Maternity Roosts of Bats at the Bosque Del Apache National Wildlife Refuge: a Preliminary Report

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Abstract—Historic and recent changes in the structure, composition, and distribution of riparian forests have likely influenced populations of bats through their effects on habitat quality for reproductive females. This project seeks to identify natural structures used by maternity colonies, determine criteria used in the selection of these roosts, and interpret how historic and current human activities may positively or negatively impact bat populations in the bosque. This paper reports first season results from this ongoing project. Thirteen reproductive female bats (5 little brown myotis, 5 Yuma myotis, 1 red bat, and 2 pallid bats) captured on the Bosque del Apache National Wildlife Refuge in the summer of 1997 were radiotracked daily to their maternity roosts. Four little brown and Yuma myotis colony roosts were found. Colony size ranged from 90 to over 1800 bats. Two colonies were in manmade structures. Two other colonies and numerous solitary roosts were found in natural structures (dead cottonwoods). A pallid bat roosted in a rocky butte, and the red bat roosted in the foliage of a large, live cottonwood. Six of the nine tree roosts were in burned areas of forests directly along the river. Individuals and colonies of little brown and Yuma myotis used under-bark crevices and snags rather than more permanent types of roosts. Additional data from subsequent years will help determine whether the use of ephemeral bark roosts, snags, and riverside forests are characteristic of bat roost selection in the bosque.

Riparian-associated bats may be found in the bosque where suitable foraging and roosting habitat exists along relatively permanent bodies of water. However, historic and recent human activities have changed the structure, composition, and distribution of these forests in New Mexico. The effects of these changes on the population status of bats have yet to be determined. Because of their unusually low reproductive rate (typically one offspring per year), bat populations can easily be affected by events that alter the availability and distribution of resources to reproductive females. Suitable roosts and a sufficient diet are critical to successful reproduction by females (Humphrey 1975, Racey 1982). Historic and ongoing changes in riparian forest structure, composition, and distribution due to agriculture, flood control, channelization, demand for fuel and wood products, and exotic plant invasion (Scurlock 1995) have undoubtedly affected the abundance and diversity of roosts and foods available to female bats during the summer. Hence, the reproductive success and status of bat populations along the Rio Grande have likely been impacted. Yet it is difficult to assess the magnitude of these historic impacts or abate future impacts because the resources critical to successful reproduction by bats in bosque habitats are not known. The goal of this project is to identify roost structures used by reproductive females, determine how historic, ongoing, and future changes in the structure and composition of the bosque may benefit or harm the resident bat communities, and provide recommendations on how to improve bat habitat.

Specific objectives of this project in progress include 1) identifying and characterizing structures used as colony and solitary maternity roosts by bats and the general environment surrounding roosts and 2) describing roost behaviors of reproductive female bats in the bosque. With this information, recommendations will be made on how land management activities may be used to positively affect critical resources for bats and how to abate negative effects on bat habitat in the bosque.

Methods

Maternity roosts were identified by radiotagging reproductive female bats and locating them at their daytime roosts. Field work was conducted on the Bosque del Apache National Wildlife Refuge (Bosque del Apache NWR) from June to August 1997. Reasons for the selection of this site include the presence of native bosque, remoteness from urban influences, and the potential to collaborate with other ongoing wildlife and vegetation studies. Candidates for radiotagging were captured by placing mist nets over various types of water following the method of Kunz and Kurta (1988). Net sites throughout the refuge included flooded water management units, canals, shallow sections of the Rio Grande, and flight corridors. Nets were opened at sunset and closed after midnight. Information on the species, sex, age, reproductive status, and weight of all bats captured was recorded.

To identify maternity roosts, pregnant, lactating, or postlactating females were fitted with radiotransmitters. One to four reproductive females were radiotagged in a single night. Fur was clipped from between the shoulder blades, and a 0.50 - 0.67 g radiotransmitter (Holohil Systems Ltd.) was glued to the back of the bat with surgical adhesive (Skin-Bond®) (Wilkinson and Bradbury 1988). Bats were released after the glue dried (approximately 30 minutes). Radiotagged bats were located each day until signals were lost or radios were retrieved.

