
Preliminary Report

Florida Bonneted Bat Acoustic Monitoring Project: Identifying critical habitat within Miami-Dade County in order to protect the rarest bat in the United States

Executive Summary

Between May – December 2019 Bat Conservation International installed ten acoustic detectors across Miami-Dade County to identify the ranging behavior and distribution patterns of the Federally Endangered Florida bonneted-bat (FBB). In total, over 3.7 million bat calls were recorded over 684 nights from the ten sites. While FBB calls were recorded across all ten sites, the large open area used as a car park at Zoo Miami showed the greatest activity with an average of over 6,000 calls/night compared to 1,000 calls/night for the next active site. At Zoo Miami, the FBB's appeared to be specifically selecting this large open area as a detector placed in a more forested area recorded far less bat activity (ca. 328 calls/night). While the importance of the Zoo Miami site at a County level was unexpected, based on the wing morphology of this species, the results highlights the importance of large, open and dark spaces this species can utilize for foraging. Combined with the population of FBB's using the artificial bat boxes on Zoo Miami grounds (45 individuals, which is the second largest known population in Florida), the Zoo Miami grounds, including the parking area, should be considered as critical habitat for this species.

Introduction

With one of the smallest range distributions of any bat species in the United States, the Florida bonneted bat (*Eumops floridanus*; Molossidae; FBB) is endemic to south Florida and listed as a federally endangered species (U.S. Fish and Wildlife Service [USFWS] 2013). The FBB is commonly associated with pine and hardwood hammock habitats. However, FBB's are also known to occur in urban areas after being first reported in Miami-Dade County in the 1930's. Although some individuals have been found using palm trees, FBB's in urban areas will roost under barrel tiles on roofs and in chimneys of houses (Barbour and Davis 1969, Belwood 1992, Timm and Genoways 2004, Gore et al. 2015). To date, 37 roosts have been identified in human-made buildings and natural roosts across Miami-Dade County. Acoustic monitoring carried out in 2017 documented the FBB in 10 counties in southern Florida, with bats reported utilizing upland, wetland, agricultural, and urban habitats (Bailey et al. 2017).

The first step in the conservation and management of a species is knowing its distribution, abundance, and habitat selection. Previous acoustic survey efforts focused on large scale distribution of the FBB throughout their known geographic range (Bailey et al. 2017). However, a systematic acoustic survey at a smaller scale (e.g. within urban habitats) is urgently needed. Identifying the mechanism that affects the distribution and habitat selection under anthropogenic pressure is fundamental for the conservation of the FBB. The data presented in this preliminary report is part of a long-term research initiative led by BCI in partnership with County, State, and Federal partners to understand Florida bonneted bat distribution and habitat use in the matrix of urban, agricultural, and natural settings in Miami-Dade County.

Methods

Acoustic detectors that have the ability to record the ultrasonic calls bats emit during flight were installed at ten sites in Miami-Dade County to assess bat activity. Monitoring locations were selected based on habitats that FBB's are thought to prefer and were commonly located at sites at the interface of agricultural and urban environments (Figure 1A). Six areas were located on County property (AD Barnes Park, Camp Owaissa Bauer, Homestead Bayfront Park, Navy Wells Pineland Preserve, Tree Island Park, and Zoo Miami). Acoustic monitoring was conducted under the research authorization No 311 (Parks, Recreation and Open Spaces Department, Miami-Dade County). Partnerships with federal and private organizations enabled us to install bat recorders at three additional sites (Homestead Air Reserve Base, Patch of Heaven, and Fairchild Botanical Garden).

Bat activity was recorded using a Song Meter SM4BAT Full Spectrum ultrasonic recorder fitted with a SMM-U2 ultrasonic microphone (Wildlife Acoustics, Maynard, Massachusetts). At each location, a bat detector (8.6" x 6.0" x 3.1") was attached to a utility pole or any other human-made structure between two and five meters high and the microphone was placed between 3 and 7 meters above the ground. The detector was set to continuously record every night from 30 minutes before sunset to 30 minutes after sunrise. Every location was visited once per month to check the equipment, change batteries, and download the data.



