

**MONITORING THE COLONY SIZE AND POPULATION
FLUCTUATIONS OF THE ENDANGERED MEXICAN LONG-
NOSED BAT IN BIG BEND NATIONAL PARK USING THERMAL
IMAGING**

FINAL REPORT
SUBMITTED TO THE
SCIENCE AND RESOURCE MANAGEMENT OFFICE
BIG BEND NATIONAL PARK

14 December 2012

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INTRODUCTION

The Mexican long-nosed bat, *Leptonycteris nivalis*, is recognized as endangered by the State of Texas, the United States Fish and Wildlife Service, Mexico and the IUCN (U.S. Fish and Wildlife Service 1994). This migratory species occurs throughout much of Mexico, and a single colony occurs in Texas during the summer months. This colony roosts in Emory Cave, which is located in the Chisos Mountains of Big Bend National Park (BBNP), along with *Corynorhinus townsendii* and *Myotis thysanodes*. One important threat to the survival of this species may include loss of food resources. In the northern half of its range, *L. nivalis* relies primarily on the nectar and pollen of *Agave* (century plants), playing an important role in pollination of these plants and in the maintenance of arid-land ecosystems (Kuban 1989). The impact of *Agave* removal for agriculture, ranching, and human development on the Emory Cave colony has not been ascertained. An accurate roost census is critical to understanding and ultimately protecting the population of *L. nivalis* in BBNP.

Both state and federal recovery plans recognize the need for accurate, long-term monitoring of this species (U.S. Fish and Wildlife Service 1994). It cannot be effectively monitored using mist net captures unless efforts are concentrated around *Agave* plants—and this method poses important logistical challenges. In the past 13 years of netting over water holes in BBNP, only 3 individuals out of over 4,600 captures have been *L. nivalis* (Higginbotham and Ammerman, 2002; L. Ammerman, unpublished data). Roost counts have been conducted over the last 15-20 years and suggest that major fluctuations in colony size occur from year to year (from 0 bats to 6630 bats; R. Skiles, personal communication). However, these estimates were conducted only once a year by counting the number of bats per square meter on the cave ceiling and then extrapolating this over the estimated area of the roost that is covered by bats (Thomas and LaVal 1988). Emory Cave has many crevices and deep cavities that are inaccessible and probably contain roosting bats that are overlooked using this census method (Ammerman 2006, Ammerman et al. 2009).

Ammerman et al. (2009) used an infrared thermal imaging camera to record and census bats that emerged nightly from Emory Cave in 2005 and compared colony estimates using this method to estimates derived from surface area estimates. Ammerman et al. (2009) concluded that thermal imaging techniques make a more accurate census of this colony possible and have several advantages over traditional census methods. Since that initial study in 2005, colony size at Emory Cave has been estimated using thermal imaging in 2008 through 2012. Colony size of *Leptonycteris* has ranged from a low of 294 individuals in 2008, to a high of 3238 individuals in 2009 (Fig. 1).

OBJECTIVE

The purpose of this project was to use thermal infrared imaging technology to determine colony size of the migratory, endangered, Mexican long-nosed bat in Emory Cave in Big Bend National Park Texas in July of 2012 during the peak in abundance of their primary food source (*Agave* nectar).

METHODS

Because infrared thermal cameras detect heat produced by bats, it is possible to record and census bats independent of ambient light (Frank et al. 2003). This method has proven successful for censusing Brazilian free-tailed bats, where millions of bats emerge nightly from selected caves in Texas (Horn and Kunz 2008), for censusing *Leptonycteris* at Emory Cave (Ammerman et al. 2009), and for numerous research applications on the behavior of free-ranging bats (Hristov et al. 2008).

