

BATS ALONG THE REPUBLICAN RIVER AND ITS TRIBUTARIES IN SOUTHWESTERN NEBRASKA: DISTRIBUTION, ABUNDANCE, AND REPRODUCTION

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ABSTRACT.—Thirteen species of bats occur in Nebraska, but limited information is available on those inhabiting southwestern parts of the state. We investigated the distribution, abundance, and reproductive activity of bats in 5 counties in extreme southwestern Nebraska (Chase, Hays, Dundy, Hitchcock, and Red Willow). From April 2007 to April 2008, we deployed mist nets on 15 occasions at 8 localities over the Republican River and its tributaries. We captured 100 individuals representing 5 species, including the evening bat (*Nycticeius humeralis*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), big brown bat (*Eptesicus fuscus*), and silver-haired bat (*Lasionycteris noctivagans*). All species raised young in this region of Nebraska, except *L. noctivagans*, which was documented only during migration. Lactating females of *N. humeralis* captured on 15 June and volant young captured on 23 June extend known dates of reproductive activity for this species in the state, and an adult female captured on 30 April represents the earliest seasonal record of this species from Nebraska. Our records of evening bats also extend the known distribution of this species farther west in Nebraska than previously reported. Changes in land use throughout the Great Plains during the last century have altered many habitats, such as gallery forests associated with rivers, and distributions of mammals, including bats, have shifted to reflect those ecological changes.

Key words: bats, Nebraska, distribution, abundance, reproduction, *Nycticeius humeralis*, *Lasiurus borealis*, *Lasiurus cinereus*, *Eptesicus fuscus*, *Lasionycteris noctivagans*.

In recent decades, researchers have investigated the distribution and biology of bats across Nebraska. The first comprehensive statewide assessment of mammals was published by Jones (1964), wherein he reported on 12 species of bats. In the late 1970s, Czaplewski et al. (1979) updated the distribution and natural history of 13 species in Nebraska. From 2000 to 2008, additional accounts of bats have been published from eastern, western, northern, southern, and central parts of the state (Benedict et al. 2000, Benedict 2004, Geluso et al. 2004a, 2004b, 2008, Geluso 2006). Although information is known throughout much of the state, only limited information is reported from species inhabiting southwestern Nebraska. For example, only the big brown bat (*Eptesicus fuscus*) is known from a 5-county region in extreme southwestern Nebraska (Chase, Hays, Dundy, Hitchcock, and Red Willow; Czaplewski et al. 1979). In the present study, we investigated the distribution, abundance, and reproductive activity of bats in extreme southwestern Nebraska.

METHODS

From April 2007 to April 2008, we attempted to capture bats on 15 occasions in 5 counties in southwestern Nebraska along the Republican River and its tributaries (Fig. 1, Appendix). Forested corridors bordered these waterways and consisted mainly of cottonwoods (*Populus deltoides*), mulberries (*Morus* spp.), Russian olives (*Elaeagnus angustifolia*), and other deciduous trees. Agricultural fields and upland prairies often surrounded the narrow bands of trees along waterways.

We placed mist nets (Avinet, Inc., Dryden, NY) over calm areas of water in rivers and streams in each county. Mist nets were deployed before dusk and monitored continuously until bat activity had declined significantly. For each bat, we recorded time of capture, species, sex, age, reproductive condition, length of forearm, body weight, and time of release. Determination of volant young was based on presence of cartilage in digits of wings (Anthony 1988). In late August and September, we recorded bats as adults if

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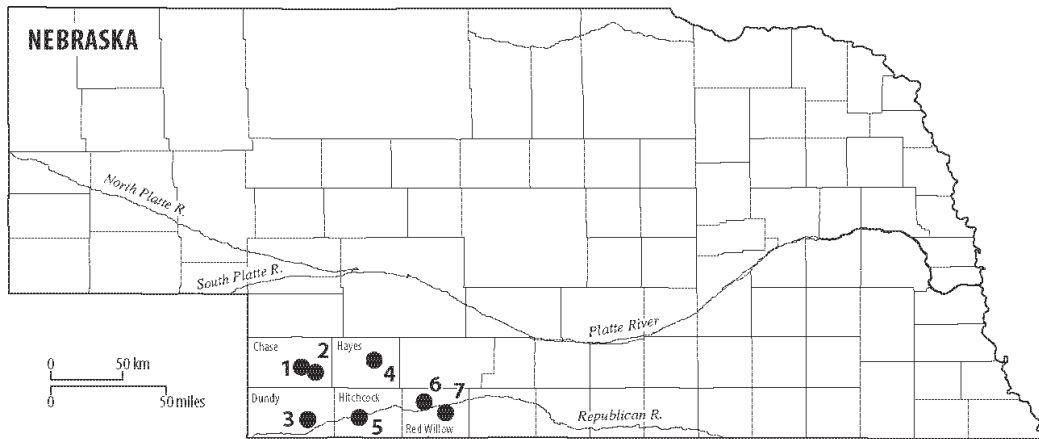