Figure 1. A) Florida bonneted bat acoustic detectors locations in Miami-Dade County. B) Overall bat activity. Heat map represents the total mean number of bat detections per night (blue = fewer calls to yellow = high number of calls).

Acoustic files were analyzed using Kaleidoscope Pro 5 (Wildlife Acoustics, Maynard, Massachusetts), using the “Bats of North America 5.3.6” classifier. The software compares the acoustic files to a known call library to identify the calls to bat species. Once identified, Florida bonneted bat calls were manually vetted by a trained member of staff to verify the auto-identification function of the software and minimize the potential of false positive results. Non-FBB call files were not manually vetted so the results presented here represent a conservative estimate of the number of FBB calls detected across all sites.

Results

In total we recorded 684 nights of data across the ten survey locations (mean number of survey nights per location = 68). Most sites were operational from May to December 2019. During this time, a total of 156,981 files were recorded and analyzed. The recordings contain 3,725,648 calls (more than one call can be recorded in each file). Eight different bat species were identified from these calls, including the Florida bonneted bat (*Eumops floridanus*), big brown bat (*Eptesicus fuscus*), northern yellow bat (*Lasiurus intermedius*), Seminole bat (*Lasiurus seminolus*), velvety free-tailed bat (*Molossus molossus*), evening bat (*Nycticeius humeralis*), tricolored bat (*Perimyotis subflavus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*). Mean activity at sites varied considerably (Figure 1B). The highest number of bat calls were detected at the open area (parking area) at Zoo Miami, with almost double the mean number of bat calls compared to the other areas monitored as part of the study. AD Barnes Park and Fairchild Botanical Garden had the second and third highest bat activity during the study (Table 1).

The Brazilian free-tailed bat is the most common species in six of the ten sites, followed by the evening bat (Zoo Miami pine forest and Fairchild Botanical Garden) and the Florida bonneted bat (Zoo Miami large open area used for parking and Camp Owaissa Bauer). The Florida bonneted bat at the Zoo Miami large open area was recorded 98% of the nights (103 of 105 nights), with a mean number of 6,057 calls (Table 1), reaching up to 26,000 calls in one single night. The mean number of calls at Zoo Miami large open area is over 580% higher than the next site at AD Barnes Park (Figure 2). The recordings at the Zoo Miami large open area show that the Florida bonneted bat use this space extensively for foraging and social interactions base on a large number of social calls recorded.

Table 1. Mean number of bat calls per species in each site. Species acronym code: EUMFLO, Florida bonneted bat; EPTFUS, big brown bat; LASINT, northern yellow bat; LASSEM, Seminole bat; MOLMOL, velvety free-tailed bat; NYCHUM, evening bat; PERSUB, tricolored bat; TADBRA, Brazilian free-tailed bat.

SITE / NUMBER OF NIGHTS	EUMFLO	EPTFUS	LASINT	LASSEM	MOLMOL	NYCHUM	PERSUB	TADBRA
ZOO MIAMI OPEN SPACE / 105	6057.0	374.6	1212.6	210.2	166.9	829.4	34.3	4645.8
ZOO MIAMI FOREST / 70	328.2	705.8	337.9	192.2	24.2	1073.3	57.2	917.8
AD BARNES PARK / 68	1034.5	878.3	1050.4	48.4	23.0	275.3	0.7	3928.3
CAMP OWAISSA BAUER / 67	860.6	295.8	34.0	106.3	4.3	30.2	0.4	499.0
FAIRCHILD BOTANICAL GARDEN / 42	69.2	310.9	1338.2	173.5	35.0	3388.3	49.7	1836.5
TREE ISLAND PARK / 29	32.0	11.0	6.3	0.0	0.0	1.1	1.4	1215.3
PATCH OF HEAVEN / 128	29.1	34.1	310.3	22.1	117.1	213.4	42.5	598.7
NAVY WELLS PINELAND PRESERVE / 34	13.4	49.4	23.0	0.0	0.8	0.6	0.8	684.0
HOMESTEAD AIR RESERVE BASE / 107	6.0	6.1	16.2	0.6	0.8	5.0	1.2	124.8
HOMESTEAD BAYFRONT PARK / 31	2.8	2.9	2.6	0.3	0.4	3.2	0.0	252.5

