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Authors: Geluso, Keith, Huebschman, Jeffrey J., and Geluso, Kenneth N.

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# BATS OF THE WILDCAT HILLS AND SURROUNDING AREAS IN WESTERN NEBRASKA

Keith Geluso[1], Jeffrey J. Huebschman[2], and Kenneth N. Geluso[3]

ABSTRACT.—During the last few decades, detailed studies of bats have been conducted in many parts of Nebraska, but comprehensive surveys were lacking in the Wildcat Hills and other western regions of the state. The Wildcat Hills represent a unique and isolated area of rugged buttes, ridges, and canyons dominated by ponderosa pine forests (*Pinus ponderosa*) in central parts of Nebraska's panhandle. This area also contains landscapes with some of the highest wind speeds in the state, making it conducive for future wind-energy development. To better understand the natural history of bats and to promote conservation efforts in the region, we report on the distribution of bats and their habitats, as well as on their relative abundance, seasonal activity, and reproduction in the Wildcat Hills and surrounding areas. From August 1997 to July 2011, we captured 968 bats representing 7 species, and we also examined museum specimens previously collected by other researchers from the region. For 5 species, we extend the known period of nonhibernating activity in the state, and we provide evidence of reproducing populations for 7 species in the region based on presence of lactating females. New reproductive information for bats in Nebraska also includes timing of pregnancy and lactation, as well as presence of volant young. For migratory species during autumn migration, hoary bats (*Lasiurus cinereus*) and eastern red bats (*Lasiurus borealis*) began moving through the region earlier (late July/early August) than silver-haired bats (*Lasionycteris noctivagans*). Documentation of the little brown bat (*Myotis lucifugus*) in riparian areas and buildings along the North Platte River represents a range extension for this species from the Pine Ridge in northwestern Nebraska. Knowledge gained from our long-term study will assist resource managers and biologists in efforts to protect and manage bats as these bats face unprecedented challenges in the future with development of additional wind-energy facilities and likely westward spread of white-nose syndrome in North America.

RESUMEN.—Durante las últimas décadas, se han llevado a cabo estudios detallados sobre murciélagos en varias partes de Nebraska, pero faltaban estudios integrales en las colinas Wildcat Hills y en otras regiones del oeste del estado. Las colinas Wildcat Hills representan un área única y aislada de colinas escarpadas, cerros y cañones dominados por bosques de pinos ponderosa (*Pinus ponderosa*) en la parte central de la franja oeste de Nebraska. Esta área también posee paisajes con algunas de las velocidades de viento más altas del estado, lo que contribuye al futuro desarrollo de la energía eólica. Para comprender mejor la historia natural de los murciélagos y para promover los esfuerzos de conservación en la región, informamos sobre la distribución de los murciélagos y sus hábitats, la abundancia relativa, la actividad estacional y la reproducción en las colinas Wildcat Hills y en las áreas circundantes. Desde agosto de 1997 a julio de 2011, capturamos 968 murciélagos que representan 7 especies y también examinamos especímenes de museo previamente recogidos por otros investigadores de la región. Para 5 especies, extendemos el período conocido de actividad (no hibernación) en el estado y proporcionamos evidencia de poblaciones de 7 especies en reproducción en la región con base en la presencia de hembras lactantes. Nueva información sobre la reproducción de murciélagos en Nebraska también incluye el tiempo de preñez y lactancia, así como también la presencia de crías voladoras. Con respecto a especies migratorias, los murciélagos blancos (*Lasiurus cinereus*) y los murciélagos colorados del este (*Lasiurus borealis*) comenzaron a trasladarse por la región antes (a fines de julio y comienzos de agosto) que los murciélagos plateados (*Lasionycteris noctivagans*) durante la migración de otoño. La documentación del murciélago marrón pequeño (*Myotis lucifugus*) en áreas ribereñas y edificaciones a lo largo del Río North Platte representa una extensión del rango de distribución de esta especie desde Pine Ridge en el noroeste de Nebraska. El conocimiento adquirido a partir de nuestro estudio de largo plazo asistirá a los manejadores de recursos y biólogos en sus esfuerzos por proteger y controlar a los murciélagos mientras enfrentan desafíos sin precedentes en el futuro, con el desarrollo de nuevas instalaciones de energía eólica y la posible propagación del síndrome de nariz blanca en Norteamérica.

During the past few decades, comprehensive surveys of bats have been conducted in many regions across Nebraska (e.g., Benedict 2004, Geluso et al. 2004a, Geluso 2006, Serbousek and Geluso 2009). These surveys greatly added to our knowledge about the biology of bats in the state (e.g., Jones 1964, Czaplewski et al. 1979); however, much of the state's panhandle, including the Wildcat Hills, Pine Ridge, and southern counties, represents some of the

[1]Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849. E-mail: gelusok1@unk.edu
[2]Department of Biology, University of Wisconsin–Platteville, Platteville, WI 53818.
[3]Department of Biology, University of Nebraska at Omaha, Omaha, NE 68182.

last areas in Nebraska without in-depth, published surveys of bats. Of the 13 species of bats in Nebraska, 11 have been reported from the panhandle (Czaplewski et al. 1979, Genoways et al. 2000, Benedict 2004), with 4 species primarily occurring in that region—the fringed myotis (*Myotis thysanodes*), long-legged myotis (*Myotis volans*), western small-footed myotis (*Myotis ciliolabrum*), and Townsend's big-eared bat (*Corynorhinus townsendii*). In general, little is known about the natural history of those western species compared to what is known about species inhabiting eastern parts of Nebraska (e.g., Geluso et al. 2004a).

The Wildcat Hills represent an isolated area of rugged buttes, ridges, and canyons in the panhandle of western Nebraska. Tops of buttes and their steep slopes often are forested with ponderosa pines (*Pinus ponderosa*) and junipers (*Juniperus* spp.), and the region is surrounded by short-grass prairies. In those ways, the landscape of the Wildcat Hills is similar to the more expansive Pine Ridge of northwestern Nebraska and to the less expansive Pine Bluffs area in Kimball County of southwestern Nebraska. The Wildcat Hills contain unique biological environments (Schneider et al. 2005) for which limited biological inventories have been conducted for mammals (e.g., Cox and Franklin 1989).

Throughout Nebraska, bats likely will face new threats in coming years, such as the increased development of wind-energy facilities and the likely westward spread of white-nose syndrome into central and western parts of North America. In the United States, Nebraska ranks as the fourth windiest state (AWEA 2010), with the Wildcat Hills and Pine Bluffs area producing the highest wind speeds in the panhandle (NREL 2010). Such areas have the greatest potential for wind-energy development, but installment of wind turbines also will negatively impact bats. For example, bats have been killed at wind-energy facilities throughout the world (Arnett et al. 2008), and in the eastern United States, many individuals of migratory species, such as eastern red bats (*Lasiurus borealis*), hoary bats (*Lasiurus cinereus*), and silver-haired bats (*Lasionycteris noctivagans*), have been discovered dead beneath wind turbines (Johnson et al. 2003, Kunz et al. 2007, Arnett et al. 2008). The paucity of information regarding migratory movements of bats limits abilities to predict how additional wind-energy development will affect bats in the future. In addition, turbines also kill nonmigratory species such as big brown bats (*Eptesicus fuscus*) and little brown bats (*Myotis lucifugus;* Johnson et al. 2003, Kunz et al. 2007, Arnett et al. 2008); therefore, these turbines might cause local population declines of resident species due to slow reproductive capabilities of bats (i.e., most species produce only one young per year; Tuttle and Stevenson 1982). In short, all species of bats in Nebraska could be negatively affected by wind-energy development if turbines occur in areas where bats are present.

Some hibernating species of bats recently have experienced widespread population declines in eastern parts of North America due to a fungal disease known as white-nose syndrome (Blehert et al. 2009, Frick et al. 2010, Foley et al. 2011). In North America, the disease was first discovered in a cave in New York (Blehert et al. 2009) and since has spread westward in the United States. Thus far, the fungus has been documented in 13 states, including as far west as Oklahoma and Missouri (Foley et al. 2011). Species such as the little brown bat and northern long-eared myotis (*Myotis septentrionalis*), both of which occur in Nebraska, have been greatly impacted in the eastern United States (Frick et al. 2010, Foley et al. 2011). The potential exists that the disease will continue to spread westward, and, as a precaution, many caves and mines on federal lands have been closed in the western United States.

To better understand the natural history of bats in western Nebraska, we examined distribution, habitats, relative abundance, seasonal activity, and reproduction of bats in the Wildcat Hills and surrounding areas. Before commencement of our study in 1997, few individuals were reported from the region—1 fringed myotis, 23 western small-footed myotis, 1 silver-haired bat, 28 big brown bats, and 14 hoary bats (Czaplewski et al. 1979). Our in-depth study will serve as a benchmark for future studies on bats, especially if populations decline in parts of or throughout the western United States. Moreover, our study increases understanding of the natural history of bats to better protect them and their habitats in the future.

## STUDY AREA

Our study area included Banner and Scotts Bluff counties, which border Wyoming, and

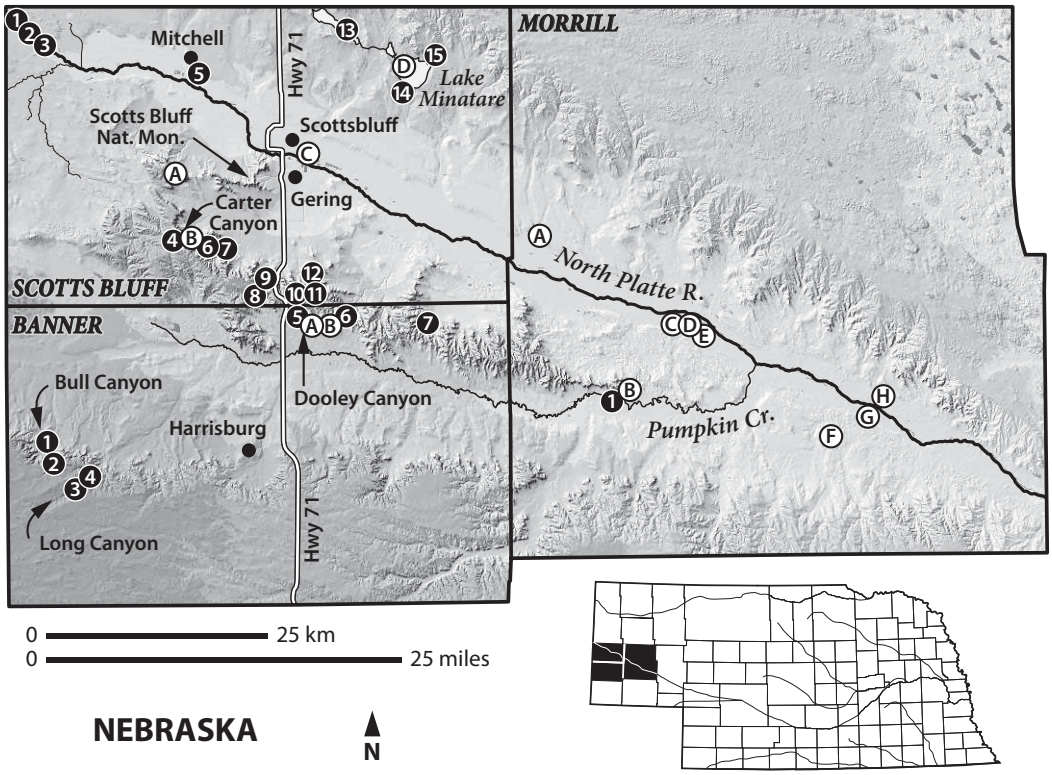


Fig. 1. Localities of captures for bats in the Wildcat Hills and surrounding area during our efforts from 1997 to 2011 in Banner, Morrill, and Scotts Bluff counties in the panhandle of western Nebraska (circled numbers). Also included are localities from museum specimens obtained by previous researchers (circled letters). See Appendix for specific details on localities.

Morrill County, which lies east of Banner and Scotts Bluff counties (Fig. 1). The 3 main topographic features of those counties include the Wildcat Hills, "Southern Wildcat Hills" (Schneider et al. 2005), and North Platte River Valley.

## Wildcat Hills

The rugged Wildcat Hills extend southeastward from near the Wyoming border for approximately 70 km, south of the towns of Mitchell, Scottsbluff, Bayard, and Bridgeport. The Wildcat Hills are bordered by the North Platte River on the north and by Pumpkin Creek on the south (Fig. 1). Highest elevations in the area reach 1421 m (Weaver 1965), and some buttes rise 300 m above the surrounding landscape. Buttes are made of clays, silts, and silty clays with thin layers of whitish volcanic ash, all dating from the Oligocene epoch and collectively known as the Brule Formation of the White River Group (Johnsgard 1995). Many of the ridges and buttes are covered with ponderosa pines; however, logging in the late 1800s and early 1900s greatly diminished pine forests, so what exists today is different from historical forests of the Wildcat Hills (Weaver 1965). Pines are mostly limited to the tops of buttes and to steep slopes surrounding them (Johnsgard 1995). Rocky mountain juniper (*Juniperus scopulorum*) also occurs on the slopes (Weaver 1965, Johnsgard 1995). In deep canyons, especially those that contain permanent or semipermanent water supplies, deciduous trees grow along canyon floors, including the eastern cottonwood (*Populus deltoides*), boxelder (*Acer negundo*), and green ash (*Fraxinus pennsylvanica*). Short- and mixed-grass prairies surround the buttes of the Wildcat Hills and are characterized by little bluestem (*Schizachyrium scoparium*), sand bluestem (*Andropogon hallii*), prairie sandreed (*Calamovilfa longifolia*), side-oats grama (*Bouteloua curtipendula*), hairy grama (*Bouteloua hirsuta*), and blue grama (*Bouteloua gracilis;* Johnsgard 1995).

