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**Mammals of Lacreek National Wildlife Refuge,
South Dakota**

Robert B. Wilhelm, Jerry R. Choate, and J. Knox Jones, Jr.

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Mammals of Lacreek National Wildlife Refuge, South Dakota

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No comprehensive account of the distribution and biogeography of mammals in South Dakota has been published. Over and Churchill (1945) compiled information available at that time on the mammals of the state, but their work was sketchy and was processed in the form of a mimeographed bulletin, which was not widely distributed. Other studies conducted in South Dakota have dealt with the mammalian faunas of particular regions, such as the Black Hills (Turner, 1974), Clay County (Findley, 1956*b*), and Harding County (Andersen and Jones, 1971), or they have pertained to distributions of individual taxa (for example, Handley, 1953; Birney and Lampe, 1972; Jones *et al.*, 1978). One unique region of the state in which the mammalian fauna has received little attention is located in Bennett County, where expansive marshland abuts the northern border of the Nebraska Sand Hills on Lacreek National Wildlife Refuge (Fig. 1). The marsh is isolated from similar habitats and is of appreciable biogeographic significance, especially with respect to mesic-adapted species.

Prior to 1969 only one publication dealt with the flora and fauna of Bennett County. This report (Perisho and Visser, 1912) was published by the South Dakota Geological Survey and was intended for use by homesteaders in Mellette, Washabaugh, Bennett, and Todd counties when those areas were opened to settlement; as such, the report emphasized the geography and geology of the region but treated the flora and, to a lesser extent, the fauna as well.

Near the turn of the last decade, Lacreek National Wildlife Refuge began to attract the attention of biologists. Hammer (1969) reported population parameters for snapping turtles (*Chelydra serpentina*) on the refuge, and Zimmerman and Burgess (1973) released an account of fishes in pools and streams there. The herpetofauna was detailed by Malaret (1977). Finally, an extension of the study reported herein resulted in a list of the nesting birds of Lacreek (Lohofener and Ely, 1978).

The objectives of this investigation were to document the species of mammals that occur on Lacreek National Wildlife Refuge and in immediately adjacent areas of Bennett County, to amass summer reproductive data for mammals in the area, to ascertain their preferred habitats, and to describe their biogeographic affinities and relationships.

METHODS AND MATERIALS

In addition to routine sampling of the mammalian fauna, three live-trap grids were operated in two habitat types at Lacreek (two on the sand hills

and one in a marsh) during the summer of 1977. These grids provided density and population estimates and also were used to determine preferred habitats of several common small mammals. Each grid on the sand hills encompassed 1.8 hectares and consisted of 100 Sherman folding traps arranged in a 10 by 10 matrix with a trap spacing of 15 meters; the marsh grid consisted of 80 traps arranged in an 8 by 10 matrix encompassing 1.4 hectares. Each trap was baited with rolled oats at dusk and was checked the following morning. An inability to check traps often during daylight hours, combined with high daytime temperatures, resulted in many diurnal mammals dying in the traps. This prompted a decision to close the traps after the morning check. Hence, data on diurnal species such as *Spermophilus* are scant but have been included where feasible. Each animal, when initially captured, was assigned a unique number (by toe clipping), and its identity and the trap number were recorded before it was released. Trap number, species, and toe-clip number were recorded for all recaptures.

Species diversity for mammals trapped on the grids was computed with the Shannon-Wiener index (Odum, 1971), and population densities were estimated by means of the Schnabel method (Overton, 1971). Ecological densities were computed by multiplying the total density recorded in a given trapping period (in numbers per hectare) by the per cent of total captures in a particular habitat (Fleharty, 1972). These figures, then, represent habitat utilization for each species and do not necessarily correspond to data on preferred habitats. Determination of ecological density was based on the assumption that the population within each habitat is distributed according to the percentage of total captures within the habitat. For example, if 53 per cent of the kangaroo rats captured on a grid are captured in a particular habitat, then it is assumed that 53 per cent of the population of kangaroo rats on that grid occur in that habitat. Preferred habitat was computed based on the number of individual captures of a species within a particular habitat (after Fleharty and Mares, 1973). Plant composition of each grid was determined by the step-point procedure.

Research on the mammals of Lacreek National Wildlife Refuge and the surrounding region was initiated in 1967 by one of us (Jones), under the aegis of the Museum of Natural History at The University of Kansas. The uniqueness of the area was recognized and a sizeable collection of mammals was amassed; however, other duties and responsibilities caused the project to be temporarily shelved. In 1977, Choate, who had participated in Jones' research 10 years previously, obtained financial assistance from Earthwatch and the Center for Field Research (of Belmont, Massachusetts) to complete the study. Robert A. Nicholson (of Fort Hays State University) participated as botanist and, together with Renne Lohofener, a graduate student, mapped the vegetative communities on the refuge. Wilhelm supervised the field investigations, compiled data (in the field, at the Museum of the High Plains at Fort Hays State University, and at the Museum of Natural History at The University of Kansas), and submitted the results of the research in

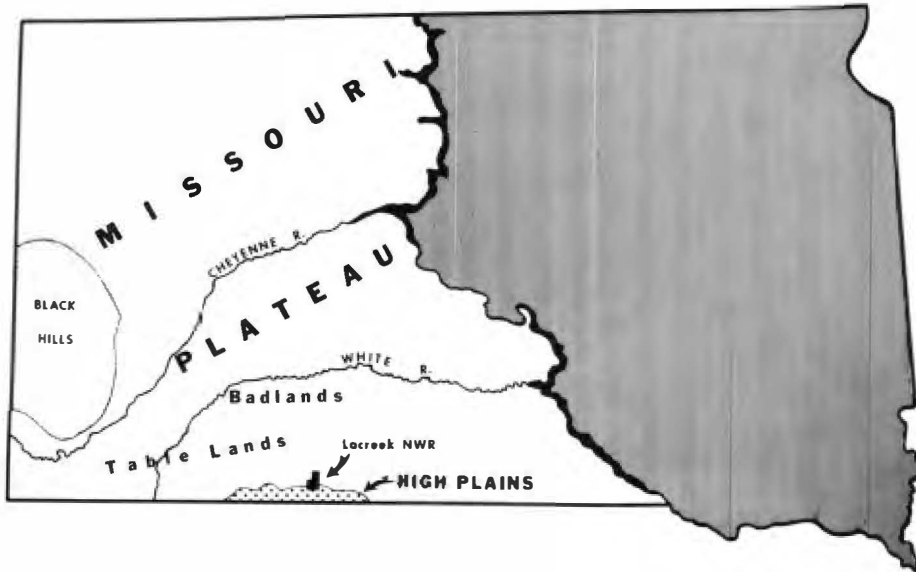


FIG. 1.—Physiographic provinces of western South Dakota (after Rothrock, 1943).

partial fulfillment of the requirements of the M.S. degree in Biology at Fort Hays State University.

DESCRIPTION OF AREA

Lacreek National Wildlife Refuge is situated in southern Bennett County, south-central South Dakota, at the northern limit of the Nebraska Sand Hills. Western South Dakota is part of the Great Plains Physiographic Province (Rothrock, 1943), see Fig. 1. According to Rothrock (1943), this province is divided into the High Plains Division (comprising that small region of South Dakota encompassed by the Nebraska Sand Hills) and the Missouri Plateau Division (including all of South Dakota west of the Missouri River with the exception of the Black Hills and the High Plains. A subunit of the Missouri Plateau Division, the Tertiary Table Lands, is situated south of the White River (Rothrock, 1943). Lacreek National Wildlife Refuge, therefore, is in the zone of transition between the High Plains (Sand Hills) and the Missouri Plateau (Tertiary Table Lands).

The refuge is located approximately 14.5 km. SE Martin and 8 km. N of the Nebraska state line. Bennett County is bordered on the north (Washabaugh County) and west (Shannon County) by the Pine Ridge Indian Reservation, and on the east (Todd County) by the Rosebud Indian Reservation. Lacreek National Wildlife Refuge presently contains 6680 hectares, of which about 2020 hectares are waterfowl habitat (Zimmerman and Burgess, 1973). The refuge is approximately 13 kilometers long, 15 kilometers wide, and is irregular in shape (Fig. 2). Elevation ranges from about 855 to 1100 meters (Hammer, 1969; Lohofener and Ely, 1978).

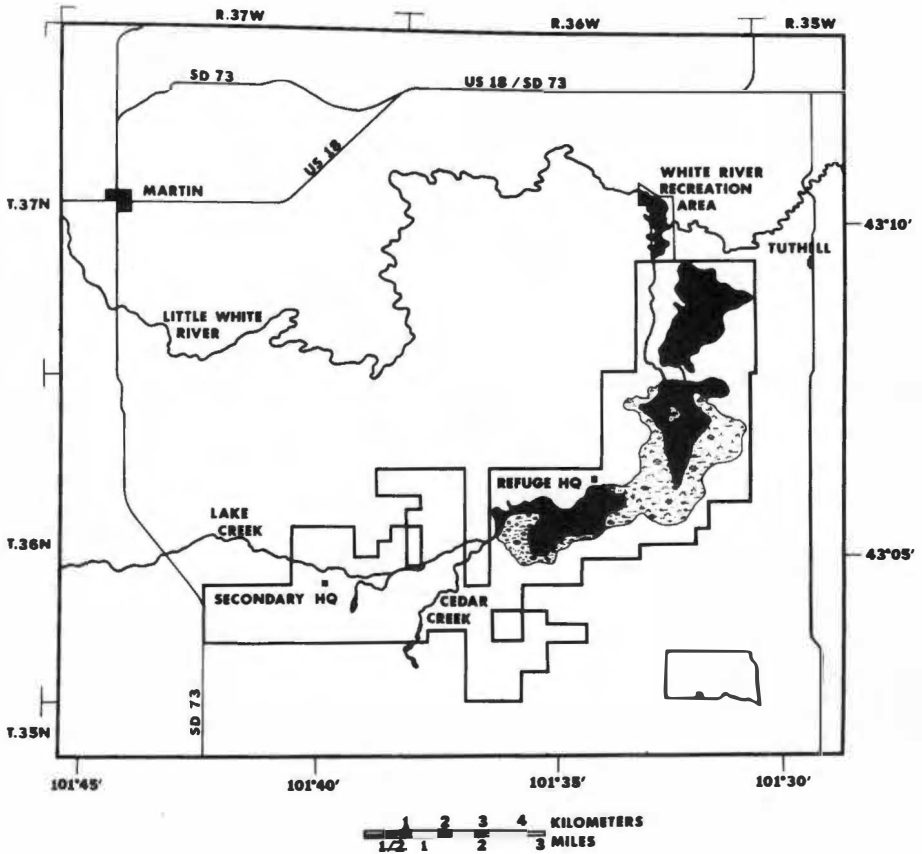


FIG. 2.—Map of Lacreek National Wildlife Refuge and adjacent regions of Bennett County, South Dakota.

South-central South Dakota has a semiarid, continental climate characterized by cold winters and hot summers. Climatological data (Chamberlin and Radeke, 1971) for Martin during the period 1934 to 1963 indicate an average annual precipitation of about 42 centimeters, with a high of 65 in 1942 and a low of about 25 in 1940. Most precipitation is received in the form of thunderstorms, which vary greatly in intensity. The average annual evaporation is three and a half times the average annual precipitation.

The range in temperature is wide, both seasonally and daily. The highest average daily temperature is 31.4°C in July, and the lowest is -11.9°C in January. However, these figures belie the fact that daily temperatures regularly climb to above 38°C in summer and drop to lower than -35°C in winter.

Average seasonal snowfall depth is 81.3 centimeters; the recorded extremes are 213.4 in the winter of 1935-36 and 33.0 in the winter of 1950-51. A snow cover of 2.5 centimeters or more remains on the ground for an average of 54 days per year (extremes were 15 days in the winter of 1961-62 and 91 days in

the winter of 1952-53). These figures might be misleading, however, as strong winds (primarily northwesterly during winter) cause extreme drifting near buildings or other sheltered areas but often remove most snow from open areas.

