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SHIFTING DISTRIBUTIONAL PATTERNS OF MAMMALS IN NEBRASKA

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ABSTRACT

New distributional records are presented for 20 species of mammals in Nebraska. The majority of these records appear to represent changes in geographic distribution rather than just better sampling in poorly known areas. One group of mammals, including the opossum, northern myotis, evening bat, red bat, woodchuck, white-footed mouse, and gray fox, is expanding westward, probably in response to increasing woodlands along river systems. Another group, including the meadow vole, masked shrew, and least weasel, is expanding southward, possibly in response to new prey species and changing microclimates. The eastern woodrat appears to be expanding northward in eastern Nebraska. The armadillo and hispid cotton rat also have been documented as expanding northward into Nebraska in previous studies. The mountain lion is expanding eastward into extreme western Nebraska and reclaiming some of its historical geographic range, whereas the northern grasshopper mouse also is expanding eastward, but in extreme eastern Nebraska. On the other hand, mammals requiring large tracts of undisturbed prairie appear to be contracting in geographic range in Nebraska.

† † †

Before the arrival of European settlers in the mid-1800s, the landscape of Nebraska was dominated by prairies. The nature of these prairies varied across the state primarily because of differences in soils and decreasing quantities of precipitation to the west (Bragg 1995, Kaul and Rolfsmeier 1993). The eastern third of the state was dominated by tallgrass prairie, in the west several types of shortgrass prairies grew, and in central Nebraska several types of mixed-grass prairies predominated (Kaul and Rolfsmeier 1993). On the fine, sandy soils of north-central Nebraska, Sandhills supported mixed-grass prairie. Three major forest types occurred in Nebraska, but they apparently were limited to areas protected from fire. Ponderosa pine forests grew in several locations in the western half of the state; upland deciduous forests, dominated by oak, hickory, and elm, grew in the eastern half of the state; and riparian forests, dominated by cottonwood and willow, grew throughout the state (Kaul and Rolfsmeier 1993). Both ponderosa pine forests and upland deciduous forests were located primarily on steep bluffs along rivers, whereas riparian forests were limited to the floodplains of major waterways.

In the decades after settlement, the landscape of Nebraska was altered dramatically, primarily because of agricultural practices (Fleharty and Channell 1997). Prairies have been impacted more heavily than other ecosystems. Over 95% of tallgrass prairie in Nebraska, for example, has been converted to agricultural fields and other anthropogenic habitats (Kaul and Rolfsmeier 1993, Noss et al. 1996). Mixed grass prairies also have been heavily impacted, with rates of habitat loss exceeding 75 % (Samson and Knopf 1994). In both tallgrass and mixed-grass prairies, remaining patches of habitat typically are small and isolated, grazed by non-native herbivores, and/or are being invaded by woody vegetation (Benedict et al. 1996, Bogan et al. 1995, Kaul and Rolfsmeier 1993). On a landscape scale, shortgrass prairies and Sandhills mixed-grass prairies have not been converted to agricultural fields at as great of a rate, but habitat loss has been high in localized areas (Bogan et al. 1995, Samson and Knopf 1994). Even where large patches of these prairies remain, however, the removal of large, free-ranging grazers (bison, elk, pronghorn), the partial control of fire and prairie dogs, and the introduction of non-native plants have caused changes in the ecosystems (Benedict et al. 1996, Bogan et al. 1995, Samson and Knopf 1994).

In contrast to prairies, riparian forests have increased dramatically and now form nearly continuous corridors along major waterways, such as the Platte, Republican, Big Blue, Little Blue, and Niobrara rivers, as well as along smaller streams (Kaul and Rolfsmeier 1993). Although riparian forests were present along Nebraska's rivers before settlement, apparently they were uncommon in central and western parts of the state and distributed as isolated patches (Johnson 1994). With the control of prairie fires, the elimination of most native grazers, and the alteration of flow patterns in many rivers, riparian forests expanded dramatically in the early part of this century (Johnson 1994). At four sites along the Platte River system in central and western Nebraska, for instance, woodlands expanded in area by an average of roughly 240 % between 1937 and 1986 (calculated from data presented in Johnson 1994). Likewise, along the Republican River in southwestern Nebraska, riparian forests increased by nearly 300 % in extent from 1952 through 1990 (Roedel 1992).

The response of upland forests to settlement has been more complicated than that of riparian forests. Ponderosa pine forests have been logged in some areas (Kaul and Rolfsmeier 1993) but appear to be stable or increasing in overall area because of the control of fire (Steinauer and Bragg 1987, Wardle and Schmidt 1981). Statewide changes in upland deciduous forests following settlement have not been well quantified, but apparently mature oak/hickory forests initially decreased in area because of logging and clearing for farmland and grazing. For example, Aikman (1929: 65), referring to the late 1800s and early 1900s, wrote:

> "…there has been constant cutting of timber during this period. … The clearings [of forests] have spread to the upland until there are in many places practically no upland forests remaining except in sheltered ravines and on other rough land unsuitable for farming. The distance between these remnants of the deciduous forest makes migration [of tree seeds] difficult and uncertain."

According to Raile (1986) and Schmidt et al. (1982), the clearing of forest continues today. In studies quantifying woodland changes for the timber industry, these authors concluded that the area of forested land in Nebraska decreased by roughly 20 % between 1955 and 1982, primarily because of clearing for crop fields. Their studies, however, primarily focused on forests with trees of harvesting size and did not include narrow woodland strips, one of the habitats that appears to be increasing in area.

On the other hand, upland deciduous forests appear to have expanded in some areas, especially in recent decades, because of the control of prairie fire (Bragg 1995) and intentional planting by humans (including urban forests, shelterbelts, and farmstead plantings). Although this expansion is most evident in early successional species (ash, elm, hackberry, maple), slower growing species also have locally increased. Again, Aikman (1929: 65) wrote:

> "Within the memory of early settlers, red oak and linden have migrated up the Weeping Water [Creek] and Nemahas [Big and Little Nemaha Rivers] and replaced the chaparral and scrubby bur oaks. Several tracts … which are known to have been subclimax prairie fifty years ago, are now covered with a good growth of bur oak and hickory."

It is difficult to determine with certainty, therefore, what the net impact of settlement has had on upland deciduous forest, but it appears that large areas of climax upland forest are less common today than in the past.

Finally, some deciduous forests in Nebraska, both upland and riparian, have changed in species composition in the last century for several reasons. First, several introduced species, including Siberian elm, white mulberry, Russian olive, and several shrubs, are locally common, and occasionally are dominant members of local forests (Kaul and Rolfsmeier 1993). Second, suppression of fire and the control of flooding has led to a shift in species composition in some forests. This change is most evident in riparian forests where the control of flooding apparently is causing an increase in later successional species at the expense of cottonwood and willow (Johnson 1992. Raile 1986).

Given the substantial changes in habitat that have occurred in Nebraska since European settlement, it is not surprising that the distributions of mammals have changed in the state in recent decades (Fleharty and Channell 1997). Jones (1964) focused his intensive study on the mammals of Nebraska and their distribution and taxonomy. His field work for the project began in the summer of 1946 and he closed his records on March 31, 1962, with particularly intensive work in the late 1950s and early 1960s with several field crews from the University of Kansas assisting with the study. Jones (1964) was able to assemble 10,339 specimens from the state for the basis of his book in addition to surveying the scientific literature for additional records. He was able to examine specimens and establish records for mammals in 91 of the 93 counties in Nebraska, with information missing only for Arthur and McPherson counties in the western Sandhills. It is our contention that he was able to thoroughly document the distributional patterns of mammals of the state as they existed in approximately 1960. Our contention is supported, at

least in part, by the results of similar studies done during approximately this same time period on the distributional patterns of mammals in the adjoining states of Iowa (Bowles 1975), Missouri (Schwartz and Schwartz 1959), Kansas (Cockrum 1952, Hall 1955), Colorado (Armstrong 1972), Wyoming (Long 1965), and South Dakota (Findley 1956, Turner 1974).

Field work conducted throughout the state in the last several decades has produced a substantial number of specimens from beyond the known distributional limits for certain species as presented in Jones (1964). In this paper, new distributional records are presented for 20 species (25.6 % of the species currently known from the state) and these combined with new records for two additional species from Nebraska—nine-banded armadillo (*Dasypus novemcinctus*) reported by Freeman and Genoways (1998) and Merriam's shrew (*Sorex merriami*) reported by Benedict et al. (1999) and Freeman et al. (1996)—indicate that as many as 22 species (28.2% of the mammalian fauna) of mammals may be shifting their distributional patterns in Nebraska.

METHODS AND MATERIALS

All measurements were taken using digital calipers and were recorded to the nearest 0.01. All measurements are given in millimeters. On the maps that follow are plotted new records presented in this paper (closed circles) and records cited by other authors (open circles) that were collected outside of the geographic ranges presented by Jones (1964). In the section describing new records, specimens are listed by county, from east to west, then south to north.

Specimens reported in this paper are housed at the following locations: University of Nebraska State Museum, University of Nebraska–Lincoln, (UNSM); Bridgeport High School, Bridgeport, NE (BHS); University of Nebraska at Kearney, (VMKSC); U.S. Geological Survey Biological Survey Collection, Albuquerque, NM, (USGS); and the University of Kansas (KU).

SYSTEMATIC ACCOUNTS

Didelphis virginiana (Virginia Opossum)

New records (3).–MORRILL COUNTY: T20N, R50W, Sec. 33 [Bridgeport], 1 (UNSM 21328); T21N, R52W, Sec. 30 [vicinity of Bayard], 1 (BHS 183). DAWES CO.: no specific locality, 1 (UNSM 21329**).**

Other records.–SCOTTS BLUFF CO.: 3 miles N McGrew (Choate and Genoways 1967); Scotts Bluff National Monument (Cox and Franklin 1989).

Sight record.–BOX BUTTE CO.: 4.5 miles E Hemingford (Druecker).

Prior to European settlement, the opossum apparently was limited to woodlands in southeastern Nebraska (Jones 1964). In the last 150 years, however, this species has expanded northward and westward in the state, probably in response to intentional introductions, increases in the amount of woody vegetation, increasing food availability (especially corn, milo, sorghum, and cereal grains), and the control of predators (Jones 1964). Choate (1987) found a similar situation to prevail in western Kansas. The distribution map presented by Jones (1964) showed the opossum occupying the eastern half of Nebraska and extending west along major river drainages. The westernmost record in his publication is from Alliance, Box Butte County, but no specimens had been collected from the Platte River west of Ogallala (Fig. 1). More recently, opossums have been recorded from north of McGrew in Scotts Bluff County (Choate and Genoways 1967), and at Scotts Bluff National Monument in the same county (Cox and Franklin 1989). Both of these localities are in the valley of the North Platte River (Fig. 1). Additionally, opossums have been collected along the North Platte in Goshen County, Wyoming (Brown 1965), probably reaching this locality by dispersing along the Platte system in Nebraska (Choate and Genoways 1967).

Three new specimens of *Didelphis virginiana* are reported in this paper from western counties in Nebraska. Two of these specimens, one male and one reproductively inactive female, were collected along the North Platte River in Morrill County. These specimens partially fill the gap between the Scotts Bluff County specimens (Choate and Genoways 1967, Cox and Franklin 1989) and the edge of the distribution along the North Platte River shown by Jones (1964), suggesting the opossum is now continuously distributed along this river (Fig. 1). Another opossum, a reproductively inactive female, was captured in Dawes County and an opossum was seen dead along State Highway 87 east of Hemingford, Box Butte County, in May 1999 by J. D. Druecker, Chadron State College. Although Jones (1964) showed the opossum extending into southern Dawes County, his distribution was not based on any specimens. This specimen from Dawes County, therefore, documents the existence of *D. virginiana* in the northwestern corner of Nebraska. All specimens reported here are referable to the subspecies *D. v. virginiana*, the only subspecies present on the Great Plains (Jones et al. 1983).

Sorex cinereus (Masked Shrew)

New records (14).–RICHARDSON COUNTY: Indian Cave State Park, 1 (UNSM 25365); 2.3 miles S, 4.5 miles W Falls City P.O., 1 (UNSM 25294). OTOE CO.: 0.9 mile S, 4.2 miles W Nebraska City P.O., 1 (UNSM 25287). CASS CO.: 0.6 mile N, 0.4 mile E Union P.O., 1 (UNSM 19812); 1 mile S, 4.65 miles W Union P.O., 1 (UNSM 25285); 1.5 miles S, 4.55 miles W Union P.O., 1 (UNSM 25286). GAGE CO.: 0.85 mile S Barneston P.O., 1 (UNSM 25292); 1.05 miles N Barneston P.O., 1 (UNSM 25293). YORK CO.: 3.5 miles S, 1 mile E Henderson, 1 (VMKSC 505). NUCKOLLS CO.: 7.1 miles S, 2 miles W Nelson P.O., 1 (UNSM 25291). WEBSTER CO.: 2.8 miles S, 0.35 mile E Blue Hill P.O., 1 (UNSM 25284). ADAMS CO.: 0.25 mile N, 5.25 miles W Hastings P.O., 1 (UNSM 25288); 2.05 miles S, 2.8 miles W Hastings P.O., 1 (UNSM 25289); 3.45 miles N, 5.8 miles W Hastings P.O., 1 (UNSM 25290).

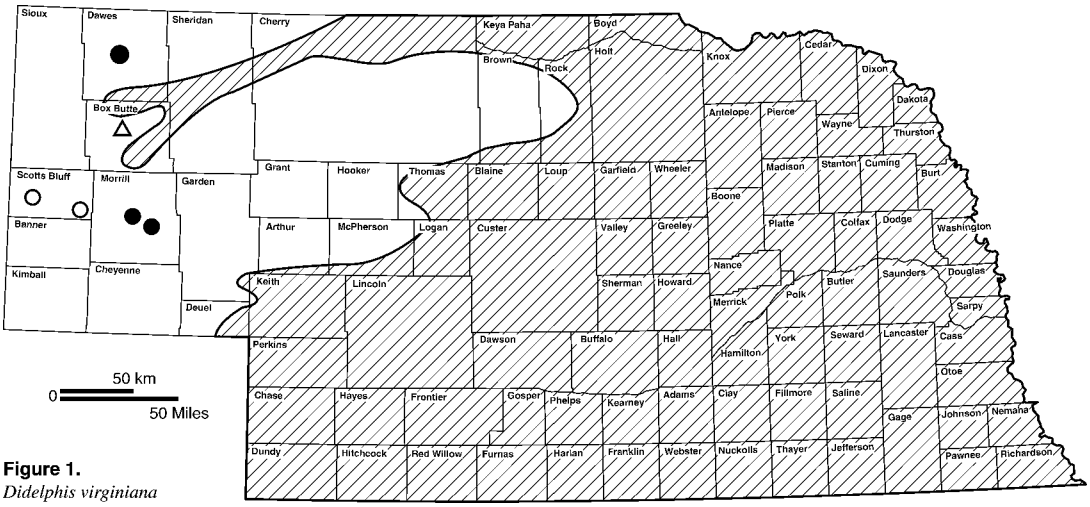

Figure 1.
Didelphis virginiana

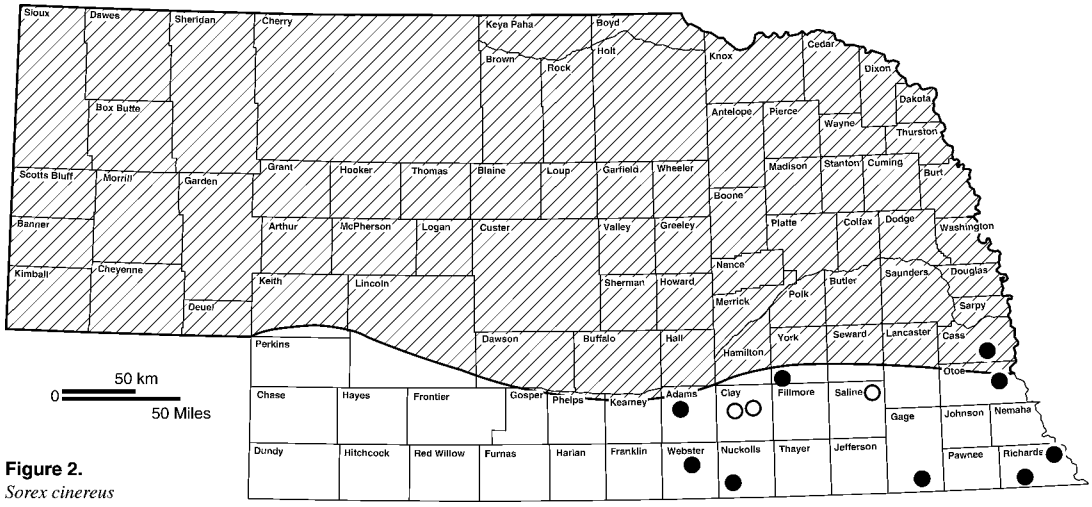

Figure 2.
Sorex cinereus

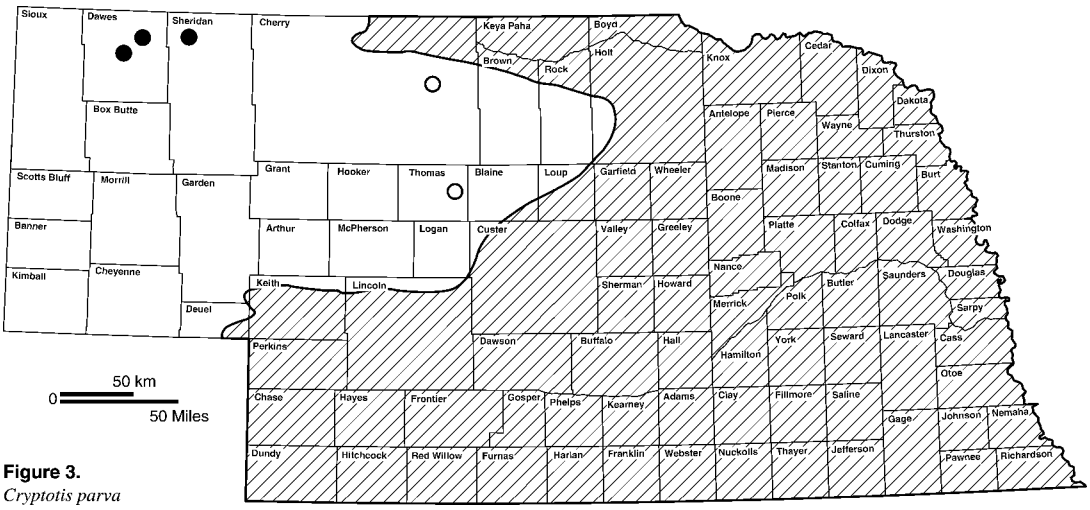

Figure 3.
Cryptotis parva

Other records (Choate and Genoways 1967).–CLAY CO.: 1.5 miles E Harvard; 7 miles E Harvard; 1 mile N, 3 miles W Saronville; 1 mile S Saronville. SALINE CO.: 1.5 miles N, 3 miles E Crete; 2 miles E Crete; 2.5 miles S, 3 miles E Crete.

