Am. Midl. Nat. 160:374–385

Diurnal Roosts of Male Evening Bats (Nycticeius humeralis) in Diversely Managed Pine-Hardwood Forests

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Abstract.—We examined attributes of 45 roost sites used by 17 adult male evening bats (*Nycticeius humeralis*) in a diverse forested landscape within the Ouachita Mountains, Arkansas. Bats roosted in a diverse array of substrates, including live or dead *Pinus echinata* ≥15 cm diam at breast height (29% of roosts) and small (<10 cm) understory or midstory hardwoods (20% of roosts). Sixty-three percent of roosts were in snags, 29% in live trees and 8% were on or near the ground. One roost was located in tree foliage, one in leaf litter and one was underground in what appeared to be a small-mammal burrow. Logistic regression models indicated that sites surrounding roosts were more likely to have fewer stumps and more hardwoods snags ≥10 cm diam at breast height than random sites. At the forest-stand level, all roosts were in stands with a mature (>50 y old) overstory. Twenty-six roosts (58%) were in stands that had undergone partial harvest, midstory removal and burning within the last 6 y, but 13 (50%) of those roosts were in unharvested inclusions (greenbelts) retained along stream drains within these stands; thus, 71% of all roosts were in unharvested patches of forest. Male evening bats were flexible in their roost selection, using a range of tree types (both live and dead), sizes and forest habitats. Possibly because cooler sites allow more frequent use of torpor during summer, they often roosted in small understory snags and in closed-canopy forest stands where these small snags were abundant. However, they also roosted in partially harvested portions of stands where a mature overstory was retained. Our results suggest that management intended to provide optimal roosting sites for females may not be applicable to male evening bats.

Introduction

The evening bat (*Nycticeius humeralis*: Vespertilionidae) is a medium-sized (8–14 g) insectivorous bat found throughout the eastern United States south of the Great Lakes and east of the Rocky Mountains (Watkins, 1972; Bat Conservation International, 2001). Although relatively common in the coastal states of the southeastern United States (Barbour and Davis, 1969), evening bats are rare and may be declining in northern portions of their range (Whitaker and Gummer, 2003). To devise effective conservation strategies for evening bats, information on ecology and habitat requirements is necessary, which is lacking throughout most of their range.

Summer roosts are necessary for bat survival and reproduction. Roosts provide protection from predators and offer suitable microclimates that provide thermoregulatory benefits (Kunz and Lumsden, 2003). Evening bats commonly roost in manmade structures (Watkins

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and Shump, 1981; Bain and Humphrey, 1986), but rarely use caves (Barbour and Davis, 1969). In forested landscapes, they typically roost in cavities, crevices and under loose bark of live trees and snags (Menzel *et al.*, 2000; Boyles and Robbins, 2006; Miles *et al.*, 2006). During summer, females generally roost in large colonies, whereas males generally roost alone (Miles *et al.*, 2006).

Most studies of bat roosting in forests have focused on females (Hayes, 2003). Past studies of roosting by evening bats in forests typically combined data for both sexes (Menzel *et al.*, 2000, 2001; Boyles and Robbins, 2006; Miles *et al.*, 2006). However, males may select different types of roosts than females during summer because of different physiological and behavioral pressures and pooling data for the sexes may mask differences that may be important to their ecology. Female evening bats typically roost in colonies during summer and likely require more space inside roosts than solitary males. Females also roost with nonvolant juveniles during the maternity period, which may result in different predation pressures. Differences in patterns of torpor between males and females of some species during summer (*e.g.*, Hamilton and Barclay, 1994) and the thermal needs associated with development of young (Racey and Swift, 1981) also may result in differences between the sexes in thermal requirements of roosts. Recent studies on other forest-roosting bats have found differences between sexes in roost site use (Broders and Forbes, 2004; Elmore *et al.*, 2004; Perry and Thill, 2007a, b). Consequently, information on sex-specific roost selection by evening bats is needed to understand the ecology and habitat requirements of this species.

