, safer, cheap, and the fishing lures can be purchased at most fishing supply outlets.

We obviously only touched on the areas we surveyed given the amount of time available and the extensive area covered. In all areas, biogeoclimatic zones adjacent to the Bunchgrass Zone represented areas of good bat habitat. In particular, riparian areas and warm stands, especially of older, mature trees (such as Douglas-fir, western redcedar, and ponderosa pine) may be particularly important for foraging and roosting. The Fraser and Thompson River valleys both had some of the more rare bat species. River valleys adjacent to these valleys (e.g., Deadman and Bonaparte valleys in the Thompson River region) may also hold rare bat fauna. More work is needed to determine this.

Clearly, there is a need for intelligent management of bat species if there is the will to conserve populations. Populations may be healthy now and may stay that way without human disturbance, but because of their colonial habits, low recruitment rates, and special habitat needs, there is a danger of quickly eliminating significant portions of the population if proper policies are not in place.

RECOMMENDATIONS

Education

Not only does the general public need to be made aware of bats and their ecological importance, other government agencies need to be made aware as well. The Ministry of Forests has taken steps recently to more adequately understand the needs of these forest-dwelling bats.

Bat Conservation International (P.O. Box 16203, Austin, TX, 78716-2603, U.S.A.) has a great educational workbook with lots of information on bats and projects for elementary school children. In our experience, teachers find this publication very useful. We recommend that this publication be promoted by maintaining it as part of a general resource file that can be used by teachers to help educate young people and change attitudes towards bats. It should be supplemented with an informative booklet on the bats of B.C. (Alberta has a publication like this, see Dept. of Fish and Wildlife, Edmonton). This could include information on rabies, habitat use, general reproductive biology, and perhaps how to attract bats that would be useful to health care workers, foresters, teachers, the general public, and BC Environment personnel. Once such a file is in place, we suggest that educators be informed that this information is available. Such files could be compiled for various fauna that the Ministry has studied and could become an invaluable bridge between the Royal B.C. Museum and BC Environment biologists and the public.

Once members of the public can visually identify distinctive species, such as Townsend's Big-eared Bats (*Plecotus townsendii*), which may be using attics in houses, more information is likely to come from the public and perhaps more bats will avoid unnecessary extermination.

Conservation

Roost sites, including maternity roosts and hibernacula, are critical. Roost types particular to individual species need to be identified. Efforts should be made to conserve major maternity roosts that are found. The actions of the BC Environment in Penticton this summer regarding the Vernon colony of Yuma Myotis should be applauded. Funding for this sort of situation should be made available because there is a high probability that bats will continue to be found cohabiting with people. Major hibernacula that are identified should be protected. Successful efforts in minimizing disturbance (i.e., keeping out people) have been made in a number of caves in the U.S. by installing gates that let bats in but keep people out.

Maternity colonies or hibernating colonies of any Red- or Blue-listed species must be protected from any disturbance (this includes entering roosts with bright lights, handling bats, and/or netting bats within roost sites). Ethical considerations should be made before any sort of disturbance, including for research, is made, whether it is for banding purposes or otherwise. Schedules should be set for monitoring known colonies considered to be important on the basis of species composition or size. Maternity colony size can be monitored externally by counting individuals as they exit and netting away from the roost to monitor numbers of reproductive individuals and reproductive condition. Hibernacula should be treated with extreme care. Generally, entry to hibernating colonies should be prohibited. Permission for entry into major hibernacula may be granted every several years to determine the status of the site, although such visits should be made only by informed and careful personnel.

Long-term Monitoring

Much of the habitat in the Okanagan Valley has been degraded from its natural state (either by agriculture or residential development). Much of the survey area was relatively remote, but this does not mean that it is impervious to the influences of human disturbance. Surveys should be made in specific areas to assess population abundance in the various areas. A survey such as the one undertaken here is far too general to assess either abundance or habitat use.

Surveys should continue in order to assess yearly population fluctuations, i.e., to identify population declines or improvements. Smaller survey areas are necessary for properly obtaining this kind of information. Networking with other groups with similar interests (i.e., Ministry of Forests, forest industry) will decrease costs associated with the work. The possible contributions from volunteer groups, such as naturalist groups, should not be undervalued or overlooked, although efforts should be made to have surveys conducted by trained and knowledgeable personnel so that techniques are consistent and results are comparable. Workshops like the one held by BC Environment in Penticton would help maintain consistency, keep regional people up-to-date, and clarify information for everyone. We suggest that future workshops be planned prior to the initiation of future studies.

Future Survey Sites

We set up nets and/or traps on 76 nights, covering 64 different sites. Some sites were sampled twice because we covered the circuit from Penticton to Williams Lake via Kamloops twice in an attempt to even out sampling of early and late season populations. Twenty-seven of these nights resulted in no captures, which was just as likely due to environmental conditions during the sampling period as it was to actual bat population levels. In addition, some areas of the survey region were never reached. The lower Fraser River canyon area, the adjacent Empire Valley Ranch in the Churn Creek area, and the more southerly Big Bar Creek Valley were not assessed. The Painted Chasm Valley north of Clinton looked like ideal Spotted Bat habitat, but we were running out of time and could not stay to examine it. The Thompson River Valley has extensive arid bunchgrass habitat, and many of the river valleys adjacent to the Thompson could potentially represent habitat for Red- and Blue-listed species. Separate surveys for each of the three regions covered in this survey (Okanagan Valley, Kamloops Region, and Cariboo Region) might more ad-

equately assess each area, although even individually, these are large areas to cover thoroughly.

Red- and Blue-listed Species

We have made specific recommendations for each species following each account (see Results and Discussion). Considerable range extensions for three (possibly four) species have been made by this survey and this information represents all that is known about those species in these new areas. More basic information is required before each species' status can be adequately assessed to determine its position on rare or endangered species lists. We recommend that bat species currently listed as Blue or Red should remain so listed until research indicates that they are not at risk.

This survey could not adequately address species abundance. The fact that a bat species is present in an area does not make it common. Further research into the biology and distribution of these species should be made to ensure that future management decisions are made with full information of the system in question. Now that more is known about the range of specific bat species, surveys to gather information on abundance, population trends, and specific habitat requirements should be made in smaller, more manageable areas.

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Appendix 1. Habitat descriptions of sites where bats were captured or observed.

Table A-1. Habitats used by Spotted Bats (*Euderma maculatum*) in central and southcentral B.C.

Gallagher Bluff; GB-1; Site #3. Roost site.
Habitat description: area is behind campground area, beside Gallagher Lake, steep rocky cliffs, with a vertical drop and an aqueduct running past at its base.
Elevation: 769 m
Biogeoclimatic Zone: Bunchgrass
Wildlife habitat class: RO-UR

Old Hedley Road #2; OHR-2; Site #5. Foraging/commuting area.
Habitat description: Bats were foraging and flying in upland and riparian/marshy areas; upland was characterized by a moderate cover of dry, ponderosa pine forest, with sage and bunchgrass ground cover; riparian area characterized by patchy dense stands of cottonwoods (*Populus* spp.) and dense patches of 5-6m high shrubs (*Salix* spp.) adjacent to a marshy area in a bend of the Similkameen River.
Elevation: 580 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: SP-ME

Ollala; Ollala-1; Site #6. Commuting area.
Habitat description: Bats were flying very high, east of townsite near high cliff areas; vegetation sparse, arid slopes, bunchgrass and sparse ponderosa pine.
Elevation: 520 m
Biogeoclimatic zones: Ponderosa Pine and Interior Douglas-fir
Wildlife Habitat Class: UR-FS-RO

Daly Slough; DS-1; Site #7. Foraging/commuting area.
Habitat description: Bats were flying and foraging parallel to cliff face that runs south of the slough; habitat varies from marshy, riparian (dense cottonwoods, shrubs - willow, dogwood) to dry, upland areas with mainly bunchgrass and sage.
Elevation: 420 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: SP-AC

Ginty's Pond; GINP-1; Site #8. Foraging/commuting area.
Habitat description: Bats were flying low over pond with lots of feeding buzzes and calls immediately over pond area; distinctly marshy area; dominant vegetation dense cattail; cottonwoods, shrubs; cliff areas to the south; this area was used early in the season (late May). No bats were heard here late in the season (early August).
Elevation: 420 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: MR-CF

Williams Lake (Scout Island Nature Centre); WL(SINC)-1; Site #39. Commuting.
Habitat description: Bats were flying very high, calls were very faint; habitat is marshy and open, dominant vegetation *Scirpus* spp. immediately adjacent to open, large, lake area.
Elevation: 640 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: MR-LL

Appendix 1. (Continued).

Table A-1. (Continued).

Alkali Lake; AL-1; Site #41. Foraging/commuting area.
Habitat description: Bats were flying and feeding over lake, over upland area south of the lake and over riparian area in the valley southwest of Alkali Lake; habitat varies from open, shallow lake to dense cattail at lake edge to dry, grazed upland with shortgrass and bunchgrass to a riparian habitat with sparse/moderate cover of shrubs and trees (water birch).
Elevation: 640 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LS-MR-CF-BS

Gang Ranch; GR-1; Site #43. Commuting.
Habitat description: Spotted Bats were flying over dry, grazed upland areas; also areas here with planted hayfields (e.g., alfalfa, clover) possibly in the direction of the Fraser River Canyon.
Elevation: 610 m
Biogeoclimatic Zones: Bunchgrass and Interior Douglas-fir
Wildlife Habitat Class: CF-BS

Dog Creek: DC(HMHF)-1; Site #45. Foraging/commuting area.
Habitat description: Bats were flying and feeding beside cliff area below Dog Creek dome; habitat in upland area beside cliffs dominated by sage and bunchgrass with sparse ponderosa pine; lowland immediately adjacent to this area with hayfields, and riparian habitat (dense cottonwood at river edge and dense shrubs); opposite side of valley, steep slopes with dense douglas fir; number of bats were heard flying together in the same area as calls were heard overlapping.
Elevation: 700 m
Biogeoclimatic Zones: Bunchgrass and Interior Douglas-fir
Wildlife Habitat Class: CF-DF-FS

Lytton, St. Georges; L(SGB)-1; Site #47. Foraging/commuting area.
Habitat description: Bats were heard flying and feeding over deserted barn buildings surrounded by overgrown pasture area (mostly knapweed, *Centaurea* spp.); area is within 1/2 km of the Fraser River Canyon across from the mouth of the Stein River Valley.
Elevation: 215 m
Biogeoclimatic Zone: Ponderosa pine
Wildlife Habitat Class: CF-UR-FS

Upper Bench Road, Keremeos; UBR(K)-1; Site #48. Commuting.
Habitat description: Bats were heard along approximately 5 to 10 km stretch of road along the north side of the Similkameen Valley between Cawston and Keremeos. The road runs through orchard areas, field areas, bunchgrass slopes and past rocky outcroppings and Keremeos Creek.
Elevation: 520 m
Biogeoclimatic zone: Bunchgrass
Wildlife Habitat Class: OV-BS-CF-FS-TR

Bull Canyon; BC-1; Site #61. Foraging/commuting area.
Habitat description: This site was within 20m of the Chilcotin River; riverside area covered with short aspen saplings; sparse large cottonwoods and shrubs (dense *Spirea* spp., sparse wild rose, sparse juniper); sparse Douglas-fir with dry bunchgrass understorey.
Elevation: 715 m
Biogeoclimatic zone: Interior Douglas-fir
Wildlife Habitat Class: FS-DF-RO

Appendix 1. (Continued).

