

Florida bonneted bat (*Eumops floridanus*): Feeding Activity and Bright Stadium Lights

by

Selena Harman

A Thesis Submitted to the Faculty of

The Wilkes Honors College

in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science in Biological and Physical Sciences

with a Concentration in Biology

Wilkes Honors College of

Florida Atlantic University

Jupiter, Florida

December 2021

Florida bonneted bat (*Eumops floridanus*): Feeding Activity and Bright Stadium Lights

by

Selena Harman

This thesis was prepared under the direction of the candidate's thesis advisor, Dr. James K. Wetterer, and has been approved by the members of her supervisory committee. It was submitted to the faculty of The Wilkes Honors College and was accepted in partial fulfillment of the requirements for the degree of Bachelor of Science in Biological and Physical Sciences.

.

SUPERVISORY COMMITTEE:

Dr. James K. Wetterer

Dr. William O'Brien

Dean Justin Perry, Wilkes Honors College

Date

ABSTRACT

Author: Selena Harman

Title: Florida bonneted bat (*Eumops floridanus*): Feeding Activity and Bright Stadium Lights

Institution: Wilkes Honors College of Florida Atlantic University

Thesis Advisor: Dr. James K. Wetterer

Bachelor of Science in Biological and Physical Sciences

Concentration: Biology

Year: 2021

The Florida bonneted bat (*Eumops floridanus*) is an endangered species found only in southern Florida. There is little ecological information known for this species, making conservation work difficult in protecting it. What we do know, however, is that they are large, insectivorous, high-flying mammals that can travel over vast distances in a single night. With these characteristics it made me wonder if *E. floridanus* would find baseball stadiums an acceptable hunting ground. They have wide-open spaces, the bright stadium lights attract insects, and the field lights themselves are hundreds of feet high. To test if this is true, I set up ultrasonic recording equipment at Roger Dean Stadium (and two other baseball fields with differing environmental factors) to see if there is a difference in activity between nights when the lights are on or off. With this information about *E. floridanus* feeding habits, current conservation practices could be improved upon.

TABLE OF CONTENTS

Introduction.....	1
Methods.....	4
Results.....	11
Discussion.....	14
Works Cited.....	17

LIST OF TABLES

Table 1: Nightly totals of <i>Eumops floridanus</i> Hits (Location A) [6:00pm to 1:00am].....	11
Table 2: Nightly totals of <i>Eumops floridanus</i> Hits (Location B) [6:00pm to 1:00am].....	12
Table 3: Hit averages for each night of the week (Location B).....	13
Table 4: Nightly Totals of <i>Eumops floridanus</i> Hits at Halpatiokee Park.....	13

LIST OF FIGURES

Fig. 1: The Florida bonneted bat, <i>Eumops floridanus</i> (from Solari 2016).....	1
Fig. 2: Song Meter SM4BAT FS Ultrasonic Recorder.	4
Fig. 3: Satellite map of Locations A and B (From google maps).....	5
Fig. 4: SM4BAT set up at Location A (above), and a view of natural area (below).....	6
Fig. 5: Day (above) and night (below) comparison of the practice field next to Location A.....	7
Fig. 6: Microphone set up inside (above) and the nighttime view outside (below) Location B.....	8
Fig. 7: Graph of Hit averages for each night of the week at Location B.....	12
Fig. 8: Halopatiokee Regional Park at night.....	16

Introduction

The Florida bonneted bat, *Eumops floridanus* (Fig. 1), of the Molossidae family, is a federally protected species endemic to southern Florida (Bailey et al. 2017). This sub-tropical region gives *E. floridanus* the most restricted geographic distribution known for any bat species in the United States (Bailey et al. 2017; Ober et al. 2016). As such, conservationists are very much concerned about the Florida bonneted bat's continued survival. Developing effective park management practices and conservation plans is an integral part of ensuring said survival in a world of ever encroaching urbanization, yet there is precious little information on this rare species to base management decisions on (Braun et al. 2016).



Fig. 1. The Florida bonneted bat, *Eumops floridanus* (from Solari 2016).

Basic information on breeding seasonality, roost locations, and social organization are lacking (Ober et al. 2016). Data on distribution and preference of habitat are limited, and what information is available is largely speculative (Bailey et al. 2017). Even reliable information on the description and identification of *E. floridanus*' roosts, which is needed to create one of the highest prioritized protection guidelines for the species, is sparse (Braun et al. 2016). This lack of knowledge hampers any conservation efforts that might be developed for these endangered mammals (Ober et al. 2016). It is my hope that this study will shine some light upon the habits of *E. floridanus* so they are more effectively protected. If we better understood what environments and conditions they prefer to feed in, current conservation strategies can be improved upon.