Fig. 1. Localities where we attempted to capture bats April 2007 to April 2008 in 5 counties in southwestern Nebraska. Locality number 5 represents 2 localities about 9 km apart (see Appendix).

TABLE 1. Sex and age of bats captured in southwestern Nebraska (Dundy, Hitchcock, Red Willow, Chase, and Hays counties), April 2007 to April 2008.

Species	Adult females	Adult males	Volant young females	Volant young males	Unknown	Total
<i>Nycticeius humeralis</i>	55	0	3	9	2	69
<i>Lasiurus borealis</i>	9	2	0	0	0	11
<i>Lasiurus cinereus</i>	4	0	0	0	0	4
<i>Lasionycteris noctivagans</i>	4	1	0	0	0	5
<i>Eptesicus fuscus</i>	7	3	0	0	1	11
Total	79	6	3	9	3	100

individuals had closed epiphyses, unless otherwise stated.

Bats were released at capture sites, except for some individuals of each species that were deposited as voucher specimens in the natural history collections at the University of Nebraska State Museum (UNSM), University of Nebraska at Lincoln. Coordinates of localities were determined with handheld global positioning units using North American Datum 1983. We also contacted UNSM and visited the vertebrate museum at the University of Nebraska at Kearney for recent, unpublished specimens of bats from Chase, Hays, Dundy, Hitchcock, and Red Willow counties.

RESULTS

From April 2007 to April 2008, we captured 100 bats representing 5 species along the Republican River and its tributaries in southwestern Nebraska (Table 1, Appendix). Four species were captured throughout the study,

including the evening bat (*Nycticeius humeralis*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and big brown bat, whereas the silver-haired bat (*Lasionycteris noctivagans*) only was captured in spring and late summer. Additional information concerning each species is provided in the following accounts.

Nycticeius humeralis

Evening Bat

Although previously undocumented from the region (Benedict 2004), evening bats were the most frequently captured species in southwestern Nebraska (Table 1). We captured 69 individuals, including 60 in Red Willow County and 9 in Hitchcock County. These captures represent a westward expansion in the geographic range of this species in the Great Plains (Fig. 2). Before our captures, *N. humeralis* was known throughout eastern Nebraska (Benedict et al. 2000, Benedict 2004) and reached

its westernmost limits in Harlan County (Geluso et al. 2008). Our study extends the distribution of evening bats 145 km from the previous westernmost locality in Harlan County. Evening bats likely occur farther west in Nebraska and also might occur in wooded habitats in northwest Kansas and extreme eastern Colorado. Phelps et al. (2008) recently reported a male evening bat only 2 km from Colorado in Stanton County in southwestern Kansas (Fig. 2).

We captured lactating females on 3 nights (15, 23, and 30 June) and volant young on 2 nights (23 June and 30 June). We suspect males captured on 6 and 7 September represent young with recently ossified epiphyses, and we considered those individuals as young in Table 1. Our dates of lactation slightly expand dates reported in eastern parts of the state (16 June–24 July; Kunz 1965, Geluso et al. 2004b). Captures of volant young in our study also extend the known range of time when young are volant in the state; previously, the earliest date was 30 June (Czaplewski et al. 1979, Benedict 2004). Our capture of an adult female on 30 April 2008 represents the earliest seasonal record of this species from Nebraska; the previous earliest date of capture was 9 May (Benedict 2004). We captured no adult males in the study area, and adult males are not known from Nebraska (Benedict 2004). In the Great Plains, the closest records of an adult male to Nebraska are from recent records in eastern and western Kansas (Davis and Boyles 2005, Phelps et al. 2008).

