

Original: Fish Division  
cc: Institute for Fisheries  
Research  
Education-Game  
R. M. Bailey  
P. H. Eschmeyer

INSTITUTE FOR FISHERIES RESEARCH  
DIVISION OF FISHERIES  
MICHIGAN DEPARTMENT OF CONSERVATION  
COOPERATING WITH THE  
UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.  
DIRECTOR

March 17, 1949

ADDRESS  
UNIVERSITY MUSEUMS ANNEX  
ANN ARBOR, MICHIGAN

Report No. 1217

THE FOOD OF YELLOW PIKEPERCH IN SOME MICHIGAN WATERS

By

Paul H. Eschmeyer

Introduction

The life history of the yellow pikeperch, Stizostedion vitreum vitreum (Mitchill), in Michigan was made the subject of an intensive study by the Institute for Fisheries Research in 1941. Work was continued in 1942 and intensified in 1947 and in 1948, after being interrupted by World War II. The data which were collected are discussed in large part in Institute for Fisheries Research Report No. 1210, "Reproduction and Migration of the Yellow Pikeperch, Stizostedion vitreum vitreum, in Michigan." The present paper concerns the food habits of the species, which were treated only briefly in the earlier report.

A total of 666 pikeperch stomachs containing food was examined. Of these, 412 were from Lake Gogebic, Ontonagon and Gogebic counties; 170 were from impoundments of the Muskegon River (essentially Newaygo and Hardy ponds, Newaygo County); 73 were collected at Lake Cadillac, Wexford County; 7 at Lake Mary, Iron County; and 4 were from Lake George, Ogemaw County.

(1210)  
W

Analyses of the stomach contents of fish collected from the various waters were made by several members of the Institute staff. Those who participated in the laboratory work include Burton Hunt, Wayne Tody, Stanley Lievens, Leland Anderson, and the writer.

Food items occurring in the stomachs were identified, sorted, counted and their volume determined by water displacement after excess moisture had been removed by blotting. Occasional food items found in the esophagus were included with the stomach contents in the analyses. Only stomachs which contained food are considered in this study. A single volume determination was made for identical food items from entire collections of young-of-the-year fish because contents of individual stomachs were often too small for accurate measurement.

#### Food of Young Pikeperch

A summary of the food of 138 young-of-the-year pikeperch, ranging from 1.0 to 6.9 inches in total length, which were collected at Lake Gogebic in 1941 and in 1947 is shown in Table 1. Fish (particularly yellow perch) greatly predominated in the food found, comprising 88 percent of the total volume and occurring in 73 percent of the specimens examined. The importance of yellow perch in the diet of young pikeperch in Lake Gogebic is outstanding. They were identified in 38 percent of the stomachs and made up 68 percent of the total volume of food. Fry of white suckers were observed being taken by young pikeperch in shallow water in early July, 1947, and constituted over 43 percent of the food taken by 29 pikeperch collected during that month. They did not occur in other collections.

Crustacea followed fish in importance in the diet of the young pikeperch collected, largely as a result of the presence of large numbers

Table 1. Food of young-of-the-year yellow pikeperch in Lake Gogebic, 1941 and 1947.

Date of collection	June 24-July 10, 1941	
Number of stomachs with food	19	
Range in total length of fish (inches)	1.4-3.0	
Total volume of food (cubic centimeters)	1.3	
Food:	Percentage of stomachs containing organisms	Percentage of total volume
Cladocera	5.3 <sup>1</sup>	tr
Insects	52.6	7.7
Ephemeroptera	...	...
Chironomidae	26.3	7.7
Other	26.3 <sup>3</sup>	tr
Fish	57.9	92.3
White sucker	...	...
Yellow perch	42.1	92.3
Unidentified remains	15.8	tr

- 1/ Daphnia.
- 2/ Leptodora.
- 3/ Unidentified insect remains.
- 4/ Homoptera and unidentified remains.
- 5/ Included in this total is one yellow pikeperch, not otherwise listed.

August 2, 1941

October 16-21, 1941

30

6

3.6-4.6

5.8-6.8

8.0

3.4

Percentage of stomachs  
containing organisms

Percentage of  
total volume

Percentage of stomachs  
containing organisms

Percentage of  
total volume

...

...

83.3<sup>2/</sup>

91.2

3.3

tr

33.3

8.8

...

...

33.3

8.8

...

...

...

...

3.3<sup>1/</sup>

tr

...

...

100.0

100.0

16.7

tr

...

...

...

...

46.7

77.5

...

...

53.3

22.5

16.7

tr

July 7-25, 1947

August 8-22, 1947

29

49

1.0-3.0

2.6-4.8

2.3

16.5

Percentage of stomachs  
containing organisms

Percentage of  
total volume

Percentage of stomachs  
containing organisms

Percentage of  
total volume

31.0<sup>✓</sup>

tr

12.2<sup>1</sup>

2.4

3.4

tr

6.1

1.2

...

...

6.1

1.2

3.4

tr

...

...

...

...

...

...

72.4

100.0<sup>5/✓</sup>

67.3

96.4

20.7

43.5

...

...

17.2

26.1

49.0

78.8

31.0

21.7

18.4

17.6

October 16, 1947

Totals

5

138

3.6-6.9

1.0-6.9

2.6

34.1

Percentage of stomachs  
containing organisms

Percentage of  
total volume

Percentage of stomachs  
containing organisms

Percentage of  
total volume

...

...

15.2

10.3

...

...

12.3

1.7

...

...

3.6

1.4

...

...

4.3

0.3

...

...

4.3

tr

100.0

100.0

73.2

88.0<sup>5/</sup>

...

...

4.3

2.9

40.0

80.8

38.4

67.8

60.0

19.2

29.7

16.7

of Leptodora in 5 of the stomachs collected in October, 1941. Two fish about three inches long taken accidentally in gill nets set in late August, 1947, at depths of over 20 feet had been feeding exclusively on Daphnia. This crustacean occurred in 16 stomachs. Insects (essentially mayfly nymphs and midge larvae) occurred in 12 percent of the stomachs but made up less than 2 percent of the volume of food consumed.

