To be published in
The Journal of Wildlife Management

Original: For publication
cc: Fish Division
Institute for Fisheries Research
Education-Game
Dr. Lagler
Mr. Ostenson

April 16, 1942

REPORT NO. 773

Early spring food of the otter (Lutra c. canadensis) in Michigan[1]

Karl F. Lagler and Burton T. Ostenson

The otter had year-round protection in Michigan for fifteen years prior to 1940. In the years immediately following 1920, it seemed that this animal faced virtual extirpation from the State, consequently a closed season was declared in 1925. Apparently as a result of this protection and of general improvement in its habitat, due in part to more effective forest fire control, the otter reestablished itself in sufficient numbers to again become a noticeable part of the animal life of the waterways of northern Michigan. With this increase came protests from trout fishermen that the depredations of the otter were seriously affecting their angling success. Beaver trappers too began to complain since the only legal disposition that they could make of the increasing numbers of otters caught in their beaver traps was to turn the animals over to the Conservation Department. Such takes brought no profit to the trapper and often meant the loss of good beaver sets.

In response to these complaints and to obtain materials for a better understanding of the place of the otter in the economy of Michigan fish and game, the Michigan Conservation Commission opened the season on otters

[1] Contribution from the Departments of Zoology of the University of Michigan and of Michigan State College and from the Institute for Fisheries Research of the Michigan Department of Conservation.

in the springs of 1940 and 1941. The period legalized for trapping was made to coincide with that for beaver, although certain counties open for beaver remained closed for otter. In both years the season extended from April 1 to 15, inclusive, in the Upper Peninsula. In the Lower Peninsula in 1940 the period was from March 20 to April 10, inclusive, and in 1941, from March 20 to April 3, inclusive. Almost all of the otters were taken after the spring break-up, which occurred approximately during the middle of the legalized period in each area during both years.

Trappers were required by regulation to turn in the carcasses of trapped otters to conservation officers, at which time the pelts were officially sealed. The officer receiving the carcass was instructed to record information as follows on blanks provided: Specific locality; date; and kind of water (trout, non-trout). From these reports for 1940 Mr. S. C. Whitlock of the Game Division of the Department of Conservation has prepared a map (Fig. 1) showing the place of capture of 255 out of the total of 266 animals and whether from trout or non-trout waters. The distribution for 1941 is much, though not exactly, the same. In 1940, 266 otter were taken (173 from trout waters, 83 from non-trout, and 10 unclassified) and in 1941, 173 were trapped (124 from trout waters, 39 from non-trout, and again 10 unclassified). In all 439 otters were trapped during the two open years.

A tag bearing locality data or other means for identification was usually attached to each carcass by the officer. Unfortunately, however, a number of carcasses were not so identified and on others the label became blood-soaked and illegible or was accidentally torn off in subsequent handling. Not all of the specimens ultimately available for food, parasite, and life history studies had sufficient data to permit their classification

as to origin from trout or non-trout waters.

Most of the carcasses were sent from the field to the Game Division Laboratory in East Lansing. Presumably the others were unsuitable for shipment because of decay. Mammalogical data were recorded by Ostenson for a life history study in preparation by him, and the stomachs and intestines, or only their contents when a parasitological examination was made, were preserved in 10 per cent formalin or 70 per cent alcohol. The formalin solution proved to be the better preservative since its fixation of fleshy materials was more complete, thus facilitating subsequent identifications of food items.

The long-range objectives to which this food study of the otter may contribute vital data are two. One is a management program for this fur-bearer; the other is the monograph of predation on fishes in preparation by Lagler. The particular study here reported deals with the spring food of the animal and it is essential to know if at this time of year the otter is an undesirable predator of fishes, for, if it is, continued open seasons may be partially justified. In addition, information on the interactions of predator and prey and on the relationships of prey species among themselves is given. A comparison and appraisal of findings obtained from analyses of the contents of stomachs and intestines with those of scats is also made.