The refuge is situated in a narrow valley that is drained primarily by the Little White River to the north and Lake Creek (from which the refuge derives its name) to the south. These streams (and numerous other tributaries) produce a natural marsh, which provides abundant nesting habitat for many species of migratory waterfowl. To supplement this natural marshland, a number of ponds were created when a series of dikes and water-control structures was constructed after the refuge was officially established in 1935 (Hammer, 1969). A total of 11 marsh and pool units now exists within the confines of the refuge.

Most of Lacreek is composed of moderately to poorly drained, deep, loamy soils of the Mosher-Minatare-Loup association. These dark-colored soils have a silt-loam surface layer about 20 centimeters thick and are underlain by claypan. The water table fluctuates between depths of 0.9 to 2.1 meters, and large areas of open water and marshland occur along Lake Creek and in the adjacent sand hills.

The southern part of the refuge includes the northern margin of the Nebraska Sand Hills. This soil type, the Valentine association, is characterized as deep, excessively drained, sandy soil with a thin surface layer slightly darkened by organic matter. It comprises a region of rolling hills and ridges varying from six to 23 meters in height. Distinct drainage patterns are not recognized. Dry valleys, subirrigated basins, spring-fed marshes, sand hill lakes, and blowouts are characteristic of sand hill habitats.

The northwestern end of the refuge, just south of the Little White River, has soil typical of the Keith-Rosebud association. This soil type is deep, with a dark-colored loam or silt-loam surface layer, and a friable, silty clay-loam or heavy loam subsoil. This area is level to gently sloping and is well-drained (Chamberlin and Radeke, 1971).

Lohofener and Ely (1978) identified four botanical provinces on Lacreek National Wildlife Refuge. These are outlined in Fig. 3 and consist of upland prairie (classified as wheatgrass-gramagrass prairie, which was estimated to comprise 31 per cent of the total area), marsh (24 per cent), lowland prairie (also classified as wheatgrass-gramagrass prairie, 23 per cent), and sand hills prairie (22 per cent). Common and scientific names for plants mentioned below are from Van Bruggen (1976), except in one instance (marked by asterisk) in which Lohofener and Ely (1978) were used as the authority.

Vegetation on upland sites is a mixture of native and introduced grasses. Dominant native grasses are western wheatgrass (*Agropyron smithii*), needle and thread (*Stipa comata*), blue grama (*Bouteloua gracilis*), and sandreed (*Calamovilfa longifolia*). Large tracts of land that once were cultivated or disturbed in some other way have been planted to crested wheatgrass (*Agropyron cristatum*), smooth brome (*Bromus inermis*), and slender wheatgrass

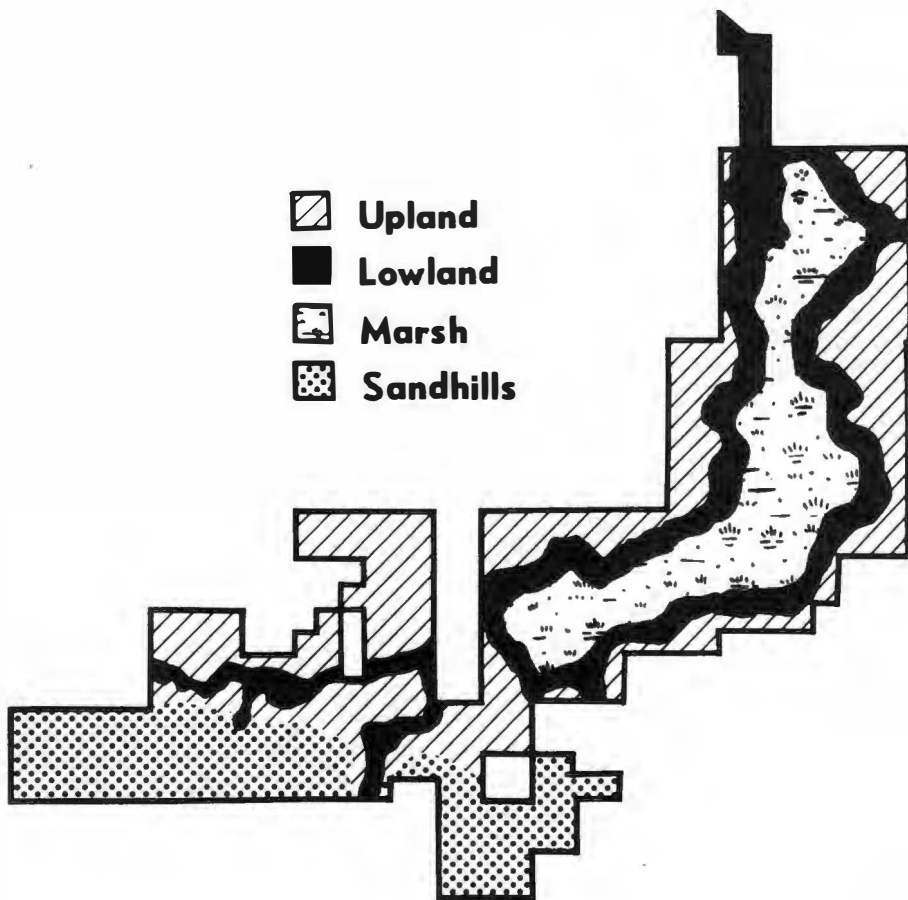


FIG. 3.—Botanical provinces of Lacreek National Wildlife Refuge (after Lohofener and Ely, 1978).

(*A. caninum*). Approximately five per cent of the upland botanical province presently is in cultivation (Lohofener and Ely, 1978).

Wooded areas, although not abundant on or around the refuge, have become increasingly evident in recent years as trees have been planted to form windbreaks, primarily on upland sites. The most common species used for this purpose are American elm (*Ulmus americana*), Siberian elm (*U. pumila*), honey locust (*Gleditsia triacanthos*), Russian olive (*Elaeagnus angustifolia*), and wild plum (*Prunus americana*). Choke cherry (*P. virginiana*) and wolfberry (*Symphoricarpos occidentalis*) also are common on the uplands.

The extensive system of dikes and water control structures mentioned previously greatly enlarged the area of marshland on the refuge. This marshland varies from areas of open water to dense vegetation of cattails (primarily *Typha latifolia*) and rushes (primarily *Scirpus validus*). Sedges (both

Carex and *Cyperus*), plume reed (*Phragmites australis*), and smartweeds (*Polygonum coccineum* and *P. pennsylvanicum*) are abundant in certain sections. Stands of inland saltgrass (*Distichlis spicata*) occur on relatively dry tracts of land, and false indigo (*Amorpha fruticosa*) can be found along most canals, creeks, and wet ditches.

Much of the land included in the lowland botanical province is mowed for hay every three to five years, and the characteristic vegetation includes both native and introduced species. Native vegetation is dominated by western wheatgrass, white sweet clover (*Melilotus albus*), licorice (*Glycyrrhiza lepidota*), Canada thistle (*Cirsium arvense*), and sedges. Timothy (*Phleum pratense*), purpletop (*Tridens flavus**), and slender wheatgrass are the dominant introduced species. Peach-leaved willow (*Salix amygdaloides*), sandbar or coyote willow (*S. exigua*), and cottonwood (*Populus deltoides*) are the most common woody species found near water in the marsh and lowland botanical provinces.

The sand hills prairie is dominated by native grasses such as needle and thread, sandreed, junegrass (*Koeleria pyramidata*), and sand bluestem (*Andropogon hallii*). Soapweed (*Yucca glauca*) also is abundant. American elm and hackberry (*Celtis occidentalis*) are native woody plants common in lowland situations on the sand hills.

HISTORY OF LACREEK NATIONAL WILDLIFE REFUGE AND BENNETT COUNTY

The area now encompassed by Bennett County, South Dakota, once was part of the Pine Ridge Indian Reservation, which was set aside, in accordance with the Laramie Treaty of 1868, for the Ogalala Tribe of the Sioux Nation. Before the treaty, the Ogalala Sioux made extensive use of the natural resources of Lake Creek Valley. In autumn, the Indians harvested the abundant wild rice and cattails. Muskrat and waterfowl, including ducks, geese, and perhaps swans, were hunted and dried for winter meat. The abundance of the muskrat and beaver in and along the streams and marshes of the valley suggests the possibility of occasional visits by fur trappers, as does the discovery on the refuge of a French coin dated 1854 (historical sketch by Refuge Staff, dated 1972). Although the region had a relatively peaceful history, it was not without its colorful moments. In January of 1876, for example, three cowboys "picked a fight" with a band of Sioux Indians on what is now refuge land. All three died and one of them, J. Boydston, is buried along the bank of one of the small creeks in the southern part of the refuge (historical sketch by Refuge Staff, dated 1972).

When Bennett County was part of the Pine Ridge Indian Reservation, the land was held in common ownership by the tribe. In 1875, the legislature of the Dakota Territory included the region now known as Bennett County in Lugenbeel County. In 1889, a new treaty with the Sioux allowed ownership of reservation land to be turned over to the heads of Indian families and other individuals. This conformed to homestead laws then in effect in other

regions of the United States. In 1909, Lugenbeel County was reorganized and Bennett County was established. Soon thereafter, in 1910, an act of Congress enabled nonallotted lands to be homesteaded in accordance with the Homestead Act and, between 1910 and 1930, this former Indian land rapidly was settled by whites (Chamberlin and Radeke, 1971).

Although most white settlers homesteaded on the uplands, a few settled in the valley. D. M. Scott, by way of illustration, constructed a house of "flax straw bales" in the northeastern part of Lake Creek Valley. However, he soon was forced to abandon his straw house when it became overrun by "mice." Little remains of these early homesteads except a few foundations and groves of trees (historical sketch by Refuge Staff, dated 1972).

In 1911, reorganization of Bennet County placed its eastern border along the boundary between the Rosebud and Pine Ridge Indian reservations. The county finally became an officially recognized political unit in 1912.

Northern sections of the county were farmed by early settlers, but southern sections, especially the sand hills, were used for grazing cattle and sheep. During the 1930s, overgrazing, coupled with severe drought, nearly denuded the sand hills of vegetation. However, they have since recovered and now generally are stabilized by plants.

Lake Creek Valley has long been known by hunters. Waterfowl, especially ducks, attracted sportsmen from surrounding states in the early years of this century. Today, Canada geese (*Branta canadensis*) and the protected trumpeter swans (*Olor buccinator*) regularly nest there. Pronghorn (*Antilocapra americana*) once were abundant on the sand hills but were extirpated by 1910; they have since been reestablished.

Hunting pressure and the drought of the 1930s reduced waterfowl populations in the valley (and, indeed, throughout the plains states). These declines so alarmed conservationists that they were spurred to take action. Together with hunters, they urged Congress to purchase marshland for the protection of waterfowl and, as a result, Lacreek National Wildlife Refuge was established by Executive Order in 1935. The following year, land that comprises approximately the eastern half of the refuge was purchased. In 1937, the Civilian Conservation Corps and general contractors constructed dikes, water control structures, buildings and shelters, and roads, and planted food and cover plants for wildlife. Also in that year, a concerted, cooperative effort among the South Dakota Game and Fish Department, the U.S. Bureau of Biological Survey (now the U.S. Fish and Wildlife Service), the Chamber of Commerce of Martin, and concerned citizens of the region resulted in the purchase of the Little White River Recreation Area, north of, and adjacent to, the refuge boundary (Fig. 1). Public Works Administration personnel constructed dikes, buildings, shelters, and swimming beaches, and planted trees (historical sketch by Refuge Staff, dated 1972). The Little White River Recreation Area now is managed cooperatively by the refuge and the South Dakota Game, Fish, and Parks Commission.

In 1971, an additional 2670 hectares of land, approximately the western half of the region presently occupied by the refuge, were purchased with duck stamp funds. This acquisition increased the area of the refuge to its present total of 6680 hectares.

