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Nongame Birds, Small Mammals, Reptiles, Fishes: Sand Lake National Wildlife Refuge, 1995-1996

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Nongame birds, small mammals, herptiles, fishes:

Sand Lake

National Wildlife Refuge, 1995-1996

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U.S. FISH AND WILDLIFE SERVICE

Sand Lake NWR is named "Wetland of International Importance"

Sand Lake NWR is the first U.S. prairie pothole refuge to be honored as a "Wetland of International Importance" by the Department of the Interior and the Convention on Wetlands of International Importance.

The convention, more commonly known as the Ramsar Convention after its place of adoption in Iran in 1971, is the only international agreement dedicated to the worldwide protection of a particular ecosystem. Currently, 108 nations subscribe to the treaty goal of stemming the loss of wetlands. Sand Lake joins 907 other sites in the world designated to have international value and is the only one in the prairie pothole region of the United States.

Sand Lake provides critical nesting and staging habitat for many bird species. The number of migrating waterfowl using the complex often exceeds hundreds of thousands of snow geese, mallards, wood ducks, and Canada geese in spring and fall. The area hosts the world's largest nesting colony of Franklin's gulls.

"Thousands of people from birdwatchers to anglers and hunters to hikers and school groups visit Sand Lake refuge each year," according to Director Jamie Rappaport Clark of the U.S. Fish & Wildlife Service. "Its popularity for outdoor recreation gives the Service and its partners a great opportunity to help refuge visitors understand how wetlands impact their lives."

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Sand Lake

National Wildlife Refuge, 1995-1996

by

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Cover photo: Aerial view of the wetland complex at Sand Lake NWR by William Schultze.

Nongame birds, small mammals, herptiles, fishes:

SAND LAKE

National Wildlife Refuge, 1995-1996

Abstract

Little is known about the abundance and distribution of nongame species in their primary habitats in the northern Great Plains. This is due, in part, to the paucity of biological surveys on public and private lands.

Even fewer surveys have occurred on isolated ecosystems in this region. Narrative reports from the 60 years of 1935 to 1995, for example, are the only records of vertebrates on Sand Lake National Wildlife Refuge (SLNWR), Brown County, South Dakota.

To fill this void, a vertebrate survey emphasizing nongame birds and small mammals was conducted during two field seasons (1995 and 1996) at SLNWR. Initial inventories also were made for reptiles, amphibians, and fishes.

Breeding nongame birds were surveyed using fixed-width belt transects, following standard count methods, in terrestrial habitats. Forty-six nesting terrestrial bird species were identified on the refuge: 35 were found in woodland habitats, 18 in tame grasslands, 12 in native grasslands, and 7 in alfalfa fields.

Nongame wetland birds were also surveyed in temporarily and seasonally flooded forested (PFOC) and semi-permanently flooded emergent (PEMF) wetland habitats using a semi-circular plot method. Playback recordings were used to determine occurrences of secretive species such as rails (Rallidae). Bird counts were conducted on 116 plots: 32 breeding species in PFOC and 41 species in PEMF were counted.

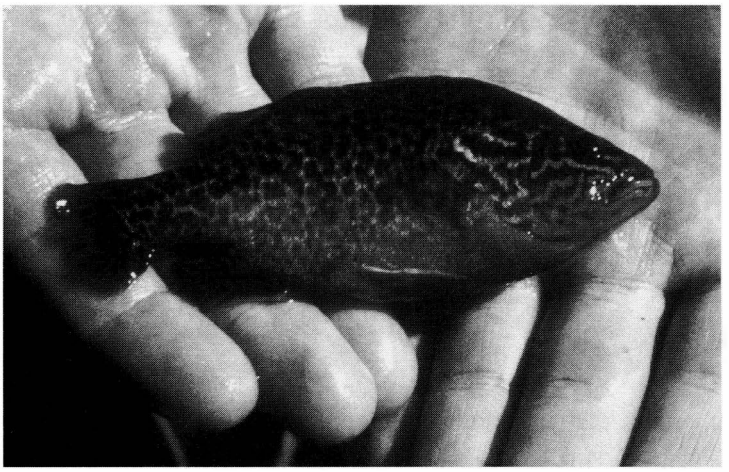
Yellow-headed blackbirds (freq of occurrence 99%) and marsh wrens (freq of occurrence 70% [PFOC] and 89% [PEMF]) were the two most abundant species in both wetland habitat types. The first nesting of a common moorhen in South Dakota was recorded in 1995.

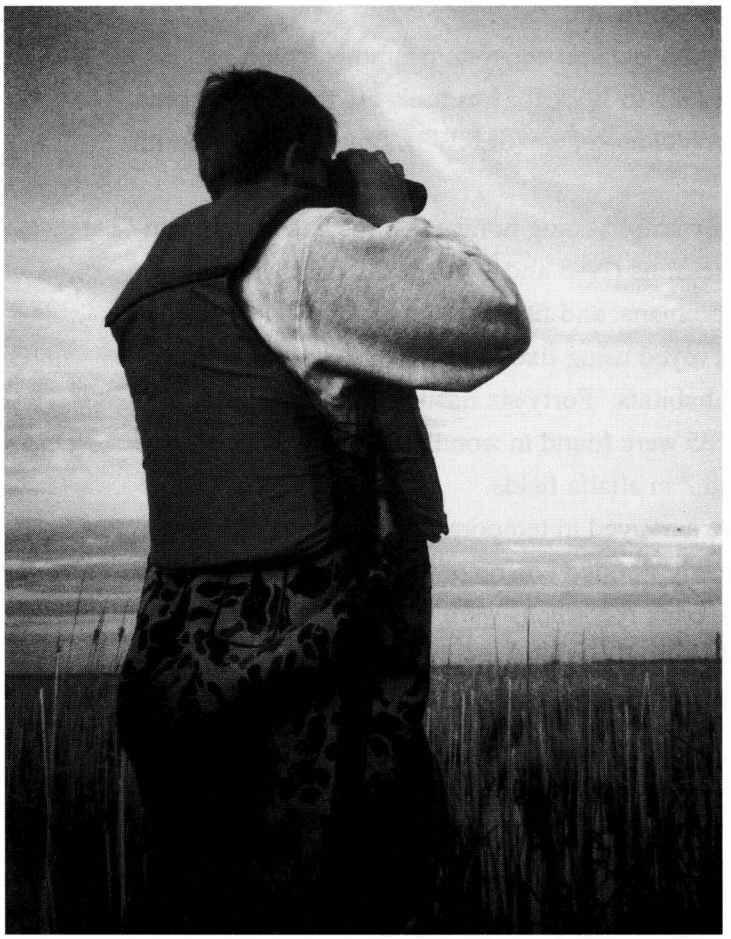
Small mammals were surveyed using snap traps and pitfall traps (3,362 trapnights combined) in woodland, grassland, cropland, and wetland-edge habitats: 800 small mammals of 11 species were captured.

Five reptile species were surveyed on the refuge. Included was a northern red-bellied snake, a state-threatened species.

Five amphibian and 16 fish species were recorded.

Detailed surveys such as this one will be useful in improving ecosystem management.





Nongame birds, small mammals, herptiles, fishes:

SAND LAKE

National Wildlife Refuge, 1995-1996

Public interest in nongame wildlife has been growing across the country, and conservation agencies now stress a broad-based approach to nongame species (Berkey *et al.* 1993), using management practices that go beyond single species to a total program encompassing communities of wildlife (Anderson and Robbins 1981).

Refuge and wildlife managers can find few resources to help them create or enhance such programs, however. Most literature on nongame species is on birds, the first to benefit from increased public concern (Szarro 1988). Much less is known about abundances or distributions of small mammals, fish, or reptiles. Yet many, if not all, nongame vertebrates play an integral part in the function of ecosystems (Gibbons 1988). Amphibian population dynamics and baseline data, for example, are virtually nonexistent, even though amphibians are ecologically indispensable components of nearly all freshwater and terrestrial habitats in North America (Bishop *et al.* 1994).

Consequently, while wildlife managers accept responsibility to conserve existing species and to maintain aesthetic values (Peterson 1980, Gibbons 1988), they find it difficult to acquire reliable data to manage these populations.

Associated with the lack of nongame vertebrate management information is the scarcity of biological surveys. Comprehensive inventories simply do not exist.

The first step in any management plan is the biological inventory. An inventory of species abundance by habitat types, successional patterns, and cultural features gives an indication of biological diversity (Scott *et al.* 1995) and consequently, a sense of the health of a system.

Inventories form the basis for evaluating species status. They have provided a wealth of basic knowledge which has led to the development of many ecological and evolutionary theories essential to research and effective management, and they are fundamental in understanding the complexity of biodiversity (Heyer *et al.* 1994).

Inventories which contain enough detail for effective management are available only for a small fraction of all land areas. Yet Bogan *et al.* (1988) believed that survey results are the "raw materials for making land management decisions," and the National Research Council (1994) has stated that effective, holistic ecosystem management requires knowledge of species biology, ecology, and distribution.

When biological surveys and inventories are completed, they can be combined with other methods, such as GAP Analysis (Scott *et al.* 1993), to assess conservation efforts for large land areas. These inventories also help state and federal agencies meet their management goals and budgets.

The only complete vertebrate inventory of any area in the northern Great Plains was conducted at Fort Niobrara and Valentine National Wildlife Refuges, Nebraska (Bogan 1995). Some recent partial vertebrate surveys include Waterfowl Production Areas in Minnesota (Niesar 1994), a mail survey to determine distributions of 42 mammal species in South Dakota (Blumberg 1993), and a list of the mammals of LaCreek National Wildlife Refuge, South Dakota (Wilhelm *et al.* 1981).

Biological surveys are nearly nonexistent for many South Dakota habitats, and distribution patterns of South Dakota mammals are poorly understood (Choate and Jones 1981). Complete vertebrate inventories for large, insular riverine ecosystems such as Sand Lake National Wildlife Refuge (SLNWR) have never been conducted (Becker 1979).

The goal of this study was to conduct a nongame vertebrate survey at SLNWR by primary habitat types, with emphasis placed on nongame breeding birds and small mammals. Specific objectives were to determine:

1) avian and mammalian species composition by primary habitat types with special emphasis on nongame/neotropical avian species and nongame small mammals,
2) the presence of other vertebrate species (amphibians, reptiles, and fishes) by primary habitat type,
3) present vertebrate biota occurrence, as compared to pre-1940

occurence as found in the literature and other records or sources,

4) significant changes in habitat and/or vegetation on SLNWR, based on current and historical literature and refuge files, and

5) to make recommendations for preserving/enhancing populations of nongame vertebrate species on SLNWR.

Study Area

Sand Lake National Wildlife Refuge is located in Brown County in north-central South Dakota (45° 45' N. latitude, 98° 15' W. longitude) (Fig 1). It is part of the National Wildlife Refuge System administered by the U.S. Fish and Wildlife Service, Department of the Interior.

The refuge is situated in the Lake Dakota Plain within the James River lowland physiographic division (USDA 1993) (Fig 2). The area is characterized by an ancient lake plain, glacial uplands, and alluvial flood plains.

The refuge is bisected into west and east halves by the James River and can be considered an isolated riverine landscape in an agricultural setting. Its 8,704 hectares are a mosaic of different land uses. Primary habitat types (n = 4) include:

- 4,453 ha (51.1%) of wetlands mostly dominated by cattail (*Typha* spp) and common reed (*Phragmites australis*),
- 3,003 ha (34.5%) of grasslands–mostly smooth brome (*Bromus inermis*) with some reseeded native grasses (big bluestem [*Andropogon gerardii*], little bluestem [*Schizachryrium scoparium*], and Indiangrass [*Sorghastrum nutans*]),
- 1,045 ha (12%) of cropland (corn [*Zea mays*]), and
- 81 ha (1%) of woodlands (cottonwood [*Populus deltoides*] and green ash [*Fraxinus pennsylvanica*]) (Naugle 1994).

Soil composition is strikingly different within and adjacent to the refuge. On the east side, the soils are characteristically sandy and loamy, similar to the Lake Dakota Plain. On the west side, soils are silty and sodium affected (USDA 1993). The soil types on either side of the refuge may enhance or restrict vegetation composition and faunal associations.

Of land adjacent to the refuge, 71% is intensively farmed cropland, 16.7% is permanent pasture, and 11.7% is idled land (Conservation Reserve Program) (Naugle *et al.* 1994).

Large seasonal fluctuations of climate are the rule rather than the exception in the region. Cold winters and hot, dry summers are common. Precipitation averages 44.6 cm annually, but cycles of drought and heavy precipitation are evident (USDA 1993). Mean annual temperature is 10.0° C (Spuhler *et al.* 1971).

Nongame Breeding Terrestrial Birds

Historical bird lists, which are only anecdotal records of species occurrences, were largely based on bird sightings during migration. They included very limited observations of breeding nongame birds on the SLNWR. Early bird observations were not associated with primary habitats.

There is still a lack of information regarding habitat use and nongame bird responses to traditional management practices. More data on neotropical migrants are also needed, because many populations are declining on a local and national scale (Robbins *et al.* 1985).

Methods

Nongame birds were surveyed in terrestrial habitats between 15 May and 14 July 1995 using fixed-width belt transects (Mikol 1980, Wakeley 1987). Belt transects were 40 m wide (20 m on each side of the survey line) and varied in length depending on field size. If a small wetland or other obstacle was encountered while walking the transect line, sampling was resumed along the line on the opposite side of the obstacle.

Habitats surveyed included deciduous woodlands and planted shelterbelts (cottonwood and green ash), tame grasslands (dominated by smooth brome, and including intermediate wheatgrass [*Agropyron intermedium*]), reseeded native grasslands (big and little bluestem), and alfalfa (*Medicago sativa*) (Table 1).

A total of 38 transects were randomly distributed among habitat types (Fig 3). Birds were counted twice within each belt transect during a field season, except in alfalfa plantings which were surveyed only once before cutting, after which they became unacceptable for a second survey. All transects occurred in homogeneous habitats, and the habitat edges were avoided (≥ 50 m, except in woodland shelterbelts) to minimize potential bias (Arnold and Higgins 1986).

