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FOOD AND HABITS OF THE COMMON WATERSNAKE, Natrix s. sipedon, IN MICHIGAN*

BY

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Introduction

The purposes of this study are to learn of the food habits of the common watersnake (Natrix s. sipedon) in Michigan, and to determine, insofar as possible on the bases of these and other data, the role of this predator in game fish production both at fish rearing stations and on natural waters. Answers to certain questions raised by Netting (1941) on the biology and economics of this reptile are given here with for one region. This is one of a series of studies by one or both of us on the natural enemies of fishes in Michigan.

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Our materials are principally from the Lower Peninsula of Michigan from both natural situations and from fish rearing establishments ~~(Fig. 1)~~. Of a total of 294 specimens that we have handled, 180 contained food for analysis; the remainder (114) were empty. All discussion of food habits and computations of food percentages in this paper are based on those snakes which contained food.

Not all of the specimens were sexed by us, but of 200 that were, 96 (48%) were females, 104 (52%) were males. Size of 287 specimens of both sexes that were measured averaged 24.4 inches and ranged from 8.4 to 38.2 inches. These individuals were collected during the months of May through September, mostly during July and August.

Habits and Ecology

Relations to the aquatic environment and populations. That watersnakes are definitely associated with the aquatic habitat is, of course, well-known. They are not, however, universally present in Michigan where there is water nor are population densities of unvarying magnitudes even in closely similar situations. We have failed to find individuals in certain springs, which were inhabited by fish and frogs. They are characteristically

lacking or very sparse in certain cold streams or in extremely well-shaded portions of some trout streams as, for example, cedar swamp sections. Around large bodies of water, either lakes or rivers, they are largely confined to marginal situations. They are apparently absent from long stretches of some of these such as the Lake Michigan shore near Grand Haven and the Lake Superior shore west of Grand Marais. We have taken specimens from lakes and ponds of a great variety of sizes and kinds and in streams from large ones to intermittant trickles, and in marshes. Brown (1940) had best collecting along certain Great Lakes' shores, both mainland and island. Our peaks of abundance were in certain medium-sized streams in the western part of the Lower Peninsula, tributary to Lake Michigan. We did not collect the habitat given special citation by Brown (ibid.): drift strewn Great Lakes' shores. However, we did find considerable use of driftwood piles as diurnal hiding places about large interior lakes.

It is our impression that watersnake populations are generally increased in streams when they are shallowly impounded. The increment is in the vicinity of the impoundments. Waters held by beaver dams appear to be an exception to this since this snake rarely frequents Michigan beaver ponds. In studies of more than a hundred such ponds, Salyer has seen watersnakes in fewer than six. The impediment to feeding offered

by the fine, impalpable muck which covers the bottoms of such sites may be the determining factor in limiting the snake population. Feeding activities would need to be carried on in a soupy mass of muck, fibre, and other debris which makes the water very turbid when disturbed. In Michigan, the watersnake is essentially an animal of clear waters.

Numerical estimates of watersnake populations are few and are based on numbers seen or collected and are therefore always less than actual. On the Platte River we once saw 93 specimens in about three miles of stream, from Honor downstream to Platte Lake. From a single, small dam of stones on the same stream near Bendon, ten individuals were taken. During three visits to the same two-mile portion of Bear Creek (Manistee County) and intensive collecting (the first time by boat and the other two times by wading in the stream) the following results were obtained (all collections about mid-day):

Date 1944	Number Captured	Number Seen But Not Captured	Total Number of Specimens Seen
July 9	7	8	15
August 8	13	8	21
August 22	12	10	22

From these data it is evident that: (1) a very

large number of watersnakes must inhabit this section of Bear Creek; (2) population estimates based on visible numbers are inaccurate and probably too low; (3) collecting can be more effectively done by wading than from a boat.