Lasiurus borealis

Eastern Red Bat

We captured 11 eastern red bats in 4 counties of southwestern Nebraska (Dundy, Hayes, Hitchcock, and Red Willow counties), but this species was not abundant at sites. In Nebraska, *L. borealis* is suspected to occur statewide but was not documented previously in extreme southwestern parts of the state (Czaplewski et al. 1979, Benedict 2004). Red bats were known from Frontier County to the north (Jones 1964) and Harlan County to the east (Czaplewski et al. 1979). In Kansas, Sparks and Choate (2000) suggest that this species occurs statewide; however, records are lacking from all 12 counties in northwestern Kansas. The closest records in Kansas are from Scott and Graham counties in western parts of the state (Sparks

and Choate 2000). With additional effort in northwestern Kansas and eastern Colorado, eastern red bats likely will be shown to inhabit many wooded habitats in the region.

We captured lactating females on 15 June, 24 June, and 30 June. Captures of lactating females in southwestern Nebraska demonstrate that this species is a summer resident and raises young in the area. Previously, Benedict (2004) reported reproductively active females throughout mainly northern, eastern, and south central Nebraska. Our records are within previous dates of lactation for this species in Nebraska (30 May–27 July; Benedict 2004). We captured 2 males (6 August and 6 September) during the study and reported them as adults because of ossified epiphyses (Table 1). Adult males are known throughout most of the state, but they are captured less frequently than adult females (Benedict 2004).

Lasiurus cinereus

Hoary Bat

We captured 4 hoary bats along the Republican River in Hitchcock and Red Willow counties. In Nebraska, the hoary bat likely occurs statewide, but documentation has not been confirmed for many counties, including most in the southwestern part of the state (Czaplewski et al. 1979, Benedict 2004). This species has been documented as close as Frontier and Furnas counties in Nebraska (Czaplewski et al. 1979) and Cheyenne County in northwestern Kansas (Sparks and Choate 2000).

Our captures of *L. cinereus* were all lactating females (17 June, 23 June, and 30 June) and are within the known dates of lactation for this species in Nebraska (6 June–30 July, Czaplewski et al. 1979). We captured no adult males, but they are known to occur sporadically in low abundance throughout most of Nebraska (Benedict 2004). Hoary bats are not known to bear and raise young in Kansas (Bee et al. 1981, Sparks and Choate 2000), but based on our close proximity to the Kansas border (17 km), we suspect females give birth to young in northern Kansas.

Lasionycteris noctivagans

Silver-haired Bat

Although silver-haired bats occur throughout Nebraska during migration, individuals have

