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Habitat Preferences and Food Habits of Striped Skunks in Eastern South Dakota

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HABITAT PREFERENCES AND FOOD HABITS OF STRIPED SKUNKS IN EASTERN SOUTH DAKOTA

By

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IN EASTERN SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

HABITAT PREFERENCES AND FOOD HABITS OF STRIPED SKUNKS IN EASTERN SOUTH DAKOTA

Abstract

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Habitat preferences of striped skunks (Mephitis mephitis) in Brookings County, South Dakota, were determined from the relationship of nighttime roadside indices to 25 habitat variables of 277, 1-square mile plots. Winter tracking was also conducted. Skunks were collected on the study area in 1972-73, and contents of 59 stomachs and 63 colons were studied to determine food habits. Indices of prey abundance in different habitat types were obtained from snap-trap surveys.

The 25 variables accounted for 14.9 percent of the variation in skunk numbers. The relationships of three of these variables to skunk numbers were significant ($P < 0.05$). The significant variables and the variation accounted for by each were: (a) number of areas of idle grassland, 6.3 percent; (b) number of rockpiles, 1.5 percent; and (c) acreage of idle grassland, 1.3 percent. Idle grasslands were the main activity centers of skunks tracked during the winter. Food habits were analyzed for the periods March-April, May-June, July-August, and September-November. Insects were the most frequently found food item in all time periods except March-April, during which mammals occurred more frequently. Mammals made up the largest volume of food in March-April and May-June.

Amphibians made up the greatest volume in July-August, while amphibians, mammals, and insects were found in nearly equal volumes in September-November. Bird remains occurred during all time periods. Eggs were found in May-June and July-August. Meadow voles (Microtus spp.), the most frequent mammalian food item during all time periods, were common only in habitat types having heavy residual cover.

Idle grassland is an important nesting cover for gamebirds and waterfowl. Since the number of areas of this cover type apparently has a stronger relationship with skunk numbers than its total acreage, grassland nesting cover might best be managed in large, homogeneous blocks. Areas managed in this way would probably support lower skunk densities than more diverse areas containing equal acreages of idle grassland, thus reducing nest predation by skunks. Skunk control programs should be most efficient when centered around idle grassland and rockpiles.

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INTRODUCTION

This study was initiated in 1972 to determine food habits and habitat preferences of the striped skunk (Mephitis mephitis)[1] in eastern South Dakota. Skunks were valued as furbearers earlier in this century, but interest now is centered around the more undesirable attributes of its predatory habits, and its role in the transmission of rabies to man and domestic animals. Trautman (1971) found that reduction of skunk, badger (Taxidea taxus), raccoon (Procyon lotor), and red fox (Vulpes fulva) numbers on 3, 100-square-mile study areas in eastern South Dakota was followed by a 94-percent increase in pheasant (Phasianus colchicus)[2] numbers compared with populations on associated check areas. Kalmbach (1938) reported that removal of 423 skunks from the Lower Souris National Wildlife Refuge in North Dakota resulted in an increase in duck nesting success of 15 percent, from 54 to 69 percent. Other studies have shown that skunk predation is a major factor in the destruction of pheasant nests in South Dakota (Kimball 1948; Trautman 1960).

That skunks are a major source of rabies outbreaks in the midwest has been documented by Verts (1969:158) and Jacobson (1969).

Wildlife biologists are interested in developing practical methods of controlling skunk populations. Use of strychnine-treated eggs is effective in reducing skunk populations over large areas

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[1] Scientific names of mammals according to Hall and Kelson (1959).

[2] Names of birds from American Ornithologists' Union Checklist (1957).

(Trautman 1971), but the use of such poisons leads to environmental and health hazards which make them undesirable (Advisory Committee on Predator Control 1972). Chesness et al. (1968) found that intensive trapping by state-employed trappers was an effective means of skunk control on a 4-square-mile study area in Minnesota, but if practiced on a statewide basis, costs would be prohibitive.

South Dakota, as well as other states, has undertaken an extension trapper program. This program is designed to instruct landowners in techniques to control predator damage on their own land and at their own expense. This program relies mainly on the use of steel traps, a method that many landowners consider too time consuming to be effective. This is especially true when dealing with predators such as skunks that have little effect on the landowner's income.

Another potential means of controlling excessive skunk populations is the use of chemosterilants. Initial attempts at controlling skunk populations with chemosterilants were unsuccessful (Storm and Sanderson 1969), but if an effective chemosterilant and baiting technique can be developed, it could probably be effectively incorporated into an extension trapper program.

An alternate approach to control of a skunk population is to manage habitat and make an area unattractive to them. Habitat changes would affect skunk populations longer than any of the control methods mentioned above. Habitat relationships of skunks have been studied in Illinois by Verts (1967:75-92) and Storm (1972), in eastern Minnesota by Houseknecht (1971), and in Kansas by Shirer and

Fitch (1970). No extensive studies of skunk habitat relationships have been conducted in eastern South Dakota.

Knowledge of an animal's food habits is important in understanding its habitat requirements and preferences. Food habits of striped skunks have been studied in Illinois by Verts (1967:68-74), in Maryland by Llewellyn and Uhler (1952), in New York by Hamilton (1936), in Iowa by Selko (1937), and in California by Dixon (1925). As is the case with habitat studies, quantitative studies of the skunk's food habits have not been conducted in South Dakota.