Acknowledgements

We thank H. D. Ruhl of the Game Division for the opportunity to conduct this investigation. We are indebted to Dr. S. C. Whitlock for permission to use the map that he prepared and for his care and kindness in preserving contents of the digestive organs. We acknowledge with gratitude

the efforts of personnel of the Field Administration Division in handling the material in the field.

The Fish Division, through its Institute for Fisheries Research, hired assistants, Carl B. Obrecht and George V. Marry, to prepare the material for identification and otherwise aid in this study.

Professor Carl L. Hubbs identified some of the fish remains and Clifford Berg, some of the aquatic insects. Dr. Josselyn Van Tyne determined the hawk and Dr. H. H. Wight verified our identification of a snowshoe hare. Drs. A. S. Hazzard and W. H. Burt critically read the manuscript and offered valuable suggestions. To these individuals and to the others who have helped us in this work, we offer our sincere thanks.

Procedure

The methods employed in the study of the food of those fish predators which swallow their food without chewing have been outlined by Salyer and Lagler.[2] Only the departures from this technique employed in the analysis of otter foods are mentioned here.

Food in the digestive organs of the otter had usually been chewed into bits 1/4 to 1/2 inch long or smaller and was always at least partially digested. Fish scales and otoliths, bones, and chitin all gave evidence of some dissolution. Fishes as small as 2 or 3 inches in length were often chopped into several pieces; few, even of this small size, were swallowed whole. Crayfishes were always particularly well chewed.

The intestinal contents consisted chiefly of incompletely digested hard parts of food organisms, such as fish scales and fin rays, bones, and pieces of the exoskeletons of crayfishes and insects. These fragments were

[2] Salyer, J. Clark, II, and Karl F. Lagler. 1940. The food and habits of the American Merganser during winter in Michigan, considered in relation to fish management. Journal of Wildlife Management, 4 (2): 186-219.

enmeshed in a "rope" of mucus about half an inch in diameter that extended throughout the entire length of the intestinal tract. Separation of food particles from this mucus (the possible function of which is to protect the intestinal lining from abrasion by the hard, sharp fragments of food items) and from the mucosa of the intestinal wall presented a serious problem. No accurate inspection was possible in the presence of this gelatinous, flocculent matter. After trying several methods, including futile attempts at dissolving the mucus and mucosa, fragmentation by agitation was found to be most successful.

The intestinal contents of each otter were placed in a jar, a tablespoonful of No. 5 lead shot added, and the jar covered and shaken until the coagulated mucoid material was broken into bits or, instead, an egg beater was used to fragment the mucus. Most of this and any food particles smaller than 1/20 inch in diameter would then pass through the No. 20 screen into which all was poured. Examinations of strained material showed loss of hard parts to be negligible but most of the small amounts of flesh reaching the intestines passed through the mesh of the sieve. The percentages of volume of food remains from intestines are thus averages of estimates of proportions by bulk as determined by inspection after straining; these percentages are not based on measured volumes as are those for stomach contents. From the point of view of technical validity, the tabular data presented in the results of the analyses of the contents of these two organs are thus not strictly comparable.

Occasional bits of vegetable debris such as a leaf of jack pine, balsam fir, or white cedar, or a small fragment of dead grass or bark were presumed to have been taken incidentally and were not considered as food. Such vegetable matter was apparently unaltered by the digestive juices.

Results of food studies

Due to losses in handling and to faulty preservation only 376 of the total number (439) of otters trapped became available for food study. These were grouped as to those taken from trout waters (187), those from non-trout waters (105), and those lacking sufficient locality data to permit placement in either of the two previous categories (64). The findings for the first two groups are treated separately, and those for all three are then combined. It was impracticable to combine stomach and intestinal contents for individual otter, so they are treated separately.

Food of otters from trout waters. Of the 187 otters from trout waters, food was contained in the stomachs of 95 and in the intestines of 133.