All birds seen or heard within each belt transect were recorded by species, sex, and age (adult/juvenile) according to visual or audio cues. Bird counts were conducted from one-half hour before sunrise to 1000 hours. Counts were made by two observers walking at 1.0-1.5 km/hr (Mikol 1980), one surveying birds, the other recording data. Sampling did not take place during substantial precipitation, low temperatures, or excessive winds (≥ 20

km/hr). These can hamper an observer's ability to detect birds or may alter bird behavior (Mikol 1980).

Bird species names (Appendix A) and abbreviations followed AOU (1983) accepted standards.

Estimates of breeding pair densities (total number of perched and/or singing males divided by the belt transect area) and total bird densities (regardless of sex) were determined for each habitat type. Percent species composition (number of birds of a given species divided by the total number of birds of all species in an area x 100), percent frequency of occurrence (number of plots in which a species occurred divided by the total number of plots surveyed x 100), and species richness (total number of bird species present in a given habitat type) were calculated for each habitat type.

Breeding bird density (number of males per belt transect area) between habitats was tested using PROC GLM (General Linear Models Procedure) (SAS 1990) to determine normality of the data and to determine any relationships between breeding bird densities and habitat type. Analysis of variance (ANOVA) was conducted to test for significant differences, using habitat type as the error term. The same procedures were performed to test for differences between overall bird densities, regardless of sex and habitat type.

Table 1. Field type and size (ha) of habitats surveyed for bird species at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Habitat Type	*n*	$\bar{x}$	*min*	*max*
Woodland	20	3.4	1.1	7.6
Tame grass	10	12.3	4.9	31.0
Native grass	4	14.1	5.4	21.8
Alfalfa	4	6.6	3.8	9.8

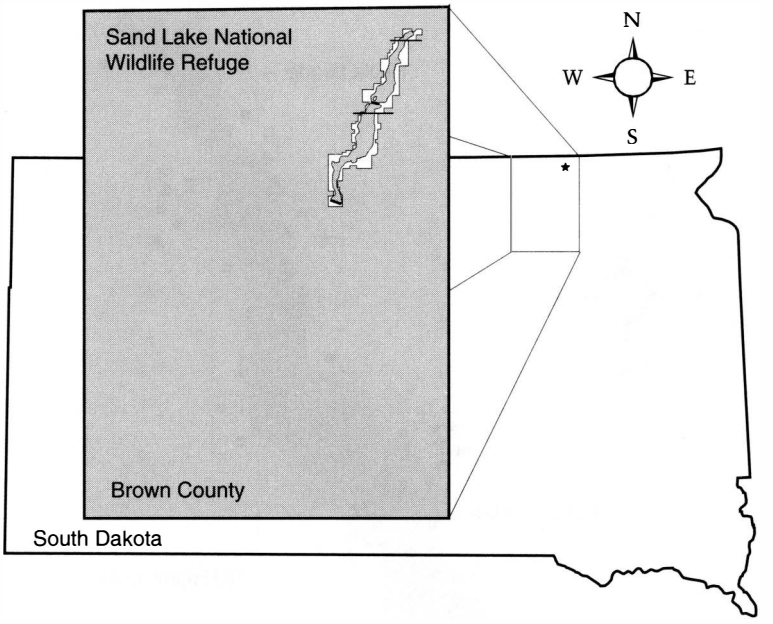


Figure 1. The Sand Lake study area, Brown County, South Dakota.

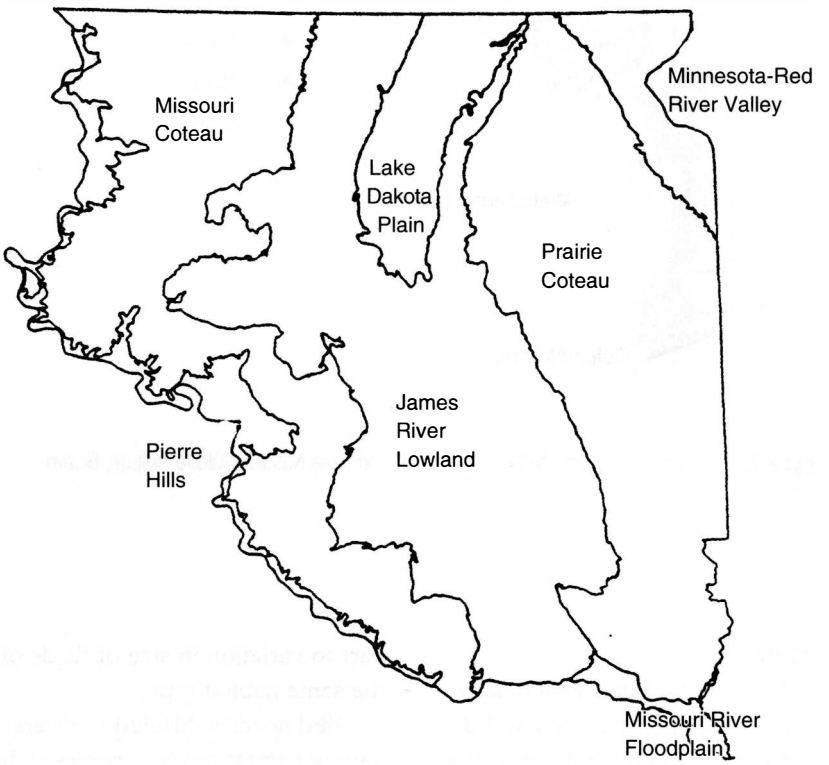


Figure 2. Physiographic divisions of eastern South Dakota (Johnson *et al.* 1995).

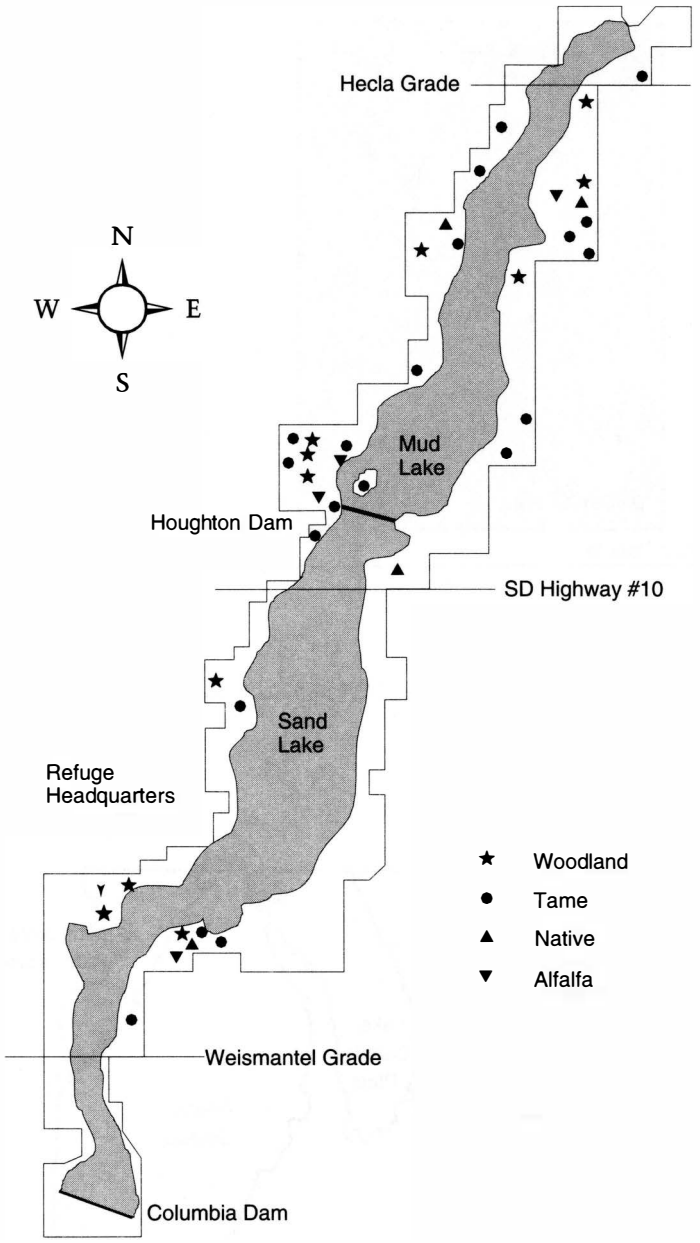


Figure 3. Location of nongame birds transects at Sand Lake National Wildlife Refuge, Brown county, South Dakota.

Table 2. Number (#) and percent composition (%) of 35 nongame bird species surveyed in woodland habitats (n = 10) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 22 May - 13 July 1995.

Species	#	%
House wren	167	26.6
Song sparrow	69	11.0
American robin	29	4.6
Mourning dove	27	4.3
Eastern kingbird	26	4.1
Brown-headed cowbird	25	4.0
Orchard oriole	24	3.8
Yellow warbler	22	3.5
Blue jay	21	3.3
Western kingbird	18	2.9
Northern oriole	18	2.9
Common yellowthroat	18	2.9
Downy woodpecker	17	2.7
Common grackle	16	2.6
Tree swallow	12	1.9
American goldfinch	11	1.8
Brown thrasher	11	1.8
Black-capped chickadee	10	1.6
Empidonax spp	10	1.6
Red-winged blackbird	9	1.4
Warbling vireo	8	1.3
Northern flicker	7	1.1
Eastern bluebird	6	1.0
Hairy woodpecker	5	0.8
Clay-colored sparrow	5	0.8
White-breasted nuthatch	4	0.6
Yellow-headed blackbird	3	0.5
Yellow-billed cuckoo	2	0.3
Least flycatcher	2	0.3
Cedar waxwing	2	0.3
Willow flycatcher	1	0.2
European starling	1	0.2
Yellow-breasted chat	1	0.2
Sedge wren	1	0.2
Unknown	1	0.2
Total number	628	
Species richness	35	

Results

Breeding bird densities (males regardless of species)/100 ha) did not differ among habitat types (P = 0.8917), nor did overall bird densities (birds/100 ha) differ among habitat types (P = 0.6449). This was due in part to variation in size of fields of the same habitat type.

Bird species differed in diversity among habitat types. Species richness in woodland habitats was greater than in alfalfa, tame grassland, or native reseeded habitats (Fig 4).

Ten woodland habitats contained 35 species (628 total detections), with 76.6% of all detections made up of 13 species–house wrens, song sparrows, American robins, mourning doves, eastern kingbirds, brown-headed cowbirds,

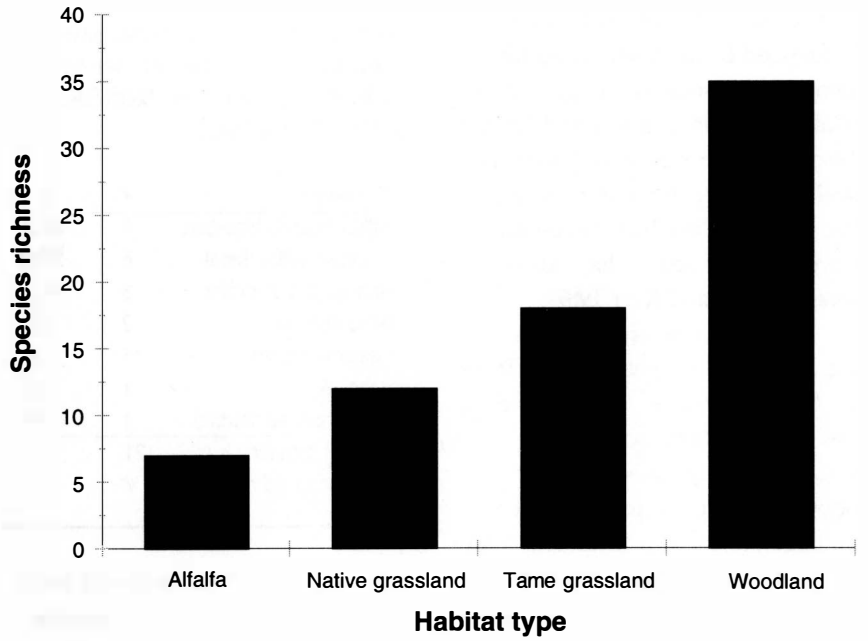


Figure 4. Species richness in four primary habitat types at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

orchard orioles, yellow warblers, blue jays, western kingbirds, northern orioles, common yellowthroats, and downy woodpeckers. House wrens and song sparrows accounted for 37.6% of all detections in woodland habitats (Table 2).

Eighteen bird species were found in tame grassland habitats (n = 20 and 505 detections, Table 3). Bird species richness (n = 18) in tame grassland habitats was about half that in woodland habitats (n = 35). Sedge wrens, common yellowthroats, red-winged blackbirds, bobolinks, and clay-colored sparrows accounted for 81.0% of all detections in grasslands.

Twelve bird species were seen in native grassland habitats (n = 4, 111 observations, Table 4). Sedge wrens, common yellowthroats, song sparrows, red-winged blackbirds, and brown-headed cowbirds accounted for 67.6% of all bird detections in native grassland habitat. LeConte's sparrows made up 2.7% of the species composition.

Alfalfa habitats (n = 4, and only surveyed once) had the lowest overall species richness (n = 7, Table 5). Yellow-headed blackbirds, common yellowthroats, and red-winged blackbirds made up 76.2% of total detections.

Discussion

The diverse terrestrial avifauna of SLNWR can be attributed to the variety of different habitat types. An interspersion of grasslands, both native and tame, and woodlands on SLNWR supports many generalist and edge species.

Woodland Birds. Woodlands are of considerable importance to birds and other wildlife (Yahner 1983), by possessing both horizontal area and vertical heterogeneity which permits co-occurrence of more bird species

Table 3. Number (#) and percent composition (%) of 18 nongame bird species surveyed in tame grassland habitats (n = 20) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 22 May - 13 July 1995.

