4-1974

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Published in *Transactions of the American Fisheries Society*, Vol. 101, Issue 2 (April 1974) at doi: 10.1577/1548-8659(1974)103<277:FIOTLB>2.0.CO;2

Food Intake of the Largemouth Bass[1]

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ABSTRACT

During 18 months of electrofishing a sample of 991 adult largemouth bass (*Micropterus salmoides*) was taken from Crab Orchard Lake. The stomach contents were removed in the field with a gastroscope. Gizzard shad (*Dorosoma cepedianum*) constituted the principal forage fish. Approximately 50% of the bass collected had empty stomachs. As the size of bass increased, the food intake as a percent of body weight decreased. Ninety percent of the bass stomachs contained one food item. When more than one food item was found, they were usually in the same stage of digestion. It is suggested that the high percent of empty stomachs was related to hunting success, or that the onset of the feeding stimulus in association with rate of digestion might result in a periodicity of feeding that involves a high percent of empty stomachs. A higher relative intake of food by small bass was postulated to be a result of the bass's typically consuming only one fish. Inasmuch as the forage fish were relatively uniform in size, one fish constituted a large meal for a small bass but not for a large bass.

Numerous studies have considered the feeding pattern of the largemouth bass (*Micropterus salmoides*) in terms of the identity and frequency of occurrence of food items in the stomach (see summary of these by Emig 1966). The present study was undertaken to determine the significance of a high percentage of empty bass stomachs which we had previously observed in several different populations. We were particularly interested in whether or not the percentage of stomachs containing food represented hunting success or some other variable. A second objective of the study was to determine at what size the largemouth bass of Crab Orchard Lake commence to utilize the full range of sizes of gizzard shad (*Dorosoma cepedianum*) available in the lake. An understanding of the first phenomenon, percent of empty stomachs, might lead to a method of determining the availability of forage organisms to a bass population. An understanding of the second occurrence, the size of shad utilized by different sizes of bass, is of particular significance in management of the Crab Orchard Lake bass population.

[1] This study was financed by the Graduate School of Southern Illinois University and the Illinois Department of Conservation. Permission to conduct the study at Crab Orchard Lake was granted by Crab Orchard National Wildlife Refuge.

MATERIALS AND METHODS

Crab Orchard Lake, located in Williamson County, Illinois, is a 2834-ha, manmade reservoir. The lake has an average depth of 2 m with gently sloping shorelines. It does not thermally stratify with the exception of the old creek channels which stratify for brief periods in the summer. The fish population is made up primarily of gizzard shad (*D. cepedianum*), carp (*Cyprinus carpio*), ictalurids, bluegill (*Lepomis macrochirus*), crappies (*Pomoxis* spp.), yellow bass (*Morone mississippiensis*), white bass (*M. chrysops*), and largemouth bass (*M. salmoides*).

The largemouth bass population of Crab Orchard Lake was sampled by electrofishing from April through October 1967 and 1968. Samples were taken at least once a week during 1967 and at least twice a month during 1968. Captured bass were weighed to the nearest g and measured in mm standard length. Stomach contents were removed in the field by a gastroscope (Dubets 1954), preserved in 10% formalin, and returned to the laboratory. It was obvious from field observations that when the correct size gastroscope was used, the interior of the stomach could be viewed directly and all contents detected. The examination did not harm the bass and they were returned to the lake. In the laboratory, stomach contents were filtered through coarse filter paper

TABLE 1.—*Percent empty stomachs for largemouth bass at various seasons*

Month	1967 Sample size	1967 Stomachs empty (percent)	1967 Average temperature (C)	1968 Sample size	1968 Stomachs empty (percent)	1968 Average temperature (C)
Apr	40	47	18	69	43	16
May	59	48	20	99	49	22
June	45	54	26	26	34	27
July	26	46	28	28	48	28
Aug	41	49	27	119	52	30
Sept	107	57	25	175	53	25
Oct	107	47	16	50	49	16

TABLE 3.—*Intake of all food by largemouth bass from Crab Orchard Lake*

Weight of bass (g)	1967 Sample size	1967 Food as percent of body weight[a]	1968 Sample size	1968 Food as percent of body weight[a]	Average percent of body weight
90– 450	125	4.6	175	3.6	4.0
451– 900	55	3.4	62	3.7	3.5
901–1,350	22	3.2	30	2.6	3.5
1,351–1,800	3	1.7	14	1.6	1.6
1,800+	5	1.6	5	1.4	1.5

[a] Wet weight of all stomach contents divided by weight of fish. Calculations include only bass containing food.

and the moist weight was determined to the nearest 0.1 g.

