A Survey of Bat Species Composition, Distribution and Relative Abundance in North Cascades National Park Service Complex, Washington

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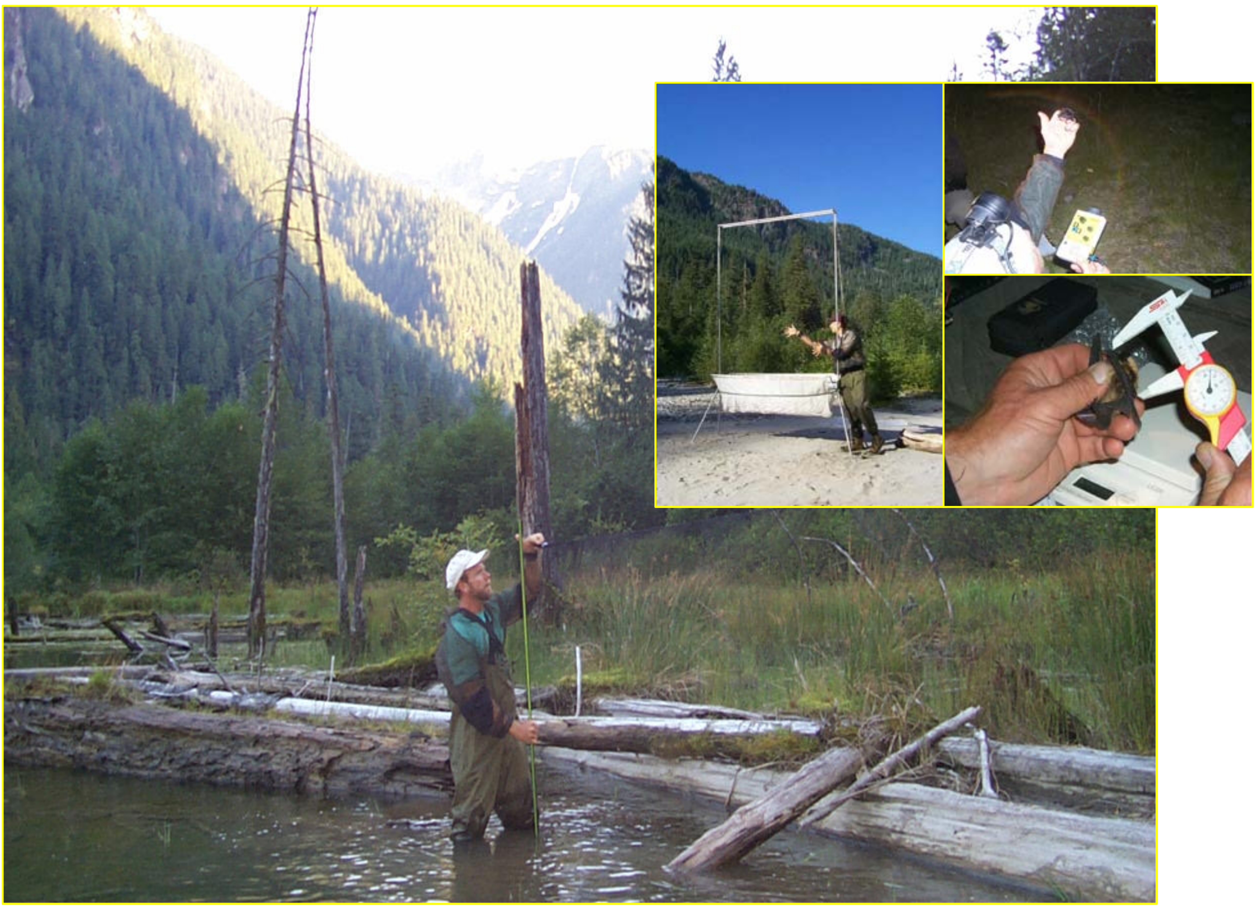

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North Cascades National Park Service Complex, comprising North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area, was established in October, 1968 and is located in northwestern Washington. North Cascades National Park was established to preserve certain majestic mountain scenery, snow fields, glaciers, alpine meadows, and other unique natural features in the North Cascades mountains for the benefit, use, and inspiration of present and future generations. Ross Lake and Lake Chelan National Recreation Areas were established to provide for outdoor recreation use and enjoyment and to conserve scenic, scientific, historic, and other values contributing to public enjoyment of these lands and waters.

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ABSTRACT

Bats are an important component of healthy ecosystems, yet little is known about their occurrence and relative activity in North Cascades National Park Service Complex (NOCA). A systematic baseline inventory was conducted during the summers of 1998-2001 to identify species composition, distribution and relative abundance of bats inhabiting the park complex. Sampling sites were stratified into three broad habitat types to include riparian, forest, and subalpine, both east and west of the North Cascades crest. Data collection focused on the utilization of Anabat II ultrasonic bat detectors and standard capture techniques using mist nets and a harp trap. We documented eight of the twelve species of bats thought to occur in the park complex. Five species were identified from capture techniques (*Myotis yumanensis, Myotis lucifugus, Myotis evotis, Myotis californicus,* and *Myotis volans*) and an additional three species were documented from acoustic recordings (*Eptesicus fuscus, Lasionycteris noctivagans*, and *Lasiurus cinereus*). At the coarsest resolution, analysis of echolocation data for all years combined identified 85.0% of calls representing the *Myotis* group and 14.7% were of the non-*Myotis* group, while 0.3% were declared as unknown. For years 2000-2001, the majority of acoustic calls (43.2%) and captures (51.4%) were from riparian habitats. Species diversity among habitat types varied slightly, whereas all five captured species were found in the riparian and forest strata and four of the capture species (excluding *M. californicus*) were found in the subalpine habitat type. Female bats were significantly more common at lower elevations than males. There were no differences in species diversity between sites sampled east and west of the Cascade crest within park boundaries. Both acoustic and capture data suggest *M. yumanensis* and *M. lucifugus* are the most abundant species in the study area, while *L. cinereus* and *M. volans* appear to be the most uncommon or elusive of the documented bat species in NOCA.

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INTRODUCTION

There has been a recent surge of interest in the study of bats, as they represent perhaps the most vulnerable mammal species in North America (Tuttle 1995). Research has revealed continuous declines in some populations, primarily attributable to the destruction of foraging habitat (Adam et al.1994), roosting disturbance in caves and mines (Tuttle 1979, Richter et al. 1993) and pesticide use (Geluso et. al. 1976). Furthermore, their slow reproductive rates, a general misunderstanding of their importance, limited research information and the difficulties encountered in attaining accurate survey data subject them to increased risks. Additional information on their ecological requirements and population status is needed in order to provide successful management practices for these imperiled mammals.

Twelve species of bats are thought to inhabit North Cascades National Park Service Complex (NOCA), Washington (Thomas and West 1991, Christy and West 1993, Johnson and Cassidy 1997, Table 1). Nine of the twelve species assumed to occur in the park, appear on the Washington State Priority-Habitats and Species List, including eight species of the genus *Myotis*, (*M. yumanensis, M. lucifugus, M. californicus, M. evotis, M. thysanodes, M. volans, M. ciliolabrum, M. keenii*) as well as the big brown bat (*Eptesicus fuscus*) (Washington Department of Fish and Wildlife 2002). In addition, both Keen's myotis (*M. keenii*) and Townsend's big-eared bat (*Coryhorninus townsendii*) are listed as Washington State Candidate species (Washington Department of Fish and Wildlife 2002). Currently, six forest bat species of the Pacific Northwest are listed as Federal Species of Concern to include *M. volans, M. thysanodes, M. evotis, M. yumanensis, M. ciliolabrum* and *C. townsendii* (U.S. Fish and Wildlife Service 2001).

In 1994, the Forest Ecosystem Management Assessment Team developed the *Northwest Forest Plan* that consequently identified a need for more information on the distribution, population status, and habitat requirements of bats associated with late-successional stage forests of the Pacific Northwest (FEMAT 1993). Eleven of the 12 species thought to occur in the park (excluding Townsend's big-eared bat) are identified in the *Northwest Forest Plan*. In addition, the NOCA Resource Management Plan (1999) identifies acquisition of baseline data to manage rare, threatened, endangered, and sensitive mammals as the park's number one natural resource priority. Despite these mandates, there is virtually no historical information on bats within NOCA. However, some bat inventory work has been conducted on neighboring Mount Baker (Perkins unpubl. rep.1989) and Darrington Ranger Districts (P. Reed, pers. comm. 2000) of the Mt. Baker-Snoqualmie National Forest. Also, occasional bat surveys have been conducted east of the park boundary on the Okanagon National Forest since 1990 (K. Woodruff, pers. comm. 2000). Surveys for bats were also conducted north of NOCA boundaries in the Skagit Valley Recreation Area, British Columbia (Firman and Barclay 1993, T. Luszca, pers. comm. 2002) and to the south in the Lake Chelan watershed (Duke Engineering & Services, Inc. 2000). Any additional bat information in the North Cascades region has been generally provided through anecdotal observations.

Table 1. Common and scientific names of bats thought to occur in NOCA (Johnson and Cassidy 1997).

Common Name	Scientific Name	Status
California myotis	*Myotis californicus*	
Western small-footed myotis	*Myotis ciliolabrum*	c
Western long-eared myotis	*Myotis evotis*	a,c
Keen's myotis	*Myotis keenii**	b
Little brown myotis	*Myotis lucifugus*	
Fringed myotis	*Myotis thysanodes*	a,c
Long-legged myotis	*Myotis volans*	a,c
Yuma myotis	*Myotis yumanensis*	c
Townsend's big-eared bat	*Corynorhinus townsendii*	b,c
Big brown bat	*Eptesicus fuscus*	
Silver-haired bat	*Lasionycteris noctivagans*	
Hoary bat	*Lasiurus cinereus*	
Western red bat	*Lasiurus blossevillii**	

a = WA state monitor species
b = WA state candidate species
c = Federal species of concern
*currently questionable if range extends into NOCA

To address this paucity of information, the NOCA resource management division initiated a 4-year systematic baseline inventory of bats in the park complex, beginning in 1998. The objectives of the study were to:

1. Document bat species composition in NOCA.
2. Describe the distribution of bats documented in NOCA
3. Describe the relative abundance of bat species in NOCA.

STUDY AREA

NOCA is located in northwestern Washington and includes North Cascades National Park, Lake Chelan National Recreation Area, and Ross Lake National Recreation Area (Figure 1). Spanning the crest of the Cascade Range, the park complex lies within two major biogeographic zones: the temperate marine west of the Cascades crest and semi-arid continental east of the Cascades crest (Franklin and Dyrness 1973). The complex includes lands from low elevation forested valleys (119 m) to high elevation glaciated mountain peaks (2,806 m), encompassing a total area of 276,815 ha. Approximately 93% of NOCA is designated wilderness.

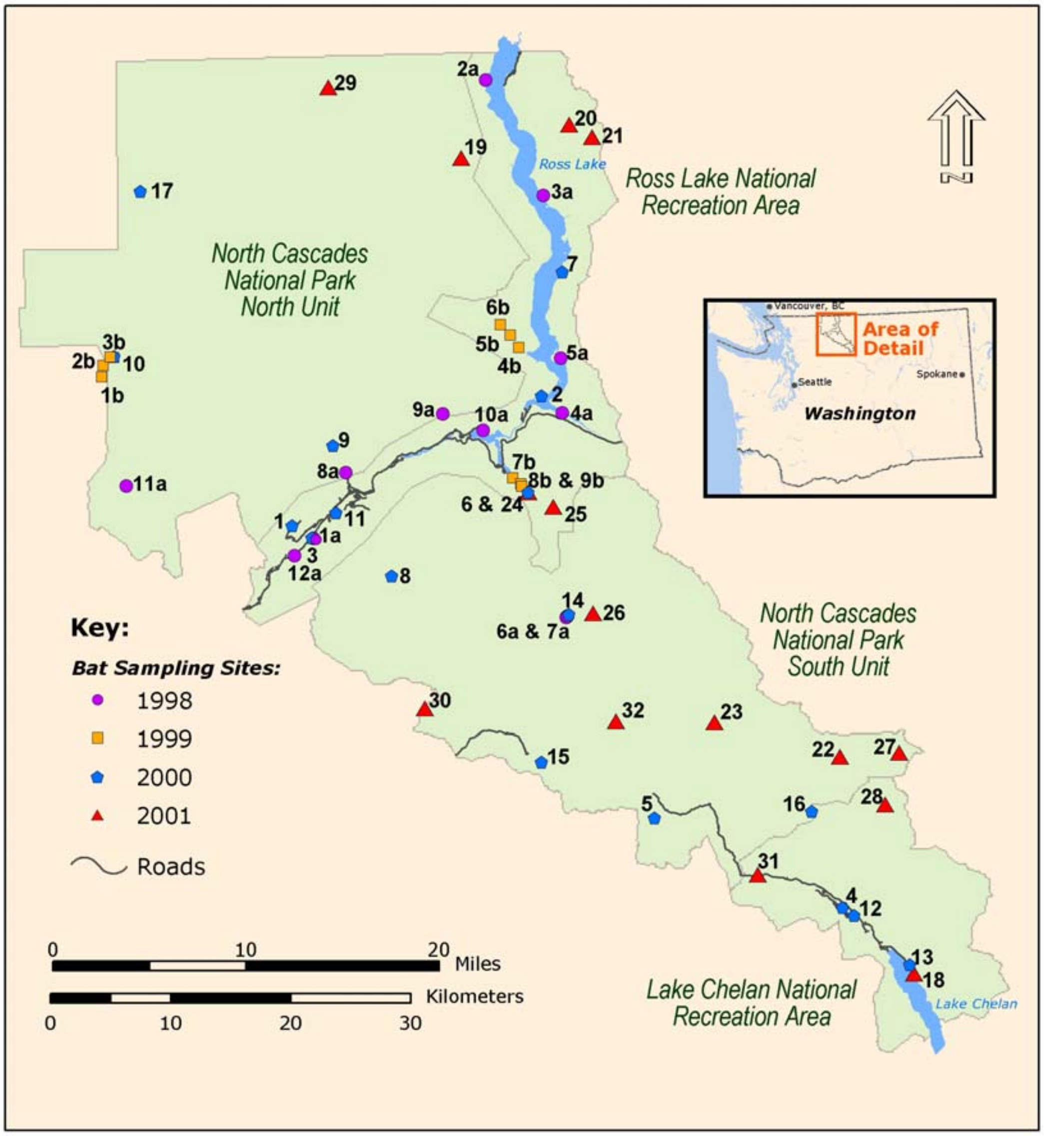

Figure 1. Study area and location of bat sampling sites. 1998 = sites 1a-12a, 1999 = sites 1b-9b, 2000-2001 = sites 1-32.

A seasonally wet maritime climate is representative of the region west of the Cascade crest. Here, summers are typically cool and dry with the majority of precipitation falling during the mild wet winters. Average annual precipitation on the west-slope ranges from 203-897 cm (Sumioka et al. 1998). As characterized by Agee and Kertis (1986), the Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) cover types dominate west-side forested habitat below 1,220 m and, at more moist sites, western red cedar (*Thuja plicata*) is also well represented in these cover types. Above 1,220 m, forested habitat west of the crest is dominated by the Pacific silver fir (*Abies amabilis*) cover type (Agee and Kertis 1986.) Other tree species interspersed at west-side higher elevations include mountain hemlock (*Tsuga mertensiana*) and Alaska yellow-cedar (*Chamaecyparis nootkatensis*).

The Cascade crest creates a rain shadow effect to the east and a climate that is much more influenced by continental air masses. As a result, east-slope conditions consist of cool winters and warm dry summers, with average annual precipitation measuring from 76 cm in the lower Stehekin Valley to 897 cm along the Cascade crest (Sumioka et al. 1998). Forested habitat below 1,220 m is dominated by the Douglas-fir cover type with lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*) cover types commonly found as minor components (Agee and Kertis 1986). Forested areas above 1,220 m are dominated by the subalpine fir (*Abies lasiocarpa*) cover type (Agee and Kertis 1986). Other tree species that are common in this zone include mountain hemlock and Englemann spruce (*Picea engelmannii*). Although less common, the Pacific silver fir cover type is also found on the east side above 1,220 m, most notably in the Bridge Creek section of the Stehekin River drainage. Both western hemlock and mountain hemlock are also encountered in this cover type.

METHODS

Sampling Strategy

Field surveys were conducted from mid-June through August of 1998-2001. We used the sampling protocol developed at Mount Rainier National Park (J. Petterson, pers. comm. 2000). Bats were surveyed using ultrasonic detectors and established capture techniques. Sampling occurred over a wide range of environmental variables including precipitation, elevation and vegetation.

Sample sites were selected from the U. S. Forest Service's Forest Inventory and Assessment (FIA) sampling scheme (FIA 2002). Sites were removed if they did not meet safety and accessibility criteria. Unsafe sites were defined as areas with slopes exceeding 35 degrees. Inaccessible sites were defined as those greater than 12 km from a road or trailhead (a day's hike with full gear). This left us with only 15 FIA sites. Consequently, a subset of random points was selected from a computer-generated matrix of points evenly distributed throughout the park. In addition, non-random sites were selected to fill in geographical gaps, and to a lesser extent, target specific areas suspected to support uncommon bat species. Ultimately, a total of 32 sites were selected for most analyses (Appendix 8). In 1998 and 1999, sampling was confined to the Skagit River watershed and conducted only in riparian areas. In the analyses, 1998 and 1999 sites are only used to document species composition, relative abundance, and distribution.

Sampling design was stratified into three broad habitat types. These included 1) low to mid-elevation forests, 2) low to mid-elevation riparian, and 3) higher elevation subalpine. We further stratified by east and west of the Cascade crest (wet vs. dry) to account for the two very distinct biogeographic areas in the park complex (Table 2). We attempted to sample a minimum of six sites in each stratum, including east and west slope. However, for some strata we fell short of this goal due to the logistical constraints of sampling in remote mountainous terrain.

Table 2. Stratification and distribution of sampling sites, NOCA 2000-2001.

	Biogeographic Area		
Habitat Strata	**West Slope**[1]	**East Slope**[1]	**Totals**[1]
Forest	9	5	14
Riparian	7	4	11
Subalpine	4	3	7
Totals	**20**	**12**	**32**

[1]= number of sites sampled in each stratum.

Habitat parameters were defined in broad terms. Forest sites were below 1,335 m, surrounded by at least a 100 m buffer of forest on all sides with at least 60% canopy cover. Dominant tree species included western hemlock, Douglas-fir, and western red cedar.

Riparian sites were below 1,335 m in elevation and extended 25 m on either side of bankfull width along third order streams or greater. Dominant canopy species here included western red cedar, western hemlock, Douglas-fir, red alder (*Alnus rubra*), and cottonwood (*Populus trichocarpa*). Vine maple (*Acer circinatum*), willows (*Salix sp*.), salmonberry (*Rubus spectabilis*), devil's club (*Oplopanax horridus*), sword fern (*Polystichum munitum*), and skunk cabbage (*Lysichitum americanum*) were prevalent in the understory.

The subalpine habitat type included areas ranging from 1,335 m to 1,982 m in elevation (Agee 1986). Overstories in this zone were dominated by mountain hemlock, subalpine fir, and Pacific silver fir. Often the landscape here consisted of a mosaic of herbaceous covered meadows, patches of forest, ephemeral wetland complexes, and ponds or lakes.

On the ground, site selection involved finding the center of each selected point using a hand-held Global Positioning System (GPS) device. Once this center point was reached, the nearest suitable bat sampling location to the point was chosen as the sample site. For example, if a subalpine meadow sampling point fell within in a small patch of forest or on a rocky outcrop, the nearest suitable area for setting up nets was chosen, generally within 100 m. Typically, in subalpine areas, this would include sampling the stand edge or over small streams and outlet channels in order to restrict the survey effort to corridors used by bats. For forest stratum points, the nearest water source or at least 20 m forest gap opening was sampled within the otherwise closed-canopy forest. In riparian sites, the nearest body of slow moving water was chosen as the sampling location.

Ultrasonic Detection

We surveyed bat activity at each study site using an Anabat II ultrasonic bat detector connected to an automated delay switch (Titley Electronics, Ballina, N.S.W. Australia). The delay switch was then connected to a tape recorder (Model VSC-2002; Radio Shack, Fort Worth, Texas, USA) outfitted with a 120-minute cassette tape. The electronic circuitry within the detectors is designed to transform the ultrasonic bat call into frequencies that can be heard by the unaided human ear or stored onto the cassette tape to be downloaded for later viewing and analysis. Each Anabat system was enclosed inside a waterproof plastic box with the detector microphone protruding through a hole in the box. To limit variation in the sensitivity setting, we consistently used "7" as the standard positioning on the Anabat sensitivity dial. The entire unit was angled upward at 30 degrees in order to receive bat echolocation calls from the maximum amount of air space. An attempt was made to elevate the equipment 1 m above ground level, again to increase the sampling space, but this was not always possible and was not standardized throughout the study. One complete Anabat detector unit was used for unattended or “passive” sampling at each site for a period of three hours following sunset. Each site was sampled for one night, by a 2-3 person crew. Sites that experienced any number of technical difficulties, which precluded a standard sampling period of 180 minutes past sunset, were not included in the final analyses. Sampling was not conducted during rain periods or adjacent to loud turbulent water where excessive noise would likely activate the detector.