In spite of close association with water, which is primarily for feeding purposes, it is by no means uncommon for watersnakes to leave this medium. Birth of young, summer basking or other sojourn in this season for warming, and hibernation are on land. Not only are secluded terrestrial places under rocks, logs, or debris utilized, but, for sunning, their exposed surfaces as well as the branches of trees are used. We have taken specimens from streamside bushes up to six feet above the water, and Brown (1940), to eight feet. Some watersnakes have been ~~taken~~ collected several hundred yards from lake shores in adjacent woodlands and marshes.

Periods of activity. The seasons of greatest activity coincide with the months during which collections were made, May through September but principally June through August. Watersnakes are torpid at temperatures less than 50° F. (Brown, 1940) and so activities are limited to the warmer months, but Apparently ~~activity is~~ are reduced in hot weather, particularly during the heat of day. If predation by this reptile, then, limits fish production, concern is at least not necessary during late fall, winter, and early spring months in Michigan.

Feeding habits. Little was learned by us regarding difference in amount of diurnal and nocturnal feeding activity. It is generally known, however, that watersnakes feed both during daylight and darkness. For example, the diamond-back watersnake (Natrix r. rhombifera) and the green watersnake (Natrix c. cyclopion) are active feeders at night (Trapido, 1943). Our observations at night are few, but we have seen common watersnakes fishing on riffles relatively undisturbed by our artificial lights. The high incidence of muddlers (Cottus spp) in the food of trout-stream watersnakes (Table 3) evidences both bottom and nocturnal feeding since these fish are characteristic bottom dwellers and are secretive in the daytime. Additional evidence of night-time feeding is the fact that specimens collected during the middle and late parts of warm days usually contain little if any food. Individuals taken before noon, on the other hand, ordinarily have food organisms in their stomachs. Watersnakes also feed in the day, however, and we have taken specimens foraging during such times.

The occurrence in the food of watersnakes of muddlers, western blacknose dace (Rhinichthys atratulus meleagris), and longnose dace (Rhinichthys c. cataractae) supports observations that feeding may be successfully pursued on the riffles of streams or in fast water. In fact, these are good sections of streams in which to

collect watersnakes at night, especially if they are strewn with boulders or lodged driftwood which may serve as feeding fulcra.

We have never seen the feeding method described for this animal by Evans (1942). In it the snake swims among groups, presumably schools, of fishes, swinging its head from side to side and closing its mouth when contact with a fish is made.

Food organisms in stomachs of watersnakes most often have their heads directed toward the tail of the snake, suggesting that they are swallowed head first. This is substantiated by Clark (1903) and Brown (1940). Tooth marks of the snake which we have found on a brook trout, however, show that prey may be grasped crosswise and manipulated until the head can be engulfed.

The size of fishes eaten varies greatly. Usually they are small, but in rare instances remarkably large prey is taken in relation to size of the predator. Clark (ibid.) records a sizeable specimen as having swallowed a sucker a foot in length. Sometimes attempted meals are so large as to be lethal. Examples of this most often encountered by us involve bullheads (Ameiurus spp.) as prey. Besides, in these, the pectoral spines of the bullheads have invariably punctured the esophageal and body walls of the snake giving a factor in addition to size which may have contributed to the demise of the reptile.

Single large items found in stomachs (usually also partly in the esophagus) were: a 7.75 inch and an 8.5 inch brown trout (Salmo trutta fario); a 7.38 inch brown bullhead; a lamprey (Ichthyomyzon castaneus), more than 8 inches long. Many small fish may also be present in a stomach at one time; one specimen had 26 brook trout all approximately 2 inches long; another had 20 brook trout ranging from 1.25 to 1.5 inches in length. As might be expected, watersnakes from fish rearing stations contain several to many fish each whereas those from natural waters average only a little more than one and a fraction prey organisms each. The two examples above with many individuals of the food item were from fish cultural stations.

