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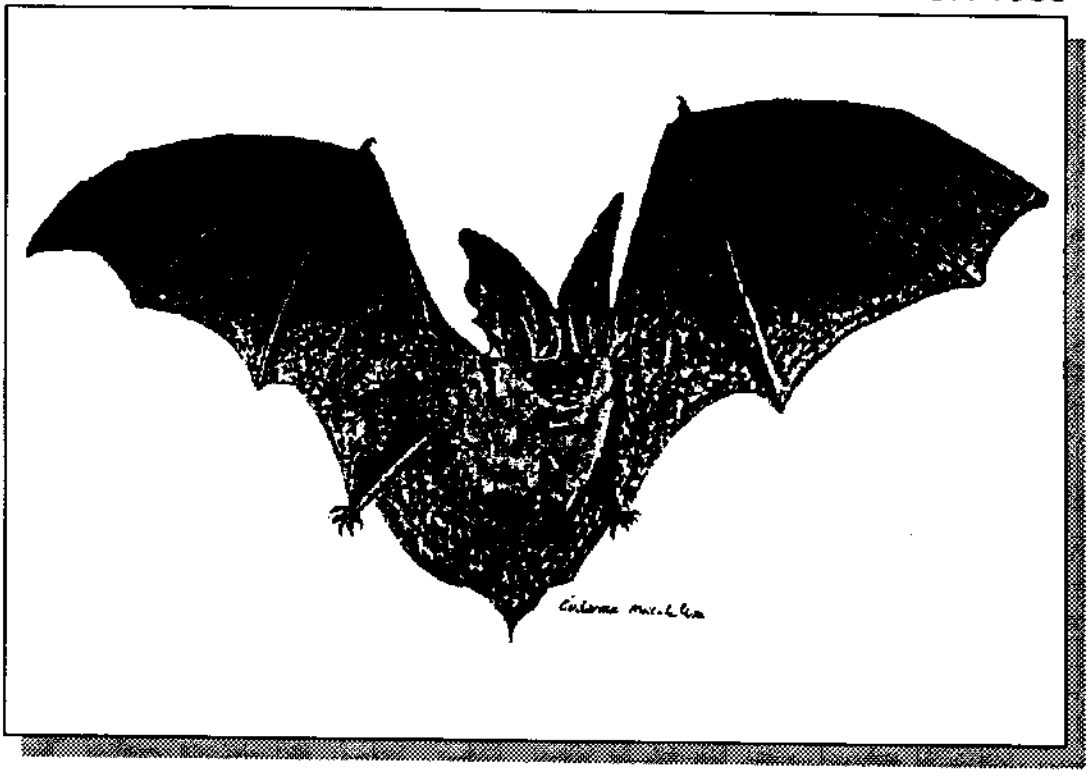

RARE BATS OF THE SHRUB-STEPPE ECOSYSTEM OF EASTERN WASHINGTON

PREPARED BY: M.J. SARELL, R.P. BIO. AND
K.P. McGUINNESS, B.SC. OF OPHIUCHUS CONSULTING
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Prepared by:
M.J. Sarell, R.P.Bio. and K.P. McGuinness, B.Sc.
of
Ophiuchus Consulting[1]

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Funded by:
Washington Department of Wildlife
Nongame Program

[1] **RR #2, Oliver, British Columbia V0H 1T0**

ABSTRACT

While the diverse bat fauna of the shrub-steppe ecosystem of Washington is sporadically documented, at least 15 species of bats are known to occur within this habitat. The Washington Department of Wildlife designates eight of these "State Concern".

The most recently discovered species, the spotted bat (*Euderma maculatum*), occurs throughout the arid regions of western North America as far north as British Columbia. Prior to a recent observation and this study, an anomaly in their range persisted: no sightings had been recorded in Washington despite one general survey and one specific survey.

This study surveyed potentially suitable bat habitat over a 3 month period during the summer of 1992, revealing a minimum of 87 spotted bats in 3 of the 6 Washington counties sampled.

Confirmation of suitable habitat for day roosts and the distributional evidence gathered during the survey suggests that spotted bats are breeding residents of Washington. Pallid bats (*Antrozous pallidus*) were found in only 2 counties. Other rare bats encountered include fringed myotis (*Myotis thysanodes*), western small-footed bat (*Myotis ciliolabrum*) and Townsend's big-eared bat (*Plecotus townsendii*).

Spotted bats can be detected through distinctive echolocation impulses audible to the human ear. They, and the other rare bats censused, roost in cliff faces during the day.

The future health of eastern Washington's rare bat population depends upon preserving suitable day roost sites, primarily cliff faces.

Keywords: shrub-steppe; cliff; *Euderma maculatum*; *Antrozous pallidus*; *Myotis thysanodes*; *Myotis ciliolabrum*; *Plecotus townsendii*; *Lasiurus blossevilli*; *Nyctinomops macrotus*.

INTRODUCTION

Fourteen bat species were previously known to inhabit the shrub-steppe ecosystem of Washington (Dalquest 1948, Perkins 1990, Washington Department of Wildlife Nongame Data System 1992). Eight of these have been designated Species of State Concern (SC): those that may be considered for endangered, threatened, or sensitive status (Washington Department of Wildlife 1990). In addition to the above mentioned list, the spotted bat (*Euderma maculatum*) was observed for the first time in 1991 (Sarell *et al.* 1992) and can now be considered a breeding inhabitant of Washington.

The status report prepared for the Office of Endangered Species of the U.S. Fish and Wildlife Service (O'Farrell 1981) recommends listing the spotted bat as a threatened species within its known range in the United States. Prior to 1991, the species was not a documented Washington inhabitant (McAllister 1990. pers. comm.) due to a lack of museum specimens, negative results from one survey designed to locate spotted bats (Fenton *et al.* 1987) and no encounters during a general bat survey by Perkins (1990). Thus, Washington Department of Wildlife has not prepared any status report for this bat.

In Canada, spotted bats are a relatively recently discovered species (Woodsworth *et al.* 1981) and are classified as rare (World Wildlife Fund of Canada 1991). The Wildlife Branch (1991) of British Columbia Environment has placed the spotted bat on its Red List (species considered threatened or endangered). The South Okanagan Critical Area Program ranks the spotted bat Priority One (Erickson and Torrance 1989).

The previous absence of records for spotted bats in British Columbia and Washington may be primarily due to: 1. their affinity for choosing high, sheer cliffs for day roosts; 2. their solitary roosting preference, which produces relatively low population densities; 3. their high-altitude foraging; and 4. a lack of knowledge that their echolocation impulses are audible to the unaided human ear (Woodsworth *et al.* 1981).