We examined roosting ecology of male evening bats in a diversely managed forested landscape. Our objectives were to: (1) characterize summer diurnal roosts; (2) determine structural characteristics of forests that affect roost selection; and (3) determine the types of forest stands used for roosting. We compared roost trees and sites surrounding roosts with random trees and sites to assess which habitat features were potentially important to roost selection.

METHODS

STUDY AREA

The study was conducted within the Winona Basin (34°48′N, 92°58′W) of the Ouachita Mountains of central Arkansas. The Ouachita Mountain ecological subregion extends from central Arkansas into eastern Oklahoma. Throughout the region, elevation was 100–800 m, mean annual precipitation was 112–142 cm, mean annual temperature was 16.0–17.0 C and the growing season was 200–240 d (McNab and Avers, 1994).

The 6545-ha study area contained no houses or buildings; manmade structures were limited to low-water concrete bridges and drainage culverts. Most (about 63%) of the study area was mixed shortleaf pine (*Pinus echinata*)-hardwood forests managed by the Forest Service, United States Department of Agriculture (Ouachita National Forest; ONF). The hardwood component in these forests was diverse and included oak (*Quercus* sp.), hickory (*Carya* sp.) and red maple (*Acer rubrum*). Other forest types present in the study area included shortleaf pine (about 12%), oak-hickory (about 14%) and riparian forests (trace). About 12% of the study area was forest-industry timberlands composed mainly of closed canopy and older thinned plantations of loblolly pine (*P. taeda*), which were generally thinned and pruned at about 12–15 y of age and managed on a 30- to 35-y harvest rotation.

National Forest lands within the study area were divided into five blocks; silvicultural treatments were implemented in four of those blocks in 2000. Blocks included: (1) single-tree selection (864 ha); (2) pine-woodland restoration (1232 ha); (3) group selection

(1044 ha); (4) mix of treatments (1791 ha), including single-tree selection, group selection, seed-tree cuts and unharvested areas in stands of approximately 18 ha; and (5) unharvested forest (836 ha) consisting mostly of mature (overstory >50 y of age), relatively unmanaged, second-growth pine-hardwood forest. Single-tree selection and pine-grassland restoration were partially harvested and underwent midstory removal whereby most hardwoods <15 cm diam at breast height (dbh) were felled. Group selection stands had openings (0.40 to 4.05 ha) that were created in the forest canopy; pines in the forest matrix surrounding those openings were thinned, but no hardwoods were removed in the matrix. Harvested stands retained unharvested buffer strips (greenbelts) along ephemeral stream drains. These drains only held water during heavy rain events. Greenbelts were primarily 15–50 m wide strips of mature (≥50 y old), second-growth forests of mixed pine-hardwood or hardwood. With the exception of the unharvested forest block and forest industry land, most of the study area was subjected to a prescription burn in winter 2000–2001. Throughout the study area, unmanaged, mature stands and stands in various stages of regeneration were interspersed within the treatment units. For more detail on the study areas and treatments, *see* Perry *et al.* (2007).

BAT CAPTURE AND TELEMETRY

From mid-May until early Aug. (summer henceforth) 2000–2005, we captured evening bats between 2100 and 0130 h with mist nets at 13 locations. Netting locations primarily were over stream pools, but also included forest roads, culverts, bridges, ponds and dry creek beds. We assessed bat age class (juvenile or adult) based on ossification of metacarpal-phalanx joints (Racey, 1974). We followed the guidelines of the American Society of Mammalogists for capture, handling and care of mammals (Animal Care and Use Committee, 1998).

