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Roosting habits of four bat species in the Black Hills of South Dakota

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The availability of suitable roosts influences the distribution and abundance of bats. Quantifying roosting requirements is a necessary step toward effectively monitoring, managing, and conserving bats. Our objectives were to locate and characterize the natural, daytime summer roosts of *Myotis septentrionalis*, *M. thysanodes*, *M. volans*, and *Eptesicus fuscus* in the Black Hills of South Dakota, USA and compare local roosts to those used in other regions. Bats were marked with radio transmitters and followed to roosts. We successfully tracked 37 bats of four species to a total of 81 roosts. *Myotis septentrionalis* and *E. fuscus* consistently used trees, while *M. thysanodes* and *M. volans* used both trees and rock crevices. Roost trees were consistently among the largest available and were found in areas of relatively high snag densities. Maintaining forests with high snag densities and large trees will likely benefit bat populations in the Black Hills. All species switched roosts, but generally remained within small (≈4 km^2) areas. Lactating *M. thysanodes* changed roosts together while carrying young. Fidelity to roosts and roost areas was demonstrated by bats in the Black Hills.

Key words: *Eptesicus fuscus*, *Myotis septentrionalis*, *M. thysanodes*, *M. volans*, roost, opportunism, switching, fidelity

INTRODUCTION

The availability of suitable roost structures is a significant factor affecting the distribution and abundance of temperate zone bats (Humphrey, 1975; Kunz, 1982). However, data concerning natural roosting habits of many species are sparse. Among Holarctic bats, males typically roost alone or in small groups during the summer months (June–August), while reproductive females form maternity groups where they communally raise their young (Hill and Smith, 1984). Because physiological stresses associated with raising young are alleviated under certain ambient conditions (Racey, 1982), the ability of reproductive females to find roosts is likely of critical importance.

The structurally heterogeneous landscape of the Black Hills offers an abundance and variety of potential roosts for bats, including trees, caves, mines, and rock crevices (Turner, 1974). Four species (*Myotis lucifugus*, *M. thysanodes*, *M. volans*, and *Eptesicus fuscus*) have been found day-roosting in caves during the summer, but these were typically only males in small numbers (Choate and Anderson, 1997). In general, reproductive female bats were found at lower elevations in the southern

Black Hills (Cryan *et al.*, 2000) and maternity colonies were primarily from buildings (e.g., Turner, 1974). Few maternity colonies were known from structures other than buildings in the region, although Mattson *et al.* (1996) determined that female *Lasionycteris noctivagans* used trees in the Black Hills.

Our primary objective was to locate and characterize natural, summer, daytime roosts of four bat species that are common in the Black Hills (Turner, 1974): northern long-eared myotis (*M. septentrionalis*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), and big brown bats (*E. fuscus*). Our secondary objective was to compare roosts used by these species in the Black Hills to those known from other regions, because all of the species studied are relatively opportunistic in maternity-roost selection elsewhere. *Myotis septentrionalis* forms maternity colonies in buildings and several tree species (e.g., Mumford and Cope, 1964; Foster, 1993; Sasse, 1995; Sasse and Perkins, 1996; Foster and Kurta, 1999); *M. thysanodes* uses buildings (e.g., Dalquest, 1947; Musser and Durrant, 1960; Studier, 1968), trees (Chung-MacCoubrey, 1996; Rabe *et al.*, 1998), mines (J. S. Altenbach, pers. comm.), and caves (Baker, 1962); *M. volans* uses buildings (Dalquest and Ramage, 1946), several tree species (e.g., Baker and Phillips, 1965; Vonhof and Barclay, 1996; Ormsbee and McComb, 1998; Rabe *et al.*, 1998), and rock crevices (Quay, 1948; T. J. O'Shea, pers. comm.); *Eptesicus fuscus* roosts in buildings (Barbour and Davis, 1969; Barclay, 1991), several tree species (Brigham, 1991; Vonhof and Barclay, 1996; Kalcounis and Brigham, 1998), cactus (Cross and Huibregtse, 1964), and rock crevices (Barbour and Davis, 1969; Barclay, 1991).

