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DAY ROOSTS OF FEMALE FRINGED MYOTIS (*MYOTIS THYSANODES*) IN XERIC FORESTS OF THE PACIFIC NORTHWEST

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?1 We radiotracked 25 adult female fringed myotis (*Myotis thysanodes*) to day roosts in xeric ponderosa pine (*Pinus ponderosa*) forests on the east side of the Cascade range in Washington and Oregon from 2001 to 2003. Bats were tracked for an average of 9.6 days/bat ± 0.1 *SE* for a total of 240 roost-days. Bats used 118 roosts, 93% of which were in the crevices of rocks. Pregnant females chose horizontal crevices 58.8% of the time, whereas lactating (60.9%) and postlactating (75%) females selected vertical crevices more often. There was no difference in crevice length or crevice width among roosts in rocks used by pregnant, lactating, and postlactating females. Snags were used as roosts on only 6 occasions, and all were in ponderosa pines situated within a single watershed. The largest emergence count of fringed myotis that we recorded was 118 bats from a ponderosa pine snag. Snags used as roosts were larger in diameter, taller in height, and extended farther above the local canopy than random snags. Bats used the same roost for 1.8 consecutive days ± 0.12 *SE* and used an average of 5.5 roosts/bat ± 0.69 *SE*. Bats moved 1.6 km ± 0.34 *SE* between capture sites and roosts, with distance between successive roosts averaging 0.55 ± 0.12 km. Roosts were 1.4 km ± 0.36 *SE* from the closest perennial stream. Examination of these data indicates that snags are a less significant component of roosting habitat of fringed myotis in ponderosa pine forests on the east side of the Cascades than has been reported for the species in other regions of its distribution.

Key words: fringed myotis, habitat, *Myotis thysanodes*, Ponderosa pine, rock crevices, roost switching, snag roosts

Degradation and loss of suitable habitat are among the greatest extrinsic threats to bat populations worldwide (Racey and Entwistle 2003). Loss of foraging habitat due to habitat fragmentation already has been demonstrated for assemblages of bats in the temperate zone (Walsh and Harris 1996a; 1996b), and fragmentation also is likely to affect other habitat elements essential for bats as well, such as available sources of water, landscape corridors, and roosting sites (Duchamp et al. 2007). Day roosts are critical to survival and reproduction of bats during the warm growing season, and many bat species depend on cavities either in trees or beneath bark for their roosts (Barclay and Kurta 2007; Kunz and Lumsden 2003). Bats that rely on trees for their day roosts may be particularly vulnerable to habitat fragmentation, because fragmentation of forests may also lead to a loss of roosting sites along with declines in available foraging habitat (Hayes and Loeb 2007). This pattern suggests that identifying characteristics of roosting habitats of bats that rely on trees for their roosts is warranted.

Bats with wide distributions often use different roost structures in different habitats and localities. Fringed myotis (*Myotis thysanodes*) are reported to use a wide variety of structures as day roosts including caves, mines, and buildings (Davis 1966; Easterla 1966; Judd 1967; Musser and Durant 1960; O'Farrell and Studier 1980; Perkins et al. 1990), bridges and crevices in rocks (Cryan et al. 2001; Davis 1966; Herder 1998; Miner et al. 1996), and snags, that is, dead trees (Cross and Clayton 1995; Cryan et al. 2001; Kurtzman 1994; Morrell et al. 1999; Rasheed et al. 1995). Recent studies using radiotelemetry techniques have demonstrated a disproportionately greater importance of snags as day roosts of fringed myotis than previously believed (Chung-MacCoubrey 1996; Rabe et al. 1998; Weller and Zabel 2001).