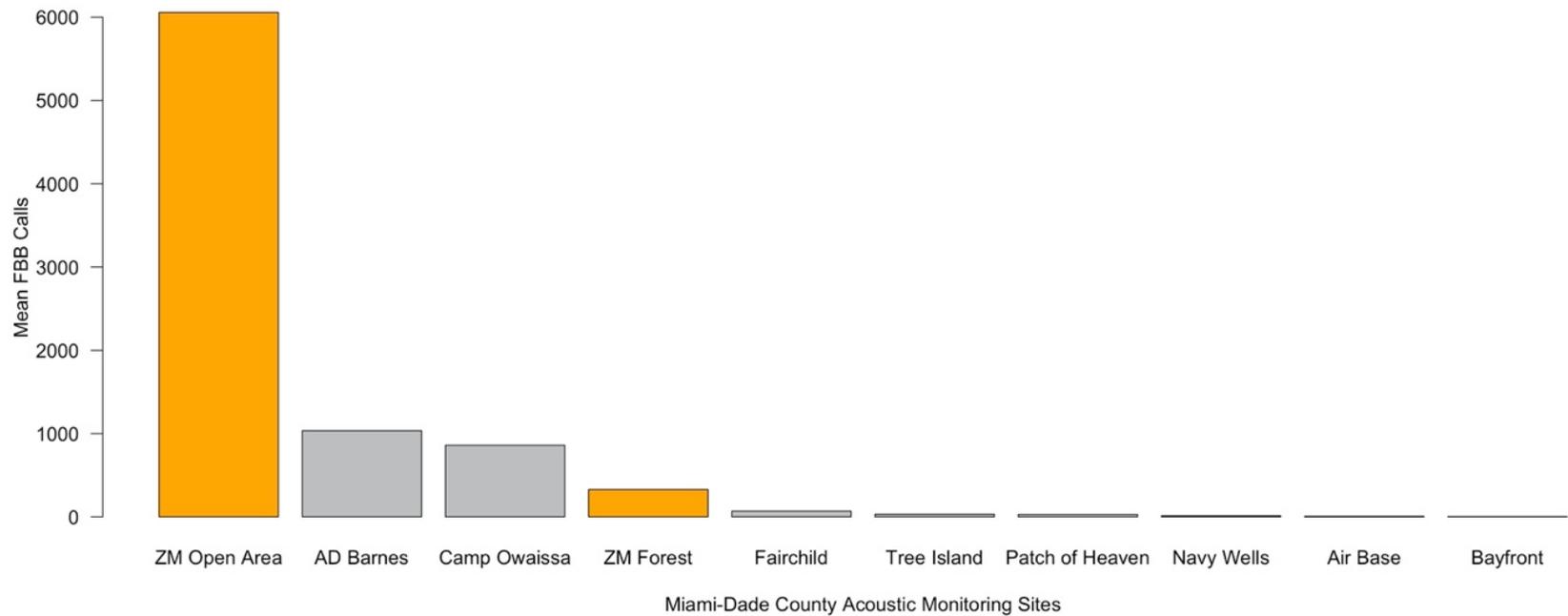


Figure 2. Mean number of calls by the Florida bonneted bat (*Eumops floridanus*) on the different study sites. Sites names from left to right: Zoo Miami Open Area, AD Barnes Park, Camp Owaissa Bauer, Zoo Miami Forest, Fairchild Botanical Garden, Tree Island Park, Patch of Heave, Navy Wells Pineland Preserve, Homestead Air Reserve Base, Homestead Bayfront Park.