According to Jones (1964), the masked shrew occupied northern Nebraska; only in the eastern third of the state did it reach south of the Platte River (Fig. 2). In 1965, *Sorex cinereus* was collected by Choate and Genoways (1967) in northern Saline and Clay counties, a short distance south of the distribution described in Jones (1964). Recent records of the masked shrew from northern Kansas (Frey and Moore 1990a, Neas et al. 1981) suggest this species may be more widespread in southern Nebraska than previously known. These Kansas records appear to represent a range expansion by this shrew, possibly in response to short-term climatic cooling on the Great Plains (Frey 1992)

A total of 14 new specimens of *Sorex cinereus* from southeastern Nebraska are reported here. The furthest south of the new specimens was captured in southern Gage County, two miles north of the Kansas border, roughly 52 miles south of the range depicted in Jones (1964). Of the new specimens, seven were reproductively inactive females, three were males, and four were individuals of unknown sex. Twelve of the new specimens were captured in dense grasses growing in roadside right-of-ways. Another specimen was captured in grasses growing adjacent to an upland deciduous forest. The last specimen was captured in thick native grasses and clumps of sumac. All new specimens are referable to the subspecies *S. c. haydeni*, the only subspecies present in the region (Jones et al. 1983); we, as Jones and Choate (1980), do not follow van Zyll de Jong (1980) and van Zyll de Jong and Kirkland (1989) in recognizing *S. haydeni* as a distinct species.

Cryptotis parva (Least Shrew)

New records (15).–SHERIDAN COUNTY: Metcalf Wildlife Management Area, 9.5 miles N Hay Springs, 2 (UNSM 25296-97). DAWES CO.: 1.1 mile N, 2 miles E Chadron, 1 (UNSM 25295); 8.9 miles S, 0.2 mile W Chadron, 12 (UNSM 25299-309).

Other records.–THOMAS CO.: Nebraska National Forest, Bessey Division (Manning and Geluso 1989). CHERRY CO.: Valentine National Wildlife Refuge (Bogan and Ramotnik 1995).

According to Jones (1964, see also Jones and Choate 1980), the least shrew occurred in the eastern half of Nebraska, extending as far west as central Cherry County in the north, and Deuel County in the southwest (Fig. 3). Two recent records indicate this species is more widespread in the Sandhills of central Nebraska than previously thought (Bogan and Ramotnik 1995, Manning and Geluso 1989).

A total of 15 new specimens of *Cryptotis parva* are reported herein from the northwestern corner of Nebraska, in Dawes and Sheridan counties (Fig. 3). These specimens represent a substantial range extension; the closest previously reported specimen was collected in Jackson County, South Dakota, 88 miles to the northeast (Hall 1981). The closest specimens reported from Nebraska were collected near Crookston, Cherry County, roughly 98 miles to the east (Jones 1964). Of the new specimens reported here, all collected in autumn of 1997, two were reproductively inactive females, 12 were males, and one was of undetermined sex. Twelve specimens were collected by domestic cats in the valley of Chadron Creek, dominated by riparian forests and pastures. Two other individuals were captured in a pitfall trap in a dry prairie surrounded by an open forest of ponderosa pine. The final specimen was captured by a cat along Little Bordeaux Creek; surrounding habitats included a narrow strip of riparian forest, open prairies, and agricultural fields. Whether these new specimens represent a previously overlooked population or indicate a recent expansion of this species into northwestern Nebraska is difficult to ascertain. It is noteworthy that this species also is dispersing westward in Kansas and Colorado (Choate and Reed 1988), New Mexico (Hoditschek et al. 1985), and Texas (Choate 1997).

Six cranial features were measured on the new specimens and compared to shrews collected in eastern Nebraska (Table 1). Two of the six measurements (length of molariform toothrow, cranial breadth) showed statistically significant differences (t-test, P = 0.0399, 0.0234, respectively) between the Pine Ridge and eastern Nebraska samples, suggesting some divergence has occurred between the two populations. Although larger samples are needed to confirm this finding, current results suggest a population of least shrews has been isolated in the Pine Ridge for sufficient time for divergence to occur. We currently assign these specimens to *C. p. parva* pending further analyses and study.

Myotis ciliolabrum (Western Small-footed Myotis)

New record (1).–GARDEN COUNTY: Ash Hollow State Historical Park, 1 (UNSM 18837).

Myotis ciliolabrum has undergone several taxonomic changes in the last several decades, being known sequentially by the names *M. subulatus*, *M. leibii*, and *M. ciliolabrum*; we follow van Zyll de Jong (1984) in the use of the specific name *M. ciliolabrum* rather than *M. leibii*, as done by Koopman (1993). Jones (1964) described the distribution of *M. ciliolabrum* [then known under the name *M. subulatus*] as western Nebraska and extending to the eastern border of the state along the northern tier of counties (Fig. 4). Jones (1976) reviewed the status of the record from Crystal Lake, Dakota Co. (Stephens 1945), in northeastern Nebraska, and

Figures 1–3. **1**. Geographic range of the opossum, *Didelphis virginiana*, in Nebraska. Shaded area represents the distribution of the opossum as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964. The open triangle represents a sight record. **2**. Geographic range of the masked shrew, *Sorex cinereus*, in Nebraska. Shaded area represents the distribution of the masked shrew as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964. **3**. Geographic range of the least shrew, *Cryptotis parva*, in Nebraska. Shaded area represents the distribution of the least shrew as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964.

Table 1. Measurements of new specimens of *Cryptotis parva* from the Pine Ridge area of Nebraska (*n* = 13 for most measurements), compared to a sample from eastern Nebraska (*n* = 8 for most measurements). Numbers are mean, standard error, and range, all in mm. Eastern Nebraska specimens are housed at UNSM.

Measurement	Pine Ridge specimens	Eastern Nebraska specimens
Occipital-premaxillary length	14.25 (±0.202) (13.6–14.9)	14.13 (±0.174) (13.2–14.7)
Breadth across nasals	1.71 (±0.081) (1.55–1.85)	1.69 (±0.074) (1.55–1.80)
Interorbital breadth	3.69 (±0.114) (3.50–3.90)	3.69 (±0.135) (3.50–3.90)
Maxillary breadth	5.12 (±0.159) (4.80–5.50)	5.06 (±0.057) (4.90–5.20)
Length of molariform toothrow	4.25 (±0.030) (4.10–4.45)	4.14 (±0.042) (3.90–4.25)
Cranial breadth	7.89 (±0.059) (7.60–8.20)	7.61 (±0.103) (7.20–8.00)

concluded that the true identity of the bat in question could not be determined because the specimen could not be found. Czaplewski et al. (1979) questioned the validity of the northeastern record and depicted the range of *M. ciliolabrum* [then known under the name *M. leibii*] as only covering western portions of the state east to areas along the Niobrara River in western Keya Paha County (Fig. 4). They included the southwestern corner of Nebraska within the range of this species because of specimens collected in Cheyenne County, in northwestern Kansas (Bee et al. 1981, Robbins et al. 1977).

The new specimen of *Myotis ciliolabrum* from Garden County, the southeasternmost specimen from Nebraska, was found dead near a small cave. Surrounding habitats include rocky outcrops, riparian forests, dry prairies, and mowed grasses. The nearest previously reported specimen was obtained about 86 miles west-northwest of the new locality, from Banner County (Jones 1964). This new specimen is of unknown sex and is referable to the subspecies *M. c. ciliolabrum* (van Zyll de Jong 1984).

Myotis septentrionalis (Northern Myotis)

New records (6).–CHERRY COUNTY: Valentine Fish Hatchery [T34N, R27W, Sec. 29 SW ¼ of NW ¼], 2 (UNSM 25312-13). SHERIDAN CO.: Metcalf Wildlife Management Area, 11 miles NW Hay Springs, 1 (UNSM 19568); Larrabee Creek, 13.7 miles N, 2 miles W Rushville, 2 (UNSM 25310-11); Larrabee Creek, 14.2 miles N, 2.5 miles W Rushville, 1 (UNSM 25314).

Other records (Czaplewski et al. 1979).–KNOX CO.: 4 miles E Niobrara; 5 miles S, 1 mile W Verdel. WEBSTER CO.: 3 miles S Red Cloud; 0.25 mile S, 2.75 miles W Guide Rock; Advent Creek, 1 mile S, 1.5 miles W Guide Rock; Willow Creek, ⅜ mile S, 2 ⅝ miles W Guide Rock; 6 miles S, 3 miles E Riverton. BROWN CO.: Fairfield Creek, 19 miles N Johnstown. KEYA PAHA CO.: 1 mile S, 18 miles E Valentine.

Jones (1964) considered *Myotis septentrionalis* a subspecies of *M. keenii*; it was elevated to specific status by van Zyll de Jong (1979). Jones (1964) examined specimens of *Myotis septentrionalis* from three counties in southeastern Nebraska (Lancaster, Cass, and Sarpy). Although this species is known from the Black Hills of South Dakota and adjacent Wyoming (Turner 1974), no specimens had been reported from the Pine Ridge area of northwestern Nebraska. Czaplewski et al. (1979) described 14 specimens from northeastern counties and 10 from the south-central part of the state and depicted the range of this species as occupying much of the eastern half of Nebraska (Fig. 5). Bogan and Ramotnik (1995) did not record this species from Fort Niobrara and Valentine National Wildlife Refuges, Cherry Co., although they did believe that the species could occur west of its known distributional limit in western Brown and Keya Paha counties.

The new material of *Myotis septentrionalis* consists of six specimens, including the first specimens from northwestern Nebraska (Fig. 5). In September of 1993 and July and August of 1998, seven adult male *M. septentrionalis* were captured in Sheridan County (four were collected, three were released). One of these individuals was caught over a stock tank on a hillside dominated by dry grasslands and open forests of ponderosa pine. Six other individuals (three of which were released) were captured over Larrabee Creek; surrounding habitats included a strip of deciduous riparian forest, open pine forests, and hay meadows. The closest previously reported specimens of *M. septentrionalis* were captured in Custer County, South Dakota, approximately 65 miles northwest of the new localities. The closest previously reported specimens from Nebraska were collected in Keya Paha County, approximately 120 miles east (Czaplewski et al. 1979).

The gender composition of the new specimens from the Pine Ridge suggests that breeding females may not occur in this region. In July and August of 1998, six adult male northern myotis were captured in Sheridan County, but no females or flying young-of-the-year were captured. During this same time period, however, nine *M. septentrionalis*, including six young-of-the-year and two lactating females, were

Table 2. External and cranial measurements of new specimens of *Myotis septentrionalis* from Nebraska. All measures are in mm, except where noted.

Measurements	UNSM **19568**	UNSM **25310**	UNSM **25311**	UNSM **25314**	UNSM **25312**	UNSM **25313**
Sex	Male	Male	Male	Male	Female	Male
Age	Adult	Adult	Adult	Adult	Adult	Juvenile
Total length	90	89	83	98	92	85
Length of tail	40	42	36	43	42	41
Length of hind foot	8	9.2	10	10.5	10	10
Length of ear	16.5	18.2	19	19	17.5	17
Length of tragus	–	10	10	9	10	9
Length of forearm	35	37	35	36	35.5	35.5
Weight (in grams)	7.7	5.7	5.3	5.6	6.9	5.7
Greatest length of skull	15.30	15.17	15.04	15.33	15.08	14.89
Condylobasal length	14.60	14.38	14.31	14.56	14.42	13.99
Zygomatic breadth	9.18	8.97	9.14	9.04	9.05	8.79
Interorbital breadth	3.69	3.76	3.59	3.63	3.55	3.70
Breadth of braincase	7.39	7.47	7.70	7.95	7.99	7.89
Length of maxillary toothrow	5.97	5.74	5.84	5.81	5.77	5.56
Length of mandibular toothrow	7.47	7.41	7.48	7.45	7.34	7.09

captured north of Valentine, 106 miles east of the Pine Ridge localities. If the northern myotis breeds in the Pine Ridge, lactating females or flying young-of-the-year should have been captured during the 1998 netting period, but none was taken. A resident population of *Myotis septentrionalis* occurs in the Black Hills of South Dakota (Turner 1974), approximately 65 miles north of the Pine Ridge, so the males captured during this study may be a bachelor colony derived from the Black Hills population.

In addition to the above specimens from the Pine Ridge, new specimens also are presented here from central and eastern Nebraska. Nine *Myotis septentrionalis* were captured in July and August of 1998 from eastern Cherry County (two collected and seven released). These animals were caught over Minnechaduza Creek; surrounding habitats included dense upland and riparian deciduous forests, pine forests, and mowed grasses. These nine animals included two lactating females, two juvenile females, four juvenile males, and one adult male. These specimens were captured about 18 miles west of the closest previously reported specimens from Nebraska (Czaplewski et al. 1979). This species appears to be expanding its geographic range into the northwestern corner of the state from the Black Hills and westward along the Niobrara River; however, there still appears to be a 106-mile gap between these eastern and western populations. Whether the gap will be closed or not is unclear, but the habitat in the intervening area along the Niobrara River currently does not appear favorable for this species, especially in western Cherry and Sheridan counties.

In eastern Nebraska, one female *M. septentrionalis* was captured and released on 30 May 1991, at Neale Woods Nature Center, in Washington County (T17N, R13E, Section 33 SW ¼). The bat was captured over a small pond surrounded by upland and riparian deciduous forests. Although this individual was captured within the distributional limits described by Czaplewski et al. (1979), it is the first reported capture from the eastern edge of the state, north of Omaha (Fig. 5). South of Omaha at Fontenelle Forest Nature Center in Sarpy County, this species was second in abundance only to *Eptesicus fuscus* (K. N. Geluso, R. A. Benedict, and F. L. Kock, *in litt.*). Given the spread of forests over the eastern half of the state, populations of this species in eastern Nebraska likely are expanding in geographic range to the west. It may be noteworthy that this species recently has become much more abundant than previously in Kansas as well (Sparks and Choate 2000). Measurements for the specimens reported here are presented in Table 2. *M. septentrionalis* is currently considered to be monotypic.

Nycticieus humeralis (Evening Bat)

New records (2).–Dixon County: Ponca State Park, 3 miles N Ponca, 1 (UNSM 16959). Merrick Co.: Bader Park, approximately 3 miles S Chapman, 1 (UNSM 25315).

