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FOOD OF LARGEMOUTH BASS *(MICROPTERUS SALMOIDES)* IN DEGRAY RESERVOIR, ARKANSAS, 1976

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ABSTRACT

Stomach contents were examined from 748 largemouth bass, *Micropterus salmoides* (<125 mm total length), collected from DeGray Reservoir during April-November 1976. Fish constituted 59% by weight of the total diet and occurred in 81% of the stomachs; crayfish made up nearly 38% of the weight and occurred in 24% of the stomachs. Sunfish, the principal fish food (about 28% by weight), were observed in 36% of the stomachs. Shad were the second most important prey (23% by weight and 29% frequency in occurrence). Crayfish constituted about 42% of the total weight of the food of bass 200 mm long or longer, but only 12% in bass less than 200 mm. Crayfish consumption was greatest during the fall.

INTRODUCTION

The U. S. Fish and Wildlife Service and the Waterways Experiment Station, U. S. Army Corps of Engineers, in cooperation with state and private universities, are investigating the effects of multi-outlet water release on DeGray Reservoir and on its tailwater. Multipurpose DeGray Reservoir, located on the Caddo River in Arkansas, has a surface area of 5,427 ha at normal pool elevation (124.4 m above mean sea level). A description of DeGray Reservoir was published by Moen and Dewey (1978). The multi-outlet design at DeGray dam allows for discharge from the epilimnion, the hypolimnion, or from an intermediate depth.

An improved scientific understanding is needed to enable more accurate prediction of the effects of water release depth on the biological production in the reservoir. A major deficiency in the understanding of reservoir fish population dynamics stems from the lack of data on predator-prey relations (Jenkins and Morais, 1976). A knowledge of the food habits of fish is vital to the understanding of reservoirs. In DeGray Reservoir it was assumed that threadfin shad *(Dorosoma Petenenese)* and young gizzard shad *(D. cepedianum)* would be the major prey, and largemouth bass *(Micropterus salmoides)* the major predator. Low production of shad, coupled with high crops of bluegills *(Lepomis macrochirus)* and longear sunfish *(L. megalotis)* estimated from cove rotenone samples in 1974 and 1975, stimulated interest in the role of sunfish and other food sources. The purpose of this study was to determine the contribution of major food items to the diet of largemouth bass.

METHODS AND MATERIALS

Study Site: DeGray Reservoir, created when the Caddo River was dammed in 1969, has an area of 5,427 ha and maximum and mean depths of 57 and 15 m at normal pool elevation, which is 124.4 m above mean sea level. The multi-outlet intake is constructed so that water can be selectively withdrawn from one of three 6.4-m^2 openings, the midpoints of which are located at elevations of 120.4, 115.8, and 108.2 m (Middleton, 1967). Water was discharged exclusively from the epilimnial outlet (120.4 m) throughout our investigation (Moen and Dewey, 1978).

Food Habits: Largemouth bass were sampled on the same schedule and at the same time described for longear and bluegill sunfish in the previous paper. Largemouth bass were placed on ice immediately after capture and returned to the laboratory, where they were weighed, measured, and scale sampled. Stomachs were excised and preserved in 10% formalin for later examination.

Stomachs were split longitudinally and the food contents of individual stomachs were examined. Food items were separated to the lowest taxon identifiable by us, and material of each taxon was drained, blotted, and weighed (to the nearest 0.01g). Fish as food items were grouped into three major categories; sunfish, shad, and miscellaneous fish. The last named category included: minnows (Cyprinidae), madtoms (*Noturus* sp.), brook silverside *(Labidesthes sicculus)*, white bass *(Morone chrysops)*, and darters (Percidae). Shad could be positively identified even in advanced stages of digestion by the presence of the gizzard (Bryant and Morais, 1970).

The examination of food in relation to size of bass was limited to two categories; less than 200 mm (here termed small bass) and 200 mm or longer ("large bass"). All small bass were yearlings when sampling began in April, but a few young-of-the-year reached 125 mm (and were thus included in the collections) by August.

RESULTS AND DISCUSSION

Of 748 largemouth bass stomachs examined, 83% contained food (Table 1). The largest proportion of stomachs containing food was in bass collected in midsummer. Fish made up 59% of the total weight of food and occurred in 81% of the stomachs. Sunfish were the most important prey fish (27.7% of total weight). Shad were the second most abundant fish both by weight and frequency of occurrence. Crayfish constituted 37.6% of the total weight and occurred in 24.4% of the stomachs.

