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AN ECOLOGICAL STUDY OF THE FOOD HABITS OF THE RED FOX

by

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Bring on the Food!

(Fox Pup at Den #5, May, 1944)

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To Jack A. Stanford, he is indebted for those pictures used in this study.

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INTRODUCTION

The fox, Vulpes fulva fulva (Desmarest) is regarded as ~~being~~ an injurious predator by farmers, sportsmen, and even ~~by~~ many scientists. They believe that ^{he} ~~it~~ is responsible for destroying large numbers of birds and mammals. Only the fox hunters and nature lovers rise to his defense, and even they give him little credit for his valuable service as a destroyer of noxious rodents and insects, and as a scavenger. Nevertheless his good as well as his bad qualities have repeatedly been demonstrated in food-habit studies.

Many papers ~~and articles~~ have been published concerning the food of both red and grey foxes. But in most of them the kinds and amounts of foods eaten are listed without considering the environment from which the food was taken. (~~See Bibliography.~~) The correct interpretation of such studies is often difficult. Recently, however, several papers have appeared that consider the fox's food reactions in the light of environmental conditions. Notable among these are papers by Scott (1943), Hamilton and Cook (1944), and Heit (1943). Murie (1936) was the first to express his findings ecologically. He showed some correlation between the number of specific food items found along trails and the occurrence of these

in scats collected at dens. Errington (1937) suggested that an ecological study of the food habits of the red fox ~~would~~ ^{might} perhaps indicate some methods of biological control.

The object of this report is to present facts that show the ecology of the fox in relation to his food supply. It is the result of an investigation on the Mud Lake Area located about $1\frac{1}{2}$ miles west of Whitmore Lake. ^{Because of} ~~Due to~~ wartime restrictions on transportation and time limitations, the study includes only fall, winter, and spring observations for one season, November 15 to May 31, 1944-45.* Although the material gathered shows a definite pattern or trend, it may not be especially significant in so far as minor foods are concerned. Also, in early May there was a temporary gap in the data due to heavy rains that made it impossible to find scats suitable for analysis and also increased the difficulties of direct observation.

* It was necessary because of transportation difficulties to plan the field work so that several men worked on the area at the same time, each engaged on different projects. In many ways this worked out advantageously because each was interested in the work of the others and the exchange of records and observations greatly increased the ground covered. Acknowledgment is due these fellow students for assistance on numerous occasions and especially to Jack A. Stanford whose observations and advice were especially helpful.

DESCRIPTION OF THE AREA

The area studied includes about 3126 acres in Washtenaw County, Michigan, lying in sections 1, 2, 11, 12 Webster Township, T1S R5E, and sections 6 and 7 Northfield Township, T1S R5E. It is bounded on the north by Barker Road, on the west by Merrill Road, on the south by Valentine Road, Webster Church Road, and Jennings Road, on the east by Jennings Road and Dead Lake.

The terrain is rolling, hilly land interspersed with marshes, bogs, kettleholes, and lakes. The elevation varies from 880 to 950 feet. The central portion of the area is wet and includes Mud Lake and Independence Lake. In the northeast corner is Dead Lake. The outer borders of the area are high ground occupied by oak-hickory ~~type~~ forest, pasture land, and crop land. The land drains in a southwesterly direction through an intermittent stream that flows from Independence Lake into Arms Creek.

Veach (1930) describes the area as a part of the glaciated plains of the Central Lowland province of the United States, ^{and as} ~~being of the~~ moranic upland ~~nature~~ characteristic of the Michigan "thumb" region. The surface features are of glacial origin and completely cover the preglacial bedrock. Some sheet erosion is

evident on the cultivated lands, and here and there gully erosion has begun on steep ^{slopes} ~~surfaces~~ excessively grazed.

Map # 1 shows the soil types in relation to den sites in the area studied. A description of the principal soil types ^{are} is as follows:

The surface layer of Miami loam is grayish-brown and granular when dry and like gritty clay when wet. Below this lies from ⁷ ~~eight~~ to ¹⁵ ~~fifteen~~ inches of yellowish-brown leached material that is more gritty and less loamy than the surface. This grades into a yellowish-brown, compact, gritty, coarsely granular clay some 36 to 40 inches in depth. The substratum is a mass of impervious clay, several feet deep. The soil is generally well-drained, being on nearly level to choppy or rolling land. It is a fairly productive, durable soil but subject to erosion. In virgin condition it produced a climax type of beech-maple forest of medium to large trees with little herbaceous or shrubby undergrowth.

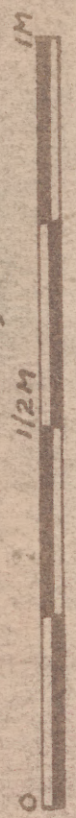
Hillsdale sandy loam is rolling or moderately hilly well-drained land. The plow soil is ⁸ ~~eight~~ to ¹⁰ ~~ten~~ inches deep of grayish-brown sandy loam or light loam. The second layer is a pale yellow, friable, sandy loam, ranging from 10 to 20 inches in thickness. A yellow to yellowish brown, fine sandy granular friable clay loam makes up the next 18 to 24 inches. Pervious sandy clay



**COVER & LAND USE MAP
MUD LAKE AREA
WASHTENAW CO., MICHIGAN**

LEGEND

- SW MARSH
- B BOG
- K KETTLE HOLE
- Sw SWAMP FOREST
- F UPLAND FOREST
- C CULTIVATED UPLAND
- P PERM. PASTURE & HAY
- HOUGHTON MUCK
- BROOKSTON LOAM
- CARLISLE MUCK
- FOX DEN



SCALE

WEBSTER TNSP T1S., R5E. SECT. 1, 2, 11, 12.
NORTHFIELD TNSP T1S., R5E. SECT. 6, 7.

LEGEND

- FARMSTEAD
- TYPE LINE
- INTERMITTENT STREAM
- SECTION LINE
- POND
- IMPROVED ROAD
- FARM ROAD
- MIAMI LOAM
- FOX SANDY LOAM
- RIFLE PEAT
- HILLSDALE SANDY LOAM

MAP # 1

moderately stony and gravelly forms the substratum. This soil has a general gradient of 10% and borders marsh or muck lands. The original forest growth was of ^{the} oak-hickory type. This kind of land is subject to sheet erosion on slopes.

Fox sandy loam lies on smooth plains underlaid with sand and gravel. The surface soil consists of light-brown sandy soil from ~~eight~~⁸ to ~~ten~~¹⁰ inches deep. It is underlaid by a layer of pale yellow, friable, sandy loam from ~~six~~⁶ to ~~fifteen~~¹⁵ inches thick. Below this is a layer of sandy and gravel held together with reddish brown clay. The substratum of coarse sand and gravel is pervious and comparatively dry to a depth of several feet. The soil is moderately fertile ^{It} occurring ^s in fairly large, uniform, nearly level or only slightly uneven areas. Some parts are pitted with shallow dry depressions and dotted with lakes and swamps. About 5% of the total area is in wood-lots or forest and 10% of the land once under cultivation is abandoned or used for pasture. This land is utilized for general farming. ^{The} Original cover was red, white, and black oaks and hickory.

Carlisle Muck has a dark brown or black surface layer of coarse granular structure and a loamy texture. At a depth of 15 to 20 inches it is underlaid with peat, marl, clay, or sand which becomes pasty when wet. ^{The} Original cover was an elm, ash, soft maple forest with an understory

of willow, aspen, and tamarack, shrubs, vines, ferns, and other herbaceous vegetation. Generally poor drainage produced swamps or bogs.

The climate is mild in summer and moderately cold in winter. The mean annual precipitation is 31.31 inches, ~~including melted snow~~. The average annual snowfall is 37 inches. The mean annual temperature 47.4°F, with extremes varying from -21°F in February to 104°F in August. The growing season averages 164 frost-free days between May 2 and October 13. The precipitation is evenly distributed throughout the year and is generally sufficient for good crop production. The prevailing winds are westerly and rarely attain high velocity. The maximum and minimum temperatures and the average daily snow depth for the period studied are shown on Charts 4 and 5 in the Appendix.

The Mud Lake Area includes twenty-four farms in whole or part and two lakes of recreational size. The farms vary from a few acres to 470 acres. Nearness to industrial centers has led some of the residents to carry on a limited amount of farming in conjunction with industrial employment, and many of the farms are operated by temporary or seasonal tenants. This practice has resulted in deterioration of lands, buildings, and equipment. The prevailing crops are corn, wheat, and hay. Since stock farming is the universal, ~~farm practice~~, a large

portion of the land is grazed including even the relatively poor wild pastures in the marshes, swamps, and woodlots. The more stable farmers practice crop rotation and other desirable farming methods.