DESCRIPTION OF STUDY AREA

Brookings County, an area of 801 square miles in eastern South Dakota, was the study area. The entire county is situated on an upland area known as the Coteau des Prairies, with elevations from 1600 to 1800 feet. The climate is continental, with temperatures of 0 F and below common between December and March, while temperatures of 90 F or above can be expected in July and August. Precipitation averages 21.6 inches annually, with the heaviest amounts occurring as rain in May and June. Annual precipitation varies widely, and drought conditions occur periodically (Westin et al. 1959).

The topography and soils of the county are glacial in origin. The central part of the county is of low relief and well drained. The western one-third and northeast corner are characterized by much stronger relief which includes many closed depressions with poorly developed surface drainage. Soils in the county belong to the Regosol, Chernozem, Humic Gley, and Soloth great soil groups (Westin et al. 1959).

The area was once covered by mid- and tall-grass prairie, with wooded areas occurring along major streams and some wetlands. About 88 percent of the area is now devoted to agriculture (Table 1). Tree plantings for windbreak purposes now occur throughout the county.

Predatory mammals found on the study area are striped skunks, spotted skunks (Spilogale putorius), badgers, mink (Mustela vison), long-tailed weasels (Mustela frenata), raccoons, red fox, and coyotes (Canis latrans). Medium-sized mammals in the area include white-tailed

Table 1. Cover types and land use on 277, 1-square-mile plots on the Brookings County Study Area, 1973.

Cover Type or Land Use	Percent of Area
Cropland	61.9
Pasture	17.8
Alfalfa	8.5
Native Hay	1.2
Wetlands	2.5
Idle grassland	3.0
Woodland	2.1
Other	3.0

jackrabbits (Lepus townsendii), cottontails (Sylvilagus floridanus), Richardson's ground squirrels (Citellus richardsonii), thirteen-lined ground squirrels (Spermophilus tridecemlineatus), Franklin's ground squirrels (Spermophilus franklinii), fox squirrels (Sciurus niger), and plains pocket gophers (Geomys bursarius). Small mammals commonly found are meadow voles (Microtus pennsylvanicus), deer mice (Peromyscus maniculatus), and short-tailed shrews (Blarina brevicauda). Less common, but also found, are prairie voles (Microtus ochrogaster), white-footed mice (Peromyscus leucopus), meadow jumping mice (Zapus hudsonium), house mice (Mus musculus), northern grasshopper mice (Onychomys leucogaster), and masked shrews (Sorex cinereus).

The leopard frog (Rana pipiens)[1] and toad (Bufo spp.) are the most common amphibians, and the garter snake (Thamnophis spp.) is the most common snake in the area.

Ground-nesting birds are common in the area. Resident game birds include the pheasant and gray partridge (Perdix perdix). Several species of ducks also nest in the area, the most common being the mallard (Anas platyrhynchos) and the blue-winged teal (Anas discors). The most common raptors are great horned owls (Bubo virginianus), red-tailed hawks (Buteo jamaicensis), and marsh hawks (Circus cyaneus).

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[1] Scientific names of amphibians and reptiles according to Stebbins (1966).

METHODS

Habitat Preference

Nightlighting index.— Jacobson (1969) concluded that roadside counts conducted by nightlighting provided reliable indices of striped-skunk populations. In my study, nightlighting was used to obtain population indices to compare with habitat features measured on each of 277, 1-square mile plots in Brookings County. Nightlighting was conducted on 1 mile of roadway bissecting each plot, and the density index used for that plot was the total number of skunks seen on that length of road. Each plot was sampled an equal number of times, and it was assumed that the number of skunks seen on each mile was proportionate to the total number of skunks that included portions of that section in their home range.

The 277 sections sampled were located along eight transects consisting of east-west roads crossing Brookings County. The transects were spaced at 3-mile intervals. Major highways were avoided when possible to reduce traffic interference.

Roadside counts were made by two observers traveling the transects during the night in a vehicle at a speed of 30 mph. All skunks observed on the roadway were included in the counts. No attempt was made to observe skunks off the roadway with spotlights, since such observations would have been influenced by the density of roadside cover. The location of each sighting was recorded, and when possible skunks were shot to obtain samples for the food-habits study.

Four of the eight transects were driven each night that night-lighting was conducted. Routes were driven in an alternating systematic order to minimize time-related differences in activity patterns of skunks.

Twenty-five habitat variables in 14 cover types were measured on each of the 277 sections sampled (Table 2). Cover types measured included all land except that under cultivation. Locations and boundaries of each cover type were determined in the field and sketched on copies of aerial photos. Acreages of each cover type were determined with a compensating polar planimeter. All mapping was conducted in May and June of 1973.

Winter tracking.— A combination of fresh, unblown snow and thawing temperatures during the daytime occurred between 18 February and 20 February 1973. Skunks were tracked in two areas during that time period to locate winter dens and to observe movement patterns. The first area centered around a CAP (Cropland Adjustment Program) field of idle-grassland cover. The second was a 12-square-mile block in central Brookings County where an attempt was made to locate all active skunk dens. In the latter area, all roads were driven and skunk tracks that were seen from the road were followed as far as possible or until a den was found. All vacant farms and other areas that appeared to be potential den sites were searched for tracks.

Table 2. Description of the 14 cover types that were used to analyze habitat preferences by skunks and the variable numbers assigned to each cover type.