Since gizzard shad constituted the principal forage occurring in the stomachs, analysis of stomach contents, rate of digestion, back-calculation of size of forage, and estimate of the frequency of feeding are based on consideration of the gizzard shad only. Each fish occurring in a bass stomach was measured in mm total length when state of digestion permitted. The live weight of the shad was then calculated by reference to the average empirical length-weight relationship by Swingle (1965).

As a basis for estimating frequency of feeding, an attempt was made to establish the digestion rate of the bass. Bass weighing 200 to 400 g were held at 18 and 27 C and force fed gizzard shad equivalent to 3.0 to 4.1% of their body weight. At 2-hr intervals following feeding, two bass were autopsied. From the laboratory study the average time of digestion (time required for the stomach to empty) was 20 hr at 27 C and 30 hr at 18 C. These values are similar to those reported by Markus (1933), Hunt (1960), and Molnar and Tolg (1962).

RESULTS

Approximately 50% of the 991 largemouth bass collected from Crab Orchard Lake had empty stomachs at the time of sampling. The percentage of empty stomachs was strikingly constant during the sampling period, April through October (Table 1). The highest percentage empty (54) was the average for June 1967, whereas the lowest percentage (34) was the average for June 1968.

The percentage of empty stomachs was independent of the size of bass (Table 2). The amount of all food present, expressed as percent of body weight and based only on stomachs containing a measurable amount of food, decreased with increasing size of the bass from an average of 4.0% in fish weighing less than 90 g to an average of 1.5% in fish weighing more than 1,800 g (Table 3).

Of the 496 bass that contained food at the time of capture, 71% contained gizzard shad, 5% bullheads, 15% crayfish, 5% centrarchids,

TABLE 2.—*Relationship between length of largemouth bass and the number that contained food in their stomachs at the time of sampling*

Standard length of bass (mm)	1967 Number of bass	1967 Stomachs empty (percent)	1968 Number of bass	1968 Stomachs empty (percent)	Average for 1967 and 1968 Stomachs empty (percent)
175–200	17	47	56	43	45
201–225	60	57	59	41	49
226–250	46	56	66	55	56
251–275	55	50	72	36	43
276–300	76	40	75	57	48
301–325	38	55	65	51	53
326–350	53	50	50	40	45
351–375	35	50	44	48	49
376–400	21	48	32	63	56
401–425	22	50	19	42	46
426–483	13	46	17	77	62

TABLE 4.—*Back-calculated weight of gizzard shad expressed as percent of body weight of largemouth bass at the time of ingestion*

Weight of bass (g)	1967 Sample size	1967 Percent of body weight	1968 Sample size	1968 Percent of body weight	Average percent of body weight
90– 450	73	10.8	43	7.5	9.2
451– 900	49	6.4	34	8.7	7.6
901–1,350	15	3.0	27	4.4	3.7
1,351–1,800	3	2.6	12	3.9	3.2
1,800+	5	2.0	5	2.2	2.1

TABLE 5.—*Utilization of shad and size utilized by various sizes of largemouth bass*

Standard length of bass (mm)	Percent stomachs containing shad		Number stomachs containing shad		Average size shad eaten[a] (mm)		Range in size of shad eaten[a] (mm)	
	1967	1968	1967	1968	1967	1968	1967	1968
175–200	50	47	2	15	80	75	60–100	51– 92
201–225	60	29	12	10	112	87	70–165	70–108
226–250	55	37	11	11	126	95	70–190	51–177
251–275	74	43	17	20	137	139	80–180	63–209
276–300	73	59	19	19	157	152	120–190	82–215
301–325	93	59	13	19	145	174	75–197	133–221
326–350	86	70	18	21	140	165	85–172	82–221
351–375	82	74	9	17	154	154	95–185	101–221
376–400	82	92	9	11	153	157	118–178	88–215
401–425	100	82	8	9	158	162	120–200	120–215
426–483	100	100	4	4	168	152	138–190	158–190

[a] Total length.

and 19% unidentified material. Limiting consideration of food items to gizzard shad at the time the shad were consumed, the smaller bass ingested relatively bigger food items than did the larger bass. Bass weighing 90 to 450 g, 451 to 900 g and more than 900 g had consumed shad averaging 9.2, 7.6, and 3.0% of their body weight respectively (Table 4). Intake values as high as 24.9% of body weight were recorded for bass less than 450 g, but a maximum of only 4.0% was noted for bass larger than 1,800 g.