A partial list of trees growing on the uplands includes white oak, red oak, black oak, shagbark hickory, hard maple, basswood, elm, black ash, white ash, soft maple, ironwood, wild black cherry, and walnut. In most cases these forests are now in a decadent condition. The best trees have been removed for lumber, posts, and fuel, leaving decayed and dead trees or trees of little commercial value. Little or no underbrush is present ^{because of} ~~due to~~ the custom of grazing with sheep or cattle. The hardwood swamps contain such woody plants as aspen, yellow birch, hazelnut, willows, green ash, elm, soft maple, dogwoods, viburnums, raspberry, greenbriar, chokeberry, huckleberry, ferns, and sedges. The original type has been altered ^{by} ~~due to~~ grazing. In the coniferous swamps, spruce, tamarack, sphagnum moss, sedges, and leatherleaf predominate. In the old cuttings highbush cranberry, chokeberry, poison sumach, blueberry, dogwoods, and aspen form dense thickets, and along the outer edge of the swamp, willow and elm grow well. The pasture lands support a cover of blue grass, white or yellow clover, alfalfa, brome grass, Russian thistle, crataegus, aster, dock, wild crab apple, service berry, cinquefoil, wild strawberry, teasel, and other

herbaceous weeds. In the fence rows grow blackberry, raspberry, greenbriar, bittersweet, wild strawberry, wild plum, crataegus, soft maple, hickory, oak, elm, sumach, wild cherry, oaks, and other woody plants.

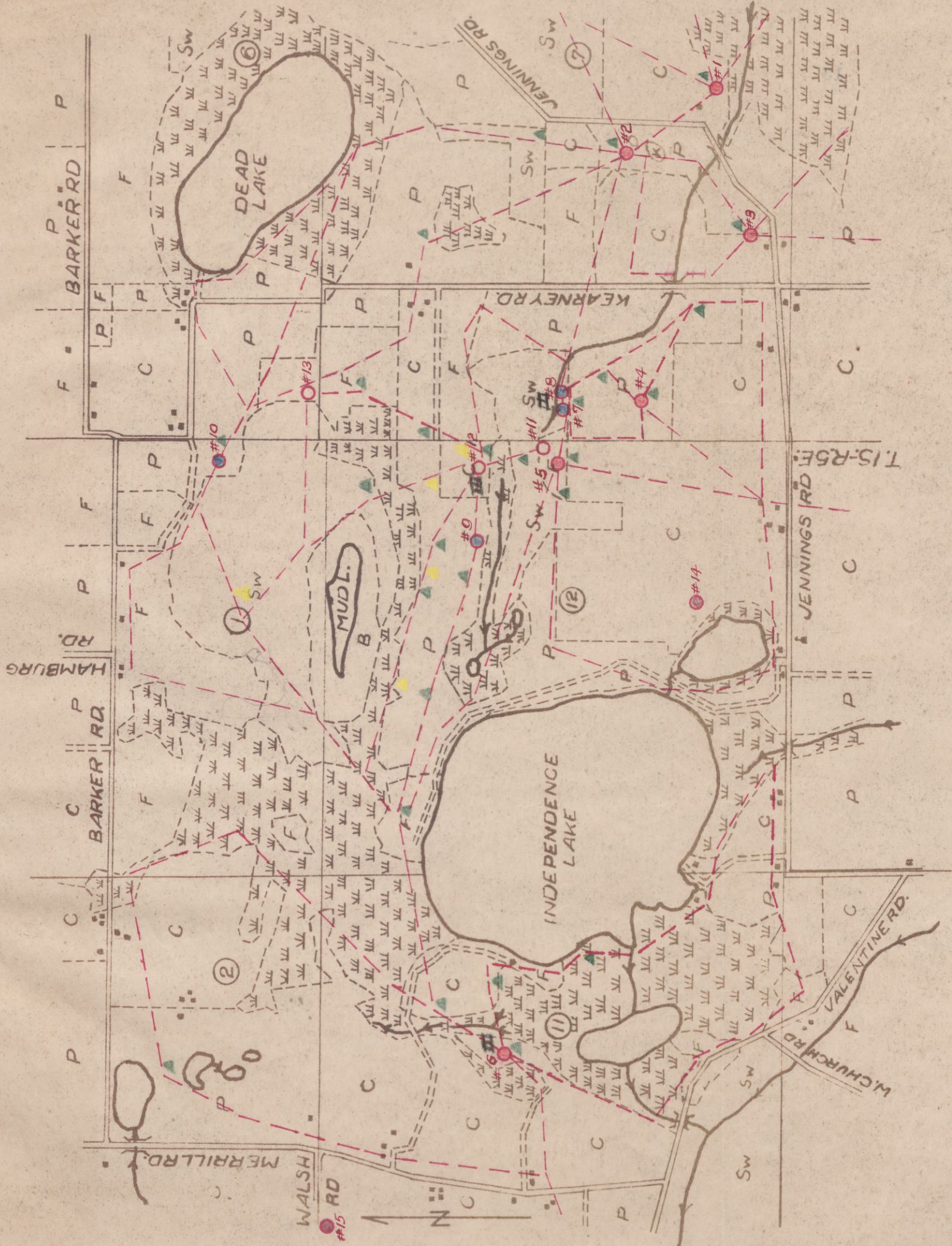
The animal inhabitants present the year round on the hilly pasture lands are meadow mice, moles, shrews, woodchucks, eastern chipmunks, white-footed mice, house mice, and the fox. Birds occupying the same area during spring and fall include numerous migrants, flycatchers, song and field sparrows, meadowlarks, the red-eyed towhee, goldfinch, and various warblers. Permanent residents are black-capped chickadee, the slate-colored junco, the starling, the bobwhite quail, and the blue jay. Animals that live in the bottomlands near the swamps or woods are meadow mice, opossum, raccoon, skunk, muskrat, weasels, eastern cottontail, fox squirrel, red squirrel, 13-lined ground squirrel, and mink. Birds found in this type are ring-necked pheasant, eastern crow, and various migrant species. The swamps and bogs are inhabited by eastern cottontail, bog lemming, and muskrat, but are used by practically all the predatory animals in search of food. In the Mud Lake bog area a deer was seen on several occasions. Birds wintering in the swamp included the ring-neck pheasant, ruffed grouse, American red-tailed hawk, and great-horned owl.

In the woods there are raccoons, fox squirrels, white-footed mice, skunks, weasels, moles, shrews, opossums, ground squirrel, possibly eastern gray squirrel, and the fox. The more important birds are ruffed grouse, barred owl, great-horned owl, hairy woodpecker, downy woodpecker, and yellow-bellied sapsucker.

FIELD TECHNIQUES

Field techniques used in this study are as follows: Step 1. A preliminary idea of the area's terrain was gained from examination of the U.S. Geological Survey topographical quadrangle sheet. The Soil Survey map of Washtenaw County, ~~Michigan~~ (Veatch, Wheeting, and Bauer, 1930) was consulted for information about the prevailing soil types and was helpful in ~~that~~ it showed ^{ing} where dens might likely occur. Aerial photographs to aid in the determination of the ground cover were not available, but Stanford, in connection with his studies had prepared a cover-type map (in 1942) of the Mud Lake Area. (See Map 2.) This map ~~was used as a basis for the fox study~~ thus saving ^{ed} much time that would otherwise have been required in the preparation of a base map.

Step 2. The farmers of the Mud Lake Area were interviewed for information about existing fox dens, numbers of foxes killed, numbers of foxes seen in the immediate region, number of barnyard fowl available to the fox, and losses of fowl sustained. A careful examination of the entire area was made and the positions of all dens were plotted on the map. (See Map 2.)



COVER & LAND USE MAP
 MUD LAKE AREA
 WASHTENAW CO., MICHIGAN

LEGEND

- FARMSTEAD
- - - TYPE LINE
- - - INTERMITTENT STREAM
- - - SECTION LINE
- POND
- == IMPROVED ROAD
- FARM ROAD
- - - FOX TRAIL
- ▲ DEFECATION POST
- CACHE
- RESTING SPOT

- ≡ MARSH
- B BOG
- K KETTLE HOLE
- Sw SWAMP FOREST
- F UPLAND FOREST
- C CULTIVATED UPLAND
- P PERM. PASTURE & HAY
- #1-6 NATAL DENS
- #7-10 WINTER DENS
- #11-13 AUX. DENS
- #14-15 ABANDON. DENS



SCALE

WEBSTER TNSP T15., R5E. SECT. 1,2,11,12.
 NORTHFIELD TNSP T15.R.5E. SECT. 6, 7.

MAP #2

Step 3. Fox trails leading from the den sites were followed. Their pattern is indicated on Map 2. Tracking snows supplied the best information on trails and aided in completing the pattern of trails.

Step 4. Scent posts, defecation posts, observation posts, resting spots, and temporary dens were found along these trails, ~~and~~ their positions are indicated on the map by appropriate symbols. ~~(See Map 2.)~~

Step 5. Scats were collected weekly from regular fox trails, den sites, scent posts, and favorite defecation posts. These were placed in small paper bags bearing pertinent field data--cover type, weather conditions, approximate topographical location, and estimated time since defecation of scat.

Step 6. Food caches, kills, and carrion were noted in the same manner as the scats.

Step 7. Population studies and home-range locations of game birds available to the fox were made by winter census (using a dog and tracking in the snow) and by spring census (crowing areas, drumming logs, and nests).

Step 8. ^{The} Population ~~studies~~ of small game mammals ^{was} were determined by fecal droppings, plant damage, nests or dens, and ~~by~~ direct observation.

Step 9. The numbers of rodents (mice) were estimated by abundance of tracks in snow, plant damage, nests, and direct observation.



Kills at Den # 4, Nichol's Pasture Field

Left Center Peking Duck, Center Cottontail Rabbit
Upper Center Pheasant Wings, Right Center Muskrat

Step 10. The locations of all garbage and food wastes available to the fox were recorded.

