CONTINUED STUDY OF BAT ABUNDANCE AND DISTRIBUTION AT HEIL VALLEY RANCH AND THE EFFECTS OF FOREST THINNING ON BAT FORAGING ACTIVITIES IN FOOTHILLS ECOSYSTEMS

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SUMMARY OF HIGHLIGHTS FROM 2003

- A PREGNANT FEMALE SMALL-FOOTED MYOTIS, *MYOTIS VOLANS*, WAS CAPTURED ON 27 JULY. THIS IS A PREVIOUSLY UNDOCUMENTED SPECIES AT HEIL VALLEY RANCH.
- 10 NETTING SITES WERE ADDED IN 2003, GIVING DATA ON A WIDER DISTRIBUTION OF SPECIES THROUGHOUT THE RANCH.
- OF THE NEW SITES NETTED IN 2003, PLUMELY CANYON IS VERY ACTIVE AND OBSERVATIONAL DATA ON RELATIVE EMERGENCE FLIGHTS AT DUSK SUGGEST THE PRESENCE OF ROOST SITES IN THE CANYON WHICH COULD BE REVEALED WITH RADIO-TELEMETRY.
- A TOTAL OF 74 INDIVIDUALS WERE CAPTURED IN 2003.
- OF THE 58 ADULTS CAPTURED IN 2003, ONLY 17 OR 29% WERE FEMALES, WHEREAS 25 OF 50 (50%) ADULTS CAPTURED IN 2002 WERE FEMALE.
- HOME RANGE, PRIMARY FOAGING HABITAT, AND ROOST SITE DATA WERE COLLECTED ON TWO INDIVIDUALS *M. THYSANODES* AND ONE INDIVIDUAL OF (*M. EVOTIS*).
- THE GEER CANYON *M. THYSANODES* COLONY REMAINS THE ONLY KNOWN ROOST SITE FOR THIS IMPERILED SPECIES ON RANCH PROPERTY; HOWEVER, TWO OTHER ROOST SITES HAVE BEEN LOCATED WEST OF RANCH PROPERTY.
- *M. EVOTIS* USES THE RANCH EXTENSIVELY FOR ROOST SITES, MOVING LOCATIONS NIGHTLY, ROOSTING ON THE GROUND UNDER ROCKS IN UNTHINNED FOREST.
- UNTHINNED FOREST MAY BE IMPORTANT TO *M. EVOTIS* FOR ROOSTING OPPORTUNITIES.
- SONAR DATA ($N = 392$ CALLS) RESULTS GATHERED FROM SIX TREATMENT PLOTS (60 DETECTOR NIGHTS) REPRESENTING FOREST, MEADOW, AND THINNED HABITATS SHOWED THINNED PLOTS TO BE SIGNIFICANTLY HIGHEST IN ACTIVITY.
- ANALYSIS OF SONAR DATA FOR SPECIES IDENTIFICATION SHOWED THINNED PLOTS TO HAVE THE HIGHEST DIVERSITY OF BATS (8 SPP) DURING NIGHTLY FORAGING BOUTS, FOLLOWED BY MEADOW PLOTS (5 SPP), AND FORESTED PLOTS (2 SPP).
- SONAR DATA INDICATED THAT THE IMPERILED SPECIES, *MYOTIS THYSANODES*, IS PREFERENTIALLY USING THICKLY FORESTED HABITATS. THINNING OF THESE AREAS COULD AFFECT POPULATION NUMBERS OF THIS SPECIES AT HEIL VALLEY RANCH.
- A TOTAL OF 66 CALLS WERE RECORDED FROM HAND-RELEASED INDIVIDUALS AND 50 OF THESE WERE DEEMED USABLE AS A CALL LIBRARY FOR COMPARISONS WITH UNKNOWNS.

ABSTRACT: In summer 2003 we continued to document bat species abundance, roost site localities, preferred foraging habitat, and minimum home ranges at Heil Valley Ranch using capture and release method and radio-telemetry. The long-eared myotis (*M. evotis*) roosts extensively on Ranch property, changing roost sites usually nightly. In addition, we began a preliminary study into the effects of forest thinning on the foraging patterns of bats at Heil Valley Ranch. Seventy four bats were captured at 10 water hole sites and at two forest and one meadow site. Capture of a pregnant female long-legged myotis (*Myotis volans*) provided the first documentation of this species at Heil Valley Ranch. Seventeen captures were adult females, 41 were adult males, and 16 were juveniles. Three adult, lactating females were fitted with 0.47g Holohil, Inc. radio transmitters, followed to the vicinity of their roost sites and tracked over several nights to determine minimum home ranges. In addition, five Pettersson 240x time-expansion, sonar detectors interfaced with Sony tape recorders were position in 0.25 hectare plots chosen randomly within two plots each of Forest, Thinned, and Meadow treatments. Results indicate that greatest activity was in Thinned plots, but this activity was not significantly different from activity recorded in Meadow plots. Forested plots, however, were significantly different than either Meadow or Thinned plots and had the least activity. In addition, Thinned plots had highest species diversity during nightly foraging bouts. Radio-tracking data gathered over the last two years collaborate sonar data. Of particular importance, the imperiled fringed myotis (*M. thysanodes*) appears to be preferentially using the unthinned forested plots, and thinning in these areas may affect the status of this species at Heil Valley Ranch. Data are preliminary from this study and replication is needed for strong conclusion to be drawn.

INTRODUCTION

This study was designed to meet the priority research needs of BCPOS for mammalian distribution and abundance in foothills habitats. Bats are known to be important components of ecosystems worldwide. In North America they act as natural insecticides and control insect populations which when unchecked may lead to massive destruction of forest stands and agricultural crops (Findley, 1993). Despite this, little is known about bat natural history and, most importantly, what components of their natural history are in jeopardy in any given region. These data are, of course, important in synthesizing a meaningful management plan for bats.

The diversity of bats is impressive in Boulder County. Eleven species have been captured in the County (Armstrong, et al., 1994; Adams and Thibault, 1999), out of 18 species occurring

statewide. Roost sites and water resources are the most important ecological limiting factors to bats (Adams, 1988, 1990; Armstrong, 1972; Armstrong et al., 1994) and such high local diversity suggests a unique assortment of usable day/night roosts, adequate water resources, and foraging habitat. In 1998, the Western Bat Working Group published a Regional Priority Matrix for bats. Of the species listed for the Colorado region, Townsend's big-eared bat (*Corynorhinus townsendii*) was designated to be the highest priority for conservation actions, whereas the fringed myotis (*Myotis thysanodes*), the hoary bat (*Lasiurus cinereus*), and the silver-haired bat (*Lasionycteris noctivagans*) were designated 'of special concern,' but information is lacking for determining their population status.