Food. Stomach contents alone were analyzed since the advanced stages of digestion in the intestine so greatly impedes recognition of items. Feces in the colon, however, do contain identifiable materials. In one specimen the brown to black, semi-solid, amorphous mass contained fish bone fragments, identifiable fish scales, and bits of insect chitin. Digestion of these things is therefore not complete. General analytical methods employed are the precise qualitative and quantitative ones described by Salyer and Lagler (1940).

Carrion composed of dead fish was recognized in one specimen collected in a lake where the fish had just been poisoned and as a snake exuvium in another

specimen from elsewhere. This type of food is, of course, utilized by this and other snakes. We once watched a common watersnake repeatedly take the viscera from yellow perch that were thrown to it at a fishery dock in Muskegon Lake. It is possible, then, that some of the organisms recorded here in the food of the watersnake were dead when taken; because of the characteristics of the material examined, we are confident that such incidence is small and probably of little significance. Moreover, the scavenging of crayfishes and certain small fishes which have general distribution and abundance in Michigan waters, particularly in streams and shallow lakes, apparently brings about rapid disappearance of the ordinary numbers of dead fish and comparable organisms.

The watersnakes from fish cultural stations here reported are all from thirteen trout rearing stations mostly in the northern part of the Lower Peninsula where these fish are held in large numbers in outdoor raceways or ponds. For the most part these rearing enclosures are in, or adjacent to, the channels of natural trout streams. At practically all of these stations, the available prey trout-species are of sizes ranging from advanced fry to fingerling length. Both size and concentration render them particularly vulnerable to predation and presumably attractive to fish predators.

Among the sixty-four watersnakes taken at these

stations and which contained some food there are many (28/43.8%) which do not contain the fish species being propagated. It may be concluded that these snakes had not fed in the rearing enclosures but this is, of course, not necessarily so. Such individuals have, however, been segregated (Table 1, B). Similarly, it is possible that trout in some of the snakes taken at these locations may have been captured in the adjacent wild waters. These are judged to be few and since we have no way of knowing for sure, they are ignored here. A parallel problem exists for the forage fishes since they occur both in the rearing enclosures and in the adjoining natural streams. In fact, forage fishes sometimes become quite abundant in the rearing ponds, presumably in response to the artificial feeding of the fish in these waters. In view of this situation, the occurrence of forage fishes in the food of these watersnakes (Table 1C) in considerable amount and frequency is within the realm of expectancy.

The numbers and sizes of trout eaten by thirty-six watersnakes at trout rearing stations are as follows (total lengths are given and are based on actual measurements of whole fish or on careful estimates made by comparing parts of fish with whole specimens): largest trout, 8.5 inches; smallest trout, 1.0 inches; average length (based on 154 fish), 1.9 inches; total number of trout found, 159; greatest number of trout

eaten by one snake, 26; average number of trout eaten by each snake which contained trout, 4.4; average number of trout per watersnake for all snakes collected at rearing stations, 2.5.

These data show that: (1) trout larger than 8.5 inches are vulnerable since the snake which contained this specimen was only 38 inches long and larger sizes are attained; (2) fingerling trout are easy prey; (3) control of watersnakes on fish rearing waters is justified and a loss of five fingerling trout may be assumed for every two watersnakes collected on the premises of rearing stations during the proper season.

Specimens from natural waters are from only two types, inland lakes and trout streams. Food habits of 18 individuals in and about inland lakes shows non-game fishes and amphibians to compose most of the food and to be eaten most frequently (Table 2). Unfortunately, the number of snakes on which this conclusion is based is small. Brown's findings (1940) for specimens mostly from Douglas Lake, Cheboygan County, Michigan, includes the following food items from waters of this kind and substantiates our meager data: common shiner (Notropis cornutus); spottail shiner (Notropis hudsonius); northeastern sand shiner (Notropis deliciosus stramineus); bluntnose minnow (Hyborhynchus notatus); brown bullhead (Ameiurus nebulosus); western mudminnow (Umbra limi); burbot (Lota maculosa); troutperch (Percopsis omiscomaycus);