Fringed myotis are rare across their distribution, but can be locally abundant; however, no long-term population data are available (Barbour and Davis 1969; Keinath 2004; O'Farrell and Studier 1980; Rasheed et al. 1995). The broad geographic distribution of the fringed myotis, and the associated breadth of habitat conditions the species likely encounters, suggests that studies of roosting habitat of fringed myotis are needed

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throughout the distribution of the species to properly assess the full range of habitat conditions required for its survival. We conducted a study of day roosts and associated behavior of adult female fringed myotis in xeric ponderosa pine (*Pinus ponderosa*) forests in the east Cascade Range of Washington and Oregon.

Materials and Methods

The study took place on the east side of the Cascade Range in Kittitas and Yakima counties in south-central Washington, and Klamath and Lake counties in south-central Oregon. The geologic history of the 2 study areas differs. Andesite and basalt from cooled magma form ridge crests dissected by deep valleys in the Washington study area, whereas basalt, pyroclastics, and alluvial sediments overly fault-block mountain topography in the Oregon study area (Franklin and Dyrness 1988). Andesite and basalt are fine-grained, extrusive, igneous rocks that fracture or crumble relatively easily. The Washington study area contains both rock faces of columnar basalt and rocky outcrops formed by lava flows (Franklin and Dyrness 1988). Rocky habitat in Oregon, in contrast, resulted from explosive pyroclastic showers of fragmented pieces of magma of various sizes, which blanketed the ground forming boulder fields (Franklin and Dyrness 1988).

Although the study areas in Washington and Oregon are $\geq$500 km apart, both areas experience dry summers (<15 mm of precipitation per month) and winters with heavy snowfall (Franklin and Dyrness 1988). On the east side of the Cascades, ponderosa pine dominates a 20- to 40-km-wide forest zone with components of grand fir (*Abies grandis*), white fir (*A. concolor*), and Douglas-fir (*Pseudotsuga menziesii*). This zone abuts shrub–steppe habitat just east of the study areas (Franklin and Dyrness 1988). We sampled forests managed by Plum Creek Timber Company, the United States Department of Agriculture Forest Service, and the Washington Department of Fish and Wildlife in the Rock Creek and Oak Creek watersheds on the Wenatchee National Forest, Washington, between 760 and 1,400 m above mean sea level. In Oregon, we sampled forests managed by U.S. Timberlands, the United States Department of Agriculture Forest Service, and the United States Department of the Interior Bureau of Land Management in the Sprague River and Pole Creek watersheds on the Fremont–Winema National Forest between 1,450 and 2,000 m above mean sea level. Watersheds in each study area were $\geq$20 km apart and each encompassed both forested and nonforested habitats, including rocky outcrops, rock faces, talus slopes, small meadows, and boulder fields.

We captured bats in mist nets placed at ephemeral ponds and pools of water along creeks at 26 sites in each study area for a total of 171 nights of netting between 22 May and 17 August 2001–2003. We weighed bats and identified them to species, recorded sex and reproductive condition, and aged them based on ossification of the finger joint cartilage (Anthony 1988). We noted pregnant bats by the presence of a fetus in the abdomen and noted lactating or postlactating females by teat condition (Racey 1988). We attached 0.48- to 0.51-g radiotransmitters (model LB-2; Holohil Systems, Ltd., Carp, Ontario, Canada) to adult female fringed myotis that weighed $\geq$6.5 g with a small amount of Skin-Bond (Smith Nephew United, Largo, Florida), after using blunt, curved scissors to carefully clip the fur between the scapulae. Transmitter mass averaged 7.1% $\pm$ 0.1% *SE* (range 5.3–7.8%) of the body mass of radiotagged bats. We used 3-element Yagi–Uda directional antennae and TRX-2000s receivers (Wildlife Materials, Inc., Carbondale, Illinois) to locate day roosts of each radiotagged bat until the end of the transmitter battery life or until the transmitter was found detached. The Institutional Animal Care and Use Committee at the University of Kentucky (00219A2001) approved all animal handling methods used in this study.

