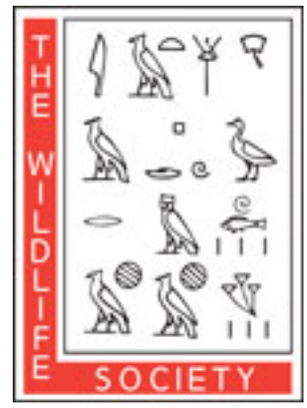

experiment in Sweetwater County where deer were damaging truck gardens and alfalfa crops. Deer did not enter the fields in sufficient numbers to make trapping economically practicable, but the few that appeared were caught without trouble.

During the entire experiment 170 deer were trapped. Of these, 28 escaped at the trap by jumping over the 7-foot panels; they barely wriggled over the top, and had the panels been six inches higher, probably none would have escaped. Eleven were killed, most of them before the trapping procedure was refined.

The Wyoming Game and Fish Department recognizes that only the rudiments of mass trapping have been worked out, but the experiments justify these conclusions:

(1) Mule deer can be attracted to desirable trapping areas for at least limited distances. (2) They can be caught in numbers, by inexpensive trapping. (3) Individual crating for transportation is unnecessary. (4) Under some conditions, deer can be driven into traps.

WINTER FOOD HABITS OF MINK IN SOUTHERN MICHIGAN[1]

John A. Sealander
Michigan State College, East Lansing, Michigan

The mink (*Mustela vison mink*) generally is about second in annual fur value among fur-bearers in Michigan. About 50 per cent of those trapped are taken from the southern half of the Lower Peninsula, which includes most of the good agricultural land in the state and yields most of the annual fur crop (Hayne, 1941).

There has been much recent controversy over the relationship of the mink to the muskrat and to game birds. Unlike some other fur-bearers, the mink has survived and even increased, despite intensive trapping, hunting, and reduction of suitable habitats in agricultural areas. Trappers and fur-buyers complain vociferously about its inroads on the muskrats. The computed kills in the study area, compiled from trappers' report cards to the Michigan Department of Conservation, tend to substantiate their conclusions in respect to population trends among mink and muskrats.

Because of the importance of the mink and its relations to other fur-bearers, especially the muskrat, it seemed desirable to gather data on the food of mink during the critical winter period when many animal populations are waning and predation may be serious. It is easy to obtain material for study from trappers and fur-buyers at this season.

The present study lacks the completeness of a year-round study but those of Dearborn (1932) and Hamilton (1936, 1940) serve to bridge the gap.

[1] B. T. Ostenson, Michigan State College, kindly criticized the manuscript.

MATERIALS AND METHODS

Most of the carcasses were obtained during the winters of 1940 and 1941 from fur-buyers in southern Michigan, including the following counties: Allegan, Barry, Berrien, Branch, Calhoun, Cass, Clinton, Eaton, Genesee, Hillsdale, Ingham, Ionia, Jackson, Kalamazoo, Shiawassee, St. Joseph, Van Buren, and Washtenaw. All were taken during the legalized trapping season in December and the stomachs and intestines were removed in the laboratory, where the date and locality of capture for each was recorded on a parchment tag; the radius from which fur-buyers secured their animals from trappers was kept in mind.

Besides the 158 carcasses from fur-buyers, 43 stomachs from southern Michigan taken during the winters of 1938 and 1939 were provided by A. E. Woodhead, of the University of Michigan.

Some stomachs and intestines examined were empty and others contained unrecognizable amorphous mixtures of dirt and black protein waste, grasses and aquatic plants, and debris such as sticks, trap pads, and toes chewed off by the trapped mink. Much of this was incidental, to be expected in predators which capture and eat small prey or carcasses on the ground. Whether an animal deliberately eats dirt or vegetation to relieve vitamin or mineral deficiencies is problematical, although ingestion of such material may be of nutritional importance. After discarding the preceding there were 102 stomachs and 101 intestines useful for appraising the winter diet. Analyses of intestinal contents were used to supplement data from the stomachs where possible. The combined data for the four-year period are not strictly comparable, however, since intestinal analyses were made only on specimens taken during 1940 and 1941.