In: Finch, Deborah M.; Whitney, Jeffrey C.; Kelly, Jeffrey F.; Loftin, Samuel R. 1999. Rio Grande ecosystems: linking land, water, and people. Toward a sustainable future for the Middle Rio Grande Basin. 1998 June 2-5; Albuquerque, NM. Proc. RMRS-P-7. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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Each roost and its immediate surroundings were evaluated, and the number of bats exiting at dusk was counted to determine total roost occupancy. Information on the number of roosts used by each bat, the type and location of roosts, and roost fidelity were collected. Roost locations were recorded with a global positioning system units (Trimble Geoexplorer GPS and Pathfinder Basic Plus).

Preliminary Results and Discussion

Mist Net Captures

From 11 June to 30 July 1997, we mist netted 13 nights at 9 sites. These sites included 4 flooded water management units, 2 streams along flight corridors, 2 sections of river, and 1 section of canal. During the earlier part of the netting period, capture success was low because water was available throughout the refuge (river level was up and many management units were flooded). However, as the summer progressed, river level went down, many management units were drained, and overall water availability decreased on the refuge. Accordingly, capture success improved. From the 13 net nights, we captured and identified 130 bats of 6 species (table 1). The most abundant species caught was the Mexican free-tailed bat (*Tadarida brasiliensis*). Moderate numbers of little brown myotis (*Myotis lucifugus*) and Yuma myotis (*M. yumanensis*) were captured. A small number of pallid bats (*Antrozous pallidus*) and a single small-footed myotis (*M. ciliolabrum*) and red bat (*Lasiurus borealis* or *L. blossevilli*) were captured. At the time of capture, field identification of the red bat, a lactating female, to one of the two species (*L. borealis* or *blossevilli*) was not possible. This individual was radiotagged and thus not available for a voucher specimen. Seventy-seven percent of the total bats captured were female, and 62 percent of these females were reproductive (pregnant, lactating, or postlactating).

Little brown myotis, Yuma myotis, hoary bats (*L. cinereus*) and Mexican free-tailed bats were reported previously on the refuge by Findley and others (1975). Reith (1982) later identified pallid bats as also present on the refuge. Recently, Valdez and others (in press) reported four previously undocumented species on the refuge: fringed myotis (*M. thysanodes*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*L. borealis*), and Townsend's big-eared bat (*Corynorhinus townsendii*). The female eastern red bat captured by Valdez and others (in press) was not reproductive. The present study is the first to document the presence of a small-footed myotis and a reproductive red bat on the refuge.

Maternity Roosts Located

From bats captured during these mist netting sessions, 13 pregnant or lactating females were selected for radiotracking. Five little brown myotis (2 pregnant, 3 lactating), five Yuma myotis (1 pregnant, 3 lactating, 1 postlactating), two pallid bats (both lactating), and one lactating red bat were radiotagged. A radiotransmitter weight not exceeding 5 percent of the bat's body weight has been recommended to minimize effects on behavior and activities (Aldridge and Brigham 1988). In this study, transmitter weight was well below the recommended maximum of 5 percent for the larger species (pallid bats and red bat). For the smaller bats (little brown and Yuma myotis), transmitter weight ranged from 5.1-8.6 percent of the bat's body weight. Brigham and others (1997) did not report any adverse effects on reproductive female *Myotis californicus* tagged with transmitters 8-9 percent of their body weight. Additional research is needed to clarify the effects on and tolerances of bats to variable loads, and further miniaturization in transmitter size will allow researchers to minimize the effects of radiotagging on bats.

