Food Habits of Yellow Perch, Smallmouth Bass and Largemouth Bass in Two Unproductive Lakes in Northern Michigan[1]

ABSTRACT: *The food habits of 248 yellow perch* (Perca flavescens), *479 smallmouth bass* (Micropterus dolomieui) *and 551 largemouth bass* (M. salmoides) *from two unproductive lakes are presented by size of the fish and month of capture. In all three species the young-of-the-year ate small entomostracans; older fish ate insects and fish. Scarcity of fish in the diets of young largemouth bass and juvenile and adult smallmouth bass undoubtedly contributed to the slow growth of these species. The phantom midge* (Chaoborus) *and chironomid midges were important as food for smallmouth bass of all sizes. Adult smallmouth bass and yellow perch and juvenile largemouth bass were especially cannibalistic. Adult largemouth bass and yellow perch usually fed on small yellow perch instead of on small largemouth bass.*

INTRODUCTION

The type and amount of food eaten by a species of fish vary between years, seasons and size groups. This variation is mainly due to inter- and intraspecific competition and differences in the availability of food organisms. As part of a larger study, I studied the food habits of yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*M. salmoides*) in two very unproductive lakes which, for the bass, were located near the limits of their geographical range. Competition for food and the abundance of food may be especially critical for survival of bass in such waters.

STUDY AREA AND METHODS

Cub and Katherine lakes are in the Sylvania Recreation Area, Gogebic Co., in Michigan's Upper Peninsula. The areas and maximum depths are 11.3 ha and 6.1 m for Cub Lake and 19.4 ha and 17.7 m for Katherine Lake. Neither lake has an inlet or outlet. Total alkalinity was 10 and 3 ppm; *p*H 6.7 and 5.7, respectively. Species of fish in Cub Lake were smallmouth bass, largemouth bass, yellow perch, white sucker (*Catostomus commersoni*), Iowa darter (*Etheostoma exile*) and central mud minnow (*Umbra limi*). Smallmouth bass and central mud minnows were the only fish in Katherine Lake. Although neither primary productivity nor density of fish foods was quantified, several characteristics of these lakes (*e.g.,* few larger aquatic plants, abundant organic materials in the bottom, low electrolyte content, low *p*H, floating mats of *Sphagnum* and other bog flora, brown-stained water in Katherine Lake) indicate a progressive state of lake succession in which biological production is generally low (Welch, 1952).

Largemouth bass and yellow perch in Cub Lake and smallmouth bass in Katherine Lake were captured from 1967 to 1969 with electrofishing gear, trap nets, gill nets, seines and hook and line. Whole small fish and the stomachs of larger fish were preserved in 10% formalin and the stomach contents were subsequently identified. With the exception of the numbers of Entomostraca and unidentifiable insect remains, the frequency of occurrence, numbers and volumes of each food organism in each stomach were recorded. Volumes were measured to the nearest 0.1 ml of water displacement in a graduated centrifuge tube. When fish were collected late or early in 1 month and also during the following or preceding month, respectively, the data for the 2 months were combined. There were also instances where fish collected over several months were combined to obtain adequate stomach samples. Fish were measured to the nearest 2.5 mm total length.

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RESULTS AND DISCUSSION

Yellow perch.—During the life span of a yellow perch, it feeds first on small crustaceans, then on insects, and finally on fish (Parsons, 1950; Kutkuhn, 1955; Pycha and Smith, 1955; Tharratt, 1959). Food habits of yellow perch in Cub Lake support this generalization (Table 1 and Fig. 1). Chironomid midge larvae and small entomostracans constituted 87.5% of the volume of food eaten by young-of-the-year yellow perch in August (Fig. 1).

Juvenile yellow perch (up to 150 mm in length) ate mainly insects, especially chironomid larvae, throughout the growing season (Fig. 1). Chironomid larvae constituted 90.5% and 92.0%, respectively, of the numbers of organisms consumed during June-July and August-September, but only 54.5% and 58.6% of the volume for the same periods. Volumetrically, the food of juveniles consisted of 11.7% fish in June-July, but only 4.3% in August-September. Only 5.0% of the juveniles had consumed small entomostracans in June-July and none in August-September. In the latter period, leeches, odonate naiads and fingernail clams (*Pisidium*) constituted 41.0% of the volume of food, while leeches, odonate naiads and trichopteran larvae made up 28.5% earlier in the summer (Fig. 1).

Although 82.4% of the organisms eaten by adult yellow perch in April-June were chironomid larvae, 56.4% of the food volume consisted of fish (43.4% yellow perch) and 32.6% was leeches (Fig. 1). During July-August, odonate naiads and trichopteran larvae constituted 51.6% of the volume and 71.2% of the numbers. Fish made up 27.3% of the volume of food in July-August (Fig.