Usually only a single item of food was represented in the stomach and intestines of an animal. That in the stomach was generally chewed into pieces $\frac{1}{2}$ inch or smaller and the fleshy material usually was partially digested. Small mammals, fish, and crayfish were more thoroughly chewed than larger prey. Since the intestinal contents could not be separated easily, an estimate of the relative proportions of each item to the total bulk was made by inspection when more than one item was represented. A wider margin of error obtains in the volumetric measurements for the intestines than for the stomachs. Identifications based on hair, teeth, feathers, scales, etc., were as specific as possible.

To facilitate comparison with other studies, both volumetric and frequency percentages of the prey are given. The number of individuals of each represented in the diet is also included to make a comparison of stomachs and intestines possible and to allow a proper evaluation to be placed on the smaller items. The percentage occurrence emphasizes items present in many stomachs even though of small bulk, whereas the volumetric method provides the best indication of the foods which furnished the bulk of the sustenance.

DISCUSSION OF RESULTS

Nelson (1918, p. 472) has aptly said that, "Few species are more perfectly adapted to a double mode of life than the mink. It is equally at home slyly searching thickets and bottomland for-

ests for prey or seeking it with otter-like prowess beneath the water." This is amply borne out by the results of my analyses (Table 1) since aquatic and non-aquatic prey items are about equally represented. All of the mink examined appeared to be exclusively carnivorous. Any grass or other debris was present only in very small quantities and usually associated with the smaller items of prey suggesting that it was taken incidentally. Therefore such material is not considered as a regular part of the diet.

TABLE 1.—FOOD OF WINTER MINK IN SOUTHERN MICHIGAN

	Individual items		Percentages			
			By volume		Occurrence	
	Stomach	Intestine	Stomach	Intestine	Stomach	Intestine
MAMMALS						
Muskrat (*Ondatra z. zibethica*)	37	24	*31*	*18*	*36*	*24*
Cottontail (*Sylvilagus f. mearnsii*)	15	16	*14*	*11*	*15*	*16*
Meadow mouse (*Microtus* sp.)	8	8	*5*	*10*	*8*	*8*
Deer mouse (*Peromyscus* sp.)	4	4	*4*	*6*	*3*	*4*
Pine mouse (*Pitymys p. scalopsoides*)	3	2	*1*	*3*	*3*	*2*
House mouse (*Mus m. musculus*)	1	1	*1*	tr.	*1*	*1*
Short-tailed shrew (*Blarina b. brevicauda*)	2	4	tr.	*3*	*2*	*2*
Star-nosed mole (*Condylura cristata*)	—	2	—	*1*	—	*2*
Long-tailed shrew (*Sorex* sp.)	—	1	—	*1*	—	*1*
Prairie mole (*Scalopus a. machrinus*)	1	—	tr.	—	*1*	—
Brown rat (*Rattus norvegicus*)	1	1	tr.	tr.	*1*	*1*
Snowshoe hare (*Lepus a. americanus*)	—	1	—	tr.	—	*1*
Unidentified mammals	—	2	—	*1*	—	*2*
Total mammals	72	66	*56*	*54*	*70*	*64*
BIRDS						
Pheasant (*Phasianus c. torquatus*)	5	2	*7*	tr.	*5*	*2*
Coot (*Fulica americana*)	1	—	*4*	—	*1*	—
Domestic chicken (*Gallus domesticus*)	2	2	*3*	*1*	*2*	*2*
Ruffed grouse (*Bonasa u. umbellus*)	—	1	—	tr.	—	tr.
Egg (Chicken)	—	1	—	*1*	—	*1*
Unidentified birds	5	2	*1*	*3*	*5*	*1*
Total birds	13	8	*15*	*5*	*13*	*6*
REPTILES						
Unidentified snakes	2	1	*2*	tr.	*2*	*1*
AMPHIBIANS						
Green frog (*Rana clamitans*)	7	—	*9*	—	*4*	—
Leopard frog (*Rana pipiens*)	8	3	*6*	*2*	*7*	*4*
Bull frog (*Rana catesbeiana*)	3	—	*3*	—	*3*	—
Spring peeper (*Hyla crucifer*)	1	—	tr.	—	*1*	—
Unidentified frogs	8	6	*2*	*5*	*8*	*6*
Total amphibians	27	9	*20*	*7*	*23*	*10*
FISH						
Centrarchids	6	7	*3*	*4*	*6*	*7*
Catastomids	2	3	*1*	*3*	*2*	*3*
Cyprinids	1	3	*1*	*4*	*1*	*3*
Cottids	—	1	—	tr.	—	*1*
Unidentified fish	2	2	*1*	*1*	*2*	*2*
Total fish	11	16	*6*	*12*	*11*	*16*
ARTHROPODS						
Crayfish (*Cambarus*)	6	18	*2*	*17*	*6*	*18*
Unidentified insects	—	3	—	*4*	—	*3*
Total arthropods	6	21	*2*	*21*	*6*	*21*