Other records.–Sarpy Co.: Fontenelle Forest Nature Center (K. N. Geluso, R. A. Benedict, and F. L. Kock, *in litt.*). Pawnee Co.: 1 mile N, 4.5 miles E Lewiston (Kunz 1965). Johnson Co.: Turkey Creek, 6 miles S, 0.5 mile E Vesta (Kunz 1965). Lancaster Co.: Salt Creek, 6 miles S, 0.75 mile E Lincoln (Kunz 1965). Webster Co.: 1 mile N, 2.25 miles W

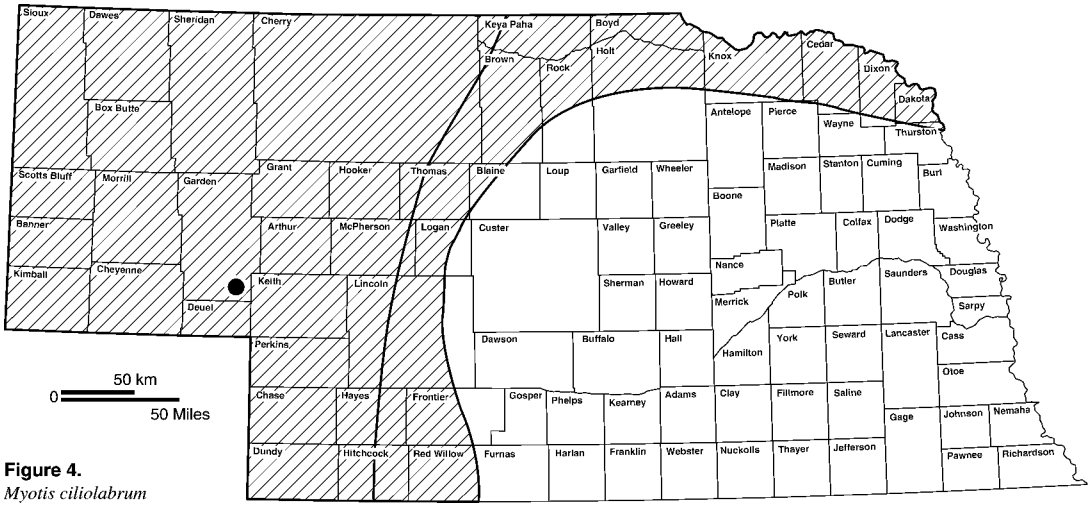

Figure 4.
Myotis ciliolabrum

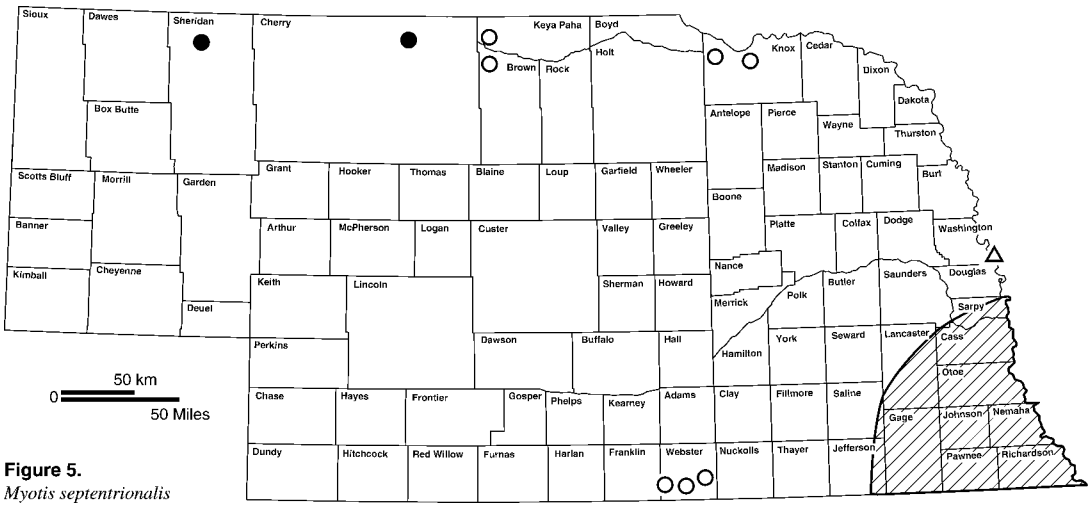

Figure 5.
Myotis septentrionalis

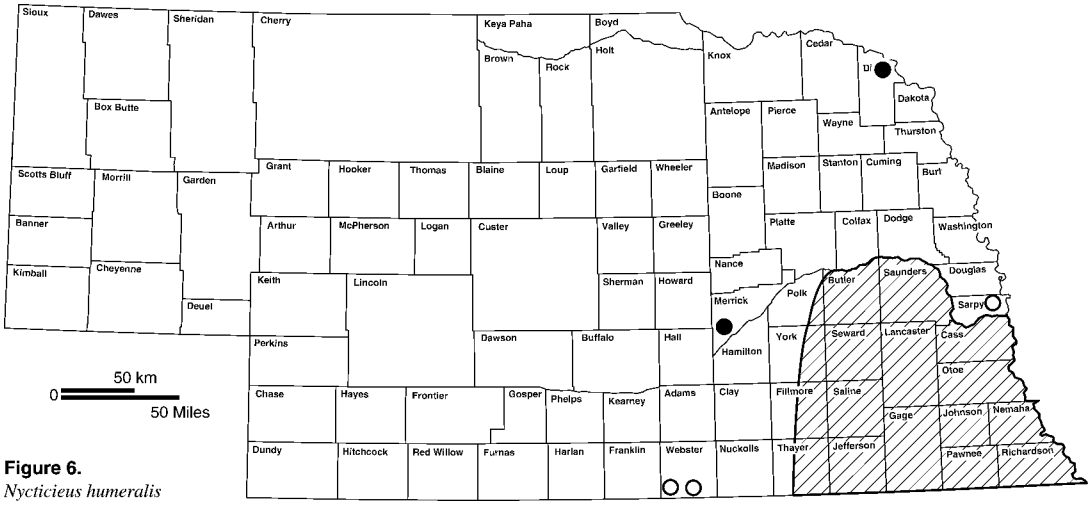

Figure 6.
Nycticieus humeralis

Guide Rock (Czaplewski et al. 1979); 3 miles S Red Cloud (Czaplewski et al. 1979).

Although Jones (1964) examined only four specimens of *Nycticieus humeralis* from Nebraska, all from one locality in Butler County (Fig. 6), he suggested this species occurred throughout the southeastern corner of the state. Shortly thereafter, Kunz (1965, see also Birney and Rising 1968) collected specimens of this species from Lancaster, Pawnee, and Johnson counties. Czaplewski et al. (1979) reported two specimens of *N. humeralis* from Webster County, in south-central Nebraska, and mapped this species as occupying the entire southeastern corner of the state (Fig. 6). Finally, K. N. Geluso, R. A. Benedict, and F. L. Kock (*in litt.*) captured 35 evening bats at Fontenelle Forest Nature Center, just east of Bellevue, Sarpy County, between 1986 and 1998.

Two new specimens of *Nycticieus humeralis* are reported in this paper. One of these specimens was collected in Ponca State Park, Dixon County, in northeastern Nebraska. This female was captured in a mist net set in a clearing surrounded by a forest of oak and other deciduous trees. This specimen represents the northwestern-most capture of this species in North America; the closest previously reported specimen was from Butler County (Jones 1964), roughly 87 miles S of the new locality. Measurements for the Dixon County specimen are as follows: total length, 101; length of tail, 35; length of hind foot, 6; length of ear, 10; length of forearm, 38; weight, 8.4 grams; greatest length of skull, 14.97; condylobasal length, 14.51; zygomatic breadth, 9.98; interorbital breadth, 4.11; breadth of braincase, 7.21; length of maxillary toothrow, 5.46; length of mandibular toothrow, 6.83.

A second specimen of *N. humeralis* was collected on 9 July 1996 in Merrick County (Fig. 6). This juvenile female was captured together with three other evening bats that were released, two were juvenile males and the third was a lactating female. The above specimen is from the western edge of the geographic range depicted by Czaplewski et al. (1979) and was captured in a forest of cottonwood, juniper, ash, and dogwood located along the Platte River. Measurements for the Merrick County specimen are as follows: total length, 79; length of tail, 25; length of hind foot, 8; length of ear, 12; length of tragus, 4; length of forearm, 35; weight, 6.8 grams; greatest length of skull, 14.06; condylobasal length, 13.32; zygomatic breadth, 8.98; interorbital breadth, 4.06; breadth of braincase, 7.81; length of maxillary toothrow, 5.41; length of mandibular toothrow, 6.69. Both of the new specimens are referable to the subspecies *N. h. humeralis*, the only subspecies present in the region (Jones et al. 1983).

The evening bat is expanding in geographic range to the west and north, probably in response to an increase in trees in the state. Similar observations regarding range expansion have been made concerning this species in Kansas (Kunz et al. 1980, Sparks and Choate 1996, 2000). Additional netting will likely indicate this bat has expanded in distribution to a greater extent than currently recognized. The new specimen of *Nycticieus* from Merrick County was captured in an open forest dominated by mature cottonwoods. Similar habitat can be found 100 to 200 miles west of this site, so the evening bat may eventually occupy the entire eastern half of Nebraska. It is also valuable to note that the new *Nycticieus* specimen from Dixon County was caught within a few miles of South Dakota. This species apparently has not been captured in South Dakota, but likely inhabits riparian forests along the Missouri River in this state, at least in the southeastern corner.

Lasiurus borealis (Eastern Red Bat)

New records (13).–Morrill County: Bridgeport, 7 (BHS). Banner Co.: Wildcat Hills, Dooley Canyon [T20N, R55W, Sec. 21 NW ¼], 1 (USGS Biological Survey Collection 23011). Dawes Co.: Coffee Mill Butte [T31N, R49W, Sec.8 SW ¼], 2 (UNSM 21096-96); Bordeaux Creek [T32N, R48W, Sec. 14 NW ¼ of NE ¼], 1 (UNSM 21097); Little Bordeaux Creek, 7.75 miles S, 3.5 miles E Chadron, 1 (UNSM 23517); one canyon E of West Ash Creek [T31N, R51W, Sec.13 NW ¼], 1 (UNSM 23518).

Other record.–Sioux Co.: Monroe Canyon, 5 miles N, 2.5 miles W Harrison (Farney and Jones 1975).

Jones (1964) depicted the red bat as occupying all but the westernmost counties of Nebraska (Fig. 7), but suggested this species may be "state-wide in suitable habitat" (1964:95). The only specimens of *L. borealis* collected west of the distribution depicted by Jones (1964) were five individuals reported by Farney and Jones (1975) in northwestern Sioux County. Czaplewski et al. (1979) described the distribution of the red bat as being "Probably state-wide . . ." (1979:13) but did not describe any additional specimens from western Nebraska.

Thirteen new specimens of the red bat, all from western counties of Nebraska, are reported in this paper (Fig. 7). Five *L. borealis* were collected in Dawes County in July and August of 1994 and 1995. These specimens were netted in the Pine Ridge area, in a mixture of deciduous riparian vegetation and open forests of ponderosa pine. Included in these specimens are four adult males and one post-lactating female.

Seven red bats were collected in the city of Bridgeport, Morrill County, in the summers of 1979 and 1985. These

Figures 4–6. **4**. Geographic range of the small-footed myotis, *Myotis ciliolabrum*, in Nebraska. The easternmost boundary of the shaded area represents the distribution of the small-footed myotis as known by Jones (1964). The western boundary in the shaded area is the extent of the geographic range as shown by Czaplewski et al. (1979) after disallowing the record from Dakota County. The closed circle is a record reported herein. **5**. Geographic range of the northern myotis, *Myotis septentrionalis*, in Nebraska. Shaded area represents the distribution of the northern myotis as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964. The open triangle in Washington County represents an individual that was captured and released. **6**. Geographic range of the evening bat, *Nycticieus humeralis*, in Nebraska. Shaded area represents the distribution of the evening bat as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964.

Table 3. External and cranial measurements of selected new specimens of *Lasiurus borealis* from Nebraska. All measures in mm except where noted.

Measurements	UNSM **21095**	UNSM **21096**	UNSM **21097**	UNSM **23517**	UNSM **23518**
Sex	Female	Male	Male	Male	Male
Age	Adult	Adult	Adult	Adult	Adult
Total length	107	103	95	103	96
Length of tail	49	47	37	45	40
Length of hind foot	9.5	7.5	7.1	7.3	8.2
Length of ear	12.1	10.9	12.4	12.5	10
Weight (in grams)	11.5	7.5	9	8.5	10.5
Greatest length of skull	13.99	14.05	13.77		
Condylobasal length	13.83	13.16	13.19		
Zygomatic breadth	9.98	9.22	9.62		
Interorbital breadth	4.00	4.38	4.19		
Breadth of braincase	8.15	7.68	7.93		
Length of maxillary toothrow	4.75	4.49	4.44		
Length of mandibular toothrow	6.31	–	5.77		

specimens include a juvenile female, an adult female, and a female collected along with four nursing young.

One *L. borealis* was collected at the Wildcat Hills Nature Center, in Banner County on 27 August 1997. This specimen was netted over a small pond; surrounding habitats included scattered deciduous trees, open forests of ponderosa pine, rocky hills, and dry grasslands. Two other male *L. borealis* were caught on the same night at the same location and were released. The new specimens of *L. borealis* reported here support previous predictions that the red bat can be found statewide in suitable habitat. Measurements for the new specimens are presented in Table 3. Since the work of Baker et al. (1988), *L. borealis* has been considered a monotypic species because all other taxa formerly assigned to this species have been placed under the species name *L. blossevillii*.

Marmota monax (Woodchuck)

New records (7).–York County: 11 miles S, 2 miles E York, 1 (vmksc 4078). Madison Co.: 1.5 miles N, 0.75 mile W Battle Creek, 1 (unsm 17378). Antelope Co.: 4 miles S, 8 miles W Neligh, 1 (vmksc 4082). Greeley Co.: 0.5 mile N, 2 miles W Spalding, 1 (unsm 17379). Buffalo Co.: 0.5 mile W Ravenna along Mud Creek, 1 (unsm 18676). Sherman Co.: 1.25 miles N, 2 miles W Litchfield, 1 (unsm 25277). Cherry Co.: Valentine National Wildlife Refuge, north side of Hackberry Lake, 1 (photograph, Valentine NWR).

Sight records (Nebraska Game and Parks Commission).–Hamilton Co.: W of Stockham; East of Stockham. Merrick Co.: Silver Creek. Boone Co.: 0.25 mile E Cedar Rapids. Antelope Co.: Orchard. Knox Co.: Wausa; Gavins Point Area. Adams Co.: Hastings Cemetery. Howard Co.: S of Elba; 0.5 mile S Cotesfield. Wheeler Co.: 0.5 mile E Ericson. Holt Co.: [T33N, 616W, Sec. 23]; 0.7 mile W Emmet; 25 miles S Stuart. Franklin Co.: 1 mile S, 0.5 mile W Franklin. Valley Co.: S of Ord; Elyria. Brown Co.: 23 miles S, 0.75 mile W Ainsworth on Highway 7.

According to Jones (1964), the woodchuck occupied the eastern quarter of Nebraska (Fig. 8), but was expanding to the west in response to increasing forestation. Seven new *Marmota monax* are reported herein, all from central counties in Nebraska (Fig. 8). A male and a female woodchuck were collected in York and Antelope counties, respectively, in August of 1992. Details are lacking concerning the collection of these specimens. Another male, collected in Madison County, in September of 1989, was killed by a vehicle in the Elkhorn River Valley, in an area surrounded by cornfields, pastures, and scattered trees. A male obtained in Greeley County in September of 1989, was killed by a vehicle on Highway 91 in the Cedar River Valley; surrounding habitats included croplands and a grove of cottonwoods. A fifth male was taken in Buffalo County in mid-summer of 1991. This animal was trapped along Mud Creek in an agricultural area. Finally, a male woodchuck was trapped further west along Mud Creek, in Sherman County in February of 1998; surrounding habitats included deciduous, riparian forest and fields of corn and alfalfa. In addition to the above specimens, a woodchuck was photographed by refuge personnel at Valentine National Wildlife Refuge, in Cherry County (Fig. 8). The photograph was taken on 12 May 1985 and is stored at the refuge headquarters, in the annual report for 1985. The animal was found in a strip of deciduous trees along Hackberry Lake. This photograph represents the westernmost record for this species on the Great Plains. All of the new specimens are referable to the subspecies *M. monax bunkeri* (Jones et al. 1983). Measurements for specimens reported in this paper are presented in Table 4.

Table 4. External and cranial measurements of selected new specimens of *Marmota monax* from Nebraska. All measures in mm except where noted.

Measurements	UNSM **17378**	UNSM **17379**	UNSM **18676**	UNSM **25277**	VMKSC **4078**	VMKSC **4082**
Sex	Male	Male	Male	Male	Male	Female
Total length	615	500	678	607	850	466
Length of tail	190	145	152	135	210	110
Length of hind foot	90	75	103	94	—	79
Length of ear	30	30	41	38	22	26
Weight (in grams)	2970	—	6638	4575	7000	3400
Greatest length of skull			108.98	106.49		
Condylobasal length			103.33	100.21		
Zygomatic breadth			67.53	64.94		
Postorbital constriction			18.33	16.85		
Length of nasals			45.48	44.77		
Length of maxillary toothrow			22.71	22.47		
Depth of skull			41.50	41.91		

In addition to the above specimens, sight records of *M. monax* have been recorded by the Nebraska Game and Parks Commission in 12 counties in the eastern half of Nebraska (Fig. 8). Given the size and unique appearance of woodchucks, we consider these to be appropriately valid records for this species. Additionally, most of the sightings occurred in areas where specimens have been collected.

Based on the above specimens, photograph, and sight records, *Marmota monax* now occupies the eastern half of Nebraska. This species typically inhabits forest edges and strips of trees extending along creeks and fence-lines where there are refuges for dens and areas of grass, alfalfa, or similar vegetation for grazing (Jones 1964, Jones et al. 1983). Given the increase in extent of trees in Nebraska, the woodchuck will likely continue to expand in range to the west, especially along riparian forests. Its expansion in Kansas has been well documented (Choate and Haner 1992, Choate and Reed 1986, Wilson and Choate 1996).

Peromyscus leucopus (White-footed Mouse)

New records (86).–Hitchcock County: Trenton Dam, 0.5 mile S, 2 miles W Trenton, 3 (unsm 18581-83); Swanson Lake, 0.5 mile N, 3.5 mile E Stratton, 4 (unsm 18584-87). Dundy Co.: Rock Creek Fish Hatchery, 5.5 miles N, 3 miles W Parks, 2 (unsm 17021, 17037); Rock Creek Fish Hatchery, 4 miles N, 2 miles W Parks, 14 (unsm 17194-97, 17894-98, 17901-02, 17913-15); Rock Creek Fish Hatchery, 3.75 miles N, 2.25 miles W Parks, 1 (unsm 17906); 3 miles N, 2 miles W Parks, 4 (unsm 17989-92); Rock Creek Fish Hatchery, 5.25 miles N, 3 miles W Parks, 1 (unsm 17999); Rock Creek Fish Hatchery, 6 miles N, 3.25 miles W Parks, 2 (unsm 18004, 18017); 7 miles N, 1.5 miles E Benkelman, 1 (unsm 18150); 2.5 miles N, 3.5 miles W Max, 2 (unsm 18203, 18216); 0.75 mile S Benkelman, 2 (unsm 18274, 18282); 2.5 miles W Benkelman, 3 (unsm 18286, 18291, 18295); Rock Creek Fish Hatchery, 5 miles N, 3 miles W Parks, 2 (unsm 18318, 18350); 0.5 mile S, 6 miles W Parks, 1 (unsm 18597); T2N, R40W, Sec. 24 SE ¼ [Rock Creek Fish Hatchery], 4 (unsm 18677-78, 18680, 18682); T2N, R40W, Sec. 25 NE ¼ [Rock Creek Fish Hatchery], 2 (unsm 18679, 18681). Keith Co.: south banks of South Platte River, 0.5 mile S, 0.5 mile E Roscoe, 19 (unsm 18948-53, 18955-63, 18965-68); north banks of South Platte River, 3.9 miles W Roscoe, 3 (unsm 25316-18); 0.4 mile S, 2.4 miles W Keystone P.O., 7 (unsm 18827-33); 0.2 mile N, 4.5 miles W Keystone P.O., 2 (unsm 25319-20); Ogallala Strip Wildlife Management Area, 0.7 mile S, 3.4 miles W Ogallala, 2 (unsm 25321-22). Dawes Co.: Pepper Creek Outdoor Learning Center, 20 miles S Chadron [T30N, R48W, Sec. 28], 5 (unsm 22658-59, 22662, 22666-67).