The major food items (fish and crayfish) occurred during all collection periods in both size groups of bass (Fig. 1 and 2). Fish made up 54.5% and crayfish 42.3% of the weight of food of large bass. Crayfish were more prevalent from July through November. However, during the early sampling periods (April through June), sunfish made up the highest percentage of total biomass (47.7%), whereas shad were highest in frequency of occurrence. Fish constituted 83.7% of the weight of the food of small bass, whereas crayfish made up only 11.9%; however, from July through September crayfish were eaten in significant numbers (27% of the total diet by weight). Shad was the principal food of small bass, contributing 37% of the total weight and occurring in 26.7% of the stomachs. Sunfish ranked second, contributing 30% of the total weight. From April through June, sunfish and miscellaneous fish accounted for the bulk of food biomass (76%) eaten by small bass. From July through September, crayfish, sunfish, and shad made up about equal amounts by weight, and in October and November shad was the principal food, composing 65% by weight and occurring in 70% of the stomachs.

The weight of consumed shad progressively decreased from compartments I through III (Table 2). Midwater trawl catches of juvenile shad followed the same pattern of decreasing abundance from compartments I through III (Multi-Outlet Reservoir Studies, unpublished data). In the upper compartment, shad was the predominant food by

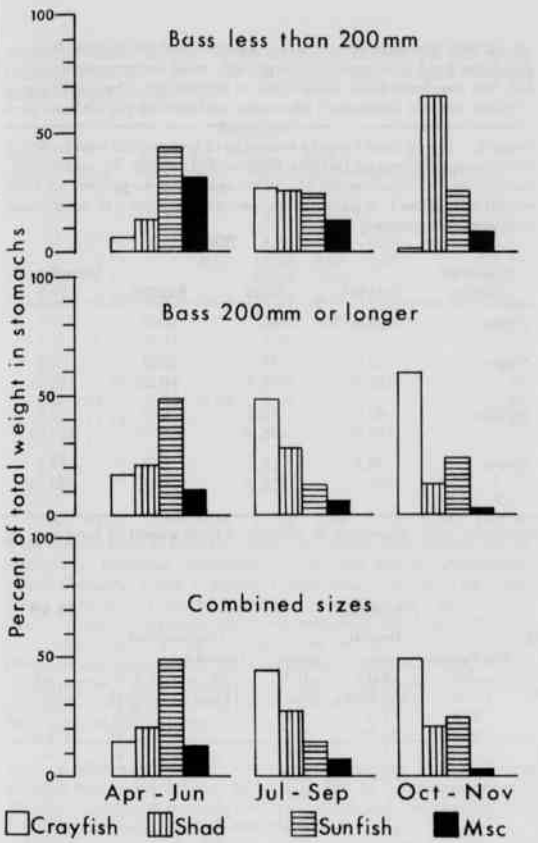

Figure 1. Seasonal distribution of major food items in the stomachs of largemouth bass from DeGray Reservoir, 15 April - 15 November, 1976, expressed as percent of total weight of food. (MSC = miscellaneous fishes; see footnote a, Table 3, for species composition.)