Cover Type	Description of Cover Type	Variable Number Assigned to Number of Areas	Variable Number Assigned to Acreage
Fence row	Idle cover associated with a fence. Fence rows grazed on both sides and those next to roads not included.	X1	X2
Railroad right-of-way	Land associated with railroads not used for agriculture	X3	X4
Idle grassland	Grassland areas showing no evidence of grazing, haying, or other agricultural use during the current or previous year.	X5	X6
Woodland	Any area having an overstory of trees, including both grazed and ungrazed woodlands.	X7	X8
Occupied farmstead	Land associated with buildings currently occupied by humans. Area measured was that encompassed by buildings.	X9	X10
Rockpile	Piles of rocks and boulders cleared from agricultural land	X11	--
Roadside	Roadside cover. One unit was one-half mile of cover on one side of the road.	X12	--
Wetland	Areas containing open water and/or emergent forms of vegetation but not including streams.	X13	X14

Table 2. (continued)

Cover Type	Description of Cover Type	Variable Number Assigned to Number of Areas	Variable Number Assigned to Acreage
Streams	Channels with water present	X15	--
Pasture	Grassland areas presently being used for grazing livestock, or showing evidence of such use the previous year.	X16	X17
Native hay	Grassland areas dominated by grasses other than brome which had been cut for hay the previous year.	X18	X19
Tame hay	Stands of brome or alfalfa used for hay.	X20	X21
Gravel pit	Open pits from which sand or gravel had been removed.	X22	X23
Vacant farmstead	Land associated with buildings not currently occupied by humans. Area measured was that encompassed by buildings.	X24	X25

Food Habits

The food habits portion of the study consisted of determining prey abundance and skunk food habits at different seasons by examination of digestive tracts.

Prey abundance.— Snap-trap surveys of small mammals and frogs were initiated in August, 1972, to compare the abundance of these prey items in different habitat types with their occurrence in the digestive tracts of skunks. Surveys were conducted on four, 160-acre plots, locations of which were chosen at random from the sites of the first 16 skunks collected along the roadside transects. The collection site served as the center point of each plot selected. Four different cover types were sampled on each plot during August-September, 1972; November, 1972; March-April, 1973; and August-September, 1973. These included idle grasslands, alfalfa fields, small-grain fields, corn fields, pastures, tree plantings, summer-fallow fields, fence rows, and road ditches.

The sampling procedure consisted of setting 60 snap-traps baited with peanut butter in each cover type for 3 consecutive days. Traps were placed three to a station, with 20 stations spaced at 30-foot intervals on a straight line through each cover type. The four cover types on each plot were sampled concurrently.

Relative densities of each species were determined from the number of individuals captured per 100 trap-nights. No attempt was made to separate the two species of Microtus and the two species of Peromyscus, since remains of these animals could not be identified to species in the digestive tracts. In the remainder of this paper both species of

Microtus will be referred to as meadow voles and both species of Peromyscus will be referred to as deer mice.

Digestive tract analysis.— Food habits were determined by examining the content of stomachs and colons of skunks killed on the study area during 1972 and 1973. Specimens were obtained by shooting at night, by trapping, and by picking up roadkills on the study area.

Digestive tracts were removed, labeled, placed in plastic bags, and frozen until analyzed. Stomach and colon contents were washed over a fine-mesh sieve to break up food masses and separate individual food items. Contents were then placed in water where light materials, such as feathers and hair, floated and could be separated. Heavier items were placed in a shallow pan and separated by hand. The material was oven dried for 2 hours at 25 C. After drying, items were separated to the lowest taxonomic group for which positive identification could be made. A dissecting microscope was used as needed.

Only stomachs or colons containing food items were used in analysis. Skunk remains and plant materials were frequently found, but these were not considered food items for the purpose of this study. The largest amounts of these items were found in trapped animals, and were believed to have been ingested in attempts to escape. Plant materials in skunks collected while nightlighting or as roadkills never consisted of more than an occasional leaf or blade of grass, and skunk remains in these animals never consisted of more than a few hairs, probably ingested while grooming. Verts (1967:71-74) held similar views on the origin of plant materials and skunk remains found in digestive tracts of trapped animals.

Volumetric measurements of each food item were made to the nearest 0.5 ml in a graduated cylinder. All volumes were recorded, with those under 0.5 ml listed as trace amounts.

Frequency of occurrence of food items in stomachs and colons, and percent volume of stomach contents, were tabulated for four time periods: (1) late winter and early spring (March-April), (2) spring (May-June), (3) summer (July-August), and (4) fall (September-October). Frequency of occurrence of an item was determined by dividing the number of stomachs or colons containing that item by the total number of stomachs or colons analyzed. Percent volume of stomach contents of an item was the volume of that item in all stomachs divided by the total volume of stomach contents.

RESULTS

Habitat Preference

Nightlighting index.— One hundred-two skunks were seen on 8,310 miles of nightlighting on the eight transects. The number of skunks observed on each of the 277 sections sampled ranged from 0 to 5, with a mean of 0.37 skunks per square mile.