Species	*#*	*%*
Sedge wren	146	28.9
Common yellowthroat	88	17.4
Red-winged blackbird	80	15.8
Bobolink	58	11.5
Clay-colored sparrow	37	7.3
Song sparrow	26	5.2
Yellow-headed blackbird	18	3.6
Brown-headed cowbird	17	3.4
Eastern kingbird	6	1.2
LeConte's sparrow	5	1.0
Marsh wren	5	1.0
Swamp sparrow	5	1.0
American goldfinch	4	0.8
Grasshopper sparrow	3	0.6
Sharp-tailed sparrow	2	0.4
Northern oriole	1	0.2
Savannah sparrow	1	0.2
Yellow warbler	1	0.2
Total number	505	
Species richness	18	

Table 4. Number (#) and percent composition (%) of 12 nongame bird species surveyed in native grassland habitats (n = 4) Sand Lake National Wildlife Refuge, Brown County, South Dakota, 22 May - 13 July 1995.

Species	*#*	*%*
Sedge wren	35	31.5
Common yellowthroat	27	24.3
Song sparrow	13	11.7
Red-winged blackbird	7	6.3
Brown-headed cowbird	7	6.3
Yellow-headed blackbird	5	4.5
Clay-colored sparrow	4	3.6
Grasshopper sparrow	4	3.6
LeConte's sparrow	3	2.7
Swamp sparrow	3	2.7
Eastern kingbird	2	1.8
Savannah sparrow	1	0.9
Total number	111	
Species richness	12	

(Blake and Karr 1987). Woodlands and shrubby areas provide foods for many granivorous and insectivorous birds and areas for breeding, nesting, and loafing (Robel and Browning 1981).

Although they made up only 1% of the total land area on the SLNWR, woodlands supported the highest bird species richness. Faanes (1982) found a similar correlation of high species numbers in woodland habitats that were a small percentage of total land area at Sheyenne Lake in North Dakota. Vertical heterogeneity may increase habitat for many generalist species and may attract a higher number of species than might be expected in a small area.

Only two species, the house wren and the song sparrow, were very common in woodland habitats, accounting for 38% of total species abundance. The remaining 32 species were less common but occured in similar frequencies.

Virtually all woodland habitats at SLNWR are artificial. Before refuge establishment and though in a riverine setting, the area had been mostly devoid of woodland vegetation. During refuge establishment, several thousand trees were planted in multi-row tree belts, and they were carefully maintained as windbreaks and wildlife cover (SLNWR narratives 1936-1939). The interspersion of trees among grassland habitats increased overall avian diversity on the refuge.

However, subdividing large contiguous habitats and increasing species diversity results in losses for habitat-size-dependent species (Temple *et al.* 1979). Grassland habitat fragmentation may have contributed to the elimination of the greater prairie chicken (*Tympanuchus cupido pinnatus*), which once was present on the refuge.

While the number of bird species in woodlands (or any habitat) is influenced by area, small habitats also may possess only edge species (Galli *et al.* 1976, Ambuel and Temple 1983). Smaller woodlands such as shelterbelts are dominated by ecological generalists that frequently travel to other nearby habitats to forage (Blake and Karr 1987).

SLNWR woodland habitats are all generally small, ranging from 1.1 to 7.6 ha in size. Excessive edge associated with these smaller woodlands may lead to smaller populations of species dependent on large blocks of habitat, and many birds detected in these woodlands may be area-independent or edge species. Habitat-size-independent species (Samson 1980) detected on the refuge included the European starling, the common grackle, and the American robin.

Grassland Birds.

Although grassland habitats in the northern Great Plains are vital to many species of birds (Faanes 1982), nongame bird affinities to these habitats are poorly understood, in comparison to those of waterfowl and upland game birds (Kantrud and Higgins 1992).

This lack of understanding becomes even more critical as grassland habitat continues to be destroyed. During the last 25 years, grasslands have been lost to modern row crop and small grains agriculture (Graul 1980, Renken and Dinsmore 1987), resulting in steeper and more consistent population declines than experienced by other taxa (Knopf 1994).

Consequently, public grasslands have become islands of habitat for native avifauna. They must play a growing part in conservation of these avian communities (Graul 1980), and public land managers will need information on the habitat requirements of nongame bird species (Renken and Dinsmore 1987).

Table 5. Number (#) and percent composition (%) of 7 nongame bird species surveyed in alfalfa habitats (n = 4) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 22 May - 13 July 1995.

Species	*#*	*%*
Yellow-headed blackbird	7	33.3
Common yellowthroat	6	28.6
Red-winged blackbird	3	14.3
Song sparrow	2	9.5
Eastern kingbird	1	4.8
Bobolink	1	4.8
Brown-headed cowbird	1	4.8
Total number	21	
Species richness	7	

Nongame grassland birds, like woodland species, are greatly affected by habitat size and distance between habitat islands (Samson 1980, Anderson and Robbins 1981). Although grassland bird diversity is generally lower than woodland bird diversity, when large blocks of habitats are available, area-dependent bird communities will increase. Species diversity will increase only minimally, for it is achieved best by maximizing habitat diversity (Anderson and Robbins 1981). However, landscapes which retain natural habitats support higher relative abundances of nongame endemic birds than do agricultural and urban areas (Flather and Sauer 1996).

Minimum habitat size requirements for nongame breeding birds in riparian grasslands and forests are not completely known (Samson 1980). Bird species positively associated with increasing habitat area include the grasshopper sparrow, the bobolink, and the savannah sparrow (Herkert 1994). In native grassland areas on SLNWR, grasshopper

and savannah sparrow percent composition was 3.6% and 0.9%, whereas in tame grasslands they were only 0.6% and 0.2% of the total bird community, respectively. Bobolinks were abundant on the refuge and, as reported by others (George *et al.* 1979, Ryan 1986), were often associated with tall residual cover which was abundant in most tame grassland habitats.

Bird species not dependent on increasing habitat size included the song sparrow, red-winged blackbird, and American goldfinch (Herkert 1994). Regardless of patch size, in native grasslands on the refuge, red-winged blackbirds made up 6.3% and song sparrows 11.7% of the bird community. In tame grasslands these two species were approximately 21% of the bird community.

Bird species that were habitat (not area) dependent included the sedge wren, the upland sandpiper, and the common yellowthroat. Sedge wrens were abundant in either tame or native grasslands. In tame grasslands ($\bar{x}$= 12.3 ha, range 4.9 - 31.0 ha) they occurred as 28.9%, and in native grassland ($\bar{x}$= 14.1 ha, range 5.4 - 21.8 ha) they were 31.5% of total detections.

Upland sandpipers (not surveyed during terrestrial surveys, but detected in 1996) and western meadowlarks (not seen in the plots) are categorized as area-dependent species (Samson 1980), but neither species occurred in any fields examined during this study.

Alfalfa. SLNWR participates in a cooperative agricultural program in which cooperators plant soybeans, corn, small grains, and alfalfa. Cropland makes up 12% (1,045 ha) of the refuge uplands.

This program, in existence since early refuge days (SLNWR narratives 1936-39), currently provides alternative food sources that help decrease white-tailed deer (*Odocoileus virginianus*) depredation on adjacent landowner crops and provides food plots for other wildlife (Wm. Schultze, pers comm, USFWS, Columbia, S.D.).

Alfalfa fields with good legume cover may be attractive to dickcissels, savannah sparrows, and bobolinks (Ryan 1986). We found only seven bird species in refuge alfalfa fields, the lowest overall species richness of all habitats surveyed on SLNWR. Alfalfa habitats had about half as many species as grasslands and about a fifth as many as woodlands. Three bird species (yellow-headed blackbirds, common yellowthroats, and red-winged blackbirds) were responsible for 75% of the total bird sightings in alfalfa fields.

Nongame Breeding Birds in Wetland Habitats

Current interest in biodiversity and landscape ecology is an indicator that refuge managers have new challenges before them and that refuge management is becoming ever more complex and comprehensive (Laubhan and Fredrickson 1993).

Devastating alterations have taken place in wetland habitats in and around refuges across the U.S. In the northern Great Plains, both private and public wetlands still are very productive and contribute to the continent's waterfowl population. They also provide necessary migration and breeding habitats for numerous nongame birds. However, drainage and the destruction of associated uplands have led to regional extirpations of birds (Delphey and Dinsmore 1993). Refuge wetlands, consequently, have become more valuable to faunal communities.

Many nongame vertebrates rely on a variety of wetlands for some part of their life history needs (Duebbert 1981); others are totally reliant on wetland habitats (Gibbs 1993). Considerably less information is available for birds in wetlands than in upland habitats.

Methods

Survey methods for large semipermanent wetland basins with tall, monotypic emergent vegetation have not been effectively standardized (Reynolds *et al.* 1980, Edwards *et al.* 1981). Often, multiple survey techniques are used; Manci (1985), for example, compared the three techniques of airboat transects, 1-ha semicircular plot counts, and roadside transects at Horicon Marsh, Wisconsin.

Edwards *et al.* (1981) found that a variable-circular plot method could effectively sample large, continuous habitats. This was a technique that estimated the distance of each detected bird in 10-m concentric bands extending away from the observer, and it accounted for a greater number of species and greater occurrences of uncommon species than other methods, they reported.

We used a semicircular plot with a fixed radius of 75 m. Semicircular plots were easier to use than centering an observer in a homogeneous stand of emergent *Typha* spp which often were over 2 meters above water surface.

Nongame birds were surveyed between 15 May and 4 July 1996. Survey plots (n = 116) were placed in representative stands of emergent vegetation.

In some instances, edges of habitats were surveyed to determine species occurrence and abundance in these areas. However, when homogeneous stands of habitat were surveyed, edges were avoided.

Wetland habitats surveyed included semipermanently flooded

emergent wetland vegetation (PEMF, *Typha* spp and *Phragmites australis*) and seasonally and temporarily flooded forested vegetation (PFOC, cottonwood, willow [*Salix* spp], and Russian olive [*Eleagnus angustifolia*]) according to the classification of Cowardin *et al.* (1979).

National Wetland Inventory maps showed 11 different types of wetlands within the refuge. However, continuous high water for 5 years (1992-1996) changed the characteristics of SLNWR wetlands. During the study, they basically functioned as a semipermanent wetland. Cattails and common reed accounted for the vast majority of the tall emergent vegetation.

Therefore, primary habitat types of the wetland area on SLNWR were grouped as emergent vegetation (n = 106, Fig 5) and flooded forested vegetation (n = 10, Fig 6).

Plots were surveyed for birds while wading or from a 16-foot boat. The boat also became an observation vantage point for surveys in vegetation which often exceeded 1.5 to 2.0 meters above the water surface.

An attempt was made to survey all wetland area at SLNWR. However, the large Franklin's gull colony south of SD Highway 10 was avoided to minimize disturbances. Nor were transect surveys via airboats conducted, reducing the probability of auditory disturbance (Manci 1985).

After a 3-minute "waiting period" upon arrival at a site for birds to become accustomed to the presence of a human (Bollinger *et al.* 1988), birds were surveyed for 10 minutes at each plot location. This time period enabled an observer to account for all birds present and to detect a greater number of uncommon birds. All birds heard singing or seen perched, flushed, or flying over the plot were recorded by species and sex (Reynolds *et al.* 1980). The first 3 minutes of a survey period were spent counting all birds in the plot area. During the next 3 minutes, recorded continuous loop tapes (Library of Natural Sounds, Cornell Laboratory of Ornithology, Ithaca, NY 14850) of territorial male calls were played to elicit responses from secretive birds (Marion *et al.* 1981) including American bitterns, least bitterns, soras, and Virginia rails. The remaining 4 minutes were spent listening and watching for any previously undetected birds.

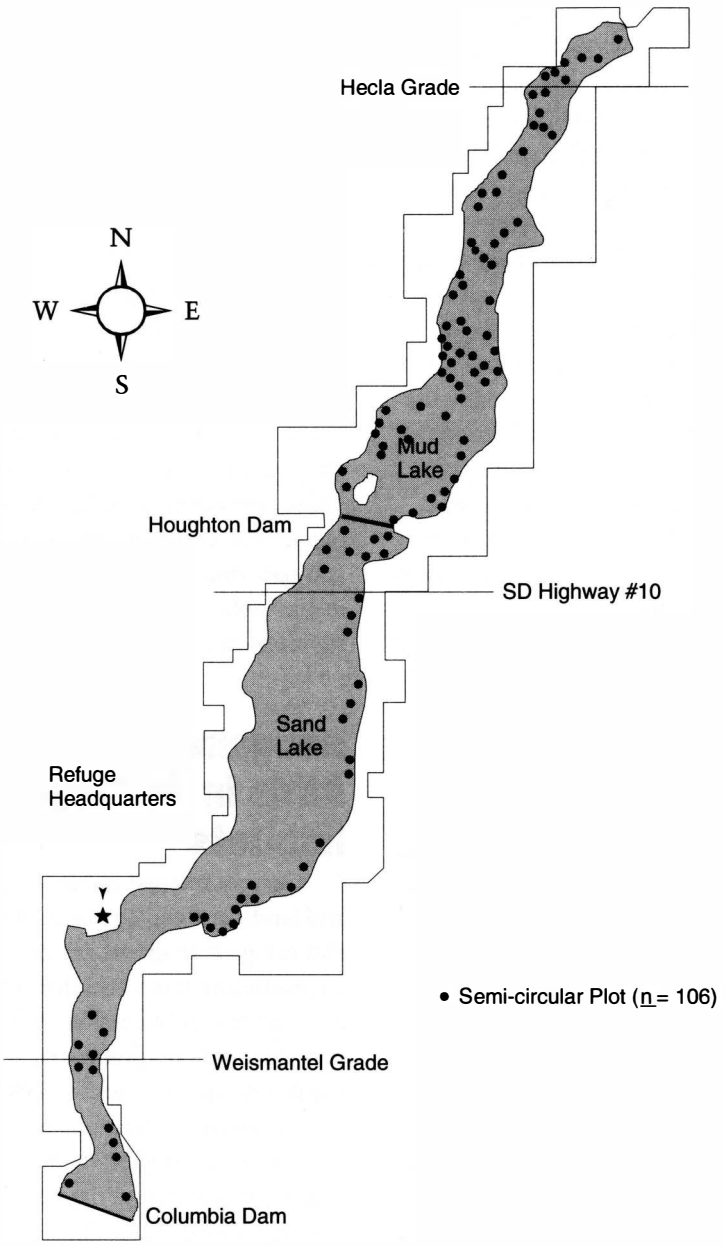


Figure 5. Location of semi-circular bird survey plots in semi-permanently flooded emergent wetlands at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Surveys were not conducted on days with heavy precipitation, low temperatures, or excessive winds (≥ 20 km/hr) (Mikol 1980). On suitable days, plots were surveyed for birds from one-half hour before sunrise until 1000 hours or from 1800 hours until sunset if morning counts could not be made.