The proportion of fish in the stomachs of 24 young pikeperch collected in Muskegon River impoundments in late July and early August, 1947, was nearly identical to that found in young fish collected from Lake Gogebic (Table 2). Fish occurred in 75 percent of the stomachs examined and comprised 88.5 percent of the total volume of food. Insects (mayfly nymphs and midge larvae) made up the remainder. No perch were identified in the stomachs but 32 percent of the total volume was composed of sunfish (black crappies and others, not identifiable to species). Some minnows were observed but the bulk of the contents was made up of partially digested fry, probably of several species, which could not be further identified.

A number of workers have studied the food of young yellow pikeperch. Although much of the early work was based on only a few specimens, several of the recent studies have been more exhaustive. The literature is briefly summarized here. Essentially it serves to further reveal the outstanding importance of fish in the diet of young pikeperch. They occur in a fair percentage of stomachs from all collections which have been reported upon by various workers and heavily predominate in many of the collections.

Forbes (1880; 1903) examined stomachs of two pikeperch, 2.0 and 2.5 inches long, from the Illinois River. One contained a small fish

Table 2. Food of young-of-the-year pikeperch in Muskegon River impoundments, July 24 to August 8, 1947.

Number of stomachs with food	24	
Range in total length of fish (inches)	2.1-4.5	
Total volume of food (cubic centimeters)	3.9	
<b>Food:</b>	<b>Percentage of stomachs containing organisms</b>	<b>Percentage of total volume</b>
<u>Insects</u>	29.1	9.0
Ephemeroptera	12.5	6.4
Chironomidae	21.3	2.6
<u>Fish</u>	75.0	88.5
Cyprinidae	4.2	5.1
Centrarchidae	16.7	32.1
Fish remains	54.2	51.3
<u>Plants</u>	8.3	2.5



and the other a few Entomostraca. Pearse (1921) studied five specimens from Lake Geneva, Wisconsin, collected on July 25, which averaged 2.0 inches in standard length. These had eaten 30 percent fish, 13 percent chironomid pupae, 52 percent Daphnia and 3 percent Cyclops. Leptodora also occurred (0.4 percent). Clemens and others (1923) found only fish remains in three young fish 2.1 to 2.7 inches in length, collected in Lake Nipigon, Ontario. In three fish from the same water, 1.4 to 1.9 inches long, Clemens et al (1924) found mostly microcrustaceans (Daphnia, Cyclops, Bosmina, and Epischura), a few chironomid larvae and pupae, and the remains of three fish. In Big Sandy Lake, Minnesota, Kidd (1927) found that Entomostraca together with some algae were the chief foods of pikeperch 1.5 to 9.0 inches in length. Gammarus and small fish were found in specimens over 2 inches in length. Adams and Hankinson (1928) reported that six fish from Oneida Lake, New York, 1.0 to 2.0 inches long, contained unidentifiable fish remains, and that one of these had nine small fry in its stomach. Sibley (1929) found only fry of Castostemidae in nine specimens ranging from 1.2 to 2.1 inches in standard length. Surber (1930) found fish in each of 10 specimens ranging from 1.7 to 3.0 inches in length from a slough in the Upper Mississippi River. In addition, he found Entomostraca in nine, Daphnia in two, copepods in three and ostracods in two. Rimsky-Korsakoff (1930) found only fish (yellow perch and Johnny darters) in 32 specimens, 1.8 to 2.8 inches in standard length, from the Lake Champlain drainage in New York. Bajkov (1930) reported that for the first month fry are plankton feeders (main items: planktonic crustacea), but shortly after this begin to feed on different insect larvae and small fish. Sibley and Rimsky-Korsakoff (1931) found that six young, 2.2 to 3.7 inches

in standard length, from the St. Regis and Salmon rivers in New York, had eaten only Johnny darters. Nurnberger (1930) examined 54 fish from Big Sandy Lake, Minnesota, ranging from 2.0 to 15.0 inches in standard length and found, in the stomachs of 28 of these which contained food, 54 fish, 30 insects, and a mass of Potamogeton. Insects were eaten when the fish were 3.0 inches in length.

Ewers (1933) examined 111 Stizostedion stomachs from western Lake Erie between June 27 and September 29, 1929. The fish averaged 2.4 inches in length and ranged from 0.9 to 7.5 inches. The stomachs of 87 of these contained food. She found 65 percent Entomostraca (by volume), 4 percent insects, and 27 percent fish.

Raney and Lachner (1942) examined 620 stomachs of young pikeperch taken in Oneida Lake from July 2 to October 24, 1940. These ranged in total length from about 1.3 to nearly 7.0 inches. Food was present in 495 of the stomachs. In contrast to Ewers' study, just mentioned, fish were by far the most important item of diet in Oneida Lake, equaling 93 percent of the total volume, with Johnny darters, pumpkinseeds, and yellow perch contributing heavily to this total. The remaining food was made up of invertebrates, particularly insects (4 percent) and crustaceans (3 percent).

Smith and Moyle (1945) examined 945 stomachs of pikeperch which ranged from 0.3 to 8.4 inches in length, and from 10 to 223 days in age, taken from rearing ponds in Minnesota. The stomachs of 818 contained food. Of these, 13 percent contained fish, 38 percent copepods, 40 percent cladocerans, and 61 percent contained insects. Rotifers, nauplii, and other organisms occurred in small numbers.

Food of Juvenile and Adult Pikeperch

The food of 78 one-year-old pikeperch collected at Lake Gogebic in 1947 is summarized in Table 3. Fish constituted over 90 percent of the volume of food in each of the four collections made during the summer and comprised 98.6 percent of the total food for all collections. They occurred in over four-fifths of the stomachs examined. Perch alone made up over 71 percent of the food; five young pikeperch were found and one small minnow was seen. Insects and crustacea were of some importance in the collection of fish made in the early season but few of these organisms occurred later in the summer.