For my thesis research, I examine whether stadium lights influence the foraging activity of *E. floridanus*. Much like the speculated environmental factors affecting bonneted bat distribution (Bailey et al. 2017), my hypothesis is based on an incidental observation. James Wetterer (pers. comm.) recalls that while attending nighttime baseball games at Roger Dean Stadium in Jupiter, Florida, he saw and heard bats fly high overhead, eating the insects attracted to the bright stadium lights. Most bats produce their calls in the ultrasonic range; however, *E. floridanus* produces the lowest-frequency vocalizations of any Floridian species, allowing them to be perceived by humans (Braun et al. 2016). Starting in April 2018, Diane Arrieta and Stephanie Brinez repeatedly recorded calls of *E. floridanus* at two nearby sites (Brinez 2019), so there was a high possibility that the bats Dr. Wetterer saw and heard were in fact *E. floridanus*.

This deduction makes sense. The Florida bonneted bat is a large, high-flying bat built for flying fast across vast distances with its narrow wings (Gore et al. 2015). This large size makes them less maneuverable in the air, so they prefer flying in areas lacking vegetative clutter that

could restrict their flight space (Braun, Ober, and McCleery 2018). Baseball stadiums have an ample amount of wide-open space for these high-flyers to make use of, and if these bats really are taking advantage of how insects are attracted to the bright lights, then my question is this: does *E. floridanus* activity in the area increase when the stadium lights are on?

Methods

To record bat calls, I used a Song Meter SM4BAT FS Ultrasonic Recorder and an SMM-U2 ultrasonic microphone made by Wildlife Acoustics (Fig. 2). To analyze recordings, I also used its accompanying Kaleidoscope Pro 5 Analysis Software.



Fig. 2. Song Meter SM4BAT FS Ultrasonic Recorder.

I first set up the Recorder on the edge of the natural area just north of the Roger Dean Stadium's practice fields (Fig. 3-5; Location A), using a 3-m pole strapped to a slash pine tree. After obtaining permission to work inside Roger Dean Stadium itself, I moved the Recorder to a spot on the first base side of the seating area (Fig. 3 & 6; Location B).