Other record.–Cherry Co.: 3 miles S, 1.25 mi W Pony Lake Sub-HQ (Bogan and Ramotnik 1995).

The white-footed mouse was found to be common in eastern Nebraska and extended into western counties in northern portions of the state, and along major rivers during the survey by Jones (1964; Fig. 9). This species inhabits wooded habitats and was limited largely to riparian habitats in central and western parts of the state (Jones 1964).

A total of 86 new specimens of *P. leucopus* is reported from four counties in western Nebraska (Fig. 9). Along the Republican River, seven white-footed mice were collected at two localities in Hitchcock County in July of 1990. These specimens were collected from riparian forests along the Republican River and include two pregnant females (four embryos each), one juvenile female, three adult males, and one reproductively inactive female. Further west, in Dundy County, 41 *P. leucopus* were collected from several localities

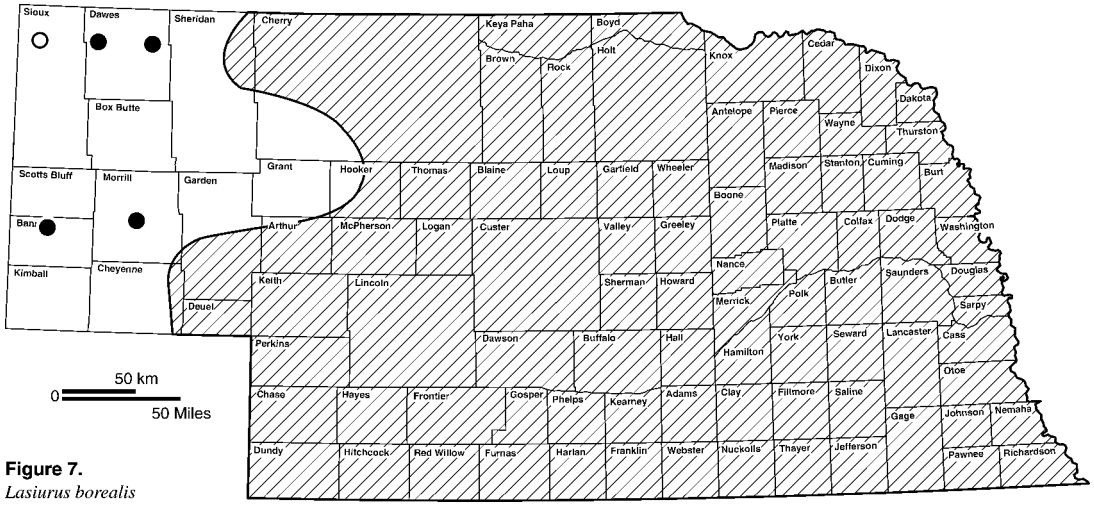

Figure 7.
Lasiurus borealis

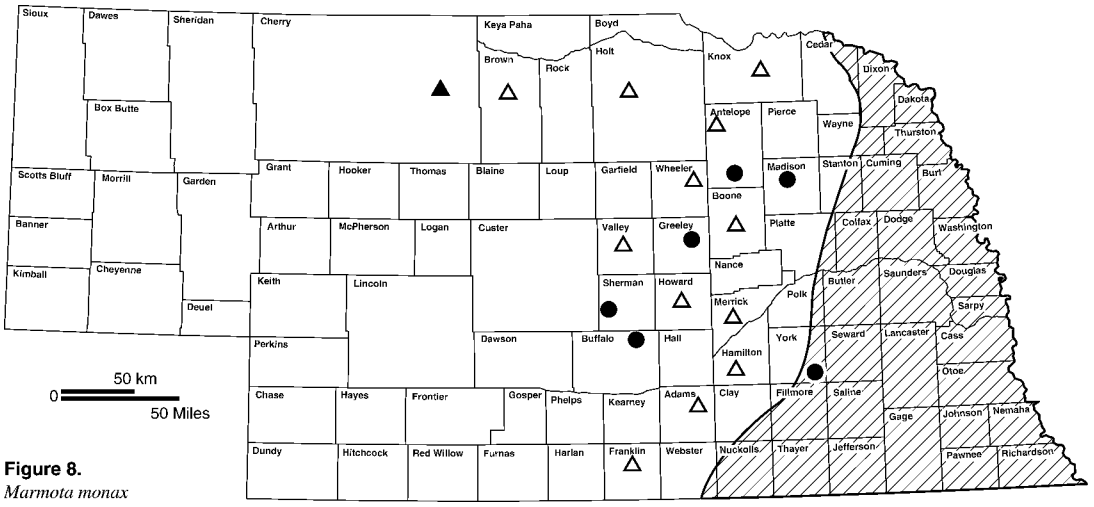

Figure 8.
Marmota monax

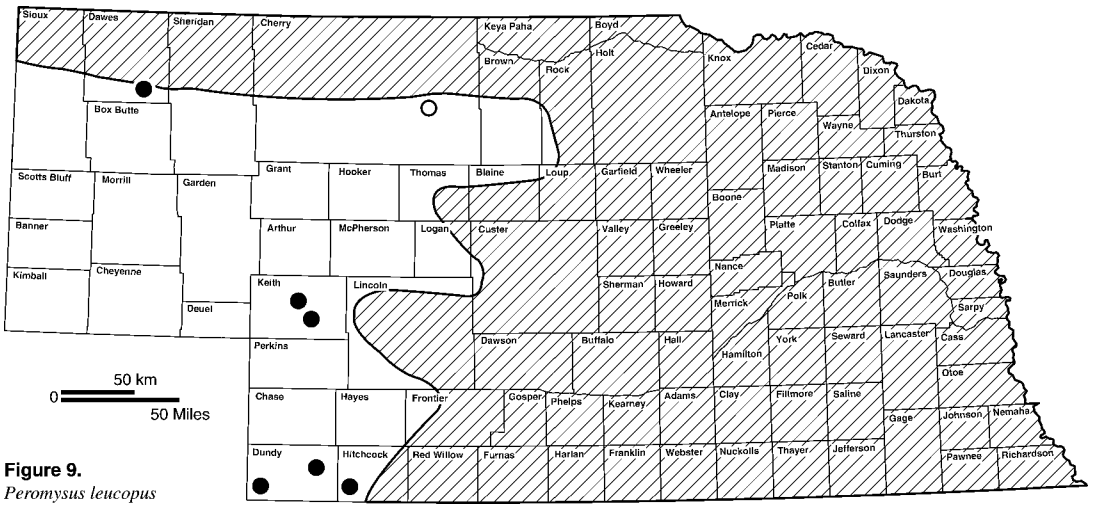

Figure 9.
Peromysus leucopus

in the drainage of the Republican River in 1988 and 1990. The Dundy County specimens include 26 males, nine reproductively inactive females, three pregnant females (number of embryos one, two, unspecified), two juvenile females, and one juvenile male, and were caught in deciduous forests along streams and lakes.

Along the South Platte River in Keith County, 19 *P. leucopus* were collected in a riparian forest in July of 1991 near Roscoe. These specimens include 13 males, five pregnant females (five, four, four, four, and two embryos), and one juvenile female. In January of 1992, three additional white-footed mice were captured 3.9 miles W of Roscoe in a riparian forest along the South Platte River. These specimens include two males and one reproductively inactive female. In July of 1998, two male *P. leucopus* were caught in a riparian forest 3.4 miles W of Ogallala. Along the North Platte River, further north in Keith County, 11 white-footed mice were collected in riparian forests in July of 1991, January of 1992, and December of 1994, just below Lake McConaughy. These specimens include seven males, three reproductively inactive females, one lactating female, and one juvenile female. All of the above specimens from the Republican and Platte Rivers are tentatively assigned to the subspecies *P. l. noveboracensis* based on their darker dorsal pelage. Lastly, five *P. leucopus* were caught in southeastern Dawes County in June of 1979 and 1989. These mice were caught in scattered deciduous trees along Pepper Creek, and include three males and two reproductively inactive females. These five specimens are referable to the subspecies *P. l. aridulus*, which occupies the western Great Plains (Jones et al. 1983).

The geographic distribution of subspecies of *P. leucopus* in Nebraska needs further investigation. Although Jones (1964) and Jones et al. (1983) assigned white-footed mice from the western half of Nebraska to *P. l. aridulus*, mice examined from along the western Republican and Platte Rivers during this study were not noticeably different in color from eastern specimens, but were clearly darker than animals from the northwest corner of the state. The mice occupying the western reaches of these rivers likely are derived from populations in eastern Nebraska. It seems logical, therefore, that the mice advancing along the Platte and Republican Rivers are more closely related to the eastern subspecies than to typical *P. l. aridulus* as found in the Pine Ridge of northwest Nebraska and possibly along the Niobrara River (Bogan and Ramotnik 1995). The new specimens collected along the Platte and Republican rivers, therefore, are tentatively assigned to the subspecies, *P. l. noveboracensis*.

The new specimens reported here indicate the white-footed mouse is spreading west in Nebraska, especially along riparian woodlands. Along the Platte River system, riparian forests are contiguous, or nearly so, for many miles west of Keith County. The white-footed mouse, therefore, likely will continue to expand west, and should reach the northeast corner of Colorado along the South Platte River in a few decades. Likewise, this species could conceivably reach southeastern Wyoming along the North Platte River if the current range expansion continues.

The rate of expansion in geographic range in *P. leucopus* in western Nebraska can be estimated. Along the Platte River system, Jones (1964) depicted the range of this species as extending west to the Lincoln/Keith County line. The westernmost specimen he examined along the Platte River, however, was captured in eastern Lincoln County in 1939 (UNSM 69). Freeman trapped in the floodplain of the South Platte River in Big Springs, Deuel County, in 1989 and captured only *Peromyscus maniculatus*. The North and South Platte rivers in Keith County were trapped in 1991 and 1992 by personnel from the University of Nebraska State Museum to determine the western limits of *P. leucopus*. The westernmost specimens from this trapping (UNSM 25316-18, and 19756-57) were caught approximately 22 miles west of the range depicted by Jones (1964) and 68 miles west of his furthest west specimen. The South Platte River was trapped again in 1998 by students from the University of Nebraska-Lincoln. The westernmost *P. leucopus* from this trapping (UNSM 25321-22) were captured 5.1 miles west of the 1991/1992 specimens.

Along the Republican River in southwestern Nebraska, Jones (1964) depicted *P. leucopus* extending west into eastern portions of Hitchcock Co. The westernmost specimens he examined, however, were captured in McCook, Red Willow Co., in 1941 (UNSM 3032-3033). Roedel (1992) trapped along the Republican River in Hitchcock and Dundy counties in 1990. The westernmost specimen, which he captured at 0.5 mile south and 6 miles west of Parks, Dundy County (UNSM 18597), was taken approximately 50 miles west of the distributional limit depicted by Jones (1964) and 62 miles west of Jones's furthest west specimen (Roedel 1992).

The work along these river systems provides baseline information for future work and indicates *Peromyscus leucopus* is moving west at a fairly rapid rate. Precise rates of expansion are impossible to determine because the western edge of the geographic range was not determined precisely in the earlier parts of the century. If the westernmost specimens examined by Jones (1964) are assumed to represent the western limit of the species at the time they were collected, then *P. leucopus* has advanced at a rate of 1.4 miles/year along the Platte River system, and 1.2 miles/year along the Republican. A more accurate estimate of expansion rate can be measured along the South Platte River, where white-footed mice were trapped in detail in 1991 and 1992, and again in 1998. Along a continuously forested stretch of river in the vicinity of

Figures 7–9. **7**. Geographic range of the northern red bat, *Lasiurus borealis*, in Nebraska. Shaded area represents the distribution of the northern red bat as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964. **8**. Geographic range of the woodchuck, *Marmota monax*, in Nebraska. Shaded area represents the distribution of the woodchuck as known by Jones (1964). Closed circles are records reported herein. Open triangles represent sight records from the files of the Nebraska Game and Parks Commission. The closed triangle represents a photographic record. **9**. Geographic range of the white-footed mouse, *Peromyscus leucopus*, in Nebraska. Shaded area represents the distribution of the white-footed mouse as known by Jones (1964). Closed circles are records reported herein. The open circle is a record reported by other authors since 1964.

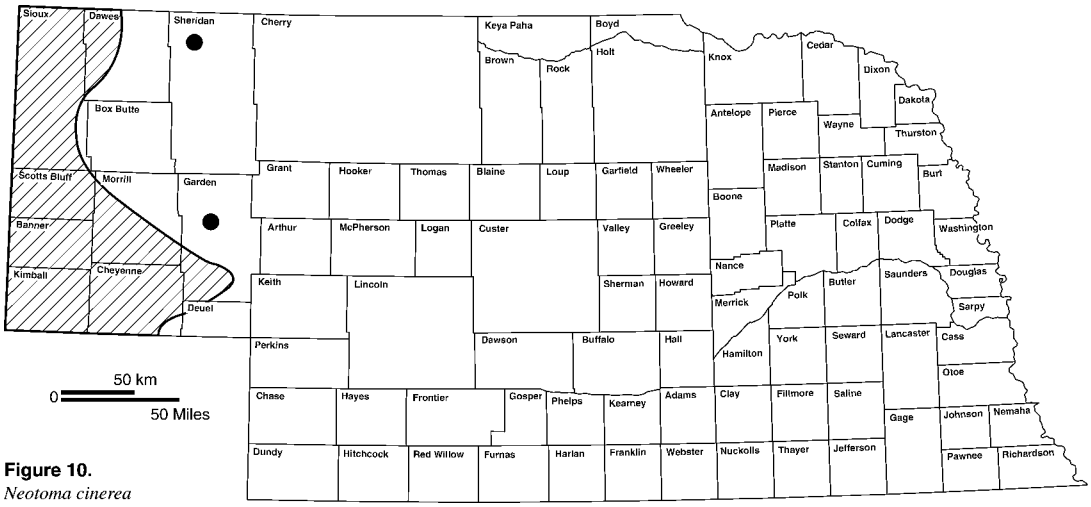

Figure 10.
Neotoma cinerea

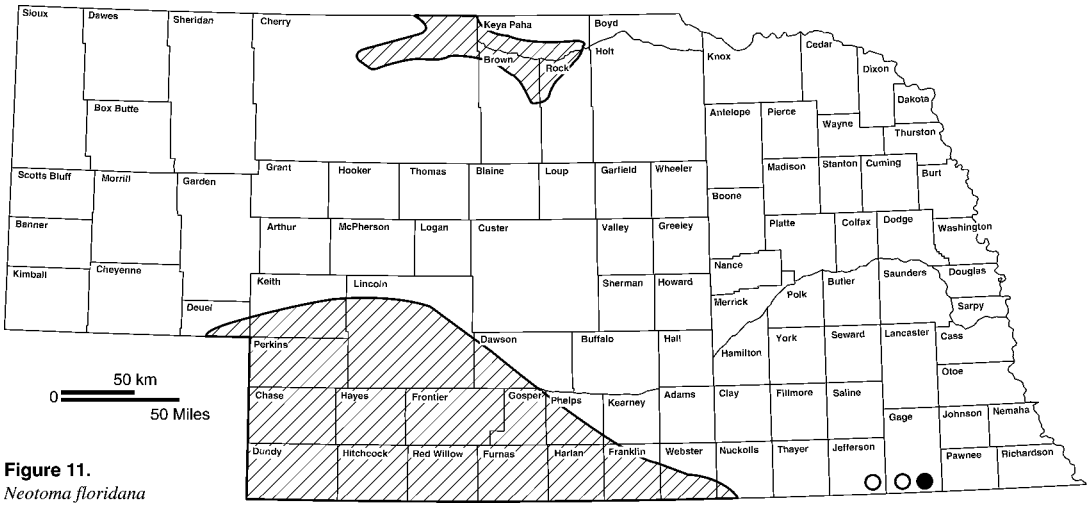

Figure 11.
Neotoma floridana

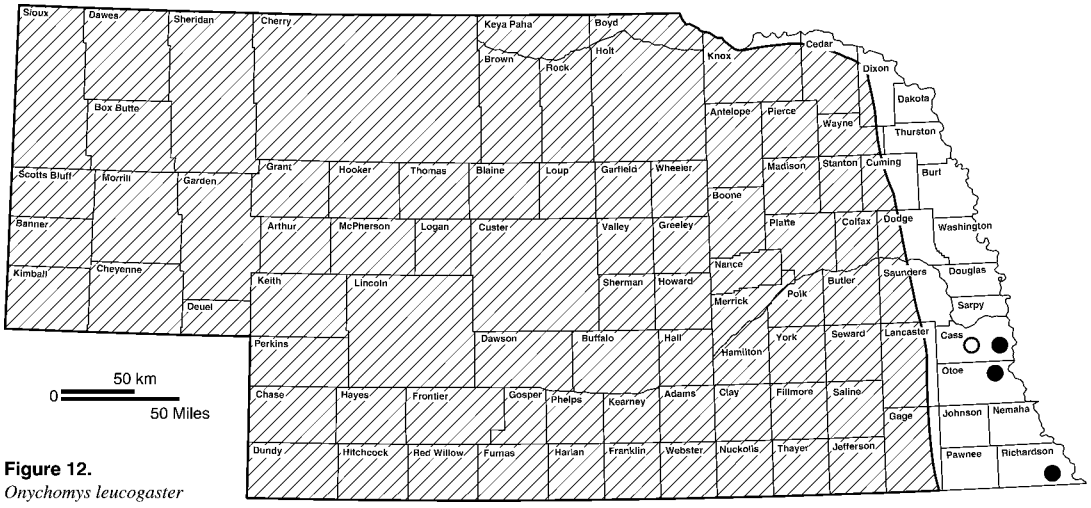

Figure 12.
Onychomys leucogaster

Ogallala, *P. leucopus* advanced roughly 5.1 miles in the 6.5 years between trapping sessions, giving a rate of expansion of 0.78 mile/year.