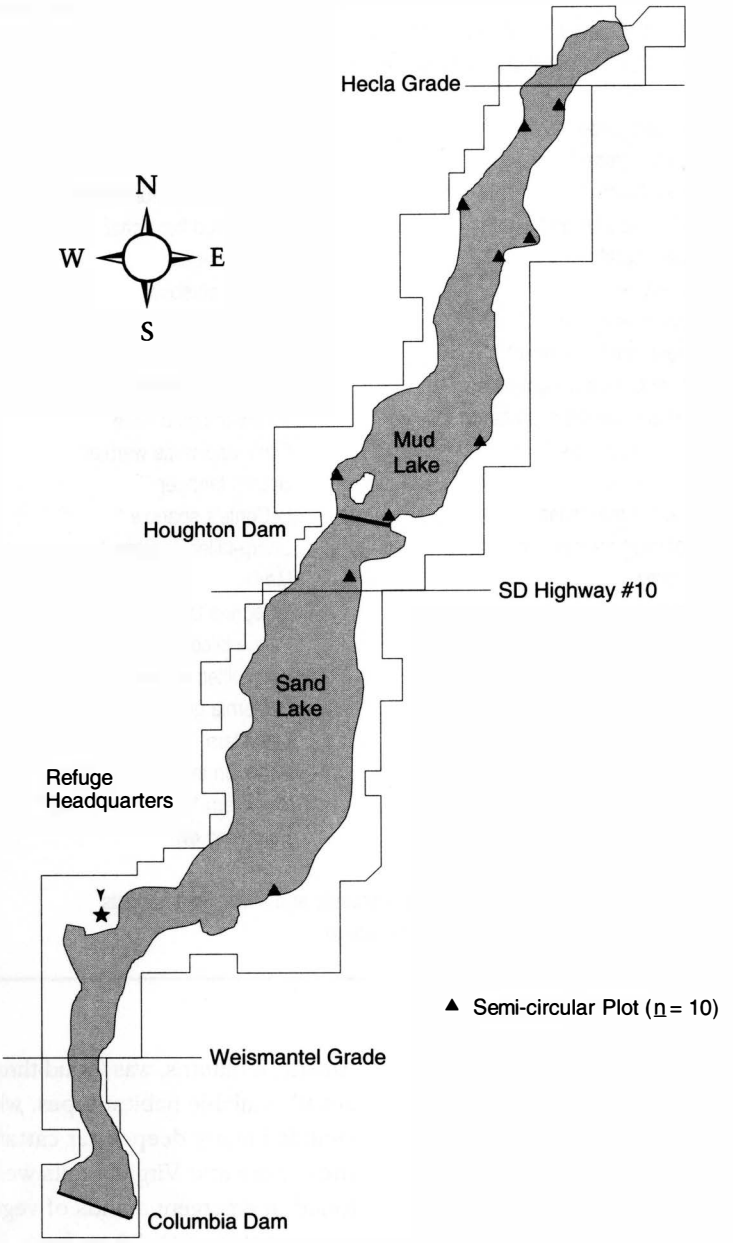


Figure 6. Location of semi-circular bird surveys in seasonally flooded forested wetlands at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Presence/absence data were compiled for every sample plot. Percent frequency of occurrence (number of plots in which a species was detected divided by the total number of plots surveyed x 100) was calculated for each avian species within primary habitat types.

Results

Thirty-two bird species were surveyed in the flooded woodland wetlands (Table 6). Species occurring in ≥ 50% of the plots included the yellow-headed blackbird, marsh wren, red-winged blackbird, American coot, tree swallow, and Franklin's gull.

Table 6. Frequency of occurrence (%) of nongame breeding birds in flooded forested wetlands (PFOC) (n = 10) and emergent wetlands (PEMF) (n = 106) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 4 June - 4 July 1996.

	Wetland habitat class	
Species	*PFOC*	*PEMF*
Yellow-headed blackbird	100	99
Marsh wren	70	89
American coot	70	84
Red-winged blackbird	60	23
Common grackle	20	19
Brown-headed cowbird	10	5
Common yellowthroat	30	15
Yellow warbler	40	1
American goldfinch	10	1
Barn swallow	10	8
Bank swallow	0	7
Cliff swallow	0	7
Tree swallow	60	11
Franklin's gull	70	72
Black tern	30	62
Forester's tern	10	12
Common tern	0	3
Sora	10	17
Virginia rail	20	25
American bittern	0	16
Least bittern	10	4
Black-crowned night-heron	10	29
Cattle egret	10	13
Snowy egret	10	2
Great egret	0	4
Great blue heron	10	2
White-faced ibis	0	8
Pied-billed grebe	20	8
Killdeer	40	4
Hairy woodpecker	10	0
Downy woodpecker	10	0
Back-capped chickadee	10	0
European starling	10	0
Eastern kingbird	40	0
Western kingbird	10	0
Brown thrasher	0	1
Mourning dove	40	2
Song sparrow	20	1
Swamp sparrow	0	1
Red-tailed hawk	10	1
Northern harrier	0	1
American kestrel	0	1
Double-crested cormorant	0	3
American white pelican	0	4
Total species	32	41

Species surveyed in flooded woodland habitat but common to terrestrial woodlands included the tree swallow, eastern kingbird, mourning dove, and yellow warbler. Many of the species surveyed in flooded woodlands were "users." They did not nest in the habitat but used it for foraging. However, tree swallows and eastern kingbirds were found nesting in flooded trees.

Surveys in semipermanently flooded emergent habitats revealed 41 bird species (Table 6). Yellow-headed blackbirds occurred in 99.1% of the plots and yellow-headed blackbirds, marsh wrens, American coots, Franklin's gulls, and black terns occurred on ≥ 50% of the plots. Virginia rails and black-crowned night-herons occurred in 25% and 29% of the plots, respectively.

Playback recordings to elicit responses from secretive species such as rails and bitterns were effective. In forested wetlands, soras and least bitterns responded in 10% of the plots and Virginia rails responded in 20% of the plots. In emergent vegetation types, soras, Virginia rails, American bitterns, and least bitterns responded to calls in 17.0%, 24.5%, 16.0%, and 3.8% of the plots, respectively. The absence of American bittern responses in the flooded forested wetlands may not necessarily represent an avoidance of these habitats but rather may be an artifact of a low sample size (n = 10) for this habitat type.

Table 7. Rare bird species monitored by the South Dakota Natural Heritage Program which have occurred at Sand Lake National Wildlife Refuge wetlands or associated habitats.

Horned grebe *	Long-eared owl
Clark's grebe *	Northern saw-whet owl
Least bittern *	Ruby-throated hummingbird
Great blue heron *	Olive-sided flycatcher
Great egret *	Brown creeper
Snowy egret *	Eastern bluebird *
Little blue heron *	Veery
Green-backed heron *	Mockingbird
Black-crowned night-heron *	Loggerhead shrike *
Yellow-crowned night-heron	Yellow-throated vireo
White-faced ibis *	Black-and-white warbler
Bufflehead	Scarlet tanager
Hooded merganser	LeConte's sparrow *
Common merganser	Sharp-tailed sparrow *
Osprey	Merlin
Bald eagle**	Peregrine falcon
Sharp-shinned hawk *	Prairie falcon
Cooper's hawk *	Long-billed curlew
Northern goshawk	California gull
Broad-winged hawk	Least tern
Swainson's hawk *	Common tern *
Ferruginous hawk	Black tern *
Golden eagle	Burrowing owl

* species which have nested on SLNWR in wetlands and associated habitats
** Bald eagles have attempted to nest on the refuge

Discussion

A third of North American birds use wetland habitats (Gibbs *et al.* 1991), and of these, 75% are nongame birds. SLNWR is located along a major migration corridor for waterfowl and numerous species of nongame bird species in the prairie pothole region of North America (Schneider 1978, Sayler *et al.* 1988). SLNWR, with its interspersion of wetlands and uplands, represents a dynamic prairie marsh ecosystem (SLNWR narrative 1990).

SLNWR supports habitat for 61% of the birds (n = 46) listed as rare species by the South Dakota Natural Heritage Program. Among these, 21 species (28%) have nested on the refuge in wetland or associated habitats (Table 7). The first nesting of a common moorhen in South Dakota was reported in 1995 (Meeks and Higgins 1997).

Secretive species such as rails and bitterns were detected by using playback recordings. At SLNWR this group of species, except American bitterns, was found throughout all available habitat types, which included many deep-water cattail sites. Sora and Virginia rails were found in emergent stands of vegetation in water up to 1.0 m deep. This differs from Capen and Low (1980) who classified rails as shallow-water marsh dwellers. Johnson and Dinsmore (1986) reported that soras preferred shoreward sites whereas Virginia rails preferred deeper-water sites with robust emergent vegetation. They found no ecological niche segregation between the two species.

Deep water may require use of morphological or behavioral characteristics for ecological separation of birds (Reid 1993). For example, Weller (1961) reported that least

bitterns grasped emergent vegetation or the vegetation in feeding platforms to facilitate their foraging in deep water sites.

Franklin's gulls occurred in 70% of the plots in flooded forested wetlands and in 72% of the plots in semipermanently flooded emergent wetland plots. These large frequencies can be attributed to the large gull colony on SLNWR. This colony of 100,000 to 150,000 pairs of Franklin's gulls is located in homogeneous stands of cattail, with the majority on the south side of Houghton Grade. The habitat supporting the Franklin's gull colony also supports white-faced ibises, Forster's terns, common terns, black terns, black-crowned night-herons, cattle egrets, great egrets, little blue herons, and snowy egrets.

Nongame Small Mammals

Small mammals affect the faunal and floral community structure directly and indirectly through mechanisms such as seed dispersal and vegetation alteration (Batzli and Pitelka 1970, Pendleton 1984). Small mammals also may be used as indicators of habitat diversity (Becker 1979). Habitat size, location, and their juxtaposition to other habitats govern the persistence of local mammal populations and their distributions (Gibbs 1993).

Much literature pertains to small mammal taxonomy, feeding requirements, and other characteristics; there is little information on conservation of small mammals and their response to management techniques.

In South Dakota, nongame small mammals are among the least understood of the mammals (Choate and Jones 1981), even though they are important components of the overall biota. Little to no data are available on small mammals of the James River Basin of North Dakota (Becker 1979) or for county distributions of mammals in South Dakota (Blumberg 1993).

Methods

Trapping was conducted 23 May to 17 August 1995 and 28 May to 22 July 1996 to inventory nongame small mammals in all upland and wetland-edge habitat types on SLNWR.

Since this was an inventory-specific project, an attempt was made to place traps in areas where burrows, grass clippings, and runways were present (Bogan and Ramotnik 1993). Bats and large- and medium-sized mammals were not sampled.

To sample all habitat types, trapping was conducted on islands and in wetland-edge areas. Rare small mammals often inhabit wetland areas and can only be sampled in these habitats (J. Cornely, pers comm, USFWS, Denver).

Trap types included snap traps (museum special and regular mouse traps) and pitfall traps. The two trap types increased the likelihood of capturing as many species as possible and yielding the most complete data on species composition (Mengak and Guynn 1987).

Four trap lines of approximately 50 (range = 25 - 60) snap traps each were set per habitat type (Fig 7). All snap traps were baited with peanut butter, rolled oats, and bacon grease. Traps were baited in the evening before sunset and checked after sunrise the next morning.

In some instances, several species of small mammals, including shrews, have been adequately caught in pitfall traps (Williams and Braun 1983, Szarro *et al.* 1988, Bogan *et al.* 1995). Williams and Braun (1983) also found that pitfall traps enable multiple captures of small mammals. Pitfalls can be effectively used without drift fences. Whitaker *et al.* (1994) placed pitfalls along runways or logs and achieved adequate samples of small mammals.

Eleven-liter plastic buckets without lids and handles were used as pitfall traps and placed in all habitats except agricultural fields. The pitfall traps were buried flush to the ground with trenches dug between them to act as runways for small mammals (D. Backlund, pers comm, SDGF&P, Pierre). Pitfall traps (n = 3 per transect) were placed in a straight line, approximately 5 m apart (Fig 8).

Pitfall trapping protocol was in compliance with the guidelines from the American Society of Mammalogists Ad hoc Committee (1987). A sufficient amount of liquid in each trap quickly drowned small mammals.

Opportunistic collection of some small mammals such as ground squirrels and pocket gophers also occurred throughout the study.

Trapped mammals were identified and recorded on data sheets and cross-referenced by trap and trap line number, date, and habitat type. Specimens were placed in moist paper towels and frozen. All specimens were verified to species, and representative samples of each species were prepared as museum voucher specimens (skull and skin) and deposited at the Natural History Museum, University of Kansas, Lawrence. Any former documentation of small mammal occurrence in the Sand Lake area prior to this study was considered a valid independent observation. Mammal species names (Appendix A) followed Banks *et al.* (1987).

Catch rates were calculated as the number of individuals captured/species/100 operable trapnights, and these were used as an index of relative abundance. Mean catch rates and standard errors (SE) of the mean were calculated. Snap trap data and pitfall trap data also were summarized and compared separately due to differential catch rates. Snap traps enable only one capture per night whereas pitfall types enable multiple captures. Percent species composition was calculated for each mammal species per habitat type per trap type. Small mammals are listed in phylogenetic order (Jones *et al.* 1985).