Data gathered in Boulder County on bats by using mist netting, radio-tracking, and roost site temperature/humidity data loggers over the past seven years have provided important insights into bat populations in the area (Adams, 1995, 1996, 1999, 2000, 2001, 2002; Adams & Thibault, 1997, 1998). Our work has led to seasonal closures of climbing rocks and caves in the area that houses maternity colonies of imperiled species and led to documentation of a previously unrecorded species in Boulder County, the Brazilian free-tailed bat (*Tadarida brasiliensis*) (Adams and Thibault, 1999). We have also shown that females and juveniles preferentially visit calcium-rich water holes that apparently aid in meeting their daily calcium demands not provided by an insectivorous diet (Adams et al., 2003). With the use of thermal cameras we have quantified distinct approach paths by bats to drinking holes that all species use, apparently to avoid aerial collisions (Adams and Simmons, 2003). This type of cooperative behavior among bat species was previously undocumented.

In Boulder County, the bat assemblage consists of nine common and two rare species (Armstrong et al., 1994; Adams and Thibault, 1999), all of which are insectivores. Eight species belong to the family Vespertilionidae, whereas one belongs to Molossidae. Four species are fast-fliers with low maneuverability and are open-area foragers [hoary bat (*Lasiurus cinereus*), silver haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), and the molossid, Brazilian free-tailed bat (*Tadarida brasiliensis*)(Adams & Thibault, 1999)]. Three species fly at moderate speeds and forage along forest edges [western small-footed myotis (*Myotis ciliolabrum*), little brown bat (*Myotis lucifugus*), and the long-legged myotis (*Myotis volans*)]. Three species are slow-speed flyers that forage within cluttered forest [long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), and Townsend's big-eared bat (*Corynorhinus townsendii*)]. Of these, two species (*M. evotis* and *C. townsendii*) specialize as gleaners, using slow maneuverable flight to pick insects from the surface of vegetation (Armstrong et al., 1994). Two of the species, *Corynorhinus townsendii* and *Myotis thysanodes*, are considered imperiled by the Western Bat Working Group, Colorado Natural Heritage Program, the Colorado Division of Wildlife, and the North American Bat Conservation Partnership.

Importance of Foraging Habitats to Management of Bat Populations: Protecting critical foraging habitats for bats is of paramount importance. Loss of critical foraging habitat can affect the stability and survivorship of bat populations, and several critical factors need be in balance. For insectivorous bats, foraging in less cluttered habitats is most energy efficient because obstacle avoidance is limited as they hunt. However, foraging in open areas has its own risks, such as predation from owls at night, or other raptors before darkness. Although such attacks are rare,

bats appear to be sensitive to this risk, foraging in shadows during times of full moon (Erickson and West, 2002). Bats foraging in open areas may incur windy conditions that can increase the energetic output for flight and affect the anticipated flight path of insect prey. To lessen the effects of wind and avoid predation, many bat species forage along forest-edges. Heterogeneous habitats composed of open, brushy, and forested areas tend to have extensive edge, resulting in opportunities that facilitate species coexistence (Adams, 1990).

Human impacts to foraging habitats usually come in the form of forest cutting and various other degradations. Clear-cutting practices have likely caused the loss of some bat populations, however, the overall effects will never truly be known. Studies in the West indicate that bats, with the exception of open-aerial specialists, tend to avoid large open habitats when possible. Therefore bat activity is low where clear-cutting has occurred. Conversely, the less-severe practice of forest thinning may enhance bat foraging areas (Perdue and Steventon, 1996).

Paradoxically, in terms of forest structure, what appears to be good foraging habitat, tends to be bad for roost opportunities and vice versa. Many tree-roosting bats prefer tall, thick, older trees for roost sites which are exactly the type having high economic value and are usually the ones culled by timber companies (Parker et al., 1996; Pierson, 1998). Indeed, the complex natural history traits of bats make conservation challenging. Hypotheses tested in this study were:

H_0: There is no significant differences in bat foraging activity as measured by sonar pass recordings between thinned, unthinned and meadow habitats.

H_A: There is a significant difference between bat foraging activity as measured by sonar pass recording between thinned, unthinned, and meadow habitats.

H_1: Bat species composition will not be significantly different between thinned, unthinned, and meadow habitats.

H_B: Bat species composition will be significantly different between thinned, unthinned, and meadow habitats.

MATERIALS AND METHODS

Capture and Release.–Mist nets were set at nine different localities; seven of which were over a water source and two of which were in thinned forest plots. Captured individuals were weighed, sexed, and reproductive condition was noted.

Telemetry.--Three adult, lactating females were fitted with 0.47g Holohil, Inc. radio transmitters and followed to the proximity of their roost sites. Transmittered individuals were followed over several nights while foraging to determine minimum home ranges.

Data Analysis.--Mapping of these data using TOPO, Inc. mapping software will give locations of roost sites and flight patterns of each individual tagged. These data will include locations and habitats of longest foraging bouts over the telemetry period.

Bat Activity and Forest Thinning.— Five Pettersson 240x time-expansion sonar detectors protected in plastic containers, interfaced with Sony tape recorders, were positioned in 0.25 hectare fixed plots in unthinned forest, recently thinned forest (2002), and open meadows. Two 0.25 hectare plots were established in each of the treatment groups. All treatment plots were in proximity to each other in order to control for sampling bias relative to regional activity differences. In addition, because attenuation of sonar calls is directly related to density of

vegetation, six detectors per 0.25 hectare plot were used in forested treatments, whereas four detectors were used per 0.25 hectare plots in meadow and thinned forest treatments. Sonar recorders were started at sunset and turned off at three hours past sunset. Tapes of sonar recording were downloaded into a Dell Inspiron 8200 laptop computer and analyzed using SononBat, Inc. software. The number of calls was counted per plot per sampling period. Analysis of bat species composition for each treatment was achieved using sequences recorded from hand-released individuals, and sampling calls included with the software.

Building a Call Library: In order to have comparative sonar calls from known individuals, captured bats were hand released and recorded with a Pettersson 240X sonar detector.

Data Analysis & Statistics. – Within site pass data from Forest, Thinned, and Meadow plots were pooled. Because assumptions were met I used one-way ANOVA analysis to compare pass data between habitat types. Using SonoBat, Inc. software, I measured fundamental frequency, call duration, high frequency, call bandwidth, maximum amplitude, and call slope for each sonar pass. I then compared these data to identical measurements taken from hand-released individuals as well as sample call sequences provided with the software. One-way ANOVA was run on fundamental frequency data for *E. fuscus, M. thysanodes, M. evotis*, and *M. lucifugus* to discern significant differences among sonar calls.