We indexed the abundance and local distribution of fringed myotis by calculating the percentage of capture sites and capture nights in which the species was caught. We calculated demographic parameters and compared differences in sex and age ratios between study areas using chi-square tests. We provide information on temporal patterns of habitat use of fringed myotis among reproductive conditions. We indexed use, occupancy, and proximity of roosts of radiotagged bats by calculating the number of days tracked/bat, number of total roosts used/bat, the number of bat days/roost, distance between capture sites and subsequent roosts/bat, and distance between successive roosts/bat; we tested for differences in these parameters between study areas using *t*-tests assuming unequal variances. We summarized information on typical movements of radiotagged bats, reuse of roosts, and use of roosts by >1 radiotagged bat, both solitarily and with other bats. To assess the presence of colonies, we counted bats emerging from roosts at dusk. Counts at each roost began just before sunset and continued for 1 h postsunset.

For each snag used as a roost and 50 randomly located snags in the same watershed, we recorded location and altitude using global positioning systems and identified the species and decay class of snags (Hunter 1990). We measured the diameter of snags 1.5 m above the ground (diameter at breast height [dbh]), and recorded height of the focal snag (m), height of canopy midpoint (m), height of the nearest live tree (m), percent slope, and slope aspect. We estimated percent canopy cover, percent midstory cover, percent branches remaining, and percent bark and percent exfoliating bark remaining. We converted percent bark coverage and percent exfoliating bark to square meters by multiplying by the surface area of each snag. Surface area of snags was determined by measuring the height of snags with a clinometer and the diameter of snags with a diameter tape. We measured the distance to the nearest live tree $\geq$ 10 cm dbh, the nearest live tree $\geq$ the focal snag in height, and the nearest available snag (i.e., $\geq$ 30 cm dbh and $\geq$ 3 m tall; sensu Ormsbee and McComb [1998] and Rabe et al. [1998]). We counted the number of live trees and snags $\geq$ 10 cm dbh within 20 m of the focal snag, and determined the basal area of live trees, snags, and large live trees and large snags (i.e., $\geq$ 25 cm dbh). We transformed all nonnormal data before analysis and tested for differences in snag- and stand-level habitat characteristics between roost snags and random snags using *t*-tests assuming unequal variances.

Table 1.—Summary statistics (*SE*) for roost history of adult female fringed myotis radiotracked on the Okanogan–Wenatchee National Forest in Washington, 2001 and 2002, and the Fremont–Winema National Forest in Oregon, 2003.

Watershed	Total no. bats	Total no. roosts	No. rock roosts	No. snag roosts	Total no. roost days	Mean no. days tracked/bat	Mean no. roosts/bat	Mean no. days/roost[a]
Washington location	12	49	23	6	138	10.7 (1.29)	4.8 (0.73)	2.4 (0.25)[A]
Rock Creek	4	15	9	6	52	13.0 (2.74)	5.3 (2.25)	2.5 (0.40)
Oak Creek	8	34	34	—	86	9.6 (1.17)	4.6 (0.53)	2.1 (0.26)
Oregon location	13	69	67	—	102	8.6 (1.5)	6.2 (1.21)	1.3 (0.10)[B]
Pole Creek	7	29	29	—	55	7.9 (2.31)	4.6 (1.13)	1.8 (0.25)
Sprague River	6	40	38	—[b]	47	9.4 (2.42)	8.4 (2.20)	1.1 (0.06)
Total	25	118	110	6	240	9.6 (1.0)	5.4 (0.69)	1.8 (0.12)

[a] Means between locations with different capital letters are different ($P = 0.001$).
[b] One roost was in a stump and another in a fallen log located in boulder field habitat.

We collected location and altitude using global positioning systems for each capture site and each roost and qualitatively described rocks used as roosts and the surrounding habitat in Washington. In Oregon, we recorded whether rocks used as roosts were inside a crevice oriented vertically (i.e., 160–200°) or horizontally (i.e., 70–110°). We measured width and length of crevices and tested these characteristics by orientation of the crevice and reproductive condition of adult females using a 2-way analysis of variance. We recorded maximum height and diameter of rocks used as roosts; percent rock, vegetation, and bare ground; percent canopy cover; number of live trees and snags within a 20-m radius of the roost; percent slope; and slope aspect at rocks used as roosts by adult female fringed myotis. We used $\alpha = 0.05$ as the minimum level of significance in all tests and present data throughout as mean ± *SE*.