Correspondence analyses were performed for all species per habitat type for each trap type, using SAS (1990). Species with sum values less than 6.0 captures in snap traps and less than 10.0 in pitfall traps were not included in correspondence analyses.

Results

Eleven species of nongame small mammals were represented in 800 captures at SLNWR when data were combined for both trap types. Captures were about equal between snap and pitfall trapping efforts.

Snap Trap Results.

Nine species and 447 individuals were captured with snap traps during 2,600 trapnights (TN) for an overall capture rate of 17.2 individuals/100 TN (Table 8).

For all habitats combined, the five most common species of small mammals captured in snap traps were the white-footed mouse, deer mouse, meadow vole, masked shrew, and meadow jumping mouse. The most common small mammal captured with snap traps (all habitats included) was the white-footed mouse, representing 24.4% of the total captures (Table 8).

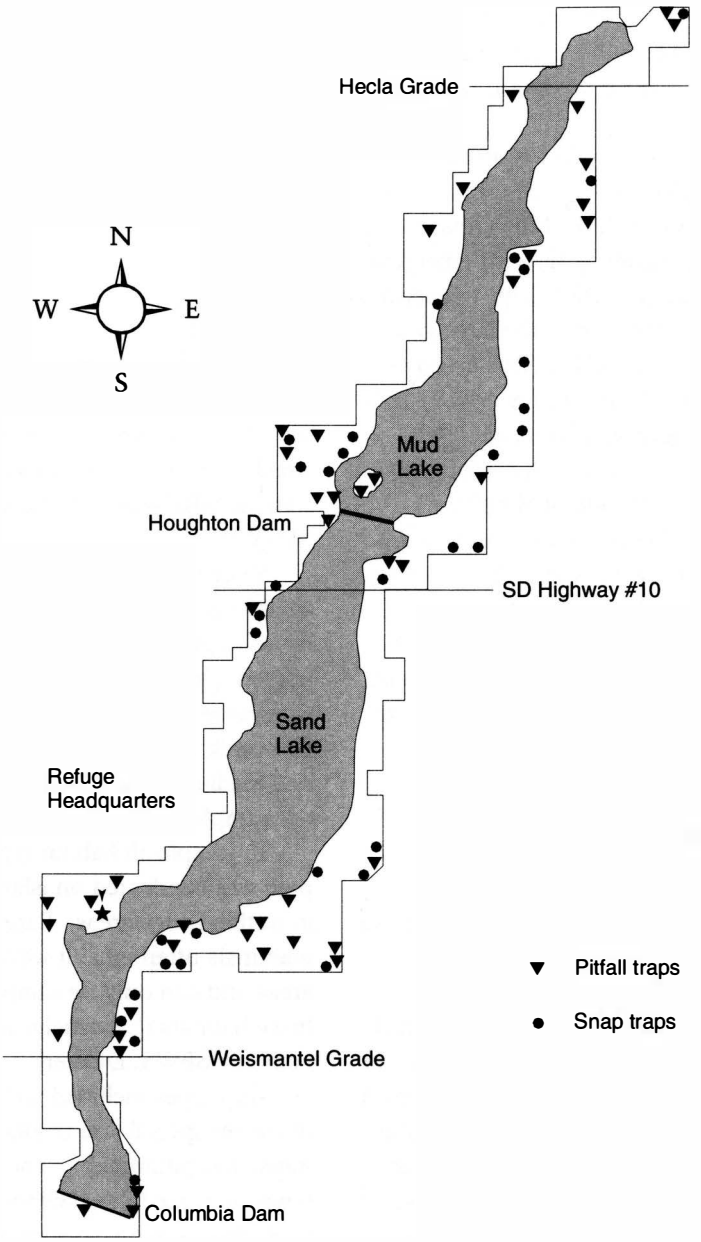


Figure 7. Location of snap and pitfall trapping sites on Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Seven species and 135 small mammals were captured with snap traps in 1,101 trapnights in tame grassland habitats on SLNWR for an overall capture rate of 12.3 individuals/100 TN (Table 9). Masked shrews (22.2%) and meadow voles (21.5%) were the most frequently captured species in tame grasslands.

Seven species and 243 small mammals were captured with snap traps in 978 trapnights in woodland habitats with an overall catch rate of 24.9 individuals/100 TN (Table 10). White-footed mice (37.0%) and deer mice (15.6%) were the most common species that were captured in woodland habitats.

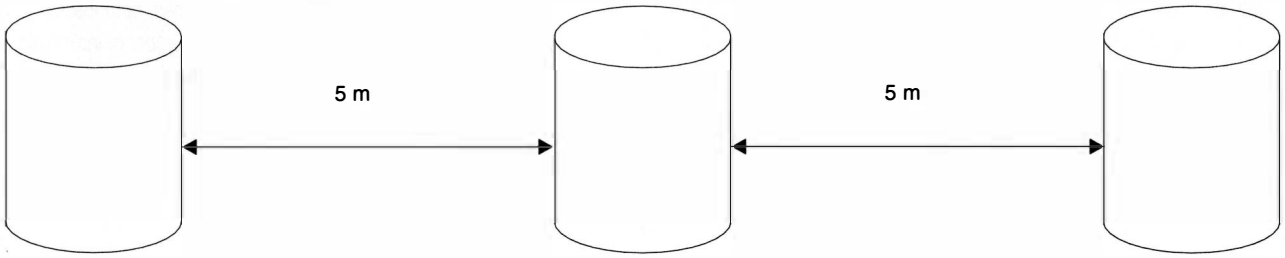


Figure 8. Illustration of pitfall placement used for sampling small mammals at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Table 8. Number, overall capture rate (number of individuals/100 trapnights), and percent species composition of snap traps (all habitats included) for nongame small mammals captured at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 to 28 May - 22 July 1996.

Species	*#*	*n/100TN*	*%*
Masked shrew	61	2.35	13.6
Short-tailed shrew	49	1.88	11.0
Thirteen-lined ground squirrel	5	0.19	1.1
Plains pocket mouse	1	0.04	0.2
White-footed mouse	109	4.19	24.4
Deer mouse	88	3.38	19.7
Peromyscus spp	2	0.08	0.4
Northern grasshopper mouse	1	0.04	0.2
Meadow vole	65	2.50	14.5
Meadow jumping mouse	57	2.19	12.8
Unknown spp	9	0.35	2.0
Total number			447
Species richness			11
Total trapnights			2,600
Overall capture rate/100 trapnights			17.19

Table 9. Number, percent composition, and mean capture rate (number of individuals/100 trapnights) of nongame small mammals captured with snap traps in tame grassland habitats (n = 16) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	*x̄*	*±SE*
Masked shrew	30	22.2	3.18	0.80
Short-tailed shrew	20	14.8	2.42	0.83
Thirteen-lined ground squirrel	4	3.0	0.61	0.44
White-footed mouse	10	7.4	1.10	0.55
Deer mouse	17	12.6	1.15	0.41
Peromyscus spp	2	1.5	-	-
Meadow vole	29	21.5	3.35	1.06
Meadow jumping mouse	20	14.8	1.60	0.75
Unknown spp	3	2.2	-	-
Total number				135
Species richness				7
Total trapnights				1,101
Overall capture rate/100 trapnights				12.3

Table 10. Number, percent composition, and mean capture rate (number of individuals/100 trapnights) of nongame small mammals captured with snap traps in woodland habitats (n = 19) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	*x̄*	*±SE*
Masked shrew	30	12.3	2.93	0.68
Short-tailed shrew	27	11.1	3.05	1.32
Plains pocket mouse	1	0.4	0.08	0.08
White-footed mouse	90	37.0	9.28	2.62
Deer mouse	38	15.6	4.34	0.84
Meadow vole	24	9.9	2.52	0.85
Meadow jumping mouse	29	11.9	3.00	0.84
Unknown spp	4	1.7	-	-
Total number				243
Species richness				7
Total trapnights				978
Overall capture rate/100 trapnights				24.8

Table 11. Number, percent composition, and mean capture rate (number of individuals/ 100 trapnights) of nongame small mammals captured with snap traps in wetland habitats (n = 7) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	$\bar{x}$	*±SE*
Short-tailed shrew	2	6.9	0.55	0.36
White-footed mouse	4	13.8	1.15	0.85
Deer mouse	7	24.1	2.12	1.25
Meadow vole	8	27.6	6.17	3.77
Meadow jumping mouse	6	20.7	3.42	2.26
Unknown spp	2	6.9	-	-
Total number				29
Species richness				5
Total trapnights				230
Overall capture rate/100 trapnights				12.6

Table 12. Number, percent composition, and mean capture rate (number of individuals/ 100 trapnights) of nongame small mammals captured with snap traps in cropland habitats (n = 3) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	$\bar{x}$	*±SE*
White-footed mouse	4	11.8	2.90	1.73
Deer mouse	25	73.5	13.90	2.14
Northern grasshopper mouse	1	2.9	0.67	0.67
Meadow vole	3	8.8	2.00	2.00
Meadow jumping mouse	1	2.9	0.67	0.67
Total number				34
Species richness				5
Total trapnights				180
Overall capture rate/100 trapnights				18.9

Table 13. Number, percent composition, and mean capture rate (number of individuals/ 100 trapnights) of nongame small mammals captured with snap traps in reseeded native grassland habitats (n = 2) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	$\bar{x}$	*±SE*
Masked shrew	1	16.67	1.62	1.62
Thirteen-lined ground squirrel	1	16.67	1.62	1.62
White-footed mouse	1	16.67	1.62	1.62
Deer mouse	1	16.67	1.62	1.62
Meadow vole	1	16.67	1.62	1.62
Meadow jumping mouse	1	16.67	1.62	1.62
Total number				6
Species richness				6
Total trapnights				111
Overall capture rate/100 trapnights				5.4

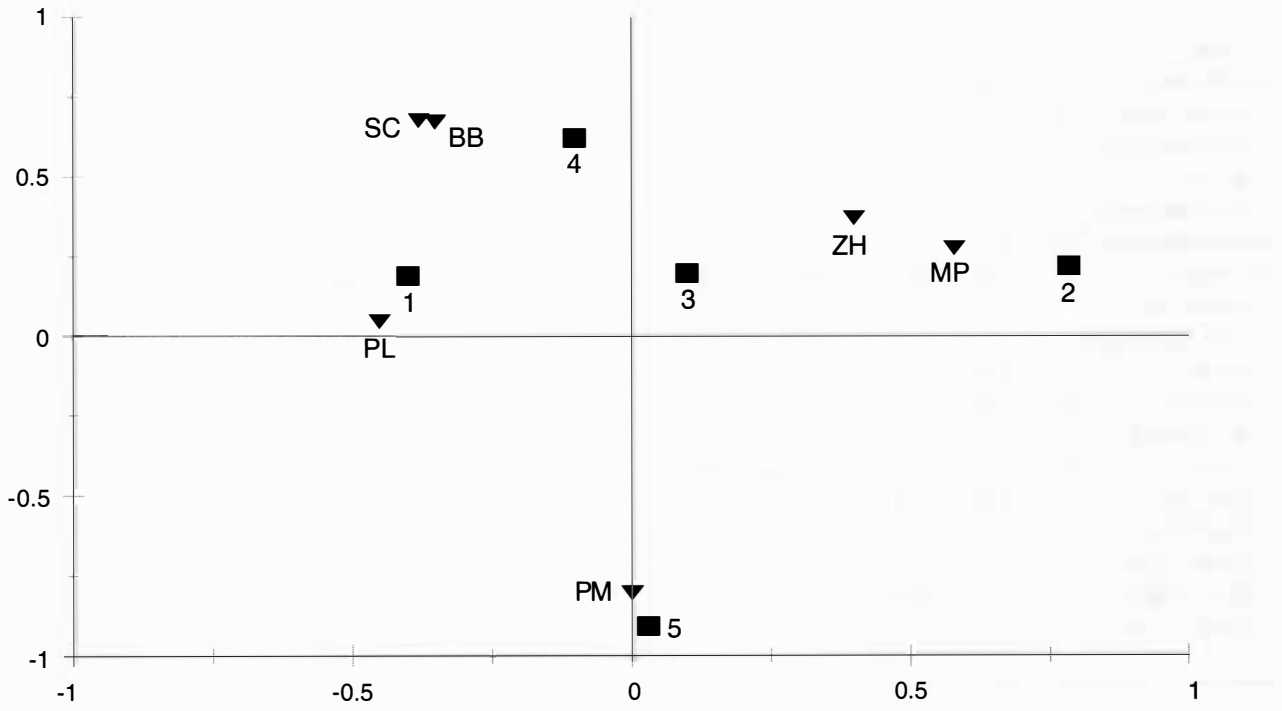


Figure 9. Correspondence analysis for small mammals captured with snap traps at Sand Lake National Wildlife Refuge, Brown County, South Dakota. SC=*Sorex cinereus,* BB=*Blarina brevicauda,* PL=*Peromyscus leucopus,* PM=*Peromyscus maniculatus,* MP=*Microtus pennsylvanicus,* ZH=*Zapus hudsonius.* 1=woodland, 2=wetland, 3=native, 4=tame, 5=crop.

Table 14. Number, overall capture rate (number of individuals/100 trap-night), and percent species composition of pitfall traps (all habitats included) for nongame small mammals captured at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 to 28 May - 22 July 1996.