yellow perch (Perca flavescens); northern logperch (Percina caprodes semifasciata); central Johnny darter (Boleosoma n. nigrum); muddlers (Cottus bairdii); mudpuppies (Necturus maculosus); leopard frogs (Rana pipiens); green frogs (Rana clamitans); wood frogs (Rana sylvatica); various tadpoles. The only food fish records included are for the brown bullhead and the yellow perch. Two specimens examined by Langlois (1925) from the same region contained fish and one, a leopard frog. Summarily stated (Brown, 1941), the food of the watersnake on natural waters in Michigan and New York is about eighty per cent fish and twenty per cent amphibians. These percentages closely approach those for our material from wild conditions (Tables 2 and 3).

Since the 18 specimens from lakes are from 15 different bodies of water, it is not surprising that a wide variety of fishes is represented. It is significant to note that kinds commonly eaten by man are represented only by common bluegill and brown bullhead. Furthermore, the burbot and the mudpuppy, which are preyed upon by this snake, usually are not considered as assets to game fish production.

The data from trout-stream watersnakes is striking and significant (Table 3). The small total of nine trout was eaten, by only 6.6% of the 106 individuals that contained food, with characteristics as follows: largest trout, 7.75 inches; smallest trout, 1.5 inches; average length of trout eaten (based on 9 fish), 3.8

inches; average number of trout per snake (7 snakes contained trout), 0.75. It seems that if only about seven (to eight) of every hundred snakes which may be seen on a trout stream in a day contain trout, the effect of this predator may be less undesirable than hitherto popularly supposed.

Such a supposition may be tested with a hypothetical case. A population estimate for some streams may be based on snakes seen on the Bear and Platte (see p.000). The average visible population on these two streams is about thirty per mile but the repeated collections on Bear Creek suggest that only a part, probably small, of all inhabitants is visually encountered. Therefore, let us assume a population of one hundred per mile. On this basis, the average loss of fingerling trout to watersnakes could be nine per mile each day or something more than a thousand per mile in a season (approximately four months in duration). Such consumption may or may not be deleterious to angling in any particular stream but it is significant to note that if stocking is to be done in such a stream the present plan of planting trout seven or more inches in length would be desirable from the point of view that such fish are about twice as long as the average susceptible to maximum predation by the watersnake.

Equally striking is the predominance of forage fishes in the watersnake food on trout streams. Most

of these by far are muddlers which occured as a total of 80 specimens in 56.6% of all snakes and composed 37.7% of the total volume of food.

Conclusion

Because of the large number of factors determining ultimate production per unit of area or of length on trout streams, it is impossible to state in any simple way, even on data as trenchant as these, the role of predation by the watersnake (or most other fish predators) on fish production. Some of the pertinent critical variables, many of which are individual for each stream or parts thereof, regarding which too little is known at present for any one predator are: (1) existing populations of the predators and prey; (2) daily food requirements and kinds and amounts of food eaten by predators; (3) direct effects of predation on populations of preferred fish species; (4) indirect effects of predation by increasing, decreasing, or offering competition for food or space; (5) related effects of any particular predator which also feeds on other predators; (6) culling effects of predation; (7) total effects of all predators in competition in any one habitat. Our information sheds a little light on each of these problems but not enough on any one. Clearly, however, the principal food of the watersnake on Michigan trout streams is not trout, but other fishes. Any wide-spread control on natural waters as in West Virginia (Netting, 1939) or in Pennsylvania

since 1933 (French, 1938; Sweigart, 1939) cannot be justified biologically at this time. We are in general agreement with the opinion of several workers, including Brown (1936) and Netting (1938), that reduction of populations at fish cultural stations is, however, requisite and justifiable.

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TABLE 1. FOOD OF THE COMMON WATERSNAKE AT TROUT REARING STATIONS

Based on 64 specimens containing 514.0 cc. of food.