Table A-2. Habitats where long-eared myotis (*Myotis evotis/septentrionalis*) were caught in nets or harp traps.

Vaseux Lake Bird Sanctuary; VLBS-1-1; Site #1. May 12, 1992.
Mists nets: one adult female.
Habitat description: Dense mixed deciduous trees and shrubs (Populus spp., waterbirch, willows) along pathway to opening onto marsh area with dense patches of cattail (Typhus spp.)
Elevation: 400 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: MR-LS

Okanagan Falls Provincial Park; OFPP-1-1; Site #2. May 13, 1992.
Mists nets: one adult female (not visibly pregnant)
Habitat description: Open campground area with short grass and sparse/moderate cover of ponderosa pine; immediately adjacent to Vaseux Creek; steep cliff area immediately to the west.
Elevation: 400 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: FS-PP-RO

Old Grist Mill (Keremeos); OGM(K)-1; Site #9. May 09 and July 22, 1992.
Mists nets: May 09: two adult females (not visibly pregnant); July 22: one adult female (not visibly pregnant)
Habitat description: Nets set at footbridge across Keremeos Creek behind interpretive centre. Creek bordered by tall poplars, dense lilac and wild rose bushes with tended lawn and gardens (no insecticides used in the grounds); horse chestnut trees and plum trees sparsely planted in the yard, dense red-osier dogwood by mill at creekside.
Elevation: 521 m
Biogeoclimatic zone: Bunchgrass
Wildlife Habitat Class: FS-UR

Chute Lake Resort; CLR-1-1; Site #11. May 26, 1992.
Mists nets: one adult male.
Habitat description: Nets set by edge of shallow lake surrounded by dense Engelmann spruce forest. Open marsh adjacent to lake bordered by dense Engelmann spruce to the ease and a wet meadow with sparse poplars (large trees and saplings) to the west.
Elevation: 1220 m
Biogeoclimatic Zones: Ponderosa Pine and Interior Douglas Fir
Wildlife Habitat Class: LS-MR-SA

Rattlebox Sheep Farm (Falkland); RATFALK-1-1&2; Site #23. June 17 and August 02, 1992.
Mist nets: June 17: two adult males; August 02: one juvenile female.
Habitat description: Short, grazed pasture bordered on the east and west with moderate/dense Douglas-fir in upland area. *M. evotis* caught in the bottom tier (ground level) of a 10 ft high net set approximately 2 m from a large slablike rocky outcropping. Cart track leads down to a small lowland pasture area adjacent to the Salmon River where other nets were set.
Elevation: 610 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: CF-FS-DF

Mouth of the Adams River; MADR-1-1&2; Site #25. June 20 and August 11, 1992.
Mist nets. June 20: one adult male; August 11: one juvenile male.
Habitat description: Nets set along paths leading away from spawning channels near the mouth of the Adams River and inside the dense mature cottonwood forested area. Trees are old with snags and hollows, understorey a mix of open grassy areas and dense shrubs (Spirea, mock orange, dogwood).
Elevation: 365 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: AC-SP-UR

Appendix 1. (Continued).

Table A-2. (Continued).

Roderick Haig-Brown Provincial Park (Loop Island Trail); RHB(LIT)-1-1&2; Site #26. June 21 and August 03, 1992.
Mist nets. June 21: six adult females (one pregnant, two lactating), two adult males; August 03, 1992: one adult female (lactating)
Habitat description: Nets set across openings onto still, overgrown channels along pathway system. Area consists of dense forest of mature western red cedar, Douglas-fir and pine with dense undergrowth of shrubs (red osier dogwood, mock orange, *Salix* spp., *Spirea* spp.) and plants (thimbleberry, baneberry and Oregon grape).
Elevation: 365 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: SP-Western Redcedar/Douglas-fir

Louis Creek Valley; LC(PWMX)-1-1; Site #29. June 23, 1992.
Mist nets: One adult female (not visibly pregnant)
Habitat description: Net set across pathway on the west bank of Louis Creek (fast-moving, narrow creek) bordered by dense mature cedar with bare, mineral soil. Opposite bank with dense cedar, opening onto a small pasture with sparse, mature poplar and birch at the edge, with an understorey of dense wild raspberry and aspen saplings.
Elevation: 610 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: FS-DF-CF-AC

Genier Lake; GL-1-1; Site #30. June 25, 1992.
Mist nets: two adult females (one not visibly pregnant), one adult male.
Habitat description: Nets set along road at opening onto lake at lake edge where habitat was marshy with dense cattail (*Typha* spp.), some sedge (*Carex* spp.) and sparse pond lily. Dense Douglas-fir above road on an uphill slope had open and dry understorey with sparse wild raspberry, moderate oregon grape and bearberry, and lots of moss.
Elevation: 580 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LS-MR-DF

Skull Mountain (Corral Lake); SM(CL)-1-1&2; Site #31. June 26 and August 09, 1992.
Mist nets: June 26: three adult females (two pregnant, one lactating); August 09: one juvenile female.
Habitat description: Nets set on the south side of small shallow lake [border covered with dense cattail (*Typha* spp.) and *Scirpa* spp.]; dense Douglas-fir to the north in upland area, open pasture to the south with sparse birch and sparse ponderosa pine (dry area with understorey of bunchgrass, and low juniper bushes).
Elevation: 825 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LS-MR-DP

Wallhachin; W-1-1; Site #34. July 01, 1992.
Mists nets: four adult females (one not visibly lactating, two lactating)
Habitat description: Small grove of cottonwoods (moderate cover, *Populus* spp.) immediately adjacent to the South Thompson River (south shore); undergrowth was dense knapweed (*Centaurea* spp.); small swampy channel on south side of grove surrounded by cottonwoods (*Populus* spp.) and low shrubs. North side of Thompson River with steep sandy bank.
Elevation: 365 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: FS-AC-UR-IN

Appendix 1. (Continued).

Table A-2. (Continued).

Soda Creek - Ian Fotheringham's; SCIF-1-1; Site #38. July 07, 1992.
Mist nets: one adult male (testes enlarged).
Habitat description: Nets set in west channel of the Fraser River, water level receded to produce a series of small sloughs and a stagnant channel area bordered on both sides with moderate/dense stands of mature cottonwood (*Populus* spp.), understorey on west bank of channel (an island bordered on the west by the Fraser River) dense bushes (*Spirea* spp. and wild rose) and long grasses.
Elevation: 425 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: IN-AC-FS

Alkali Lake (Public Viewing Point); AL(PVP)-1-1; Site #41. July 09, 1992.
Mist nets (Net over dense *Scirpus*): two adult females (one not visibly pregnant, one lactating)
Habitat description: Large swampy lake set in dry valley with bunchgrass and cactus on slopes and irrigated pasture at valley bottom. Nets set at lake edge over mucky area with dense *Scirpus*. Shrubs along fenceline along lakeside.
Elevation: 640 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LS-MR-CF-BS

Coldstream Ranch (Vernon); CR(VERNON)-1-1; Site #51. July 30, 1992.
Mist nets; one adult male, one juvenile female.
Habitat description: Nets set around a small pond (dense cover of duckweed on the surface); surrounded by native and planted trees (maple, mountain ash, waterbirch, poplar - all patchy and sparse); pond edged by dense clumps of cottonwood (Populus spp.); small stream exiting west side of pond, spanned by a bridge and lane. Opposite side of bridge was a dense grove of mature cottonwood.
Elevation: 460 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class:OW-FS-AC-UR

McAllister's Marsh (Vernon); MM(VERNON)-1-1; Site #52. July 31, 1992.
Mists nets: two juvenile females.
Habitat description: Nets set at the edge of a small, fast flowing creek bordered by very tall, mature cottonwoods (*Populus* spp.) with large oldfield (tall grasses) to the southeast and a stand of very large old cottonwoods to the northeast (understorey ungrazed pasture, with long grasses and thistle, immediately adjacent to very wet habitat where the understorey had dense shrubs and lush broad-leaved plants associated with very wet habitat).
Elevation: 620 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: FS-AC-CF-MR-ME

Tunkwa Lake Road (Cabin); T(CAB)-1-1; Site #58. August 13, 1992.
Mist nets: one adult male (testes enlarged).
Habitat description: Nets set at openings into dense Englemann spruce forest from grazed pasture area surrounding abandoned old log cabin. Small spring running along pasture edge beside openings.
Elevation: 1160 m
Biogeoclimatic Zone: Interior Douglas-fir and Montane Spruce
Wildlife Habitat Class: CF-DF

Appendix 1. (Continued).

Table A-3. Habitats where Pallid Bats (*Antrozous pallidus*) were possibly seen.

Gang Ranch (upper pastures); GR-1-1; Site #43. July 11, 1992.
Sighting by Gina and Anna Roberts of large honey-coloured bat flying low across the road in front of their vehicle while surveying upper pastures for poorwills.
Habitat description: Open grazed pasture, hayfields, shortgrass and cactus as well as bunchgrass and sage in uncultivated areas.
Elevation: 610 m
Biogeoclimatic Zones: Bunchgrass and Interior Douglas-fir
Wildlife Habitat Class: CF-BS

River Ranch - east of Hanceville on the Chilcotin River.
Sighting again by the Roberts over gravel road in the headlights of their vehicle.
Habitat description: Dry and open, over gravel road in ranchlands above the Chilcotin River.
Elevation: Unknown
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: Unknown

Table A-4. Habitats where Townsend's Big-eared Bats (*Plecotus townsendii*) were caught in nets or harp traps.

