BAT SPECIES AND HABITAT USE IN THE TRANS-PECOS OF TEXAS

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BAT SPECIES AND HABITAT USE IN THE TRANS-PECOS OF TEXAS

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ABSTRACT

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Understanding species-environmental relationships are crucial to predictive ecological modeling; however, there have been limited studies of these relationships in bats. I examined relationships between bat species and habitat and elevation at Elephant Mountain Wildlife Management Area, Brewster County, Texas. Mist netting was conducted July 2010-July 2011. Data collection sites were located over an elevational gradient of 610 m in 3 distinct habitat types: desert flats surrounding the mountain, slopes and canyons of Elephant Mountain, and desert grassland on top of the mountain. A total of 9 bat species were captured during a total of 560 netting hours. Most bats emit an ultrasonic call while foraging. Recording these calls allowed me to survey areas in which mist nets could not be used. I recorded over 9,894 echolocation calls of 18 bat species at 13 sites from June 2011-July 2011. I found no difference in bat captures over the elevational range. Additionally, no difference was found in captures between the seasons sampled. From 2010 to 2011 only two sites retained water. There was an increase in captures at one of the two sites in 2011. My research illustrates the importance of using acoustic and mist net sampling to better document the occurrence of bat species in a given area.

INTRODUCTION

Bats (Order Chiroptera) are an essential component of many ecosystems. Bats provide invaluable ecosystem services to most major habitats along with contributing to overall biodiversity (Wilson, 1997). Bats contribute to pest control in temperate zones, eating thousands of insects in one evening (Wilson, 1997). Cleveland et al. (2006) found *Tadarida brasiliensis* provided pest control services valued from 2-29% of the 6 million dollar cotton crop. Bats play a vital role in pollination of plants as well as seed dispersal in tropical regions (Neuweiler, 2000). Bats are also predators and prey and influence ecosystem processes (Altringham, 1996). Bats are also good indicators of the overall health of an ecosystem due to their mobility, prey, and trophic level (Fenton, 2003). Evaluating ecosystem disturbance, both anthropogenic and natural, using abundant and trophically diverse species is a valuable technique due to its low cost and accuracy (Medellin et al., 2000).

Bat populations have been severely declining across the world since the mid 1900s for reasons not yet fully clarified and understood (Neuweiler, 2000), and there has been valid concern about the status of several species (O'Shea et al., 2003). There are many factors pressuring bat populations. Increased human population and urbanization has decreased bat habitat and roosts, as well as increased human-bat interactions. In the United States, nearly 25% of bat species hibernate solely in caves and mines (Spanjer et al., 2005). Bats are especially vulnerable to disturbance of hibernation sites, with some populations declining as much as 95% due to human disturbance (Spanjer et al., 2005). Additional disruptions such as agriculture, insecticides, organochlorine compounds, and timber harvest have detrimental effects on bat species (Neuweiler, 2000). Additionally, the increased use of wind turbines across North America poses a threat to migrating bat species (Kuvlesky et al., 2007). The study of bats is vital for conservation because of their invaluable role in the ecosystem and the growing threats to their existence.

Mist nets and acoustic sampling are the most commonly used techniques for sampling species of bats (Winhold et al., 2008). Mist nets are generally set up before sunset and monitored throughout the night. They provide the advantage of capturing species for measurements and tissue samples. Having the specimen in hand increases a researcher's ability to identify species correctly. The flight and foraging activities of some bat species are completely out of the capture range of mist nets (O'Farrell et al., 1999). Most bats emit an ultrasonic call during foraging, which can be detected by an acoustical detector. Echolocation calls may be recorded for analysis by software programs. A larger area may be sampled by coupling mist nets with acoustical sampling; this increases the potential to survey for species that would otherwise be missed (O'Farrell et al., 1999).

Studying habitat use of species found in a specific region may provide useful insight into the ecology of specific species as well as possible reasons for declines in populations. Baseline data are essential in monitoring and evaluating populations, and determining species composition of an area (Duff et al., 2007, Winhold et al., 2008). In addition, assessment of habitat use by specific species is crucial for ecological monitoring (Duff et al., 2007). While understanding species-environmental relationships are crucial to predictive ecological modeling, there have been limited studies of such relationships with bats (Duff et al., 2007). Bat habitat use can be assessed by species occupancy within an elevational gradient. The overall goal of my research was to assess the status, distribution, and habitat use of bat species at Elephant Mountain Wildlife Management Area (EMWMA).