Food Item	A Food of Those Snakes (36) which Contained Trout		B Food of Those Snakes (28) which Did Not Contain Trout		C Food of All (64) Snakes Taken At Rearing Stations	
	Percentage by Volume	Percentage of Frequency of Occurrence	Percentage by Volume	Percentage of Frequency of Occurrence	Percentage by Volume	Percentage of Frequency of Occurrence
Trout	79.4	100.0	---	---	48.9	56.3
Bass or Sunfish	---	---	Trace	3.6	Trace	1.6
Forage Fishes	20.4	16.7	81.5	57.1	44.0	34.4
Other Fishes	---	---	9.9	10.7	3.8	4.7
Fish Remains	0.1	5.6	3.4	28.6	1.4	15.6
Amphibia	---	---	3.0	7.1	1.1	3.1
Insects	---	---	1.4	7.1	0.5	3.1
Miscellaneous Invertebrates	---	---	0.8	10.7	0.3	4.7

Annotated list of food items. The following items were identified in the food of the 28 snakes which did not contain trout and are representative of the food in trout stream habitats. LAMPREYS: 1 petromyzonid; 4 American brook lampreys (Entosphenus lamottenii). SUCKERS: 1 catostomid. MINNOWS: 3 cyprinids; 1 northern creek chub (Semotilus a. atromaculatus), 3.5 inches long; 2 western blacknose dace (Rhinichthys atratulus meleagris); 1 Great Lakes longnose dace (Rhinichthys c. cataractae). MUDMINNOWS: 2 western mudminnows (Umbra limi), each 3 inches long. DARTERS: 1 central Johnny darter (Boleosoma n. nigrum), 1.25 inches long. MUDDLERS: 11 identifiable only as Cottus sp. and ranging in length from 2 to 4 inches; 6 northern muddlers (Cottus b. bairdii) from 3 to 6 inches long; 3 northern burbot (Lota lota maculosa) with lengths of 3.5, 4, and 7 inches. FROGS: 1 frog (Rana sp.) and 1 tadpole of the green frog (Rana clamitans). INSECTS: 1 of each of Lepidoptera larva, Isogenus sp. larva, Tabanus sp. larva, grasshopper, Moriomorum minitum, and stonefly nymph. These were taken primarily and are not from the stomach of some other organism eaten by the snakes. MISCELLANEOUS INVERTEBRATES: 2 snails, Lymnea sp.; 1 millipede; 1 earthworm.

TABLE 2. FOOD OF THE COMMON WATERSNAKE ON MICHIGAN LAKES

Based on 18 individuals containing 253.8 cc. of food.

Food Item	Percentage Composition by Volume	Number of Individuals of Each Food Item	Number of Watersnakes Containing Each Food Item	Percentage Frequency of Occurrence
Game and Pan Fishes	19.3	2	2	11.1
Forage Fishes	23.4	19	8	44.4
Other Fishes	2.9	5	3	16.7
Fish Remains	1.8	2	2	11.1
Frogs and Sala-Manders	52.6	6	6	33.3
Rodents	Trace	1	1	5.6

Annotated list of food items. FISHES: 1 sunfish; 1 common bluegill (Lepomis m. macrochirus), 1.25 inches long; 1 northern brown bullhead (Ameiurus n. nebulosus), 7.4 inches in length; 1 madtom (Schilbeodes sp.); 1 northern common shiner (Notropis cornutus frontalis), 4.25 inches; 1 blackchin shiner (N. heterodon), 2.5 inches; 1 northern blacknose shiner (N. h. heterolepis); 1 shiner, (Notropis sp.); 1 hornyhead chub (Nocomis biguttatus), 4 inches; 1 northern creek chub (Semotilus a. atromaculatus), 3 inches; 1 bluntnose minnow (Hyborhynchus notatus); 1 unidentified cyprinid; 1 mudminnow (Umbra limi), 2.5 inches; 2 Johnny darters (Boleosoma nigrum), 1.8 and 1.9 inches; 1 Great Lakes muddler (Cottus bairdii kumlieni); 1 eastern burbot (Lota lota maculosa). FROGS: 1 leopard frog (Rana pipiens); 1 green frog (R. clamitans); 1 undetermined frog (Rana sp.). SALAMANDERS: remains of 1 unidentified salamander; 2 mudpuppies (Necturus maculosus); RODENTS: Traces of one small rodent.