Radiotransmitters (0.32- to 0.70-g; Blackburn Transmitters, Nacogdoches, Texas) were affixed to the mid-scapular region with surgical adhesive (Skin Bond®) after clipping fur. Batteries lasted 10–21 d and transmitter load was 3.4–8.2% of body mass (mean 5.5% ± 0.5). We radiotracked each bat to its roost site the morning following capture and approximately 5 d/wk thereafter. Once approximate roost tree was determined via radiotelemetry, we located bats within the roost tree either from the ground using binoculars or exit counts, or by tree climbing; usually we climbed adjacent trees and we were careful not to disturb roosting bats. When bats could not be visually confirmed, we collected habitat data only for the surrounding site (as indicated by radiotelemetry) and not the roost tree.

ROOST AND SITE DATA COLLECTION

For visually confirmed roosts, we recorded tree species and dbh. We measured roost height and total tree height using a clinometer. We characterized the habitat surrounding each roost in a 17.8-m radius (0.1-ha) plot centered on the roost tree. Within this plot, all woody stems >1 m tall and <5 cm dbh were counted and all woody stems >1 m tall and ≥5 cm dbh were measured by dbh and species. We measured the diameter of all pine and hardwood snags ≥5 cm dbh in the plot and tallied all stumps (tops ≥10 cm in diameter) that stemmed from recent tree harvest. We measured canopy cover at 4 locations (90° apart) along the outer edge of each plot using a spherical densiometer and averaged these values to derive a plot mean.

To determine potential site characteristics that may have affected roost selection, we selected random plots to compare with roost plots. Identical habitat measurements were collected for random and roost plots. To ensure random plots were potentially available habitat, we choose a random tree or snag ≥5 cm dbh (hardwood or pine) and >40 m distance along a random azimuth from the roost location. We selected random snags for roosts in snags and random trees for roosts in trees. When adjacent roost locations were $\leq$20 m apart (n = 5 roosts), we measured a single roost plot (centered between roosts) and a single corresponding random plot.

We collected global positioning system (GPS) coordinates for each roost location and overlaid those locations on vegetation maps in a geographic information system (GIS) to determine the proportion of roosts in each forest class (Perry *et al.*, 2007). Forest habitat classes were derived from ONF forest stand maps of the study area. Those maps were updated and corrected using a 10-m digital color orthoquad (DOQ) and ground-truthing. We combined the single-tree selection and pine-grassland restoration areas into a single habitat class (thinned mature) for analyses because both treatments had similar initial overstory and midstory reduction. We defined available habitat based on locations of roosts by creating a 1000-m radius circle (314 ha) around each roost location. Although little is known of movements and home ranges of the evening bat, the 314 ha area is comparable to the home ranges for this species in South Carolina (38.7–761.0 ha; Carter, 1998). To define available habitat to all bats, we combined all 1000-m radius circles and designated the area within this polygon the available habitat.

DATA ANALYSES

We considered each roost location an experimental unit (*e.g.*, Menzel *et al.*, 2000; Boyles and Robbins, 2006; Miles *et al.*, 2006); we assumed that individual preferences for day-roosts did not bias our results and that roost trees were independent observations. All means are presented ±SE. We compared species of trees used for roosting with available proportions using binomial tests. We used matched-pairs (each roost matched with its random location) conditional logistic regression (Hosmer and Lemeshow, 2000) to relate habitat parameters surrounding roosts with an increased likelihood of roosting. We used an exploratory method to develop candidate models. For correlated variables ($r \geq 0.70$), we selected either the easiest measurable variables to include (and discarded others) or combined variables (*e.g.*, tree size classes) into new habitat parameters that were not correlated with other variables. Thus, we included 13 habitat parameters derived from 0.1-ha plots surrounding roost and random trees (Table 1). We determined a set of candidate models using a best subsets procedure which selected the best 1-variable model, best 2-variable model and so forth based on values of the chi-square statistic (SAS Institute Inc., 2000). We then determined the most parsimonious model among all candidate models based on the value of AIC modified for small samples (AIC_c; Burnham and Anderson, 2002). We used multimodel inference by averaging parameter estimates of models within 2 units of AIC_{min} (Burnham and Anderson, 2002); we used weights (ω_i) calculated among all models within 2 units of AIC_{min} for averaging and then calculated odds ratios from averaged parameters. Odds ratios represented the odds of roosts/odds of random locations. We computed weighted unconditional standard errors for averaged parameter estimates (Burnham and Anderson, 2002).