Our most frequently visited site in the Wildcat Hills was in Dooley Canyon, located in the Wildcat Hills State Recreation Area, Banner County. Here the canyon had a series of permanent pools connected by an intermittent stream. The canyon bottom was grassy with a few boxelders and a cottonwood, whereas the slopes and ridges were dominated by ponderosa pines. Throughout the years, small ponds changed in size and were covered by different amounts of floating vegetation. Our most productive site early in the study eventually filled with cattails (*Typha* spp.).

### Southern Wildcat Hills

An east–west escarpment of buttes and canyons in central Banner County is referred to as the "Southern Wildcat Hills." In these hills, buttes and canyons were similar to those in the Wildcat Hills, and we focused our efforts in Long Canyon, Bull Canyon, and at the mouth of Bull Canyon (Fig. 1). In Bull Canyon, upper slopes of buttes tended to contain more rock-like features than those in the Wildcat Hills. Overall, vegetation in Long and Bull canyons was similar to those canyons in the Wildcat Hills. Bull Canyon had a series of permanent pools connected by an intermittent stream, and near the canyon's mouth was a large earthen pond. In Long Canyon, we netted over metal stock tanks and temporary earthen ponds.

### North Platte River Valley and Nearby Lakes

Habitats along the North Platte River generally were dominated by cottonwoods (*P. deltoides*). On Stateline Island of the North Platte National Wildlife Refuge, we attempted to capture bats over the river itself during a dry year. We also placed mist nets over a stream and nearby earthen ponds in the riparian forest. On the refuge by Lake Alice, we captured bats over the irrigation canal below the spillway of the lake. Scattered Russian olives (*Elaeagnus angustifolia*) were situated along the canal. By Lake Minatare, we also inspected nearby buildings for roosting bats; this area also was dominated by cottonwoods.

## METHODS

From 27 August 1997 to 30 July 2011, we deployed mist nets (2.6–18 m in length, Avinet Inc., Dryden, NY, USA) over water sources including metal stock tanks, temporary pools, permanent pools, river channels, canals, perennial streams, and earthen ponds. We also set nets across the floor of a narrow canyon, under canopies of trees, near human-made structures, and in front of openings of a cliff. On a number of occasions, we captured bats by hand in various buildings occupied and unoccupied by people.

We recorded species for each bat captured, and, for most individuals, we also recorded time of capture, sex, age (adult or volant young), reproductive condition (pregnant, lactating, or post-lactating), and forearm length. For most bats captured in 2010, we also recorded body weight within an hour after capture. Age was determined by examining the degree of closure between epiphyses and diaphyses of finger bones (Anthony 1988). We refer to a bat as a volant young if cartilaginous epiphyseal plates in finger joints were visible when the wing was backlit, unless otherwise explicitly stated. In late summer and autumn, it was difficult to determine whether some individuals represented young with ossified epiphyseal plates or adults; thus, some individuals classified as "adults" during that period likely were volant young of the year. For museum specimens collected by other researchers, we also noted several individuals as volant young because tapered joints in their wings were obvious compared to knobby joints observed in adults. Specimens with tapered joints likely had visible cartilage when the animals were alive. We were able to confirm pregnancy in several females close to term by gently palpating the abdomen and feeling the head of the fetus. For females kept as specimens, we examined the abdominal cavity for embryos and fetuses.

We report new county records for species not previously recorded from a county. We also report new county records in terms of the first evidence of reproduction of a species in the county based on the presence of lactating females. Because captures of pregnant and post-lactating females and some volant young might represent nonresident individuals moving toward hibernacula or migrating through the area, such captures were not considered conclusive evidence for reproduction in the county.

Most bats were released at the site of capture, but some individuals were kept as voucher specimens. Our specimens, along with associated

TABLE 1. Species and number of bats captured in mist nets and by hand in the Wildcat Hills and surrounding areas in Banner, Morrill, and Scotts Bluff counties of western Nebraska, 1997–2011. We attempted to capture bats in 10 of the 15 years (1997–2002, 2006, 2007, 2010, and 2011). Mist-netting efforts were different among years.

| Species | Number of individuals | Number of years captured | Years represented |
|---|---|---|---|
| *Eptesicus fuscus* | 619 | 10 | 1997–2002, 2006, 2007, 2010, 2011 |
| *Myotis ciliolabrum* | 124 | 10 | 1997–2002, 2006, 2007, 2010, 2011 |
| *Lasionycteris noctivagans* | 77 | 8 | 1997, 1998, 2000–2002, 2006, 2007, 2010 |
| *Lasiurus cinereus* | 62 | 8 | 1997–2002, 2006, 2010 |
| *Myotis thysanodes* | 46 | 9 | 1997–2002, 2006, 2010, 2011 |
| *Myotis lucifugus* | 23 | 2 | 2000, 2002 |
| *Lasiurus borealis* | 17 | 5 | 1997, 1999, 2000, 2002, 2010 |
| TOTAL | 968 | | |

field notes, were archived in the natural history collection in the Division of Zoology, University of Nebraska State Museum (UNSM), Lincoln, Nebraska, USA, and in the Museum of Southwestern Biology (MSB), University of New Mexico, Albuquerque, New Mexico, USA.

We also visited 3 museums and examined published and unpublished voucher specimens from our study area that were collected by other researchers—the UNSM; the Natural History Museum, University of Kansas (KU), Lawrence, Kansas; and the University of Nebraska at Kearney (UNK), Kearney, Nebraska (formerly referred to as the Vertebrate Museum, Kearney State College).

In accounts of species below, we list localities of occurrence for individuals captured during our study. Numbers in bold refer to circled numbers in Fig. 1 for each county. Localities are listed west to east. Under the subheading *Additional records,* we list localities for specimens collected by other researchers; those locations are shown in Fig. 1 with circled letters. We report date of capture, number of adults (with information on reproductive condition), number of volant young, and museum number and acronym (if voucher[s] were retained) for all individuals collected by us and others. Coordinates of localities were determined with handheld global positioning systems (GPS; Garmin GPS 12, Garmin International, Inc., Olathe, KS, USA) using North American Datum 1983. For some sites sampled early in our survey, coordinates were determined by Google Earth (v6.0; http://earth.google.com), and we note the origin of coordinates in the appendix.

## RESULTS

From 1997 to 2011, we captured 968 bats representing 7 species in the Wildcat Hills and surrounding areas (Table 1). During our field efforts, we accrued 173 mist nets on 64 evenings (Table 2). Most bats were captured in mist nets, but 18 bats were captured by hand in human-made structures including *M. ciliolabrum* and *M. lucifugus* (Table 2). We also report on 85 museum specimens collected by other researchers in our study area. Collection sites for 75 of those specimens have been previously published (Jones 1964, Czaplewski et al. 1979, Benedict et al. 2000, Benedict 2004); however, we report new information for most individuals, namely, on date of capture, sex, age, and reproductive condition.

Early and late dates of capture for volant, nonhibernating individuals in the region demonstrated that 5 species were active in Nebraska for longer periods than previously reported (Table 3). Data presented on the number of offspring in *E. fuscus* demonstrate why western Nebraska is considered a "zone of transition" for this species in temperate North America (Table 4). Lactating females were recorded for all 7 species (Table 5), including documentation for 3 species that extend the period of lactation in the state (*M. ciliolabrum, M. thysanodes,* and *M. lucifugus*). Volant young were captured for 5 species (Table 6), including records for 3 species that extend the period in which volant young are easily recognizable in Nebraska (*M. ciliolabrum, L. noctivagans,* and *L. cinereus*). In Table 7, we summarize body weights and forearm lengths of adults for all species of bats in our study area. Many individuals represent county records of occurrence and county records associated with reproduction, and, for *M. lucifugus,* we present a range extension for the species in Nebraska.

Detailed information for each species known from the Wildcat Hills and surrounding areas

TABLE 2. Total number of bats captured each year in the Wildcat Hills and surrounding area in western Nebraska, 1997–2011. Total effort for each year is given by number of nights when nets were deployed, number of nets deployed, and cumulative length of nets deployed. Each night counted as one night even if nets were set at several sites and monitored past midnight.

| Year | Number of individuals | Months sampled | Number of nights | Number of nets | Length of nets (m) |
|---|---|---|---|---|---|
| 1997 | 67 | August | 3 | 12 | 105 |
| 1998 | 123 | May–September | 13 | 23 | 201 |
| 1999 | 142 | May, June, August | 7 | 22 | 186 |
| 2000 | 166[a] | July–September | 7 | 16 | 141 |
| 2001 | 176[b] | May, July, September, November | 10 | 30 | 255 |
| 2002 | 102[c] | May–July, September | 9 | 24 | 249 |
| 2006 | 11 | September | 2 | 7 | 51 |
| 2007 | 16 | April | 1 | 3 | 24 |
| 2010 | 149 | July–October | 11 | 34 | 366 |
| 2011 | 16 | July | 1 | 2 | 18 |
| TOTALS | 968 | | 64 | 173 | 1596 |

[a]Includes 4 *Myotis lucifugus* captured by hand in a building on 28 July, 3 *Myotis ciliolabrum* captured by hand in a shed on 9 August, and 1 *M. ciliolabrum* captured by hand in a picnic shelter on 2 September.
[b]Includes 7 *M. ciliolabrum* captured by hand in a shed—2 on 30 May and 5 on 29 July.
[c]Includes 3 bats captured by hand in buildings (2 *M. ciliolabrum* and 1 *M. lucifugus* on 29 June).

is presented in the following accounts of species. Accounts include details based on our study, data from published literature, and unpublished information from museum specimens collected by other researchers. The order of accounts is based on the total number of bats captured (Table 1), starting with the most commonly captured species. Each account begins with general information about the species based mostly on literature from Nebraska. Introductory remarks are then followed by sections on distribution and habitat, seasonal activity, reproduction, and records of occurrence.

### *Eptesicus fuscus*
### (Palisot de Beauvois, 1796)

### Big Brown Bat

The big brown bat occurs throughout Nebraska (Jones 1964, Czaplewski et al. 1979, Benedict 2004), although relatively few records are known from the Sandhill Region, except for areas where humans have planted trees (Manning and Geluso 1989, Geluso 2006). In past surveys of bats in Nebraska, *E. fuscus* has been the most commonly captured species in some regions of the state (e.g., Benedict 2004, Geluso et al. 2004a). This species is a year-round resident in Nebraska, hibernating in buildings and rock quarries in winter (Jones 1964). Two subspecies occur in the state with a broad zone of intergradation extending from southwestern to northeastern Nebraska (Hoffman and Genoways 2008).

DISTRIBUTION AND HABITAT.—The big brown bat was captured in each year sampled and was the most commonly captured species in the study area, accounting for 64% of all captures (619 of 968 individuals, Table 1). We captured most individuals in canyons surrounded by coniferous forests, in part due to the frequency of effort in that habitat. Big brown bats also were captured in cottonwood forests along the North Platte River. We observed individuals roosting at night in picnic shelters in the Wildcat Hills State Recreation Area, and individuals were observed roosting during daylight hours in a barn in Carter Canyon. On 29 June 1999, we observed 13 bats emerging from a tube-like formation that formed an inverted chimney on the side of a bluff, and we suspect on the basis of body size, that individuals were *E. fuscus*.

SEASONAL ACTIVITY.—In our study, we captured nonhibernating individuals from 20 April to 29 September (Table 3). In Nebraska, volant individuals have been reported from 21 March to 1 November in eastern Nebraska (Geluso et al. 2004a); thus, our seasonal dates are within the known period of activity for *E. fuscus* in the state. In preparation for hibernation, many individuals from the Wildcat Hills contained noticeable deposits of subcutaneous fat from late July to September; some individuals weighed as much as 28 g during that period.

REPRODUCTION.—We captured 20 pregnant females, 84 lactating females, 27 post-lactating females, and 102 volant young (Tables 4, 5,

TABLE 3. Earliest and latest dates of capture for 7 species of bats in the Wildcat Hills and surrounding areas in western Nebraska. The range of previously published dates for volant, nonhibernating bats in the state also is presented. Dates in bold type represent new seasonal records for the species in Nebraska presented in this study.

| | Wildcat Hills | | Statewide dates | |
|---|---|---|---|---|
| Species | Early | Late | Early | Late |
| *Eptesicus fuscus* | 20 April | 29 September | 21 March[a] | 1 November[a] |
| *Myotis ciliolabrum* | **20 April** | **4 November** | 2 May[b] | 5 September[b] |
| *Lasionycteris noctivagans* | **20 April** | **4 November** | 21 April[a] | 2 October[b,c] |
| *Lasiurus cinereus* | **20 May** | 15 September | May[d] | 4 October[a] |
| *Myotis thysanodes* | **8 May** | **29 September** | June[d] | 13 August[e] |
| *Myotis lucifugus* | **28 May** | 28 July | 24 June[d] | 5 September[e] |
| *Lasiurus borealis* | 4 June[f] | 29 September | 26 April[b] | 1 November[a] |

[a]Geluso et al. 2004a.
[b]Jones 1964.
[c]Benedict (2004, in litt.) reported a nonvolant, nonhibernating individual in a building on 26 November.
[d]Czaplewski et al. 1979.
[e]Benedict 2004.
[f]UNSM 27902; Benedict et al. 2000.