Eighteen roosts were located from the 13 radiotagged bats. One pallid bat was not relocated. Only one or two roosts were typically found per bat because either the signal disappeared after the second roost was found or some bats rarely moved during the entire tracking period. Two colony roosts were found repeatedly from 7 independently radiotagged bats. Thus only 13 unique roosts were found. Four were maternity colonies, and nine were solitary roosts. Two of the colony roosts were in manmade structures.

The lactating red bat was the second red bat captured at the Bosque del Apache NWR and the first to be radiotracked in the state. The red bat roosted high within the canopy of a large, live Fremont's cottonwood (*Populus fremontii*) (table 2). This cottonwood was part of a small, isolated cottonwood stand along the river surrounded by dense saltcedar (*Tamarix* spp.). The roosting behavior of this red bat is consistent with the foliage roosting behavior of this genus (Barbour and Davis 1969).

Table 1—Species, sex, and reproductive status[a] of 130 bats captured during 13 mist netting events at the Bosque del Apache National Wildlife Refuge between June and August 1997.

Species	Female			Male			Total individuals
	Nonrepro	Repro	Juvenile	Nonrepro	Repro	Juvenile	
Tadarida brasiliensis	23	39	0	3	4	0	69
Myotis lucifugus	4	12	4	5	2	3	30
Myotis yumanensis	2	6	6	1	0	7	22
Antrozous pallidus	1	3	1	1	0	1	7
Myotis ciliolabrum	0	1	0	0	0	0	1
Lasiurus borealis or *L. blossevilli*	0	1	0	0	0	0	1

[a]Nonrepro = nonreproductive adult female or male. Repro = pregnant, lactating, or postlactating adult female or scrotal adult male. Juvenile = juvenile male or female young of the year.

Table 2—Description of roosts used by radiotagged, reproductive females of 4 species of bats at the Bosque del Apache National Wildlife Refuge.

Bat species[a]	Colony/solitary	# of bats	Roost type	D.b.h.(cm)[b]	Height(m)	Status
Myotis lucifugus (L)	Colony	507	*Populus fremontii*	80	14.4	dead
Myotis lucifugus (P)	Colony	90	*Populus fremontii*	50	21.6	dead
Myotis lucifugus (P)	Solitary	—	*Populus fremontii*	22	4.4	dead
Myotis lucifugus (L)	Solitary	—	*Populus fremontii*	63	26.0	dead
Myotis lucifugus (L)	Solitary	—	*Populus fremontii*	53	22.2	dead
Myotis lucifugus (L)	Solitary	—	*Populus fremontii*	32	20.2	dead
Myotis yumanensis (L)	Colony	>250	Concrete bridge	—	—	—
Myotis yumanensis (P)	Solitary	—	*Populus fremontii*	28	16.5	dead
Myotis yumanensis (L)	Solitary	—	*Populus fremontii*	—	—	dead
M. lucifugus & *M. yumanensis* (P, L)	Colony	>1800	Church roof/steeple	—	—	—
Antrozous pallidus (L)	Solitary	—	Rock crevice	—	—	—
Antrozous pallidus (L)	Solitary	—	Rock crevice	—	—	—
Lasiurus borealis/ blossevilli (L)	Solitary	—	*Populus fremontii*	76	18.0	live

[a]Reproductive status of the radiotagged bat is in parenthesis. P = pregnant, L = lactating
[b]D.b.h. = diameter at breast height

The lactating pallid bat was found in 2 separate rock crevices on the 2 days that is was relocated (table 2). These roosts were approximately 200 m apart on a lone rocky butte surrounded by grassland approximately 0.75 km east of the river. The use of crevices in vertical rock faces and cliffs is typical roosting behavior for pallid bats (Vaughan and O'Shea 1976).