Quantifying the roosting requirements of bats, particularly those of reproductive females, is a necessary step toward effectively conserving and managing species. Confounding efforts to quantify the roosting needs of bats is the fact that some species are opportunistic in their selection of roost structures. With the possible exception of climate-controlled buildings, it is unlikely that microclimate conditions experienced by bats within a given type of roost structure remain constant along gradients of latitude and elevation, potentially leading to some variability in roost use throughout a species' range. A knowledge of the range of variation in the type of natural roost structures selected by bats is a necessary prerequisite to quantifying roosting needs of bats.

Materials and Methods

This study was conducted between May and August of 1995, 1996, and 1997 in the southern Black Hills of South Dakota, USA. Two areas were delineated in which radiotracking studies were carried out. The first area measured 10 by 10 km (centered at 43°42'30"N, 103°52'30"W) and encompassed Jewel Cave National Monument. The second study area was on the western edge of the Black Hills and measured 5 by 5 km (centered at 43°48'30"N, 104°01'45"W). In both study areas, homogenous ponderosa pine (*Pinus ponderosa*) forests dominated higher elevations, while forests at lower elevations were composed of oaks (*Quercus* spp.) and junipers (*Juniperus* spp.). Steep canyon walls and rocky ridge tops were abundant throughout both areas.

We fitted bats with miniature radio transmitters tuned to 164 MHz (Model BD-2, 0.68 g, and LB-2, 0.53 g, Holohil Systems Ltd., Woodlawn, Ontario, Canada). Transmitters were attached to the interscapular region, with surgical adhesive (Skin Bond, Pfizer Hospital Products Group, Inc., Largo, Florida, USA) after trimming a small patch of the dorsal pelage. We searched for signals from tagged bats with hand-held, three-element, collapsible antennae and portable receivers (Model TRX-1000S, Wildlife Materials Inc., Carbondale, Illinois, USA). Bats were located daily until the radio was dropped or the signal was no longer detected.

We recorded geographic location, structure type (e.g., tree, boulder, cliff), slope orientation (degrees), and height of entrance above ground for each roost. Occupied roosts were monitored during evening emergence at least once to determine if marked bats roosted alone or communally. We characterized trees

used as roosts by measuring their diameter at breast height (DBH) and total height. To minimize disturbance to roosting bats, quantitative data on trees were taken after they were no longer occupied. In addition, data on DBH and tree-spacing from 5 plots surrounding the roost were collected using the point-quarter method (Cottam and Curtis, 1956). Only trees with DBH ≥ 10 cm were sampled. Trees were assigned a decay stage ranging from 1 (live) to 7 (decomposed, branch-less, bark-less) as described by Thomas *et al.* (1979). Snag density was quantified by counting the number of trees that were ranked with a decay stage > 4 in roost and random plots. We measured 200 plots at randomly selected locations throughout the study areas so that roost plots could be compared to available habitat. Characteristics of trees used as roosts were also compared to data from a random sample of 30 snags (decay stage > 4).

Characteristics of roost trees and plots were compared to random samples using two-sample, Satterthwaite *t*-tests. Data exhibiting non-normal distributions were subjected to Mann-Whitney *U*-tests. Analysis of variance (ANOVA) tests and Bonferroni multiple comparisons were used to compare characteristics of roost trees and plots among bat species. We investigated slope-aspect distribution using χ^2-tests after grouping roosts into quadrants centered on cardinal directions. Analyses were carried out in S-PLUS 2000, Release 2 (MathSoft, Inc., Cambridge, Massachusetts, USA) and MINITAB version 7.2.4 (Minitab, Inc., State College, Pennsylvania, USA). Statistical significance was set at $P \leq 0.05$.

Results

We located a total of 81 active roosts by radiotracking 37 bats of four species (Table 1). Nine female *M. septentrionalis* (2 nonreproductive, 6 pregnant, 1 lactating) were successfully tracked. All their roosts (n = 21) were located in *Pinus ponderosa* on 69 of the 71 days bats carried transmitters. There were no significant differences in the DBH (Satterthwaite *t*-test, $t = 0.7$, $d.f. = 19$, $P > 0.05$) or height of trees ($t = 0.2$, $d.f. = 19$, $P > 0.05$) used by reproductive and nonreproductive bats, so samples were pooled. No significant differences in the mean plot DBH (Mann-Whitney *U*-test, $Z = 1.2$, $P > 0.05$) or plot spacing ($Z = 1.6$, $P > 0.05$) between reproductive and nonreproductive females were observed either. Mean decay stage of trees used as roosts was 5.5 ± 2.0 and only four trees (19%) were still living. Bats typically roosted in cracks or cavities within the trunk of the tree. Roost trees had significantly greater mean DBH than random snags ($t = 2.5$, $d.f. = 49$, $P < 0.05$), but no differences were observed in height between trees used as roosts and random snags (Table 2). There were no significant differences in DBH or tree spacing between roost and random plots either (Table 3). There was evidence of timber harvesting within all but three of the roost plots used by *M. septentrionalis*. Mean number of snags in roost plots was greater than in random plots ($Z = 3.1$, $P < 0.01$ — Table 3). Slope orientation was not significantly different than expected ($\chi^2 = 3.7$, $d.f. = 3$, $P > 0.05$). One nonreproductive female *M. septentrionalis* returned to a roost in the same tree after using others.