In other studies of pikeperch food habits, juvenile fish have ordinarily been classed with adults in the publication of results. Raney and Lachner (1942), however, reported on the contents of the stomachs of 38 pikeperch, most of which were juveniles (one year old), from Oneida Lake, New York. They found that the food consisted of 81 percent fish (by volume). As at Lake Gogebic, yellow perch were most important (32 percent of the total volume), followed by the emerald shiner (Notropis a. atherinoides) which constituted 9 percent. Johnny darters, log perch and rock bass also occurred. Insects (caddis flies, mayflies, and others) made up 12 percent of the total food. Mud puppies, crustaceans, snails, roundworms, and plants were also represented.

Food of Adult Pikeperch

The food of adult pikeperch collected at Lake Gogebic during the summer months of 1929, 1940, and 1947 is shown in Table 4. Fish are revealed as being of outstanding importance in the adult diet, occurring in 80 percent of the 196 stomachs examined and making up 89 percent of the total volume of food. Insects (particularly mayflies) were also

Table 3. Food of one-year-old pikeperch, Lake Gogebic, 1947.

Date of collection (1947)	June 20	
Number of stomachs with food	16	
Range in total length of fish (inches)	3.7-6.5	
Total volume of food (cubic centimeters)	12.6	
Food:	Percentage of stomachs containing organisms	Percentage of total volume
<u>Insects</u>	31.2	3.2
Ephemeroptera	25.0	2.4
Others	6.2 <sup>1</sup>	0.8
<u>Fish</u>	56.3	94.4
Yellow perch	31.2	68.2
Others	6.3 <sup>4</sup>	15.1
Unidentified remains	25.0	11.1
<u>Miscellaneous</u>	31.2	2.4
Crustacea	25.1 <sup>6</sup>	1.6
Plants	6.2	0.8
<sup>1</sup> / <sub>2</sub> Odonata.		
<sup>2</sup> / <sub>6</sub> Trichoptera.		
<sup>3</sup> / <sub>3</sub> Chironomidae.		
<sup>4</sup> / <sub>4</sub> Pikeperch, 1.		
<sup>5</sup> / <sub>5</sub> Cyprinid, 1; pikeperch, 4.		
<sup>6</sup> / <sub>9</sub> Cladocera, 3; <u>Hyalella</u> , 1.		

2

July 3

August 19-21

10

39

4.3-5.1

6.8-8.5

1.5

39.5

Percentage of stomachs containing organisms

Percentage of total volume

Percentage of stomachs containing organisms

Percentage of total volume

20.0

tr

5.1

0.3

10.0

tr

2.6

0.3

10.0<sup>2</sup>

tr

2.5<sup>3</sup>

tr

50.0

93.3

94.9

99.7

10.0

53.3

48.7

62.5

...

...

10.3<sup>5</sup>

19.0

40.0

40.0

41.0

18.2

10.0

6.7

...

...

...

...

...

...

10.0

6.7

...

...

5

October 17-22

Totals

13

78

8.9-11.6

3.7-11.6

41.1

94.7

Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume
7.7	0.5	12.8	0.7
...	...	7.7	0.4
7.7 <sup>3/4</sup>	0.5	5.1	0.3
76.9	98.8	82.1	98.6
69.2	81.0	43.6	71.2
...	...	6.4	10.0
46.2	17.8	38.5	17.4
15.4	0.7	10.2	0.7
...	...	5.1	0.2
15.4	0.7	5.1	0.5

Table 4. Food of adult yellow pikeperch in Lake Gogebic, Michigan.

Date of collection		June 1-June 8, 1929		
Number of stomachs with food		20		
Range in total length of fish (inches)		10.2-26.8		
Total volume of food (cubic centimeters)		530.7		
Food:	Percentage of stomachs containing organisms	Percentage of total volume	Percentage of s containing orga	
<u>Insects</u>	40.0	2.8	68.4	
Ephemeroptera	40.0	2.8	68.4	
Others	...	...	7.9 <sup>1</sup>	
<u>Fish</u>	95.0	95.9	84.2	
Umbridae	5.0	0.7	...	
Cyprinidae	30.0	4.5	2.6	
Yellow perch	25.0	9.8	60.5	
Other species	40.0 <sup>7</sup>	61.1	...	
Unidentified remains	90.0	19.8	65.8	
<u>Miscellaneous</u>	15.0	1.3	7.9	
Crayfish	5.0	1.1	7.9	
Other animals	10.0 <sup>13</sup>	0.2	...	
Plants	...	...	...	
1 Neuroptera 1; Odonata 1.				
2 Neuroptera 2; Odonata 1; Coleoptera 2.				
3 Plecoptera 1; Hemiptera 1; Coleoptera 2; Diptera 9.				
4 Hemiptera 6.				
5 Diptera 3.				
6 Coleoptera 1.				
7 Cisco 5; nine-spined stickleback 24; troutperch 3.				
8 White sucker 1.				
9 Top minnows 2.				
10 Northern pike 1.				
11 Nine-spined stickleback 5; Iowa darter 1; pikeperch 1.				
12 Northern pike 1.				
13 Leeches.				
14 Snapping turtle.				
15 Leptodora.				
16 Frog.				

2

July 18-August 1, 1929		May 15-June 19, 1940		
38		8		
9.8-17.9		15.9-20.5		
120.6		45.7		
Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume	Percent contain
68.4	13.6	50.0	3.5	
68.4	13.2	25.0	2.0	
7.9 <sup>1/2</sup>	0.4	50.0 <sup>2/</sup>	1.5	
84.2	77.3	50.0	86.9	
...	...	...	...	
2.6	2.7	25.0	9.4	
60.5	53.4	...	...	
...	...	12.5 <sup>8/</sup>	43.3	
65.8	21.2	62.5	34.2	
7.9	9.1	62.5	9.6	
7.9	9.1	...	...	
...	...	12.5 <sup>11/</sup>	7.5	
...	...	50.0	2.1	



3

June 23, 1947		July 3-9, 1947	
36		9	
13.1-22.1		13.9-20.5	
279.9		54.5	
Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume
75.0	15.0	66.7	25.3
72.2	14.9	66.7	24.4
25.0 <sup>3/</sup>	0.1	55.5 <sup>4/</sup>	0.9
58.3	81.5	66.7	31.0
2.8	3.9	...	...
2.8	2.7	...	...
33.3	66.2	1.1	16.8
...	...	1.1 <sup>10/</sup>	3.5
41.7	8.7	55.5	10.7
25.0	3.5	55.6	43.7
11.1	3.4	1.1	1.8
...	...	55.5 <sup>13/</sup>	39.9
16.7	0.1	22.2	2.0

