SECTION III ROOSTING

Roosting Behaviour of Silver-haired Bats (*Lasionycteris noctivagans*) and Big Brown Bats (*Eptesicus fuscus*) in Northeast Oregon

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ABSTRACT

I used telemetry to locate maternity roost sites of four *Eptesicus fuscus* and five *Lasionycteris noctivagans* in northeast Oregon, and I measured characteristics of the roost tree, roost site itself, and surrounding habitat. I also recorded the frequency and distance of roost shifts and the size of some maternity colonies. Both species used large live and dead trees with the diameter of the trees used by *E. fuscus* being significantly larger than those used by *L. noctivagans*. Roost sites were high, uncluttered, and faced no particular direction. None of these features differed significantly between the two species. Trees used by *E. fuscus* were in significantly more open forest on flat terrain than those used by *L. noctivagans*. *E. fuscus* tended to have larger maternity colonies than *L. noctivagans*. Bats of both species changed roost trees frequently. *E. fuscus* moved farther between trees than did *L. noctivagans*, most of which remained in the same drainage. Because of roost-tree lability and the need for large trees as maternity roosts, it is important that forest planners retain large trees when laying out salvage and green timber sales.

INTRODUCTION

Until a few years ago most of the information we had on bat roosts and roosting behaviour came from observations made at artificial structures or at mines and caves. Other than occasional serendipitous observations, little was known about the use of trees as roost sites. As the miniaturization of radio transmitters has progressed, we have applied telemetry to filling this knowledge gap. The first detailed telemetry studies on roost sites in Nearctic forests were by Brigham (1991) and six speakers at the 24th Annual North American Symposium on Bat Research in Ixtapa, Mexico in October 1994 (Crampton 1994; Kalcounis 1994; Morrell et al. 1994; Rainey and Pierson 1994; Sasse and Pekins 1994; Vonhof 1994). In addition, there are eight papers in this volume that address Nearctic forest roost sites and behaviour.

Studies of the same species in different locales and of different species in the same locale are valuable for identifying intraspecific and interspecific variations in roost-site selection and behaviour. Such comparative studies should allow us to identify generalizations regarding the important characteristics of roost trees and surrounding habitat. They also should enable us to identify differences in roost choice and fidelity and the ecological conditions producing this variation. Forest maternity roost trees of big brown bats (*Eptesicus fuscus*) and/or silver-haired bats (*Lasionycteris noctivagans*) have been described in studies from Saskatchewan (Kalcounis 1994), British Columbia (Brigham 1991; Vonhof 1994), Alberta (Crampton 1994), and northern California (Rainey and Pierson 1994). The purposes of my study were (1) to describe the characteristics of maternity roost trees and the surrounding habitat, and (2) to document roost fidelity and the frequency and distance of roost shifts of *E. fuscus* and *L. noctivagans* in northeast Oregon.

MATERIALS AND METHODS

I conducted this study in the Spring Creek area approximately 20 km west of La Grande, Oregon. This area (45° 19′N, 118° 19′W), which is heavily managed by the United States Forest Service, is a mosaic of pine and fir forest patches of differing age, species composition, and openness, and contains several artificial stock ponds. Summers in northeast Oregon are typically hot and dry. Over the last 10 years maximum temperature, minimum temperature, and total precipitation have averaged 27.3°C, 10.9°C, and 26.9 mm, respectively, for June to August.

In 1994, six *E. fuscus* were captured in mist nets at Upper Hunter Pond on 20–21 June. To the back of each I glued a radio transmitter (model BD-1, Holohil Systems Ltd., 112 John Cavanagh Road, Carp, Ontario, KOA 1LO, Canada) with Skin-Bond cement (Smith & Nephew United, Inc., Largo, FL 34643, USA). Palpation indicated that all six bats were pregnant and near parturition. The signals from two of these bats were not detected after the night of release, and because of equipment problems none of the bats were located until 29 June. Thereafter the position of each transmitter was determined daily with a Telonics TR-2 receiver and a two-element antenna (Telonics, 932 E. Impala Avenue, Mesa, AZ 85204, USA) until it no longer moved during two successive nights, which occurred on 8 July for the last transmitter. Bats continued to emerge from two of the trees in which there were non-moving transmitters. The four bats carried the transmitters an average of 15 days.

In 1995, I caught five *L. noctivagans* and attached transmitters in the same manner as described above. These bats were captured on 17 July at Tip Top Pond, approximately 1.5 km south of Upper Hunter Pond. Presumably, because of the cold, rainy spring and early summer in 1995, parturition was delayed. Two of the bats were lactating and three were pregnant. I followed them until 2 August. They carried their radios for an average of 10 days.