Multiple regression was applied to determine to what extent 25 habitat factors (Table 2) could explain variability in the number of skunks per square mile. Number of skunks per square mile was used as the dependent variable (Y), and the size or number of each of the 25 habitat factors were the independent variables (X_1 to X_{25}). All 25 variables together explained 14.9 percent of the variation in skunk numbers. The relationship of three of these factors with the number of skunks per square mile was significant ($P < 0.05$). Together, these three factors accounted for 9.1 percent of the total variation. The significant factors were: (a) X_5 (number of areas of idle grassland), accounting for 6.3 percent of the variation; (b) X_{11} (number of rock-piles), accounting for an additional 1.5 percent of the variation; and (c) X_6 (acres of idle grassland), accounting for 1.3 percent of the variation. The resulting multiple regression equation was:

$$Y = .1034 + .0897X_5 + .0422X_{11} + .0028X_6$$

The source of the remaining 85.1 percent of the variation was not determined. This study provided no means of assessing what portion of this variation was due to sampling error and what was due to additional

unstudied environmental or biological factors affecting skunk densities.

Winter tracking.— Ten dens used by skunks were found during February, 1973. Three dens were located in idle grassland cover of the CAP field (Fig. 1) and one was located 0.5 miles south of the CAP field in a fence row. Seven sets of tracks originating at the latter den site followed the fence row to a grove of trees at the south end of the CAP field. The three dens in the CAP field were located within 100 yards of this same grove of trees. Most tracks originating at the dens led into the trees where skunk tracks formed such a maze that it was impossible to follow a single set. This maze of tracks was centered around the remains of a great horned owl which had been partially eaten (Fig. 2). Two sets of tracks originating at one of the dens were followed about 200 yards through the idle grassland to a low meadow. The meandering of skunk tracks in the meadow indicated that it was a hunting area. While tracking skunks through the idle grassland, I noted that they usually followed vehicle tracks or other pathways.

Six dens were located in the 12-section area; two under vacant buildings, one in a small meadow of idle grassland, one in a fence row adjacent to a stream, one in the ditchbank of a channelized stream, and one on a hill in a grazed pasture.

Nearly all tracks led directly from the dens to what appeared to be hunting grounds. Most of the tracks from the den in the small meadow crossed a grazed pasture and then entered an 80-acre block of idle grassland where most tracks wandered through a low meadow adjacent to a creek. A majority of the tracks originating at the

Fig. 1. Den in idle grassland used by striped skunks during February, 1973.

Fig. 2. Remains of a great horned owl partially eaten by striped skunks.

fence row den followed the fence for 0.5 mile, and then crossed a road into a field of idle grassland. The den located in the ditch bank had a cow path heavily traveled by skunks leading from it to a road 0.4 miles away where the tracks were lost. No tracks deviated more than 10 yards from this path into adjacent pasture and hayland. These results indicated that skunks in this area used a variety of habitat types as sites for winter dens. Idle grasslands appeared to be the main hunting-grounds. Travel between dens and feeding areas tended to be direct, and travel lanes such as fence rows, vehicle tracks, and cow paths were used when available.

Food Habits

Prey abundance.— Meadow voles and deer mice were the most abundant small mammals captured during snap-trap surveys (Tables 3 and 4). Most meadow voles were captured in cover types not presently being used for agricultural purposes (Table 3). A common characteristic of these cover types was the presence of heavy residual vegetation. The number of meadow voles captured each time period dropped sharply between 1972 and 1973 (Table 4).

Deer mice were most abundant in croplands and alfalfa fields; however, they were also found in smaller numbers in all other cover types (Table 3). The highest densities of deer mice were found during the spring trapping period in small-grain stubble that had been plowed in the fall. Numerous holes in the plowing indicated that the mice were living underground in stubble that had been turned over.

Table 3. Small mammals and frogs caught per 100 trap-nights in 9 cover types on the Brookings County Study Area, 1972-73.

Cover Type	Trap Nights	Catch per 100 Trap-Nights				
		Meadow Voles	Deer Mice	Short-Tailed Shrews	Other Mammals[a]	Frogs
Idle grassland	1,440	2.8	0.4	0.2	0.3	0.1
Road ditch	2,880	1.3	1.1	0.5	0.2	0.1
Fence row	720	0.3	0.7	1.2	0.6	0.1
Corn	1,440	0.1	2.4	--	0.1	--
Alfalfa	1,440	0.1	1.8	--	0.7	0.1
Small grain	1,440	--	5.6	--	0.1	0.1
Summer fallow	720	--	2.1	--	--	--
Pasture	720	--	0.8	--	--	0.3
Trees	720	--	1.7	--	--	--

[a]Other mammals included masked shrews, house mice, meadow jumping mice and northern grasshopper mice.

Table 4. Numbers of small mammals and frogs caught during trapping surveys on the Brookings County Study Area, 1972-73.

Species	Number Caught Each Trapping Period				Total
	Summer 1972	Fall 1972	Spring 1973	Summer 1973	
Meadow vole	37	30	4	5	76
Deer mouse	45	53	80	40	218
Short-tailed shrew	6	5	--	14	25
Other mammal[a]	7	4	1	14	26
Frog	11	--	--	--	11

[a]Other mammals included masked shrews, house mice, meadow jumping mice, and northern grasshopper mice.

Short-tailed shrews were found only in those cover types which contained heavy residual cover. Other mammals that were trapped in small numbers included house mice, meadow jumping mice, northern grasshopper mice, and masked shrews.