TABLE 3. FOOD OF THE COMMON WATERSNAKE ON MICHIGAN TROUT STREAMS

Based on 106 individuals containing 707.6 cc. of food.

Food Item	Percentage Composition by Volume	Number of Individuals of Each Food Item	Number of Watersnakes Containing Each Food Item	Percentage Frequency of Occurrence
Trout	19.0	9	7	6.6
Lampreys	3.3	9	7	6.6
Forage Fishes	55.8	108	77	72.6
Fish Remains	0.2	5	5	4.7
Burbot	7.3	3	3	2.8
Frogs	12.8	9	8	0.9
Miscellaneous Invertebrates	1.6	7	6	5.7

Annotated List of Food Items. FISHES: 3 trout unidentified to species, 2.8, 3.0, and 3.3 inches; 4 common brook trout (Salvelinus f. fontinalis), 1.5, 1.5, 4.8, and 6.3 inches; 2 unidentified lampreys, 3.1 and 4.1 inches; 5 American brook lampreys (Entosphenus lamottenii), non-parasitic, 3.5, 4.0, 4.0, 4.2, 4.5, and 4.8 inches; 1 chestnut lamprey (Ichthyomyzon castaneus), parasitic on fish, 8.0 inches; 3 undetermined catostomids averaging 4.7 inches (4.5, 4.75, 4.75); 13 common white suckers (Catostomus c. commersonnii) averaging 2.2 inches and ranging from 1.6 to 2.5 inches for 11 specimens the lengths of which were determined; 1 unidentified minnow; 2 northern creek chubs (Semotilus a. atromaculatus) of which 1 was 1.8 inches long; 1 northern pearl dace (Margariscus margarita nachtriebi), 4 inches; 1 hornyhead chub (Nocomis biguttatus), 3.5 inches; 3 western blacknose dace (Rhinichthys atratulus meleagris), 1.5, 3.0, and 3.5 inches; 2 Great Lakes longnose dace (Rhinichthys cataractae), 3.4 and 3.8 inches; 1 northern redbelly dace (Chrosomus eos), 2.0 inches; 1 northern common shiner (Notropis cornutus frontalis), 4.3 inches; 5 mudminnows (Umbra limi), 2.5, 2.5, 2.6, 3.5 inches (for 4 individuals); 1 undetermined darter, 1.5 inches; 10 northern logperch (Percina caprodes semifasciata), 3.1, 3.3, and 4.0 inches (for 3 individuals); 80 muddlers (Cottus sp.) of which 9 were slimy muddlers (C. cognatus) and 32 were northern muddlers (C. b. bairdii) averaging 3.4 inches for 71 that were treated for length; 3 eastern burbot (Lota lota maculosa), 5.0, 7.0, and 9.1 inches. FROGS: 3 unidentified frogs (Rana sp.); 2 bullfrogs (R. catesbeiana);

1 pickerel frog (R. pipiens); 1 green frog (R. clamitans); and 1 wood frog (R. sylvatica). INSECTS: 1 dragonfly nymph. MISCELLANEOUS INVERTEBRATES: 4 earthworms; 1 leech; 1 snail. These invertebrates were eaten primarily and were not from the stomach contents of some other ingested organism; all except the snail were the sole items of food in the stomachs in which they were found. The absence of crayfishes from the food of the common watersnake is puzzling since these organisms abound in trout streams, are quite nocturnal, and are of sizes in their various growth stages which should be readily acceptable to the snake.