I observed bats emerging from seven trees on 13 nights to determine the exact location of the roost site and to count the colony size. Roost sites in five other trees were identified with telemetry. I determined the species, condition (live, snag), height, and diameter at breast height (DBH) of each roost tree. If the specific location of the roost site was known, I noted the compass direction it faced and the openness of the habitat around it. To determine the latter, I imagined a half-sphere, 6 m in diameter, centred on the roost site, and then estimated the percentage of this area unobstructed by limbs or other obstacles. At the location of each tree I measured the gradient and aspect of the slope and average canopy cover (taken 3 m N, E, S, and W of the tree). As an indicator of forest density near each roost tree, I measured the diameter of each tree >5 cm DBH and calculated the total stem area within a 0.1 ha circular plot centred on each tree. Finally, I used large-scale maps to measure the distance between successive roost trees.

I used non-parametric statistics in all analyses to avoid making assumptions about data distribution. Average values are reported as mean ± 1 sd.

RESULTS

Seven and 11 roost trees were located for *E. fuscus* and *L. noctivagans*, respectively (Table 1). All the live trees used as roosts had some defect, such as dead branches, a broken top, or a split trunk that indicated internal decay. A cavity or crack was visible in the area of the defect for five of the six live roost trees. All the snags had cracks and cavities; most had some branches and loose bark. The two species of bats differed primarily in the use of live trees versus snags, but this difference was not significant (Table 1). Also, *L. noctivagans* used several grand fir (*Abies grandis*) as well as ponderosa pine (*Pinus ponderosa*), while *E. fuscus* used ponderosa pine almost exclusively. Two *E. fuscus* used the same cottonwood (*Populus trichocarpa*) and two *L. noctivagans* used the same western larch (*Larix occidentalis*).

TABLE 1 *Characteristics of roost trees used by* Eptesicus fuscus *and* Lasionycteris noctivagans *in northeast Oregon, 1994–95.*

Tree	*E. fuscus*	*L. noctivagans*	*P*
Species			
Ponderosa pine (live)	4	1	—
Ponderosa pine (snag)	2	5	—
Grand fir (snag)	0	4	—
Western larch (live)	0	1	—
Cottonwood (snag)	1	0	—
Total live, dead	4, 3	2, 9	>0.05[a]
Height (m)	18.0 ± 6.5	24.0 ± 9.2	>0.05[b]
DBH (cm)	76.3 ± 12.2	59.6 ± 13.9	0.037[b]

[a] Fisher Exact Probability Test.
[b] Mann-Whitney U Test.

The trees used by *L. noctivagans* were significantly smaller in diameter than those used by *E. fuscus*, but they did not differ significantly in height (Table 1). *E. fuscus* roost sites included a broken top, a woodpecker cavity, a split cavity next to a dead limb, and the top of a lightning-split trunk. Of the eight roost locations determined for *L. noctivagans*, one was under bark and the other seven were woodpecker cavities. The direction of the roost opening varied considerably within each species, ranging from 5°–350° for *E. fuscus* and from 25°–270° for *L. noctivagans*. There were no significant interspecific differences in the height of the roost site or the openness of the habitat around it (Table 2). Between 30 July–2 August, 1995 I determined the time at which sunlight first reached the roost site in the morning and left it in the evening for six *L. noctivagans* roosts sites. The average elapsed time between first morning and last evening solar exposure was 12.7 ± 0.6 h. Exposure time earlier in the season, when young were small, would have been even longer.

The roost trees used by *E. fuscus* were mostly on ridge tops in open pine forest, whereas those used by *L. noctivagans* were on denser forested slopes. This subjective evaluation is supported by significant differences between the two species in slope gradient, canopy cover, and stem area in the surrounding 0.1 ha (Table 3). Slope aspect varied considerably, ranging from 20°–340° for each species.

Two of the *E. fuscus* used at least four different trees each during the study period and were together in two of them. These six trees formed a fairly linear group across three ridges with the greatest distance between trees being 2.1 km. These trees ranged from 0.45–2.4 km from the capture site at Upper Hunter Pond. The other two *E. fuscus* remained in the same tree the entire time that they carried transmitters. This tree was a barkless, cottonwood snag in a broad, flat creek bottom 3.8 km from Upper Hunter Pond. The five *L. noctivagans* occupied at least 2, 4, 4, 2, and 2 trees, respectively. These are minimum numbers because I could not determine

TABLE 2 *Height and habitat openness of roost sites used by* Eptesicus fuscus *and* Lasionycteris noctivagans *in northeast Oregon, 1994–95.*

	E. fuscus	*L. noctivagans*	*P* [a]
Height (m)	10.5 ± 2.4	13.3 ± 5.5	>0.05
Openness (%)	93.0 ± 8.8	98.0 ± 2.3	>0.05

[a] Mann-Whitney U Test.