Step 11. A survey of the amount and kinds of commercial and wild fruits, berries, and nuts was made.

LABORATORY TECHNIQUE

The laboratory procedure used to analyze the contents of the fox scats was as follows: Step 1. The scats were placed in a drying rack over a steam-heated radiator and allowed to dry. ^{The} Time required for drying depending ^{ed} on size and freshness of scats ^{and} varied from ³ three to ⁷ seven days. After scats were sufficiently dried to insure no loss from decomposition or spoilage of food material through the effects of mold or decay, they were measured ^{and} weighed, and this information plus the field location of the scat was recorded on a 4 x 6 card. The scats were either analyzed immediately as to their food content or placed in a storage box containing paradichlorobenzene for later analysis.

Step 2. Scats were placed in jars containing warm water until they softened and practically disintegrated. This material was passed through a sieve (12 meshes to the inch) over a large-mouth jar to catch the fine material. The remaining heavy material in the sieve was picked out, sorted, dried, weighed, and recorded as to amount and kind of each food item. The material caught in the jar was diluted with clear water and allowed to stand overnight to settle out the heavy particles from

the fine. The feathers, hair, and other light floating particles were removed with a fine-mesh sieve (24 meshes to the inch) dried, sorted, measured by cc, and recorded as to amount and kind. The heavy material was picked out, dried, measured by cc, and recorded as to amount and kind of food items.

An alternate method of analyzing the scats was tried ^{In this method,} but discarded. The dry scats were partially crushed and then separated with forceps. The bone and large food items picked out, measured, and recorded. The finer material, ^{the} fur, small bones, feathers, ^{and} seeds were further torn apart, sifted through a small screen, and then analyzed by volume ⁱⁿ cc. ^{but} The method is only satisfactory when the scat contains ~~only~~ one or two food items, or when the mucous content has been previously dissolved by ~~the effects of~~ weathering. The danger of breaking or destroying parts of bone, feather, seed covers, or other materials that aid in the identification of food items is great, and many small items may be discarded without being recognized. At best it gives only a general idea of food items taken.

Step 3. Food items that were separated out and measured by cc. volume were identified as to whether they were mammal, bird, insect, plant, or miscellaneous. Further identification to genus or species was made by macroscopic or microscopic comparison with identified laboratory specimens and by use of keys.

CHARACTERISTIC SIGN

In determining the presence of the fox on any game area the ability to read "sign" of the animal is essential to ascertain if the area is inhabited permanently or only used occasionally by a wandering fox. Fox "sign" such as feces, scent from urination, tracks, trails, dens, food caches, kills, and resting spots all tell a story if properly interpreted. Due to the presence of farm dogs some of which were allowed to run free it is necessary to distinguish the track of dogs from foxes. The general shape of the fox track is oval with the longer axis being in the direction of travel. The toe pads are small, and the heel pad is bar-shaped with a straight rear edge. The hind foot is about 5% smaller than the front, the two middle toes and claws seem to converge and the heel bar is about one-half as wide as the fore-foot bar. Tracks vary in size, the largest being about 2.8 inches long by 1.8 inches wide. Sometimes the tracks appear wider due to melted snow or because the foxes have the habit of retracing their steps in the track previously made. The tracks may appear fuzzy in the snow due to the hair between the toe pads. A dog track equal in size is more circular in outline. A dog has larger toe pads and



Homeward Bound

less hair between them; therefore leaves a clearer impression than the fox. The female fox track is generally smaller than the male but immature males may be smaller than adult females. The distance between tracks varies from 9 to 16 inches depending on whether the fox is trotting or galloping. When the fox trots his tracks are almost in a straight line whereas a dog's tracks are usually staggered. The track of a galloping fox is similar to a dog's track: the four feet placed down close together with the hind feet overlapping the fore feet paw marks. On level ground the distance between the groups of tracks will vary in length from 30 to 88 inches depending upon the size of the fox and speed at which he is traveling.

The scent of the fox has a characteristic odor of the canine family but somewhat more skunk-like than the domestic dog. The male fox, like the male of canines generally, has favorite scent posts along the trails that traverse his home range. These may be fence posts, a rock along the trail, or an old bone or skull. These posts may also be places of defecation. This habit makes it possible to observe periodic food habits. By collecting scats weekly at "scent posts" and defecation spots the food for the week is clearly indicated. During the winter when the breeding dens are covered over with snow or filled up with dirt and litter the resident fox of that den often marks the site with scent. Location of

scent posts is made more easily when a tracking snow is present.

Fox scats are one of the best "signs" of the presence of foxes on the area. The length of scats varied from small pieces up to 9.0" (22 cms.) the average being from 4.7" (11.2 cms.) to 5.8" (14.8 cms.); the diameter about 0.5" (1.3 cms.) varying from 1/4" (0.8 cm.) to 7/8" (2.1 cms.). The color of the scats ranges from black to grayish brown with a shade of green sometimes appearing near the ends of the scats. The fresh scat is coated with a grayish mucous which appears as a silver to grayish scale when dry. This scaly layer rubs off easily after the scat is dried. The presence of the mucous coat indicates fresh scat not more than two or three days old. Day old scats also gave off a strong odor. This same odor can be detected clearly when the dried scats are broken up and dispersed in warm water. Scats that were several months old often appeared to be chalky or cottony in character due to the work of bacteria, fungi and insects. Those scats buried by early snowfall were generally washed or leached out and contained only durable items like bones, gristle, feathers, fur or seeds. Scats from carrion material were dark brown or black in color and very soft in structure.

In addition to the defecation posts associated with the odor posts, foxes usually have other spots

where they defecate again and again. The site of the rearing den was a favorite spot even when the den was filled with snow or debris. A fallen tree was another favorite place and was regularly visited by a fox. Foxes habitually used rock piles to defecate, especially piles that commanded a view of the surrounding territory. These rock piles were used in wet and dry periods alike and not only during the wet periods as reported by Scott (1943).

Large rocks along trails traveled daily by the fox also received like attention and many of these were also "scent posts". Other scats were collected along the trails, some being found at kills, food caches or carrion. Generally the fox seems to select places that afford a good view in all directions.

Resting spots were found in open fields having some vegetative cover high enough to hide the fox yet allow him an unobstructed view of the surrounding area. Usually they were near the top of a hill or on top of ridges having a cover six to ten inches high of herbaceous weeds, alfalfa stalk remains or wheat stubble. The foxes use these areas during the early afternoon periods before resuming hunting. They were readily distinguished in the snow being areas of shallow indentations, six to eight inches deep and 15 to 18 inches in diameter. These places seemed to be used more extensively during clear weather as if the foxes were "sunning" themselves.



Den # 1, Belfuss' Orchard

LOCATION OF DENS

Fox dens are found in soils which permit construction with minimum effort. Dens # 5, 9, 10, 11, 12, 13, 14 were located on hilly ridges and rolling land used extensively for croplands, pasture land or farm woodlots composed of an oak-hickory maple type forest. The prevailing soil type on the Mud Lake Area is Miami loam. Only about one-third of the pasture land is Fox sandy loam. Nevertheless most of the fox breeding dens (# 1, 2, 3, 4) were either in loose sandy soil or in the still more sandy Hillsdale sandy loam. The last provides excellent den sites, but only occurs on a single 80 acre tract. Two dens were found in Hillsdale sandy loam. (Dens # 6 and 15) Dens in Carlisle muck (# 7 and 8) were only used for temporary or winter shelter; they were flooded in spring. Only a single breeding den was found in Miami loam although several auxiliary dens occurred in that type.

Thus it may safely be concluded that sandy soil is preferred for breeding dens. The entrance of the dens observed varied from 8 to 15 inches in diameter and the burrow sloped downward at an angle of 35° to 65° for a distance of three to five feet. Then almost always it



Den # 11 -- Secondary Play Den

it turned upward for a distance of 6 to 18 inches forming a dip in the passage; thereafter it continued horizontally until it terminated in a chamber 3 to 4 feet square. The dip in the tunnel was observed in all dens used for breeding and in almost all of the auxiliary dens. It may serve to keep the rest of the tunnel and den room warm and at the same time provide for ventilation by checking the flow of warm air to the outside. See Figure 1.

35 - 65 angle with horizon

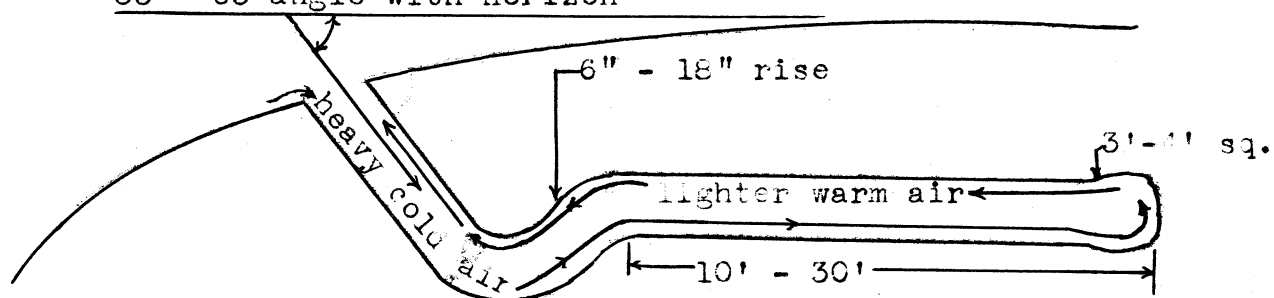


Figure 1.