Species	*#*	*n/100TN*	*%*
Masked shrew	70	9.19	19.8
Short-tailed shrew	5	0.66	1.4
Thirteen-lined ground squirrel	0	0.00	0.0
Northern pocket gopher	2	0.26	0.6
Plains pocket mouse	14	1.84	4.0
Western harvest mouse	1	0.13	0.3
White-footed mouse	20	2.62	5.7
Deer mouse	6	0.79	1.7
Peromyscus spp	4	0.52	1.1
Northern grasshopper mouse	4	0.52	1.1
Meadow vole	54	7.09	15.3
Meadow jumping mouse	173	22.70	49.0
Unknown spp	0	0.00	0.0
Total number			353
Species richness			11
Total trapnights			762
Overall capture rate/100 trapnights			46.33

Table 15. Number, percent composition, and mean capture rate (number of individuals/ 100 trapnights) of nongame small mammals captured with pitfall traps in tame grassland habitats (n = 11) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	*$\bar{x}$*	*±SE*
Masked shrew	25	21.37	9.69	3.82
Short-tailed shrew	2	1.71	1.51	1.02
Plains pocket mouse	1	0.85	0.10	0.10
Western harvest mouse	1	0.85	0.47	0.37
White-footed mouse	3	2.56	1.40	1.29
Deer mouse	3	2.56	6.47	2.91
Meadow vole	23	19.66	14.05	6.78
Meadow jumping mouse	59	50.43	31.13	8.15
Total number				117
Species richness				8
Total trapnights				281
Overall capture rate/100 trapnights				41.6

Table 16. Number, percent composition, and mean capture rate (number of individuals/ 100 trapnights) of nongame small mammals captured with pitfall traps in woodland habitats (n = 13) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	*#*	*%*	*$\bar{x}$*	*±SE*
Masked shrew	32	22.4	20.4	66.92
Short-tailed shrew	3	2.1	1.92	1.38
Plains pocket mouse	1	0.7	0.64	0.64
White-footed mouse	17	11.9	9.22	4.36
Deer mouse	2	1.4	1.28	0.87
Peromyscus spp	3	2.1	-	-
Meadow vole	16	11.2	7.49	2.58
Meadow jumping mouse	69	48.3	34.52	7.80
Total number				143
Species richness				7
Total trapnights				229
Overall capture rate/100 trapnights				62.4

Five species and 29 small mammals were captured with snap traps in 230 total trapnights in wetland-edge habitats (Table 11) at a catch rate of 12.6 individuals/100 TN. Meadow voles, deer mice, and meadow jumping mice were the most common species captured in wetland-edge habitats.

Five species and 34 small mammals were captured in snap traps in 180 trapnights, for a catch rate of 18.9 individuals/100 TN, in cropland habitat (Table 12). The most common species captured in croplands was the deer mouse.

Only six individuals representing six species were captured in 111 trapnights in seeded native grassland habitats with snap traps, for a catch rate of 5.4 individuals/100 TN (Table 13). However, only two fields of seeded native grasslands were available for sampling.

Correspondence analysis graphically depicts species:habitat associations (Fig 9). Based on snap trap data, masked shrews and northern short-tailed shrews were closely associated with tame grasslands and somewhat associated with woodland habitats, whereas meadow jumping mice and meadow voles were closely associated with wetland environments. White-footed mice showed a positive affinity for woodland habitats, and deer mice were most closely associated with cropland habitats.

Pitfall Trap Results. Ten species and 353 small mammals were captured in 762 pitfall trapnights for an overall capture rate of 46.3 individuals/100 TN (Table 14). With all habitats combined, meadow jumping mice made up 49.0% and masked shrews 19.8% of total pitfall captures with all habitats combined.

Eight species and 117 small mammals were captured in 281 pitfall trapnights, resulting in an overall catch rate of 41.6 individuals/100 TN in tame grassland habitats (Table 15). Three species (meadow jumping mouse, masked shrew, and meadow vole) made up 91.5% of pitfall trap captures in tame grassland habitats. The western harvest mouse was captured only once during the study; this occurred in a pitfall trap in tame grassland.

Seven species and 143 small mammals were caught at an overall pitfall capture rate of 62.4 individuals/100 TN in woodland habitats (Table 16). Four species (meadow jumping mouse, masked shrew, white-footed mouse, and meadow vole) made up 93.7% of all captures in this habitat type.

Six species and 52 small mammals were captured in 132 pitfall trapnights in wetland-edge habitats at an overall catch rate of 39.4 individuals/100 TN (Table 17). Meadow jumping mice, meadow voles, and masked shrews were 90.4% of the total individuals in this habitat type.

Five species and 41 individuals were captured in 120 pitfall trapnights in native grasslands at an overall catch rate of 34.2 individuals/100 TN (Table 18). The two most abundant species captured in this habitat type were meadow jumping mouse and plains pocket mouse. Eleven plains pocket mice were captured in native grassland habitats with a mean catch rate of 5.7 ± 3.26. This higher standard error is partly due to the fact that this species was captured in every habitat type but in relatively high amounts in only one native grassland on SLNWR. Plains pocket mice were caught only with pitfall traps.

Correspondence analysis performed on pitfall trap data supports species:habitat associations (Fig 10). Northern grasshopper mice and plains pocket mice exhibited a positive association with native grasslands, whereas white-footed mice showed a high affinity for woodland areas. Masked shrews were closely associated with woodland habitats, whereas meadow jumping mice and meadow voles showed a positive association with tame grassland and wetland-edge habitats.

Table 17. Number, percent composition, and mean capture rate (number of individuals/100 trapnights) of nongame small mammals captured with pitfall traps in wetland habitats (n = 5) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	#	%	$\bar{x}$	±SE
Masked shrew	8	15.4	9.90	7.68
Northern pocket gopher	2	3.9	2.67	2.67
Plains pocket mouse	1	1.9	1.67	1.67
Deer mouse	1	1.9	1.67	1.67
Peromyscus spp	1	1.9	-	-
Meadow vole	11	21.2	10.95	6.37
Meadow jumping mouse	28	53.9	40.23	18.77
Total number				52
Species richness				6
Total trapnights				132
Overall capture rate/100 trapnights				39.4

Table 18. Number, percent composition, and mean capture rate (number of individuals/100 trapnights) of nongame small mammals captured with pitfall traps in reseeded native grassland habitats (n = 4) at Sand Lake National Wildlife Refuge, Brown County, South Dakota, 23 May - 17 August 1995 and 28 May - 22 July 1996.

Species	#	%	$\bar{x}$	±SE
Masked shrew	5	12.2	10.42	7.89
Plains pocket mouse	11	26.8	5.65	3.26
Northern grasshopper mouse	4	3.0	11.11	11.11
Meadow vole	4	3.0	2.95	1.97
Meadow jumping mouse	17	12.9	28.23	23.98
Total number				41
Species richness				5
Total trapnights				120
Overall capture rate/100 trapnights				34.2

Discussion

Nongame small mammals captured at Sand Lake NWR were representative of the small mammal populations of north-central South Dakota with a few exceptions. One of these is the prairie vole, which was not captured during this study. Distribution maps (Jones *et al.* 1985) show this species inhabiting the entire state, and meadow voles and prairie voles are sympatric species in most cases. However, meadow voles prefer mesic sites, whereas prairie voles prefer xeric sites (Lewin 1968, Wrigley 1974). The high water during the past few years at SLNWR may have contributed to the lack of xeric sites and, hence, the absence of prairie voles in trap samples.

Another small mammal species not captured on SLNWR was the red-backed vole, even though it was frequently captured at Waubay NWR, Day County, about 70 km southeast of SLNWR (J. Koerner pers comm, USFWS, Columbia, S.D.). This species inhabits the very northern edge of north-central and northeastern South Dakota (Jones *et al.* 1985). Waubay NWR is located in the Prairie Couteau physiographic region, whereas SLNWR is located in the James River Lowland physiographic region of South Dakota.

The western harvest mouse was captured only once during this study. This species is described as statewide by Jones *et al.* (1985); however, Choate and Jones (1981) described its distribution in South Dakota proper as "restricted to relatively mesic habitats in the west."

Common species on the refuge were similar to those found by Searls (1974) in northwest Brookings County. Likewise, Pendleton (1984) reported that meadow voles, deer mice, meadow jumping mice, and masked shrews were 95% of total captures on Waterfowl Production Areas in northeastern South Dakota, findings very similar to our results. Additionally, species surveyed on the refuge (1936-1941) were similar to those found during this survey, with some exceptions (Table 19).

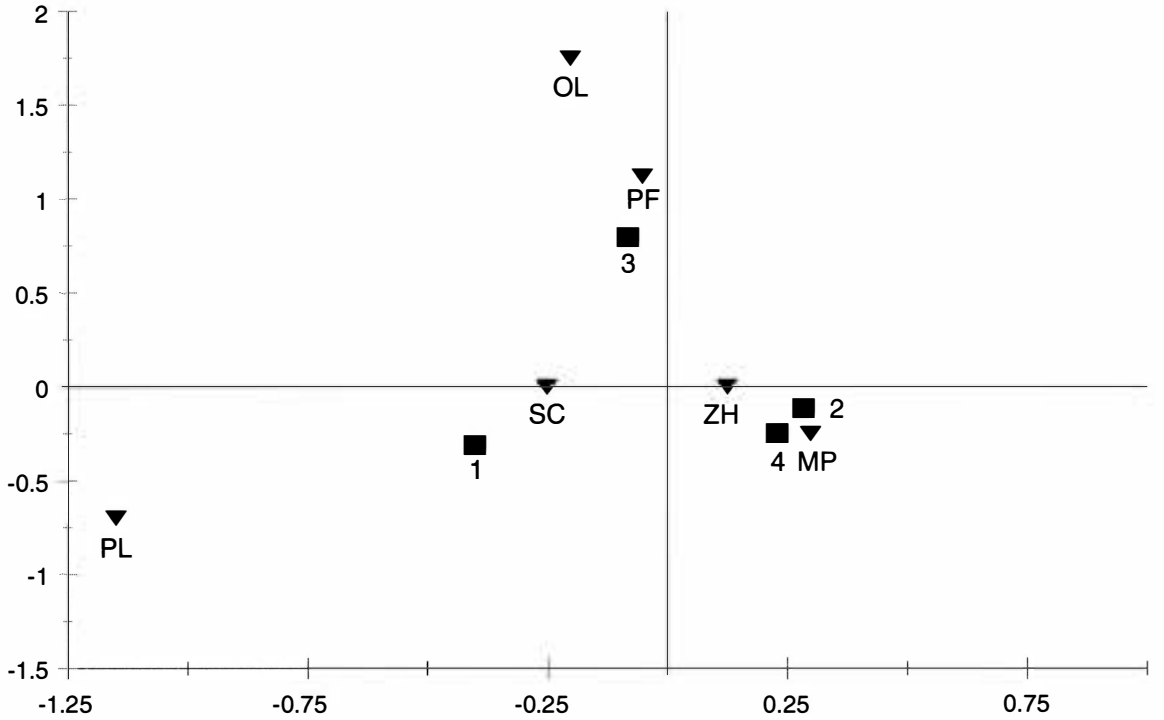


Figure 10. Correspondence analysis for small mammals captured with pitfall traps at Sand Lake National Wildlife Refuge, Brown County, South Dakota. SC=*Sorex cinereus*, OL=*Onychomys leucogaster*, PF=*Perognathus flavescens*, PL=*Peromyscus leucopus*, MP=*Microtus pennsylvanicus*, ZH=*Zapus hudsonius*. 1=woodland, 2=wetland, 3=native, 4=tame.

Habitats at SLNWR harbored representative assemblages of small mammals common to the northern Great Plains. Woodland species used man-made shelterbelts, many of which were small in size and occurred as habitat islands. Grant (1971) reported that meadow voles frequent moist grassland habitats but can be found in woodlands as a result of intraspecific competition. This species was captured in grassland and woodland habitat types at SLNWR but not in great abundance in either.

Clark *et al.* (1987) wrote that the white-footed mouse is a woodland species that may inhabit adjacent grassland habitats if densities in woodlands are high enough. The white-footed mouse was the most abundant small mammal captured with snap traps in woodland areas, whereas capture rates were lower than expected in both tame and native grassland habitats, many of which were fragmented by multi-row shelterbelts. Only one white-footed mouse was captured in seeded native grasslands throughout the entire study period.

Cropland habitats (though only sampled with snap traps and with a low trapping effort) supported habitat for five species of small mammals. Often, initial cultivation of cropland habitats decreases the species richness and diversity of small mammals (Hayslett and Danielson 1994). Species richness in cropland habitats at SLNWR was similar to that of other habitat types. However, deer mice were nearly 75% of the total captures in croplands.

Nongame Herptiles and Fishes

Amphibians and reptiles (collectively referred to as herptiles) and fishes are an integral part of most temperate ecosystems. However, there is little information about their life history needs and habitat requirements, due in part to a simplistic view of ecosystem management (Szarro 1988). But the more that is known about an area's species, the easier it is to develop a plan to manage and monitor its resources (Mixon 1993).

There has been no deliberate attempt to study herptiles in the James River Basin (Becker 1979); however, several fisheries related projects have been conducted on the refuge and in adjacent areas

Table 19. List of resident mammal species observed at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Species	Survey (1996)	SLNWR trapping records (1977-1993)*	SLNWR narrative (1941)
Marsupilia			
Virginia opossum	x**		
Insectivora			
Short-tailed shrew	x		x
Masked shrew	x		x
Chiroptera			
Large brown bat			x***
Little brown bat			x
Silver-haired bat			x
Red bat			x
Hoary bat	x		x***
Carnivora			
Coyote	x	x	x
Kit (Swift) fox			x***
Red fox	x	x	x
Raccoon	x	x	x
Bonaparte weasel			x
Long-tailed weasel	x	x	x
Least weasel			x
Mink	x	x	x
Badger	x	x	x
Striped skunk	x	x	x
Spotted skunk		x	
Artiodactyla			
White-tailed deer	x	x	
Rodentia			
Woodchuck	x		
Red squirrel			x
Fox squirrel	x		
Franklin's ground squirrel	x	x	x
Richardson's ground squirrel	x	x	x
Thirteen-lined ground squirrel	x		x
Plains pocket gopher	x		x***
Northern pocket gopher	x		x
Plains pocket mouse	x		x
Beaver	x	x	
Red-backed vole			x
Grasshopper mouse	x		x***
White-footed mouse	x		x****
Deer mouse	x		x****
Harvest mouse	x		x
Meadow vole	x		x
Muskrat	x	x	
House mouse			x
Norway rat			x
Meadow jumping mouse	x		x***
Lagomorpha			
White-tailed jackrabbit	x	x	x
Eastern cottontail	x		x

* furbearer trapping for medium-sized mammals only, and maintenance of a predator exclosure
** not trapped, but a roadkill was found by refuge personnel
*** listed as "noted locally and expected on Sand Lake Waterfowl Refuge, Columbia, South Dakota"
**** Baird white-footed mouse (*Peromyscus maniculatus*) probably both species of *Peromyscus* spp

(Elsen 1977, Becker 1979, Clark and Willis 1989, Halseth and Willis 1989, Carlson and Berry 1990, Clark *et al.* 1991, USFWS 1992, Berry *et al.* 1993).