The average as well as the maximum size of shad eaten increased with the size of bass up to a bass size of 300 mm. In general, there was a positive correlation between the size of bass and the relative importance of shad in its diet (Table 5).

Only 10% of the 496 bass stomachs containing food collected over the 2-yr period contained more than one forage organism. In 46% of these cases at least one of the forage organisms was a crayfish. In only 3% of the other fish were the forage organisms in different stages of digestion.

DISCUSSION

There are at least two plausible explanations for the constant occurrence of 50% of the bass stomachs being totally empty. If the emptying of the stomach is the cue which triggers the feeding response, then the occurrence of 50% of the bass with stomachs totally empty would suggest that the bass hunts for an extended period of time before successfully capturing prey. However, it is possible that the cue is not the emptying of the stomach, but the emptying of the entire gut. It is also possible that the feeding response is triggered by some physiological change, such as change in blood glucose level. The matter is somewhat complicated by evidence that two different stimuli may initiate the feeding response of bass.

Snow (1971) believes that the degree of satiation is an important factor affecting feeding behavior. The normal stimulus is certainly "hunger." The second is a reflex-like response to easily available prey. Vanderhorst (1967) described a feeding behavior in bass as involving a fairly lengthy series of preparatory activities. Lewis et al. (1961) reported that bass held in tanks with minnows always present and which they consumed *ad libitum* would still instantly "strike" and usually consume a minnow thrown into the tank. Furthermore, in the present study bass were seldom observed to eat more than one gizzard shad.

The number of food items eaten may depend upon the composition of forage in the lake. Snow (1971) found 1.4 crayfish per bass stomach and 1.2 fish per bass stomach in angler-caught bass from Murphy Flowage. Shad were not present in this lake.

We believe that response of the bass to the fisherman's lure is often the same reflex-like feeding response as that reported by Lewis et al. (1961). Thus, it is not unusual for Crab Orchard Lake anglers to catch bass which have full stomachs.

There is a considerable literature pertaining to the percentage of empty stomachs found in largemouth bass. For example, Larimore (1957) found by electrofishing that 8% of the 13.9- to 22.8-cm bass he examined had empty stomachs; Seaburg and Moyle (1964) found 32% of the bass they collected by seining had empty stomachs; and Snow (1971) found 68% of the largemouth bass caught by anglers in Murphy Flowage had empty stomachs. In a turbid Oklahoma reservoir, Zweiacker (1971) found 50% of the largemouth bass he sampled by electrofishing to have empty stomachs. If the percentage of empty stomachs (approximately 50) is considered in conjunction with emptying time (approximately 20 hr), and it is assumed that all bass fed with equal frequency, it appears that bass fed at intervals of approximately 40 hr.

Seasonal uniformity of the percentage of empty stomachs in 2 years (Table 1) suggests that this parameter might be a means of evaluating the availability of forage in lakes. The fact that the percentage of empty stomachs also appears to be independent of size of bass (Table 2) further supports the practicality of using this variable as an index to availability of suitable forage.

In a study of forage size preference of the largemouth bass, Wright (1970) compared the present 1967 data to his laboratory findings on size preference. As would be expected, the values he reported for food intake by bass of different sizes and average size of shad eaten by different size bass do not differ significantly from the average values for the 2 years of data reported here.

Snow (1971) noted that an increase in size of crayfish and bluegill was positively correlated with an increase in size of bass but not bullheads. Popova (1966) states that the relative size of predators to prey for young predators reaches 40 to 50%, for adult predators 20 to 25%, and for very large predators only 10%. The relatively high food intake of the smaller bass (Table 3) is best explained by the fact that the gizzard shad was the principal forage item, and both large and small bass typically consumed only one shad when their stomachs were empty. Although one shad constituted a high food intake for a small bass, it provided a low intake for a large one. Although the average size of shad eaten by bass smaller than 300 mm was considerably less than the average size of shad eaten by large bass, the food intake of the smaller fish, when expressed as a percent of body weight, was greater than that of the larger bass. Thus, it appears that the tendency of the bass to consume only one forage organism resulted in a relatively lower food intake by larger bass.

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