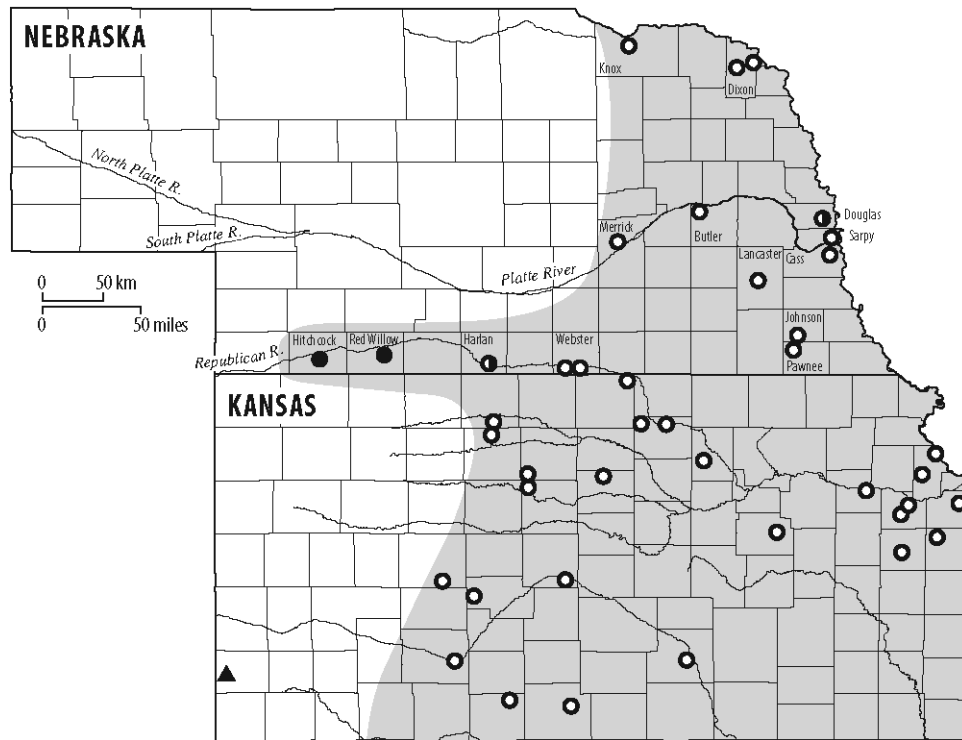


Fig. 2. Geographic distribution of evening bats (*Nycticeius humeralis*) in Nebraska and Kansas. Open circles represent previously published records (Sparks and Choate 2000, Benedict 2004); half-closed circles represent recent records in Geluso et al. (2008); the triangle represents a recent record in Kansas (Phelps et al. 2008); and closed circles represent new records presented in this study. The shaded region represents our proposed distribution of *N. humeralis* in Nebraska and Kansas. It is unclear whether the male captured by Phelps et al. (2008) on 5 September 2007 was a resident or a migratory, wandering, or lost individual; thus, we will not shade that part of Kansas until further evidence of a population is reported from the area.

not been documented in many counties (Benedict 2004, Geluso et al. 2004a). Our 5 captures in Chase and Hitchcock counties indicate that this species also occurs in extreme southwestern Nebraska. We captured *L. noctivagans* only in spring (29 April, 3 females) and late summer (7 September, 1 female and 1 male), indicating migratory movements through southwestern Nebraska. Not a single individual was captured during midsummer months, indicating that *L. noctivagans* is not a likely summer resident in southwestern Nebraska. Originally, silver-haired bats were thought to occur throughout the state only during migration (Jones 1964, Czaplewski et al. 1979), but lactating females recently have been documented in eastern and western parts of the state (Benedict 2004, Geluso et al. 2004a, 2004b). Dates of occurrence presented in this study are

within known dates of activity for *L. noctivagans* in the state (Geluso et al. 2004a, 2004b).

Eptesicus fuscus

Big Brown Bat

The big brown bat commonly is observed in buildings, is a year-round resident, and occurs throughout Nebraska (Czaplewski et al. 1979). Despite its abundance in former surveys across the state (Czaplewski et al. 1979, Geluso et al. 2004b, Benedict 2004), we only captured 11 individuals at 2 localities in southwestern Nebraska (Chase and Red Willow counties). Lack of additional captures may reflect sites being distant from cities and towns, where there are more buildings. Larger colonies of *E. fuscus* are known from at least 3 cities in these counties (McCook and Indianola in Red Willow

County, K. Geluso unpublished data; and Wauneta in Chase County, unpublished, 64 specimens UNSM). Our records confirm that *E. fuscus* also uses riparian areas in this part of the state. Prior published records were known for Red Willow County (Czaplewski et al. 1979).

We captured lactating females on 15, 18, and 23 June, and these dates are within the known reproductive period for this species in the state (31 May–5 September; Jones 1964, Geluso et al. 2004b). We also captured 3 adult males, which is not unusual because both sexes reside throughout the state and hibernate together in winter (Czaplewski et al. 1979). We observed color variation of individuals in the study area, likely reflecting the captures of 2 subspecies that can be distinguished, in part, by color. According to Hoffman and Genoways (2008), extreme southwestern Nebraska lies in the contact zone of the 2 subspecies known from the state, *E. f. pallidus* and *E. f. fuscus*.

DISCUSSION

During the last century, changes in land use throughout the Great Plains have altered many habitats, especially along rivers (Johnson 1994). By altering flow regimes with the construction of dams, the density of trees has increased in floodplains, in part because of lack of spring ice jams that once scoured woody vegetation along banks of rivers. In the Great Plains, woodland species of mammals generally associated with eastern deciduous forests, including evening bats and eastern pipistrelles (*Perimyotis subflavus*), have shifted distributions westward reflecting ecological changes to riverine habitats (e.g., Wilson and Choate 1996, Benedict et al. 2000, Sparks and Choate 2000, Geluso 2004, Roehrs and Genoways 2004, Geluso et al. 2008).

Gallery forests now associated with prairie rivers in southwestern Nebraska support a diversity of bats by providing habitat for reproductive activities and stopover areas during migration. As trees grow and senesce, more cavities and other roosting opportunities will become available for other tree-roosting species during warmer months, possibly including the eastern pipistrelle (known from hibernacula in northeastern Colorado and eastern Wyoming; Bogan and Cryan 2000, Fitzgerald

et al. 1989) and northern long-eared myotis (*Myotis septentrionalis*; documented as close as Webster County, Nebraska; Czaplewski et al. 1979). We also suspect that the western small-footed myotis (*Myotis ciliolabrum*; documented from extreme northwestern Kansas in Cheyenne County; Sparks and Choate 2000) likely occurs in the region in areas containing canyons and outcrops.