RESULTS

***Capture data*:** Seventy four bats were captured among 13 netting sites (Figure 1), 10 of which were water hole sites, two were Thinned Forest plots 1 and 2, and one was Meadow 2. Of these,

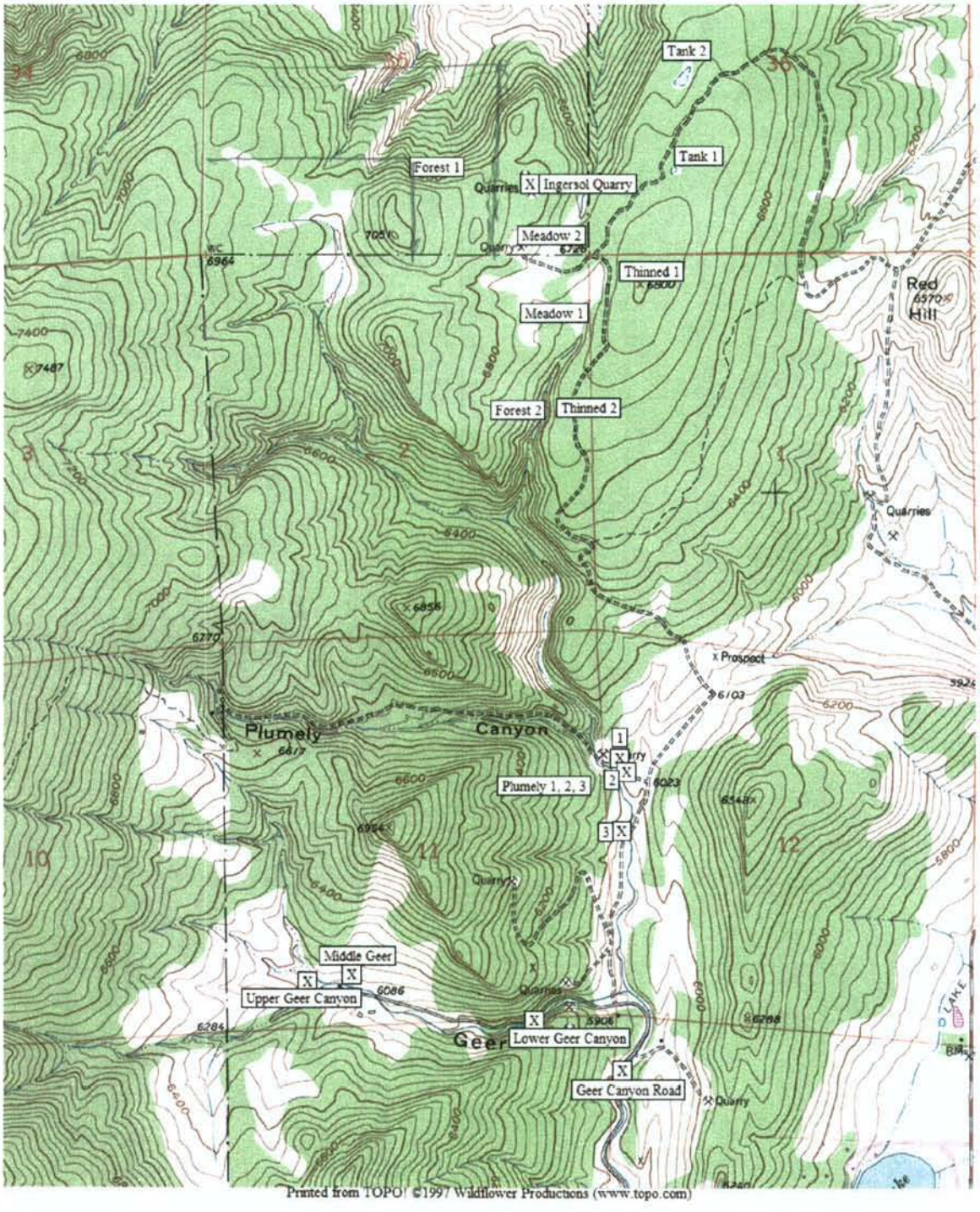

Figure 1. Sites sampled at Heil Valley Ranch in 2003

10 were sites added in 2003 (Table 1). Seven of the new sites were available in 2003 due to June precipitation that produced ephemeral water holes lasting through mid-July. Species captured in 2003 (Table 2) were: *Eptesicus fuscus* (21), *Myotis thysanodes* (20), *M. evotis* (15), *M. lucifugus* (9), *M. ciliolabrum* (7), *M. volans* (1), and *Lasionycteris noctivagans* (1). Of these, 58 captures were adult, and 16 were juveniles. Seventeen adult females were captured versus 41 adult males. Number of juveniles captured was 16. Of these, 10 were males. At Tank 1 (Table 2B), we captured five species, four were myotis species and one was a silver-haired bat (*Lasionycteris noctivagans*). Of particular note was the capture of a pregnant female long-legged myotis (*Myotis volans*) at Tank 1, a species not captured during the 2002 census at Heil Valley Ranch (Table 2B). At Tank 3 (Table 2C) four species were captured. All were myotis species except for the big brown bat (*Eptesicus fuscus*). Of the three sites censused in Plumely Canyon, only one site was successfully trapped with the capture of a male *Myotis evotis*, and a pregnant *M. thysanodes* (Table 2D). Plumely Canyon is a highly active area for foraging bats, but is also a challenging location for capturing individuals as there is little water and the canyon tends to be windy with convective currents at dusk that move the mist nets, alerting bat to our presence. Unfortunately, the female *M. thysanodes* captured was pregnant and thus could not be radio-tagged in order to locate its roost site. However, Plumely Canyon appears to be a mosaic of roost site opportunities for bats and more work in this area would likely reveal interesting data.

A species not captured at Upper Geer Canyon in 2002, but captured there on 6 July 2003 was *E. fuscus* (Table 2G). Middle Geer Canyon (Table 2G), a previously unnetted site was quite active with juvenile fringed myotis (*M. thysanodes*). Within Geer Canyon, the small-footed

Table 1. *New sites censused in 2003.*

SITE	LOCALITY
Tank II	40° 10′ 44″ N, 105° 17′ 49″ W
Tank III	40° 10′ 57″ N, 105° 17′ 48″ W
Plumely Canyon 1	40° 09′ 23″ N, 105° 18′ 00″ W
Plumely Canyon 2	40° 10′ 21″ N, 105° 17′ 58″ W
Plumely Canyon	40° 10′ 13″ N, 105° 17′ 59″ W
Middle Geer Canyon	40° 08′ 53″ N, 105° 18′ 47″ W
Geer Canyon Road	40° 08′ 39″ N, 105° 17′ 59″ W
Forest 1	40° 10′ 46″ N, 105° 18′ 28″ W
Forest 2	40° 10′ 11″ N, 105° 18′ 13″ W
Thinned 1	40° 10′ 31″ N, 105° 17′ 57″ W
Thinned 2	40° 10′ 12″ N, 105° 18′ 10″ W
Meadow 1	40° 10′ 25″ N, 105° 18′ 06″ W
Meadow 2	40° 10′ 34″ N, 105° 18′ 12″ W