Vaseux Lake Bird Sanctuary; VLBS-1-1; Site #1. May 17, 1992.
Mists nets: one adult female (not visibly pregnant)
Habitat description: Dense mixed deciduous trees and shrubs (*Populus* spp., waterbirch, willows) along pathway to opening onto marsh area with dense patches of cattails (*Typha* spp.)
Elevation: 400 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: MR-LS

Williams Lake (Roberts' place); WL(RP)-1-1; Site # 40. July 08, 1992.
Harp trap set in a flyway: one adult female (not visibly pregnant)
Habitat description: Trap set in a flyway between the lake and a shrub area (willow, waterbirch, and moderate/dense aspen saplings); running along lake edge (within 20 m) was a dense band of *Scirpus*.
Elevation: 580 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LL-UR

Coldstream Ranch (Vernon); CR(Vernon)-1-1; Site #51. July 30, 1992.
Mist nets: one adult female (lactating), one juvenile femle
Harp trap in building (night roost): one juvenile male
Habitat description: Nets set around a small pond (dense cover of duckweed on surface); surrounded by native and planted trees (maple, mountain ash, waterbirch, poplar - all patchy and sparse); pond edged by dense clumps of cottonwood (*Populus* spp.); small stream exiting west side of pond, spanned by a bridge and lane. Opposite side of bridge was a dense grove of mature cottonwood.
Elevation: 460 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: OW-FS-AC-UR

Appendix 1. (Continued).

Table A-5. Habitats where Fringed Myotis (*Myotis thysanodes*) were caught in nets or harp traps.

Alkali Lake (Public Viewing Point); AL(PVP)-1-1; Site #41. July 09, 1992.
Mist nets (Nets over dense *Scirpus*): one adult male (testes not enlarged).
Habitat description: Large swampy lake set in dry valley with bunchgrass and cactus on slopes and irrigated pasture at valley bottom. Nets set at lake edge over mucky area with dense *Scirpus*. Shrubs along fence line along lakeside.
Elevation: 640 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LS-MR-CF-BS

Alkali Lake (Old Barn); AL(OB)-1-1; Site #42. July 09, 1992.
Harp trap in an old barn (night roost): one adult female (lactating), two adult males (testes not enlarged).
Habitat description: Southwest of Alkali Lake along valley bottom, harps set in upper floor window of an old barn surrounded by pasture; small creek running west along valley bottom from Alkali Lake.
Elevation: 640 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: CF-BS-FS

Suzie Mine (Oliver); SM(O)-1-1; Site #50. July 29, 1992.
Harp trap: one adult female (lactating)
Habitat description: Mine opening in hillside surrounded by dry ponderosa pine forest with bunchgrass understorey as well as cow pasture (with cows).
Elevation: 540 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: RM-CF-BS-PP

Appendix 1. (Continued).

Table A-6. Habitats where Western Small-footed Myotis (*Myotis ciliolabrum*) were caught in nets or harp traps.

Vaseux Lake Bird Sanctuary; VLBS-1-1; Site #1, May 12, 1992.
Mist nets: four adult males.
Habitat description: Dense mixed deciduous trees and shrubs (*Populus* spp., waterbirch, willows) along pathway to opening onto marsh area with dense patches of cattail (*Typha* spp.).
Elevation: 400 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: MR-LS

Wallhachin; W-1-1; Site #34. July 01, 1992.
Mists nets: one adult female (lactating)
Habitat description: Small grove of cottonwoods (moderate cover, *Populus* spp.) immediately adjacent to the South Thompson River (south shore); undergrowth was dense knapweed (*Centaurea* spp.); small swampy channel on south side of grove surrounded by cottonwoods and low shrubs. North side of Thompson River with steep sandy bank.
Elevation: 365 m
Biogeoclimatic Zone: Bunchgrass
Wildlife Habitat Class: FS-AC-UR-IN

Alkali Lake; AL(OB)-1-1; Site #42. July 09, 1992.
Harp traps in night roost: two adult females (one lactating, one non-breeding), one juvenile female (newborn)
Habitat description: Harp trap set in large old barn approximately 1 km south of Alkali Lake immediately surrounded by pasture and irrigated hayfields. Small creek bordered by low shrubs (waterbirch) ran past barn to the north from Alkali Lake down the valley to the west. The lake is set in a valley with moderately sloping sides covered with bunchgrass, dry grassland grasses and cactus.
Elevation: 365 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: LS-MR-CF-BS

Gang Ranch; GR-1-1; Site #43. July 11, 1992.
Harp traps set in old barn (night roost): three adult females (two not visibly breeding, one pregnant), one adult male (testes enlarged).
Habitat description: Old barns within 1/2 km of main ranch buildings surrounded by irrigated pastureland. Few large mature cottonwoods along drive to barn. Area within 2 to 3 km from the Fraser River Canyon area.
Elevation: 610 m
Biogeoclimatic Zones: Bunchgrass and Interior Douglas-fir
Wildlife Habitat Class: CF-BS

Gang Ranch (Reservoir); GR(Res)-1-1; Site #44. July 12, 1992.
Harp traps set in small abandoned shack (night roost): one adult female (pregnant).
Habitat description: Shack within 1/2 km of main reservoir area surrounded by hayfield (mainly clover, lots of cactus as well).
Elevation: 730 m
Biogeoclimatic Zones: Bunchgrass and Interior Douglas-fir
Wildlife Habitat Class: CF-BS

Appendix 1. (Continued).

Table A-6. (Continued).

Dog Creek (Hay Meadows Honey Farm); DC(HMHF)-1-1; Site #45. July 13, 1992.
Harp traps set in upper floor of an old abandoned house (night roost): five adult males (all with enlarged testes).
Habitat description: Old house with no windows, set on the south side of an ungrazed pasture. Immediately to the south is the steep south side of the Dog Creek Valley, heavily forested with Douglas-fir and pine. Site is within 2 km of the Fraser River Canyon area.
Elevation: 700 m
Biogeoclimatic Zones: Bunchgrass and Interior Douglas-fir
Wildlife Habitat Class: CF-DF-FS

Old Hedley Road (site #2); OHR-2-2; Site #5. July 17, 1992.
Mist net (20 ft high, in top net): one adult female (lactating)
Habitat description: Low flat swampy riverbottom area with dense patches of large mature cottonwoods (*Populus* spp.); understorey overgrown pasture, adjacent to slow-moving channel of the Similkameen River.
Elevation: 580 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: SP-ME

Table A-7. Habitats where Hoary Bats (*Lasiurus cinereus*) were heard using QMC bat detectors.

Old Hedley Road (site 2); OHR-2-1; Site #5. May 19, 1992.
Habitat description: Low wet river bottom, dense patches of large cottonwoods (*Populus* spp.); long grassy pasture immediately adjacent to the Similkameen River (large riverbend, swampy area); rocky bluffs on the opposite side of the road from this site.
Elevation: 580 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: SP-ME

Mouth of the Adams River; MADR-1-1; Site #25. June 20, 1992.
Habitat description: Nets set along paths leading away from spawning channels near the mouth of the Adams River and inside the dense mature cottonwood forested area. Trees are old with snags and hollows, understorey a mix of open grassy areas and dense shrubs (Spirea, mock orange, dogwood).
Elevation: 365 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: AC-SP-UR

Roderick Haig-Brown Provincial Park (Loop Island Trail); RHB(LIT)-1-1; Site #26. June 21, 1992.
Habitat description: Nets set across openings onto still overgrown channels along pathway system. Area consists of dense forest of mature western redcedar, Douglas-fir and pine with dense undergrowth of shrubs (red osier dogwood, mock orange, *Salix* spp., *Spirea* spp.) and plants (thimbleberry, baneberry and oregon grape).
Elevation: 365 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: SP-Western Redcedar / Douglas-fir

Soda Creek - Ian Fotheringham's; SCIF-1-1; Site #38. July 07, 1992.
Habitat description: Nets set in west channel of the Fraser River, water level receded to produce a series of small sloughs and a stagnant channel area bordered on both sides with moderate/dense stands of mature cottonwood (*Populus* spp.), understorey on west bank of channel (an island bordered on the west by the Fraser River) dense bushes (*Spirea* spp. and wild rose) and long grasses.
Elevation: 425 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: IN-AC-FS

Appendix 1. (Continued).

Table A-8. Habitats where Silver-haired Bats (*Lasionycterus noctivagans*) were either caught in mist nets or heard on QMC bat detectors.

Rattlebox Sheep Farm (Falkland); RATFALK-1-1&2; Site #23. June 17 and August 02, 1992.
Mist nets: June 17: one adult male, August 02: one juvenile female.
Habitat description: Nets that caught silver-haired bats were set in lowland pasture area immediately beside the Salmon River. Sparse/moderate cover of mixed deciduous trees (cottonwood, waterbirch) in lowland areas, upland areas with dense Douglas-fir and more extensive short grazed pasture.
Elevation: 610 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: CF-FS-DF

Moore's Farm (Silver Creek); SC(MOORE'S)-1-1; Site #22. June 15, 1992.
QMC bat detector.
Habitat description: On the bank of the Salmon River at a bridge along main road, few large cottonwoods at this point, at the edge of a large short-grazed cow pasture (with cows). Several houses in the immediate area. Silver-haired Bat may have been night-roosting in the large cottonwood tree beside the river.
Elevation: 395 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: UR-CF-FS

Hawkes Creek/Fraser River Confluence; WL(HCFR)-1-1; Site #37. July 05, 1992.
QMC bat detector.
Habitat description: Hawke's Creek is small and fast tribuatary flowing through a small dry canyon and emptying into the Fraser River. At the confluence, forest is a moderate cover of mixed poplar and Douglas-fir with small sparse shrubs (*Spirea* spp.) in the understorey. The Fraser at this point has steep cliff faces with some sloping areas with bunchgrass. Habitat overall is dry.
Elevation: 425 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: FS-DF

McAllister's Marsh (Vernon); MM(VERNON)-1-1; Site #52. July 31, 1992.
Mist nets: four adult females (one lactating, three post-lactating), two adult males (testes enlarged), two juvenile males (testes enlarged).
Habitat description: Nets set at the edge of a small, fast flowing creek bordered by very tall, mature cottonwoods (*Populus* spp.) with large oldfield (tall grasses) to the southeast and a stand of very large old cottonwoods to the northeast (understorey ungrazed pasture, with long grasses and thistle, immediately adjacent to very wet habitat where the understorey had dense shrubs and lush broad-leaved plants associated with very wet habitat).
Elevation: 620 m
Biogeoclimatic Zone: Interior Douglas-fir
Wildlife Habitat Class: FS-AC-CF-MR-ME

Appendix 2. Broad Habitat Classes for British Columbia.

This is an abbreviated version of definitions for broad habitat classes that are used by the Habitat Inventory Section of the Wildlife Branch. It is designed to cover those broad habitats found in the dry interior of south and central British Columbia that are being sampled for bat fauna in 1992.

A Broad Habitat Class is a permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover (such as lakes or rock outcrops). A Broad Habitat Class is defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands). Broad Habitat Classes are meant to be used for small scale mapping of large areas, mainly at the 1:250 000 scale.