ACCOUNTS OF SPECIES

The following accounts are of those species of mammals, together with their preferred habitats, found on or near Lacreek National Wildlife Refuge. All measurements (in millimeters) and weights (in grams), when given, are of adults unless otherwise noted. Similarly, reproductive data relate only to adult animals unless otherwise noted. Measurements of fetuses are crown-to-rump lengths. Vernacular names of mammals are taken from Jones *et al.* (1979). Institutions housing specimens examined, which are listed from north to south, are identified as follows: Museum of the High Plains, Fort Hays State University (MHP); Museum of Natural History, The University of Kansas (KU); South Dakota State University (SDS). A synoptic series of common species has been deposited in The Museum of Texas Tech University.

Sorex cinereus haydeni Baird, 1858

Masked Shrew

Specimens examined (13).— $\frac{1}{2}$ mi. N, $2\frac{1}{2}$ mi. W Tuthill (T.37 N, R.36 W, N $\frac{1}{2}$ sec. 23), 4(MHP); 1 mi. S, $8\frac{1}{2}$ mi. E Martin, 3050 ft., 1(KU); 2 mi. S, 3 mi. W Tuthill (T.36 N, R.36 W, NW $\frac{1}{4}$ sec. 3), 1(MHP); 6 mi. S, 7 mi. E Martin (T.36 N, R.36 W, E $\frac{1}{2}$ sec. 19), 6(MHP); 7 mi. S, 6 mi. E Martin (T.36 N, R.37 W, N $\frac{1}{2}$ sec. 25), 1(MHP).

The masked shrew is uncommon on and around Lacreek National Wildlife Refuge, and is restricted mostly to mesic lowland habitats. The four specimens listed from near the White River Recreation Area (northwest of Tuthill) were collected in pitfalls placed in the draw below a dammed pond where the vegetation was dominated by cattails; likewise, the one specimen from 2 mi. S and 3 mi. W Tuthill was caught in a pitfall at the edge of a cattail marsh. The six specimens from 6 mi. S and 7 mi. E Martin were collected in a marshy grassland that had been reseeded to several tame grasses, especially timothy and redtop (*Agrostis stolonifera*), and that contained an appreciable amount of Kentucky bluegrass (*Poa pratensis*). The specimen from 1 mi. S and $8\frac{1}{2}$ mi. E Martin was trapped in a mesic fencerow dominated by bunch grasses, but containing an overstory of tall brush. The single shrew from 7 mi. S and 6 mi. E Martin was caught in a riparian community of mixed native grasses, sedges, and rushes bordering Cedar Creek at a place where that stream drains from the sand hills.

Two males had testes that measured 4 on 26 May and 10 June, and another had testes of 3 on 17 July.

Scalopus aquaticus caryi Jackson, 1914

Eastern Mole

Specimens examined (5).—4 mi. S, 8 mi. E Martin, 3050 ft., 1(KU); 6½ mi. S, 3½ mi. E Martin (T.36 N, R.37 W, SW ¼ sec. 22), 1(MHP); 7 mi. S Martin, 3100 ft., 1(KU); 7 mi. S Tuthill, 1(MHP); 8 mi. S, 2 mi. E Martin (T.36 N, R.37 W, SE ¼ sec. 29), 1(MHP)—see Jones *et al.* (1978).

Runways of moles commonly were seen in relatively moist, sandy soils both on and around the refuge, but were most abundant in mesic prairie habitats in the transition zone between sand hills to the south and marshland to the north. Three of the five moles listed above were trapped in such transitional (lowland prairie) habitats, and the remaining two were caught in lawns (one at the Refuge Headquarters and the other at the Secondary Headquarters).

A male trapped on 24 May had testes that measured 10, whereas one trapped on 8 July had testes of only 3 in length and one taken on 13 July had testes of 6. An immature female caught on 9 July evinced no gross reproductive activity.

Sylvilagus audubonii baileyi (Merriam, 1897)

Desert Cottontail

Specimens examined (12).—½ mi. S, 12 mi. E Martin, 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 11(KU).

Sylvilagus audubonii is the more common of the two species of cottontails north of the sand hills in south-central South Dakota, but brushy and marshy habitats in the sand hills and around Lacreek National Wildlife Refuge tend to favor the more mesic-adapted *S. floridanus*. Eleven of the 12 specimens listed above were collected in mowed (or otherwise managed) grassland near the Refuge Headquarters, whereas the other was shot in a roadside ditch adjacent to agricultural land just north of Tuthill.

Several of the specimens collected from 5 to 9 June were molting. Three males taken at that time had testes that measured 23, 60, and 74, respectively; five females were pregnant, two with eight fetuses each, one with six, one with five, and one with four. An immature female obtained on 7 June was lactating and had swollen uteri, and a juvenile male was obtained on 8 June. A female shot on 27 July contained five fetuses that measured 20.

Sylvilagus floridanus similis Nelson, 1907

Eastern Cottontail

Specimens examined (18).—4 mi. N, 4 mi. E Martin, 1(KU); 1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 1(MHP); ½ mi. S, 10 mi. E Martin (T.37 N, R.36 W, S ½ sec. 22), 1(MHP); 3 mi. E Tuthill, 3000 ft., 1(KU); 6/10 mi. W Refuge Headquarters, 3050 ft., 1(KU); 4 mi. S, 8 mi. E Martin, 3050 ft., 9(KU); 5 mi. S Martin, 3100 ft., 1(KU); 6 mi. S Tuthill (T.35 N, R.35 W, NW ¼ sec. 6), 1(MHP); 7 mi. S Tuthill, 1(MHP); 8 mi. S Tuthill, 1(MHP).

Eastern cottontails were abundant in 1967 and 1977 in nearly all lowland habitats affording sufficient cover. All of our specimens were shot or trapped in roadside ditches and other brushy habitats or around the Lacreek Refuge dump. Inexplicably, refuge personnel estimated (in June of 1975) the combined populations of both species of cottontails on the refuge as only 200. We would be surprised if the population of cottontails within only several kilometers of the Refuge Headquarters did not exceed 200 and would guess that the population on the entire refuge numbers in the thousands.

Several of the specimens collected in the first two weeks of June were molting. Six males taken at that time had testes that ranged from 52 to 75 in length, but two taken in mid-July had testes that measured only 21 and 25. Two of four females collected in early June were pregnant, one with nine fetuses of 65 in length and the other with seven that also measured 65. One of the remaining two females collected at that time was lactating; the other showed no signs of recent reproductive activity. An immature female was taken on 10 July.

Lepus californicus melanotis Mearns, 1890

Black-tailed Jackrabbit

The black-tailed jackrabbit is uncommon on Lacreek National Wildlife Refuge and throughout south-central South Dakota, which constitutes the northern range of the species. Our only specimen of this species from the refuge is an adult male shot on 10 June 1967 at a place 5 mi. S and 6 mi. E Martin (KU). The animal was molting to summer pelage and had testes that measured 70. None of these jackrabbits was seen during the summer of 1977.

Lepus townsendii campanius Hollister, 1915

White-tailed Jackrabbit

Specimens examined (9).—2 mi. N, 5 ¼ mi. E Martin (T.37 N, R.36 W, NW ¼ sec. 7), 1(MHP); 1 mi. N, 3 mi. E Martin, 1(KU); ½ mi. S, 10 mi. E Martin (T.37 N, R.36 W, SE ¼ sec. 22), 1(MHP); 1 mi. S, 6 ½ mi. E Martin (T.37 N, R.36 W, SW ¼ sec. 29), 1(MHP); 4 mi. S, 5 mi. E Martin (T.36 N, R.37 W, NW ¼ sec. 10), 1(MHP); 4 mi. S, 6 mi. E Martin, 1(KU); 5 mi. S, 5 mi. E Martin (T.36 N, R.37 W, NE ¼ sec. 14), 2(MHP); 7 mi. S, 2 mi. E Martin (T.36 N, R.37 W, sec. 29), 1(MHP).

As of July 1975, the population of jackrabbits (consisting mostly of this species) on the refuge was estimated by personnel there at only 20 individuals. Based on field experience, we judge this figure to be highly conservative and believe an estimate of three to six per square kilometer of suitable habitat is more nearly accurate. White-tailed jackrabbits were most common in agricultural land and pastures north of Lacreek National Wildlife Refuge; none was seen or captured on the sand hills or in marshy habitats.

An adult male obtained in early June had testes that measured 8 and was completing molt to summer pelage. An immature female also was taken in

early June. Two adult males shot on 16 July had testicular measurements of 53 and 58.

Spermophilus franklinii (Sabine, 1822)

Franklin's Ground Squirrel

Although this ground squirrel is not now known from as far west as Bennett County in South Dakota or in adjacent areas of Nebraska (Jones, 1964), we think the species occurs, at least sporadically, in the Lacreek area. Harold Burgess (Refuge Manager) informed Wilhelm that he occasionally has seen what he thought were Franklin's ground squirrels run across the road about 1 mi. W Tuthill. Habitat in that roadside ditch consisted mainly (in 1977) of cocklebur (*Xanthium strumarium*) growing in sandy soil. During the field season of 1977, three field assistants (Robert C. Dowler, Paula Dowler, and Jay C. Burns) saw what they felt certain was a *S. franklinii* running across a road 7 mi. S Tuthill. Finally, Wilhelm caught a glimpse of an animal that appeared to be of this species as it ran across the road between sections 21 and 22, T.36 N, R.37 W (6 mi. S and 3 mi. E Martin). The roadside ditches at this place were dominated by weedy annuals, such as sunflowers (*Helianthus*) and ragweed (*Ambrosia*), growing in damp, sandy soil; adjacent habitats consisted of a subirrigated pasture and a field of alfalfa (*Medicago sativa*).

Spermophilus spilosoma obsoletus Kennicott, 1863

Spotted Ground Squirrel

Although we failed to obtain specimens of this species on Lacreek National Wildlife Refuge, the existence of the species in Bennett County has been documented (Over and Churchill, 1945). The next nearest record of occurrence of *S. spilosoma* is from Merriman, Cherry Co., Nebraska, approximately 19 kilometers to the south (Jones, 1964). This species is characteristic of the sand hills, and undoubtedly will be found in the southernmost part of the refuge.

Spermophilus tridecemlineatus pallidus J. A. Allen, 1877

Thirteen-lined Ground Squirrel

Specimens examined (10).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 2(MHP); 1 mi. N, 3 mi. E Tuthill, 3025 ft., 1(KU); 1 mi. S, 11 ½ mi. E Martin (T.37 N, R.35 W, S ½ sec. 19), 1(MHP); 2 mi. S, 3 ½ mi. W Tuthill (T.36 N, R.36 W, NE ¼ sec. 4), 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 2(KU); 7 mi. S Martin, 3100 ft., 2(KU); 9 mi. S Martin, 3300 ft., 1(KU).

This ground squirrel is common in well-drained, mowed, or grazed grassland on and around Lacreek National Wildlife Refuge. The species is perhaps less common in sand hill habitats and apparently avoids marshy situations by using elevated roads to bypass wet areas in roadside ditches. All of our specimens were collected in mowed areas or roadside ditches save the

one from 2 mi. S and 3 ½ mi. W Tuthill, which was trapped in a prairie dog town.

One male taken on 8 June had testes that measured 8, and a female trapped the same day had enlarged mammae; an immature (young-of-the-year) animal was caught the following day.

Cynomys ludovicianus ludovicianus (Ord, 1815)

Black-tailed Prairie Dog

Specimens examined (10).—11 ½ mi. E Martin (T.37 N, R.36 W, S ½ sec. 13), 7(MHP); 4 mi. S, 6 mi. E Martin, 2(KU); 5 mi. S, 5 mi. E Martin (T.36 N, R.37 W, SW ¼ sec. 12), 1(MHP).

Black-tailed prairie dogs are common in Bennett County; Henderson *et al.* (1969) estimated that, in 1967, the county contained 607 hectares of active prairie dog towns. Even so, the species is much less abundant in this area of South Dakota than it was before it was settled by European man. Reagan (1908) reported prairie dogs as "numerous over the whole region" of the Rosebud Indian Reservation (located immediately east of Bennett County in what is now Todd County), but Perisho and Visser observed in 1912 (the year the county was opened for settlement) that the animals no longer were abundant because of extensive poisoning. The Refuge Narrative Report for 1976 stated that prairie dogs were absent on the refuge from about 1940 until the middle 1960s. However, four towns, ranging in size from 20 burrows in the smallest to more than 1000 burrows in the largest, were present on the refuge in 1977. Dispersal of surplus dogs into fields adjacent to established towns is discouraged (by means of selective planting) by refuge personnel, but it is not uncommon to see dogs dispersing along roads or through inhospitable habitats in summer.