Results

We captured 237 fringed myotis on 48% of 171 capture nights. We captured fringed myotis at 41% of 52 capture sites, although 47% of fringed myotis captures in Washington occurred at a single net site that was within 100 m of a 1-km-long and 100-m-tall vertical rock face. Further, 47% of fringed myotis captures in Oregon occurred at only 2 net sites, suggesting that this species was locally common but more often was rare across study locations. We captured 135 adult and 13 juvenile males, and 81 adult and 8 juvenile female fringed myotis. We captured 1.7 adult males per adult female and 0.1 juveniles per adult. Adult sex ratios differed between Washington and Oregon (3.06 male : female versus 0.79 male : female, respectively; $\chi^2 = 21.6$, $d.f. = 2$, $P = 0.0001$). We captured 19 pregnant females before 11 July, 26 lactating females between 26 June and 12 August, and 11 postlactating females after 28 July. We captured the 1st of 18 males with expanded cauda epididimys on 26 July and the 1st of 21 volant juveniles on 29 July.

We radiotracked 13 adult female fringed myotis in Washington in 2001 and 2002 and 12 adult female fringed myotis in Oregon in 2003 for an average of 9.6 ± 1.0 days/bat, encompassing a total of 240 roost-days (Table 1). Of the adult females we radiotracked, 8 were pregnant, 9 were lactating, 3 were postlactating, and 5 were nonparous. Bats used 118 roosts; 93% of roosts were in rock substrates (i.e., rocky outcrops, talus slopes, large rocks on wooded side slopes, and boulder fields), 6 roosts were in ponderosa pine snags, 1 roost was in a white fir stump, and 1 roost was in a fallen log, suggesting tree roosts were of lesser importance to fringed myotis as day roosts than were crevices in rocks. Bats used the same roost for 1.8 ± 0.12 consecutive days (range = 1–16 days) and used an average of 5.5 ± 0.69 roosts/bat. Individual bats reused 10 crevices in rocks and 1 snag after roosting elsewhere, reused 3 roosts more than 1 time, and reused 1 roost 4 times. Five bats used 1 roost at different times and 5 bats used 3 roosts previously used by 2 other bats. With few exceptions, individual bats typically moved among several roosts along 1 or 2 relatively short (i.e., 100-m) stretches of ridge-top habitat in Washington and within 1 or 2 relatively small areas (i.e., 25 m^2) of boulder field in Oregon.

Distances between roosts and capture sites, previous roosts, nearest stream channels, and perennial stream channels differed between study areas (Table 2). Overall, bats moved 1.6 ± 0.34 km ($n = 23$ bats) between capture sites and roosts. Distances between successive roosts, for bats that used more than 1 roost structure, was 0.55 ± 0.12 km ($n = 22$ bats), but ranged from 0.01 to 3.3 km. Roosts averaged 1,351 ± 28.8 m ($n = 113$ roosts) above mean sea level in elevation. Bats chose roosts that averaged 0.49 ± 0.1 km ($n = 23$ bats) from the nearest, typically dry, stream channel, and that were 1.4 ± 0.36 km ($n = 23$ bats) from the closest perennial stream.