TABLE 1.—Number of stomachs examined and number and volume of food organisms found in yellow perch and largemouth bass in Cub Lake, and smallmouth bass in Katherine Lake, 1967-1969. (Identification of food items is given in Figures 1-3)

Species and age	Month	Number of stomachs		Total food organisms	
		Examined	Containing food	Number	Volume (ml)
Yellow perch					
Fry	August	47	35	365	1.6
Juvenile	June-July	76	55	1897	7.7
Juvenile	Aug.-Sept.	49	39	1625	11.6
Adult	Apr.-June	40	15	91	4.6
Adult	July-Aug.	36	33	421	12.8
Largemouth bass					
Fry	Aug.-Sept.	35	33	85	1.0
Juvenile	June-July	116	109	482	21.3
Juvenile	Aug.-Sept.	60	51	136	20.0
Adult	May-June	80	42	248	161.2
Adult	July	46	28	127	26.3
Adult	Aug.-Sept.	214	140	345	672.7
Smallmouth bass					
Fry and fingerling	June-July	16	13	209	1.9
Fry and fingerling	Aug.-Sept.	69	66	1064	4.9
Juvenile	June	44	44	9740	29.3
Juvenile	July	71	70	9358	25.6
Juvenile	Aug.-Sept.	64	63	3742	25.5
Adult	June	104	69	3597	136.6
Adult	July	64	58	3494	136.9
Adult	Aug.-Sept.	47	40	2261	67.1

1). The extensive cannibalism by adult yellow perch in Cub Lake was unusual because Iowa darters, central mud minnows, and small largemouth bass, which were most abundant, were also present in the lake. Newly hatched bass fry were eaten by juvenile perch; yet, juvenile bass were either less available as forage, or adult yellow perch preferred small perch as food. Although Hunt and Carbine (1951) found yellow perch to be an important predator on young northern pike (*Esox lucius*), perch are probably not capable of capturing large number of bass older than 1 year.

Largemouth bass.—The size-specific food habits of largemouth bass are similar to those of yellow perch, also progressing from small crustaceans to

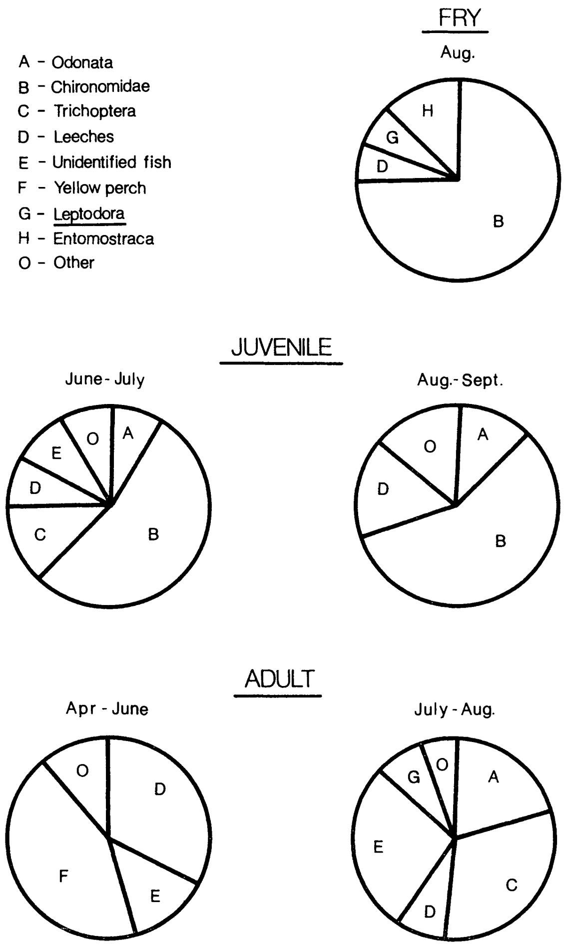

Fig. 1.—Relative volumetric composition, by month, of the stomach contents of three age categories of yellow perch from Cub Lake, 1967-69. The "other" segment of some diagrams represents food items constituting 5.0% or less of the total volume

insects to fish (Murphy, 1949; Goodson, 1965; McCammon *et al.,* 1964; Applegate and Mullan, 1967). Food analysis of largemouth bass in Cub Lake indicates this pattern (Table 1 and Fig. 2). In August and September, 90% of the food eaten by largemouth bass fry was chironomid larvae and *Leptodora* and smaller entomostracans (Fig. 2). Juvenile largemouth bass (up to 230 mm in length) also consumed large numbers of small crustaceans and odonate naiads, but fish made up 63.8% and 61.0% of the volume for June-July and August-September, respectively (Fig. 2). Vertebrates, especially yellow perch and the vole (*Microtus*), were the most important item in the diet of adult largemouth bass; they made up 80.6%, 62.2%, and 92.3% of total volume for May-June, July and August-September, respectively (Fig. 2). Odonate naiads, trichopteran larvae and leeches constituted 71.7% of the organisms eaten in May-June and 31.2% of the volume in July.