Fifteen *M. thysanodes* (2 pregnant, 11 lactating, 2 males) were successfully followed. Their roosts were found on 76 of the 80 days bats carried transmitters. Bats used trees ($n = 9$) and rock crevices ($n = 27$). The two bats that roosted in trees were both lactating females, one of which also roosted in rock crevices. Roost switching between trees and rock crevices was not observed in other individuals of this species. Trees used as roosts were all *P. ponderosa*, with a mean decay stage of 6.9 ± 0.2. Bats always roosted within cavities and cracks of tree trunks, rather than beneath exfoliated bark. Roost trees had greater DBH than random snags ($t = 2.9$, $d.f. = 14$, $P < 0.05$), but did not differ in height from random snags (Table 2). There were no significant differences in plot DBH or spacing between roost and random plots (Table 3). Snag densities in roost plots were greater than those of random plots ($Z = 3.9$, $P < 0.01$ — Table 3). Rock crevices occupied by bats were found in a variety of sedimentary substrates (e.g.,

TABLE 1. Summary statistics of bats followed by radiotracking, showing the number of individuals tracked (n), total number of roosts found (type of roost in parentheses), $\bar{x} \pm$ SD (range) number of days bats were tracked, group size, number of roosts used by each bat, height of roost entrance above the ground, distance of first roost from point of capture, distance between roosts, and $\bar{x} \pm$ SD number of days roosts were used

Species	n	No. roosts (type)	No. days tracked	Group size	Roosts per bat	Height entrance (m)	Distance from capture (km)	Distance between roosts (km)	Days per roost
Myotis septentrionalis	9	21 (all tree)	6.8 ± 3.0 (1–13)	4.4 ± 9.8 (1–41)	2.3 ± 2.1 (1–7)	4.2 ± 4.2 (1.0–15.0)	2.2 ± 1.4 (0.1–5.9)	0.6 ± 0.5 (0.1–1.5)	3.25 ± 2.82
M. thysanodes	15	36 (9 tree, 27 rock)	3.9 ± 2.3 (1–10)	8.9 ± 9.8 (1–27)	2.2 ± 1.5 (1–7)	1.9 ± 1.7 (0.0–8.0)	1.0 ± 0.6 (0.1–2.0)	0.5 ± 0.6 (0.1–2.0)	1.79 ± 1.52
M. volans	10	16 (7 tree, 9 rock)	6.2 ± 4.8 (2–14)	3.6 ± 8.0 (1–31)	1.8 ± 1.0 (1–13)	3.4 ± 2.7 (0.5–10.0)	1.9 ± 1.6 (0.4–3.7)	0.7 ± 0.5 (0.2–1.6)	3.44 ± 4.69
Eptesicus fuscus	3	8 (all tree)	8.7 ± 8.1 (5–18)	15.5 ± 3.5 (12–19)	2.7 ± 2.9 (1–6)	12.5 ± 4.4 (5.5–20.0)	1.5 ± 0.9 (0.4–1.8)	1.1 ± 0.7 (0.4–2.0)	3.25 ± 2.82

sandstone, limestone) and structures (e.g., boulders, cliff faces). Females tended to roost in deep (ca. > 25 cm) rock crevices, while males roosted in shallow crevices slightly wider and deeper than their bodies (mean width = 1.5 cm). More roosts were observed on south-facing slopes than expected ($\chi^2 = 18.3$, $d.f. = 3$, $P < 0.001$). One pregnant and one lactating female *M. thysanodes* returned to the same rock crevice after staying in other crevices.