The volumetric percentages for small mammals, fish and crayfish as well, tend to be larger for the intestines than for the stomachs, whereas for larger mammals the opposite seems true. Of larger mammals chiefly the fleshy parts are eaten entire; the percentage differences presumably are the result of differential digestive action, as the materials traverse the digestive tract. Small mammals and crayfish are eaten whole and have a larger proportion of indigestible parts, hence increase proportionately in volume while passing from the stomach into the intestine. This must be kept in mind when comparing analyses of scats, and of stomach and intestinal contents.

More crayfish were found in the intestines than the stomachs, but the reverse was true for frogs, suggesting differential rates of passsage for certain food items. Hard indigestible materials apparently are passed rather quickly into the intestine, but fleshy pieces are retained for a longer time in the stomach. Mammals, birds, and fish in which the relative proportion of soft to hard parts approaches neither extreme probably pass at rates intermediate between those for frogs and crayfish. Dearborn (1932, pp. 14–15) and Errington (1935, p. 197) have noted differential retention of food material in the stomachs and intestines of minks and foxes.

The findings reported here tend to corroborate those of Dearborn and Hamilton in most respects, save that birds and frogs were taken more frequently and fish less often. The greatest discrepancy is between my findings and those of Hamilton. Abundance and availability undoubtedly affect the proportions in which prey items appear in the diet. To learn clearly the general food habits of an animal food habits materials must be collected over its entire range for a period of years.

TABLE 2.—SEX DIFFERENCES AS TO FOOD OF WINTER MINK IN SOUTHERN MICHIGAN, 1938–41

	Individual items				Percentages							
					By volume				By occurrence			
	Male		Female		Male		Female		Male		Female	
	Stomach	Intestines	Stomach	Intestines	Stomach	Intestines	Stomach	Intestines	Stomach	Intestines	Stomach	Intestines
Muskrat	27	20	10	3	*43*	*22*	*14*	*6*	*49*	*36*	*23*	*8*
Cottontail	9	8	5	5	*16*	*10*	*12*	*6*	*16*	*14*	*12*	*14*
Small mammals	6	9	12	13	*5*	*18*	*17*	*33*	*9*	*16*	*28*	*36*
Large birds	6	5	3	2	*18*	*7*	*11*	*2*	*11*	*9*	*7*	*5*
Small birds	1	—	3	1	tr.	—	tr.	tr.	*2*	—	*7*	*3*
Snakes	1	1	1	—	*2*	*1*	*2*	—	*2*	*2*	*2*	—
Frogs	11	4	15	5	*10*	*4*	*37*	*17*	*16*	*7*	*26*	*14*
Fish	4	6	6	10	*5*	*11*	*4*	*24*	*7*	*11*	*14*	*27*
Crayfish	3	8	3	8	*1*	*22*	*3*	*12*	*5*	*14*	*7*	*22*
Insects	—	3	—	—	—	*6*	—	—	—	*5*	—	—

SEX DIFFERENCES IN FOOD HABITS

Upon separating the data for males and females, surprising differences were seen in the numerical and percentage representations of some items. There was an apparent discrimination by sex as to size of prey items taken (Table 2).

More muskrats were taken by male mink than by females, and the differ-

ences, as shown in both stomach and intestinal analyses, were highly significant by the χ^2 test; χ^2 values of 7.62 for the stomachs and 10.20 for the intestines were obtained. Both values are of one per cent significance; hence the differences would be due to chance only once in a hundred times. The differences between males and females for numbers of small mammals in stomachs and of fish in the intestines were of five per cent significance—due to chance about once in twenty times. No significant differences were found between the other items taken by the two sexes. No widely disproportionate number of either sex was taken during any one year, hence significant differences cannot be attributed to any particular year.