The extensive cannibalism by juvenile largemouth bass suggests that they live in closer proximity to bass fry and fingerlings than do yellow perch, or that they are more adept in preying on bass, or both. Adult largemouth bass selected yellow perch for forage over smaller bass. During 3 years, only

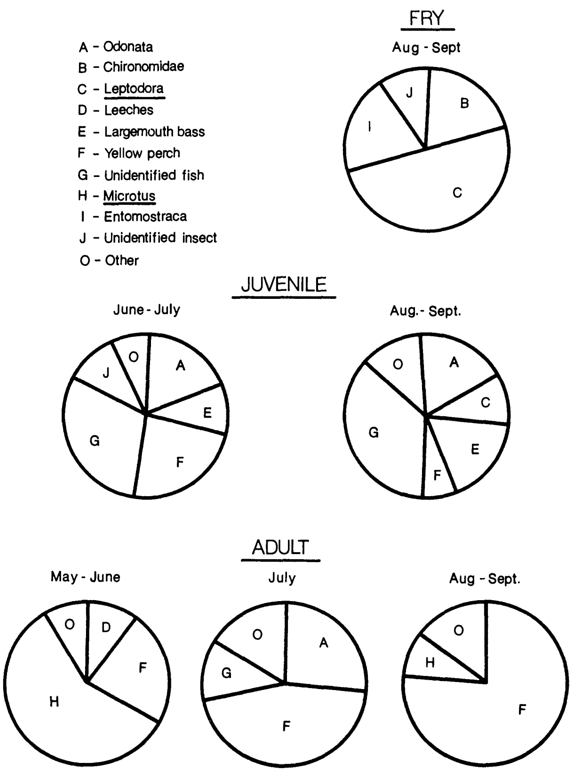

Fig. 2.—Relative volumetric composition, by month, of the stomach contents of three age categories of largemouth bass from Cub Lake, 1967-69. The "other" segment of some diagrams represents food items constituting 5.0% or less of the total volume

three of 340 adult largemouth bass were found to have eaten bass, all of which were newly hatched fry. Yellow perch constituted 22.9, 45.6 and 76.2% of the total volume of food in adults in May-June, July and August-September, respectively, while bass constituted only 0, 4.9 and 0.3% (Fig. 2). Seaburg and Moyle (1964) found that yellow perch made up 70 to 85% of the stomach contents of largemouth bass in two groups averaging 173 and 193 mm in length.

Murphy (1949) found that high production of young largemouth bass is attained only when there is a good supply of forage fish available as the bass reach a length of 63 to 75 mm. Consumption of fish by largemouth bass of this size in Cub Lake did not approach the nearly 100% frequency of occurrence reported by Murphy for bass in Clear Lake, Calif. This could be largely responsible for the slow growth of largemouth bass in Cub Lake, where older fish were 50 to 100 mm below the Michigan average reported by Beckman (1949). Kramer and Smith (1960) found that largemouth bass fry ate few fish when the forage fish spawned at the same time as the bass. Cooper (1937), working in rearing ponds, found cannibalism by largemouth bass fry when they did not have minnows of suitable size as forage. Since yellow perch spawn 1½-2 months earlier than largemouth bass in Cub Lake (April vs. June), this situation may be even more acute. At no stage of their life did the largemouth bass in Cub Lake eat fish of their own age. Juveniles exhibited substantial cannibalism by consuming younger fry and fingerlings.

Smallmouth bass.—The food of smallmouth bass is similar to that of yellow perch and largemouth bass, except adult smallmouth bass often feed heavily on crayfish (Tester, 1932; Hubbs and Bailey, 1938; Doan, 1940) and occasionally on insects (Surber, 1941). The smallmouth bass of all sizes in Katherine Lake relied heavily on aquatic insects for food, especially on the larvae of the phantom midge (*Chaoborus*) and chironomid midge larvae (Table 1 and Fig. 3). Of the total numbers of food organisms eaten by smallmouth bass fry and fingerlings (76 mm in length or smaller), 80.3% were *Chaoborus* in June-July and 89.3% were chironomids in August-September. Larger ephemeropteran nymphs and trichopteran larvae, however, constituted 68.4% and 15.8%, respectively, of the volume of food in June-July. Chironomid larvae, terrestrial insects and entomostracans made up 81.5% of the volume in August-September (Fig. 3).