Table 2. *Capture data from Heil Valley Ranch, 2003.*

A. Ingersol Quarry, 40° 10′ 43″ N, 105° 18′ 17″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
2 July	*E. fuscus*	Male	S	14.0	Adult
	E. fuscus	Male	S	12.1	Adult
	M. lucifugus	Female	L	7.3	Adult
	M. lucifugus	Female	L	8.5	Adult
	M. lucifugus	Male	NS	7.0	Adult
	M. lucifugus	Female	L	6.9	Adult
	M. lucifugus	Male	NS	none	Adult
21 July	*E. fuscus*	Male	S	none	Adult
	M. lucifugus	Male	NS	6.5	Adult
	M. evotis	Female	L	**Tagged**	Adult
	E. fuscus	Escaped			
	E. fuscus	Male	S	21.0	Adult
	E. fuscus	Male	S	20.5	Adult
	E. fuscus	Male	S	21.0	Adult
	E. fuscus	Escaped			
	E. fuscus	Male	S	22.5	Adult
	E. fuscus	Male	S	20.5	Adult
	E. fuscus	Male	S	18.0	Adult
	E. fuscus	Male	S	none	Adult
28 July	*M. evotis*	Male	NS	6.1	SubAdult
	M. thysanodes	Male	NS	10.5	Adult
	M. thysanodes	Female	L	**Tagged**	Adult
	M. thysanodes	Male	NS	9.5	Adult
	M. evotis	Female	NLNP	8.0	Adult
4 August	*M. evotis*	Female	L	8.9	Adult
	M. evotis	Male	NS	none	Juvenile
	E. fuscus	Male	S	16.5	Adult
	E. fuscus	escaped			
	E fuscus	Male	S	25.5	Adult
12 August	*M. evotis*	Male	S	7.2	Adult
	M. ciliolabrum	Male	escaped		
	M. evotis	Male	NS	6.5	SubAdult

B. Tank 1, 40° 10′ 44″ N, 105° 17′ 49″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
9 June	No captures				
22 June	*M. thysanodes*	Male	NS	8.2	Adult
27 June	*L. noctivagans*	Male	NS	10.5	Adult
	M. evotis	Male	NS	6.0	Adult
	M. lucifugus	Male	NS	6.5	Adult
	M. volans	**Female**	**P**	**7.4**	**Adult**
	M. evotis	Male	NS	9.1	Adult

C. Tank 2, 40° 10′ 57″ N, 105° 17′ 48″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
1 July	*M. lucifugus*	Female	P	6.8	Adult
	E. fuscus	Male	S	14.5	Adult
	M. evotis	Male	NS	7.5	Adult
	M. thysanodes	Male	NS	6.0	Adult
	M. thysanodes	Female	P	11.2	Adult
	E. fuscus	Male	S	10.5	Adult
	M. evotis	Male	NS	11.9	Adult
	M. lucifugus	Male	NS	7.0	Adult
12 July	No captures				

D. Plumely Canyon (Site 1) 40° 09′ 23″ N, 105° 18′ 00″ W

DATE	SPECIES	SEX	REPRO	WGT (g)	AGE
10 June	No captures	Blown out			
13 June	No captures	Blown out			
15 June	*M. evotis*	Male	NS	5.3	Adult
16 June	*M. thysanodes*	Female	P	6.1	Adult
5 July	No captures				

E. Plumely Canyon (Site 2) 40° 09′ 21″ N, 105° 17′ 58″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
5 July	No captures				

F. Plumely Canyon (Site 3) 40° 09′ 13″ N, 105° 17′ 59″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
13 June	No captures				

G. Upper Geer Canyon, 40° 08′ 52″ N, 105° 18′ 57″ W

DATE	SPECIES	SEX	RERPO	WGT	AGE
6 July	No captures	Blown out			
15 July	No captures	Windy			
13 July	*M. ciliolabrum*	Female	P	5.5	Adult
	M. thysanodes	Female	L	**Tagged**	Adult
	M. ciliolabrum	Male	NS	6.5	Adult
	E. fuscus	Male	NS	18.0	Adult

H. Middle Geer Canyon (New Site), 40° 08′ 53″ N, 105° 18′ 47″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
28 June	No captures	Blown out			
25 July	No captures	calm			
2 August	*M. ciliolabrum*	Female	NLNP	5.0	Juvenile
	M. thysanodes	Male	NS	9.9	Juvenile
	M. thysanodes	Male	NS	6.9	Juvenile
	M. sp.	Escaped			
	M. thysanodes	Male	NS	8.5	SubAdult
	M. thysanodes	Female	NLNP	8.5	SubAdult
	M. thysanodes	Female	NLNP	9.5	SubAdult
	M. ciliolabrum	Female	NLNP	4.5	Juvenile
	M. evotis	Female	NLNP	10.1	Juvenile
13 August	*M. thysanodes*	Female	L	7.9	Adult
	M. thysanodes	Male	NS	7.5	SubAdult
	M. thysanodes	Male	NS	7.5	Juvenile
	M. thysanodes	Male	NS	6.1	Juvenile
	M. thysanodes	Male	NS	7.2	Juvenile

I. Lower Geer Canyon, 40° 08′ 46″ N, 105° 18′ 14″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
19 July	*E. fuscus*	Male	S	19.5	Adult

J. Geer Canyon Road, 40° 08′ 39″ N, 105° 17′ 59″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
6 August	*E. fuscus*	Escaped			
	M. thysanodes	Male	S	6.9	Juvenile
	M. thysanodes	Female	L	10.3	Adult
	E. fuscus	Male	S	19.1	Adult
	E. fuscus	escaped			

K. Thinned 1, 40° 10′ 31″ N, 105° 17′ 57″ W

DATE	SPECIES	SEX	RERPO	WGT	AGE
30 July	*M. evotis*	Female	L	9.3	Adult

L. Thinned 2, 40° 10′ 12″ N, 105° 18′ 10″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
14 August	No captures				

M. Meadow 1, 40° 10′ 25″ N, 105° 18′ 06″ W

DATE	SPECIES	SEX	REPRO	WGT	AGE
10 August	*M. ciliolabrum*	Female	PostL	5.2	Adult
	M. evotis	Female	PostL	7.3	Adult
	M. evotis	Male	NS	7.0	Adult

** S = Scrotal, NS = Nonscrotal, P = Pregnant, L = Lactating, NLNP = nonL, nonP*

myotis is resident (Table 2G & H), however, we have not as yet captured a lactating female for radio-tagging. We netted one off-site water hole (Geer Canyon Road, Table 2J) where two species were captured, *M. thysanodes* and *E. fuscus*. This is an active site, however, wind prevented higher trap success on this night.

We had limited success netting in sonar treatment plots away from water. A single female, lactating *M. evotis*, was captured during netting in Thinned 2 (Table 2K). In a flyway leading to Meadow 1, a postlactating female *M. ciliolabrum* was captured along with two *M. evotis*, one of which was a nonscrotal male and the other a postlactating female (Table 2M).

Results of Telemetry.--Of the 17 adult females captured, three were suitable for tagging with a radio-transmitter (i.e. not pregnant, postlactating). On 19 July a lactating female *M. thysanodes* was radio-tagged at the Upper Geer Canyon Site. On 20 July, I tracked this individual to the same roost site as located in 2002 in Geer Canyon, near the lower Geer Canyon water hole. However, because in 2002 the individual tagged removed the transmitter on the first night, we gathered no home range data from this colony. In 2003, the tagged individual retained the tag for three nights. Foraging activity of this individual was along the drainage between lower and upper Geer Canyon where it flew in riparian, Ponderosa Pine forest and also montane meadow habitats (Fig. 2 blue line). Most concentrated foraging was in proximity to, and WNW of the upper Geer Canyon water hole where it was captured and tagged (Fig. 2, red line). On 23 July, stormy weather appeared to attenuate her foraging activity as she reentered the roost site at 2220, and did not emerge over the following hour.