Call Analysis

Analysis of tape-recorded echolocation calls was accomplished using a Zero-Crossing Interface Module (ZCAIM, Titley Electronics, Ballina, N.S.W., Australia) and Anabat 6 (version 5.7) and Analook (version 4.8) processing software. The software transforms the ultrasonic echolocation call into a sonogram display, shown as a function of frequency and time. By using published sonograms and call characteristics of known species (Fenton and Bell 1981, Fenton et al. 1983, Thomas et al. 1987, Erickson 1993, Corben and O'Farrel 1999) we were able to identify bat calls to a coarse resolution level of the *Myotis* genus, and in several cases to a finer resolution level of species. Using this technique, we ultimately classified Anabat calls into four *Myotis* and four non-*Myotis* species or species groups (Table 3). One non-*Myotis* category included the lumping of *L. noctivigans* and *E. fuscus*, since they have similar, but not always distinguishable calls.

In 1998 and 1999 we lumped all *Myotis* genus calls into one broad and conservative *Myotis* group category without further subdivision (see field form, Appendix 9). Classifying to a finer resolution of individual *Myotis* species or species group level was not possible, due to our limited knowledge of identifying calls at that time. In 2000 and 2001, after a 2-day training session with Chris Corben (Anabat specialist), we were able to further subdivide *Myotis* calls into four groups according to their respective minimum frequencies as outlined in Table 3 (Appendix 10 shows sample data form).

An acoustic detection, or bat pass, was recognized as a sequence of at least two or more pulses from an echolocating bat as it flew within range of the microphone (Thomas and West 1989). We equated bat activity with the total number of bat passes recorded at each site. A small percentage of passes, which contained less than two pulses were discarded and not used in the final analysis. Bat activity periods were divided into 30-minute intervals and calls were tabulated according to the time interval they were recorded. This process aided in determining the most active foraging periods, setting the framework for the standardized sampling period. Numbers of feeding buzzes, which are high repetition pulses indicating prey attack, were also reported for each interval.

Table 3. Summary of bat identification grouping based on minimum frequency of echolocation calls.

Taxon	Species/Species Group	Comments
Myotis		
Myotis californicus/Myotis yumanensis	MY50Khz	Steep slope, dropping sharply, with occasional short flat tail at minimum frequency, output a sharp "tick".
Myotis lucifugus/Myotis volans/Myotis ciliolabrum	MY40Khz	Steep slope, time between calls short, output a sharp "tick".
Myotis evotis	MY30-35Khz	Linear downslope, "tick" output.
Myotis thysanodes	MY20-25Khz	Long linear downslope, "tick" output.
Non-*Myotis*		
Eptesicus fuscus	EPFU 25-29Khz	Steep frequency sweep, ending in short tail, output a "put" sound.
Lasionycteris noctivagans	LANO 22-28Khz	Tonal "chirp" output, initial sweep, then fairly constant.
Eptesicus fuscus/ Lasionycteris noctivagans	EPFU/LANO 22-29Khz	Tonal "chirp" output, sometimes difficult to distinguish calls between these two species, therefore lumped.
Lasiurus cinereus	LACI 17-21Khz	Tonal "chirp" output, essentially constant frequency.

Capture Techniques

Bats were captured using an AUSTBAT harp trap (AUSTBAT Research Equipment, Victoria, Austrailia) and/or conventional mist nets (Avinet, Dryden, New York, USA) set over trails, slow moving water, or openings in the forest or along the forest edge where bats forage for insects. The harp trap and several mist nets, ranging in length from 2.6 m-18 m by 3 m high, were set up and continuously monitored for a 3-hour period following sunset. This was done simultaneously with the passive Anabat detector placed nearby. The number of nets set up and use of the harp trap at each site depended largely upon the number of field crew present, the feasibility of the site for multiple nets, and the logistics of backpacking the equipment to the site. We controlled for unequal sampling effort within each habitat strata by standardizing our analysis into net hours and trap hours (1 net/trap hour = 1 net or trap set for 1 hour). We did not take into account total net or trap square footage of covered area when multiple nets of different lengths were used. Captured individuals were identified to species, measured, weighed, aged (adult or juvenile), sexed, checked for reproductive condition and overall health, and then released at the place of capture (Nagorsen and Brigham 1995; Appendix 11 shows data form). Calipers were used to measure forearm, ear, and foot lengths to the nearest 0.1 mm. A digital scale was used for measuring body weight to the nearest 0.1 g. Age was determined by observing the degree of ossification of hand joints according to methods described by Anthony (1988). Females were lightly palpated for pregnancy and checked for signs of lactation to determine reproductive state. Male reproductive status was determined by assessing the extent of descending testes (Racey 1988). Upon release, a vocal signature recording of each bat was taken using an Anabat detector connected to a laptop computer for storage and subsequent analysis. This documentation of a voucher call was used to further confirm the species and to develop an echolocation call library of regional bats for use in future research.

Two *Myotis* species of this region that are often difficult to discriminate in the hand include *M. lucifugus* and *M. yumanensis*. Initially (1998-1999), we lumped captures of these species into one category. However, in 2000 and 2001, we were able to sort each capture to the species level because we could consistently apply morphological and behavioral characteristics that reliably aided in distinguishing the two species. For example, when describing *M. lucifugus*, they almost always displayed a fiesty behavior when held in the hand. Despite fur color often considered an unreliable characteristic in mammals, it appeared the color of their pelage was darker, was longer in length and had a more glossy sheen to it, the ears appeared darker, the skull longer and less steep, and the snout looked stouter and darker colored. Their counterpart, *M. yumanensis*, was generally much more docile in the hand, the fur was lighter colored and had a shorter more dull appearance, the skull was more rounded and dome shaped, and the snout appeared longer and more pink colored. Identification was not limited to any single characteristic, but generally included a combination of these factors. Obtaining a signature voucher call was especially useful when discerning these two species. Minimum frequencies of 50KHz were associated with *M. yumanensis* and 40KHhz with *M. lucifugus*. These signature call frequencies combined with the physical characteristics described, appeared very consistent throughout the study.

In 2001, wing biopsy samples were collected from all captured bat species. These samples are pending further laboratory DNA analysis and will be used to determine genetic variation and migratory pathways of regional bat species as part of a larger ongoing study headed by bat specialist, Dr. Maarten Vonhoff, from the University of Tennessee.

Unique Structures

We also investigated three building structures and a small cave-like entrance for possible bat occupancy. When bat presence was confirmed, a night-time emergence count was then conducted, in an attempt to physically count the number of bats roosting in the structure. Capture techniques were also implemented simultaneously during the exit count, in order to positively identify the species using the structures.

Statistical Analysis

Data were analyzed with SPSS statistical software package, version 9.0 (SPSS Inc. 1999). We used basic descriptive statistics (mean, standard deviation, range) to describe relative activity levels and capture success at each sampling site. Spearman's rank correlation coefficients were used to examine associations between elevation and numbers of captures of male and female bats, both east and west of the Cascade crest. An Independent-Samples T Test was used when comparing differences between the number of captures and the number of acoustic recordings at sites where both were used. All P-values quoted are for two-tailed tests, and results are significant if $P < 0.05$.

RESULTS

Analysis of Acoustic Data

During 1998-2001, we recorded a total of 5,616 bat echolocation calls from 50 individual survey sites (Table 4). This represents 216 detector/hours of effort and an average of 26 bat detections per hour. When catagorizing calls from all 4 years into the broadest and most conservative taxa groupings, (*Myotis* vs. non-*Myotis*), we found that 85.1% of the calls were identified as belonging to the *Myotis* group, while 14.7% were of the non-*Myotis* category. A rather small percentage of calls, (0.3%), were fragmented passes and difficult to identify to a species group and therefore were classified as “unknown”. Feeding buzzes constituted 4.2% of the total number of calls (Appendices 1 and 2).

Table 4. Numbers and percentages (in parentheses) of Anabat calls separated into *Myotis* and non-*Myotis* taxa groupings for each of the 4 sample years.

Sample Year[1]	*Myotis*	*Eptesicus fuscus*	*Lasionycteris noctivagans*	*L. noctivagans/ E. fuscus*	*Lasiurus cinereus*	Unknown	Total Calls
1998 (n=12)[2]	1244 (90.1)	23 (1.7)	88 (6.4)	11(0.8)	5 (0.4)	10 (0.2)	1381
1999 (n=9)[2]	2303 (85.1)	170 (6.3)	202 (7.5)	17 (0.6)	9 (0.3)	5 (0.1)	2706
2000 (n=16)	574 (97.1)	8 (1.4)	5 (0.8)	3 (0.5)	1(0.2)	0 (0.0)	591
2001 (n=13)	657 (70.0)	152 (16.2)	90 (9.6)	39 (4.2)	0 (0.0)	0 (0.0)	938
Totals (n=50)	**4778 (85.0)**	**353 (6.3)**	**385 (6.9)**	**70 (1.2)**	**15 (0.3)**	**15 (0.3)**	**5616**

[1]n=the number of sites successfully sampled for 180 minutes past sunset.
[2]some sites for these years were sampled for 2 consecutive nights.

There was great variability in relative activity levels from site to site and from year to year. The greater number of detections in 1998 and 1999 can be explained by the fact that all sample sites for those years were in riparian habitat. The number of passes recorded at each sample site, for all years combined, ranged from 2-854, with a mean of 112.3, SD ± 158.3 calls per site. A more detailed summary of recorded calls is given in Appendix 1.

For all years combined, *L. noctivagans* and *E. fuscus* were the most often detected non-*Myotis* species. There was nearly equal representation among the two species, 6.9% and 6.3% respectively (Table 4). On occasion, it was difficult to discriminate between these two species' echolocation calls, therefore a category that lumped both into one grouping was formed and included 1.2% of all calls. *L. cinereus* detections were relatively few, comprising only 0.3% of the total calls.

In 2000 and 2001, we separated the *Myotis* echolocation calls into more detailed taxa groupings and categorized species groups into the three broad habitat types (forest, riparian, and subalpine). For these two years alone, we recorded 1,529 bat echolocation calls from 29 sites (Table 5, Appendix 2). Total effort was 87 detector/hours with an average of 18 detections per hour. The most conservative grouping and coarsest resolution classification resulted in 80.5% of calls identified as *Myotis*, while 19.5% were of the non-*Myotis* group. This compares closely with all years combined. With the more detailed separation of the *Myotis* group it became apparent that the greatest number of calls were identified as MY50Khz and MY40Khz, 35.6% and 35.2% respectively. Based on capture data, it seems likely the majority of calls in the MY50Khz group are representative of *M. yumanensis*, and the majority of calls in the MY40Khz group represent *M. lucifugus*. The MY50Khz call group was represented at 58.6% of the sampling sites and calls from the MY40Khz group were present at 86.2% of all sites sampled (Appendices 1 and 2). There were no recordings identified for the MY20-25Khz call group, which would include a single species, *M. thysanodes*. Two sites, both in the forest stratum, received no recorded activity. Again, there was great variability in the number of calls recorded at each sample site, ranging from 0-291 with a mean of 52.7, SD ± 67.1.

Table 5. Number and percentages (in parentheses) of Anabat calls by species or species group within 3 broad habitat types, NOCA 2000-2001.

Habitat Strata[1]	**MY50Khz**	**MY40Khz**	**MY30-MY35Khz**	***E. fuscus***	***L. noctivagans***	***E.fuscus/ L.notivagans***	***L. cinereus***	**Total Calls**
Riparian (n=10)	483 (73.2)	135 (20.5)	20 (3.0)	7 (1.1)	12 (1.8)	2 (0.3)	1 (0.2)	**660**
Forest (n=12)	60 (12.9)	96 (20.6)	123 (26.4)	102 (21.9)	61 (13.1)	24 (5.2)	0 (0.0)	**466**
Subalpine (n=7)	0 (0.0)	308 (76.4)	6 (1.5)	51 (12.7)	22 (5.5)	16 (4.0)	0 (0.0)	**403**
Totals[2] (n=29)	**543 (35.5)**	**539 (35.2)**	**149 (9.7)**	**160 (10.5)**	**95 (6.2)**	**42 (2.7)**	**1(0.1)**	**1529**

[1]n= the number of sites successfully sampled for 180 minutes past sunset.
[2]Only 29 of the 32 sites selected had successful recordings, due to technical difficulties at 3 sites.

During this latter 2-year period, *E. fuscus* was the most abundant non-*Myotis* species, comprising 10.5% of all recorded calls and over half (53.7%) of the calls within the non-*Myotis* category. The second most common non-*Myotis* species, *L. noctivagans*, made up for 6.2% of all recorded echolocation calls and accounted for 31.9% of those calls within the non-*Myotis* group. Only one call (0.1%) of the non-*Myotis* species, *L. cinereus*, was recorded for this same 2-year period.

The greatest relative abundance of bat echolocation activity was associated with riparian habitat, accounting for 43.2% of the total number of calls. Nearly 73.2% of detections from riparian habitats were of the MY50Khz species group, and quite likely *M. yumanensis*, based on corresponding capture data. A single occurrence of a *L. cinereus* was also detected in the riparian habitat type. The riparian areas also held the greatest proportion (69.0%) of the total feeding buzzes recorded (see Appendices 1 and 2).

The forest stratum held the second most abundant bat activity with 30.5% of the total calls. The MY30-35Khz species group (likely *M. evotis* based on capture data), was the most common, representing 26.4% of the calls within that stratum. *E. fuscus* and MY40Khz calls (quite likely *M. lucifugus* based on capture data) were also quite prevalent in forested habitat, representing 21.9% and 20.6% respectively. There were no recorded calls of *L. cinereus* in the forest habitat type.

The subalpine habitat held the least amount of activity accounting for 26.4% of the total calls, where the MY40Khz species group represented 76.4% of the activity. In all likelihood, these calls are largely represented by *M. lucifugus*, given they were also the most often captured bat in the subalpine stratum. *E. fuscus* appeared to be the most common non-*Myotis* species representing 12.7% of calls in that stratum. No calls were recorded in subalpine habitat from *L. cinereus* and the MY50Khz group.

To control for uneven sampling effort within each habitat strata, we further analyzed bat activity as "number of calls per hour of effort" (Table 6). Again, riparian habitat showed the greatest amount of activity, despite having proportionately fewer total sampling hours than the forest habitat. Riparian habitat also held the greatest variance in the number of calls per site, ranging from 9-291, SD ± 84.5 (Appendix 2).

Table 6. Anabat detection effort, NOCA 2000-2001.

Habitat Stata	Number of Sites Sampled	Total Hours of Sampling	Total Calls	Mean Calls Per Hour	Standard Deviation
Riparian	10	30	660	22.0	28.2
Forest	12	36	466	12.9	19.9
Subalpine	7	21	403	19.2	18.3

Analysis of Capture Data

During the summer field seasons of 2000-2001, we sampled 31 sites and captured 144 bats from 336 net hours and 36 harp trap hours of effort (Table 7, Appendix 4). An additional 18 bats of 4-5 species were captured during the 1999 field season (Appendix 3), but were not included in this analysis, due to sampling deviations that we felt made the data incomparable. From the final 2-year endeavor, five species of *Myotis* bats were positively identified. These include *M. yumanensis, M. lucifugus, M. evotis, M. californicus,* and *M. volans*. The most frequently captured species were *M. yumanensis* (31.3%) and *M. lucifugus* (29.9%). Captures of *M. evotis* and *M. californicus* were not as common, but showed nearly equal representation, 17.4% and 16.7% respectively. *M. volans* was relatively rare, accounting for only 3.5% of total captures. No non-*Myotis* bat species were successfully captured. Individual species distribution maps are shown in Appendix 6.

Table 7. Bat captures and percentage of total (in parentheses) within 3 habitat types, NOCA 2000-2001 (sampling effort is shown as both net and trap hours).

	Habitat Strata			
	Riparian[2]	**Forest**[2]	**Subalpine**[2]	**Totals**[3]
Species	n=11	n=14	n=6	n=31
Myotis yumanensis	31 (68.9)	13 (28.9)	1 (2.2)	45
Myotis lucifigus	15 (34.9)	21 (48.8)	7 (16.3)	43
Myotis evotis	9 (36.0)	15 (60.0)	1 (4.0)	25
Myotis californicus	16 (66.7)	8 (33.3)	0 (0.0)	24
Myotis volans	1 (20.0)	3 (60.0)	1 (20.0)	5
Unknown[1]	2 (100.0)	0 (0.0)	0 (0.0)	2
Total Captures	**74 (51.4)**	**60 (41.7)**	**10 (6.9)**	**144**
Captures via net/trap	**58/16**	**51/9**	**10/NA**	**119/25**
Total net/trap hours	**123/21**	**156/15**	**57/NA**	**336/36**
Captures per net/trap hour	**0.5/0.8**	**0.3/0.6**	**0.2/NA**	**0.4/0.7**

[1] Bats escaped before they could be identified to species.
[2]n=the number of sites successfully sampled for 180 minutes past sunset.
[3]Only 31 of 32 sample sites were actually trapped.

Bats were successfully captured at 22 of the 31 sites attempted. Number of individuals captured per site ranged from 0-17 with a mean of 4.6, SD ± 5.2. Species diversity per site ranged from 0-5 with a mean of 1.7, SD ± 1.6. Overall capture success per unit effort ranged from 0-1.88 bats per net/trap hour with a mean of 0.4, SD ± 0.4. *M. lucifugus* was the most widespread species and was captured at 13 of the 31 sites where trapping occurred.

Differences were noted in numbers of captures and taxa present within each of the three habitat types. All five species captured were confirmed present in the riparian and forest strata, while in the subalpine we captured four species, lacking confirmation of *M. californicus* only. Riparian habitat constituted the greatest number of captures (51.4%), followed by forest (41.7%) and subalpine (6.9%) habitats. *M. yumanensis* was the most abundant species found in riparian habitat, representing 41.9% of captures within that stratum. The most abundant species captured in the forest and subalpine habitat types was *M. lucifugus*, 35.0% and 70.0% respectively. *M. volans*, albeit a small sample size of five, was found most often in the forest habitat (60.0%).

Captured bats were examined for sex, age and reproductive status (Table 8, Appendix 5). Adult females accounted for 84 (58.3%) of the captures and adult males totaled 53 (37.1%). One juvenile of the year was encountered, consisting of a male *M. yumanensis* captured in the forest stratum. Six bats (4.2%) escaped before they could be identified to gender. Of the 84 females identified, 56 (66.7%) were in some phase of the reproductive cycle (pregnant, lactating or post lactating), while 28 (33.3%) were classified as non-reproductive. All but two of the 54 identified males were in a non-reproductive stage.

Table 8. Sex and age composition of captured bats within 3 habitat types.

Habitat	**Elevation Range (m)**[1]	**Male Adults**	**Male Juveniles**	**Female Adults**	**Female Juveniles**	**Unknown**[2]	**Totals**
Forest	159-961	23	1	33	0	3	**60**
Riparian	162-1,092	21	0	50	0	3	**74**
Subalpine	1,330-1,685	9	0	1	0	0	**10**
Totals		**53**	**1**	**84**	**0**	**6**	**144**

[1]Elevation range of captured bats within each habitat type.
[2]Bats escaped before they could be identified to gender.

The mean elevation of captured bats (n=144) was 559 m, SD ± 364 m, and ranged from 159 m-1,685 m,. Females of all species (n=84), regardless of reproductive state, were found at a mean elevation of 443 m, SD ± 252 m, and ranged from 159 m-1,330 m. Reproductive females of all species (n=56) were captured at a mean elevation of 460 m, SD ± 182 m, and ranged from 159 m-961 m with the highest elevation representing a single capture of a lactating *M. californicus*. Males of all species (n=54), ranged in elevation from 159 m-1,685 m with a mean of 766 m, SD ± 428 m.

The distribution of captured bats was examined, both west and east of the North Cascade crest. Sixty-nine bats of five species were captured west of the crest and 73 bats of the same five species were identified east of the crest. Two bats escaped before they could be identified to species.

There was no significant correlation between the number of bats captured and the number of acoustic detections at sites where both methods were engaged (n=28 sites, r^2=0.0847). It appears there is a parallel relationship in numbers of the two most frequent Anabat call groups (MY50Khz and MY40Khz) and the two most frequently captured bat species (*M. yumanensis and M. lucifugus*). Since both capture species are included in the two most frequent call groups respectively, in all likelihood, the majority of recorded passes in the

MY50Khz were that of *M. yumanensis* and those calls in the MY40Khz call groups were probably *M. lucifugus*.

The effect of elevation was looked at to determine any trends in the distribution of male and female captures. Spearman's rank correlation coefficient showed an inverse relationship between elevation and female captures, both west and east of the Cascade crest (*rs* = -0.698, p=<0.01) (Figure 2). This association was even more evident when examining just east-side female captures (*rs*= - 0.851, p=0.001), where tree line is typically higher in elevation. Most female bats were captured at elevations less than 600 m, with a transition area of low captures from 600-800 m, followed by very few captures above 800 m. Males appeared to be more widely distributed across an elevational gradient and showed no discernable trend, either west or east of the crest (*rs*= 0.066, p = .770) (Figure 3). The data demonstrate that female bats were found more commonly than males at lower elevations and a greater number of females were captured as elevation decreased. The highest elevation of documented captures in the park complex was 1,685 m, which included 3 non-reproductive male *M. lucifugus* bats, all trapped from the same subalpine habitat site.