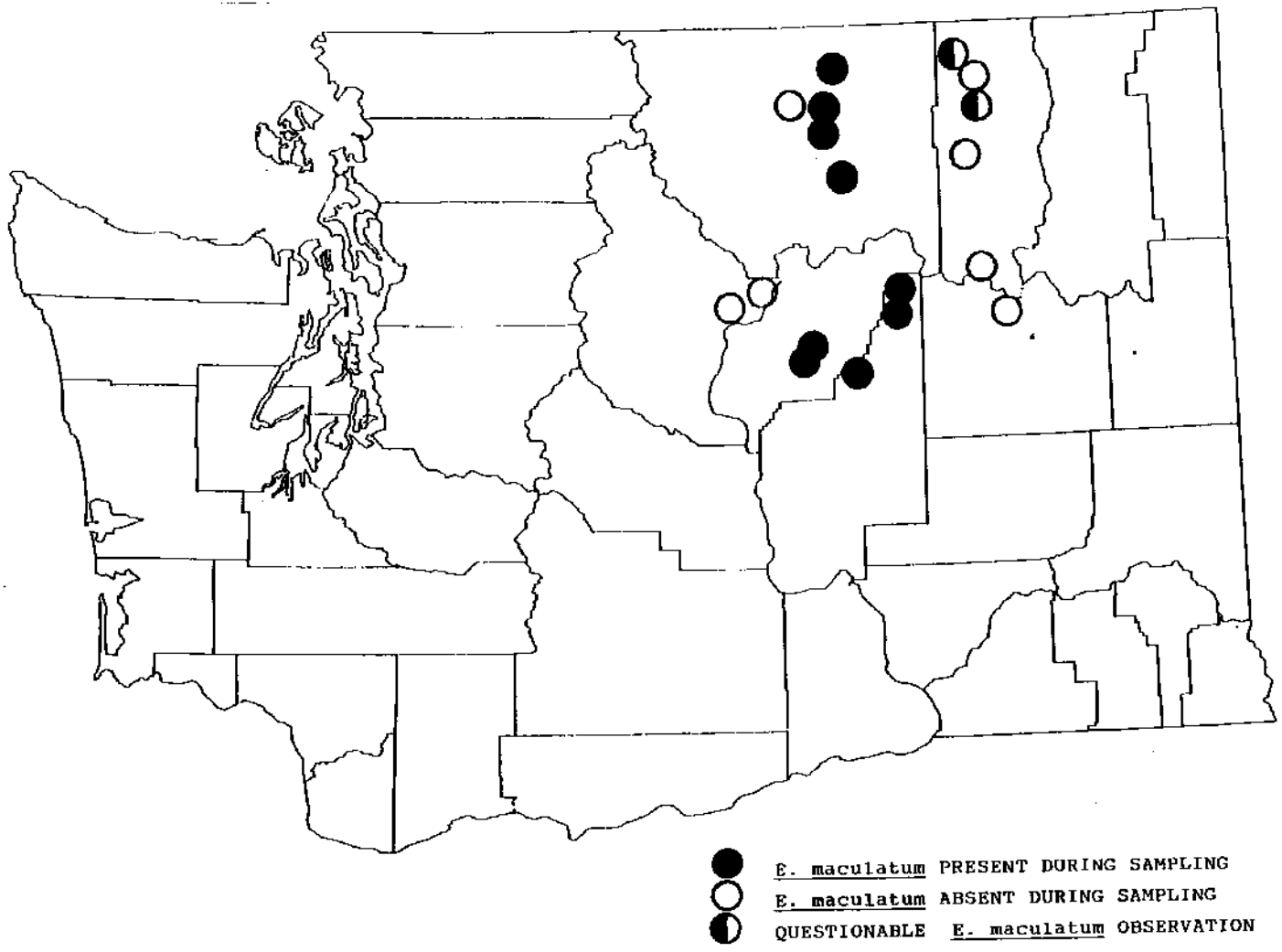
This study focused on establishing the population density and distribution of two rare bat species: the spotted and the pallid bat.

The senior author originally speculated on the presence of spotted bats in Washington due to breeding populations documented south, east and north of the state. The presence of suitable roost sites and foraging areas provoked him to investigate, subsequently observing one spotted bat foraging over a marsh and open water complex at Dry Falls, Grant County on 7 August 1991 (Sarell *et al.* 1992). The Washington Department of Wildlife supported further research to gain better documentation of the bat fauna within the shrub-steppe ecosystem.

Bat inventories were conducted in the late summer of 1992 within 6 Washington counties. Efforts concentrated on documenting the presence of the spotted bat within the state (**Figure 1**) and on assessing the suitability of various cliffs within each county for day roosts.

Spotted bat foraging habitat in B.C. and much of the U.S. consists of big sagebrush-bunchgrass, ponderosa pine-bunchgrass and wetland. This foraging preference has been summarized in

FIGURE 1
WASHINGTON SPOTTED BAT LOCATIONS



Habitat Relation Models for Mammals (Ritcey *et al.* 1988). Washington contains all of these habitat types close to known ranges of spotted bat populations outside of the state. Washington also hosts suitable day roost sites: high, low-elevation cliffs (Collard *et al.* 1991).
Pallid bats have less stringent roosting requirements, selecting low to high vertical cliffs. Their foraging requirements, however, are more restrictive as they rarely echolocate, hunting instead by tracking noises produced by their prey: terrestrial arthropods (van Zyll de Jong 1985). Thus, sparsely vegetated sites are preferred to accommodate navigation and prey attack.

Efforts also established the presence of other species of rare bats within Washington. These include the pallid bat (*Antrozous pallidus*), fringed myotis (*Myotis thysanodes*), Townsend's big-eared bat (*Plecotus townsendii*), western small-footed myotis (*Myotis ciliolabrum*) and others. Bats known to inhabit this ecosystem are summarized in Appendix 1.

Availability of suitable cliffs for day roosts limits population density and distribution of 8 of Washington's 9 rare bats, although Townsend's big-eared bat (*Plecotus townsendii*), the pallid bat (*Antrozous pallidus*) and the fringed myotis (*Myotis thysanodes*) may use anthropogenic structures when available (Kunz and Martin 1982, Orr 1954, van Zyll de Jong 1985). The exception, the southern red bat (*Lasiurus blossevilli*, formerly *L. borealis*), roosts on trees in riparian thickets (van Zyll de Jong 1985).

METHODS

The study identified areas for potential sampling based on known roost requirements for the spotted bat. This species of bat prefers high cliffs at low elevations. Indicator species of this habitat include the golden eagle and white-throated swift.

Initially, sites were selected from reviewing topographic maps and interviews with local Department of Wildlife staff. Where these sites were readily accessible, they were examined during daylight hours and cliff evaluations were conducted (Appendix 4). Sites encountered en route were also assessed for cliff characteristics suitable for spotted bat roost requirements.

Spotted bats were detected by listening for their distinctive echolocation technique. The study recorded the number of echolocation pulses, where and when the bat was first detected and the direction of travel (Appendix 5). Efforts were made to identify and avoid duplication of bats detected in order to obtain local abundance information. Pallid bats produce an audible directive call when departing and/or approaching conspecifics (van Zyll de Jong, 1985).

Those bats echolocating at frequencies above the range of human hearing were sampled using a QMC Mini Bat Detector. Information from this source was recorded on audio tape and/or in field notes.

Bat fauna samples were gathered by positioning observers along the base of suitable cliffs. Mist nets (Avinet Inc., 1-1/2 inch mesh, 7 inch 6 x 42 foot, 50 denier/ 2 ply) were positioned to intercept emerging bats flying near the ground.

Pallid bats typically fly low to the ground and may elude mist nets set too high (Chapman and McGuinness 1991).

Bats caught in mist nets were identified using keys from Nagorsen and Brigham (in press) and/or van Zyll de Jong (1985). Appropriate measurements were taken of species of bats determined to be of state concern (Appendix 6). Bats were subsequently released without being banded because individuals caught were not within an area where recapture was likely. Bands may also increase predation pressures.

Thirty minutes to one hour after the last spotted bat was detected emerging from day roosts, field sampling for foraging spotted bats over a larger geographic area was undertaken. In many instances, this involved sampling for a 10-minute duration at 5-kilometer intervals within suitable foraging habitat.

Day roosting bats using buildings and night roosts under bridges were also sampled where available.