TABLE 4. Number of embryos or fetuses in pregnant females captured in the Wildcat Hills and surrounding areas in western Nebraska, 1997–2011. Measurements of the crown-to-rump length of the largest fetus or of the greatest diameter of the largest uterine swelling are given in millimeters.

| Species | Date of capture | Number of embryos or fetuses | Largest fetus or uterine swelling (mm) |
|---|---|---|---|
| *Eptesicus fuscus* | 25 May 1999 | 1 | 6.0 (swelling) |
| | 25 May 1999 | 1 | 6.0 (swelling) |
| | 25 May 1999 | 2 | not recorded |
| | 26 May 1999 | 1 | 5.0 (swelling) |
| | 30 May 2001 | 2 | 15.0 (fetus) |
| | 17 June 1998 | 1 | 11.0 (fetus) |
| | 17 June 1998 | 1 | 14.0 (fetus) |
| | 28 June 1999 | 2 | 20.0 (fetus) |
| | 28 June 1999 | 1 | 26.0 (fetus) |
| | 28 June 1999 | 1 | 36.0 (fetus) |
| | 28 June 1999 | 1 | 30.0 (fetus) |
| | 1 July 2010 | 1 | 23.0 (fetus) |
| *Myotis ciliolabrum* | 30 May 2001 | 1 | 7.0 (swelling) |
| | 28 June 1999 | 1 | 14.5 (fetus) |
| | 2 July 2010 | 1 | 18.0 (fetus) |
| *Lasionycteris noctivagans* | 22 May 2002 | 2 | 14.0 (fetus) |
| *Lasiurus cinereus* | 20 May 2002 | 2 | 17.0 (fetus) |
| | 25 May 1998 | 2 | 27.0 (fetus) |
| *Myotis lucifugus* | 28 May 2002 | 1 | 21.0 (fetus) |
| | 28 May 2002 | 1 | 23.0 (fetus) |

TABLE 5. Dates of capture for lactating females in the Wildcat Hills and surrounding areas in western Nebraska. Total number of lactating females captured by us (1997–2011) is given in parentheses. Also included is information from published reports and from museum specimens collected by other researchers.

| Species | May | June | July | August |
|---|---|---|---|---|
| *Eptesicus fuscus* (84) | | | 4, 6, 7, 20[a], 27, 28, 29, 30, 31 | 1, 4, 9, 10 |
| *Myotis ciliolabrum* (17) | | | 7, 28, 29, 31 | 8[b], 9, 10, 11, 13 |
| *Lasionycteris noctivagans* (8) | | | 1, 2, 4, 5 | |
| *Lasiurus cinereus* (4) | | 28 | 3, 7, 28 | |
| *Myotis thysanodes* (13) | | | 8, 30, 31 | 1, 5, 10, 13 |
| *Myotis lucifugus* (6) | 28 | | 4 | |
| *Lasiurus borealis* (0) | | 4[c] | | |

[a]Collected in 1959, KU 80916.
[b]Czaplewski et al. 1979.
[c]Collected in 1985, UNSM 27902; Benedict et al. 2000.

TABLE 6. Dates of capture for volant young with cartilaginous zones in finger joints in the Wildcat Hills and surrounding areas in western Nebraska. Total number of volant young captured by us (1997–2011) is given in parentheses. Also included are museum specimens categorized as young individuals because of tapered wing joints (see Methods).

| Species | July | August |
|---|---|---|
| *Eptesicus fuscus* (102) | 20[a], 26[b], 27, 28, 29, 30, 31 | 4, 5, 8[b], 9, 10, 11, 12, 14, 15 |
| *Myotis ciliolabrum* (11) | 28, 29 | 8[b], 9, 10, 12, 14, 27 |
| *Lasionycteris noctivagans* (2) | 1, 5 | |
| *Lasiurus cinereus* (7) | 5, 19[b], 28 | 1, 4, 14 |
| *Myotis lucifugus* (3) | 28[c] | |

[a]Collected in 1959, KU 80917 and 80926; Jones 1964.
[b]Age based on dried museum specimen.
[c]Individuals were captured by hand in a building and appeared to be able to fly.

and 6). Pregnant females were captured from 8 May to 2 July—dates that are within the range previously reported for pregnant females in Nebraska (4 May–14 July; Geluso et al. 2004a and Czaplewski et al. 1979, respectively). Individuals kept as specimens in our study contained 1 or 2 young, with 9 of 12 (75%) females containing a single young (Table 4). For *E. fuscus*, the number of offspring produced is geographically variable across North America, with Nebraska lying in a transition zone where individuals in more eastern parts of the distribution commonly produce twins and those in western parts produce singletons (Czaplewski et al. 1979, Jones et al. 1983). In eastern Nebraska, Geluso et al. (2004a) reported 3 individuals containing 2 or more young. In Sioux County, 8 of 9 individuals contained a single young, whereas the other contained 2 young (Jones 1964). In Cherry County, 4 of 6 individuals contained 2 young, whereas the other 2 females contained singletons (Czaplewski et al. 1979). The Wildcat Hills lie in a broad area of intergradation between the western and eastern subspecies in the state (*E. f. pallidus* and *E. f. fuscus*, respectively), based on skull morphology, forearm length, and fur color (Hoffman and Genoways 2008). Our data further support the assertion that the Wildcat Hills are within the zone of integration for these 2 subspecies, based on number of young and variation in coloration of adults that we observed.

We captured lactating females as early as 4 July and as late as 10 August (Table 5)—dates that are within the range reported for lactation in the state (31 May–5 September; Geluso et al. 2004a and Jones 1964, respectively). We captured volant young from 27 July to 15 August (Table 6), and previous researchers captured volant young in Banner County as early as 20 July (Jones 1964). These dates also are within the known range of dates for volant young in Nebraska (6 July–21 September; Geluso et al. 2004a). Post-lactating females were observed from 28 July to 29 August.

Reproductive activity for *E. fuscus* is suspected to occur throughout Nebraska, but, thus far, evidence based on presence of lactating females has been reported for only 14 of 93 counties (15%; Jones 1964, $n = 3$ counties; Benedict 2004, $n = 8$; Geluso et al. 2004a, $n = 1$; Serbousek and Geluso 2009, Chase and Red Willow counties). Evidence of reproducing populations in Banner County existed before our study (a lactating female, see *Additional records*), but now we add Scotts Bluff County (see *Localities of occurrence*). In Morrill County, we captured only post-lactating females; with more effort in the future, we are confident that lactating females also will be documented in that county.

LOCALITIES OF OCCURRENCE.—*Banner County* (477): **(1)** 1 km S, 22 km W Harrisburg, mouth Bull Canyon, 41°32.916′ N, 104° 00.164′ W, 4 August 2010 (2 ♀♀, 7 ♀♀ lact, 4 YOY ♀♀, 3 ♂♂, 3 YOY ♂♂), 5 August 2010 (1 YOY ♂), 8 September 2010 (8 ♀♀, 5 ♂♂); **(2)** 3 km S, 21 km W Harrisburg, Bull Canyon, 41°31.783′ N, 103°59.506′ W, 31 July 2010 (5 ♀♀, 20 ♀♀ lact, 3 ♂♂), 1 August 2010 (1 ♂), 4 August 2010 (1 ♀ lact, 1 YOY ♀, 2 YOY ♂♂), 8 September 2010 (5 ♀♀, 5 ♂♂), 30 July 2011 (4 ♀♀, 3 ♀♀ lact, 2 ♀♀ post-lact, 1 ♂, 1 YOY ♂); **(3)** 5 km S, 18.7 km W Harrisburg, 41°30.513′ N, 103°57.870′ W, 1 July 2010 (1 ♀ preg [UNSM 30086], 2 ♂♂), 2 July 2010 (1 ♀ preg, 1 ♂), 28 July 2010 (3 ♀♀ lact), 29 July 2010 (1 ♀ lact); **(5)** Wildcat Hills State Recreation Area, Dooley Canyon, 41°41.738′ N, 103°40.049′ W, 27 August 1997 (8 ♀♀, 7 ♀♀ post-lact, 6 ♂♂ [MSB 126657]), 28 August 1997 (1 ♀ post-lact, 1 ♀, 5 ♂♂), 29 August 1997 (3 ♀♀, 3 ♀♀ post-lact [MSB 126658], 5 ♂♂), 25 May 1998 (22 ♀♀ [UNSM 26086], 2 ♂♂), 26 May 1998 (2 ♀♀), 17 June 1998 (2 ♀♀ preg [MSB 123237, 123238]), 6 July 1998 (1 ♀, 6 ♀♀ lact, 1 ♂ [UNSM 26042]), 7 July 1998 (2 ♀♀ lact), 14 August 1998 (2 YOY ♀♀,

TABLE 7. Mean body weight (g) and forearm length (mm) of adult bats in the Wildcat Hills and surrounding area in western Nebraska. Weights were obtained from April to November. Minimum-maximum values are given below means, and sample size is given in parentheses. Some data collected from late in the season include volant young with ossified epiphyseal plates.

| | Body weight | | Forearm length | |
|---|---|---|---|---|
| Species | Male | Female | Male | Female |
| *Eptesicus fuscus* | 17.4 | 19.7 | 45.9 | 47.3 |
| | 11–25 | 12.7–28 | 40.5–50.0 | 43–51.5 |
| | (34) | (88) | (163) | (329) |
| *Myotis ciliolabrum* | 4.9 | 5.5 | 32.7 | 33.6 |
| | 3.6–6.5 | 4.4–6.5 | 29–35 | 29–36.5 |
| | (19) | (23) | (51) | (48) |
| *Lasionycteris noctivagans* | 9.8 | 11.5 | 40.9 | 41.9 |
| | 8–13.7 | 8.5–13.5 | 38–44 | 40–45 |
| | (10) | (12) | (27) | (45) |
| *Lasiurus cinereus* | 23.7 | 29.2 | 54.3 | 55.8 |
| | 17.5–27 | 23.1–36.7 | 52–57 | 54–58 |
| | (8) | (15) | (16) | (23) |
| *Myotis thysanodes* | 7.8 | 8.8 | 42.6 | 42.7 |
| | 5.3–9.8 | 5.7–11.5 | 40–45 | 40–44.5 |
| | (13) | (17) | (23) | (20) |
| *Myotis lucifugus* | 9 | 8.8 | 36.3 | 38.7 |
| | 9 | 6.5–10 | 36–37 | 37–40 |
| | (1) | (4) | (3) | (15) |
| *Lasiurus borealis* | 10.6 | 13.0 | 38.9 | 40 |
| | 9.5–12 | 11.5–15 | 37–41 | 39–41 |
| | (6) | (7) | (10) | (7) |

2 ♂♂, 3 YOY ♂♂), 15 August 1998 (1 YOY ♂), 18 September 1998 (7 ♀♀ [UNSM 26094], 8 ♂♂ [UNSM 26095]), 25 May 1999 (23 ♀♀, 3 ♀♀ preg [UNSM 28186, 28191, 28192], 7 ♂♂ [UNSM 28187, 28190]), 26 May 1999 (10 ♀♀ [UNSM 28189], 1 ♀ preg [UNSM 28188], 1 unknown sex), 28 June 1999 (1 ♀, 9 ♀♀ preg [UNSM 28193, 28194, 28195, 28196], 5 ♂♂), 9 August 1999 (3 ♀♀, 2 ♀♀ lact, 5 ♀♀ post-lact [UNSM 28202], 7 YOY ♀♀ [UNSM 28203, 28204], 8 ♂♂ [UNSM 28201], 8 YOY ♂♂), 10 August 1999 (1 ♀, 1 ♀ lact, 1 ♀ post-lact, 4 YOY ♀♀, 1 ♂, 1 YOY ♂), 27 July 2000 (1 ♂, 3 YOY ♂♂), 28 July 2000 (3 ♀♀ lact, 10 YOY ♀♀, 7 ♂♂, 8 YOY ♂♂ [UNSM 28185]), 1 September 2000 (19 ♀♀ [MSB 124276], 19 ♂♂), 29 September 2000 (6 ♀♀ [UNSM 28160], 14 ♂♂), 8 May 2001 (7 ♀♀ [UNSM 28165], 2 ♀♀ preg, 3 ♂♂, 1 unknown sex), 30 May 2001 (9 ♀♀, 1 ♀ preg [MSB 124277]), 27 July 2001 (2 ♀♀ lact, 3 YOY ♀♀, 2 ♂♂, 3 YOY ♂♂), 28 July 2001 (1 ♀ post-lact, 2 YOY ♀♀, 4 ♂♂, 2 YOY ♂♂), 8 September 2001 (1 ♂), 21 September 2001 (4 ♀♀, 5 ♂♂), 20 September 2002 (4 ♀♀, 3 ♂♂), 15 September 2006 (1 ♂), 20 April 2007 (3 ♀♀ [UNSM 29033], 3 ♂♂), 3 July 2010 (2 ♂♂), 3 August 2010 (1 ♂); **(7)** Burchfield Property, T20N, R54W, SE ¼ Sec. 25, 41°40.526′ N, 103° 29.208′ W, 7 July 1998 (7 ♀♀ lact [UNSM 26044], 3 ♂♂), 8 July 1998 (2 ♂♂), 31 July 1998 (2 ♀♀ lact, 1 ♀ post-lact, 2 ♂♂, 1 YOY ♂), 1 August 1998 (1 ♀ lact, 1 ♀ post-lact).