Methods

Herptile and fish sampling and inventory occurred throughout the study and in conjunction with other activities. Documented past records of these species were treated as independent observations. Vouchered specimens were prepared for many of the fish and herptile species, and photographs of medium- to large-sized reptiles, amphibians, and fish also were accepted as formal documentation. Herptile species names (Appendix A) followed Banks *et al.* (1987).

Amphibians and Reptiles.

Pitfall traps work well for sampling amphibians and reptiles (Corn 1994) and were checked for herptiles in conjunction with small mammal sampling. Wetland areas often used as herptile breeding sites were visually surveyed (Scott and Woodward 1994). Amphibian larvae were sampled in wetland areas in conjunction with fish sampling since seining, netting, and trapping methods were similar (McDiarmid 1994). Turtle traps (frame and box) were also placed in wetland habitats throughout the refuge and baited with common carp remains.

Members from the Minnesota Herpetological Society assisted in a general herptile survey during 27-29 May 1995, searching in vegetation and under rocks, logs, and other debris. They provided the field identification of the herptile species on SLNWR.

Fish. Fish species from earlier studies were treated as independent observations in this study. Otherwise, fish were captured with barrel minnow traps and bag seines (9 m long x 1.2 m deep x 4.7 mm mesh). Larger species of fish were sampled with hoop or fyke nets, both with and without leads. Traps were placed selectively throughout wetland habitats on the refuge.

Results and Discussion

Amphibians and Reptiles. No historical, quantitative records of herptiles on the refuge exist. Past refuge personnel only mentioned seasonal sightings in quarterly narrative reports. For the state of South Dakota, the only historical data on herptile occurrence were compiled by Over (1943). This document contains only qualitative and anecdotal distributional accounts of amphibians and reptiles (Table 20).

Table 20. Reptiles and amphibians of Sand Lake National Wildlife Refuge, Brown County, South Dakota, and neighboring counties.

Species	*Survey (1996)*	*Over (1943)**	*Becker (1979)***
Caudata			
Mudpuppy			x
Tiger salamander	x	x	x
Anura			
Canadian toad	x		x
Woodhouse's toad		x	
Great plains toad	x	x	x
Western chorus frog	x		x
Cricket frog		x	x
Gray tree frog			x
Northern leopard frog	x	x	x
Testudines			
Snapping turtle	x	x	x
Western painted turtle	x	x	x
Squamata			
Northern prairie skink	x	x	x
Northern red-bellied snake	x	x	x
Plains garter snake	x	x	x
Red-lined garter snake		x	x
Bull snake		x	
Western smooth green snake		x	x
Eastern hognose snake		x	

* Over (1943) listed herptile occurrence for the state, observations from neighboring counties are included here.

** Becker (1979) listed species in neighboring Day, Marshall, and Roberts counties.

Many species of amphibians and reptiles may be restricted because of the northerly location of SLNWR in the U.S. (Becker 1979). SLNWR is also located between distributional boundaries of many herptiles. However, the James River and its tributaries may provide a suitable dispersal corridor for many herptile and fish species.

During this study, 10 species of herptiles representing four orders were found on SLNWR (Table 20). Tiger salamanders were found in wetland areas throughout the refuge. They were readily captured in barrel minnow traps, seine hauls, and pitfall traps and were commonly seen crossing roads, especially after rains in summer.

Four species of frogs and toads–Canadian toads, Great Plains toads, western chorus frogs, and northern leopard frogs–were commonly seen or captured on the refuge. These four species are common in South Dakota and have been known to occur in the eastern half of the state (Sharps and Benzon 1984).

Two species of turtles were found on SLNWR: the snapping turtle and the western painted turtle. Both species have statewide distribution (Sharps and Benzon 1984).

The western painted turtle occurred commonly in wetland habitats, and individuals were often seen basking along shores and on fallen trees. Snapping turtles were less common; one was seen at the Hecla Recreation Area. Refuge personnel report that very few snapping turtles are seen on the refuge.

One skink species and two snake species were found on SLNWR. The northern prairie skink was seen only occasionally near an abandoned railroad track on the southeastern part of the refuge, an area characterized by very sandy soils. The skink was found by systematically searching under rocks and logs, and it was captured in pitfall traps near such objects. Sharps and Benzon (1984) showed the prairie skink only in the eastern half of the state.

Only one snake is common to the refuge: the plains garter snake, and it is commonly seen throughout the refuge. Its distribution is statewide (Sharps and Benzon 1984).

A northern red-bellied snake was captured west of the Houghton Dam. It is listed as a state-threatened species for South Dakota (Sharps and Benzon 1984), but this may be more of an artifact of low report rates

than of the snake's rare distribution in eastern counties. For example, road-killed red-bellied snakes were found near Waubay NWR, Day County, and in Brookings County (K. Higgins, pers comm, SDSU, Brookings).

Two snakes of possible occurrence on SLNWR are the western smooth green snake and the bullsnake. Green snake sightings were mentioned in narrative refuge reports (SLNWR 1958), and bullsnakes have been seen or captured a few kilometers east (S. Glup, pers comm, USF&WS, Columbia, S.D.) and west (E. Podoll, pers comm, Columbia, S.D.) of the refuge.

Becker (1979) compiled accounts for herptiles in a technical paper for the James River. Species which have been found in Brown County and in neighboring Day, Marshall, and Roberts counties are listed in Table 20. The only herptile listed by Becker (1979) which was not found on the refuge during this study was the cricket frog.

Fish. Much more research has been conducted on James River and SLNWR fish populations than on the herptiles. Churchill and Over (1933) and Bailey and Allum (1962) provided early fish accounts for the area. Fifty-nine fish species have been reported in the James River drainage (Becker 1979), with the majority occurring in the southern reaches of the watershed. Thirty species have been collected during other studies in the James River around SLNWR (Becker 1979) (Table 21). Sixteen fish species were collected at SLNWR during The present study (Table 21).

The fish community of the James River has changed very little over the past 100 years (Berry *et al.* 1993). Many of the fish in the river, such as the common carp and walleye, represent species found in surrounding lakes (Berry *et al.* 1993).

Increasingly high water levels at the refuge have influenced the on-site fishery immensely, creating suitable habitat for many sport fish. Northern pike and walleye are among the most sought-after sport fish species in the system.

In "normal" water years, winterkill is used as a management technique to control black bullhead and common carp populations. Winterkill also reduces other local fish abundances.

Table 21. Fish species which have been surveyed in the James River and at Sand Lake National Wildlife Refuge, Brown County, South Dakota.

Species	*Survey (1996)*	*Refuge files*	*Bailey and Allum (1962)*	*Elsen (1977)*
Lepisosteiformes				
Shortnose gar	x			
Salmoniformes				
Northern pike	x	x	x	x
Cypriniformes				
Common carp	x	x	x	x
Brassy minnow	x			
Golden shiner			x	
Common shiner		x		
Spottail shiner		x		
Red shiner		x		
Sand shiner	x	x	x	
Fathead minnow	x	x	x	x
Creek chub			x	
River carpsucker		x		
White sucker		x	x	x
Bigmouth buffalo	x	x	x	x
Siluriformes				
Black bullhead	x	x	x	x
Channel catfish	x	x		
Tadpole madtom	x	x		
Gasterosteiformes				
Brook stickleback	x	x		x
Perciformes				
Green sunfish		x	x	x
Pumpkinseed			x	
Orangespotted sunfish	x	x		
Bluegill			x	
Smallmouth bass	x			
Largemouth bass		x	x	x
White crappie		x		
Black crappie		x	x	x
Iowa darter	x	x	x	
Johnny darter		x	x	
Yellow perch	x		x	x
Walleye	x	x		x
Total Species	16	22	17	12

Historical Changes in Flora and Fauna at SLNWR

Prior to refuge establishment, the James River had been referred to as a "meandering lake" with very slow discharge rates. Early maps of the area show only one substantial body of water, Sand Lake. The surrounding area was shown as mostly wetland habitat with a meandered river channel. During all early accounts there was no mention of Mud Lake.

Before the refuge was established in 1935, land use in the area was primarily native pasture and cropland (Wm. Schultze, pers comm, USF&WS, Columbia, S.D.). However, in the 1930s the area was devastated by wind erosion magnified by a combination of drought, extensive agricultural land use, and fine soil types (USDA 1993). Conservation efforts, such as the shelterbelt program (established in 1937 by South Dakota Soil Conservation District Law), began during this period (USDA 1993).

Executive Order 7169 established the SLNWR in 1935 as a "refuge and breeding ground for migratory birds and other wildlife." Active management in the form of low head dam construction began in 1937 with the initiation of the Mud Lake Dam project. In 1938, construction began on the Columbia Dam. Both dams were completed in June 1939. Numerous control structures were also built at different locations on the refuge to enhance waterfowl production, and many dike systems and nesting islands were constructed. These early management strategies have changed the landscape of the refuge to what it is today.

Vegetation has greatly changed since refuge establishment. Refuge narratives (1936) document efforts to propagate bulrush (*Scirpus* spp), burreed (*Sparganium eurycarpum*), and duck potato (*Sagittaria* spp). To transplant these wetland plants to different locations on the refuge, there must have been an on-site source. However, at present very little *Scirpus* or burreed occur on SLNWR.

Shelterbelt planting was a priority during early refuge establishment. Photographs from 1936 show no trees. However, by 1937, Civilian Conservation Corps (CCC) workers had established nearly 1.5 million seedlings in tree nurseries that would be used as wildlife food and cover (SLNWR 1937). During the entire time the CCC crews worked at SLNWR, nearly 500,000 trees were planted, including Russian olive (*Eleagnus angustifolia*), Siberian elm (*Ulmus pumila*), cottonwood (*Populus deltoides*), green ash, American elm (*Ulmus americana*), Tatarian honeysuckle (*Lonicera tatarica*), and honey locust (*Gleditsia triacanthos*).

Early refuge managers apparently collected biological data on the refuge in the form of cover maps and vegetative classifications. About 2,000 plant specimens had been collected for the herbarium. Unfortunately this information and the plant collection no longer exist.

Perhaps the most obvious floral change on the refuge came with the conversion of terrestrial habitats. Prior to refuge establishment, the primary terrestrial habitat was wet meadow, often used for hay by landowners. Native prairie pasturelands were also evident. Refuge narratives state that seeds were collected from native plants including buckbrush (*Symphoricarpos* spp). This suggests the presence of native upland areas prior to conversion and invasion by tame grasses.

All of these vegetational changes have restricted or in some instances enhanced certain vertebrate species occurrences on the refuge.

One bird species which has been extirpated from the refuge but is still present in low numbers in the Hecla Sandhills east of the refuge is the greater prairie chicken. In narratives from 1938, managers stated that there are "splendid concentrations of prairie chickens...." By 1944 there was no mention of this species nesting or wintering on the refuge. Refuge managers recognized this decline: "it is believed that when more of the land reverts to native vegetation that then and only then will we see a material increase of (prairie chickens)" (SLNWR 1938-39).

Some native bird species that were common nesters in the 1940s were not found nesting on SLNWR during this study. The short-eared owl was the most abundant nesting owl, and the northern harrier was the most abundant nesting raptor. Upland nesting shorebirds such as willets and marbled godwits commonly nested on the refuge in "typical prairie nesting cover" (SLNWR 1938). Of all these species, only the northern harrier was seen during this study, and then only occasionally.

Lack of native cover was recognized by early managers as a potential problem for endemic bird species. Managers wrote that "we will not have an increase in native upland (birds) on this refuge so long as we continue the encouragement of exotic birds by so much farming" (SLNWR 1939).

Native vegetation fragmentation resulted in an increase in bird species diversity on the refuge. The brown-headed cowbird became established. Populations of eastern and western kingbirds, orchard orioles, brown thrashers, and catbirds also increased when woodland habitat increased.

Endemic grassland species, including the sharp-tailed sparrow and LeConte's sparrow, also were rather numerous.

Wetland birds have remained relatively static throughout refuge history. However, upland nesting shorebirds have declined drastically. Species recently increasing in abundance include the exotic cattle egret, first observed on the refuge in 1961. Nesting was first documented in 1977. Presently, an estimated 1,000 cattle egrets nest on the refuge.

American white pelicans and double-crested cormorants historically have nested on the refuge. With destruction of islands and lack of suitable nesting substrates, these species have declined in abundance although they still are found nesting. The double-crested cormorant currently nests in trees throughout the refuge.

Herptiles on the refuge were seldom documented in past refuge narratives. A record of a female garter snake was the first herp record. A "grass snake" was mentioned on two occasions. In 1958, it was reported that a few snapping turtles were seen. Fish species have generally benefited from permanent water sources on SLNWR, and species diversity remains somewhat similar to that at refuge establishment.

Management Recommendations

Historically, management on the refuge has included tree plantings, fire suppression, haying, predator control, agricultural operations, wetland vegetation planting, and artificial island building (SLNWR narratives 1939-1941).

At present, SLNWR implements somewhat different management strategies: water level manipulations, prescribed burning (both wetlands and uplands), shrub planting, crop cultivation, cooperative farming programs, seeding of native grasslands, grazing, haying, and biological pest control (noxious leafy spurge [*Euphorbia esula*] control by domestic sheep grazing and Canada thistle [*Cirsium arvensis*] control by thistle weevils [*Ceutrorhynchus litura*]) (SLNWR 1990).