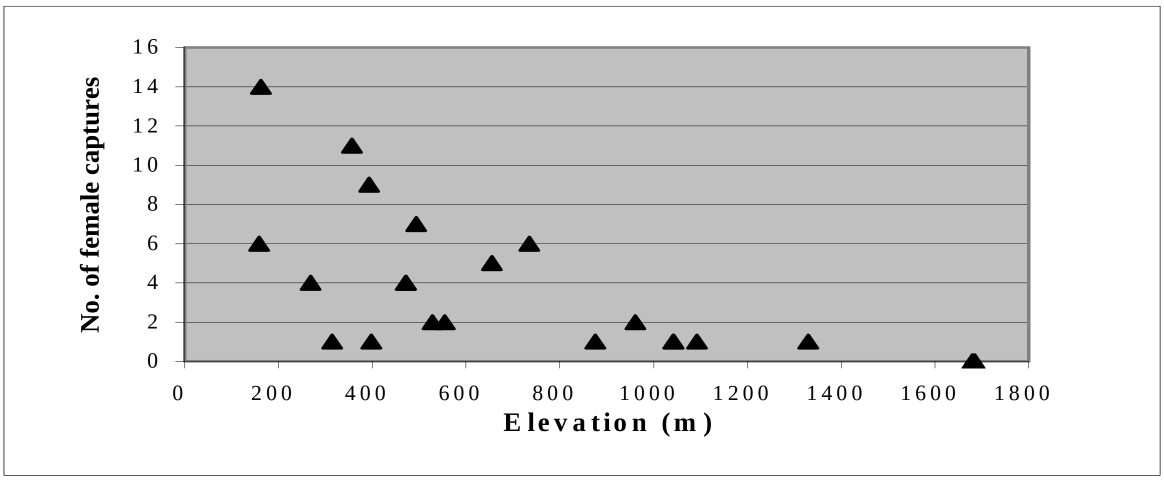

Figure 2 Scatterplot showing relationship between elevation and female bat captures.

Ten out of 12 sites (83.3%) where the harp trap was deployed produced 25 bat captures. This compares to 20 out of 31 sites (64.6%) where mist nets successfully caught 119 bats. No species were exclusively caught in the harp trap that weren't also captured in the mist nets.

Unique Structures

Two building structures and a small cave site were checked for possible day or night roost activity and to look for additional unconfirmed species. There was no evidence of bats using the cave or the smallest and most remote building investigated. A warehouse building at the Hozomeen Ranger Station contained a maternity colony of both *M.*

lucifugus and *M. yumanensis*, with a combined population of approximately 1,200-1,500 individuals, the largest known nursery colony in the park complex.

Echolocation Signature Calls
Echolocation calls from captured bats were recorded upon hand-releasing them. Illustrations of these voucher calls and examples of our interpretation of passive recordings from all *Myotis* and non-*Myotis* species group categories are shown in Appendix 7. These reference calls are available to aid in call recognition and species identification for future bat studies specific to the North Cascades geographic region.

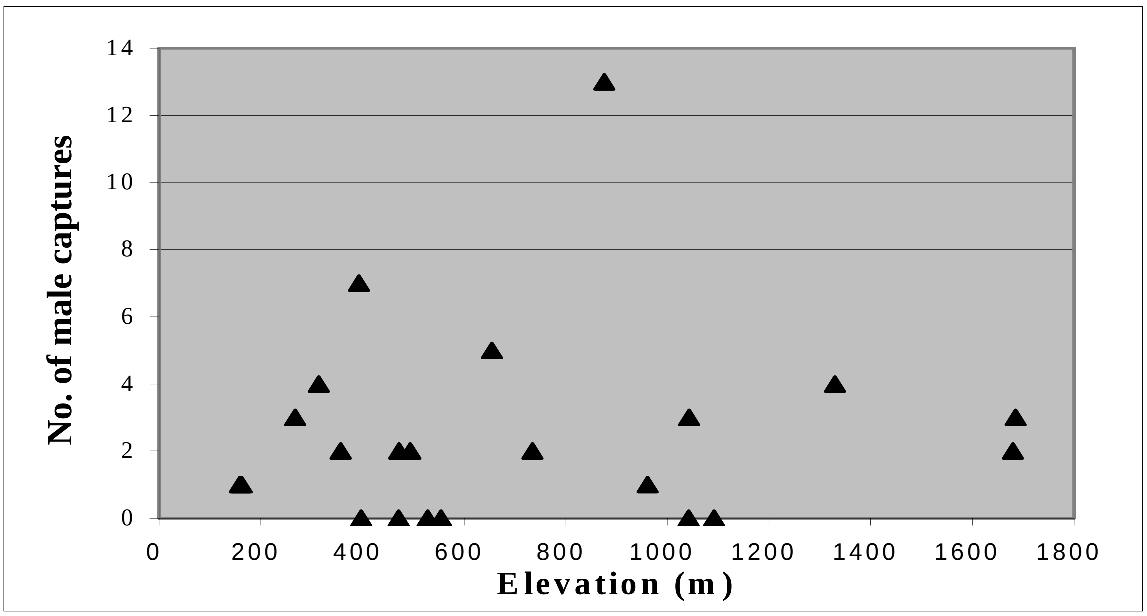

Figure 3 Scatterplot showing relationship between elevation and male bat captures.

DISCUSSION

Eight of the 12 bat species with ranges thought to extend into the park complex have now been documented as a result of this study. Over 80% of identifiable bat passes were classified as calls from *Myotis* species. The remaining less than 20% were from three non-*Myotis* species. These disproportionate values are consistent with results from other regional studies (Thomas 1988, Erickson 1993, Hayes and Adam 1996, Jenkins et al. unpub. rpt. 1999, Petterson unpub. rpt. 2001). On the whole, comparison of our study results to other survey data in the region suggest there are no major differences in bat species diversity and relative abundance of those species.

Both acoustic and capture data indicate that the most common species to inhabit the park complex are *M. yumanensis* and *M. lucifugus.* These two species accounted for nearly a third each of the total captures. The acoustic data also shows the MY50Khz and MY40Khz call groups, which includes *M. yumanensis* and *M. lucifugus* respectively, accounting for slightly over a third of the 1,529 recorded calls for years 2000 and 2001.

M. lucifugus appears to be the most widespread species across an elevational gradient, with primarily males present at the highest elevations. Since a greater proportion of MY40Khz calls were recorded in subalpine habitat and the most often captured species in the subalpine was *M. lucifugus*, it seems reasonable to assume that most of the subalpine MY40Khz calls were indeed from *M. lucifugus*. Surveys at Mount Rainier National Park (J. Petterson unpub. rpt. 2001) also reported *M. lucifugus* as the most common species overall and the most often recorded and captured bat at higher elevations. *M. californicus* appears to select for lower elevation habitats, as it was the only of five *Myotis* species not captured in the subalpine environment. This generalization is further supported by the acoustic data, since the MY50Khz call group, which includes *M. californicus*, was not present in the higher elevation subalpine sites. This finding was also consistent with Petterson's data. *M. evotis* accounted for a significant proportion of both capture and acoustic detections, and appears to be most abundant in mid to low elevation forested habitat. Limited captures of *M. volans* suggest it is either very elusive or uncommon within the study area.

For all years combined, the greatest proportion of non-*Myotis* calls were from clearly identifiable *L. noctivagans* calls and slightly outnumbered those of *E. fuscus*. However, for years 2000 and 2001, there appeared to be a greater abundance of *E. fuscus*. Since we lumped *E. fuscus* and *L. noctivagans* into a separate group when they could not easily be distinguished, it is possible an unknown proportion of the lumped category could actually be *L. noctivagans*. If this were the case, then the proportionate values of the latter two years would more closely resemble those of all years combined. The third non-*Myotis* bat detected, *L. cinerius*, showed no discernable trend and appears to be consistently very uncommon or elusive.

Given the wide gamut of environmental conditions affecting bat presence, and the limited data collected, it would be difficult to associate species richness and abundance to any of the three habitat strata. However, on a general scale it appears the riparian habitat type held the greatest species diversity and relative activity as shown from both acoustic and capture data. This habitat type also held the greatest number of feeding buzzes. These findings are not surprising, considering the increased foraging opportunities near water. The forest stratum held the second highest amount of relative activity, but with much fewer feeding buzzes, suggesting a greater proportion of the bats detected at the forest sites were commuting rather than foraging. The subalpine habitat type yielded a greater number of feeding buzzes than the forest sites exhibited. This suggests the importance of these higher elevation sites for bat foraging and likely follows a temporal pattern as insect abundance increases in the high elevation meadows and wetlands later in the summer.

The eight species of bats documented in the park complex showed varying degrees of distribution across the landscape (Appendix 6). No taxa were found exclusively on the east or exclusively on the west side of the Cascade crest. When looking at distribution across elevation gradients, it was clear that *M. lucifugus* was the most prevalent species at higher elevations and perhaps the most tolerant of associated climatic conditions.

The confirmation of reproducing females of all five species captured indicates the existence of resident breeding populations within the park complex. The fact that female bats were found more commonly than males at lower elevations is consistent with other findings in the Pacific Northwest (Fenton et al. 1980, Thomas and West 1991, Erickson 1998, Grindal et al. 1999). This partial segregation is likely related to less precipitation and warmer temperatures at lower elevations, factors that would be more desirable for female reproductive requirements (Lewis 1993, Erickson 1998, Grindal et al 1999).

Four bat species presumed to occur within the park complex boundaries were not documented during this inventory. These include *M. thysanodes*, *M. ciliolabrum*, *L. blossevillii* and *C. townsendii*. A possible record of *L. blossevillii* was detected by ultrasonic recording equipment near the mouth of the Stehekin River at the head of Lake Chelan (Duke Engineering & Services, Inc. 2000), but there is some question as to whether this detection was accurately identified. One other record of this species is documented in the upper Skagit River drainage of southern British Columbia just north of the park complex (Nagorsen and Brigham 1995). These records indicate an isolated and patchy distribution of this species, leaving some question as to whether this species actually occurs within the park complex. The occurrence of the rare *C. townsendii* bat has been documented in at least six separate locations adjacent to nearly each boundary of the park (Perkins unpubl.rep. 1989, G. Hochmuht, pers. comm. 2001, P. Reed, pers. comm. 2002, K. Woodruff, pers. comm. 2002, T. Luszca, pers. comm. 2002), but was not detected inside NOCA boundaries during the course of this study. More recently, however, an observation of a single *C. townsendii* bat was confirmed roosting inside of an old cabin situated within the western bounds of Ross Lake National Recreation Area. This incidental siting now documents the presence of this rare bat species within the park complex, albeit ancillary to this particular study. Lastly, *M. ciliolabrum* has been documented just north of the park complex in the upper Skagit River environs of British Columbia (Firman and Barclay 1993). Site conditions are drier in the upper Skagit drainage and more representative of the eastern edge of Ross Lake Reservoir and the lower Stehekin Valley, where there is a strong likelihood of this species' presence.

Precautions and Limitations

It is important to recognize that although the system of using ultrasonic detectors is a relatively simple and popular method for identifying free-flying bats, it does however, come with some limitations. For one, it is not possible to make a determination between multiple passes by one bat or several bats making single passes. Consequently, the number of bat passes detected is not an absolute measure of bat abundance, but rather, it can be used as an index of relative bat abundance or activity (Thomas and West 1989). Our acoustic data results should therefore be used with caution when making inferences regarding population estimates.

Second, we have a very limited understanding of detection probability, both within and between species. Our results show some species were detected regularly while other species may have been under-represented. In part, this may be explained by the broad range of call intensity in bat echolocation calls, and the fact that higher frequencies tend to attenuate more in the open air than lower frequencies, therefore avoiding detection at greater distances (Fenton and Bell 1981). For example, those species with high-intensity and lower frequency calls, such as *L. cinereus*, can be detected at distances exceeding 30 m, while the low-intensity call of *C. townsendii*, appears to be detectable only if it passes within 5 m of the microphone (O'Farrell and Gannon 1999). To compound this dilemma, previous studies have shown that calls can vary immensely between individuals or over geographic areas and this could lead to potential misidentification of recorded calls (Thomas et al., 1987; Brigham et al., 1989). Therefore, reliable comparisons of relative abundance between species are difficult to make and one needs to be mindful of this bias when interpreting our results.

Furthermore, the results of our echolocation monitoring quite likely provides an incomplete picture of bat activity in some habitat types, especially complex forest stands. Since we could only logistically sample at or near ground level, we may have missed species or species groups whose activity patterns are different than those taxa that we detected at that level. For example, Hayes and Gruver (2000) found a substantial difference in the use of vertical structure by bats, among both *Myotis* and non-*Myotis* species, and changes that occurred even within the same night.

Similarly, it has become evident from previous investigations (Hayes and Gruver 2000) and our field observations that some bat species are less susceptible to capture techniques than others. For example, the larger and less maneuverable species that emit high-intensity calls such as *L. noctivagans*, *E fuscus*, and *L. cinereus* were often observed or acoustically identified as flying high in open meadows, clearings or above the canopy, thus avoiding capture. Similar to ultrasonic monitoring, our capture data does provide information on presence and species distribution, but it should be recognized that it too does not provide meaningful information on absolute abundance or density of populations.

There is also a high degree of spatial and temporal variability in bat activity and species composition from night to night and throughout the year (Hayes 1997, Erickson 1998, Hummes et al. 1999), further explaining the difficulty in detecting these volant mammals. There may be several environmental conditions that influence this variability, but it is generally accepted that temperature and precipitation are key factors. These factors appeared influential in our study, given we observed virtually no bat activity during rain periods and when temperatures dropped below 6^0C. Since we sampled only one night at each site we may have missed the occurrence of some bats that were simply not foraging, due to inclement weather, or were foraging in nearby microclimates on that particular night where prey may have been more available.

Interestingly, in August 2002, after surveys for the purpose of this study were completed, we were successful in capturing for the first time, *L. noctivagans and E. fuscus*, in mist nets at a low elevation riparian site. This may indicate a shift in foraging strategies for these larger sized bats as prey diversity and availability likely changes at specific locations throughout the summer. Since we did not sample any low elevation riparian sites on more than one occasion during the study period, we may have missed an opportunity, when it appears capturing these species is more likely. This offers support for the need to replicate sample sites with sampling periods spaced throughout the summer to account for this seasonal variation in insect availability and possible changes in bat foraging activity.

Despite the limitations and biases of each sampling method, captures accounted for the positive identification of five *Myotis* species that may not have been possible otherwise. Likewise, acoustic sampling made it possible to detect three non-*Myotis* species that avoided capture. Variation in bat behavior and foraging tactics make it advisable to employ both acoustic and capture methods simultaneously when conducting distribution and abundance surveys (Rautenbach et al. 1996, Kuenzi and Morrison 1998, O'Farrell and Gannon 1999).

RECOMMENDATIONS

The results of this study have provided important baseline documentation of species diversity, relative abundance, and distribution of bats within the park complex. Data will be disseminated to local, regional and national bat management databases. Bat Conservation International (BCI) is currently undertaking the enormous task of compiling existing records and constructing a central geographical information systems (GIS) database on geographic ranges of bat species worldwide (Walsh et al. 2001). In addition to sharing our data with the BCI data source, we will provide our data to the Washington Natural Heritage and National Park Service database (NPSpecies) to assist organizations in developing and refining bat conservation priorities.

Evaluating the potential for including bats in NOCA’s long-term monitoring program was beyond the scope of this study. Long-term monitoring of bats is a very difficult task. There has been and continues to be a great deal of discussion on this issue and the potential to monitor bats effectively. Concerns over the mobility of bats, the difficulties associated with determining absolute abundance with Anabat equipment, problems discerning species identity using acoustic sampling and temporal and spatial variation all contribute to this debate. It is the opinion of most bat specialists that the techniques currently being used to monitor bats, such as ultrasonic detectors, are not robust enough to estimate and detect changes in abundance or population numbers over time (C. Corben pers. comm. 2002). However, their utility may be more appropriate in other situations, such as monitoring changes in species distributions for those species whose echolocation calls can be positively identified and to document bat species that may be present, but remain undocumented from this initial inventory.

Aside from accessing the sampling difficulties of long-term bat monitoring in NOCA, there are other information gaps that warrant further investigation. Additional survey work is needed to complete documentation of the list of species that potentially occur in the park complex. Emphasis should be placed on listed species and species of management concern, such as *M. keenii* and *C. townsendii* (Washington State Candidate species). As more information becomes available regarding the habitat requirements of these species, we recommend targeted surveys be conducted to determine their presence and distribution within the park complex. We also recommend surveying targeted habitats, such as rare habitats or habitats of special interest (e.g. talus slopes, cottonwood stands, mines).

Currently, the taxanomic status of *M. keenii* and *M. evotis* is unclear. Johnson and Cassidy (1997) state "The most recent taxonomic revision indicates that *M. evotis* may be replaced by *M. keenii* on the northern Olympic Peninsula, and that their ranges overlap in the Olympic Peninsula and the Puget Trough." The Johnson and Cassidy (1997) range maps indicate *M. keenii* does not occur in NOCA, but given the taxonomic confusion of the two species, it is uncertain what the status of *M. keenii* is in the lowland forests of the Washington Cascades. To date, the only definitive method to distinguish between these two species where both occur is through DNA analysis. Given the fact that recent DNA analysis from specimens at Mount Rainier National Park identified one individual as *M. keenii* (Jim Pettersen, NPS-MORA pers. comm., 2001), the possibility exits that we may have misidentified some individuals as *M. evotis*. We recommend tissue samples collected from our surveys be analyzed, and if necessary additional samples collected to determine if *M. keenii* is indeed present.

Many traditional bat hibernation sites, such as natural caves, have been subject to unwelcome disturbance or alterations brought about by human intervention. As a result, abandoned mines now play an important role in providing similar microclimates for cave-dwelling bat species (Tuttle and Taylor 1998). Within NOCA, there are at least 30 adits at known abandoned mines (NOCA files). Little is known about their potential for harboring bats. This presents a sampling gap that may be of major importance and could possibly turn up another species record in the park. There is currently an increased emphasis on the closure of abandoned mines on public lands, precipitated primarily by concerns of human safety. Therefore, we recommend attention be given to this habitat type within NOCA boundaries to assess the probability and identify bats using these sites prior to any potential mine closures.

Building structures within NOCA also warrant further investigation for the presence of rare bat species. Bats found in buildings that pose a human health hazard should be identified to species and an estimate of the minimum population size conducted before any attempt at exclusion occurs. It is equally important that observers are aware and practice cautionary methods while conducting roost surveys, so as not to cause any unnecessary disturbance to the colony.

We located two bat maternity colonies during this study. One maternity colony, located in a Hozomeen warehouse building, is the largest known nursery colony in the park complex and one of the largest in the state, according to Washington Natural Heritage records (J. Fleckenstein, pers. comm. 2002). Periodic emergence counts, perhaps on a two to three year cycle, should be implemented in order to reveal any potential stressors that may adversely affect this colony. Ideally, surveys should take place in the first week prior to parturition in order to estimate colony size at its most stable point and when most or all of the bats within the colony are exiting the roost.

Finally, temporal replication is necessary to account for the immense variation in bat activity from night to night, throughout the seasons and between years. We recommend two to three site-visits per year for a minimum of three years to improve our understanding of the main factors influencing bat activity in the park complex. Also, future surveys should deploy simultaneously both acoustic sampling and capture techniques. Our surveys documented that on site-specific surveys each technique detected species missed by the other method.

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APPENDICES

Appendix 1. Distribution and relative abundance of bats detected using Anabat recorders, NOCA 1998-1999.

	1998 Study Sites													1999 Study Sites									
Site Name	*COLP*	*SICK*	*EABA*	*RUAR*	*ROPT*	*THCU*	*TCWU*	*GOCK*	*STCK*	*DIRE*	*LS17-1*	*DACK*	***TOTALS***	*BARM*	*BRMU*	*BRSC*	*BBLM*	*PM09*	*BBUM*	*TGLM*	*TCMM*	*TCUM*	***TOTALS***
Site Number[1]	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12a	**1a-12a**	1b	2b	3b	4b	5b	6b	7b	8b	9b	**1b-9b**
Elevation (m)[2]	*122*	*500*	*500*	*500*	*500*	*616*	*614*	*186*	*347*	*400*	*1736*	*122*		*552*	*254*	*262*	*492*	*492*	*497*	*373*	*374*	*376*	
Habitat Strata[3]	M	R	R	R	R	S	W	S	S	R	S	R		M	W	S	M	W	M	M	M	M	
No.of detector hours[4]	6	3	6	3	3	3	3	6	3	3	6	3	**48**	15	12	6	3	9	6	6	18	6	**81**
No.of feeding buzzes	9	2	18	3	5	4	0	0	3	3	0	6	**53**	0	24	2	4	8	12	12	19	0	**81**
Number of calls																							
Myotis group	245	45	313	88	97	48	2	27	47	196	75	61	**1244**	61	470	71	175	211	186	402	703	24	**2303**
E. fuscus	5	2	11	3	0	0	0	0	0	1	0	1	**23**	104	0	10	1	0	7	2	45	1	**170**
L. noctivigans	6	0	21	10	3	2	0	0	0	0	0	46	**88**	0	83	4	0	12	0	8	94	1	**202**
E. fuscus/L.noctivigans	1	0	3	4	0	0	0	0	0	0	0	3	**11**	0	7	1	0	0	0	1	8	0	**17**
L.cinereus	0	0	2	3	0	0	0	0	0	0	0	0	**5**	0	2	0	0	7	0	0	0	0	**9**
Unknown	3	0	4	3	0	0	0	0	0	0	0	0	**10**	1	0	0	0	0	0	0	4	0	**5**
TOTALS	**260**	**47**	**354**	**111**	**100**	**50**	**2**	**27**	**47**	**197**	**75**	**111**	**1381**	**166**	**562**	**86**	**176**	**230**	**193**	**413**	**854**	**26**	**2706**

[1]Site number corresponds to sampling location as shown in Figure 1.