October 7-October 28, 1940

April 29-May 20, 1947

10

23

13.0-19.0

14.3-22.0

71.3

259.9

Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume
10.0	tr	43.5	5.3
10.0	tr	43.5	5.3
...	...	...	...
...	...	...	...
100.0	99.0	69.6	87.1
...	...	...	...
...	...	21.7	5.8
...	...	...	...
...	...	...	...
80.0	79.5	34.8	62.5
10.0 <sup>9/</sup>	12.8	...	...
60.0	6.7	39.1	18.8
10.0	1.0	21.7	7.6
...	...	...	...
...	...	...	...
10.0 <sup>15/</sup>	1.0	4.3 <sup>16/</sup>	6.5
...	...	...	...
...	...	17.4	1.1

2

August 19-26, 1947

October 14-22, 1947

41

11

11.4-20.4

12.5-21.8

195.0

114.1

Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume
12.2	0.2	27.3	0.1
12.2	0.2	18.2	0.1
2.5 <sup>5</sup>	tr	9.1 <sup>6</sup>	tr
92.7	98.9	100.0	98.4
...	...	9.1	3.7
...	...	...	...
...	...	...	...
46.3	86.1	63.6	67.0
7.3 <sup>11</sup>	3.4	18.2 <sup>12</sup>	20.8
61.0	9.4	45.5	6.9
9.8	0.9	54.5	1.5
7.3	0.4	...	...
...	...	...	...
...	...	...	...
2.4	0.5	63.6	1.5

9

October 14-22, 1947		Totals	
11		196	
12.5-21.8		9.8-26.8	
114.1		1,671.7	
Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume
27.3	0.1	45.9	6.1
18.2	0.1	43.3	6.0
9.1 <sup>6</sup>	tr	12.2	0.1
100.0	98.4	80.1	89.1
9.1	3.7	4.1	2.0
...	...	5.1	2.3
63.6	67.0	42.3	46.3
18.2 <sup>12</sup>	20.8	8.2	23.1
45.5	6.9	57.7	15.4
54.5	1.5	20.9	4.8
...	...	6.1	1.7
...	...	5.1	2.7
63.6	1.5	12.2	0.4

important in the pikeperch diet, occurring in 46 percent of the stomachs but constituting only 6 percent of the food volume. Miscellaneous items of less importance included crayfish, leeches, Leptodora, a frog, a small snapping turtle, and plant remains.

Yellow perch were identified in 42 percent of the stomachs and equaled 46 percent of the total food consumed. Minnows were of far less importance, which is probably a reflection of their scarcity in the lake. Mud minnows composed 2 percent of the volume of food whereas several species, including ciscoes, nine-spined sticklebacks, troutperch, white suckers, top minnows, northern pike, Iowa darters and pikeperch aggregated 23 percent of the total food volume, although occurring in only 8 percent of the stomachs. Much of this volume was made up by 5 ciscoes which occurred in the June, 1929, collection.

Prodigious numbers of young yellow perch occur in Lake Gogebic during most years. Short hauls with a bag seine frequently yield thousands of young-of-the-year perch. Relatively few adults occur in the anglers' catch or are taken in experimental nets. The growth rate of perch in Lake Gogebic substantially exceeds the state average, suggesting a low population density for the species. A rather complete utilization by pikeperch and northern pike of each year's crop of small perch is clearly suggested.

That young perch in Lake Gogebic lead a precarious, harried existence is indicated not only by the stomach analyses, but is suggested also by certain observations made there in 1947. At 4:00 p.m. on October 21 a haul was made with a 40-foot bag seine along a shoal ranging to 3.5 feet in depth, near the south end of the lake. The catch included approximately 5,000 young-of-the-year, 25 juvenile, and 5 adult perch;

8 young yellow pikeperch; 20 young white suckers; and 15 common shiners. The same haul was made after dark, at 8:00 p.m., and yielded 100 young yellow perch, 5 common shiners and 3 golden shiners. There also occurred, however, in the latter haul, 7 adult northern pike (14 to 17 inches in length), 5 juvenile pikeperch, and 1 adult (18 inches in length). Most young perch may have been forced to leave the area due to the presence of predators. One of their means of attempting to escape was revealed by the presence of large schools of young perch crowded close to shore in from 1 to 3 inches of water at the nearby mouth of the Slate River (Fig. 1). The perch in the schools were closely grouped; individuals were headed in various directions; there was apparently no progressive along-shore movement. Their behavior strongly suggested a response to repeated attacks by predators, rather than a search for food. The splashing rise of large fish, followed by the fluttering dispersal of the school of perch as it broke the surface to escape, was heard almost continuously at various points along the mouth of the Slate River during portions of some October nights.

Some evidence concerning the numbers of perch which may be consumed within a relatively short period of time was brought to light by the capture in a gill net of a 19-inch, 3 1/4-pound pikeperch on September 11, 1946. The stomach contained remains of 37 fish (Fig. 2), of which 34 were recognizable as yellow perch. The stomach contents had a weight equal to slightly over 6 percent of the body weight of the fish and the sum of the lengths of the perch eaten exceeded by well over four times the length of the pikeperch which had consumed them.

Adams and Hankinson (1928) stated that pikeperch are of value in keeping down the numbers of yellow perch, which are likely to become



Figure 1. School of young yellow perch near shore, at night, near the mouth of the Slate River. The fish are presumably attempting to escape predatory northern pike and pikeperch which frequent the area.