Dens that are used for housing the annual litter of pups generally have two, three or sometimes four openings as much as 30 or 40 feet apart. According to Seton and others the horizontal portion of the tunnels varies from 15 to 30 feet.

Exposure and slope seem to play an important part in the location of the dens. Dens were invariably located on slopes varying from 5 to 26% slope: those in



Den # 5, in Oak-Hickory- Maple Type Forest

the open field or pasture land were on slopes that varied from 5 to 15% whereas in forested areas somewhat steeper slopes from 18 to 26% were selected. In the open, exposure seemed to be an important consideration. All dens located in fields opened toward the southwest. On the other hand those in the woods might open in any direction but usually toward the northeast. Apparently the shelter of surrounding trees counteracted the influence of exposure. Dens in most cases were located near the top of slopes in places giving a commanding view of the surrounding area, but certain temporary or winter dens were apparently used for "holing-in" during extreme weather conditions and were not selected for their lookout qualities.



Den # 5 -- Winter, January, 1945

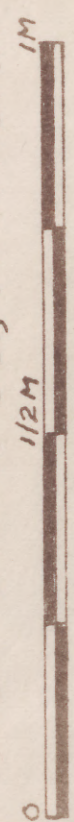
HOME RANGES

The individual home ranges of the foxes were determined by following and mapping the course of every trail that could be distinguished. These trail patterns are indicated on Map 3. Land included within the regularly used trails of a single fox plus adjacent lands that were hunted intermittently was considered to be the home range of each fox.

Starting at the den, the trails radiate out like the spokes of a wheel, each den having four or five trails leading from it. The trail pattern shows that in a general way the den lay in the center of a roughly circular area, although the shape varied somewhat depending on the location of the dens in respect to topography. The home ranges varied from $1/4$ to $1/2$ mile in radius. Because the food supply was near optimum, in 1945, the average range was smaller than those described by others (Murie, 1936, Scott, 1942). The trails led along fence rows, followed the ridges, and skirted along the marginal ditches of swamps, along stream bottoms, and along ditch banks often following old sheep and cattle trails for short distances. Trails usually inconspicuous became clear on newly plowed land in spring and fall, but a



COVER & LAND USE MAP
 MUD LAKE AREA
 WASHTENAW CO., MICHIGAN



SCALE

WEBSTER TNSP T15., R5E. SECT. 1, 2, 11, 12.
 NORTHFIELD TNSP T15. R5E. SECT. 6, 7.

LEGEND

- FARMSTEAD
- TYPE LINE
- > INTERMITTENT STREAM
- SECTION LINE
- POND
- ==== IMPROVED ROAD
- ===== FARM ROAD

LEGEND

- W MARSH
- B BOG
- K KETTLE HOLE
- Sw SWAMP FOREST
- F UPLAND FOREST
- C CULTIVATED UPLAND
- P PERM. PASTURE & HAY
- NATAL DEN
- FOX RANGE

MAP # 3

light tracking snow in the winter provided the best evidence of trail location. Some overlapping of range was observed but no evidence was found to prove that the fox actually sets up and defends a territory although it is possible that something of the sort may occur.

The land included in each range was composed of a variety of types as shown by the cover map. The grassy areas along the edges of the streams, the orchards and the marginal ditch of Mud Lake swamp contained the best mouse habitat and therefore, were subjected to heavy hunting pressure by the fox. Sumach clumps in pasture fields and the swamp hardwoods type northwest of Mud Lake contained the most rabbits and consequently received much attention from the foxes. A picnic site in an upland hardwood grove on the northeast side of Independence Lake was visited by foxes from dens # 4, 5, and 6 throughout the entire period of this study especially in the fall and spring. After the marshes were frozen, the foxes hunted in them regularly when game birds and mammals moved into them during the winter months.

Mammal and bird kills and remains left on the trails and near dens are a good indication of the daily activities and food preferences of foxes. When eating a bird the fox removes the feathers by shearing them off with his teeth instead of plucking them. Thus the basal part or calamas is left in the skin and eaten. This habit

aids in the identification of fox kills. The calamus shows up in the scat when it is analyzed and is generally 1/4 to 1/2 inch long. Tooth marks of the fox especially the marks left by the canines of the lower and upper jaw may often show on the bone of mammals killed by foxes and aid in distinguishing fox kills. The fox makes most of its kills by stalking the animal. Personal observations indicate however that they had little success in catching birds in this manner. Evidence in the snow indicated an active fox was able to catch two rabbits by jumping them and then running them down after a short chase.

Food caches are the remains of a kill not eaten. In most cases those food caches uncovered were either rabbit or pheasant and were found only during the time when 6 to 12 inches of snow was present. One cache of rabbit consisting mostly of the hindquarters and intestines was found. Caches of pheasant usually consisted of the large bones of the wing, the legs, and tail, but Stanford once found a complete carcass of a cock pheasant cached. The fox returned the next night and ate all except the wings. A house mouse was found in a cache unmarked except for the tooth marks just back of the shoulder.



Den # 5 -- Pheasant and Pekin Duck Kills

POPULATION OF FOX

To determine the relationship between the kind and amount of the food items taken by the fox, the amount of each item available on the area must be considered. First the number of foxes on the area must be approximated by den count or field observation. During the spring and summer of 1944 four natal dens on the area were under observation by Jack Stanford, the Mason brothers, and E.L. Beifuss. Jack Stanford reported seeing four pups at den # 5 located in the oak hickory forest. The Mason brothers reported four pups in den # 2, the mother being a black fox, and two pups in den # 3 150 yards from their barn. E.L. Beifuss reported four pups in den # 1. Two other dens (# 4 and 6) showed evidence of being used as natal dens. Since these dens were not under observation only an estimate can be made of any young born at these dens. Assuming a pair of adults for each den the total population for the area would be 14 young and 8 adults, plus 4 adults and whatever young were brought forth in the other dens. Therefore a population of at least 26 and probably 34 ~~was~~ on the area. The area studied contains 3126 acres or 4.7 square miles. Thus on the Mud Lake tract

there were from 5.5 to 6.8 foxes per square mile. There is also the possibility that each den could have contained more pups than were observed as the numbers of a litter are reported to vary from 4 to 9, averaging 6. A pregnant fox was killed March 2, 1945, and contained 10 embryos. Three pregnant foxes obtained from Washtenaw County fox hunters contained 7, 9, and 10 embryos. The breeding season of the red fox extends from January to February. On January 10, 1945, evidence indicated that a male and female were traveling together and occupying a temporary den under an uprooted stump covered over with snow. January 18, 1945, along the trail of two foxes in the vicinity of Klapatch's farm evidence in the snow indicated that copulation had been performed.

During March 4 of 6 old natal dens were dug out evidently to be used for breeding. However 3 of these were in open fields and were later plowed over and destroyed during April, and the fourth was filled by a farmer with stone, straw and debris.

Detroit Sportsmen's Club killed three foxes and wounded a fourth which returned to den # 5. There was no evidence that this fox ever left the den in the two weeks period following its entrance into the den, and possibly it died of wounds. Mr. Mason trapped a fox near his farm January 10, 1945. A fox was shot by the son of one of the farmers in the northwest section of the area. Thus

with ordinary hunting and trapping, the population of 26 or more was reduced by only five and possibly six foxes.

FOODS EATEN BY FOX

Mammals

Rabbit (*Sylvilagus floridanus*)

The fox is chiefly a carnivorous animal. In this study mammals and birds made up 77% of his diet (see Appendix, Chart 1). Based on frequency of occurrence the cottontail rabbit was the principle food item appearing 85 times in 186 scats. From December 10, 1944 to February 23, 1945, during extreme weather conditions with deep snow and near zero temperatures recorded, (see Appendix, Charts 4 and 5) rabbit was the fox's main food source because mice remained in their runways or nests beneath the snow and therefore were unavailable. Over this eleven week period 14 kills and 3 caches were found in the open fields, in or near sumach thickets, in the marginal ditch, or in the dense hardwood production in the swamp. Investigation of den sites yielded 3 additional kills for a total of 17 known kills. For the same period scat analyses showed 21 occurrences of rabbit compared with 4 of mice. (See Appendix, Table 1.) During all the other months studied only five rabbit kills were discovered.

The fox in most cases ate the head, part of the visceral organs, and most of the front quarters of the rabbit, and left the hind quarters either cached in the snow or exposed. On two occasions the animal returned to caches and finished eating the hind quarters of the rabbit. Evidence in the snow on two occasions indicated the fox had "jumped" rabbits after stealing up close to them while they were feeding on sumach and after a short chase, made the kill.

A direct census of the rabbits was not made but in late fall and early winter as many as 3 to 4 rabbits were jumped from a single sumach clump or briar patch. Large numbers of fecal droppings, many tracks, and heavy plant damages indicated a high population. In the adjacent fields and rock piles rabbits were occasionally seen. By spring, however, the number seen was much smaller and the amounts of fecal deposits and fresh plant damage was markedly less.

