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ROOSTING SITES OF A FLORIDA BONNETED BAT (*Eumops floridanus*)

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The Florida bonneted bat (*Eumops floridanus*) is endemic to south Florida, and its population is believed to be small (Belwood 1992, Timm and Genoways 2004). It is one of the rarest mammal species in North America and recently was listed as endangered by the U.S. Fish and Wildlife Service (USFWS 2013). Knowledge of roost site preferences is important to the conservation of bats (Fenton 1997), but little is known about roost selection by the Florida bonneted bat. Florida bonneted bats have been found roosting in tree cavities excavated by Red-cockaded Woodpeckers (*Picoides borealis*) in Charlotte and Polk counties (Belwood 1981, B. Scofield, USFWS, unpublished data). Since 2003, Florida bonneted bats have also been documented roosting in man-made bat houses in Charlotte and Lee counties (USFWS 2013). Even though the Florida bonneted bat was reported first in urban areas of southeast Florida and has been observed there intermittently since the 1930s, roost sites of Florida bonneted bats in the urban environment of southeast Florida remain poorly known (Barbour 1936, Schwartz 1952, Belwood 1992, Timm and Genoways 2004). Florida bonneted bats have been reported to roost under barrel tiles on roofs and in palm trees in urban areas, but this information comes largely from indirect reports of brief incidental observations (Barbour and Davis 1969, Belwood 1992, Timm and Genoways 2004).

Radiotelemetry offers a method of tracking bats to their roosts that is more efficient and informative than incidental observations, but because

few Florida bonneted bats have been captured away from roosts (USFWS 2013), telemetry has been attempted only twice for tracking Florida bonneted bats to roosts. We conducted those two telemetry efforts in the 1990s but did not publish results because the tracking periods were brief and we assumed that more detailed telemetry work on Florida bonneted bats would be forthcoming. Yet no subsequent similar work has been conducted, and the limited information we obtained remains the only record of nightly movements and roost selection by Florida bonneted bats. Our findings also provide the only description of the influence of radio attachment on Florida bonneted bats. As interest in the Florida bonneted bat increases with the species' designation as endangered, these results may now prove useful to those studying the ecology of the Florida bonneted bat and working to conserve the species.

We attached radios (Model BD-2N, Holohil Inc., Carp, Ontario) to two male Florida bonneted bats, one in 1995 and one in 1997, and released the bats near their capture sites in Coral Gables, Miami-Dade County, Florida. Radios were attached with latex adhesive to fur and skin between the shoulder blades (Skin-Bond, Smith & Nephew Inc., Largo, Florida); the radio and adhesive weighed <4% of the mass of each bat (Aldridge and Brigham 1988). Because the bats flew quickly through a residential neighborhood with numerous buildings and dense vegetation, we typically could triangulate precise locations for a bat only when it was roosting.

Our first study animal was a bat that flew down the chimney and into the living room of a house on Hardee Road in Coral Gables on 5 June 1995. The homeowner captured the animal with kitchen tongs and threw it onto the front yard. The next morning the homeowner retrieved the bat alive from the lawn and took it to a veterinary clinic where it was determined to be an adult male Florida bonneted bat with an injured wing. The bat weighed 36 g (forearm length = 65 mm, testes length = 7.6 mm). After an extended period of rehabilitation in captivity, the bat was transferred to the Florida Fish and Wildlife Conservation Commission for release. We fitted the bat with a radio and released the animal at dusk on 10 November 1995 at the northern edge of the University of Miami in Coral Gables. The bat was released by hand and flew quickly and directly over the university campus and out of range of the radio receivers, including a receiver on the roof of a campus building. Despite repeated attempts to detect the bat with telemetry receivers on the ground, in vehicles along the roads, and in fixed-wing aircraft above Coral Gables, we never detected the bat again.

Our second telemetry effort yielded much more information than the first. On 15 March 1997, a male Florida bonneted bat flew down the chimney and into the living quarters of a home on Alhambra Circle

in Coral Gables. The bat was injured by the family dog and taken to a wildlife rehabilitator, who determined it weighed 28 g but could not fly readily. After 6 weeks of rehabilitation, the bat was transferred to us for release. We attached a radio to the bat on 4 August, and, given the earlier experience, we kept the bat in captivity overnight to confirm that the radio was still attached and operational. But by morning, the radio had become detached from the bat. We reattached the radio and confirmed it was still attached at dusk when we released the bat at the Granada Golf Course (25.75240° N, 80.27822° W), near its capture site.

We followed the bat for 48 hours and observed it foraging and at several roost sites (Table 1). The most frequently used night roost was in a chimney of an occupied house. On one occasion, we viewed the chimney from inside the house and confirmed that the bat was roosting just below the top edge of the chimney. After the first night the bat roosted for the day on a utility pole in a residential backyard. The bat roosted on the side of the pole, but near the top and under the cover of a U-shaped conduit attached to the side of the pole. With a spotting scope we could see the bat's tail and the radio antenna protruding from the conduit. Near dusk the bat emerged from the roost and took flight directly upward from the flat top of the pole rather than dropping into flight as expected. Shortly after the bat emerged from its roost on the second day, we found it alive on the ground with the detached transmitter about 10 cm away. The bat was soaking wet and near a small decorative water fountain on the side of a house. It may have flown to drink at the bubbling fountain and fell into the metal bowl. If so, that would be counter to the presumption that these bats drink only on the wing from large open-water sources.

