

Holly K. Ober\*, Elizabeth C. Braun de Torrez, Jeffery A. Gore, Amanda M. Bailey, Jennifer K. Myers, Kathleen N. Smith and Robert A. McCleery

# Social organization of an endangered subtropical species, *Eumops floridanus*, the Florida bonneted bat

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**Abstract:** Many Chiropteran species are gregarious, yet much remains to be learned about details of the sociality of most species. This is especially true for the endangered *Eumops floridanus* (Florida bonneted bat). Scant knowledge of the species' natural history and ecological interactions has precluded the development of effective conservation strategies. We investigated several aspects of the social organization of *E. floridanus* roosting in bat houses in southwest Florida: group size, group composition, group stability, and seasonality of reproduction. Our findings suggest the species has characteristics more common to tropical bat species than temperate ones. The average roost size was 10 individuals, with colonies in a harem social structure all three times in the year they were assessed. Adults were much more likely than sub-adults to be recaptured at the same roosts during subsequent capture sessions. We suggest that the availability and distribution of roosts may alter the social structure of these bats and ultimately limit local populations. We did not find evidence of a distinct seasonal birthing period matching that of other temperate bat species. Results suggests the species is aseasonally polyestrous, making non-volant *E. floridanus* vulnerable to disturbance across a larger portion of the year than other bat species in the US.

**Keywords:** aseasonal polyestry; harem; reproduction; roost fidelity; social structure.

## Introduction

Our knowledge of patterns of sociality in the order Chiroptera is limited relative to other social animals (Kerth 2008), although the recent surge in studies investigating this topic is providing new insights (Johnson et al. 2013, Silvis et al. 2014, Burns and Broders 2015). Chiroptera is incredibly diverse (>1300 species), with representatives exhibiting a wide range of feeding habits, roost preferences, and mating systems (Racey and Entwistle 2003). Despite this heterogeneity, most species live in groups (McCracken and Wilkinson 2000, Kerth 2008). These assemblages vary from two individuals to complex groups containing millions of individuals, with the sex and age composition as well as the compositional stability of groups differing among species (McCracken and Wilkinson 2000, Chaverri and Kunz 2010). Understanding the social systems of bats is critical to developing species-specific conservation strategies that accommodate the group dynamics (and, hence, habitat requirements) of these assemblages both spatially and temporally. This is particularly true for tree-roosting species for which roost availability could potentially be manipulated through forest management activities or the creation of artificial roost structures (Barclay and Kurta 2007).

Understanding of social systems of bats within the family Molossidae is especially limited (McCracken and Wilkinson 2000). Molossids are known to have single-male/multi-female groups [e.g. *Chaerephon pumila*, the little free-tailed bat (Cretzschmar, 1826), and *Otomops martiensseni*, the large-eared free-tailed bat (Matschie, 1897)] and seasonal multi-male/multi-female groups [*Tadarida brasiliensis*, the Brazilian free-tailed bat (Geoffroy, 1824)] (Wilkinson and McCracken 2003). Of the seven Molossid species that reside in the US, aspects of mating systems and sociality have been investigated in only two: *Tadarida*

\*Corresponding author: Holly K. Ober, Department of Wildlife Ecology and Conservation, University of Florida, Quincy, FL 32351, USA, e-mail: holly.ober@ufl.edu

Elizabeth C. Braun de Torrez, Amanda M. Bailey and Robert A. McCleery: Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611, USA

Jeffery A. Gore: Florida Fish and Wildlife Conservation Commission, Panama City, FL 32409, USA

Jennifer K. Myers: Florida Fish and Wildlife Conservation Commission, Frostproof, FL 33843, USA

Kathleen N. Smith: Florida Fish and Wildlife Conservation Commission, Estero, FL 33928, USA

*brasiliensis* (Kruttsch et al. 2002, Keeley and Keeley 2004) and *Molossus molossus*, the velvety free-tailed bat (Pallas, 1766) (Dechmann et al. 2010). Virtually nothing is known of the social systems of the three species in the genus *Eumops* that occur in the US [*E. floridanus* (Allen, 1932), *E. perotis* (Schinz, 1821), and *E. underwoodi* (Goodwin, 1940)].