RESULTS

We located 45 roosts (35 visually confirmed) used by 17 adult males. Number of roosts per individual was 1–8 and averaged 2.7 ± 0.5. All bats in visually confirmed roosts were solitary. Of the 35 visually confirmed roosts, 22 (63%) were in snags, 10 (29%) were in live trees and 3 (8%) were associated with other substrates. In live trees, seven roosts were in cavities (holes in tree trunks or limbs), two were in crevices (cracks or splits in trunks or branches) and one

TABLE 1.—Habitat variables (from 0.1-ha plots) entered into logistic regression models comparing roost sites of male evening bats (*Nycticeius humeralis*) with random locations in the Ouachita Mountains of Arkansas, 2000–2005

Variable	Description
Cov	Average overstory canopy cover (%)
Stumps	Number of recently cut stumps
Under5	Number of woody stems <5.0 cm dbh[a]
H5to10	Number of hardwoods 5.0–9.9 cm dbh
H10to25	Number of hardwoods 10.0–24.9 cm dbh
$H \geq 25$	Number of hardwoods ≥25.0 cm dbh
P5to10	Number of pines 5.0–9.9 cm dbh
P10to25	Number of pines 10.0–24.9 cm dbh
$P \geq 25$	Number of pines ≥25.0 cm dbh
Hsnag < 10	Number of hardwood snags <10.0 cm dbh
Hsnag ≥ 10	Number of hardwood snags ≥10.0 cm dbh
Psnag < 10	Number of pine snags <10.0 cm dbh
Psnag ≥ 10	Number of pine snags ≥10.0 cm dbh

[a] dbh = diameter at breast height (1.4 m)

was in the foliage of a winged elm (*Ulmus alata*) where the bat hung from a leaf petiole. In snags, 13 roosts were in cavities, five were in crevices and four were under loose bark. Three roosts were on or near the ground. One of those was located in leaf litter, under approximately 29 cm of dead pine needles that had accumulated under a fallen pine limb. Another roost was under an exposed root at the base of a slippery elm (*U. rubrum*) and one roost was underground, beneath a rock that was covered with leaf litter and vines, in what appeared to be a small-mammal burrow.

Evening bats used nine species of live trees or snags for roosting (Table 2). For live trees and snags combined, shortleaf pine (31% of roost trees), followed by red maple (*Acer rubrum*; 19% of roost trees) were used most often. Red maples and northern red oaks (*Quercus rubrum*) were used for roosting more than available and ''other species'' were used less than available (Table 2). Diameter distribution of trees and snags used for roosting was bimodal (Fig. 1). Diameter of live roost trees was 5.3–55.5 cm dbh (median 37.0 cm) and height to roost in those trees was 4.8–24.0 m (median 8.0 m). Diameter of roost snags was 5.0–47.4 cm dbh (median 17.3 cm) and height to roosts in those snags was 2.6–17.5 m (median 7.8 m). Roosts were often (38% of tree or snag roosts) in cavities of small (5–15 cm) understory or midstory hardwoods (Fig. 1). Roosts also were common in larger pines and hardwoods; 25% of tree or snag roosts were in shortleaf pine 20–56 cm dbh and 25% were in hardwoods 20–47 cm dbh (Fig. 1). In live pines, roosts were in small cavities of decaying limbs, usually in the tree crown ($n = 5$). In pine snags, roosts were under loose bark ($n = 2$) or in cracks at the top of snags created when the tops of live pines were snapped off ($n = 3$).