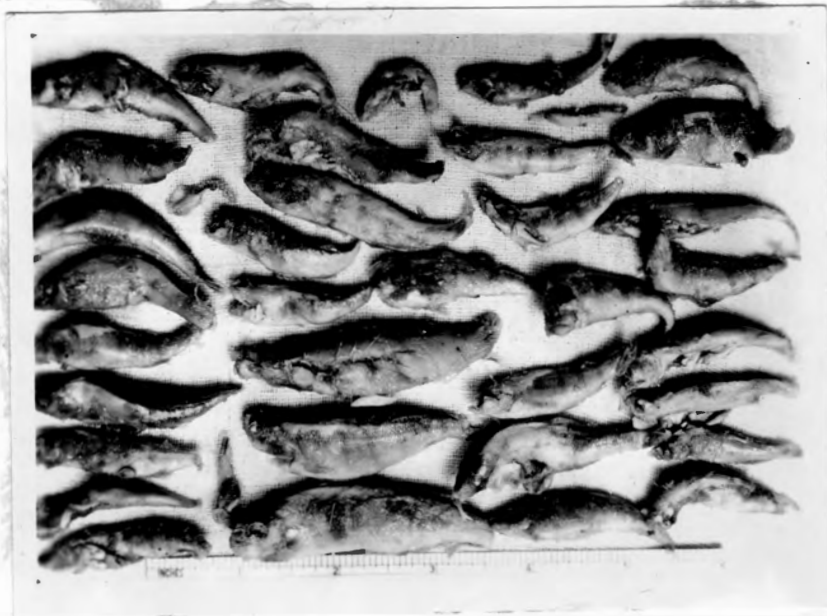


Figure 2. Contents of the stomach of a 19.2-inch yellow pikeperch taken in a gill net at Lake Gogebie on September 11, 1946.

superabundant in certain waters with consequent reduction in size so as to be too small to interest anglers. It seems clear that pikeperch, together with northern pike, serve this function at Lake Gogebic. In spite of excellent reproduction, little more than an adequate breeding stock of adult yellow perch is carried over from season to season. During most years the species contributes relatively little to the sport fishery.

The relationship of mayflies to the diet of Lake Gogebic pikeperch is interesting. Mayfly nymphs or adults have been observed in greater or lesser numbers in the stomachs of pikeperch collected from many waters (see below). In Lake Gogebic, mayflies were present in over two-thirds of the stomachs collected during the periods July 18 to August 1, 1929; June 23, 1947; and July 3 to 9, 1947 (Table 4). During the latter period, mayflies were emerging and subimagos and adults occurred in numbers ranging to as many as 79 in a single stomach. The 1929 collection named also covered an emergence period, as both nymphs and winged forms were taken in about equal numbers (193 nymphs and 212 subimagos or adults occurred in the stomachs in this collection). In many instances large nymphs and adults occurred in the same stomach.

Only nymphs occurred in the stomachs of fish collected on June 23 (as many as 158 in one stomach). Three-fourths of the fish examined contained this item of food. The fish comprising this collection were taken during a period of about two hours by less than a dozen fishermen. They were fishing from shore at the Merriweather Bridge, at the northwest end of Lake Gogebic. A very strong south wind had blown throughout the preceding night and the shallow water at the bridge was very roily.



Excellent pikeperch fishing often occurs under such conditions at Lake Gogebic and local fishermen are well acquainted with the rich rewards to be obtained from fishing along the shallow lee shore areas during or immediately after a heavy blow. Bean (1903) quoting "Dexter" in the August 14, 1890 issue of Forest and Stream noted that "..... when the wind blows very hard, or for a day or so after a big blow, you will find them [pikeperch] right on top of a reef. I think the wind changes the water over the reefs, making a new current and cooler water, so they come up to feed."

The reason for this behavior noted in pikeperch at Lake Gogebic remains obscure. It seems doubtful that changes in temperature caused by wind action would be significant in this large, open, shallow lake. The effect of such currents as may be produced by high winds on their feeding habits is not known. However, the marked roiliness of the water and the substantial disturbance of the bottom caused by the waves may be a factor. One might suppose that the gouging action which occurs makes mayfly nymphs and other bottom organisms (the latter occurred in one-fourth of the stomachs in the June 23 collection) more readily available to pikeperch. If this is true, it might conceivably lead to habitual feeding by pikeperch along lee shores during and after heavy blows. It should also be noted in this connection that roiliness of the water on such occasions decreases the light intensity and permits pikeperch to frequent shallow shoreward areas which they might otherwise be reluctant to enter during daylight hours, due to dazzlement.

Plants occurred in about one-eighth of the stomachs from Lake Gogebic. Generally only small fragments occurred and it is presumed

that these were taken accidentally when other food was sought.

The contents of stomachs of 146 pikeperch from the Muskegon River impoundments are summarized in Table 5. Except for gill net collections in late July and early August, 1947, stomachs of these fish were preserved for the Institute during the 1948 fishing season by guides at Hardy and Newaygo ponds. Receptacles containing 10 percent formalin were provided and visceral organs were preserved when the fish were dressed. No length measurements were taken. All fish were of legal size (14 inches) or larger; it is estimated that over 80 percent were between 14 and 18 inches in length.

Fish were of less importance in the diet of Muskegon River pikeperch than in those collected at Lake Gegebic. They occurred in less than one-half of the stomachs and composed only 41 percent of the total volume of food. Sunfishes (mostly black crappies) predominated. Perch were far less important and minnows were found in only one stomach. Advanced digestion prevented the identification of many of the fish found.

Mayfly nymphs or adults occurred in 56 percent of the fish studied and made up 30.5 percent of the total volume. Crayfish occurred in 20 of the 146 stomachs and contributed 26 percent of the food. Four stomachs contained Leptodora and one adult fish had taken a large quantity of Daphnia.

A collection of 52 pikeperch stomachs (Table 6) was made at Lake Cadillac by Mr. Stanley Lievens during the winter of 1947-1948. Twenty-one were collected during the following summer (15 in August).

Fish were found in 60 percent of the stomachs and composed about two-thirds of the total volume of food taken; over one-half of the fish were percids (mostly yellow perch). The latter were of greater importance

Table 5. Food of yellow pikeperch in Muskegon River impoundments, 1947 and 1948.