Field Site Description

I assessed bat communities at Elephant Mountain Wildlife Management Area (EMWMA), Brewster County, Texas (30.031577°, -103.532842°) a wildlife research and demonstration area owned and operated by Texas Parks and Wildlife Department. The area consists of 2,267 ha located in the Trans-Pecos region of southwestern Texas. It is situated north of Chihuahuan desert scrub and south of high desert grasslands, within a transition zone between the two. Desert grassland, mixed prairie, loamy bottomland, and desert scrub are the prevailing vegetation types on the property (Lawrence et al., 2004). There is a distinct change in habitat between the sides of and flats surrounding Elephant Mountain. Common woody species include honey mesquite (*Prosopis* glandulosa), tarbush (*Flourensia* cernua), juniper (*Juniperus* sp.), creosote bush (*Larrea trindentata*), pinyon pine (*Pinus cembroides* and *P*. edulis), cholla cactus (*Opuntia* imbricate), ocotillo (*Founquieria splendens*), Acacia (*Acacia* sp.), oak (*Quercus* sp.), yucca (*Yucca* sp.) and lechugilla (*Agave lechugilla*) (Hernandez et al., 2006, Lawrence et al., 2004, Relyea et al., 1994). Silver bluestem (*Bothriochloa saccharoides*), gramas (*Bouteloua* sp.), alkali sacaton (*Sporobolus airoides*), and leather-weed croton (*Croton pottsii*) are common grasses and forb of the area (Hernandez et al., 2006, Lawrence et al., 2004, Relyea et al., 1994). In addition, the top of the mountain is a unique grassland habitat, consisting predominately of alpine grassland with patches of sumac (*Rhus* sp.), oak, mountain laurel (*Sophora* secundiflora), and other shrubs (Hernandez et al., 2006). Elephant Mountain is a large flat-top mountain reaching an elevation of 1,897 m and is approximately 609 m above the surrounding land. The top of the mountain covers ~ 890 ha and spans from the northern to southern borders of the area. To the west of the mountain lies Calamity Creek and to the east are Chalk Draw and the Del Norte Mountains. The Del Norte Mountains range in elevation from 1,463 to 1,615 m and form the eastern border of the area. The vegetation has been altered over the years due to overgrazing, agriculture, drought, intense rainfall, and fire suppression and consists mainly of desert scrub and grassland, riparian zones, deciduous canyon woodlands, and juniper-pinion-oak woodlands.

MATERIALS AND METHODS

I conducted sampling surveys at 8 sites across EMWMA (Fig. 1). Three sites were selected within the first elevational gradient: desert flats (flats) surrounding Elephant Mountain (~ 1,219 m elevation); 3 more within the second elevational gradient: slopes and canyons (sides) of Elephant Mountain (~ 1,219-1,676 m elevation); and 2 final sites in the third elevational gradient: top (top) of Elephant Mountain (> 1,676 m elevation). These 3 gradient zones represented the majority of habitat found at EMWMA. The sampling sites within these habitats were situated on flyways and waterways so to maximize bat interactions and therefore captures. All 3 desert flat sites contained water at the beginning of the sampling season. Additionally, 1 site on both the sides and top of the mountain contained water. Sites were sampled between July and 15 September 2010 (summer 1), October -November 2010 (fall), April-May 2010 (spring), and June-July 2011 (summer 2) (Table 1).

Table 1: Number of sampling nights per site for each season from 2010 to 2011 at Elephant Mountain Wildlife Management Area, Texas.

Season	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
Summer 2011	2	2	2	2	1	1	0	2
Fall 2011	2	2	1	2	2	2	2	1
Spring 2012	2	2	1	2	2	2	2	1
Summer 2012	2	1	1	2	2	1	0	0