As the white-footed mouse pushes west, it apparently displaces populations of *P. maniculatus* and *Reithrodontomys megalotis* inhabiting the riparian forests. Forests to the west of the geographic range of *P. leucopus* were trapped in 1991 (364 trap nights) and *P. maniculatus* and *R. megalotis* were captured at a rate of 17.31 and 1.64 animals/100 trap nights, respectively. Forests populated by *P. leucopus*, however, contained very few *P. maniculatus* (0.27/100 trap nights) or *R. megalotis* (0.27/100 trap nights—371 trap nights). Given the high density of *P. leucopus* in these latter forests (25.61/100 trap nights), interspecific competition likely led to the displacement of *P. maniculatus* and *R. megalotis*. The riparian forests near the western edge of the range of *P. leucopus* could be excellent sites to examine competition between these rodent species.

Neotoma cinerea (Bushy-tailed Woodrat)

New records (9).–Garden County: Crescent Lake National Wildlife Refuge, Headquarters Building, 1 (unsm 18077). Sheridan Co.: Metcalf Wildlife Management Area, 11.5 miles N, 1 mile W Hay Springs, 1 (unsm 22892); Metcalf Wildlife Management Area, 10.5 miles N Hay Springs, 2 (unsm 22893-94); Metcalf Wildlife Management Area, 9.5 miles N Hay Springs, 5 (unsm 22895-99).

According to Jones (1964), the bushy-tailed woodrat occupied rocky habitats in the extreme western counties of Nebraska (Fig. 10). Nine new specimens of *N. cinerea* are reported herein, from two counties in western Nebraska. Eight *N. cinerea* were collected at Metcalf Wildlife Management Area, in Sheridan County in June and August 1993, and August 1994. These animals were caught in the Pine Ridge area, in rocky hills covered with open forests of ponderosa pine, and include one adult male, three adult females, one juvenile male, and three juvenile females. The Sheridan County specimens extend the known range of this species approximately 51 miles east-northeast of the nearest previously reported specimen (Fig. 10).

Another specimen of *N. cinerea* was trapped from the headquarters building at Crescent Lake National Wildlife Refuge, in central Garden County, on 20 September 1990. Although *N. cinerea* occasionally does occupy buildings (Jones 1964), this reproductively inactive female was caught in a building in open prairie, approximately 21 miles from typical habitat for this species. Information accompanying the specimen indicates that employees of the wildlife refuge had recently moved furniture from a house located well within the known range of *N. cinerea* in Nebraska. It is possible, therefore, that this animal reached this location with human assistance, although Jones and Choate (1980) believed the species reached "eastward in breaks along North Platte River at least to Garden County." This species was not taken or observed during a mammal survey of the Refuge between 1967 and 1971 (Gunderson 1973). All of the new specimens reported in this study are referable to the subspecies *N. c. rupicola*.

Neotoma floridana (Eastern Woodrat)

New records (2).–Gage County: 0.8 mile S, 2.25 miles E Wymore P.O., 2 (unsm 25323-24).

Other records (Clausen 1999).—Gage Co.: 0.5 mile W Barneston; 0.5 mile S, 1.5 miles E Wymore. Jefferson Co.: 7 miles S, 0.5 mile W Fairbury; Steele City.

According to Jones (1964), the eastern woodrat occupied southwestern and south-central Nebraska (*N. f. campestris*), as well as an isolated area along the Niobrara River in the north-central part of the state (*N. f. baileyii*—Fig. 11). This species is known to inhabit wooded areas, buildings, or rocky outcrops.

Two new specimens of *N. floridana* are reported in this paper, both from southeastern Gage County. These individuals, a lactating female and her nursing young, were caught by hand on 10 April 1998 from a nest mound located in a strip of deciduous trees near the Big Blue River. Surrounding habitats included cornfields, pastures, and riparian forests. Measurements for the adult are as follows: total length, 366; length of tail, 150; length of hind foot, 39.5; length of ear, 28; weight, 264.5 grams; greatest length of skull, 49.52; zygomatic breadth, 26.29; interorbital constriction, 6.60; length of nasals, 18.62; depth of skull, 16.5; length of maxillary toothrow, 9.25; length of incisive foramen, 9.72. These new specimens, along with the specimens reported by Clausen (1999), are referable to the subspecies *N. f. attwateri*, the first records of this subspecies from Nebraska (Birney 1973). These specimens, combined with animals reported by Clausen (1999), indicate the eastern woodrat is present in southeastern Nebraska, along the Big and Little Blue river drainages.

Onychomys leucogaster (Northern Grasshopper Mouse)

New records (11).–Richardson County: 1.1 miles N, 1 mile W Falls City P.O., 1 (unsm 25335). Otoe Co.: 1.35 miles S, 5.2 miles W Nebraska City P.O., 1 (unsm 25333). Cass Co.: 0.7 mile S, 4.55 miles W Union P.O., 1 (unsm 25332); 1.45 miles N, 1.9 miles W Weeping Water P.O., 1 (unsm 25324); 1.3 miles N, 0.4 mile E Union P.O., 1 (unsm 25325); 1 mile N, 1.5 miles E Union P.O., 3 (unsm 25326-28); 3.4 miles N, 2.7 miles W Union P.O., 2 (unsm 25329-30); 1 mile N, 1.65 miles W Union P.O., 1 (unsm 25331).

Other records (Genoways and Choate 1970).–Cass Co.: 0.5 mile W Manley; 0.4 mile N, 2 miles W Weeping Water.

Figures 10–12. **10**.–Geographic range of the bushy-tailed woodrat, *Neotoma cinerea*, in Nebraska. Shaded area represents the distribution of the bushy-tailed woodrat as known by Jones (1964). Closed circles are records reported herein. **11**. Geographic range of the eastern woodrat, *Neotoma floridana*, in Nebraska. Shaded area represents the distribution of the eastern woodrat as known by Jones (1964). The closed circle is a record reported herein. Open circles are records reported by another author since 1964. **12**. Geographic range of the northern grasshopper mouse, *Onychomys leucogaster*, in Nebraska. Shaded area represents the distribution of the northern grasshopper mouse as known by Jones (1964). Closed circles are records reported herein. The open circle is a record reported by other authors since 1964.

According to Jones (1964), *Onychomys leucogaster* occupied all but the extreme eastern counties of Nebraska (Fig. 12). A subsequent paper (Genoways and Choate, 1970) reported three northern grasshopper mice captured in central Cass County, to the east of the geographic range described in Jones (1964).

Eleven new specimens of *O. leucogaster* are reported, from three counties in extreme eastern Nebraska (Fig. 12). A male grasshopper mouse was captured from a railroad right-of-way on 17 January 1999, north of Falls City, in Richardson County. This site was adjacent to a cornfield and was dominated by smooth brome, switch grass, and several species of annual weeds. Another male was captured in eastern Otoe County on 7 September 1999 in smooth brome growing along a county road. Nine *O. leucogaster* were captured in central and eastern Cass County during the summer and fall months of 1992 and 1994. These animals were captured in grasses (smooth brome and several native species) growing along roadsides, and include four reproductively inactive females, two pregnant females (number of embryos three and four), two adult males, and a juvenile male. The new specimens presented here are referable to the subspecies *O. l. arcticeps* and indicate this species reaches nearly to the Missouri River in southeastern Nebraska (Engstrom and Choate 1979). It should be noted that the northern grasshopper mouse occurs in extreme northwestern Iowa (Bowles, 1975), but these mice were assigned to the subspecies *O. l. leucogaster* as were specimens from Clay County in extreme southeastern South Dakota, based upon their dark coloration (Findley, 1956) and as tenatively suggested for specimens from Antelope, Boone, and Wayne counties, Nebraska (Engstrom and Choate 1979). No individuals of the northern grasshopper mouse have been reported from central and southwestern areas of extreme western Iowa to the east of these new records from Nebraska.

Synaptomys cooperi (Southern Bog Lemming)

New records (6).–Nuckolls County: 0.9 mile S, 1.35 miles W Superior P.O., 1 (unsm 25336). Red Willow Co.: 1.5 miles S Bartley, 1 (vmksc 2650, skull from owl pellet); 6 miles N Bartley, 2 (unsm 25367-68, skulls from owl pellet). Lincoln Co.: 4.5 miles S, 1.5 miles W Brady, 1 (unsm 17371); 3.5 miles N Wellfleet, 1 (unsm 25366, skull from owl pellet).

According to Jones (1964), the southern bog lemming occupied the eastern half of Nebraska. In addition, a small relictual population was known to inhabit the extreme southwestern corner of the state, although recent attempts to locate this population have failed (Fig. 13).

Six new specimens of *S. cooperi* are reported, from three counties in south-central and southwestern Nebraska (Fig. 13). The first specimen was captured in May of 1988 in Lincoln County. This male was caught on an ungrazed hillside covered with thick prairie grasses and dense vegetative litter. A second *S. cooperi* was caught in Nuckolls County in December of 1997 in dense roadside grasses in the floodplain of the Republican River. Although this specimen is within the geographic range depicted by Jones (1964), very few specimens have been collected in south-central Nebraska.

In addition to the above specimens, four *Synaptomys cooperi* skulls collected from owl pellets outside of the known geographic range of this species are presented here (Fig. 13). Two *S. cooperi* skulls were discovered in June 1985 in pellets of Barn Owls from Red Willow County. These pellets were collected from farm buildings in an agricultural landscape. Another skull of *S. cooperi* was found south of Bartley in Red Willow County in September of 1974 from the pellet of a Barn Owl. Details are lacking on the habitat surrounding this location. Finally, a skull of *S. cooperi* was found in southern Lincoln County in June of 1985 from another Barn Owl pellet. This pellet was obtained from a steep bank along a road; surrounding habitats included dry prairies and wet meadows. The new specimens reported here suggest *Synaptomys cooperi* is more widely distributed in southwestern Nebraska than previously thought

The subspecific identity of the new specimens was analyzed using data presented in Wilson and Choate (1997). One of the new specimens is a broken cranium from an owl pellet and could not be measured. Four of the new specimens have measurements that fall within the range of values for the subspecies from eastern Nebraska, *S. c. gossi* (Table 5). The fifth specimen, however, has measurements that fall within or above the range of values presented for *S. c. relictus* (Wilson and Choate 1997). This specimen was removed from a Barn Owl pellet found in Red Willow County, 6 miles north of Bartley, approximately 78 miles ENE of the only known population of *S. c. relictus*, suggesting this subspecies is more widely distributed than previously known. Alternatively, as speculated by Wilson and Choate (1997) *S. c. relictus* is not a distinct taxon but only represents "the terminus of a geographic cline" within *S. c. gossi*.

Microtus pinetorum (Woodland Vole)

New records (2).–Sarpy County: Fontenelle Forest Nature Center, 1 (unsm 15624). Washington Co.: Neale Woods Nature Center, Settler's Hollow Trail [T17N, R13E, Sec. 33 SW ¼ of SE ¼], 1 (unsm 20056).

The woodland vole primarily inhabits upland deciduous forests and is restricted to the extreme eastern edge of Nebraska (Fig. 14). Although Jones (1964) only had 13 specimens from Richardson, Nemaha, and Gage counties in the extreme southeast corner of the state, he mapped the species extending to the north of Omaha.

Two new specimens of *M. pinetorum* are reported here, both from the Omaha area. On 22 January 1985, a female woodland vole was found dead on a hiking trail at Fontenelle Forest Nature Center, east of Bellevue. Measurements for this animal are as follows: total length 125, length of tail 17, length of hind foot 18, length of ear 11, weight 30 grams, condylobasal length 26.36, lambdoidal breadth 13.77, depth of skull 12.45, length of nasals 7.84, length of maxillary toothrow 6.69. Another *M. pinetorum* was captured at Fontenelle Forest Nature Center on 27 August 1994 and released at the request of the landowner. This animal was captured in upland deciduous forest in a Sherman live trap set next to a hole in a mole tunnel. In Washington County, north of Omaha, a juvenile male woodland vole was captured

Table 5. Measurements (in mm) of selected new specimens of *Synaptomys cooperi* compared to data from Wilson and Choate (1997). Eastern Nebraska and *S. c. relictus* samples are from Wilson and Choate (1997); numbers are mean (above) and standard deviation (below).

Measurements	**UNSM 25336 (Nuckolls County)**	**UNSM 17371 (Lincoln County)**	**UNSM 25367 (Red Willow County)**	**VMKSC 2650 (Red Willow County)**	**Eastern Nebraska sample *n* = 18/19**	***S. c. relictus* sample *n* = 2**
Width upper incisors	4.03	3.96	4.49	4.05	4.09 (±0.04)	4.34 (±0.16)
Length incisive foramen	5.45	5.31	6.25	5.30	5.57 (±0.04)	5.59 (±0.11)
Length total toothrow	17.57	17.30	19.36	18.09	18.05 (±0.10)	18.68 (±0.13)
Length maxillary toothrow	7.54	7.29	8.34	7.55	7.76 (±0.06)	8.60 (±0.09)
Zygomatic breadth	16.41	16.38	19.34	16.94	17.75 (±0.10)	17.98 (±0.13)
Interorbital breadth	3.45	3.45	3.43	3.39	3.41 (±0.02)	3.23 (±0.16)
Greatest length of skull	29.40	28.80	30.51	29.15	29.38 (±0.15)	29.51 (±0.25)
Palatofrontal depth	10.08	10.18	11.58	10.40	10.90 (±0.06)	11.35 (±0.09)

at Neale Woods Nature Center on 5 September 1994, in upland deciduous forest dominated by *Quercus borealis*, *Ulmus americana*, *Celtis occidentalis*, and *Tilia americana*. Measurements for this animal are as follows: total length 135, length of tail 23, length of hind foot 18, length of ear 11, weight 39.0 grams, condylobasal length 25.73, zygomatic breadth 14.97, interorbital constriction 4.67, lambdoidal breadth 11.86, depth of skull 10.14, length of nasals 7.95, length of maxillary toothrow 6.19. An adult female was caught in an adjacent trap and released at the request of the landowner. The two Washington County animals were caught in Sherman live traps set near holes in mole tunnels. Although all of the above individuals were caught within the range depicted by Jones (1964), the Washington County specimen was captured approximately 50 miles north of the nearest record in the state. The new specimens reported above are referable to the subspecies *M. p. nemoralis*, the only subspecies present in Nebraska (Jones et al. 1983).

Microtus pennsylvanicus (Meadow Vole)

New records (41).–Richardson County: Indian Cave State Park, 1 (UNSM 17209). Otoe Co.: 4 miles N, 0.8 mile E Dunbar P.O., 1 (UNSM 25339); 6.8 miles N, 0.2 mile E Dunbar P.O., 1 (UNSM 25338); 3 miles S, 2.55 miles W Union P.O., 1 (UNSM 25340); 0.8 mile S, 4 miles E Dunbar P.O., 1 (UNSM 25337). Gage Co.: 0.45 mile S, 2.55 miles E Barneston P.O., 2 (UNSM 25344-45); 1.1 miles N Barneston P.O., 1 (UNSM 25346). Jefferson Co.: Crystal Springs Park, 1.5 miles S, 1 mile W Fairbury, 1 (VMKSC 387); 1 mile N, 9 miles W Fairbury, 1 (VMKSC 2298). Nuckolls Co.: 0.9 mile S, 1.35 miles W Superior P.O., 2 (UNSM 25342-43). Adams Co.: 2.05 miles S, 2.8 miles W Hastings P.O., 1 (UNSM 25341). Webster Co.: 6 miles S, 0.5 mile E Bladen, 1 (VMKSC 2311). Phelps Co.: 4 miles S, 6 miles E Holdrege, 1 (VMKSC 2302); 0.5 mile N, 2 miles W Wilcox, 1 (VMKSC 2305); 5 miles N Holdrege, 1 (VMKSC 2303); 5.6 miles N, 0.5 mile W Loomis, 1 (VMKSC 2304). Red Willow Co.: 4 miles E Lebanon, 1 (VMKSC 2308). Dundy Co.: Rock Creek Fish Hatchery, 3 (UNSM 16923-25); Rock Creek Fish Hatchery, 5.5 miles N, 3 miles W Parks, 4 (UNSM 17026-27, 17360, 18484); Rock Creek Fish Hatchery, 3.75 miles N, 2.25 miles W Parks, 1 (UNSM 17910); Rock Creek Fish Hatchery, 5.25 miles N, 3 miles W Parks, 2 (UNSM 18042-43); 3.5 miles N, 3 miles W Benkelman, 1 (UNSM 18087); 7.5 miles N, 1.5 miles E Benkelman, 1 (UNSM 18103); Rock Creek Fish Hatchery, 5 miles N, 3 miles W Parks, 2 (UNSM 18329-30); 6.25 miles N, 1 mile E Haigler, 8 (UNSM 18460-61, 18653-58).