In both locations, bats used crevices formed by splits in individual rocks or spaces between rocks that were roughly 1–4 cm wide; however, this was the only similarity in roosts between the study areas. All 6 roosts in pine snags, 9 roosts in talus slopes, and 34 roosts in rock outcrops were found in Washington; the tree stump, fallen log, 5 roosts in large rocks on a wooded hillside, and 62 roosts in rocks in boulder fields were recorded in Oregon. Roosts in rocks in Washington were in splitting and crumbling basalt rock outcrops, talus slopes, or a rock face; all occurred in nonforested areas. Roosts in rock outcrops were 94.9 ± 7.02 m ($n = 34$) in elevation above the local creek bottom. We were able to see solitary bats in 14 different roost crevices on 30 occasions in Washington. On 2 occasions we noted multiple adult bats with several pups in a single 1-m-long × 4-cm-wide crevice

TABLE 2.—Summary statistics (*SE*) for elevation of roosts and distances between roosts and capture sites, roosts and previous roosts, roosts and nearest (typically dry) stream channels, and roosts and perennial streams for adult female fringed myotis radiotracked on the Okanogan–Wenatchee National Forest in Washington, 2001 and 2002, and the Fremont–Winema National Forest in Oregon, 2003.

	n[a]	Washington	Oregon	*t*	*P*
Elevation of roosts (m)	49, 64	986 (18.9)	1,621 (6.2)		
Distance (m) from roost to					
Capture site (m)	12, 11	1,780 (45)	1,390 (53.4)	0.56	NS[b]
Previous roost (m)	12, 10	790 (182)	260 (108)	2.59	0.05
Nearest stream channel (m)	12, 11	230 (46.2)	780 (163)	3.26	0.01
Perennial stream (m)	12, 11	540 (179)	2,330 (63.3)	2.72	0.05

[a] Sample sizes for elevation data based on number of roosts; sample sizes for distance data based on number of bats.
[b] NS = not significant.

in a basalt outcrop located in the Oak Creek watershed, Washington, on 29 and 30 July 2001.

In contrast to rocks used as roosts in Washington, typical roosts in rocks used by fringed myotis in Oregon were in crevices within or between large, flat rocks in nonforested boulder fields on large flat plateaus (mean slope = 6.2%). Twenty roost sites were within a crevice in a single rock and 45 were beneath and between individual rocks; 36 roost crevices were oriented vertically and 29 were oriented horizontally. Pregnant females chose horizontal crevices 58.8% ($n = 34$) of the time, whereas vertical crevices were selected by lactating females (60.9%, $n = 23$) and postlactating females (75%, $n = 8$) more often than horizontal crevices. Overall, roost crevices in rocks in Oregon ($n = 65$) were 2.4 $\pm$ 0.16 cm wide and 36.8 $\pm$ 2.75 cm in length. We observed no difference in length of crevice ($F = 0.25$, $d.f. = 5, 56$, $P = 0.78$) or width of crevice ($F = 0.7$, $d.f. = 5, 56$, $P = 0.5$) among rocks used as roosts by pregnant, lactating, and postlactating females.

Rocks used as roosts in Oregon were 32.3 $\pm$ 3.6 cm tall and 96.1 $\pm$ 6.8 cm in diameter. Areas surrounding roosts were 66% rock, 19% bare ground, and 15% vegetation. Roost sites had an average canopy cover of 2.0%, and 1.0 $\pm$ 0.16 live trees and 0.09 $\pm$ 0.04 snags within a 20-m radius of roosts. Slope aspect was typically south–southwest with an average direction of 204° $\pm$ 7.34°. Crevices in rocks used as roosts by bats in Oregon were always shallow so bats were easy to see and count. We observed bats roosting solitarily in 59 different roost crevices on 94 occasions and we noted an adult female roosting with 1 pup on 9 occasions in 6 different roost crevices. No colony roost was observed in boulder fields in Oregon.

All 6 snags used as day roosts occurred in the Rock Creek watershed, Washington, and all were ponderosa pine situated within 100 m of rocky ridge habitat. Snags used as roosts by adult female fringed myotis were larger in diameter, taller in height, and extended farther above the local canopy than random snags (Table 3). Roost snags also were located in stands of higher live tree densities, and greater basal areas of larger diameter trees and snags than random snags. Emergence counts ($n = 17$) at these trees revealed that bats were roosting solitarily on 11 occasions, and 2–7 bats were roosting together on 3 occasions. We counted colonies of 14 and 25 bats in 1 snag and 118 bats in another snag during the remaining 3 emergence counts.