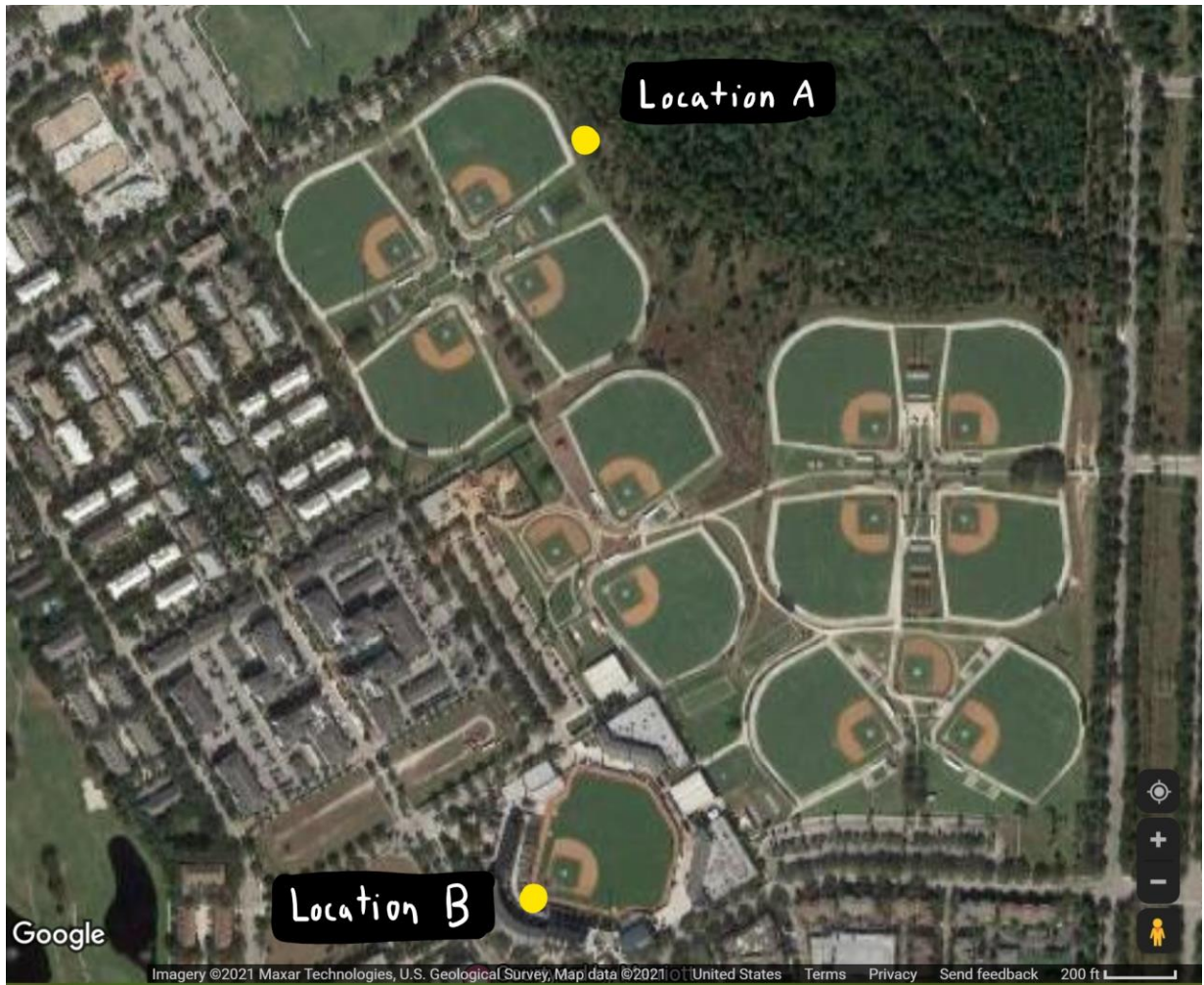


Fig. 3. Satellite map of Locations A and B (From google maps).



Fig. 4. SM4BAT set up at Location A (above), and a view of natural area (below).



Fig. 5. Day (above) and night (below) comparison of the practice field next to Location A.



Fig. 6. Microphone set up inside (above) and the nighttime view outside (below) Location B.

The two locations are ~0.6 km away from each other, but they are in vastly different environments. Location A is on the border of a natural area. The canopy of the natural area itself is very dense, and thus is a poor hunting ground for the bonneted bat; however, we are more interested in the adjacency to the practice fields. The fields provide a wide-open space with plenty of room for flying, much like the Stadium itself, but it is completely dark during the night. The recording duration for this location was originally two weeks (18-31 March 2021) and later for another four weeks (19 August - 17 September 2021) to ensure I had enough data for a comparison.

Location B was within Roger Dean Stadium itself. The recording equipment was set up right below one of the stadium's lights, where there is plenty of space for flying and bright light to attract insects. The duration for this recording was for ~13 weeks total (31 March - 2 July). These recordings were broken up into two different time periods: the Off Season [31 March - (18:00) - 4 May (7:00)], which had no baseball games occurring, and the Minor League Season [4 May (18:00) - 2 July (7:00)], which had games occurring almost every day of the week. The Minor League Season was also shortened due to Covid restrictions.

For both locations, the recording time was set to begin 30 min before sunset and end 30 min after sunrise. The equipment itself was also set up to record only when Triggered by the detection of ultrasonic frequencies. All audio files recorded from both Locations were then analyzed by Kaleidoscope Pro 5 Analysis Software to identify what species of bats made which calls. The classifier used to analyze the data was "Bats of North America 5.4.0" with the "Florida" region selected. All other settings were at default.

Once analyzed, the data regarding bonneted bats were organized into separate datasets relating to location (A and B) and time period (Off Season and Minor League Season). The

average number of audio files identified as *E. floridanus* (referred to as "hits") that were collected for each night of the week was determined and the results are displayed in a series of tables and graphs.

Only the hits recorded from 6pm to 1am, and had a match ratio above 0.7, were counted. This gives a generous time frame for night games to conclude and for employees to clean the stadium afterwards. In addition, excluding hits that were below 0.7 ensures that all recordings being considered had a significantly high chance of being produced by *E. floridanus*. The interquartile range for each set of data (specifically for the hit count recorded for each hour of the time frame) was also calculated for the purpose of identifying outliers. All outliers found were cut down to equal the maximum end of the range to make results more accurate. These modified data points are indicated with a red font in Tables 1-4.