Ten little brown and Yuma myotis roosts were found, four of which were colonies (table 2). Two little brown myotis colonies were found under the sloughing bark of cottonwoods killed in the 1996 fire. Occupancy at these two colonies declined from 507 and 90 bats in late June/early July to 50 and 0, respectively, in the first week of August. The 90-bat colony roost stood in the middle of an open grassy field. The 507-bat colony stood amongst a burned, dead stand of large and small cottonwoods along the river. The third colony, which consisted of over 250 Yuma myotis, roosted in deep, vertical crevices (1.5 cm wide) running the length of the underside of a small concrete bridge close to the river. The fourth colony roost was located 8 miles north of the refuge in the steeples and under the corrugated metal roofing of a local church. Over 1800 Yuma and little brown myotis shared this roost, but it is not known whether the two species segregated within the building. A dead Mexican free-tailed bat of unknown sex was also found in one of the steeples, suggesting that Mexican free-tails may also occasionally share this roost.

Six solitary roosts of Yuma and little brown myotis were located under the bark or in hollows of smaller cottonwood snags, also killed by the 1996 fire (table 2). The trees used as solitary roosts were generally of smaller d.b.h. ($\bar{x}$ = 39.6, SE = 7.84 cm, N = 5) than trees used as colony roosts ($\bar{x}$ = 65 cm, N = 2)

Most of the tree roosts (7 of 9 roosts) were in forests bordering the east and west side of the river. Within the Bosque del Apache NWR, forests directly along the river are relatively contiguous and unmanipulated. Forest types along the river include dense saltcedar stands, mixed cottonwood and saltcedar habitat, patches of mature cottonwood, and burned cottonwood stands with new saltcedar saplings. To the west of the river and its associated riverside forest, the refuge is a mix of wetland, grassland, agricultural, and forested habitats. Forests patches are of small to medium size, scattered, and disconnected relative to the forest along the river. Only one colony and one solitary roost were found in these patches, perhaps due to their discontinuity with other forest or perhaps as a result of the sampling error. If not the result of sampling error, the predominance of roosts in riverside forest may indicate the need for contiguous forest stands which provide food and cover for roosting, commuting, and foraging. The capture of several Yuma and little brown myotis in riverside forest 8 miles south of the church colony they used indicates that these bats travel substantial distances while feeding in this habitat. Roosts were not found in pure saltcedar stands or mixed cottonwood/saltcedar stands, perhaps due to the dense understory that would make flight difficult.

The manmade structures used as colony roosts by little brown and Yuma myotis in this study are consistent with the known roosting habits of these species. Nursery roosts of Yuma myotis are commonly found in buildings, under bridges, and in caves and mines (Barbour and Davis 1969). Nursery roosts of little brown myotis have been found in buildings, under roofs, in attics, tree hollows, and other crevices with suitable temperature regimes (Fenton and Barclay 1980).

Ephemeral roosts are associated with high roost lability in bats, and more permanent structures are associated with high roost fidelity (Lewis 1995). Roosts of little brown myotis found in forest along the Rio Grande were under the bark or in crevices of dead trees within burned cottonwood stands. Reasons for using these ephemeral roosts may include decreased commuting costs to foraging areas, lower ectoparasite levels and a higher abundance and availability of ephemeral sites (Lewis 1995). The use of ephemeral tree roosts (for example under bark of snags) rather than more permanent tree roosts (for example hollows in live cottonwoods) may be due to a lower availability or suitability of the latter type. Permanent structures such as the church and bridge

allow higher roost fidelity, the benefits of which include reduced costs in roost searching, greater site familiarity, and the ability to maintain social relationships (Lewis 1995). Year to year site fidelity of these roosts will be assessed by returning to colony roosts in subsequent years and assessing occupancy.

The results of this single season of radiotracking give preliminary data on the roosting habits of Yuma and little brown myotis, red bats, and pallid bats on the Bosque del Apache NWR and its surrounding area. Additional maternity colony and solitary roosts must be located to better understand which roosts are selected by reproductive females, what characteristics make roosts suitable, how site fidelity or lability is associated with roost type, and how roost resources may be partitioned among species. With future field seasons, roost selection and behavior of these species on the Bosque del Apache NWR will be better and more conclusively characterized.

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