Logistic regression differentiating roost sites from random sites included two models within 2 units of AIC_{min}: the single variable model (−Stumps; $AIC_c = 40.910$; $\Delta_i = 0.000$; $\omega_i = 0.620$; $R^2 = 0.13$) and the 2-variable model (−Stumps + Hsnag ≥ 10; $AIC_c = 41.892$; $\Delta_i = 0.982$; $\omega_i = 0.380$; $R^2 = 0.17$). The parameter-averaged model included Stumps (estimate = −0.074 ± 0.040 unconditional SE; odds ratio = 0.929) and Hsnag ≥ 10 (estimate = 0.052 ± 0.057; odds ratio = 1.053). Based on this averaged model, male evening bats were more likely to roost at sites with fewer recently cut stumps (Stumps) and more hardwood snags ≥10 cm dbh (Hsnag ≥ 10) than random.

TABLE 2.—Number of snags and live trees (≥5 cm dbh) of 9 species used for roosting[a] by male evening bats (*Nycticeius humeralis*) and percent of used and available tree species in the Ouachita Mountains of Arkansas, 2000–2005

Tree species	Roost			Tree composition in random plots (%)	P[b]
	Snag	Live	%		
Pinus echinata	5	5	31	18	0.051
Acer rubrum	5	1	19	7	0.009 *
Cornus florida	2		6	2	0.086
Quercus alba	2	1	9	23	0.067
Q. rubrum	3	1	13	2	<0.001 *
Q. velutina	2		6	2	0.086
Carya tomentosa	1		3	3	0.970
Ulmus alata	1	1	6	3	0.281
Nyssa sylvatica		1	3	10	0.195
Unknown or other species	1		3	30	<0.001 *
All species	22	10			

[a] Three additional roosts were not located in trees or snags

[b] Probabilities (from binomial tests) associated with comparisons of used and available proportions

* Significant at alpha = 0.05

All roosts occurred in stands dominated by a mature (≥50 y old) overstory. Although 17 roosts (38%) were in unharvested mature stands of mixed pine-hardwood or hardwood, 26 roosts (58%) were in thinned mature stands that had undergone partial harvesting, midstory reduction and burning within the last 6 y (Table 3). Thirteen (50%) roosts in thinned mature stands and both roosts in group-selection stands were located in unharvested greenbelts. Thus, at the local scale, 71% of roosts were located in unthinned patches of mature forest and 29% were in partially harvested patches. No roosts occurred in loblolly pine plantations (2.6% of available habitat) or stands with overstories <50 y old (11.3% of available).

DISCUSSION

Recent studies of evening bat roosting during summer in forested areas found roosts in cavities, crevices or under exfoliating bark in both live and dead pines and hardwoods (Menzel *et al.*, 2000, 2001; Boyles and Robbins, 2006; Miles *et al.*, 2006). Although male evening bats in our study roosted mostly (89%) in cavities and crevices of live trees and snags, they roosted in a wider variety of substrates than previously reported for this species during summer, including foliage, leaf litter and what appeared to be a small-mammal burrow. Although evening bats have been found roosting in Spanish moss (*Tillandsia usneoides*) within tree canopies (Jennings, 1958), we are unaware of previous reports of litter or foliage roosting by evening bats during summer. In other pine-dominated landscapes of the southeastern United States, cavities created between the two main forks of live pines with forked (bifurcated) tops were used frequently by evening bats (Menzel *et al.*, 1999, 2001; Miles *et al.*, 2006). Although trees of this type were common in our study area, we found no roosts in those locations; all five roosts in live pines were in small cavities within dead limbs. Boyles *et al.* (2005) found a male evening bat roosting in a rodent burrow at the base of an oak during winter in Missouri and suggested this was in response to low ambient temperatures. We found a similar below-ground roost in late Jun. However, it was unlikely a response to low ambient temperatures because average lows during Jun. were about 20 C.