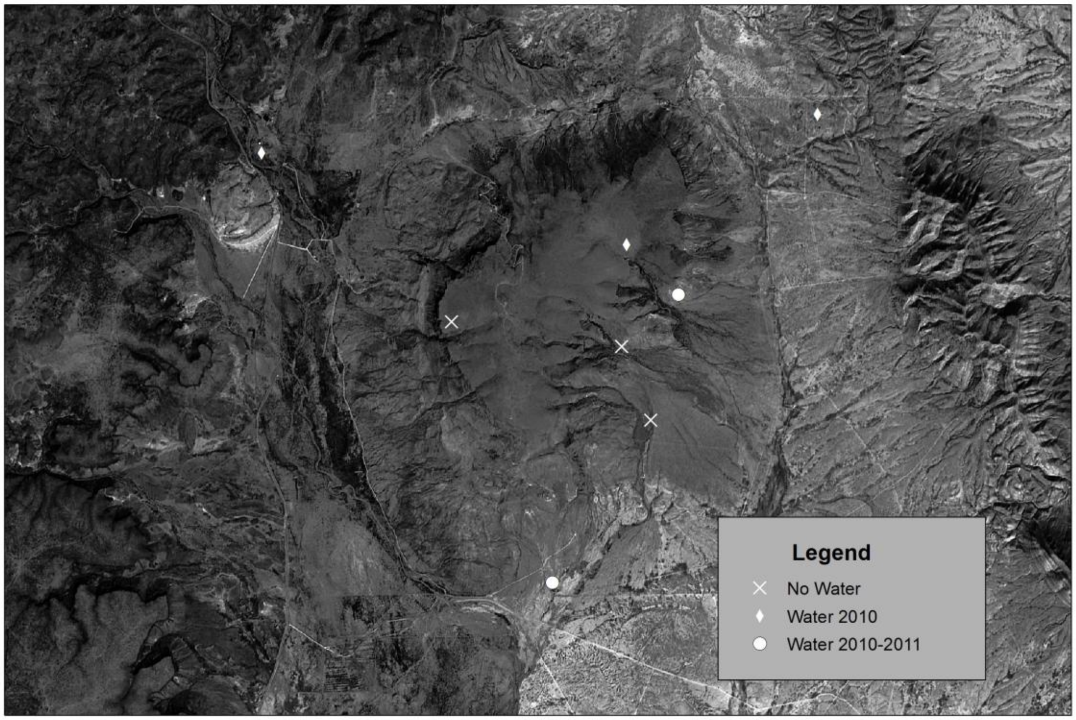

Figure 1: Mist net locations across Elephant Mountain Wildlife Management Area, Texas for sampling season 2010 to 2011.

I began mist netting on 16 July 2010 and concluded on 14 July 2011. I placed 2 nets, one 6-m and one 12-m, at each site. I positioned mist nets perpendicular to flyways or directly over water in sites that contained water. Two sites were surveyed simultaneously each sampling night. The nets were monitored at a maximum of 10-min intervals from local sunset to local sunrise for a total of 561 net hours. I removed captured bats and placed them into containers. Species was determined using characteristics and a dichotomous key contained in *Mammals of the Trans-Pecos* (Schmidly, 1977). I weighed bats using an electronic scale. Forearm length and total body length were measured using calipers. I took a wing punch from *Myotis* for DNA species analysis due to *Myotis* are often difficult to accurately identify without collection of the individual. I tagged bats with a band on the forearm of each individual beginning in April 2011.

I used a Peterson D500X Ultrasound Detector/Recorder to record passive acoustic samples from 13 sites across Elephant Mountain (Fig. 2). This model records full spectrum ultrasound in real time (D500X Ultrasound Detector/Recorder, n.d.). I affixed an acoustic sampler no less than 1 m from the ground. Five mist netting sites were included in the 13 acoustic sites. The remaining sites were located near flyways and water sources along roads. Sites were at least 1 km apart to ensure independence. I began acoustic sampling on 3 June 2011 and concluded on 14 July 2011. I conducted passive sampling by programming the Peterson detector to begin recording once an echolocation call was detected and continued recording for 5 seconds. After recording a call, the detector rested for 10 seconds before activating at the presence of a new call. The detector was fastened at a stationary point at the site and recorded throughout the night.

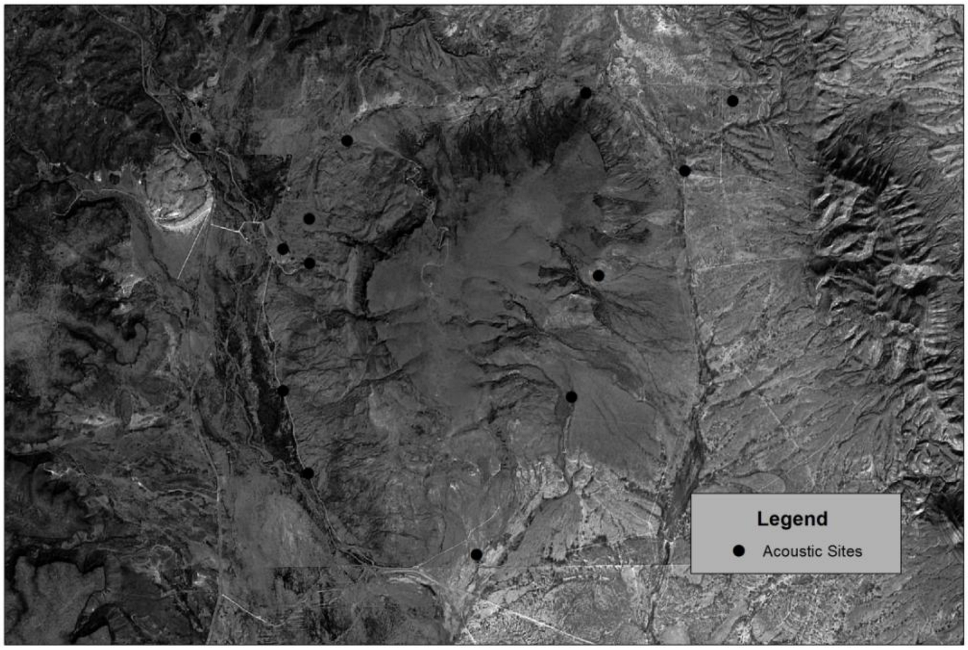

Figure 2: Acoustic sites from 2010 to 2011 across Elephant Mountain Wildlife Management Area, Texas