In addition to the main study, I also set up the SM4BAT in Halpatiokee Regional Park up in Martin County to see if an area with similar qualities to my research locations would attract the bonneted bat. The equipment was positioned right next to the baseball fields and the dense forests that bordered them. Unlike Location A, park management informed me that the park is lit up at night. The data were gathered and analyzed the same way as the data from Locations A and B. The only difference being that data from the entire night (6pm – 8am) are considered since the lights are supposed to be on all night.

Results

I found a stark contrast between the number of *E. floridanus* recorded at the two study locations. The practice fields (Location A) had barely any activity recorded for *E. floridanus* (Table 1). In fact, there was so little activity that any hits recorded at all were calculated to be outliers and had their numbers reduced to zero in the finalized version of the data. It is clear that the area of Location A is not a regular destination for the bonneted bat. Instead at most they seem to clip the edge of the microphone's range only occasionally.

Table 1. Nightly totals of *Eumops floridanus* Hits (Location A) [6:00pm to 1:00am]

Weeks:	18-31 March			19 August - 17 September				
	#1	#2	#3	#1	#2	#3	#4	#5
Sunday		--	--		--	--	--	--
Monday		0	0		--	--	--	--
Tuesday		--	--		--	--	--	--
Wednesday		--	--		--	--	--	--
Thursday	--	0		0	--	--	--	--
Friday	--	--		--	--	--	--	--
Saturday	--	--		--	--	--	--	

The stadium itself (Location B), however, had consistent *E. floridanus* activity, both in the Off Season and during the Minor League Season (Table 2, Fig. 7). The Off Season has a higher average activity, with Tuesday being the only exception. The reasons for this could potentially be the lack of light, but it could also be the lack of sound. Studies have shown that noisy environments can make hunting with echolocation more difficult for bats. As a result, bats tend to prefer hunting in quieter areas when they can (Allen et al. 2021). Meaning that Roger

Dean could be a more attractive hunting ground for the bonneted bat during periods of decreased human activity when the stadium is relatively quiet.

Table 2. Nightly totals of *Eumops floridanus* Hits (Location B) [6:00pm to 1:00am]

Weeks:	Off Season (March 31 - May 4)						Minor League Season (May 4 - July 2)								
	#1	#2	#3	#4	#5	#6	#1	#2	#3	#4	#5	#6	#7	#8	#9
Sunday		--	3	1	1	5		--	2	2	5	--	--	--	1
Monday		14	11	--	2	2		6	--	--	1	2	--	1	--
Tuesday		1	5	4	--		8	4	3	7	2	2	4	5	--
Wednesday	11	3	1	4	2		3	2	--	5	3	6	--	3	2
Thursday	11	--	3	7	7		--	5	4	6	11	5	--	1	--
Friday	7	14	1	1	7		6	10	2	3	4	6	2	2	
Saturday	9	7	5	2	6		4	4	11	3	6	3	4	4	