Two immature females were obtained on 10 June 1967. Reproductive data were not recorded from eight specimens collected in 1977.

Geomys bursarius lutescens Merriam, 1890

Plains Pocket Gopher

Specimens examined (19).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 2(MHP); 1 ½ mi. W Tuthill, 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 2(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 6(MHP); 8 mi. S Martin, 3200 ft., 4(KU); 7 mi. S, 4 mi. W Tuthill, 1(MHP); 9 mi. S Martin, 3300 ft., 2(KU); 10 mi. S Martin, 3300 ft., 1(KU)—see Jones *et al.* (1978).

This species is especially common on the sand hills and in transition habitats south of Lacreek National Wildlife Refuge. It is less abundant, but still relatively common, on the refuge and in the hills to the north. In such areas, these gophers prefer well-drained roadside ditches and the elevated borders of agricultural land. Marshy habitats constitute a barrier to dispersal, although limited circumvention of such habitats along roadbeds occurs.

Immature pocket gophers, representing young-of-the-year, were trapped in both June and July of 1967 and in July of 1977. Adult males trapped on 7 June and 9 July had testicular measurements of 13 and 12, respectively. An

adult female trapped on 8 July had two placental scars. Six females trapped in early to mid-July and one trapped on 24 May evinced no sign of reproductive activity.

Perognathus fasciatus fasciatus Wied-Neuwied, 1839

Olive-backed Pocket Mouse

Specimens examined (7).—4 mi. S, 8 mi. E Martin, 3050 ft., 6(KU); Lacreek National Wildlife Refuge, 1(SDS).

Six of our seven specimens of the olive-backed pocket mouse were trapped in 1967 in transitional upland habitats near the Refuge Headquarters. Habitats were dominated by Kentucky bluegrass, brome, and wild rose (*Rosa*), and bare soil was present between clumps of vegetation. The soil was not as sandy as that in habitats farther south, where *P. flavescens* was trapped.

We follow Williams and Genoways (1979) in referring these specimens to *P. f. fasciatus*. None of four females trapped in June and July evinced reproductive activity, and each of two males trapped in June had testes that measured only 4.

Perognathus flavescens flavescens Merriam, 1889

Plains Pocket Mouse

Specimens examined (27).—7 mi. S Martin, 3100 ft., 1(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 8(MHP); 8 mi. S, 1 ½ mi. E Martin (T.36 N, R.37 W, sec. 29), 1(MHP); 8 mi. S, 2 mi. E Martin (T.36 N, R.37 W, SE ¼ sec. 29), 1(MHP); 9 mi. S Martin, 3300 ft., 6(KU); 10 mi. S Martin, 3300 ft., 10(KU).

This species of pocket mouse is by far the most common of the three that occur on Lacreek National Wildlife Refuge. It is found mainly in the sand hills region along the southern boundary of the refuge but is present also in other relatively sandy habitats.

Two males, one trapped on 8 June and the other on 10 June, had testes measuring 8 and 6, respectively. Young-of-the-year were trapped in early June. Three females trapped on 8 July contained no fetuses but two had five placental scars each. Two males trapped on the same date had testes of 7 and 4 in length. A male with testes that measured 4 was taken on the following day along with two nonpregnant females.

Perognathus hispidus paradoxus Merriam, 1889

Hispid Pocket Mouse

Specimens examined (3).—4 mi. S, 8 mi. E Martin, 3050 ft., 2(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 1(MHP).

The hispid pocket mouse is nowhere abundant on Lacreek National Wildlife Refuge. It is characteristic of prairie habitats and may be found sparingly in northern parts of the refuge, although one specimen was trapped in sand hills. Reproductive data are available only for two specimens trapped

on 9 June; one, a female, was nonpregnant and the other, a male, had testes that measured 10.

Dipodomys ordii luteolus (Goldman, 1917)

Ord's Kangaroo Rat

Specimens examined (99).—6 mi. S, 6 ¼ mi. E Martin (T.36 N, R.37 W, NW ¼ sec. 24), 1(MHP); 7 mi. S Martin, 3100 ft., 2(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 20(MHP); 8 mi. S, 1 ½ mi. E Martin (T.36 N, R.37 W, sec. 29), 3(MHP); 8 mi. S, 2 mi. E Martin (T.36 N, R.37 W, SE ¼ sec. 29), 1(MHP); 7 mi. S Tuthill (T.35 N, R.36 W, W ½ sec. 30), 2(MHP); 9 mi. S Martin, 3300 ft., 46(KU); 10 mi. S Martin, 3300 ft., 23(KU); 10 mi. S Tuthill (T.35 N, R.35 W, NW ¼ sec. 18), 1(MHP).

This species is the most common small mammal in the sand hills region of Lacreek National Wildlife Refuge. Kangaroo rats were seen at night along roads in nearly all habitats characterized by sandy soils. They avoid compacted soils but traverse such habitats by means of well-drained roadside ditches. Numerous specimens (including some from which reproductive data were taken), besides those listed above, were collected in roadside ditches 9-10 mi. S Martin in 1967 and subsequently discarded.

Eleven males trapped in June had testes that averaged 11.0 (6-13). Mean number of fetuses for five females taken during this period was 2.6 (2-3), and these averaged 15.4 (7-36) in length. Three additional females had placental scars. Twenty-five females trapped in June had no embryos; young-of-the-year also were taken in that month. Two females were molting on the flanks in June. In July, nine males had testicular measurements that averaged 12.0 (9-17). Five females had an average of 2.0 (1-3) fetuses that ranged in length from 3 to 12. In addition to these, two had placental scars. Nine nonpregnant females were caught in July.

Castor canadensis missouriensis V. Bailey, 1919

Beaver

In 1975, the total population of beaver on Lacreek National Wildlife Refuge was estimated, conservatively, at 30, and during the 1975-76 trapping season 26 were removed from the refuge. In 1976, the population was estimated at 24 to 50 and 16 were trapped. In 1977, the population was estimated at 60 and the maximal harvest was set at 40. Our one specimen (MHP) consists of a skull salvaged from a beaver trapped on the refuge (specific locality unknown) during the 1977-78 season. We have no record of the total harvest at Lacreek in 1977-78 but suspect the population is slightly greater than estimated by refuge personnel.

In their study of Bennett and adjacent counties, Perisho and Visser (1912) described the beaver as nearly extinct. Likewise, Reagan's observations (1908) on the Rosebud Indian Reservation (just to the east of Bennett County) revealed that the species was rare. The scarcity of *C. canadensis* in this and other areas of the northern Great Plains during that time was due to intense

trapping pressure (Over and Churchill, 1945). Although the species has recovered from its precipitous decline prior to the advent of management, it is probably not so numerous as it was before the arrival of European man.

Reithrodontomys megalotis dychei J.A. Allen, 1895

Western Harvest Mouse

Specimens examined (75).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 5(MHP); 1 mi. S, 8 ½ mi. E Martin, 3100 ft., 2(KU); 1 mi. S, 9 mi. E Martin (T.37 N, R.36 W, NW ¼ sec. 26), 4(MHP); 2 mi. S, 3 mi. W Tuthill (T.36 N, R.36 W, NW ¼ sec. 3), 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 27(KU); 5 ½ mi. S, 8 mi. E Martin, 2(KU); 6 mi. S Martin, 3000 ft., 2(KU); 6 mi. S, 3 ½ mi. E Martin (T.36 N, R.37 W, NE ¼ sec. 21), 1(MHP); 6 mi. S, 7 mi. E Martin (T.36 N, R.36 W, E ½ sec. 19), 11(MHP); 7 mi. S Martin, 3100 ft., 5(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 13(MHP); 7 mi. S, 6 mi. E Martin (T.36 N, R.37 W, N ½ sec. 25), 1(MHP); 8 mi. S, 1 ½ mi. E Martin (T.36 N, R.37 W, sec. 29), 1(MHP).

The western harvest mouse rivals the deer mouse, *Peromyscus maniculatus*, in abundance at Lacreek National Wildlife Refuge. The species occurs in virtually every type of habitat, though it prefers lowland prairie and riparian communities and is uncommon on the sand hills.

Twenty-two males captured during early June had testicular measurements that averaged 7.7 (6-11). Nine females trapped during this period had a mean of 4.0 (3-6) fetuses, which measured an average of 11.3 (1-20). In addition, six nonpregnant females were trapped and two more were lactating. A few adults caught in early June were molting from winter to summer pelage. On 7 July a male had testes that measured 8.

Reithrodontomys montanus albescens Cary, 1903

Plains Harvest Mouse

Specimens examined (4).—9 mi. S Martin, 3300 ft., 3(KU); 10 mi. S Martin, 3300 ft., 1(KU).

This small harvest mouse is not common at Lacreek, and all specimens taken were in sand hill habitats in the southern part of the refuge. *Reithrodontomys montanus* and *R. megalotis* occasionally are taken in the same trapline, but the former generally prefers more arid situations.

One of the two females taken on 8 June was pregnant, and contained five fetuses that measured 17. One month later, on 8 July, a male had testes that measured 6.

Peromyscus leucopus aridulus Osgood, 1909

White-footed Mouse

Specimens examined (42).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 14(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 2(KU); 4 mi. S, 4 mi. W Tuthill (T.36 N, R.36 W, NE ¼ sec. 16), 1(MHP); 5 ½ mi. S, 7 mi. E Martin, 3000 ft., 5(KU); 6 mi. S Martin, 3000 ft., 12(KU); 6 mi. S, 3 ½ mi. E Martin (T.36 N, R.37 W, SW ¼ sec. 22), 1(MHP); 6 mi. S, 7 mi. E Martin (T.36 N, R.36 W, E ½ sec. 19), 7(MHP).

This species prefers wooded areas and, with development of wooded habitats on the refuge, is becoming increasingly abundant at Lacreek. White-footed mice were caught most frequently in areas having a heavy ground cover of scattered sedges, bluegrass, and forbs not far from water. The species occasionally was found in the same area as the deer mouse (*P. maniculatus*), especially in fencerows and streamside habitats characterized by lush grasses and forbs near trees. Turner (1974) reviewed geographic variation in external and cranial measurements and coloration of the middorsal pelage of adult *P. leucopus* from selected areas on the northern Great Plains, including Bennett County, and described characters by which *P. leucopus* and *P. maniculatus* can be distinguished in this region.

The average length of testes of eight males captured in June and July was 12.0 (3-15). In early June, one lactating female was caught, three others contained either four or five fetuses, and one was not pregnant. In early July, four females contained no fetuses whereas a fifth was lactating and had five placental scars. A subadult female caught in early July contained four fetuses.

Peromyscus maniculatus luteus Osgood, 1905

Deer Mouse

Specimens examined (89).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 9(MHP); 1 mi. S, 9 mi. E Martin (T.37 N, R.36 W, NW ¼ sec. 26), 10(MHP); 3 mi. W Tuthill (T.37 N, R.36 W, NW ¼ sec. 26), 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 26(KU); 5 ½ mi. S, 7 mi. E Martin, 3000 ft., 4(KU); 6 mi. S Martin, 3000 ft., 7(KU); 7 mi. S Martin, 3100 ft., 2(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 12(MHP); 7 mi. S, 6 mi. E Martin (T.36 N, R.37 W, N ½ sec. 25), 1(MHP); 8 mi. S, 1 ½ mi. E Martin (T.36 N, R.37 W, sec. 29), 9(MHP); 9 mi. S Martin, 3300 ft., 1(KU); 10 mi. S Martin, 7(KU).

The deer mouse is the most abundant small mammal in all but the southern (sand hills) region of Lacreek National Wildlife Refuge. It prefers upland habitats with moderate vegetative cover, and typically does not occur in marshy or heavily wooded areas. It was found most often in habitats such as those in the sand hills transition and in roadside ditches containing bluegrass, brome, various forbs, and wild rose. However, it also was taken frequently near marsh edges, along dikes, and in the sand hills. Turner (1974) compared geographic variation and external and cranial measurements and coloration of the middorsal pelage of adult *P. maniculatus* from the northern Great Plains, including Bennett County.