Mice

Meadow mouse (Microtus sp.) ranked second in the fox's diet appearing 66 times in the 186 scats. The meadow mouse was abundant in orchards near dens #1, 3, and 6, along stream banks, and in the tall grass at the edge of the marginal ditch surrounding the swamp. Due to travel restrictions and time limitation a trapping.

campaign to determine the population of mice on the area was not made. However fresh cuttings, droppings, the numbers of nests and runways and direct observation indicated high population. Meadow mouse tracks were plentiful in the shallow snow in early December but in January and February when the snow was 6 to 12 inches deep on the level and 30 inches in drifts the mice remained in their runways under the snow. As a result the incidence of mouse remains in scats defecated during this eleven week period was almost nil and the mice ceased to be a "buffer" species.

White-footed mouse (Peromyscus sp.) remains were present in 7 of the 186 scats. The white-footed mouse occurred in small numbers along fence rows in and near the edges of the upland forest. Very few tracks were observed in the snow. The fox on several occasions dug around dead stumps and rock piles in an attempt to capture these mice. The fact that white-footed mouse is a nocturnal feeder and the fox hunts in early morning and evening may be one reason for the inability of the fox to secure any great number of these mice.

Lemming mouse (Synaptomys cooperii) remains were identified twice in the scat collections. This is not surprising because suitable habitat for this mouse existed only around Mud Lake bog and swamp. As indicated by Murie (1936) and Scott (1943) these mice are readily

taken and found more often in scats picked up along the trail than in those from den sites.

Norway rat (Rattus norvegicus) and house mouse (Mus musculus) each appeared once in the scats, collected before snow fall. One house mouse was found in a cache. Rat and mouse tracks were frequently seen around corn cribs and chicken yards but, because the fox seldom visited these areas, they were exposed to little predation.

One shrew (Cryptotis parva) was dug out by the fox but discarded without being eaten.

Muskrat

Muskrat (Ondatra zibethica) occurred 5 times in the 186 scats. Two or three houses were found in Mud Lake swamp and a like number in the marsh northeast of Independence Lake. However one tenant claimed that during the winter of 1942 he trapped 98 muskrat and 4 mink from the Mud Lake region. The remains of a muskrat were found at den # 5 on December 10, 1944, and at den # 4 on April 10, 1945. The bodies of three muskrat were observed on the north shore of Independence Lake on March 2, 1945, and evidence indicated the fox had been eating parts of the carrion. Because the muskrat usually feeds under the ice during the winter months and seldom exposes itself, the fox has little opportunity to prey upon it. Scat analyses also indicates that muskrats are rarely taken in winter but

a few were eaten before snow fall in December and again in March and April after the muskrat was again exposed. It is possible, of course, that much of the muskrat remains were from animals that died and were later found by the fox.

Fox Squirrel

Fox squirrels (Sciurus niger) were numerous in all the upland forests. Seven nests were counted in the forest harboring den # 5. Squirrels were active most of the winter and the fox investigated many of their nut caches and diggings. The diurnal and arboreal habits of these squirrels makes them safe from the fox and no evidence was uncovered that indicated he was successful in making kills. Fox squirrel occurred only twice in the scats analyzed and twice at den sites.

Red Squirrel

Red squirrels (Tamiasciurus hudsonicus) were common in the swamp replacing the fox squirrel in that type, but like the other squirrel it was seldom taken by the fox. Red squirrel remains were identified twice but both scats were collected from the same vicinity, and it is probable they contained parts of the same animal.

Opossum

Opossum (Didelphis virginiana) signs were not numerous on the area, however two roadside kills and the carcass of one killed by a farmer were discovered. Only once were remains found in the scat collection although this marsupial would seem to be easy prey for the fox. The opossum was blamed by the local inhabitants for destroying young rabbits. They were much in favor of eliminating the opossum from the area.

Other Animals

Raccoon (Procyon lotor) and skunk (Mephitis nigra) signs were plentiful in the marshes. Three raccoon den trees were located in the upland forest near den # 2. Fresh raccoon tracks were seen in the soft mud on the southeast edge of Mud Lake swamp in late April. Raccoon scats were found on down trees in the swamp overlooked by dens # 5 and 9. A skunk occupied the temporary den # 7 during February and the fox moved to den # 8. None of these animals were preyed upon by the fox and in one case a dead skunk was available but left untouched.

Ground squirrels (Citellus tridecemlineatus) were numerous along the edge of the upland forests and in the rock piles and fence rows. They were active until early December then hibernated until April. During the active periods a few were taken and their remains were recorded twice in the scats.

The occurrence of house cat (Felis domestica) remains in one of the 186 scats suggests possible interception by the fox of a hunting cat. More likely, however, the sample represented carrion.

Carrion

Sheep (Ovis aries) wool was present 3 times in the 186 scats. The carcasses of four sheep and one lamb were observed in a pit on Klapatch's farm on March 10, 1945. The bodies of four ewes and seven lambs were noted on Godfrey's farm April 9, 1945. These losses occurred during lambing season. A dead calf (Bos taurus) was found on Nichols' farm April 9, 1945, and a dead cow in Mud Lake swamp on Edmonson's farm the same day. Calf carrion and cow carrion appeared 1 time each in the 186 scats and carrion unidentified once. The practice of the farmers in failing to destroy the bodies of dead livestock provided the fox with abundant food during lambing and calving time. However the fox did not use this source of food to any great extent. Over 200 lambs and 150 pigs were born on the area but no losses from fox predation were reported by the farmers.

Birds

Ringneck Pheasant

In the fall of 1944, 8 females and 2 cocks were located in a marsh near den # 5, 2 hens and 1 cock at Jennings pond, 1 male and female in a swamp on Hershey's farm totalling 15 pheasant (Phasianus colchicus torquatus) During the first week in May, 1944, Stanford had den # 5 under daily observation. From the mouth of this den in four days he removed 3 cocks and 2 hens, all fresh kills. At den # 5, December 10, 1944, the remains of a cock pheasant were found and in the swamp nearby the carcass of a female pheasant was discovered. January 21, 1945, Stanford uncovered a cock pheasant from a cache in a pasture field northwest of Mud Lake swamp. From analysis of 186 scats pheasant remains occurred 7 times. From a known fall population of 14 to 15 birds 3 known kills and 7 occurrences in scats indicate a heavy predation on the pheasant by the fox. At first glance it would be assumed that the fox accounted for 10 of the 15 birds, but further studies reveal that 6 of the 7 occurrences were in scats collected from the same area and at approximately the same time. Scott (1941) in feeding captive foxes portions of chicken discovered the chicken occurred 15 times in succeeding droppings. Assuming the same conditions exist in nature, the three kills would account for the 6 occurrences



Pheasant Cache in Pasture Field
Near Den # 10, January 21, 1945

and the loss sustained by the pheasant would be reduced to 20% of the total known population. The five kills reported by Stanford suggest that the pheasant is more susceptible to predation during nesting time. Other investigations by Errington (1937) and Hatfield (1939) also indicate this.

In general the range supports a relatively small pheasant population. Although ideal winter cover exists in the swamps and bogs,, favorable nesting sites in the spring are scarce due to overgrazing of pastures, meadows, and marshes by cattle, horses, and sheep. Many of the nesting sites in the marshes are flooded during April and May rains. Pasturage composes 33.6% of the land area and cropland occupies 18.6%. Generally the pasture land lies next to the marshes and bogs while the croplands occupy the higher land. In most cases the fence rows offer the only protected approach to the crop lands. These fence rows are grazed by livestock and, in some cases, are being completely removed by those farmers now using powered equipment. Due to presence of so much marginal to sub-marginal agriculture land, limited production of corn and other grains used as food by the pheasant have more or less held the pheasant population to a low density.

Ruffed Grouse

The ruffed grouse (Bonasa umbellus) found on the area occupy an isolated habitat. A spring drumming cock census made over a period of years show 9 to 15 cocks in the area. A 50:50 sex ratio would indicate a population of 18 to 30 birds. Three winter kills were found and one kill at den # 4. There were 7 occurrences in the 186 scats analyzed. Since the area occupied by the ruffed grouse includes some 180 acres and the yearly drumming cock count is fairly stable, the small number lost or taken by the fox could be charged off as excess birds. Errington and Hamerstrom (1936) demonstrated that predation losses for bob-white quail were proportional to the carrying capacity of the area. Over a period of 7 years the grouse population has not fluctuated to any great extent as proven by the spring census count.

Bob-white Quail

In the Mud Lake Area three coveys of quail (Colinus virginianus) were under observation. Numbers in the coveys varied from 5 to 8. These birds disappeared during the last part of January when severe weather conditions existed. Possibly some or all of them were sleeted or iced in and were made available to the fox as carrion. No evidence of any kills were found. Quail appeared 6 times in 186 scats and only in those scats found the last

week in January. One scat contained both feet of the quail in good condition. Southern Michigan is the northern limit of the bob-white quail. The quail are subject to total decimation due to adverse climatic conditions as well as limited cover and food. In the Mud Lake Area both cover and food for quail are favorable but extreme weather conditions may be an important limiting factor.