I analyzed every third acoustic sample for species identification due to the large volume of calls. I downloaded call files from the acoustic samplers and analyzed calls using SonoBat^{tm} Software for Bat Call Analysis, version 2.9.6. I selected the highest quality call for analysis from each file. Each call was defined as an individual, discrete vocal pulse (O'Farrell et al., 1999). Subsequent calls within the file were used to verify the identification. I used measurements of lowest apparent frequency, highest apparent frequency, characteristic frequency (frequency of the call at the lowest slope), maximum frequency (frequency with the greatest power), duration from beginning to the end of the call, upper slope-slope from the high frequency to the knee, lower slope (slope from the knee to the low frequency), slope at characteristic frequency, and total slope for analysis of the call (Fig. 3). These parameters were compared to known ranges of species. In addition, calls were compared to the known call library on the software to evaluate the shape of the call.

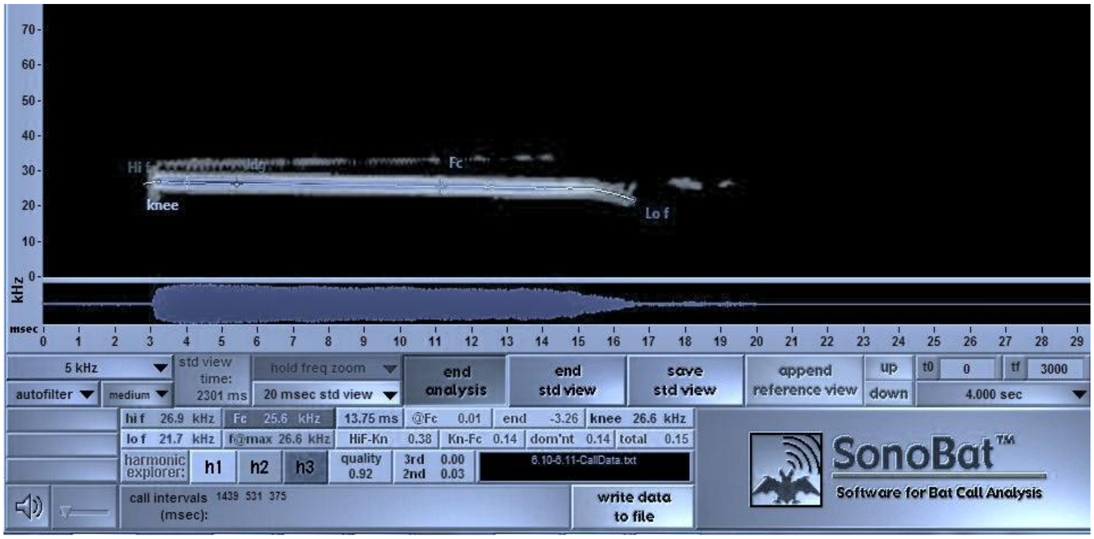

Figure 3: Acoustic call and parameters of *Tadarida brasiliensis* at Elephant Mountain Wildlife Management Area, Texas in 2011.

Call identifications were assigned a confidence ranking of 1, 2, or 3 with one being the most confident due to the overlap between species in the parameter ranges. I assigned a confidence ranking of 1 when no more than 2 measurements fell outside the standard deviations for each call parameter for the assigned species. A ranking of 2 was assigned when no more than 4 measurements fell outside of the standard deviation. A ranking of 3 was assigned when more than 4 measurements fell outside of the standard deviation of parameters for the species.

I used a two-factor analysis of variance (ANOVA) to assess the influence of elevation and season on mist net captures. Number of captures was used as our response variable, while season and elevation were independent variables. I totaled the number of captures for each elevation during each season. Each total was then divided by hours netted for each elevation and season to account for differences in effort.

I used a single factor ANOVA to compare number of species detected via acoustic sampling. I took acoustic samples at low and mid elevations due to an inability to sample the top of the mountain. I totaled the number of identified species per night for each site. I used these calculated totals for each elevation as the response variable. Sites sampled twice were used for analysis as effort was constant. Four mist net sites were sampled 2 or more times each year and yielded more than 0 captures. Three sites yielded 0 captures. These sites were not included in the analysis. Because of the number of sites with no captures, a single factor ANOVA was used on each site. The single factor ANOVAs were used to compare captures at each site for each sampling year (2010, 2011). I used Brillouin Index of diversity to assess differences in bat species captures in mist nets between three elevations.

All research was conducted under the Texas State University IACUC permit number 0903_0205_03 and State of Texas Scientific Collecting Permit SPR 0106-005.

RESULTS

I conducted mist net surveys at 8 sites between July 2010-2011 and captured 128 individuals of 8 bat species during 560 mist netting hours. I captured 35 bats at high elevation, 22 at mid elevation, and 71 at low elevation. At high elevation, 2 of these captures were in summer, while the remaining 33 were in fall. Ten captures at mid elevation were during summer, 2 during fall, and 10 during spring. Nets at low elevation yielded 41 captures during summer, 3 during fall, and 27 during spring. There was no difference in total captures between elevations ($F_{2, 4} = 0.618$, $P = 0.5836$) or season ($F_{2, 4} = 0.0626$, $P = 0.9403$).