*Morrill County* (13): **(1)** Pumpkin Creek, T19N, R51W, SW ¼ Sec. 20, 41°36.124′ N, 103°13.731′ W, 11 August 1999 (3 ♀♀ post-lact [UNSM 28209, 28211], 4 YOY ♀♀, 1 ♂ [UNSM 28208], 2 YOY ♂♂), 12 August 1999 (1 YOY ♀ [UNSM 28210], 1 ♂ [UNSM 28177], 1 YOY ♂).

*Scotts Bluff County* (129): **(3)** North Platte National Wildlife Refuge, Stateline Island, 41°59.199′ N, 104°02.224′ W, 4 July 2002 (1 ♀ lact [MSB 124420]); **(4)** Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103° 48.637′ W, 9 May 2001 (13 ♀♀, 5 ♂♂), 28 July 2001 (2 ♀♀, 15 ♀♀ lact [UNSM 28172, MSB 124284], 2 ♀♀ post-lact, 15 YOY ♀♀, 7 ♂♂, 7 YOY ♂♂ [UNSM 28173]), 29 July 2001 (7 ♀♀ lact, 1 YOY ♀, 4 ♂♂, 1 YOY ♂), 20 May 2002 (39 ♀♀), 28 September 2002 (2 ♀♀, 1 ♂); **(7)** Cedar Canyon Wildlife Management Area, T21N, R56W, NE ¼ Sec. 35, 41°45.257′ N, 103°46.458′ W, 9 July 1998 (1 ♂); **(9)** Wildcat Hills, T20N, R55W, SE ¼ Sec. 17, 41°42.230′ N, 103°41.081′ W, 2 September 2000 (1 ♂); **(10)** Wildcat Hills State Recreation Area, Picnic Shelter, T20N, R55W, NW ¼

Sec. 16, 41°42.481′N, 103°40.362′W, 6 July 1998 (1 ♂); (**12**) Kenitz Property, T20N, R55W, SW ¼ Sec. 3, 41°43.702′N, 103°39.001′W, 26 May 1998 (3 ♀♀, 1 ♂ [UNSM 26040]).

ADDITIONAL RECORDS (VIA MUSEUM SPECIMENS AND PUBLICATIONS).—*Banner County* (27): (**A**) 9 mi N, 5 mi E Harrisburg, 18 July 1959 (4 ♀♀ [KU 80912, 80919, 80920, 80921]), 19 July 1959 (2 ♀♀ [KU 80913, 80914], 1 ♂ [KU 80915]), 20 July 1959 (4 ♀♀ [KU 80922, 80923, 80924, 80925], 1 ♀ lact [KU 80916], 1 YOY ♀ [KU 80917], 1 ♂ [KU 80918], 1 YOY ♂ [KU 80926]); (**B**) 10 mi S, 2.5 mi E Gering, 7 August 1972 (1 ♀ [UNK 1604], 2 ♂♂ [UNK 1603, 1605]), 8 August 1972 (1 ♀ [UNK 1600], 1 YOY ♀ [UNK 2787], 6 ♂♂ [UNK 1598, 1599, 1601, 1602, 2788, 2789], 1 YOY ♂ [UNK 2786]).

*Morrill County* (1): (**A**) Bayard, 1966 (1 YOY ♂ [KU 105223]).

*Scotts Bluff County* (3): (**A**) 6.8 mi S, 1.9 mi W Mitchell P.O., T22N, R56W, NE ¼ NW ¼ Sec. 32, 25 July 2004 (1 ♀ [UNSM 28976]; (**B**) Carter Canyon, 12 mi S, 0.2 mi E Mitchell P.O., T21N, R56W, SW ¼ NE ¼ Sec. 28, 26 July 2004 (1 YOY ♀ [UNSM 29186], 1 ♂ [UNSM 29188]).

## *Myotis ciliolabrum* (Merriam, 1886)

### Western Small-footed Myotis

The western small-footed myotis occurs across western Nebraska, with easternmost records documented in Keya Paha County (Czaplewski et al. 1979), Thomas County (Geluso 2006), and Garden County (Benedict et al. 2000). To date, no published records are known from southwestern Nebraska in Dundy, Chase, or Hitchcock counties (Serbousek and Geluso 2009), although records are known from extreme northwestern Kansas (Sparks et al. 2011). In Nebraska, this species inhabits areas with rock outcrops or cliffs (Czaplewski et al. 1979) and also roosts in buildings (Jones 1964, Geluso 2006).

DISTRIBUTION AND HABITAT.—The western small-footed myotis was captured in each year sampled (Table 1) and was captured at a majority of sites (13 of 23). We captured 124 individuals, including adult males, adult females, and volant young. Although we captured *M. ciliolabrum* in all 3 counties of our study area, prior records were reported from each county (Czaplewski et al. 1979, Cox and Franklin 1989). Small-footed myotis occurred in deciduous forests near Lake Minatare and along Pumpkin Creek and in coniferous forests of the Wildcat Hills and Southern Wildcat Hills. On 29 June, we captured individuals (a male and pregnant female) night roosting in an abandoned building by Lake Minatare (Table 2), and, on several occasions, we documented females (pregnant and post-lactating) and volant young roosting in folds of hanging burlap sacks in a wooden shed in the Wildcat Hills. On a windy evening, we also observed western small-footed myotis feeding along the leeward side of a large shelter belt of eastern redcedars (*Juniperus virginiana*); identification of bats was based on their size, their relative abundance in the area, and our prior experience in observation of the species before capturing individuals in mist nets.

SEASONAL ACTIVITY.—In Nebraska, volant individuals previously were known from 2 May to 5 September (Table 3; Jones 1964), with the only winter record discovered inside a building in February (Dawes County, Czaplewski et al. 1979). In our study, we captured nonhibernating individuals over water sources from 20 April to 4 November (Table 3), and those seasonal dates extend the period of activity in Nebraska in both spring and autumn. On 20 April 2007, we captured 5 adults (3 females and 2 males) in Dooley Canyon on a day that air temperatures reached 22 °C in the nearby town of Scottsbluff. On that evening, we observed the first bat flying overhead (20:05) in the canyon, where the temperature was 15 °C. Four of 5 individuals produced well-formed feces within an hour of capture, demonstrating that individuals had fed during that evening. Three females on that evening had an average body weight of 5.8 g, and 2 males averaged 5 g. On 4 November 2001, we captured an adult male over a pool of water in Carter Canyon on a day that reached 23 °C in Scottsbluff. The individual produced no feces and contained noticeable deposits of subcutaneous fat.

REPRODUCTION.—We captured 4 pregnant females, 17 lactating females, 5 post-lactating females, and 11 volant young (Tables 4, 5, and 6). Pregnant females were captured from 30 May to 2 July, and individuals kept as specimens contained a single young (Table 4). Quay (1948) also reported a single young for this species in Nebraska. We captured lactating females as early as 7 July and as late as 13

August (Table 5)—dates that extend the earliest and latest dates of lactation for this species in the state. Previously, dates of lactation spanned 14 July–8 August (Czaplewski et al. 1979). Post-lactating females were observed 29 July–28 August. We captured volant young from 28 July to 27 August (Table 6). Our capture on 27 August extends the latest date for recognizable young in the state. The latest date in Nebraska when young previously were verified by cartilage in finger joints was 11 August (Benedict 2004). Before our study, presence of lactating *M. ciliolabrum* had been reported in only 4 Nebraskan counties (Banner, Cherry, Sheridan, and Sioux; Czaplewski et al. 1979, Benedict 2004); we now have evidence of reproducing populations in 2 additional counties—Morrill and Scotts Bluff (see *Localities of occurrence*).

LOCALITIES OF OCCURRENCE.—*Banner County* (81): (**1**) 1 km S, 22 km W Harrisburg, mouth Bull Canyon, 41°32.916′ N, 104°00.164′ W, 8 September 2010 (1 ♀); (**2**) 3 km S, 21 km W Harrisburg, Bull Canyon, 41°31.783′ N, 103° 59.506′ W, 31 July 2010 (2 ♀♀ lact, 3 ♂♂), 1 August 2010 (1 ♂), 8 September 2010 (2 ♀♀, 1 ♂), 30 July 2011 (1 ♂); (**3**) 5 km S, 18.7 km W Harrisburg, 41°30.513′ N, 103°57.870′ W, 1 July 2010 (1 ♀, 2 ♂♂), 2 July 2010 (1 ♀ preg [UNSM 30093]), 28 July 2010 (1 ♀ lact), 29 July 2010 (1 ♀ lact); (**4**) 4.9 km S, 17.5 km W Harrisburg, 41°30.568′ N, 103°57.443′ W, 28 July 2010 (2 ♀♀ lact), 29 July 2010 (1 ♀ lact, 1 ♂); (**5**) Wildcat Hills State Recreation Area, Dooley Canyon, 41°41.738′ N, 103°40.049′ W, 27 August 1997 (2 ♀♀ post-lact [MSB 122285], 1 YOY ♀, 3 ♂♂), 28 August 1997 (1 ♀ post-lact), 29 August 1997 (1 ♀, 2 ♂♂), 25 May 1998 (2 ♀♀, 2 ♂♂ [UNSM 26088]), 14 August 1998 (1 YOY ♂), 18 September 1998 (1 ♀, 3 ♂♂ [UNSM 26093]), 28 June 1999 (1 ♀ preg [UNSM 28197]), 9 August 1999 (1 YOY ♀, 1 YOY ♂ [UNSM 28205]), 27 July 2000 (1 unknown sex), 1 September 2000 (3 ♀♀, 5 ♂♂ [MSB 124275]), 29 September 2000 (1 ♀, 3 ♂♂ [UNSM 28174]), 8 May 2001 (3 ♀♀, 3 ♂♂), 21 September 2001 (1 ♀), 20 September 2002 (1 ♀, 1 ♂), 2 September 2006 (1 ♀), 20 April 2007 (3 ♀♀ [UNSM 29030], 2 ♂♂), 3 July 2010 (1 ♂); (**7**) Burchfield Property, T20N, R54W, SE ¼ Sec. 25, 41°40.526′ N, 103°29.208′ W, 7 July 1998 (2 ♀♀ lact [UNSM 28214], 6 ♂♂ [UNSM 26045]), 8 July 1998 (1 ♂).

*Morrill County* (2): (**1**) Pumpkin Creek, T19N, R51W, SW ¼ Sec. 20, 41°36.124′ N, 103°13.731′ W, 11 August 1999 (1 ♀ lact [UNSM 28207]), 12 August 1999 (1 YOY ♂).

*Scotts Bluff County* (41): (**4**) Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103°48.637′ W, 9 May 2001 (1 ♀, 1 ♂), 28 July 2001 (3 ♀♀ lact [UNSM 28168], 1 YOY ♀), 29 July 2001 (1 ♀ lact), 4 November 2001 (1 ♂ [MSB 124287]), 20 May 2002 (1 ♀); (**6**) Cedar Canyon Wildlife Management Area, T21N, R56W, NW ¼ Sec. 35, 41°45.254′ N, 103° 46.753′ W, 26 May 1999 (1 ♀, 3 ♂♂); (**7**) Cedar Canyon Wildlife Management Area, T21N, R56W, NE ¼ Sec. 35, 41°45.257′ N, 103° 46.458′ W, 9 July 1998 (1 ♂), 1 August 1998 (1 ♂, 1 unknown sex), 13 August 1998 (1 ♀ lact, 1 ♂), 19 September 1998 (1 ♀, 1 ♂); (**8**) Wildcat Hills, T20N, R56W, SE ¼ Sec. 13, 41°42.130′ N, 103°43.093′ W, 9 August 2000 (1 ♀ lact, 2 ♀♀ [MSB 124272], 2 unknown sex), 10 August 2000 (1 ♀ lact, 1 ♀ [MSB 124273], 1 YOY ♀), 30 May 2001 (1 ♀ preg [MSB 124283], 1 ♀), 31 May 2001 (1 ♀), 29 July 2001 (2 ♀♀ post-lact, 4 YOY ♀♀, 1 ♂); (**11**) Wildcat Hills State Recreation Area, Large Picnic Shelter, T20N, R55W, NE ¼ Sec. 16, 41°42.530′ N, 103°40.074′ W, 2 September 2000 (1 unknown sex); (**15**) Lake Minatare, 41°56.682′ N, 103°28.267′ W, 29 June 2002 (1 ♀ preg, 1 ♂ [MSB 124394]).