One eumops species, *Eumops floridanus*, the Florida bonneted bat, was recently designated as federally endangered in the US (USFWS 2013), and is categorized as critically endangered globally (IUCN 2014). These bats are believed to occur in limited numbers across a very restricted range (FWC 2011, USFWS 2013). Endemic to south Florida, the species may have the smallest geographic distribution of any species of bat in the US (Belwood 1992, Timm and Genoways 2004). It has been suggested that *E. floridanus* faces considerable and immediate threats including low fecundity, relative isolation among populations, and vulnerability to extreme weather events (USFWS 2013).

The geographic range of *Eumops floridanus* is restricted to the southern tip of Florida, a region with a sub-tropical climate. Thus, aspects of the social system of *E. floridanus* may be expected to differ in predictable ways from bats found throughout the rest of the country that experience more temperate climatic conditions. For example, most temperate bats are characterized by seasonal social groups (i.e. multi-male/multi-female groups during winter; separation between adults of different sexes during spring and summer), whereas year-round harem systems are more common among bats in the tropics (Wilkinson and McCracken 2003, Kerth 2008). Another characteristic that differentiates temperate bat species from tropical ones is the seasonality of reproduction. Most temperate bats are mono-estrous, with all individuals within a species giving birth during a restricted period during late spring or early summer to allow growth of pups during the warm season when insect prey are abundant. In contrast, many tropical bat species are aseasonally polyestrous with unrestricted birthing seasons, or seasonally polyestrous with bi- or trimodal annual birthing periods (Jerrett 1979).

Conservation efforts for *Eumops floridanus* are constrained by a lack of basic information on their roost assemblages, social organization, and breeding seasonality (Dayton 2003, Bury 2006). Documenting the typical size, composition, and seasonal changes in roost assemblages for *E. floridanus* is a fundamental step toward understanding roosting requirements, colony dynamics, and sex-specific conservation priorities. Clarification of the birthing season is critical for planning the timing of management activities, establishing seasonal restrictions on roost disturbance, and generating population models. Several lines

of anecdotal evidence suggest the social structure and seasonality of reproduction of *E. floridanus* may be more similar to that of tropical than temperate species. Based on a single observation of a male roosting with seven females at one time in one location, Belwood (1992) proposed that *E. floridanus* may have a harem structure. Morphological evidence provides additional support for a harem structure: an enlarged gular-thoracic gland was observed in one male *E. floridanus* (Belwood 1992), and has been reported in the closely related *E. glaucinus*, Wagner's bonneted bat (Silva Taboada 1979, Bowles et al. 1990). The precise function of these glands is not well understood, but secretions from similar glands in other species are thought to be used by harem males to mark females, subordinate males, and roost substrates (Heideman et al. 1990, Racey 2009). Also, the seasonality of reproductive activity of *E. floridanus* is suspected to be different than most temperate bat species. Anecdotal reports of juveniles have spanned 6 months of the year, suggesting a pattern more typical of polyestrous tropical species (Schwartz 1952, Jennings 1958, Robson et al. 1989, Smith 2010).

In this paper we provide the first detailed reports on the social structure and seasonality of reproductive behavior in *Eumops floridanus*. First, we examine roost group size and composition to determine if there is evidence of *E. floridanus* forming harems. More specifically, we determine whether roosts typically contain a single adult male with multiple adult females, or whether one male in multi-male roosts exhibits characteristics demonstrative of dominant status (i.e. an enlarged gular gland, greater mass, and larger testes). Second, we examine movements of adult females and sub-adults among roost groups to gain initial insight into roost fidelity. Third, we determine whether *E. floridanus* exhibits an extended reproductive season beyond that typical of temperate species.