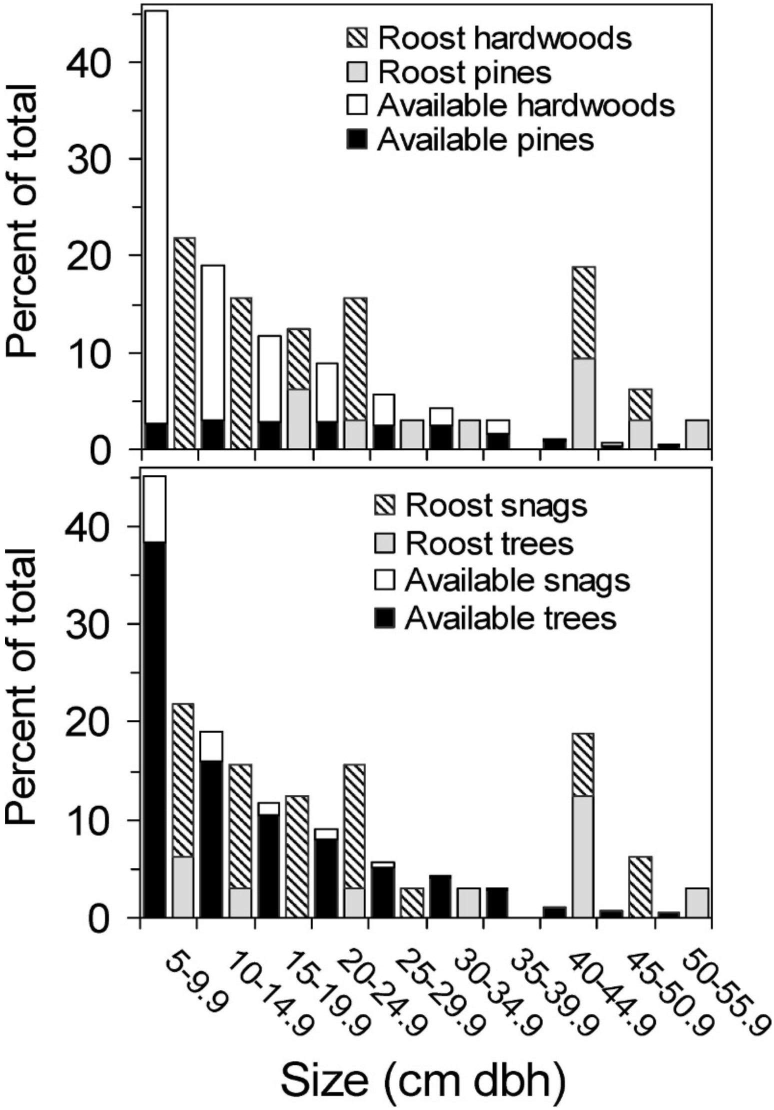

FIG. 1.—Percentage of total available trees (from random plots) that were pine or hardwood (A) and live trees or snags (B) and percent of diurnal roosts of male evening bats (*Nycticeius humeralis*) in pines or hardwoods and live trees or snags in the Ouachita Mountains of Arkansas

This same bat roosted near the ground, under an exposed root at the base of a tree the previous night.

Many species of bat select relatively large trees within a landscape for roosting (*e.g.*, Lacki and Baker, 2003; Kalcounis-Rüppell *et al.*, 2005). Although half of male evening bat roosts were in trees ≥20 cm dbh, we found they frequently roosted in small understory hardwoods. This occurred despite abundant larger trees and snags throughout the study area; density of snags ≥15 cm dbh averaged 24.0 (±3.5 SE) snags/ha in random plots. Male

TABLE 3.—Number (percent in parentheses) of roosts in 5 forest classes used by 17 male evening bats (*Nycticeius humeralis*) and percent availability of each class (based on merged 1000-m-radius circles surrounding each roost) in the Ouachita Mountains of Arkansas, 2000–2005

Habitat	Roosts	% Available
Mixed pine-hardwood, thinned mature[a]	26 (58)	28.0
Mixed pine-hardwood, group selection	2 (4)	17.0
Unharvested, mixed pine-hardwood, 50–99 y old	9 (20)	21.2
Unharvested hardwood, 50–99 y old	8 (18)	12.1
Other habitats		21.7
All habitats	45 (100)	100.0