ADDITIONAL RECORDS (VIA MUSEUM SPECIMENS AND PUBLICATIONS).—*Banner County* (22): (**A**) 9 mi N, 5 mi E Harrisburg, 18 July 1959 (1 ♀ [KU 80911]); (**B**) 10 mi S, 2.5 mi E Gering, 7 August 1972 (2 ♂♂ [KSC 1970, 1971]), 8 August 1972 (6 ♀♀ [UNK 1972, 2765, 2767, 2772, 2774, 2781], 2 YOY ♀♀ [UNK 2766, 2770], 7 ♂♂ [UNK 2768, 2769, 2771, 2776, 2777, 2778, 2780], 4 YOY ♂♂ [UNK 2773, 2775, 2779, 2782]).

*Morrill County* (3): (**B**) 1.25 mi N, 3.5 mi E Redington, Roundhouse Rock, no date given (1 unknown sex [UNK 2647]); (**E**) Bridgeport, Old High School, 24 April 1978 (1 ♀ [UNSM 21169]); (**H**) Attic Broadwater School Gymnasium, T19N, R48W, Sec. 22, 25 September 1976 (1 ♀ [UNSM 23659]).

*Scotts Bluff County* (3): (**B**) Carter Canyon, 12 mi S, 0.2 mi E Mitchell P.O., T21N, R56W, SW ¼ NE ¼ Sec. 28, 26 July 2004 (1 ♀ [UNSM 29176], 1 ♂ [UNSM 29177]); (**C**) Scottsbluff, Great Western Sugar Plant, 22 October 1977 (1 ♀ [UNSM 21168]).

*Lasionycteris noctivagans*
(LeConte, 1831)

Silver-haired Bat

Previously, the silver-haired bat was suspected to only migrate through Nebraska (Jones 1964), but lactating females captured in Lancaster and Sarpy counties in eastern Nebraska (Benedict 2004, Geluso et al. 2004a) and Scotts Bluff and Sioux counties in western Nebraska (Geluso et al. 2004b) demonstrate that females bear and raise their young in the state. Thus far, lactating females and young only have been captured in riparian habitats along rivers and streams across the state (Benedict 2004, Geluso et al. 2004a, 2004b) and in an area surrounded by pine forests in northwestern Nebraska (Geluso et al. 2004b); however, migrating individuals might occur in any wooded habitat in Nebraska. Silver-haired bats roost in small tree cavities and under loose bark and are known to use both deciduous and coniferous trees (Mattson et al. 1996).

In 2004, Geluso et al. (2004b) reported on the distribution, seasonality, and reproduction of 155 silver-haired bats from western Nebraska. Sixty-eight of those individuals were from the Wildcat Hills and surrounding area. Herein, we include information on those 68 individuals, plus data on 11 additional individuals captured since that publication (1 on 2 September 2006, 5 on 20 April 2007, 4 on 8 September 2010, and 1 on 7 October 2010).

DISTRIBUTION AND HABITAT.—Silver-haired bats captured in Banner and Scotts Bluff counties represent new records of occurrence for those counties (Geluso et al. 2004b; this study); a record from Morrill County previously had been reported by Czaplewski et al. (1979). We captured individuals in cottonwood forests along the North Platte River and in coniferous forests of the Wildcat Hills and Southern Wildcat Hills. Lactating females were captured only in cottonwood forests in our study area, but they also have been captured in an area surrounded by ponderosa pines in the Pine Ridge area (Geluso et al. 2004b).

SEASONAL ACTIVITY.—In Nebraska, volant individuals previously were known from 21 April to 2 October (Table 3; Jones 1964, Geluso et al. 2004a), and Benedict (2004, in litt.) reported a nonvolant, nonhibernating individual from 26 November. We captured *L. noctivagans* from 20 April to 4 November (Table 3), expanding dates of active individuals in the state in both spring and autumn. On 20 April, we captured 2 males and 3 females in Dooley Canyon on a warm evening (see account of *M. ciliolabrum*). Males had weights of 8 and 8.5 g, whereas females weighed 12.5, 13, and 13 g. The volant individual captured on 4 November in Carter Canyon was an adult female, had a weight of 12.5 g, and contained substantial subcutaneous fat deposits. It is unknown whether this bat represented a late migrant or an individual about to enter hibernation. On the basis of energy use and fat depletion, we calculated that this individual possessed adequate fat reserves to successfully hibernate in Nebraska throughout winter (Geluso et al. 2004b).

For silver-haired bats, seasonality and timing of migratory movements in western Nebraska were reviewed by Geluso et al. (2004b), and that review included many individuals reported in this study. In western Nebraska, summer residents were documented at 4 sites—2 sites were in riparian forests in Scotts Bluff County (captures on 1, 2, 4, and 5 July; including lactating females), 1 site surrounded by pines in the Pine Ridge in Sioux County (19 July; including a lactating female), and 1 site in coniferous forests in Banner County (27–28 July; an adult male and a volant young with ossified epiphyseal plates).

In our study, lactating females were captured only in lowlands along the North Platte River; none were captured in coniferous forests of the Wildcat Hills or Southern Wildcat Hills, even though we netted that habitat many times during the summer (4 nights in June, 13 in July, and 12 in August). In fact, silver-haired bats appeared only in coniferous forests during northward and southward migration. The Banner County individuals captured in coniferous forests on 27 and 28 July and categorized as summer residents by Geluso et al. (2004b) possibly represent early southward migrants.

In general, southward migration of silver-haired bats began later than that of red and hoary bats. Most migratory silver-haired bats were captured in September, with only a single capture in late August (Table 8). In contrast, many red and hoary bats were captured in August (see below). Southward migration of silver-haired bats likely continued at least until early November in the study area. In

TABLE 8. Dates of capture for silver-haired bats (*Lasionycteris noctivagans*) in the Wildcat Hills and surrounding areas in western Nebraska. Volant young refer only to those individuals with cartilaginous zones in finger joints; some adults captured August–November likely represent volant young with ossified epiphyseal plates (see Methods).

| Date | Adult male | Adult female | Volant young | Unknown sex |
|---|---|---|---|---|
| 20 Apr | 2 | 3 | | |
| 8 May | 1 | 3 | | |
| 9 May | | 3 | | |
| 10 May | | 1[a] | | |
| 20 May | 2 | 1 | | |
| 22 May | | 1 | | |
| 25 May | 1 | | | |
| 30 May | 1 | | | |
| 1 Jul | | 1 | 1 | |
| 2 Jul | | 1 | | |
| 4 Jul | | 3 | | |
| 5 Jul | | 3 | 1 | |
| 27 Jul | | 1 | | |
| 28 Jul | 1 | | | |
| 28 Aug | 1 | | | |
| 1 Sep | 6 | 5 | | |
| 2 Sep | 1 | | | |
| 8 Sep | 2 | 2 | | |
| 18 Sep | 1 | | | |
| 20 Sep | | 1 | | |
| 21 Sep | 2[b] | | | |
| 22 Sep | | | | 1[c] |
| 24 Sep | | 1[c] | | |
| 29 Sep | 7 | 15 | | |
| 30 Sep | | 1[d] | | |
| 7 Oct | | 1 | | |
| 4 Nov | | 1 | | |
| TOTALS | 28 | 48 | 2 | 1 |

[a]Individual incorrectly reported as captured on 9 May in Geluso et al. (2004b); it was captured at midnight (00:00) on 10 May.
[b]Individuals incorrectly reported as captured on 22 September in Geluso et al. (2004b) due to incorrectly labeled notes.
[c]Individual collected by other researchers; data from museum specimens.
[d]Individual incorrectly reported as captured on 29 September in Geluso et al. (2004b); it was captured at midnight (00:00) on 30 September.

spring during northward migration, both males ($n = 7$) and females ($n = 12$) were documented in the Wildcat Hills and surrounding area (April and May, Table 8).

REPRODUCTION.—We captured 1 pregnant female, 8 lactating females, and 2 volant young (Tables 4, 5, and 6). The pregnant female was captured on 22 May along the North Platte River (Geluso et al. 2004b). She contained 2 fetuses (Table 4), which is the usual number of young for this species (Kunz 1982). This individual represents the first reported occurrence of pregnancy in silver-haired bats in Nebraska (Geluso et al. 2004b, this study). We observed lactating females as early as 1 July and as late as 5 July (Table 5)—dates that are within the known range of lactation for this species in the state. Previously reported dates of lactation spanned from 16 June (Sarpy Co., Geluso et al. 2004a) to 19 July (Sioux Co., Geluso et al. 2004b). We captured volant young with cartilaginous epiphyseal plates from 1 to 5 July (Table 6) and noted a volant young with ossified plates on 27 July. Our captures of volant young expand the earliest date for recognizable young in the state. Dates for volant young in Nebraska previously spanned from 13 July (Lancaster Co., Benedict 2004) to 19 July (Sioux Co., Geluso et al. 2004b). Thus far in the Wildcat Hills and surrounding area, lactating females are known only from Scotts Bluff County (Geluso et al. 2004b; this study).

LOCALITIES OF OCCURRENCE.—*Banner County* (58): (**1**) 1 km S, 22 km W Harrisburg, mouth of Bull Canyon, 41°32.916′ N, 104° 00.164′ W, 8 September 2010 (1 ♀ [UNSM 30083]), 7 October 2010 (1 ♀ [UNSM 30081]); (**2**) 3 km S, 21 km W Harrisburg, Bull Canyon, 41°31.783′ N, 103°59.506′ W, 8 September 2010 (1 ♀ [UNSM 30078], 2 ♂♂); (**5**) Wildcat Hills State Recreation Area, Dooley Canyon, T20N, R55W, NW ¼ Sec. 21, 41°41.738′ N, 103° 40.049′ W, 28 August 1997 (1 ♂ [MSB 122284]), 25 May 1998 (1 ♂ [UNSM 26087]), 18 September 1998 (1 ♂ [UNSM 26096]), 28 July 2000 (1 ♂ [UNSM 28184]), 1 September 2000 (5 ♀♀ [MSB 124279], 6 ♂♂ [MSB 124278]), 29 September 2000 (15 ♀♀ [UNSM 28162], 7 ♂♂ [UNSM 28163]), 30 September 2000 (1 ♀), 8 May 2001 (3 ♀♀ [UNSM 28164], 1 ♂), 30 May 2001 (1 ♂ [MSB 124280]), 27 July 2001 (1 YOY ♀ without cartilage [UNSM 28167]), 21 September 2001 (2 ♂♂), 20 September 2002 (1 ♀ [UNSM 28171]), 2 September 2006 (1 ♂), 20 April 2007 (3 ♀♀ [UNSM 29031], 2 ♂♂ [UNSM 29032]).

*Scotts Bluff County* (19): (**1**) North Platte National Wildlife Refuge, Stateline Island, 41° 59.361′ N, 104°03.169′ W, 22 May 2002 (1 ♀ preg [MSB 124373]); (**2**) North Platte National Wildlife Refuge, Stateline Island, 41°59.323′ N, 104°02.954′ W, 1 July 2002 (1 ♀ lact [MSB 124409], 1 YOY ♀ [MSB 124410]), 2 July 2002 (1 ♀ lact); (**3**) North Platte National Wildlife Refuge, Stateline Island, 41°59.199′ N, 104° 02.224′ W, 4 July 2002 (3 ♀♀ lact [MSB 124418]), 5 July 2002 (3 ♀♀ lact, 1 YOY ♀ [MSB 124419]); (**4**) Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103° 48.637′ W, 9 May 2001 (3 ♀♀), 10 May 2001

TABLE 9. Dates of capture for hoary bats (*Lasiurus cinereus*) in the Wildcat Hills and surrounding areas in western Nebraska. Volant young refer only to those individuals with cartilaginous zones in finger joints; some adults captured in August and September likely represent volant young with ossified epiphyseal plates (see Methods).

| Date | Adult male | Adult female | Volant young | Unknown sex |
|---|---|---|---|---|
| 20 May | | 8 | | 1 |
| 25 May | | 3 | | |
| 26 May | | 1 | | |
| 28 Jun | | 1 | | |
| 3 Jul | | 1 | | |
| 5 Jul | | | 1 | |
| 7 Jul | | 1 | | |
| 19 Jul | | | 1[a] | |
| 26 Jul | 1[a] | | | |
| 27 Jul | | 1 | | |
| 28 Jul | 2 | 1 | 2 | |
| 1 Aug | | | 2 | |
| 4 Aug | 1 | 2 | 1 | |
| 5 Aug | 1 | 1 | | |
| 7 Aug | 1[a] | 2[a] | | |
| 8 Aug | 8[a] | 2[a] | | |
| 9 Aug | 2 | | | |
| 10 Aug | 2 | 2 | | |
| 11 Aug | | 1 | | |
| 12 Aug | | 3 | | |
| 14 Aug | | | 1 | |
| 23 Aug | | | | 1[a] |
| 27 Aug | 2 | 1 | | |
| 28 Aug | 4 | 3 | | |
| 1 Sep | 2 | 1 | | |
| 2 Sep | 1 | 1 | | 1 |
| 8 Sep | 2 | | | |
| 9 Sep | 1 | | | |
| 15 Sep | 1 | | | |
| TOTALS | 31 | 36 | 8 | 3 |

[a]Individual(s) collected by other researchers; data from museum specimens.