DISCUSSION

Examination of these data supports the contention that choice of day roosts by fringed myotis varies throughout the distribution of the species, especially with regard to the importance of snags for roosting in local populations. For example, radiotelemetry studies demonstrated that fringed myotis used snags exclusively for day roosting in California (100% snags, $n = 52$ roosts—Weller and Zabel 2001), New Mexico (100% snags and live trees, n = not reported—Chung-MacCoubrey

TABLE 3.—Means (*SE*) of snag- and stand-level habitat variables that were different between snags used as day roosts by adult female fringed myotis and randomly available snags (i.e., snags > 3 m tall and > 30 cm diameter at breast height) in Rock Creek, Washington, 2001 and 2002.

Habitat variable	Roosts ($n = 6$)	Random snags ($n = 50$)	*t*	*P*
Diameter at breast height of snag (cm)	82.6 (10.7)	52.8 (2.72)	6.9	0.001
Height of snag (m)	31.3 (3.81)	14.4 (1.29)	4.2	0.01
Canopy height (m)	21.0 (1.65)	17.1 (0.86)	2.35	0.05
Height of roost tree minus height of canopy (m)	10.3 (4.48)	−2.5 (1.28)	2.75	0.05
Height of nearest live tree (m)	20.5 (2.27)	13.4 (1.03)	2.92	0.05
Distance to nearest available snag (m)	16.2 (6.74)	39.0 (4.28)	2.86	0.05
Stand live tree density (trees/ha)	590 (114)	294 (27.4)	2.52	0.05
Total basal area of large-diameter (≥25-cm) trees (m^2/ha)	28.8 (4.10)	16.0 (1.59)	2.91	0.05
Basal area of live large-diameter (≥25-cm) trees (m^2/ha)	24.6 (3.83)	13.7 (1.55)	2.64	0.05
Basal area of dead large-diameter (≥25-cm) trees (m^2/ha)	4.3 (0.77)	2.2 (0.24)	2.6	0.05
Slope (%)	52.3 (6.24)	34.3 (2.91)	2.6	0.05
Elevation (m above mean sea level)	957 (53.1)	1,218 (23.8)	4.47	0.01

1996), and Arizona (100% snags, $n = 15$ roosts—Rabe et al. 1998). Conversely, fringed myotis in South Dakota (33% snags, $n = 36$ roosts—Cryan et al. 2001), Oregon (3% stumps and logs, $n = 69$ roosts—this study), and Washington (12% snags, $n = 49$ roosts—this study) relied much less on snags and roosted primarily in crevices in rocks, with the composition of rock depending on local geology.

All 3 populations of fringed myotis that exhibited limited use of snags occur in arid regions, so some reliance on rock crevices is not surprising. However, examination of data for density and basal area of snags across studies of fringed myotis does not show a lower ''numerical'' availability of snags in locations and habitats where this species demonstrated limited use of snags (Chung-MacCoubrey 1996; Cryan et al. 2001; Rabe et al. 1998; Weller and Zabel 2001; this study). The observed variability in use of day roosts by fringed myotis across its distribution, combined with the lower reliance on snags by this species in some locales, suggests that management efforts to protect habitat of fringed myotis should not rely solely on strategies centered on management of snags, but also need to consider the importance of other structural habitat features. All 3 populations of fringed myotis that showed limited use of snags (Cryan et al. 2001; this study) occur within the Intermountain Semi-Desert Province, an ecoregion where the species is of high conservation concern and where management of its habitat is a priority (Keinath 2004).