Thirteen males trapped in June had testicular measurements that averaged 8.0 (5-12). Seven females collected in this month contained a mean of 5.0 (1-8) fetuses, although seven additional females were not pregnant. Seventeen males caught in July had testicular measurements that averaged 8.0 (3-11). Only two females taken on the refuge in July contained fetuses (one had one and the other four) as compared with 14 females trapped in that month that were nonpregnant.

Onychomys leucogaster arcticeps Rhoads, 1898

Northern Grasshopper Mouse

Specimens examined (13).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 1(MHP); 2 mi. S, 3 ½ mi. W Tuthill (T.36 N, R.36 W, NE ¼ sec. 4), 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 1(KU); 6 mi. S Martin, 3000 ft., 1(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 4(MHP); 8 mi. S, 1 ½ mi. E Martin (T.36 N, R.37 W, sec. 29), 3(MHP); 10 mi. S Martin, 3300 ft., 2(KU).

The northern grasshopper mouse is fairly common on the sand hills and in upland prairie on and near the refuge in habitats characterized by short to mid-grasses with scattered forbs. Reasons for use of the subspecific name *O. l. arcticeps* were given by Engstrom and Choate (1979). One individual, which was trapped repeatedly on a live-trap grid on the sand hills, was missing its right forepaw from approximately the wrist distally but exhibited no obvious difficulty in moving about.

On 8 June, a male in winter pelage had testes that measured 21. On 7 July another male (which was molting) had testes of 19 in length. Two subadult males, one caught on 7 July and the other on 8 July, had testes that measured 14. A male having testes of 15 was trapped on 9 July. The only female examined for fetuses (on 13 July) contained none.

Microtus ochrogaster haydenii (Baird, 1858)

Prairie Vole

Specimens examined (19).—3 mi. W Tuthill (T.37 N, R.36 W, NW ¼ sec. 26), 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 3(KU); 6 mi. S Martin, 3000 ft., 3(KU); 6 mi. S, 4 mi. E Martin (T.36 N, R.37 W, S ½ sec. 22), 1(MHP); 7 mi. S Martin, 3100 ft., 2(KU); 7 mi. S, 4 mi. E Martin (T.36 N, R.37 W, E ½ sec. 27), 5(MHP); 7 mi. S, 6 mi. E Martin (T.36 N, R.37 W, N ½ sec. 25), 1(MHP); 9 mi. S Martin, 3300 ft., 2(KU); 10 mi. S Tuthill (T.35 N, R.35 W, NW ¼ sec. 18), 1(MHP).

Reasons for using the generic name *Pitymys* instead of *Microtus* for the prairie vole were summarized by Hibbard *et al.* (1978). Pending substantiation, we continue to employ the name *M. ochrogaster*. Choate and Williams (1978) referred all populations of this species on the Central Great Plains (including central and eastern South Dakota) to *M. o. haydenii*. Populations to the west of Bennett County were referred by Severinghaus (1977) to *M. o. similis*.

The prairie vole is not particularly abundant on Lacreek National Wildlife Refuge. It is restricted to the more xeric upland sites and is replaced by *M. pennsylvanicus* in mesic lowland habitats. Turner (1974) summarized geographic variation in external and cranial measurements and in coloration of middorsal pelage of adult *M. ochrogaster* from the Northern Great Plains, including Bennett County.

Two male prairie voles trapped on 7 and 8 June had testes that measured 12. A male trapped on 4 July had testes that measured 10, and two others caught on 7 and 8 July each had testes of 13. Two females caught on 7 and 8 June contained no fetuses, whereas another captured on 8 June contained

three that measured 4. Of two females trapped on 7 July, one was lactating and the other contained four fetuses that measured 18. A female trapped on 29 July was lactating.

Microtus pennsylvanicus pennsylvanicus (Ord, 1815)

Meadow Vole

Specimens examined (9).—4 mi. S, 8 mi. E Martin, 3050 ft., 2(KU); 5 ½ mi. S, 7 mi. E Martin, 3000 ft., 2(KU); 6 mi. S Martin, 3000 ft., 2(KU); 6 mi. S, 3 ½ mi. E Martin (T.36 N, R.37 W, SW ¼ sec. 22), 1(MHP); 6 mi. S, 7 mi. E Martin (T.36 N, R.36 W, E ½ sec. 19), 1(MHP); 5 mi. S, 5 ½ mi. W Tuthill (T.36 N, R.36 W, SE ¼ sec. 19), 1(MHP).

The meadow vole is another species that is closely associated with riparian habitats on Lacreek National Wildlife Refuge. It was found commonly in marshes and streamside vegetation there but was nowhere abundant.

A male captured in June had testes that measured 17. A subadult male and two juvenile males also were taken in June. A male caught on 22 July had testes of 15. A female trapped on 7 July contained five fetuses, of which four in the right horn measured 24 and the one in the left measured 4 and was being resorbed. A male caught (and discarded) on 7 July had testes that measured 8.

Ondatra zibethicus cinnamominus (Hollister, 1910)

Muskrat

Specimens examined (16).—4 mi. S, 8 mi. E Martin, 3050 ft., 10(KU); 5 mi. S, 6 mi. E Martin, 3000 ft., 1(KU); 5 ½ mi. S, 7 mi. E Martin, 3000 ft., 2(KU); Lacreek National Wildlife Refuge, 1(MHP); 5 ½ mi. S, 4 mi. W Tuthill (T.36 N, R.36 W, NW ¼ sec. 21), 2(MHP).

One of us (Choate), who was present during both the 1967 and the 1977 field seasons at Lacreek, observed that there seemed to be fewer muskrats on the refuge in 1977 than 10 years earlier. This observation was substantiated by comparison of the fur harvest for those two seasons—2245 muskrats were harvested in 1966-67, whereas only 196 were taken in 1976-77. Nevertheless, muskrats still are abundant on the refuge; the 1977 population was estimated at 2000 and the maximal allowable harvest was set at 1000.

Ten male muskrats collected in early June had average testicular measurements of 25.0 (20-35). One female taken at that time was lactating and had six placental scars.

Mus musculus Linnaeus, 1758

House Mouse

This introduced species undoubtedly appeared in Bennett County soon after European man occupied the area, although its date of arrival is not documented. Allen (1874) reported the species as common at Fort Abraham Lincoln (along the Missouri River in south-central North Dakota) despite the fact that the post had been established but one year. Allen (1895) also reported this mouse as occurring along Spring and Squaw creeks near the

Black Hills. Neither Reagan (1908) nor Perisho and Visser (1912) listed the species in the Lacreek region, but it could have been omitted by those authors because it is not a native species.

On 9 June, three male house mice were captured on the refuge and subsequently discarded; their testes were measured at 6, 7, and 9. On 9 July a male was caught (and later discarded) that had testes that measured 6. One specimen from 4 mi. S and 8 mi. E Martin (KU) was prepared but no reproductive information was saved. The species is not particularly common at Lacreek, probably because of the scarcity of human habitations.

Zapus hudsonius pallidus Cockrum and Baker, 1950

Meadow Jumping Mouse

Specimens examined (40).—2 mi. S, 3 mi. W Tuthill (T.37 N, R.36 W, SW $\frac{1}{4}$ sec. 35), 1(MHP); 4 mi. S, 8 mi. E Martin, 3050 ft., 32(KU); 5 $\frac{1}{2}$ mi. S, 7 mi. E Martin, 3000 ft., 5(KU); 6 mi. S, 3 $\frac{1}{2}$ mi. E Martin (T.36 N, R.37 W, SW $\frac{1}{4}$ sec. 22), 2(MHP).

The meadow jumping mouse is a common inhabitant of marshes and lush riparian habitats on Lacreek National Wildlife Refuge. It is found most frequently in and among stands of cattails or sedges and in the branches of brushy vegetation.

Twenty male jumping mice trapped from 3 to 8 June had testes that averaged 6.0 (5-7) in length. Four females trapped at the same time had an average of 6.2 (5-7) fetuses that measured 2-8 (mean, 4.0) in length, whereas nine other females were not pregnant. On 8 June one young-of-the-year was captured. A male caught on 7 July had testes that measured 7.

Erethizon dorsatum bruneri Swenk, 1916

Porcupine

Porcupines are relatively common along the Niobrara River in northern Nebraska (Jones, 1964) and probably occur, at least sporadically, in suitable habitats along the tributaries of the Missouri River in South Dakota. Although we collected no specimens of this species and saw no sign of its presence anywhere in Bennett County, Refuge Manager Harold Burgess informed Wilhelm that he had seen several on the refuge during his tenure there. Also, Game Protector Dennis Lengkeek related an instance in which he shot a porcupine near his home, northwest of the refuge, to prevent his dogs from being injured. Moreover, in 1967 Assistant Refuge Manager Donald Young told one of us (Jones) that he and Refuge Manager John Ellis had seen porcupines in the hills along the Little White River in the eastern part of Bennett County in September of 1966.

Canis latrans latrans Say, 1823

Coyote

Refuge personnel estimated the population of coyotes at Lacreek at 40 as of July 1975. In 1976, they estimated the population at 30 to 40. Eleven

coyotes were collected on the refuge by professional trappers in November and December of 1976. The population in 1977 was estimated at 40 and the maximal harvest was set at 30. Seven carcasses of coyotes taken by trappers during the 1977-78 winter season on the refuge were salvaged (no specific locality, MHP). Probably the population of coyotes is greater than has been estimated.

Vulpes velox velox (Say, 1823)

Swift Fox

Perisho and Visher (1912), in their report on Mellette, Washabaugh, Bennett, and Todd counties, noted that this fox was a conspicuous mammal. Over and Churchill (1945), however, reported that it was abundant over the entire state only until about 1875 and that it declined rapidly thereafter because of intense hunting pressure. It probably was absent from south-central South Dakota for nearly 60 years (Ballenberghe, 1975) but apparently is regaining a foothold there. Blus *et al.* (1967) reported a specimen taken on the Sand Hills of Nebraska in 1966, and Ballenberghe (*loc. cit.*) suggested that the reappearance of *V. velox* in South Dakota (Fall River County, 1970; Tripp County, 1972; Sulley County, 1974) resulted from an influx from the Nebraska Sand Hills.

Although we obtained no specimens of the swift fox from Bennett County, two sight records confirm its presence. On 1 July 1977, Choate saw a swift fox run across a road 9 mi. S Tuthill. The fox stopped alongside the road and stood motionless for nearly two minutes only a few yards in front of a stationary vehicle, thus enabling positive identification. On the night of 4 July 1977, Wilhelm saw a swift fox sitting alongside a road 5 mi. S and 3 mi. E Martin. The fox ran in front of the vehicle for a short distance, permitting close observation.

Procyon lotor hirtus Nelson and Goldman, 1930

Raccoon

Specimens examined (3).—6 mi. S Martin, 3000 ft., 1(KU); Lacreek National Wildlife Refuge, 2(MHP).

The population of raccoons at Lacreek was estimated at 200 by refuge personnel as of July 1975, with 100 young thought to have been produced during that year. Twenty-two raccoons were trapped on the refuge during the 1975-76 season. The 1976 population was thought to approach 300 to 400, and 13 were trapped; however, the 1977 population was estimated to be only 40. We consider the appraisal of the 1977 population to be extremely conservative. Raccoons undoubtedly are increasing in number on the refuge as wooded habitats are permitted to develop where only grasses and forbs existed previously. A male collected on 10 June had testes that measured 30.

Mustela frenata longicauda Bonaparte, 1838

Long-tailed Weasel

Specimens examined (2).—1 ¼ mi. N, 2 ½ mi. W Tuthill (T.37 N, R.36 W, S ½ sec. 14), 1(MHP); 4 ½ mi. S, 1 mi. E Martin (T.36 N, R.37 W, NE ¼ sec. 7), 1(MHP).