Date of collection	July 29-August 13, 1947		June, 1948		July, 1948	
Number of stomachs with food	28		34		17	
Range in total length of fish (inches)	7.5-25.6		14.0+		14.0+	
Total volume of food (cubic centimeters)	52.5		56.5		45.9	
Food:	Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume*
Crustacea	14.3	21.0	14.7	26.4	82.4	95.6
Crayfish	3.6	19.0	11.8	25.7	82.4	94.6
Other	10.7 <sup>1/2</sup>	2.0	2.9 <sup>1/2</sup>	0.7	5.9 <sup>2/3</sup>	1.0
Insects	96.4	75.0	94.1	66.7	11.8	2.6
Ephemeroptera	89.3	74.7	94.1	66.4	11.8	0.6
Chironomidae	7.1	0.3	14.7	0.3	...	...
Other	...	...	...	...	5.9 <sup>3/4</sup>	2.0
Fish	21.4	4.0	11.8	6.0	17.6	1.8
Cyprinidae	3.6	1.5	...	...	...	...
Percidae	...	...	...	...	...	...
Centrarchidae	3.6	1.0	3.0	5.3	5.9	tr
Unidentified remains	14.2	1.5	8.8	0.7	11.7	1.8
Gastropoda	...	...	...	...	...	...
Plants	3.6	tr	5.9	0.9	...	...

<sup>1/2</sup> Leptodora.  
<sup>2/3</sup> Daphnia.  
<sup>3/4</sup> Coleoptera 1; Trichoptera 45; Homoptera 3.

August, 1948

September, 1948

October and November, 1948

Totals

38

13

16

146

14.0+

14.0+

14.0+

...

53.9

22.2

34.9

265.9

Percentage of stomachs containing organisms

Percentage of total volume

Percentage of stomachs containing organisms

Percentage of total volume

Percentage of stomachs containing organisms

Percentage of total volume

Percentage of stomachs containing organisms

Percentage of total volume

...

...

7.7

0.9

...

...

16.4

26.3

...

...

7.7

0.9

...

...

13.7

25.6

...

...

...

...

...

...

3.4

0.7

39.5

4.3

7.7

0.4

31.3

1.2

56.2

30.5

36.9

4.3

7.7

0.4

25.0

0.9

52.7

30.0

2.6

tr

7.7

tr

6.3

0.3

6.8

0.2

...

...

...

...

...

...

0.7

0.3

73.7

91.1

92.3

91.9

93.8

97.4

46.6

41.3

...

...

...

...

...

...

0.7

0.3

13.2

19.7

7.7

24.3

6.3

17.5

4.8

8.3

10.5

34.1

...

...

31.2

52.1

8.2

15.1

55.3

37.3

84.6

67.6

62.5

27.8

34.9

17.6

...

...

7.7

1.8

...

...

0.7

0.2

18.4

4.6

15.4

5.0

18.8

1.4

10.3

1.7

Table 6. Food of yellow pikeperch in Lake Cadillac, Michigan, 1947-1948.

Dates of collection	December, 1947-March, 1948		May-August, 1948		Totals	
Number of stomachs with food	52		21		73	
Range in total length of fish (inches)	9.5-18.5		8.2-20.0		8.2-20.0	
Total volume of food (cubic centimeters)	92.3		47.7		140.0	
Food:	Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume	Percentage of stomachs containing organisms	Percentage of total volume
Crustacea <sup>1/</sup>	21.2	3.9	9.5	tr	17.8	2.6
Insects	51.9	33.4	38.1	6.3	49.3	24.1
Ephemeroptera	1.9	tr	4.8	4.6	2.7	1.6
Chironomidae	48.1	32.6	28.6	1.3	42.5	21.9
Others	1.9 <sup>2/</sup>	0.8	9.5 <sup>3/</sup>	0.4	4.1	0.6
Fish	53.8	53.6	76.2	89.9	60.3	66.0
Cyprinidae	15.4	15.4	4.8	3.6	12.3	11.4
Percidae	3.8 <sup>4/</sup>	17.3	47.6	69.4	20.1	35.1
Centrarchidae	3.8 <sup>5/</sup>	2.9	14.3	2.9	6.8	2.9
Unidentified remains	28.8	18.0	33.3	14.0	30.1	16.6
Miscellaneous	13.5	9.1	23.8	3.8	16.4	7.3
Hirudinea (leeches)	13.5	9.1	...	...	6.8	1.3
Plants	...	...	23.8	3.8	9.6	6.0

<sup>1/</sup> Gammarus, Hyalella and isopods.  
<sup>2/</sup> Unidentified remains.  
<sup>3/</sup> Zygoptera and Trichoptera.  
<sup>4/</sup> Johnny darter 1; perch 1.  
<sup>5/</sup> Bluegill.

during the summer than in the winter, when minnows of various species made up over 15 percent of the diet, judging by the specimens examined. Midge larvae were important items of winter food. They occurred in almost one-half of the stomachs collected during the period of ice cover and constituted one-third of the total volume of winter food. Some stomachs were literally crammed with the insects (as many as 277 in a single stomach). Unlike pikeperch in Lake Gogebic and in the Muskegon River, fish in Lake Cadillac did not feed freely on mayfly nymphs. These organisms occurred in only 3 of the 73 stomachs examined. Crustaceans occurred in 11 of the 30 stomachs collected during the winter but contributed little to the volume of food consumed. Leeches occurred in 7 of the stomachs collected during the winter, but did not occur in fish collected in summer.

Four pikeperch, ranging from 10.0 to 21.7 inches in length, collected by C. M. Taube at Lake George on July 24, 1947, had eaten five yellow perch and one unidentified fish.

Seven pikeperch, ranging in total length from 11.6 to 17.9 inches, were collected by L. R. Anderson at Lake Mary, Iron County on September 16, 1947. Midge larvae and pupae occurred in 6 of the fish and composed 55 percent of the food. One fish had eaten 334 midge larvae and 3 pupae, whereas two others had taken about 200 larvae each. Fish, among which only one yellow perch was identifiable, constituted 26 percent of the total food volume and crayfish made up 18 percent. Anderson noted (unpublished) that forage fish (other than young perch and suckers) were not observed at Lake Mary.

There follows a brief summary of the results reported by other workers who have studied the food of adult yellow pikeperch in various waters of their range.