Tadarida brasiliensis captures consisted of 47.7% of mist net captures, while Antrozous *pallidus* and *Myotis* spp. accounted for 20.3% and 15.6%, respectively. *Parastrellus hesperus* contributed to 8.6% of captures and the remaining 8% of captures were distributed among *Corynorhinus townsendii* (3.9%), *Lasiurus cinereus* (2.3%), *Eumops perotis* (0.78%), and *Eptesicus fuscus* (0.78%).

I collected 2 species, *Antrozous pallidus* and *Tadarida brasiliensis*, at all elevations and habitats sampled, while 2 species, *Eptesicus fuscus* and *Eumops perotis*, were collected only at low elevation sites in desert flats. I netted 1 species at both low and high elevations (*Lasiurus cinereus*). The remaining 3 species (*Pipistrellus hesperus*, *Myotis* sp., and *Corynorhinus (Plecotus) townsendii*) were netted at both mid and low elevation in desert flats and slopes and canyons (Table 2; Fig. 4).

Table 2: Species distribution during 2010 - 2011 across elevations at Elephant Mountain Wildlife Management Area, Texas.

Species	High Elevation	Mid Elevation	Low Elevation
Eptesicus fuscus			**X**
Eumops perotis			**X**
Lasiurus cinereus	**X**		**X**
Corynorhinus townsendii		**X**	**X**
Pipistrellus hesperus		**X**	**X**
Myotis sp.		**X**	**X**
Tadarida brasiliensis	**X**	**X**	**X**
Antrozous pallidus	**X**	**X**	**X**

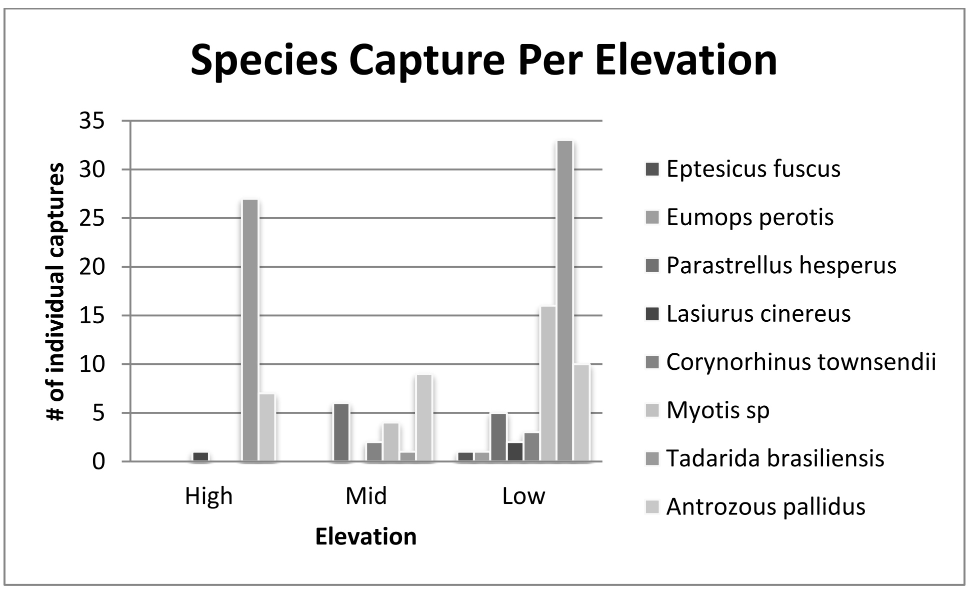

Figure 4: Species captured at each elevation via mist net during 2010 and 2011 at Elephant Mountain Wildlife Management Area, Texas.

Number of captures increased from 2 to 39 at Jug Tank and from 3 to 12 at Windmill Canyon from 2010 to 2011. This difference between years was significant for Jug Pond ($F_{1,6}$ = 17.765, P = 0.005593), but not Windmill Canyon ($F_{1,6}$ = 5.2454, P = 0.06192).

Acoustic sampling conducted at 13 sites (7 low elevation and 6 mid elevation sites) yielded 9,894 echolocation calls for 18 species identified. There was no difference in number of species captured via acoustic sampling at low and mid elevations ($F_{1,16}$ = 0.5729, P = 0.4601).

Of the 18 species I identified, *Tadarida brasiliensis*, *Myotis californicus*, and *Myotis volans* composed half of the acoustic calls at 27.1%, 13.4%, and 9.2% of calls, respectively. The remaining 15 species represented 50.3% of calls; 22% *Myotis* spp., 8.6% *Lasionycteris noctivagans*, 6.4% *Parastrellus hesperus*, 4.7% *Eptesicus fuscus*, 4.2% *Lasiurus* spp., 2.8% *Corynorhinus townsendii*, 1.2% *Antrozous pallidus*, 0.6% *Eumops perotis*, and 0.1% *Euderma maculatum* (Table 3, Fig. 5).