Emergence Counts – A thermal imaging camera capable of recording video (FLIR P65 (S65); FLIR Systems, Boston, MA) was mounted on a tri-pod and used to film Mexican long-nosed bats (*Leptonycteris nivalis*) emerging from Emory Cave for two nights in July. A crew of 5 people (Scott Burt, Krysta Demere, Leanne Dixon, Michael Dixon, and Loren Ammerman) attempted to record emergences beginning at 9:00-9:15 pm on the nights of July 3 and 4. Computer files (55 and 49 gigabytes each) were transferred to an external hard drive for storage and later analyses.

Data Analysis - Recordings of emergences were analyzed manually using ThermaCAM Researcher Pro v2.9 software from FLIR systems. By watching a slow replay of the emergence video, I tallied the number of bats exiting and entering the cave per minute. The glowing images of each bat correspond to temperatures in different parts of their body. The body temperature for *Leptonycteris* is highest in the core of its body and along the massive musculature along the left and right humerus resulting in a glowing “T” shaped thermal image. Because this image is not produced by the other bat species in Emory Cave, and because of the large size of this species, *L. nivalis* could be discerned from other species of bats and counted separately. This tally produced a conservative census of *L. nivalis* because undoubtedly there were some instances where individual bats could not be positively identified as *L. nivalis*. The net number of bats that emerged also was calculated. These data were used to generate an emergence profile by graphing in Microsoft Excel. Population size and emergence profile of *Leptonycteris* was calculated for one night because past research has shown the emergences on successive nights are similar in pattern and in number of bats emerging (Ammerman 2011).

RESULTS

On 3 July 2012, the field crew recorded bats emerging from Emory Cave from 9:02 pm until 10:48 pm. We were able to record from 9:05 pm until 10:39 pm on 4 July 2012 but this recording was not analyzed. On 3 July, sunset and moonrise were both at 9:00 pm. Moonrise on 4 July was around 9:45 pm. The weather was cloudy, windy, and cool with a 30-70% chance of rain for each of the days we planned to record. There had been scattered rain showers that afternoon, but no precipitation occurred during the time we were near the cave.

On 3 July, *Leptonycteris* individuals emerged from the cave approximately 25 minutes after sunset (Fig. 2). The maximum net number emerging (number flying in subtracted

from number flying out) was 112 bats/minute 41 minutes after sunset. Total colony size was estimated as 2443 on 3 July (Fig. 1 and 3). The number of vespertilionid bats that emerged was 108 (Fig. 1). More *Leptonycteris* were re-entering the cave instead of leaving the cave after about 1.5 hours after sunset. There were still a few bats flying when the camera battery died and recording stopped. From the social chatter that we could hear during the emergence, it sounded like the bats were staying close to the cave opening and activity didn't completely empty the cave. All computer files of the emergences are available from L. Ammerman, Angelo State University.

DISCUSSION AND MANAGEMENT RECOMMENDATIONS

I conclude that the colony size in 2012 was *at least* 2443 *Leptonycteris* individuals and 108 individuals of "other" species (such as *Myotis* and *Corynorhinus* that occupy the cave), for a total of 2551 bats. The emergence behavior appeared to be affected by the full moon this year. Bats were returning to the cave before all of the individuals had emerged. This behavior is atypical but also was observed in 2009 when there was a full moon (Ammerman 2009). Presumably, they are staying close to the cave or limiting their foraging time because of increased risk of predation in the bright night. It was assumed that bats with hot wings (light in color on the recording) had been out foraging for some period of time before returning to the cave. Bats that were re-entering the cave because of circling in the entrance before emerging tended to have colder wings (dark in color on the recording) and therefore indicated that they had not been flying for very long.

I recommend that thermal infrared recordings continue to be used to estimate colony size of the endangered Mexican long-nosed bat each year during the first half of July (avoiding the full moon phase). This method has the advantage of being less invasive and more accurate than other survey methods. These data will assist with understanding yearly fluctuations. However, fully characterizing the seasonal fluctuations in colony size would be preferable to single census efforts. The annual census in July has provided data to evaluate trends in colony size of this endangered, migratory species (Fig. 1), but it does not allow us to determine if this is an accurate estimate of maximum colony size each year. Determining the magnitude of variation in colony size across time would require additional sampling at multiple times throughout the period of flowering in agave.