Frogs and toads appeared to be more abundant in 1972 than 1973. Rainfall during the spring and summer of 1972 was above normal in Brookings County, and areas suitable for frog and toad breeding were widespread. The spring and summer of 1973 were drier, but many water areas still provided frog and toad habitat. During both 1972 and 1973, frogs were the animal most commonly observed while nightlighting. In 1973, almost all frogs observed during nightlighting operations were in the vicinity of wetlands, and none were taken in snap traps. This is in contrast to 1972 when many frogs were seen in upland areas and they were taken in most cover types during the summer snap-trap survey (Table 3). Although less often observed than frogs, toads were frequently observed both years of the study.

Digestive tract analysis.— Contents of 59 stomachs and 63 colons from skunks killed on the study area were used to evaluate food habits. Mammals were the most frequently found food item and made up 92 percent of the volume of food in the stomachs during March and April (Table 5). They continued to occur frequently during May and June and made up 57 percent of the volume at that time (Table 6). Mammals occurred infrequently,and in small amounts during July and August (Table 7), but increased again during September-November when they comprised 33 percent of the stomach food volume (Table 8).

Table 5. Food item in stomachs and colons of striped skunks collected in Brookings County, South Dakota, during March and April, 1972-73.

Food Item	Stomachs (14)[a] Percent Frequency of Occurrence	Stomachs (14)[a] Percent Volume	Colons (15) Percent Frequency of Occurrence
Insect	43	T[b]	20
Grasshopper	36	T	7
Cricket	--	--	--
Beetle (Adult)	--	--	13
Beetle (Larvae)	--	--	--
Fly (Larvae)	--	--	--
Unidentified	--	--	7
Crayfish	7	T	7
Fish	--	--	--
Snake	7	T	--
Amphibian	7	1	--
Frog	7	1	--
Toad	--	--	--
Mammal	71	92	93
Meadow vole	36	27	53
Deer mouse	--	--	7
House mouse	7	1	7
Unidentified mouse	7	T	--
Ground squirrel	7	6	7
Cottontail	14	58	20
Jack rabbit	--	--	--
Bird	14	6	13
Pheasant	7	6	7
Chicken	--	--	7
Unidentified	7	T	--
Egg	--	--	--
Pheasant	--	--	--
Unidentified	--	--	--

[a] Sample size in parentheses.

[b] Trace less than 1.0 percent.

Table 6. Food items in stomachs and colons of striped skunks collected in Brookings County, South Dakota, during May and June, 1972-73.

Food Item	Stomachs (6)[a]		Colons (7)
	Percent Frequency of Occurrence	Percent Volume	Percent Frequency of Occurrence
Insect	67	24	100
Grasshopper	--	--	--
Cricket	17	T[b]	29
Beetle (Adult)	50	20	29
Beetle (Larvae)	33	3	43
Fly (Larvae)	17	T	--
Unidentified	--	--	14
Crayfish	--	--	--
Fish	--	--	--
Snake	17	T	--
Amphibian	33	15	--
Frog	--	--	--
Toad	33	15	--
Mammal	67	57	57
Meadow vole	33	16	43
Deer mouse	17	14	14
House mouse	--	--	--
Unidentified mouse	--	--	--
Ground squirrel	--	--	--
Cottontail	--	--	--
Jackrabbit	17	27	--
Bird	33	3	--
Pheasant	--	--	--
Chicken	--	--	--
Unidentified	33	3	--
Egg	17	1	29
Pheasant	--	--	14
Unidentified	17	1	14

[a] Sample size in parentheses.

[b] Trace less than 1.0 percent.

Table 7. Food items in stomachs and colons of striped skunks collected in Brookings County, South Dakota, during July and August, 1972-73.

Food Item	Stomachs (24)[a] Percent Frequency of Occurrence	Stomachs (24)[a] Percent Volume	Colons (25) Percent Frequency of Occurrence
Insect	83	16	100
Grasshopper	17	9	20
Cricket	8	T[b]	4
Beetle (Adult)	67	7	80
Beetle (Larvae)	8	T	8
Fly (Larvae)	4	T	--
Unidentified	4	T	12
Crayfish	8	2	8
Fish	8	6	4
Snake	--	--	--
Amphibian	67	44	12
Frog	37	20	4
Toad	29	23	8
Mammal	17	23	24
Meadow vole	8	2	4
Deer mouse	4	T	4
House mouse	--	--	---
Unidentified mouse	--	--	--
Ground squirrel	--	--	---
Cottontail	--	--	--
Jackrabbit	4	21	4
Bird	20	8	12
Pheasant	8	7	4
Chicken	4	T	4
Unidentified	8	1	4
Egg	12	1	16
Pheasant	8	1	8
Unidentified	4	T	8

[a] Sample size in parentheses.

[b] Trace less than 1.0 percent.

Table 8. Food items in stomachs and colons of striped skunks collected in Brookings County, South Dakota, during September, October, and November, 1972.