(1 ♀), 4 November 2001 (1 ♀ [MSB 124286]), 20 May 2002 (1 ♀ [MSB 124368], 2 ♂♂).

ADDITIONAL RECORDS (VIA MUSEUM SPECIMENS AND PUBLICATIONS).—*Morrill County* (2): **(F)** 8.0 mi S, 7.5 mi E Bridgeport, T18N, R49W, Sec. 5 (incorrectly reported as Sec. 15 in Czaplewski et al. 1979 and Geluso et al. 2004b), 24 September 1976 (1 ♀ [UNSM 23556]); **(G)** T19N, R48W, SW ¼ Sec. 28, 22 September 1979 (1 unknown sex—incorrectly labeled "male" in Geluso et al. 2004b [UNSM 23625]).

### *Lasiurus cinereus* (Palisot de Beauvois, 1796)

### Hoary Bat

Hoary bats are known to migrate long distances during northward migration in spring and southward migration in autumn, and many individuals are suspected to reside in Mexico during winter (Cryan 2003). In summer, both sexes reside in Nebraska, and females produce young throughout the state (Czaplewski et al. 1979, Benedict 2004, Serbousek and Geluso 2009). Hoary bats roost in foliage of trees and other vegetation (Jones et al. 1983, Shump 1999).

DISTRIBUTION AND HABITAT.—We captured 62 hoary bats, including adult males, adult females, and volant young (Table 1). Individuals were captured in all 3 counties and those from Morrill County represent a new county record. A previously unreported record from Morrill County was collected in 1980, but it contained a vague locality (see *Additional records*). We captured individuals on a regular basis, with captures in 8 of 10 years sampled (Table 1). Hoary bats were captured in coniferous forests in the Wildcat Hills and Southern Wildcat Hills and in cottonwood communities along Pumpkin Creek and the North Platte River. In general, hoary bats were captured over larger surface areas of water void of obstructions. Unlike silver-haired bats, lactating females were captured in coniferous forests of Dooley and Carter canyons in the Wildcat Hills (28 June and 3, 7, and 28 July).

SEASONAL ACTIVITY.—In Nebraska, hoary bats have been observed as early as May (Czaplewski et al. 1979) and as late as 4 October (Geluso et al. 2004a). We captured hoary bats from 20 May to 15 September (Table 3). Only one other individual had been reported previously in "May" in Nebraska, but the specific date was not given (Czaplewski et al. 1979).

Although the hoary bat is a migratory species in Nebraska, little has been reported about the timing of its migration in the state. By examining monthly captures by sex and age, and by observing migratory waves of nonreproductive individuals in western Nebraska, we can comment on the timing of migratory movements in the region. In spring, we captured 12 females on 3 different days from 20 to 26 May (Table 9). The first males were captured in late July; thus, males might not use this area during spring migration. Further field efforts in spring are needed to confirm this observation. During southward migration, movements of hoary bats commence in late July/early August in western Nebraska and continue at least until mid-September (Table 9;

KG and KNG unpublished data from Pine Bluffs area of Kimball County). Czaplewski et al. (1979) stated that adult male hoary bats occur as summer residents in the Wildcat Hills and Pine Ridge, but adult males captured on 8 August 1972 (UNK specimens, see below) likely represented migratory individuals. Benedict (2004) also reported an absence of adult males in the Wildcat Hills and Pine Ridge in "summer." On the basis of current data in western Nebraska (this study, KG and KNG unpublished data), we propose that only adult males captured from mid-June to mid-July be considered summer residents in the state.

REPRODUCTION.—We captured 2 pregnant females, 4 lactating females, and 7 volant young (Tables 4, 5, and 6). Pregnant females captured on 20 and 25 May each contained 2 fetuses (Table 4), which is the usual number of young for this species (Jones 1964). These are the earliest reported occurrences of pregnant individuals in Nebraska; the former earliest date for pregnancy was 5 June (Manning and Geluso 1989). We captured lactating females from 28 June to 28 July (Table 5)—dates that are within the known range of lactation in Nebraska (6 June–4 August; Geluso 2006, Jones 1964). The earliest date of a post-lactating female was 5 August. We captured volant young from 5 July to 14 August (Table 6). On 27 July, we captured a volant young with ossified epiphyseal plates. Our captures expand the latest date for recognizable young in the state by one day. Dates for volant young in Nebraska previously spanned from late June to 13 August (Czaplewski et al. 1979, Benedict 2004).

Before our study, presence of lactating *L. cinereus* had been reported in only 11 Nebraskan counties (Czaplewski et al. 1979, Benedict 2004, Geluso et al. 2004a, Geluso 2006, Serbousek and Geluso 2009); we now have evidence of reproducing populations for an additional 2 counties—Banner and Scotts Bluff.

LOCALITIES OF OCCURRENCE.—*Banner County* (46): (**1**) 1 km S, 22 km W Harrisburg, mouth of Bull Canyon, 41°32.916′ N, 104° 00.164′ W, 4 August 2010 (2 ♀♀, 1 ♂ [UNSM 30069]), 5 August 2010 (1 ♀ post-lact, 1 ♂), 8 September 2010 (2 ♂♂ [UNSM 30070]), 9 September 2010 (1 ♂); (**2**) 3 km S, 21 km W Harrisburg, Bull Canyon, 41°31.783′ N, 103° 59.506′ W, 1 August 2010 (1 YOY ♀, 1 YOY ♂ [UNSM 30067]), 4 August 2010 (1 YOY ♂); (**5**) Wildcat Hills State Recreation Area, Dooley Canyon, T20N, R55W, NW ¼ Sec. 21, 41°41.738′ N, 103°40.049′ W, 27 August 1997 (1 ♀, 2 ♂♂), 28 August 1997 (3 ♀♀ [MSB 122282, 122283], 4 ♂♂), 25 May 1998 (1 ♀ preg [UNSM 26041], 1 ♀ [UNSM 28215]), 26 May 1998 (1 ♀), 7 July 1998 (1 ♀ lact [UNSM 26043]), 14 August 1998 (1 YOY ♀), 25 May 1999 (1 ♀), 28 June 1999 (1 ♀ lact [UNSM 28198]), 9 August 1999 (2 ♂♂ [UNSM 28200]), 10 August 1999 (2 ♀♀, 2 ♂♂), 28 July 2000 (2 YOY ♀♀), 1 September 2000 (1 ♀, 2 ♂♂ [MSB 124281]), 27 July 2001 (1 YOY with no cartilage ♀ [MSB 124282]), 28 July 2001 (1 ♂), 2 September 2006 (1 ♂, 1 ♀, 1 unknown sex), 15 September 2006 (1 ♂), 3 July 2010 (1 ♀ lact).

*Morrill County* (4): (**1**) Pumpkin Creek, T19N, R51W, SW ¼ Sec. 20, 41°36.124′ N, 103°13.731′ W, 11 August 1999 (1 ♀ [UNSM 28212]), 12 August 1999 (3 ♀♀ [UNSM 28178, 28179]).

*Scotts Bluff County* (12): (**3**) North Platte National Wildlife Refuge, Stateline Island, 41°59.199′ N, 104°02.224′ W, 5 July 2002 (1 YOY ♂ [MSB 124421]); (**4**) Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103°48.637′ W, 28 July 2001 (1 ♀ lact [MSB 124285], 1 ♂), 20 May 2002 (1 ♀ preg [MSB 124369], 7 ♀♀, 1 unknown sex).

ADDITIONAL RECORDS (VIA MUSEUM SPECIMENS AND PUBLICATIONS).—*Banner County* (13): (**B**) 10 mi S, 2.5 mi E Gering, 7 August 1972 (2 ♀♀ [UNK 1579, 1581], 1 ♂ [UNK 1590]), 8 August 1972 (2 ♀♀ [UNK 1580, 1589], 8 ♂♂ [UNK 1582, 1583, 1584, 1585, 1586, 1587, 1588, 1591]).

*Morrill County* (1): (**not plotted in Fig. 1**) tree in yard of Ron Franklin, 23 August 1980 (1 unknown sex [UNSM 23521]).

*Scotts Bluff County* (2): (**B**) Carter Canyon, 12 mi S, 0.2 mi E Mitchell P.O., T21N, R56W, SW ¼ NE ¼ Sec. 28, 26 July 2004 (1 ♂ [UNSM 29187]); (**D**) Lake Minatare, 8 mi N Minatare, 19 July 1975 (1 YOY ♀ [UNK 2746]).

### *Myotis thysanodes* Miller, 1897

### Fringed Myotis

The fringed myotis occurs in the Pine Ridge and in the Wildcat Hills of Nebraska's panhandle (Banner, Dawes, Sheridan, and

Sioux counties; Czaplewski et al. 1979, Benedict 2004). Overall, few individuals are reported from the state, and, thus, relatively little is known about this suspected year-round resident. For example, Czaplewski et al. (1979) and Benedict (2004) each reported only 6 specimens from Nebraska, totaling 12 records for the state. The only species with fewer records in the state is Townsend's big-eared bat (*Corynorhinus townsendii*), for which only a single specimen is known (Czaplewski et al. 1979).

DISTRIBUTION AND HABITAT.—From 1997 to 2011, we captured 46 fringed myotis including 24 males and 22 females (Table 1). Individuals were captured in Banner and Scotts Bluff counties, and captures in the latter county represent a new record for that county. All 8 sites with captures were from areas in or surrounded by coniferous forests in the Wildcat Hills and Southern Wildcat Hills; we did not capture any individuals in riparian forests along the North Platte River. Most bats were captured over small earthen ponds or metal stock tanks in canyon bottoms. However, one adult female was captured foraging under an apple tree in the yard of a ranch house, and another adult female was captured in a mist net set in front of a door of an open garage at the same ranch house. On a number of occasions, we captured individuals that contained a powdery substrate on their forearms and fur, suggesting that those individuals were roosting in cracks and crevices of buttes. Before our study, the only mention of habitat for this species in Nebraska was along a creek with deciduous vegetation located below pine-forested bluffs (Czaplewski et al. 1979).

SEASONAL ACTIVITY.—Known dates of seasonal occurrence for *M. thysanodes* in Nebraska are from "June" (Czaplewski et al. 1979) to 13 August (Benedict 2004). We captured individuals from 8 May to 29 September (Table 3), expanding dates of occurrence in both spring and autumn in Nebraska.

REPRODUCTION.—No reproductive information was known for this species in Nebraska before our study (Czaplewski et al. 1979, Benedict 2004). We documented lactating females from 8 July to 13 August (Table 5) but did not capture pregnant females or volant young. We provide the first evidence that females bear and raise young in Nebraska, with reproducing populations in both Banner and Scotts Bluff counties. We captured a post-lactating female on 29 August.

MANAGEMENT IMPLICATIONS.—In Nebraska, *M. thysanodes* is listed as a Tier 1 species of concern (Schneider et al. 2005) and represents the subspecies *M. t. pahasapensis*, which has a relatively limited distribution (Hall 1981). The fringed myotis in the Wildcat Hills likely represents an isolated population (Czaplewski et al. 1979); thus, the Wildcat Hills and surrounding areas may represent an important refugia for the species if white-nose syndrome reaches other populations of fringed myotis in western North America (Frick et al. 2010).

LOCALITIES OF OCCURRENCE.—*Banner County* (39): **(2)** 3 km S, 21 km W Harrisburg, Bull Canyon, 41°31.783′ N, 103°59.506′ W, 31 July 2010 (1 ♀, 3 ♀♀ lact [UNSM 30089], 2 ♂♂), 1 August 2010 (2 ♀♀ lact), 5 August 2010 (1 ♀ lact), 30 July 2011 (4 ♀♀ lact); **(3)** 5 km S, 18.7 km W Harrisburg, [Long Canyon], 41°30.513′ N, 103°57.870′ W, 28 July 2010 (1 ♂); **(4)** 4.9 km S, 17.5 km W Harrisburg, [Long Canyon], 41°30.568′ N, 103°57.443′ W, 28 July 2010 (1 ♂ [UNSM 30088]), 29 July 2010 (1 ♂); **(5)** Wildcat Hills State Recreation Area, Dooley Canyon, T20N, R55W, NW ¼ Sec. 21, 41°41.738′ N, 103°40.049′ W, 27 August 1997 (1 ♂ [MSB 122286]), 29 August 1997 (1 ♀ [MSB 122287], 1 ♀ post-lact [MSB 122288]), 18 September 1998 (1 ♂ [UNSM 26097]), 25 May 1999 (2 ♀♀, 1 ♂), 28 June 1999 (1 ♂), 10 August 1999 (1 ♀ lact [UNSM 28206]), 27 July 2000 (1 ♂), 28 July 2000 (1 ♂), 1 September 2000 (1 ♂), 29 September 2000 (3 ♂♂ [UNSM 28175]), 8 May 2001 (1 ♀ [UNSM 28166]), 20 September 2002 (2 ♂♂), 2 September 2006 (1 ♀, 1 ♂), 16 September 2006 (2 ♂♂); **(6)** Buffalo Creek Wildlife Management Area, T20N, R54W, SW ¼ Sec. 19, 41° 41.393′ N, 103°35.757′ W, 29 August 1997 (1 ♂ [MSB 122289]).