ACKNOWLEDGMENTS

I want to thank Michael Dixon for his willingness to help me to manually count emerging bats and to tally and graph the results. I am grateful for the assistance of Raymond Skiles and David Larson at Big Bend National Park. Without their help, the logistics to perform this work would not be possible. I acknowledge Scott Burt, Krysta Demere, Michael Dixon, and Leanne Dixon for their contributions to the field portion of this study. This work was performed under Texas Parks and Wildlife permit SPR-0994-703, a Resource Activity permit from the National Park Service (#BIBE-2012-SCI-0031), and an Endangered Species permit from the U. S. Fish and Wildlife Service (TE127287-0).

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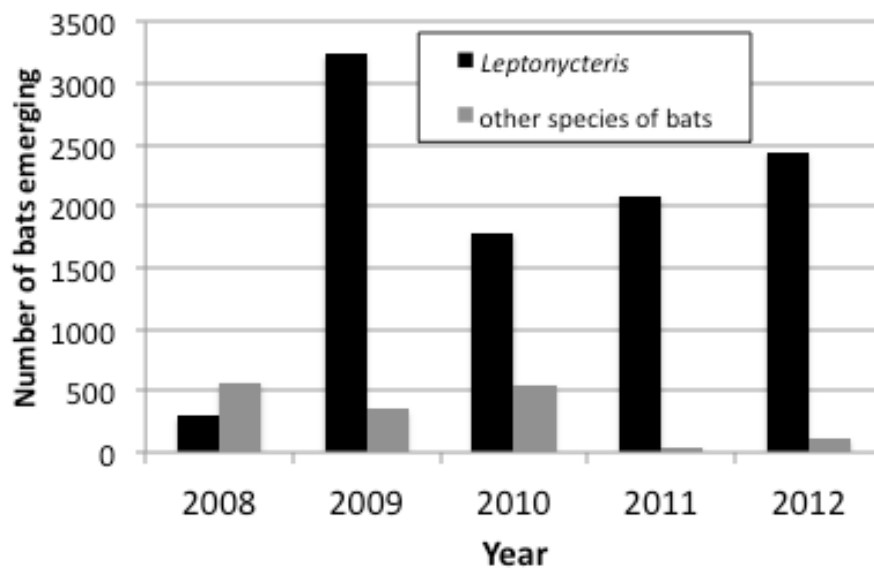


Figure 1. Census results for bats emerging from Emory Cave, Big Bend National Park annually in early July using thermal imaging techniques (Ammerman and Tabor 2008, Ammerman 2009, 2010, 2011, and this study).