On 21 July, a lactating female *M. evotis* was radio-tagged at Ingersol Quarry. Despite

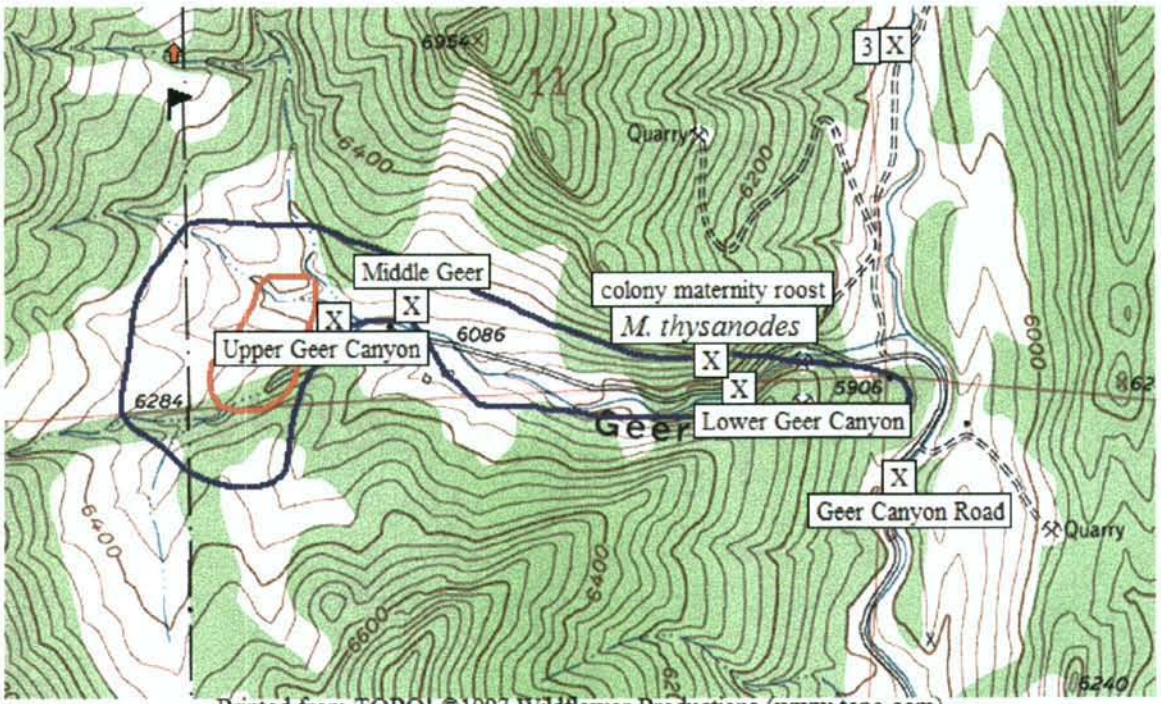

Figure 2. Minimum home range of a female lactating *M. thysanodes* radio-tagged on 13 July 2003 and followed for three nights. She followed the same circuit over the three nights (indicated in blue), spending most of her time foraging in proximity to Upper Geer canyon water hole (indicated in red). On night three, stormy weather resulted in her returning to the roost at 2220.

many hours spent searching west of the quarry, we were never able to acquire a signal while she was roosting, thus her roost site was never located specifically. We reacquired her signal on 23 July as she foraged NNW of Ingersol Quarry at a distance of approximately 1 km (Fig. 3). She foraged in areas SW of this quarry and spent considerable time foraging in an area about 1 km SW of Ingersol Quarry. We tracked her foraging along the same route again on 25 and 28 July. On 30 July, the female *M. evotis* was found to be roosting in a new location (Fig. 3) 1.6 km due south of Ingersol Quarry on a southeast facing slope approximately 0.5 km from the road as it climbs the ridge leading up to the logger's camp. Her minimum home range was 5.3 km. On 28 July, a lactating female *M. thysanodes* was radio-tagged at Ingersol Quarry and tracked until 4 August. Using three triangulation points, one from an overlook point northeast of the Quarry, another from the westernmost edge of the Ingersol Quarry plateau, and another from the road just south of private property line in Geer Canyon allowed us to gain her position that we discerned her roost site location approximately 1.0 km due west of Ingersol Quarry (Fig. 3). Although the exact location of her roost was never found, it appeared to be located in a different area than the roost site found for this species in the same area last summer. Foraging areas included forest and meadows in proximity to the quarry, and this individual also used our Thinned 2 plot. Dominant foraging area was located at the southwestern aspect of the open meadow located south and below Ingersol Quarry (Fig. 3, yellow line). Her minimum home range was 5.1 km.

Sonar Detector Plots. A total of 60 detector nights were run across two 0.25 hectare treatments each of Forest, Thinned, and Meadow plots, recording a total of 392 sonar passes. Of the three treatments, Forest plots were least active with foraging bats, whereas Thinned plots were most