Ten *M. volans* (4 lactating, 1 post-lactating, 4 females of unknown reproductive status, and 1 male) were tracked. Roosts were located on 66 of the 68 days bats carried transmitters. The male bat, two lactating females, and the post-lactating female roosted in rock crevices ($n = 9$), while the remaining two lactating females and four other females were found using dead *P. ponderosa* ($n = 7$). The post-lactating female was the only bat to switch between roosts in both trees and rock crevices. There were no clear differences in the DBH ($t = 1.6$, $d.f. = 5$, $P > 0.05$) or height of trees ($t = 0.4$, $d.f. = 5$, $P > 0.05$) used by lactating and other females, but there were significant differences in mean plot DBH ($Z = 4.4$, $P < 0.001$) and mean plot spacing ($Z = 3.8$, $P < 0.001$); mean plot DBH and spacing were both greater in areas used by reproductive females. Decay stage of roost trees was 5.8 ± 1.2 and living trees were not used. Roost trees had greater mean DBH than random snags ($t = 3.4$, $d.f. = 12$, $P < 0.01$), but did not differ significantly in height (Table 2). There were no evident differences in DBH between roost and random plots, but tree spacing and the mean number of snags were significantly greater in roost plots than in random plots ($Z = 5.3$, $P < 0.001$ and $Z = 5.6$, $P < 0.001$, respectively — Table 3). More roosts were situated on slopes that faced south than expected ($\chi^2 = 9.6$, $d.f. = 3$, $P < 0.001$). Two lactating and one post-lactating female *M. volans*

TABLE 2. Characteristics of trees used by roosting *Myotis* spp. and *Eptesicus fuscus* in the Black Hills compared to a random sample of snags. Values are $\bar{x} \pm$ SD diameter at breast height (DBH) and height of tree (Height). Test values are from Satterthwaite *t*-tests between roost values and a random sample of snags

Species	No. trees selected	DBH (cm)	*t*-value	*d.f.*	*P*-level	Height (m)	*t*-value	*d.f.*	*P*-level
Myotis septentrionalis	21	39.0 ± 8.2	2.5	49	< 0.05	9.1 ± 5.9	1.2	47	NS
M. thysanodes	9	43.3 ± 12.1	2.9	14	< 0.05	6.9 ± 6.3	1.8	15	NS
M. volans	7	42.6 ± 3.2	3.4	12	< 0.01	11.0 ± 7.1	0.1	10	NS
Eptesicus fuscus	8	42.1 ± 7.4	3.0	19	< 0.01	22.2 ± 2.5	6.9	33	< 0.001
Random	30	31.7 ± 12.4				11.4 ± 7.1			

returned to roosts in trees or rock crevices after using other sites.

Three female *E. fuscus* (1 pregnant, 2 lactating) were followed. Their roosts were located on 35 of the 36 days bats carried transmitters, and all were found in dead *P. ponderosa* ($n = 8$) with a mean decay stage of 6.3 ± 0.7. The single tree used by the pregnant female was similar in DBH and height to those occupied by lactating females. Roost trees had significantly greater DBH ($t = 3.0$, $d.f. = 19$, $P < 0.01$) and were higher than random snags ($t = 6.9$, $d.f. = 33$, $P < 0.001$ — Table 2). Plot DBH ($Z = 3.5$, $P < 0.001$), tree spacing ($Z = 3.4$, $P < 0.001$), and the mean number of snags per plot ($Z = 5.4$, $P < 0.001$) were greater in roosts than in random plots (Table 3). Slope orientation was not significantly different than expected ($\chi^2 = 0.7$, $d.f. = 3$, $P > 0.05$). One lactating female returned to the same roost in a tree after using other roosts.

There were no significant disproportions in the mean DBH of roost trees among bat species (ANOVA, $F_{3, 44} = 1.5$, $P > 0.05$). Bonferroni multiple comparisons revealed no significant differences among the mean height of such trees used by *M. septentrionalis, M. thysanodes,* and *M. volans*, but trees occupied by *E. fuscus* were taller than those used by *Myotis* spp. ($F_{3, 44} = 12.6$, $P < 0.001$).