Within Broad Habitat Classes, variation of vegetation and animal use occurs by Ecoregion or Ecosection, Biogeoclimatic Unit, site characteristics and successional stage.

Habitat Class Definitions

Big Sagebrush Shrub/grassland (SS) Habitat Class: Typically an open to dense, dry shrubland, dominated by drought tolerant shrubs and perennial grasses and generally lacking trees.

Bunchgrass Grassland (BS) Habitat Class: Typically a dense herbaceous habitat dominated by perennial grasses and forbs, and generally lacking shrubs or trees.

Cultivated Field (CF) Habitat Class: Typically a mixture of farmlands where man's influence has resulted in long-term soil and/or vegetation changes because of agricultural practices of ploughing, fertilization, and non-native crop production.

Douglas-fir - Lodgepole Pine (DL) Habitat Class: Typically a dense coniferous forest, with shrub- or pine-dominated understoreys, that includes plant communities that progress through a mixture of lodgepole pine and Douglas-fir and ponderosa pine to a Douglas-fir climax.

Douglas-fir - Ponderosa Pine (DP) Habitat Class: Typically an open to dense coniferous forest, with shrub- or bunchgrass-dominated understoreys, that includes plant communities that progress through a mixture of Douglas-fir and ponderosa pine to a Douglas-fir climax.

Fast Perennial Stream (FS) Habitat Class: Typically a freshwater riverine habitat contained within a channel that has continuously-moving, fast-flowing water, is bounded by banks or upland habitat, and has a high gradient.

Interior Douglas-fir (DF) Habitat Class: Typically a dense coniferous forest, with grass-dominated understoreys, that includes plant communities that progress directly to a Douglas-fir climax.

Intermittent Stream (IN) Habitat Class: Typically a freshwater riverine habitat contained within a channel that only periodically has moving water and is bounded by banks or upland habitat.

Large Lake (LL) Habitat Class: Typically a fresh deepwater habitat that includes permanently flooded lakes, usually found in a topographic depression, lacking emergent vegetation except along shorelines, and usually with a size of greater than 60 hectares.

Lodgepole Pine (LP) Habitat Class: Typically an open lodgepole pine forest with shrub, moss or terrestrial lichen understoreys on level, nutrient-poor, coarse-textured soils.

Marsh (MR) Habitat Class: A marsh Wetland Class that typically is permanently or seasonally inundated and that supports an extensive cover of emergent, non-woody vegetation, rooting in mineral-rich substrate.

Appendix 2. (Continued).

Meadow (ME) Habitat Class: A Meadow Wetland Class that typically is a lower elevation herbaceous community, dominated by moisture-loving species, on imperfectly to poorly drained mineral soil sites.

Orchard/Vineyard (OV) Habitat Class: Typically an agricultural area used for growing hard and soft fruit crops, with some form of symmetrical arrangement of the trees, shrubs, or vines.

Ponderosa Pine (PP) Habitat Class: Typically a sparse to open coniferous forest, with big sage or perennial grass dominated understoreys, that occur along the grassland-forest border, leading to a ponderosa pine and Douglas-fir climax.

Reclaimed Mine (RM): Typically a mined area or mine tailings that have been manipulated and planted with a mixture of agronomic grasses and forbs, and active plants.

Rock (OR) Habitat Class: Typically a mixture of nonalpine steep bedrock cliffs, escarpments and outcroppings with little soil development and relatively low vegetative cover.

Sedge Fen (FE) Habitat Class: A Fen Wetland Class that typically is an unforested wetland, dominated by sedges, found on poorly drained organic sites.

Shallow Open Water (OW) Habitat Class: A Shallow Open Water Wetland Class that typically is comprised of permanent shallow open water and that lacks extensive emergent plant cover, water is usually less than 2 m and submerged and floating aquatic plants are present.

Shrub Fen (SH) Habitat Class: A Fen Wetland Class that typically is dominated by shrubs, found on poorly drained organic sites.

Shrub Swamp (SW) Habitat Class: A Swamp Wetland Class that typically is a tall shrub wetland, characterized by willows, a sparse cover of spruce, and sedges, usually found along stream channels, and composed of a mixture of mineral and organic material.

Slow Perennial Stream (SP) Habitat Class: Typically a freshwater riverine habitat contained within a channel that contains continuously-moving, slow-moving water, is bounded by banks or upland habitat, and has a low gradient; may include channels that form a connecting link between two bodies of standing water.

Small Lake (LS) Habitat Class: Typically a fresh deepwater habitat that includes permanently flooded lakes (and sometimes reservoirs), usually 8 to 60 ha in size in a topographic depression, with most of the water less than 7 m in depth.

Spruce - Douglas-fir (SD) Habitat Class: Typically a dense coniferous forest, with soopolallie or pine grass dominated understoreys, that include plant communities that progress through a mixture of lodgepole pine, Douglas-fir and western larch to a white or hybrid spruce climax, often with subalpine fir.

Subboreal White Spruce - Lodgepole Pine (SL) Habitat Class: Typically a dense, subboreal coniferous forest that includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax.

Subboreal White Spruce - Trembling Aspen (SA) Habitat Class: Typically a dense mixed or coniferous subboreal forest, with shrub and herb dominated understoreys, that include plant communities that succeed through trembling aspen seral forests to a white spruce climax.

Talus (TA) Habitat Class: Typically sparsely vegetated, rubbly or blocky colluvial areas, at the base of rock outcroppings or escarpments.

Appendix 2. (Continued).

Transmission Corridor (TR) Habitat Class: Typically a linear-shaped land area dedicated to some form of above or below ground system for carrying products from one point to another, including transmission lines and pipelines.

Transportation Corridor (TC) Habitat Class: Typically a linear-shaped land area dedicated to some form of above ground system for carrying products from one point to another, including roads and railways.

Trembling Aspen Copse (AC) Habitat Class: Typically a dense deciduous forest, with a shrub-dominated understorey, that includes plant communities that succeed through shrub thickets to an edaphic climax of trembling aspen, found in association with shrub/grasslands.

Urban (UR) Habitat Class: Typically a mixture of man-influenced habitats that includes residential areas, urban areas, and commercial/industrial areas, but excluded major agriculture lands.

White Spruce - Black Cottonwood Riparian (WR) Habitat Class: Typically a dense deciduous, mixed, or coniferous forest, with shrub-dominated understoreys, found on or in association with fluvial sites, that includes plant communities that succeed slowly through black cottonwood to potential white spruce climax.

White Spruce - Paper Birch (SB) Habitat Class: Typically a dense, mixed subboreal forest, with dense, shrub-dominated understoreys, that include plant communities that succeed through paper birch, trembling aspen and Douglas-fir seral forests to a white spruce climax.

White Spruce - Subalpine Fir (SF) Habitat Class: Typically a dense, coniferous subboreal forest, with dense shrub-moss dominated understoreys, that include communities that progress directly to a white spruce and subalpine fir climax, sometimes with lodgepole pine or trembling aspen.

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Appendix 3. Summary of data collected on bats captured during this survey.

KEY FOR COLUMN HEADINGS

SITE CODE	Code of sampling site (see Table 1) *	
SITE NUMBER	Numeric code for each sampling site (see Table 1)	
DATE	Capture date	
JULIAN DATE	Capture date as julian date	
SEX	0 = male; 1 = female	
AGE	0 = adult; 1 = juvenile	
MASS	grams	
FA	mean of three measurements (mm)	
RC	Reproductive condition. 0 = not visibly pregnant; 1 = pregnant; 2 = lactating; 3 = post-lactating; 4 = non-reproductive; 5 = not lactating, possibly lost pup; 6 = testes not enlarged; 7 = testes starting to enlarge; 8 = testes enlarged; 9 = testes huge.	
BAND	Band number	
MC5	First metacarpal digit 5 (mm)	
MC3	First metacarpal digit 3 (mm)	
TI	Tibia (right) (mm)	
EW	Ear width at widest point (mm)	
EL	Ear length (mm)	
SP	Shoulder patch	1 = dark distinct 2 = distinct 3 = visible but not distinct 4 = not distinct - brown bat 5 = not distinct
EAR	Ear colour	1 = black 2 = dark brown 3 = brown
HOT	Hairs on tail edge	1 = none 2 = sparse 3 = few 4 = lots of fine hairs
C	Lobe on distal end of calcar?	1 = knob at distal end 2 = knob at distal end but not prominent 3 = no knob
NOTES	See numbered note below data set	
TEETH	C1 = sharp canines; C2 = dull canines; C3 = flattened canines	

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*Explanation of site codes:

GB-1-1 = Gallagher Bluff, Site #1, netting night #1
GB-1-2 = Gallagher Bluff, Site #1, netting night #2
OHR-1-1 = Old Hedley Road, Site #1, netting night #1
OHR-2-1 = Old Hedley Road, Site #2, netting night #1

Appendix 3. (Continued).

Townsend's Big-eared Bat (*Plecotus townsendii*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
VLBS-1-1	1	MAY 17	137	1	0	.	.	0
WL AG	40	JUL 08	189	1	0	11.5	42.5	0
CR(VERNON)-1-1	51	JUL 30	211	1	0	11.1	46.27	2
CR(VERNON)-1-1	51	JUL 30	211	1	1	9.1	44.23	.
CR(VERNON)-1-1	51	JUL 30	211	0	1	7.8	42.18	.

Fringed Myotis (*Myotis thysanodes*)

SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC	BAND	EAR LENGTH	EAR WIDTH	TEETH	NOTES
31	JUN 26	177	1	0	6.5	31.62	0	LB58R	16.1	7.7	.	1
41	JUL 09	190	0	0	6.9	41.33	6	LB92L	.		C2	
42	JUL 09	190	1	0	.	43	2	LB91R	.		C1	
42	JUL 09	190	0	0	.	42.97	6	LB93L	.		C1	
42	JUL 09	190	0	0	7.8	40.97	6	LB94L	.		C3	2
50	JUL 29	210	1	0	9.7	42.12	2	LB86?	.		C3	3

NOTES: 1. NOT LIKELY A FRINGE BUT HAD LOTS OF SMALL HAIRS AT TAIL EDGE.
2. R TRAGUS 1/2 SIZE, FROSTBITTEN.
3. MC5 MANGLED - BAND HAND CARVED, COULD BE REVERSE #.