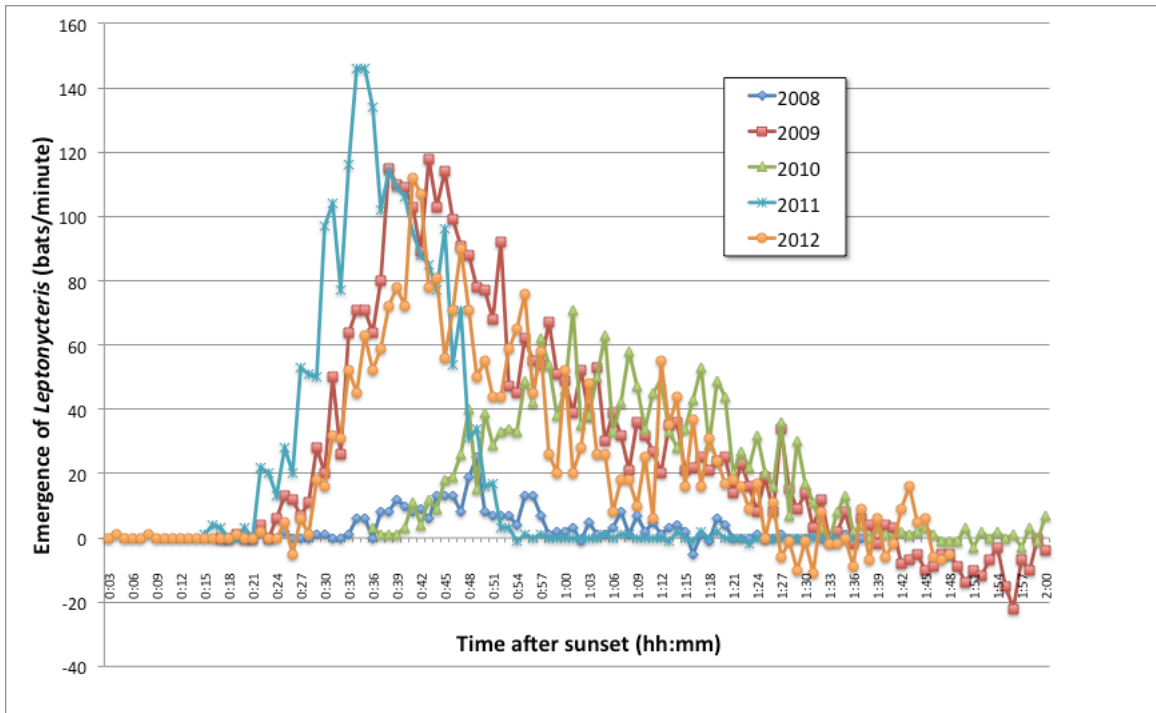


Figure 2. Comparison of annual emergence profiles for *Leptonycteris nivalis* leaving from Emory Cave per minute (Brewster County, Big Bend National Park). Results from this year (2012) are in orange.

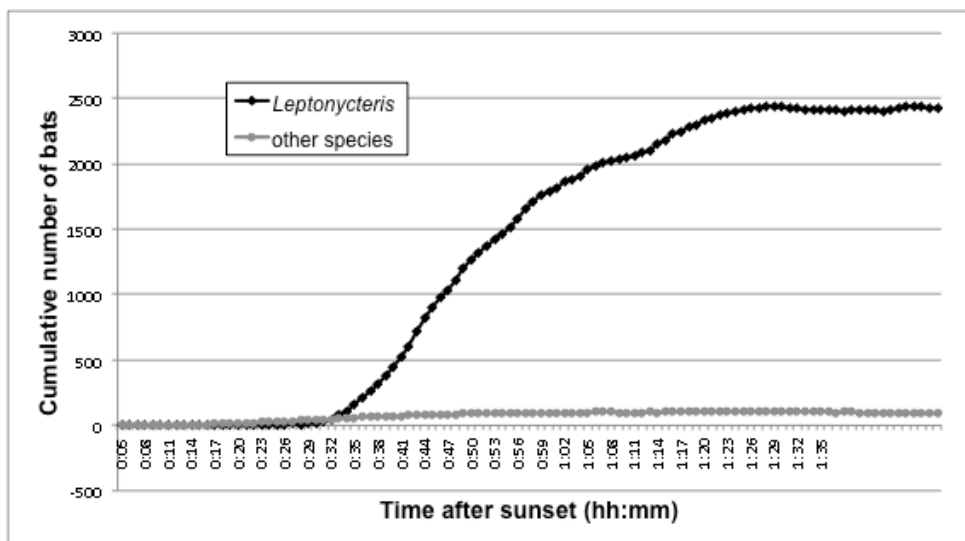


Figure 3. Cumulative net number of *Leptonycteris* and other species (*Corynorhinus townsendii* and *Myotis thysanodes*) emerging from Emory Cave (Brewster County, Big Bend National Park) over time on 3 July 2012.