Potential for Niche Overlap in Roosting Sites Between *Nycticeius humeralis* (Evening Bats) and *Eptesicus fuscus* (Big Brown Bats)

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Abstract - Many bat species have similar requirements for summer roosting sites leading to the potential for niche overlap and competition for roosts. Similarities in day roosts between bat species are rarely considered as a factor influencing population dynamics of species. We tracked *Nycticeius humeralis* (evening bats) and *Eptesicus fuscus* (big brown bats) to roost trees to evaluate the possibility of niche overlap in roost-site selection. Only tree height was significantly different between roosts used by the two species. Canopy cover, canopy height, dbh, tree species, tree condition, and roost type were not significantly different between the trees used by the two species. If competition for roosts exists between these species, similarities in roost trees may be important, especially as roost trees become scarce due to increased human alteration of roosting habitat. Competition for roost sites, in concert with other factors, may affect both competitors; however, populations of the inferior competitor, which is probably the evening bat, should be more negatively affected.

Introduction

Day roosts are an important limiting factor in habitat selection among forest-dwelling bat species and may also potentially limit their population size (Fenton 1997). In addition to absolute abundance of roosts, overlap in ideal roosts between bat species may affect habitat selection and may force one species out of the area or into suboptimal roosts. Most studies of bat roosting ecology only deal with abundance or characteristics of available roost trees, not with the similarity of roosts used by sympatric species (but see Carter and Feldhamer 2005).

It has been suggested that competition for roost sites with many bird and mammal species may affect bats (O’Donnell 2000), but these studies usually do not deal with niche overlap between bat species. Competition for nesting or roosting sites has been implicated as a factor negatively affecting species in many taxa (Confer et al. 2003, Martin et al. 2004). If suitable roosting habitat is plentiful, competition between species should not be an important factor affecting populations of the inferior competitor, but if roosting habitat becomes scarce, the inferior competitor may be negatively affected (Gause 1934, Wang et al. 2002).

*Nycticeius humeralis* Rafinesque (evening bats) are common in the southeastern United States, but apparently declining (Whitaker and Gummer 2003)
in parts of their range, and *Eptesicus fuscus* Beauvois (big brown bats) are common throughout much of North America and apparently increasing in abundance (Whitaker and Hamilton 1998, Whitaker et al. 2002). These two species exhibit similarities in appearance (Whitaker and Hamilton 1998), prey selection (Whitaker 2004), and summer roost-site selection. In natural settings, both roost in tree cavities (Boyles and Robbins 2006, Willis et al. 2003); however, they are also both commonly found roosting in anthropogenic structures (Watkins 1969, Williams and Brittingham 1997). Whitaker and Gummer (2003) suggest that big brown bats may be displacing evening bats in building roosts, and Duchamp et al. (2004) suggest that big brown bats may be more successful than evening bats in areas of human disturbance because they are more flexible in both foraging and roosting-habitat selection; however, there are no studies that directly compare natural roosts of these species.

As part of a larger study on the roosting ecology of a forest bat community, evening bats and big brown bats were radio-tracked to roost trees in northeastern Missouri. The goal of this study was to characterize roost trees used by *Myotis sodalis* Miller and Allen (Indiana bats), and evening bats and big brown bats were only occasionally captured, so data were collected opportunistically. The purpose of this paper is to compare the roost trees of evening bats and big brown bats in sympatry. If the two species use similar roost trees, evening bats, which are likely inferior competitors (Whitaker and Gummer 2003), may be forced out of ideal roosts.

**Study Area**

This study was conducted in and around Deer Ridge Conservation Area (DRCA; 40°10′N, 91°49′W), in Lewis County, in extreme northeastern Missouri. The area is 2800 ha and more than 75% forested. Oak/hickory hardwoods constitute 90% of the forested areas, and the remaining 10% is one of the largest remaining bottomland hardwood remnants in northeastern Missouri (Root et al. 2003). Most trees within the forest are 65 to 90 years old (Missouri Department of Conservation 2000). In addition to forest, there are ≈28 ha of sloughs and oxbows that hold water for the most of the year.

**Materials and Methods**

We captured bats at DRCA from mid-May to August 2001 and 2002 using mist nets of varying lengths, up to 10 m tall (Gardner et al. 1989), placed over streams, ponds, sloughs, horse-trails, and service roads. Capture periods were initiated at sundown and usually lasted until 0100 hours, weather permitting. Upon capture, individuals were identified to species (Schwartz and Schwartz 2002), sexed, and aged based on the degree of epiphyseal ossification (Anthony 1988). However, due to small sample sizes, only species is considered in analyses.

Radio-transmitters (LB-2, Holohil Systems, Carp, ON, Canada) were attached to the interscapular region using surgical adhesive (Skin-Bond
Cement, Smith and Nephew United, Largo, FL). Evening bats were fitted with 0.51-g transmitters, and big brown bats were fitted with 1.1-g transmitters. Radio-tagged bats were tracked daily to roosts with a three-element Yagi antenna and receivers (TRX-2000S, Wildlife Materials, Carbondale IL, and R1000, Communication Specialists, Inc., Orange, CA).