## Materials and methods

Data were collected at Fred C. Babcock-Cecil M. Webb Wildlife Management Area (BWWMA), Charlotte County, Florida. This 26,611 ha property, owned and managed by the Florida Fish and Wildlife Conservation Commission for over 70 years, is a mix of mesic and hydric pine flatwoods with embedded freshwater marshes, ponds, and hardwood hammocks. Average annual temperature is 23.4°C, and the area receives 128.8 cm of rain per year, with warm, wet weather during June through September and a cooler drier season extending from mid-fall through late spring (<http://www.usclimatedata.com>). *Eumops*

*floridanus* were observed near BWWMA once in 1979 and were again detected on the property in 2006. Staff at BWWMA erected matched pairs of one- or three-chamber bat houses on poles at eight sites in 2007–2008, and at five additional sites in 2012. Each pair of bat houses sharing a pole is considered a single roost. *Eumops floridanus* were observed in six of these 13 roosts during this study.

We conducted regular emergence observations at all bat houses on BWWMA to determine which houses were occupied by *Eumops floridanus* so that we knew where to direct our capture efforts, and to verify the presence of non-volant young. During each emergence observation, we recorded whether or not adults emerged, and after shining a spotlight inside once it became too dark to observe bats flying, we recorded whether any bats remained inside. We noted the number of non-volant pups, differentiated from adults by a lack of fur. Emergence observations were conducted one to five times each month ( $\bar{x}=2.65$  times) from May to December 2014.

We conducted three multi-day capture sessions spaced 4 months apart throughout a 1-year period: 27–30 August 2014, 15–17 December 2014, and 20–24 April 2015. During each capture session, we used triple-high mist nets to catch bats as they emerged from each of the occupied roosts on the property. Mist nets were opened at sunset and remained open for a maximum of 3 h. Each captured bat was placed individually in a numbered cotton bag, and then examined to determine age (adult/sub-adult), sex, body mass, forearm length and reproductive status. Sub-adults were distinguished from adults primarily through the complete or partial fusion of phalangeal cartilage; when that was indistinct, we used status of genitals and mammae as secondary indicators of age. Adult females were classified as non-reproductive, pregnant, lactating, or post-lactating. Adult males were classified as non-reproductive (testes abdominal) or reproductive (testes descended). For males, gular-thoracic glands (hereafter “gular glands”) were classified as “open”, “closed” or “not apparent”. Measurements were taken of gular gland openings and descended testes. During the first capture session, each bat was uniquely marked with a passive integrated transponder [12 mm, 134.2 kHz FDXB pit-tags (Biomark Inc., Boise, ID, USA)] implanted subcutaneously in the lower lumbar region near the plagiopatagium to enable identification of recaptured individuals. During subsequent capture sessions, all bats were scanned with a pit-tag reader (Biomark 601 Reader or Biomark Pocket Reader, Biomark, Inc., Boise, ID, USA) to determine if a tag was present, and individuals without tags were uniquely marked using the methods described above. After processing, each bat was released near the site of capture. All

capture and handling processes followed ASM guidelines (Sikes et al. 2011) and were approved by the University of Florida IACUC (#201308070).

## Data analysis

To evaluate social structure, we compared sex ratios of adults and of juveniles across seasons using  $\chi^2$  goodness-of-fit tests, and tested for an association between gular gland status and reproductive status using a Pearson's  $\chi^2$ -test. p-Values were adjusted with Bonferroni's correction for multiple comparisons. To further characterize male bats, we tested for differences in morphometric measurements between males in different gular gland status categories using two-sample Wilcoxon rank sum tests. For all morphometric comparisons, we used a single mean value to represent each characteristic for each individual that was reported in the same reproductive or gular gland category during more than one capture session.

We examined roost fidelity by assessing which individuals remained in the same roost and which moved to different roosts between capture sessions. We tested for an association between roost fidelity and age or sex using a Pearson's  $\chi^2$ -test.

Lastly, we examined seasonality of reproduction for females by comparing the proportion of adults in each reproductive status category among capture sessions using  $\chi^2$  goodness-of-fit tests. We repeated this test for males, comparing the proportion of adults that were reproductive or non-reproductive (had descended or abdominal testes) and the proportion that had open or closed gular glands during each capture session.

Statistical analyses were conducted with SPSS version 22.0 (IBM Corp 2013) and RStudio version 0.97.551 (RStudio 2013) in conjunction with R version 3.1.2 (R Core Team 2013).