Maternity colonies of *M. thysanodes* maintained group integrity through roost changes. In 1995 we simultaneously instrumented two lactating *M. thysanodes* at the same capture site and subsequently located them roosting together in the same rock crevice for two days with 23 other individuals. On the third day the tagged bats were found roosting together, but in another nearby (< 50 m) rock crevice with between 21–24 other bats. Observation at the initial roost crevice revealed only three bats emerging. The instrumented bats roosted

TABLE 3. Mean ± SD vegetation characteristics of roost plots used by *Myotis* spp. and *Eptesicus fuscus* in the Black Hills compared to 200 randomly selected plots. Snag density is expressed as the mean number of snags per plot. *Z*-test values are from Mann-Whitney *U*-tests for differences between median values of roost and random plots. Median values are in parentheses

Species	No. plots	Plot DBH (cm)	*Z*-value	*P*-level	Plot tree spacing (m)	*Z*-value	*P*-level	Snag density (snags/plot)	*Z*-value	*P*-level
Myotis septentrionalis	21	21.7 ± 10.1 (18.0)	1.6	NS	5.1 ± 3.6 (4.3)	0.4	NS	0.3 ± 0.6	3.1	< 0.01
M. thysanodes	9	23.3 ± 10.5 (22.0)	1.5	NS	5.5 ± 4.5 (4.0)	0.6	NS	0.5 ± 0.8	3.9	< 0.01
M. volans	7	23.1 ± 10.5 (21.0)	0.1	NS	7.9 ± 4.7 (7.2)	5.3	< 0.001	0.9 ± 1.0	5.6	< 0.001
Eptesicus fuscus	8	24.6 ± 10.3 (24.0)	3.5	< 0.001	6.8 ± 5.0 (4.1)	3.4	< 0.001	0.6 ± 0.7	5.4	< 0.001
Random	200	21.3 ± 9.4 (20.0)			5.4 ± 4.1 (4.3)			0.1 ± 0.4		

apart in the following days, but continued to change roosts and still roost with other bats. *Myotis thysanodes* carried non-volant young with them through roost changes. On 20 July 1995 a lactating female *M. thysanodes* was tracked to a crevice in a boulder. That evening the instrumented bat and 15 others emerged from the crevice, after which 10 newborn (hairless) pups were seen inside the crevice with an adult that had recently given birth (placenta present). This roost contained no bats the next morning, but the instrumented female was found with a similar number of bats in another nearby rock crevice.

All bats we followed remained within relatively small areas and never traveled more than 2 km between roosts. We radio-tracked reproductive female *M. thysanodes* at the same canyon during three summers and each year found maternity groups using rock crevices within the same 200-m stretch of canyon. This canyon was the only site out of 43 in the southern Black Hills at which we consistently netted reproductively-active female *M. thysanodes* during the study period.

DISCUSSION

All of the species we studied in the Black Hills roosted in trees to some degree. The consistent characteristic of trees used as roosts was that they were among the largest in diameter available, a trend observed elsewhere for these and other bat species (Barclay *et al.*, 1988; Betts, 1996; Sasse and Perkins, 1996; Vonhoff, 1996; Brigham *et al.*, 1997; Callahan *et al.*, 1997; Rabe *et al.*, 1998). Large-diameter trees likely provide more roosting opportunities for bats (i.e., beneath bark, crevices, hollows) than smaller trees and the availability of such trees likely benefits bats in the Black Hills. Other studies have also shown that trees used as roosts by bats are higher

than average and protrude above the canopy (Vonhoff, 1996; Vonhoff and Barclay, 1996; Betts, 1998; Ormsbee and McComb, 1998). Postulated benefits of roosting in taller trees includes avoidance of flight-inhibiting clutter, maximized insolation, and easy navigational recognition. However, use of tall trees is a less ubiquitous pattern among bats in the Black Hills. Among the four species we followed only *E. fuscus* used trees that were significantly higher than random. *Eptesicus fuscus* also consistently roosted higher above the ground (> 5.5 m), while both reproductive and nonreproductive female *M. septentrionalis*, *M. thysanodes*, and *M. volans* were sometimes located roosting within 1 m of the ground (Table 1). *Myotis septentrionalis* used trees that were significantly taller than random in New Hampshire (Sasse and Perkins, 1996), and *M. volans* used trees that were higher than the forest canopy in Oregon (Ormsbee and McComb, 1998). It is unclear why the species of *Myotis* we followed did not roost in higher trees.