RESULTS

Cliffs and rocky outcroppings are considered critical habitats for a number of rare wildlife species including bats (Sinnemann 1992, Maser *et al.* 1979). During this study, cliff evaluations were conducted for potential day roost sites of spotted, pallid and other rare bats (Appendix 4).

SPOTTED BAT ROOSTING HABITAT

Roosting sites of spotted bats have been described by a number of authors (Easterla 1965, Poche 1975, Leonard and Fenton 1983, Collard *et al.* 1991). All studies indicate that tall, vertical rock faces with horizontal and vertical openings (Easterla 1970, in Watkins 1977, Easterla 1972 in Snow 1974) are critical for spotted bat roost sites.

The primary rock type used for spotted bat day roosts in B.C. is granitic gneiss (Maxwell 1991. pers. comm.) This rock type occurs throughout Okanogan County, which contains numerous spotted bat sites, as well as Chelan and Ferry Counties. Potential day roosts evaluated in Grant, Douglas and Lincoln Counties are of columnar basalt, which was also found to be very suitable for spotted bats.

Ten suitable cliffs were encountered and inventoried in Okanogan County, 3 in Grant County, 2 in both Douglas and Chelan Counties, and one in Lincoln and Ferry Counties. This represents a fraction of the cliffs in each county and should not be considered comprehensive.

A minimum of 11 day roosts were identified from 34 potential roosts sampled. The bulk of day roosts were found in Okanogan County. The highest concentration of spotted bats was found in Douglas County.

In all but one location, spotted bat day roosts were situated in high (greater than 30 meters), vertical cliffs. Warm aspects were selected for day roosts in the light coloured granitic rock and cool aspects were selected for on dark basalt cliffs (warm aspects have a southeast through west exposure). Spotted bats were found roosting in cliffs ranging from 350 to 850 meters above sea level.

Numerous other cliff sites were critically examined, but may not have been evaluated on paper due to their unsuitability as spotted bat roosts.

SPOTTED BAT BEHAVIOR OBSERVATIONS

The intraspecific behavior of spotted bats is poorly known, but studies reveal that roosting is solitary (Leonard and Fenton 1983). Foraging bats avoid each other, although foraging territories may overlap (Woodsworth *et al.* 1981, Leonard and Fenton, 1983, Wai-Ping and Fenton 1989). Observations at Banks Lake, Grant County, revealed a pair of spotted bats emerging from what appeared to be the same roost and commence foraging in very close association with each other. It is assumed that this represents a mother and young pair and that maternal care/training may extend past fledging.

While solitary spotted bat roosting, with the exception of mother and young, may be standard behavior, loose aggregations occurred at McGlaughlin Canyon and Moses Coulee. This suggests that separate roost crevices may be selected, but the abundance of suitable roost sites may create relatively high local populations.

Spotted bats have been radio tracked foraging as far as ten kilometres from their day roost sites (Wai-Ping and Fenton 1989). In most instances, the proximity of a roost site to a watering source has been cited as being significant, presumably for drinking (Snow 1974, Collard *et al.* 1991).

This study's observations dispute this claim as spotted bats engaged in foraging immediately after emergence, without indication that they sought water over 690 minutes of spotted bat observation. This number includes the time lapsed between the first and last echolocation impulses heard. The potential roost sites observed in Washington were all within several kilometers of standing water.

Spotted bats were detected travelling and/or foraging over rock cliffs/talus slopes; sagebrush/bunchgrass; sparse ponderosa pine/bunchgrass; riverine; open water and deciduous copse habitats.
Presumably these habitat types produce a high number of tympanate moths, on which spotted bats feed (van Zyll de Jong 1985).

Spotted bats were also observed travelling along cliff faces, rivers and lake shore margins. These geological features may serve as navigation guides between important foraging areas.

ADDITIONAL SPECIES OBSERVED

Rare bats were sampled in six counties: Okanogan, Chelan, Grant, Douglas, Ferry and Lincoln.

Two pallid bats (*A. pallidus*) were found: a reproductively active, adult male caught in Okanogan County, and a visual sighting in Grant County. Two fringed myotis (*M. thysanodes*) were caught in the same counties. Two maternity colonies of Townsend's big-eared bats (*P. townsendii*) were found in attics in Lincoln County. One western small-footed bat (*M. ciliolabrum*, formerly *M. leibii*) was found in Grant County. An audible echolocating bat, other than a spotted bat, was observed in Grant County. An anecdotal account of a red bat roosting in an orchard in Okanogan County in 1989 may represent the southern red bat (*L. blossevilli*, formerly *L. borealis*).

A breakdown of these findings follows.

Historic records (Dalquest 1948, Non-game Data System 1992) and data collected during this study suggest that pallid bat populations are widespread within the shrub-steppe ecosystem. The male caught in Okanagan County showed evidence of being reproductively active, which suggests the presence of a female population in the vicinity. The male, when released, emitted a directive call; a series of 4 to 5 clear, high-pitched notes, thought to be emitted when other pallid bats are in close proximity (Orr 1954).

The presence of a juvenile female fringed myotis at Steamboat Rock, Grant County suggests the presence of a female nursery colony. Fringed juveniles remain within the nursery colony for approximately 2 weeks until the adult females refrain from giving aid (van Zyll de Jong 1985).

Another fringed myotis, an adult male, caught at Omak Lake, Okanogan County, provides additional distributional information. Both *M. thysanodes* were caught close to cliff faces, suggesting that they were roosting in rock crevices.

Two maternity colonies of Townsend's big-eared bats were found in attics within Lincoln County. Typically, *P. townsendii* is found in arid scrub and pine forest with roosts in caves, abandoned mines, and buildings (van Zyll de Jong 1985).

The capture of a male *M. ciliolabrum* in Grant County supports the belief that this bat is a year round breeding resident in this and neighboring counties such as Yakima (Dalquest 1948). Appropriate breeding areas consist of arid habitats associated with cliffs, and talus, with roost sites in rock face crevices or even under boulders in talus (van Zyll de Jong 1985).

An echolocating bat heard at Steamboat Rock was emitting echolocation impulses at a higher frequency than spotted bats and may represent one of the free-tailed bat species. These bats echolocate at a frequency of approximately 17 to 30 kilohertz; the spotted bat, from 8.6 to 14.5 kilohertz (van Zyll de Jong 1985).

The big free-tailed bat (*Nyctinomops macrotus*) is known to roost in cliffs in arid habitats (van

Zyll de Jong 1985). One big free-tailed bat is documented from southern British Columbia (Nagorsen and Brigham in press), but none have been documented for Washington (Dalquest 1948, Nongame Data System 1992).

An anecdotal account of a large red bat describes the southern red bat (*L. blossevilli*), observed while roosting in an Okanogan County orchard. Typically, roosting occurs in dense foliage between 1 to 6 meters above the ground (van Zyll de Jong 1985). This species has been observed as far north as southern British Columbia (Nagorsen and Brigham in press).

The more common *M. lucifugus* and *M. yumanensis* were observed throughout the study area and were abundant at Deep Lake. A maternity colony of *M. yumanensis* occurs regularly in one of the service sheds in Sun Lakes State Park, Grant County.

Rare bats encountered during the course of this survey are summarized in Appendix 2.

BREAKDOWN OF FINDINGS BY LOCALE

Okanogan County

Roosting habitat in Okanogan County is diverse and abundant. The eastern side of the valley has extensive vertical gneissic outcroppings at Mount Hull (**Figure 2**), and McGlaughlin Canyon (**Figure 3**). The bedrock outcroppings range up to approximately 150 meters high. Gneiss has extensive, deep fractures of various sizes and accommodates a variety of roosting requirements. A total of 22 individual spotted bats were detected at these two sites. It is anticipated that other rare bat species also occur in these formations such as *A. pallidus*, *M. ciliolabrum*, *M. thysanodes* and *P. townsendii*.