## Results

We captured 61 *Eumops floridanus* in August, 42 in December, and 56 in April at the roosts occupied during this study. Several bats occupying the bat houses ( $\bar{x}=11.0\pm 6.9$  per capture session) were not caught (i.e. they did not emerge from the roosts, or in a few cases escaped from nets prior to extraction), so we were unable to report their characteristics. Over the course of the three capture sessions we caught 103 unique individuals: 61 adult females, 19 adult males, eight sub-adult females, and 15 sub-adult males.

**Table 1:** Number of *Eumops floridanus* occupying each bat house during three capture sessions within a single year at Fred C. Babcock-Cecil M. Webb Wildlife Management Area, FL, categorized according to age and sex.

Bat house	August				December				April			
	Adult		Sub-adult		Adult		Sub-adult		Adult		Sub-adult	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
W4	20	1	4	4	0	3	0	0	n/a	n/a	n/a	n/a
W5	2	1	0	1	4	1	0	0	11	1	0	3
W7	0	1	0	0	n/a	n/a	n/a	n/a	0	1	0	0
W8	5	3	0	0	7	2	0	0	5	2	2	1
W11	3	1	0	0	11	1	2	0	12	2	0	1
W12	9	1	1	4	6	4	0	1	11	5	0	1
Total	39	8	5	9	28	11	2	1	39	9	2	6
Sex ratios (%)	<b>83.0</b>	<b>17.0</b>	35.7	64.3	<b>71.8</b>	<b>28.2</b>	66.7	33.3	<b>81.3</b>	<b>18.7</b>	25.0	75.0

No bats were present in roost W4 in April or W7 in December (n/a). Only one adult male with an open gular gland was present in each house during each capture session, with the exception of bat house W12 in April (three adult males with open gular glands). Statistically significant sex ratios are in bold text.

## Social structure

Groups of adults in each roost were significantly female biased in all three capture sessions: 83.0% ( $\chi^2=20.45$ ,  $p<0.001$ ), 71.8% ( $\chi^2=7.41$ ,  $p=0.019$ ), and 81.3% ( $\chi^2=18.75$ ,  $p<0.001$ ) in August, December, and April, respectively. In contrast, no consistent sex-bias was apparent among sub-adults in each roost: 35.7% ( $\chi^2=1.14$ ,  $p=0.850$ ), 66.7% ( $\chi^2=0.33$ ,  $p=1.00$ ), 25.0% female ( $\chi^2=2.00$ ,  $p=0.470$ ) (Table 1). The median number of females and males per roost was 5.0 and 1.0 in August; 6.5 and 2.5 in December; and 11.0 and 3.5 in April.

The number of bats captured per roost per capture session (hereafter “roost visit”) ranged from 1 to 29 bats ( $\bar{x}=9.9\pm 1.8$ ,  $n=16$ ). In the 13 roost visits where females were present, each group of bats was female dominated and contained at least one male (Table 1). All but one of these female-occupied roost visits contained only a single adult male with an open gular gland (Figure 1). Although additional adult males were present in six roost visits, these males had gular glands that were closed or not apparent. In every case, the single male with the open gular gland had the greatest body mass of all males present within that roost sample. We found multiple adult males with open gular glands ( $n=3$ ) during only one roost visit (W12, April 2015); one of these three males was larger than the other two individuals in three measures: mass (2.0 and 8.5 g greater), testes length (1.0 and 4.2 mm longer), and gular gland size (1.5 and 2.1 mm larger). During one roost visit (W4, August 2014), we also documented open gular glands in two sub-adults; however, these individuals were classified as non-reproductive and had much lower body mass (10.0 and 15.5 g less, respectively) and smaller gular