Forbes (1880, 1903) and Forbes and Richardson (1908) reported only fish in the stomachs of ten adult pikeperch from Illinois. Gizzard shad occurred in five of these. Minnows and one small sunfish were also found. Forbes (1888) further listed black bass and catfishes as occurring in pikeperch stomachs and reported insects wholly or nearly absent from the adult diet. Nicklas (1886) reported that the species feeds not only on fish, but also on insects and worms. Smith (1892) found that the alewife constituted the chief food of the pikeperch in Lake Ontario in 1891. Cheney (1897) reported that the food of pikeperch consists of small fish of all kinds, crustacea, and larvae of insects. Jordan and Evermann (1903) noted that pikeperch fed on crayfish during periods spent in shallow water.

The U. S. Commission of Fish and Fisheries (1903) and Leach (1927) stated that the chief food of pikeperch in Lake Erie is the lake shiner, with occasional crayfish occurring in the winter and insects and insect larvae in the warmer months. Doan (1942) corroborated the earlier findings in part when he found that 82 percent (by volume) of the food of 62 pikeperch, 10 to 17 inches in length, collected from western Lake Erie in November and December, 1940, consisted of lake shiners. Sheepshead (14 percent) and white bass (4 percent) were also found.

Hankinson (1908) found an 8-inch perch in one of two specimens from Walnut Lake, Michigan, and five small fish (possibly straw-colored minnows) in the other. Bensley (1915) reported that in Georgian Bay the species lives on minnows, small black bass, rock bass, sunfish, perch and suckers and noted that it also takes mud puppies and crayfish. Baker (1918) found fish (one common sunfish identified) in the stomachs of three pikeperch from Oneida Lake.

Pearse (1918, 1921) found 91 percent fish and 9 percent frogs (by volume) in the stomachs of 11 fish, averaging 17.3 inches in standard length, from Lake Minona and Lake Waubesa, Wisconsin. Stomachs of 11 fish (average standard length, 15.2 inches) from Lake Pepin contained 79 percent fish and 21 percent Sialis larvae. Eight fish (10.8 inches) from Lake Geneva had eaten 75 percent fish (25 percent perch). Evermann and Clark (1920) found fish remains and a few crayfish in 24 adult pikeperch examined.

Clemens and others (1924; reported in part by Clemens et al., 1923) found ciscoes and nine-spined sticklebacks predominating in the diet of 98 pikeperch collected at Lake Nipigon. Nymphs of Ephemeridae (mayflies) occurred in 8 of the specimens and constituted 100 percent of the food found in four. It was reported that at the time of emergence of the subimagos of the large burrowing mayfly (Hexagenia bilineata) the alimentary tracts of pikeperch and saugers were sometimes filled with its nymphs. A few Epischura, Leptodora, chironomid pupae and caddis larvae were also found in this study, as well as a tessellated darter, a common whitefish, 9 cottids, and a pikeperch. Dymond (1926) using these same data observed that young ciscoes were eaten almost exclusively in late August and September when the fish migrate to deeper water (60 to 90 feet) whereas small fish and mayfly nymphs were more important earlier in the year when the fish were at shallower depths (10 to 20 feet). Very few minnows were observed in Lake Nipigon (Clemens et al., 1923).

Greeley (1927) found young perch, suckers and minnows comprising about four-fifths of the food of seven pikeperch, 13 to 27 inches in total length, from New York waters. Aquatic insects made up the



remainder. Eaton (1928) examined stomachs of 56 pikeperch from other New York waters and found 10 percent perch, 28 percent minnows, 49 percent mayflies, 4 percent caddis flies, 8 percent midges, and 1 percent plant fragments. Sibley (1929) reported that 22 specimens from the Erie-Niagara system in New York had eaten only fish. Most of these were shiners (Notropis). Another minnow (Nocomis), a Johnny darter, and 3 troutperch also occurred. He also reported (1932) his observations on food habits of several pikeperch collected in the Oswegatchie and Black River systems in New York. Three fish (13.4 inches in average length) had eaten 70 percent aquatic insects and 30 percent perch; another (8.9 inches) had eaten 80 percent aquatic insects and 20 percent oligochaete worms; seven others (8.3 to 15.0 inches) had eaten only fish (yellow perch and the spot-tailed shiner, Notropis hudsonius).

Rimsky-Korsakoff (1930) found almost 100 percent fish in the stomachs of 11 fish from the Lake Champlain (New York) watershed. Smelt (Osmerus mordax), troutperch (Percopsis omiscomaycus), the silvery minnow (Hybognathus regius) and brown bullheads (Ameiurus n. nebulosus) were found. One specimen, 14.6 inches in standard length, had eaten 10 percent adult Diptera and Ephemeraeidae, 40 percent Malacostraca and 50 percent higher plants; another, 4.7 inches long, had eaten only the crustacean, Mysis relicta. Tester (1932) found 48 percent fish (mostly perch), 23 percent crayfish, and 28 percent insects in 16 specimens, 13.4 to 15.7 inches in length, from Lake Nipissing.

Pate (1933) found only fish (particularly yellow perch and sunfish) in the stomachs of 20 pikeperch (3.9 to 25.2 inches in total length) from five New York lakes. In certain other waters Pate (1934)

found 20 percent (by volume) insects, 30 percent crustaceans, and 50 percent yellow perch in 4 specimens; 10 percent insects and 90 percent perch in 3; 100 percent yellow perch in 2; 25 percent insects and 75 percent yellow perch in 1; and 100 percent insects in a 14.6-inch fish. The fish were collected in August.

Bajkov (1930) wrote that the main food of adult pikeperch is small fish, larvae of Ephemeridae, Phryganeidae, Odonata, etc., and stated that amphipods, decapods, and other crustaceans are not rare.

A report in Michigan Conservation (1934) stated that pikeperch caught in the bays of northern Lake Michigan were found "loaded to the mouth" with smelt.

In 67 pikeperch taken during the summer of 1931 and 1932 in four Wisconsin lakes, fish (yellow perch, darters and minnows) constituted 85 percent of the volume of the stomach contents (Couey, 1935). Ephemeridae, Diptera larvae, caddis larvae, dragon fly nymphs and crayfish also occurred.

Dendy (1946) reported only fish from stomachs of 232 pikeperch, ranging from 8.7 to 24.4 inches in length, from Norris Reservoir. Gizzard shad were the most important item of diet and even adult shad were utilized to some extent by the larger fish. Black crappies and skip-jacks were less important food items; bluegills, other centrarchids, log perch and channel catfish also occurred.