[a] Included single-tree selection and pine grassland restoration areas that were initially treated in 2000 with similar overstory and midstory reduction, followed by prescribed burning

evening bats used red maples more than available, and most red maples in the study area were small understory trees; average diameter of available red maples (>5.0 cm dbh) was 9.1 ± 0.4 cm. Further, most roosts in small hardwoods (58%) were located in unharvested, mature stands where smaller suppressed trees were abundant. Although many (42%) small hardwoods used for roosting were in greenbelts of thinned mature stands, there were few small hardwood snags in harvested portions of these stands because most small trees were removed during harvest and site preparation.

The best approximating models based on values of AIC_c indicated that roost sites were more likely to have fewer recently cut stumps and more hardwood snags ≥10 cm dbh than random sites. Thirty-four percent of roosts were in hardwood snags >10 cm dbh and bats apparently selected sites with a greater abundance of these snags. The lower numbers of cut stumps at roost sites was likely because many roosts were located in unharvested greenbelts surrounded by partially harvested stands, and random plots for these roosts frequently were located in harvested portions of the stand where stumps were abundant. Rather than selecting sites with an absence of stumps, some evening bats may have roosted at unharvested sites in close proximity to partially harvested areas that provided open, uncluttered areas for foraging (Perry *et al.*, 2007). Stumps were generally short (<30 cm tall), relatively fresh (not decayed) and <40 cm at the top; thus, they did not provide a roosting substrate like those found in other areas (*e.g.*, Vonhof and Barclay, 1997).

Our model relating site parameters to likelihood of bat roosting had relatively low explanatory power and R^2 for competing models within 2 units of AIC_{min} was 0.13–0.17. Furthermore, 95% confidence intervals for both parameter estimates included zero, indicating neither variable was significant in the model. Miles *et al.* (2006) suggested that evening bats are more flexible in selecting roost structure than most other cavity-roosting species. Likewise, male evening bats may be a generalist when selecting habitats for roosting and may focus more on presence of roost substrate (*e.g.*, trees or snags with cavities) than the vegetation immediately surrounding that substrate. Alternatively, the relatively close proximity of our random plots (generally 40–100 m) to the roost plots may have reduced the power of our models because random plots often fell within the same habitat as the roost location.

Recent studies that pooled male and female data suggested evening bats favored roosting in areas of mature forest subjected to burning, with open midstories and relatively lower tree densities. Menzel *et al.* (2000, 2001) found that evening bats roosted in open, park-like pine stands with less canopy cover and fewer overstory stems than random. Furthermore, they suggested that suitable evening bat habitat is maintained by prescribed fire and precommercial thinning in pine stands. In Georgia, Miles *et al.* (2006) found evening bats most often roosted in areas with an open midstory and suggested that biennial prescribed burns provided abundant roost structures and favorable stand conditions for roosting. In Missouri, most roosts were located in stands previously subjected to prescribed burning where canopy cover was lower and more snags were present than in unburned areas (Boyles and Aubrey, 2006). Except for the unharvested forest block and industry lands, most (approximately 70%) of our study area was subjected to a prescription burn in 2000, and all but three roosts (93%) were located in areas that were burned <5 y earlier, similar to results of Boyles and Aubrey (2006).