For juvenile smallmouth bass up to 203 mm, the relative numerical composition of *Chaoborus* in the diet dropped from 94.2% in June to 87.3% in July to 61.2% in August-September. Occurrence by volume dropped from 64.8% to 33.2% to 21.2% (Fig. 3). The relative numerical composition of chironomid larvae increased from 3.3% in June to 7.1% in July to 30.8% in August-September, with a similar trend for volume (Fig. 3). Chironomid midges and phantom midges constituted from 92.0 to 97.5% of the numbers, and from 39.1 to 65.5% of the total volume of food.

The stomachs of adult smallmouth bass contained from 50.0 to 88.5% *Chaoborus* by numbers, but only 6.6 to 10.7% by volume (Fig. 3). Consumption of chironomids again increased throughout the season to a maximum of 38.1% of numbers and 9.7% of volume in August-September. Fish made up from 23.9 to 33.9% of the food volume of adult smallmouth bass during the summer. The relative volumetric composition of crayfish (*Cambarus*) declined from 30.5% in June to 10.2% in July to 2.2% in August-September (Fig. 3).

In Katherine Lake, predation by smallmouth bass was minimal on the central mud minnow, which was the only possible forage fish. Only one mud minnow was identified from stomachs of 394 juvenile and adult bass during the three years of study. Electrofishing revealed that the mud minnow lived in extremely shallow backwaters and other isolated areas where contact with the smallmouth bass was minor.

Smallmouth bass in Katherine Lake, lacking a suitable forage fish, apparently did not adapt easily to feeding on smaller bass. By volume, cannibalism by juveniles was less than 6.3%, while total consumption of fish, including unidentifiable individuals, was not over 10.3%; cannibalism by adults ranged from 15.4% in August-September to 26.7% in June (Fig. 3). Only in June, when 64.4% of the total volume of food was fish and crayfish, did the adult smallmouth bass in Katherine Lake have a diet similar to that which is cited in most literature.

Surber (1941) found that river populations of smallmouth bass which ate relatively large fish had faster growth and better body condition than those consuming large numbers of small food items, mainly insects. Undoubtedly the small sizes of adult smallmouth bass in Katherine Lake, which were 50 to 100 mm below the Michigan average reported by Beckman (1949), can be attributed to a diet consisting mainly of aquatic insects.

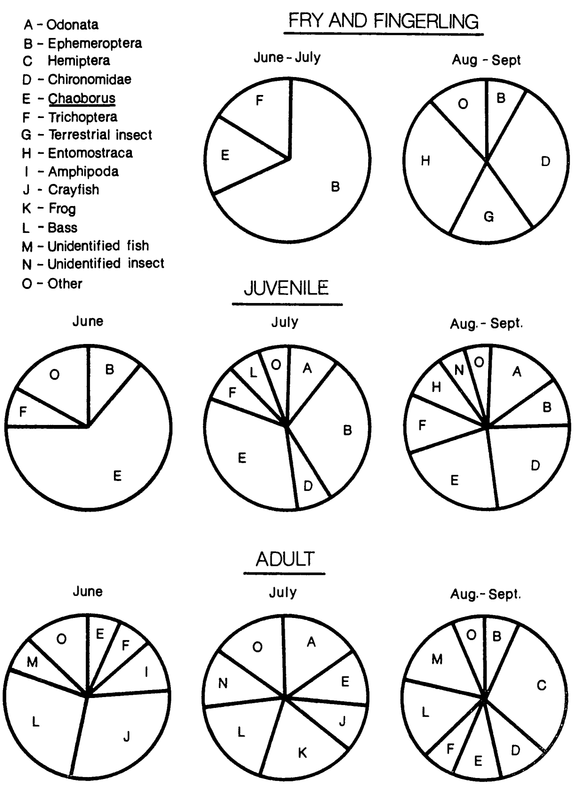

Fig. 3.—Relative volumetric composition, by month, of the stomach contents of three age categories of smallmouth bass from Katherine Lake, 1967-69. The "other" segment of some diagrams represents food items constituting 5.0% or less of the total volume

Messrs. Clinton Harris, Bernard Otterpohl, Thomas Cannon and Joseph Kowalis aided in the field studies. Drs. James McFadden and W. C. Latta supervised the research and preparation of the manuscript. Dr. Gerald Cooper and Mr. Duane Karna edited the manuscript. Dean Armstrong prepared the figures.

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