Barnyard Fowl

Chickens are raised on all the farms in the area. Losses sustained by the farmers are in direct proportion to the methods of rearing and protection employed. Those farmers who do not let their flocks range free in the surrounding fields and woods, who maintain rat and predator proof chicken yards and buildings, and who keep a good farm watchdog, suffer little or no losses. In most cases these three conditions exist only on those farms producing chickens on a commercial basis. The common practice is to allow the chickens to roam free through the spring, summer and fall months and pen them up during winter months or periods of inclement weather. On some farms the watchdog is chained up thus greatly reducing the effectiveness of protection afforded to the barnyard fowl. The losses are summarized in a table showing number of chickens, and prevailing protection methods on the several farms. (See following page)

Farm ¹	No. of Chickens	Losses	Enc. Bldg. Yard	Range Free	Protection Afforded			No. of Ducks	Losses
					None	Chained	Unchained		
Hershey	400	3--4*	x				x		
Kimble	100	----	x				x		
Davy	100	5--6		x					
Gray	200	65		x		x		8	--
Godfrey	50	18		x		x		10	8
Hause	18	4		x		(Eird) x			
Mason	200	Several		x				10	1
Biefuss	45	10		x			x		
Merril	50	----					x		
Nichol	100	----					xx		
	1263	102 plus						28	9

*Mr. Hershey reports that a fox entered his chicken house through an open door about 7:30 PM one summer evening and killed 3 or 4 chickens before it was driven off. He believed the fox killed for the sport of killing rather than for food.

¹ Other farmers contacted did not know the number of poultry lost or else refused to give any information. The practice of changing tenants made it difficult to secure information.

Three white leghorn chicken remains were found around the den # 4. Stanford recorded one fresh killed Pekin duck at den # 5, and Mr. Mason reported finding a fresh killed duck in a culvert near his ~~farm~~ on March 10, 1945. From analysis of 186 scats white leghorn chicken occurred 11 times, barred rock chicken 3 times and others 2 times, white duck 2 times and hen egg once.

The common practice of discarding heads, feet, and visceral organs of the chickens when preparing them for market or home use furnished an additional source of food to the fox. Evidence that the fox visited such refuse piles was recorded during February when the area was covered with snow 12 to 30 inches in depth.

The monetary loss resulting from fox predation sustained by the farmers of this area amounts to \$125 to \$135 for the fall-winter season 1944-45. This figure is based on an average farm market price of \$1.25 for a chicken or duck. From the table it can readily be seen that if adequate protective measures were undertaken by all farmers, annual losses due to fox predation would be reduced to a minimum. Losses depend upon the number of foxes occupying the area and the accessibility of barnyard fowl to the fox.

Passerine Birds

In the 186 scats the presence of small bird remains occurred 6 times and crow once. Parts of the carcass and feathers of a crow were found in the immediate vicinity where the scats were obtained. The number of birds killed by the fox appears to be small. On April 14, 1945, 1:30 PM near the edge of the marginal ditch of Mud Lake swamp, a fox was observed attempting to work his way close to some small birches in which a flock of juncoes were resting. Moving forward with slow motion, the fox approached the low trees but each time he drew near the birds flew to adjacent brush. After a half hour of unsuccessful hunting the fox gave up the hunt.

In this same area the carcass of a screech owl was discovered and in analyzing the scats two occurrences of owl were present.

Invertebrates

Arthropods

Crayfish (Cambarus) appeared twice in the 186 scats so can be considered of little importance of food.

Insects

Insects make up a large bulk of the summer and fall food as indicated by Hamilton, Hosley and MacGregor (1937), Scott (1943) and others. Some insects were available for food before snowfall in the late fall and after the snow disappeared in the spring. All insects were of adult form.

Orthoptera. Red-legged grasshopper (Melanoplus femur-rubrum) occurred 6 times; katydids (Tettigonidae) and crickets (Gryllidae) once each in the 186 scats.

Lepidoptera. Tent caterpillar (Lasiocampidae) was the only moth to be found. It was taken twice by the fox.

Coleoptera. Beetles were present 22 times in the 186 scats. Of these ground beetles (Carabidae) appeared 12 times; May beetles (Scarabaeidae) 5 times; and Carrion beetle (Silphidae) 3 times. Perhaps the latter species were taken when carrion was eaten.

Hymenoptera. Wasps (Vespidae) were recorded twice in the scat collection while ants (Formicidae) occurred 3 times.

The invertebrates made up 21.8% of the fall food items of the fox, 1.1% of the winter food items, and 13.7% of the spring food items, based on frequency per cent occurrence.

Plants

Plant material, especially fruits and berries, makes up a large portion of the fox diet during the summer and fall. Plant material and insects disappear from the fox's food in the winter months; however, some use is made of grasses and similar plant foods during the winter months.

Sedges and grasses occurred 5 times in the 186 scats. They formed only a part of the scat and were generally in conjunction with insects which completed the remaining parts. Therefore, they may have been ingested accidentally.

Corn (Zea maize) appeared 17 times. On several occasions chewed corn cobs were found near the dens. Some of the corn was of whole kernels and was possibly contained in the digestive tract of birds eaten. During one adverse period when zero weather prevailed, the fox dug old horse droppings to obtain the corn. Many of the farmers used mechanical corn pickers to harvest their crop which left considerable corn in the field available to the birds and fox.

Wheat (Triticum), barley (Hordeum), clover (Trifolium), and alfalfa (Medicago) were each noted once in the scats, but in such small quantities that it is likely they were accidental.

Fruit in the form of Fox grape (Vitus) and common pear (Pyrus communes) each appeared once in the scats although they were obtainable in fair amounts in the orchards or swamp.

Acorns (Quercus) and dogwood berries (Cornus) occurred once each in the 186 scats. The acorn was intact and may have been ingested along with some other food. The mast crop of red and white acorns was of meager quantity.

Young turnip leaves (Brassica) were present twice in small quantities.

Miscellaneous Material

Dirt and woody material occurred twice in the scats and each time made up more than one-half of the scat. Fox hair appeared once possibly as the result of the fox cleaning its fur. Paper was found twice in scats taken from the picnic area. The fox was seen on several occasions in this area. The number of scats collected in this area gave indication that the fox made use of available garbage or refuse left by picnickers.

A summary of the food items indicates that foxes are opportunists, taking any food available to them. It suggests that they do not have definite predilections for certain foods but that those foods which appear more often in their diet are more abundant and therefore more readily accessible. It appears that the fox returns to areas where food was previously found. Through daily visits to these areas containing a relatively high population or large amounts of the food item taken, the fox establishes a pattern of trails on his home range where he has made successful kills or found sufficient food to satisfy his immediate needs.

PROBABLE EFFECTS OF PREDATION ON FOOD

As stated before the cottontail rabbit suffered heavy losses from fox predation. Few rabbits were observed during the spring period. The bob-white quail disappeared from the area during the study probably due to weather conditions. At the end of the winter of 1945 the ring-neck pheasant population was low. During mating season 3 cocks and 1 hen were seen at different times. Although the fox preyed successfully, the number taken was not great enough to account for the low population. The ruffed grouse population seemed to be normal in the spring. Fox squirrels and red squirrels were not appreciably affected by fox predation. A study of a 16 foot square section of meadow land revealed 1 new meadow mouse nest and 3 old nests with a moderate amount of grass clippings and fresh scats present, indicating a normal population for the spring.

CHANGES IN POPULATION

A high population of foxes existed on the Mud Lake area for the 1944-45 season. The farmers reported a gradual increase in foxes since 1939.

Karl Brushaber, county game protector, reported that seven years ago, 1939, 25 to 35 foxes were killed in Washtenaw County. Since that time the number killed has increased 1 1/2 to 1 2/3 times each year until in 1945 150 foxes were killed in the county. He reported that only five or six foxes were taken from the area adjacent to and including Mud Lake. He believed that if a good trapper had worked the area a much larger number of foxes would have been taken.

A visit to the area on November 15, 1945, resulted in finding 5 fox scats, 3 of which were over a month old and 2 comparatively fresh -- possibly 2 days. Information obtained from the farmers of the region revealed no losses of poultry and no foxes seen during the summer. Two new dens located outside of the Mud Lake Area were found by Karl Leebrich. It is probable that some of the foxes moved to these dens when their original dens were destroyed. A trip to the range on January 19, 1946, disclosed the Detroit Sportsman Club holding a fox hunt.

From Mud Lake swamp they had jumped and killed 3 foxes on January 12, 1946, and on January 19, 1946, had shot and killed one fox near Independence Lake. Scattered red fox tracks were found in the swamp hardwood section of Mud Lake indicating this region is still being used by the fox but not as frequently as the preceding winter. No foxes were taken by trapping.

It is now evident that the fox population is on the decline in the area. Since most of the breeding dens were destroyed or made uninhabitable in the spring of 1945, the fox either migrated to adjacent areas or reared fewer young on the Mud Lake Range. The reduction of available food may also have caused the fox to hunt in the adjacent areas that were more plentifully supplied with food.

CONCLUSIONS AND SUMMARY

1. The red fox (Vulpes fulva) was studied on the Mud Lake Area from November 15, 1944 to May 31, 1945, in an attempt to determine whether some relationship exists between amounts of food taken and relative abundance of the various food items found on the area.

2. The reading and interpreting of "field sign" and the laboratory analysis of fox scats furnished the data for this study.

3. The food items found in this study were grouped in four major headings: mammal, bird, plant, and invertebrate.

4. The collection and analysis of 186 scats revealed the red fox to be primarily carnivorous, consuming 77% of mammal and bird material and 12.3% invertebrate against 10.7% plant. (See Chart 1.) Relative amounts of food available in the four major food groups varied over the seven month period studied. Seasonal and monthly variations of these food items appearing in the fox's diet are indicated by Charts 2 and 3.