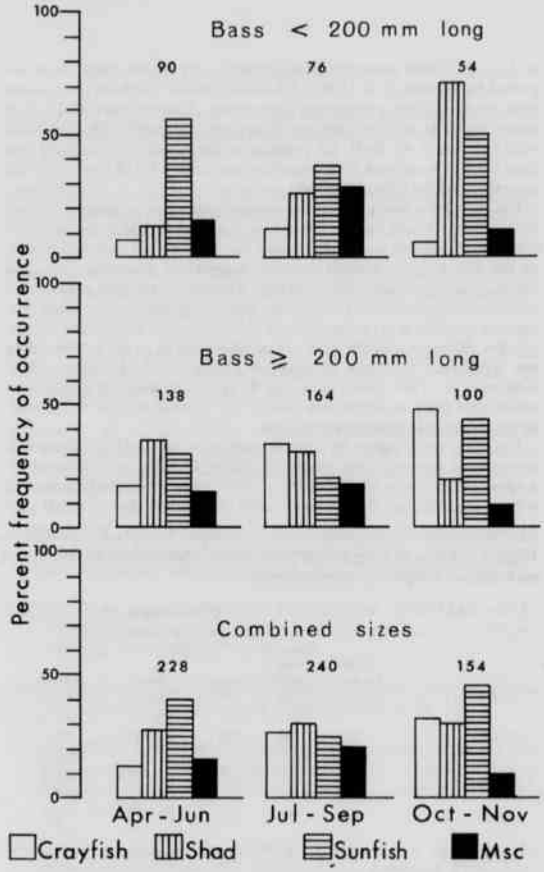

Figure 2. Seasonal distribution of major food items in the stomachs of largemouth bass from DeGray Reservoir, 15 April - 15 November, 1976, expressed as percent frequency of occurrence. Number of stomachs with food indicated by season and size (MSC = miscellaneous fishes; see footnote a, Table 3, for species composition).

weight; sunfish ranked third by weight and first in frequency of occurrence; crayfish ranked second in biomass and third in frequency of occurrence. In the middle and lower compartments, crayfish ranked first by weight and shared second ranking with sunfish in frequency of occurrence.

When stomach contents of fish collected in different seasons are examined, investigators must consider seasonal changes in water temperature and changes in digestion rates. Food may be digested five to six times faster during summer than during winter (Johnson and Charlton, 1960; Molnar and Tolg, 1962). In addition, various food items may differ in the retention of identifying characteristics during the course of digestion. For example, crayfish may be identifiable even when badly fragmented because the integument breaks down slowly. Similarly, threadfin and gizzard shad can be identified during the advanced stages of digestion by the presence of the gizzard (Bryant and Morais, 1970). Smaller prey organisms may lose their identity shortly after ingestion. Digestion rates, as influenced by temperature, could bias the relative importance assigned to different organisms.

Diel variation in feeding and time of collection strongly influence the number of empty stomachs and the amounts of food in stomachs. In the present study, feeding activity of bass apparently was intense immediately before and during collection. Although we found that 83% of all bass contained food, Aggus (1972) found this percentage to be only 47% among bass caught by anglers in Bull Shoals Reservoir. Similarly, Zweiacker and Summerfelt (1973) reported that stomachs of 45% of the bass in Lake Carl Blackwell contained food. Collections by Aggus (1972) and Zweiacker and Summerfelt (1973) were made throughout the year, and those by Zweiacker and Summerfelt were made during the morning (0600-1200 hours) and afternoon (1200-2300). After examining reports of other investigators, these authors suggested that 56% (the frequency of occurrence of empty stomachs) might be used to evaluate forage availability for largemouth bass. Such a guideline may be useful only under general conditions. However, because foraging is strongly influenced by seasonal water temperature, time of day, behavior, and prey availability, we believe it is of limited value for most fishery investigations.

Further evidence that feeding was intense during our sampling period is indicated by the ratio of stomach content weight to weight of fish. Small bass contained an average of 18 grams of food per kilogram of fish; the monthly range was 10.5 to 37 g/kg. Large bass contained 12.4 g of food per kilogram of fish; the monthly range was 8.8

to 15.4 g. These amounts were considerably higher than those reported by Heman et al. (1969), who used similar methods to examine bass feeding after a reservoir drawdown. The amount of food in stomachs of bass from DeGray Reservoir was positively correlated with fish size ($r = .914$). Six percent of the stomachs contained less than 0.1 g of food, and 38% contained more than 1 g of food; one fish contained 60.7 g (55g/kg of fish).

Crayfish have been somewhat overlooked as an important forage item of largemouth bass in reservoirs. Lorman and Magnuson (1978) stated that crayfish were not an ideal food source because about 50% of the dry weight of adult crayfish consists of inorganic salts and chitin, which are indigestible by fish. Therefore, crayfish may not be as valuable for providing energy as are fish; however, the large biomass of crayfish in largemouth bass stomachs must be considered important. Bass apparently maintain normal growth patterns when they eat significant numbers of crayfish (Taub, 1972; Lambou, 1961; Heman et al., 1969; Lewis et al., 1974). Although crayfish may be less vulnerable prey for some fish (Stein, 1977), they appear to be relatively vulnerable to largemouth bass.