In 1976, the population of long-tailed weasels on the refuge was estimated by refuge personnel at 50 to 100, and in 1977 to be near 120. We consider the long-tailed weasel one of the most common and ecologically important of the small predators on Lacreek National Wildlife Refuge and suppose that the population estimates are conservative.

Mustela nigripes (Audubon and Bachman, 1851)

Black-footed Ferret

Bennett County, in addition to the surrounding counties and adjacent Nebraska, has been an area of much ferret activity in previous years (Cahallane, 1954; Hillman, 1968; Henderson *et al.*, 1969). In the winter of 1905-1906, a ferret was killed in Bennett County just across the state line from Merriman, Nebraska; Perisho and Visser (1912) termed the ferret a conspicuous mammal on grassy flats and terraces along valleys; in early June of 1965 one was observed in a prairie dog town in northeastern Bennett County; Assistant Refuge Manager Donald Young observed a ferret near the village of Tuthill, approximately 1.6 km. E Lacreek, in 1966; a road-killed animal was found on State Highway 18, west of Lacreek, in 1967 (Henderson *et al.*, 1969). In addition, three unconfirmed sightings (one by C. J. Ritts in the 1950s and two by Donald Young, one in 1968 and the other in 1974) have been made by refuge personnel in the recent past. The possibility exists that a few black-footed ferrets still live on or around the refuge.

Mustela nivalis campestris Jackson, 1913

Least Weasel

One specimen (KU) of this species was obtained at a place 4 mi. S and 8 mi. E Martin, 3050 ft., on 9 June 1967. It was a female that evinced no signs of reproductive activity. During the 1958-59 trapping season, three least weasels were caught in mink sets on the refuge. In November of 1966, Assistant Refuge Manager Donald Young saw one of these weasels along a country road that forms the northern boundary of the refuge. Over and Churchill (1945) reported only one specimen of *Mustela nivalis* from South Dakota (no specific locality or date of collection), and Schantz (1951) reported three additional specimens from the eastern part of the state. Turner (1974) did not record the least weasel from the Black Hills region of South Dakota, and the Lacreek specimen thus constitutes the westernmost locality of record for the species in the state.

Mustela vison letifera Hollister, 1913

Mink

Specimens examined (2).—5 ½ mi. S, 6 ½ mi. E Martin (T.36 N, R.36 W, E ½ sec. 18), 1(MHP); 6 ½ mi. S, 7 mi. E Martin (T.36 N, R.36 W, NE ¼ sec. 19), 1(MHP).

In 1975, 1976, and 1977, the population of mink at Lacreek was estimated by refuge personnel at 100, 100 to 150, and 120, respectively. Mink were occasionally seen around the marshes at Lacreek in 1977. The specimen from 5 ½ mi. S and 6 ½ mi. E Martin is a skull salvaged from a road-killed individual found near a pool southwest of the Refuge Headquarters. The other specimen is a skull found along a dike south of the Refuge Headquarters.

Population estimates made by refuge personnel are conservative; probably at least twice as many mink occur there as previously supposed.

Taxidea taxus taxus (Schreber, 1778)

Badger

The population of badgers at Lacreek in 1975 and 1977 was estimated by refuge personnel at 10 and 20, respectively. These estimates likely are conservative. One weather-worn skull (MHP) was picked up at the edge of an old prairie dog town located ½ mi. S and 2 ½ mi. W Tuthill (T.37 N, R.36 W, N ½ sec. 26) on 7 July 1977. In addition, numerous sight records for badgers were reported at various localities on the refuge by field parties in both 1967 and 1977.

Spilogale putorius interrupta (Rafinesque, 1820)

Eastern Spotted Skunk

Schantz (1953) listed numerous records of the spotted skunk from South Dakota, including one sight record from Lacreek National Wildlife Refuge. In December of 1936, the Refuge Manager (C. R. Young) related (in his annual report) seeing approximately 50 spotted skunks on the refuge. In 1967, Assistant Refuge Manager Donald Young told one of us (Jones) that he had seen two *Spilogale* the previous year. One was in the window well at the manager's house, and the other was on a dike near what was then the western boundary of the refuge. We neither saw nor obtained any individuals of this species in 1967 or 1977. Probably it has undergone a long-term decline in abundance (as described by Choate *et al.*, 1973) but still occurs uncommonly on the refuge.

Mephitis mephitis hudsonica Richardson, 1829

Striped Skunk

The striped skunk is not common now on Lacreek National Wildlife Refuge but probably will become more abundant as riparian communities develop along watercourses near Lacreek. We collected no specimens of this

species but examined an individual killed on U.S. Highway 18 at a place 2 mi. N and 6 ½ mi. E Martin. Refuge personnel have seen striped skunks on several occasions and have estimated the population on the refuge, as of July of 1975, to be 40 individuals. By 1977, the estimate had dropped to 20, and only one striped skunk was trapped during the subsequent season.

Felis rufus rufus Schreber, 1777

Bobcat

Bobcats are known from rugged regions in northwestern Nebraska (Jones, 1964) and evidently occur infrequently in Bennett County. The population of bobcats on the refuge in 1975 and 1977 was estimated by refuge personnel at 10 and five, respectively. At least one unconfirmed sighting (in 1974) of a bobcat on Lacreek National Wildlife Refuge was reported by personnel there. One of us (Jones) recorded in his field notes, during the visit to Lacreek in 1967, that a bobcat was killed in the White River Recreation Area during the winter of 1965-66. Other than these two reports, we know of no bobcats that recently have been killed or seen on the refuge or elsewhere in Bennett County.

Odocoileus hemionus hemionus (Rafinesque, 1817)

Mule Deer

Mule deer are seen commonly on the sand hills of the southern part of Lacreek National Wildlife Refuge and throughout southern Bennett County. They doubtlessly also occur, in lesser numbers, in other regions of the county. In 1977, the population on the refuge was estimated by personnel there to be 150. In Bennett County as a whole, this species probably numbers somewhat less than one per three square kilometers.

Deer killed on roads in Bennett County do not long remain there. They are valued for their meat and other useful products, and evidently are picked up by local residents whenever they are found. As a result, no specimens of this species were obtained during either the 1967 or the 1977 field seasons in Bennett County.

Odocoileus virginianus macrourus (Rafinesque, 1817)

White-tailed Deer

Individuals of this species were seen commonly in and around the lush riparian vegetation at Lacreek Refuge and in its immediate vicinity. In 1975 and 1977, the population on the refuge proper was estimated by personnel there to be 300 and 600 to 700, respectively. Wilhelm salvaged the skull of an individual found dead on the refuge (no specific locality, MHP) by Assistant Manager Robert Brasatiers in the winter of 1978. Poaching for deer is a problem in Bennett County, and care should be taken not to allow populations to drop precipitously low.

Antilocapra americana americana (Ord, 1815)

Pronghorn

The pronghorn, like the two species of deer, is subject to appreciable poaching in Bennett County. Although refuge personnel estimated the population on the refuge, as of July 1975, at only two, approximately 800 live on the sand hills just south of the refuge in southern Bennett County and occasionally wander onto the refuge. Numerous pronghorn were seen in Cherry County, Nebraska (just south of the Bennett County line), where the species has been reintroduced in recent years by the Nebraska Game Commission, but only one was seen in Bennett County (several kilometers south of Tuthill). No specimens were collected.

EXTIRPATED SPECIES

The following taxa of mammals probably occurred in the past in the region where Bennett County is located but have been extirpated: *Canis lupus nubilus*, Gray Wolf; *Ursus americanus americanus*, Black Bear; *Ursus arctos horribilis*, Grizzly Bear; *Lutra canadensis interior*, River Otter; *Felis concolor hippolestes*, Mountain Lion (Puma); *Cervus elaphus canadensis*, Wapiti (Elk); *Bison bison bison*, Bison.

Perisho and Visser reported that, in 1912, the gray wolf still was "moderately plentiful" in the Badlands and that otter occasionally were trapped "especially along the Little White River." Reports of pumas in the rugged Badlands region to the north and west of Bennett County are not infrequent even now. The two species of *Ursus* were common over the entire state of South Dakota prior to the arrival of European man, but both were extirpated by 1900 (Over and Churchill, 1945). Wapiti and bison also were extremely common and have been reintroduced to various regions of the state, notably the Black Hills.

SPECIES OF UNVERIFIED OCCURRENCE

Didelphis virginiana virginiana Kerr, 1792, Virginia Opossum.—The Virginia opossum was listed in the Annual Narrative Report for Lacreek National Wildlife Refuge in 1967, but it is not known certainly whether pioneers of this species occasionally wander into Bennett County.

Sorex nanus Merriam, 1895, Dwarf Shrew.—The dwarf shrew was first reported in South Dakota from Custer County, approximately 145 km. NW Lacreek (Findley and Baker, 1956). This specimen originally was misidentified as *S. vagrans* (Baker and Findley, 1953). The species subsequently was reported from Fall River County and from Pennington County, 160 km. W and 160 km. NW Lacreek, respectively (Martin, 1971). More recently, Cinq-Mars et al. (1979) reported the dwarf shrew from Jackson County about 100 km. N Lacreek. Prior to this report, *S. nanus* was presumed to occur only in montane and foothill areas; however, the Jackson County specimens were collected in roadside ditches consisting of grasses, clover, and sagebrush. The

possibility exists, therefore, that the dwarf shrew eventually might be found on or around Lacreek National Wildlife Refuge.

Blarina brevicauda brevicauda (Say, 1823), Short-tailed Shrew.—The short-tailed shrew is listed as a hypothetical resident of Lacreek National Wildlife Refuge based on a visual record of the species by Harold Burgess, Refuge Manager, in 1973. The nearest locality of record for the species is Valentine, Cherry Co., Nebraska.

Cryptotis parva parva (Say, 1823), Least Shrew.—No records for this shrew are yet available from Bennett County, but the species is known from approximately the same longitude as the refuge near Crookston, Cherry Co., Nebraska, along Minnechaduz Creek, a tributary of the Niobrara River (Jones, 1964). The species also is known from northwest of the refuge at a place 1 ½ mi. S Cottonwood, Jackson Co., South Dakota (Findley, 1956a), along Cottonwood Creek, a tributary of the Missouri River. It is reasonable to assume that scattered populations of this shrew occur in South Dakota along the White River and its tributaries, such as the South Fork, and that it eventually might be found along that river or on the refuge in Bennett County.

Myotis keenii septentrionalis (Trouessart, 1897), Keen's Myotis.—This species may well migrate across south-central South Dakota, possibly including Bennett County.

Myotis leibii ciliolabrum (Merriam, 1886), Small-footed Myotis.—The small-footed myotis is known from a number of localities in north-central and northwestern Nebraska (Czaplewski *et al.*, 1979) and from the Badlands and Black Hills of South Dakota. Although the species ordinarily prefers rock crevices, breaksites, and badlands in which to roost (Robbins *et al.*, 1977), it occasionally is found in man-made structures (Jones, 1964) and, accordingly, eventually might be taken on or around the refuge.

Myotis lucifugus (Le Conte, 1831), Little Brown Myotis.—Individuals of either of two subspecies (*M. l. carissima* or *M. l. lucifugus*) might migrate across Bennett County, but we have no reason to suspect that the species is a summer resident at Lacreek or in the immediately surrounding area.

Lasionycteris noctivagans (Le Conte, 1831), Silver-haired Bat.—The silver-haired bat migrates across central South Dakota each spring and autumn, and specimens of the species eventually might be collected on the refuge.

Eptesicus fuscus pallidus (Young, 1908), Big Brown Bat.—The big brown bat is distributed ubiquitously across the Great Plains and commonly roosts in man-made structures where no natural roost-sites are available. Assistant Refuge Manager Donald Young related to Jones in 1967 that, in autumn of 1965, a bat that had bitten a boy was taken to Pierre, South Dakota, to be checked for rabies (the test proved negative). Mr. Young thought that it was a "brown bat," but no specimen was saved to document this tentative identification. Reagan (1908) reported the species as occurring on the Rosebud Indian Reservation, east of Bennett County. Additional records (Perisho and Visher, 1912; Jones and Genoways, 1967) document its presence in this

region of South Dakota, and it is likely that the species will be found living in Bennett County.