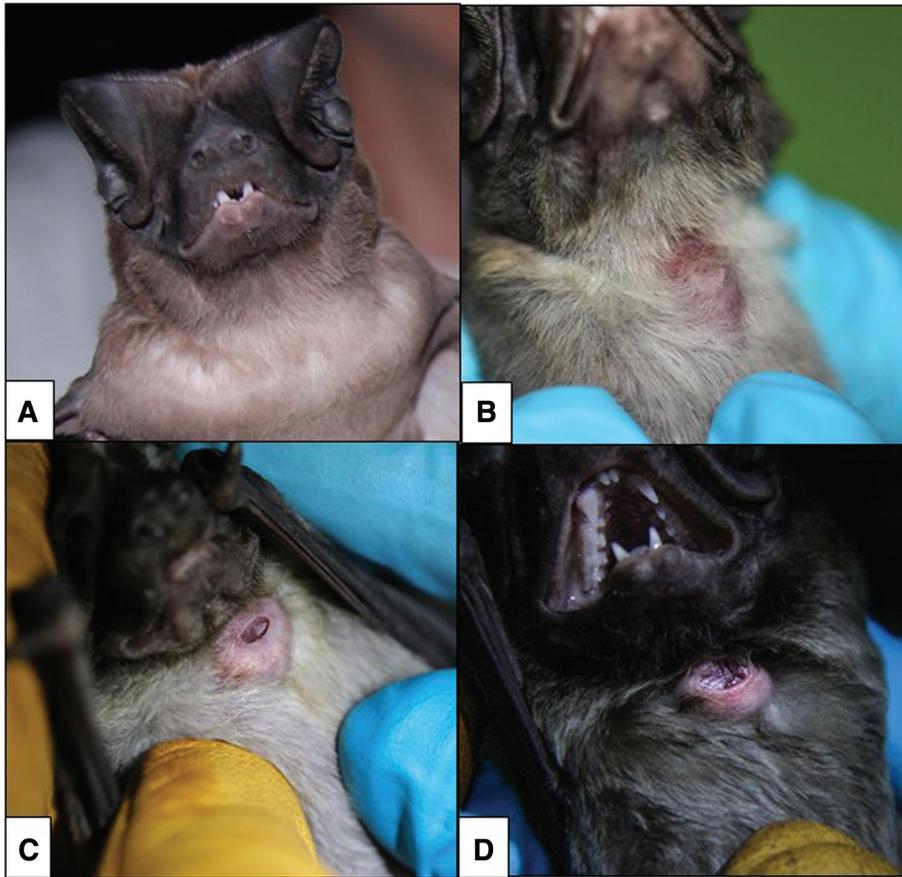
gland openings (0.1 and 0.6 mm less, respectively) than the adult male with the open gular gland in that roost.

Several morphological characteristics differed significantly between adult males with different gular gland status. For these analyses, only males with open and closed gular glands were compared because all individuals with gular glands not apparent ( $n=5$ ) were sub-adults. Body mass and testes length of males with open gular glands were significantly greater than those of males with closed gular glands, despite similar forearm lengths (Table 2). Furthermore, there was a significant association between gular gland status and reproductive status for adult males ( $\chi^2=4.59$ ,  $p<0.032$ ); males with open gular glands had descended testes and males with closed gular glands had abdominal testes more often than expected by chance.

## Roost fidelity

Roost fidelity varied between individuals of different ages ( $\chi^2=9.135$ ,  $p=0.003$ ), with sub-adults much more likely to be found in a different roost in a subsequent capture session than adults. Sub-adult females exhibited no fidelity to roosts between capture sessions: all five individuals that were recaptured at least once moved between their initial and subsequent capture locations. Fidelity of sub-adult males was more variable: three of eight bats categorized as sub-adults were subsequently captured at the same roost, yet all had switched roosts by the following capture session (i.e. none remained at their natal roost 8 months after initial capture).

Fidelity of adults was similar between sexes ( $\chi^2=0.48$ ,  $p=0.553$ ), but varied among roosts. Two roosts (W8 and



**Figure 1:** Male *Eumops floridanus* were classified as having gular glands that were: (A) “not apparent”, (B) “closed”, or (C, D) “open”. The size and color of open gular glands varied among individuals (C, D).

**Table 2:** Comparison of morphological characteristics between adult male *Eumops floridanus* with open and closed gular glands.