[2]Determined from altimeter and GPS unit and then verified from 1:24,000 topographical maps.

[3]Separated into 5 broad habitat types: M=mainstem river, R=reservoir, S=stream, W=wetland, S=subalpine

[4]Determined by passive Anabat II bat detector.

Appendix 2. Distribution and relative abundance of bats detected using Anabat recorders, NOCA 2000-2001.

Site Name	*THLA*	*FS184*	*COPO*	*COCR*	*FLCR*	*THCR*	*DECR*	*NECR*	*GOCR*	*BARI*	*SPCH*	*HACA*	*PUCR*	*MECA*	*CAPA*	*RALA*	*CORI*	*HACR*	*LIBC*	*WILA*	*LICR*	*FIWE*	*NFBC*	*THCR*	*PAPO*	*FICR*	*DALA*	*MCLA*	*DEPC*	*HILC*	*COLA*	*PCPA*	*Totals*
Site Number[1]	1	2	3	4	5	6	7	8	9	10[5]	11	12	13	14	15	16	17	18	19	20	21	22	23[5]	24[5]	25	26	27	28	29	30	31	32	**1-32**
Elevation (m)[2]	*866*	*525*	*162*	*393*	*735*	*472*	*555*	*506*	*268*	*314*	*159*	*357*	*494*	*528*	*1662*	*1195*	*1656*	*398*	*631*	*876*	*668*	*1092*	*961*	*471*	*1042*	*1043*	*1685*	*1680*	*1470*	*1869*	*655*	*1330*	
Habitat Strata[3]	F	F	R	R	R	F	F	R	R	R	F	R	F	R	S	F	S	F	F	F	R	R	F	F	F	R	S	S	S	S	F	S	
No. of detector hours[4]	3	3	3	3	3	3	3	3	3	NA	3	3	3	3	3	3	3	3	3	3	3	3	NA	NA	3	3	3	3	3	3	3	3	**87**
No. of feeding buzzes	0	0	1	55	0	1	1	2	0	NA	0	1	2	1	0	0	10	0	0	2	8	0	NA	NA	0	1	1	5	3	0	6	0	**100**
Number of calls																																	
MY50Khz	0	0	6	287	5	17	8	13	1	NA	3	15	9	5	0	0	0	0	4	0	53	80	NA	NA	14	18	0	0	0	0	5	0	**543**
MY40Khz	0	1	32	0	4	1	3	24	4	NA	0	1	8	21	7	1	14	0	2	11	26	16	NA	NA	32	7	29	31	142	14	37	71	**539**
MY30-35Khz	0	0	0	0	0	0	17	3	1	NA	0	7	18	0	0	38	0	0	0	0	0	0	NA	NA	47	9	1	0	4	0	3	1	**149**
E. fuscus	0	0	0	1	0	0	0	2	2	NA	0	0	2	1	0	0	0	0	0	0	0	1	NA	NA	3	0	51	0	0	0	103	0	**166**
L. noctivigans	0	0	1	2	0	0	0	0	1	NA	0	0	0	1	0	0	0	0	0	7	0	7	NA	NA	20	0	17	5	0	0	28	0	**89**
E. fuscus/L.noctivigans	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	23	0	**42**
L.cinereus	0	0	0	0	0	0	0	0	0	NA	0	0	0	1	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	0	0	0	**1**
TOTALS	**0**	**1**	**39**	**291**	**9**	**18**	**28**	**43**	**9**	**NA**	**3**	**23**	**38**	**29**	**7**	**39**	**14**	**0**	**6**	**18**	**79**	**104**	**NA**	**NA**	**116**	**34**	**114**	**36**	**146**	**14**	**199**	**72**	**1529**

[1]Site number corresponds to sampling location as shown in Figure 1.

[2]Determined from altimeter and GPS unit and then verified from 1:24,000 topographical maps.

[3]Separated into 3 broad habitat types: R=riparian, F=forest, S=subalpine

[4]Determined by passive Anabat II bat detector.

[5]Technical difficulties with recording equipment, no calls recorded for these sites.

Appendix 3. Distribution and relative abundance of captured bats at study sites, NOCA 1999.

Site Name	BRMU	BBLM	PM09	BBUM	TCLM	
Site Number[1]	2b	4b	5b	6b	7b	**Totals**
Elevation (m)[2]	255	492	493	493	373	
Habitat strata[3]	W	M	W	M	M	
TH[4]	6	2	0	3	4	**15**
NH[5]	15	8	4	9	10	**46**
Number of bats						
M. lucifugus/yumanensis	0	6	2	0	0	**8**
M. evotis	0	0	1	1	0	**2**
M. califonicus	2	0	1	2	2	**7**
M. volans	0	0	0	0	1	**1**
Total	**2**	**6**	**4**	**3**	**3**	**18**

[1]Site number corresponds to sampling location as shown in Figure 1.

[2]Determined from altimeter and GPS unit and then verified from 1:24,000 topographical maps.

[3]Separated into 2 broad riparian habitat types: W=Wetland, M=Mainstem river,

[4] Number of harp trap hours (ie, 1trap x 3 hours = 3 trap hours).

[5] Number of net hours (ie., 2 nets x 3 hours hours).

Note: Since the 1999 sampling scheme deviated from that of 2000-2001 (sites were not stratified into 3 separate habitat types or randomly selected and some sites were sampled on more than one occasion), we presented the 1999 capture data separately and in this appendix only.

Appendix 4. Distribution and relative abundance of captured bats at study sites, NOCA 2000-2001.

Site Name	*THLA*	*FS184*	*COPO*	*COCR*	*FLCR*	*THCR*	*DECR*	*NECR*	*GOCR*	*BARI*	*SPCH*	*HACA*	*PUCR*	*MECA*	*CAPA*	*RALA*
Site Number[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Elevation (m)[2]	*866*	*525*	*162*	*393*	*735*	*472*	*555*	*506*	*268*	*314*	*159*	*357*	*494*	*528*	*1662*	*1195*
Habitat strata[3]	F	F	R	R	R	F	F	R	R	R	F	R	F	R	S	F
Trap Hours[4]	0	0	3	3	3	3	3	0	3	3	3	3	3	0	0	0
Net Hours[5]	6	6	15	6	9	6	9	9	9	9	12	12	9	12	12	12
Number of bats																
M. yumanensis	0	0	10	12	3	0	0	0	0	2	6	4	1	0	0	0
Myotis lucifugus	0	0	4	2	0	1	0	0	5	1	1	0	2	0	0	0
M. evotis	0	0	0	0	1	1	1	0	0	0	1	7	5	0	0	0
M. califonicus	0	0	2	2	3	2	1	0	2	2	0	2	2	2	0	0
M. volans	0	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0
unknown[6]	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**17**	**17**	**8**	**6**	**2**	**0**	**7**	**5**	**8**	**13**	**11**	**2**	**0**	**0**

Site Name	*CORI*	*HACR*	*LIBC*	*WILA*	*LICR*	*FIWE*	*NFBC*	*THCR*	*PAPO*	*FICR*	*DALA*	*MCLA*	*DEPC*	*HILC*	*COLA*	*PCPA*	*Totals*
Site Number[1]	17	18	19	20	21	22	23	24	25	26	27	28	29	30[7]	31	32	**1-32**
Elevation (m)[2]	*1656*	*398*	*631*	*876*	*668*	*1092*	*961*	*471*	*1042*	*1043*	*1685*	*1680*	*1470*	*1869*	*655*	*1330*	
Habitat strata[3]	S	F	F	F	R	R	F	F	F	R	S	S	S	S	F	S	
Trap Hours[4]	0	0	0	0	0	3	0	3	0	0	0	0	0	NA	0	0	**36**
Net Hours[5]	6	12	15	15	15	15	12	15	12	12	15	12	12	NA	15	12	**336**
Number of bats																	
M. yumanensis	0	0	0	0	0	0	0	0	0	0	0	0	0	NA	6	1	**45**
Myotis lucifugus	0	0	0	13	0	0	0	0	0	3	3	2	0	NA	4	2	**43**
M. evotis	0	0	0	1	0	0	1	4	1	1	0	0	0	NA	0	1	**25**
M. califonicus	0	1	0	0	0	1	2	0	0	0	0	0	0	NA	0	0	**24**
M. volans	0	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	1	**5**
unknown[6]	0	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	**2**
Total	**0**	**1**	**0**	**14**	**0**	**1**	**3**	**4**	**1**	**4**	**3**	**2**	**0**	**NA**	**10**	**5**	**144**

[1]Site number corresponds to sampling location as shown in Figure 1.

[2] Determined from altimeter and GPS unit and then verified from 1:24,000 topographical maps.

[3]Separated into 3 broad habitat types: R=Riparian, F=Forest, S=Subalpine

[4] Number of harp trap hours (ie., 1 trap x 3 hours = 3 trap hours).

[5] Number of net hours (ie., 1 net x 3 hours = 3 net hours).

[6]Bats escaped before we could identify them.

[7]No attempt was made to capture bats at this site, due to landscape limitations.

Appendix 5. Bat capture data to include morphological measurements, NOCA 1999-2001.

Record No.	Map Site No.	Location	Date	Strata	East/West	Elev. (m)	Start Temp (C)	End Temp (C)	% Cloud	Wind mph	Mist/Harp	Time	Taxon	Sex	Age	Repr. Status	Forearm (mm)	Ear(mm)	Foot(mm)	Keel	Wt(g)	Voucher No./Comments
1	4b	BBLM	07/22/99	NA	West	492	18	17	20	UKN	UKN	21:18	M. yuma/luci	F	A	UKN	36	11.6	7	UKN	5.7	
2	4b	BBLM	07/22/99	NA	West	492	18	17	20	UKN	UKN	21:47	M. yuma/luci	M	A	UKN	34.4	11.5	7	UKN	5.4	myyu?
3	4b	BBLM	07/22/99	NA	West	492	18	17	20	UKN	UKN	21:55	M. yuma/luci	M	A	UKN	35	11.5	7.6	UKN	5.8	myyu?
4	4b	BBLM	07/22/99	NA	West	492	18	17	20	UKN	UKN	22:11	M. yuma/luci	M	A	UKN	36.3	11.2	7.6	UKN	5.9	myyu?
5	4b	BBLM	07/22/99	NA	West	492	18	17	20	UKN	UKN	22:26	M. yuma/luci	F	A	UKN	34.1	11.9	7.6	UKN	6.3	myyu?
6	4b	BBLM	07/22/99	NA	West	492	18	17	20	UKN	UKN	22:35	M. yuma/luci	F	A	NR	36.2	11.7	7.2	UKN	5.8	
7	7b	TCLM	08/05/99	NA	West	373	17	14	100	UKN	UKN	21:12	M. californicus	F	A	L	34.2	11.8	UKN	UKN	4.9	
8	7b	TCLM	08/05/99	NA	West	373	17	14	100	UKN	UKN	21:27	M. volans	F	A	NR	41.1	11.1	7.1	UKN	7.1	
9	5b	PM09	08/17/99	NA	West	493	16	12	5	UKN	UKN	20:45	M. yuma/luci	M	A	NR	35.2	12	UKN	N	5.6	
10	5b	PM09	08/17/99	NA	West	493	16	12	5	UKN	UKN	20:45	M. yuma/luci	M	A	R	33.7	12	UKN	UKN	6.4	
11	5b	PM09	08/17/99	NA	West	493	16	12	5	UKN	UKN	21:15	M. evotis	F	A	PL?	39.6	18	6	N	6	
12	5b	PM09	08/17/99	NA	West	493	16	12	5	UKN	Harp	21:40	M. californicus	F	A	L	32.4	9	UKN	Y	5.5	bare around teat
13	6b	BBUM	09/01/99	NA	West	493	10	6	0	UKN	UKN	20:36	M. evotis	F	A	PL?	38.4	16	UKN	UKN	5.8	
14	6b	BBUM	09/01/99	NA	West	493	10	6	0	UKN	UKN	21:00	M. californicus	F	A	PL?	35.4	14	UKN	UKN	5.2	fur brown/blonde
15	6b	BBUM	09/01/99	NA	West	493	10	6	0	UKN	Harp	21:00	M. californicus	F	A	PL?	33.3	13	UKN	UKN	4.2	
16	7b	TCLM	09/07/99	NA	West	373	9	7	0	UKN	Harp	20:10	M. californicus	F	A	PL	34.5	14	UKN	UKN	4.6	caught in harp trap @bridge
17	2b	BRMU	09/14/99	NA	West	255	14	9	0	UKN	Mist	20:15	M. californicus	F	A	PL	34.2	14	UKN	UKN	5.5	darker cinnamon
18	2b	BRMU	09/14/99	NA	West	255	14	9	0	UKN	Harp	20:35	M. californicus	F	A	PL	33.7	14	UKN	UKN	5.2	
19	3	COPO	06/15/00	Riparian	West	162	18	16	0	0	Mist	22:05	M. yumanensis	F	A	NR	31.6	12	7	N	5.7	A6272251.2
20	3	COPO	06/19/00	Riparian	West	162	18	16	0	0	Mist	22:05	M. lucifugus	F	A	NR	37	13	7	N	6.5	A6272310.19
21	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	22:05	M. yumanensis	F	A	P	34	12	7	N	6.1	A6272323.54
22	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Harp	20:45	M. californicus	M	A	NR	32	10.3	5.1	Y	4.5	A6272325.07, ear mites
23	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	22:05	M. yumanensis	F	A	P	35	11	9	N	6.9	A6272327.16
24	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	20:45	M. yumanensis	F	A	NR?	36	12	7	N	6.5	A6272347.44
25	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	20:45	M. lucifugus	F	A	NR?	36.7	11	7	N	7	A6272349.34
26	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Harp	23:28	M. lucifugus	F	A	NR	37	13	6	N	6.2	A6272357.54
27	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Harp	23:28	lost	lost	lost	lost	lost	lost	lost	lost	lost	lost
28	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	23:32	M. yumanensis?	lost	lost	lost	lost	lost	lost	lost	lost	lost

Record No.	Map Site No.	Location	Date	Strata	East/West	Elev. (m)	Start Temp (C)	End Temp (C)	% Cloud	Wind mph	Mist/Harp	Time	Taxon	Sex	Age	Repr. Status	Forearm (mm)	Ear(mm)	Foot(mm)	Keel	Wt(g)	Voucher No./Comments
29	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Harp	23:58	M. californicus	F	A	NR	33	13	6	Y	5.9	A6280048.39
30	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	0:03	M. yumanensis	F	A	NR?	36	12	9	N	7.4	A6280036.57
31	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	0:03	M. lucifugus	F	A	NR?	36.5	13	7.5	N	5.6	A6280038.16
32	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	0:03	M. yumanensis	F	A	NR?	34	11	8	N	5.2	A6280047.04
33	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	1:15	M. yumanensis	F	A	NR	35	11	8	N	6.4	A62802,on Chris's comp.
34	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	1:15	M. yumanensis	F	A	P?	34	11	9	N	6.2	A6280159.59,on Chris's comp.
35	3	COPO	06/27/00	Riparian	West	162	18	16	0	0	Mist	1:15	M. yumanensis	F	A	NR	35	12	9	N	5.2	A6280201.44,on Chris's comp.
36	4	COCR	06/27/00	Riparian	East	393	13	11	80	0	Mist	21:10	M. californicus	F	A	UKN	32.5	11	6	Y	5.2	7042139.06
37	4	COCR	06/27/00	Riparian	East	393	13	11	80	0	Mist	21:20	M. californicus	F	A	UKN	32.9	12	5	Y	4.9	7042140.1
38	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:30	M. yumanensis	F	A	UKN	34.7	12	7	N	6.8	
39	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:35	M. yumanensis	F	A	P	35.2	12	8	N	8.1	
40	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:40	M. lucifugus	M	A	NR	34.9	8	6	N	4.7	
41	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:45	M. yumanensis	F	A	UKN	34	7	8	N	7.3	none
42	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:55	M. lucifugus	F	A	UKN	37.8	12	10	N	5.8	
43	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:56	M. yumanensis	F	A	P	34.8	13	8	N	6.5	
44	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	21:57	M. yumanensis	M	A	NR	34.5	8	8	N	4.8	
45	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	22:20	M. yumanensis?	M	A	NR	43	11	7.5	N	4.4	
46	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Harp	22:30	M. yumanensis	M	A	NR	33.3	11	7	N	999	none
47	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	22:35	M. yumanensis	M	A	NR	34	11	7.5	N	4.6	
48	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Harp	22:30	M. yumanensis	M	A	NR	33.3	10.8	8	N	5.3	
49	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Harp	22:30	lost	lost	lost	lost	lost	lost	lost	lost	lost	lost
50	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	22:55	M. yumanensis	F	A	UKN	36.9	10	8	N	5.7	
51	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Mist	23:00	M. yumanensis	F	A	P?	34.7	12	7	N	5.5	
52	4	COCR	07/04/00	Riparian	East	393	13	11	80	0	Harp	23:24	M. yumanensis	F	A	P?	33.6	11	10	N	6.3	
53	5	FLCR	07/04/00	Riparian	East	735	19	11	90	2.5	Mist	21:37	M. volans	F	A	P	40.4	10	8	Y	8.6	7052149.38,7052149.32, 7052149.16
54	5	FLCR	07/04/00	Riparian	East	735	19	11	90	2.5	Harp	21:38	M. californicus	F	A	NR	32	10	5	Y	4.8	7052140.08, 40 k
55	5	FLCR	07/05/00	Riparian	East	735	19	11	90	2.5	Harp	22:10	M. californicus	F	A	NR?	44.6	10	6	Y	4.9	
56	5	FLCR	07/05/00	Riparian	East	735	19	11	90	2.5	Mist	22:10	M. yumanensis	F	A	UKN	34.1	12	7	N	4.5	7052214.04, ear mites
57	5	FLCR	07/05/00	Riparian	East	735	19	11	90	2.5	Mist	22:39	M. californicus	F	A	UKN	33.2	12	5	Y	5.1	7052240.45, leg 20mm
58	5	FLCR	07/05/00	Riparian	East	735	19	11	90	2.5	Mist	22:39	M. evotis	F	A	P	38	15	9	N	999	

