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Food habits of red foxes (*Vulpes vulpes*) in Nebraska were determined by analysis of 234 fox stomachs obtained from fur dealers during October 1978 through February 1979. Mammals were found most frequently (84%) and constituted the majority (77.4%) of the volume of food items. Cottontails (*Sylvilagus floridanus*) and jackrabbits (*Lepus* sp.) were the most important items consumed based on frequency of occurrence (45.8%) and volume (49.2%). Remains of birds were difficult to identify, but ring-necked pheasants (*Phasianus colchicus*) occurred in 6.9% of the stomachs and comprised 8.4% of the volume of items consumed. Male foxes had a higher volume of rabbits (55.6%) in their stomachs than did females (39.3%), whereas females had a higher volume (24.6%) of mice and voles than did males (14.6%). Remains of livestock and poultry in fox stomachs rarely were found (2.6%) and constituted only about 1% of the volume of the foxes' diet. Game animals comprised 62.5% of the volume of the foxes' diet.

† † †

INTRODUCTION

Food habits of red foxes have been studied in Kansas (Stanley, 1963), Iowa (Scott, 1950), and the Midwest in general (Errington, 1935), but the results of these studies might not be typical of present conditions. For example, in Nebraska the average farm increased in size by 33%, to 279 ha (690 acres) from 1960 to 1975. During those years the amount of land under irrigation doubled to an estimated 2.1 million ha (Vollmar, 1976). Changes in agricultural technology and in land usage possibly result in significant changes in habits and densities of wildlife species. The purpose of this report is to document the food habits of the red fox in Nebraska during fall and winter of 1979.

MATERIALS AND METHODS

Carcasses of red foxes were obtained from fur dealers in Nebraska from October 1978 through February 1979. A total of 234 stomachs was obtained during the study. Foxes were collected from 22 counties, but most (156) were from Cass, Colfax, Cuming, Dodge, Douglas, Sarpy, Saunders, and Washington counties in eastern Nebraska. Nine or fewer foxes were collected from each of 14 additional counties, mostly along the Platte River. No fox was obtained from counties in the Sand Hills, and only eight were from the Panhandle.

Each fox was assigned an identification number and the sex, county, and probable month of purchase were recorded. Carcasses obtained from fur dealers were brought frozen to our laboratory. They were thawed, then stomachs were removed and individually frozen for up to several weeks until they could be analyzed. Stomachs were thawed overnight at room temperature prior to analysis. They then were opened and their contents were washed in tap water on a Tyler number 10 (2 mm opening) screen to remove blood and mucous. Contents were dried on paper towels, separated into petri dishes, and identified.

Remains of mammals were identified from skulls or guard hairs (Moore, Spence, and Dugnolle, 1974). Hairs were cleansed in ether, secured (to a microscope slide) with double-stick transparent tape, and examined. Features used in identification included color, length, width, shape, presence or absence of strictures, and configuration of the medulla. When necessary, scale patterns were determined by placing the hair on a microscope slide sprayed with a clear lacquer and allowed to dry. An imprint of the hair remained on the slide when the hair was removed. Remains of birds were identified by comparing feathers, feet, and beaks found in red fox stomachs with study skins.

Frequency of occurrence was calculated as the number of stomachs containing a specific food divided by the number of stomachs that were not empty. Volume was calculated as the volume of each food item found in all stomachs divided by the volume of all items found. Volumes were determined

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to the nearest milliliter by measuring displacement of water by the food item in a partially filled graduated cylinder.

RESULTS AND DISCUSSION

Food items identified and percentages of occurrence and volume for 188 foxes are summarized in Table I. Forty-six (19.7%) of the stomachs were empty and were excluded from the analysis. Trapped foxes sometimes disgorge (Cook and Hamilton, 1944), and this could have contributed to the large number of empty stomachs in this study. Also, if foxes were in traps for 12 hr or more, most food would have been digested. However, the method of capture was unknown to us.

TABLE I. Occurrence and volume percentages of food items identified in 188 Nebraska red fox stomachs.