Table 3: Percentage of species captured via acoustic sampling in 2011 at Elephant Mountain Wildlife Management Area, Texas.

Species	**% of captures**
Tadarida brasiliensis	27.1
Myotis californicus	13.4
Myotis volans	9.2
Myotis lucifugus	8.6
Lasionycteris noctivagans	8.2
Parastrellus hesperus	6.4
Myotis yumanensis	4.9
Eptesicus fuscus	4.7
Myotis thysanodes	4.5
Myotis ciliolabrum	3.9
Corynorhinus townsendii	2.8
Lasiurus cinereus	2.5
Antrozous pallidus	1.2
Lasiurus blossevillii	1.1
Eumops perotis	0.6
Lasiurus borealis	0.6
Myotis evotis	0.4
Euderma maculatum	0.1

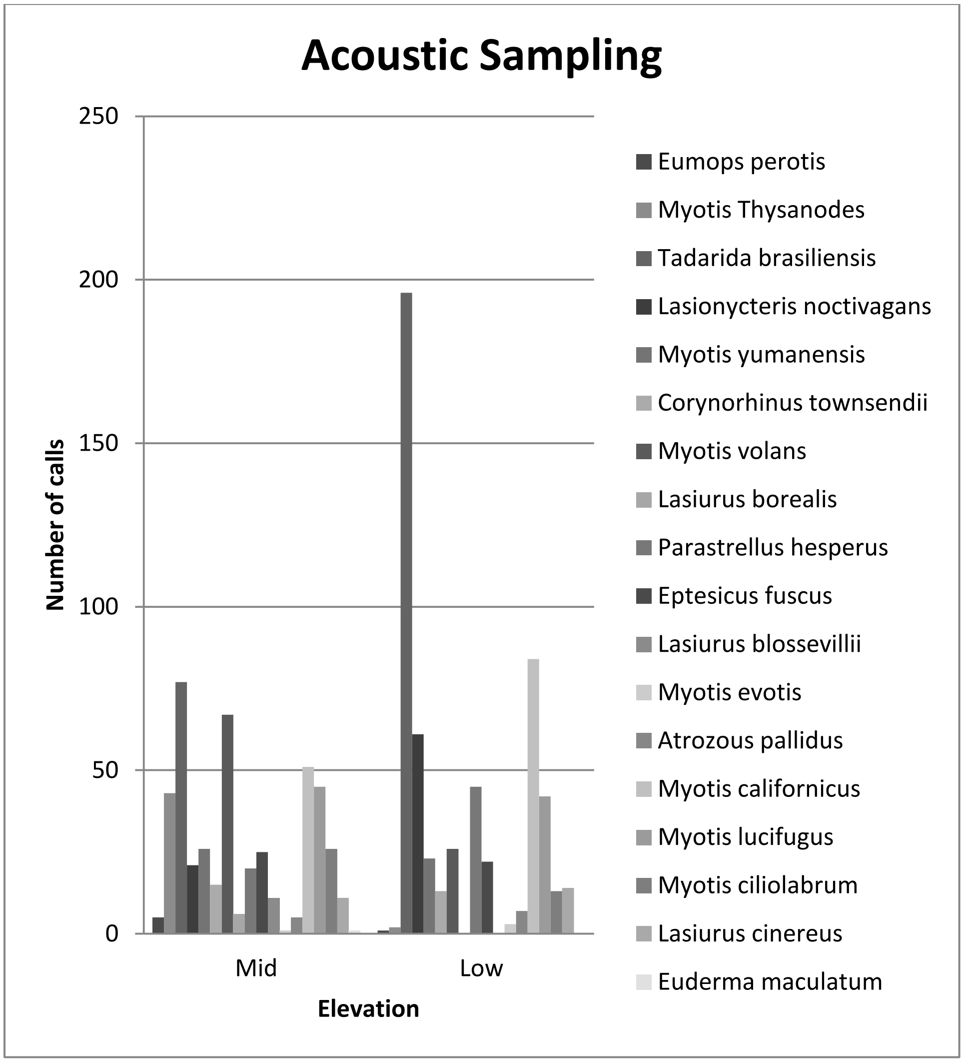

Figure 5: Species detected via acoustic sampling at mid and low elevations at Elephant Mountain, Texas in 2011.

The Brillouin Index of diversity indicated differences in species diversity based on mist net captures between the three elevations. Top yielded a diversity value of 0.54438, mid 1.14628, and bottom 1.36055.