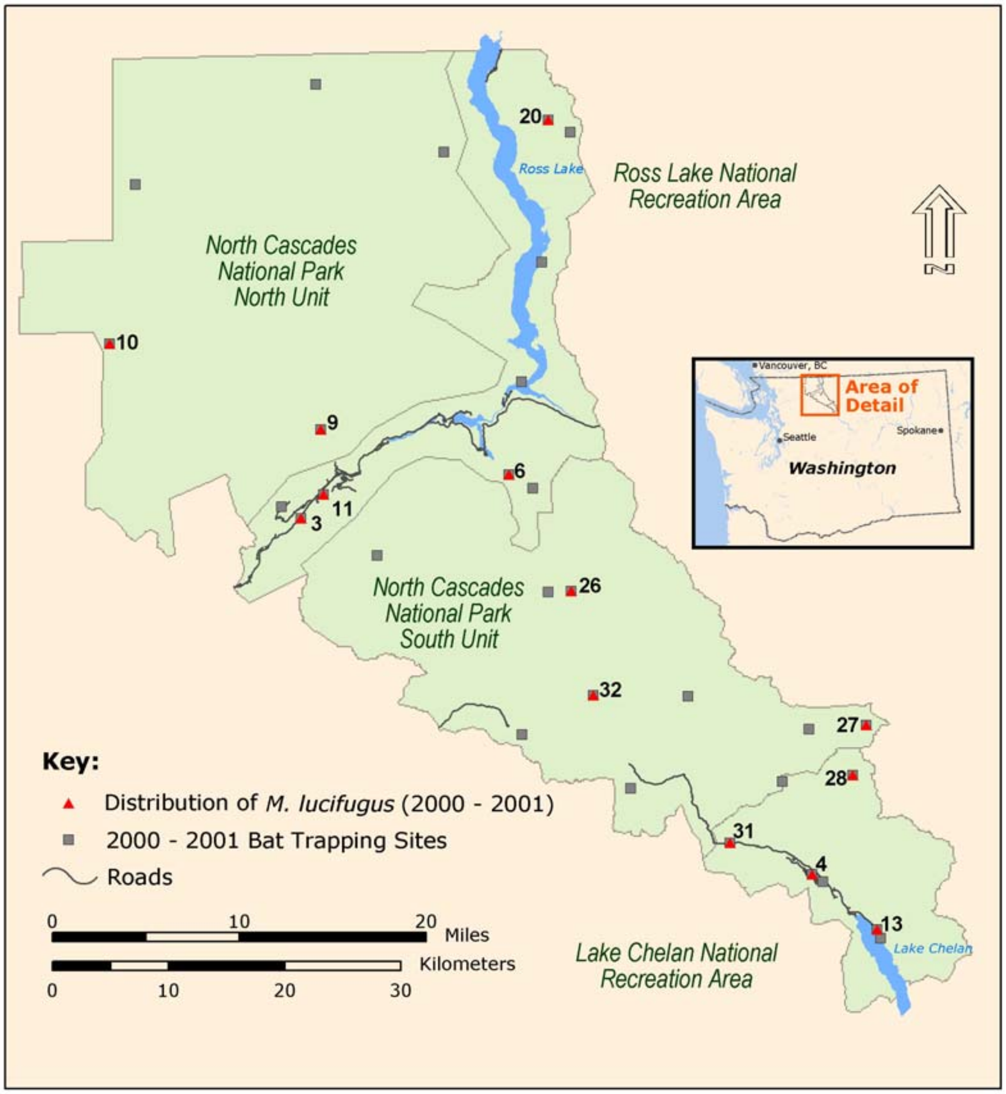
Record No.	Map Site No.	Location	Date	Strata	East/West	Elev. (m)	Start Temp (C)	End Temp (C)	% Cloud	Wind mph	Mist/Harp	Time	Taxon	Sex	Age	Repr. Status	Forearm (mm)	Ear(mm)	Foot(mm)	Keel	Wt(g)	Voucher No./Comments
59	5	FLCR	07/05/00	Riparian	East	735	19	11	90	2.5	Mist	23:08	M. yumanensis	M	A	NR	35	11	7	N	4.6	7052306.37, ear mites
60	5	FLCR	07/05/00	Riparian	East	735	19	11	90	2.5	Harp	23:08	M. yumanensis	M	A	NR	34.8	7.4	7.4	N	5.4	
61	6	THCR	07/05/00	Forest	West	472	14	11	10	2.5	Harp	21:15	M. californicus	F	A	UKN	32.8	11.5	6.5	Y	5.9	
62	6	THCR	07/05/00	Forest	West	472	14	11	10	2.5	Harp	21:24	M. lucifugus	M	A	NR	37.5	9	8	N	5.9	
63	6	THCR	07/10/00	Forest	West	472	14	11	10	2.5	Mist	21:40	M. evotis	F	A	UKN	39	15	8	N	5.8	7102204.58, ear mites, missing wing membrane
64	6	THCR	07/10/00	Forest	West	472	14	11	10	2.5	Harp	23:45	M. volans	F	A	NR	41	10	7.5	Y	7.5	
65	6	THCR	07/10/00	Forest	West	472	14	11	10	2.5	Harp	23:45	M. volans	F	A	P	38.8	11	9	Y	8.8	chestnut-colored
66	6	THCR	07/10/00	Forest	West	472	14	11	10	2.5	Harp	23:55	M. californicus	M	A	NR	33	10	5	Y	4.2	
67	7	DECR	07/10/00	Forest	West	555	17	14	0	2.5	Harp	21:50	M. californicus	F	A	NR	31.5	12	5	Y	4.2	photos 813-815
68	7	DECR	07/10/00	Forest	West	555	17	14	0	2.5	Mist	23:20	M. evotis	F	A	P	39.4	16	8.6	N	7.6	ear mites
69	9	GOCR	07/11/00	Riparian	West	268	12	11	5	2	Harp	21:21	M. californicus	M	A	NR	33.3	10	5.5	Y	4.9	
70	9	GOCR	07/11/00	Riparian	West	268	12	11	5	2	Mist	21:52	M. lucifugus	F	A	L	37.3	12	7.9	N	5.7	
71	9	GOCR	07/17/00	Riparian	West	268	12	11	5	2	Mist	21:52	M. lucifugus	M	A	R	34.7	10	8	N	5.5	none
72	9	GOCR	07/18/00	Riparian	West	268	12	11	5	2	Mist	21:52	M. lucifugus	F	A	L	36.5	12	7	N	7	
73	9	GOCR	07/18/00	Riparian	West	268	12	11	5	2	Mist	23:35	M. lucifugus	F	A	P	37.28	12	7.5	N	8	
74	9	GOCR	07/18/00	Riparian	West	268	12	11	5	2	Harp	0:17	M. lucifugus	M	A	NR	34.2	12	7	N	7.2	none
75	9	GOCR	07/18/00	Riparian	West	268	12	11	5	2	Harp	0:17	M. californicus	F	A	L	32.7	11	6	Y	5.1	none
76	10	BARI	07/18/00	Riparian	West	314	16	12	2	2.5	Mist	21:40	M. yumanensis	M	A	NR	33.7	12	5.7	N	5.9	
77	10	BARI	07/18/00	Riparian	West	314	16	12	2	2.5	Mist	22:05	M. lucifugus	M	A	NR	35.5	12	7	N	5.7	
78	10	BARI	07/18/00	Riparian	West	314	16	12	2	2.5	Mist	22:05	M. californicus	F	A	UKN	34	12	5	Y	4.9	check this one
79	10	BARI	07/24/00	Riparian	West	314	16	12	2	2.5	Mist	22:05	M. californicus	M	A	NR	32	9	4	Y	4.6	
80	10	BARI	07/24/00	Riparian	West	314	16	12	2	2.5	Mist	22:30	M. yumanensis	M	A	NR	33.5	11	8	N	5.5	
81	11	SPCH	07/24/00	Forest	West	159	18	16	90	0	Mist	21:40	M. lucifugus	M	A	NR	36.5	12	7	N	5.4	
82	11	SPCH	07/24/00	Forest	West	159	18	16	90	0	Mist	21:56	M. yumanensis	F	A	L	34.6	10	9	N	5.7	
83	11	SPCH	07/24/00	Forest	West	159	18	16	90	0	Mist	22:25	M. evotis	F	A	NR	38.8	17	10	N	6.7	7252220.38, tail 1mm, photo 842
84	11	SPCH	07/25/00	Forest	West	159	18	16	90	0	Mist	22:44	M. yumanensis?	lost	lost	lost	lost	lost	lost	lost	lost	lost
85	11	SPCH	07/25/00	Forest	West	159	18	16	90	0	Mist	22:44	M. yumanensis	F	A	UKN	35.7	12	8	N	6.9	
86	11	SPCH	07/25/00	Forest	West	159	18	16	90	0	Mist	22:44	M. yumanensis	F	A	UKN	34.8	10	7	N	6.4	
87	11	SPCH	07/25/00	Forest	West	159	18	16	90	0	Mist	23:23	M. yumanensis	F	A	UKN	35.3	12	7.2	N	6.6	
88	11	SPCH	07/25/00	Forest	West	159	18	16	90	0	Mist	23:23	M. yumanensis	F	A	UKN	35.3	10	8	N	7.3	

Record No.	Map Site No.	Location	Date	Strata	East/West	Elev. (m)	Start Temp (C)	End Temp (C)	% Cloud	Wind mph	Mist/Harp	Time	Taxon	Sex	Age	Repr. Status	Forearm (mm)	Ear(mm)	Foot(mm)	Keel	Wt(g)	Voucher No./Comments
89	12	HACA	07/25/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. evotis	F	A	L	39.2	18	10	N	6.4	8012220.57, photo 832
90	12	HACA	07/25/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. californicus	F	A	NR	34.7	12	6	Y	5.3	
91	12	HACA	07/25/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. yumanensis	F	A	NR	34.4	13	7	N	5.5	
92	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. evotis	F	A	L	40	18	6	N	6.2	
93	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. californicus	M	A	NR	32	12	5	Y	5	8012246,photo 835
94	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. evotis	F	A	NR	40.4	18	10	N	6.2	none
95	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. evotis	F	A	NR	41	20	9	N	6.3	8012256.17, photo 836
96	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. evotis	F	A	L	39.2	18	10	N	6.1	
97	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	23:00	M. yumanensis	M	A	NR	36	14	7	N	6.1	
98	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	21:25	M. evotis	F	A	L	39.9	18	9	N	6.3	8012312.23, photo 840
99	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	23:00	M. yumanensis	F	A	L	34.6	12	6	N	5.4	8012316.57, photo 841
100	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Mist	23:45	M. evotis	F	A	L	39.8	18	8	N	6.8	
101	12	HACA	08/01/00	Riparian	East	357	26	23	0	15	Harp	0:15	M. yumanensis	F	A	L	35.7	12	8	N	6.6	none
102	13	PUCR	08/01/00	Forest	East	494	25	21	0	12.5	Mist	21:05	M. lucifugus	F	A	L	35.9	10	8	N	5.7	
103	13	PUCR	08/01/00	Forest	East	494	25	21	0	12.5	Mist	21:05	M. evotis	F	A	NR	41.5	16	9	N	6.2	
104	13	PUCR	08/01/00	Forest	East	494	25	21	0	12.5	Mist	21:20	M. lucifugus	M	A	NR	36	13	8	N	4.4	
105	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	21:20	M. volans	M	A	NR	39.6	11	7	Y	7	8022143.33, photo 846,847
106	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	21:20	M. californicus	F	A	L	22.8	7	8	Y	4.3	8022153.22. Photo 849
107	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	21:05	M. yumanensis	lost	lost	lost	lost	lost	lost	lost	lost	lost
108	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	22:05	M. evotis	F	A	L	39.9	18	12	N	7.3	8022211.04, photo 850
109	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	22:30	M. evotis	F	A	L	38.5	17	9	N	6	
110	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	22:30	M. evotis	lost	lost	lost	lost	lost	lost	lost	lost	lost
111	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Harp	22:30	M. evotis	F	A	L	38.3	18	9	N	6.5	
112	13	PUCR	08/02/00	Forest	East	494	25	21	0	12.5	Mist	23:50	M. californicus	F	A	L	31.6	10	4	Y	5.2	none
113	14	MECA	08/02/00	Riparian	West	528	19	13	0	0	Mist	21:14	M. californicus	F	A	L/PL	33.9	10	7	Y	5.7	none
114	14	MECA	08/02/00	Riparian	West	528	19	13	0	0	Mist	21:24	M. californicus	F	A	L	32.9	10	6	Y	5.3	none
115	12	HACR	08/02/00	Forest	East	398	14	13	100	0	Mist	21:23	M. californicus	F	A	P	32.3	11	6	Y	5	Drizzle
116	21	WILA	08/07/00	Forest	West	876	16	13	0	0	Mist	21:44	M. lucifugus	M	A	NR	38.5	9.3	7.8	N	6.1	
117	21	WILA	08/07/00	Forest	West	876	16	13	0	0	Mist	21:45	M. lucifugus	M	A	NR	36.7	9.6	7.5	N	6	
118	21	WILA	08/14/00	Forest	West	876	16	13	0	0	Mist	21:55	M. lucifugus	M	A	NR	34.1	11.5	6.9	N	5.6	

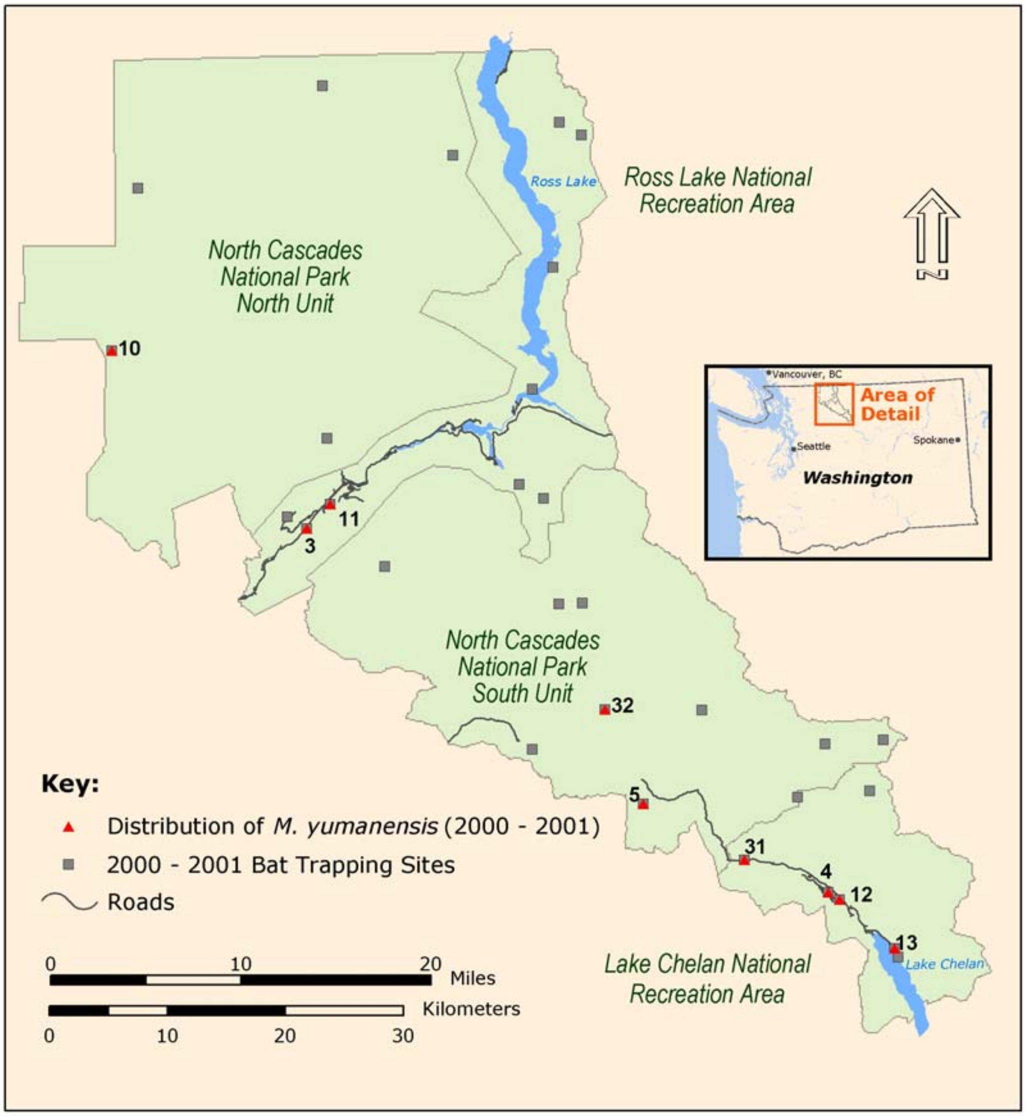
Record No.	Map Site No.	Location	Date	Strata	East/West	Elev. (m)	Start Temp (C)	End Temp (C)	% Cloud	Wind mph	Mist/Harp	Time	Taxon	Sex	Age	Repr. Status	Forearm (mm)	Ear(mm)	Foot(mm)	Keel	Wt(g)	Voucher No./Comments
119	21	WILA	08/14/00	Forest	West	876	16	13	0	0	Mist	21:55	M. lucifugus	M	A	NR	34.5	11.6	8.4	N	5.9	ear mites
120	21	WILA	08/22/00	Forest	West	876	16	13	0	0	Mist	21:55	M. lucifugus	M	A	NR	35.1	12.7	8.1	N	5.4	
121	21	WILA	08/28/00	Forest	West	876	16	13	0	0	Mist	21:55	M. lucifugus	M	A	NR	36.8	12	7.8	N	5.8	
122	21	WILA	06/26/01	Forest	West	876	16	13	0	0	Mist	22:00	M. lucifugus	F	A	P	37.3	9.9	7.2	N	6.8	
123	21	WILA	07/02/01	Forest	West	876	16	13	0	0	Mist	22:00	M. lucifugus	M	A	NR	36.3	10.1	7.4	N	5.4	
124	21	WILA	07/09/01	Forest	West	876	16	13	0	0	Mist	22:05	M. lucifugus	M	A	NR	34.8	11.7	6.4	N	5.6	ear mites
125	21	WILA	07/09/01	Forest	West	876	16	13	0	0	Mist	22:10	M. lucifugus	M	A	NR	35	12.1	6.1	N	6.2	
126	21	WILA	07/09/01	Forest	West	876	16	13	0	0	Mist	22:10	M. lucifugus	M	A	NR	35.9	12.6	7	N	5.5	ear mites
127	21	WILA	07/09/01	Forest	West	876	16	13	0	0	Mist	22:15	M. lucifugus	M	A	NR	35.6	10.8	5.9	N	5.6	
128	21	WILA	07/09/01	Forest	West	876	16	13	0	0	Mist	22:25	M. lucifugus	M	A	NR	36	11	6.3	N	7	
129	21	WILA	07/09/01	Forest	West	876	16	13	0	0	Mist	22:25	M. evotis	M	A	NR	37.3	21	7	N	6.5	photo # 7
130	23	FIWE	07/09/01	Riparian	East	1092	16	12	50	0	Harp	20:20	M. californicus	F	A	NR	33.7	12	5	Y	5.5	4.4mm thumb, hairy from armpits to knee, NC-01
131	24	NFBC	07/09/01	Forest	East	961	15	10	10	0	Mist	22:30	M. californicus	F	A	NR	34.4	9	5.7	Y	4.6	3.0mm thumb, dull chestnut dorsal fur, photo # 7,8
132	24	NFBC	07/09/01	Forest	East	961	15	10	10	0	Mist	23:00	M. californicus	F	A	L	34.5	12	5	Y	5	NC-02
133	24	NFBC	07/09/01	Forest	East	961	15	10	10	0	Mist	23:50	M. evotis	M	A	NR	38.9	17	6.7	N	5.3	wing length 11cm, body width 3cm, NC-03
134	25	THCR	07/09/01	Forest	West	471	16	13	0	0	Mist	21:20	M. evotis	F	A	NR	36.9	17	6	N	5	17262140.37, NC-04
135	25	THCR	07/09/01	Forest	West	471	16	13	0	0	Mist	21:30	M. evotis	F	A	NR	40.3	20	8	N	6.7	17262158.11, tech.difficulties, no collection of NC-05
136	25	THCR	07/09/01	Forest	West	471	16	13	0	0	Harp	21:40	M. evotis	F	A	L	38.9	16	7	N	6	17262206.56, NC-06
137	25	THCR	07/09/01	Forest	West	471	16	13	0	0	Harp	23:15	M. evotis	F	A	L	38	12	7	N	6.7	no tissue sample
138	26	PAPO	07/10/01	Forest	West	1042	15	11	40	0	Mist	22:59	M. evotis	F	A	NR	39.5	17	6	N	5.7	CR301, NC-07
139	27	FICR	07/23/01	Riparian	West	1043	13	6	30	0	Mist	21:10	M. lucifugus	M	A	NR	40	12	7	N	6.6	
140	27	FICR	07/24/01	Riparian	West	1043	13	6	30	0	Mist	21:12	M. lucifugus	M	A	NR	38.2	12	7	N	7.7	NC-08, 302-CR
141	27	FICR	07/24/01	Riparian	West	1043	13	6	30	0	Mist	21:12	M. lucifugus	M	A	NR	35.9	12	6	N	5.5	NC-09
142	27	FICR	07/24/01	Riparian	West	1043	6	6	30	0	Mist	23:45	M. evotis	F	A	NR	39.3	16	7	N	7	NC-10
143	28	DALA	07/26/01	Subalpine	East	1685	12	4	0	5	Mist	21:10	M. lucifugus	M	A	NR	35.6	11	7	N	6	NC-11
144	28	DALA	07/26/01	Subalpine	East	1685	4	4	0	0	Mist	23:30	M. lucifugus	M	A	NR	35.6	12	7	N	6	NC-12
145	28	DALA	07/26/01	Subalpine	East	1685	4	4	0	0	Mist	23:32	M. lucifugus	M	A	NR	34	12	6	N	6	NC-13
146	29	MCLA	07/26/01	Subalpine	East	1680	14	4	0	0	Mist	22:10	M. lucifugus	M	A	R	36.5	9	6	N	6.7	NC-14
147	29	MCLA	07/30/01	Subalpine	East	1680	4	4	0	0	Mist	23:30	M. lucifugus	M	A	NR	33.2	11	6	N	6.3	NC-15

Record No.	Map Site No.	Location	Date	Strata	East/West	Elev. (m)	Start Temp (C)	End Temp (C)	% Cloud	Wind mph	Mist/Harp	Time	Taxon	Sex	Age	Repr. Status	Forearm (mm)	Ear(mm)	Foot(mm)	Keel	Wt(g)	Voucher No./Comments
148	32	COLA	07/31/01	Forest	East	655	19	15	0	0-5	Mist	20:33	M. yumanensis	M	J	NR	30.4	11	6	N	4.6	Pale dorsal, docile
149	32	COLA	07/31/01	Forest	East	655	19	15	0	0-5	Mist	20:33	M. lucifugus	F	A	PL	35.5	12	7	N	5.6	Aggressive, NC-16
150	32	COLA	07/31/01	Forest	East	655	19	15	0	0-5	Mist	20:33	M. yumanensis	F	A	PL	36.1	11	6	N	7	Docile, NC-17
160	32	COLA	07/31/01	Forest	East	655	19	15	0	0-5	Mist	20:33	M. lucifugus	F	A	PL	37	12	7	N	6	Docile, NC-18
161	32	COLA	08/07/01	Forest	East	655	19	15	0	0-5	Mist	20:33	M. yumanensis	F	A	PL	34.6	12	8	N	5.8	Docile, NC-19
162	32	COLA	08/07/01	Forest	East	655	19	15	0	0-5	Mist	21:30	M. yumanensis	M	A	NR	34.6	12	7	N	5.5	Docile
163	32	COLA	08/07/01	Forest	East	655	19	15	0	0-5	Mist	21:30	M. yumanensis	M	A	NR	34.2	11	6	N	5.4	pinkish face
164	32	COLA	08/08/01	Forest	East	655	19	15	0	0-5	Mist	22:55	M. lucifugus	F	A	PL	36.5	12	7	N	7.4	dark mask, NC-20
165	32	COLA	08/08/01	Forest	East	655	19	15	0	0-5	Mist	22:57	M. lucifugus	M	A	NR	37.6	12	7	N	6.2	Aggressive
166	32	COLA	08/14/01	Forest	East	655	19	15	0	0-5	Mist	22:57	M. yumanensis	M	A	NR	35	12	7	N	6.1	pinkish face
167	33	PCPA	08/20/01	Subalpine	East	1330	15	7	0	0-5	Mist	20:20	M. yumanensis	M	A	NR	35.6	8	6	N	6.6	Ear mites, spider-like parasite, dull fur, aggressive, NC-21
168	33	PCPA	08/28/01	Subalpine	East	1330	15	7	0	0-5	Mist	20:21	M. lucifugus	M	A	NR	36	12	7	N	6.5	Dark face, long shiny dorsal fur, NC-22
169	33	PCPA	08/28/01	Subalpine	East	1330	15	7	0	0-5	Mist	20:23	M. lucifugus	M	A	NR	35.9	12	7	N	5.7	ear mites, NC-23
170	33	PCPA	08/28/01	Subalpine	East	1330	15	7	0	0-5	Mist	20:24	M. volans	F	A	NR	40.5	10	8	Y	7.6	11" wing span, very docile, very black
171	33	PCPA	08/28/01	Subalpine	East	1330	15	7	0	0-5	Mist	20:38	M. evotis	M	A	NR	37.3	17	7	N	8.1	8.5" wingspan, NC-24
172	1	THLA	08/28/01	Forest	West	866	10	8	5	0-5	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
173	2	FS184	08/28/01	Forest	West	525			0		Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
174	8	NECR	08/28/01	Riparian	West	506			0	0-5	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
175	16	CAPA	08/28/01	Subalpine	West	1662			0	0-5	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
176	17	RALA	08/28/01	Forest	East	1195			0	0	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
177	18	CORI	08/29/01	Subalpine	West	1656			90	NA	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
178	20	LIBC	08/29/01	Forest	West	631			0	0	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
179	22	LICR	08/29/01	Riparian	West	668			10	0-5	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
180	30	DEPC	08/29/01	Subalpine	West	1470			0	0-5	Mist	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No bats captured
181	31	HILC	08/29/01	Subalpine	West	1869			100	0-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No attempt made to trap due to unsafe landscape conditions.