Crayfish were eaten by largemouth bass in DeGray Reservoir throughout the year, but primarily during October and November. Aggus (1972) observed that more crayfish were consumed during the winter than during the summer, and concluded that crayfish sustained bass and were beneficial for gamete production. Crayfish, the dominant food in stomachs of large bass, were consumed during the fall, but also were eaten from April to September. The utilization of crayfish was not diminished when shad and sunfish populations were

Table 2. Major food items in stomachs of largemouth bass from the three compartments of DeGray Reservoir (I, upper; II, middle; III, lower), April 15-November 15, 1976, expressed as percent of total weight of food and, in parentheses, percent frequency of occurrence in stomachs containing food.

	FOOD			
Reservoir Section	Crayfish	Shad	Sunfish	Miscellaneous Fish
Upper	32.0	34.7	27.3	
Upper	32.0 (16.7)	34.7 (29.9)	27.3 (41.2)	4.2 (13.2)
Middle	40.3 (27.7)	23.2 (38.3)	25.3 (27.7)	7.6 (18.0)
Lower	38.2 (24.7)	12.3 (12.3)	33.2 (35.2)	12.1 (24.7)

Table 1. Food of largemouth bass shown with collection dates, DeGray Reservoir, 1976, expressed as percent of total weight of food and, in parentheses, frequency of occurrence.[a]

			Total Length of Fish (mm)		ANIMALS							PLANTS
					Fish			Insects		Unidentified		
	Total Stomachs	Stomachs with Food (%)	Average	Range	Sunfish	Shad	Miscellaneous	Crayfish	Aquatic	Terrestrial		
April 15	50	58	288	154-535	48.3 (41.4)	33.3 (6.9)	3.2 (13.8)	8.0 (13.8)	0.3 (20.7)	0.7 (17.2)	0.2 (13.8)	1.1 (10.3)
May 3	50	78	233	140-451	36.0 (48.7)	—	20.0 (28.2)	41.0 (30.8)	0.5 (7.7)	—	0.5 (12.8)	2.0 (12.8)
May 17	48	83	213	134-424	85.4 (67.5)	5.1 (12.5)	3.8 (5.0)	4.2 (10.0)	0.1 (5.0)	— —	1.4 (12.5)	—
June 1	50	92	197	127-411	68.3 (43.5)	18.6 (28.3)	8.5 (15.2)	1.8 (8.7)	0.1 (4.3)	t (2.2)	0.4 (13.0)	0.6 (2.2)
June 14	31	90	258	142-409	33.0 (35.7)	12.8 (21.4)	26.1 (17.9)	25.6 (10.7)	0.1 (3.6)	0.6 (7.1)	1.3 (28.6)	0.5 (10.7)
June 28	50	92	220	166-300	—	68.0 (76.1)	24.9 (19.6)	6.7 (6.5)	0.2 (6.5)	—	0.2 (2.2)	—
July 12	50	92	191	145-330	29.0 (41.3)	25.7 (21.7)	10.4 (21.7)	25.2 (13.0)	5.1 (28.3)	t (2.1)	3.5 (17.4)	1.1 (8.7)
July 26	25	100	237	166-439	12.8 (0.24)	27.2 (36.0)	12.7 (28.0)	46.5 (16.0)	0.5 (16.0)	0.2 (8.0)	—	0.1 (8.0)
Aug. 9	48	92	236	186-330	17.7 (31.8)	26.2 (36.4)	15.8 (15.9)	38.8 (18.2)	0.7 (15.9)	0.2 (4.5)	0.1 (2.2)	0.5 (11.4)
Aug. 23	50	96	248	193-352	3.7 (8.3)	32.5 (45.8)	1.5 (6.3)	51.5 (41.8)	0.2 (12.5)	—	0.8 (4.2)	0.1 (4.2)
Sept. 7	49	82	248	130-460	27.3 (32.5)	3.9 (7.5)	4.8 (27.5)	59.3 (42.5)	0.1 (5.0)	—	—	0.2 (5.0)
Sept. 20	48	77	239	132-409	12.7 (27.0)	48.5 (29.7)	11.6 (27.0)	26.1 (21.6)	—	0.4 (8.1)	0.6 (2.7)	0.1 (5.4)
Oct. 4	50	88	222	136-450	20.7 (40.9)	49.5 (45.5)	—	28.5 (20.5)	0.5 (6.8)	—	0.2 (4.5)	0.6 (9.1)
Oct. 18	49	84	246	132-422	43.6 (58.5)	22.4 (22.0)	4.3 (12.2)	29.5 (36.6)	—	—	0.2 (4.9)	t (2.4)
Nov. 1	50	74	227	148-498	14.4 (44.7)	19.0 (40.5)	—	66.4 (18.9)	—	0.2 (2.6)	t (2.7)	—
Nov. 15	50	64	297	150-521	14.2 (35.5)	1.9 (9.4)	9.5 (32.3)	74.0 (59.4)	0.2 (3.2)	—	0.2 (12.5)	—
Mean Total	748	83	234	127-535	27.7 (36.0)	23.3 (28.8)	8.0 (16.2)	37.6 (24.4)	0.3 (8.5)	0.1 (2.7)	0.5 (8.0)	0.5 (5.5)