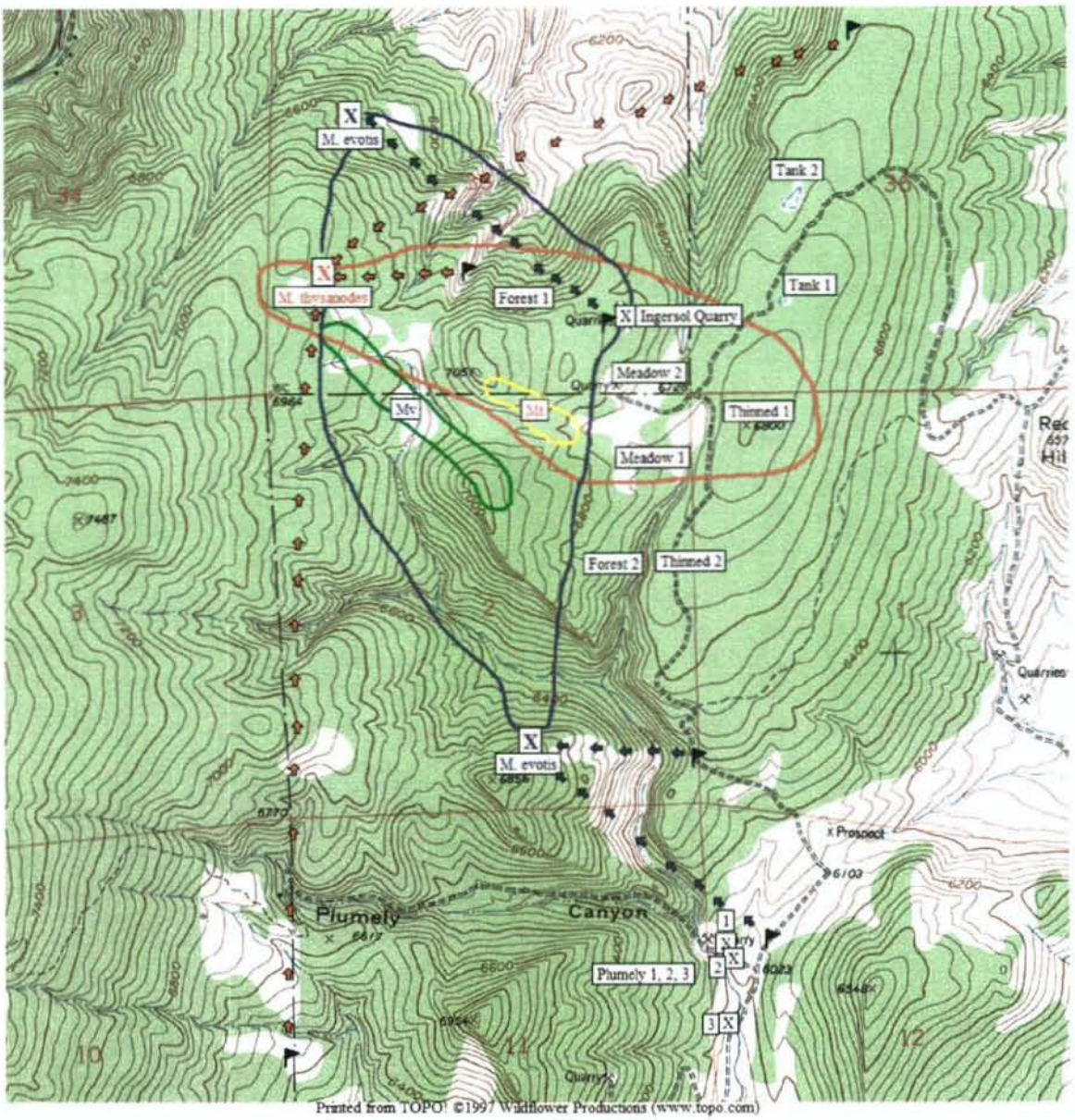

Figure 3. Map of roost site localities, telemetry positions, and minimum home ranges for *M. thysanodes* (red, yellow) and *M. evotis* (blue, green) tagged at Ingersol Quarry. Smaller areas mark most intensive foraging areas by each species. *M. evotis* was found to use two roost sites during the tracking period. Black Xs mark trapping sites. Flags mark fixed locations for telemetry.

active, and Meadow plots were most similar in activity to Thinned plots (Fig. 4a, b). One-way ANOVA showed significant differences in activity among plots ($p = 0.005$). Bonferonni Pairwise analysis showed specific significant differences between Forest plots versus Thinned and Meadow plots, but could not significant distinguish between Thinned and Meadow plots in activity.

***Bat Call Library*:** A total of 66 hand-release calls were recorded from six species, downloaded into SonoBat, Inc. sonar analysis software resulting in 50 calls usable as comparative sequences to unknown calls recorded in the treatment plots. Figure 5 shows box plots of means of the fundamental frequency of four species: *Eptesicus fuscus, Myotis thysanodes, M. evotis*, and *M. lucifugus*. One-way Analysis of Variance (ANOVA) showed significant differences ($p = 0.001$) among species in the use of the fundamental frequency. Bonferroni pairwise test (Table 3) indicated that *M. lucifugus* used a fundamental frequency distinguishable from the other three species, whereas *M. evotis, M. thysanodes*, and *E. fuscus* could be distinguished from one or two of the other species.

***Species Identifications per Treatment Plot by Sonar Analysis*:** Figure 6 shows number of species (diversity) identified based upon analyses of sonar calls within each treatment plot. Thinned sites had the highest diversity with eight species identified. Five species were identified in Meadow plots and Forest plots showed activity from two species. Table 4 gives a species list per treatment plot. Forested areas appear to be important to *M. evotis* and *M. thysanodes*. Forest 1 had both species present, whereas Forest 2 had one species. Of the calls recorded in forested plots, *M. thysanodes* far outweighed those of *M. evotis*. Thinned plots were highest in diversity where five *Myotis* species, *E. fuscus, L.cinereus*, and *L. noctivagans* foraged. Species

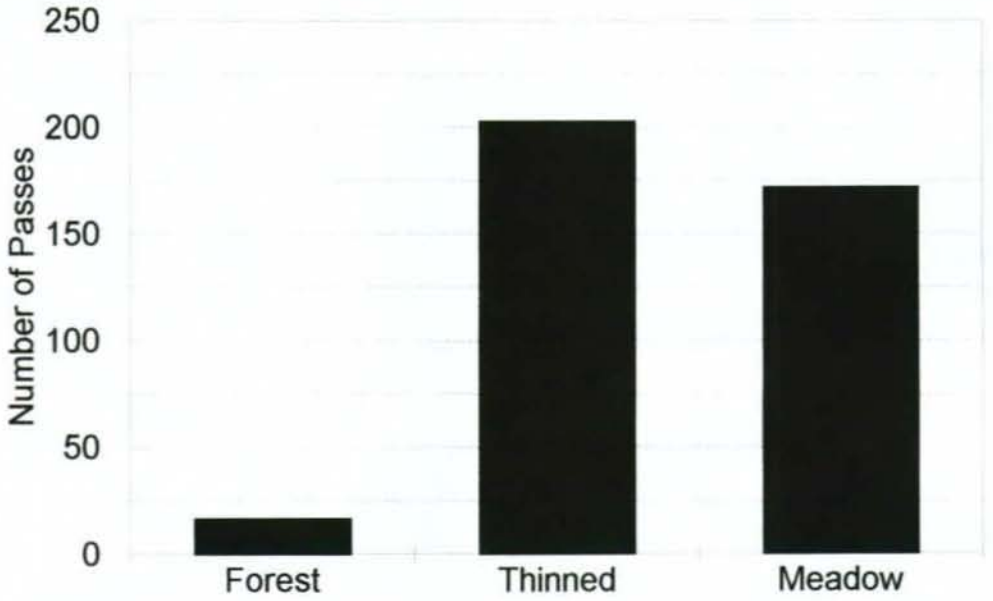

Figure 4a. Number of passes from pooled data ($n = 392$) collected in two treatments of each of three plots. One-way ANOVA gave significant differences between groups ($p = 0.005$).