Figure 2: Mount Hull, Okanogan County

Figure 3: McGlaughlin Canyon, Okanogan County

The Omak Lake area (**Figure 4**), within the Colville Indian Reservation, is an extension of the previously described area. Observed bat species in these formations included *E. maculatum, A. pallidus*, and *M. thysanodes*. Again, the area should also harbor *M. ciliolabrum, P. townsendii* and possibly *P. hesperus*. Both sample sites above the lake had a general southwest aspect.

Figure 4: Omak Lake, Okanogan County

The west side of the Okanogan Valley is characterized by exposed, friable, detrital sedimentary deposits with numerous crevices of varying sizes and orientations. Cliff height is restricted by the accumulation of talus at the base. Spotted bats were detected foraging along these cliffs, north of Tonasket. Because detection occurred 6 minutes after the average first emergence time (Appendix 3), these east facing cliffs likely provide day roost sites (**Figure 5**).

Figure 5: Tonasket Cliffs, Okanogan County

The Sinlahekin Valley has suitable granitic cliffs for roosting (particularly near Blue Lake) as well as suitable foraging habitat (*Pinus ponderosa*, *Purshia tridentata* and *Agropyron spicatum*). However, the only one bat species, *M. lucifugous*, was encountered and abundant at various lakes in this drainage. This north/south valley may be too cool for many of the rare shrub-steppe bats, particularly the spotted and pallid bats.

The Similkameen drainage has excellent habitats for pallid bats, but lacks high, sheer cliffs for roosting, with the exception of one cliff face at the southwest corner of Palmer Lake. This area was not sampled due to time constraints.

Several warm-aspect, mid-sized cliffs occur on private lands in the West Sanpoil (**Figures 6a, b, & c**). Mixed, open forests of *Pinus ponderosa* and *Pseudotsuga menziesii* and adjacent wetlands provide suitable foraging habitat for spotted bats. Suitability for pallid bats is considered minimal. Sampling was not conducted here.

Figure 6a: West Sanpoil, Okanogan County

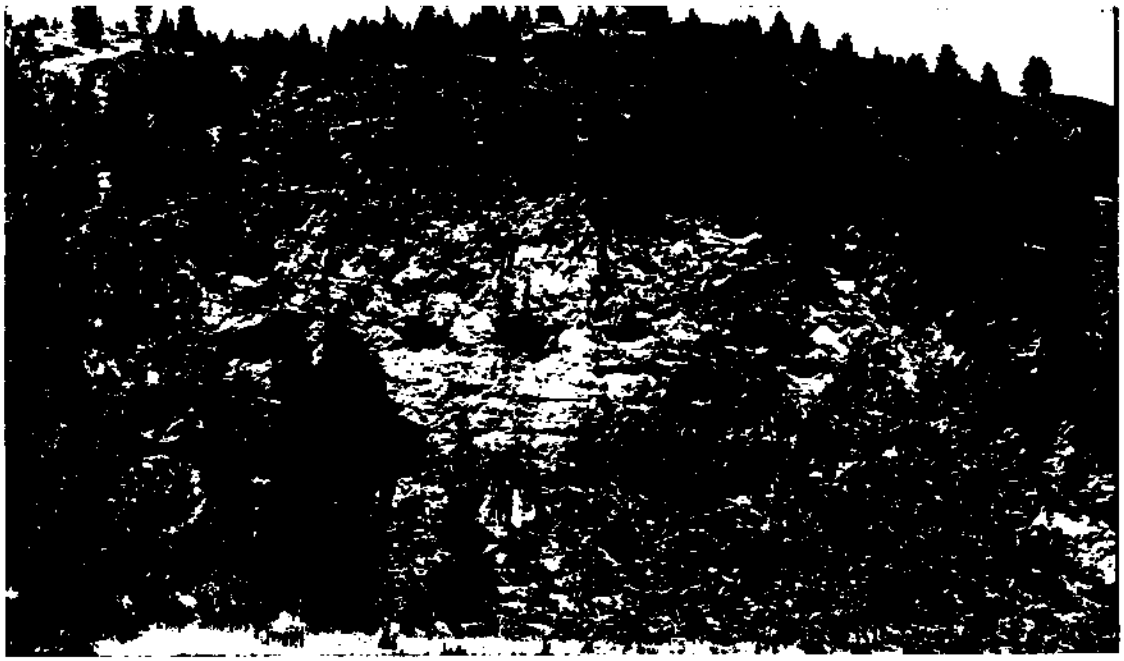


Figure 6b: West Sanpoil, Okanogan County

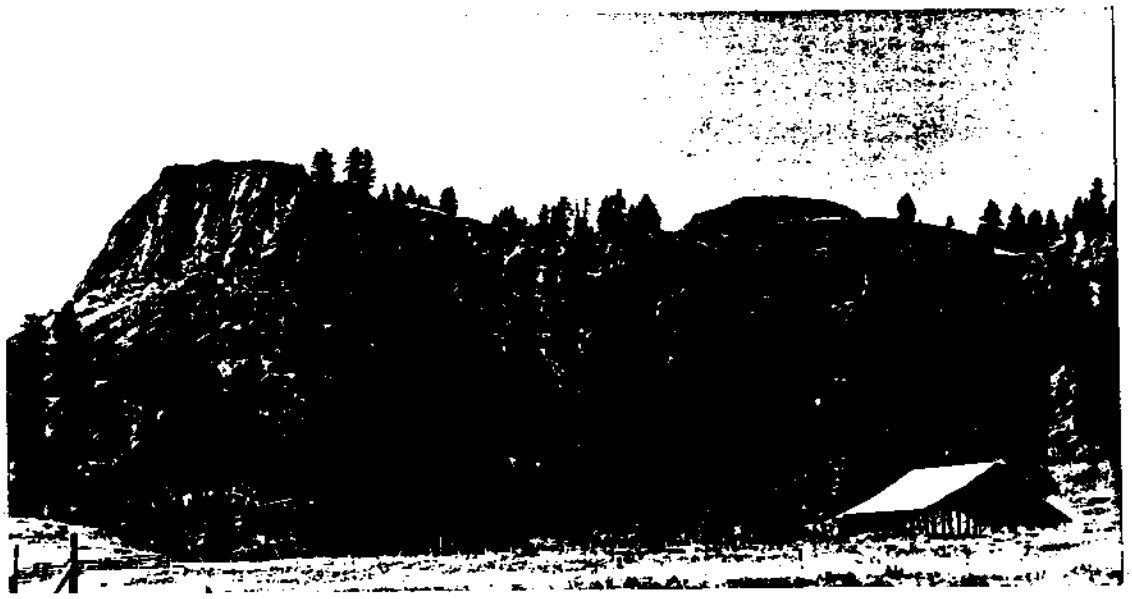


Figure 6c: West Sanpoil. Okanogan County

The large, exposed chalk deposits, known as Whitestone Mountain (**Figure 7**), exhibited good potential for spotted and pallid bats. A relatively small number of vertical crevices were observed on the western face even though carbonate rock is very susceptible to chemical weathering. Foraging habitat was also considered as being suitable as the natural landscape is vegetated with *Artemisia tridentata*, *Agropyron spicatum* and *Aristida longiseta*. The Jerusalem cricket, (*Stenopelmatus fuscus*), one of the preferred prey items of the pallid bat, was also observed. The only bats detected in this area were several *Myotis* species.