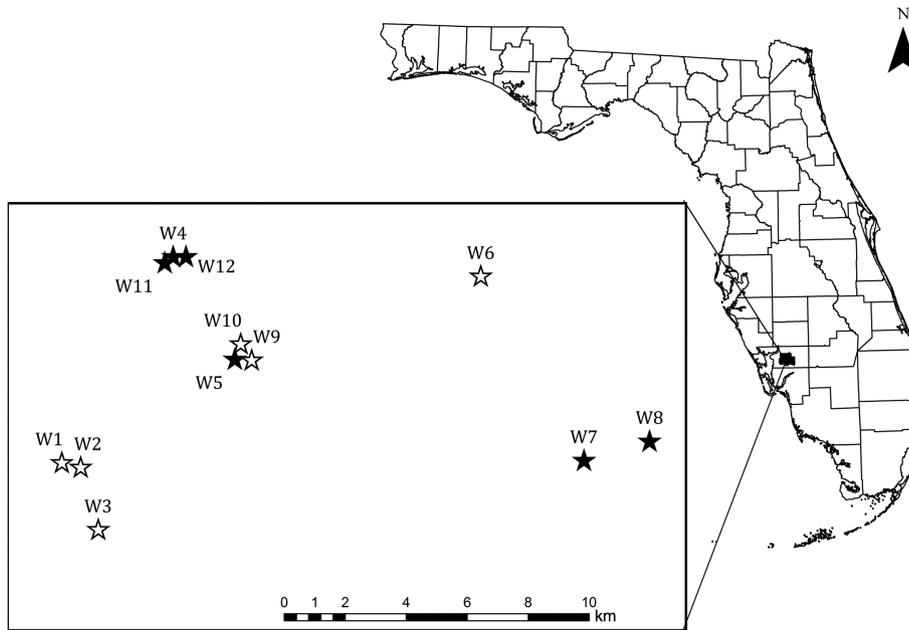
Character	Status of gular gland				W	p-Value
	Open	n	Closed	n		
Forearm length (mm)	63.9±0.48	12	63.4±0.57	9	63.5	0.522
Mass (g)	45.7±1.00	12	40.3±1.47	9	91.0	0.009
Testes length (mm)	7.9±0.51	11	5.7±0.67	4	38.0	0.042

All measurements were taken on bats occupying bat houses at Fred C. Babcock-Cecil M. Webb Wildlife Management Area, FL.

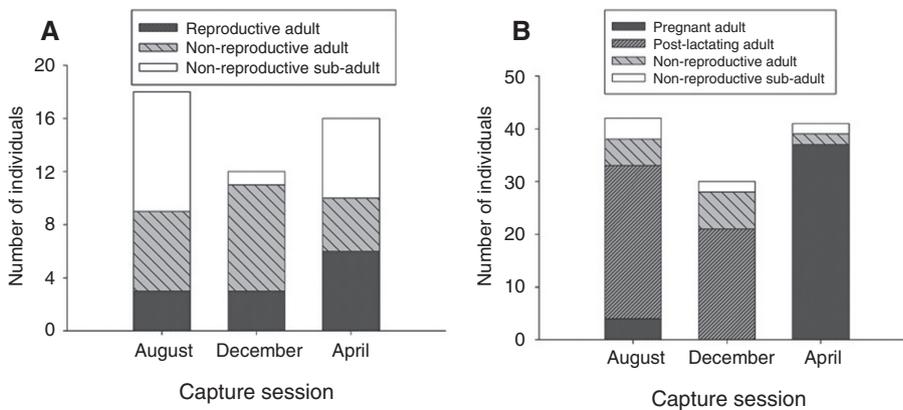
W12), exhibited little turnover in the composition of females between capture sessions, despite turnover in the presumed dominant male (the individual with the open gular gland, greatest mass, and largest testes) between capture sessions (Figure 2). In these roosts, most adult females were recaptured in all three sessions (5 of 7 and 5 of 9, respectively). Two other roosts (W4 and W5) were characterized by low fidelity of both sexes. In these roosts, the presumed dominant male moved between capture sessions, and the majority of adult females were caught during only one of the three capture sessions (17 out of 19 and 5 out of 6, respectively).

### Seasonality of reproduction

The percentage of adult female bats in each reproductive status category varied greatly among the three capture sessions ( $\chi^2=84.35$ ,  $p<0.0001$ ) (Figure 3). The percentage of adult females that were pregnant was 10%, 0%, and 95% during August, December, and April, respectively. In contrast, the proportion of adult males that were reproductively active was similar among capture sessions ( $\chi^2=2.58$ ,  $p=0.276$ ) (Figure 3), as was the proportion of adult males with open gular glands ( $\chi^2=4.686$ ,  $p=0.096$ ).