DISCUSSION

Mist net captures did not differ among elevation or season. *Tadarida brasiliensis* and *Antrozous pallidus* had the most captures of bats via mist nets; these results are not unexpected as they are some of the most common bat species in Trans-Pecos Texas (Schmidly, 1977). *Corynorhinus townsendii* is considered one of the rarest bats in Texas (Schmidly, 1977); however, I captured 5 individuals at 2 sites. These sites were in 2 elevational ranges; 1 in the flats and 1 at mid elevation. The capture of *Lasiurus cinereus* is notable not because it is rare, but because it is generally restricted to woody mountains (Schmidly, 1977). The remainder of my captures with the exception of *Myotis* spp, are generally considered common in the Trans-Pecos, although I only captured some species once (*Eptesicus fuscus* and *Eumpos perotis)*. *Myotis* spp. was only identified to genus.

All species captured via mist net were also captured via acoustic sampling. All species captured via acoustic sampling, however, were not captured via mist net. Ten species captured via acoustic sampling were not captured in nets. Mist nets are only capable of sampling a small area compared to the total area utilized by bats (O'Farrell et al., 1999). Some bat species are not detected via mist netting due to their mobility, and a relatively low proportion are actually sampled (O'Farrell et al.,1999), and this can biased a sample (Flaquer et al., 2007). O'Farrell et al. (1999) asserted that bats seem to detect and avoid mist nets; my results for some species concur with this finding. I observed bats exhibiting avoidance behavior near mist nets while sampling at Elephant Mountain. This seemed especially common on evenings with wind. The limitations of mist netting coupled with weather conditions may have contributed to the low number of species captured.

The number of species totaled for echolocation calls include specific *Myotis* species because calls could be identified to the species level. *Myotis* caught in mist nets were only identified as *Myotis* sp., potentially underestimating the total number of species caught via mist net. O'Farrell et al. (1999) also found substantially fewer species were captured by mist nets than detected via.

Acoustic sampling should be incorporated into survey methods. Flaquer et al. (2007) found it necessary to combine sampling techniques to produce a thorough survey of bat species. This may be especially significant for rare species and species of concern. Even with intense efforts, rare species may be missed by using only one method (Flaquer et al., 2007).

During summer and fall 2010, five of 8 mist net sites were associated water. The annual precipitation for Alpine, Texas in 2010 was 26.3 cm (History of Alpine, TX, n.d.). During spring and summer 2011, only 2 of 8 sites were associated water. The annual precipitation for Alpine, Texas was 5.3 cm (History of Alpine, TX, n.d.). The sites remaining wet in 2012 were artificially supplied with water by Elephant Mountain managers. The first site, Jug Pond, had drastically reduced amounts of water compared to the previous year; however, enough water was supplied to keep the site wet. The second site, Windmill Canyon, contained roughly the same amount of water in 2011 and 2012. The 2 water sites were distinctly different in structure. The water at Windmill Canyon is contained in 2 tanks with 1 approximately 2 feet from the ground and 1 approximately 6 feet from the ground. Both tanks are free of surrounding vegetation. Jug Pond is a free-standing pond surrounded by tall grasses and trees. There was a significant increase in captures at these sites during 2012.

Given this increase in captures at 2 differing sites, it is important for managers to actively manage water for bats, especially during drought years. Jackrel et al. (2010) found larger, full tanks with small amounts of vegetation increased bat use. Vegetation can be controlled near natural water sources to increase bat activity. Additionally, supplemental water sources should be provided in years of extreme drought.

There was not a significant decrease in captures at sites with water in 2011 and 2012. This may be due to individuals frequenting several sources of water, resulting in fewer captures at each water site. Additionally, while 2 sides and 1 top site were not included in this analysis due to 1 or no captures, 1 top site was excluded due to only 1 sampling in 2012. The side site yielded several captures while containing water in 2011 and no captures by a single survey during 2012. Ideally this site should have been sampled again during 2012.

Continued monitoring of bat species at Elephant Mountain over the next several years will provide more accurate data regarding water usage during wet and dry years. My data were collected during only 1 sample year per condition. Additionally, incorporating acoustic sampling into surveys will likely increase the number of species detected.

Water has a proven effect on both bat community and structure (Aadams et al., 2008). Bats are susceptible to local weather patterns, specifically temperature, precipitation, and humidity (Aadams et al., 2008). Aadams et al. (2008) modeled decreasing water availability with predicted climate change in arid regions of North America. They found a significant decrease in reproductive ability of bats (Aadams et al., 2008). While effects vary regionally, climate change is occurring in North America with changes in temperature and rainfall expected (Aadams et al., 2008; Cameron et al., 2001). It is crucial to monitor bat populations as these changes take place and implement necessary management practices. Conducting comprehensive surveys are vital when developing management strategies. Incorporating mist netting and acoustic sampling will provide a more accurate representation of the population, allowing for thorough sampling of species present. Using both methods will also provide information about habitat use, including water site usage. Supplying water during reproduction periods of bats will aid in reproduction success. This is particularly important during years of drought. Additionally, vegetation should be managed around both artificial and natural water sources to increase attractiveness to bats. Incorporating these methods into current management practices will promote habitat conservation for bats.