The food remains (761.8 cc.) in the stomachs (Table 1 and Fig. 2) were composed largely of forage fishes (35.9 per cent) principally mudminnows,[3] muddlers, and minnows. Amphibians (frogs and mudpuppies) were next in importance (25.3 per cent) and game and pan fishes, mostly trout and bass or sunfishes, next (22.7 per cent).

Forage fishes apparently constitute effective buffers against otter predation for the game and pan species in trout-water habitats since they are eaten frequently (in 63.2 per cent of the stomachs) in goodly numbers, and in significant bulk as indicated. Fish remains, such as fragments of ribs, vertebrae, and fin rays most likely represent species identified from other parts.

Crayfishes were found in several of the stomachs (42.1 per cent), but constituted only a small proportion of the total food from these organs

[3] Scientific names of food items given on pp. ____.

(7.4 per cent of the volume). In the intestines, however, the bulk (37.8 per cent) of these crustacean remains was disproportionately large owing to the persistence and accumulation of hard parts.

Vertebrates other than fish and amphibians, insects, and snails constituted the remainder of the food. The vertebrates (a Goldeneye duck, and some unidentified flesh) contribute some bulk (4.5 per cent), but the insects, although rather consistently taken, lend little to the total volume (0.4 per cent). The small snails found as a trace in one intestine were not more than 4 mm. in length and may have been ingested accidentally by the otter or have been taken secondarily within some other food organism. This latter possibility was obviously the explanation for the infrequent occurrence of smaller insects occasionally found in the intact stomachs of fishes taken from the same organ of the otter. These were not listed as otter food. Large water beetles and bugs were quite certainly taken primarily.

Food of otters from non-trout waters. The stomachs of 40 and the intestines of 51 of the 105 otters taken from non-trout waters contained food (Table 2 and Fig. 3).

Game and pan fishes in this instance constituted by far the most prominent food group (65.3 per cent by volume) in the stomachs. As might be expected, however, because of nearly complete digestion, they appear less significant in the intestines (21.0 per cent). Forage fishes were present about as often as game species and in about the same numbers in the stomachs, but represent about one-sixth as much volume as do the game fishes. This disparity seems obviously due to the greater average size of the game species.

Amphibians, including frogs and mudpuppies, appeared quite prominently in otters from non-trout waters where they made up a little more than an

eighth of the bulk of the food found in the stomachs. Portions of 14 frogs and 7 mudpuppies were recognized in the stomachs and intestines.

Only a small amount of the volume (3.7 per cent) of the food in stomachs was composed of crayfishes although they occurred in one-fourth of these organs that contained food. As expected for reasons previously given, these crustaceans assume considerably greater volumetric significance and occur more often in the intestines than in the stomachs.

Discussion and summary

As is generally known from scat analyses, fishes, crayfishes, and amphibians are the predominant items in the food of the otter. Trautman [4] analyzed 600 cc. of scats collected on April 14, 1936, from the inlet of Pickerel Lake, Dickinson County, Michigan. The remains of food items in these droppings were as follows: 65.8 per cent, minnows and suckers; 27.5 per cent, crayfishes; and 6.7 per cent, a miscellany of fragments of plants, large aquatic beetles, and of a snail.

Analyses of the total collection of the Game Division's 568 otter scats, to 1938, presumably made by the U. S. Bureau of Biological Survey, showed that "fish remains found in 57.6 per cent of the scats were unidentifiable as to species. Trout remains, if present, were too fragmentary to be identified. Frogs, crayfish, and diving beetles appear to form an extremely important part of the winter food of the otter." [5] It should be noted that these statements are based on winter feeding, and

---

[4] Milton B. Trautman, 1936. Analysis of a collection of otter scats from the inlet of Pickerel Lake, Dickinson County, Michigan. Institute for Fisheries Research Report No. 367. Typewritten. 2 pp.