Unlike previous studies that included female roosts, we found most roosts (71%) in patches that were not thinned or subjected to midstory reduction or removal, although 33% of all roosts were in narrow, linear greenbelts of unharvested forest embedded in partially harvested forest stands. Differences in habitat selection between sexes may account for the lower occurrence of male evening bat roosts in open forest sites and their frequent use of small snags compared with other studies. Temperate insectivorous bats are highly thermolabile and control energy expenditure by regulating the frequency, depth and duration of torpor (Speakman and Thomas, 2003). Because torpor can slow fetal development (Racey, 1973) and reduce milk production (Wilde *et al.*, 1995), reproductive females during summer may spend less time in torpor than nonreproductive solitary females (Solick and Barclay, 2006) and males may enter torpor more frequently than females (Kurta and Fujita, 1988; Hamilton and Barclay, 1994; Cryan and Wolf, 2003). Consequently, female tree-roosting bats may select warmer roosts during parturition (*e.g.* Kerth *et al.*, 2001), which may speed development of young (Racey and Swift, 1981) and cluster to retain metabolic heat (Burnett and August, 1981). In contrast, males may choose roosts with lower ambient temperatures than females to reduce energy expenditure (Hamilton and Barclay, 1994), and males may use trees and snags in shady stands that remain cooler during the day to allow frequent, deeper bouts of torpor during summer. Aside from the thermoregulatory benefits of cooler roosts, solitary males require less space within roosts than colonies. Males simply may be more flexible than females and may be able to use a wider array of roosts, including small cavities in the more-abundant smaller trees and snags.

Differences in roost selection between sexes often are found among other forest-roosting bats (Broders and Forbes, 2004; Perry and Thill, 2007a). For example, solitary male northern long-eared bats (*Myotis septentrionalis*) frequently roosted in cavities of small understory and midstory hardwoods, whereas colonies of maternal females rarely did. Also, males roosted more in unharvested patches of forests and used greenbelts more often than females (Perry and Thill, 2007a). Roost locations of male evening bats were remarkably similar to those of male northern long-eared bats in our study area; 67% of male northern long-eared bats were at unharvested sites versus 71% of male evening bats and 21% of male northern long-eared roosts and 20% of male evening bat roosts were in trees or snags <10 cm dbh (Perry and Thill, 2007a). Thus, males of these two species may have similar roosting strategies or respond similarly to available habitats within a landscape.

We could not directly compare roosts of male and female evening bats in our study area because we captured only three females (all juvenile) during the study. During summer, female evening bats are captured as often as males in other areas of Arkansas (Baker and Ward, 1967; Wilhide *et al.*, 1998; Fokidis *et al.*, 2005). However, large maternity colonies of evening bats often are found in buildings approximately 20 km from the study area (Saugey *et al.*, 1989), and buildings may provide thermoregulatory benefits over natural roosts during parturition for some bats (Lausen and Barclay, 2006). Thus, female evening bats in the vicinity of our study may have roosted primarily in buildings or other man-made structures, which were absent in (or close to) our study area and the juveniles we captured may have been dispersing from these areas.

Recent studies have quantified evening bat roosting in forested landscapes; however, this is the first paper to characterize roost selection by males alone. We found male evening bats were flexible in their roost selection, using a variety of roosting substrates and forest habitats that retained a mature overstory. Based on previous studies of evening bats that were weighted towards females and studies of other cavity-roosting species, our results suggest that management that maintains roost sites for many female forest-roosting bats (*e.g.*, large snags in relatively open forests; Perry and Thill, 2007a) may not be optimal for male evening bats. Additional study on thermal benefits of small snags and cooler sites on male survival and condition in forests during summer is warranted.

Acknowledgments.—We thank D. A. Saugey, S. A. Carter, J. H. Williamson, R. A. Buford and students from Stephen F. Austin State University, University of Arkansas at Monticello and Arkansas Tech University for their field assistance and expertise. The Arkansas Game and Fish Commission provided partial funding for this study through the efforts of D. B. Sasse. Additional funding was provided by the Ouachita National Forest and the Ouachita Mountains Ecosystem Management Research and Demonstration Project through the efforts of L. D. Hedrick and J. M. Guldin, respectively. We thank N. E. Koerth, D. M. Leslie, Jr., R. M. Brigham and S. B Castleberry for comments on an earlier draft. The use of trade or firm names in this publication is for reader information and does not imply endorsement of any product or service by the U.S. Department of Agriculture.

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SUBMITTED 12 DECEMBER 2007 ACCEPTED 27 MARCH 2008