Food Item	Stomachs (15)[a] Percent Frequency of Occurrence	Stomachs (15)[a] Percent Volume	Colons (16) Percent Frequency of Occurrence
Insect	73	34	100
Grasshopper	40	4	50
Cricket	33	18	41
Beetle (Adult)	27	2	63
Beetle (Larvae)	27	10	13
Fly (Larvae)	--	--	---
Unidentified	13	T[b]	6
Crayfish	7	T	--
Fish	--	--	--
Snake	--	--	--
Amphibian	67	31	--
Frog	53	29	--
Toad	20	2	--
Mammal	33	33	31
Meadow vole	33	33	31
Deer mouse	--	--	--
House mouse	--	--	--
Unidentified mouse	--	--	--
Ground squirrel	--	--	--
Cottontail	--	--	--
Jackrabbit	--	--	--
Bird	13	2	19
Pheasant	--	--	--
Chicken	--	--	--
Unidentified	13	2	19
Egg	--	--	--
Pheasant	--	--	--
Unidentified	--	--	--

[a] Sample size in parentheses.

[b] Trace less than 1.0 percent.

The meadow vole was the mammal most frequently found during all time periods (Tables 5 to 8) and it was the only mammal found in stomach (Fig. 3) illustrated the extent to which skunks will prey on this mammal.

Cottontails and jackrabbits occurred less frequently than meadow voles, but were the most important mammal in food volume during the March-April, May-June, and July-August time periods (Tables 5 to 7). Maggots were found associated with jackrabbit remains in one stomach. Remains of deer mice, house mice, and ground squirrels were also found, but their occurrence was infrequent (Tables 5 to 7).

Insects were the food item most frequently found during all time periods except March-April, but were most important in food volume during the September-November time period (Tables 5 to 8). Grasshoppers, beetles, and crickets were most prevalent. Beetles were primarily members of the families Carabidae and Scarabaeidae. Larvae of the latter family (white grubs) were especially common.

Remains of frogs and toads were frequently found in stomachs (Fig. 4), but rarely in colons (Tables 5 to 8). Frogs and toads evidently left few undigestible residues that could be identified in the colon. Amphibians were the most important food item in volume in July-August (Table 7) and were also common May-June and September-November food items (Tables 6 and 8). Frogs occurred more frequently than toads but both were common.

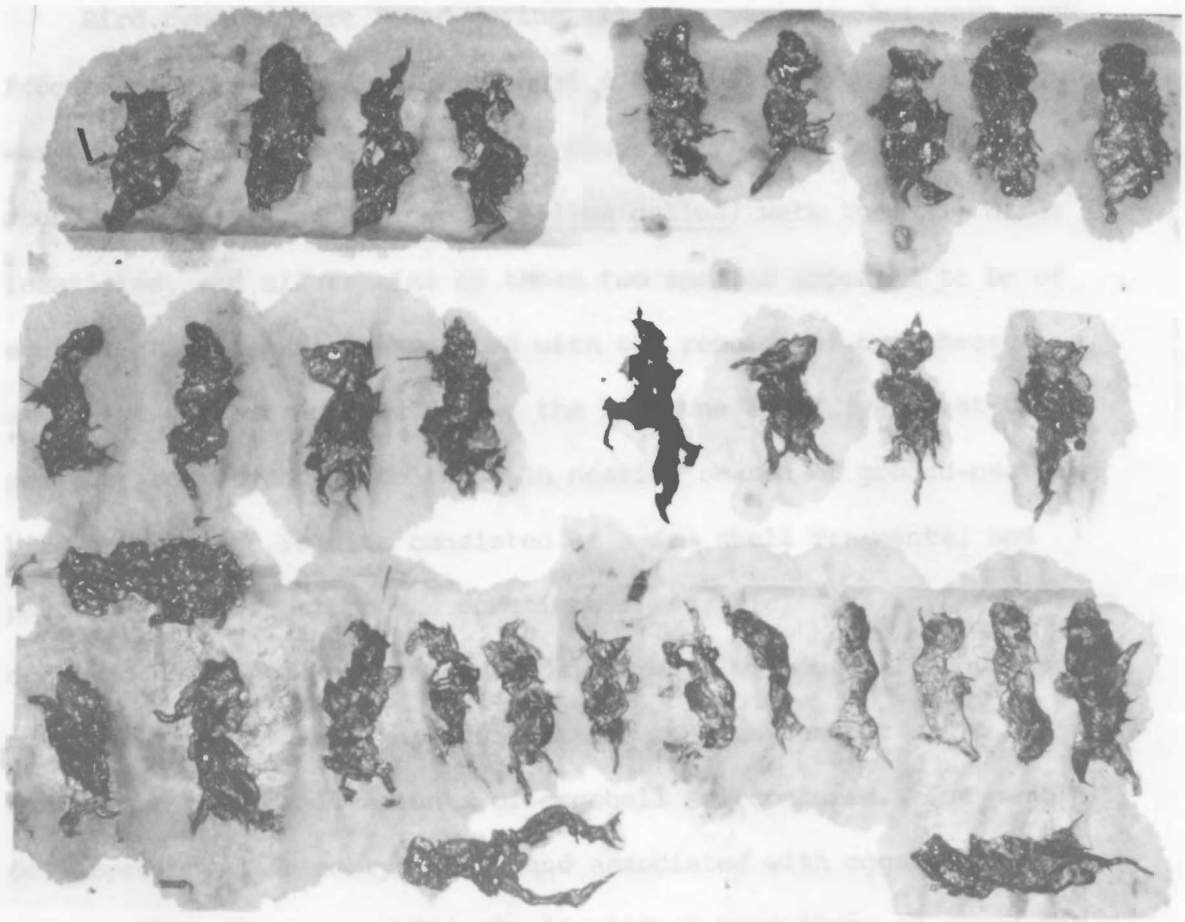

Fig. 3. Thirty meadow voles and one frog found in the stomach of a striped skunk collected 3 November 1972.