[5] Michigan Department of Conservation. 1938. Ninth Biennial Report, 1937-38 (1938): 229.

also on scat analyses. The dominance of crayfish, insect, and frog material found may be due to the misleading nature of scat evidence as described elsewhere in this paper or it may evidence seasonal variation in feeding habits.

The material that we have studied permits more specific determinations of food items than in scat analyses, and more accurate estimations of size and enumerations of individuals consumed, and yields reliable information on the relative importance to the otter of the organisms eaten (see Annotated List of Food Items).

In the tabular (Table 3) summaries of our findings on the food of the otter in early spring, we have added the information obtained from 38 stomachs and 36 intestines (of 47 otters) from unknown localities to that for specimens from trout and non-trout waters. The total thus becomes 173 stomachs with 2316.5 cc. of food and 220 intestines.

The considerable proportion (25.8 per cent) of the total volume of stomach contents represented by vertebrates other than fishes and amphibians (Table 3) is due mostly to the presence of a large part of a snowshoe hare in one stomach, of a Red-shouldered Hawk in another, and of a Goldeneye in yet another. These obviously are not staples in the food of the otter and may or may not have been carrion. Their atypical incidence and occurrence in such bulk must be kept in mind when comparisons are made between food groups in stomachs with those in intestines. The percentage of volume for fish, for example, would be seen to decrease markedly from stomachs to intestines if the proportions in the former were not upset by the "abnormally" large volume of hare and birds.

Since fishes and amphibians have relatively large proportions of soft parts, they may be expected to become less and less significant in bulk

as they pass through the alimentary canal, in spite of some accumulation. Crayfishes and insects have proportionately more indigestible hard parts and these arthropods come to make up more and more of the volume of food remains as they travel the same course. These facts have direct implications for the degree of validity of three sources of information on which food studies of the otter are based; namely, on contents of stomachs, of intestines, or of scats.

From the volumetric point of view it is concluded that the findings for the stomachs disclose far better the relative importance of the various food items than do those for intestines (barring the atypical occurrence of such bulky, fleshy foods as the hare and birds). Scat analyses would be least valid when considered in this way because of the still greater effects on scat contents of digestion and accumulation of undigestible food remains. Making a similar comparison regarding the percentage frequency, disparity in representation of each food group from stomachs to intestines is not so great. A similar tendency may, however, be noted.

The adequacy of our material for depicting the early spring food of the otter in the area studied is evidenced by the rather close identity of the data for each year when considered separately. This comparison was made and only minor differences were found to obtain.

It is unfortunate that our efforts to learn of the frequency of feeding and of the daily food requirements of the otter have been fruitless to date. When this information has been gained we may be able more critically to interpret for their management implications the kinds, relative amounts, numbers, sizes, and frequency of the items found in the food.

Annotated list of food items

The following list of organisms found in the spring food of the otter provides technical designations for the common names used in the text and includes information as to some of the hard parts which persist and are useful for identification purposes. Materials that disclose something of the feeding habits of the otter, such as sizes and habitats of prey species, are also mentioned here.

Game and pan fishes.

Salmonidae—Trout. Most remains of trout were not specifically identifiable. Diagnostic for this group were the maxillary, premaxillary, and dentary bones and their dentition, and the last several vertebrae. The sizes of the trout eaten ranged from 2 3/4 to 9 inches, averaging about 4½ inches in total length. Species identified were the brook trout (Salvelinus f. fontinalis), the brown trout (Salmo trutta fario) and the coast rainbow trout (Salmo gairdnerii irideus).

Ameiurus spp.—Bullheads. Some were identifiable as the brown bullhead (A. n. nebulosus). Of particular value for recognition were cleithra [6] and the "spines" of the pectoral fins. The average total length was about 5 inches.

Esox lucius—Northern pike. Identifications were aided by the characteristic stout teeth and by the scales. The specimens found were usually of considerable size, averaging approximately ten inches.