Western Small-footed Myotis (*Myotis ciliolabrum*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC	BAND	TEETH	NOTES
VLBS-1-1	1	MAY 12	132	0	0	3.9	31.82				
VLBS-1-1	1	MAY 12	132	0	0	4.1	33.58				
VLBS-1-1	1	MAY 12	132	0	0	4	31.6				
VLBS-1-1	1	MAY 12	132	0	0	3.9	31.47				
W-1-1	34	JUL 01	182	1	0	5.9	33.28	2		C3	
AL-1-1	42	JUL 09	190	1	0	4.8	33.7	2	Y152R		
AL-1-1	42	JUL 09	190	1	0	4.3	30.6	0	Y151R	C3	
AL-1-1	42	JUL 09	190	1	1	1.1	12.4		PUP		1
GR-1-1	43	JUL 11	192	1	0	4.7	32.55	0	Y153R	C1	
GR-1-1	43	JUL 11	192	0	0	3.9	31.5	8	Y154L	C1	
GR-1-1	43	JUL 11	192	1	0	4.3	32.3	1	Y155R	C2	
GR-1-1	43	JUL 11	192	1	0	4.2	31.3	0	Y156R	C1	
GR(RES)-1	44	JUL 12	193	1	0	5.5	31.78	1	Y157R	C1	
DC(HMHF)-	45	JUL 13	194	0	0	4.9	34.33	6	Y158L	C2	
DC(HMHF)-	45	JUL 13	194	0	0	4.8	33.78		Y159L	C1	
DC(HMHF)-	45	JUL 13	194	0	0	4.4	31.28	8	Y160L	C1	
DC(HMHF)-	45	JUL 13	194	0	0	4	30.12	7	Y161L	C2	
DC(HMHF)-	45	JUL 13	194	0	0	4	30.83	7	Y162L	C1	
OHR-2-2	5	JUL 17	198	1	0	5.5	34.42	2	Y163R	C1	

NOTES: 1. MOTHER IS Y152; THIS IS A NEWBORN PUP.

Appendix 3. (Continued).

Western Long-eared Myotis (*Myotis evotis*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC	MC5	MC3	TI	EW	EL	SP	EAR	HOT	C	NOTES
VLBS-1-1	1	MAY 12	132	1	0	5.5	35.3		31.95	30.67	16.08							
OFPP-1-1	2	MAY 13	133	1	0	6	39.0	0	36.37	33.2	18.93	8.5	19.12					
OGM*K-1-1	9	MAY 23	143	1	0	6	39.8	0	35.68	33.35	18.6	8.42	15					
OGM*K-1-1	9	MAY 23	143	1	0	6.5	39.2	0	36.4	34.88	18.48	9.43	16.77					
CLR-1-1	11	MAY 26	146	0	0	5.4	37.8		33.72	33.42	18.57	6.42	15.95		3	3		1
RATFALK-1-1	23	JUN 17	168	0	0	5	37.8		35.67	32.92	18.82	8.13	16.9		1	3		
RATFALK-1-1	23	JUN 17	168	0	0	5	37.8		35.35	34.5	19.87	8.27	18.13		2	3		
MADR-1-1	25	JUN 20	171	0	0	5	38.2		34.35	34.2	18.72	8.15	17.5	2	3	3		
RHB(LIT)-1-1	26	JUN 21	172	1	0	7.3	36.9	2	32.25	31.65	18.15	7.95	17.45	2	1	3		
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.5	38.3		34.27	34.27	19.48	7.2	17.5	1	2	3		
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.2	36.9	0	32.17	30.62	18.55	9.32	18.15	1	1	3		
RHB(LIT)-1-1	26	JUN 21	172	0	0	7	39.8		36.23	33.47	19.03			4	1	2		
RHB(LIT)-1-1	26	JUN 21	172	1	0	4.6	37.1		32.4	32.18	17.68		16.25	2	3	3		
RHB(LIT)-1-1	26	JUN 21	172	1	0	6.2	38.9	2	33.82	32.42	19.18			5	2	3		
RHB(LIT)-1-1	26	JUN 21	172	1	0	5	38.1	1	33.78	33.17	17.93	8.32	17.9	2	1	3		
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.2	38.1	0	34.75	33.3	19.23	8.22	18					
LC(PWMX)-1-1	29	JUN 23	174	1	0	6.9	40.8	0	34.97	34.42	20.05	8.32	16.63	2	2	3	1	
GL-1-1	30	JUN 25	176	1	0	6.4	39.4	0	33.07	31.48	18.37	6.35	16.13	1	1	2		
GL-1-1	30	JUN 25	176	0	0	6.3	37.5		33.97	33.37	20.08	9.9	18.58	5	2	2		
GL-1-1	30	JUN 25	176															2
SM(CL)-1-1	31	JUN 26	177	1	0	8.5	38.4	2	33.47	33.13	19.05	8.72	16.2	5	1	2		
SM(CL)-1-1	31	JUN 26	177	1	0	9	40.6	1	35.05	35.15	20.52	8.55	17.15	1	1	2		
SM(CL)-1-1	31	JUN 26	177	1	0	8	39.3	1	34.28	33.02	20.07			2	1	2		
W-1-1	34	JUL 01	182	1	0	7.6	39.2	2	34.58	33.68	19.58	8.05	18.43	4	3	2	1	3
W-1-1	34	JUL 01	182	1	0	7.7	40.1	0	35.1	34.45	19.85		18	2	1	1		4
W-1-1	34	JUL 01	182	1	0	6.8	37.8		34.43	32.13	19.15	8.05	17.32	3	2	3		5
W-1-1	34	JUL 01	182	1	0	7.7	38.6	2	34.2	32.95	19.45	8.5	18.23	3	2	1		6
SCIF-1-1	38	JUL 07	188	0	0	6.2	36.7	8	31.63	31.9	18.25	9.15	18.85	2	1	3	1	7
AL(PVP)-1-1	42	JUL 09	190	1	0	5.9	39	0	33.72	33.82	18.57	7.63	19.05	2	1	4	2	8
AL(PVP)-1-1	42	JUL 09	190	1	0	6	37.8	2	32.33	31.1	17.43							
OGM-1-2	9	JUL 22	203	1	0	6.1	39.1	0	34.17	33.45	19.38	8.17	18.43	3	1	1	3	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.9	39.1		33.85	33.28	18.72	6.78	17.53	2	1		1	9
CR(VERNON)-1-1	51	JUL 30	211	1	1	6.7	38.9											10
MM(VERNON)-1-1	52	JUL 31	212	1	1	6.3	38.6											11
MM(VERNON)-1-1	52	JUL 31	212	1	1	5.6	37.9							2	1	3		
RATFALK-1-2	23	AUG 02	214	1	1	4.9	37.9				18.2	10.02	19.72	5	1	3	3	12
RHB(LIT)-1-2	26	AUG 03	215	1	0	6.5	38.1	2	31.75	30.52	17.62	8.95	16.88	4	1	2	3	13
SM(CL)-1-2	31	AUG 09	221	1	1	4.9	38.4							2	3	1	1	14
MADR-1-2	25	AUG 11	223	0	1	4.8	37.8							2	1	1	1	15
T(CAB)-1-1	58	AUG 13	225	0	0	5.9	37.5	8	33.05	33.45	18.23	7.85	18.7	2	1		1	16

NOTES: 1.SEPTENTRIONALIS?
2.ESCAPEE
3 - 13. HAIR SAMPLES TAKEN
7 & 8. C1
10. RIGHT CANINE FLATTENED - CAUGHT IN NET?
13. MISSING LEFT TRAGUS
14. FLEA COLLECTED
15 & 16. HAIR SAMPLES TAKEN

Appendix 3. (Continued).

California Myotis (*Myotis californicus*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
VLBS-1-1	1	MAY 12	132	0	0	4.4	33.53	
OGM*K-1-1	9	MAY 23	143	0	0	5	38.45	
OGM*K-1-1	9	MAY 23	143	1	0	7	37.83	
OGM*K-1-1	9	MAY 23	143	1	0	4.5	34.55	0
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.7	33.03	1
RHB(LIT)-1-1	26	JUN 21	172	1	0	4	31.87	
RHB(LIT)-1-1	26	JUN 21	172	0	0	4.5	33.52	
RHB(LIT)-1-1	26	JUN 21	172	0	0	4.6	34.07	
RHB(LIT)-1-1	26	JUN 21	172	0	0	3.7	33.9	
OGM-1-1	9	JUL 22	203	0	0	4.7	33.37	7
CR(VERNON)-1-1	51	JUL 30	211	1	0	4.9	32.33	2
CR(VERNON)-1-1	51	JUL 30	211	0	0	4.5	32	
CR(VERNON)-1-1	51	JUL 30	211	1	1	3.4	31.55	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.1	33.03	8
RATFALK-1-2	23	AUG 02	214	0	0	4.9	33.15	8
RHB(LIT)-1-2	26	AUG 03	215	1	0	4.7	34.53	3
LC(CAB)-1-1	56	AUG 08	220	1	1	3.6	34.1	
LC(CAB)-1-1	56	AUG 08	220	0	1	4.4	32.15	7

Silver-haired Bat (*Lasionycterus noctivagans*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
RATFALK-1-1	23	JUN 17	168	0	0	11.4	42.35	
MM(VERNON)-1-1	52	JUL 31	212	1	0	11	42.02	3
MM(VERNON)-1-1	52	JUL 31	212	0	0	11.1	40.17	8
MM(VERNON)-1-1	52	JUL 31	212	1	0	14.2	41.13	3
MM(VERNON)-1-1	52	JUL 31	212	1	0	12.7	41.38	3
MM(VERNON)-1-1	52	JUL 31	212	0	1	9.8	39.93	8
MM(VERNON)-1-1	52	JUL 31	212	0	0	12.4	41.02	7
MM(VERNON)-1-1	52	JUL 31	212	0	1	9.6	40.38	7
MM(VERNON)-1-1	52	JUL 31	212	1	0	12.3	41.75	2
RATFALK-1-2	23	AUG 02	214	1	1	10.7	41.78	

Appendix 3. (Continued).