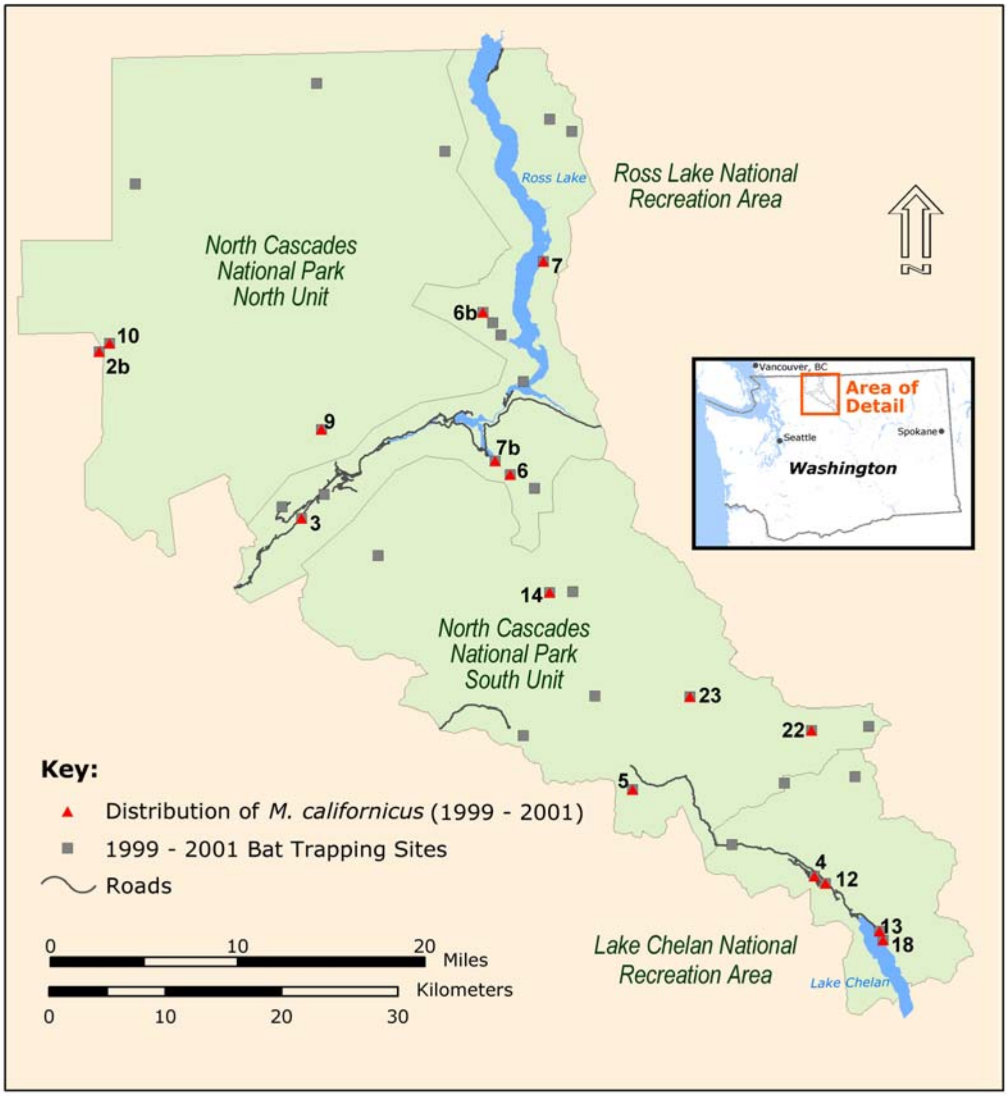
Appendix 6. Distribution of Little Brown Myotis (*M. lucifugus*), NOCA 2000-2001.



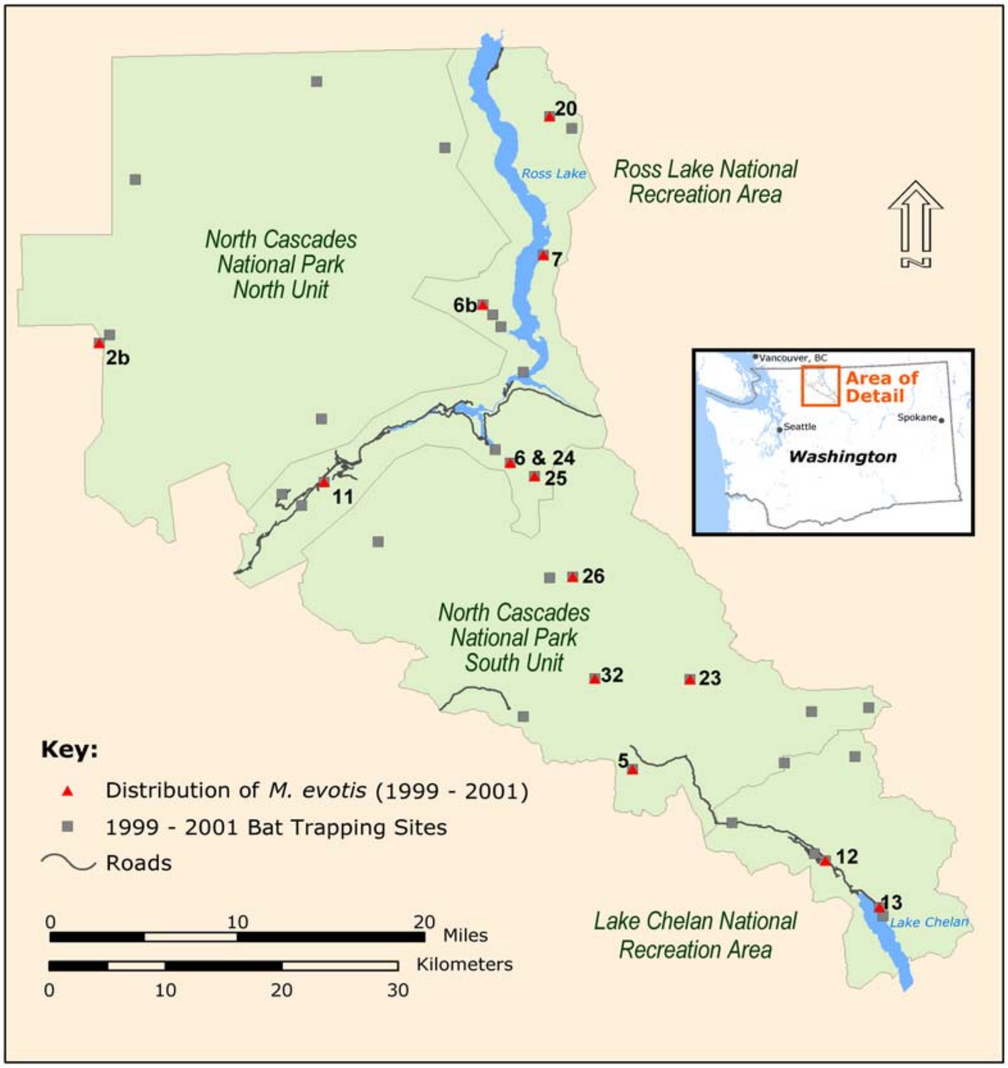
Appendix 6 (cont.). Distribution of Yuma Myotis (*M. yumanensis*), NOCA 2000-2001.



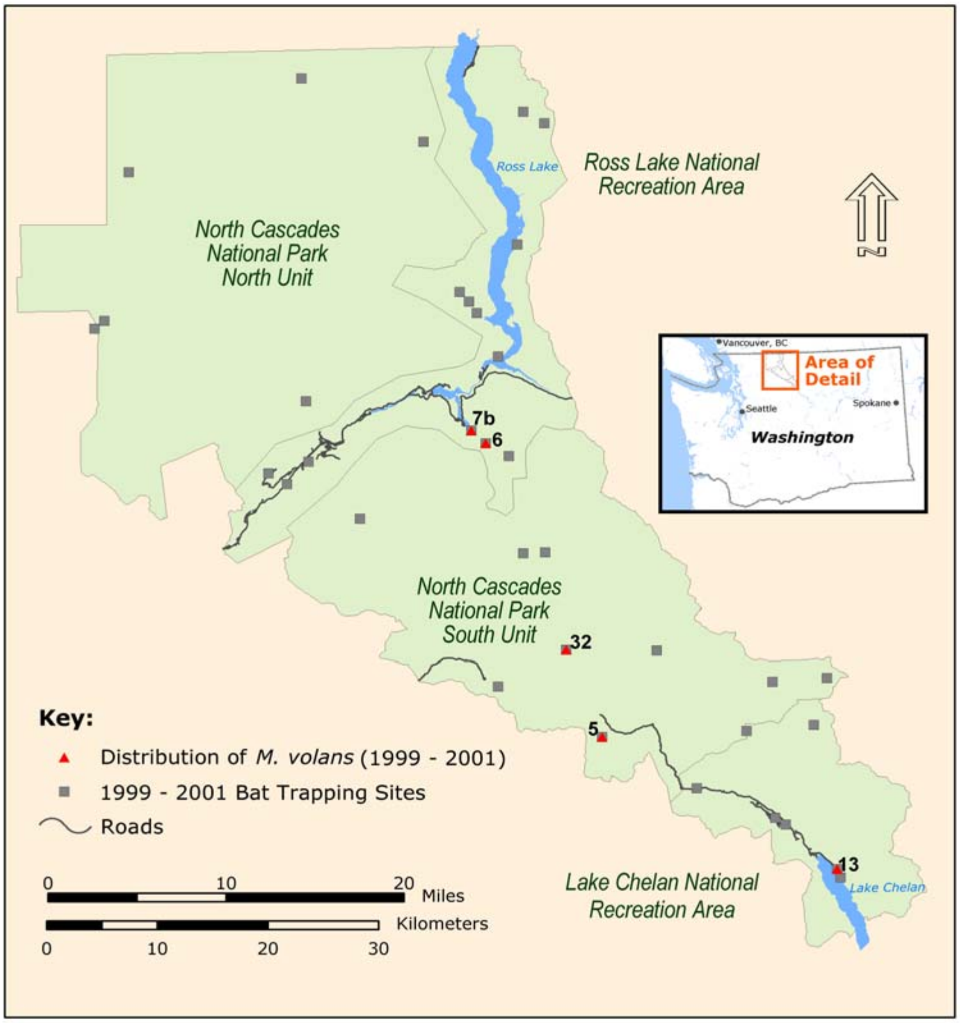
Appendix 6 (cont). Distribution of California Myotis (*M. californicus*), NOCA 1999-2001.



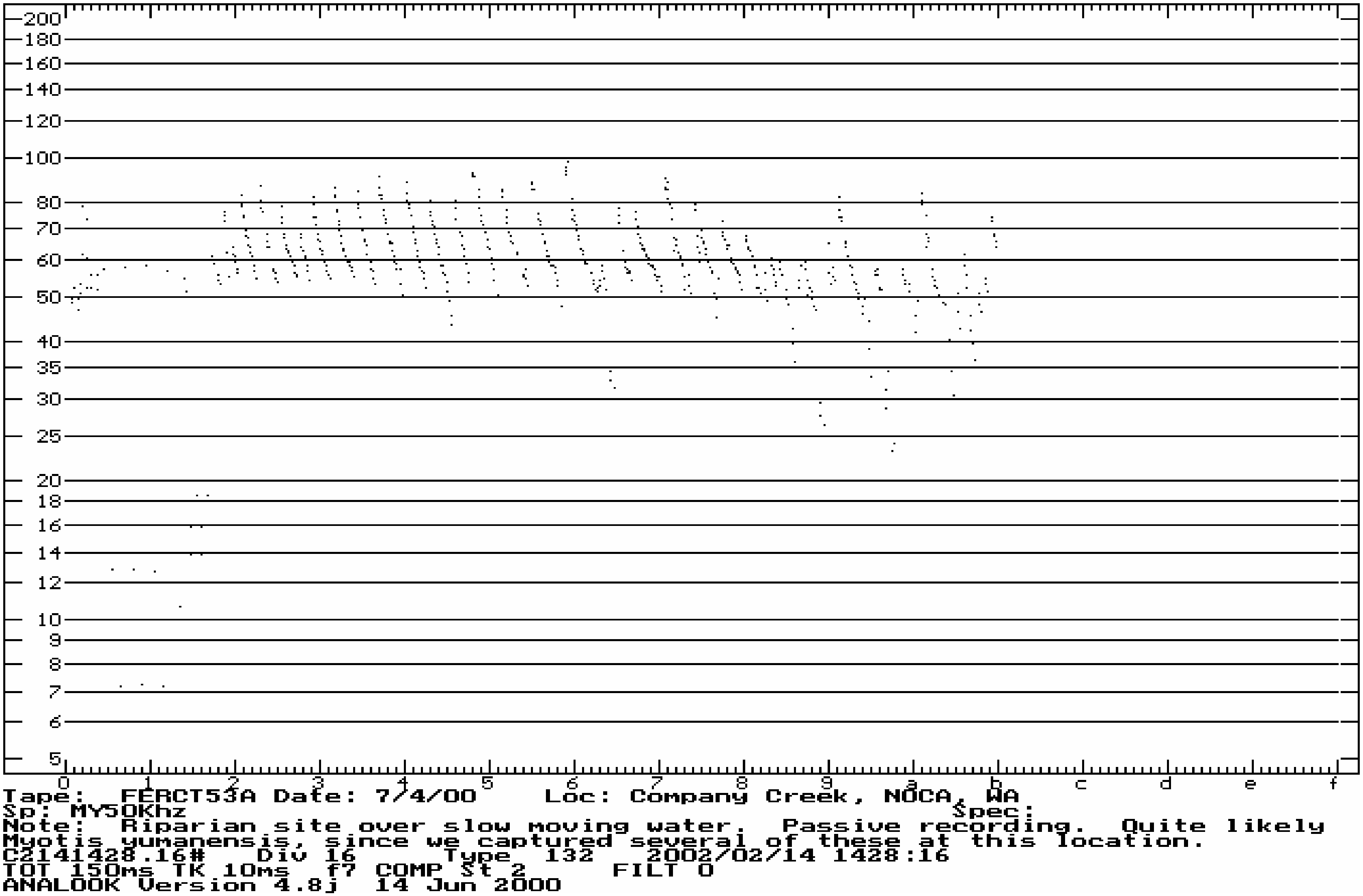
Appendix 6 (cont.). Distribution of Western Long-eared Myotis (*M. evotis*), NOCA 1999-2001.



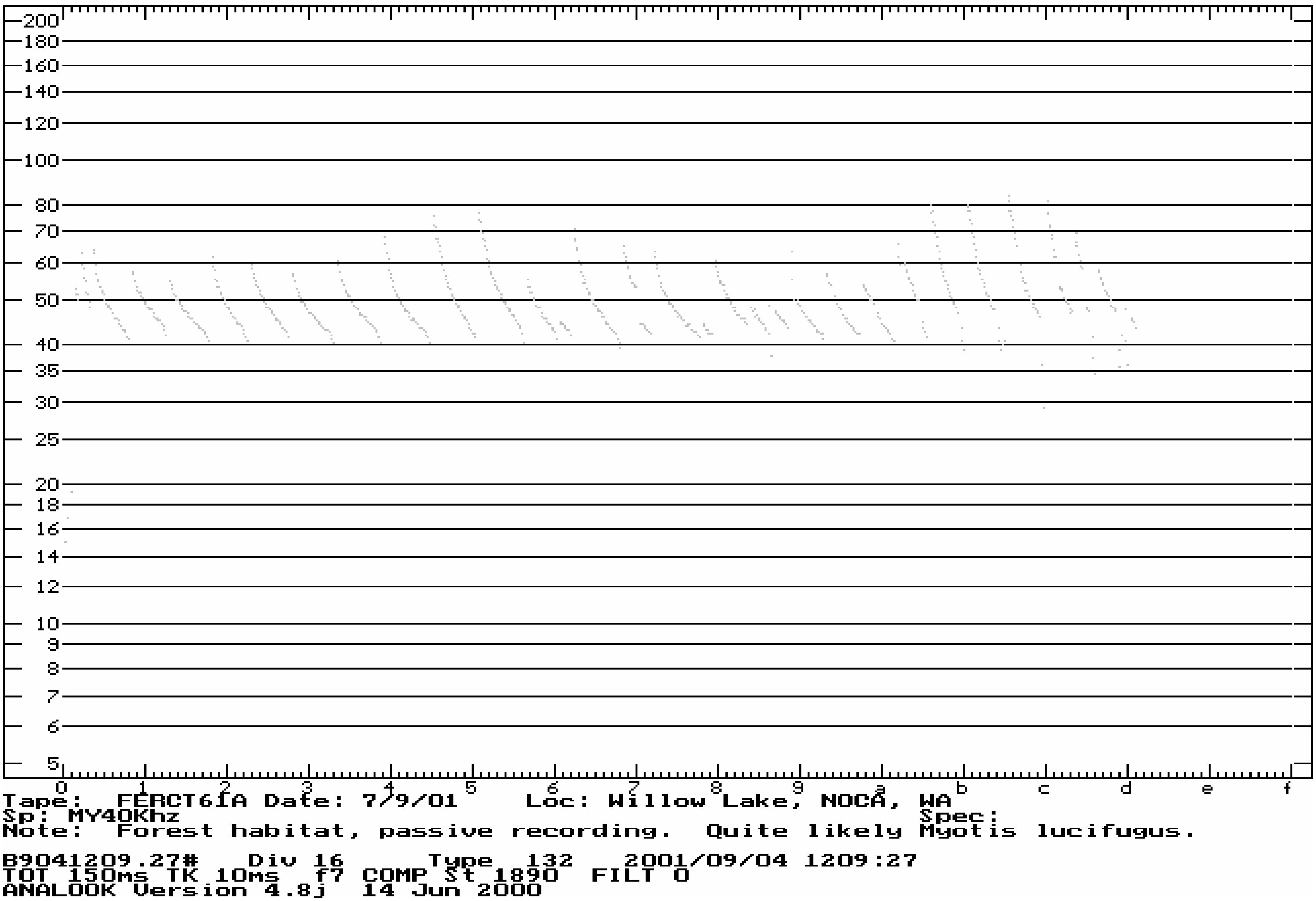
Appendix 6 (cont.). Distribution of Long-legged Myotis (*M. volans*), NOCA 1999-2001.