Other records (Cass Co. based on Genoways and Choate 1970; remaining counties based on Choate and Genoways 1967).—Cass Co.: 1 mile N, 2 miles W Weeping Water; 0.4 mile N, 2 miles W Weeping Water; 2 miles W Weeping Water; 0.3 mile S, 2 miles W Weeping Water; 2 miles S Weeping Water. Saline Co.: 2 miles N, 2.5 miles E Crete; 1.5 miles N, 3 miles E Crete; 1.5 miles S, 3 miles E Crete; 2.5 miles S, 3 miles E Crete; 5 miles S, 3 miles E Crete; 8.5 miles S, 3 miles E Crete; 1 mile N, 3 miles W Wilber. Fillmore Co.: 2 miles N, 2 miles E Fairmont. York Co.: 4 miles S York. Clay Co.: 1.5 miles E Harvard; 0.5 mile N Inland; 1 mile N, 5 miles W Saronville; 1 mile N, 3 miles W Saronville; 1 mile N, 2 miles S Saronville; 1 mile N Saronville; 1 mile S Harvard; 1 mile S Saronville. Adams Co.: 9 miles S Hastings.

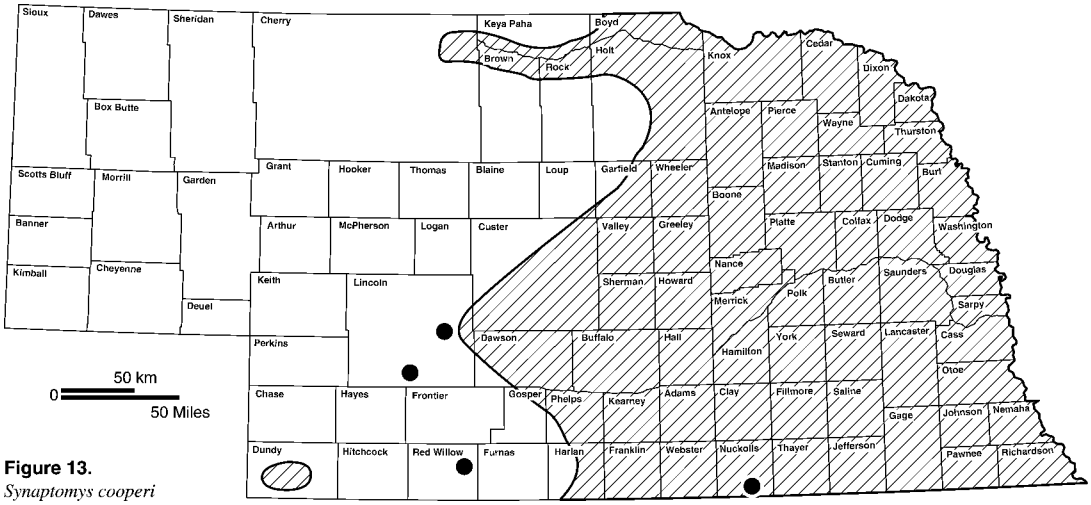

Figure 13.
Synaptomys cooperi

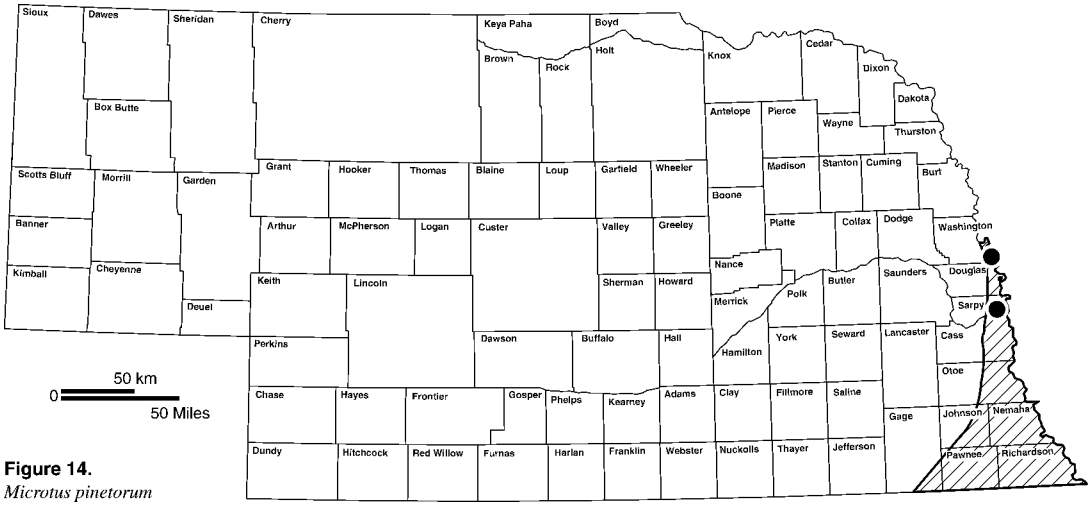

Figure 14.
Microtus pinetorum

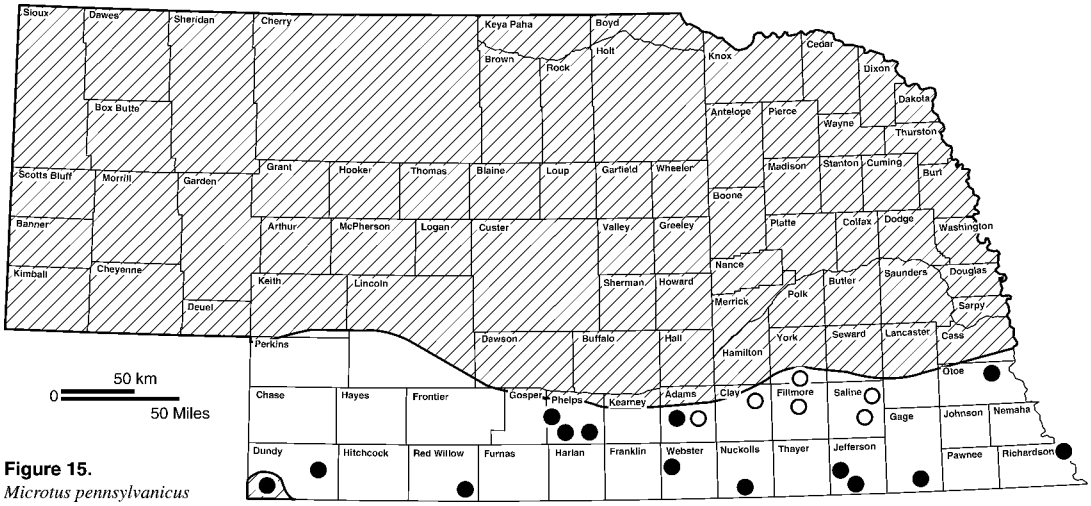

Figure 15.
Microtus pennsylvanicus

According to Jones (1964) the meadow vole occupied northern Nebraska, only extending south of the Platte River in the eastern portion of the state (Fig. 15). In addition, as in *Synaptomys cooperi*, a relictual population of *M. pennsylvanicus* occurs in Dundy County. In the last three decades, however, this species has extended its geographic range into northern Kansas (Andersen and Fleharty 1967, Bee et al. 1981, Fleharty and Andersen 1964, Frey and Moore 1990b), indicating it is likely now more widely distributed in southern Nebraska.

A total of 41 new specimens of *M. pennsylvanicus* are reported herein, from nine counties in southern Nebraska (Fig. 15). One *M. pennsylvanicus* was collected in Richardson County, at Indian Cave State Park, north of Barada, in May of 1988. This male was captured in dense grasses growing along a creek, a short distance from its junction with the Missouri River. In northeastern Otoe County in September and October of 1994, four *M. pennsylvanicus*, including two males and two pregnant females (four embryos each), were captured in dense, roadside grasses. Three *M. pennsylvanicus* were captured in southeastern Gage County in April of 1998 in dense, roadside grasses; these specimens include one male, one pregnant female (five embryos), and one reproductively inactive female. Two meadow voles were captured in western Jefferson County in November of 1968 and December of 1969, one female and one of undetermined sex. Two *M. pennsylvanicus*, both reproductively inactive females, were captured in extreme southern Nuckolls County in December of 1997 in dense, roadside grasses. In western Adams County a juvenile male *M. pennsylvanicus* was captured on 20 October 1994 in dense, roadside grasses. A female meadow vole was collected in southwestern Webster County in July of 1969. Another *M. pennsylvanicus* was captured in northwestern Webster County in January of 1973. Four meadow voles were taken at different localities in Phelps County in 1970 and 1973, including two males and two females. Lastly, a male *M. pennsylvanicus* was captured in Red Willow County, in October of 1973. The above specimens indicate the meadow vole reaches to the Kansas border in the central and eastern portions of Nebraska. *Microtus pennsylvanicus* may now occur statewide in Nebraska in suitable habitats. All of the above specimens are referable to the subspecies *M. p. pennsylvanicus*.

The isolated population of *M. pennsylvanicus* in Dundy County is still extant. In 1988 and 1990, 22 meadow voles were collected from central and western Dundy County. These specimens include nine males, six reproductively inactive females, four juvenile females, one juvenile male, one pregnant female (two embryos), and one lactating female. These Dundy County specimens are referable to the subspecies *M. p. finitus*. If *M. p. pennsylvanicus* continues to extend its range, it will likely come in contact with *M. p. finitus* in the next several decades.

Erethizon dorsatum (Common Porcupine)

New record (1).–Saunders County: 3 miles N, 1 mile W Valparaiso, 1 (unsm 15257).

Sight records (Nebraska Game and Parks Commission).–Johnson Co.: 5 miles E Cook. Saunders Co.: T15N, R7E, Sec. 12 SE ¼ of NE ¼ [approximately 4 miles N, 2 miles W Wahoo]. Jefferson Co.: 2 miles S Steele City. Butler Co.: 2.5 miles southwest of Linwood. Thayer Co.: Chester.

According to Jones (1964), the distribution of the porcupine in Nebraska changed in the first half of the twentieth century: "Formerly the porcupine occurred farther east in Nebraska than now and may have been state-wide in distribution" (Jones 1964: 242). In his distribution map for the porcupine, Jones (1964:242) drew a dashed line indicating the approximate eastern limit of the species as of 1964 (Fig. 16).

One new specimen of *Erethizon dorsatum* is reported herein, obtained 21 November 1981, in Saunders County to the east of Jones' 1964 line. This male is referable to the subspecies *E. d. bruneri*. In addition to this specimen, Nebraska Game and Parks Commission personnel have records of sightings of porcupines from five counties in southeastern Nebraska subsequent to 1964. Given the size and unique appearance of this species, these sightings probably are valid. These records indicate that the porcupine is present in southeastern Nebraska, but the species is not common.

Mustela nivalis (Least Weasel)

New records (8).–Richardson County: 3.5 miles NW Verdon, 1 (ku 139238). Gage Co.: 1.05 miles N Barneston 1 (unsm 25780). Nemaha Co.: Brock, 3 (unsm 12931-32, 13019); 3.5 miles W Peru, 1 (vmksc 499). Morrill Co.: Town of Bridgeport, 722 "O" Street, 1 (bhs 208); T20N, R50W, Sec. 20 [just north of Bridgeport], 1 (bhs 215).

Jones (1964) stated that the least weasel occupied much of central and eastern Nebraska but was absent from western and extreme southeastern counties (Fig. 17). Recent records of this species in Kansas (Choate et al. 1979, 1988, Hoofer and Choate 1997) and Oklahoma (Clark and Clark 1988), however, indicate the least weasel is significantly expanding its geographic range on the Great Plains.

Eight new specimens of *M. nivalis* are reported herein, from southeastern and western Nebraska. One male least weasel was obtained in central Richardson County in mid-January of 1984. Three *M. nivalis*, two females and a juvenile male, were captured 25 August 1964, in northern Nemaha County. Another *M. nivalis* of unknown sex was captured on 28 September of 1968, in northeastern Nemaha County. A female trapped in Gage County on 8 February 1999 evinced

Figures 13–15. **13**. Geographic range of the southern bog lemming, *Synaptomys cooperi*, in Nebraska. Shaded area represents the distribution of the southern bog lemming as known by Jones (1964). Closed circles are records reported herein. **14**. Geographic range of the woodland vole, *Microtus pinetorum*, in Nebraska. Shaded area represents the distribution of the woodland vole as known by Jones (1964). Closed circles are records reported herein. **15**. Geographic range of the meadow vole, *Microtus pennsylvanicus*, in Nebraska. Shaded area represents the distribution of the meadow vole as known by Jones (1964). Closed circles are records reported herein. Open circles are records reported by other authors since 1964.

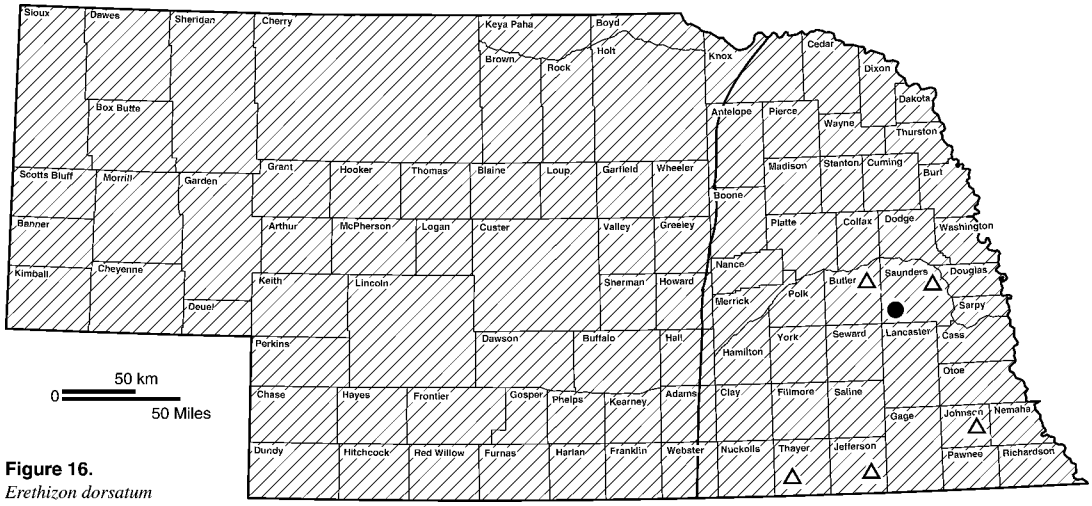

Figure 16.
Erethizon dorsatum

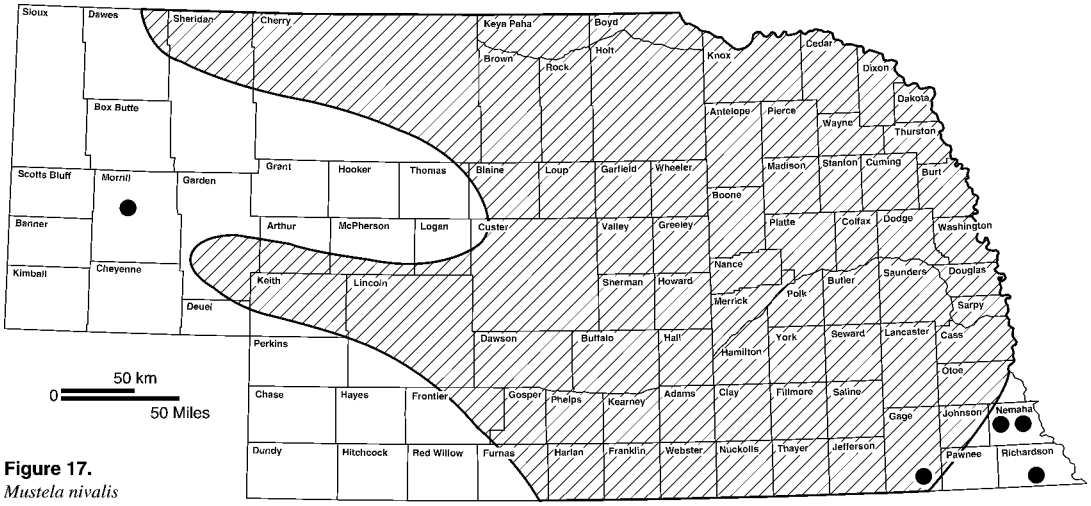

Figure 17.
Mustela nivalis

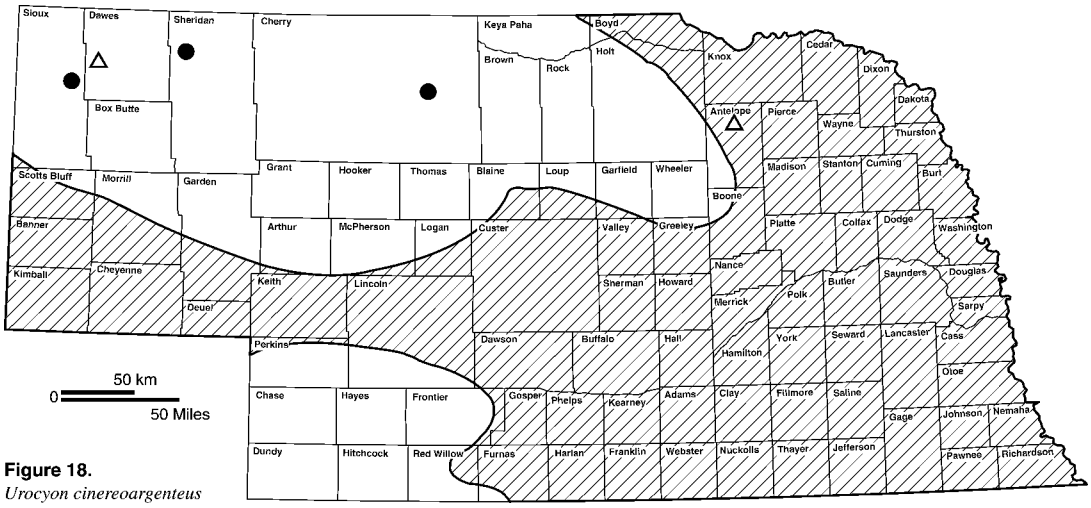

Figure 18.
Urocyon cinereoargenteus

no reproductive activity and remained in its white winter pelage. The individual was taken in dense roadside grasses (native and non-native) with rose and smartweed. The above specimens indicate the least weasel occupies all of eastern Nebraska.