Fig. 4. Five frogs found in the stomach of a striped skunk collected 7 August 1972.

Bird remains were found during all time periods, but were most frequent in May-June and July-August (Tables 5 to 8). Identification was often difficult, since in most cases only a few feathers were found. Pheasants and chickens (Gallus gallus) were the only birds identified, and all remains of these two species appeared to be of adults. Maggots were associated with the remains of one pheasant.

Bird eggs were found during the May-June and July-August time periods, corresponding to the main nesting season of ground-nesting birds. Most egg remains consisted of a few shell fragments, and positive identification was sometimes impossible. The number of eggs consumed could not be determined, since eggs without well-developed embryos leave little or no identifiable residues except shell fragments, and only small amounts of eggshell are consumed. One partially developed pheasant embryo was found associated with eggshells in a colon. The only eggs positively identified were those of pheasants, although other shell fragments appeared to represent eggs of other species of birds smaller than pheasants or waterfowl.

The remains of fish, crayfish, and snakes were other food items occasionally found.

DISCUSSION AND CONCLUSION

Idle grassland was the most important habitat feature associated with high skunk densities on the study area. The number of areas of idle grassland on a section had a much stronger association with skunk densities than the total acres of idle grassland on that section, indicating that the greatest densities of skunks in the area occurred in a diverse habitat of idle grassland interspersed with other cover types.

Food habits and winter activities indicated that idle grasslands were important as hunting grounds for skunks. The mammal most frequently encountered in the digestive tracts of skunks at all seasons of the year was the meadow vole. During late winter, spring, and fall it was also one of the most important components of the skunk's diet. This was particularly true in late winter and early spring when most prey items were scarce. Since meadow voles were found almost exclusively in undisturbed cover types containing heavy residual vegetation, skunks must use this cover type extensively while hunting. By comparison, deer mice were infrequently found in skunk diets, although they appeared to be the most common small mammal in all cover types except idle grassland. It is not known whether skunks hunt in undisturbed cover because of a preference for meadow voles or if they take meadow voles because they prefer to utilize undisturbed cover types. Verts (1967:200) found that deer mice were a common item in the diets of Illinois skunks, demonstrating that skunks will use this prey species when available. This suggests that skunks on my study area made little

use of agricultural lands as hunting grounds. Storm (1972) found that radio-tracked skunks tended to avoid croplands during night-time activities. Winter tracking conducted in the present study also demonstrated a preference by skunks for idle areas as hunting grounds.

Although I found no dens in rockpiles, the importance of rockpiles to skunks probably stems from their value as undisturbed den sites. Conversations with several trappers in the region revealed that when skunks were of greater value as furbearers, rockpiles were considered one of the best spots for trapping or den hunting of skunks. Trautman et al. (1973) reported that 19 percent of all skunk dens found in eastern South Dakota during October den surveys were situated in rockpiles. Shirer and Fitch (1970) located four radio-tracked skunks in their dens on 60 occasions. Thirty-eight of the locations were in hilltop limestone-outcrops, a natural landform that in many ways is similar to the man-made rockpiles found on my study area.

Mammals and insects have been ranked as the most important food items of skunks at all seasons of the year by many workers (Verts 1967: 71; Selko 1937; Dixon 1925; and Llewellyn and Uhler 1952). Hamilton (1936) found plants to be important in the diets of skunks in New York. He found that fruit was the most important food during fall and winter and that it was second in importance during spring and summer. My study showed that mammals and insects were the main items in the late-winter and spring diet of skunks, but that amphibians were equal or greater volume in summer and fall. Amphibians were never of more than minor importance in studies of other workers reviewed above.

However, many of these studies relied heavily on scat and colon analysis and amphibians do not usually leave identifiable residues at that stage of digestion. The high use of amphibians as food by skunks that I found probably resulted from utilization of an abundant and easily captured prey species when the opportunity presented itself.

Remains of adult pheasants, chickens, and rabbits probably represented use of carrion. Maggots associated with one rabbit and one pheasant indicated that at least these individuals were scavenged. During the course of the study two skunks were observed feeding on road-killed animals. No evidence was found of skunk predation on young pheasants or waterfowl.

The low but uniform utilization of eggs of ground-nesting birds by skunks during the nesting season indicated that skunks probably raided nests as they were found in the course of their hunting activities. Idle grasslands were preferred as nest sites by ground-nesting birds, as well as important hunting areas for skunks.

My study indicates that removal of idle grasslands from an area would reduce the attractiveness of that area to skunks. However, the importance of this cover type to ground-nesting birds and other wildlife would make such removal undesirable. Since skunk densities appear to be more dependent on the number of areas of idle grassland than on the total acreage of this cover type, small patches of idle grassland would probably offer poor nesting security to gamebirds as compared with large, unbroken blocks of similar vegetation. Several authors have reported that the greatest loss of pheasant nests to

mammalian predators occurs in cover types such as fencerows and odd areas of idle cover (Linder et al. 1960; Trautman 1960; Chesness et al. 1968; Gates and Ostrom 1966). Duebbert (1969) observed one of the highest nest densities and nest-success rates for dabbling ducks ever reported in the literature on a 125-acre block of retired cropland in South Dakota having extremely dense nesting cover. He attributed the high success to low levels of predation by mammals. Although skunks, as well as other predators were common in the general vicinity, little sign of predator activity was found within the heavy cover. In management of game production areas in this region, blocks of cover unbroken by such features as roads or food patches probably would provide the greatest security of nests from skunk predation.