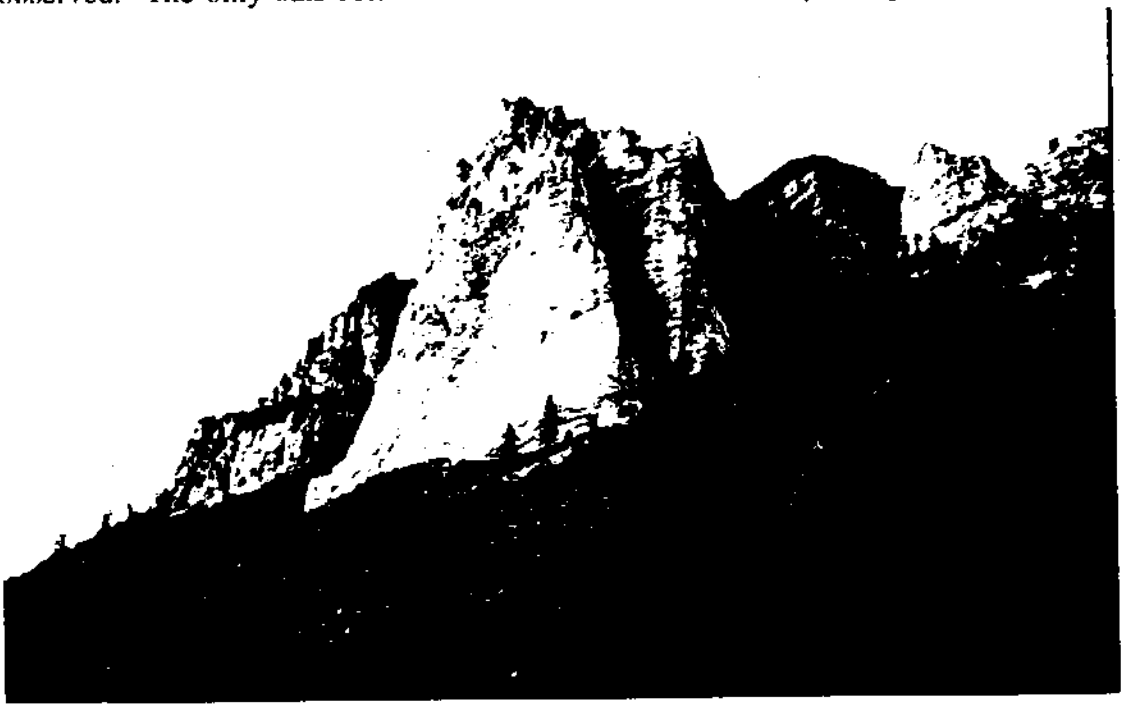


Figure 7: Whitestone Mountain, Okanogan County

Future surveys may wish to include the Methow Valley as a number of vertical cliffs occur within this drainage. However the high elevation may restrict the occurrence of both spotted and pallid bats.

Douglas County

The largest concentration of spotted bats encountered in this survey was discovered in the north end of Moses Coulee, Douglas County (**Figure 8**). The east facing side of this north/south coulee was sampled. During one night, 32 individual spotted bats were detected foraging over the sagebrush/bunchgrass basin, after emerging from day roosts provided by columnar basalt outcroppings exposed by water erosion. Crevices between columns form repeated vertical openings of various widths and lengths, likely providing appropriate roosting sites for several different species of rare bats. The sides of the coulee rise approximately 50 meters from the basin. Roosts occurred on cool aspects, the dark basalt may be too hot for many bat species during hot summers. Other bats observed were the big brown bat (*Eptisicus fuscus*) and several *Myotis* species individuals.

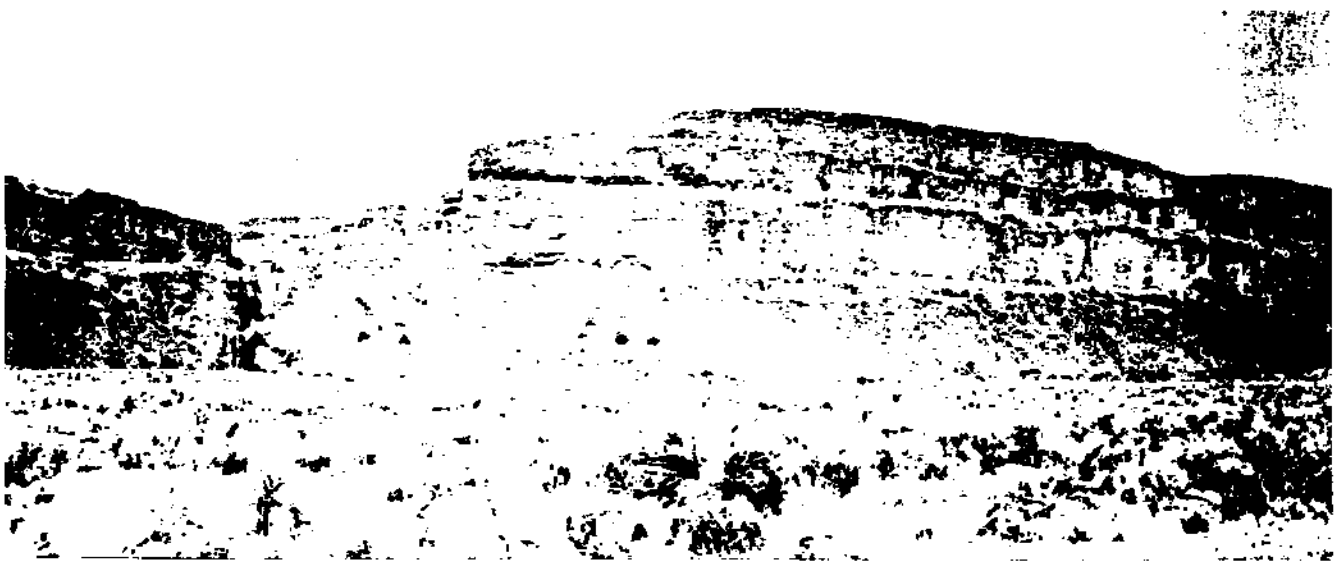


Figure 8: Dutch Henry Falls, Moses Coulee, Douglas County

Similar east-facing geological formations occur on the west side of Banks Lake on the border between Douglas and Grant Counties. Sample sites fell within Grant County, but the same results should be gained at a Douglas site of the same formation.

Low to moderately high, northwest-facing cliffs along the Columbia River on the eastern edge of Douglas County may be used as roosting sites for pallid as well as spotted bats. The remaining areas of the county are of low relief and do not provide many cliff roosting opportunities. A lack of time prevented the sampling of these sites.

Grant County

Columnar basalt formations abound within the northwestern portion of Grant County. Water erosion has created extensive cliffs with primarily warm aspects. The cliffs range up to 75 meters high with excellent vertical, crevice and some overhanging parallel crevice roosting opportunities.

Spotted bats were observed emerging from northeast-aspect cliffs along the northwest portion of Banks Lake. There were, however, a number of equally suitable areas that did not harbor any spotted bats, such as Dry Falls (**Figure 9**), Deep Lake (**Figure 10**), and the east side of Banks Lake and Steamboat Rock (**Figure 11**). Many of these sites have southern exposure and may get too hot from solar radiation as the basalt is black. Other reasons for patchy distribution may be related to human disturbance, such as proximity of road traffic.