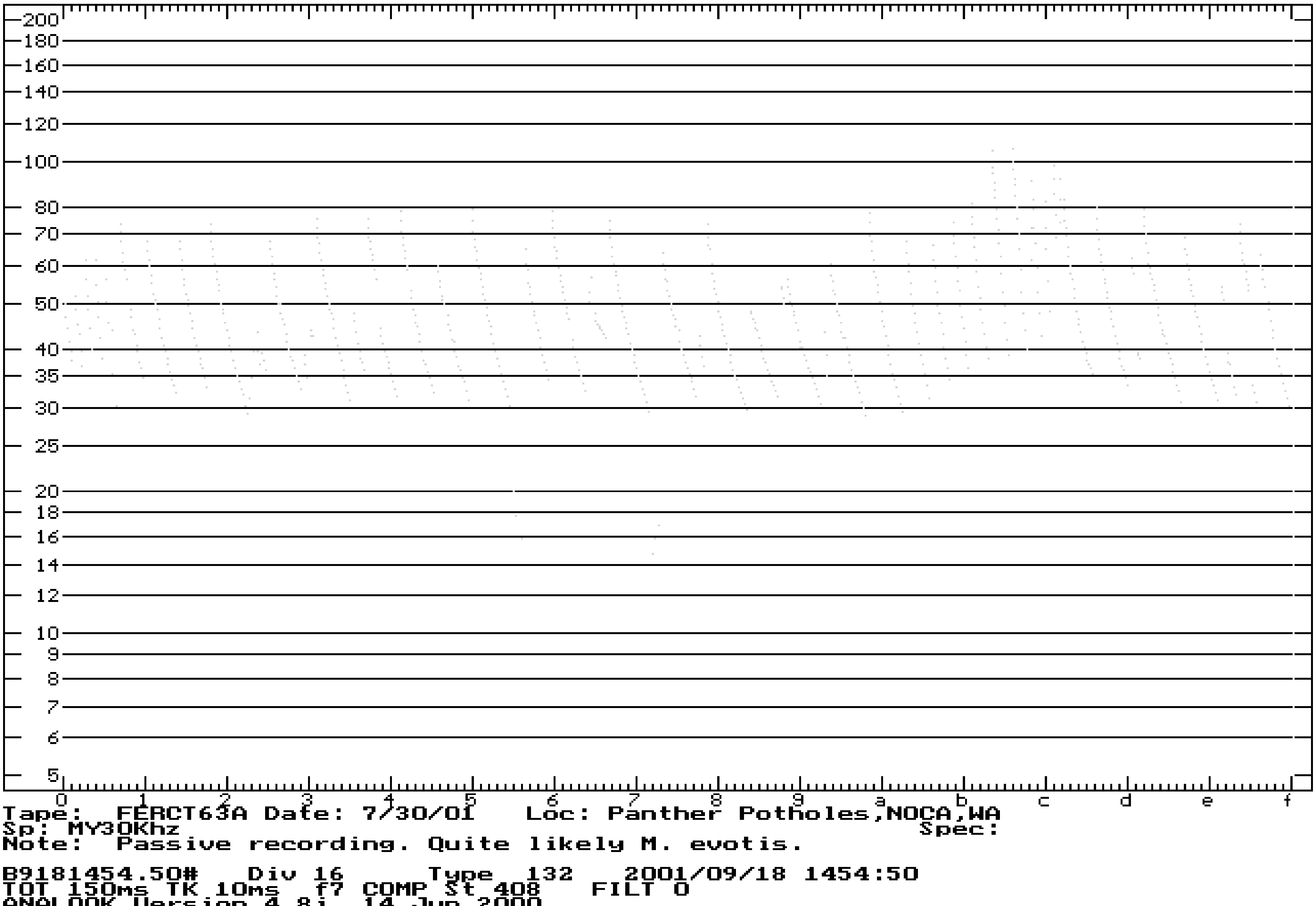
Appendix 7. Example of passive recording from MY50Khz call group, NOCA 1999-2001.



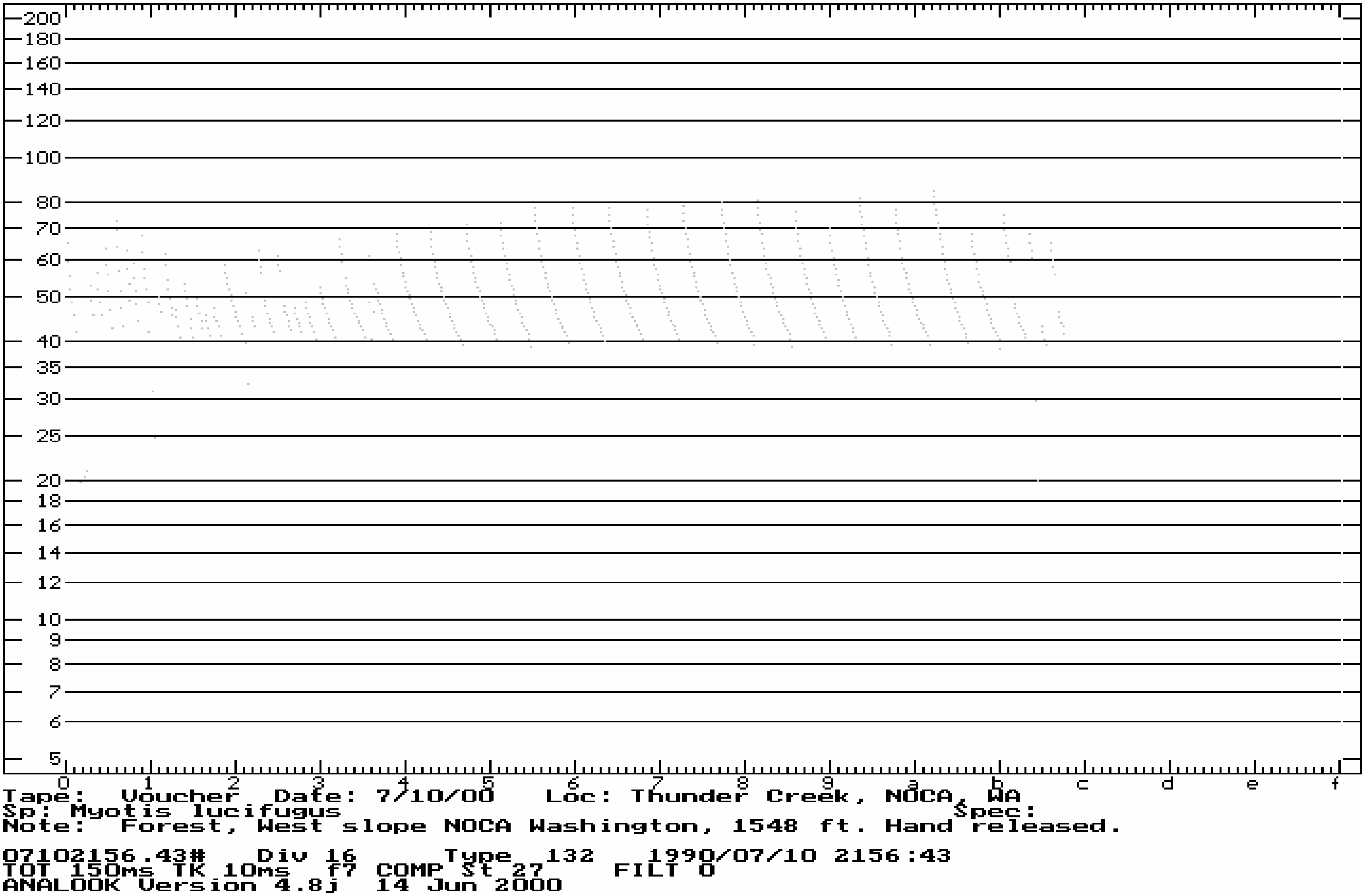
Appendix 7 (cont.). Example of passive recording from MY40Khz call group, NOCA 1999-2001.



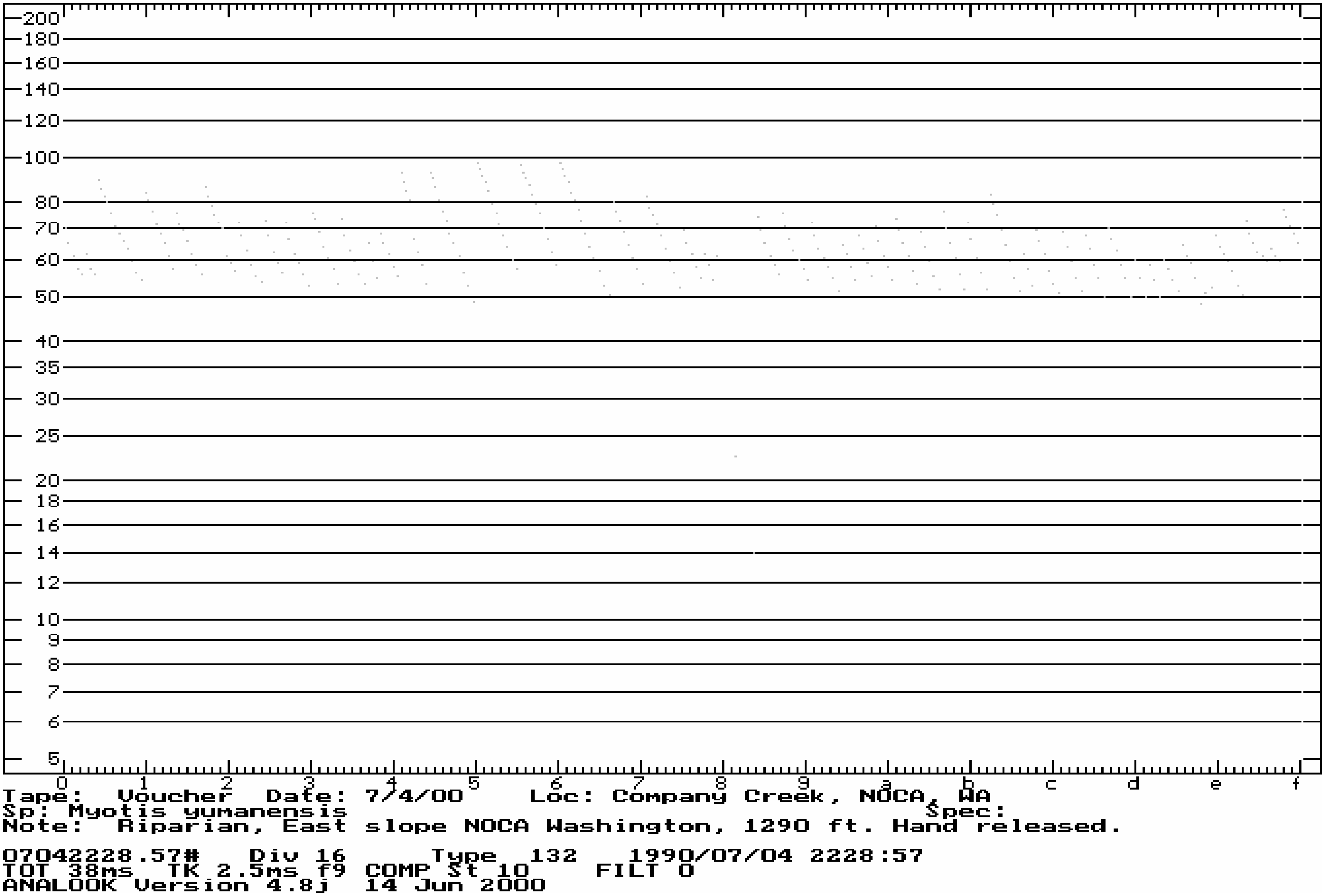
Appendix 7 (cont.). Example of passive recording from MY30-35Khz call group, NOCA 1999-2001.



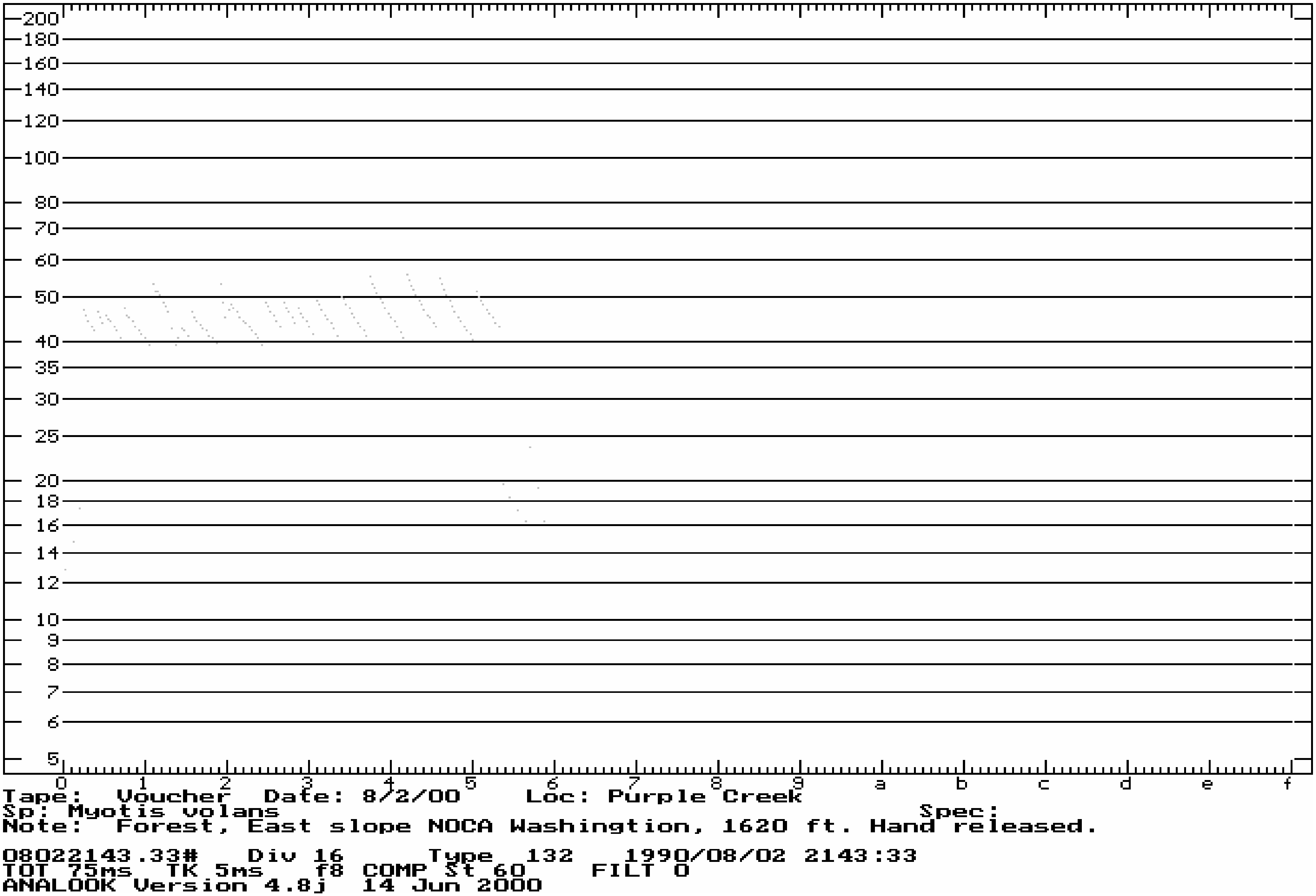
Appendix 7 (cont.). Example of Little Brown Myotis (*Myotis lucifugus*) voucher call, NOCA 1999-2001.



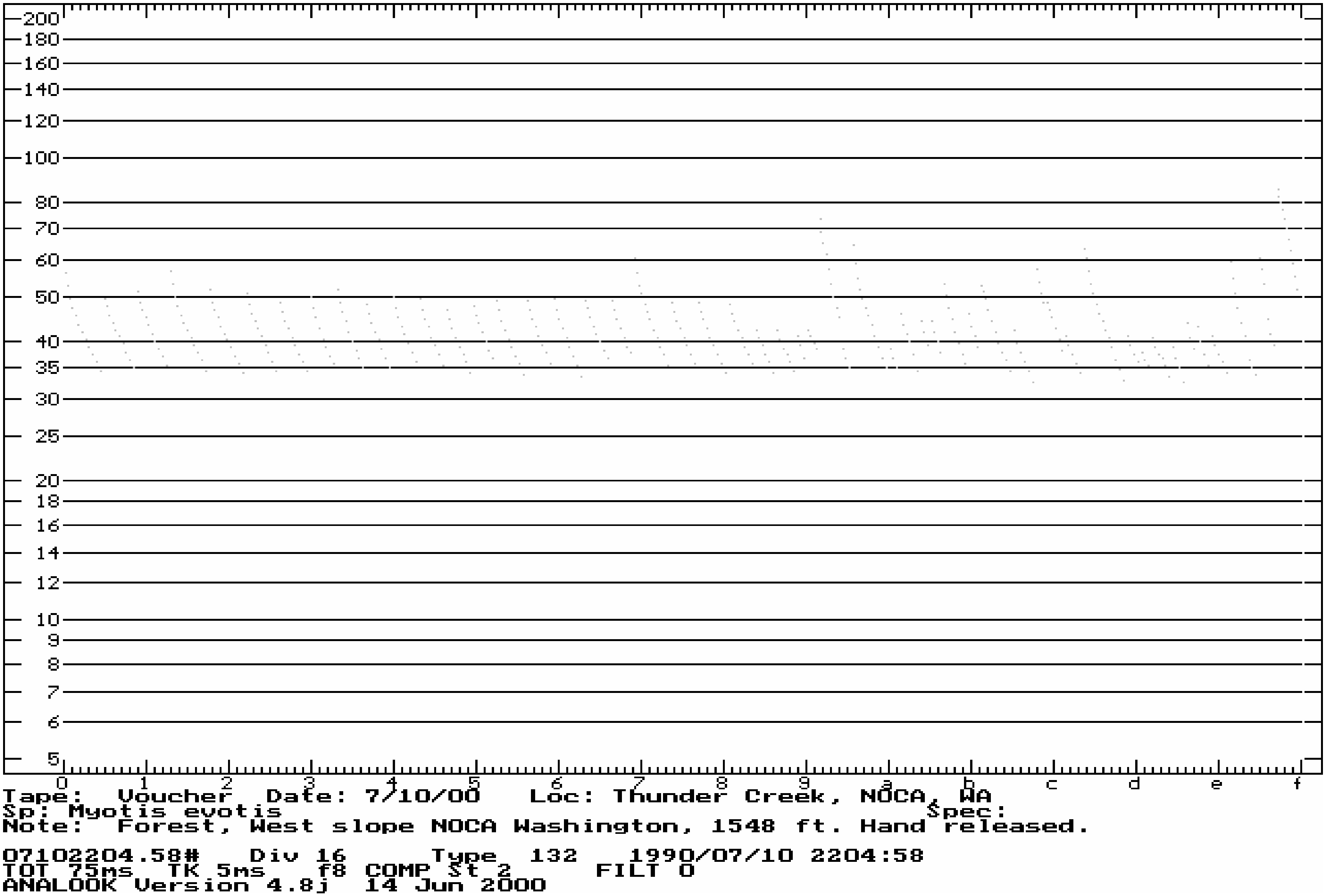
Appendix 7 (cont.). Example of Yuma Myotis (*Myotis yumanensis*) voucher call, NOCA 1999-2001.



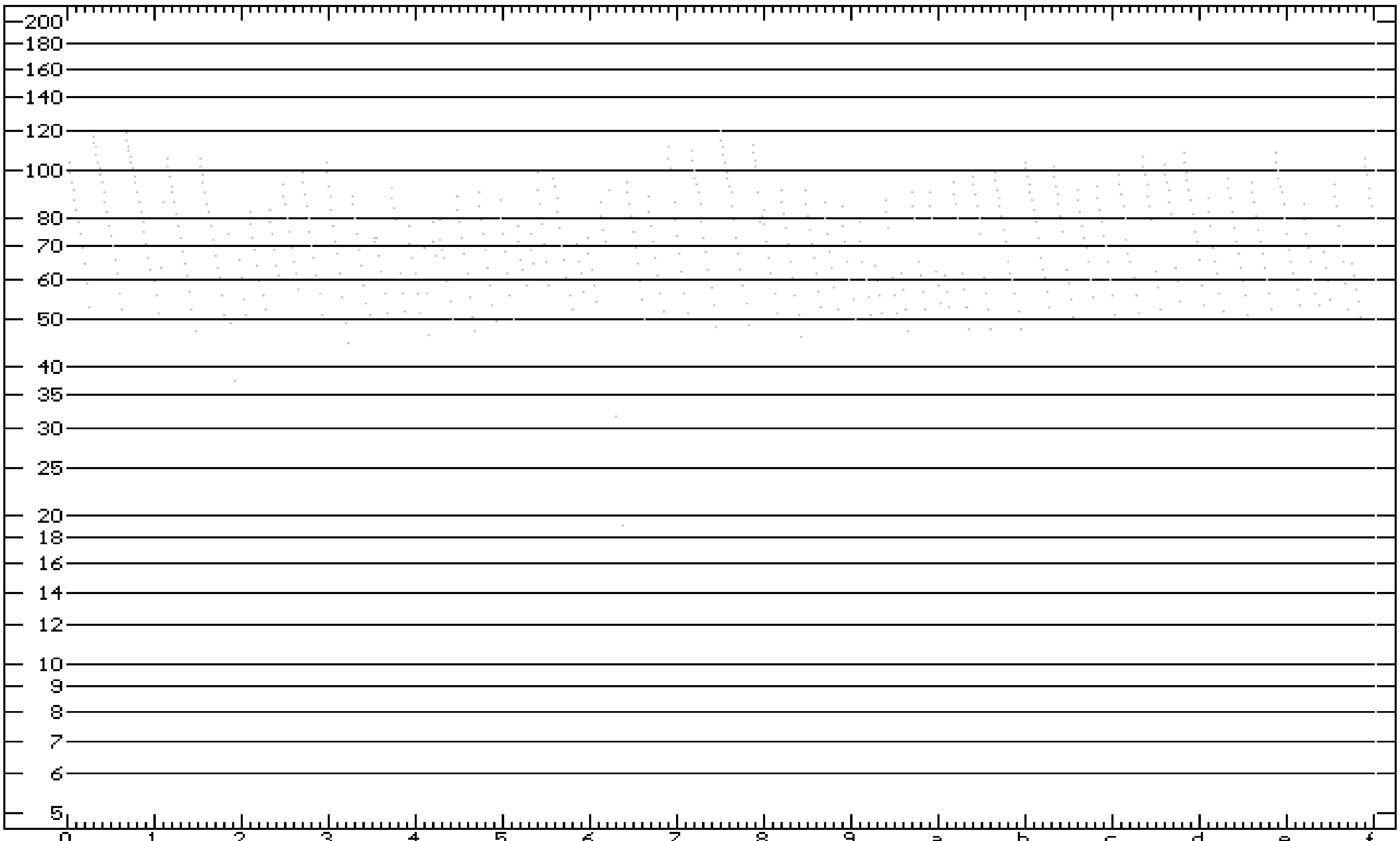
Appendix 7 (cont.). Example of Long-legged Myotis (*Myotis volans*) voucher call, NOCA 1999-2001.