Big Brown Bat (*Eptesicus fuscus*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
OFPP-1-1	2	MAY 13	133	1	0	18.3	46.68	0
OFPP-1-1	2	MAY 13	133	1	0	17	47.07	1
OFPP-1-1	2	MAY 13	133	1	0	19.4	48.28	1
OFPP-1-1	2	MAY 13	133	1	0	18.4	49.08	0
OFPP-1-1	2	MAY 13	133	1	0	16.1	45.07	0
MADR-1-1	25	JUN 20	171	1	0	18.6	48.3	1
MADR-1-1	25	JUN 20	171	1	0	19	48.83	2
MADR-1-1	25	JUN 20	171	1	0	16	47.1	1
MADR-1-1	25	JUN 20	171	1	0	20.4	49	1
MADR-1-1	25	JUN 20	171	1	0		46.23	2
MADR-1-1	25	JUN 20	171	1	0	19	46.28	1
MADR-1-1	25	JUN 20	171	0	0	17.3	48.4	
RHB(LIT)-1-1	26	JUN 21	172	1	0	18.3	47.48	2
RHB(LIT)-1-1	26	JUN 21	172	1	0	19.5	49.77	1
RHB(LIT)-1-1	26	JUN 21	172	1	0	16.5	50.47	2
RHB(LIT)-1-1	26	JUN 21	172	1	0	20.5	50.43	1
RHB(LIT)-1-1	26	JUN 21	172	1	0	18.5	45.62	1
RHB(LIT)-1-1	26	JUN 21	172	1	0	20.5	46.77	2
RHB(LIT)-1-1	26	JUN 21	172	1	0	18	46.67	2
RHB(LIT)-1-1	26	JUN 21	172	1	0	20.5	47.37	2
W-1-1	34	JUL 01	182	1	0	24.9	47.5	1
WLCC-1-1	36	JUL 04	185	0	0	17.9	47.95	8
WLCC-1-1	36	JUL 04	185	0	0	16.9	45.7	8
WLCC-1-1	36	JUL 04	185	1	0	20	49.08	2
GR-1-1	43	JUL 11	192	0	0	18.9	45.9	8
DC(HMHF)-1-1	45	JUL 13	194	1	0	17.9	47.13	0
L(SGB)-1-1	47	JUL 16	197	1	0	17.8	46.13	2
L(SGB)-1-1	47	JUL 16	197	1	0	18.9	43.98	2
L(SGB)-1-1	47	JUL 16	197	1	0	20.8	45.03	2
L(SGB)-1-1	47	JUL 16	197	1	0	21.1	46.73	2
L(SGB)-1-1	47	JUL 16	197	1	0	17.9	48.27	2
L(SGB)-1-1	47	JUL 16	197	1	0	19.3	45.97	2
L(SGB)-1-1	47	JUL 16	197	1	0	19.9	49.03	2
L(SGB)-1-1	47	JUL 16	197	1	0	18.9	47.47	2
L(SGB)-1-1	47	JUL 16	197	1	0	20.6	48.15	2
L(SGB)-1-1	47	JUL 16	197	1	0		47.82	2
L(SGB)-1-1	47	JUL 16	197	1	0	17.5	45.17	2
L(SGB)-1-1	47	JUL 16	197	1	0	21.2	45.98	2
L(SGB)-1-1	47	JUL 16	197	1	0	21.1	46.52	2
L(SGB)-1-1	47	JUL 16	197	1	0	19.9	47.35	0
L(SGB)-1-1	47	JUL 16	197	0	1	13.1	44.23	7
L(SGB)-1-1	47	JUL 16	197	1	1	12.8	45.33	
L(SGB)-1-1	47	JUL 16	197	0	1	15.9	46.73	7
L(SGB)-1-1	47	JUL 16	197	0	1	14.2	47.75	7
L(SGB)-1-1	47	JUL 16	197	1	1	15.4	49.13	
L(SGB)-1-1	47	JUL 16	197	0	1	16.4	47.02	7
OGM-1-2	9	JUL 22	203	0	0	16	46.48	8
MM(VERNON)-1-1	52	JUL 31	212	1	0	15.4	45.98	4
MM(VERNON)-1-1	52	JUL 31	212	1	0	21.5	49.32	3
MM(VERNON)-1-1	52	JUL 31	212	1	0	21.5	48.63	3
MM(VERNON)-1-1	52	JUL 31	212	1	0	18.9	48.08	3
MM(VERNON)-1-1	52	JUL 31	212	0	0	17.3	46.68	9
MM(VERNON)-1-1	52	JUL 31	212	0	0	17.1	46.22	9
MM(VERNON)-1-1	52	JUL 31	212	0	0	22.5	48.3	9
MM(VERNON)-1-1	52	JUL 31	212	0	0	13.6	45.07	7
MM(VERNON)-1-1	52	JUL 31	212	0	0	20.7	47.88	8
MM(VERNON)-1-1	52	JUL 31	212	0	0	18	45.55	8
MM(BPS-VERNON)-1-1	53	AUG 01	213	0	0	19	48.15	8
RATFALK-1-2	23	AUG 02	214	1	0	16.1	47.27	4
AS-1-2	35	AUG 15	227	1	0	22	49.82	3

Appendix 3. (Continued).

Long-legged Myotis (*Myotis volans*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC	NOTES
OGM*K-1-1	9	MAY 02	143	1	0	7.7	40.46	1	
RHB(LIT)-1-1	26	JUN 02	172	1	0	7.5	39.6	2	
RHB(LIT)-1-1	26	JUN 02	172	1	0	8.3	39.23	1	
RHB(LIT)-1-1	26	JUN 02	172	1	0	9	41	2	1
RHB(LIT)-1-1	26	JUN 02	172	0	0	6.5	39.12		
AL(PVP)-1-1	42	JUL 09	190	1	0	7.3	38.97	0	
AL(OB)-1-1	42	JUL 09	190	1	0	9.9	40	2	
AL(OB)-1-1	42	JUL 09	190	1	0	8	38.45	2	
AL(OB)-1-1	42	JUL 09	190	1	0	7.8	38.15	2	
AL(OB)-1-1	42	JUL 09	190	1	0	7.4	37.1	0	
AL(OB)-1-1	42	JUL 09	190	1	0	6.9	39.65	0	
AL(OB)-1-1	42	JUL 09	190	1	0	7.9	40.8	0	
AL(OB)-1-1	42	JUL 09	190	1	0	7.7	38.5	0	
AL(OB)-1-1	42	JUL 09	190	1	0	7.8	40.1	5	
AL(OB)-1-1	42	JUL 09	190	1	0	7.6	39.1	0	
AL(OB)-1-1	42	JUL 09	190	1	0	7.1	38.65	5	
AL(OB)-1-1	42	JUL 09	190	1	0	6.7	36.6	0	
AL(OB)-1-1	42	JUL 09	190	1	0	6.9	41.05	0	
AL(OB)-1-2	42	JUL 10	191	1	0	8.5	38.85	2	
AL(OB)-1-2	42	JUL 10	191	1	0	7.1	39.45	0	
AL(OB)-1-2	42	JUL 10	191	1	0	7.4	39.6	0	
AL(OB)-1-2	42	JUL 10	191	1	0	9.2	39.2	0	
AL(OB)-1-2	42	JUL 10	191	1	0	8.1	38.75	5	
AL(OB)-1-2	42	JUL 10	191	1	0	8.8	39.25	2	
AL(OB)-1-2	42	JUL 10	191	1	0	7.8	38.15	5	
AL(OB)-1-2	42	JUL 10	191	1	0	8.9	38.5	2	
AL(OB)-1-2	42	JUL 10	191	1	0	8.6	39.75	5	
AL(OB)-1-2	42	JUL 10	191	1	0	8.7	41.3	0	
AL(OB)-1-2	42	JUL 10	191	1	0	7.4	38.65	0	
AL(OB)-1-2	42	JUL 10	191	1	0	9.1	40.75	2	
AL(OB)-1-2	42	JUL 10	191	1	0	6.8	39.3	0	
AL(OB)-1-2	42	JUL 10	191	1	0	9.4	40.25	0	
AL(OB)-1-2	42	JUL 10	191	1	0	7.3	39.35	0	
AL(OB)-1-2	42	JUL 10	191	1	0	7.8	39.45	2	
AL(OB)-1-2	42	JUL 10	191	1	0	8.1	40.1	2	
AL(OB)-1-2	42	JUL 10	191	1	0	7.4	38.55	0	
GR(GC)-1-1	43(b)	JUL 11	192	1	0	9.9	39.4	0	
GR-1-1	43	JUL 11	192	1	0	8.8	40.75	5	
GR-1-1	43	JUL 11	192	0	0	6.9	38.05	8	
GR-1-1	43	JUL 11	192	0	0	7	38.85	6	
GR-1-1	43	JUL 11	192	0	0	7.8	39.05	8	
GR(RES)-1-1	44	JUL 12	193	1	0	8.5	38.15	0	
DC(HMHF)-1-1	45	JUL 14	194	0	0	7.2	36.3	8	
DC(HMHF)-1-1	45	JUL 14	194	1	0	7.8	39.47	0	
DC(HMHF)-1-1	45	JUL 14	194	0	0	7.8	38.5	6	
DC(HMHF)-1-1	45	JUL 14	194	1	0	7.6	38.78	0	
DC(HMHF)-1-1	45	JUL 14	194	1	0	8.4	40.02	0	
L(SGB)-1-1	47	JUL 17	197	1	0	7.9	39.08	2	
CR(VERNON)-1-1	51	JUL 31	211	1	0	8.7	39.08	2	
RATFALK-1-2	23	AUG 03	214	1	0	7.5	40.7	4	
LC(CAB)-1-1	56	AUG 09	220	1	0	6.9	37.85	2	
WL-CNP(LLH)-1-1	60	AUG 17	228	1	0	8	38.98	3	

NOTES: 1. RECENT BIRTH.

Appendix 3. (Continued).