APPENDIX

Bat Species

The Trans-Pecos region of Texas is home to many bat species. Bats are one of the most common mammals of the Trans-Pecos with 23 species in 4 families (Schmidly, 1977). A single species within the family Mormoopidae, the ghost-faced bat (*Mormoops megalophylla*), is found in the region (Schmidly, 1974). This bat is often found in desert scrub and riverine habitats (Schmidly, 1974). The Mexican long-nosed bat (*Leptonycteris nivalis*) is an endangered species within the family Phyllostomidae (Schmidly, 1974). It has been found primarily in the Big Bend region and its only range known in the United States is the Trans-Pecos (Schmidly, 1974; 1977).

Several members of the family Vespertilionidae are present, including the California myotis (*Myotis californicus*), fringed myotis (*Myotis thysanodes*), cave myotis (*Myotis velifer*), western pipistrelle (*Pipistrellus hesperus*), and pallid bat (*Antrozous pallidus*). These are some of the most common bats in western Texas (Schmidly, 1974). The California myotis is found in wooded canyons, open deciduous and coniferous forests, and brushy hillsides with roots in cliffs, cavities, and tops and sides of shallow caves (Schimdly, 1974). Fringed myotis inhabit various habitat types including mountainous pine, pinyon-juniper, and oak, desert scrub, and grassland at intermediate elevations (Schmidly, 1974). Fringed myotis occur only in the Trans-Pecos in Texas (Schimdly, 1974; 1977). Cave myotis are colonial and range across central and western Texas in every county of the Trans-Pecos but El Paso (Schimdly, 1974; 1977). The western pipistrelle, the smallest bat in the Trans-Pecos, inhabits rocky areas located near water and is more diurnal than many bats in the region (Schimdly, 1974; 1977). The tricolored bat (*Perimyotis subflavus*) may occur in wooded areas with water; however, its range just enters the eastern Trans-Pecos (Schmidly, 1977). Pallid bats often roost in caves, mines, tunnels, and rock crevices and are often found between 600-1800 m in elevation (Schimdly, 1974). They generally occupy rocky outcroppings around these areas (Schimdly, 1974). The western yellow bat (*Lasiurus xanthinus*), and long-legged myotis (*Myotis volans*) appear to be rare in this area (Schmidly, 1974). Western small-footed myotis (*Myotis ciliolabrum*) is rare as well having been collected in only 5 counties in the Trans-Pecos (Schmidly, 1977). Schmidly (1974) recommends further monitoring of these species due to the lack of data. The southwestern little brown bat (*Myotis occultus*) is one of the rarest species in the region (Schmidly, 1974; 1977). Yuma myotis (*Myotis yumanensis*), western red bat (*Lasiurus blossevillii*), eastern red bat (*Lasiurus borealis*), big brown bat (*Eptesicus fuscus*), and hoary bat (*Lasiurus cinereus*) are all common throughout the Trans-Pecos (Schmidly, 1974). The Yuma myotis roosts in caves and mines and is extremely colonial (Schmidly, 1977). Eastern red bats inhabit a variety of habitats, including grama grasslands, oak-juniper, and elm communities (Schmidly, 1977). The hoary bat roosts in the foliage of trees and is restricted to wooded mountainous areas (Schmidly, 1977). The big brown bat occupies desert scrub as well as mountainous wooded areas (Schmidly, 1977). The silver-haired bat (*Lasionycteris noctivagans*) has a wide distribution within Texas, however, is not common in the Trans-Pecos (Schmidly, 1974; 1977). The spotted bat (*Euderma maculatum*) has only been collected in Big Bend National Park but is likely to occur in other areas of the Trans-Pecos. It is an extremely rare bat, known to reside on cliffs, roosting in the crack and crevices (Schmidly, 1977). Townsend's big-eared bat (*Corynorhinus townsendii*) is considered one of the rarest bats in Texas and the Trans-Pecos. It prefers mountainous areas with rocky outcroppings (Schmidly, 1974). The Brazilian free-tailed bat (*Tadarida brasiliensis*) is one of the most common bats present in the Elephant Mountain area (Schmidly, 1974). It is most common in lowland areas; however, it has been recorded in all major habitat types (Schmidly, 1977).

Brazilian free-tailed bats along with the pocketed free-tailed bat (*Nyctinomops femorosaccus*), big free-tailed bat (*Nyctinomops macrotis*), and western mastiff bat (*Eumops perotis*) are members of the family Molossidae in the Trans-Pecos. The pocketed free-tailed bat is only known to reside in the Big Bend National Park region of the Trans-Pecos along high cliffs in desert areas (Schmidly, 1977). The western mastiff bat can be found at lower elevations in arid areas and roosts in canyons and cliffs (Schmidly, 1977).

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