My study also indicates that removal of rockpiles would make an area less attractive to skunks. Rockpiles are of no known value to any game animals and their removal would appear to be entirely beneficial from a game-production standpoint.

Additional studies are needed to determine if the above land management practices would provide increased pheasant and duck production. Such studies should evaluate changes in the production of these birds, and in the population densities of skunks and other predators, on study areas after the management practices are applied.

Skunk control programs in this region should be most efficient when centered around idle grasslands and rockpiles. Extensive programs of trapping or baiting limited to these cover types would probably reach most of the skunks in an area. Since the size and

number of these cover types are small in most portions of this region, such control programs could be conducted at minimum cost and effort. Additional studies would be necessary to determine the effectiveness of these control measures. Trapping could be evaluated by experimental programs using mark and release methods in conjunction with nightlighting. Baiting with physiological markers as used by Nelson and Linder (1972) would provide information on the effectiveness of baiting in these cover types.

LITERATURE CITED

American Ornithologists' Union. 1957. Checklist of North American birds. Am. Ornithol. Union, Baltimore. 691pp.

Chesness, R. A., M. N. Nelson, and W. H. Longley. 1968. The effect of predator removal on pheasant reproductive success. J. Wildl. Manage. 32(4):685-697.

Duebbert, H. F. 1969. High nest density and hatching success of ducks on South Dakota CAP land. Trans. N. Am. Wildl. Nat. Resour. Conf. 34:218-229.

Dixon, J. 1925. Food predilections of predatory and fur-bearing mammals. J. Mammal. 6(1):34-46.

Gates, J. M., and G. E. Ostrom. 1966. Feed grain program related to pheasant production in Wisconsin. J. Wildl. Manage. 30(3):612-617.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Co., N. Y. 1083pp.

Hamilton, W. J., Jr. 1936. Seasonal foods of skunks in New York. J. Mammal. 17(3):240-246.

Houseknecht, C. R. 1971. Movements, activity patterns, and denning habits of striped skunks (Mephitis mephitis) and the exposure potential for disease. Ph. D. Thesis. Univ. of Minnesota (Libr. Congr. Card No. Mic. 71-28244). 46pp. University Microfilms. Ann Arbor, Mich.

Jacobson, J. O. 1969. Application of a nighttime roadside census to striped skunk population studies. M. S. Thesis. North Dakota State Univ. 83pp.

Kalmbach, E. R. 1938. A comparative study of nesting waterfowl on Lower Souris Refuge: 1936-1937. Trans. N. Am. Wildl. Conf. 3: 610-623.

Kimball, J. W. 1948. Pheasant population characteristics and trends in the Dakotas. Trans. N. Am. Wildl. Conf. 13:291-311.

Linder, R. L., D. L. Lyon, and C. P. Agee. 1960. An analysis of pheasant nesting in south-central Nebraska. Trans. N. Am. Wildl. Nat. Resour. Conf. 25:214-230.

Llewellyn, L. M. and F. M. Uhler. 1952. The foods of fur animals of Patuxent Research Refuge, Maryland. Am. Midl. Nat. 48(1):193-203.

Nelson, R. L. and R. L. Linder. 1972. Percentage of raccoons and skunks reached by egg baits. J. Wildl. Manage. 36(4):1327-1329.

Selko, L. F. 1937. Food habits of Iowa skunks in the fall of 1936. J. Wildl. Manage. 1(3-4):70-76.

Shirer, H. W., and H. S. Fitch. 1970. Comparison from radio tracking of movements and denning habits of the raccoon, striped skunk, and opossum in northeastern Kansas. J. Mammal. 51(3):491-503.

Stebbins, R. C. 1966. Field guide to western reptiles and amphibians. Houghton Mifflin Co., Boston. 279pp.

Storm, G. L. 1972. Daytime retreats and movements of skunks on farmlands in Illinois. J. Wildl. Manage. 36(1):31-45.

_____, and G. L. Sanderson. 1969. Results of a field test to control striped skunks with diethylstibestrol. Trans. Illinois State Acad. Sci. 62(2):193-197.

Trautman, C. G. 1960. Evaluation of pheasant nesting habitat in eastern South Dakota. Trans. N. Am. Wildl. Nat. Resour. Conf. 25:202-213.

_____, 1971. Relationship of red foxes and other predators to populations of ring necked pheasants and other prey. Conf. Western Assoc. State Game and Fish Commissioners. 19pp. Typescript.

_____, L. F. Fredrickson, and A. V. Carter. 1973. Relationship of red foxes and other predators to populations of ring necked pheasants and other prey, 1964-71. South Dakota Dept. Game Fish, and Parks. P-R Proj. Rep., W-75-R-15. 158pp. Multilith.

Verts, B. J. 1967. The biology of the striped skunk. University of Illinois Press, Urbana. 218pp.

Westin, F. C., G. J. Buntly, F. E. Shubeck, L. F. Puhr, and N. E. Bergstreser. 1959. Soil survey, Brookings County, South Dakota. U. S. Dept. of Agriculture. 87pp.