In western Nebraska, two least weasels were collected in Morrill County, in the North Platte River valley, one on 16 March 1982, and the other on 17 February 1985. The former specimen is a male that was found dead on a street within the city limits of Bridgeport; the latter specimen also is a male. The two Morrill County specimens indicate that the least weasel extends further west in the state than previously recognized (Fig. 17); the closest previously reported specimen was captured in Oshkosh, Garden County (Swenk 1926), 43 miles southeast of the specimens reported here. All of the above specimens are referable to the subspecies *M. n. campestris*, the only subspecies present in Nebraska (Jones et al., 1983). External measurements for the new specimens are presented in Table 6. Cranial measurements for UNSM 12932 are: condylobasal length 30.09, zygomatic breadth 15.72, interorbital constriction 6.44, postorbital constriction 6.81, mastoid breadth 14.49, length of maxillary toothrow 8.65.

Urocyon cinereoargenteus (Gray Fox)

New records (3).–CHERRY COUNTY: W of Valentine National Wildlife Refuge [T30N, R29W, Sec. 33 NW ¼], 1 (UNSM 25348). SHERIDAN CO.: approximately 6 miles SW Whiteclay, 1 (Len McDaniel personal collection). SIOUX CO.: T30N, R53W, Sec. 6 [vicinity of Glenn], 1 (UNSM 23439).

Sight records.–ANTELOPE CO.: 3 miles N, 2 miles E Orchard (Freeman, June 1989). DAWES CO.: Fort Robinson State Park (David Oates, Nebraska Game and Parks Commission).

According to Jones (1964), the gray fox occupied much of eastern Nebraska, extending into western counties along the Platte River system (Fig. 18). Three specimens of *U. cinereoargenteus* are reported herein, from northern and northwestern Nebraska. The skull of a gray fox was recovered on 24 October 1972, from the remains of an animal killed by trappers the previous spring in eastern Cherry County. This animal was trapped adjacent to the Valentine National Wildlife Refuge; surrounding habitats included marshes, riparian woodlands, and Sandhills prairie. Cranial measurements for this specimen are as follows: condylobasal length, 125.15; zygomatic breadth, 71.75; interorbital constriction, 25.82; postorbital constriction, 26.67; palatal length, 63.11; length of nasals, 44.97; length of maxillary toothrow, 52.46. Another specimen was captured in January of 1963 in western Sheridan County. This skull-only specimen is currently held by Leonard L. McDaniel, a biologist at Valentine National Wildlife Refuge. Mr. McDaniel trapped the individual, along with several other *U. cinereoargenteus*, in the early 1960s. Habitats in this area include rocky hills with open forests of ponderosa pine, dry prairies, riparian deciduous woodlands, and agricultural fields. Finally, a gray fox was captured in eastern Sioux County on 28 September 1972. This male was taken in an area dominated by rocky hills with open forests of ponderosa pine, dry prairies, riparian deciduous woodlands, and agricultural fields. Measurements for this specimen are as follows: total length, 920; length of tail, 375; length of hind foot, 120; length of ear, 73; weight, 4545 grams; condylobasal length, 125.15, zygomatic breadth, 71.75; interorbital constriction, 25.82; postorbital constriction, 26.67; palatal length, 63.11; length of nasals, 44.97; length of maxillary toothrow, 52.46. All of the above specimens are referable to the subspecies *U. c. ocythous*, the only subspecies present on the plains (Jones et al. 1983). These new specimens indicate the gray fox has been more widely distributed in northern and western Nebraska than previously recognized. In Kansas, Choate and Krause (1975) documented a similar movement of gray fox across the state, but Zumbaugh and Choate (1985) believed that after becoming common in certain areas of western Kansas in the 1960s and 1970s the species subsequently had become rare and its geographic range diminished eastward. We do not have data at hand that would allow for an assessment to learn if a similar contraction in geographic range has occurred in Nebraska.

Puma concolor (Mountain Lion)

New records (3).–BOX BUTTE COUNTY: approximately 5 miles N Berea, 1 (UNSM 25870). SCOTTS BLUFF CO.: 3 miles S, 1.25 miles E Mitchell, 1 (UNSM 20909). SIOUX CO.: Harrison, 1 (UNSM 25869).

Other record.–SIOUX CO.: 8 km N, 22.5 km E Harrison [T32N, R14E, Sec. 13] (Genoways and Freeman 1996).

Prior to settlement, the mountain lion was found throughout Nebraska but was apparently extirpated from the state by the early 1900s. Despite a number of newspaper reports of this species, Jones (1964) did not include *P. concolor* on his list of extant species in the state because of the lack of verified records. Documentation of this species' presence in the state occurred in 1991, when a mountain lion was shot near Fort Robinson State Park, in eastern Sioux County (Genoways and Freeman 1996)

Three additional specimens of *P. concolor* have been taken in Nebraska since this initial report (Fig. 19). The animal from Scotts Bluff County was found dead on railroad tracks in the valley of the North Platte River on 21 April 1996. Based on the unfused epiphyses, this female was not fully grown. Surrounding habitats included wet meadows, deciduous riparian woodlands dominated by cottonwoods, dry prairies, and agricultural fields; rocky hills containing open forest of ponderosa pine are located several miles south.

Figures 16–18. **16**. Geographic range of the porcupine, *Erethizon dorsatum*, in Nebraska. Shaded area represents the former distribution of the porcupine as known by Jones (1964), but Jones (1964) believed that the porcupine as of 1964 no longer occurred to the east of the boundary indicated. The closed circle is a record reported herein. Open triangles represent sight records from the files of the Nebraska Game and Parks Commission. **17**. Geographic range of the least weasel, *Mustela nivalis*, in Nebraska. Shaded area represents the distribution of the least weasel as known by Jones (1964). Closed circles are records reported herein. **18**. Geographic range of the gray fox, *Urocyon cinereoargenteus*, in Nebraska. Shaded area represents the distribution of the gray fox as known by Jones (1964). Closed circles are records reported herein. Open triangles represent sight records.

Table 6. External measurements of selected new specimens of *Mustela nivalis* from Nebraska. All measures in mm except where noted.

Measurements	KU **139238**	UNSM **12931**	UNSM **12932**	UNSM **13019**	BHS **208**	BHS **215**
Sex	Male	Female	Female	Male	Male	Male
Total length	–	152	183	123	200	194
Length of tail	31	24	32	18	26	30
Length of hind foot	23	19	22	14	15	25
Length of ear	–	10	14	6	13	14
Weight (in grams)	–	30	41.4	18.8	64.3	53.2

Cranial measurements for this specimen are: greatest length of skull 188, condylobasal length 168, zygomatic breadth 132, height of cranium 68, interorbital breadth 38.5, breadth across postorbital process 68, length of maxillary toothrow 61.

A male mountain lion was shot in Harrison, Sioux County, on 9 May 1999 (Porter 1999). The lion was observed lying along a small barn within the city limits of Harrison and was concealed by a stack of wood and fencing materials. The animal did not attempt to leave after being observed for several hours. It evidently had been injured recently, possibly being hit by a vehicle, because a number of broken ribs and a skin laceration were noted upon necropsy. Dr. Dale M. Grotelueschen of the Panhandle Veterinary Diagnostic Laboratory, University of Nebraska–Lincoln, who performed the necropsy noted "in excellent body condition with large amounts of fat stores throughout." The animal weighed 121 pounds [≈ 55 kilograms]. The large intestine was noted as containing "moderate amounts of hair." The endoparasite *Toxascaris leonina* was identified from the gastrointestinal tract and the ectoparasitic tick *Dermacentor variablis* was numerous in the coat. The town of Harrison sits along the edge of the Pine Ridge in extreme northwestern Nebraska, where shortgrass prairie interdigitates with stands of ponderosa pine.

The fourth individual was another male mountain lion taken on the morning of 29 September 1999 at a location approximately 5 miles north of Berea (Hammel 1999). The animal was shot after being treed near a farm house. This general area is in heavy agricultural use, with fields primarily for raising wheat and sugar beets. On necropsy this male was considered to be "in fair body condition," weighing 86 pounds [≈ 39 kilograms]. Sperm cells were noted in the testes and epididymus. The necropsy revealed that the animal had a healing injury to the ribs that had occurred several weeks prior to death.

These four recent records of mountain lions in western Nebraska provide convincing evidence that this species is reclaiming some of its former geographic range in Nebraska. We believe that these animals are moving eastward from the Rocky Mountains in Wyoming or southeastward from the Black Hills of South Dakota where populations have increased under management protection. These specimens are referable to the subspecies *P. c. hippolestes*. We follow Wozencraft (1993) in using the generic name *Puma* for this species previously placed in the genus *Felis*.

Lynx rufus (Bobcat)

New records (16).–Richardson County: Shubert area, 1 (unsm 14669). Pawnee Co.: Pawnee Prairie, 1 (unsm 15022); 0.5 mile S, 6 miles W Pawnee City, 1 (vmksc 3675); 5 miles S, 1 mile W Pawnee City, 1 (vmksc 3679); 3 miles S Pawnee City, 1 (vmksc 3681); 3 miles E Liberty, 1 (unsm 14672). Gage Co.: 3 miles W Liberty, 1 (unsm 14670); 1 mile N, 3 miles W Odell, 1 (vmksc 3678). Lancaster Co.: 1.5 miles W of Coddington Avenue on W. Denton Road [approximately 3.5 miles E Denton], 1 (unsm 20533). Jefferson Co.: 2 miles N Steele City, 1 (unsm 15021); 2 miles N, 1.5 miles E Endicott, 1 (unsm 15029); 1 mile W Thompson, 1 (unsm 14656). Thayer Co.: 0.5 mile E of Highway 53 on Little Blue River, S of Alexandria, 1 (vmksc 3677); 2 miles E Hubbel, 2 (unsm 15030, 19778); 0.5 mile W Gilead on Highway 136, 1 (unsm 18189).

Jones (1964) described the bobcat as occupying all of Nebraska, except the southeastern corner (Fig. 20). Sixteen newly acquired specimens of bobcats from the southeastern corner of the state indicate that this species is now statewide in distribution. Three bobcats were killed by vehicles: a male was killed on a county road in Lancaster County, in October of 1995; a female was killed on a state highway in Thayer County in spring/summer of 1988; and a male was killed on a county road in Thayer County on 1 November 1989. The remaining bobcat specimens were collected by fur trappers. An adult male bobcat was trapped in northern Richardson County in December of 1977. Five *L. rufus* were captured in different localities in Pawnee County during the winter months of 1978, 1980, 1981, and 1982, including three males and two females. In Gage County, two bobcats were trapped, a juvenile female in December of 1977 in the southeastern corner of the county, and a male in January of 1982 in the southwestern corner. Three bobcats, two females and a male, were captured at different localities in Jefferson County on 22 December 1977, 15 December 1978, and 11 June 1979. Finally, two female *L. rufus* were trapped at different sites in Thayer County on 24 December 1978 and 2 January 1982. All of the above specimens are referable to the subspecies *L. r. rufus*. We follow Wozencraft (1993) in using the generic name *Lynx* for this species, which some recent authors have placed in the genus *Felis*.

DISCUSSION

The geographic ranges of a number of mammalian species inhabiting Nebraska appear to have changed dramatically since the last comprehensive survey of mammals in the state was conducted by J. K. Jones, Jr., in the 1950s and early 1960s and published in 1964 (Jones 1964). New distributional records are presented in this report for 20 of the 78 native mammals currently found in the state (25.6 %). Although some of these specimens simply may represent better sampling in previously untrapped areas, records suggest expansions in the geographic ranges of at least 15 of the species involved.

Species expanding to the west

The majority of species increasing in geographic range in Nebraska are expanding to the west and are mammals associated with forests or forest ecotones; species in this category for which new records have been presented here include the opossum, northern myotis, evening bat, red bat, woodchuck, white-footed mouse, and gray fox. The least shrew also may be a member of this group. These species have sufficiently broad habitat requirements to allow them to survive in the expanding forests of central and western Nebraska. Some of these species may also be increasing because of the removal of large predators.

The westward expansion in geographic ranges of woodland mammals described herein is occurring elsewhere on the Great Plains (Frey and Moore 1990a, 1990b, Hoofer and Choate 1997, Sparks and Choate 1996, 2000, Wilson and Choate 1996), and the fossil record indicates that the distributions of many mammals of the Great Plains have shifted in the past with changes in climate and vegetation (Hoffmann and Jones 1970, Rhodes and Semken 1986, Voorhies and Corner 1985). Nonetheless, the recent mammalian distributional changes have important implications for conservation biology. As these species increase in geographic range and abundance, they impact populations of grassland species, as has been shown in the case of *Peromyscus leucopus* (Benedict et al. 1996). White-tailed deer, for example, have a negative impact on mule deer (*Odocoileus hemionus*) through hybridization (Carr et al. 1986) and possibly competition. Furthermore, as populations of eastern forest mammals expand westward, they eventually meet and interact with organisms inhabiting western forests, a process termed faunal mixing (Knopf 1994). In Colorado, for instance, recently arrived fox squirrels compete with resident populations of Abert's squirrel (*Sciurus aberti*), a species with a small geographic range and highly restricted habitat requirements (Fitzgerald et al. 1994).

Species expanding to the east

Five species are expanding to the east in Nebraska, namely the northern grasshopper mouse, porcupine, mountain lion, Merriam's shrew (Fig. 21), and bobcat. The porcupine and bobcat are well established in central and western Nebraska and are expanding into the eastern quarter of the state, possibly in response to increasing woodlands, decreased predation, and/or managed trapping and hunting. Likewise, the northern grasshopper mouse occupies central and western Nebraska and apparently has expanded in geographic range into the extreme eastern counties of the state. The reasons for this expansion are unclear, but may be related to the clearing of forests and the increase in agricultural use of lands. Alternatively, the species may be expanding its geographic range along the roadside ditches of highways in eastern Nebraska. Choate and Terry (1974, see also Fleharty and Channell 1997) believed these ditches were a preferred habitat of the northern grasshopper mouse because the ditches provided successional species of plants and animals for food, bare patches of sandy soil for dusting, and some forbs for shelter. In irrigated cornfields in the sandsage prairie of southwestern Kansas, the northern grasshopper mouse was found to be the most abundant small mammal. The species was reproducing in the open stubble fields in early spring before planting (Fleharty and Navo 1983). In eastern Nebraska, the tall grass prairie has been replaced by just such irrigated cornfields.

The mountain lion, which was extirpated from Nebraska early in the twentieth century, is re-colonizing the extreme western edge of the state, probably from populations in Wyoming, South Dakota, and/or Colorado. The reasons for this geographic range expansion may include increased control of hunting and trapping by humans and increases in deer populations that are allowing mountain lion populations to increase in the Rocky Mountains. Likewise, Merriam's shrew appears to be expanding in geographic range in the extreme northwest corner of Nebraska for unknown reasons (Benedict et al. 1999, Freeman et al. 1996, McDaniel 1967).

Species expanding to the south

Another group of mammals increasing in geographic range in Nebraska includes species with predominantly northern distributions that are expanding southward on the Great Plains. Species in this category for which new distributional records have been presented here include the masked shrew, meadow vole, and least weasel. The latter species also appears to be expanding westward (Fig. 17).