We found variation in the age of forest stands used by each species except for *E. fuscus*. All roost areas with *E. fuscus* were located in mature forest stands characterized by large-diameter trees and relatively open canopy. In contrast, several of the roost areas used by reproductive and nonreproductive *M. septentrionalis* were found in recently forested (< 5 years) places in which snags and small stems (DBH 5–15 cm) were the only trees left standing. These results are different than those of Sasse and Perkins (1996) who observed *M. septentrionalis* primarily occupying forest stands with greater mean DBH than available. Nevertheless, the largest colony ($n = 41$) of *M. septentrionalis* we encountered in the Black Hills was in a mature forest stand that had not been harvested in > 50 years. Roost areas used by *M. thysanodes* and *M. volans* were found on sparsely forested slopes, in stands of dense saplings, and in mature forests. However, forest stands used by pregnant and lactating *M. volans* comprised larger, more widely spaced trees than those used by nonreproductive females. There was no noticeable trend between forest condition and use of rock crevices by bats. Rock crevices occupied by *M. thysanodes* and *M. volans* were situated in sparsely forested areas as well as mature forest stands with relatively high densities of large-diameter snags. Greater tree spacing in roost plots, as observed for *M. volans* and *E. fuscus*, has been noted elsewhere for other insectivorous bat species (Vonhof and Barclay, 1996; Rabe *et al.*, 1998). This may reflect selection of roosts in areas of limited clutter and increased insolation (Campbell *et al.*, 1996; Ormsbee and McComb, 1998). Relatively high snag density was observed among all roost areas for the species we studied, as for *Lasionycteris noctivagans* (Mattson *et al.*, 1996). Because bats predominantly occupied the largest-diameter trees in areas of high snag density, forest stands with these characteristics should be maintained in the Black Hills.

Bats using trees as roosts may select for physical structure rather than species of tree (Mattson *et al.*, 1996; Callahan *et al.*, 1997; Kalcounis and Brigham, 1998; Foster and Kurta, 1999). Trees are undoubtedly important to bats because they offer abundant potential roosts and in some areas may be the only suitable structures available. Species capable of roosting opportunistically likely benefit by having access to a wider range of potential roosts than species with less flexible roosting requirements. We found that both trees and rocks used as maternity roosts by *M. thysanodes* and *M. volans* were more likely to face south, where afternoon insolation was probable. Such orientation may be related to common thermal features of maternity roosts that were relatively independent of structure

type. Opportunism in selection of maternity-roost structures points to an underlying set of roost characteristics that are relatively independent of structure type, such as internal temperature or humidity. Studies are needed which quantify such common characteristics across the entire range of a species.

Each species we followed displayed roost-switching behavior. Postulated benefits of such roost switching include predator and parasite avoidance, microhabitat selection, and the ability to track resources that are spatially and temporally dispersed (Lewis, 1995), while likely benefits associated with roost fidelity include familiarity with high-quality roosts and the maintenance of social bonds (Kunz, 1982; Lewis, 1995). Although the bats we tracked moved frequently, we observed each species using roost areas repeatedly and, to a lesser extent, reusing specific roosts. Bats moving amidst a network of familiar roosts in a discrete area may increase their fitness by gaining benefits associated with both lability and fidelity. Group cohesion through roost changes in *M. thysanodes* may reflect social organization that is facilitated by fidelity to a given location. Annual occurrence of reproductive *M. thysanodes* in a discrete area during this research and banding studies in other regions (Easterla, 1973; Cockrum *et al.*, 1996) indicate that *M. thysanodes* annually returns to the same place. Area fidelity by foliage and tree-roosting bats has been observed elsewhere (Lewis, 1995; Sasse and Perkins, 1996; Vonhof and Barclay, 1996).

In addition to needing adequate roost structures, some bats may seek discrete areas in which they are familiar with a number of roosts. Several other studies in which bats were followed with radio transmitters also revealed that, although bats switch roosts, they remain in fairly discrete areas (Betts, 1996; Ormsbee, 1996; Sasse and Perkins, 1996). Are bats dependent in some way on a familiar roosting area? Little is known about the costs and benefits of dispersal to new roosts in terms of fitness. If the cost of finding new roosts is low, bats would be capable of relocating to alternate areas with adequate roost structures if local habitat was lost. However, if the cost of finding new roosts is high, then loss of familiar roost areas may adversely affect bats therein. A necessary next step toward the effective conservation and management of bat populations is to gather more information on the local movements and dispersal abilities of roost-switching bats.

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