[a]Food items not shown in the table [and not] included in the totals were amphibians 2.0 (1.6) and miscellaneous animals t (.05). The dates of collection, percent of total weight, and, in parentheses, frequency of occurrence of the items were as follows: amphibians — April 5, 4.9 (6.9); June 1, 1.7 (2.2); August 23, 9.7 (10.4); and September 7, 4.4 (2.5). Miscellaneous animals: May 3, t (5.1); and June 1, t (2.2).

Table 3. Mean weight (kg/ha) of available prey by size group, DeGray Reservoir, 1976, as determined from August rotenone samples (from Jenkins, 1976).

	SPECIES[a]							
Length Group (mm)	Shad	Red-horse	Cat-fish	Sun-fish	Black bass	Crappie	Misc. Fish	Total
b								
25				2.43				2.43
51	11.50		0.01	4.11	0.12	0.06		15.80
76	6.53		0.01	17.96	0.81	0.05		25.36
102	2.30		t	16.09	0.47	t		18.86
127	0.24	0.01	0.02	7.74	0.37			8.38
152		0.04		7.02	0.05	0.12		7.23
178	0.12	0.21		4.96				5.29
203		0.85	0.10	4.72				5.67
229	9.44	0.61		1.74				11.79
254	25.77	0.85	0.04	0.24				26.90
279	17.18							17.18
305	13.55							13.55
330	2.30							2.30
336	2.30							2.30
25-127							4.44	4.44
Total	91.23	2.57	0.18	67.01	1.82	0.23	4.44	167.48

[a]Fish species were as follows: shad *(Dorosoma cepedianum* and *D. petenense)*, redhorse *(Moxostoma erythurum* and *M. duquesnei)*, catfish *(Ictalurus melas, I. natalis, I. punctatus, I. furcatus* and *Pylodictis olivaris)*, sunfish *(Lepomis cyanellus, L. gulosus, L. machochirus, L. megalotis,* and *L. microlophus)*, black bass *(Micropterus dolomieui, M. punctulatus,* and *M. salmoides)*, crappie *(Pomoxis annularis* and *P. nigromaculatus)*, and miscellaneous fish (Cryprinidae, *Aphredoderus sayanus, Fundulus olivaceus, Labidesthes sicculus, Morone chrysops,* and Percidae).
[b]Mid-point of inch-groups.

high, as shown by August cove rotenone samples. For small bass, crayfish dominated the prey taken from July to September, suggesting that largemouth bass selected for crayfish and that crayfish were important in predator-prey interactions.

Largemouth bass of both size categories consumed sunfish from April through June, consuming larger though fewer sunfish during this period. Sunfish were the most abundant prey during this interval. Sunfish consumption decreased from July through September but increased slightly in October and November, accompanied by a decrease in shad consumption (Fig. 1 and 2).

Young-of-the-year shad first appeared in bass stomachs on 17 May and reached a maximum by 28 June, when they constituted 68% by weight and occurred in 76% of all stomachs (Table 1). Estimates of the numbers of young-of-the-year shad, based upon samples collected in midwater trawls, were high in 1976 and reached a peak on 17 June. During August, estimates of the standing crop of shad in the one- to three-inch groups in coves (collected after the application of rotenone) were twice as high as those of similar-sized sunfish (Table 3). Thus, even though the available crops of shad were considerably higher than those of sunfish, they generally did not dominate the dietary intake. In this study, we collected no shad along the shoreline but frequently collected young sunfish.

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