TABLE 3 *Habitat characteristics around roost trees used by* Eptesicus fuscus *and* Lasionycteris noctivagans *in northeast Oregon, 1994–95.*

	E. fuscus	*L. noctivagans*	*P* [a]
Sample size	7	11	—
Slope gradient (%)	12.3 ± 8.9	3.5 ± 12.7	0.0372
Canopy cover (%)	25.0 ± 16.7	42.2 ± 12.9	0.0236
Stem area (m^2)/0.1 ha	1.1 ± 0.2	2.6 ± 1.1	0.0008

[a] Mann-Whitney U Test.

their locations every day. One of the bats that used four different trees twice moved back and forth between two of them. One bat spent three days at a site more than 5 km from the capture site at Tip Top Pond, and then moved to a tree only 0.2 km from the pond. With this exception, all the *L. noctivagans* stayed within the same drainage. The average distance moved between successive trees was significantly different for the two species (*E. fuscus*: 0.83 ± 0.81 km, n = 5; *L. noctivagans*: 0.12 ± 0.05 km, n = 8; Mann-Whitney U = 3, $p = 0.016$).

Although the data are limited, I found more *E. fuscus* roosting together than *L. noctivagans*. I observed 69 *E. fuscus*, including two carrying transmitters, emerge from one roost tree, but only five emerged from this tree on each of the following two evenings. A week later, I observed 46 *E. fuscus* exit another tree, again including the same two bats carrying transmitters. No bats emerged from this tree four days later. Three groups of *L. noctivagans* were observed exiting five trees on eight nights. Each group contained one bat with a transmitter. Group size ranged from 3 to 16 individuals.

DISCUSSION

In her review of roost fidelity of bats, Lewis (1995) identified five benefits of roost lability, including predator avoidance, escape from disturbance, parasite load reduction, avoidance of unfavourable microclimate, and reduction of commuting distance between roost and changing foraging locations. Neither *E. fuscus* nor *L. noctivagans* in this study showed strong fidelity to specific maternity roost trees, which is contrary to the generalization reached by Lewis (1995) that cavity-dwellers in large trees tend to be site-faithful compared to those roosting in small trees. However, the bats in my study did remain in the same general area, and it thus seems unlikely that reduction of commuting distance is a probable explanation, especially given the extra energy expenditure that must accompany movement of the young. Brigham (1991) provided evidence that tree-roosting *E. fuscus* in British Columbia also did not minimize commuting distance. I noticed no disturbance that would explain the frequent roost shifts of some individuals compared to those that moved less often. The relative importance of potential predators, parasites, and microclimate is harder to discern and is an area ripe for study.

Both *E. fuscus* and *L. noctivagans* exhibited variation in the species and condition of trees selected as maternity roost sites, but this seems largely dependent upon what is available. In this study, *E. fuscus* used mostly ponderosa pine, similar to the results of Brigham (1991). However, in his study all the bats used snags, while four of the six pines used in my study were alive. In another part of southern British Columbia (Vonhof 1994), *E. fuscus* used dead white pine (*Pinus strobus*), and in Saskatchewan (Kalcounis 1994) they used both live and dead trembling aspen (*Populus tremuloides*). The *L. noctivagans* in this study used mostly snags of three species. They used white pine snags in Vonhof's (1994) study, snags of eight species in northern California (Rainey and Pierson 1994), and both live and dead trembling aspen in Alberta (Crampton 1994, this volume).

Parsons et al. (1986) found a small maternity colony in a hollow, dead section of a living basswood (*Tilia americana*). Although *E. fuscus* seems to prefer cavities, *L. noctivagans* occasionally roosts under bark (this study; Pierson and Rainey 1994).

The most consistent characteristic of the maternity roost trees used by these two species, as well as other bat species, is tree size. Both diameter and height, which are generally correlated, have been used as measures of size. Large diameter has been reported as an important requirement for *E. fuscus* (Brigham 1991; this study), *L. noctivagans* (Parsons et al. 1986; Rainey and Pierson 1994; this study), and several *Myotis* species (Sasse and Pekins, this volume). Obviously, trees must be large enough to contain cavities if they are to be used by cavity-roosting bats, but large diameter may also be important because of the insulatory value of the wood around the cavity. Roost trees have also been reported as being taller than average (Crampton 1994; Kalcounis 1994; Vonhof 1994; Sasse and Pekins 1994). The value of height may reflect the need for the cavity to be high enough to provide adequate solar exposure and avoid the clutter of understorey vegetation (Kalcounis 1994; this study).

Regardless of the reasons that these bats need big trees and regardless of the reasons for roost site lability, it is clear that individuals use several large trees each breeding season. Unfortunately, large trees, both live and dead, are often the most valued by humans for lumber, other wood products, and firewood. There is tremendous political pressure in our study region to increase the salvage logging of large tracts of timber killed by recent insect attacks and drought before the trees lose their value through decay and before they fuel a devastating fire. Lumber companies want large trees as well as small, but even if only the smaller ones are removed the remaining isolated ones are more likely to fall in a windstorm. It is important that forest managers recognize the value of large trees to bats as well as other species as they plan salvage and green timber sales. Hopefully, the information coming out of this conference will help provide the documentation that they will need to plan wisely.

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