Figure 9: Dry Falls, Grant County

Figure 10: Deep Lake, Grant County

Figure 11: Steamboat Rock, Grant County

Adjacent lands support typical shrub-steppe vegetation as well as littorine foraging opportunities. Spotted bats were observed foraging over sagebrush/bunchgrass and marsh habitats near the aforementioned sites. Bats were observed travelling along the shore of Banks Lake.

Ferry County

Spotted bats were not detected in Ferry County. However, this should not exclude future surveys in this area, which exhibit several suitable roosting habitat for spotted bats. Suitable sites include: the Curlew Lake basin, the Sanpoil drainage and the north side of Roosevelt Lake.

The Curlew Lake area consists of granitic outcroppings and grasslands with timbered upper elevations. The nearby southeast facing Mt. Elizabeth and the Tonata Creek Canyon sites exhibited these suitable features, but at higher elevations than successful sighting areas, which may have contributed to lack of findings in the area. Cold weather may also have influenced Mt. Elizabeth data; no other bats were sighted or captured.

The Sanpoil site is composed of mixed stands of Douglas-fir and ponderosa pine. Sedimentary and granitic outcroppings are common throughout the drainage, providing ample roosting sites for spotted and pallid bats, although neither of these species were observed.

From one cliff (FE-01, Appendix 4), a large number of bats emerged, including *Myotis* species, larger bats (possibly big brown bats [*Eptisicus fuscus*]) and one hoary bat (*Lasiurus cinerus*). Further sampling is required to confirm whether spotted and pallid bats use this drainage.

The northern side of Roosevelt Lake is characterized by steep, tall, granitic cliff faces, with a southern aspect. Adjacent foraging areas are also suitable for both spotted and pallid bats. Many *Myotis* species were viewed foraging on the margins of Roosevelt Lake, but no spotted bats were encountered. This may again be due to the small sample size and the distance of survey sites from roost sites.

Lincoln County

Two colonies of *P. townsendii* were found in attics of abandoned houses in Lincoln County, but no spotted bats were encountered. Cliffs sampled near Lincoln (LI-01, Appendix 4; **Figure 12**) had good roosting characteristics and cool aspects. Cliffs consisted of globular and columnar basalt ranging up to approximately 45 meters high.

Much of the remainder of the county is low relief, low-elevation farmland and scablands, inappropriate habitat for cliff-roosting bat species.

Three areas (Sylvan Lake, Crab Creek and Lake Creek), identified by J. Hickman (W.D.W.), in the south central section of the county may prove suitable to support a spotted and/or pallid bat population.

Figure 12: Lincoln Cliffs, Lincoln County

Chelan County

Two areas of Chelan County were also sampled due to positive cliff evaluations, but no spotted bats were encountered. Both sample sites, one on the Columbia River near Well's Dam and one in Navarre Coulee, were close to vertical granitic cliff faces averaging 70 meters high, with appropriate crevices and talus slopes. Both sites were at elevations of approximately 500 meters, within the range of successful observation sites, and both had warm, eastern aspects. Vegetation at the Well's Dam site included sagebrush and various grasses while the Navarre Coulee site was dominated by ponderosa pine, Douglas-fir, and serviceberry (*Amelanchier alnifolia*). The overall elevation, topography and vegetation of both sites suggests spotted bats should be present. Possible explanations for not recording spotted bats at this site include: 1. sample site choices may not have been in the vicinity of roost sites; and 2. adverse weather may have inhibited bat emergence on one occasion. Several small *Myotis* species were observed.

The cliffs parallel to the Columbia River on the boundaries of the Entiat and Swakane Wildlife areas may prove to be inhabited by spotted bats as well as other rare bat species. These are low to moderately high granitic cliffs with crevices, overhangs, talus slopes and southeast aspects.

The southwest side of Lake Chelan also hosts low to moderately high granitic cliffs with crevices, overhangs, talus slopes and southeast aspects. However, this topography is not likely to afford appropriate roost sites for spotted or pallid bats as most of these mountains are at higher elevations with few to no vertical faces.

THREATS TO *E. maculatum*

Anthropogenic threats to spotted bat individuals occur through mist netting and collecting by shooting. Natural population levels are typically low and, as a result, collecting could be devastating to local populations.

Pesticides may also be harmful to spotted bats as their diet is comprised solely of insects and therefore susceptible to biomagnification of pesticides.

Habitat degradation, primarily day roost sites, would pose the greatest threat to spotted bats. Common threats to day roost sites include: large scale operations such as road construction, dam building, mineral extraction and the stabilizing of hazardous falling rock when developments occur at the base of cliffs. Rock climbing may also be detrimental for spotted bats since it has been documented to cause roost abandonment in *P. townsendii* (Barbour and Davis 1969).

More obscure threats, such as a Mount Rushmore type development proposed for the most prolific spotted bat roost in British Columbia must be anticipated.

Natural threats to the spotted bat are considered minimal (O'Farrell 1981). Crevicé roosting habits create a relatively predator-free environment though raptors have been documented capturing bats as they emerged from roosts (Easterla 1973 and Black 1976 in O'Farrell 1981, Vaughan and O'shea 1976). Orr (1954) states that the comparatively late emergence time of pallid bats minimizes the risk of exposure to diurnal predators. The emergence time of spotted bats is also comparatively later than the smaller bat species, therefore this threat would be minimized for the spotted bat also. Many of the sites that sheltered spotted bats were also inhabited by great horned owls, which may produce some predatory pressures.

The only population decimating disease that has been identified in this species is rabies (Medeiros and Heckman 1971 in O'Farrell 1981). The individual with this disease would die quickly, as many animal species do. The Rio Bravo virus shows rabies-like symptoms but is harmless in bats and humans (Tuttle 1988).

RECOMMENDATIONS

1. The Washington Department of Wildlife may wish to extend spotted bat surveys to cover other suitable areas (e.g. Snake River watershed and negative samples from this study).

2. Further surveys should attempt to document other species of bats, with special emphasis placed on those species considered to be of management concern.

3. Any study that involves the direct investigation of roost sites and/or the capture or handling of live bats should be done by trained individuals, with an emphasis on minimum disturbance.

4. Bat research in Washington could be accompanied by an education campaign of the merits on this misunderstood mammal.

5. Habitat enhancement for bat species would compliment any research and education effort, as well as provide additional benefits to chiropterans.

6. State Parks and Recreation Commission could heighten bat profiles by providing interpretive opportunities within Parks, providing that this could be accomplished with no impact on bat populations. (This could integrate all of the aforementioned recommendations.)

7. There are a relatively large number of bat records from universities and old surveys (e.g. Dalquest 1948) that have not been incorporated into the Nongame Data System. Effective research and management of bats depends upon the collation of this information.

8. Because spotted bats and many of the other bat species encountered during this survey are considered rare, threatened or endangered, management of their habitats is critical for species conservation. Many of the sites studied are located on state or federally controlled land; management policies could incorporate protection of cliff faces for day roosts.