Discussion

This study represents the largest acoustic monitoring survey for Florida bonneted bats across Miami-Dade County. As recommended in the Florida bonneted bat species action plan (Florida Fish and Wildlife Conservation Commission 2013), using acoustic detectors is the most effective way to assess the distribution of this species of bat. In deploying ten remote acoustic sensors across the County we have found that the large open space and used for parking at Zoo Miami had the highest call activity for the Florida bonneted bats when compared to anywhere else assessed in Miami-Dade County. The mean number of calls recorded in one of the forested areas on the Zoo Miami grounds (328 FBB calls/night compared to 6,057 FBB calls/night in the open area) indicates that the bats are actively selecting this open space and avoiding more cluttered habitats. Similar observations were reported by the study conducted by the Conservation and Research Department at Zoo Miami in 2012 commissioned by the U.S. Fish and Wildlife Service (Ridgley et al. 2012). The study identifies the open space as a critical area for Florida bonneted bats.

Based on the morphological features of this species these results may not be surprising. Due to their long and narrow wings, Molossid bats such as the FBB avoid flying in cluttered environments and instead prefer to utilize open spaces for foraging (Vaughan 1966, Hedenström and Johansson 2015). In addition, this activity may also be attributed to the largest and most biodiverse fragment of the globally critically endangered Pine Rockland outside the Everglades National Park. Zoo Miami and adjacent properties (Larry and Penny Thompson Memorial Park and Martinez Pineland Preserve) consists of over 1,100 acres of Pine Rockland habitat, lakes, large open areas, and low impact activities. These characteristics offer the settings to maintain a prey base that provides food resources for insectivorous bats, such as the Florida bonneted bat.

Other features that are likely to contribute to the importance of this area for heightened FBB activity are the year-round freshwater resources and roosting availability, mainly from artificial structures such as bat boxes installed along with the property. In late 2018 six custom-designed single-chamber bat boxes were installed at Zoo Miami and within three weeks Florida bonneted bats were observed using at least one of the artificial roosts. Currently, all six bat boxes are occupied and approximately 45 individuals are using these structures making it the second-largest known population of the species across their entire range. These bats are also reproducing, evidenced by young pups being recorded during regular counts at the roosts. Based on the roosting availability at Zoo Miami, combined with the large open (car parking) area in front of the zoo, this area provides critical habitat elements for this species' survival and further research needs to be carried out to promote recovery and conservation plans.

Comparing all the locations surveyed we found that Florida bonneted bat activity was greatest at the Zoo Miami open area, AD Barnes Park, and Camp Owaissa Bauer. While Granada golf course has also been documented as another important foraging site (Kirsten Bohn, unpublished data) we were unable to install an acoustic recorder at that location to verify previous work and compare it to the activity recorded at the large open space at Zoo Miami. All these identified FBB areas share a common feature – large open spaces. As highlighted by the Zoo Miami acoustic survey results (Ridgley et al. 2012), FBB activity is usually focused in relatively large wide-open spaces, with no vertical obstruction and little to no artificial lighting. The main difference between the three sites in our acoustic monitoring results appears to be their size. Our results suggest that the larger area at Zoo Miami is unique and heavily used, potentially because the larger size

and proximity to Pine Rocklands can hold a more extensive prey base and, consequently support a larger population of Florida bonneted bats. In addition, the physical properties of the large open space currently being used for parking at the zoo is likely to be warmer than the surrounding area. These higher temperatures are likely to attract ectotherms such as beetles, moths and other insects (Briere et al. 1999) which in turn will increase prey availability for bats (Meineke et al. 2013).

In conclusion, our preliminary acoustic monitoring reveals that Florida bonneted bats can be found in several areas within Miami-Dade County. However, bat activity varies significantly between locations. Zoo Miami open space has the highest Florida bonneted bat foraging and social activity within the county. Characteristics such as nearby bat population size, roost availability, prey base provided by Pine Rockland habitat, and low-impact open spaces make this location the most important site for recovery and conservation of the Florida bonneted bat in Southeastern Florida based on the available data.

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