When possible, we conducted exit counts to verify use of each day roost identified via radio-tracking, estimate colony size, and determine roost type (cavity or broken limb). At each roost site, we identified the species of tree occupied and decay status. Due to the small sample size, trees were classified as either live or dead (snag); if < 50% of a tree was living, it was categorized as a snag (Foster and Kurta 1999). The diameter at breast height (dbh) was measured using a dbh tape, and tree height was measured using a clinometer (PM-5/360, Suunto Company, Espoo, Finland). Canopy cover was estimated at 1 and 3 m from the base of the tree, and values were averaged to give one canopy cover measurement. Height of surrounding canopy was estimated by averaging the height of five dominant trees within a 0.05-ha plot around the roost tree.

All continuous variables were analyzed with a binary logistic regression model (Brigham et al. 1997). To facilitate analysis, trees were grouped into the following groups: oak/hickory, silver maple, and all other trees. Separate chi-square tests were used to evaluate if evening bats and big brown bats used tree species, live and dead trees, and roost type in similar proportions to each other. Statistical tests were done in Minitab Version 14. All data are presented as mean ± SE, and $\alpha = 0.05$ was used for all analyses. All methods comply with the guidelines set forth by the American Society of Mammalogists (1998), and were conducted under permits from the Missouri Department of Conservation and the US Fish and Wildlife Service.

**Results**

_Eptesicus fuscus_

Four female big brown bats (2 pregnant, 2 lactating) were tracked to a total of 10 roost trees. Six trees were *Acer saccharinum* L. (silver maples), three were *Robinia pseudoacacia* L. (black locusts), and one was a *Quercus palustris* Muenchh. (pin oak). Mean height of roost trees was 20.2 ± 2.0 m, and mean dbh was 44.0 ± 3.0 cm. Canopy coverage for big browns was 61 ± 4.9%, and individuals switched roosts every 2.42 ± 1.2 days. Three of the bats roosted exclusively in live trees within a small patch of riparian bottomland forest, and one lactating female occupied four silver maple snags in a swamp over an eight-day tracking period. One tree, a live black locust, was used by three of the four bats tracked. Exit counts varied from 8–22 bats, and all but one bat roosted in cavities that were probably created by primary cavity excavators.

_Nycticeius humeralis_

We located a total of 25 roost trees by radio-tracking seven evening bats (5 pregnant, 2 juveniles). Seventeen of the trees used by evening bats were live,
and the remaining eight were snags. Thirteen roosts were silver maples, eight were pin oaks, two were *Carya laciniosa* (Michx. f.) G. Don (shellbark hickories), one was a *Carya cordiformis* (Wangenh.) K. Koch (bitternut hickory), and one was a *Betula nigra* L. (river birch). Mean height of roost trees was 16.3 ± 1.3 m, and mean diameter of roost trees was 56.7 ± 7.1 cm. Average canopy coverage for roosts was 67.6 ± 4.8%. All roost trees were located in riparian bottomland forest, and bats switched roosts every 2.3 ± 0.6 days.

Four of the evening bats used at least four different trees during each tracking period and two of them occupied the same shellbark hickory, though not simultaneously. Evening bats occupied cavity roosts 84% of the time (21/25). Exit counts of evening bat roosts indicated groups from 1–23.

**Comparison of roost trees used by *E. fuscus* and *N. humeralis***

Of the continuous variables measured, only tree height was significantly different between trees used by evening bats and big brown bats (*Z* = 2.00, *p* = 0.045), with trees used by big brown bats being significantly taller than those used by evening bats. Evening bats and big brown bats did not use tree species, roost types, or live and dead trees in significantly different proportions (*p* > 0.10 in all cases). One evening bat and one big brown bat were tracked to a roost tree simultaneously, but it could not be determined if they were occupying the same roost area as multiple cavities were visible on the bole.

**Discussion**

We found extensive overlap in the roosts selected by these bats. Both species roosted exclusively in ≈ 25 ha of bottomland forest, the majority of roost trees used by both species were silver maple, and roost trees were also structurally similar. These data have important conservation implications because population trends appear to be very different between these otherwise similar bats. Evening bats are declining in parts of their range (Whitaker and Gummer 2003, Whitaker and Hamilton 1998), while big brown bats are increasing (Whitaker et al. 2002). It is unlikely that an increase in big brown bat populations alone could cause a decline in evening bats, but increasing competition may act in concert with loss of summer and winter habitat, predation, and possible pesticide poisoning to increase the apparent decline. In addition, it has been suggested that evening bats may be less able to cope with human disturbance because they appear to be less flexible in foraging-habitat selection than big brown bats (Duchamp et al. 2004). If evening bats are equally inflexible in roosting-habitat selection, destruction of forest habitat may negatively affect evening bat populations.

Evening bats and big brown bats are occasionally found simultaneously inhabiting the same roost tree (Duchamp et al. 2004; J.G. Boyles, pers. observ.), supporting the idea that they have overlapping requirements for roost sites. Cohabitation suggests that competition for roost trees may not be occurring; however, the evening bat colonies generally do not return to a roost tree where a big brown bat roosted the day before.
Studies characterizing the roost trees of these two species have been done (Bowles et al. 1996, Boyles and Robbins 2006, Cryan et al. 2001, Kalcounis and Brigham 1998, Menzel et al. 2001), but have they have not been done on both species in areas of sympatry. Further studies are needed to determine the extent of overlap in roost trees used by these two species and if an increase in big brown bat populations exasperates population declines in evening bats caused by a decrease in habitat. In addition, more studies are needed to evaluate the level of niche overlap between similar bat species to determine if competition may be a factor in population decline of some species.

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Literature Cited