Females apparently take smaller prey more often than do males. Some male mink weigh twice as much as an average female. Smaller females may deliberately hunt small animals which they can master easily, and large powerful males may prefer to hunt bigger prey to satisfy their appetities more quickly. There was no significant difference in the numbers of cottontails taken by the two sexes, possibly because a cottontail is not so formidable to a female mink as is a muskrat. Another factor is the cruising radius of the two sexes. Marshall (1936) found that a female mink tends to remain in an area not exceeding twenty acres, whereas a male cruises an area too large to be estimated accurately. It seems logical to assume that the wider ranging males will encounter more muskrats than do females. In areas lacking concentrations of muskrats the proportion taken by males should be larger. The females must take most of their sustenance from smaller prey. Also the females seem more retiring or wary in the period prior to the spring breeding season and are not then caught in exposed situations as readily as are males. By frequenting less exposed situations the females then might have fewer encounters with muskrats which would be reflected in the diet.

ANNOTATED LIST OF FOOD ITEMS

The following list of items in the winter diet of mink is included so that material not noted elsewhere might be mentioned. The text also contains references to diagnostic items useful for identification.

Mammals. Mammals comprised over 50 per cent of the diet by both volume and frequency of occurrence. Muskrats were easily first, cottontails and meadow mice being of lesser importance. The mink appears to be an important winter predator on muskrats, but the author has information suggesting that the net effect of mink predation may be minor in comparison with other limiting factors on muskrats. Meadow mice were not represented in the 1938 and 1939 stomachs, possibly indicating low poplations in those years. Blair (1940, p. 161) states that meadow mice were scarce in southern Michigan in the summer of 1939 in contrast with their abundance in 1938; decimation of the population may have occurred during the winter of 1938. The remainder of the mammalian food consisted of mice, shrews, moles, and one snowshoe hare. The snowshoe hare at present is known only in the "thumb" region of southern Michigan and the mink in which the hare was found came from the northeastern part of the study area close to

the "thumb"; it is presumed, therefore, that the snowshoe hare occurs south at least to Genesee County.

Materials most useful in identifying remains of mammals to genera were hair, teeth, and claws. Few mink contained bones or teeth which could be used; most of the identifications were based on cross sections, cuticular scale patterns, and medullary patterns of guard hairs.

Birds. Remains were found more often in the stomachs. By volume and frequency pheasants and chickens formed the largest percentages. Pheasants are evidently important to the mink although the stomach and intestinal analyses vary as to the amounts present. Domestic chicken is not important as compared with other items. Remains of a coot comprised the contents of one stomach. Since this bird migrates in the autumn it was likely a cripple. Ruffed grouse feathers were found in one intestine. Most of the unidentified birds were small passerines. One was evidently a cardinal, but could not be identified certainly. Size, shape, and color pattern of feathers proved to be most useful for identification when compared with known specimens. Sturgis' breast feather key to orders (Wight, 1939) was helpful in verifying identifications but the action of digestive juices on the feathers and accumulations of grease and gummy protein wastes which could not be removed satisfactorily mitigated its value somewhat.

Reptiles. Relics of snakes were rather infrequent and specific identifications were not possible.

Amphibians. Relative percentages of frogs entering into the diet over a four year period seem to indicate that, together with small mammals, they may serve in a buffering capacity against predation upon the muskrat. The characteristic color patterns of the skin were most useful in determining species; bones, feet, and skin served to identify items listed as "frogs."

Fish. Usually fishes were identified only to families because the scales were digested. Remains of a few small mouth black bass and bluegills were identified positively, and a miller's thumb was recognized by its characteristic otoliths.

Arthropods. Specific identifications of crayfish and insects were not attempted because of the thoroughness with which most of them had been chewed.

SUMMARY

A study of 102 stomachs and 101 intestines of mink from southern Michigan taken during the legalized trapping season in December over a four-year period yielded results as follows: Mammals constituted over 50 per cent of the winter food by bulk and by frequency. The remainder consisted of birds, snakes, frogs, fish, crayfish, and insects.

Muskrat was the most important individual prey item; cottontail ranked second and meadow mouse third. Of lesser importance were deer mice, pheasants, green and leopard frogs, and crayfish. Nonfood items present were mixtures of dirt and black protein waste, vegetation, and debris.

Differential rates of passage for hard and soft parts of prey were indicated, the former reaching the intestine more rapidly.

Males took significantly more muskrats than did females; the reverse was true for smaller food items. The size of

a mink may determine the size of its prey. Females, because of their smaller size, may deliberately select smaller prey, whereas large powerful males may do the opposite. The wider ranging males also may encounter muskrats more frequently than do the females.

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