SLNWR, with its uplands and interspersion of emergent vegetation and water, now represents a dynamic prairie marsh ecosystem (SLNWR 1990). However, the refuge is also an insular ecosystem surrounded by vast tracts of tilled soil and cultivated agricultural lands.

Active management such as haying and grazing changes the floral community and in turn affects faunal associations. Such practices should be carefully mapped out in advance to provide a mosaic of habitat types and successional patterns for a variety of vertebrate life history needs.

An attempt should be made to reduce encroachment of woody species into idled grasslands. This will provide grassland habitat for several species of nesting birds, small mammals, and herptiles. Tame grassland communities should be managed by burning and/or grazing. These measures mimic natural processes better than other options; however, they should be timed to avoid avian breeding and nesting seasons.

Cultivated agricultural lands benefit nongame wildlife less than do native habitats, especially when biodiversity is a goal. When possible these areas should be reverted to native grasslands to provide habitat for prairie endemic species.

The variety of habitats which enables high species diversity on the refuge is the result of fragmentation of primary habitat types. However, a checkered pattern of habitats prohibits certain endemic populations from inhabiting the refuge. Large, contiguous blocks of single habitat types in a mosaic pattern to meet life history requirements of nongame vertebrates should be provided if conservation or enhancement of biodiversity is a management goal.

Nongame vertebrate populations should be closely and regularly monitored. Monitoring techniques for nongame birds are well standardized. Pitfall traps effectively capture nongame small mammals, requiring little time to place and being useful in different habitats. They may be very nearly permanent installations. Formalin may be a better option than water as a killing solution because it preserves the specimens and requires less frequent monitoring. Pitfall traps will also capture nongame herptiles.

Baseline data collected during this study will facilitate better-informed management of nongame species on SLNWR. However, to further understand species:habitat associations, more research should be conducted on nongame animal responses to management practices.

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Appendix A

Complete vertebrate list of resident and breeding species at Sand Lake National Wildlife Refuge

Sand Lake NWR possesses habitat for many different species of vertebrates. The following list includes all of the resident and breeding vertebrates on the refuge inclusive of the past two decades. This comprehensive list includes 5 classes, 32 orders, 160 genera, and 202 species of which 6 were amphibian, 5 reptile, 127 bird, 34 mammal, and 30 fish species. This complete list of vertebrates includes observations made from this inventory, refuge narratives and trapping records, personal communications, and other independent observers. Taxonomic order and names follow Banks *et al.* (1987).

Class **Amphibia**

- Order Caudata
  - Mudpuppy (*Necturus maculosus*)
  - Tiger salamander (*Ambystoma tigrinum*)
- Order Anura
  - Great Plains toad (*Bufo cognatus*)
  - Canadian toad (*B. hemiophrys*)
  - Western chorus frog (*Pseudoacris triseriata*)
  - Northern leopard frog (*Rana pipiens*)

Class **Reptilia**

- Order Testudines
  - Snapping turtle (*Chelydra serpentina*)
  - Western painted turtle (*Chrysemys picta*)
- Order Squamata
  - Northern prairie skink (*Eumeces septentrionalis*)
  - Northern red-bellied snake (*Storeria occipitomaculata*)
  - Plains garter snake (*Thamnophis radix*)

Class **Aves**

- Order Podicepidiformes
  - Western grebe (*Aechmophorus occidentalis*)
  - Clark's grebe (*A. clarkii*)
  - Eared grebe (*Podiceps nigricolis*)
  - Pied-billed grebe (*Podylimbus podiceps*)
- Order Pelicaniformes
  - American white pelican (*Pelecanus erythrocephalus*)
  - Double-crested cormorant (*Phalacrocorax auritus*)
- Order Ciconiformes
  - Great blue heron (*Ardea herodias*)
  - Great egret (*A. alba*)
  - American bittern (*Botaurus lentiginosus*)
  - Cattle egret (*Bubulcus ibis*)
  - Green-backed heron (*Boturides striatus*)
  - Little blue heron (*Egretta caerulea*)
  - Snowy egret (*E. thula*)
  - Least bittern (*Ixobrychus exilis*)
  - Black-crowned night-heron (*Nycticorax nycticorax*)
  - White-faced ibis (*Plegadis chihi*)
- Order Anseriformes
  - Wood duck (*Aix sponsa*)
  - Northern pintail (*Anas acuta*)
  - American wigeon (*A. americana*)
  - Northern shoveler (*A. clypeata*)
  - Green-winged teal (*A. crecca*)
  - Blue-winged teal (*A. discors*)
  - Mallard (*A. platyrhyncos*)
  - American black duck (*A. rubripes*)
  - Gadwall (*A. strepera*)
  - Lesser scaup (*Aythya affinis*)
  - Redhead (*A. americana*)
  - Canvasback (*A. vallisineria*)
  - Canada goose (*Branta canadensis*)
  - Bufflehead (*Bucephala albeola*)
  - Hooded merganser (*Lophodytes cucullatus*)
  - Ruddy duck (*Oxyura jamaicensis*)
- Order Falconiformes
  - Cooper's hawk (*Accipiter cooperii*)
  - Sharp-shinned hawk (*A. striatus*)
  - Red-tailed hawk (*Buteo jamaicensis*)
  - Swainson's hawk (*B. swanisoni*)
  - Northern harrier (*Circus cyaneus*)
  - American kestrel (*Falco sparverius*)
- Order Galliformes
  - Ring-necked pheasant (*Phasianus colchicus*)
  - Sharp-tailed grouse (*Tympanuchus phasianellus*)
  - Gray partridge (*Perdix perdix*)
- Order Gruiformes
  - American coot (*Fulica americana*)
  - Common moorhen (*Gallinula chloropus*)

- Sora (*Porzana carolina*)
- Virginia rail (*Rallus limicola*)

Order Charadriifomes

- Killdeer (*Charadrius vociferus*)
- Upland sandpiper (*Bartramia longicauda*)
- Spotted sandpiper (*Actitis macularia*)
- Willet (*Catoptrophorus semipalmatus*)
- Marbled godwit (*Limosa fedoa*)
- American avocet (*Recurvirostra americana*)
- Wilson's phalarope (*Phalaropus tricolor*)
- Ring-billed gull (*Larus delawarensis*)
- Franklin's gull (*L. pipixcan*)
- Black tern (*Chlidonias niger*)
- Forster's tern (*Sterna forsteri*)
- Common tern (*S. hirundo*)

Order Columbiformes

- Rock dove (*Columba livia*)
- Mourning dove (*Zenaida macroura*)

Order Cuculiformes

- Yellow-billed cuckoo (*Coccyzus americanus*)
- Black-billed cuckoo (*C. erythropthalmus*)

Order Strigiformes

- Long-eared owl (*Asio otus*)
- Short-eared owl (*A. flammeus*)
- Eastern screech owl (*Otus asio*)
- Great horned owl (*Bubo virginianus*)

Order Caprimulgiformes

- Common nighthawk (*Chordeiles minor*)

Order Apodiformes

- Chimney swift (*Chaetura pelagica*)

Order Coraciiformes

- Belted kingfisher (*Ceryle alycon*)

Order Piciformes

- Northern flicker (*Colaptes auratus*)
- Red-headed woodpecker (*Melanerpes erythrocephalus*)
- Downy woodpecker (*Picoides pubescens*)
- Hairy woodpecker (*P. villosus*)

Order Passeriformes

- Eastern wood-pewee (*Contopus virens*)
- Least flycatcher (*Empidonax minimus*)
- Willow flycatcher (*E. traillii*)
- Eastern phoebe (*Sayornis phoebe*)
- Eastern kingbird (*Tyrannus tyrannus*)
- Western kingbird (*T. vericalis*)
- Horned lark (*Eremophila alpestris*)
- Cliff swallow (*Hirundo pyrrhonota*)
- Barn swallow (*H. rustica*)
- Purple martin (*Progne subis*)
- Bank swallow (*Riparia riparia*)
- Northern rough-winged swallow (*Stelgidopteryx serripennis*)
- Tree swallow (*Tachycineta bicolor*)
- American crow (*Corvus brachyrhynchos*)
- Blue jay (*Cyanocitta cristata*)
- Black-capped chickadee (*Parus atricapillus*)
- White-breasted nuthatch (*Sitta carolinensis*)
- Marsh wren (*Cistothorus palustris*)
- Sedge wren (*C. platensis*)
- House wren (*Troglodytes aedon*)
- American robin (*Turdus migratorius*)
- Eastern bluebird (*Sialia sialis*)
- Gray catbird (*Dumetella carolinensis*)
- Brown thrasher (*Toxostoma rufum*)
- Cedar waxwing (*Bombycilla cedrorum*)
- Loggerhead shrike (*Lanius ludovicianus*)
- European starling (*Sturnus vulgaris*)
- Warbling vireo (*Vireo gilvus*)
- Red-eyed vireo (*V. olivaceous*)
- Yellow warbler (*Dendroica petechia*)
- Common yellowthroat (*Geothylpis trichas*)
- Dickcissel (*Spiza americana*)
- Sharp-tailed sparrow (*Ammodramus caudacutus*)
- LeConte's sparrow (*A. leconteii*)
- Grasshopper sparrow (*A. savannarum*)
- Chestnut-collared longspur (*Calcarius ornatus*)
- Lark sparrow (*Chondestes grammacus*)
- Swamp sparrow (*Melospiza georgiana*)
- Song sparrow (*M. melodia*)
- Savannah sparrow (*Passerculus sandwichensis*)
- Vesper sparrow (*Pooecetes gramineus*)
- Clay-colored sparrow (*Spizella pallida*)
- Field sparrow (*S. pusilla*)
- Red-winged blackbird (*Agelaius phoeniceus*)
- Bobolink (*Dolichonyx oryzivorus*)
- Brewer's blackbird (*Euphagus cyanocephalus*)
- Northern oriole (*Icterus galbula*)
- Orchard oriole (*I. spurius*)
- Brown-headed cowbird (*Molothrus ater*)
- Common grackle (*Quiscalus quiscula*)
- Western meadowlark (*Sturnella neglecta*)
- Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)
- American goldfinch (*Carduelis tristis*)
- House finch (*Carpodacus mexicanus*)
- House sparrow (*Passer domesticus*)

Class **Mammalia**

- Order Marsupialia
  - Virginia opossum (*Didelphis virginianus*)
- Order Insectivora
  - Northern short-tailed shrew (*Blarina brevicauda*)
  - Masked shrew (*Sorex cinereus*)
- Order Chiroptera
  - Hoary bat (*Lasiurus cinereus*)
- Order Carnivora
  - Coyote (*Canis latrans*)
  - Red fox (*Vulpes vulpes*)
  - Raccoon (*Procyon lotor*)
  - Long-tailed weasel (*Mustela frenata*)
  - Least weasel (*M. nivalis*)
  - Mink (*M. vison*)
  - Badger (*Taxidea taxus*)
  - Striped skunk (*Mephitis mephitis*)
  - Spotted skunk (*Spilogale putorius*)
- Order Artiodactyla
  - White-tailed deer (*Odocoileus virginianus*)
- Order Rodentia
  - Woodchuck (*Marmota monax*)
  - Fox squirrel (*Sciurus niger*)
  - Franklin's ground squirrel (*Spermophilus franklinii*)
  - Richardson's ground squirrel (*S. richardsonii*)
  - Thirteen-lined ground squirrel (*S. tridecemlineatus*)
  - Plains pocket gopher (*Geomys bursarius*)
  - Northern pocket gopher (*Thomomys talpoides*)
  - Plains pocket mouse (*Perognathus flavescens*)
  - Beaver (*Castor canadensis*)
  - Northern grasshopper mouse (*Onychomys leucogaster*)
  - White-footed mouse (*Peromyscus leucopus*)
  - Deer mouse (*P. maniculatus*)
  - Western harvest mouse (*Reithrodontomys megalotis*)
  - Meadow vole (*Microtus pennsylvanicus*)
  - Muskrat (*Ondatra zibethicus*)
  - House mouse (*Mus musculus*)
  - Norway rat (*Rattus norvegicus*)
  - Meadow jumping mouse (*Zapus hudsonius*)
  - White-tailed jackrabbit (*Lepus townsendii*)
  - Eastern cottontail (*Sylvilagus floridanus*)

Class **Osteichthyes**

- Order Lepisosteiformes
  - Shortnose gar (*Lepisosteus platostomus*)
- Order Salmoniformes
  - Northern pike (*Esox lucius*)
- Order Cypriniformes
  - Common carp (*Cyprinus carpio*)
  - Brassy minnow (*Hybognathus hankinsoni*)
  - Golden shiner (*Notemigonus crysoleucas*)
  - Common shiner (*Luxilus cornutus*)
  - Spottail shiner (*Notropis hudsonius*)
  - Red shiner (*Cyprinella lutrensis*)
  - Sand shiner (*Notropis stramineus*)
  - Fathead minnow (*Pimephales promelas*)
  - Creek chub (*Semotilus atromaculatus*)
  - River carpsucker (*Carpiodes carpio*)
  - White sucker (*Catostomus commersoni*)
  - Bigmouth buffalo (*Ictiobus cyprinellus*)
- Order Siluriformes
  - Black bullhead (*Ameiurus melas*)
  - Channel catfish (*Ictalurus punctatus*)
  - Tadpole madtom (*Noturus gyrinus*)
- Order Gasterosteiformes
  - Brook stickleback (*Culaea inconstans*)
- Order Perciformes
  - Green sunfish (*Lepomis cyanellus*)
  - Pumpkinseed (*L. gibbosus*)
  - Orangespotted sunfish (*L. humilis*)
  - Bluegill (*L. macrochirus*)
  - Smallmouth bass (*Micropterus dolomieu*)
  - Largemouth bass (*M. salmoides*)
  - White crappie (*Pomoxis annularis*)
  - Black crappie (*P. nigromaculatus*)
  - Iowa darter (*Etheostoma exile*)
  - Johnny darter (*E. nigrum*)
  - Yellow perch (*Perca flavescens*)
  - Walleye (*Stizostedion vitreum*)

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