Yuma Myotis (*Myotis yumanensis*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC	TEETH
GBR-1-1	16	JUN 03	154	1	0	6.9	35.52	1	
GBR-1-1	16	JUN 03	154	1	0		35.35	1	
GBR-1-1	16	JUN 03	154	1	0	7.3	35.35	1	
GBR-1-1	16	JUN 03	154	1	0	6	34.83	1	
GBR-1-1	16	JUN 03	154	0	0	5	34.13		
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.6	35.85	2	
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.6	35.73	2	
RHB(LIT)-1-1	26	JUN 21	172	1	0	6.1	33.97	2	
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.2	34.4	2	
RHB(LIT)-1-1	26	JUN 21	172	1	0	6	35.08	2	
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.6	34.27		
RHB(LIT)-1-1	26	JUN 21	172	0	0	4.8	36.88		
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.3	34.5		
RHB(LIT)-1-1	26	JUN 21	172	0	0	4.5	34.53		
SQB(ABR)-1-1	28	JUN 22	173	1	0	5.9	35.1	4	
SQB(ABR)-1-1	28	JUN 22	173	0	0	6	36.72		
SQB(ABR)-1-1	28	JUN 22	173	0	0	6.2	34.78		
SQB(ABR)-1-1	28	JUN 22	173	0	0	5.6	33.9		
SQB(ABR)-1-1	28	JUN 22	173	0	0	6	33.72		
T-1-1	32	JUN 29	180	1	0	5.6	34.77	2	
T-1-1	32	JUN 29	180	0	0	5.3	35.23		C3
AS-1-1	35	JUL 02	183	0	0	5.9	34.37		
AL(PVP)-1-1	42	JUL 09	190	0	0	5.4	34.65	6	
AL(OB)-1-2	42	JUL 09	190	0	0	5.9	34.5	8	C1
AL(OB)-1-2	42	JUL 09	190	0	0	6.3	35.9	8	C1
AL(OB)-1-2	42	JUL 09	190	0	0	5.9	35.45	8	C1
AL(OB)-1-2	42	JUL 09	190	0	0	5.5	34.3	8	C1
AL(OB)-1-2	42	JUL 09	190	0	0	5.9	35.3	8	C1
AL(OB)-1-2	42	JUL 09	190	0	0	6.2	34.7	7	C1
AL(OB)-1-2	42	JUL 09	190	0	0	6	35.2	8	C2
AL(OB)-1-2	42	JUL 09	190	0	0	5.8	34.35	8	C1
GR-1-1	43	JUL 10	191	1	0	5.4	35	0	C1
GR-1-1	43	JUL 10	191	1	0	5.9	35.85	2	C1
GR-1-1	43	JUL 10	191	1	0	4.9	35	2	C2
GR-1-1	43	JUL 10	191	1	0	6.4	36.95	2	C2
GR-1-1	43	JUL 10	191	1	0	5.9	36.45	0	C1
GR-1-1	43	JUL 10	191	1	0	6.1	36.4	0	C1
GR-1-1	43	JUL 10	191	1	0	6	35.25	5	C1
GR-1-1	43	JUL 10	191	1	0	5.7	36.05	2	C1
GR-1-1	43	JUL 10	191	1	0	5.9	34.7	0	C1
GR-1-1	43	JUL 10	191	0	0	6.6	36.45	7	C1
GR-1-1	43	JUL 10	191	0	0	6.4	35.2	6	C1
GR-1-1	43	JUL 10	191	1	0		35.55	0	C1
GR(RES)-1-1	44	JUL 11	192	0	0	6.1	35.25	8	C1
GR(RES)-1-1	44	JUL 11	192	1	0	6.1	35.25	0	C1
GR(RES)-1-1	44	JUL 11	192	0	0		36.12	7	C1
CR(VERNON)-1-1	51	JUL 30	211	1	0	6	34.58	4	
CR(VERNON)-1-1	51	JUL 30	211	1	0	5.9	35.5	3	
CR(VERNON)-1-1	51	JUL 30	211	1	0	6.1	35.58	3	
CR(VERNON)-1-1	51	JUL 30	211	0	0	4.8	33.62	8	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.2	34.47	8	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.5	34.22	8	
CR(VERNON)-1-1	51	JUL 30	211	1	0	6.8	34.75	2	

Appendix 3. (Continued).

Yuma Myotis (*Myotis yumanensis*) (continued)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC	TEETH
CR(VERNON)-1-1	51	JUL 30	211	1	0	6	34.3	3	
CR(VERNON)-1-1	51	JUL 30	211	0	0	4.9	33.85	8	
CR(VERNON)-1-1	51	JUL 30	211	1	0	5.8	36	4	
CR(VERNON)-1-1	51	JUL 30	211	0	0	4.9	35.52	8	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.1	34.88	7	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5	33.88	8	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.1	34.97	8	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.8	34.37	7	
CR(VERNON)-1-1	51	JUL 30	211	0	0	4.9	33.5	6	
CR(VERNON)-1-1	51	JUL 30	211	1	1	5	34.38		
CR(VERNON)-1-1	51	JUL 30	211	0	1	5	34.88	6	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.6	34.37	7	
CR(VERNON)-1-1	51	JUL 30	211	0	1	5.3	34.58	6	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.9	34.12	6	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.8	34.28	7	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.8	35.37	7	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.9	34.45		
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.9	34.25	7	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.8	33.5	7	
CR(VERNON)-1-1	51	JUL 30	211	0	1	5.1	34.5	7	
CR(VERNON)-1-1	51	JUL 30	211	0	1	5.1	34.07	6	
CR(VERNON)-1-1	51	JUL 30	211	0	1	4.5	33.6		
RATFALK-1-2	23	AUG 02	214	0	0	5.9	34.57	8	
RHB(LIT)-1-2	26	AUG 03	215	1	0	6.1	34.13	3	
RHB(LIT)-1-2	26	AUG 03	215	1	0	6.9	35.55	3	C2
RHB(LIT)-1-2	26	AUG 03	215	0	0	5.7	33.98	8	
RHB(LIT)-1-2	26	AUG 03	215	0	0	5.8	33.9	8	C1
MADR-1-2	25	AUG 11	223	1	0	5.1	34.95	3	

Appendix 3. (Continued).

Little Brown Myotis (*Myotis lucifugus*)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
OFPP-1-1	2	MAY 13	133	1	0	6.9	38	0
OHR-2-1	5	MAY 19	139	0	0	8	40.75	
DS-1-1	7	MAY 21	141	1	0	7	35.42	0
DS-1-1	7	MAY 21	141	0	0	5.1	34.53	
GinP-1-1	8	MAY 22	142	1	0	5.7	34.85	1
GinP-1-1	8	MAY 22	142	1	0	5.3	33.58	1
GinP-1-1	8	MAY 22	142	1	0	5.9	33.22	1
GinP-1-1	8	MAY 22	142	1	0	5.9	34.72	0
GinP-1-1	8	MAY 22	142	1	0	5.1	33	1
GinP-1-1	8	MAY 22	142	1	0	6	36.17	0
GinP-1-1	8	MAY 22	142	1	0	5	33.57	0
GinP-1-1	8	MAY 22	142	1	0	6	34.33	1
GinP-1-1	8	MAY 22	142	1	0	4.9	32.5	1
GinP-1-1	8	MAY 22	142	1	0	7.1	38.5	1
OGM*K-1-1	9	MAY 23	143	1	0	6.4	36.03	0
CLR-2-1	12	MAY 27	147	1	0	6	35.85	0
LOYAM-1-1	15	JUN 02	153	0	0	5	36.98	
LOYAM-1-1	15	JUN 02	153	1	0	7	36.17	1
GBR-1-1	16	JUN 03	154	1	0	6.9	35.63	1
GBR-1-1	16	JUN 03	154	1	0	6.2	36.5	1
GBR-1-1	16	JUN 03	154	0	0	4.8	33.25	
RATFALK-1-1	23	JUN 17	168	0	0	5.5	35.17	
RATFALK-1-1	23	JUN 17	168	0	0	6.8	35.87	
RATFALK-1-1	23	JUN 17	168	1	0	4.8	37.57	0
WPW-1-1	24	JUN 18	169	1	0	8.1	38.38	1
WPW-1-1	24	JUN 18	169	1	0	6.2	36.3	0
WPW-1-1	24	JUN 18	169	1	0	6.5	36.23	2
WPW-1-1	24	JUN 18	169	1	0	6	39	2
WPW-1-1	24	JUN 18	169	1	0	6.5	36.33	
WPW-1-1	24	JUN 18	169	0	0	5.1	35.05	
WPW-1-1	24	JUN 18	169	0	0	5.5	33.93	
WPW-1-1	24	JUN 18	169	0	0	5.2	35.17	
WPW-1-1	24	JUN 18	169	0	0	7.4	37.13	
WPW-1-1	24	JUN 18	169	0	0	6.3	37.28	
MADR-1-1	25	JUN 20	171	0	0	5	36.55	
MADR-1-1	25	JUN 20	171	0	0	6.5	36.03	
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.5	34.73	0
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.5	35.07	2
RHB(LIT)-1-1	26	JUN 21	172	1	0	5.6	35.25	0
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.7	35.15	
RHB(LIT)-1-1	26	JUN 21	172	0	0	4.6	35.57	
RHB(LIT)-1-1	26	JUN 21	172	0	0	6	37.4	
RHB(LIT)-1-1	26	JUN 21	172	0	0	6.6	39.38	
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.5	36.1	
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.6	34.87	
RHB(LIT)-1-1	26	JUN 21	172	0	0	5.7	37.17	
SQB(ABR)-1-1	28	JUN 22	173	0	0	6.3	37.03	
GL-1-1	30	JUN 25	176	1	0	7.4	36.68	1
GL-1-1	30	JUN 25	176	1	0	9.5	37.23	1
GL-1-1	30	JUN 25	176	1	0	9.5	37.67	1
GL-1-1	30	JUN 25	176	1	0	9.1	39.02	1
GL-1-1	30	JUN 25	176	1	0	9	37.8	1
GL-1-1	30	JUN 25	176	1	0	7.7	36.73	1
GL-1-1	30	JUN 25	176	1	0	6.4	37.3	0
GL-1-1	30	JUN 25	176	1	0	7.4	37.87	2
GL-1-1	30	JUN 25	176	1	0	8.4	36.1	1
GL-1-1	30	JUN 25	176	1	0	8.5	35.72	1
GL-1-1	30	JUN 25	176	0	0	5.4	35.65	
AS-1-1	35	JUL 02	183	0	0	6.9	36.33	

Appendix 3. (Continued).