*Scotts Bluff County* (7): **(4)** Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103°48.637′ W, 28 July 2001 (2 ♂♂ [UNSM 28169]); **(7)** Cedar Canyon Wildlife Management Area, T21N, R56W, NE ¼ Sec. 35, 41° 45.257′ N, 103°46.458′ W, 8 July 1998 (1 ♀ lact [MSB 123247]), 13 August 1998 (1 ♀ lact, 1 ♂ [MSB 123249]); **(8)** Wildcat Hills, T20N, R56W, SE ¼ Sec. 13, 41°42.130′ N, 103°43.093′ W, 9 August 2000 (2 ♀♀ [MSB 124274]).

ADDITIONAL RECORDS (VIA MUSEUM SPECIMENS AND PUBLICATIONS).—*Banner County* (1):

(**B**) 10 mi S, 2.5 mi E Gering, 7 August 1972 (1 ♂ [UNK 1988]).

*Myotis lucifugus*
(Le Conte, 1831)

Little Brown Bat

Two subspecies of the little brown bat occur in Nebraska—*M. l. lucifugus* in eastern parts of the state and *M. l. carissima* in the northwestern corner of the state (Jones 1964, Czaplewski et al. 1979, Benedict 2004). Jones (1964) reported that little brown bats are one of the most common species of bats in the Pine Ridge, yet little information is known about the northwestern subspecies. In Nebraska, *M. l. carissima* is known to roost in buildings in the Pine Ridge (Jones 1964), and it has been captured over creeks in Sheridan County (Benedict 2004).

DISTRIBUTION AND HABITAT.—During our surveys, we captured 23 individuals, including 17 adult females, 3 adult males, and 3 volant young (Table 1). We captured little brown bats in Scotts Bluff County in cottonwood forests and by hand in buildings along the North Platte River (Table 2). We also captured individuals over the canal below the spillway of Lake Alice and by hand in a building by Lake Minatare. Previously, *M. l. carissima* was known from only Dawes, Sheridan, and Sioux counties in northwestern parts of the state (Benedict 2004). Our records in Scotts Bluff County represent a 54-km range extension south of the closest locality in Sioux County at Agate Fossil Beds National Monument along the Niobrara River (Jones 1964). Our captures also represent a new river drainage for the species in Nebraska, that is, the North Platte River. The extent of the distribution for *M. lucifugus* eastward along the North Platte River is unknown at this time.

Little brown bats were captured during only 2 years of the study (Table 1); such data reflect our relatively limited efforts to capture bats in riparian habitats and buildings along the North Platte River. Although we accrued many more net-nights in the coniferous canyons of the Wildcat Hills, we never captured a single *M. lucifugus*. This lack of captures suggests that little brown bats do not inhabit such forests in the Wildcat Hills and Southern Wildcat Hills, but the species does inhabit coniferous forests in other parts of its distribution (e.g., Black Hills, South Dakota; Turner 1974).

SEASONAL ACTIVITY.—Little brown bats are possibly year-round residents in the Pine Ridge, but hibernacula have not been reported in western Nebraska (Czaplewski et al. 1979). Individuals have been observed in Nebraska from 24 June (Johnson County; Czaplewski et al. 1979) to 5 September (no county given; Benedict 2004). We captured individuals from 28 May to 28 July (Table 3); thus, our captures in May expand the early date of activity in the state by about a month.

REPRODUCTION.—Jones (1964) states that this species gives birth to a single young from May to July. We observed 2 pregnant females each on 28 May and 4 July, and 2 of them kept as specimens contained a single fetus (both 28 May; Table 4). On those dates, we also captured lactating females—2 on 28 May and 4 on 4 July (Table 5). Previously, lactating females were known from 24 June to 16 July in the state (Czaplewski et al. 1979, Benedict 2004); thus, we expanded the early date of lactation for the species in Nebraska. We captured a single post-lactating female on 4 July. On 28 July, we captured 3 young in a building; on the basis of forearm length and body weight (Table 6), these young likely could fly. Volant young are known in Nebraska from 15 July to 5 August (Benedict 2004). We also captured adult males along the North Platte River. Adult males already were known from the Pine Ridge (Czaplewski et al. 1979). Presence of lactating females in Scotts Bluff County provides the first evidence of reproducing populations of little brown bats in that county.

LOCALITIES OF OCCURRENCE.—*Scotts Bluff County* (23): (**3**) North Platte National Wildlife Refuge, Stateline Island, 41°59.199′ N, 104° 02.224′ W, 4 July 2002 (3 ♀♀, 2 ♀♀ preg, 4 ♀♀ lact [MSB 124417], 1 ♀ post-lact); (**5**) Mitchell, 14th Avenue and 13th Street, 41° 56.418′ N, 103°48.424′ W, 28 July 2000 (1 ♀ [UNSM 28180], 1 YOY ♀ [UNSM 28183], 2 YOY ♂♂ [UNSM 28181, 28182]); (**13**) North Platte National Wildlife Refuge, Spillway of Lake Alice, T23N, R54W, SW ¼ Sec. 9, 41°58.867′ N, 103°35.544′ W, 28 May 2002 (1 ♀, 2 ♀♀ preg [MSB 124391, 124392], 2 ♀♀ lact, 3 ♂♂ [MSB 124393]); (**14**) Lake Minatare, 41°55.436′ N, 103°30.618′ W, 29 June 2002 (1 ♀ [MSB 124401]).

TABLE 10. Dates of capture for eastern red bats (*Lasiurus borealis*) in the Wildcat Hills and surrounding areas in western Nebraska. Some adults captured in August and September likely represent volant young with ossified epiphyseal plates (see Methods).

| Date | Adult male | Adult female |
|---|---|---|
| 4 Jun | | 1[a] |
| 28 Jul | | 1 |
| 29 Jul | | 1 |
| 31 Jul | 1 | 1 |
| 1 Aug | 1 | |
| 4 Aug | 1 | 2 |
| 5 Aug | 1 | 1 |
| 9 Aug | | 1 |
| 27 Aug | 2 | |
| 28 Aug | 1 | |
| 8 Sep | 1 | |
| 28 Sep | 1 | |
| 29 Sep | 1 | |
| TOTALS | 10 | 8 |

[a]Individual collected by other researchers; data from museum specimens.

## *Lasiurus borealis* (Müller, 1776)

### Eastern Red Bat

Eastern red bats are summer residents across Nebraska (Benedict 2004) and are more common in eastern parts of the state (Czaplewski et al. 1979). Similar to hoary bats, red bats roost in foliage of trees and other vegetation (Jones et al. 1983, Shump 1999), and both species are known to use deciduous and coniferous trees (Jones et al. 1983, Menzel et al. 1998, Hutchinson and Lacki 2000, Elmore et al. 2004, Perry and Thill 2007). Eastern red bats are migratory in Nebraska, but hibernation in the state is a possibility because red bats are common in winter at latitudes as far north as the Ohio River Valley (Davis and Lidicker 1956, Jones et al. 1983). If eastern red bats are discovered to winter in the state, they likely would be observed in deciduous forests in southeastern areas such as Indian Cave State Park in Nemaha and Richardson counties.

DISTRIBUTION AND HABITAT.—The eastern red bat was the least frequently captured species during our survey (17 individuals), and it was documented in 5 of 10 years sampled (Table 1). Individuals were captured in Banner and Scotts Bluff counties, with both counties representing new records of occurrence for those counties (our captures in Dooley Canyon, Banner County, in 1997 were previously reported by Benedict et al. 2000 with our permission). All of our captures of red bats were associated with coniferous-covered canyons in the Wildcat Hills and Southern Wildcat Hills. We did not capture individuals in cottonwood forests along the North Platte River, but red bats are known from the town of Bridgeport near the North Platte River in Morrill County (Benedict et al. 2000).

SEASONAL ACTIVITY.—In Nebraska, eastern red bats have been observed as early as 26 April and as late as 1 November (Table 3). We captured red bats from only 28 July to 29 September, but an earlier date (4 June) is available from our study area (Morrill County; UNSM 27902; Benedict et al. 2000). A lack of captures in coniferous forests during spring migration, in June, and for most of July, suggests that those forests are infrequently inhabited by *L. borealis* during those times of the year in the Wildcat Hills.

In western Nebraska, autumn migration for *L. borealis* appears to begin in late July/early August. From 28 July to 5 August 2010, we consistently captured 1–3 individuals most nights (Table 10). Moreover, 18 nonreproductive red bats (6 adult males and 12 adult females) were captured in a single evening and early morning in early August 2010 in the Pine Bluffs area of Kimball County (KG and KNG unpublished data), suggesting a migratory wave. Benedict (2004) reported 7 captures of red bats from Sheridan County in the Pine Ridge, all from 29 July to 5 August, with no lactating females or volant young. Thus, we suggest that, to state with confidence that red bats are summer residents in western Nebraska, especially individuals that are not lactating females, individuals should be captured before late July. On the basis of this definition, few summer residents of red bats exist in western Nebraska—the June record mentioned above (a mother and 4 young), a lactating female captured in the Pine Ridge in Sioux County on 15 July (Czaplewski et al. 1979), and an adult male captured on 1 July in Dawes County (Benedict 2004). Thus, most of the other adult males reported by Benedict (2004) from 21 July to 6 August likely were migratory or wandering individuals. In our study area, migratory movements of red bats continued at least until late September (Table 10).

Records of red bats in western Nebraska from July to September appear to be mainly

nonreproductive individuals, but it is unclear where these migratory bats are coming from. Cryan (2003) showed that red bats are not common across western and north-central parts of the Great Plains (including western Nebraska) until July–September and reported few females north of western Nebraska in June. Might many of our captures represent individuals arriving from easterly localities (including eastern Nebraska) and not necessarily from northerly locations? Cryan (2003) reported an "apparent expansion onto the northern Great Plains by some *L. borealis* during August." Further research in western Nebraska is warranted to know where individuals are coming from during autumn migration and where they are headed. Few red bats are known directly to the south of our study site (e.g., New Mexico and West Texas), and during cooler months, most eastern red bats appear concentrated in areas with deciduous forests in the eastern United States, considerably east of our study site.

From 1997 to 2002, we captured only 6 individuals (49 nights of netting with 127 nets), but in 2010, 11 red bats were captured during our field efforts (11 nights of netting with 34 nets, Table 2). The increase in captures in 2010 likely represents a trend of increasingly more individuals of this species in western Nebraska and surrounding states. Originally, red bats were not documented in the westernmost parts of Nebraska, even in the Pine Ridge, despite efforts to capture bats (Jones 1964). However, in subsequent years, other researchers have reported red bats from western Nebraska, commenting that the red bat now occurs statewide (Farney and Jones 1975, Benedict 2004).

REPRODUCTION.—Reproduction is known from both eastern and western parts of Nebraska (Czaplewski et al. 1979, Benedict et al. 2000, Benedict 2004). Although we did not document pregnant or lactating females during our survey, a female with 4 young previously was reported in Morrill County on 4 June (UNSM 27902; Benedict et al. 2000). Dates of lactation in Nebraska span from 30 May to 27 July (Benedict 2004). We also did not capture volant young during our study. Dates for volant young in Nebraska span from 13 July to 5 September (Benedict 2004, Geluso et al. 2004a).

LOCALITIES OF OCCURRENCE.—*Banner County* (16): (**1**) 1 km S, 22 km W Harrisburg, mouth of Bull Canyon, 41°32.916′ N, 104° 00.164′ W, 4 August 2010 (1 ♀ [UNSM 30074]), 5 August 2010 (1 ♀, 1 ♂ [UNSM 30075]); (**2**) 3 km S, 21 km W Harrisburg, Bull Canyon, 41°31.783′ N, 103°59.506′ W, 31 July 2010 (1 ♀, 1 ♂ [UNSM 30073]), 1 August 2010 (1 ♂), 4 August 2010 (1 ♀, 1 ♂), 8 September 2010 (1 ♂); (**3**) 5 km S, 18.7 km W Harrisburg, [Long Canyon], 41°30.513′ N, 103°57.870′ W, 28 July 2010 (1 ♀), 29 July 2010 (1 ♀ [UNSM 30072]); (**5**) Wildcat Hills State Recreation Area, Dooley Canyon, T20N, R55W, NW ¼ Sec. 21, 41°41.738′ N, 103°40.049′ W, 27 August 1997 (2 ♂♂ [MSB 123011]), 28 August 1997 (1 ♂), 9 August 1999 (1 ♀ [UNSM 28199]), 29 September 2000 (1 ♂ [UNSM 28161]).

*Scotts Bluff County* (1): (**4**) Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103°48.637′ W, 28 September 2002 (1 ♂ [MSB 124288]).

ADDITIONAL RECORDS (VIA MUSEUM SPECIMENS AND PUBLICATIONS).—*Morrill County* (7): (**C**) south part of Bridgeport, 4 June 1985 (1 ♀ lact with 4 young [UNSM 27902]); (**D**) Bridgeport, no date given (7 unknown sex [housed at Bridgeport High School, Bridgeport, NE, Benedict et al. 2000—5 of these 7 specimens likely represent the family group from 4 June 1985 housed at UNSM]).