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APPENDIX 1

BAT FAUNA OF WASHINGTON'S SHRUB-STEPPE ECOSYSTEM

Common Name	Code	Latin Name	Status	Roost
Little Brown	M-MYLU	*Myotis lucifugus*	-	A,S
Yuma Myotis	M-MYYU	*Myotis yumanensis*	-	A,S
Long-legged	M-MYVO	*Myotis volans*	SC	A,S
Western Small-footed	M-MYCI	*Myotis ciliolabrum*[1]	SC	C
California	M-MYCA	*Myotis californicus*	-	A
Fringed Myotis	M-MYTH	*Myotis thysanodes*	SC	C,A
Western Long-eared	M-MYEV	*Myotis evotis*	SC	C,S
Townsend's Big-eared	M-PLTO	*Plecotus townsendii*[2]	SC	C,A,S
Western Red	M-LABL	*Lasiurus blossevelli*[3]	SC	T
Hoary	M-LACI	*Lasiurus cinerus*	-	T
Silver Haired	M-LANO	*Lasionycteris noctivagans*[4]	-	T,S
Big Brown	M-EPFU	*Eptesicus fuscus*	-	C,S,A
Pallid	M-ANPA	*Antrozous pallidus*	SC	A,C
Western Pipistrelle	M-PIHE	*Pipistrellus hesperus*	SC	C
Spotted	M-EUMA	*Euderma maculatum*[5]	-	C
Big Free-tailed	M-NYMA	*Noctinomops macrotus*[6]	-	C

[1] Formerly *M. leibii*
[2] Formerly *Corynorhinus rafinesquii*
[3] Formerly *L. borealis*, inhabits riparian within shrub-steppe
[4] Inhabits riparian within shrub-steppe
[5] Not documented until 1991
[6] Currently not documented for Washington State, formerly *Tadarida*

Status:

SC = State Concern
- = no status

Habitat Types:

A = anthropogenic, (houses,barns)
C = cliffs, may include talus
S = snags, cavities or under bark
T = tree, roosts on tree and relies on camouflage

APPENDIX 2

RARE BATS ENCOUNTERED IN WASHINGTONS SHRUB-STEPPE BY SARELL AND MCGUINNESS																
SPECIES	MIN_NUMI	CRIT	LOCATION	COUNTY	TNSHP	RANGE	SECT	QRTR	DD	MM	YY	TIME	HABDESC	ELEV_M	COMMENTS
M-MYCI	1 M	IO	DRY FALLS	GRANT	T24N	R28E	06	SE	17	07	92	2200	BG/BS/RO	350	ASSOC.MYLU/MYYU
M-EUMA	6 UNID	IO	E WHITESTONE	OKANOGAN	T37N	R27E	04	NE	25	07	92	2143	RO/TA	400	ROOST NEARBY
M-EUMA	9 UNID	IOCR	MCGLAUGHLIN C.	OKANOGAN	T36N	R27E	03	W	02	08	92	2143	RO/PP/BS	450	EXTENSIVE ROOST
M-EUMA	4 UNID	IO	MT HULL	OKANOGAN	T39N	R27E	14	SW	08	08	92	2132	RO/PP/BS	575	STRAIGT TRAVEL
M-EUMA	1 UNID	IO	OKANOGAN RIVER	OKANOGAN	T40N	R27E	34	S	08	08	92	2353	OW/RIP	280	FLYING UPSTREAM
M-EUMA	9 UNID	IOCR	MT HULL	OKANOGAN	T39N	R28E	30	W	08	08	92	2112	RO/PP/TA	850	ROOST AND FORAG
M-EUMA	2 UNID	IO	STEAMBOAT ROCK	GRANT	T27N	R29E	10	NE	13	08	92	0206	OW	483	STRAIGHT TRAVEL
M-EUMA	6 UNID	IOCR	NW BANKS LAKE	GRANT	T28N	R29E	13	SW	14	08	92	2122	RO/TA/PD	520	ROOST AND FORAG
M-EUMA	1 UNID	IO	N BANKS LAKE	GRANT	T30N	R28E	05	SW	14	08	92	2215	RO/TA/BS	535	FORAGE
M-EUMA	1 UNID	IO	N BANKS LAKE	GRANT	T30N	R28E	05	SE	14	08	92	2310	BS/BG	490	FORAGE
M-EUMA	1 UNID	IO	N BANKS LAKE	GRANT	T30N	R28E	04	SE	14	08	92	2315	BS/BG/RO	520	FORAGE
M-ANPA	1 UNID	IO	N BANKS LAKE	GRANT	T30N	R28E	04	SE	14	08	92	2316	BS/BG/RO	520	FORAGE/VISUAL
M-MYTH	1 F/J	IO	STEAMBOAT ROCK	GRANT	T27N	R29E	02	SW	13	08	92	2135	BS/BG/TA	500	MIST NET
M-EUMA	10 UNID	IOCR	JAMESON LAKE	DOUGLAS	T25N	R25E	13	SW	15	08	92	2115	BS/BG/RO	550	FORAGE & EMERGE
M-EUMA	19 UNID	IO	DUTCH HENRY CK	DOUGLAS	T25N	R25E	15	SE	15	08	92	2107	BS/BG/RO	600	FORAGE & EMERGE
M-EUMA	5 UNID	IO	MOSES COULEE	DOUGLAS	T25N	R25E	13	W	15	08	92	2100	BS/BG/RO	400	FORAGE
M-EUMA	2 UNID	IO	PARK LAKE	GRANT	T24N	R27E	11	E	15	08	92	2355	BS/BG/RO	350	STRAIGHT TRAVEL
M-EUMA	4 UNID	IO	OMAK LAKE	OKANOGAN	T33N	R27E	27	NE	04	09	92	2025	BS/BG/PP	550	FORAGE
M-MYTH	1 M/A	IO	OMAK LAKE	OKANOGAN	T33N	R27E	27	NE	04	09	92	2050	BS/BG/PP	550	MIST NET
M-ANPA	1 M/A	IO	OMAK LAKE	OKANOGAN	T33N	R27E	27	NE	04	09	92	2111	BS/BG/PP	550	MIST NET
M-EUMA	4 UNID	IOCR	OMAK LAKE	OKANOGAN	T33N	R27E	27	NE	04	09	92	2030	BS/BG/PP	550	FORAGE & EMERGE
M-EUMA	3 UNID	IO	OMAK LAKE	OKANOGAN	T33N	R27E	27	W	04	09	92	2023	BG/PP	620	FORAGE
M-EUMA	1 UNID	IO	CURLEW LAKE	FERRY	T37N	R33E	08	SE	30	09	92	0032	BG/PP/LI	500	QUESTIONABLE
M-EUMA	1 UNID	IO	TONATA CK RD	FERRY	T39N	R32E	11	NE	29	09	92	2100	BG/PP	700	QUESTIONABLE
M-PLTO	60 F&J	CRBR	JONES BAY	LINCOLN	T28N	R33E	24	NESW	12	09	92	1100	BG/PP	350	ATTIC COLONY
M-PLTO	7 F&J	CRBR	LINCOLN	LINCOLN	T27N	R35E	20	NW	12	09	92	1700	BG/PP	400	ATTIC COLONY
M-NYMA	UNID 1	N/A	STEAMBOAT	GRANT	T27N	R29E	2	SW	13	8	92	2134	BS/BG/TA	500	AUDIBLE, UNCERT.
M-LABL	UNID 1	IO	CORDELLE	OKANOGAN	T39N	R27E	22	NE	0	0	89	N/A	ORCHARD	290	ANECD., UNCONF.