Perca flavescens—Yellow perch. Commonly found in sizes smaller than an estimated 5 inches, total length. The serrate preopercle, the opercle, scales, and otoliths are among the chief bases for determinations.

---

[6] Bones of the pectoral girdle.

Centrarchidae—Bass and sunfishes. Some remains, usually scales, were identifiable only as "bass or sunfish." In other instances Lepominae (sunfishes) were evidenced either as such or often more specifically as pumpkinseeds (Lepomis gibbosus), bluegills (L. m. macrochirus), Great Lakes longear sunfish (L. megalotis peltastes), and rock bass (Ambloplites r. rupestris). Reconstructed sizes ranged between 2 and 4 inches. Pharyngeal teeth and scales were particularly helpful in identification.

Forage fishes.

Catostomidae—Suckers. Most remains of suckers were identifiable only to family, this on the basis of scales and comb-like pharyngeal teeth. Some, however, were definitely of the genera Moxostoma and Catostomus. A few in the latter were the common sucker (Catostomus c. commersonnii). Although large suckers are sometimes classed as "coarse fish" rather than as "forage fish", the average small size of the individuals found permitted their classification as the latter. One sucker was estimated to have been 16 inches long; all the others apparently were 7 inches or less in total length, averaging about 5 inches.

Cyprinidae—Minnows. Pharyngeal teeth or fragments thereof provided the most valuable evidence for recognizing the presence of minnows and for enumerating them. Identifications of some of the members of this family were also facilitated by this means as well as by the scales. The size of individuals where estimations were possible ranged between 1½ and 5 inches although some of the creek chubs and one common shiner were larger. Species determined were: western blacknose dace (Rhinichthys atratulus meleagris); Great Lakes longnose dace (Rhinichthys cataractae); northern creek chub (Semotilus a. atromaculatus); northern redbelly dace (Chrosomus eos); western golden shiner (Notemigonus crysoleucas auratus); blackchin shiner (Notropis heterodon); bluntnose minnow (Hyborhynchus notatus).

common shiner (Notropis cornutus);

Schilbeodes sp.—Madtom. The remains of a madtom was found in the intestine of one otter.

Umbra limi—Mudminnow. The most important single fish species in the food examined was the mudminnow. In stomachs the caudal peduncle with its dark, sub-terminal vertical bar provided a ready means for identification and enumeration whereas in the intestines scales and opercles were most usable for the purpose. The unique arrangement of the circuli on the scales of the mudminnow separates it at once from all other fishes of the region. Individuals ingested by the otter average a little less than 3 inches in total length; one individual was estimated to have been 4 inches long. The high incidence and numbers in which these fish occurred suggests that otters grub in the mud which is the special environment of the mudminnow at this season, and at all times is an important escape cover. That this fish dives into the mud when pursued is well known.

Etheostomatinae—Darters. Only three species of this percid subfamily were recognized: the Johnny darter (Boleosoma nigrum); the barred fantail (Catonotus f. flabellaris); and the Iowa darter (Poecilichthys exilis). The few individuals found were 2 3/4 inches or less in length.

Cottidae—Muddlers. These characteristic inhabitants of cavities under stones on riffles of streams perhaps come second in importance to the mudminnows among the forage fishes eaten by the otter in early spring. The abode of stream-dwelling muddlers coincides with that for certain crayfishes. This apparently renders both of these organisms particularly vulnerable to predation by the otter and indicates feeding behavior of this mammal. The cottids are difficult to identify from fragmentary remains; specific determinations were possible only a few times when

pelvic fins were found intact. Identified on such occasions was Cottus b. bairdii. The muddlers eaten were estimated to average about 2½ inches long. As a group they are distinguished, and number of individuals were rendered determinable, by the spine-bearing preopercles and the characteristic hypurals.

Eucalia inconstans--Brook stickleback. These small fishes, each about 2 inches long, occurred particularly in association with mudminnows from trout streams. In such streams sticklebacks are to be found in weedy, soft-bottomed, spring-fed backwaters. Characteristic fin spines, opercles, hypural, and pectoral and pelvic girdles mark these fishes for ready identification and enumeration from the food remains.