#### Summary

In Lake Gogebic fish made up 88 percent of the food of 138 young-of-the-year fish, about 99 percent of the food of 78 one-year-old pikeperch, and 89 percent of the stomach contents of 196 adult fish studied.

The importance of yellow perch in the diet was outstanding.

In the Muskegon River impoundments fish made up over 88 percent of the food of 24 young fish and 41 percent of the contents of 146 stomachs of adult fish. Immature and mature mayflies and crayfish contributed heavily to the diet of the latter group.

Fish constituted 66 percent of the volume of food in 73 stomachs from Lake Cadillac. Midge larvae comprised about 33 percent of the volume of food and occurred in 25 of 52 stomachs collected in this lake during the winter months.

The analyses of stomach contents of pikeperch collected both in Michigan and in outstate waters reveal, in general, a marked predominance of fish in the diet of this species in all size groups (with the possible exception of pikeperch less than one inch in length, in natural waters which have not been adequately studied). The species of fish consumed vary with locality and in some waters with the season. As would be expected, the species most readily available to pikeperch in the largest numbers generally forms the bulk of the diet. Individual species comprising major food items in each of several widely separated localities (see above) include yellow perch, alewives, gizzard shad, smelt, lake shiners and ciscoes. Other species of minnows, centrarchids, nine-spined sticklebacks, troutperch, darters and suckers have been found in smaller numbers in several of the various collections studied. Extensive predation by pikeperch upon their own young is not indicated.

Aquatic insects are an important constituent of pikeperch diet in some waters, particularly during certain seasons. They do not usually constitute the major portion of the volume of food occurring in entire

collections although not infrequently individuals are found with stomachs crammed with the organisms. In general, burrowing mayflies are the most important group of insects occurring in pikeperch stomachs, particularly during the period of emergence, when nymphs, subimagoes, and adults may for a time comprise the major portion of the diet. Midge larvae are next in importance; other forms occur infrequently and are rarely found in significant numbers.

Crustacea were present in the stomachs of young and adult pikeperch from several localities but in general they do not make up the bulk of the food consumed. Entomostraca commonly occur in small fish. Occasional adult pikeperch were observed which have eaten large numbers of such forms as Daphnia or, more often, Leptodora. Crayfish are commonly eaten, though generally in small numbers, by adult pikeperch.

In addition to fragments of plants which are commonly found in pikeperch stomachs (perhaps ingested accidentally with other food), miscellaneous items which have been reported include such diverse forms as leeches, oligochaete worms, snails, mud puppies, frogs and even small turtles. None of these, however, make a substantial contribution to pikeperch diet in the waters in which the food of the species has been studied.

INSTITUTE FOR FISHERIES RESEARCH

Paul H. Eschmeyer

Approved by A. S. Hazzard

Typed by M. J. Lambert

Literature Cited

(Only references not cited in I.F.R. Report No. 1210, "Reproduction and Migration of the Yellow Pikeperch in Michigan," to which the reader is referred, are included in the following list.)

Baker, Frank Collins

1918. The productivity of invertebrate fish food on the bottom of Oneida Lake, with special reference to molluscs. N. Y. State College of Forestry, Tech. Pub. No. 9, pp. 1-264.

Couey, Faye M.

1935. Fish food studies of a number of northeastern Wisconsin lakes. Trans. Wis. Acad. Sci., Arts and Letters, Vol. 29, pp. 131-172.

Dendy, Jack S.

1946. Food of several species of fish, Norris Reservoir, Tennessee. Jour. Tenn. Acad. Sci., Vol. 21, pp. 105-127.

Eaton, E. H.

1928. The Finger Lakes fish problem. A biological survey of the Oswego River system. Supp. to 17th Ann. Rept. N. Y. Cons. Dept., (1927) pp. 40-66.

Forbes, S. A.

1888. On the food relations of fresh water fishes: a summary and discussion. Bull. Ill. State Lab. Nat. Hist., Vol. 2, pp. 475-538.

Forbes, Stephen A. and Robert E. Richardson

1908. The fishes of Illinois. Natural History Survey of Illinois, State Lab. Nat. Hist. 357 pp.

Greeley, J. R.

1927. Fishes of the Genessee region with annotated list. In: A biological survey of the Genessee River System. Supp. to

16th Ann. Rept. N. Y. Cons. Dept. (1926), pp. 47-66.

Hankinson, Thomas L.

1908. A biological survey of Walnut Lake, Michigan. Mich. State Board Geol. Surv., Rept. for 1907, pp. 157-288.

Jordan, D. S. and B. W. Evermann

1923. American food and game fishes. Doubleday, Page and Co., New York. I-L + 574 pp.

Michigan Conservation

1934. Wall-eyed pike gorge on smelt. Michigan Conservation, Vol. 4, No. 3, p. 4.

Nicklas, Carl

1886. Pond culture. Rept. U. S. Comm. of Fish and Fisheries (1884) pp. 467-655.

Pate, U. S. L.

1933. Studies on fish food in selected areas. A biological survey of the upper Hudson watershed. Supp. 22nd Ann. Rept. N. Y. Cons. Dept. (1932), pp. 130-156.

1934. Studies on the fish food supply in selected areas of the Raquette watershed. A biological survey of the Raquette watershed. Supp. 23rd Ann. Rept. N. Y. Cons. Dept. (1933), pp. 136-157.

Pearse, A. S.

1918. The food of the shore fishes of certain Wisconsin lakes. Bull. U. S. Bur. Fish., Vol. 35, pp. 245-292.

Sibley, C. K.

1932. Fish food studies. In: A biological survey of the Oswegatchie and Black River systems. Supp. 21st Ann. Rept. N. Y. Cons. Dept. (1931), pp. 120-132.

Tester, Albert L.

1932. Food of the small-mouthed black bass (Micropterus dolomieu)  
in some Ontario waters. Univ. of Toronto Studies, Biol.  
Series No. 36. Pub. Ont. Fish. Res. Lab. No. 46, pp. 169-221.