BG=BUNCHGRASS, BS=SAGE,RO=ROCK,TA=TALUS,PP=PONDEROSA RIAN,PD=POND

APPENDIX 3 SPOTTED BAT EMERGENCE TIMES

DATE	SUNSET	AVG EM	MAX EM	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7	EM 8	EM 9	EM 10	EM 11	EM 12	EM 13	EM 14	EM 15	EM 16	EM 17	EM 18	EM 19	EM 20
25-Jul	0.8681	0.923	0.95278	0.9	0.9125	0.9146	0.917	0.937	0.95														
26-Jul	0.8667																						
27-Jul	0.866																						
28-Jul	0.8653																						
29-Jul	0.8639																						
30-Jul	0.8632																						
31-Jul	0.8625																						
01-Aug	0.8611																						
02-Aug	0.8604	0.9033	0.92847	0.89	0.8944	0.8965	0.901	0.903	0.91	0.93													
03-Aug	0.859																						
04-Aug	0.8576																						
05-Aug	0.8569																						
06-Aug	0.8556																						
07-Aug	0.8549																						
08-Aug	0.8535	0.8993	0.92847	0.88	0.8861	0.8875	0.888	0.89	0.89	0.89	0.89	0.9	0.897	0.899	0.899	0.9	0.901	0.903	0.905	0.906	0.91	0.927	0.928
09-Aug	0.8521																						
10-Aug	0.8514																						
11-Aug	0.85																						
12-Aug	0.8486																						
13-Aug	0.8472	HAS FORG																					
14-Aug	0.8458	0.8983	0.92708	0.89	0.891	0.8917	0.892	0.897	0.93														
15-Aug	0.8451	0.8925	0.91875	0.87	0.8708	0.8715	0.874	0.875	0.88	0.88	0.88	0.88	0.885	0.886	0.887	0.89	0.89	0.891	0.892	0.892	0.894	0.895	0.896
16-Aug	0.8438																						
17-Aug	0.8424																						
18-Aug	0.841																						
19-Aug	0.8396																						
20-Aug	0.8382																						
21-Aug	0.8368																						
22-Aug	0.8354																						
23-Aug	0.834																						
24-Aug	0.8326																						
25-Aug	0.8313																						
26-Aug	0.8299																						
27-Aug	0.8285																						
28-Aug	0.8271																						
29-Aug	0.8257	0.875	0.875	0.88																			
30-Aug	0.8243																						
31-Aug	0.8229																						
01-Sep	0.8215																						
02-Sep	0.8201																						
03-Sep	0.8188																						
04-Sep	0.8174	0.8696	0.90278	0.85	0.85	0.8507	0.854	0.856	0.86	0.86	0.88	0.88	0.878	0.882	0.885	0.885	0.903						
05-Sep	0.816																						
06-Sep	0.8139																						

TIMES REPRESENTED AS FRACTION OF 24 HOURS

APPENDIX 4

CLIFF EVALUATIONS FOR SIX COUNTIES OF WASHINGTON

Cliff Evaluation Form

Project: _____ **Date:**_____ **Cliff #:**____

Location:_____**Photo #'s:** _____

Township:_____ **Section:**_____ **Lot:** _____

UTM Grid (Z/E/N): ___/_____/_____.

Elevation: min_____ **max**_____ **metres/feet**

Adjacent to Site or Note:____**Distance:** ____m **Direction:**___

Cliff ID: on maps _____Mapped on _____.

Cliff Height: L (<50m)
(circle one) M (50-100m)
H (>100m)
Height estimated at _____ m

Cliff Aspect:_____

Cliff Type: Sheer face____% Terraced____%

Bedrock Type: _____

Fracturing:

Amount		Size	
	Nil_____%		Fine (<10cm) _____%
	Low_____%		Med (10>100cm)_____%
	Mod_____%		Large (>100cm)_____%
	High_____%		

Comments: _____

Angle of Fracturing:

Vertical	_____%	Comments
Horizontal	_____%	
Diagonal	_____%	
Parallel	_____%	

Amount of Ledging:

Nil	_____%	Comments
Low	_____%	
Moderate	_____%	
High	_____%	

Amount of Overhangs:

Nil	_____%	Comments
Low	_____%	
Moderate	_____%	
High	_____%	

Amount of Talus:

Nil	_____%	Comments
Low	_____%	
Moderate	_____%	
High	_____%	

Type of Talus:_____

Species Ratings:

EUMA (crevices in towering cliffs)	_____
MYCI, MYTH, ANPA (crevices in small cliffs)	_____
WTSW (overhangs?)	_____
GOEA, TUVU (ledges)	_____
PIME, CRVI, COMO (deep crevices at base)	_____
CAWR (blocky talus)	_____
HYTO, EUSK (rock and talus)	_____
COPO (talus, rocky terraces)	_____

General Comments:

_____

_____

_____

Cliff Form/Harper 92

APPENDIX 5

RARE BAT FIELD FORM

APPENDIX 3

BAT RECORDING FORM

Project Name: _____ Observers: _____

General Location: _____ Date: _____

Township: _____ Section: _____

Mapsheet: _____ Airphoto: _____

UTM (Z/E/N): _____

Biophysical Information:

Habitat: _____

Adj. Habitat: _____

Net Information:

Set Time: _____ Down Time: _____

Net #1 Min Ht: _____ Max Ht: _____

Net #2 Min Ht: _____ Max Ht: _____

Comments: _____

_____

_____

_____

Sketch:

Net #	Bat Spp.	Time	Net Ht	Sex	Age	Rep St.	TL	E	HF	WS	FA	WT	Band	Parasite

TL = Total Length
HF = Hindfoot
FA = Forearm

E = Ear Length
WS = Wingspan
WT = Weight

APPENDIX 6

SPOTTED BAT OBSERVATION FIELD FORMS

WASHINGTON BAT FORM

DATE:_____ OBSERVERS:_____

LOCATION:_____ _____

TOWNSHIP:_____ SECTION:_____

CLIFF EVAL. #:_____

CLIFF HEIGHT:_____ ASPECT:_____

COMMENTS:_____

_____

_____

SPOTTED BAT OBSERVATIONS

#	TIME	ORIGIN	ECHOS	DESTINATION	FEEDING	REL.ELEV.	REPLI
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							

MAP:

SKETCH (include position of other observers, flight paths, etc)

APPENDIX 7

RARE BAT HABITAT USE IN WASHINGTON										
LOCATION	**SPECIES**	**BG**	**BS**	**RO**	**TA**	**PP**	**RIP**	**OW**	**PD**	**LIT**
GRANT	M-MYCI	X	X	X						
E. WHITESTONE	M-EUMA			X	X					
MCGLAUGHLIN CNY	M-EUMA		X	X		X				
MT. HULL	M-EUMA		X	X		X				
OKANOGAN RIVER	M-EUMA						X	X		
MT. HULL	M-EUMA			X		X				
STEAMBOAT ROCK	M-EUMA							X		
NW BANKS	M-EUMA			X	X				X	
N BANKS LAKE	M-EUMA		X	X	X					
BANKS LAKE	M-EUMA	X	X							
BANKS LAKE	M-ANPA	X	X	X						
BANKS LAKE	M-EUMA	X	X	X						
STEAMBOAT ROCK	M-MYTH	X	X		X					
JAMESON LAKE	M-EUMA	X	X	X						
DUTCH HENRY CR.	M-EUMA	X	X	X						
MOSES COULEE	M-EUMA	X	X	X						
PARK LAKE	M-EUMA	X	X	X						
OMAK LAKE	M-EUMA	X	X			X				
OMAK LAKE	M-MYTH	X	X			X				
OMAK LAKE	M-ANPA	X	X			X				
OMAK LAKE	M-EUMA	X	X			X				
OMAK LAKE	M-EUMA	X				X				
CURLEW LAKE	M-EUMA	X				X				X
TONATA CREEK RD	M-EUMA	X				X				
JONES BAY	M-PLTO	X				X				
LINCOLN	M-PLTO	X				X				

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