Fish remains.

Included in this category are fragmentary remains of fishes identifiable only as such. Also listed here are a certain few bits of esocids remains doubtfully pike (Esox lucius) or mud pickerel (E. vermiculatus). Known distribution of the mud pickerel in the State (apparently confined to the southern half of the Lower Peninsula) makes it likely that all these remains were of pike, but the evidence, particularly for the otter from unknown specific localities, seemed insufficient to warrant this conclusion for all such remains.

Amphibians.

Ranidae--Frogs. The only species identified was the bullfrog (Rana catesbiana); others were probably represented in those remains (usually bits of the characteristic, tubular long bones of the limbs, fragments of vertebrae, or portions of tooth-bearing bones) recognizable only as "frog." It is possible, however, that some of these remains were those of toads.

Necturus maculosus—Mudpuppy. Skeletal material and characteristically colored integument of apparently juvenile mudpuppies were found in a few otters.

Other Vertebrates.

Lepus americanus—Snowshoe hare. The remains of one individual were found in one otter; the hare was perhaps carrion as perhaps were also the following vertebrate items.

Buteo l. lineatus—Red-shouldered Hawk. Fleshy remains, possibly carrion and including a few feathers but lacking bones, were contained in one otter.

Bucephala clangula americana—American Goldeneye. The considerable remains of one American Goldeneye were found in one otter.

Insects.

Large beetles (Coleoptera) of the families Dytiscidae, Haliplidae, and Gyrinidae and sizable water bugs (Hemiptera) of the family Belostomatidae (often the electric light bug, Lethocerus) were found. A few aquatic insect larvae apparently eaten directly were also encountered and were identified as Sialidae and Corydalinae (Neuroptera) and Tipulidae and Leptidae (Diptera).

Crayfishes.

Crayfishes (Cambarus spp.) were most often rendered unidentifiable to species because of the thorough mastication to which they had been subjected. The individuals specifically determined on the basis of occasional, complete chelae, of antennal scales, and of external genitalia were for the most part C. virilis and C. propinquus; both are common inhabitants of the

situations described for the stream-dwelling muddlers as well as elsewhere. Noted only once each were C. diogenes, a burrower, and C. immunis.

Karl F. Lagler
Dept. of Zoology
University of Michigan
Ann Arbor, Michigan

Burton T. Ostenson
Dept. of Zoology
Michigan State College
East Lansing, Michigan

INSTITUTE FOR FISHERIES RESEARCH

Report approved by: A. S. Hazzard

Report typed by: R. Bauch

Table 1. Early spring food of the otter from trout waters in Michigan

Based on the contents of 95 stomachs (761.8 cc.)
and of 133 intestines.

FOOD ITEM	STOMACHS			INTESTINES		
	Number of individuals of each item eaten	Percentage of total volume of food	Percentage frequency of occurrence	Number of individuals of each item eaten	Average estimated percentage of food by bulk	Percentage frequency of occurrence
GAME AND PAN FISHES	...	22.7	27.4	...	16.3	45.9
Trout	19	...	...	45	...	...
Bullheads	5	...	...	9	...	...
Northern pike	2	...	...	7	...	...
Perch	4	...	...	26	...	...
Bass and sunfish	17	...	...	36	...	...
FORAGE FISHES	...	35.9	63.2	...	21.1	69.2
Suckers	16	...	...	40	...	...
Minnows	51	...	...	158	...	...
Madtoms	...	...	...	1	...	...
Mudminnows	81	...	...	72	...	...
Darters	22	...	...	5	...	...
Muddlers	69	...	...	99	...	...
Sticklebacks	25	...	...	41	...	...
FISH REMAINS	...	3.9	34.7	...	14.0	49.6
AMPHIBIANS	23	25.2	21.1	32	6.4	21.8
OTHER VERTEBRATES	3	4.5	3.2	1	0.7	0.8
INSECTS	16	0.4	10.5	61	3.7	6.3
CRAYFISHES	48	7.4	42.1	132	37.8	54.9
SNAILS	...	...	...	2	Trace	0.8

Table 2. Early spring food of the otter from non-trout waters in Michigan.