Food Item	N	Percent Frequency of Occurrence	Percent Volume
Mammals	158	84.0	77.4
Eastern cottontail (*Sylvilagus floridanus*)	74	39.4	44.0
White-footed mouse (*Peromyscus* sp.)	38	20.2	7.4
Vole (*Microtus* sp.)	28	14.9	5.9
Harvest mouse (*Reithrodontomys* sp.)	19	10.1	3.0
Jackrabbit (*Lepus* sp.)	12	6.4	5.2
Unidentified mammal	11	5.8	1.6
House mouse (*Mus musculus*)	9	4.8	1.3
Norway rat (*Rattus norvegicus*)	5	2.6	2.5
Striped skunk (*Mephitis mephitis*)	5	2.6	2.6
Grasshopper mouse (*Onychomys leucogaster*)	4	2.1	0.6
Fox squirrel (*Sciurus niger*)	3	1.6	2.2
Raccoon (*Procyon lotor*)	3	1.6	0.7
Muskrat (*Ondatra zibethicus*)	2	1.1	0.7
Short-tailed shrew (*Blarina brevicauda*)	2	1.1	0.2
Unidentified mouse	2	1.1	tr
Woodrat (*Neotoma* sp.)	1	0.5	0.1
Masked shrew (*Sorex cinereus*)	1	0.5	0.1
Unidentified shrew	1	0.5	0.1
Domestic cattle	1	0.5	0.1
Plains pocket gopher (*Geomys bursarius*)	1	0.5	tr
White-tailed deer (*Odocoileus virginianus*)	1	0.5	tr
Birds	61	32.4	19.6
Unidentified bird	27	14.4	6.3
Ring-necked pheasant (*Phasianus colchicus*)	13	6.9	8.4
Meadowlark (*Sturnella* sp.)	10	5.3	2.0
Domestic poultry	4	2.1	0.9
Bobwhite (*Colinus virginianus*)	3	1.6	0.8
Horned lark (*Eremophila alpestris*)	1	0.5	0.5
Common grackle (*Quiscalus quiscula*)	1	0.5	tr
Mallard (*Anas platyrhynchos*)	1	0.5	0.5
Unidentified duck	1	0.5	0.1
Unidentified woodpecker	1	0.5	0.1
Miscellaneous	27	14.4	2.0
Debris	16	6.9	0.2
Paper	4	2.1	tr
Powdery meal	3	1.6	1.2
Apple	1	0.5	0.5
Fat (possibly bait)	1	0.5	0.1
Garter snake (*Thamnophis* sp.)	1	0.5	tr
Grasshopper	1	0.5	tr
Unidentified fish	1	0.5	tr
Plastic bag	1	0.5	tr

Mammals occurred most frequently (84%) and constituted the majority (77.4%) of food items by volume. Birds occurred in 32.4% of the stomachs and made up 19.6% of the volume. Items other than mammals and birds occurred in 14.4% of the stomachs and comprised only 2% of the volume.

Cottontails and jackrabbits (*Sylvilagus floridanus* and *Lepus* sp.), constituted 49.2% of the volume and occurred in 45.8% of the stomachs examined. The importance of rabbits in the diet of red foxes has been established previously in Kansas (Stanley, 1963), New York (Cook and Hamilton, 1944), Virginia (Nelson, 1933), and Wisconsin (Pils and Martin, 1978).

Mice and voles (*Microtus* sp.) occurred in 53.2% of the stomachs. However, as a group, mice and voles comprised only 18.2% of the volume. These data differ from those of Errington (1935), Hamilton (1935), and Hatfield (1939), who concluded that mice were the staple food of red foxes.

Most bird material could not be identified to genus. However, of the identifiable material, ring-necked pheasants (*Phasianus colchicus*) occurred in 6.9% of the stomachs and comprised 8.4% of the total volume. Although this frequency of occurrence was quite high, the volume was comparable to values reported by Pils and Martin (1978).

Stomachs from 125 males, 102 females, and seven foxes of unknown sex were examined. Although frequency of rabbit in stomachs was similar (46.6% in males and 43.0% in females), the volume was greater in males (55.6%) than in females (39.3%). There was a higher frequency of mice and voles in males (55.3%) than in females (49.4%), but the volume was greater in females (24.6%) than in males (14.6%). These data suggest sexual differences in food preference. Such differences could result from sexual dimorphism because male foxes are larger than females (Storm, Andrews, Phillips, Bishop, Siniff, and Tester, 1976); however, no significant difference was found between sexes for volume of prey consumed [$p>0.5$, t-test on arcsin transformed percentages according to procedure of Steel and Torrie (1960)].

Domestic poultry was found in only 2.1% of the stomachs. The Nebraska Department of Agriculture (Anonymous, 1972) reported a $21,160 loss of livestock and chickens to foxes in the state for one year. Chickens accounted for 68% of the losses and the rest was due to loss of lambs. Hatfield (1939) and Korschgen (1959) noted that poultry was an important component of the diet of red foxes in their studies in Minnesota and Missouri, respectively. The infrequent occurrence of poultry and livestock we found in fox stomachs could be due to changes in animal husbandry, time of year samples were obtained, abundance of wild prey, or other reasons.

Remains of game species—cottontail, jackrabbit, fox squirrel (*Sciurus niger*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), white-tailed deer (*Odocoileus virginianus*), ring-necked pheasant, bobwhite (*Colinus virginianus*), and mallard (*Anas platyrhynchos*)—were identified as food items in our study. This does not mean that all the items were killed by foxes, and it does not imply that foxes have any impact on those animal populations. However, in South Dakota, Trautman, Fredrickson, and Carter (1974) reported that a 5-yr fox-control program resulted in larger pheasant and jackrabbit populations.

In summary, although these data represent a sample of red fox food habits for several months during a single year, results are similar to other published studies. Mammals are the predominant food of red foxes. The actual mammalian species preyed upon by red foxes is variable and may be influenced by prey abundance, prey availability, predator abundance, and predator preference for certain prey. In addition, red foxes do not appear to be a major predator on livestock or poultry in Nebraska.

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