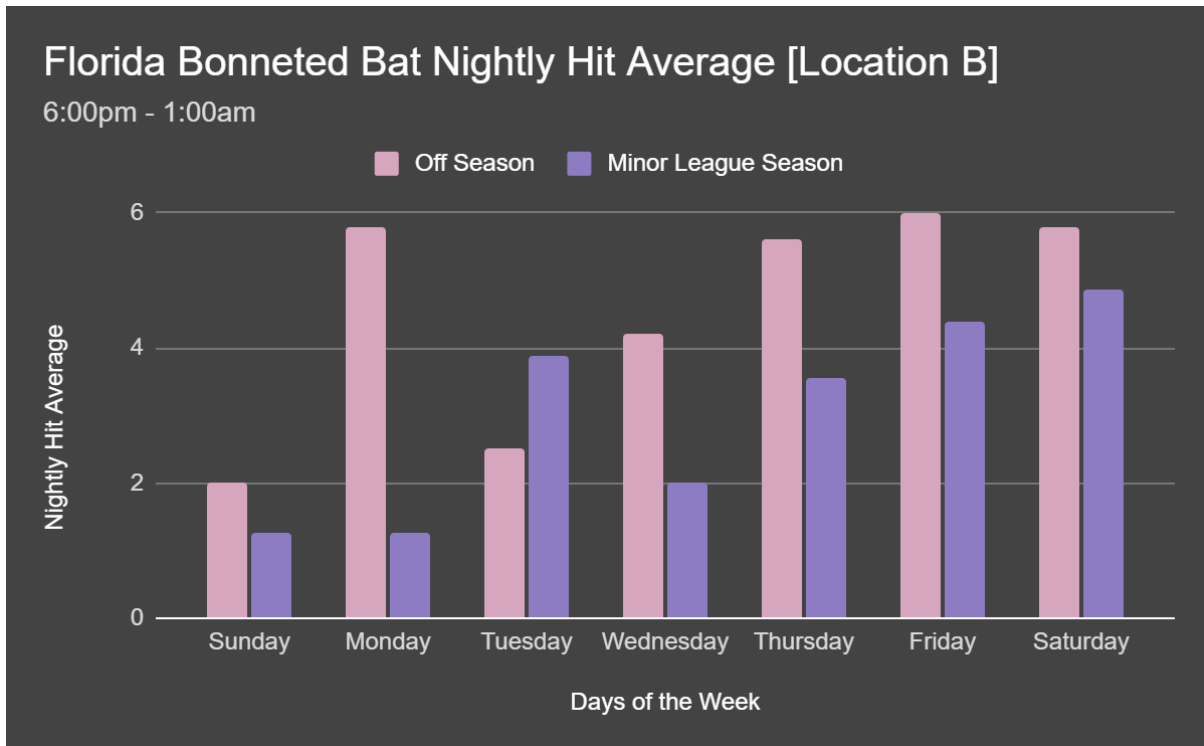


Fig. 7. Graph of Hit averages for each night of the week at Location B.

Table 3. Hit averages for each night of the week (Location B)

Nightly Hit Average: 6:00pm - 1:00am [Location B]		
	Off Season	Minor League Season
Sunday	2	1.25
Monday	5.8	1.25
Tuesday	2.5	3.889
Wednesday	4.2	2
Thursday	5.6	3.556
Friday	6	4.375
Saturday	5.8	4.875

Game Schedule Legend		
Day Game w/o Audience	Night game w/o Audience	Night game w/ Audience

As for the Halpatiokee Park data (Table 4), they are very similar to Location A (Table 2). The call of *E. floridanus* had been recorded on several nights but calculating for outliers similarly reduced all data points to zero. It is not a frequent destination for bonneted bats either.

Table 4. Nightly Totals of *Eumops floridanus* Hits at Halpatiokee Park.

Weeks:	Halpatiokee Park (July 14 - August 11)				
	#1	#2	#3	#4	#5
Sunday		--	--	--	--
Monday		0	--	--	--
Tuesday		0	--	--	--
Wednesday	--	--	--	--	--
Thursday	0	--	--	--	--
Friday	--	--	0	--	--
Saturday	--	0	--	--	--

Discussion

I set out asking the question of whether *E. floridanus* activity increases when the stadium lights are on. Comparing my two main study sites, there was much *E. floridanus* activity at the stadium, which was regularly brightly illuminated at night, but essentially no activity at the neighboring practice fields that were not illuminated. During the Minor League baseball season, there was higher activity on nights with night games (Tuesday, Thursday, Friday, Saturday) than on nights without games (Sunday, Monday, Wednesday).

The game-less nights during this time period all have the lowest hit averages of the week, with the highest being two hits for Wednesday. During these nights the stadium lights would not be on at all, as any games and the following cleaning of the stadium would have likely finished before sunset on Sunday and Wednesday (when daytime games are scheduled), and not even be present at all on Monday (no games scheduled).

The days with nighttime games however have a significantly increased rate of activity when compared to nights without games, with the lowest average being Thursday at 3.556 hits. That is 1.5 hits more than the highest average from the non-nighttime game days. Tuesday in particular is of special interest, as it is an audience-less night game day nestled between two nights without any light or noise occurring. It has a massive spike in activity compared to Monday and Wednesday. Since all the nights from Sunday to Wednesday are relatively quiet, it is very telling that the only night with lights on has such a noticeable jump in activity.

I was also surprised that there was actually more *E. floridanus* activity at the stadium during the Off Season than during the Minor League baseball season. Reasons for this could be the previously mentioned lack of ambient noise that could interfere with the bonneted bat's

echolocation, or some other unknown environmental factor having to do with the Abacoa area. Regarding the stadium lights, however, I do not know when they could have been on during the Off Season. Initially I had anticipated Off Season nights to always be dark, but as it turns out there was a chance the stadium lights could have been turned on by the cleaning crew during the Off Season. Since they were from a third-party company, Roger Dean Stadium employees did not know their schedule during this time frame; only that they came in once or twice a week at some point during the day (or night) to clean. To what extent this affected the Off Season data are unfortunately unknown.