Management practices of the past have affected the diversity and abundance of fauna currently observed on prairie rivers throughout the Great Plains. Current and future management plans also need to consider those species that have colonized these altered habitats, before plans are carried out, such as the wide-scale removal of trees along prairie rivers.

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APPENDIX. Localities of netting sites in southwestern Nebraska along the Republican River and its tributaries. Dates of capture are followed by parentheses that contain the number and size of mist nets deployed, number of hours (h) nets were up, and number of males and females captured for each species. Abbreviations for species are as follows: NYHU = *Nycticeius humeralis*, LABO = *Lasiurus borealis*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, and EPFU = *Eptesicus fuscus*. Catalog numbers of voucher specimens at the University of Nebraska State Museum (UNSM) are given in brackets. The number in parentheses before each locality refers to numbers in Fig. 1.

CHASE COUNTY: (1) Enders Reservoir State Wildlife Management Area [SWMA], Church Grove Campground, 40°25.701'N, 101°35.053'W, 29 April 2007 (four 9-m nets, 13 h; LANO 3 ♀ ♀ [UNSM 29046], EPFU 1 ♀ [UNSM 29045]); (2) Enders Reservoir SWMA, below dam, Frenchman Creek, 40°25.251'N, 101°30.772'W, 18 June 2007 (two 9-m and two 12-m nets, 8 h; EPFU 3 ♀ ♀ [UNSM 29044] 2 ♂ ♂), 7 July 2007 (one 12-m and two 18-m nets, 4 h; no bats).

DUNDY COUNTY: (3) 1.6 mi S, 1.75 mi W Max, 40°05.317'N, 101°26.027'W, 6 August 2007 (one 6-m, one 9-m, and one 18-m net, 4.25 h; LABO 1 ♂ [UNSM 29053]).

HAYES COUNTY: (4) Hayes Center SWMA, Camp Hayes, 40°25.251'N, 101°30.785'W, 8 July 2007 (two 9-m and one 18-m nets, 1 h; LABO 1 ♀ [UNSM 29052]), 5 August 2007 (two 9-m and one 18-m nets, 3 h; LABO 1 ♀).

HITCHCOCK COUNTY: (5a) Swanson Reservoir SWMA, Republican River, upstream of spillway, 40°08.451'N, 101°11.121'W, 18 June 2007 (four 18-m nets, 5.5 h; LACI 1 ♀ [UNSM 29037]); (5b) Swanson Reservoir, downstream of spillway, 40°09.934'N, 101°02.679'W, 30 June 2007 (one 9-m and two 12-m nets, 4 h; NYHU 5 ♀ ♀ [UNSM 29047] 1 ♂, LABO 1 ♀ [UNSM 29048], LACI 1 ♀ [UNSM 29049]), 7 September 2007 (one 9-m net and two 12-m nets, 4 h; NYHU 3 ♀ ♀, LANO 1 ♀ [UNSM 29050] 1 ♂ [UNSM 29051]).

RED WILLOW COUNTY: (6) 3 mi E, 4 mi N McCook, Red Willow Diversion Dam, 40°16.797'N, 100°32.465'W, 24 June 2007 (one 2.6-m, one 9-m, and three 12-m nets, 2 h; LABO 3 ♀ ♀); (7) 0.5 mi S, 2 mi E Indianola, Bartley Diversion Dam SWMA, 40°13.528'N, 100°23.280'W, 15 June 2007 (two 18-m nets, 4 h; NYHU 16 ♀ ♀ [UNSM 29034] 1 sex unknown, LABO 1 ♀ [UNSM 29035], EPFU 1 ♀ [UNSM 29036] 1 sex unknown), 23 June 2007 (two 18-m nets, 5.5 h; NYHU 13 ♀ ♀ 2 ♂ ♂ 1 sex unknown, LABO 1 ♀, LACI 2 ♀ ♀ [UNSM 29038], EPFU 1 ♀), 6 September 2007 (two 18-m nets, 4 h; NYHU 17 ♀ ♀ 6 ♂ ♂, LABO 1 ♂, EPFU 1 ♀ 1 ♂), 16 September 2007 (two 18-m, 1.5 h; NYHU 3 ♀ ♀, LABO 1 ♀), 30 April 2008 (two 18-m nets, 1 h; NYHU 1 ♀).