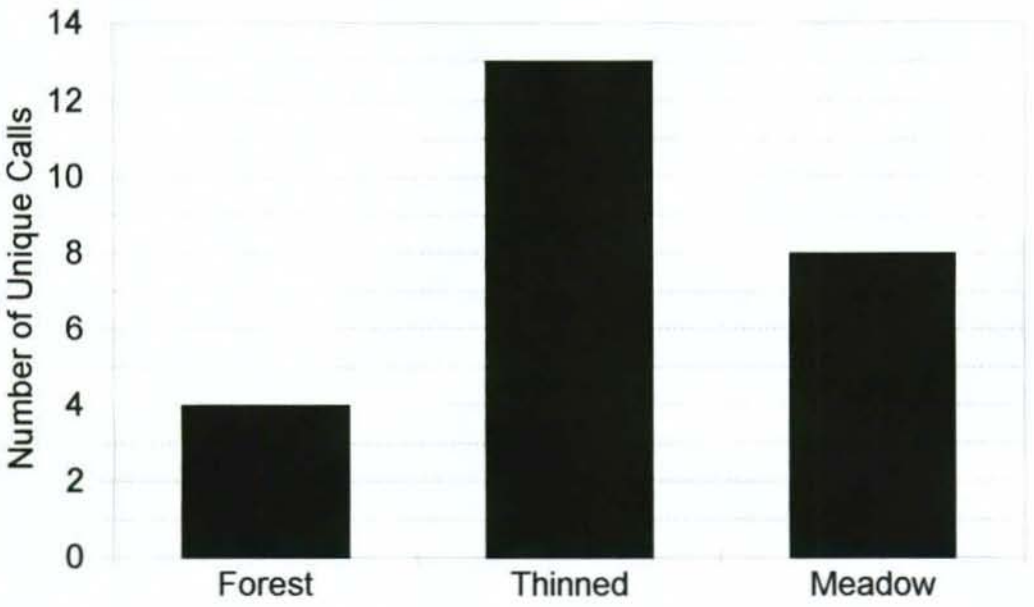

Figure 4b. Number of distinctive call patterns discerned from each test plot. Not indicative of number of species, but indicative of diversity of calls used in each habitat type.

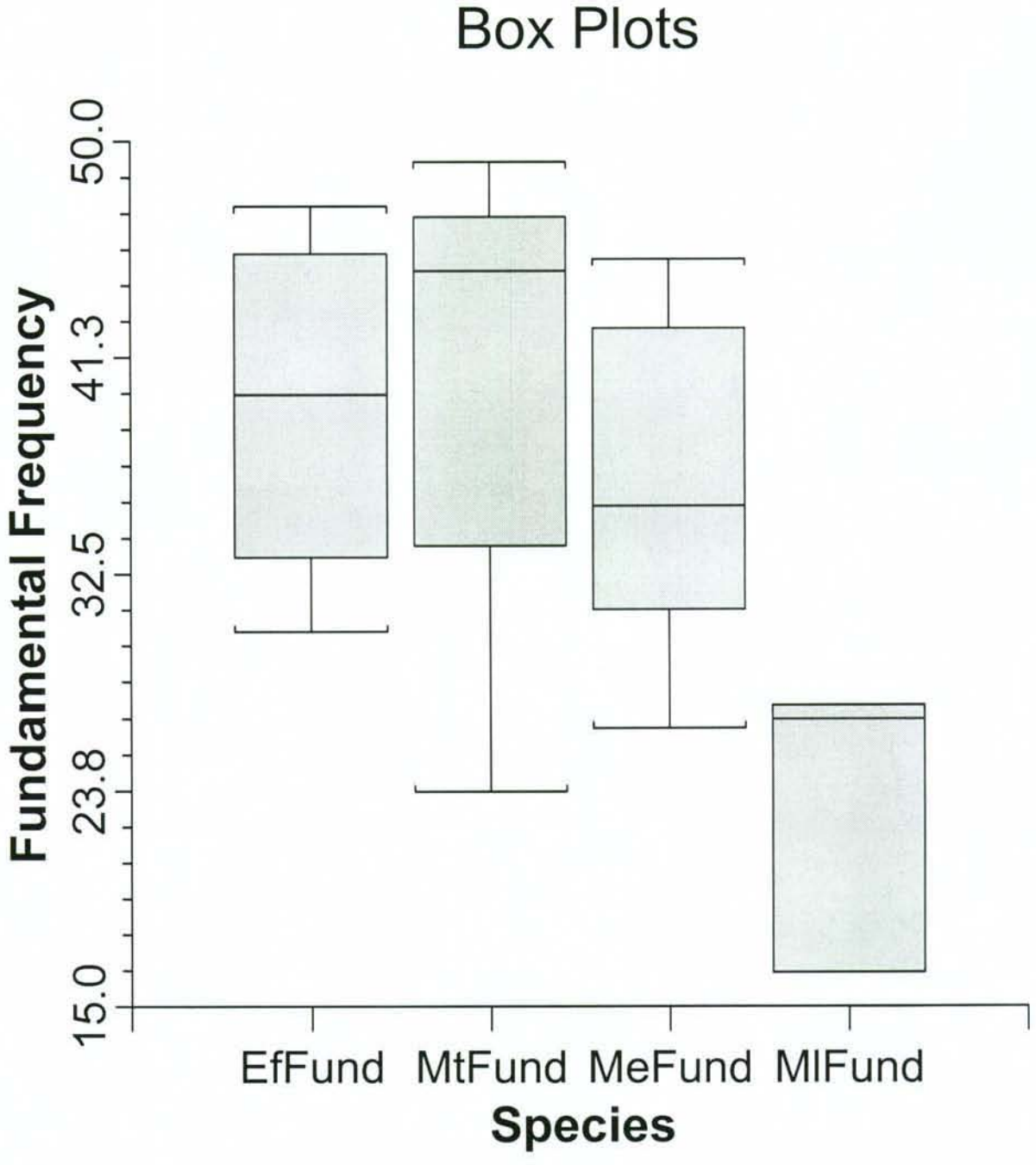

Figure 5. Box plots showing mean and standard deviation of frequencies of the fundamental call of *Eptesicus fuscus, Myotis thysanodes, M. evotis,* and *M. lucifugus* based upon hand-release calls. On-way ANOVA results are presented in Table 4.