Appendix 7 (cont.). Example of Western Long-eared Myotis (*Myotis evotis*) voucher call, NOCA 1999-2001.



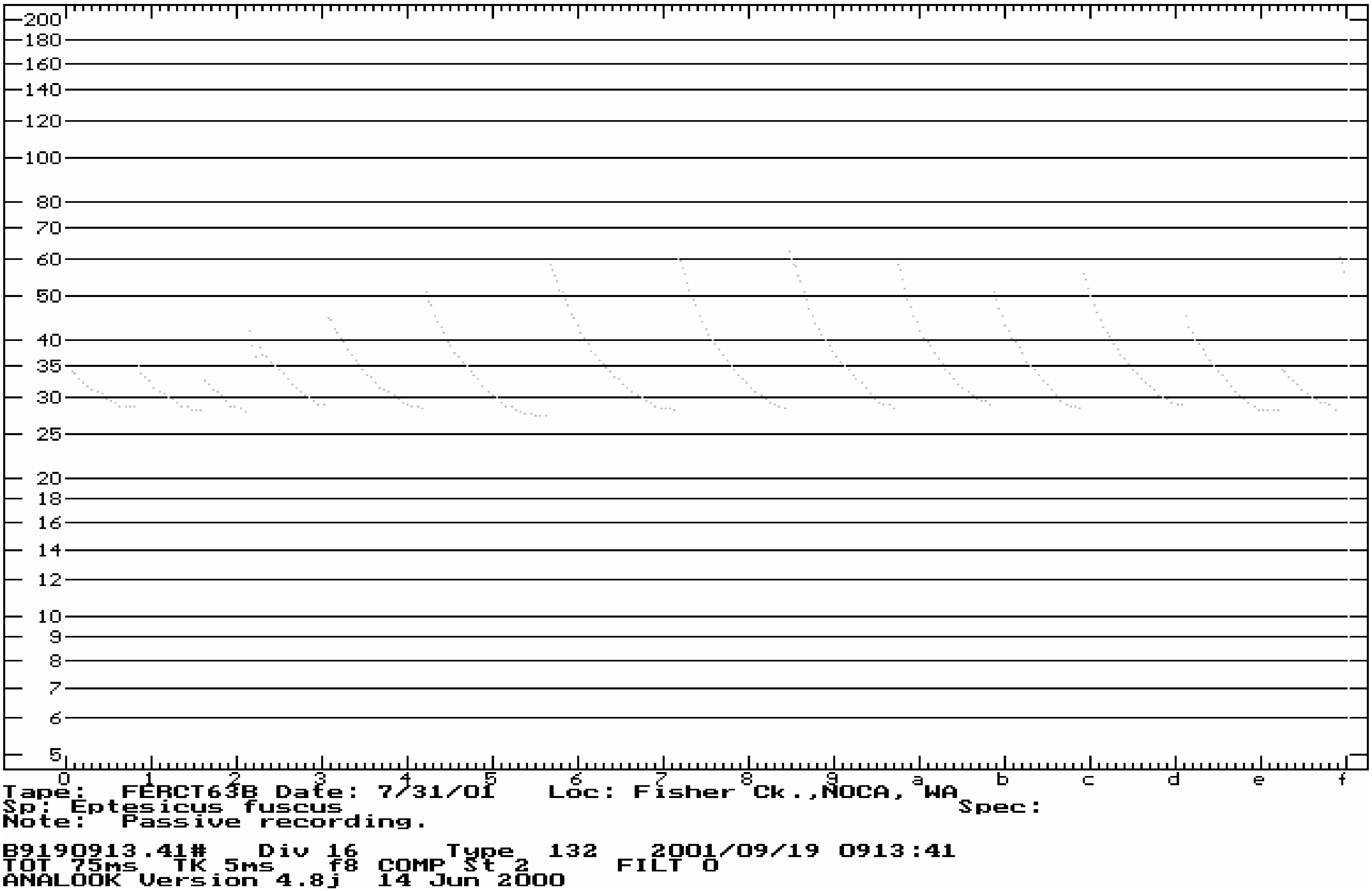
Appendix 7 (cont.). Example of California Myotis (*Myotis californicus*) voucher call, NOCA 1999-2001.



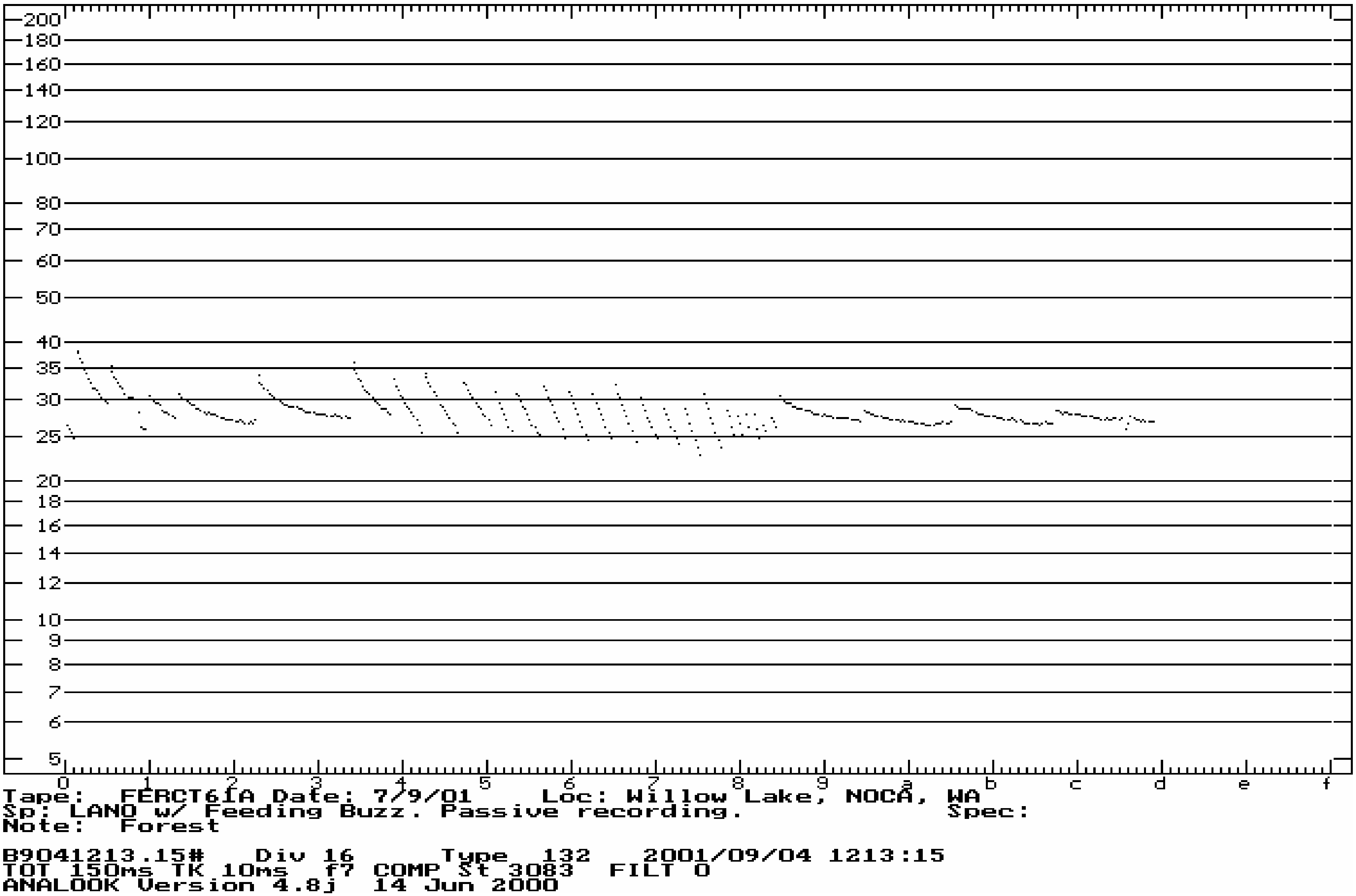
Tape: Voucher Date: 7/24/00 Loc: Baker River, NOCA, WA
Sp: Myotis californicus Spec:
Note: Riparian, West slope NOCA Washington, 1030 ft. Hand released.

07242210.30# Div 16 Type 132 1990/07/24 2210:30
TOT 75ms TK 5ms f8 COMP St 20 FILT 0
ANALOOK Version 4.8j 14 Jun 2000

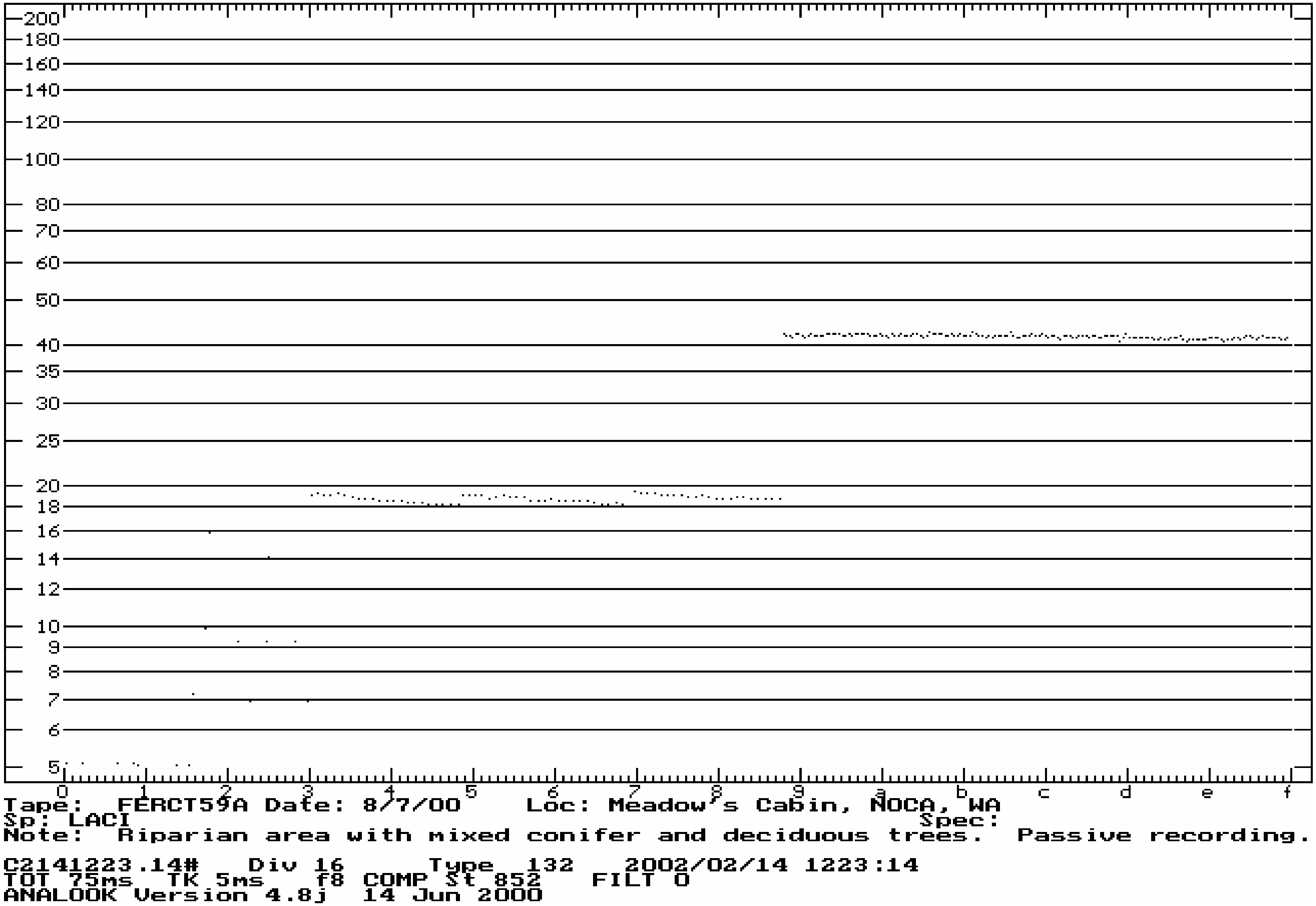
Appendix 7 (cont.). Example of Big Brown bat (*Eptesicus fuscus*) passive recording, NOCA 1999-2001.



Appendix 7 (cont.). Example of Silver-haired bat (*Lasionycteris noctivagans*) passive recording with feeding buzz, NOCA 1999-2001.



Appendix 7 (cont.). Example of Hoary bat (*Lasiurus cinereus*) passisve recording, NOCA 1999-2001.



Appendix 8. NAD 27 Universal Transverse Mercator (UTM) coordinates of bat sample sites, NOCA 1998-2001.

1998 Bat Sample Sites

Map Site No.	Code	Site Name	Easting	Northing
1a	COLP	County Line Ponds	624519	5388576
2a	SICK	Silver Ck.	638874	5426709
3a	EABA	East Bank	643657	5417111
4a	RUAR	Ruby Arm	645232	5399026
5a	ROPT	Roland Point	645090	5403558
6a	THCU	Thunder Ck. Upper	645573	5382015
7a	TCWU	Thunder Ck.Wetland Upp	645702	5382124
8a	GOCK	Goodell Ck.	627208	5394061
9a	STCK	Stetattle Ck.	635309	5398938
10a	DIRE	Diablo Lake Resort	638654	5397566
11a	LS17-1	High Lake LS-17-1	608985	5392917
12a	DACK	Damnation Ck.	622943	5387126

1999 Bat Sample Sites

Map Site No.	Code	Site Name	Easting	Northing
1b	BARM	Baker River Mainstem	606904	5401978
2b	BRMU	Baker River Marsh Upper	607021	5402968
3b	BRSC	Baker River Side Channel	607899	5403629
4b	BBLM	Big Beaver Ck. Lower Mainstem	641573	5404422
5b	PM09	Big Beaver Pond PM09	640879	5405473
6b	BBUM	Big Beaver Ck. Upper Mainstem	640037	5406358
7b	TCLM	Thunder Ck. Lower Mainstem	641079	5393577
8b	TCMM	Thunder Ck. Middle Mainstem	641744	5393094
9b	TCUM	Thunder Ck. Upper Mainstem	641848	5392876

2000 Bat Sample Sites

Map Site No.	Code	Site Name	Easting	Northing
1	THLA	Thornton Lakes	622752	5389629
2	FS184	Field Site 184	643490	5400421
3	COPO	County Line Ponds	624420	5388629
4	COCR	Coon Creek	668553	5357892
5	FLCR	Flat Creek	652891	5365353
6	THCR	Thunder Creek	642381	5392391
7	DECR	Devil's Creek	645239	5410743
8	NECR	Newhalem Creek	631028	5385424
9	GOCR	Goodell Creek	626148	5396283
10	BARI	Baker River	607926	5403699
11	SPCH	Spawning Channels	626380	5390693
12	HACA	Harlequin Bridge Campground	669491	5357260
13	PUCR	Purple Creek	674135	5353156
14	MECA	Meadows Cabin	645769	5382254
15	CAPA	Cascade Pass	643496	5369986
16	RALA	Rainbow Lake	665958	5365915
17	CORI	Copper Ridge	610139	5417423

2001 Bat Sample Sites

Map Site No.	Code	Site Name	Easting	Northing
18	HACR	Hazard Creek	674444	5352397
19	LIBC	Little Beaver Talus Slope	636771	5420217
20	WILA	Willow Lake	645781	5423001
21	LICR	Lightning Creek	647670	5421942
22	FIWE	Fireweed	668286	5370440
23	NFBC	North Fork Bridge Creek	657846	5373284
24	THCR	Thunder Creek	642380	5392391
25	PAPO	Panther Potholes	644464	5391208
26	FICR	Fisher Creek	647749	5382329
27	DALA	Dagger Lake	673209	5370773
28	MCLA	McAlister Lake	672040	5366460
29	DECR	Depot Creek	625734	5426082
30	HILA	Hidden Lake	633756	5374442
31	COLA	Coon Creek	661459	5360624
32	PCPA	Park Creek Pass	649653	5373337

Appendix 9. Data form used when tallying *Myotis* and non-*Myotis* acoustic calls into species groups, NOCA 1998-2001.

tallysht1.xls
rev. 1/99

BAT RELATIVE ABUNDANCE IN
NORTH CASCADES NATIONAL PARK SERVICE COMPLEX

Site:	
Date:	

Counter #	Time	MYgr	Subtotal	EPFU	LANO	EPFU/LANO	LACI	COTO	UNK	FB	Comments
	1900-1929										
	1930-1959										
	2000-2029										
	2030-2059										
	2100-2129										
	2130-2159										
	2200-2229										
	2230-2259										
	2300-2329										
	2330-2359										
	2400-0029										
	0030-0059										
	0100-0129										
	0130-0159										
	0200-0229										
	0230-0259										
	0300-0329										
	0330-0359										
	0400-0429										
	0430-0459										
	0500-0529										
	0530-0559										
	0600-0629										
TOTALS											

Appendix 10. Data form used when tallying *Myotis* acoutic calls into species groups, NOCA 2000-2001.

tallysht2.xls							
rev. 8/01		BAT RELATIVE ABUNDANCE IN					
		NORTH CASCADES NATIONAL PARK SERVICE COMPLEX					
Location:							
Site #:							
Date:							
Counter #	**Time**	**50K Myotis**	**40K Myotis**	**30-35K Myotis**	**20-25K Myotis**	**FB**	**COMMENTS**
	1900-1929						
	1930-1959						
	2000-2029						
	2030-2059						
	2100-2129						
	2130-2159						
	2200-2229						
	2230-2259						
	2300-2329						
	2330-2359						
	2400-0029						
	0030-0059						
	0100-0129						
TOTALS							

Appendix 11. Field data form used when recording bat captures, NOCA 1999-2001.

Bat Capture Form - Mistnetting/Harp Trapping

Sample Unit: ______________ Site NAD27 UTM: N 5__________ E 6__________ Elev.(ft.) ____ Recorder(s): ______________________

Location: ____

Habitat Description: ____

Primary Strata: __________________________________ West or East: __________ Back or Frontcountry: ________ Random? (Y/N) ___

Trap dimensions (m). Harp?(Y/N) ____ Harp size: ________ Mist 1 size: __________ ht.: ___ Mist 2 size: ___________ ht.: ___________

Set Over/Near Water? YES NO --If "YES" dim. of Pool-Size:_______W x ______L and of Swoop-Zone:______W x _________L

	Date	Time	% Cloud	Wind (mph)	Precip.	Lunar Phase	Comments
Start							
End							

Obs #	Mist or Harp	Time	Taxon	Sex (M/F)	Age (J/A)	Repr. St. (P/L/PL/NR)	FA (mm)	Ear (mm)	H. Foot (mm)	Keel (Yes/No)	Weight (g)	Comments

Rep. St.: P (pregnant), L (lactating), PL (post-lactating), or NR (non-reproductive);

Precip: N=None; F=fog; M=misty; D=drizzle; LR=light rain; HR=hard rain

Note: UTM Coordinates are for the true sample point, not the anchor point. Page: ____ of _____

LUNAR PHASE: NM: New Moon, FQ: First Quarter; SQ=Second Quarter; TQ=Third Qua

PRIMARY STRATA: Subalpine Meadow, Forest or Riparian

As the nation's principal conservation agency, the Department of Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interest of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

(NPS D 262) July 2003