5. During periods of deep snow and zero temperatures as illustrated by Charts 4 and 5, availability of most food items were greatly reduced except the rabbit.

This condition would account for the heavy predation suffered by this animal as shown by 85 occurrences (Table 1) in 186 scats and 22 kills (Table II). 11 kills and 3 caches occurred during the period of most inclement weather mainly January and February.

6. Seasonal and monthly variation in the diet of the red fox is indicated by Charts 2 and 3. The readiness of the fox to take any food item available in varying amounts--except a limited group consisting of moles and shrews that may be distasteful -- depends upon the relative numbers present. Individual food items such as rabbit occurring 85 times in 186 scats, meadow mouse 66 times, and corn 17 times show considerable monthly variations as indicated in Table 1. This suggests that a definite food preference does not exist but is the result of chance interception of the daily relative numbers of these food items present and available to the fox.

7. Domestic poultry losses can be reduced to a minimum if adequate protective measures are employed by the farmers. These methods include predator and rat proof chicken yards and buildings, a good farm watch dog, and preventing the poultry from ranging free in the fields and woods.

8. The population of foxes on the area has not been kept in check due to abundance of food and den sites on the area and an absence of a good trapper and lack of skilled fox hunters present during fox chases.

9. Losses sustained by the game birds, ring-neck pheasant, ruffed grouse, and bob-white quail are due more to unfavorable weather, poor nesting conditions, and lack of food than to the activities of the fox.

However when both fox and game birds are numerous a considerable number of ground nesting species will be taken.

10. All the data collected point to the fact that the fox is an opportunist. He eats what he can find or catch. His hunting follows a definite pattern developed through experience and modified according to seasonal availability of the various food materials.

11. Since 1939 there has been a great increase in the fox population reaching a maximum in 1944 and 1945. This peak has been followed in 1946 by a marked reduction in the number of foxes.

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APPENDIX

TABLE 2

Individual food items found in the field along trail, at dens, and at caches from November 13, 1944 to May 19, 1945.

<u>Item</u>	<u>Den</u>	<u>Trail</u>	<u>Cache</u>
Ringneck pheasant	1	1	1
Ruffed Grouse	1	3	
Chicken	2	1	
Pekin duck	1	1	
Crow		1	
Screech Owl		1	
Rabbit	3	19	3
Muskrat	2	3	
Opossum		2	
Skunk		1	
Ground hog	1		
Fox squirrel	2		
House mouse			1
Least shrew		1	
Cow		2	
Sheep	2	16	

Chart 1

Total Percentage Occurrences of Major Food Groups Taken by Red Fox
On Mud Lake Area For Period Nov. 15, 1944 To May 31, 1945

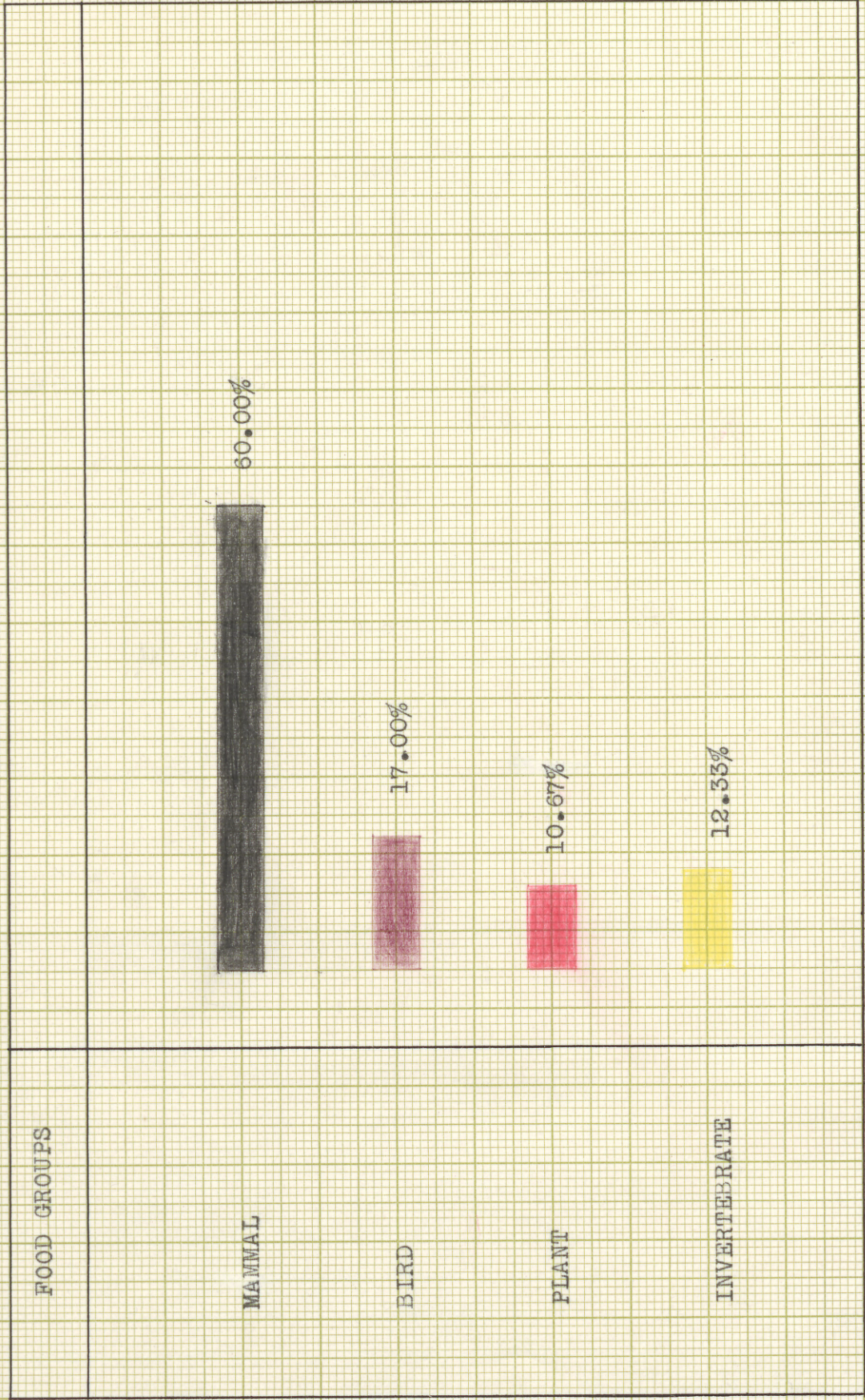


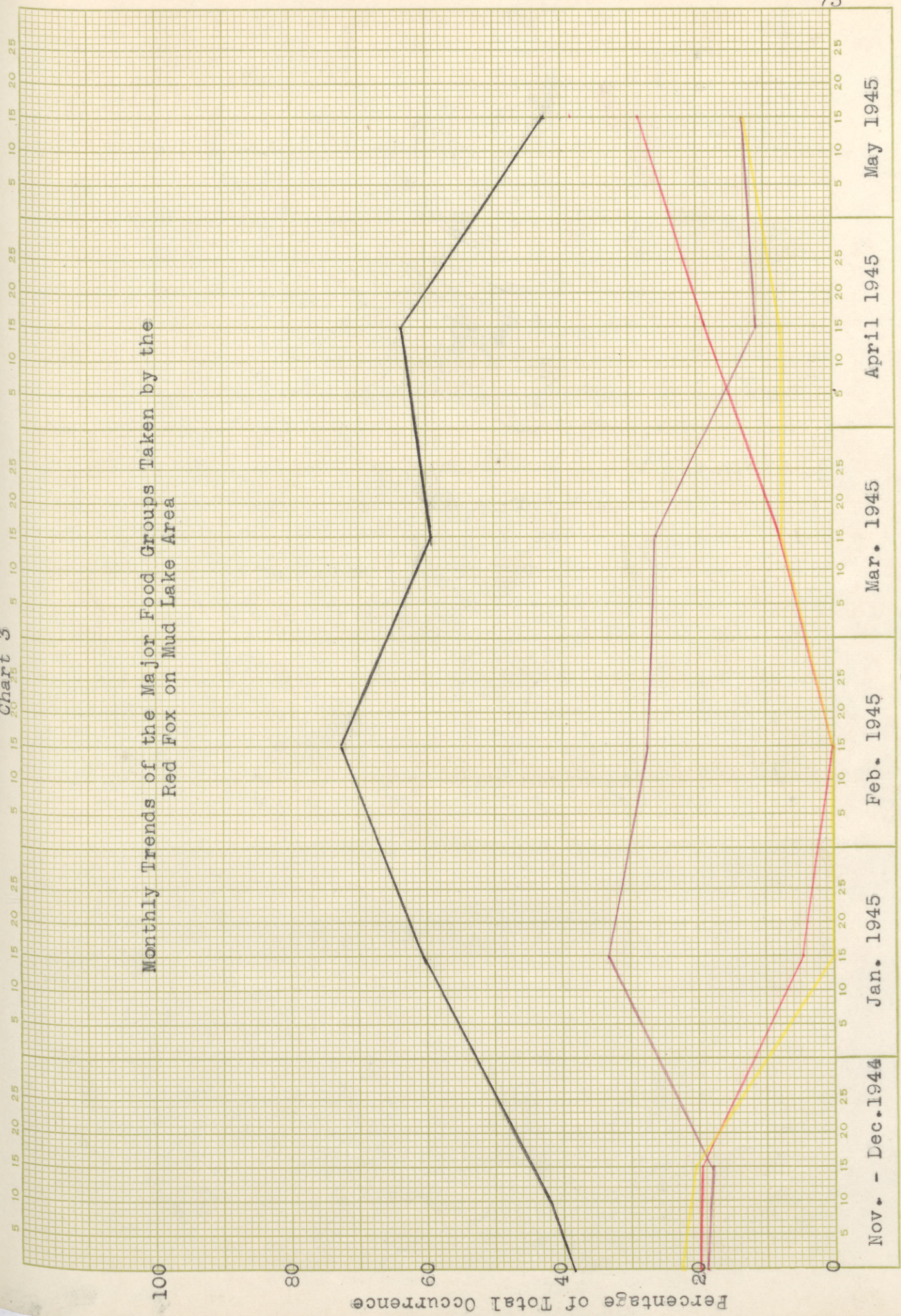
Chart 2

Seasonal Representations of Major Food Groups in the Red Fox's Diet
For Period Nov. 15, 1944 to May 31, 1945 Mud Lake Area