We returned the bat to the wildlife rehabilitator and after 4 days released it at Granada Golf Course with the radio again attached. The bat flew as before over golf courses and neighborhoods and used several night roosts (Table 1). But at 2315 (EST) on the second night the bat stopped moving, and we assumed it was roosting in a backyard. The next morning we found the bat near the ground clinging to the outside of an air conditioning unit with the detached radio transmitter nearby. The bat's back was injured where the radio had been detached. We returned the bat to the wildlife rehabilitator, and it died 4 days later.

Over 5 nights, the bat roosted at least 19 times at 11 locations, including three day roosts (Table 1). The bat spent an average of 35.2 min at each night roost (n = 10, range 2–118 min). The day roosts were in a structure on a utility pole, in a cavity in a slash pine (*Pinus elliottii*), and in the chimney of a house. The greatest distance between any two signal locations was 3.9 km north to south and 2.8 km east to

Table 1. Location, substrate, and minimum time occupied for roosts used by a Florida bonneted bat over 5 days, Coral Gables, Miami-Dade County, Florida, August 1997.

Date	Observation time	Location/street	Roost substrate/activity	Minimum time at roost (minutes)
5 Aug	20:38	Granada Golf Course	bat released	
	22:30	Granada Golf Course	pine tree A[a]	25
	23:30	2412 North Greenway	chimney A	118
6 Aug	2:03	Granada Golf Course	pine tree A	16
	2:19	Granada Golf Course	royal palm A	37
	3:16	Granada Golf Course	pine tree A	32
	9:00	912 Sorolla	utility pole cavity	day roost >12 h
	20:23	912 Sorolla	left utility pole	
	22:00	2412 North Greenway	chimney A	37
	23:03	2412 North Greenway	chimney A	37
7 Aug	0:23	2412 North Greenway	chimney A	22
	3:18	1125 Milan	royal palm B	2
	4:00	1125 Milan	royal palm B	26
	6:25	915 Milan	pine tree B	day roost >12 h
	20:30	915 Milan	left pine tree B	
	20:40	1415 Capri	bat captured on ground	
11 Aug[b]	20:20	Granada Golf Course	bat released 2nd time	
	21:05	30th and Red	Ficus tree (*Ficus* sp.)	
	21:45	2412 North Greenway	chimney A	
12 Aug	0:20	2412 North Greenway	chimney A	
	1:45	Desoto and Andalusia	tree or utility pole	
	20:22	843 Almeria	chimney B	day roost >12 h[c]
	20:55	Granada Golf Course	pine tree C	
	21:35	642 Sevilla	chimney C	
	23:15	636 Palermo	unknown	
13 Aug	7:00	636 Palermo	injured and captured	

[a]Species was not recorded for pine tree A. Pine trees B and C were slash pines (*Pinus elliottii*).
[b]Time in the roost was not recorded on 11–13 August.
[c]The bat left the roost at Desoto at an unknown time and was not found until just before sunset the next evening at Almeria; presumably it spent the entire day in chimney B.

west, but the bat may have ranged farther during short periods when we were unable to detect it. Roosts were tightly clustered within the area in which the bat flew; the mean distance between a roost and its nearest neighbor was 330 m, and the greatest distance between two roosts was 2.0 km. The bat frequently flew over the Granada and Biltmore golf courses, and we occasionally heard feeding buzzes there, but the bat also flew and presumably foraged above houses and tree-lined streets throughout the neighborhood around the golf courses.

Florida bonneted bats have been reported roosting in longleaf pines (*Pinus palustris*), royal palms (*Roystonea* sp.), and buildings, especially under barrel tile roofs (Jennings 1958, Barbour and Davis 1969, Belwood 1992). Our data support these observations, but the bat we followed frequently roosted in chimneys and did not use barrel tile roofs. Most houses in Coral Gables are of a Mediterranean architectural style that may enhance their attraction as bat roosts; chimneys of many houses have a stucco surface with an integrated arch cover over the flue opening. Bats may find this to be a more appealing roost than a typical squared-off, open-top chimney. The observation we made of the bat taking flight upward from the flat top of a utility pole corroborates a similar report received by Barbour and Davis (1969:234) and indicates that this species does not always require a roost that allows individuals to drop into flight. Our brief tracking suggests that Florida bonneted bats use a variety of night roosts and may switch regularly among day roosts. We do not know, however, whether the roosting behavior of the single rehabilitated male bat we followed is typical of Florida bonneted bats. Interestingly, in 2014, Florida bonneted bats were found roosting at the edge of the roof of the same house, at 305 Alhambra Circle, where the bat we followed in 1997 was first found (K. Bohn, Florida International University, personal communication), which suggests that roost sites may be used over multiple years.

Florida bonneted bats are large molossids with narrow wings suited for fast flight across long distances (Best et al. 1997), and it has been speculated that they may cover long distances nightly when foraging (Barbour and Davis 1969, Belwood 1992). The bat we released in 1995 flew quickly beyond our detection range, but the bat we followed in 1997 ranged <4 km from its day roosts. We do not know how either of these bats may have moved over longer time periods or how the radio transmitters or their prior injuries affected their behavior. The distance that Florida bonneted bats range has important implications for conservation of the species, especially if local populations have become isolated through habitat fragmentation. More research is needed to determine roost selection and movement patterns of Florida bonneted bats in urban and natural habitats. However, alternative methods of attaching transmitters should be evaluated before other telemetry studies of Florida bonneted bats are conducted.

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