**Figure 2:** Location of the study area within the state of Florida, and relative location of bat houses used as day roosts by *Eumops floridanus* (filled stars) as well as those not used (open stars) in Fred C. Babcock-Cecil M. Webb Wildlife Management Area, 2014–2015.



**Figure 3:** Number of (A) male and (B) female *Eumops floridanus* in each age group and reproductive stage during each capture event in bat houses in Fred C. Babcock-Cecil M. Webb Wildlife Management Area, FL, 2014–2015.

The percentage of adult males that were reproductively active during August, December, and April was 33%, 27%, and 60%, respectively, while the percentage with open gular glands was 33%, 36%, and 86%. No adult female was pregnant during more than one capture session.

In addition to finding reproductively active adults during all three capture sessions, we documented non-volant pups in roosts during all 8 months of the year we conducted emergence observations (May through December). Non-volant pups remained in roosts after volant individuals emerged during 18 of 21 emergence observations.

Non-volant pups were not detected on three emergence observations; all of these occurred during late August.

## Discussion and Conclusion

### Social structure

The presence of year-round social groups is common among tropical bat species, whereas temperate bat species typically change seasonally in social composition, with

sexually segregated groups during summer and mixed-sex groups during colder times of year (Kerth 2008). We found that *Eumops floridanus* assembled in relatively small groups all three periods of year we assessed, with an average size of 10 individuals. This occurred despite the presence of adequate space in all roosts for many more individuals.

Three of our findings collectively provide compelling evidence that this species forms a harem structure, as was previously speculated (Belwood 1992): (1) despite a fairly even sex ratio among sub-adults, there was a clear female bias among adults in most roosts during all capture sessions, with the majority of roost visits having only one adult male with an open gular gland; (2) the one male with the open gular gland consistently had the highest mass of any male within each roost; and (3) on average, males with open gular glands had larger testes than those with closed glands.

Many tropical bat species are known to form harems where males either defend females (female defense polygyny) or the resources within a territory where females reside (resource defense polygyny) (Bradbury and Vehrencamp 1977, McCracken and Wilkinson 2000). The large mass, large testes, and open gular gland of one male per roost in *Eumops floridanus* supports the concept of a dominant harem male defending females and/or the roost site. These physical traits are likely important in intraspecific competition, sexual selection, and predator defense (Heideman et al. 1990, Brooke 1997, Weckerly 1998). It has been suggested that secretions from Molossid gular glands play a role in not just sexual, but also social interactions (Kruttsch and Crichton 1990). Presence of odiferous skin glands in males is thought to be associated with harem formation and maintenance (Kruttsch 2000).

The one exception we observed where a roost contained three adult males with open gular glands may be an example of multiple males competing for dominant male status. One of these males had greater body mass, larger testes, and a larger gular gland than the other two males; this may be the dominant male. Although speculative, the finding that some roosts contained only males (with or without open gular glands) suggests that “bachelor” males may temporarily utilize vacant roosts until they are able to establish a harem of their own. This is consistent with other harem bat species where solitary or groups of bachelor males often roost separately from harem roosts (McCracken and Wilkinson 2000).

The presence of a harem structure in *Eumops floridanus* has important ecological and conservation implications. First, it highlights the importance of males and maintenance of social groups. Many conservation actions for US bat species focus primarily on the maternity season and do not account for male behavior. Disturbance of *E. floridanus*

roost sites at any time of year may alter a colony’s social dynamics and consequently their reproductive success. Second, a harem structure may necessitate a small colony size, defensible by a dominant male. Thus, to bolster populations, augmenting the number of available small roost sites may be more important than providing or protecting large structures. We suspect that *E. floridanus* will not use large, so-called “community bat houses” that are suitable for other Molossid species such as *Tadarida brasiliensis*, which roosts in colonies of hundreds or thousands of individuals. Additional roost structures also may be required for dispersing sub-adult male *E. floridanus* attempting to establish new harems. If human intervention alters the abundance or distribution of roost sites (through destruction of natural cavities or addition of anthropogenic structures), this may unintentionally alter the social dynamics of the population (Blumstein 2010). Longer-term research is needed to understand the species’ roost fidelity and how colony dynamics influences roosting habitat requirements.