Chart 3

Monthly Trends of the Major Food Groups Taken by the Red Fox on Mud Lake Area

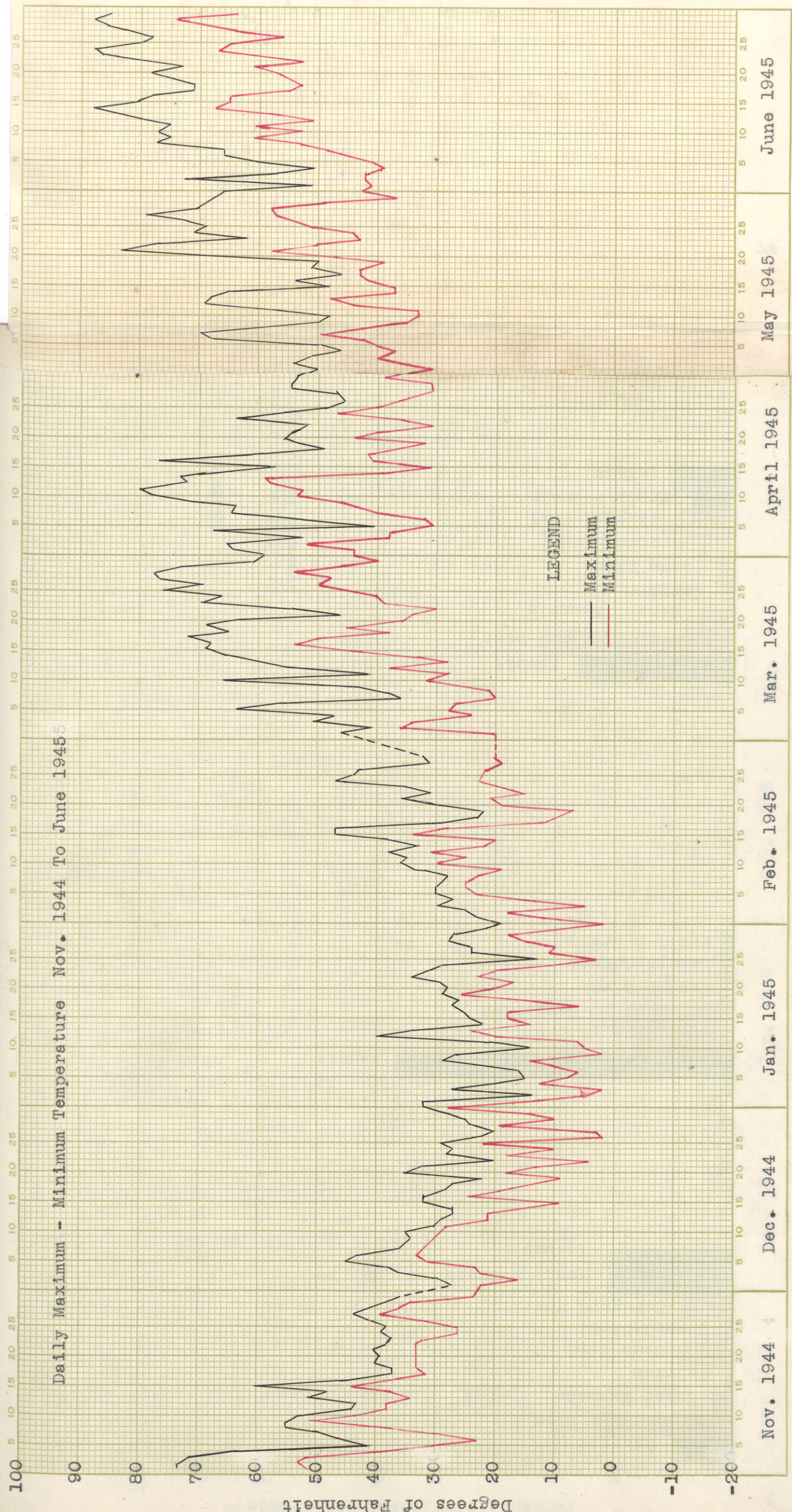


LEGEND

- Mammal
- Bird

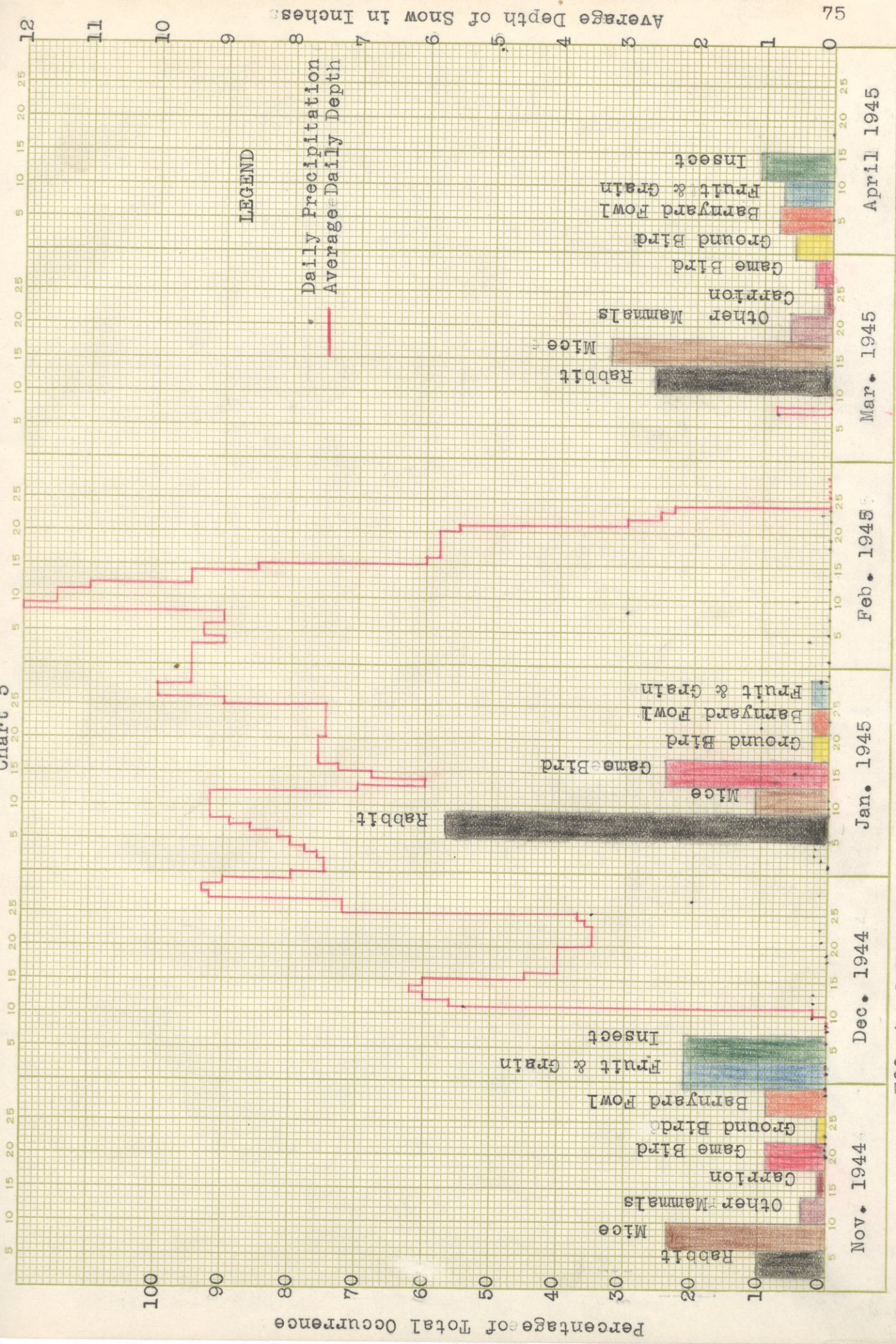
- Plant
- Invertebrate

Daily Maximum - Minimum Temperature Nov. 1944 To June 1945



LEGEND
— Maximum
— Minimum

Chart 5



Effect of Snow Depth on Seasonal Variation of Individual Food Items Taken by the Red Fox Mud Lake Area

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