Lasiurus borealis borealis (Müller, 1776), Red Bat.—The development, largely in the past decade, of sparse woodland communities on Lacreek National Wildlife Refuge has increased the likelihood that red bats will be found there. Perisho and Visser (1912), in their report on the survey of Mellette, Washabaugh, Bennett, and Todd counties, suggested that the red bat was common in "open groves along the streams." Although no records for the species yet exist from Bennett County, red bats doubtlessly migrate across the region and might reside there in summer.

Lasiurus cinereus cinereus (Palisot de Beauvois, 1796), Hoary Bat.—A bat, said to be of this species, was found at Lacreek by Harold Burgess (Refuge Manager) on 20 October 1974. It died, apparently as a result of its wing becoming entangled in a barbed wire fence, but was not preserved. The hoary bat, like the red bat, is increasingly apt to be found on the refuge because of the recent development of wooded communities.

Sciurus niger rufiventer (É. Geoffroy St.-Hilaire, 1803), Fox Squirrel.—The relatively recent westward dispersal of fox squirrels across the Great Plains by means of riparian woodland has been documented by Jones (1964) and others. Because of the sparceness (in both diversity and quantity) of the riparian and wooded communities in Bennett County, it is doubtful that fox squirrels occurred there in 1967. However, the possibility now exists that a few fox squirrels have moved up the South Fork of the White River into Bennett County. In this regard, Harold Burgess (Refuge Manager) and Dennis Lengkeek (State Game Protector) informed Choate and Wilhelm that fox squirrels have been caught by professional trappers in wooded habitats along the Little White River south of Martin. Wilhelm searched, unsuccessfully, for sign of fox squirrels on and around the refuge in 1977; we suspect, however, that the species will be found there and that numbers will increase in the future.

Neotoma floridana baileyi (Merriam, 1894), Eastern Woodrat.—The eastern woodrat is not known from the immediate vicinity of Lacreek National Wildlife Refuge, but eventually might be found there or in riparian habitats along the Little White River. The nearest locality of record for the species is along the Niobrara River at several locations near Valentine, Nebraska (Jones, 1964). Potentially suitable habitats on and around the refuge were investigated, but no evidence of woodrats was found.

Rattus norvegicus (Berkenhout, 1769), Norway Rat.—This introduced rat is a common, commensal species throughout much of North America, and likely will be found around barns and other old buildings in Bennett County.

Vulpes vulpes regalis Merriam, 1900, Red Fox.—Although we were unsuccessful in documenting the existence of the red fox on Lacreek National Wildlife Refuge (or anywhere else in Bennett County), its occurrence in this area of South Dakota is expected. The westward dispersal and increasing

TABLE 1.—Plant composition of habitats in grids (A, B, and C) described in text.

Grid and habitat no.	Dominant species	Associated species
A1	<i>Calamovilfa longifolia</i> / <i>Koeleria pyramidata</i> / <i>Bouteloua hirsuta</i> / <i>Carex</i> sp.	<i>Andropogon hallii</i> / <i>Yucca glauca</i>
A2	<i>Carex</i> sp.	<i>Calamovilfa longifolia</i> / <i>Sporobolus cryptandrus</i>
A3	<i>Koeleria pyramidata</i> / <i>Calamovilfa longifolia</i> / <i>Carex</i> sp.	<i>Andropogon hallii</i> / <i>Astragalus spatulatus</i>
A4	<i>Calamovilfa longifolia</i> / <i>Carex</i> sp./ <i>Yucca glauca</i>	<i>Bouteloua hirsuta</i> / <i>Andropogon hallii</i> / <i>Koeleria pyramidata</i>
A5	<i>Calamovilfa longifolia</i> / <i>Carex</i> sp./ <i>Koeleria pyramidata</i> / <i>Bromus tectorum</i>	<i>Stipa occidentalis</i>
A6	<i>Carex</i> sp./ <i>Calamovilfa longifolia</i> / <i>Koeleria pyramidata</i>	<i>Bouteloua hirsuta</i> / <i>Andropogon hallii</i>
B1	<i>Calamovilfa longifolia</i> / <i>Carex</i> sp./ <i>Heliotropium curassavicum</i>	<i>Koeleria pyramidata</i>
B2	<i>Calamovilfa longifolia</i> / <i>Carex</i> sp.	<i>Heliotropium curassavicum</i> / <i>Bouteloua hirsuta</i>
B3	<i>Calamovilfa longifolia</i> / <i>Carex</i> sp.	<i>Andropogon hallii</i> / <i>Yucca glauca</i>
B4	<i>Salsola iberica</i> / <i>Helianthus petiolaris</i>	<i>Agropyron smithii</i> / <i>Bromus tectorum</i> / <i>Calamovilfa longifolia</i> / <i>Carex</i> sp.
C1	<i>Poa pratensis</i> / <i>Carex</i> sp./ <i>Phalaris arundinacea</i>	<i>Spartina pectinata</i> / <i>Eragrostis trichodes</i>

abundance of the species in riparian woodlands across the Great Plains was mentioned by Jones (1964). Localities of record nearest Bennett County are in Hyde County, South Dakota (Over and Churchill, 1945), and Brown County, Nebraska (Jones, 1964), and unconfirmed sightings of the species near the eastern border of the refuge were made by a farmer in 1972.

Urocyon cinereoargenteus ocythous Bangs, 1899, Gray Fox.—The Refuge Manager's annual report for 1963-1964 mentioned a gray fox that was trapped approximately 1.6 kilometers west of the refuge boundary. Additionally, John W. Ellis, Refuge Manager in 1967, told Jones that a gray fox was taken north of the refuge several years previously by a U.S. Fish and Wildlife Service trapper. These reports are the only evidence we have that the species occurs on or near the refuge, although it is known to be dispersing westward across the plains in riparian habitats (Choate and Krause, 1974).

POPULATION STUDIES

Live-trap grid A, located 7 mi. S and 1 ½ mi. E Martin, was operated for 14 days (2 July through 15 July) in 1977. Six microhabitats were sampled on this grid, and the plant composition of each is given in Table 1. A total of

TABLE 2.—Ecological densities of the five most common small mammals trapped on grids A and B (numbers/hectare).

Grid	Habitat No.	Reithrodontomys megalotis	Dipodomys ordii	Perognathus flavescens	Onychomys leucogaster	Peromyscus maniculatus
A	1		0.04	0.07	0.00	0.04
	2		0.11	0.00	0.05	0.22
	3		0.04	0.00	0.05	0.00
	4		0.30	0.50	0.19	0.36
	5		0.00	0.00	0.19	0.06
	6		0.08	0.22	0.05	0.06
B	1	0.05	0.03	0.07	0.02	0.21
	2	0.00	0.49	0.07	0.02	0.19
	3	0.49	0.98	0.70	0.27	0.48
	4	0.44	0.58	0.49	0.19	0.62

35 individuals representing five species of rodents (*Perognathus flavescens*, *Dipodomys ordii*, *Peromyscus maniculatus*, *Onychomys leucogaster*, and *Spermophilus tridecemlineatus*) was trapped on the grid. A sixth species (*Scalopus aquaticus*) also was taken there, although not as part of the grid (that is, not in one of the Sherman traps). These six species yielded a species diversity index of 2.25. Population densities (in numbers per hectare) of the four most common mammals on grid A were: *Perognathus flavescens* 0.78; *Peromyscus maniculatus* 0.74; *Dipodomys ordii* 0.57; *Onychomys leucogaster* 0.55. Ecological densities (also in numbers per hectare) are presented in Table 2. As can be seen, all four species utilized habitat 4 most often. As was mentioned in the section entitled Methods and Materials, this will not (and does not) necessarily agree with preferred habitat data, which are based on distribution of captures among habitats. These data are presented in Table 3 and show that there is little overlap. *Perognathus* occurred more often in habitat 6, *Onychomys* in habitat 5, and *Dipodomys* and *Peromyscus* in habitat 2.

Chi-square values for *Dipodomys*, *Perognathus*, and *Onychomys* reveal no significant differences ($P \geq 0.05$) between the expected and observed number of captures. The Chi-square value for *Peromyscus* would seem to indicate a significant difference between expected and observed captures, especially with respect to habitat 2 (3.33 expected as opposed to 11 observed). However, the deviation computed for habitat 2 (+7.67) is too high to enable any statements to be made regarding habitat preference.

Live-trap grid B, also in the sand hills, located 7 mi. S and 3 ½ mi. E Martin, was operated for 26 days (3 July through 29 July) in 1977. Four microhabitats were sampled on this grid, and the plant composition of each is given in Table 1. Ninety individuals of eight species of rodents (*Dipodomys ordii*, *Peromyscus maniculatus*, *Perognathus flavescens*, *Onychomys leucogaster*, *Reithrodontomys megalotis*, *Microtus ochrogaster*, *Spermophilus tridecemlineatus*, and *Perognathus hispidus*) were trapped on the grid. These eight species, together with *Scalopus aquaticus* and *Geomys bursarius*

TABLE 3.—Habitat distribution of the four most common small mammals trapped on grid A. Observed captures includes recaptures.

Habitat number	No. traps	Expected captures	Observed captures	Deviation	D ² /E
<i>Dipodomys ordii</i>					
1	8	1.2	1	-0.20	0.03
2	9	1.4	3	+1.65	2.02
3	6	0.9	1	+0.10	0.01
4	52	7.8	8	+0.20	0.01
5	16	2.4	0	-2.40	2.40
6	9	1.4	2	+0.65	0.31
Total	100	15.1	15		X ² =4.78
<i>Perognathus flavescens</i>					
1	8	0.88	1	+0.12	0.02
2	9	0.99	0	-0.99	0.99
3	6	0.66	0	-0.66	0.66
4	52	5.72	7	+1.28	0.29
5	16	1.76	0	-1.76	1.76
6	9	0.99	3	+2.01	4.08
Total	100	11.00	11		X ² =7.80
<i>Onychomys leucogaster</i>					
1	8	1.6	0	-1.60	1.60
2	9	1.8	2	+0.20	0.02
3	6	1.2	2	+0.80	0.53
4	52	10.4	7	-3.40	1.11
5	16	3.2	7	+3.80	4.51
6	9	1.8	2	+0.20	0.02
Total	100	20.0	20		X ² =7.79
<i>Peromyscus maniculatus</i>					
1	8	2.96	2	-0.96	0.31
2	9	3.33	11	+7.67	17.67
3	6	2.22	0	-2.22	2.22
4	52	19.24	18	-1.24	0.08
5	16	5.92	3	-2.92	1.44
6	9	3.33	3	-0.33	0.03
Total	100	37.00	37		X ² =21.75

(which also were found on the grid but were not captured in the Sherman traps) were used to compute species diversity. The resulting figure of 2.78 indicates a more diverse community structure than on grid A. Population densities (in numbers per hectare) of the five most common species of mammals live-trapped on grid B were: *Dipodomys ordii* 2.08; *Peromyscus maniculatus* 1.50; *Perognathus flavescens* 1.30; *Reithrodontomys megalotis* 0.97; *Onychomys leucogaster* 0.50. Ecological densities are given in Table 2. Data on distribution of captures among habitats (Table 4) indicate the preferred habitats of these five species. As on grid A, *Dipodomys* and *Peromyscus* were found to occur most often in the same habitat (habitat 2), and *Perognathus flavescens* occupied its own habitat (4). However, *Onychomys*

TABLE 4.—Habitat distribution of the five most common small mammals trapped on grid B. Observed captures includes recaptures.