Based on the contents of 40 stomachs (561.3 cc.)
and of 51 intestines.

FOOD ITEM	STOMACHS			INTESTINES		
	Number of individuals of each item eaten	Percentage of total volume of food	Percentage frequency of occurrence	Number of individuals of each item eaten	Average estimated percentage by bulk	Percentage frequency of occurrence
GAME AND PAN FISHES	...	65.3	40.0	...	21.0	41.2
Bullheads	3	...	...	5	...	...
Northern pike	4	...	...	2	...	...
Perch	7	...	...	5	...	...
Bass and sunfish	60	...	...	121	...	...
FORAGE FISHES	...	11.2	45.0	...	22.2	66.7
Suckers	12	...	...	10	...	...
Minnows	38	...	...	28	...	...
Mudminnows	20	...	...	76	...	...
Darters	2	...	...	1	...	...
Muddlers	4	...	...	8	...	...
Sticklebacks	8	...	...	6	...	...
FISH REMAINS	...	2.0	40.0	...	11.8	47.1
AMPHIBIANS	...	14.4	10.0	...	8.7	21.6
Frogs	4	...	...	10	...	...
Mudpuppies	5	...	...	2	...	...
OTHER VERTEBRATES	2	0.5	5.0	...	...	...
INSECTS	16	2.9	25.0	129	7.0	35.3
CRAYFISHES	10	3.7	25.0	37	29.3	51.0

Table 3. Summary of the early spring food of the otter in Michigan, 1940.

Based on the contents of 173 stomachs (2316.5 cc. of food) and of 201 intestines. The data in this table combine those of Tables 1 and 2 with the additional findings from otters for which specific data as to place of collection was lacking.

	STOMACHS			INTESTINES		
FOOD ITEM	Number of individuals of each item eaten	Percentage of total volume of food	Percentage frequency of occurrence	Number of individuals of each item eaten	Average estimated percentage of food by bulk	Percentage frequency of occurrence
GAME AND PAN FISHES						
Trout	20	...	...	52	...	...
Bullheads	8	...	...	18	...	...
Pike	8	...	...	10	...	...
Perch	15	...	...	35	...	...
Bass and sunfish	83	...	...	166	...	...
TOTALS	134	32.0	29.5	281	15.9	47.3
FORAGE FISHES						
Suckers	21	...	...	55	...	...
Minnows	104	...	...	214	...	...
Mudminnows	151	...	...	193	...	...
Muddlers	90	...	...	137	...	...
Miscellaneous	70	...	...	73	...	...
TOTALS	436	17.6	56.6	672	22.7	76.1
FISH REMAINS	...	3.0	37.6	...	13.8	53.2
FROGS AND MUDPUPPIES						
Frogs	32	...	...	53	...	...
Mudpuppies	5	...	...	2	...	...
TOTALS	37	16.1	16.2	55	7.5	25.4
OTHER VERTEBRATES	7	25.8	4.1	1	0.9	1.0
INSECTS	25	0.8	13.3	81	4.2	31.8
CRAYFISHES	64	4.7	35.3	165	35.0	59.2

Fig. 1. Map of northern Michigan showing the counties open to trapping, the location where otters were taken, and the nature of the waters (trout or non-trout) from which they were removed in 1940.

Fig. 2. Percentage composition by volume of food from 95 stomachs of otters taken in early spring on trout waters in Michigan, 1940 and 1941.

Fig. 3. Percentage composition by volume of food from 40 stomachs of otters taken in early spring on non-trout waters in Michigan, 1940 and 1941.