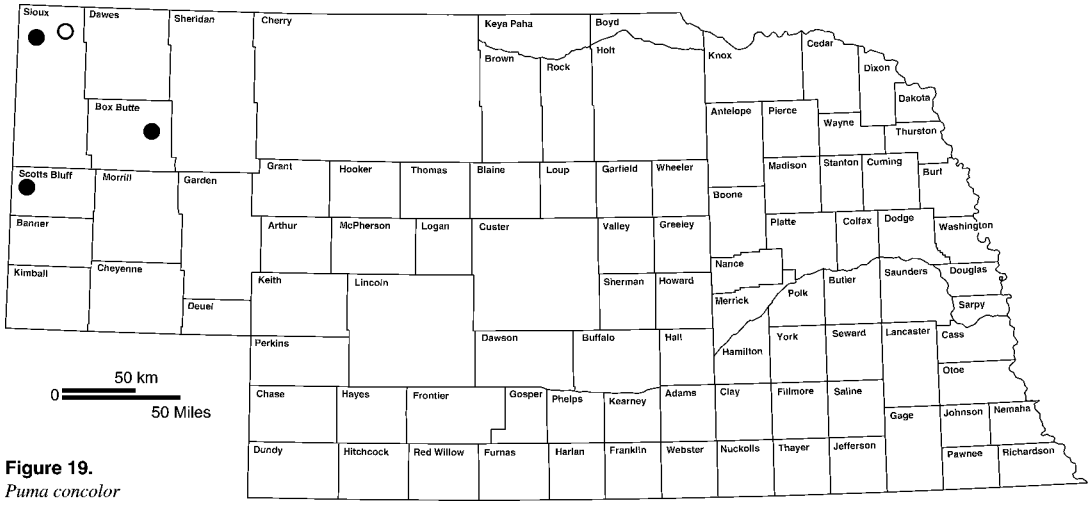

Figure 19.
Puma concolor

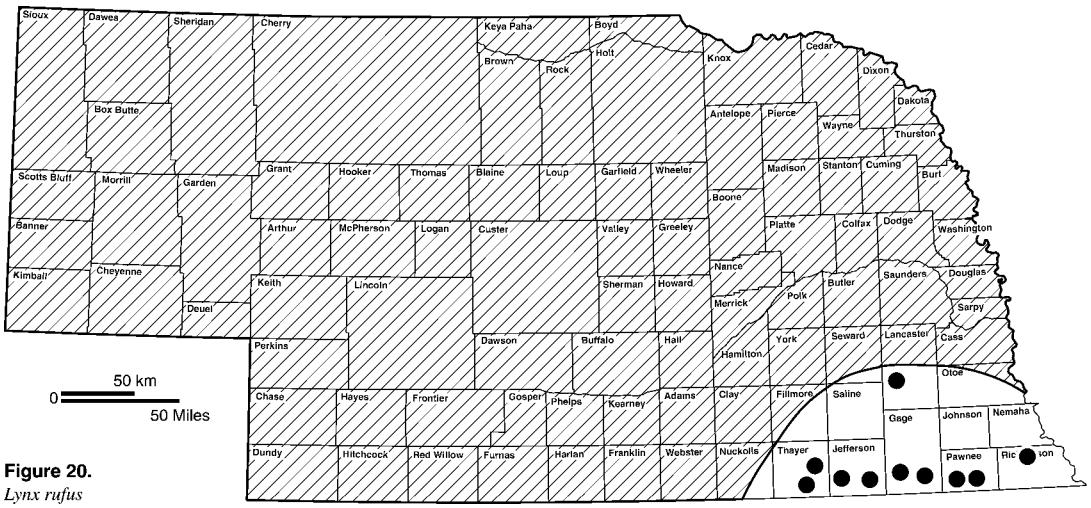

Figure 20.
Lynx rufus

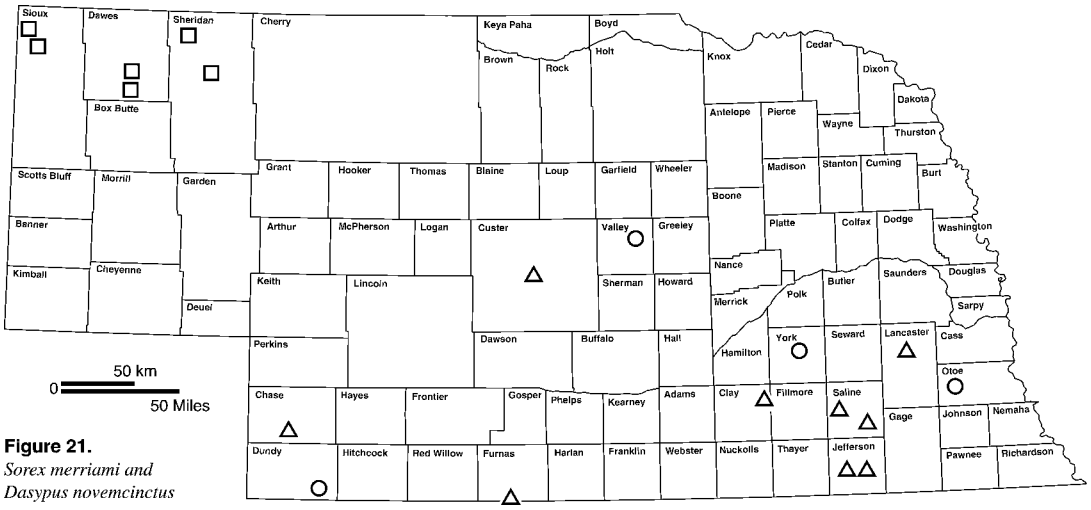

Figure 21.
Sorex merriami and
Dasypus novemcinctus

According to Frey (1992), these species are expanding south in response to cool, moist conditions prevailing locally on the central plains during the last several decades. Another possible factor benefiting these species in this region is the abundance of fencerows and strips of roadside vegetation dominated by grasses, especially *Bromus inermis* in Nebraska and native tallgrass species in Kansas. In many places, these habitats receive irrigation run-off from surrounding croplands and are rarely mowed. These conditions lead to the accumulation of tremendous quantities of vegetative litter, creating cool, moist conditions at the soil surface. Litter of this depth appears to be uncommon in native prairies, possibly attributable to different vegetative composition or the more frequent occurrence of fire. These mesic, linear grassland habitats, therefore, may have provided corridors for the dispersal of these species into the southern plains. All three of these species are caught in substantial numbers in roadside strips with thick vegetative litter. During 32,109 trap nights conducted on roadsides from 1991 through 1999, the meadow vole, masked shrew, and least weasel were captured at rates of 1.68, 0.97, and 0.06 animals per 100 trap nights, respectively (Benedict unpublished field data). In Kansas, Welker and Choate (1994) found that they "caught no meadow voles or southern bog lemmings in traplines set in areas other than roadside ditches or fencerows." "All meadow voles were trapped within 50 m of standing water."

The explosive expansion of the least weasel also may be attributable to its recent contact with the cotton rat (*Sigmodon hispidus*), a likely new prey species, which is an abundant rodent in many mesic grasslands in the southern U. S. (Hoofer and Choate 1997). Conversely, the slowing of the movement of *Sigmodon* populations northward may be the result of its contact with this new predator along the border of Nebraska and Kansas.

Species expanding to the north

In contrast to the above species, a number of mammals are expanding into Nebraska from the south, apparently in response to long-term climatic warming trends or the increase in woodlands. *Neotoma floridana* is the only species with new distributional records reported herein that fits into this category. This species appears to be advancing north along the Big and Little Blue river systems in southeastern Nebraska, possibly in response to increasing woodlands or the changing composition of woodlands caused by a lack of fire.

Although new distributional records for these species are not presented in this paper, the nine-banded armadillo (*Dasypus novemcinctus*) and hispid cotton rat (*Sigmodon hispidus*) also have advanced northward into the state in recent decades. The armadillo apparently invaded southern Nebraska around 1970 and has continued its northward expansion in recent years; the northernmost specimen in Nebraska and in North America is from Valley County (Freeman and Genoways, 1998; Fig. 21). To date no evidence of breeding has been found in armadillos in Nebraska; the three specimens examined for gender have all been males.

Following a well documented spread through Kansas, the hispid cotton rat was first captured in Nebraska in 1958, in Richardson County (Jones 1964). Subsequent trapping yielded specimens from south-central counties in Nebraska as far north as the northern edge of Kearney County (Choate and Genoways 1967, Farney 1975, Genoways and Schlitter 1967). The most recent specimens of *S. hispidus* in Nebraska were collected in 1988 and 1989 in Harlan County (UNSM 16926-28, 17306-07). Several attempts to locate this species along the Kansas border during the 1990s have been unsuccessful. *Sigmodon hispidus* may have reached the limits of its climatic tolerance and now is retracting in range or perhaps as mentioned previously, it has contacted a new predator species, the least weasel, and this has slowed its northward movement.

Mammals with contracting ranges

Although it is difficult to document, a number of mammalian species appear to be contracting in geographic distribution in Nebraska. The majority of species in this category are associated with prairies—ecosystems which have been very heavily impacted by humans (Fleharty and Channell 1997, Noss et al. 1995, Samson and Knopf 1996). Due to loss of prairie habitat, species such as the white-tailed jackrabbit (*Lepus townsendii*), black-tailed prairie dog (*Cynomys ludovicianus*), northern pocket gopher (*Thomomys talpoides*), plains pocket mouse (*Perognathus flavescens*), and plains harvest mouse (*Reithrodontomys montanus*) may be absent from parts of their historical ranges.

Figures 19–21. **19**. Geographic range of the mountain lion, *Puma concolor*, in Nebraska. Mountain lions were once statewide in distribution, but were believed by Jones (1964) to have been extirpated from the state by the early 20th Century. The closed circles are records reported herein. The open circle is a record reported by other authors since 1964. **20**. Geographic range of the bobcat, *Lynx rufus*, in Nebraska. Shaded area represents the distribution of the bobcat as known by Jones (1964). Closed circles are records reported herein. **21**. Geographic range of Merriam's shrew (*Sorex merriami*) represented by open squares and the nine-banded armadillo (*Dasypus novemcinctus*) represented by open circles for specimens and open triangles for sight records in Nebraska. Records shown are based upon Benedict et al. (1999) and Freeman and Genoways (1998), respectively.

The white-tailed jackrabbit at one time occupied nearly all of Nebraska but has gradually disappeared from southern and eastern portions of its range, apparently in response to the plowing of prairies and increasing numbers of the black-tailed jackrabbit (Bogan and Ramotnik 1995, Jones 1964). Likewise, the black-tailed prairie dog formerly occupied all but the easternmost portions of Nebraska but now appears to be absent from the eastern third of the state. Even in the expansive prairies of the Sandhills, prairie dog towns are so small and isolated that genetic exchange between them may not be possible. The reduction in range of this important species can be attributed to epidemics, intentional eradication programs, and the conversion of prairies to agricultural lands (Benedict et al. 1996, Bogan and Ramotnik 1995, Whicker and Detling 1993).

Several small mammals occupying prairies also may be decreasing in range in Nebraska, but further work is necessary to confirm this. In Nebraska, *Thomomys talpoides* originally occupied the northwestern and southwestern corners of the state (Jones 1964). Although two specimens of this species were collected in Kimball County in July of 1988 (UNSM 17161-62), this species may be reduced in geographic range in the southwestern portions of Nebraska (Jones 1964). Likewise, in northwestern Nebraska, this species is uncommon and may be declining. Only a single specimen of *T. talpoides* has been trapped in northwestern Nebraska in recent decades (UNSM 21528, collected in 1974 in Sioux County); during this same time, 34 *Geomys bursarius* have been collected within the area supposedly occupied by *Thomomys*. Similarly, *Perognathus flavescens* and *Reithrodontomys montanus* may be absent over portions of their historic geographic ranges in eastern Nebraska. Despite over 35,000 trap nights conducted in prairies and roadside grasses in eastern Nebraska, *P. flavescens* has not been collected in the last decade and *R. montanus* has only been collected at a single locality, a prairie remnant in southwestern Lancaster County (UNSM 25359-60). Although *P. flavescens* and *R. montanus* may still exist as isolated populations in eastern Nebraska, they likely do not occupy as wide of a geographic range as depicted in Jones (1964).

Contracting geographic ranges also may characterize the southern flying squirrel (*Glaucomys volans*), gray squirrel (*Sciurus carolinensis*), and eastern chipmunk (*Tamias striatus*), species dependent on mature or climax oak/hickory forests. The mature oak/hickory woodlands of southeastern Nebraska apparently declined in extent following the arrival of European settlers. The decline of mature forests may have impacted these mammals by reducing mast production, reducing nesting sites such as holes in dead snag trees, and increasing the complexity of the understory and forest floor. The above species of mammals now appear to be absent from northern and western portions of their historic ranges in Nebraska. *Tamias striatus* formerly occurred in southeastern Nebraska north to Washington and Dodge counties, but has been declining since the arrival of European settlers (Jones 1964, and references therein). In the last two decades, no specimens of the eastern chipmunk have been collected in the state, and this species may now be extirpated from Nebraska. The only evidence of the existence of *T. striatus* in Nebraska was a sighting in May of 1991, at the Rulo Bluffs Preserve in extreme southeastern Richardson County (Steinauer 1991).

Like the eastern chipmunk, *Glaucomys volans* formerly occurred in southeastern Nebraska as far north as Douglas County and far west as Seward County (Jones, 1964, and references therein). Today, this secretive squirrel is known with certainty only from Richardson, Nemaha, and Otoe counties in southeasternmost Nebraska. Efforts to locate populations of *G. volans* by the Nebraska Game and Parks Commission from 1983 through 1993 did not find any individuals further north than Nebraska City, Otoe County (personal communication, Frank Andelt, Nebraska Game and Parks Commission). Likewise, *Sciurus carolinensis* formerly occurred in eastern Nebraska as far north as Cedar County (Jones 1964). The present distribution of this species is poorly known, but contiguous populations are known only from forests along the Missouri River, from southern Cass County southward. An apparently isolated population occurs at Fontenelle Forest Nature Center, just east of Bellevue, in Sarpy County (UNSM 25347).

Two additional mammals with apparently contracting geographic distributions in Nebraska, or at least with decreasing population levels, are the eastern spotted skunk (*Spilogale putorius*) and the long-tailed weasel (*Mustela frenata*). According to Jones (1964), these two species were statewide in distribution, although the spotted skunk had only recently invaded the state from the south. The long-tailed weasel still occurs in central and western parts of Nebraska but apparently has not been recorded from eastern portions of its historic range in recent years (personal communication, Frank Andelt, Nebraska Game and Parks Commission). Likewise, the spotted skunk has not been recorded from eastern Nebraska in recent years and does not appear to be common anywhere in the state (personal communication, Frank Andelt, Nebraska Game and Parks Commission), which is similar to population changes in spotted skunks in Kansas (Choate et al. 1974). If these two species are absent from eastern Nebraska, the reasons for their decline are unclear. Both species are found in a variety of habitats (Jones et al. 1983) so habitat modifications would not seem ca-

pable of solely causing their decline. Perhaps the conversion of prairies to agricultural land, combined with other factors has impacted their populations (Choate et al. 1974).

Finally, several formerly widespread species are now extirpated from Nebraska. Bison, elk, and bighorn sheep were eliminated from the state by the end of the nineteenth century (Bogan 1997, Jones 1964). Bison and elk occur in Nebraska today as isolated, reintroduced populations or as ranch animals. Although bighorn sheep have been reintroduced in the Pine Ridge of northwestern Nebraska, the reintroduced animals are a different subspecies than the native individuals; the native subspecies, *Ovis canadensis auduboni*, is extinct (Jones 1964). Likewise, the grizzly bear, black bear, wolverine, lynx, and wolf were eliminated from the state by the late 1800s or early 1900s and the black-footed ferret by the early 1960s (Bogan 1997, Bogan and Ramotnik 1995); the subspecies of wolf on the plains, *Canis lupus nubilus*, is now extinct (Jones 1964). The river otter also was believed to have been extirpated from Nebraska, but recent records of the river otter in Nebraska from Cass County in 1964 (Farney and Jones 1978) and Furnas County in 1977 (Farney and Jones 1978, UNSM 15117) would call this assumption into question. However, with the release between 1986 and 1991 of otters from Wisconsin, Idaho, Michigan, Alaska, Louisiana, British Columbia, and Ontario (Andelt 1992), it probably will never be known if small isolated populations of native river otters had remained in Nebraska.

CONCLUSIONS

During the last century, shifting geographic distributions have been the rule for many of the mammals inhabiting Nebraska. Prairies have been heavily impacted by humans in a variety of manners, and large mammals–both herbivores and predators—have been eliminated from the region. Riparian and early successional forests have increased in extent, and mature oak/hickory forests have been logged, grazed, and converted to croplands (Benedict et al. 1996). Given these dramatic habitat changes, it is not surprising that the geographic distributions of mammals have shifted substantially. New distributional records have been presented in this paper for 25.6 % of the mammals currently inhabiting Nebraska. The majority of mammals expanding in geographic distribution are species associated with woodlands and forest edges. On the other hand, mammals requiring large tracts of prairie appear to be decreasing in range in some areas.

- Mammals moving to the west in response to the expanding woodlands and forest edges in Nebraska include the opossum, northern myotis, evening bat, red bat, woodchuck, white-footed mouse, and gray fox and possibly the least shrew.

- The mountain lion is moving eastward into Nebraska from Wyoming and possibly South Dakota, probably because of increases in population of this species because of management protection.

- The causes of the eastward expansion of bobcats and porcupines in Nebraska and of Merriam's shrew into Nebraska are unclear, but it is hypothesized that the movement of the northern grasshopper mouse may be in response to the establishment of roadside ditches along highways in eastern portion of the state, which provide many of their habitat requirements.

- Three species (masked shrew, meadow vole, and least weasel) are expanding their geographic range to the south in Nebraska and into Kansas. These species may be responding to the microhabitats created in the mesic, linear grassland habitats formed along highway right-of-ways in which tremendous quantities of vegetative litter have been allowed to accumulate.

- The explosive expansion of the least weasel across Kansas and into Oklahoma may be attributable to its recent contact with *Sigmodon hispidus*, a likely new prey species.

- Three species have been expanding their geographic range northward into Nebraska of which the eastern woodrats movements into southeastern Nebraska are probably in response to the increase and change in composition of the woodland in this part of the state.

- In the case of the nine-banded armadillo and the hispid cotton rats, their movement northward has been attributed to a general warming trend that has allowed these southern species to expand to the north; however, in recent years this movement appears to have stopped in the hispid cotton rats and to have been at least partially reversed in Nebraska. It is suggested that this may be the result of contact with a new predator–the least weasel.

- Several species of mammals are believed to have become rare in Nebraska or to have contracting geographic ranges in the state. Because these cases involve documenting of negative evidence, they have been much more difficult to understand than the species that that are increasing in their geographic distribution.

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