Habitat number	No traps	Expected captures	Observed captures	Deviation	D ² /E
<i>Reithrodontomys megalotis</i>					
1	9	1.8	1	-0.8	0.35
2	6	1.2	0	-1.2	1.20
3	41	8.2	10	+1.8	0.39
4	44	8.8	9	+0.2	0.01
Total	100	20.0	20		X ² =1.94
<i>Dipodomys ordii</i>					
1	9	11.52	2	- 9.52	7.87
2	6	7.68	30	+22.32	64.87
3	41	52.48	60	+ 7.52	1.08
4	44	56.32	36	-20.32	7.33
Total	100	128.00	128		X ² =81.15
<i>Perognathus flavescens</i>					
1	9	1.71	1	-0.71	0.29
2	6	1.14	1	-0.14	0.02
3	41	7.79	4	-3.79	1.84
4	44	8.36	13	+4.64	2.57
Total	100	19.00	19		X ² =4.72
<i>Onychomys leucogaster</i>					
1	9	4.05	2	-2.05	1.04
2	6	2.70	2	-0.70	0.18
3	41	18.45	24	+5.55	1.67
4	44	19.80	17	-2.80	0.39
Total	100	45.00	45		X ² =3.28
<i>Peromyscus maniculatus</i>					
1	9	8.73	14	+5.27	3.18
2	6	5.82	12	+6.18	6.56
3	41	39.77	31	-8.77	1.93
4	44	42.68	40	-2.68	0.17
Total	100	97.00	97		X ² =11.84

occurred most often in the same habitat (3) as *Reithrodontomys megalotis*, a species not found in grid A. Why the western harvest mouse was found on grid B and not A is not clear, as the two had essentially the same plant composition. Perhaps the fact that grid B was within 0.4 km. of a grassland community to the north might explain the presence not only of *Reithrodontomys* but also of *Microtus ochrogaster* and *Perognathus hispidus* on grid B, and their absence from grid A.

Chi-square values for grid B reveal a significant difference ($P < 0.05$) between the expected and observed number of captures of *Dipodomys* and *Peromyscus*. *Dipodomys* occurred most often in habitat 2, which differed from the other habitats by having *Heliotropium curassavicum* and *Bouteloua hirsuta* as associated species (see Table 1). There were significant differ-

ences between the expected and observed captures of *Peromyscus* with regard to both habitats 1 and 2. These habitats were unique in that they contained *H. curassavicum*, *B. hirsuta*, and *Koeleria pyramidata*.

Live-trap grid C was operated in a marshy habitat 6 mi. S and 7 mi. E Martin for 12 days (18 July through 29 July) in 1977. This grid was fairly uniform in plant composition (Table 1), and only one "microhabitat" (the whole grid) was found. Forty individuals of seven species (*Reithrodontomys megalotis*, *Peromyscus leucopus*, *Microtus pennsylvanicus*, *Mus musculus*, *Zapus hudsonius*, *Sorex cinereus*, and *Perognathus hispidus*) were trapped on the grid. The Shannon-Wiener index was computed at 2.32, which reveals a diverse community although not as diverse as either of the sand hill communities. Populations (in numbers per hectare) for the three most commonly trapped species were: *Reithrodontomys megalotis* 2.14; *Peromyscus leucopus* 0.99; *Microtus pennsylvanicus* 0.52. We feel certain that *Zapus* is more common than trapping indicated due to the fact that this species spends much of its time in the upper levels of vegetation and traps were placed on the ground. Only two jumping mice were trapped, marked, and released, and neither was recaptured. No population estimates could be calculated for *Sorex* because all individuals caught died in the traps. Because there was only one "microhabitat" on grid C, ecological densities and preferred habitats were not computed. One marked hispid pocket mouse (*Perognathus hispidus*) was recaptured three times. This species usually is considered an inhabitant of grasslands, but the nearest grassland habitat was approximately 0.8 kilometer to the south of the grid.

DISCUSSION

Four distinct habitats are present on and around Lacreek National Wildlife Refuge: woodland, marsh, wheatgrass-gramagrass prairie (subdivided into upland prairie and lowland prairie), and sand hills prairie. Species of mammals occurring on Lacreek are not, however, necessarily restricted to only one of these habitat types; rather, there are broad areas of overlap, especially among those mammals present in the woodland and marsh habitats and among those in wheatgrass-gramagrass prairie and sand hills prairie habitats.

Of the 39 species of mammals (exclusive of bats) that reside on Lacreek National Wildlife Refuge, eight (*Sylvilagus floridanus*, *Erethizon dorsatum*, *Procyon lotor*, *Mustela nivalis*, *Spilogale putorius*, *Mephitis mephitis*, *Felis rufus*, and *Odocoileus virginianus*) are most abundant in woodland, six (*Sorex cinereus*, *Castor canadensis*, *Microtus pennsylvanicus*, *Ondatra zibethicus*, *Zapus hudsonius*, and *Mustela vison*) occur almost exclusively around marshes, and one (*Peromyscus leucopus*) is found commonly in both woodland and marsh habitats. Twelve species (*Sylvilagus audubonii*, *Lepus townsendii*, *L. californicus*, *Spermophilus tridecemlineatus*, *S. franklinii*, *Cynomys ludovicianus*, *Perognathus fasciatus*, *P. hispidus*, *Reithrodontomys megalotis*, *Microtus ochrogaster*, *Mustela nigripes*, and *Taxidea taxus*) occur

most frequently on wheatgrass-gramagrass prairie, nine (*Scalopus aquaticus*, *Geomys bursarius*, *Perognathus flavescens*, *Dipodomys ordii*, *Reithrodontomys montanus*, *Onychomys leucogaster*, *Vulpes velox*, *Odocoileus hemionus*, and *Antilocapra americana*) are most abundant in sand hills prairie, and one (*Peromyscus maniculatus*) is common in both the wheatgrass-gramagrass and sand hills prairies. Two species (*Canis latrans* and *Mustela frenata*) show no particular habitat affinity.

The eastern spotted skunk (*Spilogale putorius*) is listed herein as a woodland species even though it was classified in general as a steppe species by Hoffmann and Jones (1970:364; see discussion on p. 381). We suspect that eastern spotted skunks around Lacreek construct dens along forested watercourses, and that they forage in whatever habitats are nearby (see also Choate and Fleharty, 1975, Choate *et al.*, 1973). Likewise, the least weasel (*Mustela nivalis*), classified as a boreal species by Hoffmann and Jones (1970), is most abundant on the Great Plains in mesic lowlands near watercourses (Choate *et al.*, 1980), and thus is listed tentatively as a woodland species in our more restricted classification (the one specimen obtained was trapped under bushes in a wooded area near the Refuge Manager's residence).

Five other mammals (*Erethizon dorsatum*, *Procyon lotor*, *Mephitis mephitis*, *Felis rufus*, and *Odocoileus virginianus*) herein listed as woodland species were classified by Hoffman and Jones (1970) as widespread. Lack of suitable cover other than that afforded in wooded areas is a major factor in including these species as members of this habitat type. The eastern cottontail (*Sylvilagus floridanus*) also is most abundant in wooded areas but commonly is found in roadside ditches, near human habitation, and in other situations that provide adequate cover; it was classified as a deciduous forest species by Hoffmann and Jones (1970).

Three species of small mammals (*Sorex cinereus*, *Microtus pennsylvanicus*, and *Zapus hudsonius*) are restricted in distribution at Lacreek to luxuriant vegetation at the peripheries of marshes. All were classified as boreal species by Hoffmann and Jones (1970). Three additional species (*Castor canadensis*, *Ondatra zibethicus*, and *Mustela vison*) that are here regarded as marshland species were classified as widespread by Hoffmann and Jones (1970).

Of the 11 species that occur most commonly in wheatgrass-gramagrass prairie, eight (*Lepus townsendii*, *Spermophilus tridecemlineatus*, *S. franklinii*, *Cynomys ludovicianus*, *Perognathus fasciatus*, *P. hispidus*, *Microtus ochrogaster*, and *Mustela nigripes*) were classified as steppe species by Hoffmann and Jones (1970). One (*Taxidea taxus*), which they referred to as widespread (p. 365), is most common on wheatgrass-gramagrass prairie at Lacreek, probably because its prey species (such as ground squirrels) are most abundant in this type of habitat. Audubon's cottontail (*Sylvilagus audubonii*) and the black-tailed jackrabbit (*Lepus californicus*) were classed as invaders from the southwest by Hoffmann and Jones (1970). As is the case with the eastern cottontail, these two species may be found in roadside ditches and managed areas wherever suitable cover exists.

The eastern mole (*Scalopus aquaticus*) was regarded by Hoffman and Jones (1970) as a deciduous forest species; however, nearly all our specimens were collected (and most evidence of mole activity was observed) near the sand hills in the sand hill transition zone. The friable nature of the soil in this region is conducive to the burrowing activities of moles, and the interdigitation of sand hill and mesic lowland habitats has facilitated the dispersal of moles onto the sand hills, in some cases several kilometers from watercourses or other sources of water (see also Jones *et al.*, 1978).

The plains pocket gopher (*Geomys bursarius*), the plains pocket mouse (*Perognathus flavescens*), and the plains harvest mouse (*Reithrodontomys montanus*), all classified as steppe species by Hoffmann and Jones (1970), are more numerous on the sand hills than in the wheatgrass-gramagrass prairie at Lacreek. The swift fox (*Vulpes velox*, another steppe species according to Hoffmann and Jones, 1970), also evidently is more common on the sand hills than on other prairie habitats based on visual records of its presence at Lacreek National Wildlife Refuge and on reports of previous investigators (Blus *et al.*, 1967; Ballenberghe, 1975). Two invaders from the southwest, *Dipodomys ordii* and *Onychomys leucogaster* (Hoffmann and Jones, 1970) also are frequently encountered in the sand hills at Lacreek. Ord's kangaroo rat occupies sandy soils throughout its range, but the northern grasshopper mouse prefers prairie communities in disclimax where bare, sandy soil facilitates "dusting" (Choate and Terry, 1974). At Lacreek, the grasshopper mouse is not restricted to the sand hills and is, in fact, relatively common on upland sites. Mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) are widespread species (Hoffmann and Jones, 1970) that commonly are found on the sand hills at Lacreek.

Two species that show no habitat preference on or around Lacreek, the coyote (*Canis latrans*) and the long-tailed weasel (*Mustela frenata*), also were classified as widespread by Hoffmann and Jones (1970).

The western harvest mouse (*Reithrodontomys megalotis*), a species that has invaded this area of the Great Plains from its center of origin in the southwest (Hoffmann and Jones, 1970), shows no particular preference between prairie, sand hills, and marshland habitats at Lacreek, but is more common in mesic lowlands and in riparian communities than on the sand hills or upland prairies.

The two species of *Peromyscus* at Lacreek, *P. leucopus* (a deciduous forest species according to Hoffmann and Jones, 1970) and *P. maniculatus* (widespread according to Hoffmann and Jones, 1970) compete for space in certain areas of the refuge. *P. leucopus* is more common in woodland and marsh habitats, whereas *P. maniculatus* is most abundant in wheatgrass-gramagrass prairie and on the sand hills. In areas where the ranges of these two species overlap, *P. leucopus* lives in trees and the upper parts of tall vegetation and *P. maniculatus* dwells on the ground and in the lower vegetational strata.

In summary, the mammalian fauna of Lacreek National Wildlife Refuge is a mixture of elements of the steppe (13 species), the eastern deciduous

forest (three species), the boreal forest (four species), the arid southwest (five species), and of species (14) that have widespread distributions. Eight of the steppe species are most abundant in wheatgrass-gramagrass prairie, four are more common in sand hills prairie, and one is a probable inhabitant of riparian woodland. One of the deciduous forest species is most common in brushy and wooded areas, one in riparian woodland and around marshes, and one in mesic prairie habitats and the sand hills transition zone. Three of four boreal species are common in areas bordering the marshlands at Lacreek, and the fourth is an inhabitant of wooded areas. Two of the invaders from the Southwest are common in sand hills prairie, and three others occur primarily in wheatgrass-gramagrass prairie. Five widespread species are most abundant in wooded areas, three are common inhabitants of marshes, two are common in sand hills prairie, one is common in wheatgrass-grama grass prairie, and one is equally common in both kinds of prairie. Two widespread species show no preference for a particular habitat at Lacreek.

Thus, Lacreek National Wildlife Refuge supports complex biotic communities in which mammalian species characteristic of semiarid habitats occur alongside those that are common in mesic environs. These habitats should be maintained in a manner that will insure the survival of all elements of the native fauna and flora and not just those associated with marshy habitats.

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