Most tree-roosting *Myotis* bats change roosts frequently (Barclay and Kurta 2007), and fringed myotis is no exception because all studies where such data are reported have shown these bats to switch roosts more than every 2 days on average (Cryan et al. 2001; Weller and Zabel 2001; this study). Frequent roost switching, combined with the tendency for this species to be localized in occurrence (Keinath 2004; Rasheed et al. 1995), suggests the need for an abundance of roosts, both snags and crevices in rocks, to be maintained within watersheds where this bat occurs. Examination of data on distance between successive roosts shows means of 0.1 km in Oregon (this study), 0.25 km in California (Weller and Zabel 2001), 0.49 km in Washington (this study), and 0.5 km in South Dakota (Cryan et al. 2001), all of which support the contention that fringed myotis exhibit a tendency toward roosting within a localized area. Mean distances from roosting sites to capture sites of fringed myotis are much longer (range: 0.42–1.88 km—Cryan et al. 2001; Weller and Zabel 2001; this study), indicating that this species drinks, and likely forages, in habitats away from where it roosts.

Although fringed myotis are considered to be rare across their distribution (Keinath 2004; Rasheed et al. 1995), they were the 3rd most common species captured in Washington (Baker and Lacki 2004) and the 2rd most common species captured in Oregon (M. Baker, in litt.); both sites supported xeric, ponderosa pine ecosystems. The capture of more males per female in Washington, a more northern but lower-elevation location, than in Oregon, a more southern but higher-elevation location, is counter to published studies that show that female bats of a number of species, including fringed myotis, predominate at lower elevations in topographically complex landscapes (Cryan et al. 2000; Grindal et al. 1999). An explanation for this discrepancy is not readily clear, but the role of latitude in affecting this sex and elevation interaction cannot be ruled out.

Researchers have examined the thermoregulatory ecology of bats using rocks as roosts (Chruszcz and Barclay 2002; Lausen and Barclay 2002, 2003), with examination of data indicating that pregnant females use shallow crevices with narrow openings and lactating females choose deeper crevices with wider openings. Advantages in both microclimate and predator avoidance were postulated to explain the patterns observed (Lausen and Barclay 2002), with lactating females selecting crevices that were more stable in temperature, remained warmer at night, and that were more secure from predators to house their young. It is possible that these same advantages affect fringed myotis that roost in crevices in rocks, although we observed no difference in the width or length of crevices among roosts in rocks used by pregnant, lactating, and postlactating females.

It also has been shown for big brown bats (*Eptesicus fuscus*) that pregnant females choose horizontal roosts that warm quickly during the day and that lactating females select more vertical roosts that stay warmer at night (Chruszcz and Barclay 2002). We also observed use of both horizontal and vertical crevices in rocks by adult female fringed myotis; however, differences in use between pregnant and lactating females were slight.

Accumulated studies now demonstrate commonalities in patterns of use of snags by cavity-roosting bats (Barclay and Kurta 2007; Kalcounis-Rüppell et al. 2005; Lacki and Baker 2003). Although the number of snag roosts recorded in our study was small ($n = 6$), results showed trends in use of snags by female fringed myotis similar to that observed for the species in other geographic locations (Cryan et al. 2001; Rabe et al. 1998; Weller and Zabel 2001); fringed myotis chose roosts in tall, large-diameter snags situated in stands with a greater density of large-diameter live and dead trees. The consistency across studies in the type of snag and stand conditions used by fringed myotis suggests that this species actively selects for the same snag and stand conditions throughout its distribution. This finding should be helpful to governmental agencies and private landholders that manage forests within the range of the fringed myotis, because concern for the welfare of this species has increased and will likely continue into the future (Keinath 2004).

Examination of our data indicates that reliance on snags for day roosting by fringed myotis varies greatly across the distribution of the species, and in arid regions snags are used much less than crevices in rocks for roosting. Whether this is an actual preference for crevices in rocks by fringed myotis or represents a shortage of quality snags for roosting is unclear and warrants further study. Regardless, until further data are obtained, we recommend that snags continue to be managed for in arid regions of the species' distribution, because all large emergences of bats that we observed from roosts known to be used by fringed myotis were from snags and not crevices in rocks.

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