## Roost fidelity

Defining characteristics of social groups are group size and the degree of stability, or rates of movement of individuals between groups (McCracken and Wilkinson 2000, Kerth 2008, Chaverri and Kunz 2010). Our results on movements of individuals among roosts should be interpreted with caution because they represent just three brief snapshots in time, and assessed only the use of artificial roost structures present in the region. We found that adults of each sex showed similar levels of roost fidelity among the roosts investigated, with approximately half of all adult males and females staying in the same roosts between capture sessions. However, a closer look indicated that the dominant male in two roosts moved between capture sessions despite little change in the composition of females. Although only two of the roosts investigated showed this pattern and additional investigation is clearly warranted, this pattern suggests the possibility that males may attach themselves to cohesive groups of females, as demonstrated by the omnivorous *Phyllostomus hastatus* (greater spear-nosed bat) (Pallas, 1767), and the piscivorous *Noctilio leporinus* (greater bulldog bat) (Linnaeus, 1758) (Brooke 1997, McCracken and Wilkinson 2000). Females in these species form roost groups as age cohorts born the same year, with low relatedness among females (McCracken and Wilkinson 2000). Future investigation of ages of uniquely marked *Eumops floridanus* within roost groups will enhance understanding of social structure and dispersal patterns.

In contrast to adults, all sub-adults left the roost in which they were initially captured within 8 months of initial capture. The lack of integration of both male and female sub-adults into existing roost groups suggests that harems are not kin groups, as has been reported for another insectivorous Molossid, *Chaerephon pumila*, the little free-tailed bat (McWilliam 1988). Although PIT tags allowing for the individual marking of each bat have begun to contribute to our understanding of sociality in these bats, future genetic analyses would provide much needed resolution regarding kin relationships among individuals within and between roost groups.

### Seasonality of reproduction

In contrast to most temperate bat species in North America, our results suggest that *Eumops floridanus* is aseasonally polyestrous, with a peak pregnancy period in April. The closely related *Eumops glaucinus* shows a similar pattern, with pregnant females reported in various portions of its geographic range in March, April, May, June, September, October, and December (Gardner et al. 1970, Silva Taboada 1979, Myers and Wetzel 1983, Bowles et al. 1990). Several incidental observations made prior to our study suggested that *E. floridanus* also has an extended breeding season (Schwartz 1952, Jennings 1958, Barbour and Davis 1969, Belwood 1981, Robson et al. 1989, Smith 2010). Our data documenting pregnant females in April and August, along with males with descended testes in April, August, and December, and observations of non-volant pups 8 months of the year, corroborate the occurrence of extended parturition. Because no individual female bat was pregnant more than once within the year, it does not seem likely that the species is seasonally polyestrous, but rather aseasonally polyestrous.

The length and timing of the reproductive season has important conservation implications because non-volant *Eumops floridanus* may be vulnerable to disturbance across a larger portion of each year than other species. The species is known to roost in buildings (Barbour and Davis 1969, USFWS 2013, Gore et al. 2015). Currently, bats cannot legally be excluded from man-made structures in Florida when non-volant pups are present (i.e. during bat maternity season), which is designated from 15 April through 15 August (Florida Administrative Code Chapter 68A-4.001 and 68A-9.010). Although *E. floridanus* is protected due to its endangered status, bats are often not identified to species before being excluded and *E. floridanus* could be unknowingly excluded from roosts when their non-volant young are present. Our results suggest

that it may be important to lengthen the period during which bat exclusions are prohibited throughout the range of the species and/or to educate pest control professionals and the public about the need to confirm whether *E. floridanus* is present before undertaking bat exclusions. More generally, institution of a single standardized definition of a “maternity season” to prevent roost disturbance of bats in those nations with primarily but not entirely temperate climate may fail to protect those chiropteran species geographically confined to warmer regions.

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