## DISCUSSION

### Species Richness

Our surveys of bats in the Wildcat Hills and surrounding areas yielded 7 species of bats. All species previously were known from the region except the little brown bat (Jones 1964, Czaplewski et al. 1979, Benedict et al. 2000). We suspect that 3 other species of bats might inhabit the area because of their occurrence in the Pine Ridge; these species include the long-legged myotis (*Myotis volans*), northern long-eared myotis (*Myotis septentrionalis*), and Townsend's big-eared bat (*Corynorhinus townsendii;* Jones 1964, Czaplewski et al. 1979, Benedict et al. 2000). Additionally, the pallid bat (*Antrozous pallidus*) and tricolored bat (*Perimyotis subflavus*) might reside in the region because of occurrences in eastern Wyoming (Clark and Stromberg 1987, Bogan and Cryan 2000).

The long-legged myotis is a common inhabitant of the Pine Ridge (Czaplewski et al. 1979) and has been reported as close as Torrington,

Goshen County, Wyoming (Bogan and Cryan 2000). Torrington is only 13 km from our study sites along the North Platte River in Scotts Bluff County. It is unclear why *M. volans* does not appear to occur in the Wildcat Hills, but the species might have occurred there in the past before extensive logging in the region in the late 1800s and early 1900s (Weaver 1965). Moreover, the Wildcat Hills encompass a smaller geographic area of pine-forested buttes compared to the Pine Ridge; thus, specific requirements for this species might be lacking in our study area.

The northern long-eared myotis occurs in eastern and northern parts of Nebraska and has recently been documented in eastern parts of the Pine Ridge (Sheridan County, Benedict et al. 2000). This species also is known to occur in the Black Hills of South Dakota (Turner 1974). It is unclear whether *M. septentrionalis* recently has expanded its distribution into the Pine Ridge or whether it has always occurred there but was never detected due to limited surveys of bats in the area. If the species has expanded its range, it might eventually occur in the Wildcat Hills, pending requisite habitats. Additional surveys of bats are warranted in the Pine Ridge to determine whether or not individuals of *M. septentrionalis* from Sheridan County represent an isolated population. Recently, the species has been petitioned to be listed as threatened or endangered under the Endangered Species Act in response to population declines in eastern parts of its range associated with white-nose syndrome.

Only a single record of *C. townsendii* has been reported from Nebraska; a male was captured on a structure in Sheridan County north of Hay Springs (Czaplewski et al. 1979). The species also occurs in the Black Hills of South Dakota (Turner 1974) and in eastern Wyoming (Platte County, Bogan and Cryan 2000; Goshen County, Fort Laramie National Historic Site, KG unpublished data). Due to difficulty in capturing this species in mist nets, *C. townsendii* might occur at low densities in the Wildcat Hills but was undetected by our efforts. Its potential occurrence is likely tied to the presence of appropriate hibernacula, but we are unaware of any deep caves or mines in the study area.

The pallid bat has been recorded from a building in Torrington, Wyoming (Stromberg 1982, Clark and Stromberg 1987), about 11 km from Nebraska's border, just west of our study sites in northwestern Scotts Bluff County. The paucity of records from eastern Wyoming suggests that the species is not a common inhabitant of the area. Pallid bats produce audible calls (K. Geluso, personal observation), and we never heard such calls during our survey. All unusual reports of bats (e.g., individuals with large ears and pale coloration) in structures should be investigated in the future, even in grasslands away from pine-covered buttes (Clark and Stromberg 1987). If *A. pallidus* is eventually documented in Nebraska, it would represent a state record.

The tricolored bat (formerly named the eastern pipistrelle, *Pipistrellus subflavus*) has expanded its distribution across the Great Plains in recent decades (Geluso et al. 2005). Records of occurrence now are reported from the Black Hills of South Dakota (Geluso et al. 2005), eastern Wyoming (Bogan and Cryan 2000), and eastern Colorado (Fitzgerald et al. 1989). The tricolored bat inhabits deciduous forests and hibernates in caves and mines. This species also is infrequently captured in mist nets compared to other species, so it might already reside in the area but went undetected by our efforts.

### Seasonal and Reproductive Records

We documented 5 species of bats active in our study area for longer periods during warmer months than previously reported in the state. For 7 species, we observed evidence of reproducing populations in the region based on presence of lactating females, and for a number of species, we extended dates for pregnancy, lactation, and presence of volant young in Nebraska. For example, we presented the first evidence of reproduction for the fringed myotis in Nebraska, a Tier 1 species of state concern (Schneider et al. 2005). Such new records for those species demonstrate the paucity of information for bats in western parts of the state. Our study in the Wildcat Hills was similar to another long-term study in eastern Nebraska that spanned 13 years in the floodplain of the Missouri River (Geluso et al. 2004a). Geluso et al. (2004a) also reported many seasonal records of activity and much new information regarding reproduction in the eastern part of the state. Such studies demonstrate the importance and

need for long-term efforts and wide-ranging, seasonal attempts to capture volant bats (e.g., April–November in our study); these efforts and attempts ultimately assist researchers and resource managers in understanding and managing bats.

## Migration

The Wildcat Hills and surrounding area represent a unique assemblage of bats in Nebraska—4 hibernating and 3 migratory species. The migratory species (hoary bat, eastern red bat, and silver-haired bat) are of current interest because of expansion of wind-energy facilities to generate electricity for human use. These migratory species appear attracted to wind turbines, which are reported to kill many individuals during their southward migration in late summer and autumn (e.g., Kunz et al. 2007, Arnett et al. 2008). To date, only a single, small wind facility exists in the panhandle of Nebraska (in Kimball County, which is south of Banner County), but many wind turbines already are established just south of the Nebraskan border in northeastern Colorado. The potential for additional wind facilities to be developed in western Nebraska appears great because of high wind speeds at 80 m above the ground (NREL 2010).

Our data demonstrate that migratory patterns differ among the 3 migratory species in western Nebraska. During late summer and autumn migration, movements of eastern red bats and hoary bats generally begin earlier than movements of silver-haired bats. In Pennsylvania and West Virginia, timing of fatalities of eastern red bats and hoary bats also was correlated (Arnett et al. 2008), suggesting that migration in those species occurs concurrently, as observed in western Nebraska. In Iowa, Arnett et al. (2008) reported substantial bat fatalities in July, August, and September, which is the period of migration for bats in western Nebraska. In the Wildcat Hills and surrounding areas, northward migration in spring included male and female silver-haired bats and female hoary bats. Although most bat fatalities associated with wind turbines occur in late summer and autumn, turbines also cause fatalities for silver-haired bats in spring (Arnett et al. 2008). More intensive efforts on migratory patterns of bats are needed during spring in western Nebraska and throughout the Great Plains.

Understanding the timing of migratory movements of bats can be used to reduce bat mortalities in the future, especially pending development of more wind turbines in Nebraska. For example, a study in Pennsylvania demonstrated that reducing wind-turbine operation during periods of low wind speeds can greatly reduce bat mortality (Arnett et al. 2011). Those authors demonstrated that relatively small changes to turbine operation ($\leq$1% total annual output) reduced nightly mortality of bats by as much as 93%.

## Conclusions

Information regarding the natural history of these unique, nocturnal species is more difficult to gather compared to diurnal species such as birds. Our study provides a baseline inventory, but many additional studies could be conducted to learn more about bats in western Nebraska, including study of roosting sites in winter and summer. We hope that publications (e.g., Benedict 2004, Geluso et al. 2004a, this study) reporting detailed information on seasonal and reproductive activities will serve as templates and incentives to continue further studies on the natural history of bats in the Great Plains and elsewhere.

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Wildlife Conservation Fund, Nebraska Game and Parks Commission (Lincoln, NE). In 2002, KG surveyed mammals at the North Platte National Wildlife Refuge while employed by the U.S. Geological Survey, Arid Lands Field Station, Albuquerque, New Mexico, and data obtained on bats are included within this paper.

JJH memorializes his uncle, Rob Ziegler (12 May 1952–6 November 2011), formerly of Scottsbluff, Nebraska, who provided hospitality, encouragement, and company in the field on many occasions during this project.

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APPENDIX. Localities of capture sites for bats in 3 counties in the panhandle of Nebraska during our survey (1997–2011) and localities of specimens obtained by previous researchers. Numbers preceding localities refer to numbered locations in Fig. 1 for each county for our study sites. Letters preceding localities refer to locations in Fig. 1 for each county of specimens collected by other researchers. Localities are listed in order from west to east. For our study sites, coordinates were determined with handheld global positioning systems using North American Datum 1983, unless stated otherwise.

*Banner Co.*: (**1**) 22 km W, 1 km S Harrisburg, mouth of Bull Canyon, 41°32.916′ N, 104°00.164′ W; (**2**) 21 km W, 3 km S Harrisburg, Bull Canyon, 41°31.783′ N, 103°59.506′ W; (**3**) 18.7 km W, 5 km S Harrisburg, [Long Canyon], 41°30.513′ N, 103°57.870′ W; (**4**) 17.5 km W, 4.9 km S Harrisburg, [Long Canyon], 41°30.568′ N, 103°57.443′ W; (**5**) Wildcat Hills State Recreation Area, Dooley Canyon, T20N, R55W, NW ¼ Sec. 21, 41°41.738′ N, 103°40.049′ W (via Google Earth); (**6**) Buffalo Creek Wildlife Management Area, T20N, R54W, SW ¼ Sec. 19, 41°41.393′ N, 103°35.757′ W (via Google Earth); (**7**) Burchfield Property, T20N, R54W, SE ¼ Sec. 25, 41°40.526′ N, 103°29.208′ W (via Google Earth); (**A**) 9 mi N, 5 mi E Harrisburg; (**B**) 10 mi S, 2.5 mi E Gering.

*Morrill Co.*: (**1**) Pumpkin Creek, T19N, R51W, SW ¼ Sec. 20, 41°36.124′ N, 103°13.731′ W (via Google Earth); (**A**) Bayard; (**B**) 1.25 mi N, 3.5 mi E Redington, Roundhouse Rock; (**C**) south part of Bridgeport; (**D**) Bridgeport; (**E**) Bridgeport, Old High School; (**F**) 8.0 mi S, 7.5 mi E Bridgeport, T18N, R49W, Sec. 5; (**G**) T19N, R48W, SW ¼ Sec. 28; (**H**) Attic Broadwater School Gymnasium, T19N, R48W, Sec. 22; (**not plotted in Fig. 1**) tree in yard of Ron Franklin.

*Scotts Bluff Co.*: (**1**) North Platte National Wildlife Refuge, Stateline Island, 41°59.361′ N, 104°03.169′ W; (**2**) North Platte National Wildlife Refuge, Stateline Island, 41°59.323′ N, 104°02.954′ W; (**3**) North Platte National Wildlife Refuge, Stateline Island, 41°59.199′ N, 104°02.224′ W; (**4**) Carter Canyon, T21N, R56W, NE ¼ Sec. 28, 41°45.968′ N, 103° 48.637′ W; (**5**) Mitchell, 14th Avenue and 13th Street, 41°56.418′ N, 103°48.424′ W (via Google Earth); (**6**) Cedar Canyon Wildlife Management Area, T21N, R56W, NW ¼ Sec. 35, 41°45.254′ N, 103°46.753′ W (via Google Earth); (**7**) Cedar Canyon Wildlife Management Area, T21N, R56W, NE ¼ Sec. 35, 41°45.257′ N, 103°46.458′ W (via Google Earth); (**8**) Wildcat Hills, T20N, R56W, SE ¼ Sec. 13, 41°42.130′ N, 103°43.093′ W (via Google Earth); (**9**) Wildcat Hills, T20N, R55W, SE ¼ Sec. 17, 41°42.230′ N, 103°41.081′ W (via Google Earth); (**10**) Wildcat Hills State Recreation Area, Picnic Shelter, T20N, R55W, NW ¼ Sec. 16, 41°42.481′ N, 103°40.362′ W (via Google Earth); (**11**) Wildcat Hills State Recreation Area, Large Picnic Shelter, T20N, R55W, NE ¼ Sec. 16, 41°42.530′ N, 103°40.074′ W (via Google Earth); (**12**) Kenitz Property, T20N, R55W, SW ¼ Sec. 3, 41°43.702′ N, 103°39.001′ W (via Google Earth); (**13**) North Platte National Wildlife Refuge, Spillway of Lake Alice, T23N, R54W, SW ¼ Sec. 9, 41°58.867′ N, 103°35.544′ W (via Google Earth); (**14**) Lake Minatare, 41°55.436′ N, 103°30.618′ W; (**15**) Lake Minatare, 41°56.682′ N, 103°28.267′ W; (**A**) 6.8 mi S, 1.9 mi W Mitchell P.O., T22N, R56W, NE ¼ NW ¼ Sec. 32; (**B**) Carter Canyon, 12 mi S, 0.2 mi E Mitchell P.O., T21N, R56W, SW ¼ NE ¼ Sec. 28; (**C**) Scottsbluff, Great Western Sugar Plant; (**D**) Lake Minatare, 8 mi N Minatare.