Little Brown Myotis (*Myotis lucifugus*) (continued)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
AS-1-1	35	JUL 02	183	0	0	7.5	37.1	
AS-1-1	35	JUL 02	183	1	0	7.4	38.58	0
AS-1-1	35	JUL 02	183	1	0	6.4	36.52	0
AS-1-1	35	JUL 02	183	1	0	8.9	37.62	1
AS-1-1	35	JUL 02	183	1	0	6.3	37.17	0
AS-1-1	35	JUL 02	183	0	0	6.3	37.17	
AS-1-1	35	JUL 02	183	1	0	9.1	36.28	1
SCIF-1-1	38	JUL 07	188	1	0	6.9	37	0
WL(SINC)-1-1	39	JUL 08	189	1	0	7.7	37.62	2
WL(SINC)-1-1	39	JUL 08	189	0	0	6.7	36.7	
WL(SINC)-1-1	39	JUL 08	189	1	0	7.1	36.05	0
AL(PVP)-1-1	42	JUL 09	190	1	0	6.4	38.05	0
AL(PVP)-1-1	42	JUL 09	190	1	0	6.5	35.8	0
AL(PVP)-1-1	42	JUL 09	190	1	0	7.5	38.35	0
AL(PVP)-1-1	42	JUL 09	190	1	0	7.5	37.15	2
AL(PVP)-1-1	42	JUL 09	190	1	1	4.1	36.25	
AL(PVP)-1-1	42	JUL 09	190	0	1			
AL(PVP)-1-1	42	JUL 09	190	1	0	6.6	36.4	2
AL(PVP)-1-1	42	JUL 09	190	1	0	6.3	36.5	0
AL(PVP)-1-1	42	JUL 09	190	0	0	7	36.55	8
AL(PVP)-1-1	42	JUL 09	190	1	0	7.5	36.6	2
AL(PVP)-1-1	42	JUL 09	190	1	0	9	40	2
AL(PVP)-1-1	42	JUL 09	190	0	0	7	37.55	8
AL(PVP)-1-1	42	JUL 09	190	1	0	6	34.95	0
AL(PVP)-1-1	42	JUL 09	190	1	0	6.2	39	2
AL(PVP)-1-1	42	JUL 09	190	0	0	6.9	35.65	8
AL(PVP)-1-1	42	JUL 09	190	0	0	6.5	36.25	7
AL(PVP)-1-1	42	JUL 09	190	1	0	6.6	36.65	0
AL(PVP)-1-1	42	JUL 09	190	1	0	7.5	37.55	2
AL(PVP)-1-1	42	JUL 09	190	1	0	7	36.35	2
AL(PVP)-1-1	42	JUL 09	190	1	0	8.5	37.1	2
AL(PVP)-1-1	42	JUL 09	190	1	0	5.5	36.6	0
AL(PVP)-1-1	42	JUL 09	190	1	0	6.9	36.65	2
AL(OB)-1-1	42	JUL 10	191	1	0	7.2	37	2
AL(OB)-1-1	42	JUL 10	191	1	0	7	36.7	0
AL(OB)-1-1	42	JUL 10	191	1	0	6.1	35.25	5
AL(OB)-1-1	42	JUL 10	191	1	0	7.8	37.15	0
AL(OB)-1-1	42	JUL 10	191	1	0	6.4	36.2	0
AL(OB)-1-1	42	JUL 10	191	1	0	6.6	36.6	2
AL(OB)-1-1	42	JUL 10	191	1	0	7.2	38.05	2
AL(OB)-1-1	42	JUL 10	191	1	0	6	37.55	5
AL(OB)-1-1	42	JUL 10	191	1	0	7.2	39.5	0
AL(OB)-1-1	42	JUL 10	191	1	0	7.1	38.75	2
AL(OB)-1-1	42	JUL 10	191	1	0	7.9	38.55	2
AL(OB)-1-1	42	JUL 10	191	1	0	6.9	37.3	0
AL(OB)-1-1	42	JUL 10	191	1	0	7.7	36.3	0
AL(OB)-1-1	42	JUL 10	191	1	0	7	37.8	0
AL(OB)-1-1	42	JUL 10	191	1	0		36.7	2
AL(OB)-1-1	42	JUL 10	191	1	0	7.1	36.75	5
AL(OB)-1-1	42	JUL 10	191	1	0	6.8	36.25	2
AL(OB)-1-1	42	JUL 10	191	1	0	6.9	37.15	0
AL(OB)-1-1	42	JUL 10	191	1	0	7.9	38.1	2
AL(OB)-1-1	42	JUL 10	191	1	1	4.9	36.4	
AL(OB)-1-1	42	JUL 10	191	1	0	6	37.9	0
AL(OB)-1-1	42	JUL 10	191	1	0	5.9	34.95	0
AL(OB)-1-1	42	JUL 10	191	1	0	7.1	37.2	0
AL(OB)-1-1	42	JUL 10	191	1	0	6.9	37.7	0
AL(OB)-1-1	42	JUL 10	191	1	0	7.6	36.6	0
AL(OB)-1-1	42	JUL 10	191	1	0	6.2	35.6	0

Appendix 3. (Continued).

Little Brown Myotis (*Myotis lucifugus*) (continued)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
AL(OB)-1-1	42	JUL 10	191	1	0	7	36.5	0
AL(OB)-1-1	42	JUL 10	191	1	0	7.7	39.4	0
GR-1-1	43	JUL 11	192	1	0	5.8	39.5	0
GR-1-1	43	JUL 11	192	1	0	4.8	37.3	0
GR-1-1	43	JUL 11	192	1	0	7.1	36.3	2
GR-1-1	43	JUL 11	192	1	0	6.4	37.7	2
GR-1-1	43	JUL 11	192	1	0	5.9	35.8	2
GR-1-1	43	JUL 11	192	1	0	5.7	36.2	0
GR-1-1	43	JUL 11	192	1	0	5.4	37.5	0
GR-1-1	43	JUL 11	192	1	0	5.9	36.8	5
GR-1-1	43	JUL 11	192	1	0	6.1	38.1	0
GR-1-1	43	JUL 11	192	1	0	6.4	36.6	2
GR-1-1	43	JUL 11	192	1	0	6.4	36.5	0
GR-1-1	43	JUL 11	192	1	0	7.5	37.6	2
GR-1-1	43	JUL 11	192	1	0	7.9	38.4	0
GR-1-1	43	JUL 11	192	1	0	7.1	37.0	0
GR-1-1	43	JUL 11	192	0	0	6.1	37.9	7
GR-1-1	43	JUL 11	192	1	0	7.5	37.2	5
GR-1-1	43	JUL 11	192	0	0	6.9	36.5	6
GR-1-1	43	JUL 11	192	0	0	7	38.1	8
GR-1-1	43	JUL 11	192	1	0	6.7	36.5	0
OGM-1-2	9	JUL 22	203	0	0	6	35.3	6
OGM-1-2	9	JUL 22	203	1	0	5.9	36.6	0
OGM-1-2	9	JUL 22	203	0	0	5.9	35.6	6
CR(VERNON)-1-1	51	JUL 30	211	1	0	7	38.7	4
CR(VERNON)-1-1	51	JUL 30	211	1	0	6.9	37.8	
CR(VERNON)-1-1	51	JUL 30	211	1	0	6.8	38.0	2
CR(VERNON)-1-1	51	JUL 30	211	1	0	6.1	35.8	4
CR(VERNON)-1-1	51	JUL 30	211	0	0	6.3	36.2	
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.4	34.8	8
CR(VERNON)-1-1	51	JUL 30	211	0	0	5.7	36.2	8
CR(VERNON)-1-1	51	JUL 30	211	1	1	5.4	37.0	
CR(VERNON)-1-1	51	JUL 30	211	1	1	5.9	37.0	
CR(VERNON)-1-1	51	JUL 30	211	1	1		35.4	
CR(VERNON)-1-1	51	JUL 30	211	0	1	5	35	
CR(VERNON)-1-1	51	JUL 30	211	0	1	5	35.5	6
CR(VERNON)-1-1	51	JUL 30	211	0	1	5	37.2	6
MM(VERNON)-1-1	51	JUL 31	212	0	0	5.3	36.2	8
RATFALK-1-2	23	AUG 02	214	1	0	7	35.7	3
RATFALK-1-2	23	AUG 02	214	1	0	6.9	37.9	4
RATFALK-1-2	23	AUG 02	214	1	0	7.7	37.1	2
RATFALK-1-2	23	AUG 02	214	1	0	7.7	37.4	3
RATFALK-1-2	23	AUG 02	214	1	0		37.5	4
RATFALK-1-2	23	AUG 02	214	0	0	7	36.0	8
RATFALK-1-2	23	AUG 02	214	0	0	6.2	36.9	8
RATFALK-1-2	23	AUG 02	214	0	0	7.1	36.9	7
RATFALK-1-2	23	AUG 02	214	0	0	6.5	40.8	8
RATFALK-1-2	23	AUG 02	214	0	0	7.4	36.2	
RATFALK-1-2	23	AUG 02	214	1	1	5.2	36.7	
RATFALK-1-2	23	AUG 02	214	1	1	6	38.7	
RATFALK-1-2	23	AUG 02	214	1	1	5.8	36.8	
RATFALK-1-2	23	AUG 02	214	1	1	5.9	36.2	
RATFALK-1-2	23	AUG 02	214	1	1	5.9	38.0	
RATFALK-1-2	23	AUG 02	214	0	1	5.2	34.3	7
RATFALK-1-2	23	AUG 02	214	0	1	6.1	39.2	7
RHB(LIT)-1-2	26	AUG 03	215	1	0	6.9	38.2	4
T(CAB)-1-1	58	AUG 13	225	1	0	7	36.7	4
WL(CNP-LLH)-1-1	60	AUG 16	228	0	0	6.2	37	9

Appendix 3. (Continued).

Little Brown Myotis (*Myotis lucifugus*) (continued)

SITE CODE	SITE NUMBER	DATE	JULIAN	SEX	AGE	MASS	FA	RC
CM(RS)-1-1	63	AUG 19	231	1	1	6.4	37.5	
CM(RS)-1-1	63	AUG 19	231	1	1	6.2	37.3	
CM(RS)-1-1	63	AUG 19	231	1	0	8.4	37.2	3
CM(RS)-1-1	63	AUG 19	231	1	0	7.7	38.7	4
CM(RS)-1-1	63	AUG 19	231	1	1	6.6	37.5	
CM(RS)-1-1	63	AUG 19	231	1	0	8.7	37.5	3
CM(RS)-1-1	63	AUG 19	231	1	1	6.6	38.0	
CM(RS)-1-1	63	AUG 19	231	0	0	6.7	37.7	8
CM(RS)-1-1	63	AUG 19	231	1	1	7.6	40.1	
CM(RS)-1-1	63	AUG 19	231	1	0	7.6	37.3	
CM(RS)-1-1	63	AUG 19	231	1	0	7.6	37.1	3
CM(RS)-1-1	63	AUG 19	231	1	1	5.8	35.4	
CM(RS)-1-1	63	AUG 19	231	0	0	7.6	36.2	7
CM(RS)-1-1	63	AUG 19	231	1	0	8.4	38.0	4
RFSR(FB)-1-1	64	AUG 20	232	1	0	9.1	37.4	3
RFSR(FB)-1-1	64	AUG 20	232	1	1	7	36.9	
RFSR(FB)-1-1	64	AUG 20	232	1	1	5.9	38.1	
RFSR(FB)-1-1	64	AUG 20	232	0	0	7	36.1	7

Wildlife Working Reports should not be cited because of the preliminary nature of the data they contain. Working Reports 1 - 10 are out of print.

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WR-13 Kechika Enhancement Project of northeastern B.C.: wolf/ungulate management. 1984-85 annual report. J.P. Elliott. September 1985. 28pp.

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WR-25 The effects of snowmobiling on winter range use by mountain caribou. K. Simpson. February 1987. 15pp.

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WR-31 Wildlife habitat suitability of the Mackenzie Heritage Trail corridor. V. Hignett. May 1988. 16pp + 6 maps.

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WR-35 Causes of bighorn sheep mortality and dieoffs - literature review. H.M. Schwantje. April 1988. 54pp.

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Continued from inside back cover

WR-37 Bio-physical habitat units and interpretations for moose use of the upper Cariboo River Wildlife Management Area. E.C. Lea, T. Vold, J. Young, M. Beets, D. Blower, J. Youds, A. Roberts. December 1988. 24pp.

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