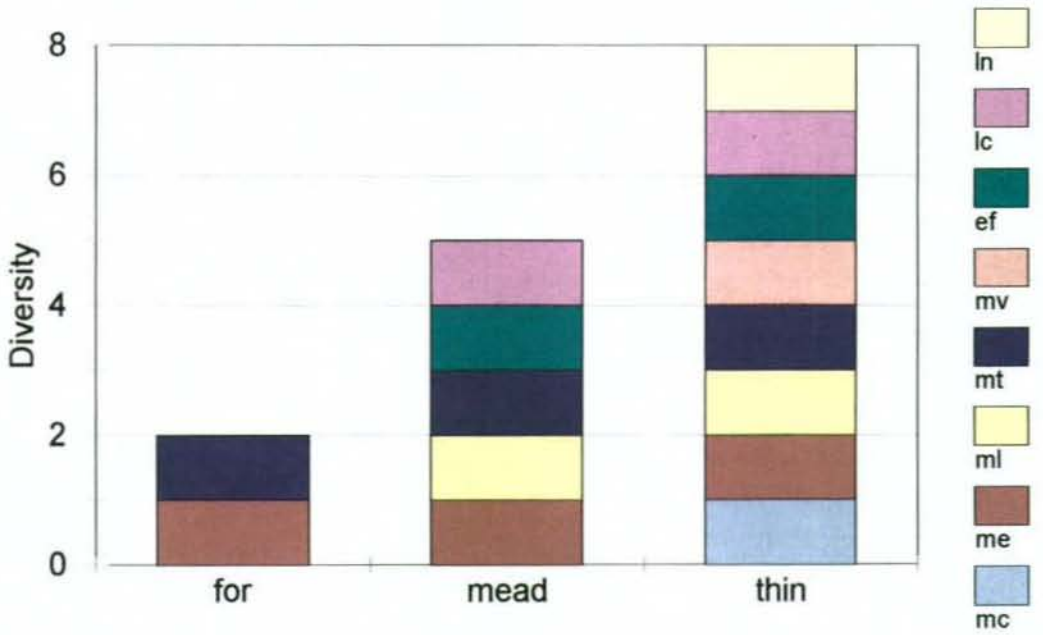

Figure 5. Stacked bar graph showing diversity of species per treatment type (forest, meadow, thinned) based upon sonar analyses of unknown calls. ln = *Lasionycteris noctivagans*, lc = *Lasiurus cinereus*, ef = *Eptesicus fuscus*, mv = *Myotis volans*, mt = *M. thysanodes*, ml = *M. lucifugus*, me = *M. evotis*, Mc = *M. ciliolabrum*.

Table 3. *Results of one-way ANOVA with Bonferronni correction on fundamental frequency data (kHz) gathered from hand-released individuals. Groups were significantly different*, p = *0.001*.

GROUP	COUNT	MEAN	DIFFERENT
M. lucifugus	3	23.4	*M. evotis, M. thysanodes, E. fuscus*
M. evotis	16	35.5	*M. lucifugus, M. thysanodes*
M. thysanodes	23	42.1	*M. lucifugus, M. evotis*
E. fuscus	8	39.1	*M. lucifugus*

Table 4. *Species associates per treatment habitat based upon sonar passes, radio-telemetry of individuals, and mist net captures.*

TREAMENT	DATES SURVEYED	SPECIES
Forest 1	7/2/03, 7/9/03, 7/21/03, 7/28/03	*M. evotis, M. thysanodes*
Forest 2	7/30/03, 8/02/03, 8/14/03, 8/17/03	*M. evotis*
Thinned 1	7/2/03, 7/9/03, 7/21/03, 7/28/03	*M. evotis, M. thysanodes, M. volans, M. lucifugus, M. ciliolabrum, E. fuscus, L. cinereus, L. noctivagans*
Thinned 2	7/30/03, 8/02/03, 8/14/03, 8/17/03	*M. evotis, E. fuscus, M. lucifugus, L. cinereus*
Meadow 1	8/4/03, 8/5/03	*M. evotis, E. fuscus, M. thysanodes, L. cinereus*
Meadow 2	8/12/03, 8/15/03	*M. evotis, M. thysanodes. E. fuscus, M. lucifugus, L. cinereus*

not recorded foraging in Meadow plots were *M. ciliolabrum*, *M. volans*, and *L. noctivagans*.

Discussion

Number of captures at Heil Valley Ranch was similar to that of 2002, however, captured from 10 previously uncensused sites afforded a greater understanding of species distribution and habitat use. Curiously, of the 58 adults captured, only 17 or 29% were females, whereas 25 of 50 (50%) adults captured in 2002 were female. Reasons for the paucity of adult females captured in 2003 remain unclear. Curiously, more female juveniles (16) were captured than male (10) in 2003. Of particular note was the capture of a pregnant long-legged myotis (*Myotis volans*) not previously captured at Heil Valley Ranch. Unfortunately, pregnant females cannot be radio-tagged and thus we could not follow this individual and locate its roost site. Similarly to 2002, individuals radio-tagged at Ingersol Quarry were roosting west outside the borders of the Ranch and on National Forest or private lands. However, Heil Valley Ranch apparently provides preferred foraging areas for the individuals thus far tagged. In addition, telemetry data show clearly that the long-eared myotis, *Myotis evotis*, uses Ranch property extensively for diurnal roosting where it forms colonies usually on the ground under rocks and moves its roost site nightly. The *M. thysanodes* tagged in Geer Canyon remained in proximity to the roost indicating that she maintained a young inside the roost during this time. Thus far, this is the only roost of *M. thysanodes* discovered at the Ranch.

Preliminary sonar data show high levels of foraging activity at the Ranch which corroborates radio-tracking data. Data gathered from treatment plots indicate that areas being

thinned may be opening up more foraging habitat for bats on Heil Valley Ranch. Most activity was found to occur in Thinned plots, followed closely by Meadow plots. In addition, thinned areas had the highest species diversity of bats foraging. These preliminary data indicate that thinned areas may be providing preferred habitat for foraging perhaps because they offer some cover, but are not cluttered enough to hamper pursuit of night-flying insects. It may also be that thinned areas have an insect composition that differs other habitats that may provide more optimal foraging conditions of some bat species. The lack of tree roosts found at Heil Valley Ranch suggests that the forest thinning process is not affecting roosting opportunities for bats. However, roost sites for *M. evotis* found throughout the Ranch occur in unthinned plots; none have been located thus far in Thinned or Meadow plots. **These data suggest that unthinned forest may be important to *M. evotis* for roosting opportunities despite the fact that this species has not been found to use tree roosts at the Ranch.**

Although preliminary data indicate that thinning practices at Heil Valley Ranch are supportive of foraging patterns of the bats using the site, replication and expansion of the study are required before strong conclusions can be made. In addition, because our call library is incomplete for some species and is low in sample size for some species, identification of some of the unknowns was hampered and thus not used in the analyses. Revisiting the sonar data set from 2003 after we have more "known" may add to information concerning species abundance and distribution in the treatment plots. **As is, preliminary data show that *M. thysanodes*, an imperiled species was preferentially using unthinned forested areas more so than any other species.** Thus, the loss of cluttered forested habitat may impact the use of Heil Valley Ranch as a

foraging area for *M. thysanodes*. This in turn could impact reproductive success of colonies of this species in the area. Expanding the study to census more cluttered habitat, especially those areas cited to be thinned, is important to the management of Heil Valley Ranch relative to its bat diversity.

Future Research

For future research relative to this project, emphasis should be placed on replicating and expanding the sonar analysis of treatment plots. In particular, further research in forested areas to determine use by the imperiled fringed myotis (*Myotis thysanodes*). Although forested areas are low in bat diversity and activity, all but two of the call sequences were from *M. thysanodes*, suggesting this species may use unthinned forest extensively for foraging. In addition, five of six roost sites for M. evotis thus far located are on Ranch property and all five were in unthinned forests. It is conceivable that too much thinning at Heil Valley Ranch could impact local populations of these species. In addition, more plots throughout the property will give a better indication of foraging patterns used by bats and give better indicators for management. Future study should also include continued search for roosting sites on Heil Valley Ranch and in understanding minimum home range and preferred foraging habitats using radio-telemetry.

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