As for the Halpatiokee Park collection site, I was at first confused by the results. According to the conclusions I was drawing from Locations A and B, I thought I would see much more activity than the small handful of hits I recorded. At first, I believed it was because of the park being located next to Interstate-95. I had set up the equipment as far away from the noisy highway as I could, but it could have still been considered too loud for *E. floridanus* to want to hunt there. This still could have been a factor in the lack of activity, but after visiting the park at night I have developed a different conclusion. Halopatiokee is indeed perpetually lit at night but only with streetlamps, and most of these lamps are located next to trees along the sidewalks. My hypothesis speculates that the bonneted bat is attracted to the insects that are attracted to the stadium lights, not to the light itself. I did not see many insects swarming these dimmer lights like what I have seen with the intensely bright baseball field lights. In addition to that, these lamplights are located much lower to the ground, and they are crowded by vegetation or other manmade structures. For a large bat that flies high and dislikes clutter, Halopatiokee Regional Park made for a poor hunting ground as well despite my original presumptions.



Fig. 8. Halopatiokee Regional Park at night.

In any case, this study could stand to be improved upon. For example, none of the data collected at any of the Locations were recorded at the same time, as I only had a single Recorder at our disposal. If I had at least one more Recorder to collect data simultaneously, I could have made a much more definitive comparison between the study areas.

In the end though, does *E. floridanus* activity increase when the stadium lights are turned on? Based on the collected data, I have to say yes. There is just too big a leap in hit averages between the nights with the lights on and nights with the lights off. Despite the noise, the stadium is clearly visited by the bonneted bat much more frequently when the lights are turned on. Even a completely dark, spacious area less than a kilometer away, located right next to a natural area, is completely ignored in favor of the stadium and Downtown Abacoa areas. The analysis of the Halopatiokee data also bolster the idea that *E. floridanus* prefers their artificial light to be high up, intensely bright, and away from obstacles for an ideal, urban hunting environment. The bright lights attract the insects, and the increased concentration of insect activity attracts the Florida bonneted bat. There is no doubt in my mind that this is true.

Works Cited

- Allen, L.C., N.I. Hristov, J.J. Rubin, J.T. Lightsey, and J.R. Barber. 2021. Noise distracts foraging bats. *Proc. R. Soc. B.* 288(1944): 20202689. doi.org/10.1098/rspb.2020.2689
- Bailey, AM, Ober HK, Sovie AR, McCleery RA. 2017. Impact of land use and climate on the distribution of the endangered Florida bonneted bat. *Journal of Mammalogy* 98: 1586-1593. doi.org/10.1093/jmammal/gyx117
- Braun de Torrez, E.C., H.K. Ober, and R.A. McCleery. 2016. Use of a Multi-tactic Approach to Locate an Endangered Florida Bonneted Bat Roost. *Southeastern Naturalist* 15(2):235-242. dx.doi.org/10.1656/058.015.0204 8
- Braun de Torrez, E.C., H.K. Ober, and R.A. McCleery. 2018. Restoring historical fire regimes increases activity of endangered bats. *Fire Ecology* 14(9). doi.org/10.1186/s42408-018-0006-8
- Brinez, S. 2019. Bats in the Abacoa Greenway. Undergraduate thesis. Florida Atlantic University.
- Gore, J.A., M.S. Robson, R. Zambrano, and N.J. Douglass. 2015. Roosting sites of a Florida Bonneted Bat (*Eumops floridanus*). *Florida Field Naturalist* 43(4):179–184. sora.unm.edu/sites/default/files/7.%20GORE,%20BONNETED%20BAT,%20FFN%2043(4).pdf
- Ober, H.K., E.C. Braun de Torrez, J.A. Gore, A.M. Bailey, J.K. Meyers, K.N. Smith and R.A. McCleery. 2017. Social organization of an endangered subtropical species, *Eumops floridanus*, the Florida Bonneted Bat. *Mammalia* 81(4): 375-383. doi.org/10.1515/mammalia-2015-0183
- Solari, S. 2016. *Eumops floridanus*. *The IUCN Red List of Threatened Species*. 2016: e.T136433A21984011. National Geographic. https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T136433A21984011.en.